

Natural Resources



Introduction

Berlin's natural resources support the city's residents, its wildlife, its economy, its recreational needs, and overall quality of life. Berlin's history has been built on the significant natural resources of the region, and these critical resources need good stewardship so they can continue to serve all of the communities in the region. The type and distribution of Berlin's natural resources also influences the location and type of development that takes place within the community. Some areas of the community are better suited for a particular use than others, based on the natural features that are present there. The information provided in this chapter will assist Berlin in determining compatible future uses for certain land areas in the community.

In 2005 the City of Berlin contracted with Watershed to Wildlife (an environmental firm from Bethlehem, NH) to complete a Natural Resource Inventory (NRI). That NRI has been used as the basis for this Chapter of the Master Plan, so that the important natural resource data for Berlin can be integrated with the other topics included in the Master Plan. This Chapter is also accompanied by a series of maps in the Appendix that depict the natural resources within Berlin.

With significant portions of Berlin protected as conservation land in the White Mountain National Forest, and with little population growth in recent years, the city retains much of its traditional central-place development pattern. With little suburban growth, Berlin exhibits the Smart Growth development pattern that many communities hope to achieve: dense development around a downtown core, surrounded by residential development with easy access both to the core and to the natural resources that surround it. Unlike many communities that are seeking to achieve this, Berlin needs only to recognize it and work to retain it wherever practical.

With significant portions of Berlin protected as conservation land, or covered with valuable natural resources and working landscapes, a pattern of development has developed that concentrates most activities within the Downtown area making Berlin a wonderful example of a Smart Growth community.

Natural Setting

Berlin contains approximately 56.5 square miles (36,134 acres) of land and 0.7 square miles (448 acres) of inland waters. The Androscoggin River runs north to south through the eastern side of the city, and was once heavily polluted with industrial waste and human sewage. The rivers and the forests are now used for numerous recreational purposes, and contain a wide range of ecological habitats including some exemplary natural communities.

Berlin is comprised of unusually large areas of exposed and shallow ledge. Co-occurring in the city are the Upper Ammonoosuc River headwaters, the Dead River, and the drainage of the Middle Androscoggin River, and some rare or endangered animal and plant species. Berlin contains several open water bodies, perennial streams, large wetland complexes, and uplands with numerous rock outcrop peaks offering spectacular views.

Approximately 45% of Berlin is in the Kilkenny Unit of the White Mountain National Forest (WMNF). Another 20% is owned by the State of New Hampshire and others for recreation and conservation purposes. The WMNF land and state owned lands are contiguous throughout the western portion of Berlin, providing protection from development for over half of the City.

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Climate

The primary characteristic of Berlin's climate in the past has been the ability for conditions to change very quickly. A large range of temperatures and conditions can be experienced in a single day, and are guaranteed over the course of a year. The area also experiences great differences between the same seasons from year to year.

During the warmer half of the year most of the precipitation comes from showers and thunderstorms. Frontal precipitation in the colder season is occasionally supplemented by coastal "Northeasters" which can bring a strong wind and heavy snowfall, and on occasion, rain or sleet. Berlin receives an average of 41.73 inches of precipitation annually. Seasonal snowfall varies widely, with a 99 inch average. Summers are very comfortable, with afternoon temperatures mostly in the middle and upper 70's. Nighttime temperatures usually drop to near 50°. Winters are cold, with a December through February normal mean of 18.0°. Based upon the occurrence of the freezing temperature, 32°, Berlin's "growing season" for susceptible tender vegetation averages 110 days, from May to September.

Freezing winter weather or a hot summer can increase utility bills in the City. Calculating how much of the rise in cost is a result of the weather requires using a unit of

measure called the "degree-day." A degree-day compares the outdoor temperature to a standard of 65 degrees Fahrenheit (F); the more extreme the temperature, the higher the degree-day number. Thus, degree-day measurements can be used to describe the effect of outdoor temperature on the amount of energy needed for space heating or cooling. Cold days are measured in heating degree-days. For a day with a mean temperature of 40 degrees F, 25 heating degree-days would be recorded ($65 \text{ base} - 40 = 25 \text{ HDD}$). Two such cold days would result in a total of 50 heating degree-days for the 2-day period. From 1971 to 2000 the average annual heating degree-days for Berlin are 8,515. This is similar to other North Country communities and somewhat higher than communities in southern New Hampshire. Meanwhile the number of cooling degree days is very low at 169 annually.

Wind speeds within Berlin are highly variable and very dependent on location. Data on wind resources is important for any potential renewable energy facilities. One of the largest barriers to the use of wind energy in New England is the lack of detailed information about the wind conditions throughout the region. The performance and economics of wind energy systems are very sensitive to the magnitude and variability of the wind resource, which by nature is highly site specific. A site's wind conditions are influenced by regional weather patterns as well as many other factors, including the elevation of the site relative to surrounding lands, the shape and orientation of the terrain, the vegetative cover, the size and proximity of local buildings, and other obstacles. Wind resource maps for Berlin indicate that the locations with the highest mean wind speeds (15 miles per hour and higher) are on the high ridges and peaks, but also depend on the height of the turbine above the ground.

The unpredictability of weather is forecast to continue as the effects of climate change are realized. This may result in greater variation from year to year, and greater amounts of precipitation during more severe weather events. At a minimum these weather events will lead to more issues related to stormwater runoff, and winter loading of snow on rooftops. It is important for Berlin to consider these changes seriously and ensure that development standards and building codes are written to address larger amounts of precipitation during storms. It is also important to protect or enhance the remaining ecosystems in the city so they can protect and assist the infrastructure, and work to address the impacts of climate change by reducing greenhouse gas emissions.

Air Quality

The air quality in Coos County is very good overall, and has likely improved as some of the largest facilities creating emissions in the County have closed their operations in Groveton and Berlin. Specific data for the City of Berlin is only available for a few pollutants, and some of the data is not up to date. There is no longer a State operated air monitoring station in the City, but data is available on the County level and seems appropriate for this resource. Table 1 presents data collected by the US Environmental Protection Agency for Coos County. On average Coos County experiences good air quality 87% of the time, and as of 2002 was considered an average County on the national level related to the amount of air pollution generated. The air quality ratings for

the County that relate to the overall health risks for residents placed it among the cleanest Counties in the US in 2002.

