BRISTOL/NEW HAMPTON TRIBUTARIES WATERSHED CONSERVATION PLAN

Ayers Island Dam, Bristol & New Hampton, NH

DECEMBER 2008

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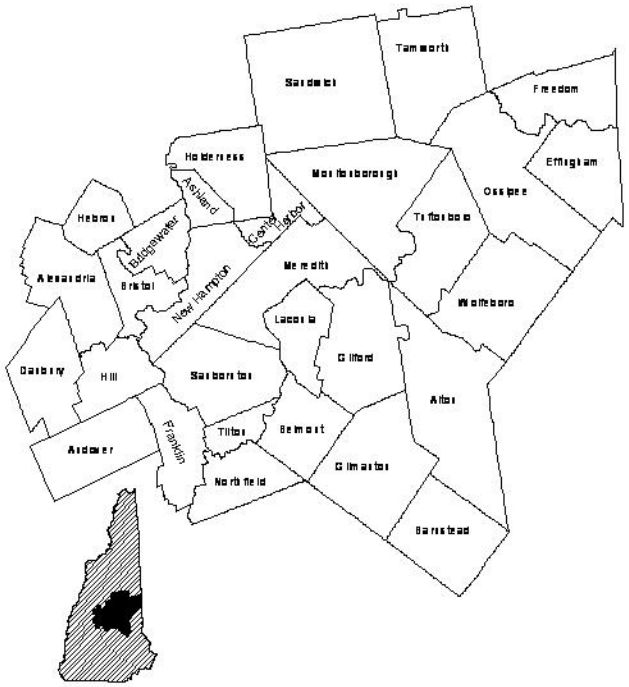

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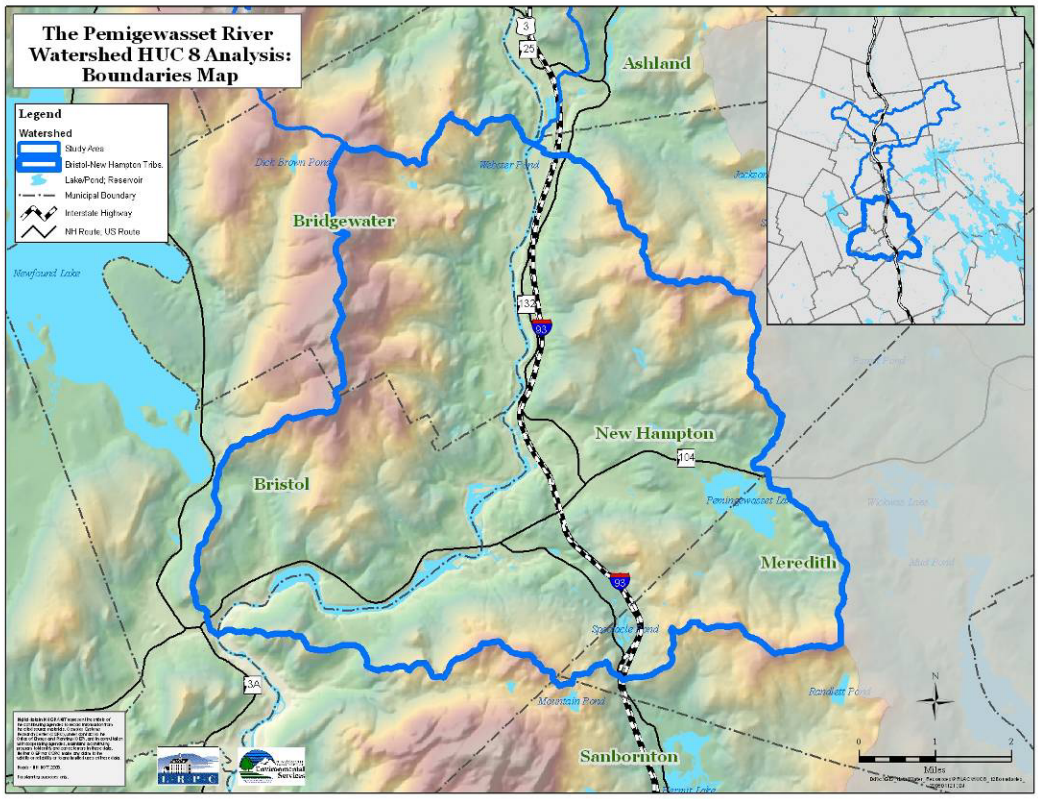

Figure 1. Bristol-New Hampton Tributaries Watershed

The Bristol-New Hampton Tributaries (BNHT) watershed spans 40.7 square miles and lies primarily within four towns along the Pemigewasset River corridor. This plan is designed to provide assistance to the Pemigewasset River Local Advisory Committee (PRLAC), municipalities, and other planning entities for identifying conservation planning opportunities in the watershed through the development of a co-occurrence map and analysis of the data. The map shows where areas of high quality waters, wetlands, and uplands occur. The map and analysis also illustrate areas of high quality agricultural soils, water withdrawals, potential contamination sources, where current protections exist, and recommendations where further protection would benefit the water quality.

Areas along the major transportation corridors are seeing increasing industrial, commercial and residential development. The corridors also happen to traverse the highest transmissivity areas of the underlying aquifer – the drinking water source for much of the watershed population. The development of this plan has enabled a cooperative, regional approach for watershed conservation. The committee's vision is for this plan to be used as a tool for future land use planning decisions that provides consistent strategies across town borders. In this way the natural resources can have consistent protection for the entire watershed.

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I. INTRODUCTION

WHY DEVELOP A CONSERVATION PLAN?

The Lakes Region is facing increasing development pressures due to population growth, particularly around our lakes and rivers near the I-93 corridor. In order to better prepare for growth near these sensitive resources, a conservation plan will identify areas of high priority for conservation. A plan will improve knowledge of the resources in the watershed and provide a basis for regional cooperation. In this way municipalities and organizations can take a proactive, planned approach to development in their communities.

PURPOSE

The purpose of this plan is to identify areas of high quality waters (surface and ground water), wetlands, and uplands for the BNHT watershed. The plan will provide site specific recommendations to assist PRLAC and the municipalities make informed land use planning decisions to preserve, conserve, or restore these identified areas.

Conservation planning across political boundaries is often a challenge due to differing datasets, regulations, and policies. The goal of this plan is to provide natural resources information to facilitate regional decision-making among the four municipalities that are partly or wholly within the BNHT watershed boundary; Bridgewater, Bristol, Meredith, and New Hampton .

The co-occurrence results will supply all municipalities within the Pemigewasset watershed with baseline data on which they can make land use planning decisions. It also provides PRLAC an opportunity to recommend areas of preservation and/or restoration to the NH DES In-Lieu Fee Program.

Since the maps illustrate locations of high quality resources, they also highlight the areas where few high quality areas remain, due in part to development. This information can often be just as valuable as it gives stakeholders an opportunity to protect the remaining open space in these areas through land use planning.

GOAL STATEMENT

The goal of the BNHT Conservation Plan is to focus conservation efforts on areas where high quality waters, wetlands, and uplands currently exist, and where greater protection on these or adjacent areas would be most beneficial for water quality conservation. The co-occurrence map and analysis has guided the identification of regional strategies for continued and improved conservation techniques.

PUBLIC OUTREACH

In order to improve the plan, public meetings were held for watershed towns, PRLAC and interested citizens. At each meeting, feedback was received from the attendees that helped inform and direct the plan development. :

September 23, 2008	Public Meeting at the Gordon Nash Library, New Hampton
December 9, 2008	Draft Plan Presentation and Discussion
December 18, 2008	Final Plan and Presentation

DEFINITIONS

The following definitions may be useful when reading this report:

Catchment

A catchment is a part of the surface of the earth that is occupied by a drainage system, which consists of a surface stream or a body of impounded surface water together with all tributary surface streams and bodies of impounded surface water.[1]

Watershed

A watershed is a geographic area in which all water drains to a given stream, lake, wetland, estuary, or ocean.[2] The greater Pemigewasset watershed is comprised of many sub-watersheds, which are, in turn, comprised of many catchments.

Hydrologic Unit Code (HUC)

The HUC is a hierarchical, numeric code that uniquely identifies hydrologic units. Hydrologic units are subdivisions of watersheds nested from largest to smallest areas and are used to organize hydrologic data. HUCs are constructed as follows:

- the first two digits identify the region,
- the first four digits identify subregions,
- the first six digits identify accounting units,
- the first eight digits identify cataloging units,
- the first ten digits identify watershed units,
- the full twelve digits identify subwatershed units.

