Appendix XIV

Natural Resources Inventory Summary

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Natural Resources Inventory Summary

Introduction

This natural resources inventory summary follows the guidelines established in **Natural Resource Inventories; A Guide for New Hampshire Communities and Conservation Groups**[1] and is condensed by Tina Cotton from a more detailed version written by her for the Andover Conservation Commission and further condensed for Chapter VII of the Master Plan. This appendix, as of October, 2011, provides:

- A general background of educational information explaining the terms and importance of subjects covered,
- References for town boards and landowners for further information, both paper and online,
- General natural resources with supporting maps, tables, lists, and photographs, and
- Potential priorities, focus areas, constraints, and recommendations to consider.

Please note that many sections of this appendix have overlapping information for the user who refers only to a specific section.

Andover is a rural community with a 2009 population estimated at 2,010. The town (26,271.5 total acreage) contains 40.09 square miles of land area (25,657.5 acres) and 0.96 square miles (614 acres) of inland surface water area in Merrimack County, central New Hampshire.[2] Andover is bordered by Franklin, Salisbury, Warner, Wilmot, Danbury, and Hill.

The growth of Andover can be documented by viewing older maps of the town. One of the earliest maps appeared in the **Town and City Atlas of the State of New Hampshire**, compiled from government surveys, county records, and personal investigations, by D.H. Hurd & Co., in Boston, 1892. Of note is that Andover was small enough that individual houses and the name of each owner were shown. The road network and village centers are still recognizable and many of the residents have descendents still residing here.

The U.S. Geological Survey published two earlier editions of topographic maps based on latitude and longitude in the 15-minute quadrangle series in 1927 and 1956. Andover falls within the Mount Kearsarge, Penacook, and Holderness topographic quadrangles. The most recent topographic map is in the 7.5-minute series based on aerial photography of the early 1980s as shown in figure 1. Andover's rectangular shape is roughly transected by Routes 11 and 4, following the valleys of Sucker Brook and the Blackwater River. The highest topographic feature is Ragged Mountain, which peaks at 2,267 feet, followed closely by the northwestern flank of Mount Kearsarge at 2,260 feet in Andover. The lowest elevation is about 470 feet where Sucker Brook flows into Franklin, followed by the The Bays of the Blackwater River entering Salisbury at 598 feet.

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[1]Auger, P., McIntyre. J., 2001, revised by A.J. Lindley Stone, 2007, **Natural Resource Inventories; A Guide for New Hampshire Communities and Conservation Groups,** UNH Cooperative Extension, Durham, 132 p., http://extension.unh.edu/resources/files/Resource000215_Rep233.pdf.

[2] **GRANIT**, 2007.

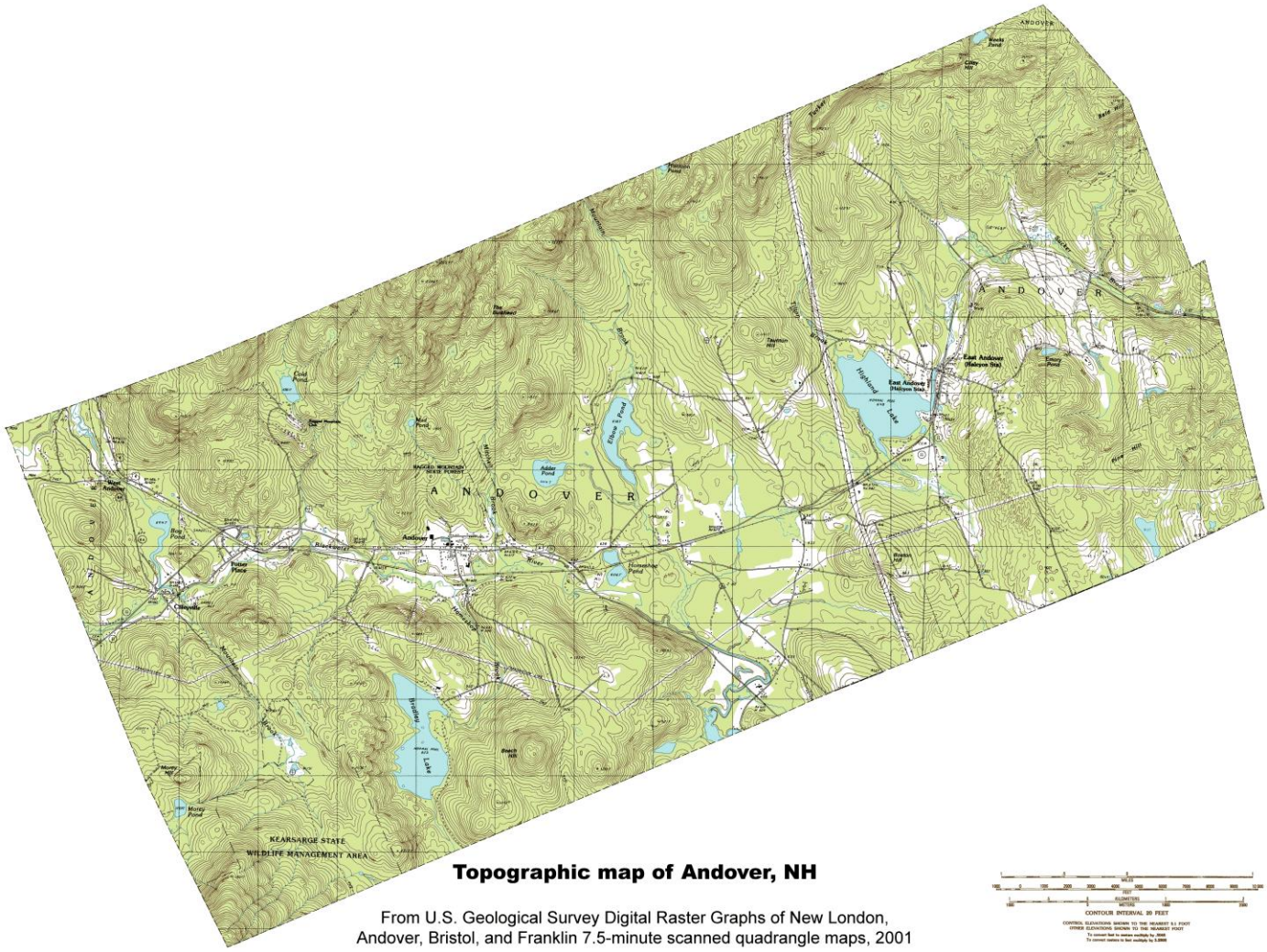


Figure 1. Topographic map of Andover based on aerial photography of the early 1980s.

Many maps shown in this appendix came from digital files that can be accessed over the internet. **Greater detail** of digital files and identification and labeling of map units are **possible by zooming in** on areas of interest. Map units are supported by tables of data. Maps accessed over the internet are updated as newer information becomes available.

Shaded relief provides another way of viewing Andover's topography (figure 2).

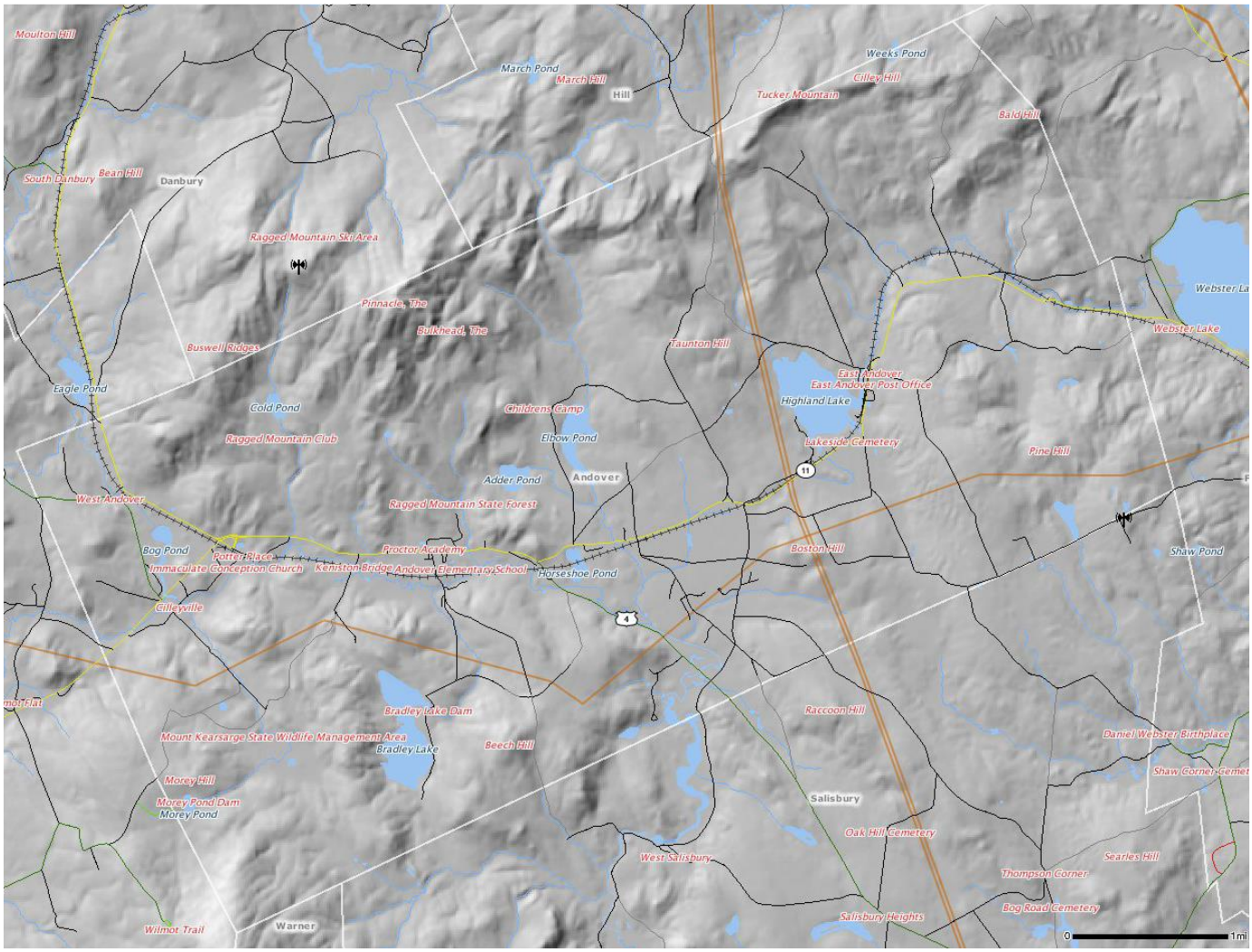


Figure 2. Shaded relief map of Andover from NH GRANIT (Geographically Referenced Analysis and Information Transfer) Data Mapper.[3]

Maps of Andover portray a rural character of mountains, rivers, streams, forests, and fields. Andover's natural resources contribute toward our quality of life, public health and and sense of well being, economic structure, culture, and an excellent habitat for a diversity of native plants and wildlife.

The topographic map emphasizes the green forested areas and road network. The shaded relief map reveals Andover's rugged terrain, particularly the flanks of Ragged Mountain and the remaining northern strip of the town. The road network, established relatively early in Andover's history, has remained the focus of development. Few new roads have been added, most notably in the Ragged Mountain Fish and Game development in the early 1900s, the Fenvale development in the 1990s, and shorter road segments in the Plains area from the 1970s to 1990s.

The comparison of older maps and data with updated ones can document how Andover is changing and provide enough lead time to anticipate and plan for future trends. The Andover Conservation Commission has the important role of ensuring that the Master

[3] http://mapper.granit.unh.edu/viewer.jsp.

Plan includes provisions and guidelines for conserving and protecting land, water, and other resources in both a town-wide aspect and a regional context. To retain the rural character, Andover's natural, historic, scenic, and agricultural resources need to be protected and sustainably used. Although conservation planning can have a positive influence on the future usage of important resource areas, it will never be capable of comprehensive protection by itself. Conservation planning can have a positive influence on the future use of important resources and can help achieve a compromise to balance sustainability of resources with development. The goal is to ensure the future ecological and sustainable health of Andover, as well as its rural character.

The natural resources inventory (NRI) prepared for the Conservation Commission by Tina Cotton is a description and catalogue of the land, water, wildlife, forest, natural communities, agricultural, and soil resources, as well as lands that have been permanently conserved for the benefit of future generations. Natural resources are not always blatantly evident. Clean water, fresh air, scenic views, and dark night-time skies revealing stars, planets, and the aurora borealis are some less obvious but important natural resources. Our natural resources, many of which have been relatively unchanged by development, are a significant component of Andover's rural character. Over time, some resources have been used (sand and gravel), endangered or damaged (water quality), or improved (forest quality).

Two informal surveys concerning conservation issues were initiated by the Conservation Commission: one distributed in **The Andover Beacon** and the other in an informal poll on town meeting day. The results of both are reproduced below as they were published in **The Andover Beacon**.[4]

[4] **The Andover Beacon**, February 2005, p. 5, http://www.andoverbeacon.com/0502/p05.pdf and May 2006, p. 12, http://www.andoverbeacon.com/0605/p12.pdf.

Andover Conservation Survey 2004

The Conservation Commission thanks **you** for the enthusiastic response to the green Conservation Survey insert in the December issue of *The Andover Beacon*! Almost 150 surveys were returned, presumably one per household. To put this in perspective, Andover has 1,457 registered voters and about 1,000 households, of which about 10 percent are seasonal.

The Conservation Commission had several reasons for distributing the survey.

- The Conservation Commission wanted to hear directly from **you**, the Andover residents, about what directions the Conservation Commission should pursue. Our board, like others in town— planning, zoning, budget, selectmen, and master plan—is small but making important decisions that affect the town.
- The revised Master Plan will have a conservation component with input from the Conservation Commission and will contain recommendations for conservation programs to protect our town's undeveloped open lands.
- The town boards need to know how the townspeople feel about acquiring or preserving undeveloped land and how to accommodate funding requests.
- In acquiring conservation easements or additional town land, the Conservation Commission needs to know how townspeople would like to use the land and what restrictions they might favor.

You may reach your own conclusions from the results of the survey graphed here, but several seem to stand out.

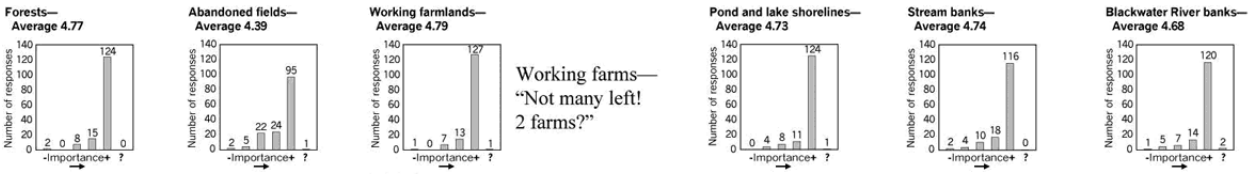
- Andover residents value undeveloped land, or open space, as an important part of our town's rural character and worthy of protection from development.
- You favor a combined approach for protection through voluntary conservation, master planning, zoning regulations, and town forests.
- If land cannot be acquired through voluntary donations or easements, you prefer to pay for land through private donations and grants.
- You favor non-motorized recreational vehicular usage on conserved lands.

Hopefully, you will find the results interesting and will enjoy comparing your views with those of your neighbors.

Each graph should be read as **not** (-) to **very** (+) from left to right; **?** is **uncertain**. Not all questions were answered The original survey ranked categories from 1 (not important or not acceptable) to 5 (very important or very acceptable); average ranking here does **not** include the uncertain category. Quotes are from you; all are included.

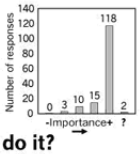
1. Andover's undeveloped, open lands: How important are they?

"Define OPEN."



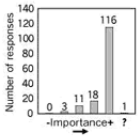
Working farms— "Not many left! 2 farms?"

2. Rural character: how important are undeveloped, open lands?



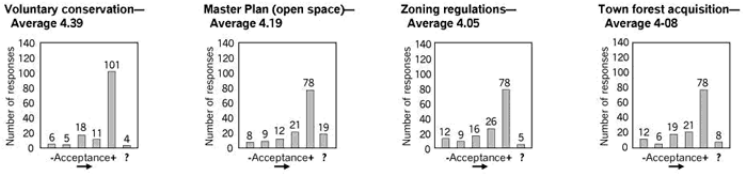
Rural character— "Bias inherent in how question is phrased."

3. Protecting our undeveloped, open lands: how important is it?



4. Protecting our undeveloped, open lands: How should we do it?

"Voluntary conservation is not enough. Money speaks louder than anything else."



"Thank you for taking the interest and making the time to do this.

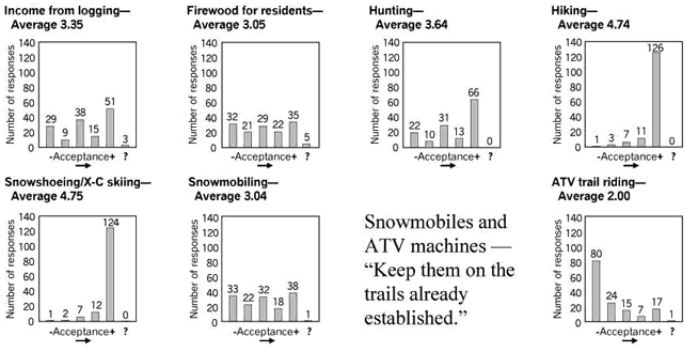
5. Town forests: How should we use them?

Income from logging— "This would be acceptable if part of the forest would support the acquisition of the other or its maintenance."

"Management requires occasional logging!"

"Stop dreaming about town forest, you're going overboard, get a good night's sleep and you won't dream so much."

"No to rail trail. Trash, animals loose on private land, noise, destruction of private property, crimes."



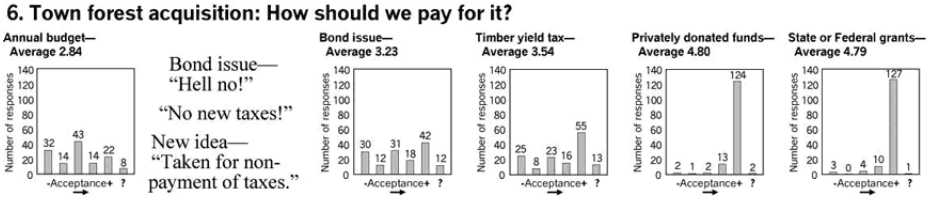
Snowmobiles and ATV machines — "Keep them on the trails already established."

"Questions are skewed towards a gov't is the best answer format!"

"Boston ☹, New Hampshire ☺"

"Do some informational sessions so people understand what it means to donate an easement. Most don't know the tax benefit and how flexible easements can be."

6. Town forest acquisition: How should we pay for it?



Bond issue— "Hell no!"

"No new taxes!"

New idea— "Taken for non-payment of taxes."

The Master Plan Committee intends to circulate a survey later in the year that will be far more extensive. Please support them in this endeavor, come to the open meetings of the various boards with your opinions, and even volunteer to serve as a member.

"As a former New Jersey resident, I saw how, over 30 years, forests and farms were destroyed and/or sold for development, causing higher taxes, crowded schools, higher traffic, and pollution. Don't let this happen here."

"I am very concerned about the rate of growth in Andover and question if it is following our current Master Plan. For Andover to be desirable, livable and wealthy for generations to come, we must protect our natural open lands."

"I am grateful you are thinking ahead to Andover's future. I would like Andover to keep it's rural nature. I hear talk of 'if only we had the tax base of...', but all these places like Concord pay higher taxes and the quality of its natural setting is diminished. I would like to have Andover take advantage of Mother Nature's beauty and wisdon NOW and for future generations. I would like this minedness to attract the like minded in the future for I believe this will make for a truly wholesome life and lifestyle".

Special Places

"Town meeting day some of you shared your special places with post-its on a town map. Town committees could make a list of places, but they wanted to have input from more townspeople. These may receive special consideration in master plan considerations. Here are some of your favorite things, generally from east to west, the asterisks denoting other people in agreement.

Hersey farmland******
Shaw farm****
Artist's Bluff (early postcards of Highland Lake were painted from here)*
Maple Street
Chase Hill Rd., old town pound, site of first homestead, old cemeteries**
James Keniston birthplace*
Highland Lake*********
Highland Lake Grange Hall, church, school complex***
Highland Lake views from the Graves/Bernhard farms*******
End of class VI road by the power line at top of Old College Rd. going to Hill, view of Mt.Washington
Views from College Rd. clear cut within the Newman easement
Mountain Brook waterfalls, the Cascades**********
Elbow Pond****
Hopkins Pond***
Ragged Mountain, balanced rock, west peak of Ragged********
The Bulkhead from Old College Rd. and Elbow Pond junction ******
The Bays*
The Rookery**
Top of Beech Hill (ridgeline) as seen from Rtes. 4 & 11
Proctor Academy land
Yavanovich Nature Trail (around AEMS wetland)**
Cornfields along the Blackwater River*
Covered bridges
Blackwater Ski area
Council Rock, historic and views****
Bradley Lake, town water supply and views*****
Kearsarge Mountain foothills and approach*
The Meadows**
Potter Place Railroad Station**
Leadmine (actually in Salisbury, but accessed past the Meadows or from Salisbury)
Old sawmill foundation on Kearsarge Mountain Rd.*
Finny (fishing) Hole*
Bog Pond, especially before the dam was removed*
Sunapee-Ragged-Kearsarge Trail
Mill foundation and bridge abutments on Mountain Brook
My home, several times!

These entries should be taken with a grain of salt. As time went on, people thought of additional categories of special things and added 'stars' to previously mentioned things. And a 'star' to you if you know all of them!"

The Conservation Commission established priorities based upon these surveys and the Natural Resource Inventory (NRI). These priorities, namely drinking water resources;

ecologically important areas, including wildlife habitats and unfragmented land; agricultural land, including soils of statewide importance; forest resources; and scenic resources, are closely aligned with those of the Society for the Protection of NH Forests (SPNHF) and the Ausbon Sargent Land Preservation Trust (ASLPT). These priorities should be considered in Andover's planning and zoning regulations for local land use controls—the regulatory component as guided by the Master Plan. "…**Most land use decisions are irreversible in the long run and therefore a great deal of consideration must precede the actual decision. All parties affected must accept their responsibility for their role in this process for it is their future and the future of their children which are being decided upon.**"[5]

Residents stated that they value Andover's open spaces (forests and fields) and the undeveloped landscape. Residents do not want to increase property taxes to preserve our existing framework of small village centers surrounded by a rural landscape that supports scenic views and ample recreational opportunities. The NRI can provide an impartial, scientific base for planning. Ultimately, Andover should try to keep its natural resources and habitats intact for the benefit of various living species, including humans. One of the goals of Proctor Academy stated in 2008 is to live sustainably, which is defined as meeting the present generation's needs without compromising the ability to meet the needs of future generations. This broad goal should serve as a unifying principle for natural resources management and protection. Sustainability depends on four basic parameters: sustainability must be financially profitable, improve the environment, produce more energy than consumed, and leave society better off.

Four important initiatives of regional significance have been completed by multiple public and private agencies using maps and data stored in GRANIT. These initiatives are noted in the NRI because they encompass Andover. They include the Quabbin to Cardigan Collaborative completed in 2004,[6] The Wildlife Action Plan (WAP) unveiled by the NH Fish and Game Department in 2006 and updated in 2007 and 2010,[7] the New Hampshire Forest Land Base Study completed by the Society for the Protection of New Hampshire Forests in 2000, and the Colby-Sawyer College environmental studies community-based project study prepared for ASLPT completed in 2005, updated in 2010.[8] Surely what natural resources are considered important for preservation by outside groups should be considered important by residents of Andover. **Recommendations for preservation are made throughout this appendix.**

Natural Resources Inventory

The natural resources inventory was prepared following guidelines provided in Auger, P., McIntyre. J., 2001, revised by A.J. Lindley Stone, 2007, **Natural Resource Inventories; A Guide for New Hampshire Communities and Conservation Groups,** UNH Cooperative Extension, Durham, 132 p.,

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[5] Lougee, Jeremy, 2009, **Sustaining Agriculture in the Granite State: A Citizen's Guide to Restoring Our Local Foods, Farms and Independence**, NH Coalition for Sustaining Agriculture, 59 p., http://www.newhampshirefarms.net/Sustaining_Agriculture_in_the_Granite_State.pdf.

[6] http://www.spnhf.org/landconservation/q2c.asp.

[7] NH Fish & Game Department. 2005, revised 2007 and 2010, **Wildlife Action Plan**. Concord, http://www.wildlife.state.nh.us/Wildlife/wildlife_plan.htm.

[8] http://www.colby-sawyer.edu/environmental/projects/project-2005.html.

http://extension.unh.edu/resources/files/Resource000215_Rep233.pdf. Recent inventories from Fremont, prepared by volunteers, and from Washington, prepared by a consultant, were cited as examples that were well done and were used as models. Other selected references for town officials and landowners, in addition to those cited, include:

Bennett, Karen P., editor, 2010, **Good Forestry in the Granite State: Recommended Voluntary Forest Management Practices for New Hampshire,** second edition, UNH Cooperative Extension, Durham, 225 p., http://extension.unh.edu/goodforestry/index.htm.

Chase, V., Deming, L., and Latawiec, F., 1995, revised 1997, **Buffers for Wetlands and Surface Waters—A Guidebook for New Hampshire Municipalities**, Audubon Society of NH, NH Office of State Planning, and Natural Resources Conservation Service, 82 p., http://www.nh.gov/oep/resourcelibrary/referencelibrary/b/buffers/documents/handbook.pdf.

Clyde, M.E., Covell, D., and Tarr, M., 2004, **A Landowner's Guide to Inventorying and Monitoring Wildlife in New Hampshire,** UNH Cooperative Extension, Durham, 86 p., http://extension.unh.edu/resources/files/Resource000418_Rep440.pdf.

Kanter, J., Suomala, R., and Snyder, E., 2001, **Identifying and Protecting New Hampshire's Significant Wildlife Habitat,** Non-Game and Endangered Wildlife Program of the NH Fish & Game Department, Concord, 143 p.

Lakes Region Planning Commission, 2005, **Regulating Development on Steep Slopes, Hillsides, and Ridgelines**, www.lakesrpc.org.

Lougee, Jeremy, 2009, **Sustaining Agriculture in the Granite State: A Citizen's Guide to Restoring Our Local Foods, Farms and Independence**, NH Coalition for Sustaining Agriculture, 59 p., http://www.newhampshirefarms.net/Sustaining_Agriculture_in_the_Granite_State.pdf.

NH Department of Environmental Services, 2004, **Best Management Practices to Control Nonpoint Source Pollution: A Guide for Citizens and Town Officials**, 72 p., http://des.nh.gov/organization/commissioner/pip/publications/wd/documents/wd-03-42.pdf.

NH Department of Environmental Services, 2002 revised 2010, **Innovative Land Use Planning Techniques: A Handbook for Sustainable Development**, http://des.nh.gov/organization/divisions/water/wmb/repp/innovative_land_use.htm.

NH Department of Environmental Services, 2002 revised 2009, **Innovative Stormwater Treatment Technologies Best Management Practices Manual**, http://des.nh.gov/organization/divisions/water/stormwater/manual.htm.

NH Department of Environmental Services, 2008, **New Hampshire Water Resources Primer,** Pillsbury, Sarah, Currier, Paul, Susca, Paul, eds., http://des.nh.gov/organization/divisions/water/dwgb/wrpp/primer.htm.

NH Department of Environmental Services and New Hampshire Fish and Game Department, 2004, **Habitat-Sensitive Site Design and Development Practices to**

Minimize the Impact of Development on Wildlife, 6 p., http://des.nh.gov/organization/commissioner/pip/factsheets/co/documents/id-4.pdf.

NH Department of Environmental Services and NH Office of Energy and Planning, 1999 revised 2006, **Model Groundwater Protection Ordinance**, WD-06-41, 109 p., http://des.nh.gov/organization/commissioner/pip/publications/wd/documents/wd-06-41.pdf.

NH Fish & Game Department, 2008-2011, **Wildlife Action Plan Habitat Stewardship Series: Appalachian Oak-Pine Forests, Floodplain Forests, Grasslands, Headwater Streams, Hemlock-Hardwood-Pine Forests, Lowland Spruce-Fir Forests, Marsh and Shrub Wetlands, New England Cottontail Rabbits in NH, Northern Hardwood-Conifer Forests, Peatlands, Shorelines, Shrublands, Vernal Pools,** Concord, NH, each 6 pages, http;//extension.unh.edu/FWT/HabBrochures.htm.

NH Fish & Game Department, 2004, **Identification and Documentation of Vernal Pools in New Hampshire**, Michael Marchand, ed., 2nd edition, 76 p., http://www.wildnh.com/Wildlife/Nongame/RAARP/Vernal_pool_manual.pdf.

Randolph, J., 2004, **Environmental Land Use Planning and Management**, Island Press.

Stone, Amanda L., and Mitchell, Frank, 2011, **Method for Inventorying and Evaluating Freshwater Wetlands in New Hampshire (NH Method),** University of New Hampshire Cooperative Extension, Durham, 150 p., http://extension.unh.edu/resources/files/Resource001874_Rep2706.pdf.

Thematic data from many sources have been compiled in maps and tables by GRANIT (Geographically Referenced Analysis and Information Transfer) from the Complex Systems Research Center at UNH in Durham using a common scale and format. The result of their efforts for Andover can be viewed using the NH GIS Data & Metadata website http://www.granit.unh.edu/data/data101/distributionpolicy.html and the NH GRANIT Data Mapper website http://mapper.granit.unh.edu/viewer.jsp. Easy to follow instructions for using Data Mapper are online at http://extension.unh.edu/GISGPS/Docs/DMExercise_March2008.pdf. The NH Wildlife Action Plan (WAP), 2007, also has many themed maps for Andover and a series of 12 habitat pamphlets have been published with more to be released.[9] **It is important to remember that these analyses are not necessarily accurate or up to date for site-specific information. For site-specific use, additional mapping should be undertaken to refine these maps and the supporting database for each. Any natural resources document should be regularly updated as new information becomes available and conditions change.**

[9] NH Fish & Game Department, 2008-2011, **Wildlife Action Plan Habitat Stewardship Series: Appalachian Oak-Pine Forests, Floodplain Forests, Grasslands, Headwater Streams, Hemlock-Hardwood-Pine Forests, Lowland Spruce-Fir Forests, Marsh and Shrub Wetlands, New England Cottontail Rabbits in NH, Northern Hardwood-Conifer Forests, Peatlands, Shorelines, Shrublands, Vernal Pools,** Concord, NH, each 6 pages, http;//extension.unh.edu/FWT/HabBrochures.htm.

The importance of natural resources is stated in **RSA 674:2 III-d Master Plan—purpose and description**…

"(d) A natural resources section which identifies and inventories any critical or sensitive areas or resources, not only those in the local community, but also those shared with abutting communities. This section provides a factual basis for any land development regulations that may be enacted to protect natural areas. A key component in preparing this section is to identify any conflicts between other elements of the master plan and natural resources, as well as conflicts with plans of abutting communities. The natural resources section of the master plan should include a local water resources management and protection plan as specified in **RSA 4-C:22**.

(e) A natural hazards section which documents the physical characteristics, severity, frequency, and extent of any potential natural hazards to the community. It should identify those elements of the built environment at risk from natural hazards as well as extent of current and future vulnerability that may result from current zoning and development policies."

Land Use and Land Cover

The topographic map (figure 1) shows the current land use areas in terms of building and transportation corridors, forest cover, surface water resources, and wetlands. Andover encompasses a total of 26,271.5 acres, or 41.049 square miles. The land cover is predominantly a mixed forest of hemlock, hardwood, and pine. Details appear in the supporting table 1 and figure 3, one of many themed maps generated for the NH Wildlife Action Plan (WAP).[10] Descriptions of each mapped unit are at http://www.wildlife.state.nh.us/Wildlife/Wildlife_Plan/habitat_types.htm.

Habitat	Acres	Protected and conserved acres	Protected and conserved percentage
Hemlock, hardwood, pine	20,602.2	5,075.3	22.5
Hardwood, conifer	679.8	432.8	63.7
Lowland spruce, fir	993.3	367.9	37.0
Grassland	1,816.3	275.2	15.2
Forest floodplain	1,003.4	69.1	6.9
Wet meadow, shrub wetland	629.3	125.4	19.9
Peatland	121.6	30.4	25.0

Table 1. Wildlife habitat land cover shown in figure 3.

[10] NH Fish & Game Department, 2005, revised 2007 and 2010, **Wildlife Action Plan**. Concord, www.wildlife.state.nh.us.

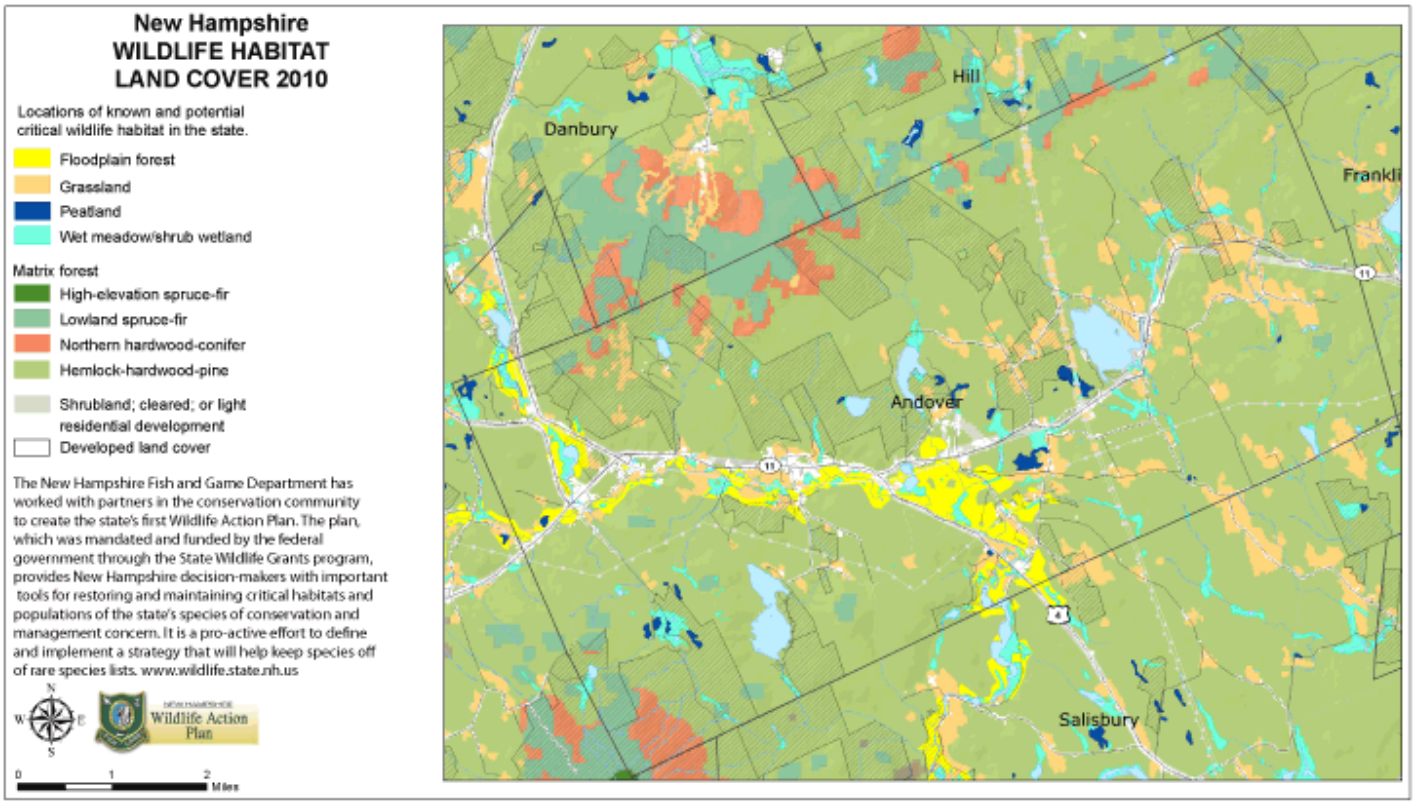

Figure 3. Wildlife habitat land cover in Andover, March 2010.[11] Increase the detail of specific areas in this figure by using the online digital file.

Table 2 lists additional land cover categories determined by Colby Sawyer students from satellite photography and 2001 GRANIT data.

Land Cover	Acres	Percent
Mixed forest	3,579	13.62
Cleared/other	618	0.02
Beech/oak	3,828	14.57
White/red pine	997	3.79
Water	614	2.34
Other hardwood	1,022	3.89
Transportation	2,827	10.76
Open water	3,514	13.38
Forested wetland	588	2.24
Non-forested wetland	239	0.90
Hay/pasture	6,445	24.53
Disturbed	210	0.80
Hemlock	8,611	32.78
Orchards	133	0.51
Row crops	233	0.89
Developed/residential	925	3.52

[11] NH Fish & Game Department, 2005, revised March 2010, **Wildlife Action Plan**, Concord, http://maps.wildlife.state.nh.us/website/maps/WAPmaps/Andover/andover11x17habitat.pdf.

Paper birch/aspen	1,553	5.91
Spruce/fir	3,014	11.47
Total	**26,271.5**	**100.00**

Table 2. Land cover in Andover determined by Colby Sawyer students, 2001.[12]

An excellent discussion of New Hampshire's changing landscape was published in 1992 that is still relevant in 2009.[13] Native Americans had minimal impact upon the land. They used whatever they took from local forests, fields, and water. The Europeans changed the scenario in that they exported goods from the land for trade and profit—timber for masts, pelts, food—and they formed permanent settlements. These settlements generally had a central core that was more densely settled for protection and farms with large land parcels located farther away. This model is retained in our vision of the typical New England village in a rural setting. Water power helped fuel the Industrial Revolution and railroads and rivers helped move the products. Larger settlements grew along the rail lines. Most of the forested land was clear cut as seen in these turn of the century views of Andover from Beech Hill (figure 4) and another from West Andover (figure 5) around 1870.