Table 1 Air Quality Data for Coos County

Year	Air Quality Data Collected (Days)	Number of Days When Air Quality was...			
		<i>Good</i>	<i>Moderate</i>	<i>Unhealthy for Sensitive Groups</i>	<i>Unhealthy</i>
2000	366	350	16	0	0
2004	246	205	38	3	0
2006	245	222	23	0	0

Source: US Environmental Protection Agency

Geology

Bedrock Geology

As the name implies, bedrock geology is concerned with the underlying rock or ledge. Formed hundred of millions of years ago, Berlin’s bedrock is composed mostly of igneous rocks such as granite, and metamorphic rock such as schist. The metamorphic rock was formed under heat and pressure from many layers of mud, sand, and silt. It was later uplifted by the earth’s internal forces. The youngest bedrock in Berlin was formed during the Carboniferous Age, some two hundred million years ago.

Being the least eroded of all the bedrock in the region, these rocks make up the rugged, scenic areas of the White Mountains. The Eastern portion of the community contains large areas of bedrock which has been a challenge to development in the past. This needs to be considered when looking at new development or redevelopment activities.

The bedrock in Berlin has been a challenge to development in the past, and has lead to complications with some of the infrastructure that needs to be placed in the ground. One of the historic impacts has been on water use.

Surficial Geology

Surficial geology includes all of the deposits above bedrock. The surface layer of weathered material (i.e. soil) is not included in the study of surficial geology. Surface deposits are unconsolidated, loose conglomerations of rock fragments. These surface deposits in Berlin are the result of glaciation. As the glaciers advanced the bedrock was scraped and gouged, and this material was picked up and carried along in the glacial ice.

As the climate warmed and the ice retreated, it deposited two major types of material—till and glacial outwash deposits. Till is composed of a mixture of soil and rock fragments that were scoured loose by the moving ice, carried for a distance, and then deposited directly as the melting ice released its unsorted contents. It is generally highly compacted and contains many large angular stones and boulders. Glacial melt waters also deposited material, but the moving waters actually sorted the material and deposited like sizes together along glacial streams or in glacial pools and lakes. These are stratified drift outwash deposits. Outwash deposits are important economically for mining purposes, but they also serve as major groundwater-recharge areas.

Three of the largest stratified drift aquifers in Berlin are located near Head Pond, along the Dead River on the northern side of Route 110, and along the Androscoggin River north of the Downtown area. The maps included in the Appendix identify these aquifer areas.

Soils

The nature of soil has a profound effect on plant growth. Whether it is rich with organic material, very poorly drained, or sandy, will affect the type of vegetation adapted to grow in those conditions. Soil information is critical in making sound land use decisions. By examining soil types and morphology, many predictions are made regarding forest management, erosion potential, and development possibilities. For example, residential development should be located away from areas with unstable soil conditions, high water tables, and slow percolation rates due to constraints for building foundations and septic system placement.

Soil information is also an excellent indicator of critical resource areas such as wetlands, agricultural lands, forestlands, and wildlife habitat. In descriptions of soil types, the Natural Resource Conservation Service (NRCS) evaluates soil types according to their capacity for agriculture, woodlands, community development, recreation, and wildlife habitat. Several factors exert a major influence on soil development in Berlin. These include climate, time, topography, parent material, biota, and human activities. Future development activity must be sensitive to the fact that certain soils are not appropriate for development, and some soils are better suited for future agricultural operations and should not be removed or destroyed.

The soils found in Berlin can be broken down into seven basic groups. Table 2 summarizes these groups and the approximate area they cover in Berlin. Map included in the Appendix illustrates the extent of these soils in Berlin.

Table 2 Soils in Berlin

Soil Group	% of Berlin's Non-Federal Land
Group 1 – Wetland Soils	11%
Group 2 – Seasonally Wet Soils	21%
Group 3 – Floodplain Soils	1%
Group 4 – Sandy and Gravelly Soils	2%
Group 5 – Shallow to Bedrock Soils	19%
Group 6 – Compact Till Soils	23%
Group 7 – Deep Loose Till Soils	22%
Other (water, man made land, etc.)	1%

Source: 1992 Master Plan, Soil Conservation Service (Now NRCS)

Topography, Slopes and Scenic Resources

Topography describes surface features of the land in terms of shape, relief and relative positions of natural features. Topography is usually expressed as elevation (height above mean sea level) and slope (change in vertical distance over a given horizontal distance). Berlin's topography is a mixture of various terrain features. Much of the City is steep and hilly with some exposed bedrock, but some of Berlin contains flat river valley areas. Some of the highest elevations in Berlin include Mt. Weeks (3,890 feet) and the slopes of Deer Mountain (2,770) in the Kilkenny, Mt. Carberry (1,754 feet), Mt. Forist (2,068 feet), Mt. Jasper (1,584), Jericho Mountain (2,487), and Cates Hill (2,040 feet). By way of comparison, the front steps of City Hall on Main Street are at 1,010 feet.

Slope is one significant aspect of landform, which presents limitations for development. As slopes become steeper, the expense of building increases. Furthermore, increased slope means there is a greater chance of erosion, structural problems, and water pollution problems. In general, slopes greater than 25% are considered too steep to provide adequate sites for structures such as roads, homes, and septic systems. Even slopes of 15% are problematic. Of interest, portions of Hillside Avenue are at 17%. On steep slopes, soils are usually shallower, the volume and velocity of surface water runoff is higher, and the erosion potential is greater than on flatter areas. The consequences of

Approximately 9,518 acres or 40.6% of land throughout Berlin (excluding the White Mountain National Forest) contains slopes that are over 15%. Of that, approximately 2,825 acres or 12.1% contain slopes over 25%.

erosion are loss of soil resulting in sedimentation of surface waters and loss of the productive capacity of the land.