The USGS developed the first eight-digit HUC for the United States, while the U.S. Department of Agriculture, Natural Resource Conservation Service (USDA-NRCS) within each state is developing the full twelve-digit HUC.[3]

[1] http://water.usgs.gov/wsc/glossary.html#TOC, website accessed June 6, 2008.
[2] http://www.des.state.nh.us/wmb/was/, website accessed June 6, 2008.
[3] http://www.mass.gov/mgis/nrcshuc.htm, website accessed June 6, 2008.

II. WATERSHED OVERVIEW

SIGNIFICANT NATURAL RESOURCES

The BNHT watershed drains approximately 40.7 square miles in four municipalities: Bridgewater, Bristol, Meredith, and New Hampton. The northern section of the watershed is characterized by hills and steeply forested land intersected by streams. The land typically becomes less steep on the eastern side of the river as it travels south. The incidence of wetlands increases in these less steep areas and around Pemigewasset Lake. Figure II-1 (a larger version is also found on page 19) illustrates the topography and water resources of the watershed.

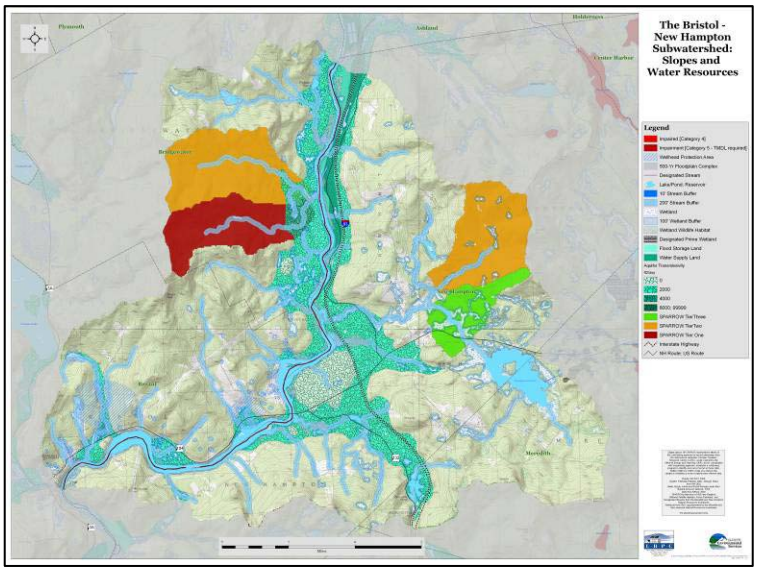


Figure II-1. Topography and Water Resources in the BNHT Watershed

Surface Waters

The Pemigewasset River flows south through the watershed. The Ayers Island Dam impounds the river near the southern watershed boundary. Depending on the time of year and rain or runoff amounts, the impoundment can cause the river level to rise or fall several feet in a matter of hours. Additionally, the banks along the river can be steep with very sandy soil characteristics. All of these land characteristics pose challenges to development near the river.

Numerous un-named streams, and several named streams contribute to the BNHT watershed:

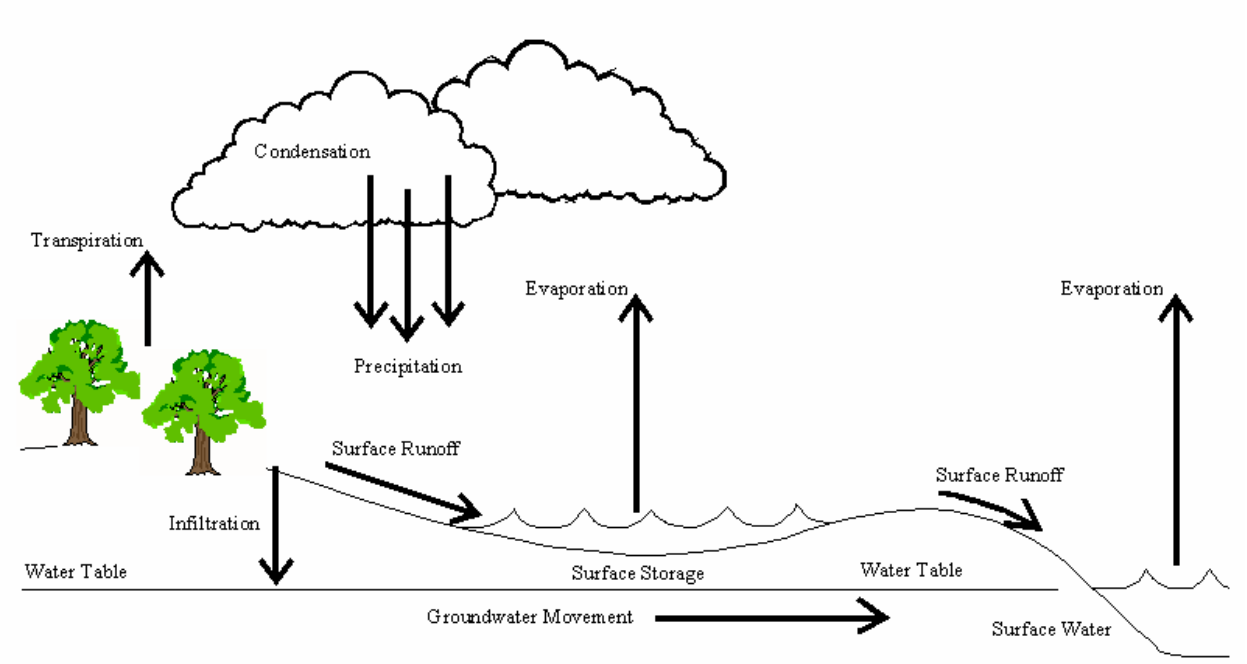
Town	Stream Name
Bridgewater	Great Brook Woodman Brook Abel Brook Fogg Brook
Bristol	Danforth Brook Tenmile Brook
Meredith	Merrill Brook (*Designated Stream*)
New Hampton	Dry Brook Harper Brook Magoon Brook Hoyt Brook

Pemigewasset Lake is the largest lake in the watershed covering 250 acres in Meredith and New Hampton. Spectacle Pond in Meredith and Webster Pond in Bridgewater are other small waterbodies. Wetlands are located throughout the watershed, with a higher incidence in the towns of Meredith and New Hampton. Combined with upland areas, the wetlands provide valuable wildlife habitat. They also provide a water filtration buffer for surface and groundwater, further protecting the resources. The town of Meredith has designated Prime Wetlands; however only 3.5 acres of a much larger complex (over 45 acres) lie within the BNHT watershed.

Ground Water

Sand and gravel deposits form a stratified-drift aquifer beneath, and adjacent to, the Pemigewasset River for most of its length. Bedrock typically lies about 100 feet below the surface, although in some areas it may be as much as several hundred feet below. Wells in the aquifer currently provides municipal water for Bristol. New Hampton Village District is also pursuing a large water withdrawal permit for a municipal water supply. These and adjoining aquifers also provide domestic water for innumerable household wells. Flow in the aquifers ultimately discharges underground into the Pemigewasset River (Figure II-2).[4]

Figure II-2: The Hydrologic Cycle



Groundwater eventually discharges into rivers, streams and wetlands. Wetland functions include the storage of water, transformation of nutrients (purifying water), the growth of living organisms that need the protection of grasses and shallow water to mature, the diversity of wetland plants, and they are also temporary refuge to an extraordinary number of migrating birds.

[4] *Pemigewasset River Corridor Management Plan*, LRPC, 2001

Water stored in the aquifer is recharged, or replenished, when rain and snowmelt soak the ground and move down through the soil to the saturated zone below the water table, rather than evaporating or running off to surface waters. One of the most critical determinants of groundwater quality is the location of these recharge areas in relation to land use and potential contamination sources.

STATUS OF LAND CONSERVATION

The BNHT watershed contains 26,048 acres, or 40.7 square miles. There are currently a total of 1,185 acres, or 4.5 percent, of land in conservation, shown in Figure II-3 (also found on page 21). Types of conservation consist of fee ownership, conservation easements, and scenic easements. The parcels range in size from 1.3 acres to 170 acres and are owned by a variety of entities including private landowners, municipalities, US Army Corps of Engineers, NH Department of Fish and Game, NH Department of Transportation, and the Society for the Protection of New Hampshire Forests. Additional parcels of land are continuously being sought for conservation, either by an easement or purchase, in order to further conserve sensitive natural resources.