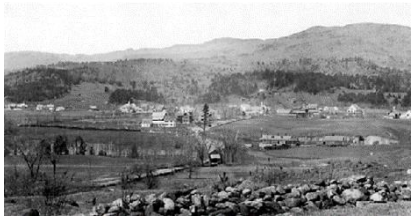

Figure 4. Beech Hill ~1870.

Figure 5. West Andover from ~1870.

Soil was eroded and fires flourished on the logging debris. This scenario caused alarm and resulted in the start of the conservation movement and the establishment of the Society for the Protection of NH Forests (SPNHF), the Appalachian Mountain Club, and the White Mountain National Forest. The automobile brought a radical change. Families could travel farther and faster, especially along paved roads. Towns flourished along major roads.

Tourism boomed from the 1950s when the state actively promoted agricultural, industrial, and recreational opportunities. Second homes and permanent homes doubled the size of many communities. Conservation commissions, planning boards, zoning boards, land trusts, and regulations were established to help maintain the appearance of the towns and manage growth, which affected municipal and school budgets. However, minimum lot size and frontage requirements have done little to preserve the rural character of most towns. Instead, such regulations have tended to expand suburban sprawl. Formerly compact town centers spread due to minimum lot sizes of one, two, and three acres. Affordable housing on small lots meant small houses and modular units. Much larger lots supported much larger, expansive, wealthy homes. Lack of community infrastructure has required larger lots to accommodate individual septic systems and wells. Developers have been frustrated with regulations, especially since many regulations prohibit a well-planned, resource protected, cluster-type of development. Jeffrey Taylor, former State Planner, points out that although master plans are well intentioned, most zoning and regulatory systems have little semblance to their stated goals of preserving rural character.

[12] http://www.colby-sawyer.edu/environmental/projects/project-2005.html.

[13] NH Historical Society and the Society for the Protection of NH Forests, 1992, **At What Cost? Shaping the Land We Call New Hampshire**, Richard Ober, editor, 97 p.

The Andover tax map (figure 6), showing individual parcels and placement, illustrates this historical development of land use. Most of the smaller lots have houses, whereas the larger parcels have large tracts of open space that may or may not have buildings. Because of the road frontage requirement and the expense of creating town approved roads in subdivisions, long, narrow lots, so called 'bacon-strip' lots, have been created; the most extreme of these lots is in the southeastern corner of Andover. As a result, buildings tend to be close to the road and the back portions are not used. Note the remnants of the original lot and range layout.

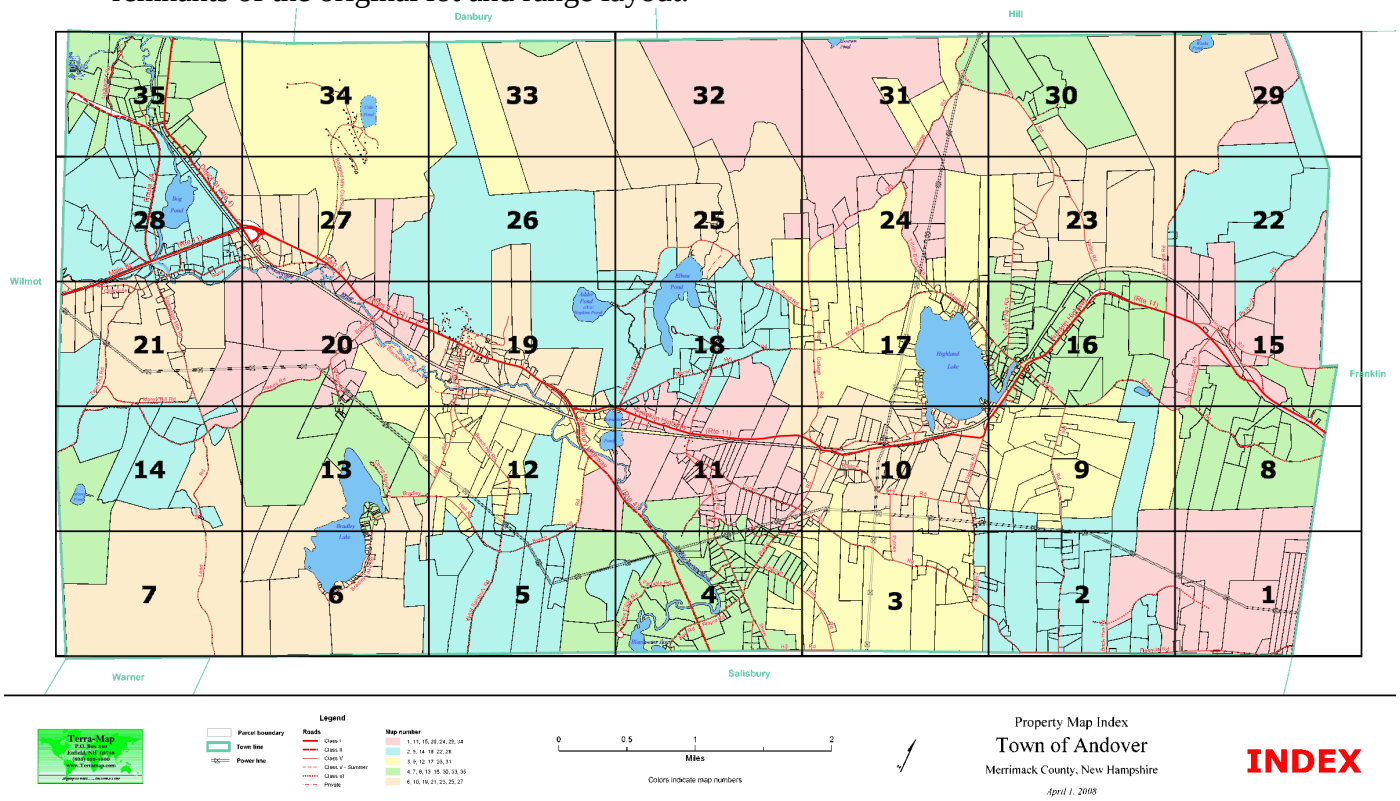

Figure 6. Andover tax map, 2008.

Current use legislation (RSA 79-A) has helped landowners keep larger parcels by not having to pay property taxes on what the land would be worth if it were developed. According to Charles Souther, "The average lot size in current use is just 27 acres. It's a lot of mom-and-pop operations. They own a piece of New Hampshire and they want to keep it." Revenue Commissioner Phil Blatsos said, "The highest use for open space is often subdivision, but nobody can afford to own it at a subdivision rate." A current use parcel must be in excess of 10 acres, unless a gross income in excess of $2,500 is generated from an agricultural related business. Several different categories of current use determine the amount of taxation: whether the land is in forest or agricultural use and whether the public can access the property for recreational purposes of hunting, hiking, nature observation, snowshoeing, and skiing. Figure 7 is a draft map of current use property in 2002. This map is more legible when zooming in. If land is removed from current use in Andover, a penalty tax is assessed, half of which goes into a conservation fund. As of September 2011, 66 percent (17,429.9 acres) of Andover was in current use.

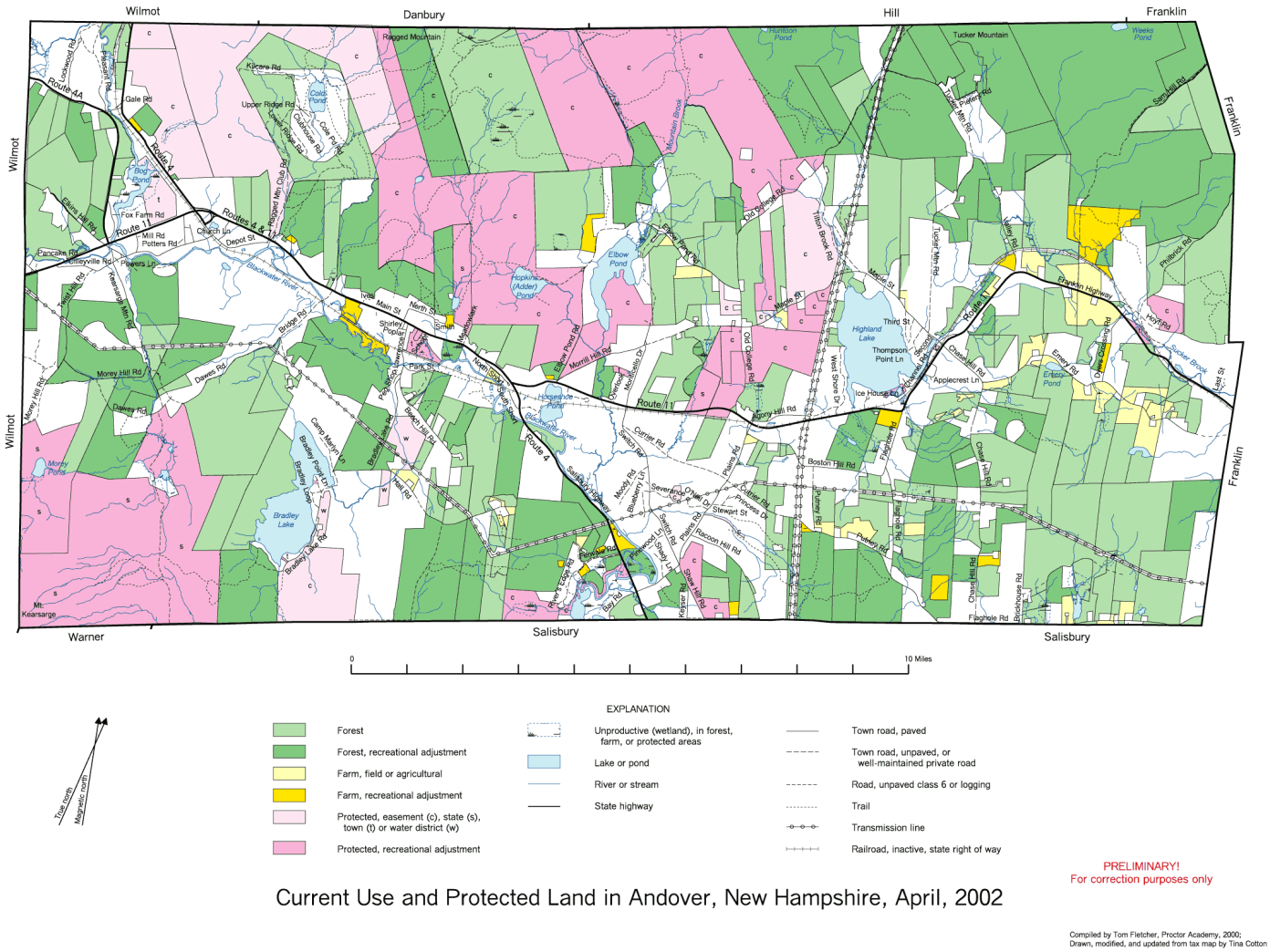

Figure 7. Draft map of current use and protected land, 2002.

Open Space and Protected Land

Henry David Thoreau stated, "In wilderness is the preservation of the world." We preserve wilderness because it is precious. According to the Society for the Protection of NH Forests in of 2008, "New Hampshire has been the fastest-growing state in New England—and in the entire nine-state Northeast region —for four straight decades." In addition, "New Hampshire has lost forest and cropland to development at a rate of more than 20,000 acres per year in the past five years... Each of us is but a temporary caretaker of our woodlots, and part of our legacy should be to leave them better than we found them," said Forest Society President/Forester Jane Difley at the annual meeting September 20, 2008. Furthermore, 25 percent of all economic activity in New Hampshire is dependent on undeveloped land.

Open land costs the average town half the taxes actually paid on it[14] in municipal and school budget expenditures. Statistics for the cost per dollar of taxes paid to 17 towns in central and southern New Hampshire, including Sutton but ranging from Peterborough to

[14] Dornin, Chris, 2008, **The Ongoing Case for Current Use**, Forest Notes, Summer 2008, Society for the Preservation of NH Forests, p. 10-15, http://www.spnhf.org/pdf/fn20082.pdf.

Dover to Groton, were averaged by Tina Cotton in table 3. Much of this undeveloped land is in current use (RSA 79-A); generally, a minimum of 10 acres is needed for consideration.

	Year	Population	Open land	Housing	Commercial/ industrial	Open land
Range	1993-2005	339-25,500	35-78%	$0.92-1.23	$0.04-0.94	$0.21-0.94
Average	1999	5,899	55%	$1.10	$0.38	$0.51

Table 3. Average cost of land use per tax dollar from 17 towns in central and southern New Hampshire.

As of September 2011, 17,429.9 acres, or 66 percent, of the total acreage in Andover was in current use. If land is removed from current use, a penalty tax is assessed, half of which in Andover goes into a conservation fund. Conservation easement land is land that is restricted from development in perpetuity by deed. Land in conservation easement is taxed at current use rates, which vary according to forest versus field and whether recreational use by the public is allowed (figure 7).

Conservation easement land may be owned publicly or privately. Conservation easements generally have no buildings or complex man-made structures in current service. The land may remain in its natural state to serve important environmental and/or aesthetic functions or it may be used for agriculture, forestry, and outdoor recreation with or without buildings or structures used for purposes stated in the easement deed. Conserved land ensures the continued functioning of the natural and recreational resources that are essential to sustaining Andover's rural quality of life. Open space lands may have historic structures that supported former uses, which may reflect important elements of Andover's history. Protection of private lands in the public interest does not necessarily require public access to these lands. Indeed, public access might be incompatible with other open space uses such as wildlife habitat supporting fragile plant and animal communities, flood control, or water supply. Also, public access might be incompatible with an individual property owner's right to privacy. Andover should identify potential needs and opportunities for expanding these areas to provide links between protected areas and to add protected buffers to sensitive areas.

Three types of protection exist in Andover: fee ownership, deed restriction, and conservation easements. Figure 8 shows protected land in Andover. As of June 2011, 6,305.6 acres or 24 percent of Andover was protected by easements. Most of the easement land is held by private organizations. Andover is the primary holder of several parcels, the largest of which is the Newman easement with 727 acres. The Andover Village [Water] District has land for the protection and operation of the public water supply serving Andover village; it is not permanently protected, nor is land owned by Proctor Academy, but both intend to manage the land in its natural state.

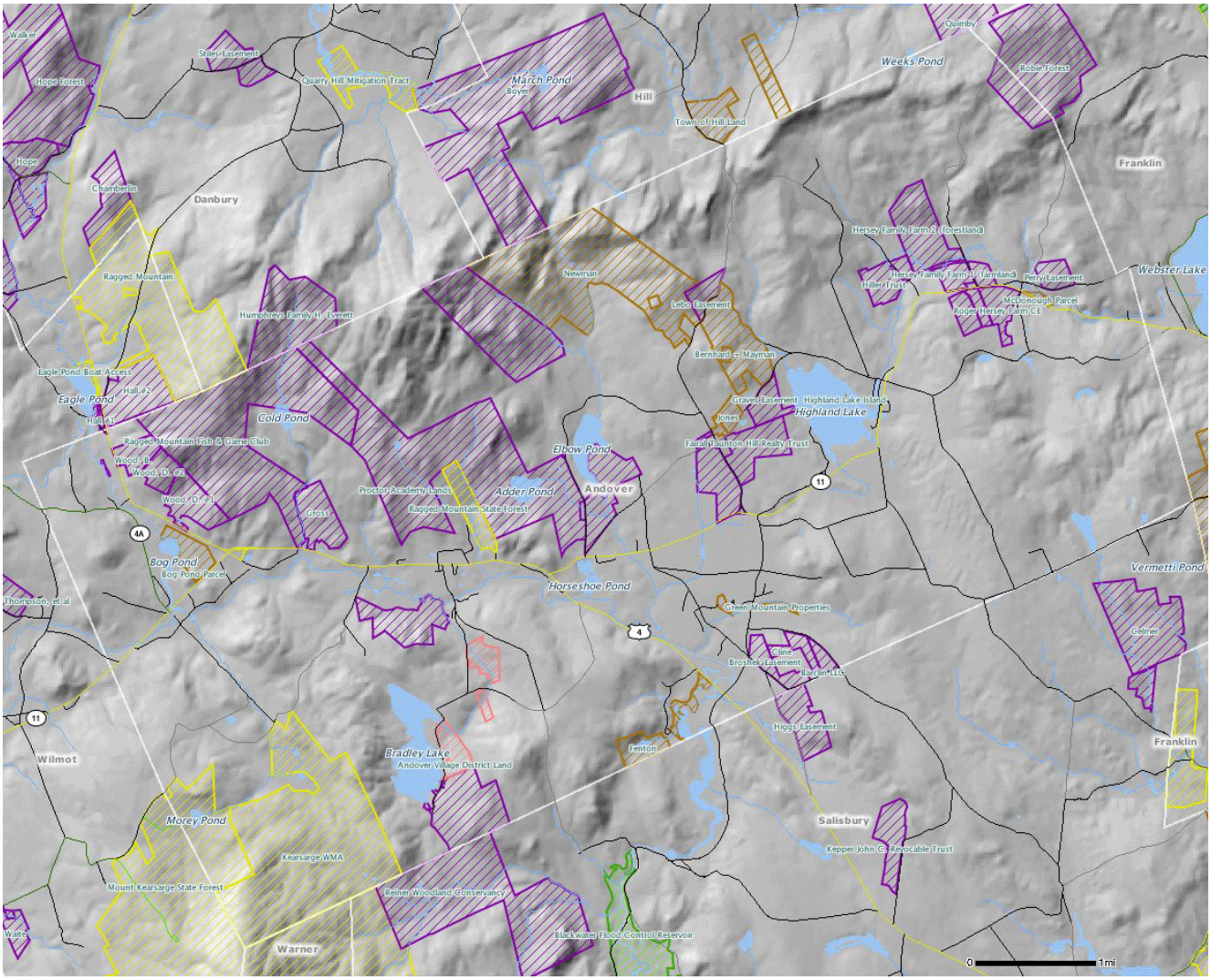

Figure 8. Map showing agency responsible for protected land: brown, town; purple, land trust; yellow, state; pink, water district.[15]

Unfragmented Land

Unfragmented lands are large tracts of undeveloped land unrelated to ownership boundaries that have few or no roads. These areas include a mix of forest blocks, open water, wetlands, riparian areas, and farmland that provide a habitat that can support a wide range of mammals, birds, fish, reptiles, amphibians, and plants. The Master Plan can be a valuable tool in implementing a broad-scale approach to wildlife habitat protection by providing an overall strategy for maintaining unfragmented blocks of habitat that are key to healthy wildlife populations.

Large blocks of forest, wetlands, and farmland that are unfragmented by development or public roads are valuable for many reasons. They:

- Provide essential forest interior habitat for species, such as some songbirds, that need to be distanced from human activity, pets, and the forest edge in order to survive;

[15] http://mapper.granit.unh.edu/viewer.jsp.

- Provide habitat for mammals, such as bobcat, otter, and moose, that have large home ranges and prefer to avoid human contact;
- Enable owners of large parcels of forestland to conduct timber harvests that are economically viable (10 to 20 acre minimum recommended by foresters);
- Minimize conflicts that can arise when managed forests and farms are surrounded and interspersed with development; and
- Offer opportunities for remote recreation, including hunting, hiking, skiing and snowmobiling, where permitted by landowners.

Larger fragments are more likely to support viable populations of species that can then move to another fragment. Larger fragments have habitat critical for goshawk, black bear, bobcat, Canada lynx, and wolf.[16] Smaller fragments may be unable to support breeding populations, but are critical for red-shouldered hawk, Cooper's hawk, American woodcock, ruffed grouse, whip-poor-will, veery, wood thrush, Canada warbler, and Cerulean warbler. Road kills can be particularly devastating for migrating amphibians. Persistent fragmentation may lead to genetic changes and a loss of genetic diversity if populations are subdivided into small, locally inbreeding populations.

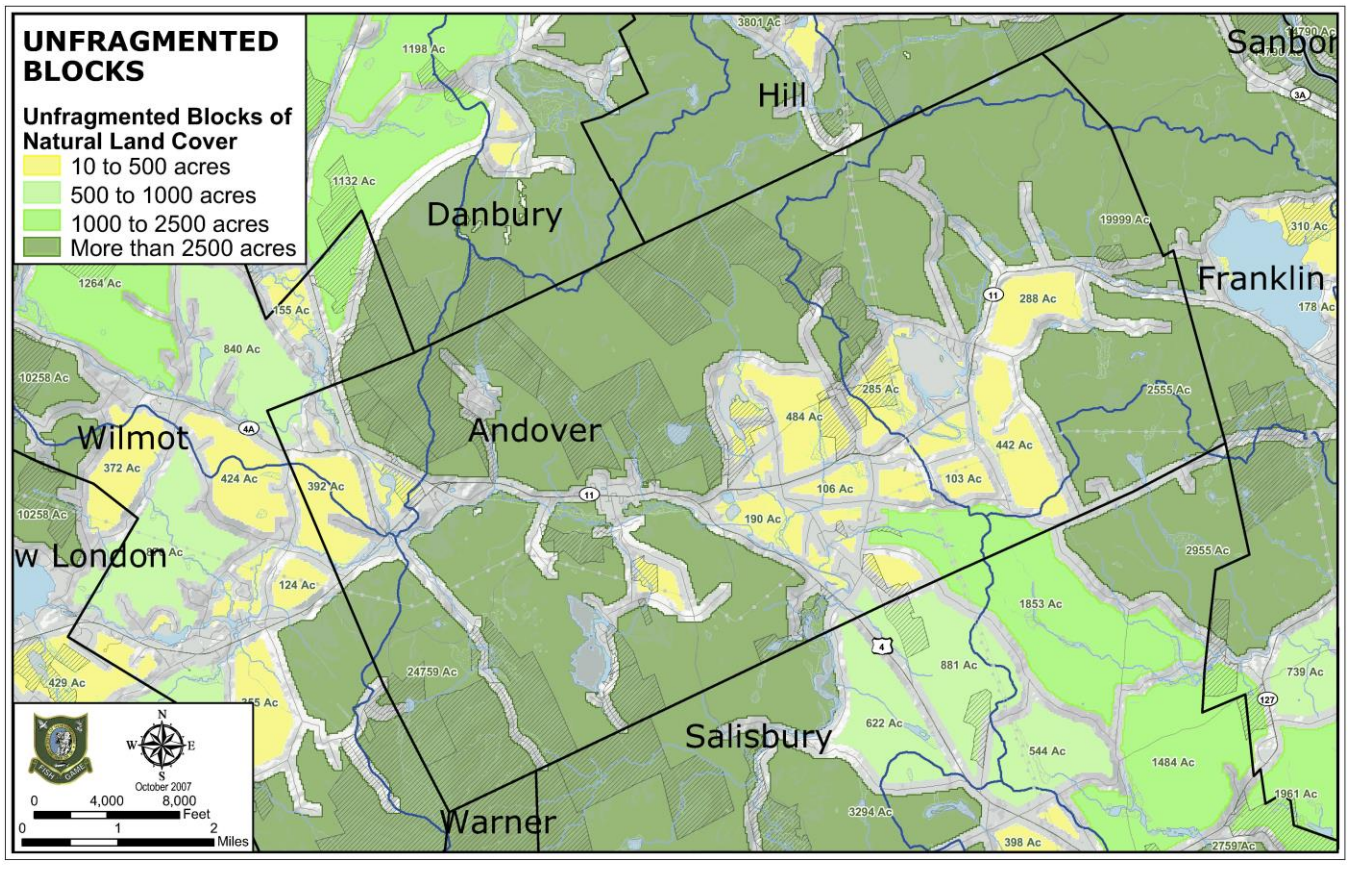

Figure 9. Unfragmented and protected land in Andover, October 2007.[17] Increase the detail of specific areas in this figure by using the online digital file.

Many large blocks of unfragmented land are still intact in Andover. These are shown

[16] http://www.wildlife.state.nh.us/Wildlife/Wildlife_Plan/critical_habitats_species.htm#smallmosaic.

[17] NH Fish & Game Department, 2005, revised 2007, **Wildlife Action Plan**, Concord, www.wildlife.state.nh.us.

with conserved parcels in figure 9, which can be zoomed in for greater legibility. The unfragmented map clearly shows that most of the northern part of Andover is unfragmented and should provide an excellent undisturbed habitat for a wide variety of plant and animal species. This block, extending into the surrounding towns of Danbury, Hill, and Franklin has a total of about 20,000 acres. Class V and VI roads do not pose a significant barrier to wildlife, but other roads should have a 500-foot buffer for wildlife dependent upon unfragmented land. The larger the size of the unfragmented parcel, the more beneficial it is to the local wildlife. The large block of land covering most of the northern half of the town is approximately 33 percent conserved. The second largest parcel of unfragmented land in the southwestern part of town is 2,244 acres and is approximately 60 percent conserved. Three other unfragmented parcels of land along the southern boundary of town represent fewer than 4,000 acres and are approximately 20 percent conserved.

Table 4 lists the acreage requirements for several species of wildlife in New England estimated by NH Fish and Game. Note that these acreages may include forests, meadows, and wetlands.

Acres	Species
25	Minimum size for breeding pair of whip-poor-wills
100	Minimum size for a red-shouldered hawk
100	Area required for viable population of wood thrush
500	Approximate maximum dispersal area for wood, spotted or Blanding's turtle
1,200	Minimum home range for northern goshawk
1,320	Minimum home range for Cooper's hawk
3,900-6,144	Minimum home range for lynx
9,400	Area required for breeding pair of northern goshawks

Table 4. Varied unfragmented land requirements per select species.

Forest Resources

Maine, then New Hampshire is the most forested state in the United States. However, as land becomes more expensive, forest product companies are losing their ability to manage huge forests as long-term assets that can provide jobs and recreation for local residents and tourists. Timber harvesting declined statewide from 2000 to 2004 according to the NH Department of Revenue Administration. Andover is approximately 88 percent forested; the state average is approximately 85 percent.[18] Much of Andover's mature forests have grown from abandoned agricultural land. However, due to increased development, the area of Andover's forests is decreasing. Much of the forested land is on hillsides that have steep slopes and shallow soils that are more difficult or unsuited for development.

Principal products from forest harvests statewide are: high grade wood, 35%; whole tree chips, 30%; hardwood pulp, 20%; softwood pulp, 10%; fuel wood, 5%. The fuel wood sector includes firewood, pellets, and chips. Some wood chips from Andover have been

[18] NH Division of Forest and Lands.

transported to the wood-to-energy plant in Bridgewater. Proctor Academy woodlands are harvested for heating several dormitories with wood-fired boilers, boards, chips, and pulp.

Andover's forests provide valuable habitat for wildlife. The land surface in forests absorbs rainwater, increases groundwater infiltration, and buffers surface waters from sedimentation and contamination. Trees cool summer temperatures by 10 degrees or more, break winter winds, and filter dust and pollutants from the air. Healthy forests host scenic recreational trails and hunting grounds that attract tourists and are of value to residents. Well managed forests can provide a sustainable supply of maple syrup, home firewood, commercial wood products, and jobs. Forests also constitute a major storage of carbon not only in the trees themselves, but also in the forest soils. Forests create modified microclimates, stabilize steep slopes and snow packs, and create and maintain stream habitat for aquatic life. Most importantly, forests provide us with biodiversity. For these reasons, the Conservation Commission has identified several forested areas for preservation.

A forest is the total assemblage of several factors:

- Substrate (soil and/or rock) on which trees depend for anchorage and support, nutrition, moisture, and oxygen;
- Other plants with which they interact in terms of mutual shelter, competition, or benefit;
- Animals that derive shelter from, feed on, and benefit plants through fertilization;
- Microorganisms that exert beneficial or antagonistic effects on all other living organisms; and
- Soil and atmospheric climate, including fire and moisture, that influence the distribution and abundance of all life in the forest.

Forest types named for predominant tree species have distinctive associations of trees, shrubs, and herbaceous plants. A forest type may be dominated by a single tree species or by several species growing together. Common forest types in Andover include white pine; northern hardwood (sugar maple, beech, yellow birch, red maple, white ash, and lesser amounts of other species); spruce-fir, red oak, hemlock, and aspen-birch. Dense softwood stands are particularly important for the winter survival of deer and moose. Oak, hickory, and beech forests provide mast and orchard trees, particularly apples, provide a winter food source for mammals and birds. Dead and dying trees provide shelter and nesting sites.

As trees mature, crown closure occurs, shading the ground and retarding undergrowth. Without sunshine-induced undergrowth there is little food or shelter for wildlife. Park-like conditions make for easy walking, but are not hospitable to wildlife, thus limiting certain species of wildlife. The US Forest Service and NH Department of Resources and Economic Development are attempting to provide a diverse habitat for a wider variety of wildlife by providing openings, edge habitat, and early successional forests. A study in Maine showed that lynx were more numerous next to regenerating clear cuts because that was where their primary food, the snowshoe hare, existed. In a bird study in the White Mountain National Forest, two bird species were netted in the mature forest, whereas twenty-two species were netted in an adjoining clear cut with

head-high regeneration. Forest improvement harvests carefully remove poor quality trees and provide growing space for healthy stands that enhance wildlife habitat.

Most forested land in Andover is privately owned, but the state owns a large block in the southwestern part of town. Proctor Academy and the Ragged Mountain Fish and Game Club have extensive forest land. The Conservation Commission oversaw logging in the Newman conservation easement in 2004. This area has been logged several times to generate income since the easement was created; many Andover residents have enjoyed walking the logging roads, scenic vistas, and increased wildlife sightings.

Several brochures published in the Wildlife Action Plan Habitat Stewardship Series[19] feature specific forest habitats that are critical for some species on the decline. Although not all species listed below have been reported in the map areas of Andover, citizens should be on the lookout for them because they may have been overlooked and undocumented in the past. These species and several other habitat areas that support threatened and endangered species (the circled areas) are shown on in figure 10 on which you can zoom in. Refer to figure 3 for colored areas not explained here.

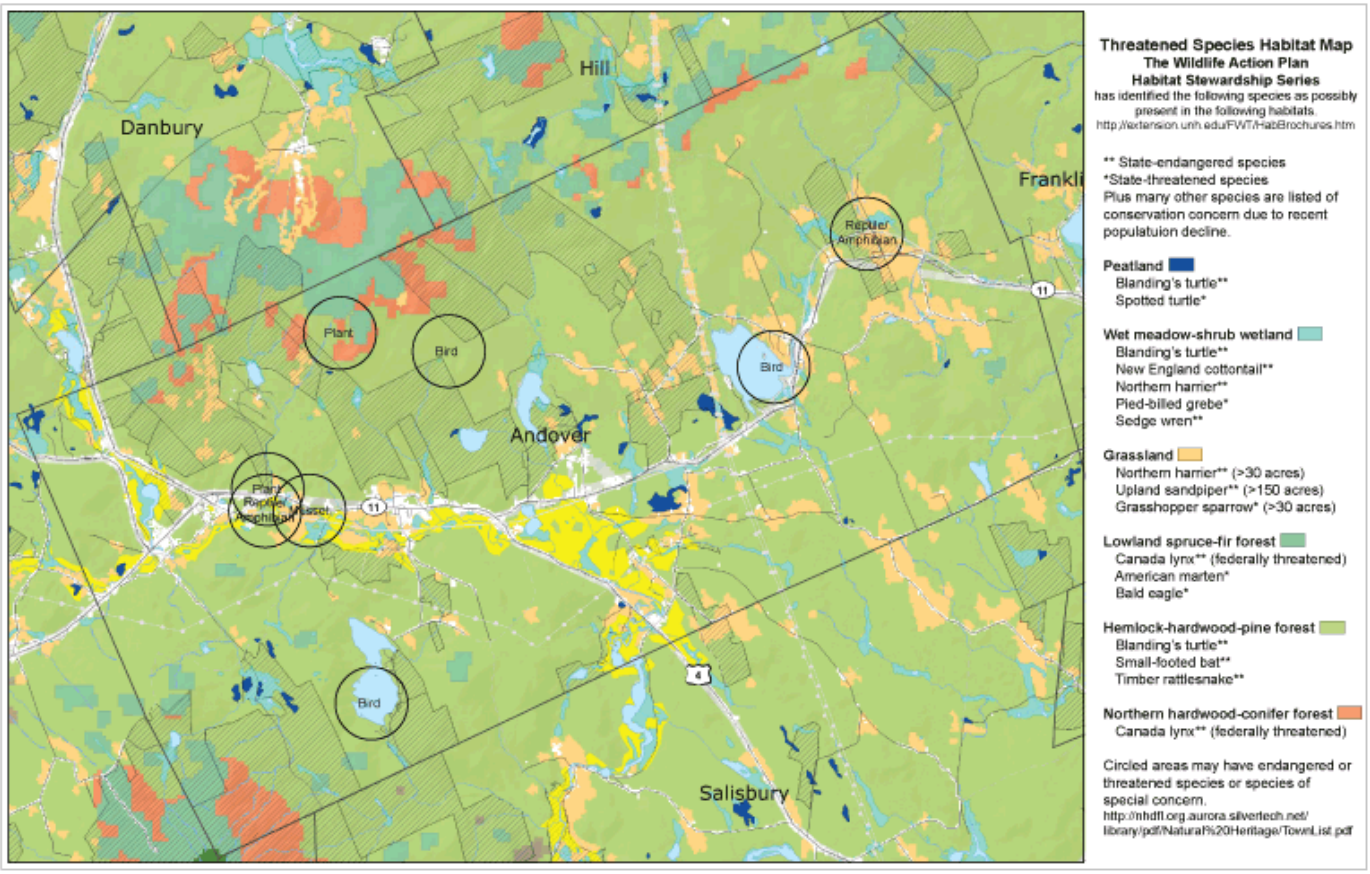

Figure 10. Threatened species habitat map of Andover, 2011.[20]

[19] NH Fish & Game Department, 2008-2011, **Wildlife Action Plan Habitat Stewardship Series: Appalachian Oak-Pine Forests, Floodplain Forests, Grasslands, Headwater Streams, Hemlock-Hardwood-Pine Forests, Lowland Spruce-Fir Forests, Marsh and Shrub Wetlands, New England Cottontail Rabbits in NH, Northern Hardwood-Conifer Forests, Peatlands, Shorelines, Shrublands, Vernal Pools,** Concord, NH, each 6 pages, http;//extension.unh.edu/FWT/HabBrochures.htm.

[20] NH Fish & Game Department, 2005, revised 2011, **Wildlife Action Plan**, Concord, www.wildlife.state.nh.us.

Hemlock-hardwood-pine forests[21] form the most widespread habitat in Andover. White pine and eastern hemlock are dominant, but beech, sugar maple, white ash, and red oak are also common. The understory may have witch hazel, maple-leaved viburnum, black birch, black cherry, and ironwood with starflower and Canada mayflower on the forest floor. White pine growing in abandoned pastures is replaced by hemlock and hardwoods in forest succession. Standing dead trees, decaying wood on the ground, and varied tree sizes and ages support a rich diversity of wildlife that may also live in adjacent vernal pools, headwater streams, and wetlands. Acorns and beech nuts are an important food source for mammals and birds; raptors perch, nest, and hunt from tall trees. Larger areas of these forests are habitat for the scarlet tanager, hermit thrush, Blackburnian warbler, and black-throated green warbler. Development eliminates corridors between other habitats used by wildlife and paved roads separate wildlife populations, inhibit migration, increase predation, and promote wildlife-vehicle collisions. Hemlock woolly adelgid, an invasive insect from Asia, kills hemlocks that provide critical winter cover. Stewardship guidelines include conserving large forested blocks (>1,000 acres), checking for disease, maintaining forest adjacent to wetlands, maintaining areas of young, regenerating forest blocks of least 2 acres as well as areas of mature forest, consulting a licensed NH forester for timber harvests, and following Best Management Practices. A few of the many species found in this habitat include the American toad, **American woodcock**, barred owl, ***Blanding's turtle***, **blue-spotted salamander**, **bobcat**, broad-winged hawk, **Canada warbler**, **Cerulean warbler**, **Cooper's hawk**, **eastern pipistrelle**, **eastern red bat**, **eastern small-footed bat**, **eastern towhee**, flying squirrel, fisher, **Jefferson's salamander**, moose, **northern goshawk**, **northern long-eared bat**, pine elfin butterfly, porcupine, **purple finch**, **red-shouldered hawk**, **ribbon snake**, **ruffed grouse**, **silver-haired bat**, six-spotted tiger beetle, **smooth green snake**, ***spotted turtle***, ***timber rattlesnake***, **veery**, **whip-poor-will**, wood nymph butterfly, wild turkey, **wood thrush**, and **wood turtle**. Bold type indicates species of conservation concern, while italics signify state-threatened or endangered species.

Northern hardwood-conifer forests[22] typically occur between 1,500 and 2,500 feet on well-drained fertile hillsides. Sugar maple, American beech, and yellow birch dominate over red maple, white ash, and hemlock at lower elevations; red spruce and balsam fir are more prevalent at higher elevations. Striped maple, witch hazel, and hobblebush are typical of the understory and wild sarsaparilla, starflower, and blue-beaded lily are on the forest floor. Standing dead trees, decaying trees on the ground, seeps in wetland pockets add to the diversity of wildlife. Larger unfragmented blocks (>1,000 acres) that have been sustainably harvested support a greater diversity of wildlife and are critical for many migrating songbirds. A few of the many species found in these forests include the **American woodcock**, black-throated blue warbler, **blue-spotted salamander**, **bobcat**, ***Canada lynx***, **Canada warbler**, **Cooper's hawk**, **eastern pipistrelle**, **eastern red bat**, eastern wood-pewee, flying squirrel, gray fox, **hoary bat**, **mink frog**, **northern goshawk**, moose, **northern long-eared bat**, ovenbird, pileated woodpecker, **purple finch**, red-eyed vireo, **ribbon snake**, **ruffed grouse**, **silver-haired bat**, **smooth green snake**, **veery**, **wood thrush**, and **wood turtle**.

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[21] Clyde, Malin Ely, 2010, **Hemlock-Hardwood-Pine Forests,** NH Wildlife Action Habitat Stewardship Series, http://extension.unh.edu/resources/files/Resource001815_Rep2548.pdf.