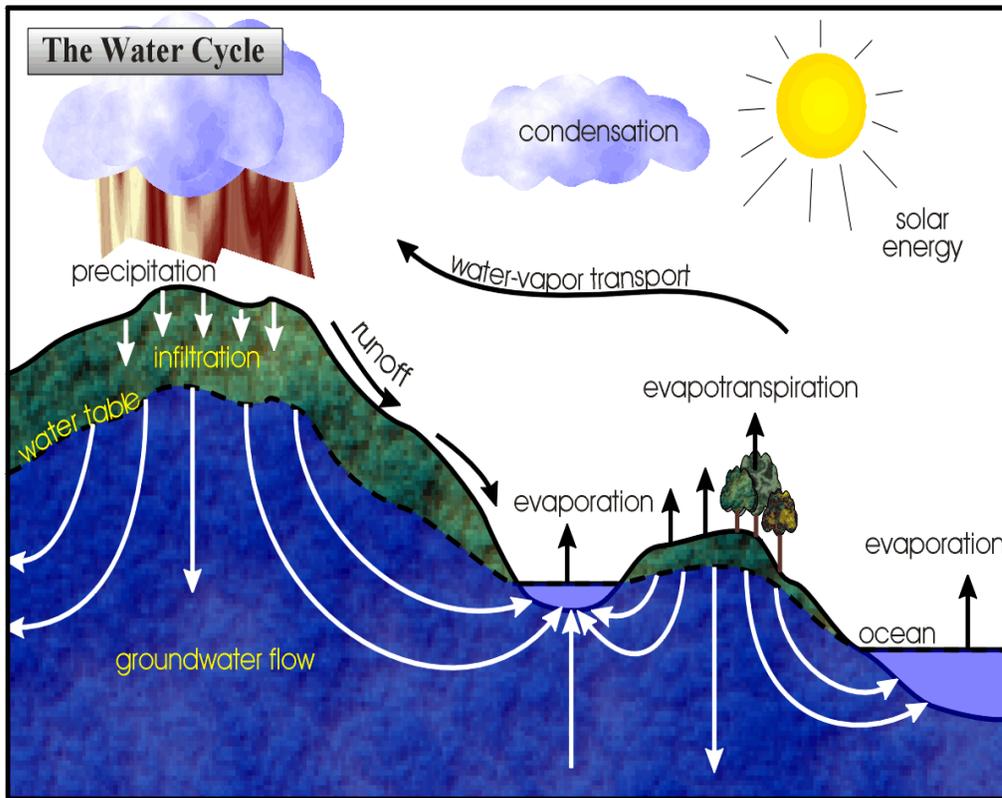
The NRCS soils maps were used to determine areas with slopes equal to and greater than 15%: areas where development would be difficult to build and costly to maintain. Approximately 9,518 acres or 40.6% of land throughout Berlin (excluding the White Mountain National Forest) contains slopes that are over 15%. Of that, approximately 2,825 acres or 12.1% contain slopes over 25%. The flat land throughout Berlin is located mostly along and around the Androscoggin River and Dead River floodplains. These flatlands, though, are often associated with flood hazard areas, especially if the water table is high. The net impact for Berlin is a relatively small portion of the land that meets ideal conditions for development.

A positive aspect of Berlin's steep slopes is the opportunity for panoramic views in numerous locations throughout the community. Identification and proper planning are important to Berlin to maintain these viewsheds. The following are some of Berlin's many scenic vista points.

- Cates Hill
- Nansen Riverfront Park
- Head Pond
- Androscoggin River
- Jericho Lake State Park
- Northern Forest Heritage Park riverfront
- Several locations on Route 16
- Several locations on Route 110
- Mount Forist Summit
- Mount Jasper
- Numerous peaks throughout the WMNF

Water Resources

Water is one of our most precious natural resources. Water moves continuously in an inter-dependent fashion known as the water cycle. All water is involved in this cyclical movement that continues indefinitely. With increased land use and human activity, the water cycle can become damaged. Humans not only take water out of the cycle (drinking water, for example), but can also put polluted water back into the cycle (such as contaminated runoff). Communities have often taken a reactive approach to protecting water resources in the past, and nothing is done until a threat is identified and contamination is imminent or has already occurred. However, with good planning and conservation, plentiful clean water should be available for all uses.



Surface water is precipitation that does not soak into the ground, but runs off into streams, ponds, lakes, and rivers. Watersheds are the catch basins for all precipitation falling from the sky, and rain or snow falling within the confines of a watershed’s interconnected high points eventually becomes surface and groundwater.

Watersheds

A watershed is usually associated with a particular river or stream that it feeds. For example, the Androscoggin River drains the eastern half of Berlin and land areas north of the city as well. The Upper Ammonoosuc River drains the western half of Berlin to the Connecticut River. Each tributary of the Androscoggin, Upper Ammonoosuc, and Dead Rivers has a smaller sub-watershed of its own that contributes to the larger watershed. There are ten identified watersheds in Berlin, and they are delineated on a map in the Appendix.

While groundwater flows may follow the same watershed boundaries, that is not assured and determining accurate groundwater flow can be an expensive and difficult task. Land use within a watershed may be an important factor in water quality, therefore, it is very important for communities to work together in order to plan effectively for protection of water resources. This is especially important in Berlin where most of the surface water passing through the city is arriving as a clean resource because it has started its journey in the clean surface waters of the WMNF and other large unfragmented blocks of land outside of Berlin’s downtown area. When these waters leave the eastern portion of the

community they have been degraded to some degree by the existing development activity.

Surface Waters

The Androscoggin River flows for approximately six miles through the eastern side of the City along Route 16. Along this stretch there are numerous boom piers that were constructed of stone and logs (some with large metal pins and chains that still remain today), used historically when the river was used for log and pulpwood drives. The site of the former paper mill in Downtown Berlin abuts the Androscoggin River for approximately one mile. The US Environmental Protection Agency has tested the river for pollutants as part of the study at the Chlor Alkali site. The findings of this study have been included in the Appendix.

The Dead River flows for approximately three miles through Berlin in a diagonal from northwest to southeast direction along Route 110. Though a much smaller flowage in volume, steepness, and energy than the Androscoggin River, the Dead River has a wide floodplain which provides much riparian habitat and adjacent large wetland complexes. The Dead River joins with the Androscoggin River just south of the Route 110 and 16 intersection.

The Upper Ammonoosuc River is also located in Berlin and flows for approximately six miles, running first northerly, before swinging northwesterly, then westerly through Milan and on to Groveton. In Berlin most of the Upper Ammonoosuc River flows through the WMNF and has relatively steep slopes. The Head Pond drainage flows northerly into Milan where it ultimately joins the Upper Ammonoosuc River.

Protecting the biological diversity and scenic values along these rivers is a priority for the City of Berlin. An excellent example of the attraction and value of such rivers to a community is the Northern Forest Heritage Park, developed along the Androscoggin River in the northern section of the city's Main Street area. Kayaks and canoes are often used as recreational devices for the public to enjoy the river. The abundance of wildlife sign observed along these rivers and adjacent buffers during the Natural Resource Inventory indicates the importance of maintaining the quality of these areas for the range of species that rely on them. These species include song birds, ground nesting birds and other avian species, terrestrial mammals such as beaver, muskrat, river otter, white-tailed deer, moose, black bear, raccoons, and smaller mammals.

With the exception of the area where the former paper mill site abuts the Androscoggin River, there are generally vegetative buffers (though narrow along Route 16) that help control erosion and road runoff to varying degrees. There are a few other areas of concern in the downtown area where little or no buffers exist and in some cases, impervious surfaces are located along the riverbank. As future development occurs along the floodplain, careful planning, maintenance of riparian buffers, and stormwater runoff control will be essential to maintain the quality of the adjacent waters.