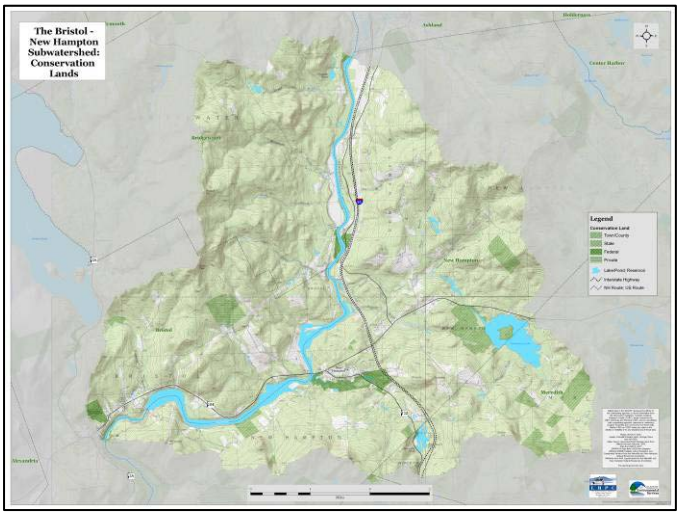


Figure II-3. Conservation Lands in the BNHT Watershed

DEVELOPMENT HISTORY AND TRENDS

Over the last several years there has been substantial growth throughout the Lakes Region, including in the towns of Bridgewater, Bristol, Meredith, and New Hampton. Meredith has seen the most growth in housing units with 434 added in the last five years. New Hampton saw the largest increase in commercial building, with 25 new buildings added from 2000-2005. Despite the fact that Bridgewater has seen relatively few new housing permits and no new commercial permits over the five year period, the number is still notable due to the considerably smaller population. Housing units in all four towns had the largest increase from single-family homes. Table II-1 shows the number of permits issued from 2000-2005 for residential and commercial purposes.

Table II-1. Municipal Population and Permitting[5]

Town	2005 Population (NH OEP)	2015 projection (NH OEP)	Residential Housing Permits 2000-2005	Commercial Permits 2000-2005
Bridgewater	1,030	1,110	65	0
Bristol	3,190	3,410	153	9
Meredith	6,350	7,360	434	10
New Hampton	2,130	2,440	147	25

The majority of development in the watershed is occurring adjacent to the transportation corridors (NH Routes 104 and 132), Pemigewasset Lake, and the smaller ponds and streams. This is consistent with the current zoning for each town, shown in Figure II-4 (also page 23). There has been significant development east of I-93 for exiting traffic. In the last several years fuel and service centers have been built with plans for an additional service station currently being implemented. There are plans for additional development including large retail stores and service centers at this interchange. How development is conducted in this area should be carefully considered due to the sensitive natural features; such as the steep slopes and large aquifer underlying the corridor – which is currently being proposed as the municipal drinking water source.

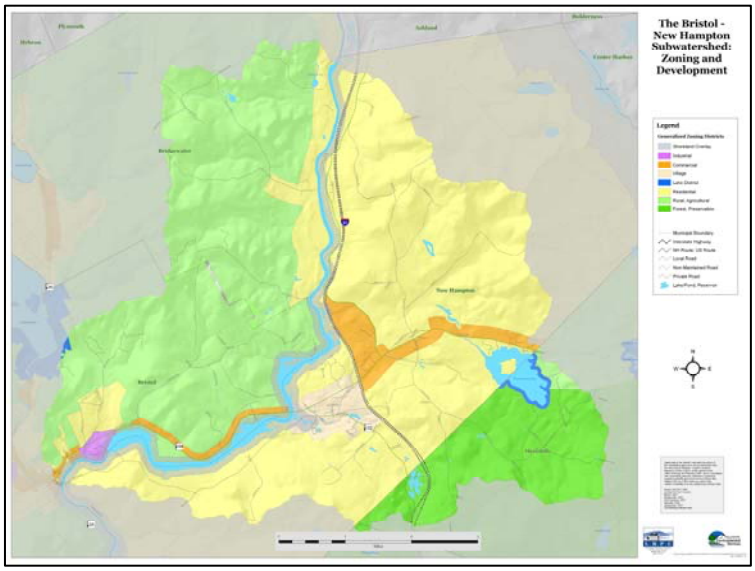


Figure II-4. Zoning in the BNHT Watershed

[5] Population projections: *Municipal Population Projections 2010-2030*, NH Office of Energy and Planning, January 2007.
Residential and Commercial Permits: *Development Activity in the Lakes Region, 2007 Annual Report,* Lakes Region Planning Commission, March 2008.

III. CO-OCCURRENCE ANALYSIS

WHY CONDUCT CO-OCCURRENCE MAPPING?

Co-occurrence mapping is created by layering a series of individual maps (i.e. datasets) on top of one another to create a graduated snapshot of the region. For the BNHT watershed datasets were used to create a snapshot of current conditions. The end-product is a map that uses graduated colors to illustrate where the areas of highest quality waters, wetlands, and uplands are located within the watershed. This map can become the foundation for conservation planning efforts in the watershed.

GENERAL APPROACH

The goal was to identify areas of high quality waters, wetlands, and uplands in the BNHT watershed for conservation planning purposes. This conservation plan builds on earlier work completed in June 2008 with the *Pemigewasset Watershed Resource Co-occurrence Mapping and Analysis*. The LRPC used the following approach:

- Employ a science-based approach using existing, statewide data.
- Incorporate documented natural resource features and predictive GIS modeling.
- Analyze data at the catchment scale for the watershed (HUC 12).
- Synthesize information to identify significant areas for conservation, restoration and/or preservation.

All of the maps mentioned in this report can be found in *Chapter V: BNHT Watershed Co-occurrence Maps*, starting on page 19.

DELINEATING THE RESOURCE CO-OCCURRENCE AREAS

For the purpose of this report, the LRPC interpreted "significant resource features" to include those lands and waters most important for identifying living resources (flora and fauna) and water quality. Five categories of key features were identified (listed below) that best address living resources and water quality. These features are embedded in the datasets used in the co-occurrence analysis.

1. High quality stream watersheds
2. Large and high quality wetland systems
3. Riparian zones on freshwater rivers, streams, lakes and ponds
4. Unfragmented forest ecosystems
5. Exemplary natural communities and significant wildlife habitat

A Supplementary Layers map was also created for the watershed. The Supplementary Layers map was not included in the co-occurrence scoring (see below), as the datasets did not

necessarily identify a high quality water, wetland, or upland. However, they were added to the final co-occurrence maps as an overlay for planning purposes. This layer includes well-head protection areas, conservation lands, potential contamination sources, water withdrawals, and impaired waterbodies. The only impaired waterbody in the BNHT watershed is the Pemigewasset River, according to the 2008 NH DES 303(d) list. It is currently impaired for dissolved oxygen and pH.

Upon completion of the composite map and addition of local datasets, the co-occurrence analysis for high quality waters was created for the watershed. The co-occurrence analysis identifies areas where several resource values coincide and overlap, thus signaling locations with multiple key features and potentially higher priority for protection. The following steps outline the process used to determine the areas of high quality waters for the co-occurrence analysis.

Step 1. Research and Develop Co-occurrence Analysis Methodology

Discussions with New Hampshire Department of Environmental Services, Department of Fish and Wildlife, and municipal staff were conducted to determine the best approach for a science-based co-occurrence analysis, and continued throughout the modeling process. Several plans were used to shape the methodology, including, *The Land Conservation Plan for New Hampshire's Coastal Watersheds (2006)*, *Ammonoosuc Watershed Region Conservation Plan (2005)*, *A Land Conservation Plan for the Ashuelot River Watershed (2006),* and *Pemigewasset Watershed Resource Co-occurrence Mapping and Analysis (2008).*

Step 2. Assemble Datasets

Datasets used to create the model came from a variety of sources, listed below. Descriptions of the datasets are found in Appendix A.

1. Wildlife Habitat (NH Wildlife Action Plan)
2. Water Quality
    a. Aquifer (NH DES)
    b. Flood Storage Lands (Natural Services Network)
    c. 500-year Floodplains (NH WAP)
    d. SPARROW Catchment Water Quality (USGS)
3. Water Supply Lands (Natural Services Network)
4. Wetlands (NWI)
5. Farmland Soils (NRCS)
6. Data from the Meredith and New Hampton Natural Resource Inventories
    a. Stream buffers
    b. Designated stream

c. Wetland buffer

d. Wetland wildlife habitat buffer

e. Designated prime wetland

f. Active farmland

7. Stream and wetland buffers were delineated for Bristol and Bridgewater by LRPC based on the Meredith and New Hampton NRI methodologies.

