

Natural Resources

OVERVIEW

Lincoln's biodiversity and its many acres of protected woodlands and fields attest to its success in protecting natural resources. Through land acquisitions, public education, and building a strong conservation ethic, Lincoln has done an exceptional job of preserving ecologically sensitive areas and the quality of its drinking water supply. However, the high cost of land and changing lifestyles of residents make it increasingly difficult for Lincoln to protect its land and water resources. It will take a sustained commitment to environmental regulation and enforcement, water management, public education, and stewardship to ensure the continued quality and abundance of these resources as the town continues to grow and change.



Key Findings

- ❖ Lincoln has approximately 2,609 acres of wetlands, or twenty-seven percent of the town's total area. There are large, contiguous wetland areas in North Lincoln and the southeast side of town. Lincoln regulates activities that affect wetland resources by diligent administration of the State Wetlands Protection Act and an even more restrictive local wetlands bylaw. Approximately half of all wetland acres in Lincoln are protected by public or non-profit ownership, conservation restrictions, or state regulations that govern activity in the watersheds of the Lincoln and Cambridge drinking water reservoirs.
- ❖ Lincoln has approximately 100 vernal pools, including eight certified by the Natural Heritage and Endangered Species Program (NHESP).
- ❖ According to the U.S. Department of Agriculture, nearly half of Lincoln's total area is composed of soils conducive to various types of farming: gently sloped, loamy soils found primarily in the western half of town, nutrient-rich "muck" soils suitable for fruits and vegetable crops, and some moderately sloped soils that can support productive agriculture if managed properly.
- ❖ Lincoln depends on local water resources to provide drinking water to residents and businesses. Flint's Pond meets most of Lincoln's drinking water needs, supplemented by a well on Tower Road.
- ❖ Lincoln is withdrawing increasingly large amounts of water from its own water supplies. Since 2005, maximum day demand has steadily increased from 0.97 to 1.19 million gallons per day (gpd), and average day demand per capita exceeds the state's water resource planning guidelines under the Water Management Act. Much of this growth in demand goes hand-in-hand with summer water use, notably outdoor watering.

Lincoln also appears to be losing water through water main leaks and other conditions because its annual percentage of unaccounted-for water exceeds state standards, too.

Key Challenges

- ❖ Lincoln has done an exceptional job of protecting farmland. It has a renowned agricultural licensing program for its conservation land, and a number of small farms continue to thrive. Of Lincoln's 547 acres of productive agricultural land, 158 acres are not protected by restrictions against a change in use. The high cost of land in Lincoln will make it increasingly challenging to protect the remaining farms. In addition, it is difficult for farmers to live in Lincoln near their agricultural fields.
- ❖ Lincoln is concerned about the impacts of chemical pesticides, herbicides, and fertilizers on wetland and water resources and the quality of its wildlife habitats, but state law makes it very difficult for individual communities to regulate pesticide use. Public education and voluntary guidelines and standards can help, but it takes constant leadership, volunteer and staff resources, and incentives to change public behavior.
- ❖ Despite Lincoln's impressive efforts to protect land and water resources and wildlife habitats within its borders, the town is not immune to the direct and secondary effects of development throughout the region. Local concerns about traffic, air quality, watershed protection, stormwater, habitat disturbance, and environmental hazards will remain challenging to address without concerted regional action and regional cooperation. Although many neighboring towns share Lincoln's interests in environmental quality, problems with growth management and needs for tax revenue make it difficult for cities and towns along Route 128 to work toward a consistent vision of the region.
- ❖ Although many of the surrounding communities obtain water from the Massachusetts Water Resources Authority (MWRA), Lincoln relies on its own local water supplies, both surface water and groundwater. It will take effective leadership, public education, and investment of town funds to reduce residential water consumption and improve the water distribution system so that it works efficiently and loses less water.

EXISTING CONDITIONS & TRENDS

Lincoln's agricultural landscapes and acres of protected woodlands attest to the town's success in protecting its land and natural resources. Hilltops, valleys, wetlands, red maple swamps, wooded drumlins, ponds, streams, rivers, agricultural fields, and forest are all part of the natural features found within and near Lincoln's boundaries. Lincoln has attractive, prominent water features that serve local and regional interests, too, including Flint's Pond, the town's primary water supply, and the Cambridge Reservoir, which provides water to the City of Cambridge. The tendency to fuse "open space" with "natural resources" is common in most communities, often leading people to assume that if only a town buys enough land, its water resources, vegetation, wildlife, air, and other elements of the natural environment also will be protected. However, this is not really true. It takes a culture of public responsibility, effective regulations and enforcement, and stewardship to ensure high quality land and water resources and plentiful wildlife habitat.

Geology, Soils & Topography

Geology, soils, and topography play a key role in the development of communities. For example, areas with bedrock at or near the surface are difficult to build or farm on, agriculture does well in floodplain soils and soils high in nutrients, and level terrain tends to be built on before steep terrain. The slope and mineral content of soils influence the establishment of local flora and fauna and associated natural communities. Slope also influ-

ences habitat formation, such as riffles and pools in streams, vernal pools, and soil development, accumulation, and erosion. Further, the mineral content of soils affects soil fertility and water chemistry. Natural landscape features provide economic and recreation opportunities, such as conservation land in areas of valuable habitat or agricultural tourism. Lincoln's underlying geology and soil structure have had a profound impact on its development. Much of the town's landscape is wet, rocky, or otherwise not conducive to intensive use. These conditions place great pressure on Lincoln's developable land, including parcels that have already been built upon. With fewer and fewer vacant parcels, environmentally constrained land and land that supports Lincoln's older housing stock will continue to be targeted for development.

BEDROCK GEOLOGY

Lincoln's landscape expresses its underlying geology. Like all of New England, Lincoln's geology reveals evidence of glacial scouring from the relatively recent past overlaid onto remnants of intense tectonic activity from the more distant past. The erosion, weathering, and accumulation of materials since the last glacier retreated resulted in a mix of soil types built up over much of Lincoln's landscape. The bedrock consists of igneous and metamorphic rock ledges trending from southwest to northeast (Map 3.1), formed in the early to middle Paleozoic Era (490 to 354 million years ago) when the continent experienced tremendous mountain building along its margins. In many areas, notably along the east side of town and to the south along Route 117, pronounced bedrock outcrops reveal the hard rock of the land's crust. In fact, areas characterized by outcrops and shallow bedrock cover more than seven percent of the town.¹

SURFICIAL GEOLOGY

The unconsolidated materials that form the building materials of soil are called *surficial geology*. Lincoln's surficial geology is the result of erosion and deposition of materials by the glaciers that once covered this area. Natural climate cycling caused the glaciers to descend and retreat many times over, crushing, scraping, and carrying soil and rock that in turn smoothed hilltops and gouged valleys. As the glacier rode over the landscape, crushing the rock below, it left behind a compacted material called *glacial till*, an unconsolidated mixture of varying sizes of broken rock to silt. When the glacier receded, meltwater filled with debris and sediment poured off and formed rivers, lakes, dams, and deltas. It deposited a generally well-sorted (consistent grain sizes) layer of *stratified drift* or *glacial outwash* in the valleys and depressions of the land.

Glacial till deposits may be shallow, sparsely covering bedrock between visible outcrops, or more than 20 feet deep, forming elongated hills and rough plains. In Lincoln, shallow or thin till extends across roughly 30 percent of the town and, not surprisingly, it occurs in the higher elevations. Virtually all of the bedrock outcrops in Lincoln coincide with areas of thin till. A pocket of thick till occurs northwest of Beaver Pond, manifested on the land as a *drumlin*. Glacial till usually serves as a stable base for building, but it transmits water slowly, making it poorly suited for groundwater supply or sewage disposal. Specific soil types have developed on glacial till: generally dense and stony, like the till, making farming difficult as well. These soils produced the large rocks that colonial farmers used to build the stone walls found in Lincoln and much of southern New England today.

More than half of Lincoln's total area is composed of glacial outwash deposits, mainly coarse deposits. A large area of *glaciolacustrine* deposits (material left by lakes that formed temporarily as the glacier melted) extends northeasterly from Concord Center into Bedford and across Bedford Levels, covering most of southern Bedford and the northern tip of Lincoln, where Hanscom Air Force Base (HAFB) is located. The well-sorted sediments formed from glacial meltwater are generally more level and free of large stones. The soil types associated with

¹ Derived from U.S. Geological Survey, "Surficial Geology 1:24,000" GIS Database, MassGIS, <http://www.mass.gov/mgis/sg24k.htm>.

outwash deposits tend to be suitable for farming if they are not too sandy and fast-draining. Outwash deposits often form productive aquifers and provide storage for seasonal hydrologic cycling and floodwaters. Lincoln's underlying aquifers coincide with these deposits (Map 3.2).

