

4 ENVIRONMENTAL INVENTORY AND ANALYSIS

A. Geology, Soils and Topography

The town of Hadley is underlain by five distinct bedrock formations. The oldest bedrock, Amherst Schist, dates back to the Paleozoic Era and was formed by the intense heat and pressure accompanying the collision of continental plates. The dark gray, foliated rock is primarily composed of biotite and muscovite. Outcrops are found at the base of Mt. Warner (Balk 1957).

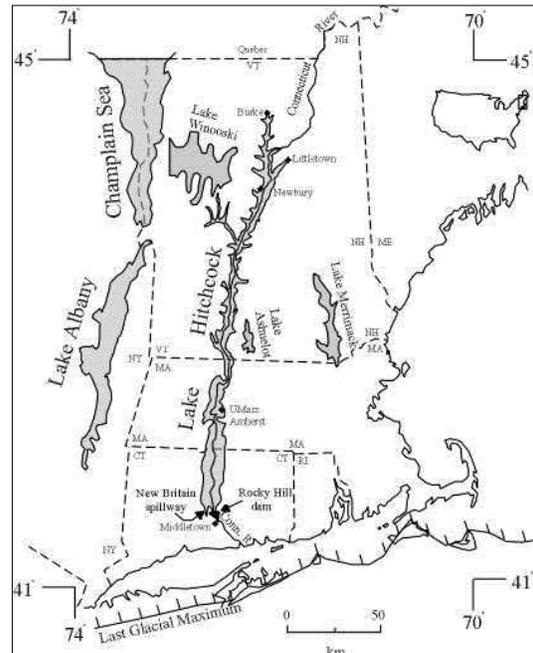
Most of the bedrock units, however, formed in the early Mesozoic Era (Balk 1957). During the Triassic age, tectonic stress uplifted the hills to the east while the land to the west was lowered. This process continued for nearly 85 million years. Sedimentary bedrock units were then formed as the Eastern Highlands were eroded (Little 1986, 23-25). The oldest sedimentary formation is Sugarloaf Arkose that may be seen at the western base of Mt. Warner (Hinthorne 1967).

In the Lower Jurassic, the valley entered a period of volcanism. Tectonic activity produced flows of fine-grained basalt that overlies the Sugarloaf Arkose. Referred to as the Holyoke Basalt, this bedrock formation makes up the foundation of the Holyoke Range (Hinthorne 1967). The Holyoke Range is the most prominent geologic feature in Hadley created from a series of lava flows and interbedded sediments. The ridge veers to the east in South Hadley and rises nine hundred feet above the flood plain. Renewed volcanic activity spewed volcanic ash and debris over the landscape, forming the Granby Tuff. Outcrops of the tuff are scattered along the eastern flank of the Holyoke Range and on its summit (Balk 1957).

Approximately 140 million years ago, the eastern border fault became inactive and volcanism in the valley ceased. Headward erosion caused the streams flowing from west to east to "capture" each other. The intersection and diversion of these streams formed the Connecticut River (Little 1986, 50).

Beginning two and a half million years ago, the Connecticut Valley endured a number of glacial advances and retreats. The most recent glaciation began approximately twenty thousand years ago. At this time, the Wisconsin glacier extended over the Connecticut Valley blanketing the Holyoke range in a sheet of ice (Little 1986, 55). As the glacier retreated, approximately fourteen thousand years ago, a natural dam collected glacial melt water. The resulting lake, glacial Lake Hitchcock, extended from what is now Rocky Hill, Connecticut (just north of Middletown) to Lyme, New Hampshire (Little 1986, 61).

Evidence of glaciation and glacial Lake Hitchcock is found throughout Hadley. Striations are found on the summit of Mt. Holyoke. These deep scars in the rock are a testament to the grinding force of the thick ice sheet that blanketed the Holyoke



Range (Little 1986, 55). The ice sheet also coated the landscape with an amalgam of silt, sand and larger rocks. Glacial melt waters deposited sorted materials such as gravel that can be found at the foot of the Holyoke Range, and along the eastern bank of the Connecticut River.

Varved clays are another remnant of the ice age. The sediment, found in the central portion of Hadley from the foot of the Holyoke Range into North Hadley, appears as thin bands which alternate in texture and color. The darker layers contain fine silts and clay, while the lighter layers are sandier deposits. These sediments are the lake bottom deposits of glacial Lake Hitchcock. Some theorize the difference in the bands signifies a seasonal change in streams' carrying capacity. The darker layers correspond with winter months when the water is relatively still and the finest particles could settle out. In turn, the lighter bands represent deposits laid down in the spring when the carrying capacity of the tributaries was greatest (Little 1986, 63).

