Mount Hope River watershed - watershed-based plan of conservation

Denise Burchsted
Mount Hope River Watershed
Watershed-Based Plan of Conservation: Phase IA

Watershed Assistance Small Grants Program
Final Report
Project Number 03-10-E

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Denise Burchsted, Project Manager
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Executive Summary

This project involved data collection in the Mount Hope River watershed for use in conservation planning in that watershed and in the larger Naubesatuck watershed in northeastern Connecticut. Data collection was comprised of the following: 1) stream assessments, which were GIS-based with ground-truthing where possible and needed, and 2) existing plans of conservation and/or development in the watershed.

Stream Assessments

As verified by the assessments, the watershed in general is largely unbuilt and forested. The streams appear to have high water quality, and many are known to support wild trout. The main stem of the Mount Hope River appears to be most in need of protection, with relatively higher levels of development, lower amounts of open space, and higher road density along the river. The largest potential drinking water aquifer in the watershed also runs along the Mount Hope River. The watercourses located within lake association boundaries (i.e. Lake Chaffee and Ashford Lake) are also highly altered, with land use in these areas largely under the purview of the associations.

Much of the watershed is in dedicated open space – particularly the East Branch of the Mount Hope and the Goss drainage basins -- although some important parcels are unprotected in the long term. This is notable in the Goss basin, which has no protected open space although the June Norcross Boy Scout Camp provides a significant level of unprotected open space.

Members of the fishing community note that stream temperatures are rising – particularly in the neighboring Natchaug watershed – which is damaging trout populations. The Mount Hope watershed contains a relatively high density of dams, particularly in the Knowlton Pond Brook basin and in the upper reaches of the Knowlton Brook basin, which tend to cause temperature increases. There are also two large impoundments created for lakeside community development. Some of the smaller dams in the watershed could be targeted for modification due to the relatively high density and their contribution to warming river water.

Nearly all the watercourses are rated by DEP as Class AA (potable), with the main stem of the Mount Hope rated as B/AA (not meeting potable standards). The “B” rating is due to a town landfill located near the headwaters of the river, with a leachate plume extending to the river. Other known leachate locations – including two salt storage sheds and two agricultural waste disposal areas – could but are not known to have impacted water quality.

A more extensive summary of the assessments is provided in the results section of this report, and documentation of the assessments is provided in the Appendix.

Plan Review

Overall, review of the plans revealed a tremendous amount of work and thought already put toward conservation of natural resources in the watershed. All the reviewed plans include natural resource protection as a major goal, including both open space as well as wetlands and watercourses. Specific
objectives / actions included most of plans are detailed and largely complete, although the Town of Chaplin plan is somewhat limited and requires updating. Overall, the primary difficulty toward achieving actual protection appears to be lack of implementation rather than lack of planning.

Recommendations for implementation of planning goals include the following:
- create a regional database / registry of protected lands including conservation easements and lands protected under PA 490;
- create a regional water authority for the Naubesatuck watershed;
- use the designated greenways to create a watershed-based forum regarding resource protection;
- include lake associations in watershed planning, forums, and regulatory recommendations;
- encourage municipalities to share strategies for protection of natural areas;
- educate policy-makers and the public at large about the importance of the existing resources and potential regulations that can provide resource protection; and
- provide recommendations generated by this report during updates of plans in the watershed.

Specific recommendations for the following are generally overlooked in the reviewed plans, though some are included in at least one of the reviewed plans:
- provision of regional context in conservation planning;
- best management practices for road maintenance;
- new road construction with limited impacts – particularly in currently interior forest areas;
- protection of specific wetland and watercourse features;
- protection of potential aquifers;
- protection of the main stem of the Mount Hope River (this river, of all those assessed, is most at risk of degradation and also runs through the largest potential drinking water aquifer in the watershed);
- monitoring of known pollutant sources; and
- provision of separate zones that a) encourage public access and b) limit public access.

Details of the recommendations generated by this project are provided in the results section of this report.

**Introduction**

The 162-square mile Naubesatuck Watershed, also know by the DEP as Basin #32 and by the Town of Windham / Willimantic as the Windham Waterworks Watershed, is the state's largest surface water supply. In its larger geographic context, the watershed sits in the middle of what some people call The Last Green Valley – visible in nighttime satellite photographs as a solitary patch of darkness amidst the glow of urban settlement that festoons the eastern seaboard from Washington D.C. to Boston. The Naubesatuck watershed includes relatively pristine habitats such as the Stonehouse Brook Valley – a lush complex of ponds, wetlands, and upland hardwood forest that includes the Natchaug State Forest – and private timberland recently accepted into the federal government's Forest Legacy Program. This contiguous habitat is wild enough to support bobcat and black bear and the occasional moose.

Despite conservation efforts, the relatively undeveloped Last Green Valley, which extends into Massachusetts and Rhode Island, is under immense pressure that is likely to affect the health of its streams and aquifers. Within the greater area of this valley, the less protected parts of the Naubesatuck
watershed are subject to even more intense pressure from development, as this rural part of Connecticut becomes more populated, and as the University of Connecticut expands its campus.

Since most of the Naubesatuck watershed is in private hands, and since municipal laws do not govern the state lands within it, the watershed presents many vexing, but not intractable, drinking water conservation and management problems. Dialogues about river conservation over municipal borders have begun since NWC appeared on the scene to catalyze them, but have been haphazard and fleeting, and have not led to memos of understanding, or any other written compacts, between towns. This project was created in order to improve the discussions and available planning tools, with an eye toward preserving the resources within The Last Green Valley.

The Resource and Environmental Problems Addressed

Resources

This project is designed to protect the resources of the Naubesatuck Watershed. First and foremost, these resources include the drinking water of Willimantic and portions of Mansfield. This water is provided by the Willimantic Reservoir, fed by the rivers and streams of the watershed. These rivers and streams, when delivering high quality water to the reservoir, also provide important aquatic habitat. In order to provide these values, the streams require well-protected groundwater and generally forested riparian areas. Water quality is further protected through maintenance of forested land in the watershed at large, which also provides important wildlife habitat.

Environmental Problems

The pressures for conversion of forested Naubesatuck land to suburban or exurban land use threatens the resources of the watershed. Common damaging inputs from residential land use includes nutrients from poorly-functioning septic systems and/or lawn care, as well as biocides from home maintenance. Nutrient imbalances can upset the ecology of the reservoir, which in turn decreases the drinking water quality primarily through increased undesirable odor and color. Biocides are dangerous for human consumption and are also disruptive of the stream ecology.