[22] Clyde, Malin Ely, 2011, **Northern Hardwood-Conifer Forests**, NH Wildlife Action Habitat Stewardship Series, http://extension.unh.edu/resources/files/Resource001816_Rep2549.pdf.

Lowland spruce-fir forests[23] generally occur between 1,000 and 2,500 feet on poor wet soils or on rocky ridgelines. Red spruce and balsam fir predominate along with yellow and paper birch. Hobblebush and blueberry are in the understory and bunchberry and trillium are on the forest floor. Dense, low-hanging evergreen branches form important winter cover for deer yards. Wind-thrown trees add to the diversity of these forests. Clear cutting, unsustainable forest harvests, and sporadic infestations of spruce-budworm pose a threat to this important habitat. Preserving areas with a mature forest canopy, patchy forest openings, and timber harvests greater than 70 years apart should be encouraged for greatest wildlife diversity. A sampling of species favoring the lowland spruce-fir forests includes ***bald eagle*****, bay-breasted warbler,** black-backed woodpecker, black bear, ***Canada lynx***, Cape May warbler, **Cooper's hawk, hoary bat, mink frog,** moose, **northern goshawk, purple finch,** and **wood turtle.**

Shrublands[24] tend to be temporary, forming the intermediate stage between field and forest. Within 25 to 30 years, a field may revert to a young forest. Commonly shrublands occupy power line corridors or are found in old gravel pits and recent clear cuts. Abandoned beaver ponds may support shrublands for twenty years or more before reverting to forest succession. Typical shrubland plants include dogwood, alder, viburum, and pincherry. Impenetrable dense shrublands provide cover and food for many birds and mammals. Development, fewer large beaver impoundments, and fire suppression practices have caused a dramatic decrease in shrublands and the species that depend upon them. Shrublands greater than 5 acres should be conserved, particularly if they have wetter soils. This can be accomplished by cutting small patches over time by brush-hogging or mowing every 3-5 years. Species that may be found in shrublands include **American bittern, American woodcock,** black bear**,** ***black racer*****, bobcat,** ***Canada lynx*****, eastern box turtle,** ***eastern hognose snake*****, eastern towhee, golden-winged warbler,** moose**,** ***northern harrier*****, purple finch, ruffed grouse, smooth green snake,** ***timber rattlesnake*****, whip-poor-will,** and **wood turtle.**

Andover has several tree farms enrolled in the national American Tree Farm System® (ATFS), a program of the American Forest Foundation. While each state Tree Farm program is self governing, all work follows the guidelines developed at the national level. Certification as a Tree Farm requires a management plan that emphasizes the tenants of wood, water, wildlife, and recreation. Eric Johnson is the program director of the NH Timberland Owners Association. New Hampshire loggers are encouraged to follow recommended forest management practices[25] and the Best Management Practices (BMPs) for Forestry, especially to protect water quality.[26] **(Please note that there are a series of Best Management Practices for construction, road building, and other alterations of the natural terrain.)** Fundamental BMPs for forestry include:

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[23] Clyde, Malin Ely, 2009, **Lowland Spruce-Fir Forests**, NH Wildlife Action Habitat Stewardship Series, http://extension.unh.edu/resources/files/Resource001110_Rep1534.pdf.

[24] Clyde, Malin Ely, 2009, **Shrublands**, NH Wildlife Action Habitat Stewardship Series, http://extension.unh.edu/resources/files/Resource001109_Rep1536.pdf.

[25] Bennett, Karen P., editor, 2010, **Good Forestry in the Granite State: Recommended Voluntary Forest Management Practices for New Hampshire,** second edition, University of New Hampshire Cooperative Extension, Durham, 225 p., http://extension.unh.edu/goodforestry/index.htm.

[26] UNH Cooperative Extension, 2005, **Best Management Practices for Forestry: Protecting New Hampshire's Water Quality**, Sarah Smith, editor, 100 p., http://extension.unh.edu/resources/representation/Resource000248_Rep267.pdf.

- Defining objectives and responsibilities for landowners, foresters, and loggers
- Pre-harvest planning to determine area to be harvested noting water features including wetlands, topography, road and landing locations, sensitive natural resources, soil types, drainage areas, closeout operations, and future harvesting
- Anticipating site conditions including weather and unusual conditions
- Controlling water runoff and gradual dispersal
- Minimizing soil disturbance of the forest floor and stabilizing exposed soil
- Protecting stream channels and banks, buffering shoreland
- Proper handling of hazardous materials such as fuel and oil.

The largest managed tree farm (2,700 acres), chosen as the 2008 Outstanding Community Tree Farm, is managed by licensed forester Dave Pilla on Proctor Academy land. Harvesting in the Proctor woodlands follows Best Management Practices and the location of logging roads, landings, and tree selection is done with wildlife habitat and sustainability paramount. Six to eight snags, standing trees in various degrees of decay, are left for bird and mammal homes in each acre. Trees are harvested using a fella buncher, delimbed, and cut to log length more or less in place, leaving brush piles for wildlife cover and to decay over time to replenish soil nutrients. Clear cuts about an acre in size are created that provide excellent browse for deer, moose, and other wildlife. Water channels are crossed with bridges and temporary pole logs laid parallel to the channel. Trees are harvested for many uses depending upon the quality and type of wood: wood working, saw logs, firewood, and chips. Annual net income supports the whole woodlands program and 250 cords of firewood heat several campus dormitories. In 2009 the biomass facility producing steam for the remaining campus buildings was completed. Will Ames and Kurt Meier oversee the biomass facility.

Andover's current use assessment in 2011 identified 55 parcel owners of forest land greater than fifty acres. These owners had some acreage in the following categories: nineteen managed hardwood forests, 5 managed for pine, and 17 other managed forests; 15 are unmanaged hardwood, 2 unmanaged pine, and 24 unmanaged other. Of the 55 parcels of land, 9 have conservation easements and 32 provide a public benefit, which was determined by whether or not the parcel received a recreational current use tax discount.

In 2007, Laura Alexander created a working forests map based on input from Conservation Commission members. This map was updated in 2010 to reflect the Master Plan definition of a working forest and the 2008 USDA National Agriculture Imagery Program (NAIP) aerial photography (figure 11). Her maps are on a CD given to the Planning Board and Conservation Commission and they can be viewed in ArcReader to enable viewers to zoom in for details and to activate different layers for a variety of perspectives. Her line work can be modified using GIS software. Initially, the Conservation Commission had considered working forests as those forested parcels currently being logged and managed, but a forest map should include all forests, whether or not they are being logged.

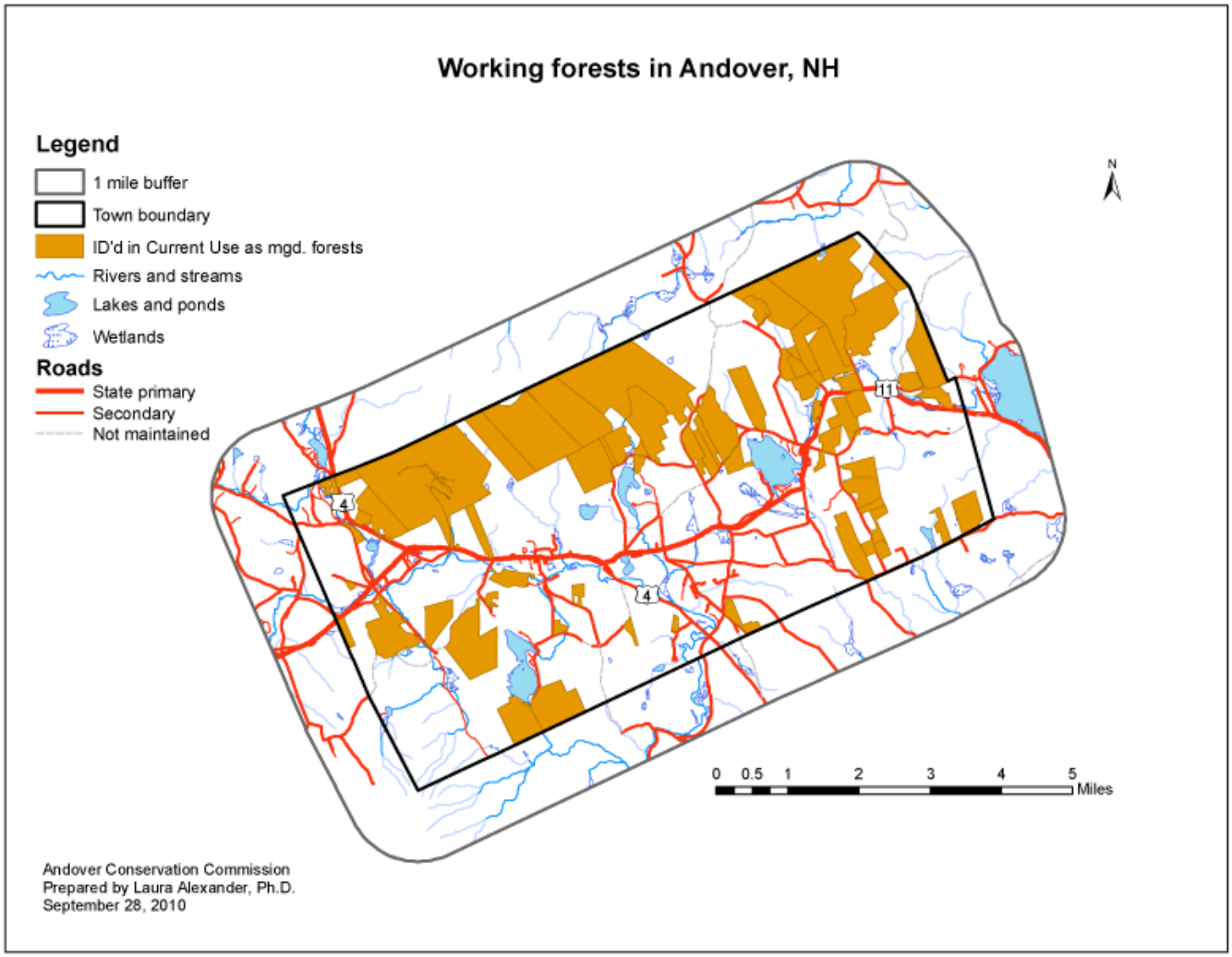

Figure 11. Managed working forests in current use as defined in the Master Plan, 2010.

The forest soils map (figure 12) highlights productive forest soils that have been rated by the Natural Resources Conservation Service (NRCS) for timber productivity. **Much more map detail of individually labeled soil units appears by zooming in on this map in GRANIT Data Mapper.**[27] Three groups of productive forest soils are mapped: 1A, 1B, and 1C. Supporting data for each mapped soil group is in table 5. Fragmentation of large tracts of forested acreage into smaller unmanageable units is a problem of statewide concern.

[27] http://mapper.granit.unh.edu/viewer.jsp.

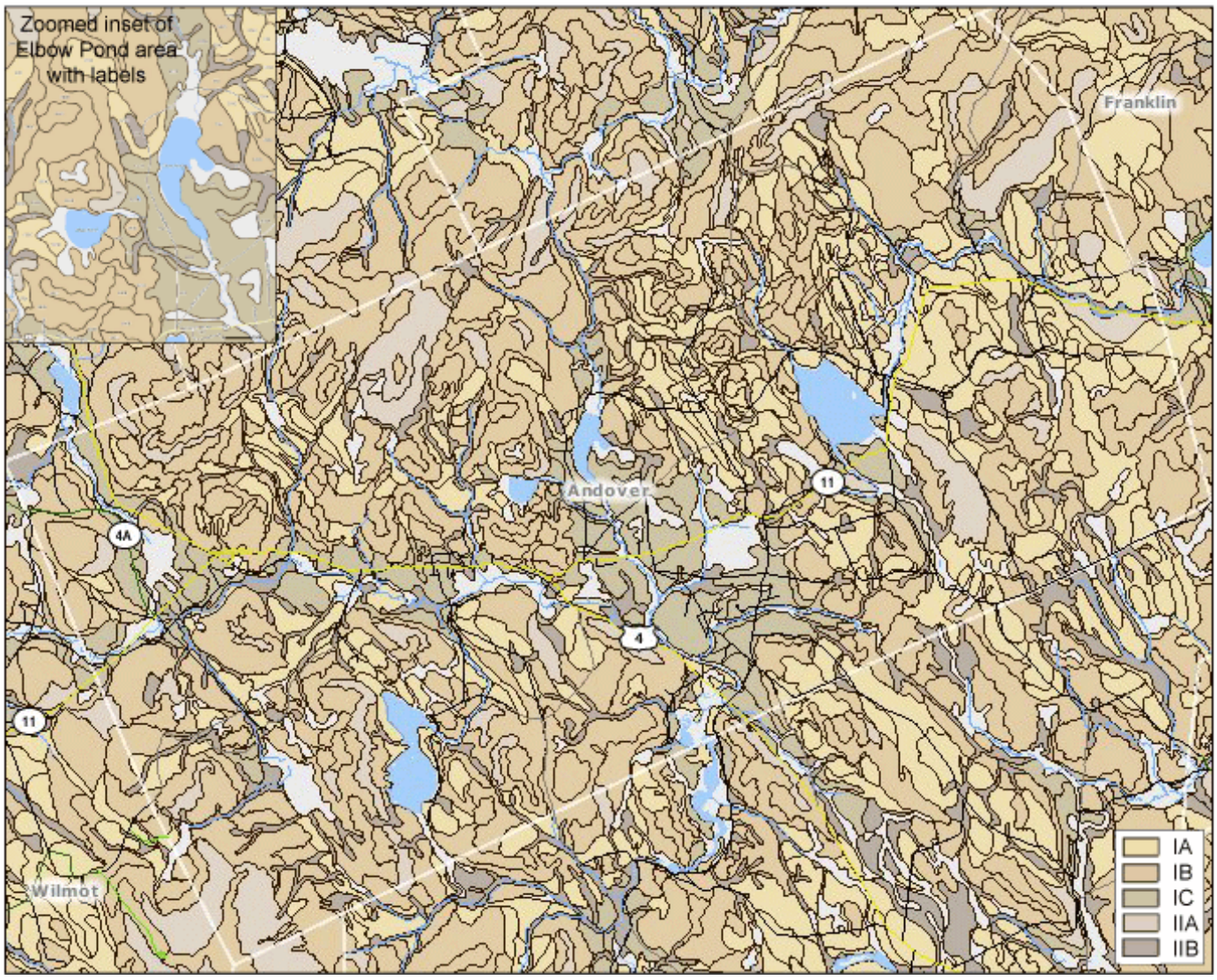

Figure 12. Forest soils map of Andover from GRANIT Data Mapper, 2009. Increase the detail of specific areas in this figure by using the online digital file.

Forest soils group	Acreage
IA: deep, fertile, loamy, moderately- to well drained, few limitations for forest management; best suited for hardwood	6,036.7
IB: loamy over sandy soils, moderately well-drained; best suited for hardwoods;slightly less fertile than IA	11,035.2
IC: somewhat droughty, less fertile, outwash sand and gravel, somewhat moderate- to excessively well-drained; best suited for softwood, especially white pine	2,531.3
IIA: similar to groups IA and IB, except physically limited due to steep slopes, bedrock outcrops, etc.	2,014.9
IIB: poorly drained soils, seasonal high water table generally within 12" of surface	2,144.5

Table 5. Preliminary forest soils group and acreage in Andover, 2009.

In addition, the soil manual for site evaluations[28] could be useful for many applications. Some of the information is dated, but overall, the manual contains a wealth of information that applies to many sections of this appendix.

Farmlands

"Land kept open by agricultural activity is essential to the distinctive New Hampshire landscape, with its close positioning of fields and pastures to forests and the built environment. Vistas afforded by our meadows are essential to our enjoyment or what we call 'rural character,' and the seasonal rhythms of farming are very much embedded in our culture and traditions."[29, 30] Ninety percent of New Hampshire's farmland has been lost since 1925 and those remaining supply fewer than four percent of our local food.[31]

Farms provide an important historic link to Andover's rural heritage; farms used to dominate the local landscape. Much of Andover's character is due to those who have sustained their farms and agricultural lands for generations. By the 1990s farms and back yard garden plots were mostly enterprises of the past. More recently, agricultural endeavors are on the upswing and small scale growers and residents are participating in farmer's markets in Wilmot, Franklin, and beyond. Organic foods have a niche market and, according to the NH Department of Agriculture, markets and farm stands may be increasing as consumers want local food sources with shorter transport distances and are concerned with national food recalls.[32] Some communities and nonprofit organizations have established community gardens, similar to the 'victory gardens' of the 1940s, where individuals without yards can rent plots to grow their own food. Franklin had one along Route 127 until the land was sold for house lots. A similar fate for community garden plots happened along Clinton Street in Concord that is now a large rental housing complex.

"In a time when the world is trying to figure out how to live more sustainable lives, an intact system of working family farms is something we cannot afford to lose."[33] In 2011, Andover's current use assessment identified 20 parcel owners having actively managed agricultural land greater than ten acres. Of these 20 properties, 6 have conservation easements (Hersey Family Farm, figure 13) and 9 provided a public benefit, which was determined by whether or not that particular land parcel received a recreational current use assessment. The Fenton dairy farm took the federal governments' buyout in the 1980s. Next the Hersey and Shaw farms eliminated dairy operations.

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[28] US Department of Agriculture and NH Department of Environmental Services, 1991, **Soil Manual for Site Evaluations,** 2d edition, 228 p., http://des.nh.gov/organization/commissioner/pip/publications/wd/documents/soil_manual.pdf.

[29] Steve Taylor, former NH Commissioner of Agriculture.

[30] NH Coalition for Sustaining Agriculture, 2000, **Preserving Rural Character Through Agriculture,** 61 p., http://extension.unh.edu/resources/representation/Resource000023_Rep23.pdf.

[31] Lougee, Jeremy, 2009, **Sustaining Agriculture in the Granite State: A Citizen's Guide to Restoring Our Local Foods, Farms and Independence**, NH Coalition for Sustaining Agriculture, 59 p., http://www.newhampshirefarms.net/Sustaining_Agriculture_in_the_Granite_State.pdf

[32] Lakes Region Planning Commission, February 2009, **Draft Lakes Region Plan for Sustainable Progress: A Comprehensive Economic Development Strategy**.

[33] Pfeiffer, Nancy, 2009, **The Leader**, National Outdoor Leadership School, v.23, no. 2.

As of 2011, the Hersey farm raises Herefords and the Shaw farm sells hay. Andover has several other farms that do not have livestock as a primary focus, except for the Robinson farm on Route 4. The Ragged View Farm, started in 1999 by the Cowdreys, has gradually expanded to sell pork, garlic, and maple syrup as a partner in the Tucker Mountain Maple Co-operative. The Cline's Wychwood Farm also sells maple products. The Zac's Highland Lake Apple Farm sells several fruits and vegetables along with honey and preserves.

Figure 13. Hersey farm, East Andover.

The Applecrest Lane Farm Stand has expanded its offerings of vegetables and John Siemanowicz has planted blueberries for a pick-your-own operation. Katherine Darling, of Two Mountain Farm that is in a conservation easement, initiated a 30-family Community Supported Agriculture (CSA) program in Andover, whereby shares are sold for the season to help meet expenses in return for weekly harvests of produce given to the shareholders according to the growing season. Katherine initiated a farm-to-school program in 2010, whereby primary and middle school students have a garden plot on school grounds and harvest the produce for the school lunch program and food pantry. In 2011, she hosted a week-long Farm and Adventure day camp for youth. In addition, many pastures scattered throughout town are harvested for hay. Fruit, vegetables, honey, eggs, and maple products are sold informally from homes or at nearby farmer's markets. Many families have backyard vegetable and herb gardens, fruit and berries, and horses, sheep, chickens, and other animals for their own use.

Preserving productive farmland will help ensure locally grown produce and a sustainable future.[34] Kat Darling gives tours of her sustainable organic farming practices. State statute recognize that, "Agricultural activities are a beneficial and worthwhile feature of the New Hampshire landscape and shall not be unreasonably limited by use of municipal planning and zoning powers or by the unreasonable interpretation of such powers."[35] Development patterns that direct development away from productive farmland onto lower quality soils or in a clustered village pattern are more supportive of agriculture by leaving larger open areas with the best soils available for farming.[36] Generally, larger farms, such as the Hersey farm, provide a variety of habitats—fields, forests, streams, wetlands, and transitional areas—that are essential for species diversity and larger farms provide scenic vistas.

Soils are crucial to the health of our planet. As ecosystems, soils support terrestrial plant life and other life, including ourselves. Soils are important sinks of carbon through the regulation of atmospheric carbon dioxide and climate. Soil chemical processes regulate

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[34] Lougee, Jeremy, 2009, **Sustaining Agriculture in the Granite State: A Citizen's Guide to Restoring Our Local Foods, Farms and Independence**, NH Coalition for Sustaining Agriculture and UNH Department of Natural Resources and the Environment, 59 p., http://www.newhampshirefarms.net/Sustaining_Agriculture_in_the_Granite_State.pdf

[35] RSA 672:1, III-b, http://www.gencourt.state.nh.us/rsa/html/LXIV/672/672-1.htm.

[36] NH Office of State Planning, revised 2000, **Preserving Rural Character: The Agriculture Connection**, Technical Bulletin 6, 16 p., http://www.pelhamweb.com/planning/NHOSP/TechBulletin6.pdf.

nutrient and toxic element concentrations in the environment. The fundamental chemical and biogeochemical processes that occur in soils, including adsorption, redox processes, mineral weathering, and infiltration of precipitation, are vital to the regulation of nutrient and contaminant concentrations. Basically, soils are composed of pulverized rock fragments and decayed organic matter. The more organic matter, the richer the soil, the better it is for growing things, and the better the water retention. That is why adding compost to gardens is so beneficial. Soils overlying quartz-rich rocks drain well because of their sandy nature, whereas clayey, silty soils retain moisture.

The Farmland Protection Policy Act of 1981[37] was established to minimize the unnecessary and irreversible conversion of farmland to non-agricultural uses. The NRCS recognizes four classes of important farmland soil defined in general terms as:[38]

Prime farmland, the best, is defined by saturation, pH, erodibility, permeability, and other factors. Prime farmland soils, as defined by NRCS, are soils that produce or have the potential to produce the highest yields with minimal expenditure of energy and economic resources.

Unique farmland, other than prime, is used for the production of specific high-value food and fiber crops in New Hampshire. Sites represent a special combination of soil quality, location, growing season and moisture supply needed to economically produce sustained high quality and/or high yields of a specific crop when treated and managed according to acceptable farming methods. In order to qualify as unique farmland, a high-value food or fiber crop must be actively grown. In New Hampshire, unique farmland crops include, but are not necessarily limited to, apples, peaches, pears, plums, strawberries, raspberries, cranberries, blueberries, pumpkins, squash, and tomatoes. Areas of unique farmland are site specific and can not be related to soil map units of the NRCS. This class has not been mapped in Andover because farms here grow a variety of crops.

Farmland of statewide importance is used for the production of food, feed, fiber, forage, and oilseed crops. Criteria for defining and delineating farmland of statewide importance are determined by a state committee chaired by the Commissioner, NH Department of Agriculture, Markets and Food, with members representing the UNH Cooperative Extension, NH Association of Conservation Districts, and the NH Office of State Planning. Soils of statewide importance do not include soils that are prime or unique and are mapped areas; have slopes less than 15 percent; are not stony, very stony, or bouldery; are not somewhat poorly, poorly, or very poorly drained; include soil complexes comprised of less than 30 percent shallow soils and rock outcrop that have a slope not exceeding 8 percent; and do not have excessively drained soils developed in stratified glacial drift having a low water-holding capacity.

Farmland of local importance is not prime, unique, or of statewide importance, but has local significance for the production of food, feed, fiber, and forage. Locally important farmland is determined by County Conservation District Boards. The criteria for mapping soils of local importance in Merrimack County are generally as follows: soils that are

[37] http://www.farmlandinfo.org/farmland_preservation_laws/index.cfm?function=article_view&articleID=29780.

[38] U.S. Department of Agriculture, Natural Resources Conservation Service, 2002, **New Hampshire Soil Attribute Data Dictionary,** 34 p., http://www.nh.nrcs.usda.gov/Soil_Data/soil_data_documents/datadict.pdf.

poorly drained have artificial drainage established and are being farmed; specific soil map units are identified from the NRCS soil survey for Merrimack County; soils have slopes less than 25 percent; soils are not extremely stony or bouldery; soils are not poorly or very poorly drained; and include soil complexes comprised of less than 40 percent shallow soils and rock outcrop that have a slope not exceeding 25 percent.

The degree slope is important for farmland because of the potential for erosion. Figure 14 shows slopes for Andover that determine, in part, the classification of farmland soils. Figure 15 shows generalized farmland soils mapped by the NRCS in 2009. **By zooming in on the NH GRANIT Data Mapper web site, soil units appear as detailed individual labeled units based on mineral and organic matter[39] and from the Natural Resources Conservation Service (NRCS) website http://websoilsurvey.nrcs.usda.gov/app/WebSoilSurvey.aspx.** Of the 26,271.5 total acres in Andover, about 67 percent of land in Andover has significant potential as farmland (table 6). The Planning Board should consult these maps, particularly for development
on smaller lots where no municipal sewer and water service is available. Severely limiting physical land features including rock outcrops, bedrock shallower than 18 inches, slopes greater than 35 percent, and wetlands or very poorly drained areas with hydric soils[40] should be clearly delineated on site plans and excluded in lot size dimensions. Laura Alexander's summary is easier to visualize (figure 16).

[39] http://mapper.granit.unh.edu/viewer.jsp.

[40] New England Interstate Water Pollution Control Commission, 2004, **Field Indicators for Identifying Hydric Soils in New England**, version 3, 103 p., http://www.neiwpcc.org/hydricsoils.asp.

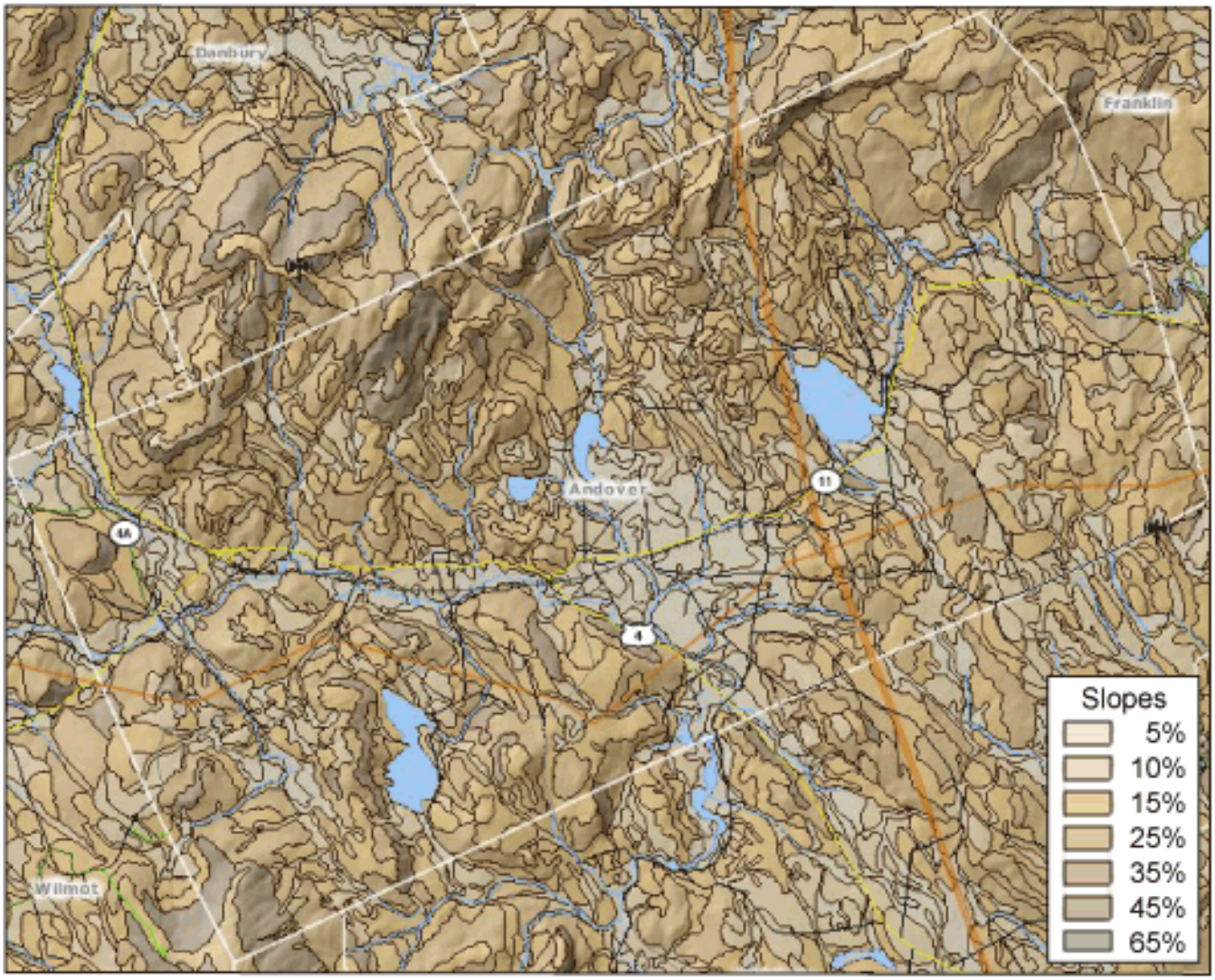

Figure 14. Slopes in Andover.[41] Increase the detail of specific areas in this figure by using the online digital file.

[41] http://mapper.granit.unh.edu/viewer.jsp

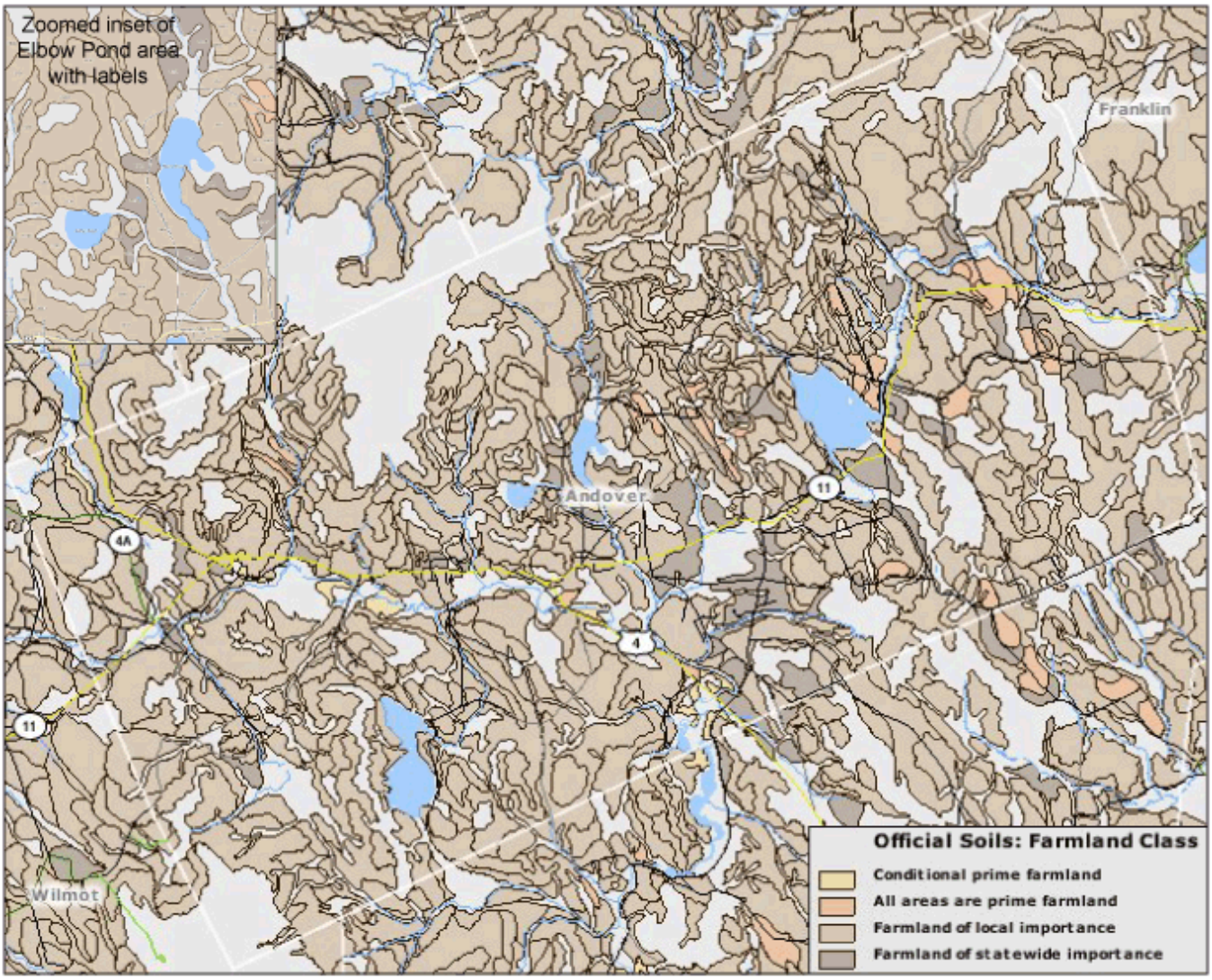

Figure 15. Farmland class soils, 2009. Increase the detail of specific areas in this figure by using the online digital file.

Farmland soils	Acreage
Conditional prime farmland	157.4
Prime farmland	464.6
Farmland of local importance	15,643.8
Farmland of statewide importance	1,374.5

Table 6. Farmland class soils and acreage in Andover, 2010.

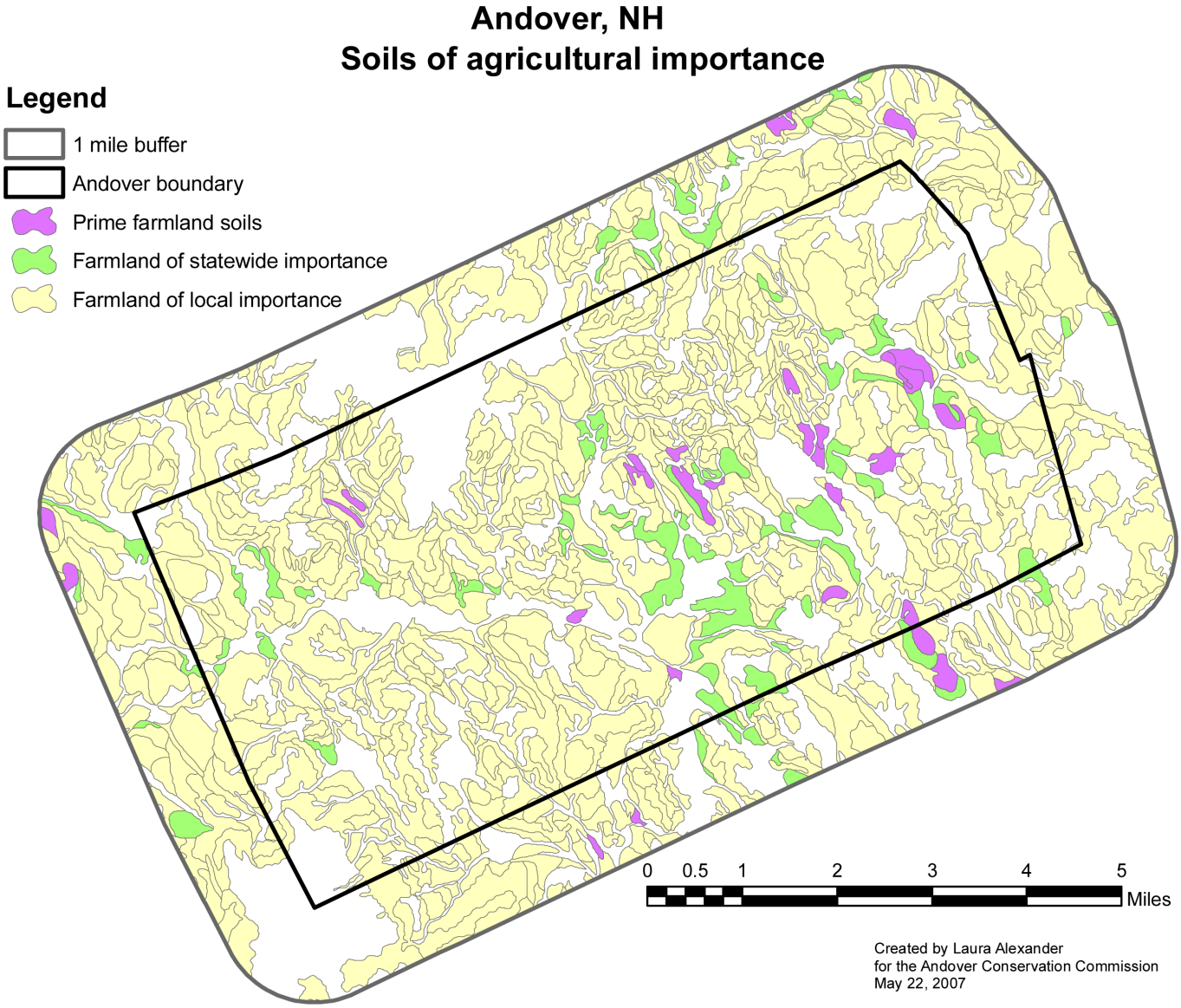

Figure 16. Farmland soils of agricultural importance, 2007.

The following criteria supporting agriculture were adopted by the Andover Conservation Commission to create the agricultural lands map (figure 17):

- Prime soils and soils of statewide importance as identified on current co-occurrence maps, or
- Lands that meet the current use definition for farm lands, or
- Lands used for agriculture, farming, dairying, pasturage, apiculture, horticulture, floriculture, silviculture, and animal and poultry husbandry in accordance with RSA 21:34-a. Such use can be income producing or not and there is no minimum or maximum acreage limit.

Agricultural land was identified by Conservation Commission members, input from Andover residents, and the master plan committee. Because of its prevalence, farmland of local importance was omitted from figure 17 to highlight the most important soils for farming. The maps are on a CD given to the Planning Board and Conservation Commission and they can be viewed in ArcReader to enable viewers to zoom in for

details and to activate different layers for a variety of perspectives. Laura's line work can be modified using GIS software.