Step 3. Refine Datasets for the Watershed

Hydrology, Habitat and Revised Catchment Hydrology Composite maps were created while developing the *Pemigewasset Watershed Resource Co-occurrence Mapping and Analysis.* In order to provide more specific hydrologic detail for the BNHT watershed, the LRPC used USGS SPARROW data. The USGS SPARROW data are based on the catchment scale, a larger scale than a subwatershed. Additional information about USGS SPARROW data is found in Appendix A. Municipal datasets were also incorporated in this analysis to add greater refinement. The specific datasets included in the composite map, as well as the local datasets, are listed in Table III-1.

Step 4. Conduct Co-occurrence

Areas of high quality waters, wetlands, and uplands are areas of highest co-occurrence in the watershed. A numerical value was assigned to each dataset in order to create a weighted analysis of different datasets.

A straight-forward, systematic scoring system was used to maximize transparency so the analysis can be reproduced by municipalities, PRLAC, NH DES, and others. Since the scoring system is very basic, it can also be modified and adapted based on additional local input and municipal requirements. There are twenty-five points available within the BNHT watershed using this scoring system, although the highest score for this analysis was fourteen. The numerical value assigned to each data layer for the watershed analysis is shown in Table III-1.

This analysis is weighted most heavily towards water resources. Seventeen of the twenty-five possible points in the scoring system are based on water resources, and four of those are specific to groundwater (variable transmissivity levels). This is important for the watershed because the vast majority of the population relies on small or individual groundwater withdrawal wells due to rural development patterns. In order to better protect the aquifer and drinking water resources the system is thus weighted heavily in favor of groundwater.

Table III-1. BNHT Watershed Co-occurrence Analysis Scoring System [1-25]

Composite	Data layer	Value
Water Quality		
	Aquifer Transmissivity (maximum)	
	over 8,000 sq ft/day)	4
	4,000 sq ft/day	3
	2,000 sq ft/day	2
	0 sq ft/day but with aquifer boundaries	1
	Flood Storage Land	1
	Wetlands	
	100-year floodplains	
	Water Supply Land	1
	Highly transmissive aquifers	
	Favorable gravel well sites	
	Designated Stream	1
	Stream Buffer (10')	1
	Stream Buffer (200')	1
	500-year Floodplain	1
	Wetlands	1
	Wetland buffer (100')	1
	Designated Wetland	1
Catchment Water Quality (SPARROW data)		
	Tier 1: <20 persons/sq mi, <1% developed, <5% agricultural land use	4
	Tier 2: <36 persons/sq mi, <1% developed, <5% agricultural land use	3
	Tier 3: <64 persons/sq mi, <1% developed, <5% agricultural land use	2
	Tier 4: <90 persons/sq mi, <1% developed, <5% agricultural land use	1
Habitat		
	Wildlife Action Plan Habitat	
	Tier 1: Highest ranked habitat in NH	3
	Tier 2: Highest ranked habitat in biological region	2
	Tier 3: Supporting landscape	1
	Wetland Wildlife Habitat	1
	Farmland Soils	
	Prime Farmland Soil	3
	Farmland Soils of Statewide Importance	2
	Farmland Soils of Local Importance	1
	Active Farmland	1

Composite	Data layer	Value
Supplementary Layers (for planning purposes)		
	Impaired waterbodies (NH DES 303d list)	NA*
	Wellhead Protection Areas	NA
	Water Users	NA
	Registered Water Withdrawal	NA
	Above Ground Storage Tanks	NA
	Underground Storage Tanks	NA
	Potential Pollution Source	NA
	Conservation Lands	NA

*NA = Not Applicable

DATA LIMITATIONS

This report was developed using the best data and guidance available to LRPC. Based on the data described above, and in the Appendix B, the BNHT watershed contains a range of significant ecological resources. While this analysis provides an understanding of the location and status of certain resources, the site specific distribution of these resources is incomplete due to local differences in available data. Therefore this analysis should be used in cooperation with other planning tools and local expertise.

Most of the data used in this project was developed on a statewide scale and is not site-specific. The NH Wildlife Action Plan and USGS SPARROW data are predictive, based on Land Use and other data sources. While SPARROW catchments are far smaller than even HUC 12 watersheds (there are 19 catchments within the BNHT watershed), the data refinement is limited to the catchment.

The datasets and scoring system used in this analysis may be revised or adapted to better reflect the goals of the municipality or organization. Modifying the numerical values for each dataset will produce different results.

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IV. CONSERVATION AND IMPLEMENTATION STRATEGIES

CO-OCCURRENCE ANALYSIS

Areas of high quality waters, wetlands, and uplands are areas of highest co-occurrence. Final analysis shows where these high quality areas are located within the BNHT watershed. As one may expect, the majority of the highly ranked (darkly shaded) areas are within lesser developed regions of the watershed and along the river corridor, as shown in Figure IV-1 (larger version found on page 25). Several of the lesser developed streamsheds can be categorized as moderate to high quality. These include Woodman, Fogg, and Harper Brooks. Also of high priority are areas along the Pemigewasset River in the northern section of the watershed and just east of downtown Bristol on Danforth Brook. This is due to the occurrence of high aquifer transmissivity, flood storage lands, and water supply lands.

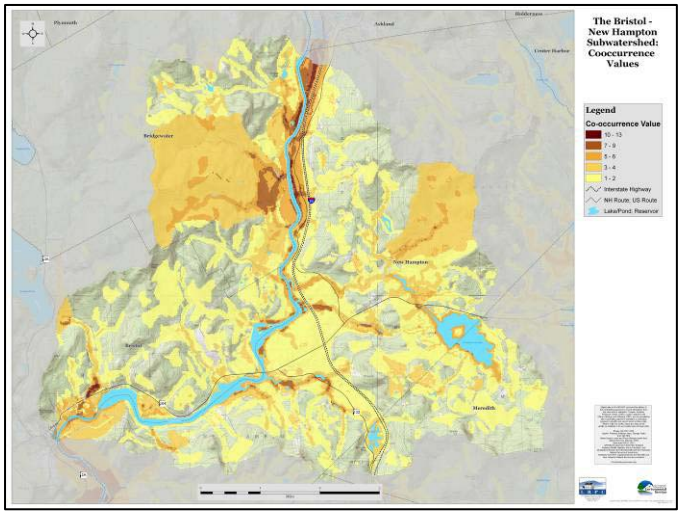


Figure IV-1. BNHT Watershed Resource Co-occurrence

However, there are a number of exceptions where areas of moderate quality are within areas under development pressure. Most notably are stream corridors in the population centers of New Hampton Village and the NH Route 104 corridor. Each of these areas is experiencing increasing development pressure as waterfronts and steeper slopes are built upon.

PLANNING RECOMMENDATIONS FOR THE BNHT WATERSHED

The following recommendations can assist municipal planning boards, conservation commissions, and boards of selectmen, PRLAC, and other planning entities identify locations for preservation and/or restoration. Entities responsible for these recommendations will vary depending on the municipal structure of each town. Entities typically responsible for specific recommendations have been noted; however this does not necessarily reflect the structure in every town.

General recommendations for watershed conservation planning:

- Areas of high co-occurrence should be targeted for preservation and/or restoration through programmatic and land use planning and conservation. Techniques can include zoning and regulation, land acquisition, and outreach and education. Depending on the technique used, possible responsible entities would be the municipal planning boards and conservation commissions. Planning and zoning boards apply the

zoning and regulations for specific projects. Enforcement of zoning and regulations generally falls to the boards of selectmen, code enforcement officers, fire departments, building inspectors, and health inspectors – dependent on the town structure and type of regulation.