Additionally, residences are often associated with an opening of the riparian canopy which increases temperature, decreases removal of pollutants from runoff, and decreases availability of wood needed for a well-functioning river. Of these impacts, increased temperatures alter the stream ecosystem since the organisms living the stream are adapted to certain temperature regime. Decreased removal of pollutants results in increased nutrient inputs causing the damages listed above. Residences are also associated with direct removal of wood from rivers in addition to removing the source of wood. Wood in the rivers is necessary for providing diversity of habitat as well as for providing the varied stream conditions necessary to remove nutrients and pollutants from the water.

Roads associated with this land use conversion pose a risk to water quality due both to the direct input of materials from the road as well as due to impacts from the houses served by the road. Road inputs damaging to water quality include sand, salt, and herbicides from road maintenance, and petroleum products and heavy metals from car wear and tear. Sand will damage a river by burying important nesting habitat. It is also damaging to a water supply reservoir by decreasing the reservoir's capacity.
and requiring expensive and environmentally-damaging dredging to restore the capacity. The other inputs from roads are damaging to human health as well as the river ecosystems.

In addition to the impacts on water that are of primary concern here, the conversion of land also decreases important wildlife habitat and recreation opportunities. Recreation opportunities from a well-protected watershed include in-water activities such as angling, boating, and swimming, as well as more terrestrial activities such as birding, hiking, biking, and camping.

The Solution

The solution to these problems requires protection of the water resources themselves and the forested areas in the watershed that also protect the water resources. Recognizing that a significant portion of these areas are in private hands, and funding is unavailable for purchase of all of it, a part of the solution includes planning and municipal regulations. This project was developed as a first phase of creation of a watershed-based plan of conservation, which involves working with the municipal agencies, regional planning agencies, regional conservation organizations, and other public and major private stakeholders in the watershed.

This phase of the project involved data collection in the Mount Hope River subwatershed, to serve as a prototype for the larger Naubesatuck watershed. Data collection was comprised of the following: 1) stream assessments, which were GIS-based with ground-truthing where possible and needed, and 2) existing Plans of Conservation and Development in the watershed. These steps were conducted to identify gaps in existing plans and data needed to generate a plan of conservation.

Stream Assessments

The watershed was broken into nine drainage basins for analysis, as shown in the figure at right. These basins, based on DEP’s delineations, were selected from all those available due to their perceived levels of conservation importance. Note that some of these basins are nested within others.
The main stems of each of the basins were analyzed for the following predictors of stream quality:

- density of roads in a 500' buffer; and
- percentage of open space in a 500' buffer.

Additionally, each of the basins were analyzed for the following:

- land use;
- change in land use from 1995 – 2002;
- density of dams;
- groundwater leachate locations; and
- amount and level of open space protection.

Other important water resources were identified through examination of the following:

- aquifer protection areas;
- stratified drift (potential aquifers);
- DEP surface and ground water quality classification;
- DEP's natural diversity database;
- public access points to the river; and
- known fishing easements.

**Plan Review**

The following plans in the watershed were collected and reviewed:

- Mansfield Plan of Conservation and Development, effective April 15, 2006
- Ashford Plan of Conservation and Development, effective April 4, 2005
- Windham Region Land Use Plan, adopted by WINCOG March 22, 2002
- Willimantic Water Department Water Supply Plan, revised November 1992
- Mount Hope Greenway Nomination, March 1, 2006

Note that the POCDs for Willington and Union were not reviewed in depth as part of this project due to their limited influence in the watershed. The portion of the watershed in Willington contains less than one mile of watercourse. Most of the watershed located in Union is owned by DEP (Natchaug State Forest and Morey Pond).

**Project partners and funding**

Funding for the project is from the watershed assistance small grants program administered by CT Rivers Alliance. Additional funding was provided by pro bono services from NWC staff and volunteers.

The project involved consulting with staff and volunteers from the following agencies: the towns of Mansfield, Ashford, Willington, and Chaplin; The Nature Conservancy; the Green Valley Institute; WINCOG (Windham Region Council of Governments); and Trout Unlimited.
Results

Stream Assessment Results

Documentation of the information generated by the stream assessments is provided in the appendix to this report. The following summary provides the key points of the assessments:

Summary

1. Of all the basins examined, incompatible land use is most likely to impact water quality in the main stem of the Mount Hope River. This basin includes I-84 and the Crystal Lake community.

2. Agriculture in the Bebbington Brook drainage basin may impact the water quality: on-site remediation, rather than land use conversion, would be recommended if this is the case.

3. There are high densities of small dams in the Knowlton Pond Brook basin and in the upper reaches of the Knowlton Brook basin. It is likely that these dams negatively impact water quality through increased water temperatures and nutrients. Modification of one more of these dams may improve water quality.

4. Large parcels of existing open space are unprotected. Pursue open space protection for large unprotected parcels such as the Yale Forest and the June Norcross Boy Scouts of America camp. Pursue farmland preservation for large agricultural parcels such as Crooke's Orchards.

5. Mapping of land partially protected by conservation easements and PA 490 is not available. Creation and maintenance of a regional database/registry with this information would greatly aid conservation efforts.

6. Riparian land along many of the primary rivers and streams is less well protected than the drainage basins at large, despite the greater importance at preserving the riparian corridor for protection of in-stream habitat and water quality. A focus on acquisition and regulation of riparian areas is recommended, particularly in the upper Mount Hope River which has no protected open space at all in the 500' buffer surrounding the river.

7. High road densities along the lower 2/3 of the main stem of the Mount Hope River as well as along Squaw Hollow and Bebbington Brooks is anticipated to result in greater impacts on these watercourses, which should be visible in increased road sand deposits on the stream beds. The presence of road sand on the streambeds has been confirmed by anglers with Trout Unlimited, who have identified this issue as a primary concern.

8. The lower 2/3 of the Mount Hope River is lined by sand and gravel deposits that are potential aquifers. Protection of these deposits from contamination is important for both drinking water quality in the Willimantic Reservoir as well as potential future drinking water wells in these aquifers. There are also a few potential aquifers scattered throughout the watershed.

9. There are two notable sources of groundwater pollution that likely enter the Mount Hope River. One is the landfill located in the upper reaches of the watershed and less than 1000 feet from the river. The second is a salt storage shed located on the potential aquifer along the river described above. These leachate locations should be monitored and remediated if necessary. The sites should be protected and properly maintained to prevent groundwater contamination.
10. The above-noted landfill provides a source of leachate that results in both a classification of the associated groundwater as Class GAA-impaired, as well as classification of the downstream surface water as B/AA (not meeting the designated drinking water criteria). Monitoring of the leachate from the landfill would provide information regarding the damage to water quality and need for further action.