There are numerous small streams and brooks throughout the City of Berlin (see the maps in the Appendix) such as Cold Brook, Stony Brook, Spruce Brook, Refuge Brook, Brandy Brook, Spring Brook, Number 9 Brook, West Brook, One Mile Brook, Bend Brook, Jericho Brook, Cascade Alpine Brook, Bean Brook, and Horne Brook to name some, with several unnamed drainages.

Jericho Lake (135 acres), Head Pond (87 acres), York Pond (23 acres), Godfrey Dam (10 acres), and numerous smaller unnamed ponds are found in Berlin. All ponds have associated wetland complexes, some of them covering very large areas. These extensive networks of wetlands contain excellent wildlife habitat. Head Pond, Jericho Lake, and the Godfrey Dam have some degree of protection from future development as they are over 10 acres in size and classified as Public Waters subject to the Comprehensive Shoreland Protection Program. Jericho Lake is also under a conservation easement through the State of New Hampshire. York Pond and Godfrey Dam are in the WMNF and are therefore protected from development. All water bodies offer recreational and wildlife value for Berlin, its immediate abutters, and the entire region. Swimming, kayaking, canoeing, bird-watching, hiking, fishing and hunting are all common occurrences in Berlin. Tourism accounts for a large portion of income for northern New Hampshire and these water bodies are significant components.

Impoundments

In the state of New Hampshire there are over 4,400 dams registered with the Department of Environmental Services. Twenty-four of these are in Berlin. The majority of dams in Berlin are related to hydroelectric operations, water supply, and recreation. Table 3 lists the twenty-four dams in Berlin that are registered with the New Hampshire Department of Environmental Services. There are 7 dams across the Androscoggin River as it flows through Berlin, with numerous dams along its tributaries and to the north and south of Berlin that greatly impact the river and its former natural flow. One dam is located on the Dead River, and any of the remaining dams are located in the White Mountain National Forest.

Table 3 Dams

NAME	RIVER	IMPOUNDMENT (Acres)	HEIGHT (Feet)	OWNER
Cross Power Dam	Androscoggin	10	40	Brookfield Power
Glen Mill	Androscoggin	20	27	PSNH
Glen Mill B Dam	Androscoggin	NA	30	James River Corp.
Smith Dam	Androscoggin	20	27	PSNH
Riverside Dam	Androscoggin	7	21	Brookfield Power
Sawmill Dam	Androscoggin	100	14	Brookfield Power
Dead River Dam	Dead	NA	8	James River Corp.
Godfrey Dam	Upper Ammonoosuc	10	18	Berlin Water Works
Upper	Upper	NA	NA	International Paper

Ammonoosuc Crib Dam	Ammonoosuc			Co.
Beane Reservoir Dam	Bean Brook	2	15	Berlin Water Works
Above Godfrey Dam	Upper Ammonoosuc	NA	NA	Unknown
Bog Dam	Upper Ammonoosuc	NA	NA	Town of Lancaster
York Pond Dam	Cold Brook	21	12	NH Fish & Game
Dead River Dam 1	Jericho Brook	132	47	DRED
Burgess Wastewater Lagoons	Natural Swale	1	10	Androscoggin Valley Regional Refuse Disposal District
Steward Dam	Androscoggin	.5	14	Berlin Water Works
Alpine Cascade Brook Dam	Alpine Cascade Brook	1	30	Fraser NH LLC
Diversion Pond Dam	No. 9 Brook	3	20	NH Fish & Game
Cold Brook Dam	Cold Brook	.25	6	NH Fish & Game
Settling Pond	Unnamed Stream	1.5	12	NH Fish & Game
West Branch Dam	West Branch Ammonoosuc	.5	10	NH Fish & Game
Cold Brook Dam III	Cold Brook	.25	6	NH Fish & Game
Cold Brook Dam II	Cold Brook	.5	8	NH Fish & Game
Upper Trail Pond Dam	No. 9 Brook	.25	20	NH Fish & Game

Source: NH Department of Environmental Services, Dam Bureau

Riparian Habitat and Floodplains

The rivers and streams in Berlin contain many acres of riparian habitat rich in plant and wildlife species. Within these periodically flooded areas are upland and wetland soil habitats with a multitude of ‘edges’ creating unique opportunities for plant and animal species to thrive. The diverse riparian habitat in Berlin includes scrub-shrub, grassland, meadow, and forest. The riparian buffers are adequate for the majority of the floodplain areas, but could use improvements in some areas. Along the Androscoggin River buffers are generally not adequate in areas close to roads, parking lots, and industrial and commercial lots with impervious surfaces.

Riparian buffers also provide travel corridors containing shelter, food, and birthing places for numerous terrestrial mammals such as beaver, muskrat, river otter, white-tailed deer,

moose, black bear, raccoons, skunks, red and gray fox, coyote, weasel, mink and smaller mammals.

Floodplain forests are unique natural communities that occur within floodplain areas along river corridors. Their uniqueness and location adjacent to riparian habitat and rivers provide valuable wildlife habitat for breeding birds, spring migratory birds, insect populations, and amphibians. Generally, larger patches of forested floodplains exhibit greater species richness and support greater diversity of wildlife. Hemlock, White Pine, Box Elder, White Cedar, Spruce and Balsam Fir are abundant along the Berlin reaches of four rivers, and are dominant tree species in much of the floodplain. The interwoven root system of these species is important in controlling bank erosion.

The importance of maintaining, and in many cases increasing, these areas cannot be overstated. As development pressures and natural resource management increase, the effect on these areas needs to be carefully weighed and a balance found to prevent loss of the functionality of this habitat. It is intended that digital tools such as the maps produced during the NRI and this Master Plan will assist Berlin in assessing proposed future impacts before they occur. Retaining existing buffers, and promoting the expansion of additional riparian buffers are critical to maintaining water quality, preventing erosion, improving fisheries habitat and wildlife travel corridors, and minimizing flooding.

Wetlands

There are many reasons why wetlands are valuable to the community. They benefit flood control, erosion control, pollution filtration, water supply, wildlife habitat, environmental health and diversity, recreation, and aesthetics. These are but a few of the important functions wetlands perform in helping protect the quality of water, land, and the community. Wetlands are the core of life for the majority of plant and animal species and contain diverse habitats with numerous edge habitat needed by many species. It is estimated that riparian areas and wetlands are utilized by over 90% of the region's wildlife species, and provide the preferred habitat for over 40% of local species.