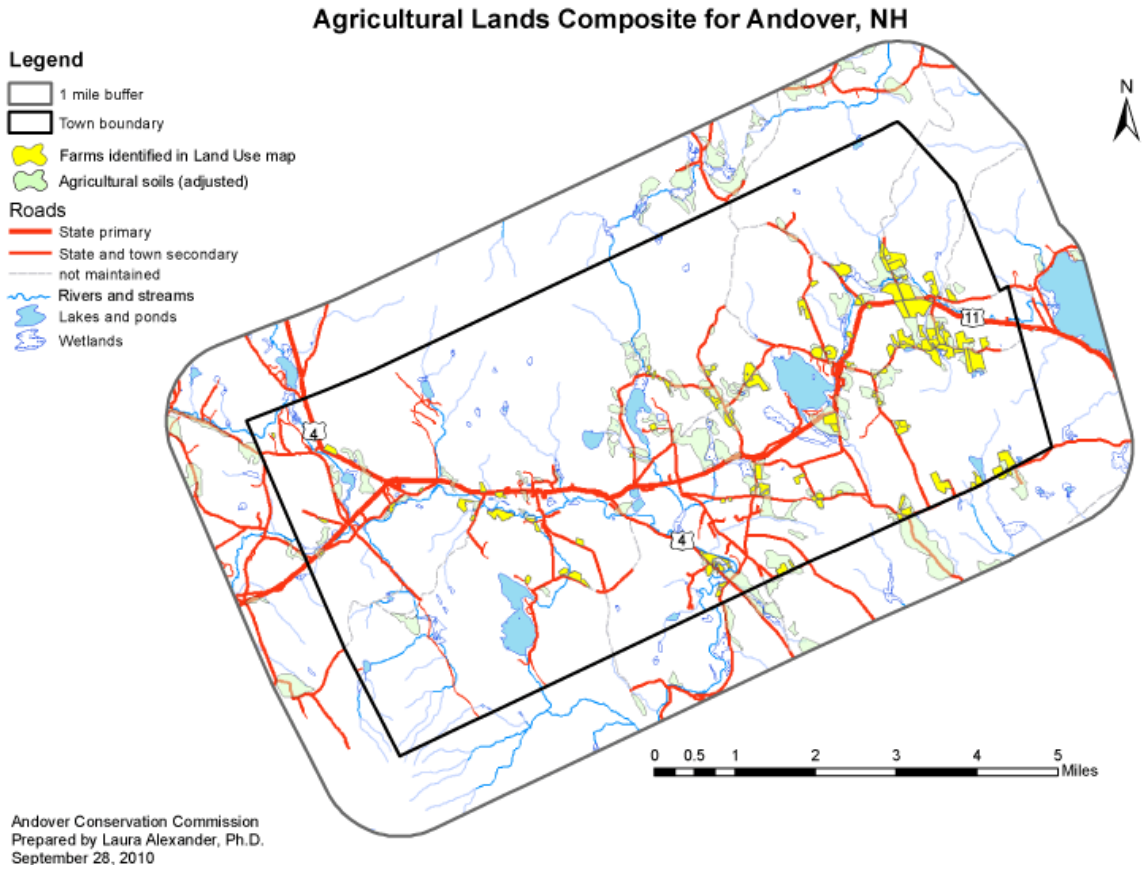

Figure 17. Working farms in soils of prime and statewide importance, 2010.

Today, open fields and agricultural cropland account for little of Andover's landscape. In contrast to much of the steep forested area, agricultural lands generally pose the least constraint to development for residential, commercial, industrial or institutional uses. Increasing expenses lower profits, and hard physical work day in and day out are major challenges for the farmer; the pressure and profit from escalating development and subdivision is tempting.

The community needs to understand and recognize the importance of these agricultural and open space resources to the town and act to preserve them. The value imparted by open space and agricultural lands includes the following: enhancement the rural and small-town character, scenic views that contribute to the quality of life, understanding of the natural world and how it sustains us, enhancement and protection of wildlife habitats and wildlife corridors, protection of water quality by absorbing and filtering water, recreational opportunities, positive fiscal impact on the town, and retention of property values.

No one farmland preservation technique alone is sufficient to succeed. Generally, coordinated financial incentives and land use regulations are needed. According to the American Planning Association, at least six techniques are useful in preserving farmland:

a comprehensive plan, transfer or purchase of development rights, differential assessment, right-to-farm laws, agricultural zoning, and urban or village growth boundaries.[42] Development rights were secured for the Hersey farm conservation easement after considering a comprehensive plan for the property, land in easement is taxed as current use (differential assessment), and it is in the agricultural and residential zone of 1974.

Grasslands are a special type of habitat that support more than 70 species of wildlife with cover, food, and breeding habitat.[43] Vegetation consists of grasses, sedges, and wildflowers in hayfields, pastures, and fallow fields. This vegetation may vary from fewer than 6 inches high to more than four feet; different species prefer different heights. Native grasses, such as bluestem, goldenrod, aster, and other wildflowers are common, along with introduced grasses, such as timothy, Kentucky bluegrass, orchard grass, and perennial ryegrass.

Grasslands require maintenance or else they will revert to forest. Farmers growing high quality forage for livestock generally mow fields two or three times per season. Between May and mid-July is nesting season for birds; mowing during this time period could destroy nests, eggs, or fledglings or encourage nest abandonment. Farmers can accommodate wildlife during the nesting season by raising the mowing bar to six inches or more, mowing only in daylight, using flushing bars, and delaying mowing in wet areas. Ideal mowing is from August through October; nesting is over and aster and goldenrod are blooming, providing nectar for migrating butterflies. Annual burning of fields can improve soil nutrients and disburse warm-season grasses which require less fertilizer, lime, and herbicides. Bare ground areas between plants are necessary for killdeer and horned larks. Interestingly, the barren, clinker-laden ground in what is now the Blackwater Park ball field was an excellent nesting area for killdeer.

What species depend upon **grassland** habitat? These are some, the bold being species of concern and bold italicized being state threatened or state endangered: **American bittern**, American kestrel, **black racer**, **Blanding's turtle**, bobolink, **eastern hognosed snake**, **eastern meadowlark, *grasshopper sparrow*, horned lark, *northern harrier*, northern leopard frog, *purple martin*,** Savannah sparrow, various rodents, **smooth green snake,** turkey, ***upland sandpiper*, vesper sparrow, whip-poor-will**, white tailed deer, and **wood turtle**. Birds living in grasslands smaller than 25 acres include bobolink (5 acres, dense grass taller than 3 feet), **eastern meadowlark** (15 acres, dense grass and wildflowers taller than 3 feet), and Savannah sparrow (20 acres, short and tall vegetation). Larger fields are necessary for the ***grasshopper sparrow*** (30 acres, short sparse grass), ***northern harrier*** (30 acres, short grass but nesting in wet meadows), and ***upland sandpiper*** (150 acres, short spare grass).

[42] NH Department of Environmental Services, 2008, **Innovative Land Use Planning Techniques: A Handbook for Sustainable Development**, p. 104, http://des.nh.gov/organization/divisions/water/wmb/repp/innovative_land_use.htm.
[43] Clyde, Malin Ely, 2008, **Grasslands**, NH Wildlife Action Habitat Stewardship Series, http://www.wildnh.com/Wildlife/Wildlife_Plan/Habitat_stewardship/Hab_Grasslands.pdf.

Geologic Resources

Like most of New England, Andover has been shaped by its underlying bedrock, long periods of mountain building and terrestrial erosion, and subsequent continental glaciation. Sediments deposited in the ocean long ago were compacted at depth and became solid rock. These rocks were intruded by molten magma and volcanic eruptions. All the rocks were metamorphosed by heat and pressure at depth and then deformed by faulting and folding as the earth's crust shifted. As these rocks were uplifted and exposed at the earth's surface, physical and chemical weathering has broken down these rocks over time. More recently, glaciation eroded and transported rock, deposited sand and gravel from pulverized rock in fast moving glacial streams, deposited fine-grained silt and clay in glacial lakes, and smoothed the land's surface, giving it a more rounded appearance.

A generalized bedrock geologic map (figure 18) of Andover was prepared for the compilation of the 1997 state bedrock map.[44] Andover has metamorphosed intrusive igneous rocks of the New Hampshire Plutonic Series of Upper to Lower Devonian age and sedimentary rocks of the Central Maine Trough of Lower Devonian to Lower Silurian age. These rocks are now foliated gneiss, schist, and veins of pegmatite. Contacts between rock types are either conformable or faulted.

The formal rock names were named and described at their type localities in New Hampshire and Maine. The names of the metamorphosed plutonic rocks vary depending upon the abundance of quartz to feldspar and the relative abundance of potassium feldspar to alkali feldspar. Mica consists of muscovite and biotite. Foliation refers to the alignment of minerals, especially mica, due to metamorphism (heat and pressure deep within the earth's crust) and tectonic (structural) influences of doming, folding, and faulting. The rock descriptions here are greatly simplified.

From youngest to oldest, the intrusive rocks are: Concord Granite (of Svenson Quarry fame in Concord), Spaulding Tonalite (darker than the Concord Granite), and Kinsman Granodiorite (characterized by large crystals of potassium feldspar).

Hundreds of millions of years ago eroded rock particles were transported by streams and deposited as sediments in layers at various depths in the ocean. Coarser sediments—sand and gravel—were deposited in a near shore environment and finer sediments—mud, silt, and clay—were deposited farther offshore. Calcium-rich rocks came from shells of ancient organisms. The sediments were buried and consolidated into rocks at depth and later subjected to folding, faulting, and metamorphism. From youngest to oldest, these rocks include: Littleton Formation (two schist members, the lowest part being somewhat rusty colored due to iron), Madrid Formation (massive calcium-rich purple gneiss), Smalls Falls Formation (very rusty weathering schist with pyrite, pyrrhotite, and graphite), Perry Mountain Formation (quartzite), and Rangeley Formation (two somewhat rusty calcium- and quartz-rich members with interbedded schist, quartzite, and

[44]Lyons, John B., Bothner, Wallace A., Moench,, Robert H., and Thompson, James B., 1997, **Bedrock geologic map of New Hampshire**, U.S. Geological Survey state map, 2 sheets, scale 1:250,000, http://des.nh.gov/organization/commissioner/pip/publications/geologic/documents/generalized_bedrock.pdf.

conglomerate). Bedrock is well-exposed in Andover, especially on the steeper slopes of the Bulkhead on Ragged Mountain. Most of the bedrock has a trend, or strike to the northeast and a slope or dip to the southeast in the eastern limb of a large regional anticline fractured by major faults.

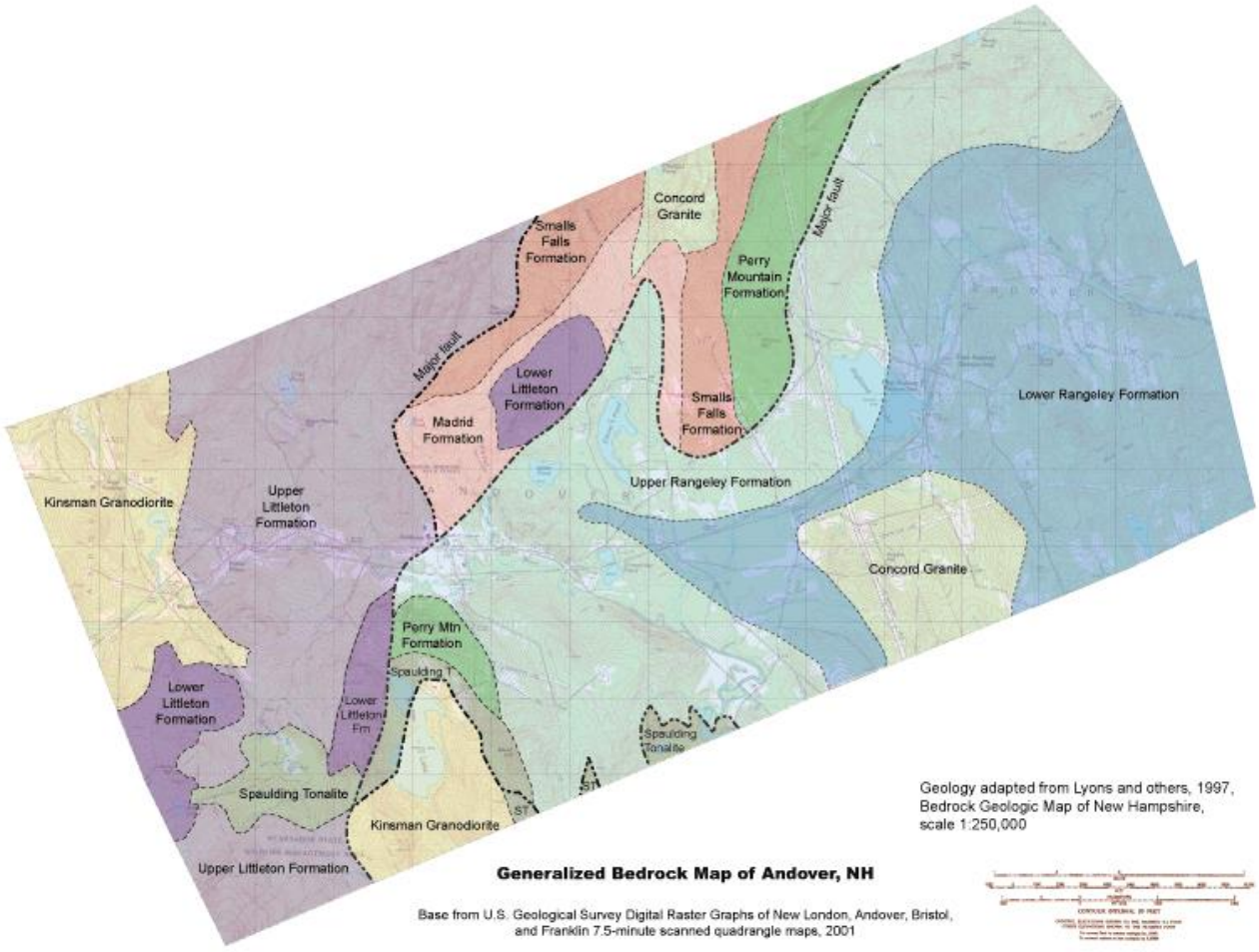

Figure 18. Generalized bedrock map of Andover.

Earthquakes are not unknown in the Andover area although they are low on the Richter seismic scale. Most have sounded like a heavy truck rumbling by and little damage has been recorded other than minor cracking of cement walls or chimneys. The probability of an earthquake exceeding 5.0 on the Richter scale within the next 50 years is low, the latest being recorded in Ossipee in 1940 at 5.5. In 1638 an estimated 6.5 earthquake was noted somewhere in central New Hampshire.

Several geologic sites in New Hampshire have scenic qualities that attract tourists. Andover has the falls, a series of cataracts, of Mountain Brook that are protected by the Newman conservation easement. Artist's Bluff or Artist's Ledge offers spectacular views that have been the subject of paintings and postcards. This is an unprotected site off Emery Road. The most prominent bluff that dominates Andover is the Bulkhead of Ragged Mountain which is semi-protected by Proctor Academy. In addition to views, the Bulkhead is a good rock climbing place, which is documented in figure 19 of a Proctor

student scaling the upper member of the Littleton Formation. To the west and northwest of Andover is a belt of pegmatites that have been quarried for feldspar, mica, and, to a minor extent, tourmaline, garnet, beryl, and several rare minerals. In the 1970s Tina Cotton heard of an abandoned gold pit on top of Beech Hill, but she could not find any evidence of it. Pyrite, or fool's gold, was probably the culprit that led to this information. The Kearsarge Mountain Road extension into Salisbury passes by an abandoned underground 'lead' mine that was the source of graphite (carbon) for lead pencils. The mine exists today with evidence of the tracks laid down for hauling out rock in small cars from the mine and small dump piles near the mine opening. The lead mine harbors a resident bat colony, although it has been compromised by the white nose syndrome appearing in 2008. Rock caves, overhangs, and crevasses provide shelter for other wildlife species.

Figure 19. The Bulkhead.

At least four episodes of glaciation and weathering have eroded and rounded the bedrock surface. The last continental glacier, known as the Wisconsin Ice Sheet, is estimated to have had an average thickness of 3,500 feet. This ice sheet receded from New Hampshire approximately 12,000 years ago. During its active movement, it eroded loose surficial earthen material and solid bedrock. Some of this material was dumped at the base of the ice directly on the buried land surface. These deposits are called **till**, a mixed, unlayered jumble of rock boulders, gravel, sand, silt, and clay. Many till soils have a characteristic hardpan layer at shallow depth. Material textures are angular because the material was dumped in place by the glacier instead of being rounded by rapidly moving glacial melt water streams. In the waning stages of glaciation, much of the earthen material within the ice sheet was transported by streams formed by melting ice away from the retreating ice margins. Many of the present landforms, the northwest-southeast trend of the landscape, and grooves or striations carved on exposed bedrock surfaces are the result of glaciation.

The lowlands are covered by **stratified drift** (layered glacial sediment) that was deposited by glacial melt water streams flowing within or emanating from the melting glacier. The glacial streams followed topographic lows of the underlying bedrock. Some of these lows were aligned with the trend of the bedrock, but many were influenced by structural folding and faulting of the rocks and rocks that were less resistant to physical or chemical weathering. The primary areas for glacial deposits include the Blackwater River and Sucker Brook and the broad Plains area. Wetlands form in some of the depressions or in oxbow meanders from former glacial or present streams.

When sediment is carried by water, stream velocity, which is influenced by slope and impediments, determines the size of the sediment deposited by the water. Coarse materials are heavier and require a faster velocity to maintain buoyancy. Finer sediments can be carried greater distances. The Blackwater River and Sucker Brook valleys have sand, gravel, pebbles, and cobbles, all rounded by the scouring action of rapidly moving water. The Plains area is sandy, but underneath the sand is clay and silt deposited by slower moving water in a temporary glacial lake that occupied the flat lowland.

Sand and gravel are known for good drainage qualities and gritty texture. Sand and gravel deposits allow groundwater penetration to wells, as in the field of well points and large capacity individual wells developed by Franklin for its municipal water supply. Material from excavation pits is used in developing septic leach fields, backfilling around building foundations, road construction, and providing traction on roads in the winter. Active and inactive pits are present along the valleys and in higher level terraces, such as along Route 11 between Route 4 and the Ragged Mountain Club Road and north of the railroad between Sam Hill and Hoyt Roads. Present day streams have eroded through these higher deposits of deltas and kame terraces. Sand pits in the Monticello Drive area are limited at depth because of the water table and poor drainage due to the underlying finer material of a former glacial lake. Eskers, discontinuous narrow ridges of sand and gravel deposited in tunnels within the ice sheet, have been excavated along the Blackwater near the junction of Routes 4 and 11 east of Andover village and along the west shore of Highland Lake. Because sand and gravel drains well, it is reasonably workable in all seasons. Clearly, stratified drift is a valuable commodity that should be used wisely.

The NH Geological Survey has scheduled John Cotton to map the surficial geology of the Andover topographic quadrangle in 2012-2013. However, the boundary between till and unconsolidated stratified material can be roughly approximated by the break in slope in the valleys and the predominance of pine trees over hardwoods. Pines favor sand and gravel areas. Areas of till are characterized by boulders scattered about the land surface. Nearby boulders from till were used to build stone walls and foundations by early settlers. The discussions of ground water and soils are closely linked with surficial geology. Detailed surficial mapping of Andover should locate various glacial and recent unconsolidated deposits forming eskers, deltas, kame terraces, and alluvial fans.

The esker landform is created in glacial melt water tunnels. Melt waters streamed through these tunnels under the ice sheet, both transporting and depositing sediments. An esker is a snake-like ridge of sand and gravel with steep slopes that winds through lower lying marshes. Because eskers are generally flat topped, high and dry roads and railroads were commonly built along the top.

Some landforms or deposits may be worthy of protecting for local educational purposes. The ‘Hogback’ along Route 11 is a good example of fine-grained basal till. This dense, compacted material has low permeability and was used in building the core part of the Franklin Falls dam. The Plains area is underlain by sand, silt, and clay from a glacial lake, with sand overlying the finer sediments. Property owners, hikers, hunters, and fishermen are knowledgeable for suggesting geologic sites within Andover that might be worth noting, either for preserving the geologic type of deposit or for the material within the deposit that could be used.

The flat bottom lands immediately adjacent to streams are **floodplains**. When a stream floods, fast moving water within the stream channel erodes the bottom and banks of the stream. Water flows more slowly over flooded flat-lying areas. As flooding recedes and velocities slow, eroded material is deposited both within the main channel and on the floodplain. Because of flooding and erosion, housing and other important structures should not be located in floodplain areas. The Federal Emergency Management Agency (FEMA) maps at town hall show areas likely to be flooded in storm event scenarios—50-

year floods, 100-year floods, and so on. Owners of structures in flood prone areas can purchase flood insurance in Andover because Andover adopted all the required restrictions specified by the US Department of Housing and Urban Development (HUD). Some towns have enacted fluvial erosion and flood hazard zones;[45] additional information is in the natural hazards section. Floodplains are important as wetlands areas that can accommodate and settle out pollutants and sediment in excess flood water, thus averting farther downstream damage. Floodplains are also valuable for raising crops in its rich soils. More on floodplains is in the shoreland and wetland buffers section. Floodplain forests occur primarily along the Blackwater River and are discussed in the wetlands section.

Wetlands

Wetlands are areas that are inundated by surface water or saturated by groundwater at a frequency and duration sufficient to support a prevalence of vegetation adapted for life in saturated soil conditions. Thus, a wetland is defined by the three "H's": **h**ydrophytes (wetland vegetation), **h**ydrology, and **h**ydric (wetland) soils.[46] Wetlands can be an open swamp or marsh or forested; they can be an integral part of a floodplain. The National Wetland Inventory (NWI) maps of the U.S. Fish and Wildlife Service do not include wetlands typically without standing water in the spring or vernal pools, but if used in combination with more detailed soils maps, a good approximation can be made for existing wetlands in Andover. An excellent inventorying and evaluation resource for wetlands is available and by the end of 2011 a NH Wetlands Mapper will be available.[47] Various maps showing wetlands in this appendix are from the NWI.

The U.S. Army Corps of Engineers developed WetDataShed, software that simplifies the wetland delineation process by automating calculations and by providing a consistent means for collecting necessary data, by performing ecological or watershed scale studies, and by using wetland plant indicators. This software can be downloaded free from www.crrel.usace.army.mil/rsgisc but has not been used in Andover (2009).

Wetlands are an integral part of Andover's natural resources. Specifically, wetland functions and values identified include those shown in figure 20 and the bulleted items.[48]

- Groundwater recharge/discharge
- Flood flow and stormwater runoff moderation
- Sediment/toxicant/pathogen attenuation
- Nutrient removal

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[45] NH Department of Environmental Services, 2008, revised 2010, **Innovative Land Use Planning Techniques: A Handbook for Sustainable Development**, http://des.nh.gov/organization/divisions/water/wmb/repp/innovative_land_use.htm.

[46] New England Interstate Water Pollution Control Commission, 2004, **Field Indicators for Identifying Hydric Soils in New England**, version 3, 103 p., http://www.neiwpcc.org/hydricsoils.asp.

[47] U NH Cooperative Extension, 2011, **Method for Inventorying and Evaluating Freshwater Wetlands in New Hampshire (NH Method)**, 150 p., http://extension.unh.edu/resources/files/Resource001874_Rep2706.pdf.

[48] Pillsbury, Sarah, Currier, Paul, Susca, Paul, editors., 2008, **New Hampshire Water Resources Primer,** NH Department of Environmental Services, http://des.nh.gov/organization/divisions/water/dwgb/wrpp/primer.htm.

- Production export
- Sediment/shoreline from wind and wave action
- Microclimate moderation
- Nutrient removal
- Production export
- Sediment/shoreline stabilization from wind and wave action
- Microclimate moderation
- Wildlife and wildlife habitat diversity and integrity
- Recreation value
- Education/science/research
- Uniqueness.

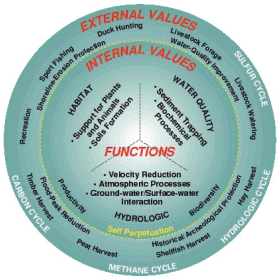

Figure 20. Functions and values of wetlands.

In addition, they are scenic, especially in the fall when the red maples and heath plants, such as wild cranberries, turn scarlet. Several residents harvest wild cranberries from the wetlands at the end of Kearsarge Mountain Road. All residents are familiar with the red maple swamp by cemetery corner along Route 11 in East Andover. Wetlands are commonly found along streams and adjacent to ponds and lakes as a part of the ecological integrity. They may form valuable clustered complexes. Approximately 66 percent of the species of conservation concern in New Hampshire are wetland- or surface-water dependent.[49] Vernal pools are a special type of wetland that dry out completely in the summer and have no fish population. However, they are critical for amphibian reproduction. The peepers that herald springtime in the evening are the auditory evidence of frogs.

Wetland vegetative types in Andover are diverse, including areas of open water with emergent vegetation such as cattails, forested wetlands, and scrub-shrub wetlands. **Forested wetlands** (figure 21) are shady, cooler in summer, and maintain moisture. **Marsh and shrub wetlands** have wet soils most of the year.[50] **Wet meadows** are characterized by sedges and grasses and provide a rich habitat for ribbon snake, **spotted turtle,** and ***northern harrier*****.** Marsh plants grow out of water but are rooted in water; examples are cattails, pickerel weed, and water lilies. Species relying on a marsh habitat for feeding and lifecycles include **Banding's turtle**, **American black duck**, and red-winged blackbird. Shrub wetlands have thickets of shrubs and young trees growing in wet soils that are routinely flooded. Species using these wetlands for cover, food, and breeding include **spotted turtle**, Canada warbler, and **American woodcock**. Additional species found in marsh and shrub wetlands include **American bittern**, **common moorhen**, **eastern red bat**, **great blue heron**, green darner dragonfly, **least bittern**, mink, muskrat, **northern leopard frog**, **osprey**, ***pied-billed grebe***, ***ringed boghaunter dragonfly***, **rusty blackbird**, ***sedge wren*****, silver haired bat**, spring peeper, and Virginia rail.

[49] NH Fish & Game Department, 2005 revised 2007, **Wildlife Action Plan**, Concord, http://www.wildlife.state.nh.us/Wildlife/wildlife_plan.htm.

[50] Clyde, Malin Ely, 2008, **Marsh and Shrub Wetlands**, NH Wildlife Action Plan Habitat Stewardship Series, http://www.wildnh.com/Wildlife/Wildlife_Plan/Habitat_stewardship/Hab_Marsh_Shrub_Wetlands.pdf.

Figure 21. Two examples of forested wetlands.

To help preserve wetland habitats:

- Houses, roads, and recreational trails ideally should be 1,000 feet but at least 300 feet away;
- Wetlands should be surrounded by intact natural vegetation;
- Beaver dams, flowage, and impoundment should be left intact;
- Invasive plants such as purple loosestrife, common reed, Japanese knotweed, and glossy buckthorn should be discouraged; and
- Dead trees, overhanging vegetation, and downed logs should left undisturbed.

The WAP land cover habitat map (figure 3) shows small areas of **peatland**. Peat is formed in wetlands from dead vegetation that has accumulated and become compacted by overlying material. Peat bogs generally formed in late glacial times in remnant kettle holes (isolated depressions with standing water) that lacked a drainage outlet. Sphagnum moss is a predominant plant forming peat. Floating peat mats may tremble underfoot and are called 'quaking' bogs. Because of their high acidity, lack of nutrients, and low oxygenation, peat bogs favor heath plants, such as wild cranberries, carnivorous plants, such as the pitcher plant and sundew, and several colorful orchids. The NH Natural Heritage Bureau tracks 54 rare plant species occurring in peatlands; many insects depend upon a single peatland plant for food or completion of their life cycle.[51] Some species that depend upon peatlands for breeding, feeding, cover, or nesting include **Blanding's turtle** (state endangered), **eastern towhee**, **mink frog**, southern bog lemming, **palm warbler**, **ribbon snake**, and **spotted turtle** (state threatened). The bold species are of conservation concern. **Peat swamps** are commonly rimmed with red maple in Andover.

Even though there are few peat areas in Andover, they form a significant wildlife habitat and they should be preserved. Threats to peatlands are filling and draining due to development, runoff from agricultural fields, lime and fertilizer runoff from lawns, and the timing and type of timber harvesting. A 300-foot buffer of naturally occurring brush and woody material should be maintained around peatlands. Trails allowing motorized vehicles should be at least 100 feet from peatlands. Walking trails should have raised boardwalks constructed across peatland soils and vegetation.

[51] Bowman, Pete, and Brunkhurst, Emily, 2009, **Peatlands**, NH Wildlife Action Plan Habitat Stewardship Series, http://www.wildnh.com/Wildlife/Wildlife_Plan/Habitat_stewardship/Hab_Peatlands.pdf.

The NH Natural Heritage Bureau lists floodplain forest, marsh and peatland as significant wildlife habitat, and a medium level fen system as an exemplary natural community. A **fen** is a type of wetland fed by alkaline, mineral-rich, moving groundwater and is characterized by distinctive sedges and shrubs growing in peat soils; acidity varies. Fens are often confused with **bogs**, which are highly acidic, fed primarily by rainwater, and inhabited by sphagnum moss, leatherleaf, and bog laurel. The Philbrick-Cricenti Bog in New London is traversed by boardwalks for people to enjoy while preserving the bog. Like other wetlands, fens will ultimately fill in and become a terrestrial community through the process of ecological succession.

The areas and acreage of some wetland types in Andover are shown in table 7. Wetlands account for 4.7 percent of the acreage in Andover.[52] The wetlands count does not reflect separate wetlands, but patches of wetlands classified as a particular type. **Palustrine** wetlands are inland wetland systems which lack flowing water. **Lacustrine** wetlands are associated with lakes and ponds. **Riverine** wetlands are fed by water flowing through a channel. The latter two were unaccounted for in the NWI.

Wetland Type	Acres
Forested	521.2
Scrub shrub	452.9
Emergent (e.g. cattails)	118.1
Palustrine	140.2
Total	**1,232.4**

Table 7. Wetland types in Andover.

Federal and state legislation for wetlands mitigation is intended to offset wetlands that are destroyed in development. New wetlands are created, but the majority of these newly created wetlands fall short of their natural equivalents. The U.S. Army Corps of Engineers determined that only 17 percent of mitigated wetlands worked as well as the natural wetlands they replaced. Some of these mitigated wetlands were designed for different ecosystems. For example, complex forested wetlands of red maple were replaced by simpler, cheaper ecosystems found in shrub wetlands or open ponds fringed by a narrow band of wetland plants. The NH Audubon Society concluded that 40 percent of re-created wetlands derived most of their water supply from stormwater drainage and surface water runoff, not from groundwater. Re-created wetlands with poor water quality are recognized by algal blooms, sediment, trash, or an oily sheen from oil and gas runoff. When the NH Department of Transportation created the wetland adjacent to Route 11 west of Old College Road necessitated by road improvement, the wetland was connected to the existing natural wetland so that natural vegetation could migrate into it. In 2003, the Environmental Protection Agency (EPA) estimated the cost of successful wetlands mitigation at $100,000 per acre. Developers normally will not spend that amount of money to create an effective wetland. Leaving a wetland that has evolved over the past 12,000 years intact with buffers is preferred over a cheaply made simple wetland. Buffers are critical for amphibian life cycles.

Before embarking upon any project involving dredging or filling of wetlands, an application must be made to the Wetlands Board of the NH Department of Environmental Services for a permit to do the planned work to assure that the project as proposed is the least impacting alternative and that no significant loss of value as a wetland will occur. Among other considerations, applications are assessed for the impact to threatened and endangered wildlife, plants, and plant communities.

[52] http://mapper.granit.unh.edu/nwireport.jsp.

Prime Wetlands

RSA 482-A-15 legislation was passed to protect wetland areas of high, or prime, value. These wetland areas also include a minimal 100-foot buffer surrounding the wetland. Although 14 criteria on function and value are listed, only 10 need be present to establish an importance worthy of special safeguards. These 14 criteria are: ecological integrity, wildlife habitat, finfish habitat, educational potential, visual/aesthetic quality, water-based recreation, flood control potential, groundwater use potential, sediment trapping, nutrient attenuation, shoreline anchoring and dissipation of erosive forces, urban quality of life potential, historical site potential, and noteworthiness.[53]

A comparative study of the functions and values of Andover's wetlands was completed in 1988 by Derek Mansell and Susan Schnare.[54] Such an analysis is necessary to prioritize significant wetlands and provide the data necessary to designate wetlands as prime under RSA 482-A:15. At that time, the NH Wetlands Board stipulated that to qualify as a prime wetland, it **must** be underlain by very poorly drained soils. Several soil series mapped in Merrimack County by the NCRS are very poorly drained: Mh or marsh; Mp or muck and peat; RdA and RdB or Ridgebury and Whitman very stony loams that are present in the Fenvale heron rookery; Sc or Scarboro fine sandy loam; and Sa or Saco silt loam. The latter three may have closed depressions that are poorly drained. In addition to soil type, Derek and Susan added the following conditions: water at or near the surface during a significant part of the growing season and an organic-rich mineral layer extending 16 inches deep or organic material extending at least 4 inches above the mineral soil.

The prime wetlands of Andover shown in figure 22, approved by ballot vote March, 1989, receive special consideration from the Wetlands Bureau of NH Department of Environmental Services. When a wetland is designated as prime by a community, it is recognized as a valued natural resource, and protected as such. When a landowner has a project involving a prime wetland, a special hearing is held before a permit is issued. Other wetlands could also be designated prime in the future. Much greater detail of methodology, ratings, descriptions, and photographs are contained in the Mansell and Schnare report. Legibility of the wetland site numbers is increased by zooming in. Of the 32 sites initially considered worthy of extensive evaluation, only 26 were selected as prime. Those rated of highest value and designated as prime are summarized in table 8. Users of the Rail Trail have exclaimed over the beauty of wetlands they have discovered from the trail, several of which are prime.

[53] NH of Environmental Services, 2008, revised 2010, **Innovative Land Use Planning Techniques: A Handbook for Sustainable Development**, p. 201, http://des.nh.gov/organization/divisions/water/wmb/repp/innovative_land_use.htm.

[54] Mansell, Derek and Schnare, Susan E., 1988, **An Inventory and Evaluation of Andover Wetlands**, available from the Andover Town Hall and the Andover, Bachelder, and Proctor libraries.

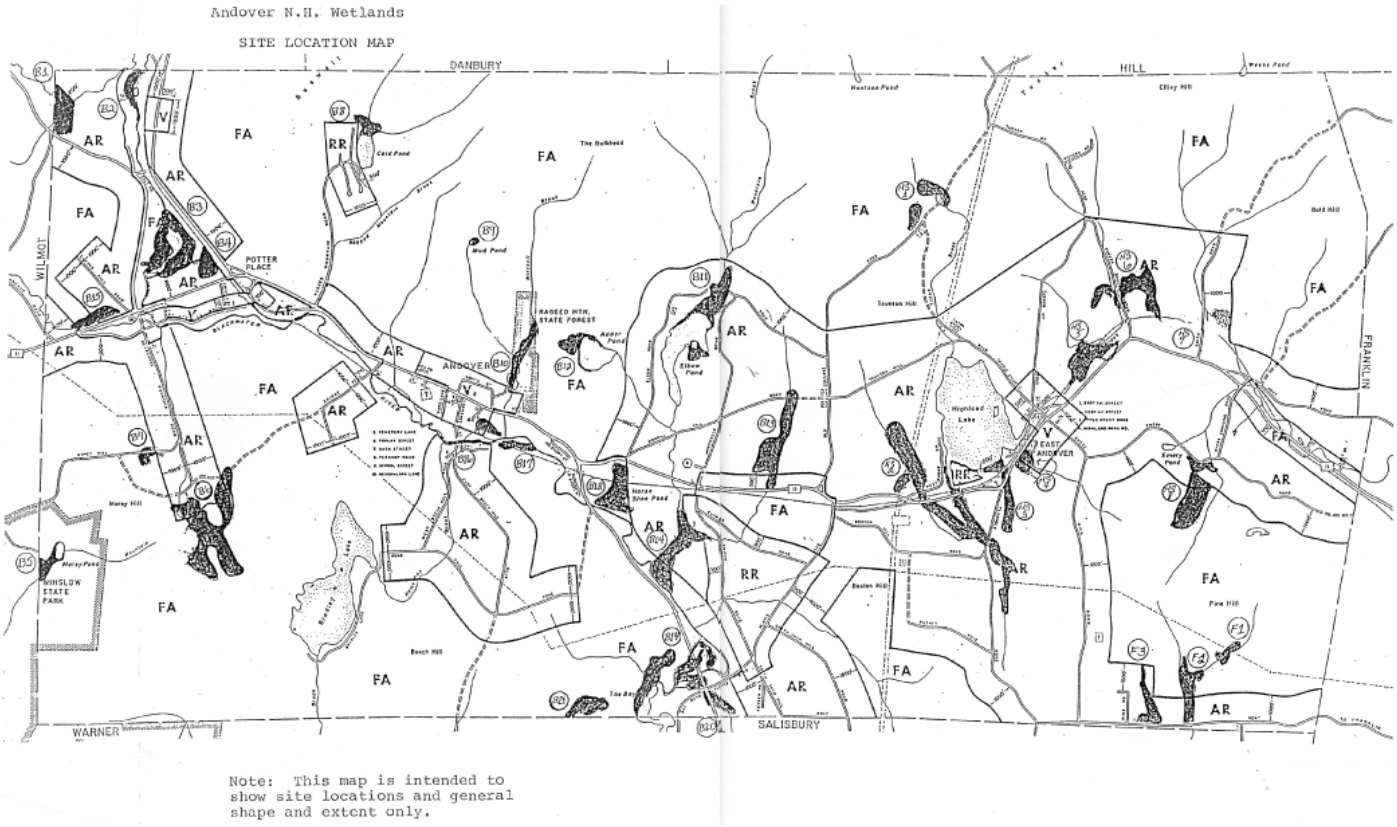

Figure 22. Prime wetlands shown on the 1974 zoning map of Andover (Mansell and Schnare, 1988). Wetlands are listed in table 7.