11. Public access points and fishing easements on the Mount Hope River and Knowlton Brook provide necessary public opportunities for recreation and resource visibility. Protection of the river resources, however, also require limited public access. Some river segments could be designated as limited access to decrease impact and improve wildlife habitat and value.

12. There is limited availability of resource mapping. Continued documentation of the resources of the watershed – particularly features such as vernal pools, or threatened and endangered species – will enhance planning effectiveness.

Plan Review Results and Recommendations

The following recommendations are provided to synthesize the existing plans into a regional conservation effort:

Broad-Level

1. **Implementation:** More than needing a new plan, it appears that overall the watershed requires implementation of the existing plans. These plans all include goals, objectives, and actions that would greatly benefit the water quality, habitat value, and public use of the watercourses, if only they were in place. The Mansfield POCD and WINCOG Land Use Plan include specific recommendations for implementation of many of the plans' objectives.

2. **Regional Context:** The maps in the municipal plans are created within the town boundaries themselves, and can overlook the broader context. This is of particular importance when prioritizing and/or evaluating areas for protection. Municipal open space preservation efforts should be strongly encouraged to consider the regional context.

3. **Protected Lands Database:** While lands protected in fee are relatively well-mapped, mapping of conservation easements is spotty and generally unavailable. Conservation planning will be greatly aided if and when easements and lands enrolled in the PA 490 program are included in a regional database.

4. **Regional Water Authority:** The Windham Water Work's (WWW) Water Supply Plan includes the recommendation to create a regional water authority. Creation of a regional water authority could be a strong step toward enabling implementation of the existing watershed protection goals. It would also provide a tool for continuing cross-town dialogue regarding watershed needs. Currently, the Water Department is governed by a commission populated solely by Windham residents, and has limited public outreach.

5. **Greenways:** The Greenway Nomination for the Mount Hope River includes a commitment to regional discussion regarding protection of the greenway's resources. The now-designated
greenway, including all the perennial watercourses of the watershed, can be used immediately as a forum to encourage implementation of conservation and water quality protection goals.

6. **Lake Associations:** The Ashford POCD includes recommendations for working with the associations managing the lakeside communities. These associations generate revenue and provide for their own road maintenance, and are responsible for their own water quality and septic monitoring. As the primary maintenance body for the highest density areas in the watershed, it is important that these associations are included in any implementation efforts.

7. **Plan Updates:** The Naubesatuck Watershed Council will work to maintain contacts with the identified agencies in the watershed in order to learn of plan updates. In particular, the Chaplin and WINCOG plans are due for updates in the near future. It will be valuable to participate in these updates to ensure that the recommendations of this report are included in the new plans to the greatest extent possible.

**Specific Issues**

1. **Roads:** Road maintenance has been identified as a significant contributor to decreased water quality, including the following practices: a) Sand runoff has been identified by the local TU chapter as the major issue in river health; b) The WWW and Ashford plans recommend modification of salt practices; and c) herbicide use at stream crossings can provide a major source of these pollutants. It is strongly recommended that specific recommendations based in best road management practices be created from a watershed standpoint and incorporated into state DOT and local DPW practices. Some good specific recommendations are provided in the Ashford POCD. Additionally, specific regulations for road building and density can be used to implement intended protection of interior forest parcels. It is understood that Union regulations contain strong road density limits that help minimize damage in the build-out scenario, and could potentially be used as model regulations.

2. **Natural Areas:** Each municipality has its own strategy for limiting damage to the resources in privately-held natural areas. All of the reviewed plans state this as a major goal. Protection of natural areas and resources in both the Ashford and Mansfield POCDs also fall within the recommendations in the WINCOG Land Use Plan. The Chaplin POCD has limited recommendations but requires updating, and will also fall under the WINCOG plan when that occurs. Each of the plans' strategies are extensive and multi-faceted. An in-depth analysis of these strategies is beyond the scope of this report. A sharing of these ideas and strategies between towns will increase the ability of each town to protect the watershed's resources.

3. **Wetland and Watercourse Features:** While recommendations needed to protect wetland and watercourse features are included in the plans (such as a review area), the features themselves are largely unmentioned. The Ashford POCD is a notable exception to this. Examples of specific features that require protection include in-stream woody debris, wildlife habitat, and riparian canopy.

4. **Potential Aquifers:** While all the plans recognize the importance of protection of potential drinking water, only Chaplin provides a specific recommendation to enable this protection (3-
acre minimum lot size in designated potential aquifer zones). The Mansfield POCD recommends investigating the possibility of regulating potential aquifers. It is understood that some municipalities (e.g., Windham) have an overlay zone for regulation of potential aquifers, dating from the 1980s, however these zones are not enforced since the maps have been lost. It will be valuable to remake and/or create these maps for the watershed and put zones in place for all municipalities in the watershed.

5. **Education:** The WWW Plan and the Greenways Designation include education components. This component is critical for preservation of the watershed resources, with education of both policy-makers and the public at large required.

6. **Public Access:** Provision of public access to the rivers is important for recreation opportunities and to enhance visibility of the resource. However, protection of the river from the public is also necessary to protect the river resources. Therefore, it is suggested that both encouraged and limited public access areas be planned.

7. **Water Quality Monitoring:** Leachate from the Ashford landfill has been determined by DEP to impact the water quality classification of the Mount Hope River. Additionally, leachate from the salt storage shed on Route 89 just north of Route 44 has the potential to damage the important stratified drift deposit along the river. Monitoring of important pollutant sources such as these will help in determining the appropriate remediation and/or maintenance measures. The Ashford POCD also recommends that the lakeside associations provide water quality monitoring of the lakes due to the potential for water quality impacts by the surrounding densely built area.

8. **Mount Hope River:** Encourage riparian conservation efforts along all rivers, and particularly along the main stem of the Mount Hope River. One or more of the three assessed segments of this river consistently rank high in the analysis of risk factors. These include the following: the upper segment of the river contains the highest density of built / developed land; there is no protected open space at all in the upper segment, and limited protection in the lower segments; the lower segments have high road densities along the river; and a landfill and salt storage shed are sited adjacent to the river, with known leachate from the landfill to the river. These risk factors are heightened by the fact that the greatest potential aquifer in the watershed is located along the lower 2/3 of the river and is in need of additional protection.

**Future Plans and Conclusions**

This project was a successful first step at addressing conservation needs in the Naubesatuck watershed from a watershed-based perspective. The Mount Hope subwatershed was selected to serve as a prototype. The primary lesson learned from this prototype is that the agencies involved have already created excellent plans that provide for the needed conservation: the real need is specific action items that can be implemented.