SOILS

Soil is a dynamic resource that affects hydrology, supports plant life, controls biogeochemical cycles, determines plant and animal habitat, and supports human habitation. However, soils are fragile resources, vulnerable both to human impacts and extreme events, such as flooding. They can be damaged easily by erosion, disturbance, or covering over, reducing their value for the natural environment and for human use. Significant erosion can cause damaging sedimentation in streams and low lying land, which in turn can have harmful impacts on natural habitats.

Soils have identifiable properties that allow for their description and classification. Soils with broadly similar properties and profiles make up a distinct *soil series*. All the soils of one series have generally comparable major *horizons* (texture and color), composition, and thickness because they developed from similar parent materials in a similar environment. *Soil map units* are typically comprised of one or more components and consist of the soil series name modified by factors such as texture, slope, and stoniness (e.g. Canton Fine Sandy Loam, 3 to 8 percent slope, extremely stony). They are classified by origin, formation, and identifiable properties that make them suitable for specific uses. Lincoln has nearly eighty soil map units, from hydric (wet) soils to well-drained, sandy soils (Map 3.3). Lincoln's soil types vary widely due to differences in topography, substrate type, vegetation, groundwater conditions, micro-climate and land-use history. The most common soils in Lincoln include Freetown Muck, Canton Fine Sandy Loam, Narragansett-Hollis-Rock Outcrop Complex, Narragansett Silt Loam, Merrimac Fine Sandy Loam, Haven Silt Loam, and Montauk Fine Sandy Loam.²

Prime Farmland Soils. Agriculture has played a key role in Lincoln's economy and cultural identity since well before the town was incorporated in 1754. Despite the amount of bedrock in Lincoln, the soils that cover more than half the town have value for farming even though much of the land in these locations has been developed. The Natural Resource Conservation Service has certified 2,273 acres as Prime Farmland, 1,200 acres as Farmland of Unique Importance, and an additional 1,265 acres as Farmland of Statewide Importance. The Prime Farmland soils are gently sloped, loamy soils such as Merrimac Fine Sandy Loam, Haven Silt Loam, Narragansett Silt Loam, Canton Fine Sandy Loam, and several other soil series occurring in larger bands and in somewhat greater concentrations on the west side of town. Farmland of Unique Importance also has strong production capacity for high-value food and fiber crops, such as fruits and vegetables. In Lincoln, these soils occur throughout town and they are composed primarily of nutrient-rich "muck" soils. Finally, Lincoln's Farmland of Statewide Importance include moderately sloped Windsor, Hinckley, Narragansett and other soils capable of producing high-value crops "if treated and managed according to acceptable farming practices."

TOPOGRAPHY

The natural beauty of Lincoln – its hills and valleys, ponds, forests, swamps and fields – is largely a product of the shape of its land. The town's topography resulted from glacial scouring of the land, modified by the ceaseless action of water. Lincoln's landscape may be thought of as a blanket of soil overlaying ancient bedrock, with vegetation and surface waters serving as other character defining features. Lincoln's major landforms include the hilly, generally high terrain that extends across its geographic center, the pattern of ridges and valleys found throughout the town, the large wetland areas off Route 2 and in Lincoln's southeast quadrant, and the Stony

² U.S. Department of Agriculture, Natural Resources Conservation Service, Soil Survey Geographic (SSURGO) database for Middlesex County, Massachusetts, <http://soildatamart.nrcs.usda.gov/>. See also, Appendix C.

Brook, which drains roughly two-thirds of the community. Lincoln's topography ranges from a high of about 380 feet above sea level at the Reservoir on Bedford Road to a low of about 112 feet above sea level on the Sudbury River.³

Water Resources

WATERSHEDS

Since most natural resources do not follow or lie wholly within municipal boundaries, it is more practical to use natural land features to describe natural resource boundaries. Watersheds provide a useful perspective because they encompass an area's topography, drainage patterns, and to a large degree, soils, vegetation and wildlife. They also provide an excellent example of the interrelatedness of natural resources, as can be seen in Lincoln. Watersheds are divisions of the land surface into sections in which water drains to a common point or water body. The line dividing any two drainage basins is a topographic divide, or relatively higher area. The term "watershed" describes both the divide between two areas and the area itself, also known as a drainage basin.

The U.S. Geological Survey (USGS) Water Resources Division divides Massachusetts into eight large drainage basins and a total of twenty-seven drainage basins associated with major rivers.⁴ The drainage basins of the major rivers include thirty-two watershed planning areas both for the rivers and their principal tributaries, and each watershed typically has several sub-watersheds. In a condition that speaks to Lincoln's relatively high elevation in the region, the town is located within three USGS-designated river basins. (Map 3.4). Most of Lincoln is drained by the Stony Brook, a tributary of the Charles River, which in turn drains all or part of thirty-five cities and towns in a 308 sq. mi. area from its headwaters in Hopkinton east to Boston Harbor.⁵ In addition, the Concord River watershed includes two sub-watersheds in Lincoln: the Sudbury River and the Concord River mainstem, both federally designated as Wild and Scenic Rivers in 1999.⁶ The Concord River, part of the 377 sq. mi. SuAsCo watershed, ultimately flows into the Merrimack River in Lowell. Finally, the Shawsheen River originates near Hanscom Field and drains most of North Lincoln, eventually merging with the Merrimack River in Lawrence. Its watershed covers about 78 sq. mi. in twelve communities.⁷ Though Lincoln is a fairly small town, both in population and land area, its environmental policy decisions and practices have consequences far beyond its own political boundaries.

SURFACE WATER

Lincoln has open bodies of water, several brooks, and extensive wetlands, but it is not a river town. The absence of rivers or major streams crossing through Lincoln has a great deal to do with the town's rural-agricultural appearance today, for unlike Concord and Acton, Lincoln never attracted early industries and their attendant village settlement patterns. The Sudbury River forms part of Lincoln's westernmost boundary, but its broad, low-lying meadows supported farming. Lincoln's surface waters nonetheless have profound importance to local and regional drinking water supplies and the wildlife diversity that endures in town, in addition to contributing to its scenic beauty. Lincoln has several named water bodies:

³ Town of Lincoln, Open Space Committee, *Open Space and Recreation Plan* (2008), 4.

⁴ U.S. Geological Survey, Massachusetts-Rhode Island Water Science Center, <http://ma.water.usgs.gov/basins/>.

⁵ Charles River Watershed Association, <http://www.crwa.org/>.

⁶ SuAsCo Watershed Community Council, Ambient Engineering, *Sudbury-Assabet-Concord Watershed Action Plan* (2005), 1-1. The National Wild and Scenic Rivers Act, passed in 1968, permanently protects rivers with outstanding scenic, geological, recreational, ecological, historical, or cultural significance.

⁷ U.S. Geological Survey, *Water Resources of Massachusetts* (1992), 16.

- ❖ The Cambridge Reservoir, which extends along the border between Lincoln and Waltham and provides nearly all of the City of Cambridge’s drinking water;
- ❖ Valley Pond, Todd Pond, and Beaver Pond in Lincoln’s southeast quadrant;
- ❖ Farrar Pond on the southwest;
- ❖ Walden Pond (though located primarily in Concord); and
- ❖ Lincoln’s primary drinking water supply, the 156-acre Flint’s Pond (Sandy Pond), a state-designated Great Pond situated northwest of the geographic center of town.⁸ Lincoln withdraws approximately 200 million gallons of water per year from Flint’s Pond.⁹ Remarkably, the town has protected ninety-two percent of the pond’s 464-acre watershed as open space managed by the Lincoln Conservation Commission.¹⁰

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Each of Lincoln’s named water bodies is connected, directly or through adjacent wetlands, to a brook or stream. The most noteworthy streams include the Stony Brook and Hobbs Brook, both source waters to the Cambridge Reservoir; Iron Mine Brook, which flows into the Stony Brook from a large wetlands area near Flint’s Pond; and Elm Brook (Tanner’s Brook), a tributary of the Shawsheen River.¹¹ Under the three-tier framework for regulating activity within the watersheds of drinking water supplies, the Stony Brook, Iron Mine Brook, and Hobbs Brook constitute part of the Cambridge Reservoir’s “Zone A” and they are regulated and monitored as a Class A Public Water Supply under the Massachusetts Surface Water Quality Standards.¹²

WETLANDS

Wetlands are protected by federal and state law due to their importance to the health and balance of the natural environment. Wetlands offer aesthetic and recreational value, and in Lincoln they are integral to the diversity and beauty of the landscape. Most of Lincoln’s 2,609 acres of wetlands are forested bottomlands located shoreward of, and hydrologically related to, surface waters. These wetland communities, typically composed of red maple swamp, make up about seventy-five percent of the wetlands in Lincoln,¹³ with the largest contiguous areas occurring at the headwaters of Hobbs Brook in North Lincoln and surrounding the Stony Brook on its course through the southeast part of town to the Cambridge Reservoir. Shrub swamps and shallow marshes often line the edges of forested wetlands, such as around the Iron Mine Brook and north of Flint’s Pond, but

⁸ Commonwealth of Massachusetts, Executive Office of Energy and Environmental Affairs, Department of Environmental Protection (DEP), “Massachusetts Great Pond List,” <http://www.mass.gov/dep/water/resources/grtpond.htm>.