Prime wetlands of Andover		
Name	**Site (map) number**	**Weighted point value**
Blackwater Bay	B19	46
Dawes Meadow	B6	43
South Highland wetlands	HS2	42
Bog Pond	B3	39
Flaghole pond	F2	39
Sucker Brook section	HS6	36
Great Brook-Blackwater	B14	35
Public beach wetlands	HS3	35
Elbow Pond	B11	34
Morrill Hill marsh	B13	34
Morey Pond	B5	33
Horseshoe Pond	B18	31
Eagle Pond	B2	30
Cilleyville floodplain	B15	30
Mill Brook section	HS5	30
Kimpton Brook	B1	29
Hopkins (Adder) Pond	B12	27

Applecrest Lane pond	HS4	27
Emery Road wetland	HS8	27
Mitchell Brook marsh	B10	26
Ponds south of Blackwater	B17	26
Cole Pond	B8	25
AE/MS marsh	B16	25

Sites chosen because of 'other' considerations		
Heron rookery	B21	22
Flaghole muck and peat	F3	22
Mud Pond	B9	19

Table 8. Informally named prime wetlands of Andover from Mansell and Schnare.

The following sites were not included in the list of prime wetlands, but may be deemed worthy of evaluating in the field and adding in the future:

West Andover swamp	B4
Newt pond	B7
South of Plains Road	B20
Tilton Brook-Old College Rd	HS1
Smith Road section	HS7
Powerline muck and peat	F1

Because it received the highest rating, the Blackwater Bay area is summarized in the Natural Resources Inventory as an example of the fine work done by Derek and Susan for each of the wetlands evaluated and described. The Bays and buffer pollutants from nearby agricultural land and residents cite the natural beauty and peacefulness of The Bays area. When the Fenvale development in The Bays area was approved, Paul Fenton, Jr., gave a conservation easement to the Society for the Protection of NH Forests. The easement fringes the house lots along The Bays and includes the heron rookery (figure 23). However, due to natural decay of the trees over time, most of the tall nesting trees have fallen. Boy Scouts constructed and installed wood duck nests in the rookery pond one winter in the 1990s.

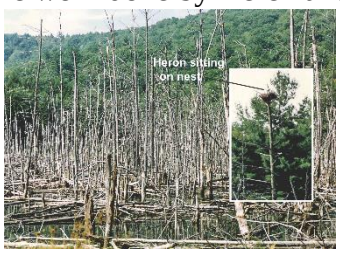

Figure 23. The Bays heron rookery.

As a Boy Scout Eagle project in 2000, Scott Kidder constructed a trail around the prime wetland adjacent to the Andover Elementary/Middle School to promote and enhance outdoor education.[55] This wetland is used for hands-on learning by local science classes. Heather L. Givens from the Department of Natural Resources at the University of New Hampshire[56] also studied this wetland saying, "…I found ten species of amphibians breeding in the wetlands—bullfrogs, green frogs, pickerel frogs, wood frogs, American

[55] http://www.andover.k12.nh.us/yvanovich/ytrail.htm.
[56] http://www.andover.k12.nh.us/yvanovich/study00.htm.

toads, spring peepers, gray treefrogs, spotted salamanders, and eastern newts… I saw northern leopard frogs in several places, but I did not find them breeding… I did find that some of the amphibians (spotted salamanders, spring peepers, and eastern newts) preferred wetlands that were surrounded by a lot of forest. Green frogs preferred wetlands that were closer to other wetlands. The reason for these preferences is probably because young amphibians, after reaching metamorphosis…travel to new wetlands to breed the following year. They need a friendly environment in which to do that traveling. For spotted salamanders, spring peepers, and eastern newts, a lot of their time is spent out of water, so they need cool, moist forests in which to travel. Green frogs, on the other hand, spend a lot of time in or near water, so they prefer to travel through areas with a lot of wetlands."

Several other photographs taken in 1987 illustrate the diversity found in Andover's prime wetlands (figures 24-30).[57]

Figure 24. Kimpton Brook wetland.

Figure 25. Elbow Pond wetland.

Figure 26. Morrill Hill marsh with hawk.

Figure 27. Eagle Pond wetland.

[57] Mansell, Derek and Schnare, Susan E., 1988, **An Inventory and Evaluation of Andover Wetlands**.

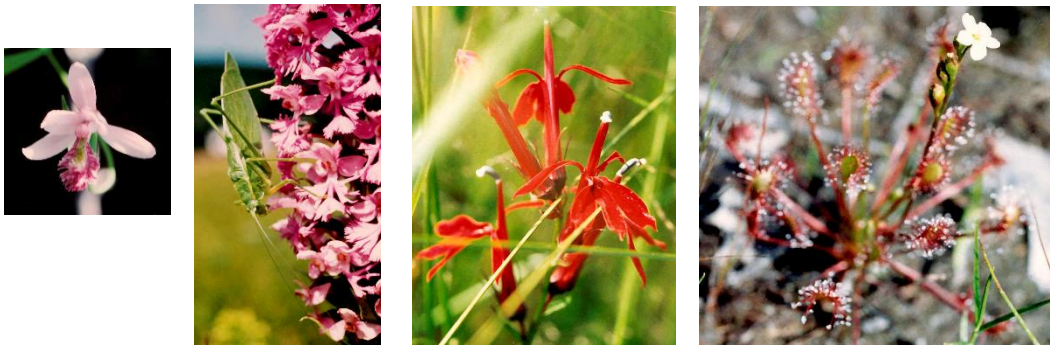

Figure 28. Wetland flowers. Rose pogonia, Hopkins (Adder) Pond; small purple-fringed orchid, Sucker Brook; cardinal flower and round-leaved sundew, Bog Pond.

Figure 29. Dragonfly, Cilleyville floodplain.

Figure 30. Bog fritillary, Bog Pond.

Wetlands not designated as prime can be inventoried and evaluated in a similar fashion.[58] This publication lists: functions, ecological integrity, wetland-dependent wildlife habitat, educational potential, fish and aquatic life habitat, scenic quality, wetland-based recreation, flood storage, groundwater recharge, sediment trapping, nutrient trapping/retention/transformation, shoreline anchoring, and noteworthiness. Data sheets for each of these items have associated questions. In late 2011 and online mapping tool, the NH Wetlands Mapper, similar to the GRANIT Data Mapper, will be available using 2010 aerial photography. Use of the NH Method is explained, as well as how to evaluate, interpret, and analyze the results. Having access to GIS software allows more flexibility.

The species of amphibians that use any given wetland is determined by their hydroperiod —defined as the length of time and portion of the year that a wetland holds water.[59] Understanding hydroperiod is an important initial step in guiding management decisions aimed at minimizing or avoiding loss or degradation of wetlands providing a significant amphibian breeding habitat. To conserve the greatest diversity of pond-breeding amphibians, wetlands should span all the hydroperiods listed below:

- Wetlands inundated for *less than four months* are functional and important components of the landscape. These wetlands may provide critical breeding

[58] Stone, Amanda L., and Mitchell, Frank, 2011, **Method for Inventorying and Evaluating Freshwater Wetlands in New Hampshire (NH Method),** University of New Hampshire Cooperative Extension, 150 p., http://extension.unh.edu/resources/files/Resource001874_Rep2706.pdf.

[59] Tarr, Matt, and Babbitt, Kimberly J., 2009, **The Importance of Hydroperiod in Wetland Assessment: A Guide for Community Officials, Planners, and Natural Resource Professionals**, UNH Cooperative Extension and UNH Department of Natural Resources, 25 p. http://extension.unh.edu/resources/files/Resource000812_Rep847.pdf.

habitat for fairy shrimp and may support wood frogs, spring peepers and American toads. During years when precipitation is high, these wetlands may support a greater diversity of amphibian species. These wetlands may also function as stepping stones for amphibians dispersing to new habitats.

- Wetlands with hydroperiods *at least four months* long are required by the majority of pond-breeding amphibians.
- Wetlands with hydroperiods *between four and 11 months* are especially important for supporting the widest diversity of amphibians and for protecting against complete reproductive failures during years with low precipitation.

Wetlands *without inlets or outlets* may be especially important to pond-breeding amphibians because they are less likely to support fish. Modifying wetlands with hydroperiods less than four months long may have less impact on amphibian species diversity than modifying non-permanent wetlands with longer hydroperiods. Recommended actions to preserve diversity of species in wetlands include:

- Avoid disturbances such as the construction of buildings, roads, and driveways within 300 feet of wetlands whenever possible. Outside the breeding season, adults of many pond-breeding amphibians regularly use upland habitats between 50 to 300 feet away from the nearest wetland.
- At a minimum, retain intact upland habitats between adjacent wetlands to provide suitable amphibian migration and dispersal routes.
- Retain cover objects such as leaf litter, surface stones, and fallen logs in corridors between adjacent wetlands and within 300 feet of all wetlands.
- Redirect new roads away from upland habitats between adjacent wetlands and at least 300 feet from wetlands when possible.
- When locating roads and driveways, avoid changes to surface water flow that will redirect water away from or into breeding wetlands. Such disturbances can alter the hydroperiod of affected wetlands.
- Avoid filling, ditching, draining, or deepening wetlands that provide functional amphibian breeding habitat.
- Avoid creating ruts in soils around wetlands during timber harvesting activities. Such disturbances can alter wetland hydrology and introduce sediment into wetlands that can interfere with the development of amphibian embryos and larvae.

Shoreland and Wetland Buffers

Large blocks of undeveloped forested uplands surrounding a wetland are essential for a healthy wetland and reduce the adverse effects of human activity. **Naturally vegetated riparian buffers are the single most effective protection for surface waters.** Vegetation in buffers intercepts rainfall, benefits water quality, slows melt water, promotes water infiltration, stabilizes stream banks to control erosion, provides habitat for species dependant on the wetland system, and provides travel corridors for larger mammals. Some wildlife species associated with shorelines may include the **American eel**, ***bald eagle***, bank swallow, **banded sunfish**, belted kingfisher, ***bridle shiner***, bullfrog, ***common loon***, common merganser, crayfish, dragonflies and damselflies, eastern chain pickerel, eastern kingbird, **eastern pond mussel**, eastern spotted newt, great blue heron, mink, moose, musk turtle, ***northern harrier***, northern water snake, **osprey**, painted turtle, raccoon, **redfin pickerel**, ring-billed gull, snapping turtle, warbling vireo, white sucker,

wood turtle, and yellow perch.[60] Bold type indicates species of conservation concern, while italics signify state-threatened or endangered species. A minimum buffer width of 100 feet around wetlands and other shorelines is recommended for wildlife species that are aquatic or that stay very close to the wetland edge, but 300 feet is desirable to maintain good habitat for terrestrial species, as well as loons and eagles.[61] Because of the impacts to human health of tainted water supplies, buffers wider than 100 feet should be prescribed around existing or potential water supplies.

Shorelines of lakes, ponds, rivers and streams are called **riparian** areas, corridors, or buffers. Wider, forested buffers are more effective than narrow, grassy ones and wider buffers are needed where the land is sloped, in a floodplain, or the land use is intensive with development, construction, and crops.[62] Table 9 summarizes buffer recommendations. Buffers along streams should be given priority over road setback requirements for buildings on small lot parcels.

Function	Buffer width, in feet
Stabilize banks	35 to 50
Filter sediment to protect water quality	35 if slope is less than 15 percent
Filter dissolved nutrients and pesticides to protect water quality	100 to 500; 100 feet removes about 60 percent of pollutants
Protect fisheries	At least 100
Protect wildlife	300 minimum
Flood control	Varies with size and topography

Table 9. Riparian buffer recommendations.

Because of the importance of buffers, the flagrant violation of them by residents, and the lack of protection in town regulations across the state, the NH Department of Environmental Services drafted a Comprehensive Shoreland Protection Act (CSPA)[63] which went into effect by legislation on July 1, 2008. Because of enforcement issues, this has evolved (2011) into the Shoreland Water Quality Protection Act (SWQPA) and the vegetative point system has been modified to include groundcovers.[64] Among other things are regulations on removal of vegetation and erection of buildings within a 250-foot setback from rivers 4th order and above and lakes and ponds greater than 10 acres. Jurisdiction also extends to wetlands and streams located within the protected shoreland. A good reference for landowners is **Landscaping at the Water's Edge: An Ecological Approach.**[65] published by the UNH Cooperative Extension Service in 2007.

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[60] Carpenter, Matt, Brunkhurst, Emily, and Clyde, Malin E., 2011, **Shorelines**, NH Wildlife Action Plan Habitat Stewardship Series, http://extension.unh.edu/resources/files/Resource001817_Rep2551.pdf.
[61] Chase, Victoria, 1995, revised 1997, **Buffers for Wetlands and Surface Waters**, **A Guidebook for New Hampshire Municipalities**, NH Office of State Planning, Audubon Society of NH, UNH Cooperative Extension, 82 p., http://extension.unh.edu/CommDev/Buffers.pdf.
[62] Connecticut River Joint Commission for New Hampshire and Vermont, 2000, **Introduction to Riparian Buffers,** Living with the river series, no. 1, 4 p., http://www.crjc.org/buffers/Introduction.pdf.
[63] NH Department of Environmental services, 2008, **Comprehensive Shoreland Protection Act**, 39 p., http://des.nh.gov/organization/commissioner/legal/rules/documents/env-wq1400.pdf.
[64] RSA 483-B, http://www.gencourt.state.nh.us/rsa/html/nhtoc/nhtoc-l-483-b.htm.
[65] UNH Cooperative Extension, 2007, **Landscaping at the Water's Edge: An Ecological Approach**, 93 p., http://extension.unh.edu/resources/files/Resource001799_Rep2518.pdf.

Water bodies (4th and 5th order streams, lakes, and ponds) affected by the SWQPA in Andover are:

Blackwater River	Bradley Lake
Cascade Brook	Cold Pond
Frazier Brook	Elbow Pond
Adder Pond (Hopkins Pond)	Highland Lake
Bog Pond	Horseshoe Pond

Septic systems, which generate excess nutrients and pathogens, not at the minimum recommended setback are potentially very detrimental to wetland systems. Septic systems have a finite useful life if not properly maintained; unfortunately, remediation is seldom done until the system fails. Hydric B wetlands are usually a waterbody's first defense against pollutants. Hydric B wetlands need just as much of a buffer as Hydric A soils to provide an acceptable rate (60 percent) of pollutant removal. Buffering wetlands and surface waters should be a part of a comprehensive natural resource protection plan.

As far as wildlife and instream habitats are concerned, the more free flowing a stream is, the better. Many dams in the state have been removed because they are no longer needed for power to serve mills; the dam at the former R.P. Johnson site was removed. In a similar scenario, natural bottoms retained in a culvert are desirable for sustaining aquatic species. **Culverts** have recently become an issue for creatures living and migrating in streams. Bridges and culverts should maintain a natural stream bed without changes in bottom height; bridges and culverts can restrict the natural stream channel, which could lead to upstream flooding. Larger culverts are better because they are less liable to wash out or be blocked by debris; square culverts allow more natural light and maintain the natural substrate, both of which simulate natural stream bottom conditions and stream velocity for migrating fish and amphibians. More expensive culverts are being produced that are open on the bottom (hoop shaped), but still maintain the strength needed to support vehicular traffic. Research by the Nature Conservancy and NH Fish and Game's Nongame and Endangered Wildlife Program have substantiated the importance of good culvert construction and installation.[66]

Beaver dams create ponds that have flooded roads. In the mid-2000s Elbow Pond Road was flooded repeatedly from beaver activity that blocked culverts on Mountain Brook. Raising the road bed and replacing the bridge only temporarily deterred the beavers. In 2008 the Conservation Commission hired Skip Lisle to install Beaver Deceivers that have been effective or else he will return and modify his installation.

Surface Water Resources

Andover's water resources consist of a hydrologically connected system of rivers, streams, brooks, small ponds and lakes, wetlands, and groundwater. Andover's surface and ground waters are intricately interconnected. Depending upon location and conditions, surface waters can recharge the groundwater or the groundwater can feed our

[66] NH Fish and Game, 2007, **Wildlines**, Nongame and Endangered Wildlife Program, 4 p., http://www.wildlife.state.nh.us/Wildlife/Nongame/Wildlines_issues/Wildlines_07_Summer.pdf.

rivers, ponds, wetlands and streams and keep surface waters flowing even during droughts. The quality and quantity of one can significantly affect the other.

Water resources are vital for plant and animal habitats. Undeveloped shoreline areas are essential for almost all wildlife species during some portion of their life cycle. Except in the Andover village area, residents rely upon clean groundwater from private wells, whether dug, well point, or drilled (so called 'artesian'). Rivers, streams, and ponds and the quality of their waters and shoreline, are very important to the quality of life for residents and visitors for fishing, boating, and swimming.

A **watershed** is an area of land that is drained by a river and its tributaries; watersheds are nested according to size and connected by the water flowing through them. Ridges or topographic highs separate watersheds. A watershed stores and sheds (run off) water. Andover lies within three larger watersheds, the Contoocook, Pemigewasset, and Merrimack River watersheds, that contain smaller watersheds of the Blackwater River, Highland Lake, and other smaller streams, which are nested within larger ones. Many intermittent streams in Andover are unnamed, flow seasonally, and are located in areas with poorly and very poorly drained soils, but these streams flow into larger perennial streams and rivers. Streams are classified by order (figure 31).

Headwater streams[67] are the beginnings of a stream and may start as wetlands or small trickles of flowing water that increase in size down gradient. Examples are mountain streams, sluggish valleys streams, spring-fed brooks, and warm rocky streams. Wide annual variations in flow and temperature have created unique adaptations of plants, amphibians, and insects to these changing conditions. The larvae of stoneflies, mayflies, and dragonflies live underwater while upland insects such as moths, beetles, and grasshoppers are on land. The concentration of insect food attracts bats, hawks, raccoons, and ribbon snakes. In addition, many bird species are attracted by the water and the food sources located nearby. Excess nutrients such as nitrogen from leaves are trapped by branches in the water thus helping water quality downstream. The water courses and their adjacent riparian corridors are important habitat and travel corridors for most of Andover's terrestrial wildlife. Increase the detail of specific areas in figure 31 by using the online digital file.

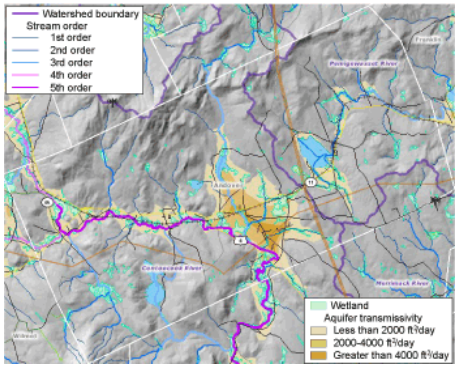

Figure 31. Watersheds, stream order, and transmissivity.[68]

Headwaters should be protected in town planning from development within 300 feet, adverse timber harvesting, storm water pollution, and inadequate culverts. Sediment from erosion can destroy spawning habitat and fill stream beds. Removal of streamside vegetation raises water temperatures and can destroy habitat for trout and other species.

Some species using headwater streams include **American eel**, **banded sunfish**, ***Blanding's turtle***, ***bridle shiner***, caddisflies, craneflies, cusk, dusky salamander, **eastern brook trout**, eastern spotted newt, ebony jewelwing, fishing spider, **little brown bat**,

[67] Carpenter, Mat, and Clyde, Malin E., 2011, **Headwater Streams**, NH Wildlife Action Plan Habitat Stewardship Series, http://extension.unh.edu/resources/files/Resource001817_Rep2551.pdf.
[68] http://mapper.granit.unh.edu/viewer.jsp.

Louisiana waterthrush, northern long-eared bat, northern water snake, **redfin pickerel**, riffle snaketail, spring salamander, **swamp darter**, two-lined salamander, and white sucker. Bold type indicates species of conservation concern, while italics signify state-threatened or endangered species.

Development pressure is increasing along Andover's rivers, streams, and lakes. There are no significant human withdrawals of water from Andover's streams or rivers, although water is withdrawn from the Blackwater River to irrigate athletic fields in Andover village. Bradley Lake is the public water supply source for the Andover village (see drinking water section). Dams disrupt the natural flow of rivers, can alter the cycles of high and low water, and block pathways for migratory species. As development pressures mount, Andover's surface waters may be threatened.

Floodplains

A typical river corridor has several features resulting from geological and hydrological processes. As the river current erodes the valley landscape and meanders through flatter lands, several features become prominent: wetlands form in depressions, floodplains form in level areas bordering the river, and older floodplains may eventually become terraces higher above the stream as the river continues to cut down through the sediments.

Flooding is a routine natural process that occurs when flows exceed the capacity of stream channels to carry them. The adjacent flooded lands, called floodplains, present unique properties and serve an important function because the velocity of the flow is reduced, thus reducing both lateral and downward erosion. Vegetation also helps slow the velocity of water. Stream water has a higher velocity in steeper areas and can rapidly erode the banks and stream bed in non-rocky sections. Transported material is deposited again when the velocity drops. As much as 80 to 90 percent of the sediment carried by flood waters can be deposited in floodplains, thus reducing the sediment-bound pollutants and nutrients that would have been carried downstream. Wetland plants and microorganisms then transform and neutralize the would-be pollutants.[69] Deposited material in the flat-lying areas is rich in organic and mineral matter. Because of these rich soils, many areas along the Blackwater River have been used to raise crops, especially corn.

Flooding can cause great economic hardship if buildings are located in the floodplain. The statistical possibility of flooding has been categorized as 25-, 50-, 100-, or 500-year storm event flooding, or once in 25 years and so on. Homes built within floodplains may have wells contaminated during flood events and the residents may have to boil their water until remedial efforts restore water quality suitable for drinking. Andover has several remaining dams, such as at Bradley Lake, Cold Pond, and Highland Lake, constructed primarily for recreational purposes, unlike the Franklin dam constructed for flood control.

[69]Madison, S., and Paly, M., 1994, **A World in our Backyard: A Wetlands Educational and Stewardship Program**, New England Interstate Water Pollution Control Commission, Chapel Hill, NC, Environmental Media Center.

Much of the forested area along Route 4 is a **floodplain forest**[70] that may contain uncommon plants and animals and an important reservoir of biodiversity. Some areas of this floodplain have temporary vernal pools and oxbows (remnants of the former river course) and dense shrub thickets. Some wildflowers, ferns, trees, and shrubs tolerate periodic flooding and thrive only in these nutrient-rich soils. In return, these plants help filter pollutants and sediment, improve water quality, control erosion, and serve as a buffer against catastrophic flooding.

Damp floodplain soils create rich insect and amphibian breeding habitats, which become prey for birds, including woodcock and barred owl, mammals, such as mink and raccoon, and reptiles, such as smooth green snake and **wood turtle**. Spring flooding thaws the soils of floodplains earlier than in uphill areas, which means early spring migrating birds have an earlier food source along floodplain corridors. The overhanging tree canopy keeps the water cool enough in the summer to support brook trout. Additional wildlife closely associated with forested floodplains include **American black duck,** Baltimore oriole, belted kingfisher, blue-gray gnatcatcher, **Cerulean warbler, eastern red bat,** green heron, **Jefferson salamander, northern leopard frog,** otter, red-bellied woodpecker, **red-shouldered hawk, silver-haired bat, wood turtle,** and yellow-throated vireo. Species listed in bold are species of conservation concern. The Cerulean warbler was documented along the Blackwater River in Salisbury. Development can permanently eliminate many of these species and paved roads inhibit migration. Dams can prevent natural flooding that these species need. 'Run-of-river' dams that use available river flow by not storing water behind the dam allow for a more natural flow.

Leaving floodplains as open space is environmentally, ecologically, and economically prudent and provides a scenic resource for recreation and other minimal human disturbances. In summary, a natural floodplain has many benefits: enhancing stormwater management by storing flood waters; moderating flood damage; recharging groundwater; improving water quality, recreational opportunities and aesthetics; sustaining economic prosperity; preserving wildlife and natural habitats; sustaining biological productivity; enhancing erosion control; increasing property values; preserving cultural resources; and maintaining natural systems.

Vernal Pools

Little is known about the number and location of vernal pools in Andover. Given their importance for maintaining biodiversity, this is unfortunate. One of the problems is that vernal pools are not easy to identify for most of us and people need to know what to look for.[71] Although vernal pools are classified as wetlands, the pools may vary in size from a few square feet to a number of acres and may be located in a number of different sites—woods, floodplains, fields, swamps, or gravel pits.

Vernal pools do have certain features in common. They appear in the same place year after year, but are defined as a temporary bodies of water because most dry up in hot

[70] Clyde, Malin Ely, 2008, **Floodplain Forests,** NH Wildlife Action Plan, Habitat Stewardship Series, http://www.wildnh.com/Wildlife/Wildlife_Plan/Habitat_stewardship/Hab_Floodplain_Forests.pdf.
[71] Tappan, Anne, 1997, **Identification and Documentation of Vernal Pools in New Hampshire**, NH Fish and Game Department Nongame and Endangered Wildlife Program, 76 p., http://www.wildnh.com/Wildlife/Nongame/RAARP/Vernal_pool_manual.pdf.

weather or times of drought. All are contained bodies of water without a permanent outflow.[72] Vegetation in and surrounding a vernal pool varies considerably. Some may contain sphagnum moss, sedges, ferns, high-bush blueberries, or buttonbush. They may be fringed by red maple or eastern hemlock. They may only appear as dark, matted leaves within a depression.

Vernal pools do not support fish and, therefore, are excellent breeding grounds for species whose eggs, tadpoles, and larvae would provide an excellent food source for fish. Some indicator species are so dependent on vernal pools for their survival that their very presence is enough to establish that a particular basin of water is a vernal pool. Several indicator species include wood frogs, salamanders, and, perhaps the best indicator, fairy shrimp. The wood frog sounds very much like the quacking of ducks and is an early sign of spring. This frog is brown with a black mask, and is commonly seen in the woods during the summer. Many other species use vernal pools although they do not have the same dependency upon them; these may include: the four-toed salamander; Eastern and red-spotted newts; spring peeper; American and Fowler's toads; gray tree, green, bull, and pickerel frogs; snapping turtle; eastern garter snake; damselflies; dragonflies; giant water bugs; clam shrimp; fingernail clams; and amphibious snails; caddis flies; and other aquatic insects. No reptile is an indicator species. The **spotted turtle**, the earliest turtle to appear in the spring, often uses vernal pools as a source of food and a place for courtship and mating. **Blanding's turtle**s have been known to overwinter in vernal pools. Both of these species, as well as the **blue-spotted, Jefferson** and ***marbled*** (state endangered) **salamander**s, the **northern leopard frog**, **ribbon snake**, and **wood turtle,** are of special conservation concern.

At present vernal pool protection is best accomplished at the municipal level by combined efforts of landowners and town boards. Development is the biggest threat to vernal pools because they are filled during re-grading of the land, the cooling forested canopy is removed, roads cut across the migration routes of the amphibians, the water table is altered, runoff can introduce pollution, and many species are killed by vehicular traffic. All development should be at least 300 feet away from vernal pools and other wetlands. **Although vernal pools provide crucial breeding and foraging habitat for a variety of species, populations of these species will NOT be maintained without adequate protection of surrounding uplands**. Many amphibians breed annually in the pools in which they were hatched. If the pool no longer exists, the amphibian may cease to exist as well. Amphibians spend most of the year in nearby woodlands, most within 600 yards of the wetland. Some vernal pools may require 30 acres of undisturbed upland drainage area to thrive. NH Fish & Game Non-Game and Endangered Species Division and the Audubon Society of NH have forms for documenting vernal pools and the sighting of reptiles and amphibians seen in them. Photographs are very helpful.

Groundwater Resources

Water in the saturated zone (below the water table) under the surface of the earth is called **groundwater**. The water table roughly approximates the land surface but in a more subdued, gradual state. Groundwater and surface water are interconnected. Where the

[72] Clyde, Malin Ely, 2008, **Vernal Pools**, NH Wildlife Action Plan, Habitat Stewardship Series, http://www.wildnh.com/Wildlife/Wildlife_Plan/Habitat_stewardship/Hab_Vernal_Pools.pdf.

water table intersects the land's surface, groundwater becomes surface water. Depending on the site, the time of year, the weather, and nearby withdrawals and discharges, groundwater may discharge to surface water or vice versa. Precipitation seeps down from the surface into soil, unconsolidated deposits, and rock (**infiltration**) to the water table (**saturation**). Like surface water, groundwater also moves but more slowly. The movement of groundwater is driven by gravity, which creates a hydraulic head, or water pressure. Groundwater moves from areas of high head to areas of low head. Pumping a well creates an area of low hydraulic head, causing groundwater to move from the surrounding area toward the well. In general, the greater the amount of water being pumped from a well, the greater the area of land that contributes water to the well. This is why in densely populated areas served by private wells and septic systems, drinking water can be compromised by septic leachate. A wellhead protection area is an approximation of the contributing area. Paul Currier was instrumental in implementing the Wellhead Protection Program to prevent contamination of groundwater used for drinking water in public water supply areas.[73]

An **aquifer** is a formation, group of formations, or part of a formation that contains sufficient saturated, permeable material to yield significant quantities of water to wells and springs. Sand and gravel aquifers are generally more productive (quantity) than bedrock aquifers. The flatter areas of town that follow major drainages generally have sand and gravel aquifers. These are glacial deposits of sand and gravel that hold significant amounts of water in the pore spaces between the particles of sand and gravel. This groundwater is continuously replenished by rain and sometimes by surface water. John Cotton was instrumental in seeing that the aquifers in the stratified drift (layered, loose sands and gravels primarily of glacial origin) of the state were mapped in a reconnaissance study in the 1970s that was followed by more detailed work in the 1980s and 1990s. Most of the detailed mapping in Andover was done by him. Andover was given copies pertinent to the town of the reconnaissance and more detailed maps and reports, which include some well locations and logs. Recognizing that bedrock also contained significant amounts of groundwater in fractures, he initiated a bedrock lineament study for the state. These maps are also at town hall.

The air spaces (**porosity**) between grains of sand and other unconsolidated material are filled with water beneath the water table (**saturation zone**). The size of and degree to which these spaces are interconnected (**permeability**) determines how easily groundwater can flow through them. **Transmissivity** integrates permeability over the saturated thickness. Transmissivity is the rate that water travels (is transmitted) through a unit width of the aquifer under a unit hydraulic gradient. Transmissivity is the all important factor in determining whether the flow, water storage, and recharge rates are adequate for a public water supply. Obviously, the greater the porosity, transmissivity, and total storage area, the greater the available ground water supply, assuming adequate recharge from precipitation and no excess of withdrawal or surface runoff due to impervious surfaces.

Historically, wells were dug near where the water was used. The best wells in terms of digging and yield are in sand and gravel areas (stratified drift aquifers, see geologic

[73] NH Department of Environmental Services, 2007, **Delineating Wellhead Protection Areas**, Fact Sheet WD-DWGB 12-2, http://des.nh.gov/organization/commissioner/pip/factsheets/dwgb/documents/dwgb-12-2.pdf.

resources section) where the water table remains sufficiently high throughout the year, typically 10 to 20 feet below the land surface. Sand and gravel aquifers generally are less than 100 feet deep and follow the major stream valleys. Upland areas are generally covered with glacial till, which commonly has a characteristic hardpan layer at shallow depth. Till is a dense mixture of clay- to boulder-sized material with small-sized pore space and slow water movement that results in a low water yield and higher recovery time. Many shallow wells are vulnerable to contamination. As household demand for water has increased, many residents have replaced dug wells with drilled bedrock wells, which generally are more reliable in dry seasons and less susceptible to contamination. Well points are also used in sand and gravel areas.

The stratified drift aquifers in Andover fall generally in the middle of the town's development. Although this is not necessarily a good thing, it is normal for a town to be developed around its main sources of water. When towns were originally developed and transportation was not easy, being close to water was a main priority; roads followed the gentle stream valleys and water power provided energy for mills. The water resources map (figure 32) shows where these aquifers and conserved land overlap in Andover. The darker the aqua-colored areas, the more favorable the area is as a potential water source.

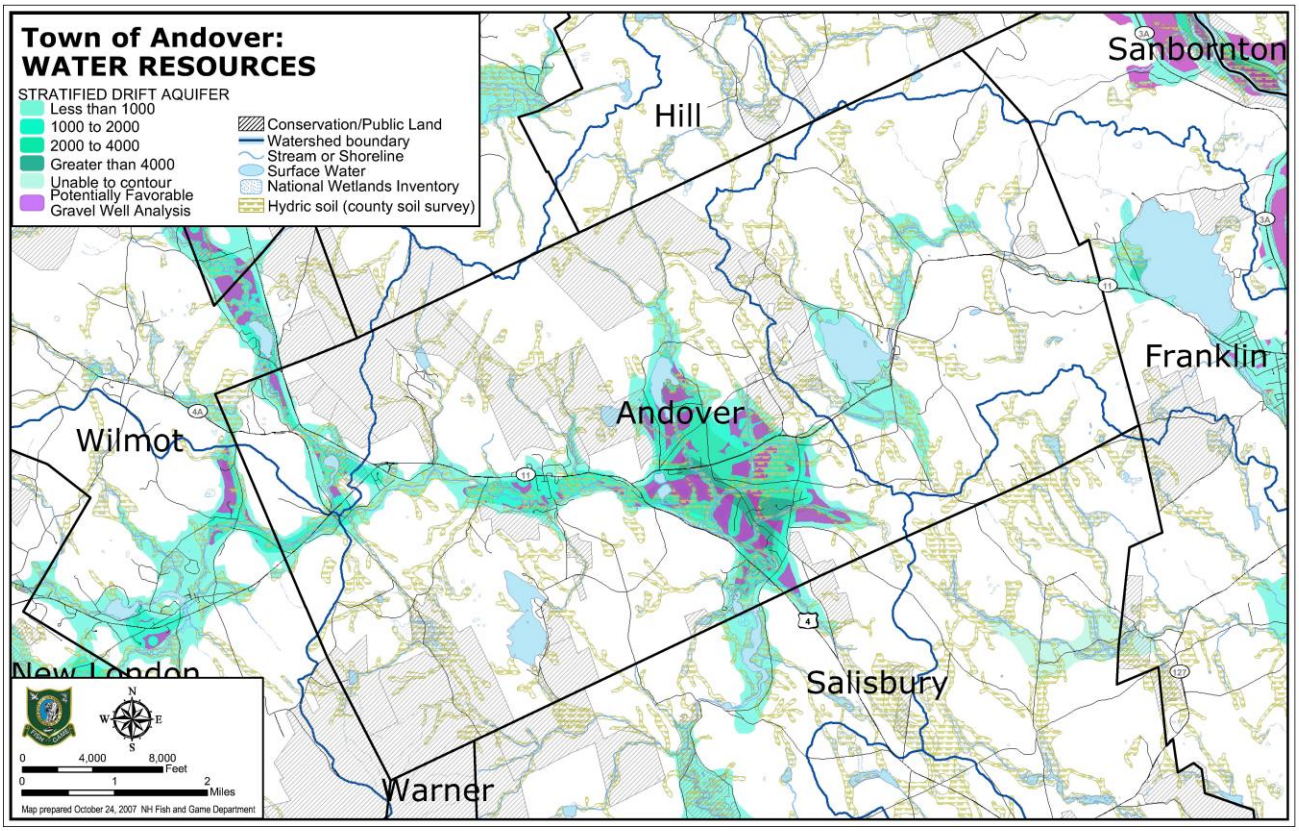

Figure 32. Water resources map of Andover, 2007.[74] Increase the detail of specific areas in this figure by using the online digital file

[74] NH Fish & Game Department. 2005, revised 2007, **Wildlife Action Plan**. Concord, http://www.wildlife.state.nh.us/Wildlife/wildlife_plan.htm.

Groundwater is vulnerable to contamination, most commonly from leaking underground storage tanks, poorly maintained septic systems, improper disposal of hazardous chemicals, or vehicular accidents (see section on contamination sources). Most gravel pits are located over aquifers. Land over aquifers is relatively level and easily excavated for development. The identification and careful monitoring of land uses near aquifers is important. Many towns have adopted an aquifer protection ordinance that, for example, requires lot sizes to be a minimum of three acres and have no more than 10 percent of an impervious surface (buildings, driveways, see impervious surfaces section). The ordinance also may prohibit certain activities, such as auto repair and hazardous waste storage, to protect the underlying aquifer. Andover should consider such an ordinance to protect its aquifers for the future if regulations change to prohibit using surface water (Bradley Lake) for a public water supply and to protect our aquifers if we need to expand the public supply to other village districts. Similarly, a groundwater protection ordinance could be considered.

Aquifer **recharge** is the process by which rainwater and snowmelt seep through the soil into the aquifer. Many natural processes determine how much water actually becomes groundwater and how much evaporates, how much is consumed by plants and animals, or how much runs off the ground surface into surface water bodies. In addition to eliminating contamination sources, water must be allowed to seep into the ground (**infiltrate**) in order to protect both the quality and the quantity of water in an aquifer. Much attention has been directed to the importance of protecting surface waters and wetlands from being filled in and contaminated, but much less effort has been directed towards protecting critical aquifer recharge areas—areas where contamination could directly impact potable water supplies. Requiring new developments to retain all stormwater and melt water on site would help maintain pre-development levels of recharge.[75] The NH Department of Environmental Services website provides much additional information on groundwater and water resources.

Large groundwater withdrawals not associated with community water systems that might occur in Andover include: bioenergy, ball fields, agriculture, light industry using water for cooling/product ingredient/transfer media/or sanitation, skiing, landscape nurseries, and lumber yards. These larger withdrawals might impact community or private water sources, water-dependent natural resources, traffic/emission of pollutants, or might be incompatible with existing land use. The protection of water sources for others could be safeguarded by hiring a licensed geologist or engineer, who could review well completion records, install long-term water level monitoring equipment, review geologic maps, or measure stream flow to estimate recharge rates and instream low-flow rates.