The next step for this project is to bring together members of the identified agencies to understand and appreciate the shared plans for conservation, and to identify projects, policies, and regulations that can be implemented to achieve the goals in these plans. An example of such a regulation is the creation of
an overlay buffer zone for the river with limited permitted uses.

The Naubesatuck Watershed Council plans on hosting a watershed-wide workshop in 2007 using the 2006 designation of the perennial watercourses in the watershed as a state greenway. This workshop is intended for staff from municipal planning and conservation agencies, multi-town planning agencies, Windham Water Works, UConn, the three lake associations, and other private and public stakeholders in the watershed, as well as the public at large. Joshua's Trust, the Citizens for Responsible Growth, and The Nature Conservancy have all expressed interest in co-hosting this workshop. It is likely that the 2007 workshop will focus on regional water supply planning. It is envisioned that NWC will continue to provide this type of workshop on an annual basis, with each year's workshop addressing another one of the needs for regional discussion identified in this project.

The initial vision for this project included streamwalks under an EPA-approved QAPP, rather than the stream assessments that were actually conducted and described in this report. This proved to be a major challenge for this project, due to the need for the streamwalks to be conducted by trained volunteers under the QAPP. The need to train volunteers and then digest the collected information greatly expanded the time involved from the initial estimates. It further limited the usefulness of the streamwalks when considering a watershed-based POC, since volunteers – not the staff conducting the analysis – would conduct the streamwalks and gain the first-hand knowledge needed for the POC analysis. This issue was finally resolved by conducting GIS-based assessments with stream-bank verification in place of the streamwalks. Nonetheless, volunteer-based streamwalks provide both a useful outreach tool as well as documentation of baseline conditions. It is hoped that NWC will be able to pursue such a project in the future.

An additional success of this project was to enable NWC staff to continue knowledge-building of the resources, issues, and potential avenues for conservation and protection. The addition of GIS data and analyses to the NWC library will enable further efforts in the watershed. Additionally, this project has continued the dialogue regarding resource protection and planning with the agencies.
Appendix

This Appendix includes the deliverables as described in the scope of work for this project, as follows:

A) A written summary of collected GIS data and plans of conservation.
B) A Microsoft Access database of the stream assessments and written summary of that data.
C) A written assessment of additional data needs required for creation of a watershed plan of conservation

A) Collected GIS Data and Plans of Conservation

GIS Data

Green Valley Institute

Data from GVI was provided to NWC in 2006 by request.

Greenways Workshops: includes envisioned connections determined at multi-town workshops, public access locations, and fishing easements.

Open space: based on federal, state, and municipal property data provided by DEP; municipal property data includes land owned by land trusts or other institution (e.g., Yale Forest); updated in the region by GVI with local data, including some larger conservation easements in Ashford.

Trails: based on trails data from road mapping provided by DEP; heavily edited by GVI staff and greenways workshop participants to represent known conditions on the ground.

DEP

All DEP data was collected either from the Environmental GIS data for Connecticut, 2005 edition, or downloaded from the DEP GIS web site. Complete data descriptions are available at the DEP website.

Aquifer Protection Areas: Areas determined to contribute to public drinking water wells based either on groundwater modeling (final) or simple topographic assumptions (preliminary).

Drainage Basins: Delineations of watershed boundaries based on topography.

Roads: Includes all roads shown on USGS topographic maps. Classifications include major highway, minor highway, local road, minor road, and trail.

Hydrography: Includes mapping of all water bodies on USGS topographic maps. Relevant classifications for polygons include wetlands, open water, and inundated land; relevant classifications for lines include shoreline, water, and intermittent stream.

Dams: Includes all dams known by DEP Office of Dam Safety; hazard information included.

Water Quality Classification – Surface & Ground: Includes DEP's water quality classifications for surface water bodies and groundwater; groundwater classifications can be used to infer locations of public water supply wells.

Leachate: Includes all known pollutant points to groundwater; in some cases, this data can be combined with the groundwater water quality classification to determine extent of known...
contaminant plumes.

**Natural Diversity Database:** All known locations of state and federal threatened and endangered species are mapped by DEP. A ½-mile buffer is placed around these locations to protect the individuals, and the resulting map is provided in the Natural Diversity Database.

**Federal, State, and Municipal Property:** Municipal property data includes property owned by land trusts and other conservation organizations as well as property owned by other large institutions. This dataset is out of date and missing many important properties.

**USGS topographic & orthophoto quads:** USGS topographic maps are digitally scanned and georeferenced to enable overlays of other GIS data. Orthophotos are aerial photographs that have been georeferenced. These are very useful basemaps.

**Town, County, and State Boundaries:** Political boundaries according to the USGS topographic maps. Regional planning zones are embedded in the town data and can be mapped.

**Land Use / Land Cover 1995:** Classification of land use based on satellite data; more coarse-scale and unreliable than LU/LC data from CLEAR (see below).

**NRCS soils mapping:** Highly detailed soils data; each soil type is mapped; database tables are provided to extrapolate wetland soils or soils of agricultural importance, among others.

**Quaternary Geology:** Includes features of interest primarily of glacial origin, such as eskers or kame terraces.

**Surficial Geology:** Primarily used in this study to identify potential aquifers, which are located in areas of sand and/or gravel (commonly referred to as “stratified drift”).

**Naubesatuck Watershed Council**

**Joshua's Trust:** 2005 update to the GVI open space data with then-new acquisitions by Joshua's Trust.

**Stream Segments & Basins:** Stream segments and their corresponding drainage basins identified for assessment as part of this project; based on DEP hydrography.

**Stream Buffers:** Polygons covering 250' on either side of the identified stream segments; used in combination with DEP roads and GVI/NWC open space to assess riparian conditions.

**CLEAR (Center for Land use Education And Research)**

**Land Use / Land Cover:** 30-m grid classification of land use based on satellite data; downloaded Tolland and Windham County data for 1995 and 2002. Data for earlier years and the rest of the state is available but was not collected.

**Orthophotos:** 0.8' resolution aerial photos from 2004 that have been compiled in a mosaic; represents the joint effort of many agencies, and made available by CLEAR.

**Plans of Conservation and/or Development**

**Municipal Plans**

**Ashford Plan of Conservation and Development:** A detailed document covering town development and resource patterns, recommended actions to achieve planning goals, and recommendations for
specific planning areas; recommended actions are detailed and comprehensive, though there is little recommendation regarding implementation (i.e. regulatory body); maps embedded in the document; effective April 4, 2005.

Chaplin Comprehensive Plan of Development: A less complete plan than the others, though with more goals; natural resource conservation listed as the primary goal; some embedded maps; in need of updating; submitted September 5, 1989.