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Wetlands perform all of these functions with no charge to society. Dams, tertiary sewage treatment plants, water purification plants, dikes, and other sophisticated and expensive man-made water control measures all try to copy what wetlands do naturally. Each acre of existing wetland provides significant benefits to Berlin.

Based on National Wetland Inventory (NWI) data there are approximately 1,983 acres of wetlands in Berlin, (5% of the land mass). Based on NRCS data, which excludes the

WMNF land, there are approximately 2,972 acres of hydric soils in Berlin, (12.7% of the land mass). New Hampshire requires three parameters in defining wetlands; wetland vegetation, hydric soils, and hydrology. Although excellent tools, generally NWI data under represents the size and number of wetlands, and NRCS hydric soil data alone over represents the size and number.

Field determinations and a comprehensive inventory will be necessary over time to accurately delineate all wetlands in Berlin, but most of the known wetland complexes in the community are found in the Head Pond and Dead River drainage areas. Wetlands can be found along the surface waters and in forested upland areas as well. This is the portion of the community where all development activity is taking place so great care must be taken not to impact wetland resources.

Vernal pools are unique and often isolated wetlands. A vernal pool is a depression that holds water temporarily during spring months. They provide essential breeding habitat for certain reptiles, amphibians, and crustaceans – such as wood turtles, wood frogs, spotted salamanders, and fairy shrimp. They fill annually from precipitation, runoff, and rising groundwater. Vernal pools are usually dry by the middle of summer, making them uninhabitable for fish, and therefore a safer environment for amphibians. Vernal pools vary in size, shape, and location. Vernal pools are common in New Hampshire, and the State recognizes their value as important habitat. Several vernal pools were documented during field work for the NRI, and future studies could easily document additional ones throughout the city.

Groundwater

There are three types of groundwater aquifers: Stratified-drift; till; and bedrock. The basic difference between them is that stratified drift and till aquifers are composed of unconsolidated glacial deposits (loose earth materials), while bedrock aquifers are solid rock. In stratified drift aquifers, the materials have been sorted by moving water into concentrations of sand and gravel, all sorted by particle size. In till aquifers, the material is a gravel, sand, silt and clay mixture, all deposited in an unsorted manner. In bedrock aquifers, the rock is fractured.

Stratified-drift aquifers are an important source of ground water for commercial, industrial, domestic, and public-water supplies in the State of New Hampshire. Approximately 14% of land surface in the State is underlain with stratified drift aquifers. In and around Berlin they consist of stratified, sorted, principally coarse-grained sediments (sands and gravels) deposited by glacial melt-water during the time of deglaciation. Approximately 3.4 square miles (2,147 acres) or about 5.4% of the area of Berlin is underlain with stratified drift aquifers. These are located primarily along the Androscoggin River and Dead River floodplains, but also found in other areas of the City such as the Godfrey Dam area in the Upper Ammonoosuc River watershed.

The maps included in the Appendix illustrate the extent and the location of the aquifers in Berlin. Three of the largest stratified drift aquifers in Berlin are located in the eastern

portion of the community near Head Pond, along the Dead River on the northern side of Route 110, and along the Androscoggin River north of the Downtown area.

One location of particular concern is along the eastern side of the Androscoggin River in the vicinity of the Maynesboro Industrial Park. This is a location that needs additional protection, and regulations related to the use and storage of hazardous materials are critical in this area to prevent pollution of the aquifer.

Berlin is fortunate to have two developed sources of drinking water; the Brown Farm gravel packed well which supplied the City for many years within the Androscoggin River watershed (and is still used for emergency situations as a back up), and the Godfrey Dam impoundment in the Upper Ammonoosuc watershed which currently serves as the primary source for the City. Wells used by communities and private landowners draw groundwater from aquifers. The stratified-drift aquifers represent further potential groundwater sources for the City of Berlin. These aquifers should be protected to insure their future quality and availability.

Working Landscapes

Forested Lands

As with surrounding New Hampshire towns, the City of Berlin contains large acreages of forest including mixed hardwood and softwood forests, dense softwood forests, and Boreal Forest wetlands. Much of Berlin's land mass has been devoted to forestry, and harvesting has occurred as growth cycles have warranted. Berlin is an exemplary example for the State of New Hampshire in its long historical dependence and utilization of forestland which continues to this day.

From a planning perspective, forestlands are not just a source of wood products, or a yield of tax revenue. The forest industry also provides many area jobs. Forestlands also play an important role in providing areas for outdoor recreation, wildlife habitat, and scenic enjoyment. They play a role in the water quality of Berlin's ponds and streams. All of these uses are potentially sustainable, and each can co-exist. Timber harvesting, while having dramatic visual impacts in some cases, is rather short-term. However, subdividing large woodland parcels into small lots for development can have a long term, nearly irreversible impact.

New Hampshire's Vanishing Forests (2001) found that while New Hampshire remains predominately forested, the amount of forest cover will decline to 80% statewide within the next 20 years, and of that, less and less will be committed to long term forest management in large tracts. Additionally, most landowners no longer rank timber production as their main reason for owning the land. Only 10% of the landowners include timber production as primary reason, with aesthetic enjoyment now more than 50% of the landowners' reason for owning the land.

It was found that parcels of land 500 acres or more are the most common for long term forest management due to economies of scale. With regard to the short-term impacts of logging, the town has a built in mechanism to monitor logging operations – the notice of ‘Intent to Cut.’ Once an ‘Intent to Cut’ is filed, it is reviewed to determine if the logging operation is going to impact sensitive or critical natural resource areas, such as wetlands, deer yards, fragile biotic communities, etc. Landowners and foresters could be educated to the need to carry out logging operations in a manner sensitive to important natural resources. It could also help to identify logging operations that are planned on areas used for recreation such as paths and trails. Steps could then be taken to work with landowners and foresters to temporarily close or re-route trails during the logging operations. In many communities, these reviews are conducted by the local conservation commission.

Typical tree species that grow in Berlin are white pine, white birch, yellow birch, red maple, sugar maple, beech, poplar, white ash, eastern hemlock, red spruce, balsam fir, and tamarack. Northern white cedar is also prevalent, in some sections of Berlin, especially in some of the Boreal Forest Wetlands. Northern white cedar provides particularly dense cover for wildlife, including winter deer yards. Over 84% of Berlin contains forested habitat. The NRI identified many dense softwood forests in the eastern portion of Berlin, and some of the largest blocks of this forest type are located east of the Androscoggin River.

As forest resources are looked upon for their potential to be used as biomass fuel great care must be taken to ensure that this use is sustainable. Several studies have started to calculate the amount of biomass that may be sustainably harvested from the northern forests, and further investigation may be necessary in the coming years.