- Areas of high co-occurrence outside of, but adjacent to, existing conservation lands should also be of high priority for conservation planning, particularly if these areas could potentially link designated conservation lands. These could be locally or regionally identified by an overlay district to improve regional cooperation. Priority lands can be conserved through purchase, conservation easements, or other land conservation means. This would improve connectivity, the prevalence of habitat corridors, and increased recreation opportunities. Primary responsible entities would be the municipal conservation commissions.
- Conversely, areas that show low to moderate co-occurrence and face significant development pressure should also be under consideration for further protection through land use planning and/or conservation. Municipal planning boards and conservation commissions would be the primary entities responsible for these actions. Conservation commissions and historic commissions could also implement education/outreach programs to raise awareness of the sensitive natural and cultural features in the watersheds – particularly in high development areas. These techniques can be quite successful in reaching non-regulatory protection strategies for properties.
- The datasets and scoring system used in this analysis may be revised or adapted to better reflect the goals of the municipality or organization. For example, if one wants to place greater weight on wetland protection, wetland features can be scored with a graduated point system, thereby placing the highest value on the desired wetland feature. The LRPC can assist planning boards, conservation commissions, and PRLAC if they choose to restructure the scoring system to suit a specific project – such as proposing parcels for the NH DES In-Lieu Fee Program.
- Periodic updating of local datasets would be of great value since this plan is based on a variety of statewide, regional, and local datasets. As municipalities complete additional, or update current datasets, providing a copy to the LRPC will facilitate the regional cooperation necessary for land use planning and conservation on watershed-based plans such as this conservation plan. Municipal staff, planning boards, conservation commissions, boards of selectmen, or any other town or planning entity may be responsible for these datasets.

Specific recommendations for the BNHT watershed:

- Natural Resource Inventories (NRI) should be developed for the towns of Bristol and Bridgewater in order to better identify existing resources. This is particularly important when developing wetland datasets for the community. Municipal conservation commissions are typically responsible for developing, or contracting the development of an NRI.

- Meredith has implemented buffer setback restrictions around all surface waters in town, including lakes, streams, and wetlands. The setback restrictions provide greater protection to the surface waters from development due to the negative effects of stormwater and pollutant runoff. This model could be implemented in the other towns to provide consistent protection for the watershed. Setback regulations are typically implemented by the planning boards in either subdivision regulations and/or zoning.
- Prime wetlands could be designated for the towns of New Hampton, Bristol and Bridgewater. A prime wetland designation heightens protection of the referenced wetland at the state and local level. Prime wetlands can be determined during development of a NRI or through a separate process. Both are typically conducted through the conservation commission.

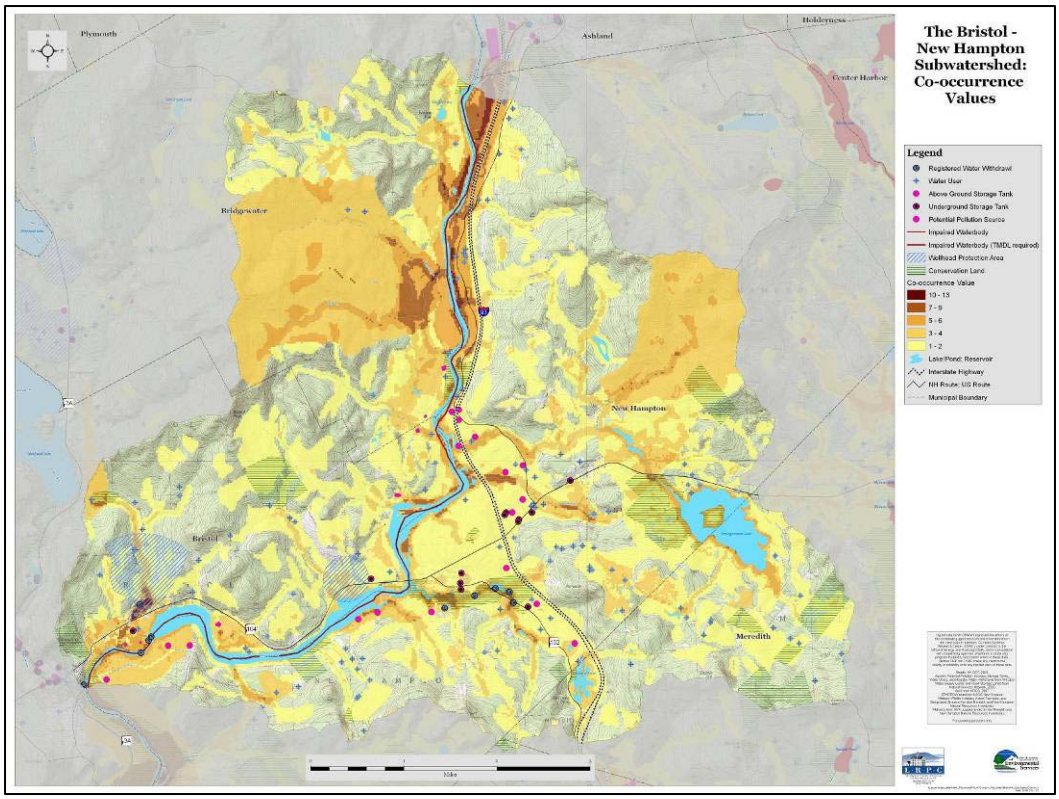


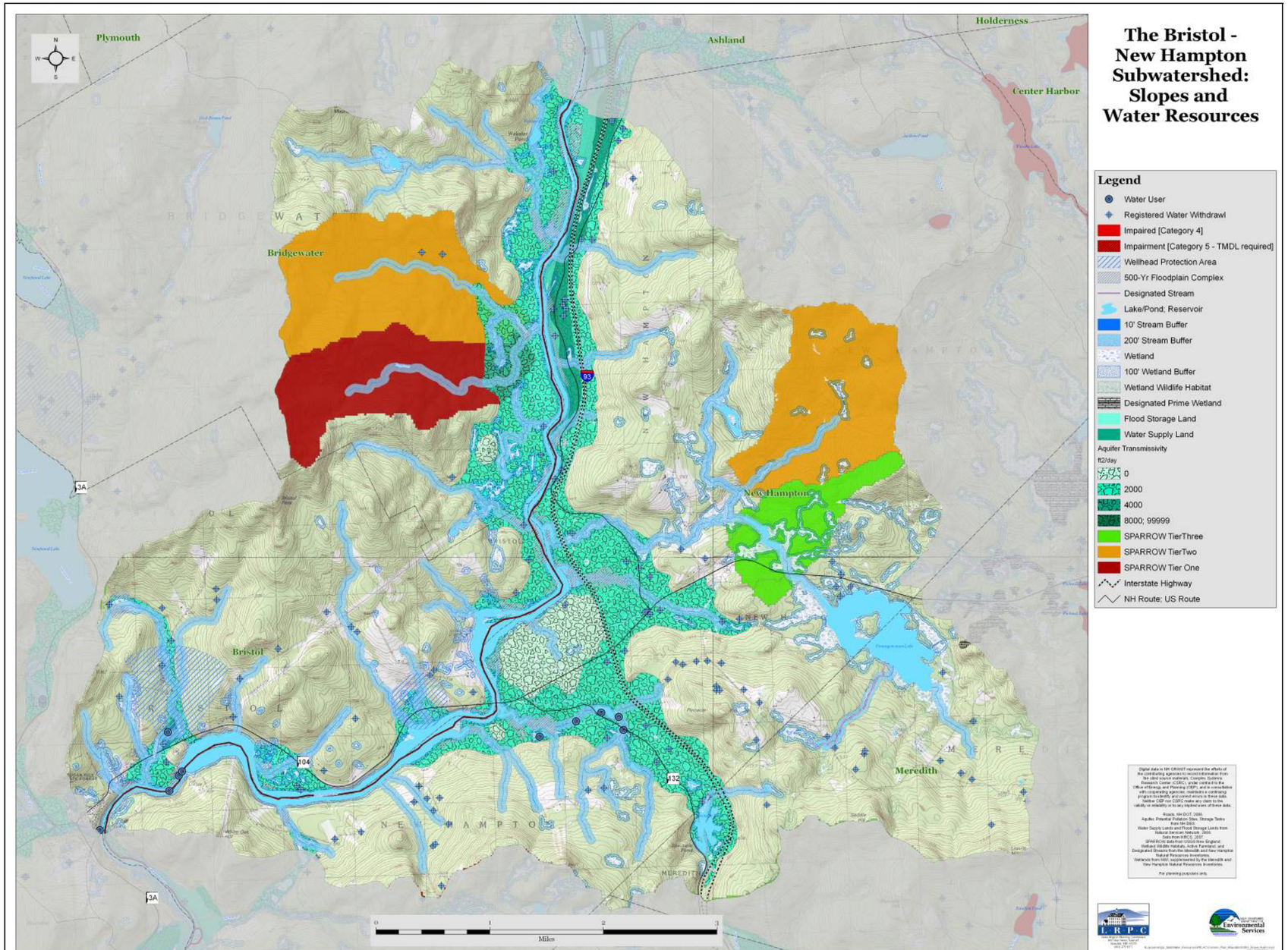
Figure IV-2. BNHT Watershed Resource Co-occurrence & Supplementary Data

- Drinking water protection ordinances can be implemented for each town. These include surface, aquifer or ground water protection strategies that limit certain types of high risk land use practices in areas of high transmissivity or surface water withdrawals. The 2008 *Innovative Land Use Planning Techniques Handbook* provides models for these ordinances. The planning boards are typically responsible for developing ordinances.