Mansfield Plan of Conservation and Development: An extensive document covering town history, resources, and planning goals and objectives; tends to be focused on implementation of objectives through naming of relevant regulatory bodies; includes 22 separate maps of resources and planning zones; effective April 15, 2006.

Regional Plans

Windham Region Land Use Plan: A comprehensive plan with clear implementation recommendations; includes recommendations for conservation planning; recommendations for resource protection could be expanded and more detailed; adopted by WINCOG March 22, 2002

Willimantic Water Department Water Supply Plan: A short-but-sweet plan; includes recommendations for municipal plans and regulations; focused specifically on the few issues of greatest importance to the reservoir; revised November 1992

Mount Hope Greenway Nomination: Includes goals for protection of the designated Mount Hope Greenway, which includes all perennial watercourses; goals include natural resource protection and essentially fall within the goals and objectives of the other plans; submitted March 1, 2006
B) Stream Assessment Summary

Methods

The watershed was broken into nine subwatersheds for analysis, as shown in the figure at right. These subwatersheds, based on DEP's subwatershed delineations, were selected from all those available due to their perceived levels of conservation importance.

The main stem of each of the selected subwatersheds was analyzed for the following predictors of stream quality:

- number of road crossings;
- density of roads in a 250' buffer; and
- percentage of open space in a 250' buffer.

Additionally, each of the subwatersheds were analyzed for the following:

- density of roads;
- land use;
- change in land use from 1995 – 2002;
- density of dams;
- groundwater leachate locations; and
- amount and level of open space protection.

Other important water resources in the watersheds were identified through examination of the following:

- aquifer protection areas;
- stratified drift (potential aquifers);
- DEP surface and ground water quality classification;
- DEP's natural diversity database;
- public access points to the river; and
- known fishing easements.

Where applicable and possible, the GIS assessments were verified with visual inspection of the watercourses from the streambanks.
**Results**

**General**

The stream assessments were conducted on the following basins:

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<th>Basin Size *(ac)</th>
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<tr>
<td>Mt Hope River 2-2</td>
<td>3206-00_02-2</td>
<td>6.6</td>
<td>4,174</td>
</tr>
<tr>
<td>Squaw Hollow Brook</td>
<td>3205-00</td>
<td>3.3</td>
<td>5,468</td>
</tr>
</tbody>
</table>

* Basin size for the Mt Hope River includes nested subwatersheds, but does not include the basin area for upstream segments.

**Land Use**

The watershed's 1995 and 2002 land use / land cover (LULC) GIS data created by CLEAR (Center for Land use Education And Research) were examined. This data is comprised of various land classifications, based on satellite data, of each 30m x 30m square in the watershed. Detailed descriptions of the classifications are provided on the CLEAR website at http://clear.uconn.edu/projects/landscape/category_description.htm. Spot ground-truthing of the LULC data show generally good accuracy. The following tables provide the breakdown of the various land use-land cover classifications for the watershed in 1995, 2002, and shows the change between those years.

**Watershed Land Use / Land Cover 1995 and 2002**

<table>
<thead>
<tr>
<th>Segment name</th>
<th>LU/LC 1995</th>
<th></th>
<th></th>
<th></th>
<th></th>
<th></th>
<th></th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>forest</td>
<td>wetland</td>
<td>ag</td>
<td>grass</td>
<td>barren</td>
<td>built</td>
<td>water</td>
<td></td>
</tr>
<tr>
<td>Bebbington Brook</td>
<td>64%</td>
<td>28%</td>
<td>1%</td>
<td>0%</td>
<td>7%</td>
<td>1%</td>
<td></td>
<td></td>
</tr>
<tr>
<td>East Br. Mt Hope</td>
<td>92%</td>
<td>3%</td>
<td>0%</td>
<td>0%</td>
<td>5%</td>
<td>1%</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Goss</td>
<td>80%</td>
<td>5%</td>
<td>0%</td>
<td>0%</td>
<td>7%</td>
<td>7%</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Knowlton</td>
<td>78%</td>
<td>12%</td>
<td>0%</td>
<td>0%</td>
<td>6%</td>
<td>3%</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Knowlton Pond</td>
<td>68%</td>
<td>16%</td>
<td>1%</td>
<td>0%</td>
<td>6%</td>
<td>10%</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Mt Hope 1</td>
<td>80%</td>
<td>9%</td>
<td>1%</td>
<td>1%</td>
<td>7%</td>
<td>3%</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Mt Hope 2-1</td>
<td>78%</td>
<td>11%</td>
<td>1%</td>
<td>0%</td>
<td>7%</td>
<td>3%</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Mt Hope 2-2</td>
<td>74%</td>
<td>12%</td>
<td>1%</td>
<td>0%</td>
<td>10%</td>
<td>3%</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Squaw Hollow Brook</td>
<td>79%</td>
<td>11%</td>
<td>1%</td>
<td>0%</td>
<td>7%</td>
<td>2%</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Segment name</th>
<th>LU/LC 2002</th>
<th></th>
<th></th>
<th></th>
<th></th>
<th></th>
<th></th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>forest</td>
<td>wetland</td>
<td>ag</td>
<td>grass</td>
<td>barren</td>
<td>built</td>
<td>water</td>
<td></td>
</tr>
<tr>
<td>Bebbington Brook</td>
<td>64%</td>
<td>28%</td>
<td>0%</td>
<td>0%</td>
<td>7%</td>
<td>1%</td>
<td></td>
<td></td>
</tr>
<tr>
<td>East Br. Mt Hope</td>
<td>91%</td>
<td>3%</td>
<td>0%</td>
<td>0%</td>
<td>0%</td>
<td>5%</td>
<td>1%</td>
<td></td>
</tr>
<tr>
<td>Goss</td>
<td>80%</td>
<td>5%</td>
<td>0%</td>
<td>0%</td>
<td>7%</td>
<td>7%</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Knowlton</td>
<td>78%</td>
<td>13%</td>
<td>0%</td>
<td>0%</td>
<td>0%</td>
<td>6%</td>
<td>3%</td>
<td></td>
</tr>
<tr>
<td>Knowlton Pond</td>
<td>68%</td>
<td>16%</td>
<td>1%</td>
<td>0%</td>
<td>6%</td>
<td>10%</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Mt Hope 1</td>
<td>80%</td>
<td>10%</td>
<td>1%</td>
<td>1%</td>
<td>7%</td>
<td>3%</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Mt Hope 2-1</td>
<td>78%</td>
<td>12%</td>
<td>1%</td>
<td>0%</td>
<td>7%</td>
<td>2%</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Mt Hope 2-2</td>
<td>73%</td>
<td>13%</td>
<td>1%</td>
<td>0%</td>
<td>10%</td>
<td>3%</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Squaw Hollow Brook</td>
<td>79%</td>
<td>11%</td>
<td>1%</td>
<td>0%</td>
<td>7%</td>
<td>2%</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>
The amount of land in the “built” category – “developed” as defined by CLEAR – ranges from 6 to 10% and appears to be relatively high for a rural landscape. This appears to be largely due to an overestimation of the amount of roads. Wherever a road occurs, the entire 30m x 30m grid cell is classified as “developed,” whether or not the road fills the majority of that cell. Additionally, the reflective nature of open water areas appears to result in an occasional erroneous classification of open water as developed.