Agricultural Land

Traditional agricultural activity in New Hampshire is at its lowest level in history in terms of acreage and production. New Hampshire ranks 49 out of 50 in the level of agricultural production in the U.S. One reason for this is that land suitable for agriculture is also excellent for development. Agricultural land is gently sloping, open, and scenic. The agricultural land that remains undeveloped adds a special rural character to a town while at the same time providing habitat for local wildlife.

Prime farmland, as defined by the U.S. Department of Agriculture, is the land that is best suited to food, feed, forage, fiber, and oilseed crops. It can be cultivated land, pasture, woodland, or other land, but it is not urban and built-up land or surface water areas. It either is used for food or fiber crops, or is available for those crops. The soil qualities, growing season, and moisture supply are those needed for a well-managed soil to produce a sustained high yield of crops in an economic manner. Prime farmland produces the highest yields with minimal inputs of energy and economic resources, and farming it results in the least damage to the environment.

One factor that influences farmland along the Androscoggin River is the presence of an abundant volume of moving water. The fact that water reacts much more slowly than air to temperature changes provides a mini-climate within the floodplain area, offering cooler temperatures in the extreme heat of summer and warmer temperatures (including the formation of fog) in the cooler fall temperatures extending the growing season.

Throughout the City of Berlin there are only 572 acres (0.9 square miles) of land classified as USDA prime and/or statewide importance farmland. This represents less than 2.5% of land base in Berlin. Most of these soil types lie in a band along the Androscoggin River flood plains. Additionally, Berlin has 5,135 acres of farmland classified as local importance. These soils are mostly located in the Cates Hill area.

Decision makers must be aware of the long term implications of various land use options for the production of food, fiber, forage and oilseed crop, and the trade-offs involved. Actions that put high quality farmland in irreversible uses should be initiated only if those actions are clearly in the public interest.

As is the situation in most all of New Hampshire, the City of Berlin has experienced a loss of working farms. As the percentage of non-developed, permanent openings in the landscape in New Hampshire has decreased significantly over the past 50 years, the state is encouraging landowners to create or maintain permanent openings as important wildlife habitat. These permanent openings, dominated by grasses, forbs, brambles, or fruiting shrubs, provide necessary habitat for about 22% of New England's wildlife species, and seasonally important habitat to nearly 70% of species. Permanent openings in general also have the advantage of creating edge habitat.

Approximately 721 acres of land is managed for permanent openings, including agriculture, in Berlin. This is approximately 1.8% of the total town's land area, and is well below the average of 10% openings throughout the State of NH. Most of the permanent openings identified in the NRI are located in the portions of Berlin outside the WMNF.

Most of the larger permanent openings are found along Cates Hill and the Androscoggin River. Often overlooked areas of permanent opening are below the miles of electrical transmission lines that run through most municipalities. Berlin has nearly 7.5 miles of transmission lines traveling mostly in a north-south direction through the eastern end of the City. Retaining permanent openings will be beneficial to the diversity of wildlife and vegetation throughout the town.

According to the New Hampshire Department of Agriculture the face of agricultural operations in New Hampshire is changing quickly. Niche markets including specialty crops and herds, customized farm products, and small scale operations are redefining agriculture. There may be opportunities to put some new agricultural models into place by encouraging urban agricultural operations that provide local food and value added products. All of these efforts are important to increasing Berlin's food security and generating opportunities for farmers and small scale specialty growers. Considering the

fact that most food sold in Berlin is being shipped long distances, at a great cost and with less nutritional value, it may be time for a local food initiative. The addition of a farmers market in the downtown area could support existing businesses in the region, and new businesses coming online.

Rare Species and Exemplary Natural Communities

The City of Berlin has the potential for numerous occurrences of these rare species and communities due to the unique and diverse habitats throughout the community. Berlin also has a large amount of exposed rock outcrop which is critical habitat to some plant and animal species. There are some documented plant and bird species occurrences in this area with ongoing studies.

New Hampshire's Natural Heritage Bureau has documented important Natural Communities occurring in Berlin including; Terrestrial Red Oak – piny rocky ridge, Palustrine northern white cedar seepage forest, Palustrine herbaceous riverbank/floodplain, Palustrine kettle hole bog system, and Palustrine medium level fen system. Each of these Natural Communities are composed of a specific mix of plant species, and are known to be important for supporting a range of species that are important in New Hampshire.

The bald eagle is making a comeback in New Hampshire and has been documented in Berlin. With abundant lakes and ponds over 10 acres in size, the common loon is also found and documented in Berlin. Other rare bird species documented in Berlin are the common nighthawk and rusty blackbird.

The abundance of steep slopes, forestland, and wetland complexes in Berlin suggest that other rare plant and animal species exist, but need further investigation and documentation. The NRI includes a list of rare, threatened, or endangered species documented throughout the City of Berlin. Most of these species are cited as having historical occurrences, which means that they have not been seen for over 20 years. Data for that effort was extracted from the New Hampshire Natural Heritage Inventory Bureau.

New Hampshire is home to more than 500 species of vertebrate animals. Many of these animals live in Berlin and the surrounding towns. The number would be considerably larger if a complete list of invertebrates (insects, crustaceans, clams and snails) were included. About 75 percent are nongame wildlife species - not hunted, fished or trapped. Twenty-one species are endangered and thirteen are threatened in the state. The New Hampshire Fish and Game Department maintains a list of Endangered or Threatened animal species in New Hampshire, which is also included in the NRI. Little information is available relative to their occurrence in Berlin, but their habitats, when identified should be protected.

Conservation Land

At the time of the NRI (2005), there were approximately 16,982 acres of conserved or protected land in Berlin. This is 43% of the City's land area. Since that time other areas, such as the ATV Park, have been placed into conservation easements adding another 7,200 acres. The City now has 61% of its land area in conservation. Most of this conserved land is part of the WMNF, which contains nearly 16,367 acres of land (41% of Berlin's land area). The map included in the Appendix illustrates the extent of the network of conservation and recreation land in Berlin.

The City now has 61% of its land area in conservation. Most of this conserved land is part of the WMNF, which contains nearly 16,367 acres of land (41% of Berlin's land area).

A conservation easement on private land is a property right that can be bought or sold. It allows property owners to put limitations on their property when an easement is sold, or for another person to set limitation upon the property owner when an easement is purchased. There are efforts by landowners in the City to conserve and connect smaller parcels into one larger, contiguous area of land for conservation, both for wildlife corridors and for recreation.