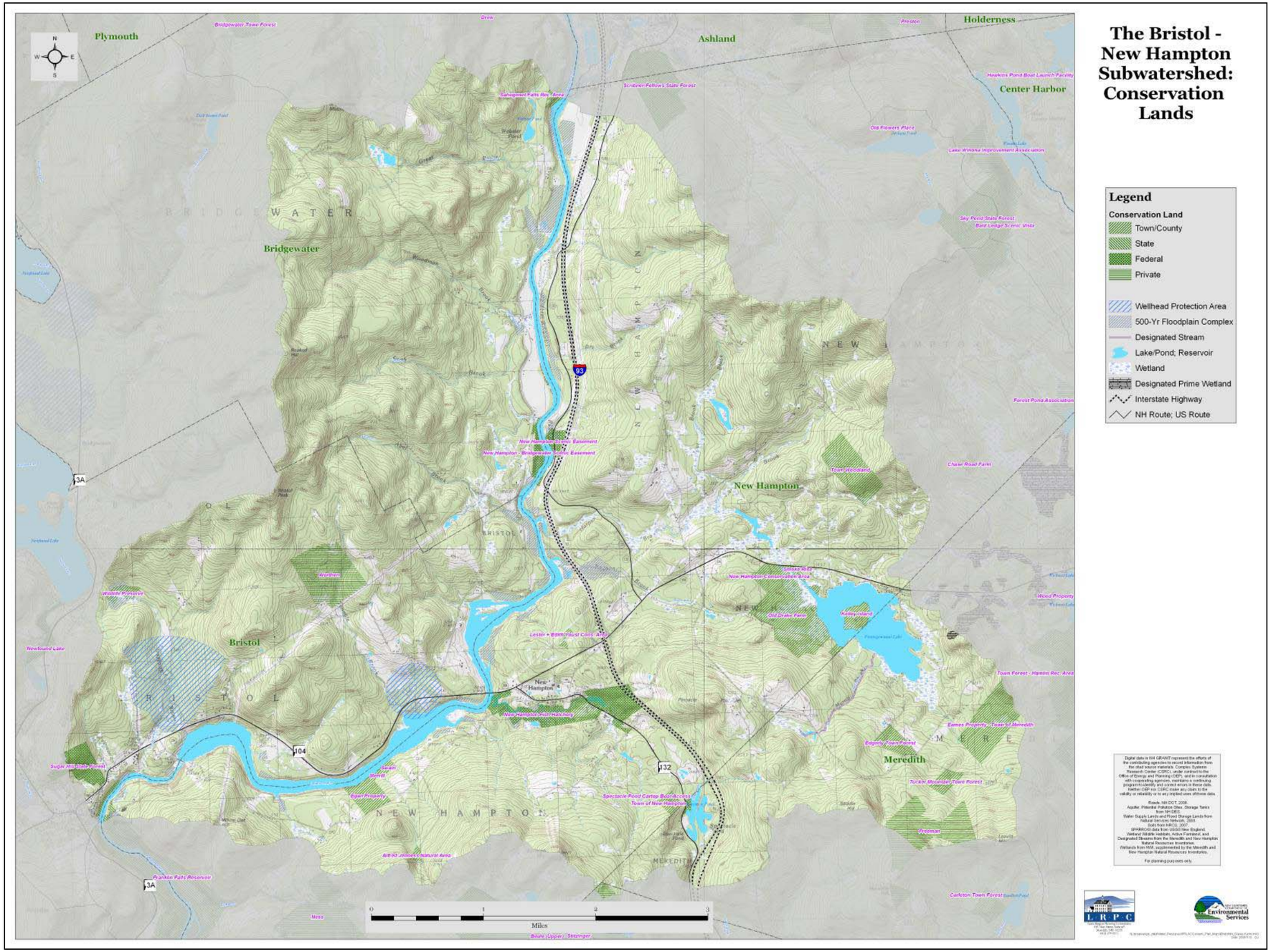
- Wellhead Protection Areas (WHPAs) can also be developed, or extended, for water withdrawals. There are numerous registered water withdrawals shown on Figure IV-2 (also on page 27), none of which have a designated protection area. The towns may place WHPAs on these transient water supplies for the purposes of zoning. Radii on transient WHPAs vary from 1,300 to 4,000 feet depending on the source type (bedrock or stratified drift aquifer) and maximum daily withdrawal. The NH DES can assist municipalities with these determinations. Boards of selectmen, planning boards and/or conservation commissions can all participate in developing these WHPAs.
- Numerous potential contamination sources (PCSs) are shown Figure IV-2 (also on page 27). A PCS inventory can be completed at either the local or regional level to better determine the type and threat to resources. The PCSs should be monitored to ensure best management practices are being followed, particularly in areas adjacent to surface waterbodies or over the aquifer. NH DES has a statewide inventory of PCSs that can be expanded through a windshield survey and local expertise (The NH DES database has not been updated since 1995.). These can be conducted by any municipal entity, and are often identified in correlation with other projects such as hazard mitigation plans. Data from completed local PCS inventories should be submitted to NH DES and the LRPC to better reflect the current local conditions, and improve regional conservation planning and coordination.
- Steep slope and ridgeline protection ordinances can be implemented in each town to protect the sensitive soils and landscape of slopes greater than 15 or 25 percent. The ridgeline protection ordinance can also heighten awareness of each community's viewshed, and thereby the rural character as it is noted as a vital element for each municipality. The 2008 *Innovative Land Use Planning Techniques Handbook* (available on the NH DES website) provides models for these ordinances. The planning boards are typically responsible for developing ordinances.
- Stormwater and Low Impact Development ordinances can also be implemented to ensure greater water quality protection from new and existing development. Associated design guidelines can also help protect the aesthetic village and rural characters of each town in the watershed. As mentioned above, the 2008 *Innovative Land Use Planning Techniques Handbook* provides models for these ordinances and the planning boards are typically responsible for developing ordinances. However, implementing the innovative planning techniques would be a good opportunity for planning boards and conservation commissions to work together toward conservation planning.