⁹ Lincoln Water Department, *Public Water Supply Annual Statistical Report 2007* (26 February 2008), Table E1.

¹⁰ Lincoln Water Department, *Annual Water Quality Report 2006*; and *Open Space and Recreation Plan*, 15.

¹¹ Massachusetts Department of Fish and Game, Massachusetts Riverways Program, “Massachusetts Rivers and Streams,” <http://www.mass.gov/dfwele/river/>.

¹² See 314 CMR 4.05(3)(a). A Class A inland water supply is an authorized public drinking water supply, suitable for aquatic habitat and contact recreation, with excellent aesthetic value. The water supply, its tributaries, and associated wetlands are regulated as Outstanding Resource Waters, a designation that prohibits discharges of any kind without prior DEP approval.

¹³ Derived from DEP Wetlands Conservancy Program Maps, GIS Database, April 2007, <http://www.mass.gov/mgis/wetdep.htm>.

they also occur in pockets all over town. Further, Lincoln has identified and mapped more than 100 vernal pools, or temporary woodland ponds, including eight certified by the Natural Heritage and Endangered Species Program (NHESP).¹⁴ Approximately 1,417 acres of wetlands, or more than half of all wetland acres in Lincoln, are protected by conservation deeds, conservation restrictions, and the City of Cambridge's watershed land.¹⁵

FLOODPLAINS

Floodplains hold water during times of increased flow, usually in early spring as the snow melts or during times of heavy rainfall. They serve important public safety, public health, and environmental interests. Any disturbance within the floodplain, such as filling, earth removal, or construction has the potential to alter its water-holding capacity. When this happens, flooding can extend beyond the actual boundary of the floodplain, causing damage to roads and buildings and potentially redirecting the course of rivers and streams. The Federal Emergency Management Agency (FEMA) determines the boundaries of floodplains and publishes the data on Flood Insurance Rate Maps (FIRM), used by the National Flood Insurance Program as a uniform standard for establishing property insurance requirements. Massachusetts and other states also use the FIRM for floodplain management. The 100-year floodplain is determined by the edge of the water level of a flood that has a one percent chance of occurring each year.

GROUNDWATER

In most parts of New England, groundwater is obtained from large areas of stratified drift, which support the storage and flow of water (transmissivity) far better than glacial till or fractured bedrock. Stratified drift generally occurs in lowland areas, and valleys of stratified drift are often isolated or separated by uplands of till and shallow bedrock. Lincoln's surficial geology is a classic example of this pattern. *Groundwater recharge* is the part of the hydrologic cycle that replenishes aquifers. Water enters the aquifer through rainfall and often by downward discharge of some of the surface water in streams, rivers, lakes, and ponds. It leaves the aquifer by flowing into other aquifer areas or surface water bodies, or through direct removal by pumping for human use. When more water enters the aquifer than is taken out, the water table rises; when more is taken out, it falls. Most aquifers can support a specific volume of pumping removal and maintain equilibrium with the volume of water entering them. The U.S. Geological Survey and Massachusetts Department of Environmental Protection (DEP) classify aquifers as low, medium, and high yield, according to the volume of water they can sustainably produce.

Lincoln provides drinking water from Flint's Pond and a groundwater well on Tower Road, which supplements Flint's Pond year-round, though mainly during non-peak periods.¹⁶ The Tower Road well has a *safe yield* of 750,000 gallons of water per day. Its watershed (Zone II) includes about 1,000 acres extending from Flint's Pond to South Great Road. A majority of the Zone II is composed of coarse outwash deposits, which facilitate the movement of groundwater as well as pollutants. For this reason, DEP characterizes Lincoln's Tower Road Well as "highly susceptible" to contamination.¹⁷ According to local records, naturally occurring chloride and sodium levels have increased since the well was brought on line in 1966. Lincoln operated a third well, the Farrar Pond Well, until 1986, when the water supply was converted to an emergency standby well following discovery of trichloroethylene (TCE), a toxic industrial solvent.¹⁸ In addition to its own surface water and groundwater

¹⁴ Executive Office of Energy and Environmental Affairs, Department of Fish and Game, NHESP, "Number of Certified Vernal Pools by Town," 13 April 2007, <http://www.mass.gov/dfwele/dfw/nhesp/nhesp.htm>.

¹⁵ *Open Space and Recreation Plan* (2008), 48.

¹⁶ *Public Water Supply Annual Statistical Report, 2006-2007*, Tables E and E-1.

¹⁷ DEP, *Source Water Assessment and Protection (SWAP) Report for Lincoln Water Department* (23 June 2003), 2.

¹⁸ *Open Space and Recreation Plan* (2008), 14-15.

supplies, Lincoln is among the Cambridge Reservoir's host communities and contains portions of the recharge areas for water supplies in neighboring towns (Map 3.5).

Land Cover

The types and patterns of vegetation found in Lincoln contribute to its beauty. The town is predominantly forested and located in a transitional place in the mosaic of forest types that characterize New England: a blend of northern (hardwood-hemlock-white pine) and southern (hardwood-oak-hickory) New England forests. Lincoln's woodlands contain most of the tree varieties typical of the southern New England hardwood (mixed deciduous) forest, including red, black, and white oak (*Quercus rubra*, *Q. velutina*, and *Q. alba*), white pine (*Pinus strobus*), red maple (*Acer rubrum*), eastern hemlock (*Tsuga canadensis*), beech (*Fagus grandifolia*), and hickory varieties (*Carya* spp.), occurring at varying densities and proportions based on geologic setting, soil drainage, soil texture, nutrient levels, stoniness, and topography of the land. The understory tends to be dominated by lowbush blueberry (*Vaccinium angustifolium*), mountain laurel (*Kalmia latifolia*), witch-hazel (*Hamamelis virginiana*), and huckleberry (*Gaylussacia baccata*), and ferns and wildflowers. This diverse mixture of hardwoods and conifers and their associated shrubs and herbaceous cover provide a wide range of habitats for wildlife. Lincoln also has some fine examples of sandplain grasslands, too, notably at Hanscom Field.

Lincoln's history of efforts to protect its natural resources can be seen just about everywhere. Despite the presence of suburban development, Lincoln remains largely open and undeveloped, with views from the road made interesting by the mix and extent of terrestrial communities in each part of town. Contiguous vegetated areas provide habitat not only for rare plant species, but for many species of native plants and wildlife that require large areas or corridors of land for their habitat. Both common and rare wildlife in Lincoln have been documented by the Conservation Department and the Lincoln Land Conservation Trust. NHESP recognizes many of Lincoln's unique, ecologically significant areas:

- ❖ Exemplary freshwater habitats known as "Living Waters" and their supporting watersheds, which include Walden Pond and its watershed, and Elm Brook in North Lincoln.¹⁹
- ❖ Highly valuable "core" habitats and supporting natural lands: within and adjacent to HAFB and Hanscom Field in North Lincoln, the Hobbs Brook watershed, the Cambridge Reservoir, Walden Pond, the marshes and upland along the Sudbury River, and Farrar Pond.²⁰
- ❖ Significant rare species habitats include most of the areas listed above, along with the wetlands that form the headwaters of Hobbs Brook and Stony Brook adjacent to Flint's Pond, and the extensive wetlands between Lincoln Road and Old Sudbury Road in South Lincoln.²¹

According to NHESP, ten vascular plant species classified under the Massachusetts Endangered Species Act (MESA) as threatened, endangered, or rare have been identified in Lincoln. They include a species of special concern, the terete arrowhead (*Sagittaria teres*); five threatened species, the resupinate bladderwort (*Utricularia resupinata*), grass-leaved ladies'-tresses (*Spiranthes vernalis*), swamp oats (*Sphenopholis pensylvanica*), rigid flax (*Linum medium* var. *texanum*), and dwarf bulrush (*Lipocarpa micrantha*); and four endangered species, wild

¹⁹ NHESP, *Living Waters: Guiding the Protection of Freshwater Biodiversity in Massachusetts* (2003), Living Waters Program, <http://www.mass.gov/dfwele/dfw/nhesp/>, and associated GIS Data, MassGIS.