Natural Hazards

Wildfire Mitigation Plan

The City of Berlin's Wildfire Mitigation Plan is a tool for use by the City of Berlin in its efforts to reduce future losses from natural and/or man-made wildfire hazards. The Plan has been adopted as an addendum to the City of Berlin's All-Hazards Mitigation Plan adopted by the City on January 9th, 2004.

The Federal Emergency Management Agency (FEMA) defines wildfires as an uncontrolled fire spreading through vegetative fuels, exposing and possibly consuming structures. They often begin unnoticed and spread quickly and are usually signaled by dense smoke that fills the area for miles around. Naturally occurring and non-native species of grasses, brush, and trees fuel wildfires. The Plan identifies potential hazards within the City, provides a history of wildfires, includes a listing critical facilities that need to be protected, identifies vulnerable structures, outlines current policies and regulations related to wildfires, and proposes mitigation strategies.

The Plan calls for the City of Berlin's Capital Improvement Plan to include Wildfire Mitigation strategies, such as water storage facilities in identified locations. The Plan also recommends an ordinance that would require sprinklers in homes within subdivisions and multi-family homes, or to have sufficient water sources available prior to construction. Work on awareness issues within the community, reducing slash left

along the natural gas pipeline, and best management practices in the forests were also recommended.

Hazard Mitigation Plan

In 2008 the City of Berlin updated the Hazard Mitigation Plan to better inform the Master Plan, and to reduce the loss of life and property, human suffering, economic disruption, and disaster assistance costs resulting from disasters in the city. New Hampshire is subject to many types of natural hazards: floods, hurricanes, nor'easters, winter storms, earthquakes, tornadoes and wildfires, all of which can have significant economic and social impacts. Some, such as hurricanes, are seasonal and strike in relatively predictable locations. Others, such as floods, can occur anytime of the year and almost anywhere in the state.

The scope of this Hazard Mitigation Plan includes the identification of natural hazards affecting the City, as identified by the Hazard Mitigation Planning Committee. In addition, the Committee discussed issues related to man-made hazards and further development of this topic should be included in future revisions of the Plan.

The City of Berlin is susceptible to a variety of natural hazards including flooding, river ice jams, severe winter storms, hurricanes, and other hazards. Based on the history of the hazards described in the Hazard Mitigation Plan, the Probability Matrix (Figure 1) was created.

Figure 1 Hazard Probability Matrix

Hazard	Probability of Occurrence		
	Likely (3)	Possible (2)	Unlikely (1)
Riverine Flooding	3		
Ice Jam Flooding			1
Dam Breach			1
Drought		2	
Extreme Heat			1
Wildfire		2	
Earthquake			1
Landslide			1
Geomagnetism			1
Radon		2	
Tornadoes			1
Hurricane		2	
Downburst	3		

Lightning Strike	3		
Winter Weather	3		
Man-Made Hazards		2	
Public Health All Hazard		2	

Source: Berlin Hazard Mitigation Plan, 2008

Flooding

Berlin’s steep slopes prevent flooding citywide, but the community does have a history of isolated flooding events and has taken steps to reduce the potential for flooding within the city. The spring of 1969 brought major flooding to Berlin because of heavy snowmelt. Flood events were most recently experienced in Berlin during June and July of 1998. The flood control dams on the Androscoggin River break up ice and remove the risk of flooding related to ice jams. The Jericho Dam project was designed to reduce flood events on the Dead River around the “Moxie Alley” and other areas, and the project has successfully reduced the risk of flooding.

The City of Berlin has been participating in the National Flood Insurance Program (NFIP) since 1982. There are 3 structures in Berlin that have NFIP flood insurance policies, and no repetitive loss properties. There has only been one flood insurance claim made since 1978. As of 1998, the City of Berlin had approximately 46 residential structures located in the FEMA designated 100-year floodplain. The estimated population within these structures is 300 persons. Riverine flooding and ice jam flooding would primarily affect the 100-year floodplain. Much of the damage from these two hazards could be expected to occur not only on privately owned structures, but also on public property, such as roads and bridges. Dollar estimates from this type of hazard can range widely depending on the nature and severity of the hazard. A small to medium sized event could be expected to produce a loss from \$10,000 to \$5,000,000.

Assuming 50% of structures in the floodplain sustain 30% damage, the estimated cost of repairing or replacing these homes after a major flood event is approximately \$500,000. This estimate assumes a one or two story house with a basement, and a flood depth of four feet. Infrastructure damage could also be extensive, including roads, bridges, utilities, towers, etc. If a major devastating flood were to occur, the damage to properties located within the floodplain could be expected to exceed this estimated amount. The cost-benefit ratio for these items makes it clear that Berlin will benefit greatly from any flood mitigation measures that will help to reduce the losses that typically occur during a major flood event.

Dam and/or breach failure could have catastrophic results in Berlin, including loss of human life. A major dam breach would affect more than the 46 structures in the 100-year floodplain. Assuming twice that number was destroyed, along with major losses to utilities and public properties, the total damage could exceed \$20,000,000.

A major hurricane can cause significant damage to a community. Since Berlin is inland from the coast, but is noted as being within a hurricane susceptible region, less damage

could be expected to occur here than in coastal areas. Assuming an assessed structural valuation of approximately \$75,000, damaging 30% of the 46 structures in the 100-year floodplain, flooding could result in losses of approximately \$1,000,000. This would not include other damages expected to occur on public property within the community.

Tornados

Building to modern wind standards provides significant property protection from these hazard events. New Hampshire is located within Zone 2 for Design Wind Speed for Community Shelters, which is 160 mph. Tornados rarely occur in this part of the country, so damage from this hazard would not be very likely. Historically only one tornado has been recorded in Berlin, and that occurrence was in 1929.

Severe Winter Weather

Nor'easters and ice storms typically vary greatly depending on the amount of snow and ice that accumulates during the storm. The ice storm of 1998 caused much damage to power lines, structures, the surrounding forestry, and the agricultural economy in northern New England and southeast Canada, with 1.1 billion in insurance claims and 35 lives lost due to the storm. These types of storms in Berlin could be expected to cause damage ranging from a few thousand dollars to several million, depending on the severity of the storm.

Forest Fire

A forest fire can strike at any time in any place. Forest fires may be expected to occur during years of drought. Presuming a small to medium size fire that destroys a small number of homes, damage from this hazard could be expected to range from \$180,000 to \$3,600,000, which would damage or destroy from one to 20 homes or more within the City.