V. BNHT Watershed Co-Occurrence Maps

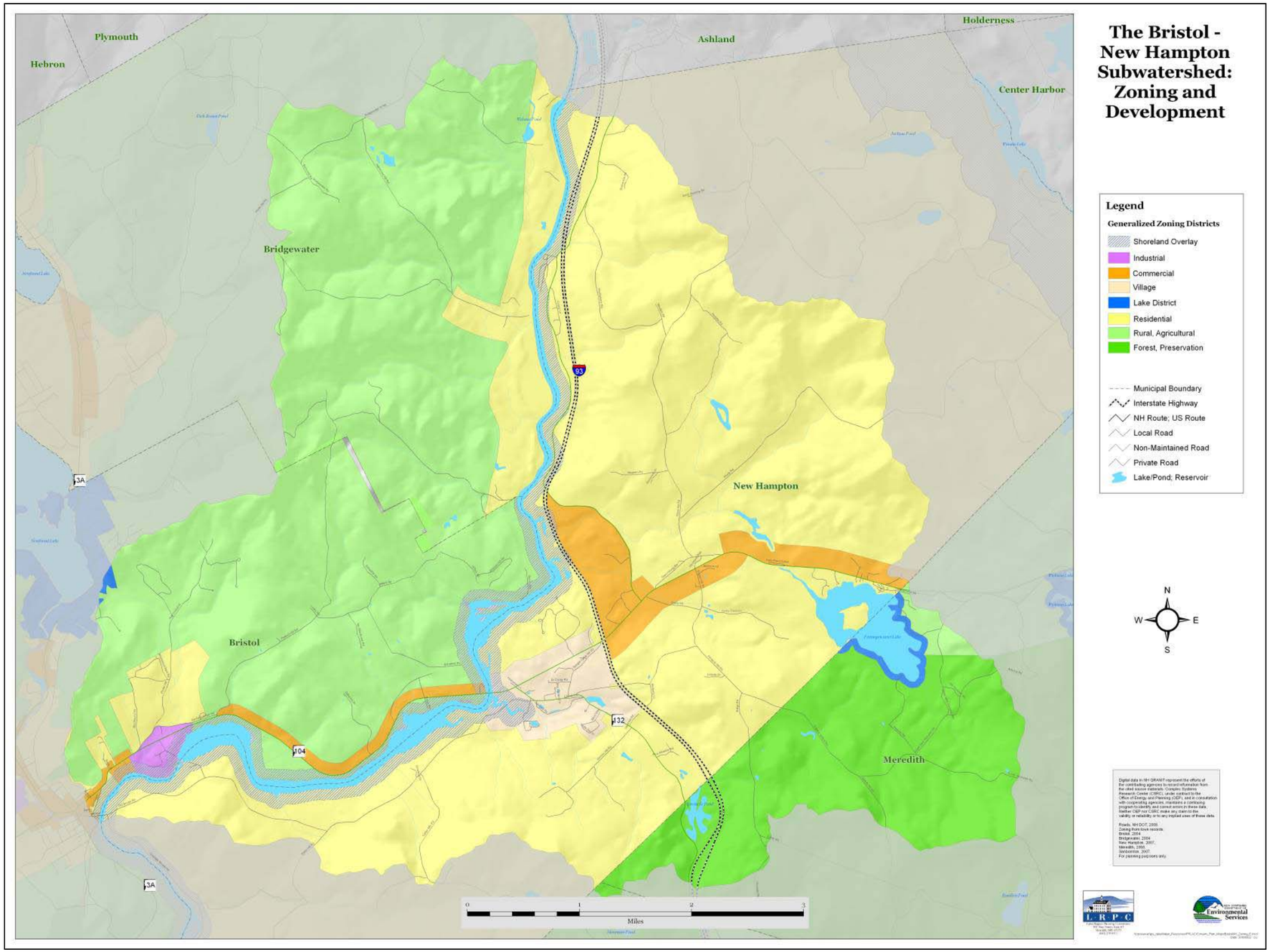
Map 1. The BNHT Watershed Topography and Water Resources



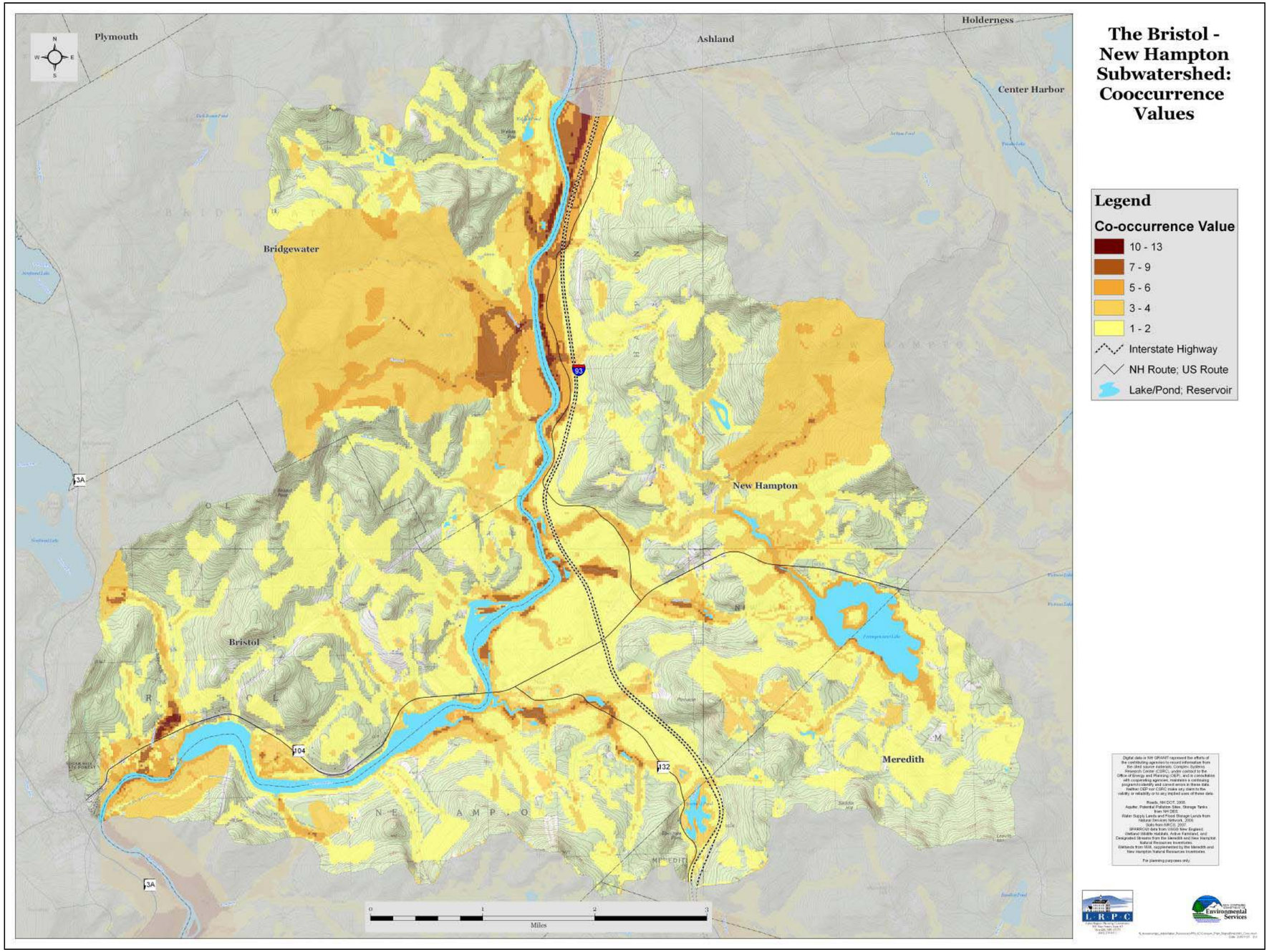
MAP 2. THE BNHT WATERSHED CONSERVATION LANDS



MAP 3. THE BNHT WATERSHED ZONING



MAP 4. THE BNHT WATERSHED RESOURCE CO-OCCURRENCE



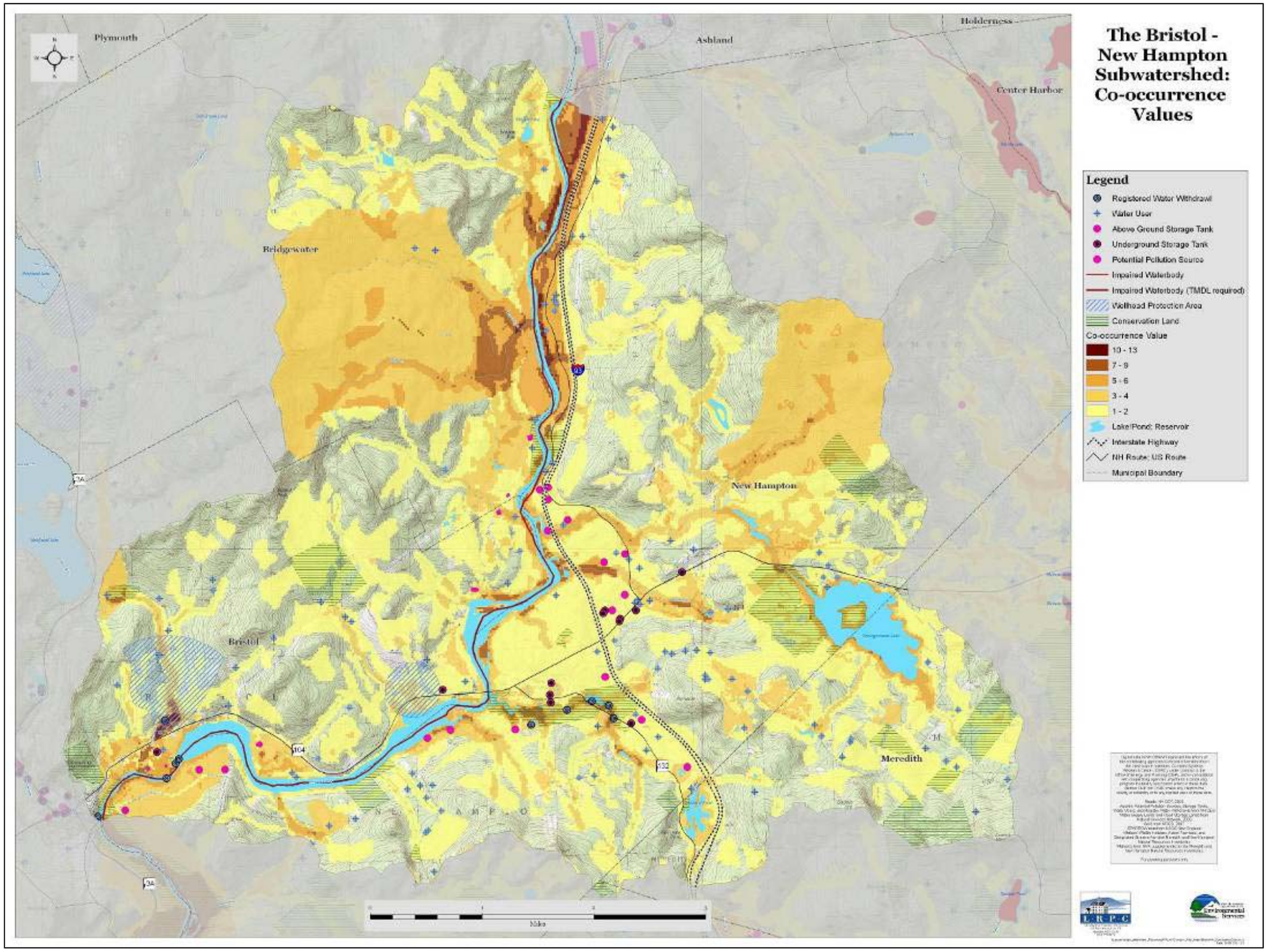
The Bristol - New Hampton Subwatershed: Cooccurrence Values