²⁰ NHESP, *BioMap: Guiding Land Conservation for Biodiversity in Massachusetts* (2001), and associated GIS Data, MassGIS.

²¹ NHESP, *Massachusetts Natural Heritage Atlas*, 12th Ed. (2006), and associated GIS Data, MassGIS.

senna (*Senna hebecarpa*), violet wood-sorrel (*Oxalis violacea*), cornel-leaved aster (*Doellingeria infirma*), and Andrew's bottle gentian (*Gentiana andrewsii*).²²

Fisheries and Wildlife

Lincoln's forests, open fields, ponds, and brooks host many common and some rare species of birds, fish, and other wildlife. The native species are generally interdependent; impacts to the habitat of one species will likely affect that of others. The most critical aspect of protecting both rare and common wildlife is protecting natural habitats. Wildlife habitats tend to overlap, with gradual variation in physical characteristics. The presence of large tracts of protected open space shared by Lincoln and neighboring towns has helped to preserve functional wildlife corridors in an otherwise suburban region. This is particularly important for birds and large animals, which often require multiple natural communities and large areas or corridors to thrive. Lincoln has considerable wildlife diversity because of its varied terrestrial and wetland communities, which support a wide range of flora and fauna and provide areas for breeding and shelter. (Map 3.6)

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Lincoln contains many species of birds, mammals, reptiles, amphibians, insects, invertebrates, and fish. The wide variety of birds observed in Lincoln speak to the diversity of its landscape and vegetation. For example, the eastern wood-pewee (*Contopus virens*), red-eyed vireo (*Vireo olivaceus*), brown creeper (*Certhia americana*), hermit thrush (*Catharus guttatus*), red-tailed hawk (*Buteo lineatus*), yellow warbler (*D. dominica*), black-capped chickadee (*Poecile atricapillus*), red-breasted nuthatch (*Sitta canadensis*), crested flycatcher (*Myiarchus crinitus*), and scarlet tanager (*Piranga olivacea*) reside in the mixed wooded and coniferous forests, while the red-wing blackbird (*Agelaius phoeniceus*), tree swallow (*Tachycineta bicolor*), red-eyed vireo and wood ducks (*Aix sponsa*) inhabit the marshes and wooded swamps. Bobolinks (*Dolichonyx oryzivorus*) nest and thrive in the open fields, and the grasslands at Hanscom Field support the upland sandpiper (*Bartramia longicauda*), an endangered bird, and grasshopper sparrow, (*Ammodramus savannarum*) classified as a threatened species in Massachusetts. Other species documented in Lincoln include wood thrush (*Hylocichla mustelina*), goshawk (*Accipiter gentilis*), common loon (*Gavia immer*), red-necked grebe (*Podiceps grisegena*), common merganser (*Mergus merganser*), black duck (*Anas rubripes*), and goldeneye (*Bucephala clangula*).²³

In addition to common animals such as eastern chipmunks (*Tamias striatus*), gray and red squirrels (*Sciurus carolinensis*, *Tamiasciurus hudsonicus*), raccoons (*Procyon lotor*), and deer (*Odocoileus virginianus*), Lincoln has red fox (*Vulpes vulpes*), beaver (*Castor canadensis*), fisher (*Martes pennanti*), and coyote (*Canis latrans*). The forests provide habitat for a variety of shrews (*Soricidae* spp.), the woodland jumping mouse (*Napaeozapus insignis*), white-footed mouse (*Peromyscus leucopus*), and redbacked vole (*Clethrionomys gapperi*), while the grasslands support populations of meadow voles (*Microtus pennsylvanicus*), meadow jumping mice (*Zapus hudsonius*), the northern short-tailed shrew, long-tailed weasels (*Mustela frenata*), kestrels (*Falco sparverius*), and wintering northern harriers (*Circus cyaneus*). Mink (*Mustela vison*), deer, beaver, and raccoons use marshland habitats. The

²² NHESP, "Rare Species Occurrences by Town," http://www.mass.gov/dfwele/dfw/nhesp/info_by_town.htm.

²³ For a comprehensive inventory of birds observed in Lincoln, see Lincoln Land Conservation Trust, *A Guide to Conservation Land in Lincoln* (2005); and *Open Space and Recreation Plan* (2008), 20-28 passim.

northern redback salamander (*Plethodon cinereus*) is common in Lincoln's woods, while the marshes provide habitat for leopard, pickerel, green and bull frogs (*Rana* spp.), and red-spotted newts (*Notophthalmus viridescens*). Lincoln's vernal pools provide breeding areas for wood frogs (*Rana sylvatica*), spotted turtles (*Clemmys guttata*), and two species of mole salamanders (*Ambystoma* spp.), as well as invertebrate fauna, including fairy shrimp (*Eubranchipus* spp.).

For Lincoln, NHESP's inventory of rare wildlife lists eleven species classified as threatened, of special concern, or endangered. The species of special concern include the purple tiger beetle (*Cicindela purpurea*); two amphibians, the four-toed salamander (*Hemidactylium scutatum*) and blue-spotted salamander (*Ambystoma laterale*); two birds, the barn owl (*Tyto alba*) and sharp-skinned hawk (*Accipiter striatus*); and a dragonfly, the mocha emerald (*Somatochlora linearis*). A threatened bird species, the grasshopper sparrow (*Ammodramus savannarum*), and four endangered birds, the gold-winged warbler (*Vermivora chrysoptera*), the sedge wren (*Cistothorus platensis*), Henslow's sparrow (*Ammodramus henslowii*), and the upland sandpiper have been observed in Lincoln as well.²⁴

Resource Protection and Management Capacity

Lincoln has done far more than most communities to identify, assess, and protect its natural assets. It has acquired a considerable amount of land for conservation purposes and instituted local capacity to plan and carry out sophisticated conservation projects. Lincoln's successful conservation program reflects the efforts of the town through its Conservation Commission and its partnerships with two local non-profit organizations, the Lincoln Land Conservation Trust and the Rural Land Foundation. These and other organizations have worked with the town to protect 3,282 acres in perpetuity.²⁵

- ❖ Lincoln established a conservation commission in 1958. The Lincoln Conservation Commission includes seven members appointed by the Board of Selectmen. It oversees a department with four staff, including a director, conservation planner, land manager, and ranger, as well as seasonal employees. It has statutory responsibility for administering the Massachusetts Wetlands Protection Act, M.G.L. c. 131, s. 40, and local responsibility for administering Lincoln's Wetlands Protection Bylaw.²⁶ It also is responsible for managing the 1,500 acres of conservation land owned by the town, initiating new acquisitions or conservation restrictions, and protecting wildlife habitats. In support of the Commission's work, the Conservation Department provides educational programs on natural resources and public safety through its Conservation Ranger Program.²⁷

²⁴ NHESP, "Rare Species Occurrences by Town."

²⁵ *Open Space and Recreation Plan* (2008), 34.

²⁶ The Massachusetts Wetlands Protection Act gives local Conservation Commissions and DEP authority to regulate activities affecting wetlands for the following specific interests: protection of public and private water supply; protection of ground water supply; flood control; prevention of storm damage and pollution; protection of land containing shellfish; protection of fisheries; and protection of wildlife habitat. In 1996, the Massachusetts Rivers Protection Act expanded the purview of the Wetlands Protection Act by creating authority to regulate activities within 200 feet of perennial rivers and streams. Many years ago, Lincoln enacted its own local wetlands bylaw to provide more protection for wetlands and establish jurisdiction over resources not regulated very effectively under the state law, e.g., geographically isolated wetlands, vernal pools and surrounding woodland habitat, the 100-ft. area adjacent to wetlands, and wildlife corridors. For example, Lincoln's Wetlands Bylaw establishes an inner 50 ft. "no-disturb" zone within the 100-ft. buffer area. Recent bylaw amendments empower the Conservation Commission to require, as part of an approved Order of Conditions, undisturbed upland buffers and deed restrictions to protect buffers on existing lots from future alteration.

²⁷ *Annual Town Report* (2007), 116-119.

- ❖ Founded in 1957, the Lincoln Land Conservation Trust (LLCT) was among the nation's first private community land trusts. The LLCT currently owns 500± acres of conservation land and holds conservation restrictions on another 420 acres. Beyond its land holdings, the LLCT provides advocacy and public education about natural resources through school programs, forums, lectures, and special events.
- ❖ The Rural Land Foundation (RLF) was formed in 1965. It is acclaimed for its creative use of limited development to finance the cost of purchasing open space, often saving large tracts of land by developing only a few house lots.