Earthquakes

Assuming a moderate earthquake occurs in Berlin where structures are not built to a high seismic design level, presuming mostly wood frame construction, it could be estimated that about 1% to 5% of the assessed structural valuation could be lost, including damage to homes and homes that are totally destroyed. Historically there have been two events in the Berlin area. The first event was a 4.0 magnitude earthquake in 1988 that had an epicenter five kilometers northeast of Berlin. The second event was a 4.1 magnitude earthquake that took place in 1989.

Downbursts

Recent "unofficial" downburst activity occurred in July of 2002. Several trees in the City ball fields and several rooftops were damaged as a result. In addition, several residential homes incurred minor damage to siding and rooftops as well as the need to clear debris. Downbursts are unpredictable in New Hampshire, yet there have been many official recordings, some of which caused severe damage to limited areas.

The complete Hazard Mitigation Plan should serve as an appendix to the Master Plan, and should be consulted when existing codes, infrastructure guidelines and land use

regulations are reviewed and updated.

Land Use Implications and Potential Actions

Berlin’s natural resources have a direct impact on the community and the region. Below are the critical items related to the natural resources in Berlin, and an array of possible actions the City may want to consider pursuing. This section will be used to identify the specific actions for Berlin to take upon completion of the master plan.

Land Use Implications	Potential Actions
<p><i>Climate</i></p> <p>Seasonal changes contribute to the character of the region, and the variety of recreational and economic activities available. Air pollution from vehicles, homes, and commercial and industrial facilities threatens the character of our seasons, and the quality of our water. Recognition of the role local activities have on the global problem of climate change will help to preserve these distinct seasons and the industries and character they support.</p>	<ul style="list-style-type: none"> • Conduct a greenhouse gas inventory to develop some baseline data specific to Berlin. • Identify ways to reduce emissions within Berlin, and reduce the City’s contribution to climate change. • Review municipal guidelines for buildings and infrastructure to ensure they are appropriate for more severe weather events.
<p><i>Topography and Slope</i></p> <p>Development at higher elevations on the high ridges, slopes, and lower hills in Berlin presents challenges and impacts. Without thoughtful site design, these areas can greatly impact the scenic character of the community and disrupt scenic views. Access to these areas also provides an opportunity for increased environmental impacts (erosion, increased runoff rates, longer roadways, and fragmentation of habitat to name a few). As steeper slopes are developed, costs increase for both the property owner and the community. Construction and maintenance of roads becomes more costly on steeper slopes. Problems with erosion, storm water runoff, and non-point pollution are also increased.</p>	<ul style="list-style-type: none"> • Designate viewshed areas of high value and make open space subdivision mandatory in those areas. • Review site plan review regulations to ensure they reinforce the Steep Slope Development Standards, and reduce the impact of development on steep slopes. • Berlin’s regulations, relative to erosion and sediment control, should be revisited to ensure that they are following the most current “best management practices” (BMPs).

Water Resources

All of the activities taking place on land will eventually impact both surface and ground water. So, minimizing the impact of development is critical to the quality and quantity of both surface and sub-surface waters. Minimizing the amount of pollutants entering Berlin's waters will also help avoid expensive future expenditures to treat and clean these waters. There is a direct correlation between impervious surfaces and increased non-point source pollution. Reducing impervious surfaces will reduce runoff rates and increase filtering.

- Review and Promote Best Management Practices (BMPs) to reduce nonpoint source pollutants from industrial, commercial and residential developments.
- Consider maintenance plans for all storm water systems in industrial, commercial and residential developments.
- Consider standards for natural buffers along the Androscoggin River, the Dead River, and the streams and brooks that empty into these surface waters.
- Promote the use of permeable surfaces, and other Low Impact Development (LID) techniques that promote infiltration and storm water treatment in the site plan review process.
- Consider the required road widths for new development and incorporate bioretention areas in the design standards.
- Snow removed from streets and parking areas should be stored away from wetlands and water bodies. This will allow for a higher rate of filtering out of pollutants and infiltration of water as it melts. Find new locations for snow storage. Review new technologies.
- Continue to monitor and document all underground storage tanks in Berlin.
- Continue to examine the Brown Farm water protection zone to determine if it should include more of the underlying aquifer.

Wetlands

The health of Berlin's wetlands is critical to the function of natural systems within the community. It is important to point out that small wetlands (under three acres) are usually not shown on the USDA Natural Resource Conservation Service (NRCS) Soil Maps. Also, even smaller Vernal

- Develop buffer regulations that protect the natural upland vegetation adjacent to wetlands.

Pools don't always support wetland vegetation, but are an important resource in the life cycle of balanced ecosystems.

Agricultural Resources

Farmland soils are a precious resource with great value to the community and the region. Preserving the possibility of farming in the future adds to the sustainability and diversity of the community. If agricultural resources are converted to residential and business uses they will no longer be viable options for producing goods locally. There is an economic benefit when produce and products are generated locally, and the land does not require the high level of city services that development demands.

- Review and consider protection of the limited agricultural land that remains through outright purchase, purchase of easements/development rights, and donations.
- Make all of Berlin's land use regulations "farm friendly" and support non-traditional agricultural operations (small scale, seasonal, organic, specialty or "niche markets") and urban agricultural operations.
- Consider leasing underutilized City owned land to individuals interested in using it for organic farming.

Conservation

Conservation lands provide habitat, recreational opportunities, and protect critical natural resources. These resources also pay their own way in terms of City services. Conservation lands contribute to Berlin's character as a community, and support its quality of life. Habitat is easily fragmented by new development, and this disrupts the landscape and impacts wildlife movement and survival. Berlin is fortunate to have so much of the community within the White Mountain National Forest, but the natural resources systems in the developed portions of the community also need protection so they remain healthy and continue to function for the good of the community.

- Continue efforts to secure conservation easements on undeveloped land with significant natural resources.
- Identify city owned (and other) lands that would be suitable for the expansion of community.
- Protect areas that are known to support or have the potential to support important wildlife.
- Concentrate habitat protection efforts on preserving corridors between habitats and protected open space, particularly along waterways, to allow wildlife to avoid conflict with humans while maintaining the ability to gain access to food, shelter, water and breeding areas.

Natural Hazards

The *Wildfire Mitigation Plan* and *Hazard Mitigation Plan* are resource documents for the Master Plan, and should be consulted when existing codes, infrastructure

- Review the land use ordinances and building codes to ensure that they meet the recommendation of the Wildfire Mitigation Plan.

guidelines and land use regulations are reviewed and updated.

- Reduce the potential loss of life and property from natural hazards in Berlin by discouraging development in areas of high risk, and ensuring that local codes and standards relate to the type of natural hazards that Berlin experiences.