Fluvial processes have had the greatest impact on Hadley's landscape in recent years. The gentle gradients of the Connecticut and Fort Rivers indicate that there is little downcutting. Instead, erosional force is exerted on the banks leading to meandering channels.

The Rainbow Beach meander bend continues to migrate to the east, eroding the riverbank in Hadley. In fact, the lateral movement cut off route 47 in the 1930s and a new road was built farther to the east. The Hadley bank is steep and roughly cut with large trees toppled over into the water. Abandoned river channels scar Hadley's landscape and indicate earlier courses of the Connecticut and its tributaries. As late as the 1968, the Fort River entered the Connecticut River farther south than today. The migrating meander bend, however, captured the Fort River farther north diverting its flow. Although vegetated, the abandoned channel is still noticeably lower than the surrounding topography.

Soils

The soils in Hadley are some of the most fertile agricultural soils in the United States. The Natural Resources Conservation Service has mapped five significant soil associations in Hadley.

Hadley, Winooski and Limerick Soils

Adjacent to the Connecticut and Fort Rivers, is a grouping of Hadley, Winooski and Limerick soils. These soils are deep, silty loams that typically form in alluvial material on flood plains. Both Hadley and Winooski soils are considered to be prime agricultural soils. Components of the Hadley-Winooski-Limerick association soils vary in pH from 4.5 to 7.3, which is relatively less acidic than other soils in the region. The soils also have a high available water capacity. Typically found in areas prone to flooding, this series has severe development limitations, with a high potential for frost action that can damage buildings, roadways and other structures (USDA, SCS 1981). This association underlies Hadley center.

Hinckley-Merrimac-Windsor Soils

The Hinckley-Merrimac-Windsor association extends from along Route 47 just north of the Holyoke Range to the Rainbow Beach meander bend. Another grouping of these soils is found in North Hadley, adjacent to Route 47. These well-drained mineral soils developed in stratified sand and gravel deposits. According to the Hampshire County Soil Survey, these soils are less productive than the former association. This may be due to the relatively lower pH. Moreover, there is generally less available water. Still, Merrimac soils are considered prime agricultural lands. This group is moderately difficult to develop since they are found on slopes and may be susceptible to erosion. In addition, these highly permeable soils are poor filters for septic systems (USDA, SCS 1981). Sand and gravel are often extracted from areas covered by this association.

Not surprisingly, a sandpit is located just off of Bay Road in an area mapped as part of the Hinckley association.

Amostown-Scitico-Boxford Soils

The Amostown-Scitico-Boxford association is the primary soil group in Hadley stretching from the base of the Holyoke Range up into North Hadley. These loamy to somewhat clayey soils can be moderately well to poorly drained, formed in lacustrine sediments on terraces and old lakebeds. Both Amostown and Boxford soils are classified as prime agricultural lands that have demonstrated relatively high rates of crop production. Similar to the Hadley-Winooski-Limerick association, the pH varies from 4.5 to 7.3. The available water capacity is somewhat higher than the Hinckley association. These slow draining soils present development limitations: the sites are wet and generally unsuitable for septic systems. Also there is a moderate to high potential for frost action on these soils (USDA, SCS 1981). This association underlies the most highly developed section of town, the Route 9 corridor.

Rock Outcrop-Narragansett-Holyoke Soils

Capping the Holyoke Range and atop Mt. Warner is the Rock Outcrop-Narragansett-Holyoke association. This group of shallow soils is found on gentle to steep slopes. The association is made up of generally well-drained loamy soils that formed in glacial till. These soils are not productive and are also not appropriate for development given the shallow depth to bedrock and the excessive slopes. Much of the land is forested, and a portion is contained within Skinner State Park (USDA, SCS 1981).

Gloucester-Montauk-Paxton Soils

The Gloucester-Montauk-Paxton soil association parallels the Connecticut River. This group of deep, well drained, moderately sloping soils are found on the sides and lower slopes of hills, often with seasonally perched water table. Due to their slope and the stony Paxton series in some places, these soils are not well-suited to farming and likely forested where not encroached upon by active agriculture.

B. Landscape Character

Hadley's landscape is characterized by extensive acreage of contiguous farmland situated on the flood plain of the Connecticut River. The predominantly flat topology is interrupted by the Holyoke Range in the south and Mt. Warner in the north, both of which are heavily forested. The existence of three registered historic districts and an abundance of open farmland both define and preserve the community's rural character.

A Scenic Landscape Inventory conducted by the Massachusetts Department of Environmental Management in 1983 classified 75 percent of the town as either "noteworthy" or "distinctive" (Massachusetts Department of Environmental Management, 1981).