Other organizations have natural resource protection responsibilities, too. Through zoning, subdivision control, and wastewater disposal regulations, the Planning Board, Zoning Board of Appeals, and Board of Health help to minimize adverse impacts from development. Lincoln adopted zoning in 1929 and established its first Planning Board in 1937. During the 1960s, Lincoln adopted the Open Space-Conservation District, a conservancy zone designed to preclude development on land placed in the district with the owner's consent. Later, the town created another conservancy zone, the Wetland and Watershed Protection District (1973), which applies mainly to wetlands and surface water resources within the Flints Pond watershed. Lincoln also has zoned the flood hazard areas shown on the FIRM as a local Flood Plain District. Further, the Board of Health protects groundwater through its authority over septic system installations and upgrades, operating under its own local regulations as well as Title V. The Board is currently exploring changes to its local regulations due to recent Title V amendments that could make some land easier to develop.²⁸

Aside from regulation, Lincoln has many governmental policies, programs, and services that help to protect environmental quality. Town departments routinely use Lincoln's website for public education, such as the Conservation Commission's online repository of information about invasive plants and the Recycling Commission's recycling guidelines. The Conservation Department sponsors conservation land walking tours every week and encourages residents to notify the Conservation Commission of unusual or common species observed in Lincoln. Under the aegis of the Green Energy Committee, the town is looking at its own municipal building operations for ways to reduce energy.²⁹ In short, Lincoln actively promotes environmental awareness, and support for natural resource protection runs deep throughout the town.

NEEDS, ISSUES & CHALLENGES

Protecting the quality and quantity of natural resources requires many tools: a strong regional planning framework, open space acquisitions, environmental regulations systematically and competently enforced, zoning and transportation policy decisions informed by natural resource interests, and everyday actions by citizens to place resource protection ahead of their own convenience. Lincoln's environmental ethic is to enhance awareness of the role that individuals play as stewards of their environment. Lincoln's conservation brochure, *Community Conservation in Lincoln*, says that residents should: "...accept membership in that larger community – of soils, of water, of animals, of plants – and that we must, in good conscience, always weigh the consequences of our individual and collective decisions as humans upon the rest of the community." Taking natural resources seriously is a strong community ethic in Lincoln.

²⁸ Elaine Carroll, Board of Health, to Community Opportunities Group, Inc., 10 June 2008.

²⁹ Town of Lincoln, <http://www.lincolntown.org/>.

Regional Initiatives

Lincoln has recognized for a long time that protecting natural resources requires a regional approach. The town has good working relationships with other towns, federal and state agencies, and non-profit organizations such as the SuAsCo Watershed Association and Charles River Watershed Association. It also collaborates with Cambridge to protect the Cambridge Reservoir watershed.³⁰ The Lincoln Conservation Commission is currently working with the National Park Service and the Town of Concord to develop new trails within the park and to control invasive aquatic species.³¹ The Commission has also conducted annual inspections and joint work projects over the past six years with Concord and the Great Meadows National Wildlife Refuge to remove invasive species in Fairhaven Bay.³²

Lincoln's determination to protect natural resources is both enhanced and sometimes frustrated by policies in neighboring communities. Despite efforts by the Metropolitan Area Planning Council (MAPC) to promote regional planning and regional collaboration, the interests of other communities in MAPC's large service area – 101 cities and towns around Boston – and within the small sub-region that includes Lincoln do not always coincide harmoniously. In an era dominated by concerns about climate change, direct emissions from use of fossil fuels, and the larger “carbon footprint,” metropolitan Boston suburbs and small cities find themselves in a seemingly irreconcilable conflict between environmental responsibility and their own fiscal condition. About four million sq. ft. of new office, retail, and multi-family development have been permitted in Waltham and other nearby communities on Route 128, much of it destined to bring more traffic through Lincoln and potentially complicate the town's interest in preserving the character of its roads.

In coordinating with other towns, Lincoln may not have taken full advantage of one mechanism that is already in place, namely the Hanscom Area Town Selectmen (HATS). Although somewhat misleading in its title, the forum is intended to include representation from each of the four towns' (Bedford, Concord, Lexington and Lincoln) Conservation Commissions. As the pressure to allow development at HAFB increases, this body may become even more important in maintaining vigilance over the area's natural resources.

Lincoln's traditional focus on protecting its rural character finds company in some of the plans that guide growth in nearby communities, but not to the same extent and not always for the same reasons. A good example of a core value that distinguishes Lincoln from most communities is the town's enduring commitment to protecting wildlife and habitat diversity, yet effective habitat preservation requires a synchronized regional approach. It is difficult to engage Massachusetts communities in a conversation about regional resource protection when each city and town has its own master plan and must balance preservation interests with the need to provide government services and build a secure tax base. With terms such as “structural deficit” echoing in the background, even Lincoln has found itself confronting some of the same issues. As one speaker observed at a community meeting for this Comprehensive Plan, “Land use decisions and town finance decisions are starting to co-mingle. We need to keep them separate.”³³

³⁰ *Open Space and Recreation Plan* (2008), 40.

³¹ Angela Seaborg, Conservation Planner, to Community Opportunities Group, Inc., 9 June 2008.

³² *Open Space and Recreation Plan* (2008), 50.

³³ Comprehensive Long-Range Plan Committee, “Large-Group Discussion Notes: February 9, 2008 Public Meeting,” <http://www.lincolntown.org/depts/planning.htm>.

Drinking Water

Like neighboring Wayland, Sudbury, and Concord, Lincoln relies on drinking water supplies located within its own boundaries.³⁴ It also sells some of its own water to adjacent communities, including those connected to the Massachusetts Water Resources Authority's (MWRA) water system. In addition, Lincoln is host to the City of Cambridge's primary water supply. While Lincoln is ultimately responsible for its own water, ground waters that flow through Lincoln feed other municipal water supplies downstream, and this makes Lincoln's stewardship of water resources a matter of regional importance.

Table 3-1 reports Lincoln's monthly water use in 2005, 2006, and 2007. This data points to the challenges of operating a public water supply in an affluent, low-density town. Lincoln's water rate structure rewards water conservation, but residents seem willing to pay higher water bills in order to maintain their lawns. Lincoln's daily residential consumption per capita exceeds the state standard for groundwater withdrawals in a stressed river basin such as the Charles River, which is sixty-five gallons per capita per day.³⁵ Also disconcerting is the steady annual increase in maximum day demand – that is, a measure of the greatest stress placed on Lincoln's drinking water system in any twenty-four hour period, usually in the summer. Moreover, “unaccounted for water,” or the difference between water withdrawn and water attributable to metered use, hydrant flushing, water main breaks, and other known factors, increased from 23.5 to 32.8 million gallons in Lincoln, or 13.6 to sixteen percent of total water use, between 2006 and 2007. The Water Management Act (WMA) planning standard is ten percent.³⁶

The pattern illustrated in Table 3.1 – a decline in consumption in 2006 and a significant increase in 2007 – is consistent with MWRA water use during the same period.³⁷ The summer of 2006 was cooler, and a considerable amount of rain fell in the Boston area in June and July. According to the Lincoln Water Department's *Annual Water Quality Report*, summer water use can be as much as 1½ times the amount of water used during the winter.³⁸ Given these significant seasonal increases, Lincoln's water customers need to do more to conserve water.

Lincoln's water rate structure rewards conservation, but residents seem willing to pay higher water bills in order to maintain their lawns. Residential consumption per capita exceeds the state standard for groundwater withdrawals in a stressed river basin such as the Charles River, which is sixty-five gallons per capita per day. It is very challenging for affluent towns to convince the public to conserve because the financial incentives that sometimes work in other communities have little if any impact on people who can afford to pay for the resources they consume.

³⁴ Bedford, Lexington, Waltham, and Weston obtain their drinking water from the Massachusetts Water Resources Authority (MWRA).

³⁵ Massachusetts Water Resources Commission, *Water Conservation Standards* (July 2006), 18; and “Stressed Basins in Massachusetts,” 11 December 2001, http://www.mass.gov/dcr/waterSupply/intbasin/stressed_basins.htm.

³⁶ In 2007, DEP adjusted the locally reported percentage of unaccounted for water to 24 percent, based on data in the town's annual report. See DEP, “Residential Gallons per Capita Day (RGPCD) and Unaccounted for Water (UAW),” 2007 Spreadsheet [Electronic Version], *Performance Standards for Public Water Supplies*, <http://www.mass.gov/dep/water/resources/watercon.htm>. See also, Chapter 9, Community Services & Facilities.