Despite the errors in estimation of built / developed land cover, trends can still be interpreted. The East Branch of the Mount Hope basin is nearly completely unbuilt, with most of the watershed in Natchaug State Forest and Yale Forest ownership. This is ranked as being 5% built. The upper Mount Hope, on the other hand, is calculated as being 10% built. This relatively high percentage is due both to the dominance of I-84 in that watershed, as well as the presence of the relatively dense Crystal Lake community. Based on this analysis, water quality in the upper Mt Hope River is expected to be diminished in comparison with the other subwatersheds. However, ground verification of the stream draining Crystal Lake show the presence of trout, so any impact from the lake has not yet reached the level of damaging the instream community. A second dense lakeside community at Ashford Lake is located in the Goss subwatershed. This development is offset by the large open area of the June Norcross Boy Scout camp in the same watershed. Since Ashford Lake is upstream of the Boy Scout camp, it is anticipated that some of the potential degradation caused by the lakeside community is remediated downstream. The rest of the watersheds are at similar levels of development.

The high percentage of agriculture in the Bebbington watershed – due primarily to Crook's Orchards – and high percentage of agriculture and water due to small ponds in the Knowlton Pond watershed are expected to lead to relatively higher concentrations of nutrients from these watersheds in comparison with the others. Nonetheless, agricultural uses in the watersheds are a land use desired by the municipalities. If nutrients and/or biocides associated with agricultural practices should become a water quality issue, on-site mitigation of these impacts is recommended rather than land use change. Modification and/or outright removal of the dams in the Knowlton Pond watershed, on the other hand, could improve water quality in keeping with the municipal and regional plans.

### Watershed Land Use / Land Cover Change: 2002 - 1995

<table>
<thead>
<tr>
<th>Segment name</th>
<th>forest and wetland</th>
<th>ag</th>
<th>grass</th>
<th>barren</th>
<th>built</th>
<th>water</th>
</tr>
</thead>
<tbody>
<tr>
<td>Bebbington</td>
<td>-1%</td>
<td>0%</td>
<td>0%</td>
<td>0%</td>
<td>0%</td>
<td>0%</td>
</tr>
<tr>
<td>East Br. Mt Hope</td>
<td>0%</td>
<td>0%</td>
<td>0%</td>
<td>0%</td>
<td>0%</td>
<td>0%</td>
</tr>
<tr>
<td>Goss</td>
<td>0%</td>
<td>0%</td>
<td>0%</td>
<td>0%</td>
<td>0%</td>
<td>0%</td>
</tr>
<tr>
<td>Knowlton</td>
<td>0%</td>
<td>0%</td>
<td>0%</td>
<td>0%</td>
<td>0%</td>
<td>0%</td>
</tr>
<tr>
<td>Knowlton Pond</td>
<td>1%</td>
<td>1%</td>
<td>0%</td>
<td>0%</td>
<td>0%</td>
<td>-2%</td>
</tr>
<tr>
<td>Mt Hope 1</td>
<td>0%</td>
<td>0%</td>
<td>0%</td>
<td>0%</td>
<td>0%</td>
<td>1%</td>
</tr>
<tr>
<td>Mt Hope 2-1</td>
<td>0%</td>
<td>0%</td>
<td>0%</td>
<td>0%</td>
<td>0%</td>
<td>0%</td>
</tr>
<tr>
<td>Mt Hope 2-2</td>
<td>-1%</td>
<td>1%</td>
<td>0%</td>
<td>0%</td>
<td>0%</td>
<td>0%</td>
</tr>
<tr>
<td>Squaw Hollow</td>
<td>0%</td>
<td>0%</td>
<td>0%</td>
<td>0%</td>
<td>0%</td>
<td>0%</td>
</tr>
</tbody>
</table>

Note: the sum of changes in each subwatershed do not necessarily add up to zero due to rounding errors.
These results demonstrate that, despite the increase in residential building between these dates, the watershed at large remains unaltered.

**Open Space**

Federal, State and Municipal property data provided by the DEP and updated by GVI were examined to determine the level of open space in the watershed. Note that municipal property data also includes other open space owned by private entities such as land trusts. These data are incomplete in that they do not include conservation easements or lands partially protected under PA 490. The following table provides the amount of documented protected and unprotected open space in the watershed:

<table>
<thead>
<tr>
<th>Segment</th>
<th>Protected</th>
<th>Unprotected</th>
<th>Total</th>
</tr>
</thead>
<tbody>
<tr>
<td>Bebbington</td>
<td>7%</td>
<td>0%</td>
<td>7%</td>
</tr>
<tr>
<td>East Br. Mt Hope</td>
<td>36%</td>
<td>17%</td>
<td>53%</td>
</tr>
<tr>
<td>Goss</td>
<td>2%</td>
<td>53%</td>
<td>54%</td>
</tr>
<tr>
<td>Knowlton</td>
<td>10%</td>
<td>11%</td>
<td>21%</td>
</tr>
<tr>
<td>Knowlton Pond</td>
<td>20%</td>
<td>0%</td>
<td>20%</td>
</tr>
<tr>
<td>Mt Hope 1</td>
<td>17%</td>
<td>0%</td>
<td>17%</td>
</tr>
<tr>
<td>Mt Hope 2-1</td>
<td>10%</td>
<td>13%</td>
<td>23%</td>
</tr>
<tr>
<td>Mt Hope 2-2</td>
<td>4%</td>
<td>7%</td>
<td>11%</td>
</tr>
<tr>
<td>Squaw Hollow</td>
<td>13%</td>
<td>9%</td>
<td>22%</td>
</tr>
</tbody>
</table>

Unlike the LU/LC data, the open space data reveals a wide disparity among the basins. Generally, the main stem of the Mount Hope enjoys less protection than the upper reaches of the watershed, with as little as 11% in the upper Mount Hope. The low value of 7% in the Bebbington subwatershed may be due in part to the classification of Crooke's Orchards as agriculture, and not open space. Nonetheless, this would be a valuable property to pursue for farmland preservation. The high values in the East Branch of the Mount Hope represent land under DEP and Yale Forest ownership. The high values in the Goss subwatershed represent land at the June Norcross Boy Scouts of America camp. Yale Forest and the BSA camp, however, are unprotected.