Drinking Water

Arden L. Bement, Jr., Director of the National Science Foundation, stated that water links natural systems and human social systems. One of the greatest environmental and economic challenges of this century is to ensure an adequate, high-quality water supply for human use while maintaining the integrity of ecosystems.

[75] NH Department of Environmental Services, 2009, **New Hampshire Stormwater Manual**, http://des.nh.gov/organization/divisions/water/stormwater/manual.htm.

The majority of drinking water supplies in Andover are from private bedrock wells, so called 'artesian' wells, ranging in depth from 145 to 550 feet below ground surface and from much shallower dug wells or well points. While the average water use per person per day in New Hampshire is about 100 gallons, only 2 to 3 gallons of this is used for consumption and cooking; 70 gallons are used indoors (half for toilets and washing machines) and the remaining 30 gallons are used outdoors.[76] Clearly, not all of this consumption needs to be of drinking water quality and gray water could be substituted. In general, the smaller the living quarters, the less water is used.

Sand and gravel aquifers can yield moderate to large sustained yields from groundwater that is generally of good quality. Bedrock wells are deeper, tend to have a lower yield, are more expensive to develop, and can have water quality concerns such as iron, manganese, and, in some areas, arsenic. Contamination from septage has been a problem in dug wells where house lots are small and the distances between wells and septic systems are too close. Andover can help alleviate this problem with appropriate zoning and planning. The NH Department of Environmental Services has a database of privately owned water wells that have been installed or replaced since 1984. Well drillers turn in logs of stratified and bedrock material penetrated, which reveal information on the underlying material beneath the surface. These well records also note total depth of the well, depth to bedrock, static water level, and measured yield.

Bradley Lake is the source of water for the Andover Village District, which has 117 service connections (2011). Water quality from Bradley Lake does not meet state standards for a public water supply without treatment. The Andover Village [Water] District is responsible for treatment. State regulations concerning the Bradley Lake public water supply are stated in **Env-Ws 386.10** Protection of the Purity of Bradley Lake and Its Watershed. Among other stipulations:

"…g (1) A person shall not build, continue or maintain a privy, pig-pen, stable, or other buildings or structure in which horses, cattle, swine or other animals or fowls are kept within 75 feet of Bradley Lake or within 75 feet of any inlet or tributary thereto;
(2) A person shall not permit urine, sink water, or water that has been used for washing or cleansing materials, persons or food, to run into said lake, or into any inlet thereof, or into any cesspool, septic tank or other excavation or onto the surface of any ground within 75 feet of said lake, meaning the high water mark;
(3) A person shall not deposit or throw a dead animal, or fish, or parts thereof, kitchen waste, garbage or refuse of any kind, nor manure of either human or animal origin, into said lake, nor shall they leave or permit such materials to remain within 75 feet thereof;
(4) A person shall not permit the activities or conditions described in (1), (2), and (3) above within the watershed area tributary to Bradley Lake even though beyond the minimum limit of 75 feet, if the purity of the water shall be deemed by the department to be endangered in accordance with the criteria in Env-Ws 386.03;
(5) A person shall not permit sawdust to be thrown or allowed to fall into said lake or into any inlet thereto;
(6) A person shall not permit any domestic animals to enter said lake;

[76] Pillsbury, Sarah, Currier, Paul, Susca, Paul, editors, 2008, **New Hampshire Water Resources Primer,** NH Department of Environmental Services, p. 8-5, http://des.nh.gov/organization/divisions/water/dwgb/wrpp/primer.htm.

(7) A person shall not swim or bathe, nor shall a person fish in the waters of said lake south of a line drawn from a point on the easterly shore approximately 1700 feet north of the present water supply intake to the point on the westerly shore located by describing an angle of 90^{o} from the true north direction; and
(8) A person shall not use seaplanes on said lake…"

Public hearings were held in 2011 to permit fishing throughout the lake and allow swimming and domestic animals in the northern part of the lake marked by the power line, instead of the provision of g (7) above, to more accurately reflect common practice.

Mike Vercelloti, formerly an Andover Village [Water] District commissioner, summarized the public water supply in applications for a 2008-09 and 2009-10 grant from the NH DES through the local source water protection program, but neither received funding.

"The Andover Village Water District (AVD) water system serves over 900 people within the village of Andover, New Hampshire including the Andover Elementary Middle School (AEMS), Proctor Academy (PA), businesses, professional offices, town government buildings, the Post Office and about 90 single-family and multifamily homes. The AVD is a public water system which is funded through user fees with the annual operating budget reviewed and approved by the Town of Andover Budget Committee. Water distribution system piping was installed in approximately 1910 to deliver water from an intake on the southern portion of Bradley Lake to the former Hame Shop, PA and Andover Village."

"A surface water filtration plant was constructed above the village off of Hall Road in 1994 to comply with the surface water filtration requirements of the federal Clean Water Act. The filtration plant has peak flow capacity of 180 gallons per minute (gpm) through two banks of three ceramic media pressure filters manufactured by Kinetico Systems, Inc. Potable water is stored in one 100,000 gallon tank at the Hall Road filtration plant and one 200,000 gallon tank located on Ragged Mountain above Proctor Academy. The AVD monitors the system water quality consistent with New Hampshire Department of Environmental Services (NHDES) requirements."

"The protection of the pristine Bradley Lake water shed is critical for the AVD to continue to provide safe drinking water for the village. The Town of Andover and NHDES have taken measures to protect the purity of Bradley Lake and its watershed by establishing New Hampshire Code of Administrative Rules Env-Ws 386.10…"

The protection of Bradley Lake as a public water supply extends beyond the surface water body of the lake itself. Care must be exercised for the whole Bradley Lake watershed seen in figure 33. Community water systems, defined by RSA 485:1-a, have at least 15 service connections or serves at least 25 people for 60 or more days per year. The testing frequency for possible contaminants varies according to the type of system and number of people served. Testing can vary from only monitoring for bacteria, nitrate, and nitrite to more than 100 contaminates. Bradley Lake volunteers tested for total phosphorus, acid neutralization capacity chlorophyll-a, conductivity, pH, clarity (Secchi

disk), turbidity, and chloride in 2011. The results indicated that Bradley Lake is an ogliotrophic lake with low algal production and clear water with high drinking-water quality. Public water supplies also are used at the Andover Congregational Church, Proctor Academy including mountain classroom on Elbow Pond, Continental Machine, former Potter Place Inn, Circle K Convenience Store in Potter Place, Blackwater Ski Area, Bluewater Lodge, and similar establishments.

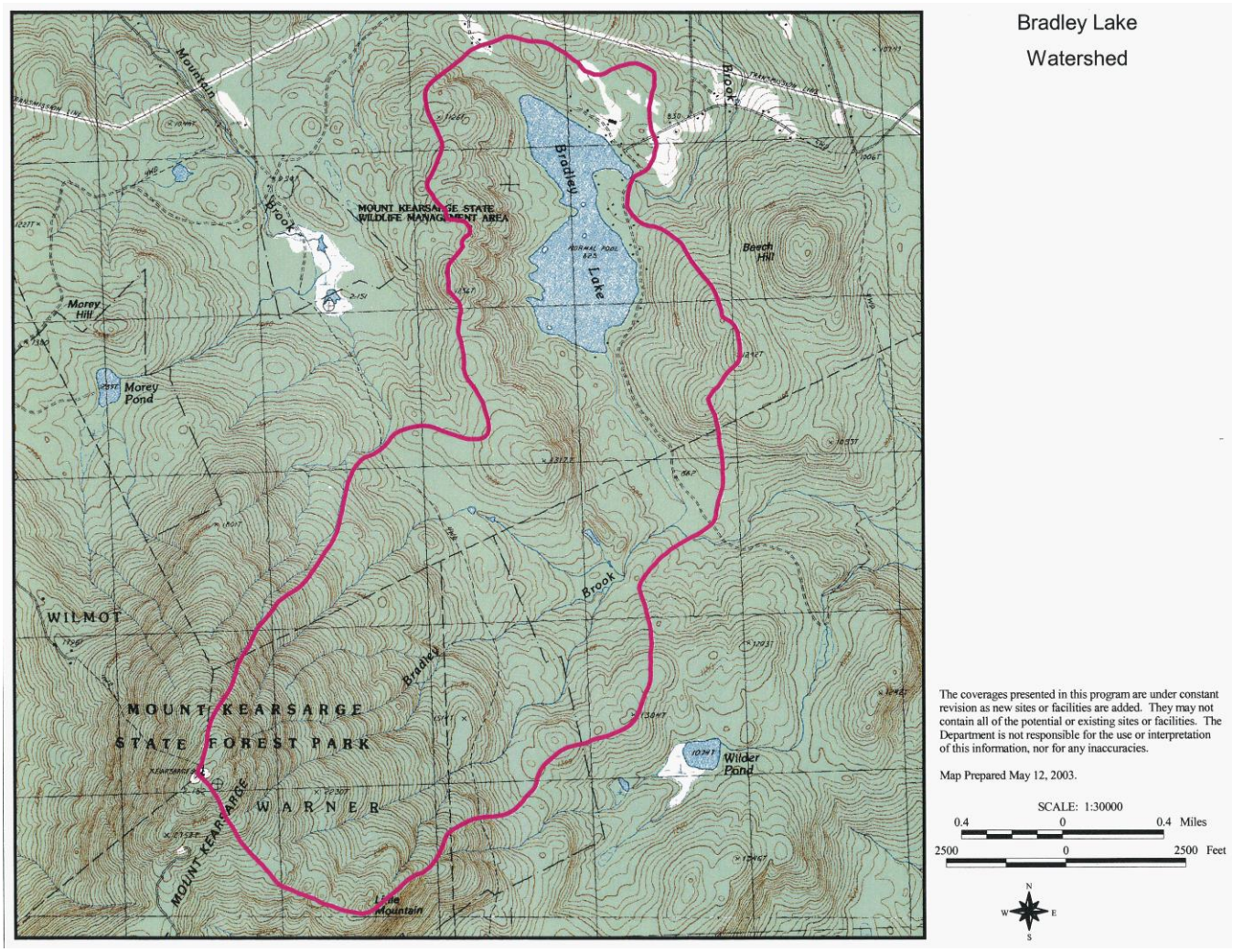

Figure 33. Bradley Lake watershed prepared by the NH Department of Environmental Services.

Several sections from the **New Hampshire Water Resources Primer** are worth quoting: "New community wells must be located at least 150 to 400 feet (depending on the yield of the well) from existing development. As a consequence, nearly two-thirds of the 328 square miles of high-yield stratified-drift aquifers in New Hampshire that have the potential to support wells yielding 75 gallons per minute or more are already unavailable as future well sites, not because of ownership, but because of nearby development. Predictably, the situation is worse in areas where water demand is likely to grow the most…"

"**Land use decisions, which are largely under the control of local planning and zoning boards, are critical in either protecting groundwater or placing it at risk for contamination or depletion.** The protection of groundwater resources, therefore, depends on the ability of planning and zoning boards to make well-informed decisions that balance groundwater protection goals with other local goals such as economic development…"

"At the same time, the effectiveness of groundwater protection measures enacted in some communities is compromised when they are not consistently applied, such as when local zoning boards grant variances to land use restrictions. While the solution to this problem is not quite clear, municipalities would probably do well to ensure that their groundwater protection programs are carefully crafted, frequently reviewed and updated, consistently applied, and well understood by officials as well as the public…"

"Increased public education and awareness regarding groundwater is needed in several areas. First, improved public awareness of groundwater would enable citizens to make better informed decisions regarding the protection and management of groundwater on the community level. Second, improved awareness would enable residents to make more responsible decisions regarding their own use and handling of hazardous substances and other potential pollutants. This would help ensure proper storage, use, and disposal of household chemicals and other pollutants with the potential to contaminate groundwater. Finally, because the quality of water supplied by private wells is not monitored or regulated by state programs and few municipalities require testing prior to occupancy or real estate transfer, the responsibility for testing and monitoring lies solely in the hands of the water user. Improved awareness of private well issues would enable private well users to make better informed decisions about testing and treating their water supply." [77]

Homeowners with private wells should be aware that at least a 75-foot protective radius around the well is recommended by the state; this includes a setback from property lines, septic systems, stump dumps, livestock pens, and similar conditions. For more information on protecting drinking water supplies, the NH Department of Environmental Services (DES) has many useful fact sheets including Site Selection for Private Drinking Water Wells and Protecting Public Drinking Water Sources Based on Source Assessment Reports that can be found at the NH DES web site.

Ordinances might be considered to protect water levels in streams and lakes, maintain stable ground-water levels inasmuch as possible, and protect sources of drinking water.[78] These could prohibit certain land uses in defined areas through environmental-characteristics zoning or enforcing provisions in the Goundwater Protection Act. In addition to septic contamination, other substances may occur in the groundwater including MTBE, other volatile organic compounds (VOCs), nitrate, nitrite, fertilizers with phosphorus, medicines, pesticides, bacteria, copper, arsenic, uranium, radon, iron, manganese, hydrogen sulfide, fluoride, lead, beryllium, animal waste, and methane. Increasingly, toxic 'blue-green algal blooms' or cyanobacteria, have caused water

[77] Pillsbury, Sarah, Currier, Paul, Susca, Paul, editors, 2008, **New Hampshire Water Resources Primer,** NH Department of Environmental Services, http://des.nh.gov/organization/divisions/water/dwgb/wrpp/primer.htm.

[78] New England Interstate Water Pollution Control Commission, 2004, **Protecting Drinking Water Sources in Your Community: Tools for Municipal Officials, Water Today…Water Tomorrow?,** 52 p., http://www.neiwpcc.org/sourcewateroutreach/.

problems, such as at Webster Lake in Franklin. Homeowners can have their tap water tested for various substances; testing is recommended every three years. If amounts in excess of recommended limits exist, remediation through treatment and backflow prevention devices may be in order.

Contamination Sources

Groundwater quality can be impaired by landfills, commercial and industrial wastes, agricultural fertilizers, human and animal sewage, and road salt, as well as background arsenic, hydrogen sulfide, and, commonly, iron and manganese. NH Department of Environmental Services (DES) has mapped known and potential contamination sites as part of a groundwater hazards inventory (figure 33). Known sites are where contamination of the soil or groundwater has occurred and has been cleaned up or is being monitored by DES. Impervious surfaces can also increase contamination.

Although Andover has several community septic systems, the largest of which serves Proctor Academy, most residents have individual septic systems. Pollution of private wells has occurred from proximity to or failure of septic systems. Many residents do not realize or heed the signs of a failing septic system. According to DES, an estimated 35 percent of all unused medications and personal care products are flushed into wastewater systems. Garbage disposals are known for clogging pipes, tanks, and leach fields because of the grease component. Small summer camps along shorelines that are converted to larger, year-round homes generally do not have the capacity to handle the increased load on septic systwms. As a result, sewage and bacteria may pollute groundwater and surface water. Unsafe levels of coliform bacteria have forced temporary closures of the public beach on Highland Lake. The Highland Lake Association tests the water each summer for various levels of bacteria, chlorophyll A, algae, and clarity. DES and the U.S. Environmental Protection Agency (EPA) websites have links to information on septic systems and remediation for failed septic systems. If properly cared for and regularly pumped, a septic tank and well constructed leach field could last a lifetime.

The EPA erroneously lists an area in the Plains as a Superfund site. Monitoring of the former McLeod landfill site on Monticello Drive has been ongoing since its closure. John Cotton filed the required annual documents with DES addressing the latest revision of requirements in 2011. Contamination has been decreasing over time and there are no areas of concern.

Road salt has contaminated wells along the heavily treated state roads. Several new wells have been installed by DES for homeowners affected in Andover. Instances of fuel oil contamination have also been remedied by DES in Andover. The NH Department of Transportation storage sheds by Route 11 and Currier Road for equipment and road salt storage have been covered for many years to reduce contamination of the aquifer and private wells in the area.

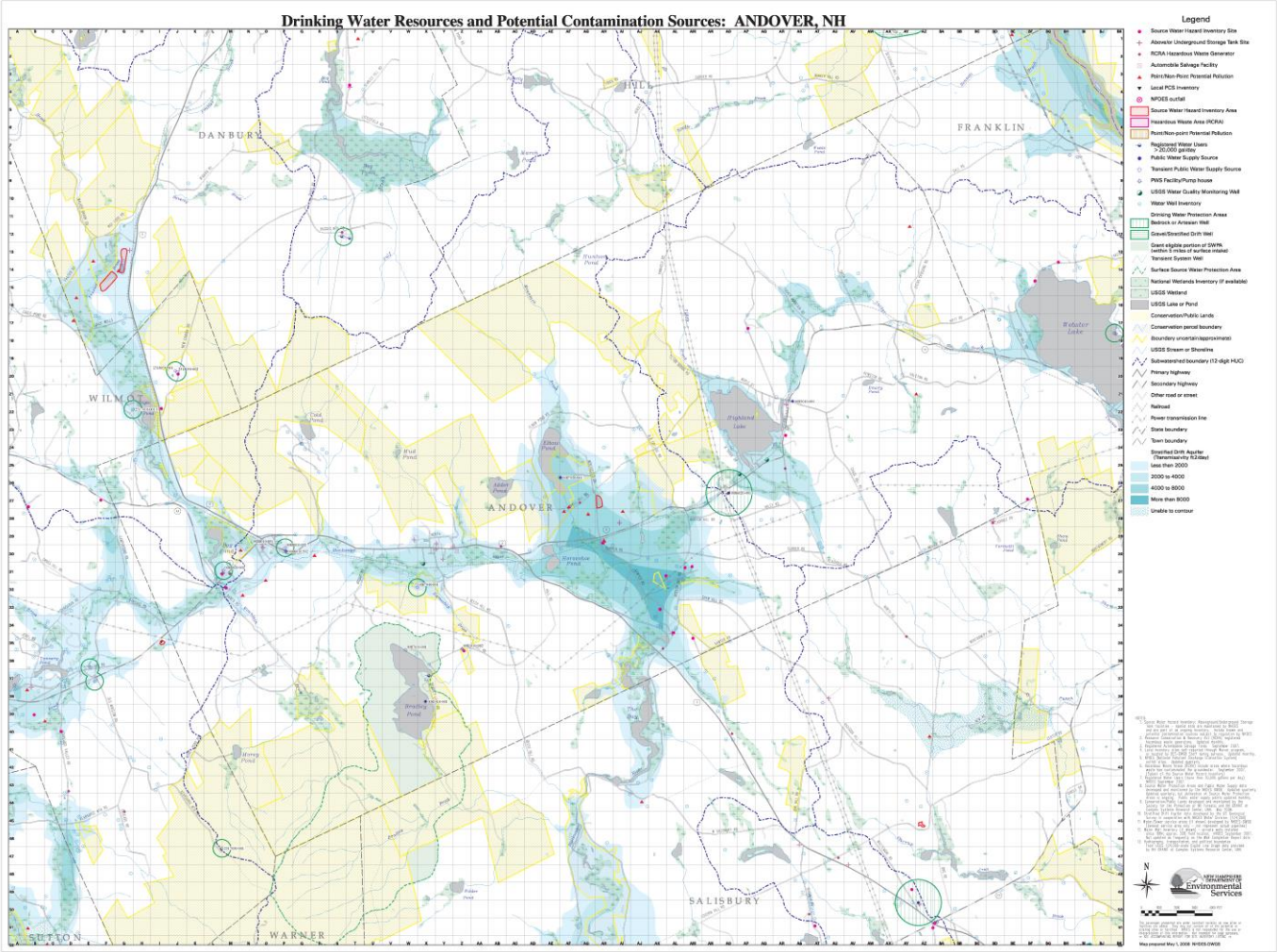

Figure 34. Inventory of public water supply sources and potential and existing sources of groundwater contamination in Andover.

The map of the drinking water and possible sources of contamination (figure 34) was prepared by the DES Drinking Water and Groundwater Bureau in May 2008. This map has an incredible amount of detailed information and provides invaluable information for town planning purposes, both for areas worth preserving and areas of potential risk. Zooming in on the map increases legibility. The blue (aqua) colored areas are aquifer areas. Of particular note is the Bradley Lake area where a large expanse (the entire Bradley Lake watershed shown in figure 32) is delineated as a surface-water protection area and a smaller area, especially on the western flanks adjacent to the lake, is shown as eligible for grant money through the Surface Water Protection Act. Although Andover is fortunate in having no large areas of hazardous, point, or nonpoint potential pollution areas, a number of small places exist due to automobile repair facilities, storage tanks, landfills, and similar human activities. Most of these possible contamination sites are in red, whereas most of the well or water supply sites are in blue. The possible contamination sites database includes a groundwater hazard inventory, remediation sites, and initial response spill sites regulated by DES to ensure water resource protection. Typical commercial sources of contamination are given in table 10. Individuals should also be aware that many domestic activities can contaminate groundwater, such as

washing cars in the driveway, leaving pet waste on the ground, fertilizing lawns, allowing oil to leak from the cars, and spilling gasoline while filling lawn mowers.

Potential Contamination Sources[1]	
• Vehicle service and repair shops • General service and repair shops • Metalworking shops • Manufacturing facilities • Underground and above-ground storage tanks • Waste and scrap processing and storage • Transportation corridors • Septic systems (at commercial and industrial facilities) • Laboratories and certain professional offices (medical, dental, veterinary	• Use of agricultural chemicals[2] • Salt storage and use • Snow dumps • Stormwater infiltration ponds or leaching catch basins • Cleaning services • Food processing plants • Fueling and maintenance of earth moving equipment • Concrete, asphalt, and tar manufacture • Cemeteries • Hazardous waste facilities
[1] As identified in New Hampshire's Groundwater Protection Act (RSA 485-C:15). [2] Subject to BMPs developed and administered by NH Department of Food, Agriculture, and Markets.	

Table 10. Potential sources of contamination for groundwater.[79]

Impervious Surfaces

When a watershed is increasingly covered with pavement, buildings, and other compacted surfaces that are impervious to water infiltration, significant changes in water quality and quantity result. Rain that falls on impervious surfaces runs off faster into surface waters, carrying with it sediment and pollutants from road surfaces, lawns, construction sites, and parking lots. The result may be flooding, warming, and channelization of streams. Infiltration of rainfall into the ground to replenish groundwater is reduced, impacting the quantity of groundwater available for withdrawal.

This type of runoff, called non-point source pollution, is a serious threat to water quality in New Hampshire. The biggest sources of non-point pollution are from urban runoff, failed septic systems, poorly planned and managed construction sites, changes in stream and groundwater flow after development, and agricultural runoff. Remedies such as construction and site designs that promote retention and infiltration of rainwater and runoff, narrower curved streets and driveways when possible, shrub and tree buffers to waterways, and more compact development patterns can protect Andover's water quality and quantity as the town grows. Porous cement, asphalt, and pavers are possible alternatives to impervious ones. Best Management Practices (BMPs) should be followed. In general, these include minimizing pollutants in the first place, retarding the transport of pollutants, remediating and intercepting pollutants by biological or chemical transformation.[80] Detailed recommendations, laws, and resource publications are available from the state for households, site excavation, road construction, road salting, snow dumping, motor vehicle salvage and storage facilities, agriculture, timber

[79] NH Department of Environmental Services, 2009, **Best Management Practices (BMPs) for Groundwater Protection,** Fact Sheet WD-DWGB 22-4, http://des.nh.gov/organization/commissioner/pip/factsheets/dwgb/documents/dwgb-22-4.pdf.

[80] NH Department of Environmental Services, 2004, **Best Management Practices to Control Nonpoint Source Pollution: A Guide for Citizens and Town Officials**, Watershed Assistance Section, WD-03-42, 63 p., http://des.nh.gov/organization/commissioner/pip/publications/wd/documents/wd-03-42.pdf.

harvesting, sand and gravel excavation, stormwater management, and chemical and petroleum storage.

By converting as little as 10 percent of a watershed to impervious surfaces, stream water quality and organisms begin to deteriorate; with more than 25 percent impervious surface, water quality is seriously degraded. Figure 35 illustrates the effects of impervious surfaces. The percent of urban land use in riparian buffer zones and the percent of surface in a watershed have been used as indicators of overall stream quality.

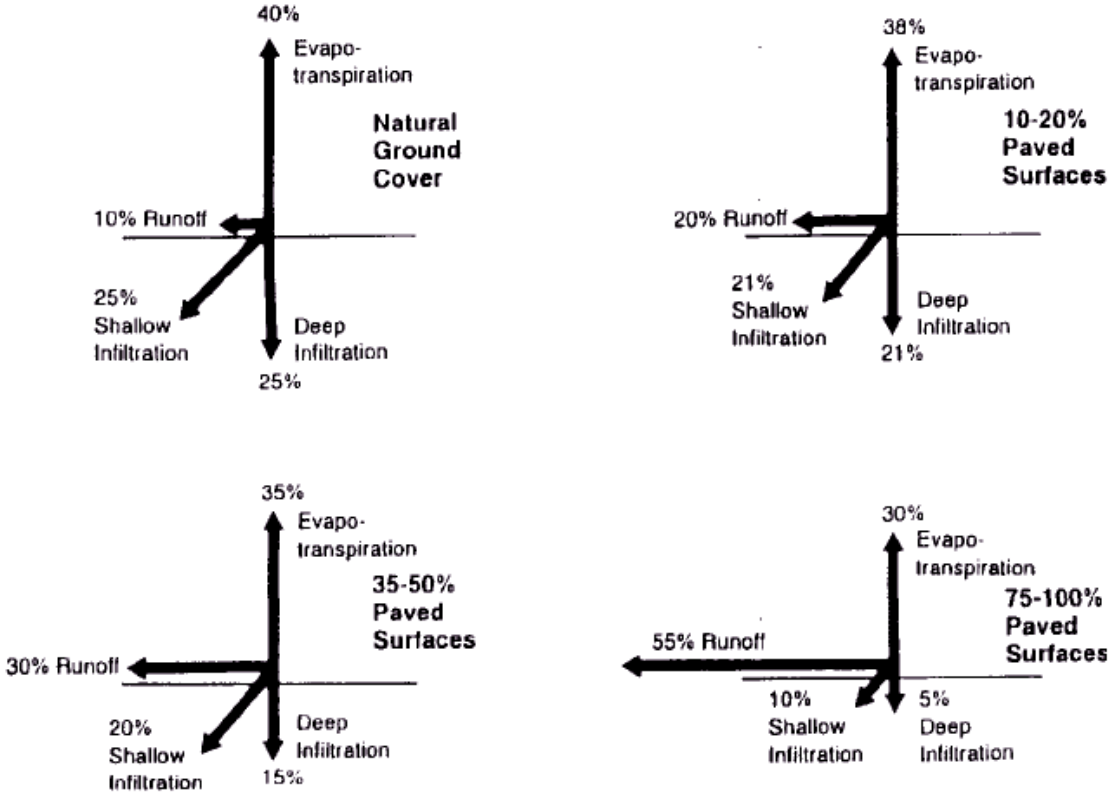

Figure 35. Infiltration rate effects of development.[81]

Legislation in the Shoreland Water Quality Protection Act[82] (SWQPA) addresses impervious surfaces near water bodies. A summary sheet is available at http://des.nh.gov/organization/divisions/water/wetlands/cspa/documents/summary_standards.pdf and vegetative requirements are summarized at http://des.nh.gov/organization/commissioner/pip/factsheets/sp/documents/sp-5.pdf. An alteration of terrain permit is required for disturbing 100,000 square feet of land and 50,000 square feet of shoreland within 250 of the water to minimize stormwater runoff. Grass, rain gardens, or other vegetation and channels for groundwater to flow into depressions and swales also help mediate surface runoff. Implementing feature-based zoning and allowing conservation subdivisions should be encouraged.

[81] Delaware Department of Natural Resources and Environmental Control and Brandywine Conservancy, 1997, **Conservation Design for Stormwater Management: A Design Approach to Reduce Stormwater Impacts from Land Development and Achieve Multiple Objectives Related to Land Use**

[82] http://www.gencourt.state.nh.us/rsa/html/nhtoc/nhtoc-l-483-b.htm.

Energy

Available, affordable energy and green technologies have gained importance in the past few years. While Andover does not have any oil, natural gas, or coal resources, other sources of energy are available. Some of these have been regulated on the state level, but the town may want to regulate others. Some towns have established an energy committee to investigate ways of conserving energy, to develop sustainable energy efficient methods, and to investigate sources of cheaper energy. In 2011 the selectmen were awarded an energy grant to support an energy audit of Town Hall and possibly other municipal buildings.

Firewood has been a source of heating and cooking since the settlement of Andover. Today residents use wood boilers and furnaces, wood stoves, and pellet stoves for heating homes and water. Proctor Academy has upgraded its steam plant to provide non-polluting heat for many of its buildings with biomass solids using bole wood chips. They are more uniform in size than whole tree chips and bole chips can be used in small-scale automated or semi-automated wood chip heating systems. Bole chips could be efficiently used in community-scale heating facilities, especially if the chips were produced locally.[83] The Andover School Board enlisted Jeff Dickinson for information on gasification for energy using biofuels and additional feasible energy-saving methods (2009) and met with him again for further energy-saving alternatives in 2011.

In the past, ice blocks cut were the sole method of refrigeration for perishable food each summer. The ice was shipped to Boston from the large Winter Hill Ice Company on Highland Lake.

Power for mechanical jobs has been used for centuries. Early settlers used perennial streams, particularly those having a good gradient, for power. Sawmills and grist mills became early enterprises. More recently, hydroelectric power has been developed. Franklin has a small hydroelectric dam along the Winnipesaukee River. The Blackwater River, Sucker Brook, and Hameshop Brook have been used in the past century.

Most residents receive electricity from the NH Electric Cooperative. While a few homeowners have chosen to live 'off the grid', others may increasingly turn to innovative ways to supplement power needs. South-facing glass helps heat homes passively. Alternatively, deciduous trees can shade those glass exposures during the summer for passive cooling. South-facing solar panels can provide electricity. Solar panels are becoming more affordable and visually less intrusive, particularly when incorporated as roofing shingles. Electrical energy is stored in batteries or fed into the existing power grid to be used by the homeowner or the electric company as the homeowner need dictates. Another alternative to storing electrical energy in batteries is to store it in the form of hydrogen. Very light weight hydrogen is easily generated by electrolysis and converted to electricity.

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[83] North Country Resource Conservation & Development Area Council, 2010, **Community Roadmap to Renewable Woody Biomass Energy: A Step-by-Step Decision-Making Tool for New Hampshire Communities,** 312 p., http://www.nhrcd.net/files/CommunityRoadmapToRenewableWoodyBiomassEnergy%20FINAL%2012%2015%2010%20footer%5B1%5D.pdf.

Earth mass can also provide passive heating and cooling energy using stone walls, flooring, and earth embankments. A home in Sanbornton has a sod roof. Earth embankments can be as ordinary as cellar holes or as homes recessed into a hill slope; several newer dormitories at Proctor are built into the hillside. More recently, geothermal power has been developed. An example of large-scale geothermal heating and cooling is in the Merrimack County nursing home, but smaller applications, such as in the newest Proctor dormitory, can been applied in residential heat pumps.

Wind power was recognized as a force by early farmers. Some barns were sited to block winter winds from homes or placed such that snow drifts would not block doorways. New, small wind turbines may be installed for homes. Generally, a consistent wind with average speeds of about 11 miles per hour is needed for a feasible wind energy system.[84] Ridge crests obviously have the best potential, but residential siting away from trees and similar obstacles is still effective; the greater the height the more effective the turbine. The US Department of Energy produced a booklet, **Small Wind Electric Systems—A New Hampshire Consumer's Guide**[85] that could be useful for a home or small business. With the increasing cost of energy, the development of small, efficient, low-cost, high-yield wind turbines is bound to increase and be installed by home owners and developers. Small wind energy systems are regulated in New Hampshire.[86] Model local ordinances may recommend a maximum tower height at 150 feet, but for small systems to be effective, a tower should be at least 35 feet taller than the surrounding tree canopy. Further information and an example of an ordinance are available from the NH Office of Energy and Planning.

A small New Hampshire based company in Newmarket, Green Power Management representing Tangarie Alternative Power,[87] manufactures a vertical axis wind turbine. The Greenpower Utility System (GUS™) line of vertical axis wind turbines has design considerations that make the turbine versatile and environmentally friendly. Various soundless sizes with variable wind speeds are available to power street lights, homes, and businesses. A few benefits of the GUS vertical axis wind turbine are:

- Produces up to 50 percent more energy on an annual basis versus conventional turbines with the same sweep area
- Generates electricity in winds as low as 4 mph (1.5 m/s) and continues to generate power in wind speeds up to 130 mph (60m/s), depending on the model
- Withstands extreme weather such as frost, ice, sand, humidity
- Non-polluting through a sealed unit design with no gearbox
- Easy on the eyes and ears being the only soundless wind turbine with non-reflecting surfaces to eliminate shadow strobing effect
- Does not harm wildlife, such as bird strikes

The Isle of Shoals has a colorful non-obtrusive rotating vertical wind turbine that looks like a sculpture. Horizontal axis wind turbines have also been developed. Small 12-volt

[84] NH Electric Co-op, November, 2008, **Today**, p. 4, http://www.nhec.com/filerepository/november2008_news_web_1.pdf.
[85] http://www.windpoweringamerica.gov/pdfs/small_wind/small_wind_nh.pdf.
[86] http://www.gencourt.state.nh.us/rsa/html/lxiv/674/674-63.htm.
[87] http://www.tangarie.com/.

300-400-watt wind turbine generators can be purchased for $300-$400, making them affordable for the average homeowner.

The development and use of nuclear energy has stalled. However, newly developed hybrid fusion-fission reactors generate energy and burn the radioactive waste produced. Clearly, interest and innovations in green technologies will affect Andover in the future.

Air Quality

The Air Resources Division of the NH Department of Environmental Services (DES) monitors air quality across the state. Air quality in Merrimack County is monitored in Concord by DES. Ground level ozone and fine particle pollution, along with wind speed and direction, and outside temperatures are recorded hourly and recorded in an online map and supporting table. Air pollution is regulated by the state for emissions from acid deposition, asbestos, fuel burning, pulp, asphalt, sand and gravel sources, and municipal waste. Federal information is available online from the DES web site as EPA Criteria Air Pollutants, Fact Sheet ARD-41 (http://des.nh.gov/organization/commissioner/pip/factsheets/ard/documents/ard-41.pdf), which addresses the National Ambient Air Quality Standards for Criteria Pollutants covering ozone, carbon monoxide, nitrogen dioxide, particulate matter, sulfur dioxide, and lead.

Andover's air quality is generally good to excellent, having a minimal health impact except on extremely humid summer days or when temporary blankets of wood smoke settle in valleys during calm or temperature inversion conditions in the winter. Dieback in New Hampshire forests, especially for higher elevation conifers, is attributed to acid rain coming from the Midwest. Smoke from chimneys generally contains particulate matter and other pollutants from burning wood and petroleum products. This smoke could cause breathing problems for a few residents. Proctor Academy's new biomass furnace provides steam heat to many buildings; it is 99 percent cleaner than the former oil-based system. Most of the plume is comprised of water vapor. The old Andover dump, discontinued in the early 1980s, consolidated waste by burning before burying. Open burning dumps were discontinued statewide to reduce toxic materials being released in the smoke.

Light

Light pollution is minimal in Andover because outdoor lighting is minimal. During the winter, the Blackwater ski area is lit for night skiing events and snowmaking. The new professional building east of Andover village has spotlights, but they deflect light downward. Increased commercial development will increase light pollution, especially in the winter when the days are shorter. A glow in the night sky from the Tilton and Concord areas is evident on very clear crisp nights. This glow is from poorly designed outdoor lighting in which upward-beamed light reflects off dust particles and fine water droplets.[88] However, on a clear night Andover residents can see the stars, planets, and aurora borealis.

[88] NH Department of Environmental Services, 2008, **Innovative Land Use Planning Techniques: A Handbook for Sustainable Development,** pp. 359-361**,** http://des.nh.gov/organization/divisions/water/wmb/repp/innovative_land_use.htm.

Newly developed street lights direct light downward. Light-emitting diode (LED) fixtures are more energy efficient. Others, such as GALE light poles,[89] utilize wind or solar power. Some communities require a cut-off shielding feature, which are sometimes called "dark sky friendly". Legislation passed in 2009 establishes the "New Hampshire dark skies" policy to encourage outdoor lighting efficiency at the municipal level. Outdoor residential lighting has been termed light trespass or nuisance lighting by neighbors.

Relatively simple measures to regulate outdoor lighting can promote energy savings with little or no burden for public cost. Well designed lighting can preserve safety and security while maintaining rural character and minimizing the impact on wildlife habitat. Darkness is essential to predation, migration, and reproduction of many nocturnal species of migratory birds, frogs, salamanders, and valued insects.

Wildlife Habitat

The wildlife habitat land cover map (figure 3) displays several different vegetative zones. A major concern for wildlife is that haphazard patterns of development have caused habitat fragmentation. Wildlife sensitive to human encroachment is restricted to islands of undisturbed land and may die out if the area is too small. Fragmentation also creates barriers to the movement of many terrestrial species and increases the frequency of road kill. Wildlife corridors are tracts of undeveloped land that provide linkages between significant habitat areas. Travel ways and migratory routes are often located along streams and rivers. Linkage corridors can be virtually any type of traversable land of at least 200 feet in width that provide avenues for wildlife movement and discourage the creation of habitat islands. When one habitat type is converted to another, such as clear cutting forest to make fields, another habitat type is created.

Ecologically important areas for habitat (figure 3)[90] were combined with the unfragmented areas (figure 9) using GIS to produce the co-occurrence habitat map (figure 36)[91] that illustrates areas most favorable for supporting a diverse wildlife population in diverse habitats. Table 11 gives the acreage of these habitats and the amount of land protected in each. From a different perspective **based on older soils data**, the darker the area in figure 37, the more favorable the area is for a diversity of wildlife. The highly diverse areas should be considered for protection through planning and zoning regulations or conservation easements. Zooming in on the maps can enhance legibility. Appendix D in the 1992 Master Plan lists wildlife species expected to occur in Andover—mammals, birds, reptiles, amphibians, and fish. Other sections in this current appendix list species of concern, threatened, or endangered that are specific to habitat or Andover.