³⁷ Massachusetts Water Resources Authority, “Water System,” <http://www.mwra.state.ma.us/>.

³⁸ *Annual Water Quality Report 2006*, 2.

Table 3.1
Lincoln Water Department: Water Withdrawal and Consumption Statistics, 2005-2007

Withdrawal Period	Millions of Gallons of Water/Year				
	2005	2006	Change	2007	Change
January	12.39	12.23	-0.16	12.47	0.24
February	10.62	10.76	0.13	11.80	1.04
March	13.00	11.90	-1.10	13.00	1.10
April	13.55	13.95	0.40	12.07	-1.88
May	15.10	16.18	1.08	17.47	1.29
June	20.94	16.83	-4.11	21.92	5.09
July	24.42	19.67	-4.76	23.27	3.60
August	22.97	20.21	-2.75	25.51	5.30
September	19.87	15.98	-3.89	24.81	8.83
October	13.22	13.74	0.52	17.29	3.55
November	11.80	11.80	0.00	12.93	1.13
December	11.89	11.89	0.00	13.40	1.51
<i>Annual Total</i>	189.77	175.14	-14.64	205.94	30.81
Water Transfers					
Sold to Other Towns	3.48	4.18	0.70	4.01	-0.17
Purchased from Weston	2.24	1.75	-0.49	2.33	0.58
<i>Net Local Water Use</i>	188.53	172.70	-15.83	204.26	31.56
Actual Metered Consumption	154.33	137.83	-16.50	151.17	13.34
Residential Consumption	144.76	127.45	-17.32	135.64	8.19
<i>Residential Per Capita</i>	79.72	70.19	-9.54	74.70	4.51
<i>Residential % Total</i>	93.8%	92.5%		89.7%	
Maximum Day Demand	0.97	1.12	0.15	1.19	0.07

Source: Lincoln Water Department, *DEP Public Water Supply Annual Statistical Report, 2005, 2006, 2007*. Water withdrawal statistics represent finished, not raw, water.

Eliminating leaks, installing water conservation devices, e.g., low-flow faucets, showerheads and toilets, reducing lawn irrigation through use of Best Management Practices (BMPs), and implementing water management plans in municipal and school facilities, commercial establishments and institutional uses would help. Lincoln is not the only town that needs residents and others to use water more efficiently; other communities face similar challenges, and some are experimenting with a variety of conservation strategies. For example, Concord offers rebates to homeowners for purchasing low water use appliances and installing water conservation devices, and also offers information on its website about sustainable landscaping practices. The Lexington DPW’s web page includes a link to a “Water Saver Home” website with water conservation guidance for residential customers.³⁹

WATER QUALITY

Lincoln has taken many steps to protect the quality of its drinking water. Flint’s Pond is largely surrounded by protected land and meets state regulatory requirements. However, because the aquifer that supports the Tower Road well lies within a glacial outwash basin with no impediments to the movement of contaminants, it is rated “highly susceptible” to water quality degradation according to DEP’s Source Water Assessment and Protection (SWAP) report. Further, the Zone II recharge area contains some potentially high-risk land uses: railroad tracks and institutional, multi-family, and commercial development. The potential contaminant sources include spills and leaks of oils and automotive fluids, excessive use of herbicides and pesticides, septic waste, releases from

³⁹ Town of Concord, Department of Public Works, http://www.concordnet.org/Pages/ConcordMA_Water/index, and Town of Lexington, Department of Public Works, <http://ci.lexington.ma.us/dpw/dpw.htm>.

transported chemicals and other hazardous materials or waste, and even microbial contaminants from aquatic wildlife. In contrast, Flint’s Pond ranks as a “moderately susceptible” water supply. Its risk factors include residential uses around the Pond and the threat of septic waste, home heating oil, and lawn care chemical releases.

DEP identified several measures already undertaken by the Lincoln Water Department to protect the town’s water supplies, and recommended some additional ones:

- ❖ Increase monitoring of non-water supply activities within Zone A of Flint’s Pond;
- ❖ Adopt land use controls that meet current requirements of 310 CMR 22.21(2) [wellhead protection bylaw] and 310 CMR 22.20C [surface water protection bylaw]; and
- ❖ Develop and implement a surface water supply and wellhead protection plan.⁴⁰

Wildlife

HABITAT PROTECTION

Despite episodes of wavering support for wildlife protection at the federal and state levels, Lincoln has persevered with public education, land acquisitions, and documenting the town’s biodiversity. The Open Space and Recreation Plan (2008) includes a fine analysis of Lincoln’s natural communities, yet much of this information is not reflected in the Commonwealth’s wildlife mapping. In most cases, the natural communities that exist in Lincoln do not qualify as priority communities under a state-prescribed ranking system. However, Lincoln has extensive and very beautiful habitat and wildlife corridors of value both to common and rare species. Unfortunately, Lincoln’s natural communities are at risk of degradation from the spread of invasive plants. The 2008 Open Space Plan notes that three species in particular have increased most noticeably in the past several years: black swallow-wort (*Cynanchum louiseae*), garlic mustard (*Alliaria petiolata*), and Japanese knotweed (*Polygonum cuspidatum*), a plant known to tolerate a wide range of soil conditions.⁴¹

Lincoln has several areas of designated Priority Habitat – that is, habitat for state-listed rare species. When the state updated its habitat maps following recent amendments to the Massachusetts Endangered Species Act regulations (2005), Lincoln made some modest gains in Priority Habitat and Estimated Habitat areas.⁴² This partially reflects the town’s species identification efforts and its success at enlisting help from residents.

INVASIVE PLANT SPECIES

Non-native and invasive plant species are common in many parts of Lincoln. “Invasive species” include plants, animals, and other organisms that can cause environmental damage or economic loss, or threaten human health, when introduced in areas where they do not usually occur.⁴³ Lincoln has been particularly concerned about

⁴⁰ DEP, “Source Water Assessment and Protection (SWAP) Report for Lincoln Water Department (2003)” [Electronic Version].

⁴¹ *Open Space and Recreation Plan* (2008), 25.

⁴² NHESP, “Classification of Natural Communities,” and “Priority Natural Communities,” http://www.mass.gov/dfwele/dfw/nhosp/natural_communities/natural_communities.htm, and “Massachusetts Endangered Species Act,” http://www.mass.gov/dfwele/dfw/nhosp/regulatory_review/reg_review_home.htm. See also, NHESP, *Massachusetts Natural Heritage Atlas*, 12th Ed. (2006). The central difference between Priority and Estimated Habitat areas is a regulatory distinction, the former being subject exclusively to MESA and the latter being subject both to MESA and the Wetlands Protection Act.

⁴³ National Invasive Species Council, <http://www.invasivespeciesinfo.gov/council/main.shtml>

combating invasive plants, which reproduce rapidly and disrupt the habitats of naturally occurring (native) plants. Some of the more prevalent invasive species in Lincoln include Black Swallow-wort (*Cynanchum rossicum*), Garlic Mustard (*Alliaria petiolata*), Glossy Buckthorn (*Frangula alnus*), Tree-of-Heaven (*Ailanthus altissima*), Japanese Knotweed (*Polygonum cuspidatum*), and Oriental Bittersweet (*Celastrus orbiculatus*). The Conservation Commission has developed several initiatives to address this problem, including an “Invasive Exotic Plants in Lincoln” webpage on the town’s website, an Invasive Exotic Plants brochure, and public outreach events to identify and control invasive species. Recently the Conservation Commission received CPA funds to support invasive species management on conservation land.

WILDLIFE CONFLICTS

The reforestation of New England has allowed the recovery of many of the region’s original wildlife populations. As suburban development continues to spread into reforested areas, some animals have adapted well enough to co-exist with human habitation and their activities can conflict with human interests. Red fox, fishers, deer, raccoons, and beavers have become increasingly common in Lincoln. Fishers are known to prey on pets and livestock, and while raccoons are usually thought of as garbage thieves, they and some other mammals are potential vectors for rabies. The deer population in Lincoln, estimated at twelve to fifteen deer per sq. mi., or about 200 resident deer, raises several concerns.⁴⁴ Deer can carry ticks that host Lyme disease, a serious illness that has become fairly well established in Eastern Massachusetts. In addition, deer can cause accidents on local roadways. Beaver have the potential to cause flooding and loss of property for homes constructed close to floodable land. The Conservation Commission has developed informational material for homeowners to address some of these wildlife conflicts.