Legend

Co-occurrence Value

- 10 - 13
- 7 - 9
- 5 - 6
- 3 - 4
- 1 - 2
- Interstate Highway
- NH Route; US Route
- Lake/Pond; Reservoir

MAP 5. THE BNHT WATERSHED RESOURCE CO-OCCURRENCE & SUPPLEMENTARY DATA



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APPENDIX A: DATA DESCRIPTIONS

This report was developed to serve two functions: assist PRLAC in its education and outreach efforts and serve as a guide to municipalities as they consider land use and land protection policies. Therefore, much thought was given to the choice of data and any data customization that might occur. Utilizing data that has as much local detail as possible was desirable for both functions.

The data processing needed to be fairly straightforward. Some data customization did occur for this project to provide the best available analysis at this watershed scale. Further customization could be conducted by adjusting point values to give greater emphasis to certain features, dependent upon the desired goal. Care should be taken when conducting this type of customization to document the process, especially when making comparisons with other watersheds.

Below is an outline of the materials and processes used to develop the maps for the BNHT Watershed Conservation Plan:

I. Software
   A. ESRI ArcGIS 9.3– ArcMap
   B. ESRI Spatial Analyst Extension

II. Data Sets
   A. Base layers
      1. political boundaries (NH GRANIT)
      2. hydrology (NH GRANIT)
      3. watersheds (NH DES)
      4. roads (NH DOT)
      5. elevation – derived from Digital Elevation Models (NH GRANIT) using Spatial Analyst Extension
      6. hillshade – derived from Digital Elevation Models (NH GRANIT) using Spatial Analyst Extension.
   B. Habitat layers
      1. Highest ranked habitat - the condition of wildlife habitats was analyzed by ranking the biological, landscape, and human impact factors most affecting each habitat type, including rare plant and animal species, biodiversity, size of habitat and how close it is to other patches of that

habitat, density of roads around the habitat, dams, recreational use, and pollution. - NH Wildlife Action Plan (NH F&G)

2. Wetland Wildlife Habitat Areas – taken from the Meredith (2005) and New Hampton (2008) Natural Resource Inventories (NRIs), this includes a 200' buffer to streams, a 250' buffer along shorelines, and a 200' buffer on palustrine wetlands.

C. Hydrology layers

1. aquifer transmissivity – maximum transmissivity (daily groundwater output) of the aquifer (USGS at NH GRANIT)
2. flood storage lands – including 100-year floodplains as well as lacustrine, riverine, and palustrine wetlands (Natural Services Network)
3. water supply lands – high transmissivity aquifers and favorable gravel well sites (Natural Services Network)
4. Wetlands – palustrine wetlands from the National Wetlands Inventory, supplemented by identifications in the Meredith (2005) and New Hampton (2008) NRIs.
5. Wetland Buffer – 100' buffer around all identified wetlands (developed by LRPC based on the buffer applied in the Meredith and New Hampton NRIs)
6. Prime Wetlands – wetland areas designated by the town of Meredith (Meredith NRI, 2005).
7. Designated Streams – streams so designated in the Meredith NRI (2005).
8. 10' Stream Buffer – buffer of 10' applied to all streams based on the Meredith (2005) and New Hampton (2008) NRIs (buffering done by LRPC).
9. 200' Stream Buffer – buffer of 10' applied to all streams based on the Meredith (2005) and New Hampton (2008) NRIs (buffering done by LRPC).
10. 500' Floodplain Complex (NH Fish & Game).

D. SPARROW data - **SPA**tially **R**eferenced **R**egressions **O**n **W**atershed

1. Attributes relate in-stream water-quality measurements to spatially referenced characteristics of watersheds, including contaminant sources and factors influencing terrestrial and stream transport (USGS).

E. Farmland data

1. Farmland Soils – from NRCS soils for Belknap and Grafton Counties and classified as Prime Farmland, Farmland of statewide importance, and Farmland of local importance

2. Active Farmland – identified in the Meredith (2005) and New Hampton (2008) NRIs.

F. Supplemental layers

1. conservation lands – Land held in conservation by either a public or private entity (NH GRANIT)
2. wellhead protection areas – area of protection surrounding community wells, exact dimensions depend on the size of the well and shape of the landscape (NH DES)
3. Impaired water bodies – from hydrologic assessment units, whether waterbodies and stream segments are impaired by a chemical or organism and to what degree (NH DES).
4. Above Ground Storage Tanks – (2008) (NH DES)
5. Underground Storage Tanks – (2008) (NH DES)
6. Point/Non-Point Potential Pollution Sources – (1996) (NH DES)
7. Water Users – (2008) (NH DES)
8. Registered Water Withdrawals – (2008) (NH DES)

III. Analysis

A. SPARROW data

1. The criteria used for determining High Quality Stream Watersheds in this report mirrors that of the *Coastal Watersheds Plan (2006).* Three attributes were used to establish the four tiers, population density, percent developed land, and percent of agricultural land use (see Figure A-1). For a catchment to qualify for any of the tiers, it had to have less than 5% agricultural land use. Note – No tier 4 catchments were found within the BNHT HUC 12 watershed.

Figure A-1. SPARROW Data Qualifications for a Catchment

Tier	Population Density	% developed land cover	% of land use is Agricultural
Tier 1	< 20 persons/sq.mi.	< 1%	< 5%
Tier 2	< 36 persons/sq.mi.	< 2%	< 5%
Tier 3	< 64 persons/sq.mi.	< 3%	< 5%
Tier 4	< 90 persons/sq.mi.	< 5%	< 5%

B. Convert to Raster

1. To conduct co-occurrence mapping, all layers that were in shapefile/vector format needed to be converted to raster format. This was done using the ArcToolbox → Conversion Tools → To Raster →

Feature to Raster. The WAP data is already in raster format, therefore cell size (100 ft.) and raster extent were all registered to the waptiers raster during vector to raster conversion.

C. Reclassify

1. Each of these new rasters was then reclassified, assigning point values for the relevant attributes. This was done using Spatial Analyst Tools → Reclass → Reclassify. Again the waptiers raster was used as the reference for cell size and raster extent. In most situations, all values above "0" were assigned a value of "1"; "No data" was reclassified as "0".
2. The point values of 3, 2, 1, 0 (waptiers and Farmland Soils) and 4, 3, 2, 1, 0 (aquifer transmissivity) were assigned based on existing classifications.
3. Each of the three SPARROW data rasters was reclassified with a value appropriate to the Tier ranking. (It should be noted that Tier 1 in the SPARROW data represents the highest quality catchment (example; Tier 1 = 4, NoData; Tier 3 = 2, NoData).

D. Weighted Sum/Final Score

1. The values in each cell of the reclassified rasters were then added together using Spatial Analyst Tools → Overlay → Weighted Sum. Each raster had a weight of "1", thus all features have equal weight.