Landscaping in developed areas can significantly affect wildlife habitat. Landscaping can

- Provide the cooling effect from shade in the summer,

[89] http://www.tangarie.com/products/gale_wind_turbine_lightpole.php, http://www.diamondwindsolutions.com/LIghtPoleWindTurbine.html.
[90] NH Fish & Game Department, 2005, revised 2010, **Wildlife Action Plan**, Concord, www.wildlife.state.nh.us.
[91] NH Fish & Game Department, 2005, revised 2007, **Wildlife Action Plan**, Concord, www.wildlife.state.nh.us.

- Increase natural light in the winter or buffer artificial light,
- Reduce noise through vegetated buffers,
- Attenuate water pollution from sediment and human activities,
- Buffer the effects of heavy rainfalls, and
- Filter air borne particles.

Vegetation provides food and cover for wildlife from trees, shrubs, and ground covers. Combinations of plant types can attract varied wildlife, even on a small lot. Native plant species generally are more nutritious for native wildlife and tolerate fluctuating temperature and water needs better than imported ornamentals. Visual aesthetics are enhanced by softening the hard lines of buildings and providing privacy.

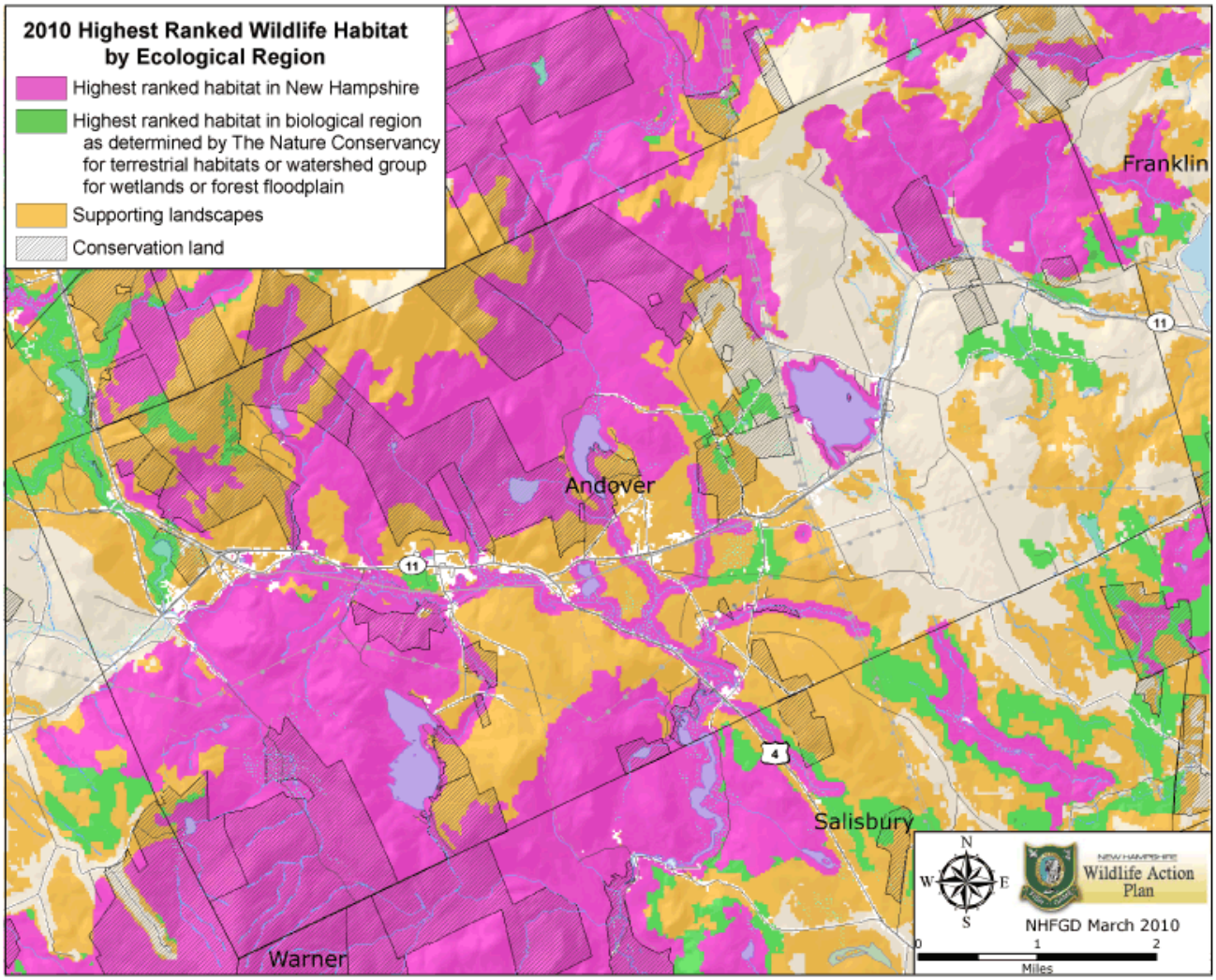

Figure 36. Highest ranked wildlife habitat by ecological condition. Increase the detail of specific areas in this figure by using the online digital file.

	Tier 1, highest ranked in NH	Tier 2, highest ranked biological region	Tier 3, supporting landscape
Acres	12,416.1	942.0	7,628.1
Conserved	3,931.8	161.4	1,484.1
% Conserved	31.7	17.1	19.5

Table 11. Highest ranked habitat and protected areas in Andover, March 2010.

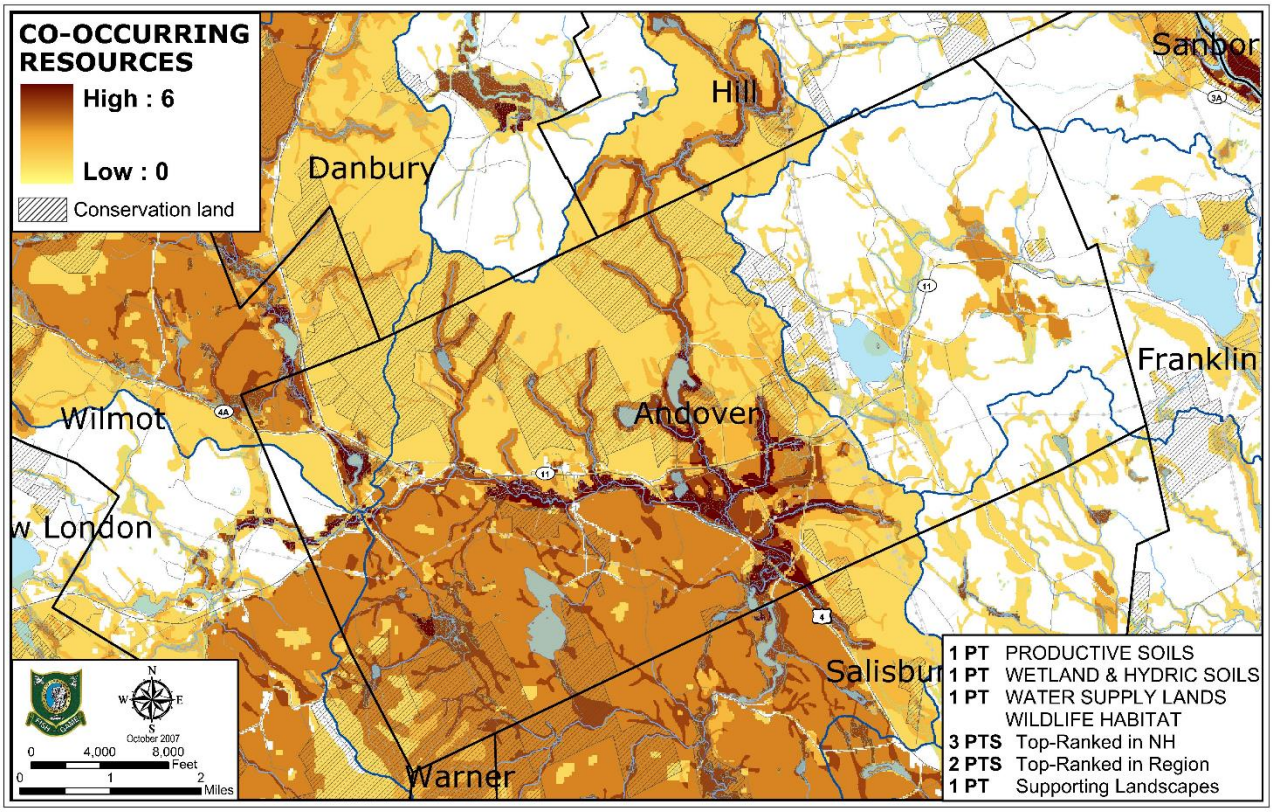

Figure 37. Co-occurrence map of favorability for diversity of wildlife habitat, 2007. Increase the detail of specific areas in this figure by using the online digital file.

The NH Fish and Game Department has been managing wildlife populations and keeping records since 1960 starting with the deer population. Management involves tracking populations of various species, controlling hunting through the licensing of hunting and trapping, and managing wildlife habitat through selective clear cutting. Hunting seasons vary annually in length, methods of hunting, and sex of hunted species. Management of aquatic species is accomplished through similar methods.

The **2010 New Hampshire Wildlife Harvest Summary**[92] provides statistics for Andover. Statistics can be compared over the years from various regions of the state. The desirable deer population is determined in large part by the severity of the previous winter. In 2010 9,759 deer were killed by all methods statewide; 27 were reported from Andover, 1,041 from Merrimack County. The desired population objective in our area is to increase the deer population by 35 percent from 2006 to 2015. Deer wintering areas are typically comprised of dense softwood cover with a crown closure greater than 60 percent, preferably with a southern slope exposure.

The bear population fluctuates according to food supply because some feed areas are more favorable for hunting success. A high mast year encourages bears to remain in the

[92]New Hampshire Fish and Game, 2011, 52 p., http://www.wildlife.state.nh.us/Hunting/harvest_summary/Wildlife_Harvest_2010.pdf

woods. Notable mast includes blueberries, raspberries, blackberries, mountain ash berries, acorns, and beechnuts. In a poor mast year, bears head for apple orchards and cornfields and become easier targets for hunters. During poor food years, bears tend to enter dens earlier in the fall and fewer are killed during the deer hunting season. Five of the 707 bear killed statewide in 2010 were reported from Andover.

Moose season lasted 9 days in 2010 and the number of permits issued to hunters and the specific area of the state each can hunt in were chosen by lottery. Of the 399 permits issued, 302 moose were harvested. Andover is in the central region, where a total of 4 moose were taken, mostly by rifle. The central region boundary is determined by roads—Interstate 93 to the east, south and west along Interstate 89, and finally northeastward along Routes 11, 4, and 104.

Two seasons are open for wild turkeys, spring and fall. The statewide turkey population was estimated at 35,000 in August of 2007. Statewide, 3,669 turkeys were killed in the spring of 2010, 23 of which were from Andover. In the fall, 1,010 were taken, 5 from Andover.

Trapping is used to manage furbearing populations and is considered an important public service in damage control. During the 2009-10 season, 465 trappers were licensed. The annual winter fur auction that year generated $82,980 based on average pelt values. The harvest from the central region was 797 beaver, 143 coyote, 76 fisher, 128 gray fox, 68 mink, 528 muskrat, 126 otter, 83 raccoon, and 102 red fox.

Fisheries

Fishing is a popular pastime in Andover. Native brook trout used to run 20 inches or more in length in the 1600s.[93] Early in the 1900s, trout were caught by the thousands in Poverty Pond just north of Andover in Hill. Fishing like that is long gone. Overfishing, destruction of streamside habitat, and the introduction of other species such as pickerel, hornpout, and shiners have contributed to the loss of native species and size reduction. Brook trout are threatened by higher water temperatures caused by clearing land near streams and the loss of forest floor duff. The tree canopy and duff retain water throughout the year, releasing it into streams and keeping water level higher and colder throughout the summer months.

Today most Andover fishermen catch brook trout, rainbow trout, salmon, bass, and hornpout. Obviously, Sucker Brook was named for suckers. NH Fish and Game stocks fish in Highland Lake in April and May. The Andover Fish and Game Club buys large hatchery-raised trout for its annual spring kid's fishing derby in May. The youngsters have fun dumping buckets of fish into the channel the night before the derby. The winter kid's ice-fishing derby used to be held in February at Horseshoe Pond, but due to limited success in recent years, the location has moved to Eagle Pond in Wilmot. The Andover Fish and Game Club provides the children with equipment, food, and trophies for the ice fishing, but simple fishing outfits are not provided in the spring. Both derbies place the emphasis on family fun and learning to fish with ample assistance provided to the youngest participants. SHARE Day at the Andover Elementary/Middle School generally

[93] Noon, Jack, 2003, **Fishing in New Hampshire: A History**.

offers workshops in fly tying and fly fishing. The annual winter Lakes Region fishing derby included Highland Lake a few years ago, but local residents requested removal from the derby area because of pollution and trash problems from out-of-town anglers. Areas stocked by Fish and Game in Andover are online at http://www.wildnh.com/Fishing/Stocking/current.html. In 2011, stocking occurred in the Blackwater River, once; Highland Lake, 5 times; Hopkins Pond, 4 times; Morey Pond, once; and Sucker Brook, once from April to June.

The NH Fish and Game Department has prepared bathymetric (water depth) maps (figures 38-40) showing approximate depth contours in feet for several lakes in Andover along with access points, likely fish species, trophic level, and acreage. Each of these maps is downloadable at http://www.wildlife.state.nh.us/Fishing/bathy_maps.htm.

Fish Species Codes shown on figures 37-40

ECP chain pickerel **SMB** smallmouth bass **HP** hornpout (same as BBH —brown bullhead) **EBT** brook trout **RT** rainbow trout

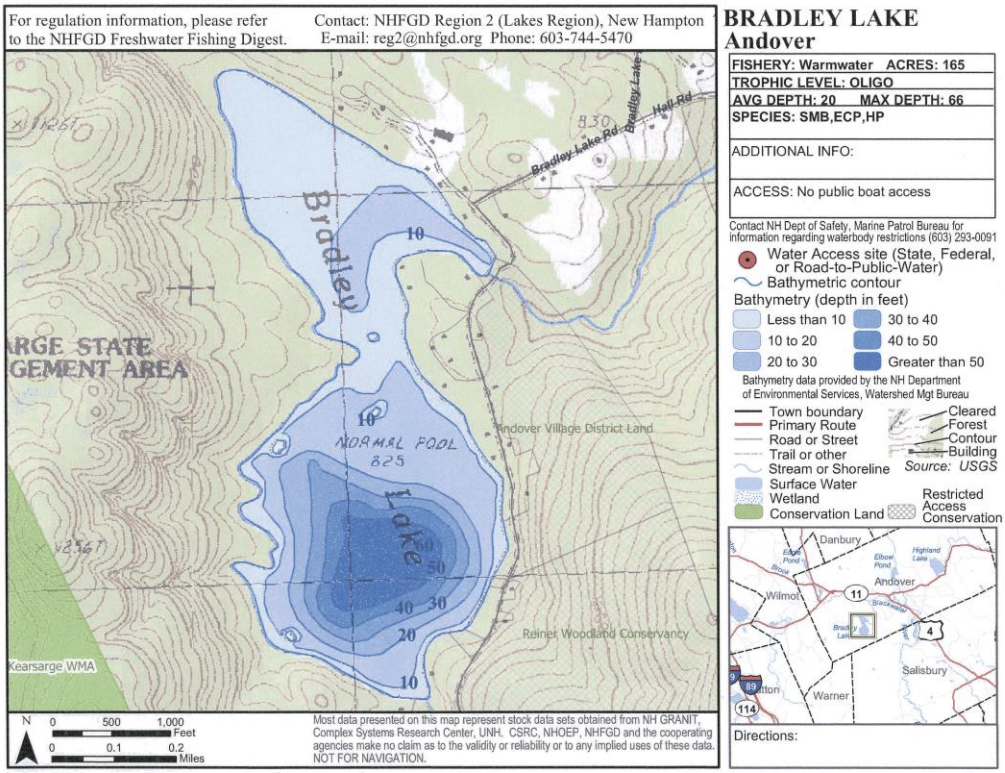

Figure 38. Bathymetric map of Bradley Lake.

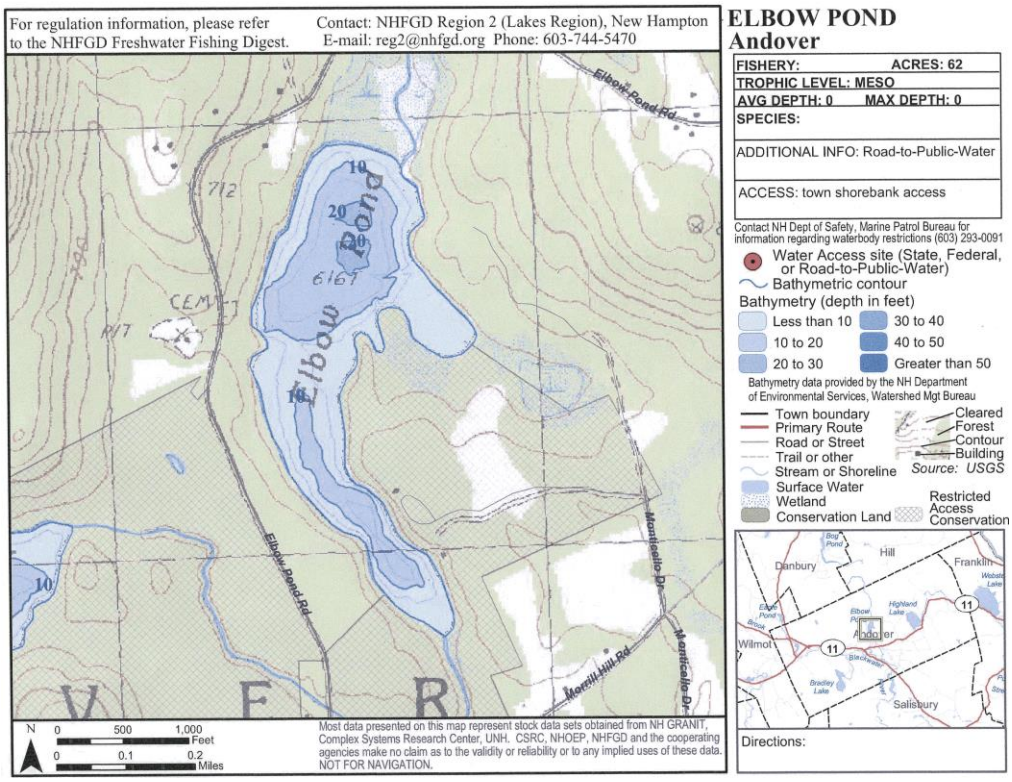

Figure 39. Bathymetric map of Elbow Pond.

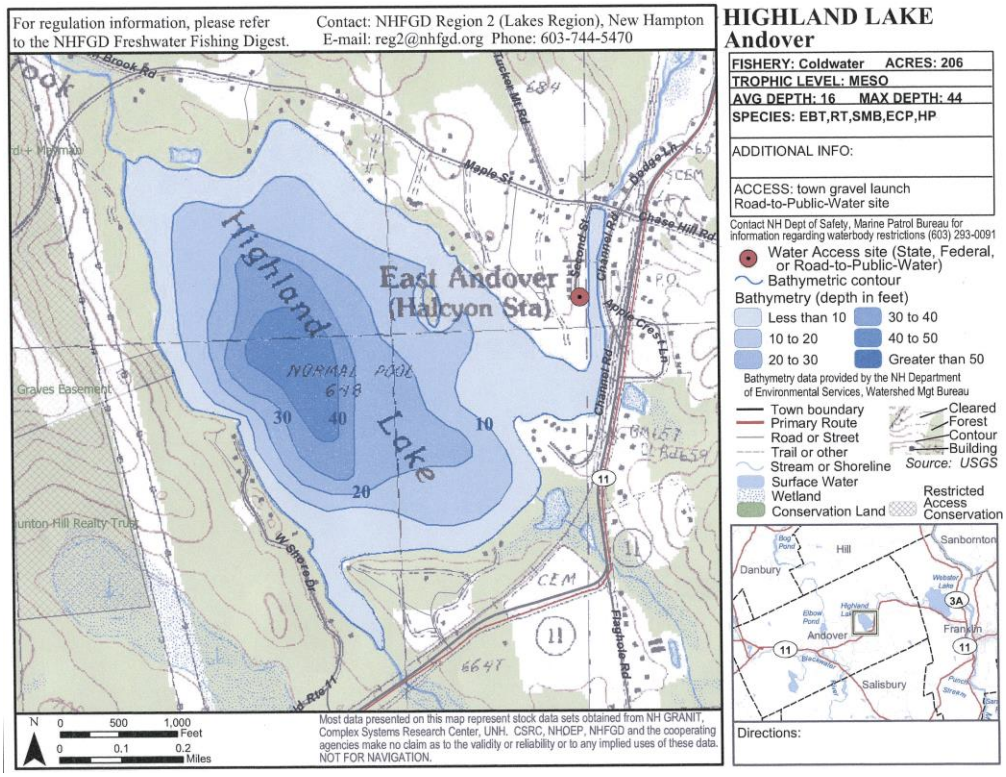

Figure 40. Bathymetric map of Highland Lake. Note: boat ramp is incorrectly located; it is on Channel Road across from the fire station.

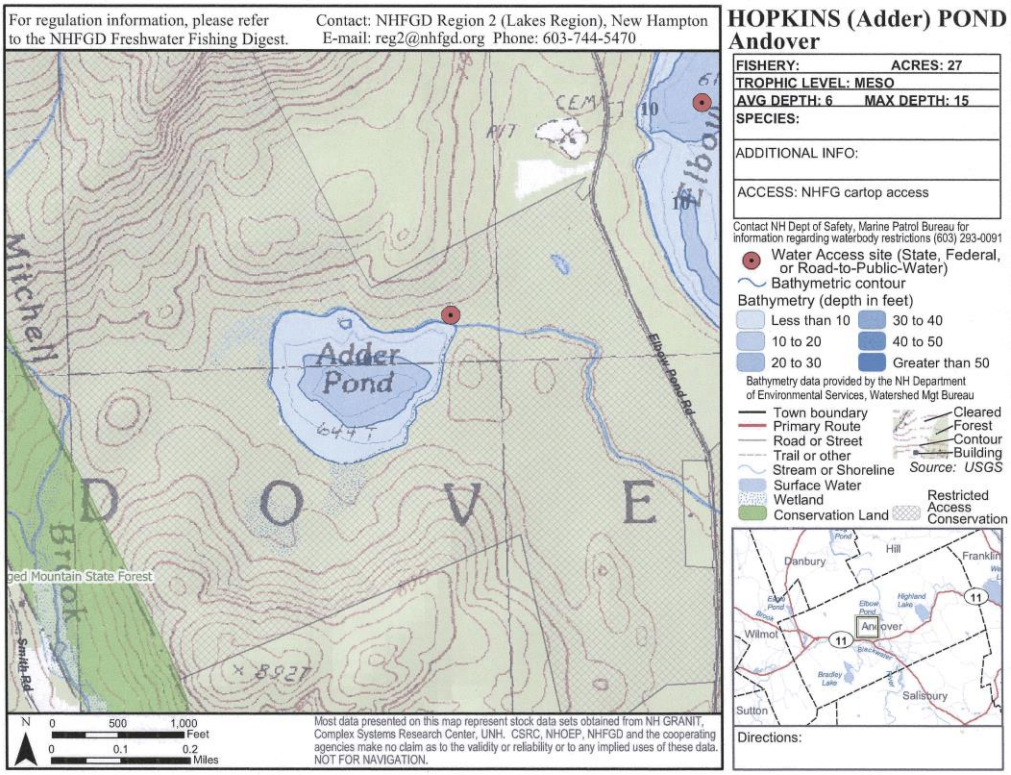

Figure 41. Bathymetric map of Hopkins (Adder) Pond.

Beneficial Insects

Beneficial insects are a natural way to fight insect pests and protect our environment. Encouraging beneficial insects increases biodiversity and decreases dependency on poisonous chemical controls. This creates a more beautiful and safer environment. Beneficial insects are enticed to yards and gardens by providing them with the three basic necessities: water, food, and shelter. Spraying broad-spectrum insecticides should be avoided. The ladybug has long been known as a beneficial insect, but in recent years the Asian ladybug has spread to New Hampshire and likes to winter over inside houses. The praying mantis and certain wasp species are also beneficial in killing insect pests.

Bees are necessary in pollinating fruit, berry, and vegetable crops and for producing honey. Unfortunately, honeybees are declining due to disease. Some hives have been replenished by buying bees from southern states. Several Andover residents maintain bee hives as a hobby, for honey production, and for better pollination. Richard Brewster and Peter Zak are well known for keeping bees and sharing their knowledge with potential beekeepers. Bears searching for honey can be very destructive to hives unless the hives are protected by an electric fence.

Invasive Species

Invasive species (plants, insects and fungal species) are not naturally native to a particular region and have the ability to thrive and spread aggressively outside their natural range. Invasive species thrive and spread in a new habitat because they have no natural predators (insects, diseases and/or foraging animals) that naturally keep their growth

under control as in their native habitat. Invasive species have the potential to destroy and displace natural resources that are vital to our biodiversity. According to the New England Wildflower Society, nearly a fifth of New England's 3,000 plant species are in danger of disappearing from our region. In addition, invasive species are degrading public natural areas at an estimated rate of 4,600 acres per day.

Without natural predators to prevent its spread, an invasive species, particularly in the case of plants, will put extreme pressure on native plants and animals. Ultimately, the invasive plant will alter native habitats and reduce biodiversity by choking out native vegetation, threatening rare and endangered species, and degrading wildlife habitat. Native animal, bird, and insect species depend on native plants for survival. Berries from invasive plants such as bittersweet and buckthorn are lower in nutrition than berries from native shrubs and plants. Invasive species present the worst threat in wetlands, floodplains, fire-prone areas, and other unique areas where rare plants are found.[94]

The NH Invasive Species Committee was formed after passage of NH House Bill 1258-FN in 2000. A list of plant species prohibited in New Hampshire as of January 1, 2007 includes: Norway maple; tree of heaven; garlic mustard; Japanese and European barberry; Oriental bittersweet; black and pale swallow-wart; autumn olive; burning bush; giant hogweed; yellow-flag iris; blunt-leaved privet; showy bush, Japanese, Morrow's, and tatarian honeysuckle; Japanese knotweed; common and glossy buckthorn; and multiflora rose. Prohibited invasive aquatic plant species include fanwort, variable milfoil, European water milfoil, Brazilian elodea, curly-leaf pondweed, European naiad, water chestnut, purple loosestrife, and common reed. Descriptions, photographs, and control methods are given in the **Guide to Invasive Upland Plant Species in New Hampshire**.[95] Some of these species are in Andover. A list of invasive species found in Merrimack County as of March 2011 is online at http://www.eddmaps.org/tools/countyplants.cfm?id=us_nh_33013.

Variable milfoil has been known to lower property values by as much as 20 percent and reduce the aesthetic and recreational value of water bodies. Flood potential can be increased due to the displacement of water by huge volumes of the plants. Water temperature can increase with mats of exotic aquatic plants, thus increasing bacterial growth and pollution under stagnant water conditions. Invasive plants may even deplete groundwater. Fortunately, the water bodies of Andover have only a native, non-invasive species of milfoil, but boats not scrubbed clean and launched after being in infested waters elsewhere could easily introduce invasive species. The common milfoil found in Highland Lake several years ago was reported to be non-invasive by the late Jody Connor of the NH Department of Environmental Services.

Endangered species

NH Natural Heritage Bureau in the Division of Forests & Lands finds, tracks, and

[94] United States National Arboretum.
[95] NH Department of Agriculture, Markets and Food, Plant Industry Division and NH Invasive Species Committee, 2005, **Guide to Invasive Upland Plant Species in New Hampshire**, 19 p., http://extension.unh.edu/forestry/Docs/invasive.pdf.

facilitates the protection of New Hampshire's rare plants,[96] animals, and exemplary natural communities. Currently more than 740 plant and animal species and 195 natural communities are being studied throughout the state. The Natural Heritage Bureau maintains a database with information on more than 5,000 species or natural community occurrences in each town.[97] The records are updated as new populations or natural communities are reported. **A few species that are highly vulnerable to collection are not included in the town lists** because collectors might inadvertently eradicate them; likewise, exact locations are not described or mapped.

Most of the New Hampshire landscape is covered by relatively common natural community[98] types. Particular sets of natural communities tend to co-occur and are linked by a common set of driving forces, such as landforms, flooding, soils, and nutrient regime. An "exemplary" natural community or system in a given place is a rare occurrence in the state. Most of New Hampshire's rare plants are listed as "threatened" or "endangered" under the NH Native Plant Protection Act of 1987 (RSA 217-A). The most recent revision of the list is July 2011. A subset of species is also listed under the federal Endangered Species Act. The federal Endangered Species Act of 1973 prohibits federal agencies from funding, authorizing, or carrying out acts that destroy or adversely modify critical habitats.

The presence of a rare plant or natural community does not limit a landowner's ability to use their land. This is stated explicitly in the NH Native Plant Protection Act. **Whenever a permit for dredge and fill is filed with the NH Department of Environmental Services, a data check is required using the NH Natural Heritage Bureau DataCheck tool.**[99] Landowners applying for state wetland permits are required to review options for achieving their land-use objectives while protecting a rare plant or natural community, but projects will not be denied solely on the basis of a rare plant occurrence. **Rare plants are typically destroyed because landowners are not aware of them; minor changes in projects usually can save the rarities**. The goal of the NH Natural Heritage Bureau is to help landowners protect rarities on their properties **voluntarily**.

Many rare plant and animal populations have not been checked since they were originally found, some more than 50 years ago; therefore, the status of these populations is currently unknown. Table 12 of rare species applies to Andover. These species are approximately located within the circles shown in figure 10. Populations not reported in the last 20 years are listed as "historical only"; these populations may still be present, but field surveys are necessary to confirm their survival. If no locations are indicated (- -), the species is known to have once occurred in the state but the exact location is unknown. T, threatened; M, marginal; E, endangered; SC, special concern; **, New Hampshire rarity.

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[96] NH Natural Heritage Bureau, **Rare Plant List for New Hampshire**, 2011, 16 p., http://nhdfl.org.aurora.silvertech.net/library/pdf/Natural%20Heritage/TrackingList-PlantGeneral.pdf.
[97] NH Natural Heritage Bureau, 2011, 205 p., http://www.nhdfl.org/library/pdf/Natural%20Heritage/Townlist.pdf.
[98] Sperduto, Daniel D., 2005, **Natural Community Systems of New Hampshire**, NH Natural Heritage Bureau and The Nature Conservancy, 133 p., http://www.nhdfl.org/library/pdf/Finalsystemsreport.pdf.
[99] http://www.nhdfl.org/about-forests-and-lands/bureaus/natural-heritage-bureau/services/.

Species name	Federal	State	Number last 20 years	
			Town	State
Plants				
Back's sedge	--	E	Historical	14
Ginseng	--	T	Historical	14
Vertebrates-Birds				
**Common loon	--	T	2[1]	274
*Peregrine Falcon	M	E	1	11
Vertebrates-Reptiles				
*Wood turtle	--	SC	2	164
Invertebrates-Mollusks				
**Brook floater	--	E	1	31
[1] 8 loons—pair plus 2 chicks on Bradley and Highland Lakes, 2011.				

Table 12. Rare species reported in Andover.[100]

The following plants are not tracked by the NH Natural Heritage Bureau: narrow-leaf and wild leek, wild ginger, blue cohosh, sea lavender, ostrich fern, Canadian burnet, and slippery elm. Ginseng grows in rich woods and talus of rich mesic forests, dry rich forests, and enriched talus communities such as the Bulkhead. New England cottontail rabbits were reported in our area between 1950 and 1973, but are only in Southeastern New Hampshire now.[101] A striped-back salamander was reported at Huntoon Pond years ago. Blanding's turtle had been noted in Salisbury and historical records note the eastern spotted turtle was in Danbury and Franklin. Andover residents should be on the lookout for these two turtles, as well as other species of concern, and, if found, should document the occurrence with photographs and report the sighting to the NH Fish and Game Endangered Species Program or the NH Natural Heritage Bureau.

Colby Sawyer students[102] summarized Andover's endangered species, which have been added in the following habitat map (figure 10) as large circular areas. Zoom in on the map for greater legibility. Refer to figure 3 for an update of colored areas. The NH Natural Heritage Bureau tries to protect these areas by not revealing the exact location where endangered species are reported. Instead, a buffered circle is drawn in the approximate location. Ausbon Sargent Land Preservation Trust conducts a wildlife inventory of all properties for which they may potentially be a primary holder of a conservation easement. They reported a finding wood turtle, ginseng, and brook floater to the NH Natural Heritage Bureau in the Gross and Hersey easements.

Natural Hazards

The most common natural hazard in Andover is flooding and accompanying erosion. Flooding occurs from heavy spring rains, runoff, ice jams, and coastal storms. Damage

[100] NH Natural Heritage Bureau, 2011, p. 7, http://www.nhdfl.org/library/pdf/Natural%20Heritage/Townlist.pdf.
[101] Carcagno, Emma, 2010, **New England Cottontail Rabbits in New Hampshire,** NH Wildlife Action Habitat Stewardship Series, http://extension.unh.edu/resources/files/Resource001135_Rep1417.pdf.
[102] http://www.colby-sawyer.edu/academic/ces/curriculum/thirdyearprojects/2005thirdyear/Index.html.

can be localized, but the cost of repairs is always high. Floodwaters are dangerous and the debris carried by floodwaters can obstruct bridges, dams, and culverts with devastating effects. Historically, rivers have been the focal point of transportation, power, and development and flooding can cause major damage to the infrastructure along these rivers.

The Blackwater River is particularly susceptible and Route 4 near Plains Road is commonly closed. The floods on Mother's Day 2006 were the worst in recent memory; Andover village was isolated one day. Elbow Pond Road was repeatedly flooded by beaver activity on Mountain Brook. The road was raised and a new bridge was built, but the beavers were persistent. In 2008 the Conservation Commission retained Skip Lisle to install Beaver Deceivers[103] to solve the beaver problem of plugging the culverts. Skip will return if his devices fail to work.

A floodplain management program is an important part of community land use planning. Flood prone areas likely to be flooded in major storm events are delineated on the Federal Emergency Management Agency (FEMA) maps at town hall. The National Flood Insurance Program (NFIP) is a partnership between a community and FEMA. In communities that participate in the NFIP, property owners and renters can purchase insurance as protection against losses from flooding. Additional information can be found at http://www.nh.gov/oep/programs/floodplainmanagement/aboutus.htm. Communities participate by agreeing to adopt and enforce a floodplain management ordinance designed to reduce future flood risks. Andover adopted this in 1974: the most recent maps were published in 2010[104] in 9 panels that are joined in figure 42. Flood prone areas can change over time. An overlay district of flood prone areas and a flood ordinance could help minimize property damage and eliminate "future human presence and investments in river corridors."[105]

Severe weather events seem to be increasing with the effects of climate change. These events may include nor'easters bringing heavy rain, ice, and snow and accompanying high wind. Tornadoes and hurricanes may be more common. These events can cause flooding, washouts, roof and building collapse, power outages, uprooting of trees, rerouting of streams, and other potentially destructive forces.

[103] http://www.beaverdeceivers.com/.
[104] http://www.granit.unh.edu/dfirms/d-townhtmls/andover.html
[105] NH Department of Environmental Services, 2008, revised 2010, **Innovative Land Use Planning Techniques: A Handbook for Sustainable Development**, http://des.nh.gov/organization/divisions/water/wmb/repp/innovative_land_use.htm.

Cave-ins can occur in construction areas and sand and gravel pits. Reclamation of pits can alleviate such slumping and is considered a best management practice. Similarly, during periods of heavy rain and runoff, erosion along roads can create transportation hazards. Rock slides can occur along steep roadside cuts due to freeze and thaw cycles over time. The cliffs of the Bulkhead may have rock slides. Andover is located in a seismically active area extending from Hopkinton to Meredith. However, only minorearthquakes have caused rumbling in Andover and little damage other than cracked masonry. The nearest, most recent earthquakes felt were centered in Boscawen in 2010 measured at 3.1 on the Richter scale and a 2.5 quake in Ashland in 2011.

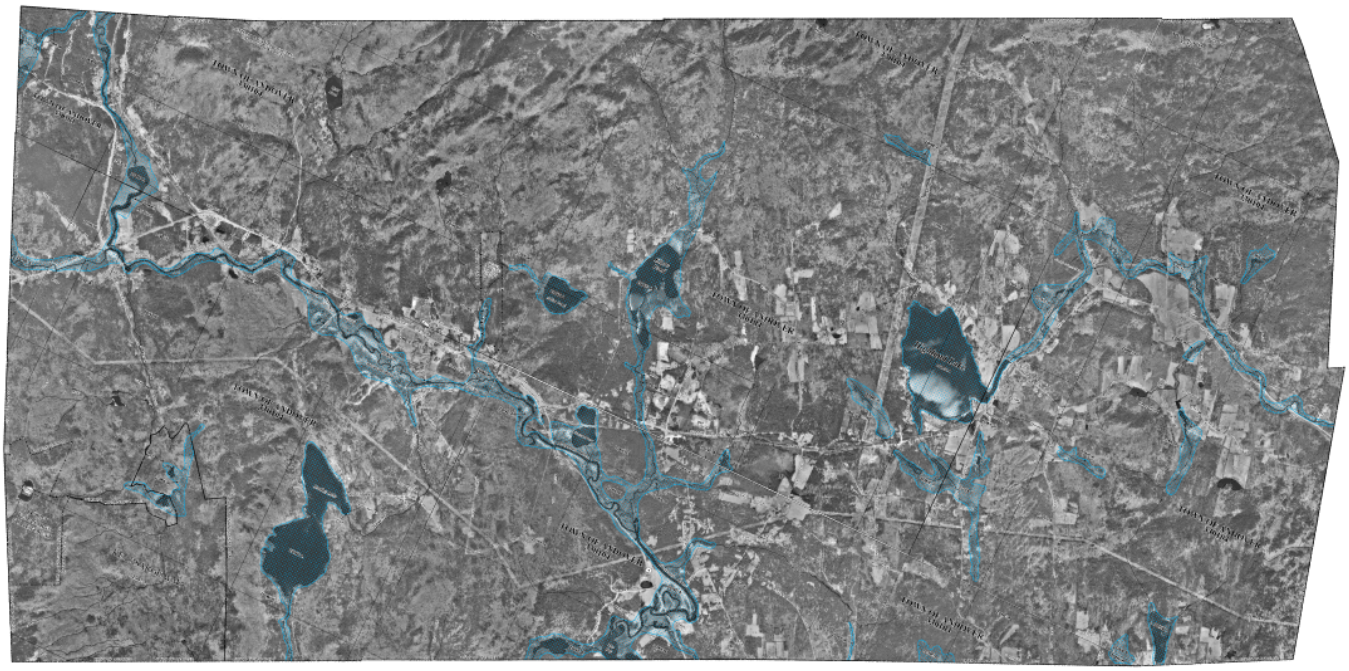

Figure 42. FEMA flood prone map of Andover, 2010. Increase the detail of specific areas in this figure by using the online digital file.