Environmental Quality

STORMWATER MANAGEMENT

Federal law requires communities to manage *stormwater runoff*, which carries nutrients and pollutants from farm fields, lawns, roads, and other sources into waterways. Some communities have adopted **Low-Impact Development (LID)** bylaws that encourage or require developers to include stormwater BMPs in future projects. These principles encourage the reduction of impermeable surfaces, mimicking the natural system as closely as possible, and relying less on engineered structures to achieve stormwater and erosion control. Examples include the use of native vegetation in buffer strips, open channels, and rain gardens to trap and filter pollutants. Such techniques also help to reduce stormwater runoff volume through infiltration into the groundwater.

Municipalities must require applicants for construction sites greater than one acre to file a Stormwater Pollution Prevention Plan that meets local approval. In addition, they are required to implement a stormwater management program that (1) reduces the discharge of pollutants to the “maximum extent practicable” (MEP), (2) protects water quality, and (3) satisfies the appropriate water quality requirements of the Clean Water Act. In 2004 and 2005, Lincoln submitted stormwater management progress reports to DEP.⁴⁵ While the reports demonstrate overall compliance with the town’s general stormwater permit, they also list some shortcomings, e.g., locating and mapping stormwater outfalls that may affect rare or endangered species or historic properties (the reports indicate neither would be applicable), as well as water quality assessments. Lincoln had begun implementing public education and outreach programs, detecting and eliminating illicit discharges, controlling of pre-and post-construction site stormwater runoff, and preventing pollution at the municipal level.

⁴⁴ *Open Space and Recreation Plan* (2008), 26.

⁴⁵ Town of Lincoln, National Pollutant Discharge Elimination System (NPDES) Small MS4 General Permit Annual Report, November 2004.

Lincoln's abundant open space is not a shield against the effects of intensive development elsewhere in the region. The amount of impervious cover in a watershed increases with the construction of more buildings, roadways, and parking lots. In 2003, the Center for Watershed Protection evaluated data from 225 studies of impervious cover and its effect on the watershed. Stream impairment becomes evident in watersheds with ten percent impervious cover (corresponding with two-acre lots) and is significant in watersheds with twenty-five percent impervious cover (corresponding to 0.25-acre lots).⁴⁶ A major component of these impairments is poor stormwater management practices that allow untreated stormwater to enter streams and waterways.

LID offers one way to reduce impervious cover without banning development outright. For example, LID promotes designing building envelopes to avoid intruding upon natural resources, increasing on-site infiltration and groundwater recharge, keeping land disturbance and impervious cover to a minimum, and preserving and enhancing natural drainage patterns. Engineering firms often incorporate LID techniques as part of the site planning process, with or without local requirements. They can be expected to do so more frequently because the same techniques qualify as BMPs under the state's stormwater management standards, which require some degree of stormwater infiltration on all sites.⁴⁷ While Lincoln does not have a LID bylaw, the town's website offers stormwater management information to developers and homeowners through links to state and federal online repositories.⁴⁸ The state recently featured plans for the "Discovery Barn" at the Massachusetts Audubon Society's Drumlin Farm Sanctuary as an example of LID design for rural communities.⁴⁹

CONTAMINATION CONCERNS

The SWAP report notes that while industrial uses are not a significant concern within Lincoln, adjacent communities have industrial activities that could be harmful to the local water supply in the event of an accidental release. The risk of a release affecting Lincoln relates directly to the presence of regional highway corridors that support truck transportation and multiple transportation facilities, including the railroad. Train operations routinely release chemicals during normal use and track maintenance and herbicide use. In addition, DEP points out that accidents can cause spills of train engine fluids. Lincoln will need to remain cognizant of these issues, as it has in the past, mainly by monitoring activities within the watersheds of its drinking water supplies.

Lincoln has largely been spared from many of the serious, costly consequences of industrial contamination, though the town had to reclassify the Farrar Pond well as an emergency-only supply due to the discovery of organic compounds years ago. In May 2008, the DEP database of Chapter 21E Tier Classified Oil and Hazardous Material Sites included fifty-six releases reported in Lincoln between 1985 and 2007. All that required remediation appear to have met state regulations.⁵⁰ The only outstanding hazardous waste site is the old sanitary landfill on Virginia Road at Hanscom Field. HAFB and Hanscom Field accounted for more than twenty of the releases in DEP's database. Another eight releases were associated with leaks or spills from gasoline stations or automotive garages, and others were relatively small oil spills resulting from electrical transformer failures or roadway accidents. The few industrial releases listed appear to relate to the former military uses in the area, such as the former Nike missile installation on the Wayland border. Only one classified site, a transformer oil spill on Sandy Pond Road (RTN 03-0011522), is listed as a location within a water supply protection zone.

⁴⁶ Center for Watershed Protection, *Impacts of Impervious Cover on Aquatic Systems* (2003).

⁴⁷ DEP, *Massachusetts Stormwater Handbook* (February 2008), see Chapter 1 and Chapter 3

⁴⁸ Town of Lincoln, "Stormwater Management," <http://www.lincolntown.org/depts/stormwater.htm>

⁴⁹ EOEEA, Smart Growth Toolkit, Low-Impact Development Case Studies, http://www.mass.gov/envir/smart_growth_toolkit/pages/SG-CS-lid.html.

⁵⁰ DEP, <http://db.state.ma.us/dep/cleanup/sites/Results2.asp>

Hanscom Field presents undeniable risks to Lincoln's natural resources. Recent proposals to expand the airport have included the addition of jet fuel storage tanks, one of which was located above ground over a protected aquifer. Yet, while the Chapter 21E database reinforces these concerns, Hanscom Field is not Lincoln's only environmental problem. The town has other indicators of environmental stress as well. According to the Proposed Massachusetts Year 2008 Integrated List of Waters (Clean Water Act Sections 303d and 305b), the Upper Basin of the Cambridge Reservoir, the Elm Brook, and the Shawsheen River all constitute impaired waters requiring a Total Maximum Daily Load (TMDL), or a plan and regulatory strategy to control the amount of pollutants that a degraded water body can accept from point, non-point, and natural sources.⁵¹

Local Government Environmental Initiatives and Challenges

Town government has conducted many public education programs. Lincoln's official town website has numerous links to information about environmental topics, mainly to educate homeowners about steps they can take to protect the local and regional environment. In conjunction with the town's conservation groups, the Lincoln Board of Health prepared a pamphlet, *Healthy Lawns and Landscapes*, to encourage residents to consider organic lawn care. The Conservation Department has also created educational programs to encourage conservation and knowledge of Lincoln's regulations and bylaws. Through brochures, educational work days and site visits, the Conservation Commission promotes the use of native plants, reduced lawn area, and BMPs on agricultural fields including drip irrigation, cover crop and companion planting. It also encourages residents to water during early morning and evening hours.

Water conservation is as challenging for town government as for homeowners, businesses, institutions, and farms. Lincoln does not have a local bylaw or regulations for water conservation, but the Water Department charges different water rates based on consumption and it can impose voluntary water restrictions. The town also employs water conservation measures by limiting irrigation of its recreation fields, but balancing landscape management and water conservation on recreation fields is difficult. Presently, Lincoln does not irrigate most of its athletic fields and relies on a routine of annual slice seeding, aeration, lime application, and a quarterly fertilization. The Town Offices Field has an irrigation system, but the field's lack of proper drainage renders it unusable most of the year. (The irrigation system has not been used more than once or twice since it was installed years ago.) Lack of irrigation will become more problematic as demands on playing fields continue to increase.

The town has installed an irrigation system for its tennis courts but avoids watering during mid-day hours. Watering typically occurs at midnight and around 5 p.m. in order to keep the clay surface playable. The irrigation system is equipped with a sensor to shut down when it rains. As the summer progresses, the town applies calcium chloride to the surfaces to help them retain moisture better, and typically increases the irrigation schedule as seasonal temperatures rise. Of all of Lincoln's recreational facilities, the Codman Pool obviously uses the largest amount of water. The pool shell was repaired about seven years ago to improve its holding capacity, but the town is still required to add water daily during the peak season due to evaporation and user displacement. There is no regular irrigation of the pool lawn area.⁵²

⁵¹ DEP, Massachusetts Year 2008 Integrated List of Waters Proposed Listing of the Condition of Massachusetts' Waters Pursuant to Sections 303(d) and 305(b) of the Clean Water Act (April 2008); Charles River Watershed 2002-2006 Water Quality Assessment Report (April 2008), and Shawsheen River Water Quality Assessment Report (July 2003), <http://www.mass.gov/dep/water/resources/tmdls.htm>. A TMDL currently exists for pathogens in the Shawsheen River and Elm Brook.

⁵² Dan Pereira, Lincoln Recreation Director, to Community Opportunities Group, Inc., 10 June 2008.