In addition to examining open space in the basin at large, the amount of protected and unprotected open space within a 250' buffer on each side (500' total width) of the main stem of the assessed rivers was also determined:

<table>
<thead>
<tr>
<th>Segment</th>
<th>Protected</th>
<th>Unprotected</th>
<th>Total</th>
</tr>
</thead>
<tbody>
<tr>
<td>Bebbington</td>
<td>25%</td>
<td>0%</td>
<td>25%</td>
</tr>
<tr>
<td>East Br. Mt Hope</td>
<td>45%</td>
<td>7%</td>
<td>52%</td>
</tr>
<tr>
<td>Goss</td>
<td>0%</td>
<td>91%</td>
<td>91%</td>
</tr>
<tr>
<td>Knowlton</td>
<td>12%</td>
<td>0%</td>
<td>12%</td>
</tr>
<tr>
<td>Knowlton Pond</td>
<td>14%</td>
<td>0%</td>
<td>14%</td>
</tr>
<tr>
<td>Mt Hope 1</td>
<td>24%</td>
<td>0%</td>
<td>24%</td>
</tr>
</tbody>
</table>
While protection of the basin at large is important to preservation of watercourses that drain a basin, protection of a riparian corridor is even more important. The above data show a disconcerting trend of decreased protection along the riparian corridor for many watercourses including: Knowlton Brook (from 21% basin-wide to 12% riparian protection); Knowlton Pond Brook (from 20% to 14%); Mount Hope River 2-2 (upper river segment – from 11% to 1%); and Squaw Hollow Brook (from 22% to 14%). It is important that protection of the riparian corridor becomes a focus of open space acquisition, without detracting from critical forest tract protection. The upper segment of the Mount Hope River contains no protected open space at all in the riparian corridor. This compounds the damaging land use present in that basin (see previous discussion).

Roads

The road data provided by DEP (based on roads shown on USGS topographic maps) was analyzed to determine road density in the 500' riparian buffer and in the basin at large. The results are presented in the following table:

<table>
<thead>
<tr>
<th>Segment</th>
<th>Length (ft)</th>
<th>Length / Buffer Area (ft/acre)</th>
<th>State Hwy</th>
<th>Major Road</th>
<th>Minor Road</th>
<th>Dirt Road</th>
<th>Total</th>
</tr>
</thead>
<tbody>
<tr>
<td>Bebbington</td>
<td>4900</td>
<td>34</td>
<td>0.05</td>
<td>0.23</td>
<td>0.06</td>
<td>0.05</td>
<td>0.39</td>
</tr>
<tr>
<td>East Br. Mt Hope</td>
<td>2800</td>
<td>10</td>
<td>0.00</td>
<td>0.05</td>
<td>0.03</td>
<td>0.04</td>
<td>0.12</td>
</tr>
<tr>
<td>Goss</td>
<td>2100</td>
<td>15</td>
<td>0.02</td>
<td>0.05</td>
<td>0.00</td>
<td>0.10</td>
<td>0.17</td>
</tr>
<tr>
<td>Knowlton</td>
<td>7000</td>
<td>21</td>
<td>0.05</td>
<td>0.13</td>
<td>0.03</td>
<td>0.03</td>
<td>0.24</td>
</tr>
<tr>
<td>Knowlton Pond</td>
<td>3800</td>
<td>29</td>
<td>0.04</td>
<td>0.12</td>
<td>0.00</td>
<td>0.16</td>
<td>0.33</td>
</tr>
<tr>
<td>Mt Hope 1</td>
<td>11300</td>
<td>33</td>
<td>0.21</td>
<td>0.13</td>
<td>0.02</td>
<td>0.01</td>
<td>0.37</td>
</tr>
<tr>
<td>Mt Hope 2-1</td>
<td>7300</td>
<td>35</td>
<td>0.28</td>
<td>0.01</td>
<td>0.04</td>
<td>0.07</td>
<td>0.39</td>
</tr>
<tr>
<td>Mt Hope 2-2</td>
<td>8900</td>
<td>23</td>
<td>0.03</td>
<td>0.11</td>
<td>0.05</td>
<td>0.07</td>
<td>0.26</td>
</tr>
<tr>
<td>Squaw Hollow</td>
<td>5400</td>
<td>28</td>
<td>0.17</td>
<td>0.03</td>
<td>0.08</td>
<td>0.04</td>
<td>0.32</td>
</tr>
</tbody>
</table>

As expected from the analyses presented earlier, buffers along the East Branch of the Mount Hope River and Goss Brook have lower road densities than along the other assessed streams. This disparity is even greater when considering just the larger roads. Squaw Hollow and Bebbington Brooks and the lower 2/3 of the Mount Hope River are expected to have the greatest impacts from road maintenance due to a high density of major roads in the riparian buffer along these watercourses.

Dams

The dams regulated by the DEP Office of Dam Safety were enumerated by drainage basin as follows:
### Number of Dams in Watershed

<table>
<thead>
<tr>
<th>Segment</th>
<th>Hazard Classification</th>
<th>Total # of Dams</th>
<th>Dams / Basin Area (number / mi²)</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>unrated A A BB B C</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Bebbington</td>
<td>1</td>
<td>1</td>
<td>0.43</td>
</tr>
<tr>
<td>East Br. Mt Hope</td>
<td>2</td>
<td>2</td>
<td>0.42</td>
</tr>
<tr>
<td>Goss</td>
<td>1 1 1 3</td>
<td></td>
<td>1.52</td>
</tr>
<tr>
<td>Knowlton</td>
<td>2 1 4 1 2 10</td>
<td></td>
<td>1.46</td>
</tr>
<tr>
<td>Knowlton Pond</td>
<td>1 2 1 4</td>
<td></td>
<td>2.25</td>
</tr>
<tr>
<td>Mt Hope 1</td>
<td>2 0 2 0 1 0 5</td>
<td></td>
<td>0.66</td>
</tr>
<tr>
<td>Mt Hope 2-1</td>
<td>2 2 6 1 3 1 15</td>
<td></td>
<td>0.84</td>
</tr>
<tr>
<td>Mt Hope 2-2</td>
<td>1 1 1 3</td>
<td></td>
<td>0.46</td>
</tr>
<tr>
<td>Squaw Hollow</td>
<td>2 1 4 1 2 0 10</td>
<td></td>
<td>1.17</td>
</tr>
<tr>
<td><strong>Entire Watershed</strong>*</td>
<td></td>
<td><strong>25</strong></td>
<td><strong>0.43</strong></td>
</tr>
</tbody>
</table>

* Counts for the entire watershed do not equal the sums of the rows: dams in nested basins are counted both in the nested basin and in the larger basin that contains it.