The town center is located in the western portion of the town, and is composed of three broad streets lined with mature shade trees. The historic single-family residences, most of them over 100 years old, are situated on narrow lots of various lengths, arranged in the distinctive layout of a traditional seventeenth-century New England village. About 65 long, thin lots front on the town common, a beautiful open space which is under the direct control of the Town's Board of Selectmen.

Hadley is bisected by the Route 9 commercial corridor, an area which was once farmland, but has become an increasingly dense strip development. Important soils for farmland are also the best

lands for development, due to being well-drained and flat, and this makes Hadley's open spaces especially vulnerable to development pressures

Connecticut River National Scenic Farm Byway

Route 47 in Hadley is part of the 39 mile Connecticut River National Scenic Farm Byway in western Massachusetts, known commonly as the Connecticut River Scenic Byway. The Byway links a series of six villages, several of which date from the 1600s and are the oldest in the region, including Hadley, Sunderland, Northfield and South Hadley. In addition to the rich cultural and historic heritage found along the byway, outstanding natural scenery and recreational opportunities abound. The 215-mile New England National Scenic Trail, formerly called the Metacombet Monadnock Mattabesett Trail, crosses the byway near Mount Holyoke and provides miles of great hiking opportunities. The Connecticut River, the one and only designated American Heritage River, is a popular site for power boating and fishing and has a state-designated Connecticut River Water Trail set aside for kayaking and canoeing.

C. Water Resources

The Town of Hadley lies within the Connecticut River watershed and possesses nearly fifteen miles of river frontage. Two sizable tributaries, the Mill and Fort Rivers, are found within Hadley's boundaries. The Fort River follows a meandering channel to the southwest, fed by numerous streams, including Harts Brook, with their headwaters in the Holyoke Range. The Fort River provides important wildlife habitat, floodwater storage (nearly the entire length lies within the FEMA Flood Overlay district), and helps protect water quality. It is within the recharge area for the Callahan well field (Hadley Master Plan). Most of the Fort River is bordered by agricultural land with some narrow wooded buffers. The Mill River flows out of Puffer's pond in North Amherst and turns west in Hadley to flow through a major wooded wetland until it empties into Lake Warner. The Mill River then continues a short distance to the Connecticut River. The lower part of Russellville Brook, a tributary of the Connecticut River, has been identified by the state as part of a large and significant natural habitat along the Connecticut River.

Public access to the major river systems in town is very limited. Access to the Connecticut River is mostly from private land and marinas. Areas of state owned land next to the river are difficult to locate and reach by land. Access to the Fort and Mill Rivers on protected land would be across APR land, and require permission from the farmers first. State owned land along the Mill River near Lake Warner is also difficult to locate and reach by land.

Lake Warner and the Hadley Lower Reservoir are Hadley's major bodies of water. Water rights to the sixty-five acre Lake Warner belong to Kestrel Land Trust, which merged with Valley Land Fund becoming one non-profit land trust operating in Hampden, Hampshire, and Franklin counties. Public access is available near the dam. Access to Hadley Lower Reservoir requires a town parking permit for passive recreation.

The Fort River

The Fort River area lies in the heart of the Pioneer Valley in Hadley, just north of the Mount Holyoke Range. It contains more than 2,000 acres of the most prized grassland fields and farmland with prime soils that support working dairy farms, row crops, hay, and prizewinning breeding programs. The Fort River is the longest free-flowing tributary to the Connecticut River in Massachusetts and is a priority focus area for the Silvio O. Conte National Fish and Wildlife Refuge. It is also NHESP BioMap Core and Living Waters Core habitat, which are considered the most critical areas for biodiversity conservation in the state. Area residents value the area for

its incredible vistas, both looking toward and down from the Mount Holyoke Range and in all directions from within the Valley. They also value the river for its good fishing and birding. It is also a valuable connection to the Connecticut River Greenway, Norwottuck Rail Trail, and the Skinner and Mt. Holyoke Range State Parks. The Fort River area contains wildlife habitat that supports the federally endangered dwarf wedge mussel, biologically rich wetlands, and grasslands that can support rare migratory birds. Another very important aspect of the Fort River area is that it contains the aquifer recharge zone for the Callahan Wells, Hadley's public water supply.

This river, as it flows from Amherst into Hadley to join the Connecticut River, is a key freshwater habitat for fishes, freshwater mussels, and aquatic insects. The predominantly sandy riverbed and the combination of riffles and pools along the Fort River provide important habitats for a diverse group of freshwater mussels, with seven of the state's twelve species found here. Several specimens of the federally and state-Endangered Dwarf Wedge mussel were recently rediscovered in the river. The Triangle Floater occurs in good numbers and is distributed throughout the river, whereas the Eastern Pond mussel is found less frequently in sandy pools or quieter waters. The uncommon Eastern Pearlshell is abundant and very well-distributed throughout the river, and is an indicator of cool, clean rivers that support its trout fish hosts. While some mussel populations are abundant here, many of the state-listed rare species appear to be declining. Permanent protection of the undeveloped riparian areas adjacent to the Fort River and control of sediment inputs from roads and agricultural areas are first steps toward protecting this valuable freshwater habitat. Rare dragonflies can also be found in the Fort River habitat. These aquatic insects are good indicators of ecosystem health, confirming that these freshwater habitats are important for other aquatic species as well.