To address the management needs of its own open space, Lincoln is currently working on property management plans for conservation land. Stewardship efforts primarily include maintenance of open field habitats through mowing, management of non-native invasive plants by hand-pulling, mowing and cutting, and protection of wetland resource areas and preservation of existing contiguous woodland habitats.

GOALS & RECOMMENDATIONS

Goal NR-1. Preserve Lincoln’s natural resources and agricultural land uses.

- NR-1.1. By purchase, restriction, or other method, continue to protect lands which contain or contribute to the protection of valuable natural resources, including public drinking water supplies.
- NR-1.2. Continue to secure deed restrictions to protect wetland buffer zone areas.
- NR-1.3. Establish goals for water use in order to conserve water and bring Lincoln in line with the state’s water use guidelines.
- NR-1.4. Develop property management plans for the protection of conservation land and habitat areas.
- NR-1.5. Encourage or require best management practices for soil and water conservation on all construction projects in Lincoln, including agricultural lands to the extent allowed by law.
- NR-1.6. Ensure that developers comply with requirements for environmental impact reports, stormwater management, and open space development guidelines.

DISCUSSION

Lincoln has worked diligently over a long period of time to protect natural resources through regulatory controls, conservation land acquisitions, public education, and thoughtful administration of the local wetlands bylaw. The town’s population is changing, and while many people are attracted to Lincoln because of its abundant open space, they may not be familiar with the role of conservation and stewardship in Lincoln’s culture. Public education tools that reach people in a wide variety of locations and settings could help to increase local knowledge of the town’s conservation agenda and how individuals can be part of it. The following are essential or “foundation” steps to guide the implementation of this Comprehensive Plan:

- ❖ Continue to protect lands of conservation interest through land acquisitions and conservation restrictions, and regulatory techniques such as obtaining deed restrictions for wetland buffer areas as part of the process of issuing an Order of Conditions, and site development standards (through zoning) to guide construction away from critical resources.
- ❖ Increase efforts to educate the public about water conservation, and explore options in addition to the existing water rate structure to reduce water use by residents, businesses, and institutions both through voluntary and legally enforceable means, including establishing goals for appropriate water consumption.
- ❖ Adopt a land clearing and grading bylaw to ensure the use of best management practices (BMPs) during site construction.
- ❖ Make a consistent commitment to stewardship by providing adequate financial and staff support for the Conservation Commission’s baseline inventory and monitoring program.

- ❖ Review site plan and special permit submission requirements to ensure that town officials receive the information they need to evaluate, regulate, and minimize the adverse impacts of development on land and water resources. This effort should be paired with a comprehensive review and update of the town’s Zoning Bylaw and subdivision regulations.
- ❖ Implement the 2008 *Open Space and Recreation Plan*.

Goal NR-2. Promote water conservation, ecological landscaping practices, and energy and resource conservation among all property owners and town employees.

- NR-2.1. Develop conservation guidelines for all public buildings, including schools, the town offices, public safety, and public works.
- NR-2.2. Continue to educate the public about Lincoln’s conservation ethic and commitment to stewardship.
- NR-2.3. Investigate and seek opportunities to participate in state, national, and global environmental programs, such as dark skies and green cities initiatives.

DISCUSSION

For communities seeking to conserve water and energy and encourage ecological landscaping practices, it makes sense to set an example by implementing conservation guidelines in all municipally owned properties. Several Massachusetts towns have planted low water use gardens with non-invasive species on the grounds of their town halls and libraries, instituted rainwater harvesting, redesigned municipal parking lots to incorporate bioretention, and implemented the recommendations of energy audits in older buildings. Lincoln has been working to promote energy and water conservation in public buildings and should continue its existing efforts. Implementing a consistent approach to conservation on municipal and school property will be challenging because Lincoln’s public buildings are managed by the individual departments that occupy them. Establishing a full-time Facilities Manager (Chapter 10: Community Services & Facilities) will enhance Lincoln’s ability to develop and carry out water and energy conservation guidelines.

Lincoln has done more than most communities to maintain and increase public support for conservation and stewardship. Through programs and publications by the Conservation Commission, Board of Health, and LLCT, Lincoln residents have access to all of the information they need in order to understand the roles that individuals can play to conserve energy and water. It is very challenging for affluent towns to convince the public to conserve because the financial incentives that sometimes work in other communities have little if any impact on people who can afford to pay for the resources they consume. Continued use of the town’s website to disseminate information, working with the Lincoln Public Schools and community organizations to provide environmental education for children, making presentations at the State of the Town Meeting and the Annual Town Meeting, and encouraging residents to organize conservation activities at the neighborhood level are appropriate steps for Lincoln to take to reinforce the town’s conservation ethic. In addition, establishing and maintaining a “skills bank” database (Chapter 11, Governance) could help to identify residents with the skills, interest, and time to take on special environmental projects, such as leading the development of a climate action plan or identifying ways for Lincoln to engage more actively in national and global environmental programs.

Goal NR-3. Improve controls against environmental degradation and pollution.

- NR-3.1. Continue to educate the public about alternatives to chemical pesticides, herbicides, and fertilizers in landscaping and lawn maintenance activities.
- NR-3.2. Consider adopting a Low-Impact Development (LID) bylaw, consistent with state stormwater regulations and guidelines, to require developers to include stormwater BMPs in future projects.
- NR-3.3. Identify and evaluate the town's options for regulating chemical and sediment pollution of private and public water supplies and establishing local standards for the use of chemical pesticides, herbicides, and fertilizers, to the extent allowed by law.
- NR-3.4. Adopt noise pollution regulations, with clear standards to define noise disturbance.
- NR-3.5. Ensure that new construction projects meet appropriate environmental standards by creating an avenue for reviewing such projects.
- NR-3.6. Through identification, public education, regulations, and guidelines, increase the effectiveness of programs to control invasive species.

DISCUSSION

The Massachusetts courts have held that cities and towns lack authority to regulate the use of chemical pesticides, herbicides, and fertilizers because the state retains exclusive jurisdiction. Lincoln could try to enlist support from other towns, the Massachusetts Association of Boards of Health, or the Metropolitan Area Planning Council to petition for amendments to the Massachusetts Pesticide Control Act, but this would be a long-term endeavor. It will be important to continue providing public education in multiple formats – such as the internet, special inserts in water bills, working with local landscaping contractors to promote environmentally responsible alternatives, or display boards in the Town Offices and the library – in order to engage residents, business owners, and institutional property owners as partners. It also makes sense to develop guidelines for chemical pesticides, herbicides, and fertilizers and work with some of the town's large property owners to institute them voluntarily. In addition, while the town may not be able to prohibit chemical pesticides, it could establish site development standards such as limits on the percentage of a site that can be covered by turf, prohibitions against landscaping with invasive species, and requirements for water conservation plans. These types of standards could be incorporated in the Zoning Bylaw and enforced through site plan review and the special permit process.

Some communities in Massachusetts have recently adopted bylaws and ordinances to regulate offensive noise. Lincoln could establish a working group or committee that includes staff and designees of the Conservation Commission to review the town's options for a workable noise-reduction bylaw and the administrative requirements for implementing it. Factors to consider in any noise bylaw include not only a clear definition of offensive noise and ambient noise, but also the sources of noise and noise-generating activities that will be regulated under the bylaw, the intensity, duration, and frequency of regulated noises that would constitute an offense, and activities that would be exempt, e.g., emergency work, special events, or the operation of farming equipment.

Goal NR-4. Improve communication and coordination between the Water Department and other town agencies responsible for developing and implementing natural resource protection plans.

- NR-4.1. Ensure that town agencies have a basic understanding of Lincoln's drinking water supplies and water storage and distribution systems.

- NR-4.2. Ensure consistency between Lincoln's land use policies and water resource protection laws that affect the amount of water Lincoln can withdraw from surface water and groundwater supplies.
- NR-4.3. Coordinate water conservation efforts among Lincoln's land use and natural resource agencies and all town departments with operations and maintenance responsibilities for public buildings and grounds.

DISCUSSION

A decentralized government like Lincoln's can make it difficult to coordinate the work of independently elected boards and the departments they oversee. During this Comprehensive Plan process, it became clear that many town officials and department heads had limited knowledge of the Water Department, the state of the town's water system, and the degree to which water supply may be a controlling factor in meeting many of the town's Comprehensive Plan goals. Although water quality is a very high priority in Lincoln's land use and conservation policies, there does not appear to be a clear or widely shared understanding of constraints on the town's water supply. Simple measures such as ensuring the water superintendent's attendance at department head and development review team meetings, and engaging the Board of Water Commissioners to participate in land use planning and policy discussions, would improve Lincoln's ability to integrate water management with growth management.