The density of dams in the Knowlton Pond drainage basin, with more than two per square mile, is far greater than in the other basins in this assessment. This factor appears in the LU/LC analysis as high percentage of open water in the basin. Generally speaking, the lower hazard and unrated dams are smaller than the higher hazard ones (with AA being the lowest and C being the highest hazard). Since the dams in the Knowlton Pond basin tend to be lower hazard, it is likely that these are relatively small dams and therefore create relatively shallow ponds. Shallow ponds tend to decrease downstream water quality through increased water temperatures and increased nutrients caused by the eutrophication process. It is likely that water quality in Knowlton Brook is decreased relative to the other watercourses due to this high density of dams. There is also an additional cluster of small dams in the headwaters of Knowlton Brook, leading to the relatively high density in that watershed. Water quality in Knowlton Brook may also be impacted by these dams.

**Other Resources**

The following GIS data were examined as maps and were not used to generate assessment data:

- **Locations of stratified drift (potential aquifers):** most stratified drift in the watershed is located along the lower portion of the Mount Hope River.

- **Locations and types of groundwater leachate known to DEP:** Five notable sources of groundwater pollution are mapped, as follows: 1) a landfill located in the upper basin of the Mount Hope River and less than 1000 feet from the river; 2) two salt storage sheds, one of which is located on the potential aquifer comprised of sand and gravel running along the Mount Hope River; and 3) two agricultural waste deposits.

- **DEP's surface water quality classification:** All surface water in the watershed is classified as AA (for drinking water), with the notable exception of the Mount Hope River. This river is classified as B/AA from the above-noted landfill to the river's mouth at Mansfield Hollow.
● **DEP’s groundwater quality classification:** All groundwater in the watershed is classified as GAA (suitable for drinking) with the exception of a plume extending from the above-noted landfill to the Mount Hope River.

● **Public Access Points:** Numerous access point provide public access to the Mount Hope River and Knowlton Brook at regular intervals. Public access is necessary for recreation and visibility of the resource to encourage public buy-in of the need for protection. Nonetheless, protection of the water resources would include creation of some limited-access areas without public access points.

● **Fishing Easements:** The middle segment of the Mount Hope River is bordered by fishing easements providing important public angling opportunities. Continued documentation of these easements is useful for conservation efforts. Also see Public Access Points above.

● **DEP’s Natural Diversity Database:** There are no know threatened or endangered species in the watershed. This absence is likely due more to limited investigation rather than lack of these species. Resource inventories would help provide this information.

● **Aquifer Protection Area:** There are no mapped aquifer protection areas around existing public water supply wells. These mapped areas do not account for potential aquifers that may be relied on in the future.

**Summary**

1. Water quality in the main stem of the Mount Hope River is most likely to be affected by incompatible land use, which includes I-84 and the Crystal Lake community.

2. Agriculture in the Bebbington Brook subwatershed may impact the water quality: on-site remediation would be recommended if this is the case.

3. Ponds in the Knowlton Brook subwatershed may impact water quality: dam modification and/or removal could remediate these impacts.

4. Large parcels of existing open space are unprotected. Pursue open space protection for large unprotected parcels such as the Yale Forest and the June Norcross Boy Scouts of America camp. Pursue farmland preservation for large agricultural parcels such as Crooke's Orchards.

5. Mapping of land partially protected by conservation easements and PA 490 is not available. A regional database / registry with this information would greatly aid conservation efforts.

6. Riparian land along many of the primary rivers and streams is less well protected than the drainage basins at large, despite the greater importance at preserving the riparian corridor for protection of in-stream habitat and water quality. A focus on acquisition and regulation of riparian areas is recommended, particularly in the upper Mount Hope River.

7. High road densities along the lower 2/3 of the main stem of the Mount Hope River as well as along Squaw Hollow and Bebbington Brooks is anticipated to result in greater impacts on these watercourses, which should be visible in increased road sand deposits on the streambeds. The presence of road sand on the streambeds has been confirmed by anglers with Trout Unlimited, who have identified this issue as a primary concern.

8. There are high densities of small dams in the Knowlton Pond Brook basin and in the upper
reaches of the Knowlton Brook basin. It is likely that these dams negatively impact water quality through increased water temperatures and nutrients. Modification of one more more of these dams may improve water quality.

9. The lower 2/3 of the Mount Hope River is lined by sand and gravel deposits that are potential aquifers. Protection of these deposits from contamination is important for protection of drinking water quality in the Willimantic Reservoir as well as potential future drinking water wells in these aquifers. There are also a few potential aquifers scattered throughout the watershed.

10. There are two notable sources of groundwater pollution that likely enter the Mount Hope River. One is the landfill located in the upper reaches of the watershed and located less than 1000 feet from the river. The second is a salt storage shed located on the potential aquifer described above. These leachate locations should be monitored and remediated if necessary. The sites should be protected and properly maintained to prevent groundwater contamination.

11. The above-noted landfill provides a source of leachate that results in both a classification of the associated groundwater as Class GAA-impaired, as well as classification of the downstream watercourse as B/AA (not meeting the designated drinking water criteria). Monitoring of the leachate from the landfill would provide information regarding the damage to water quality and need for further action.

12. Public access points and fishing easements on the Mount Hope River and Knowlton Brook provide necessary public opportunities for recreation and resource visibility. Protection of the river resources, however, also require limited public access. Some river segments could be designated as limited access to decrease impact and improve wildlife habitat and value.

13. There is limited availability of resource mapping. Continued documentation of the resources of the watershed – particularly features such as vernal pools, or threatened and endangered species – will enhance planning effectiveness.

**Database**

A database with the data presented in the tables in this summary is available on request.
C) Additional Data Needs

The following data needs were identified to better create a plan of conservation for the watershed:

1. Regional database or registry of conservation easements and land partially protected under PA 490.
2. Water quality data, particularly in the main stem of the Mount Hope River near locations of known groundwater pollutants, and before and after tributary confluences.
3. Groundwater quality data, particularly at known leachate locations.
4. Wetland functions and values.
5. Resource mapping, particularly of wetland and watercourse features such as vernal pools, and of threatened and endangered species.

More important than the missing data, however, is the fact that a tremendous amount of data and planning already exist. On completion of this study, it appears that regional conservation and preservation of natural resources require implementation of the plans on the books, rather than creation of a new plan.