The buildup of radon released by naturally occurring radioactive minerals in rock and soil may occur beneath building foundations. Good air exchange can alleviate this. Road cuts along I-89 in New London have higher than background amounts of radioactivity. Naturally occurring arsenic from the underlying rocks has been reported in water supplies, particularly in the southeastern part of New Hampshire. Arsenic has not been a problem in Andover, but well water can be tested for its presence.

Scenic Resources

Scenic resources in Andover were identified by a viewshed committee chaired by Susan Schnare as an offshoot of the Master Plan Update Committee. Members included Mary Anne Broshek, Tina Cotton, Sandra Graves, Nan Kaplan, and Ed Spencer. Particularly scenic, rural, natural landscapes in town were identified according to the following criteria: uniqueness/or value, distinguishing characteristics contributing to visual quality, size of site, place(s) from which the view is best, land use, and potential threats. Colby Sawyer students included a scenic resources section with map and photographs in a

classroom project prepared for the Ausbon Sargent Land Protection Trust.[106] Their map was based on elevation and scenic vantage points were from roads. Past and present tourism and second homes have taken advantage of our scenic resources.

Several observations should be considered. Views are subjective. Landscape views are more plentiful where fields are present. Such views must have been spectacular from many vantage points a hundred years ago when much of the town was clear cut for timber and farming. Now views are enhanced during the winter when deciduous trees are bare. Also of note is that when a landscape is viewed, that landscape looks back at the viewing point. For example, if Taunton Hill is visible from Chase Hill, viewers from Taunton Hill, likewise, can see Chase Hill.

Andover has several views that have been featured in the past. The area of Highland Lake (figure 43), the channel, and the church-grange-school buildings has been pictured in puzzles, on calendars, particularly those from the A.W. Frost Agency, and the cover of the AARP glossy monthly magazine back in 1973 for a featured article of best places to retire in the United States. A sketch of the Sam Hersey historic buildings was printed on paper place mats used by Mr. D's restaurant in Franklin in the 1990s. Bill Bardsley's photographic postcard of his daughter viewing the Mountain Brook Falls had statewide distribution in the 1970s. Ralph and Grace Chaffee collected puzzles, postcards, and other illustrated and written items from Andover. Much of their collection was donated to the Andover Historical Society for safe keeping and preservation. Many of the scenic views of Andover are worth preserving from a historical perspective.

Figure 43. Highland Lake, Ragged Mtn.

Perhaps the most famous painting of our landscape was from Artist's Ledge or Bluff on the Fulton estate. As Peter Miner, husband of Nancy Fulton, documented:
"In the nineteenth century, an important movement of American artists painting New Hampshire landscapes, in a style similar to the Hudson River School in New York, inspired artists to travel to distant and remote places in the state to paint untamed nature. Mary Bartlett Pillsbury Weston was one of the artists in this movement. In 1849 or 1850, she traveled to East Andover and painted from a vantage point above Highland Lake; she painted from the Ledges on the Fulton estate called Hillside. One of these paintings, titled "View of Kearsarge and Ragged Mountains from East Andover," is listed in the Smithsonian American Art Museum's inventory of American Paintings. Mary Weston later moved to the Midwest, where her painting, "Spirit of Kansas" was exhibited in the Kansas pavilion at the Chicago 1893 Columbian World Exposition. She also exhibited at the National Academy of Design."

An image of her painting from the Ledges appeared in the **Andover Beacon**,[107] as well as from an early postcard from 1907-14 (figure 44). Marion and Lester Fulton collected postcards, old and new, of views of East Andover. One postcard shows a view of the Ledges ridge and the high pines from a field located on Taunton Hill Road. Another

[106] http://www.colby-sawyer.edu/assets/pdf/CES2005Andover.pdf.
[107] **The Andover Beacon**, August 2007, p. 22, http:www.andoverbeacon.com/0708/p22.pdf.

postcard shows a view of the village of East Andover from across Highland Lake. This view appeared on several postcards as well as on calendars, a jig-saw puzzle, and an ad for Kodak film.

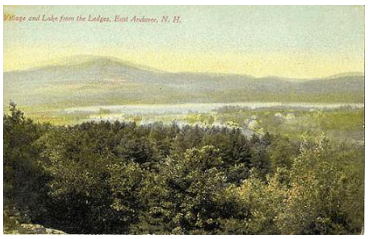

Figure 44. Views from Artist's Ledge.

The Cilleyville Bog covered bridge and Keniston covered bridge (figure 45) have been maintained by tax dollars, a LCHIP grant, and private fund raising over the years. Both bridges are mentioned in tourist guides, documentary films, and histories. Lisa Jelleme (figure 46) and Hilary Mishcon have painted beautiful scenes of Andover.

Figure 45. Blackwater bridge.

Figure 46. Keniston River.

Scenic roads

Scenic roads are generally thought of as having magnificent views, but views can be simply back country roads with a rural flavor (figures 47-50).

Figure 47. Fields from Emery Road.

Figure 48. Chase Hill Road.

Figure 49. Shaw farm, Emery Road.

Figure 50. Emery Road pond.

Several Andover roads have been officially designated as scenic roads according to state statutes. NH RSA 231:157 allows the establishment of scenic roads, which are local town designations. These roadways are not class I or II roads. Designation as a scenic road means that repair, maintenance, and reconstruction work to the roadway should not involve the cutting or removal of trees (defined as 15 inches in diameter or more) or the tearing down or destruction of stone walls within the road right of way without prior written consent of the planning board or board responsible for the local scenic roads program. **Scenic road designation does not affect the rights of any abutting landowners on their property and does not affect the eligibility of the town to receive construction, maintenance, or reconstruction aid.** The following roads have been formally adopted by townspeople as scenic, although additional ones could be added:

- Old College Road, including the former Taunton Hill Road, 1977
- Maple Street, from Old College Road to Tilton Brook, 1977
- Dawes Road, from Bridge Road to Kearsarge Mountain Road, 1978
- Beech Hill Road, 1980
- Elbow Pond Road, 1980
- Emery Road, 1981
- Valley Road, for all of its maintained portion, 1998.

Some towns have established tree committees or a tree warden to replace dead or dying trees along roadsides to retain the rural appeal of shaded tree-lined roads with an overhead canopy. Other towns prefer to cut trees and woody growth within the road right of way so that sun can help melt icy roads in the winter, dry wet roads that are subject to winter heaving, and minimize power outages due to overhanging branches subject to ice damage.

Historic Resources

A historic resources map available as a GIS coverage from GRANIT (not Data Mapper) includes data from the National Register of Historic Places. The register includes Cilleyville Bog bridge, the Gersham Durgin house (391 Franklin Highway), East Andover Village Center Historic District (church-grange-school), Hersey farm buildings, Keniston bridge, Potter Place Railroad Station, and the Tucker Mountain schoolhouse. Older barns,

farm houses, cemeteries, and stone walls and foundations are present reminders of Andover's rich historic past that should not be lost to future generations. The Andover Historical Society has documented many of these. Several comprehensive and invaluable histories of Andover include the books by Eastman, Chaffee, and **Elder Moody's Hat**, which was taken from Ralph Chaffee's newspaper articles in the Franklin Journal Transcript. The Historical Society has reproduced the several additional write ups that Ralph Chaffee had placed in the Bachelder library, as well as writings by Paul Fenton, Jr., (**Halfway up the Hill**) and Helen LaPlante Duchesne (**In Their Time**, reprinted from 1997). Local residents reading selections from **Elder Moody's Hat** document facets of life in Andover; a DVD completed in 2009 called **This Old Town** is available from the Andover Historical Society.

At the turn of the 20th century, many homes were opened to summer boarders from metropolitan areas like Boston. These boarders enjoyed fresh air and eating fresh meat, poultry, and produce from local farms to satisfy their appetites after a day of swimming, walking, and reading from porch rockers. Andover was a back-to-nature destination easily accessible by train.

Ed Hiller compiled a list of 210 structures built before 1900 in appendix XVI in addition to chapter XI of the Master Plan. In it he includes homes, businesses, cemeteries, farms, covered bridges, cellar holes and foundations, and many scenic views and roads. Some of the foundations are important archeological sites, such as on Old College Road, where the town's first center was located. Others, such as the site of the old Mill Pond along Sucker Brook, harken back to Andover's water-powered industry. Hameshop Brook, with it's remnants of foundations and bricks from the manufacturing of hames, and Ice House Lane, recalling the ice-cutting industry at Highland Lake, also are reminiscent of past industries. The Historical Society produced a DVD on the history of the Winter Hill Ice Company in 2008. The Historical Society prepared another DVD in 2010 on the **Early Days of Education in New England** featuring local children in a reenactment of a school day at the Tucker Mountain School in the late 1800s. A DVD produced by the Fortnightly Club documents places, people, and fishing in the East Andover area in the 1930s. **The History of Proctor Academy** was produced in a DVD in 2008. Chuck Will also recalls some past history in his Proctor web site, **Chuck's Corner** and more than 9,700 old photographs have been scanned on Flickr.com at http://www.proctoracademy.org/podium/default.aspx?t=131057.

Stone walls reflect the difficult task of plowing upland fields. Some of these are unusual, such as this single-stone wide, open latticework one on the Fulton property (figure 51) and the extra-wide one along Chase Hill Road (figure 52). Stone also formed retaining walls for dug wells and the old fire pond along Chase Hill Road (figure 53).

Figure 51. Single-stone wide, open latticework stone wall.

Figure 52. Wide stone wall, Chase Hill.

Figure 53. Fire pond, Chase Hill.

Recreation

Much of Andover's outdoor recreation and tourism are based upon its natural resources.[108] Opportunities for diverse recreation abound for all residents of varying abilities. We are fortunate that educational institutions in the area have opened their doors to the community. The Blackwater ski area, owned by the Proctor Academy and run with the Andover Outing Club (AOC), offers a combination of alpine skiing, ski jumping, and Nordic skiing. The alpine facilities include a ski club for youth racing, six trails, two lifts, and night lighting over 85 percent of the hillside. The Blackwater has four ski jumps, K 10, K 18, K 34, and K 38, making ski jumping safe for all abilities to experience the sport. Under the leadership and coaching of Tim Norris, local Andover skiers have earned a worldwide reputation and three have participated in recent Olympic competitions. Kris Freeman is the most widely known, although Justin Freeman and Jed Hinkley also were Olympians. More skiers have competed in the Junior Olympics. The Blackwater Nordic area with seven kilometers of groomed trails is at the base of the alpine facilities. Residents may use these facilities when they are not otherwise engaged in team practice and events; students at Andover Elementary/Middle School use them during the winter recreation program.

Snowmobile trails from the Andover Snowmobile Club and the New Hampshire Snowmobile maps shown on the trails map (figure 54) is very approximate because the snowmobile maps show few reference points. Map legibility is enhanced by zooming in.

[108] http://www.colby-sawyer.edu/assets/pdf/CES2005Andover.pdf.

The Andover Snowmobile Club does an excellent job of maintaining its trail system, cutting brush in the summer, and grooming trails regularly throughout the winter. Signage and gates are in place to guide the many out-of-town snowmobile enthusiasts. Local establishments in Andover, East Andover, and Potter Place provide food, lodging, and services.

Many different hiking options exist. Sections 9 and 10 of the Sunapee-Ragged-Kearsarge (SRK) Greenway (figure 54) and the network of trails on Proctor Academy's lands are extensive. A worthy endeavor for the future is to connect the SRK trail system eastward across the topographic spine, connecting with the Philbrick woods road eastward to the Heritage Trail in Franklin. The goal for the Heritage Trail is to extend it from the Massachusetts border to Canada. So far, most of the existing Heritage Trail follows the Merrimack and Pemigewasset Rivers. Logging roads and class VI roads also provide good walking, snowshoeing, and skiing options. These roads are good corridors for larger mammals in otherwise unfragmented areas. Residents have skied from the top of Kearsarge Mountain to East Andover on hiking trails and woods roads. Accessibility on private land is subject to landowner permission, which can be revoked if vandalism, littering, or a general disregard for the property becomes an issue. Education for those few in preventing destructive activities is essential so that hikers can continue enjoying the privately owned land of others. New Hampshire has legislation for the designation municipal trails in RSA 231-A. Andover does not have any such trails. However, provisions are made in the legislation for reclassifying existing class V or VI town roads as class A or B trails. This reclassification may be something the town may want to pursue.

A regional trail loop encompassing about 75 miles in 10 towns is maintained by members of the Sunapee-Ragged-Kearsarge (SRK) Greenway Coalition.[109] Trail segments are changed as needed and trail location on roads is avoided as much as possible. Although hikes, including winter snowshoe/cross country ski hikes, are sponsored as a group activity, the trails are open for enjoyment any time. The guide and website give excellent trail descriptions, places to park, and other useful information.

[109] The Sunapee-Ragged-Kearsarge Greenway Coalition, 2008, **SRKG Trail Guide,** 52 p., http://www.srkg.com/.

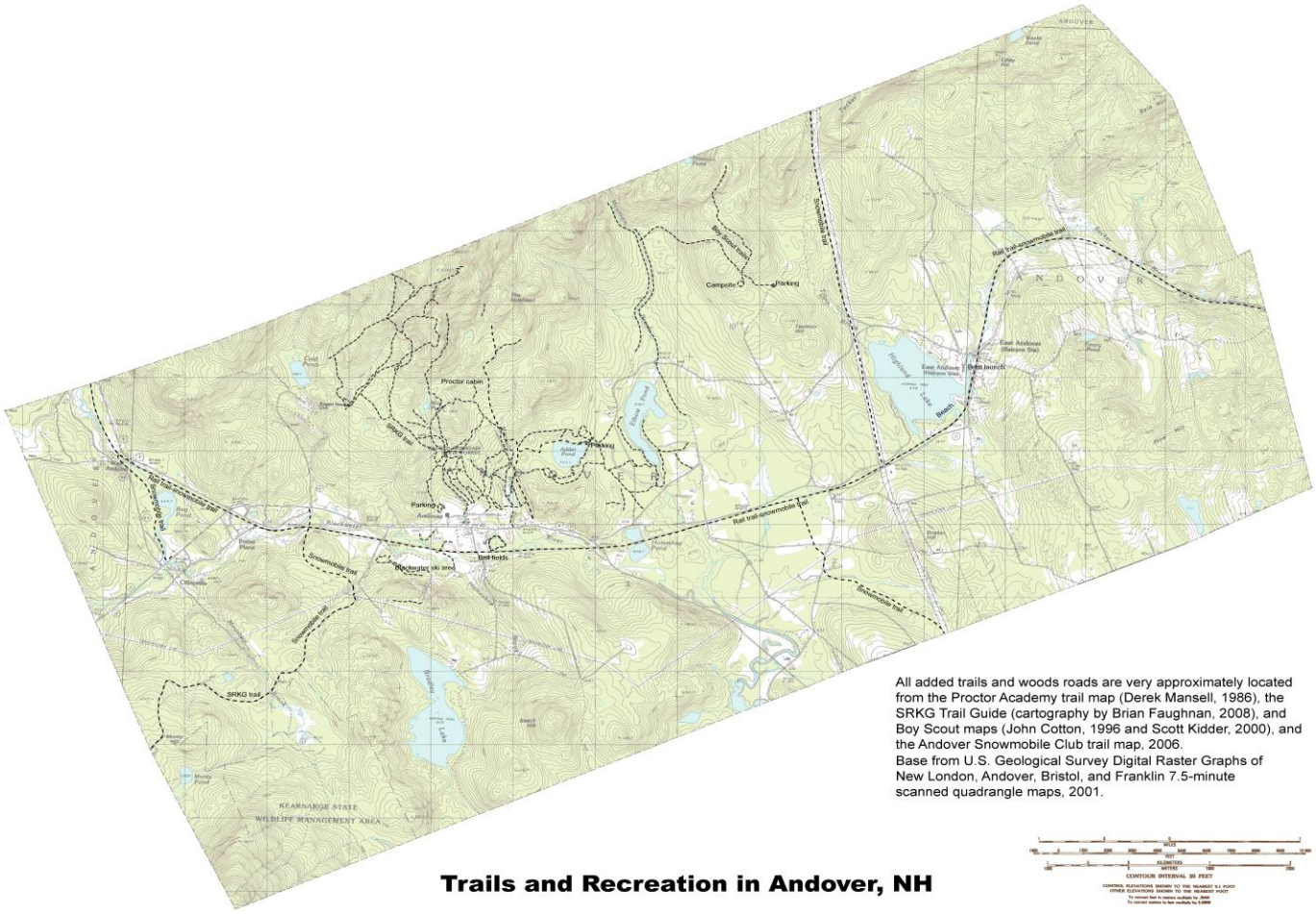

Figure 54. Trails and recreation areas in Andover.

Andover is bisected by the state-owned rail system from Danbury, through West Andover, and eastward to West Franklin. The rail system nationwide has been called a linear park. The Friends of the Northern Rail Trail (FNRT) have resurfaced the former rail bed from Danbury eastward to Franklin (figure 54) through the ongoing securing of grants. The rail corridor is owned by the NH Department of Resources and Economic Development (DRED); all improvements and construction must be approved by DRED. From Danbury the trail extends to Lebanon and enthusiasts hope to extend the eastern end from Franklin southward to Concord and eastward along the Winnipesaukee River in the near future.[110] The resurfaced parts of the trail have proved popular with walkers, bikers, horses, skiiers and families with strollers, wagons, and tricyles. Some Andover school children are commuting to school on the trail, thus avoiding traffic on Routes 11 and 4. **Motorized OHRVs, including ATVs and trail bikes are not permitted.** Snowmobiles are permitted only when there is ample, contiguous snow cover on the trail.

The geological and natural features along the rail trail are interesting. Beautiful views of woods, water, wetlands, and fens are exposed. Sightings of beaver dams and various species of plants, mammals, reptiles, amphibians, and birds are common. Views of glacial kettles, kames, eskers, outwash plains, and drumlins and spectacular views of

[110] http://www.fnrt.org/index.htm.

Ragged and Kearsarge all combine to enhance an enchanting trail accessible to all. The Andover Historical Society houses its museum in the Potter Place Depot whith shared parking for rail trail participants. People can visit the museum on weekends during the summer and fall and then reflect on what they have learned while traversing the rail trail. Additional parking is at the ball field (Blackwater Park) off Lawrence Street and along Channel Road. The Highland Lake Inn serves as headquarters and host for users of the trail. Charles Martin, an active member of FNRT, published **New Hampshire Rail Trails**[111] that includes descriptions, maps, and photographs of the trail, including Andover. Parking, food, and hospitality are offered in Potter Place, Andover, and East Andover.

Andover Boy Scout Troop 489 created four trails as a result of Eagle Scout projects. The first three, by Jerry Williams, Jon Cotton, and Greg Bourdon, are in the Newman conservation easement (figure 54); a sign and small parking space at a logging road along Old College Road mark the starting place. One trail goes to Mountain Brook and the falls, another follows the height of land to the Tucker Mountain ridge, and a third offshoot leads to a backpacking campsite complete with a table, fire pit, clearings for tents, and a latrine area. Water is carried in from home for consumption and from a nearby stream for washing dishes. These trails are marked and maintained by the scouts as a community service; the ravages of the ice storm of 1998 and extensive logging of the Newman easement by Fortin and Redmond in 2004 have been real challenges. A fourth trail by Scott Kidder, the Yvanovich trail, leads around the prime wetland adjacent to the elementary/middle school from behind the Andover Service Club Thrift Shop. A well constructed bridge extends over the drainage way.

Rock climbing on the Bulkhead is a sport mostly pursued by Proctor students. See figure 19.

Ice skating on natural ponds is limited by snow cover. In recent years, townspeople have skated at the Blackwater Park and the channel on Highland Lake. In 2009 the basketball/skateboard court on Andover School District land was flooded for skating. Proctor Academy has opened their hockey rink to youth hockey leagues and Andover residents at designated times.

The Recreation Committee has organized many activities over the years. They sponsor soccer and baseball for younger school children. Adults have formed basketball and softball teams. The summer swimming program at the town beach (Chaffee Park) is popular and has been supported by the Andover Lions Club through the building and maintenance of a bath house. Tennis, kayaking, and other programs have been offered over the years depending upon the availability of willing instructors and equipment.

A competitive horseshoe club meets regularly during summer evenings in the Monticello Drive area. Car racing at the Canaan speedway is also popular. The skateboard park has many children and teenagers practicing daily, weather permitting. Its proximity to the elementary/middle school, Proctor Academy, town hall, library, Jake's Market, Pizza Chef, and the police station has ensured its success and safe haven for youth.

[111] Martin, Charles, 2008, **New Hampshire Rail Trails**, 304 p.

The Kearsarge Council on Aging (COA) for people aged 50 and over offers many regularly scheduled indoor and outdoor recreational programs. A popular fitness program is walking in the Proctor gym during the winter. The Hogan Sports Center at Colby Sawyer has paid memberships for using the swimming pool, racquet court, and other facilities. A weight loss program for all ages meets at the elementary/middle school.

Many conservation easements permit non-motorized exploration, hunting, and fishing. Some easements have logging trails for walking or skiing. Contacting the landowner is always a good practice and fosters good relationships.

Conservation Priorities

The Andover Conservation Commission established resource priorities for potential preservation that are aligned closely with those of the Ausbon Sargent Land Preservation Trust (ASLPT) and the Society for the Protection of NH Forests (SPNHF). The priorities were chosen as relatively broad categories in areas at risk for development and could help ensure the future of Andover's well being, sustainability, and overall rural character. These include:

- Drinking water resources
- Ecologically important areas, including wildlife habitats and unfragmented land
- Agricultural land, including soils of statewide importance
- Forest resources and
- Scenic resources identified informally by Andover residents.

Laura Alexander from Colby Sawyer College was retained to map these priorities (figure 55) using GIS technology with input from the Conservation Commission in 2007; the map was refined in 2010 to use 2008 NAIP photography and 2009 work of the Master Plan Update Committee. The darker the color in the map, the higher the resource priority because of overlapping areas of these broad categories. Recommendations for preservation are based upon the greatest coincidence (occurrence or overlapping) of the mapped priority areas, which are given equal weight or treated equally. A CD was given to the Planning Board and Conservation Commission of the GIS layers used in figure 55 along with ArcReader, to enable viewers to zoom in for details and to activate different layers for a variety of perspectives. The line work can be modified only by using GIS software. The areas do not target any landowner, for the resource maps were drawn without land ownership information. However, the lot parcel information can be added in ArcReader.

Priority areas contain the most significant natural resources by virtue of being high quality, uncommon, at risk by development, critically important, or in pristine condition. Taken altogether, they encompass much of what still makes Andover special and unique—rural landscapes and productive forest and farms. The Conservation Commission agrees with the protection goals of ASLPT: productive farmlands, forests, scenic views, wildlife habitats, recreation lands, wetlands, watersheds, and undeveloped shorelines.

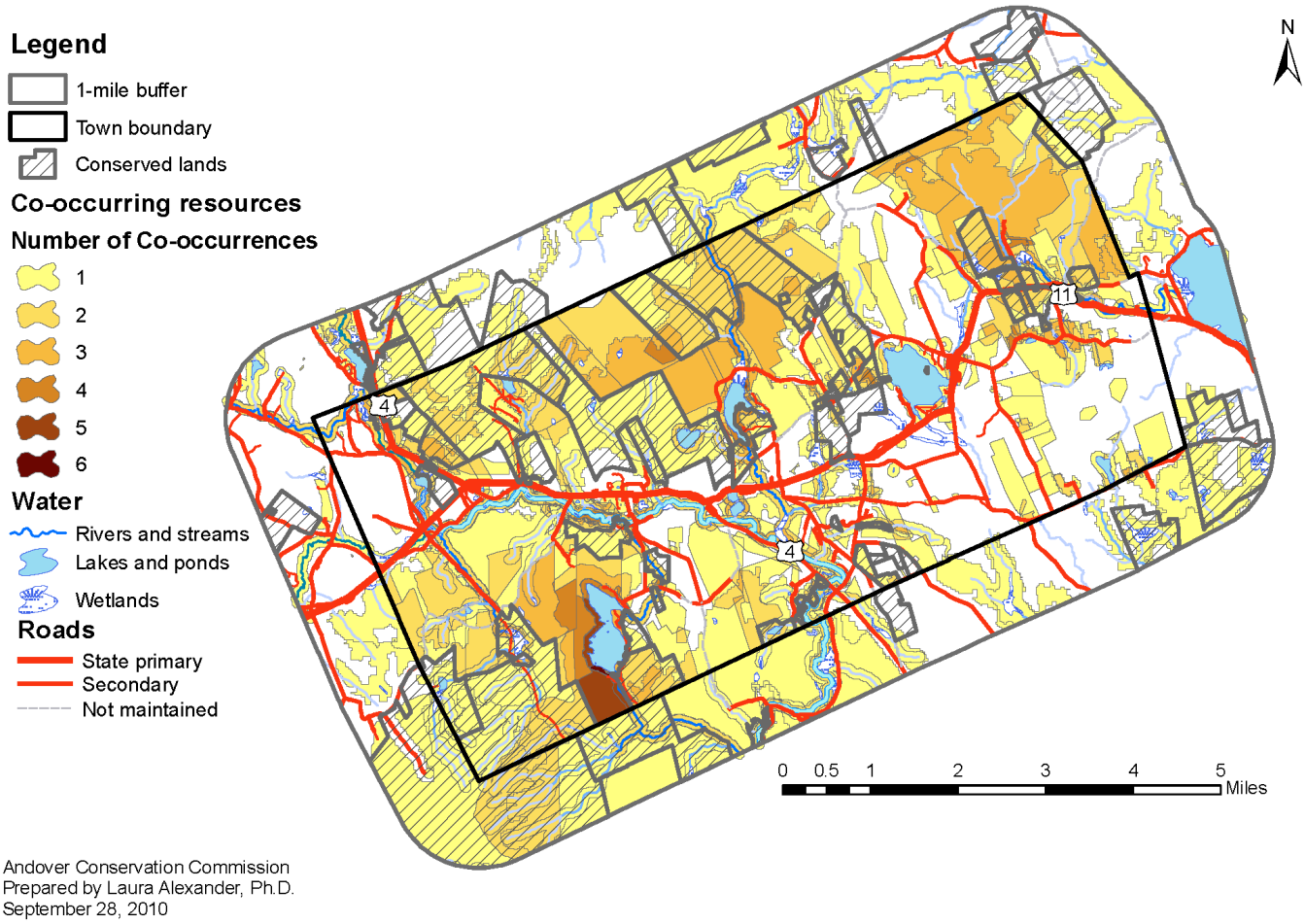

Figure 55. Co-occurring resources in Andover, 2010.

Each area ultimately selected as a priority focus area should include a description of the area and benefits of conservation, which may include flood damage prevention, forestry and agricultural productivity, biodiversity of wildlife, wetlands, recreation, historic or cultural significance, scenic assets, rural character, connections and buffers, surface water quality, groundwater quantity and quality, and public benefit.

The multi-agency Wildlife Action Plan group, using similar methods and some of the same criteria, developed a co-occurring resource map (figure 36) for Andover.[112] **The fact that several maps in this appendix are very similar is no coincidence; they reinforce each other with slightly different information.** Also, several maps in this appendix were used to guide the delineation of possible future zoning districts in this Master Plan. Zooming in will enhance detail on the maps.

[112] NH Fish & Game Department, 2005, revised 2007 and 2010, **Wildlife Action Plan**. Concord, www.wildlife.state.nh.us.

A map produced in 2005 by the Natural Services Network is outdated by newer information (most notably soils, wildlife habitat, open space, developed and protected land) appearing elsewhere in this appendix, but the criteria used are still valid. The Natural Services Network[113] is a GIS-based tool identifying lands that provide important ecological services that are difficult and expensive to replicate. Loss of these services could affect human health, safety, quality of life, and economic opportunity. The collaborative effort of planning and natural resource professionals used four components:

- Water supply lands, including highly transmissive aquifers identified by the U.S. Geological Survey and favorable gravel well sites identified by the NH Department of Environmental Services.
- Flood storage lands, including 100-year floodplains identified by FEMA and lacustrine (lake), riverine (river), and palustrine (non-tidal) wetlands identified by the U.S. Fish and Wildlife Service's National Wetlands Inventory.
- Productive soils, including prime farmland and farmland of statewide importance identified by the Natural Resources Conservation Service (NRCS).
- Important wildlife habitat, including habitat of statewide priority and habitat of eco-regional priority identified by the NH Wildlife Action Plan.

The Natural Services Network user's guide also recommends the following additional strategic overlays:

- Open space priorities
- Developed land
- Protected land
- Steep slopes
- Vernal pools
- Existing farms.

The Lakes Region Planning Commission prepared several maps for the Planning Board. These include a 1992 zoning map, a buildout analysis based on the 1992 zoning map, and a composite constraints map that can be used to direct future development. The first two appear in chapter I (introduction) and chapter III (land use) in this Master Plan and the constraint map **based on 2006 data** is shown in (figure 56).

Field surveys can more accurately delineate some of the boundaries on these maps. In addition, important resources, such as vernal pools, are present but not available in the GIS data of the National Wetlands Inventory (NWI). Therefore, additional priority areas may be identified in the future based on information yet to be gathered or additional defined priorities. **Any natural resource inventory needs regular updating due to changing conditions and additional data.** The single most important document for subdivisions is a map prepared at the outset showing:

- Streams, wetlands, and their buffers;
- 100-year flood prone (likely severe storm event) areas, soil types and contours with areas of slopes over 15 percent indicated;
- Other valued natural resources such as farmland, aquifers, and public water supply protection areas, woodlands, and significant wildlife habitat; and

[113] NH Audubon and The Jordan Institute, 2007, **Addressing Wildlife Habitat and Natural Resource Protection in Municipal Land Use Documents: Ideas for New Hampshire Municipalities**.

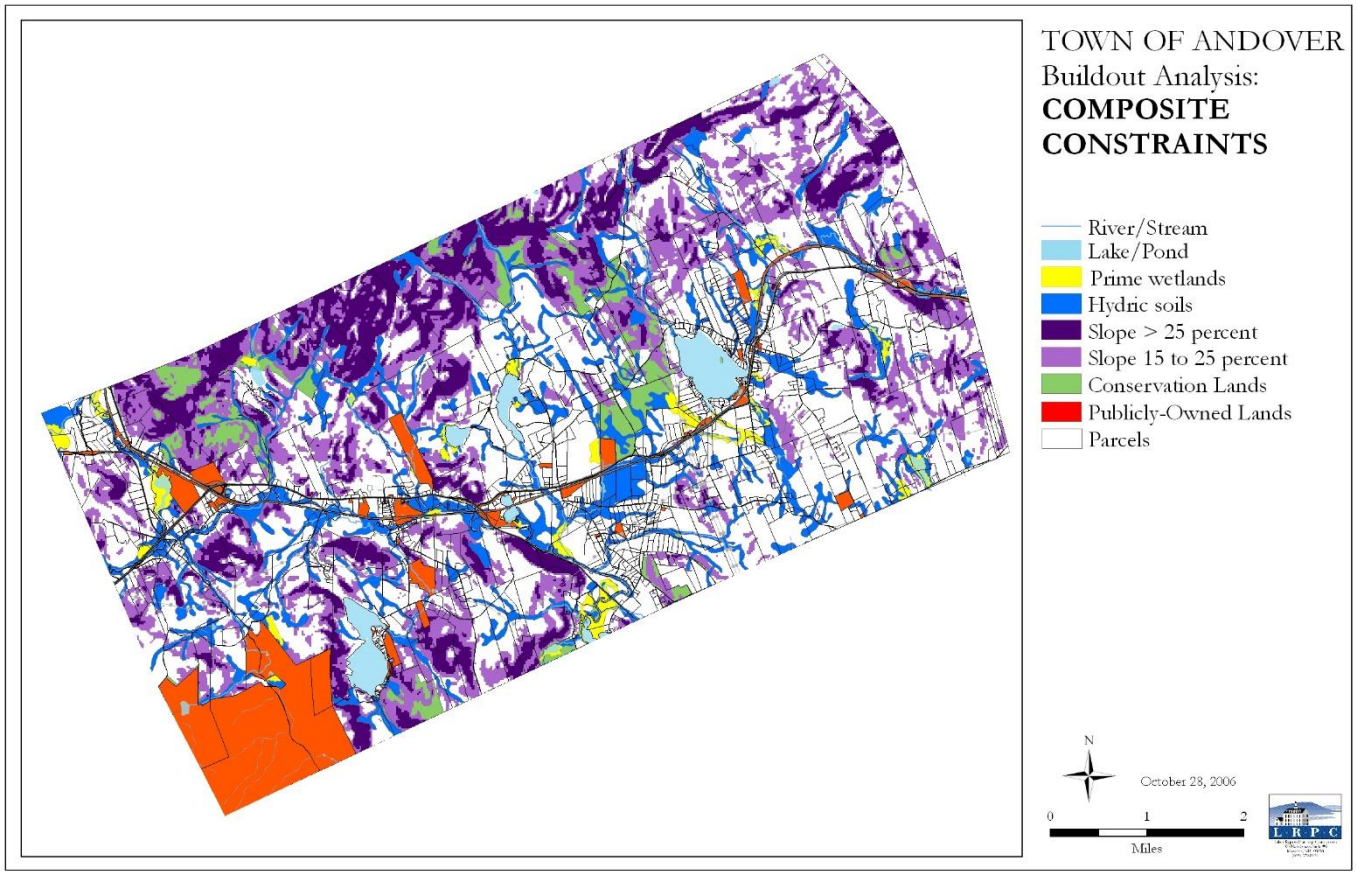

Figure 56. Composite constraint map of Andover, 2006.

- Cultural resources such as historic/archeological features and views into and out of the site.[114]

This information is readily available, requires little or no cost or engineering except for detailed slopes and soils, and should form the basis for all the major design decisions. Aerial photographs available from the Natural Resources Conservation Service (NRCS) and others can be invaluable.

Townspeople[115] prefer areas to be preserved **voluntarily** by private individuals through such mechanisms as conservation easements. Conservation funding is available through a variety of sources (see the Conservation Plan and Recommendations document prepared by Tina Cotton for the Conservation Commission). However, natural resource priorities can be aided by planning and zoning regulations in local land use controls—the regulatory component—as guided in the Master Plan. To address the need for guidance and technical assistance, innovative land use controls authorized by RSA 674:21, NH Department of Environmental Services, the NH Association of Regional Planning Commissions, the NH Office of Energy and Planning, and the NH Local Government Center, produced the **Innovative Land Use Planning Techniques: A Handbook for**

[114] Connecticut River Joint Commission for New Hampshire and Vermont, 2000, **Introduction to Riparian Buffers,** Living with the river series, no. 7, 6 p., http://www.crjc.org/buffers/Guidance%20for%20Communities.pdf.
[115] **The Andover Beacon**, February 2005, p. 5, http://www.andoverbeacon.com/0502/p05.pdf.

Sustainable Development in October, 2008 and addition in 2010.[116] This document defines problems, suggests remedies, and provides sample ordinances. Four general categories formed the guiding principles of this document: prosperity, sustainability, livability, and mobility. Regulations on innovative land use controls, some of which are suggested above in various sections of this appendix, must be supported by the Master Plan.

Numerous federal and state regulations have been passed to help protect our natural resources. Some of these are listed in the Conservation Plan and Recommendations document. Important natural resources occur in variety of scales and locations and, in many cases, can not be protected by land conservation alone. Public education is needed. Residential areas have already been established in and near important resources. Although conservation planning can have a positive influence on the future usage of important resource areas, such planning will never be capable of comprehensive protection by itself. Documents about and assessments of conservation planning typically contain conflicting statements concerning ideals and reality. Good conservation planning is a compromise, balancing sustainability of resources and socio-economic development.

In addition to the potential land use districts proposed in this Master Plan, other districts could be considered in the future: conservation, agricultural, aquifer or wellhead protection, flood hazard, forest conservation, historic, or wetland districts. Other possibilities might include establishing an agricultural commission, class A trail designation, class VI road moratorium, conservation subdivision ordinance, energy efficiency requirements for new construction, environmental characteristics or feature-based zoning, erosion and sediment control measures, farm-friendly ordinance, fluvial-hazard ordinance, landscaping and outdoor lighting plans, riparian/wetland buffer ordinance, additional scenic road designations, small wind energy systems ordinance, steep slope and ridgeline protection ordinance, stormwater management regulations, and a watershed protection ordinance. These and others are described in this appendix and the Conservation Plan and Recommendations document.

Former resident and selectman Gracia Snyder captured Andover's natural rural character that townspeople want to preserve when she drew the sketch for the town's letterhead.

[116] NH Department of Environmental Services, 2008, revised 2010, **Innovative Land Use Planning Techniques: A Handbook for Sustainable Development**, http://des.nh.gov/organization/divisions/water/wmb/repp/innovative_land_use.htm.