A section of the Fort River in Hadley supports one of six known populations of Bridle Shiner in the Connecticut Watershed. This fish Species of Special Concern has a small range from southern New England to South Carolina, and has been declining or extirpated in much of the region. The Bridle Shiner is typically found in well vegetated, quiet waters. It feeds on small aquatic insects and other invertebrates, and is an important part of the freshwater ecosystem as prey for larger fishes (Massachusetts Natural Heritage and Endangered Species Program 2004).

The Fort River meanders through acres of open farmland before entering the Connecticut River immediately south of Hadley Cove. Originally, the Fort joined the Connecticut farther south, near Mitch's Marina. The section of the Fort between South Maple Street and its confluence with the Connecticut is narrow and steep-sided and prone to erosion. The channel is lined with silver (*Acer saccharinum*) and red maple (*Acer rubrum*), black ash (*Fraxinus nigra*), and American elm (*Ulmus americana*). Wetland shrubs and herbaceous plants thrive in the understory. According to Alexandra Dawson, the Chair of the Conservation Commission, the Fort River provides not only important wildlife habitat but also floodwater storage. Nearly the entire length of the Fort is included in the Flood Overlay District and helps protect water quality.

These features define the Pioneer Valley; they contribute greatly to area quality of life and also mark a landscape whose protection serves larger regional and national interests. Yet, few other places in the Valley face a greater risk of losing everything to sprawling development. Encroachment by subdivisions and large homes decreases farm viability, makes the return of grassland dependent birds less likely, and has a negative effect on water quality, recreational possibilities, and the scenic and rural character of the region. With an increasing population, a rising number of developers in the wings, and escalating land prices, time is quickly running out to protect the habitat and farmland that surrounds the Fort River. But for the next few years, a narrow window of opportunity still exists to conserve this private land for the public good.

Fortunately, there are several existing conservation initiatives in the Fort River area that the town can build upon. Over 2000 acres of APR land forms the keystone of what could be a much larger block of protected land. The area's periphery has benefited from important local, state, federal, and private investments along the Connecticut River, the Norwottuck Rail Trail, the Mount Holyoke Range, and the Fort River in Amherst. Grasslands in the Fort River watershed are a priority focus area for the Silvio O. Conte National Fish and Wildlife Refuge, and the US Fish and Wildlife Service has begun acquisitions in this area. Several key landowners are looking to the conservation community to give them solid offers so that they can avoid selling for development. The Town of Hadley has a strong track record of working to protect farmland and the Mount Holyoke Range. A number of public awareness campaigns initiated by concerned citizens have served to build momentum to protect these lands.

The Mill River and Lake Warner

The Mill River corridor is located in North Hadley and include a variety of habitats, rich in plant and bird life, with outstanding opportunities for nature study and protection of Hadley's natural heritage, including the 65 acre Lake Warner. The section between Route 116 and the University of Massachusetts' Mullins Center is a narrow wooded stream corridor. North, near the campus' maintenance storage areas, the river corridor is largely intact but somewhat degraded, and is the home of an unusual wooded swamp plant association that includes tupelo and pin oak.

To the west of Roosevelt Street, the Mill River is at first densely vegetated and then opens up into the wide, bayou-like ponds that form Lake Warner or North Hadley Pond. Lake Warner is bordered by a combination of agricultural land, residential land and wet woodland on the north side. Protected and forested, Mt. Warner bounds the south side. These forests support a small section of the Tupelo-Swamp White Oak-Pin Oak Association. The area is used for fishing and waterfowl hunting and has the potential for passive recreation, if the water quality is improved.

Lake Warner is identified as a Category 4a Water – TMDL Completed in the 2012 Integrated List of Impaired Waters (MA DEP, March 2013). Listed impairments include non-native aquatic plants, excess algal growth, dissolved oxygen, total phosphorus, and turbidity. Suspected sources of the impairment date back to when the Amherst sewage treatment plant discharged to the east of the pond, but may also reflect contributions from agriculture and septic systems. The impounded lake is retained by an old mill dam. The owner of the dam, Kestrel Land Trust, is working with the Town of Hadley and other stakeholders to develop feasible strategies for restoring the lake and providing recreational access, including attempts to raise funds to restore the dam. Hadley Town Meeting in May 2014 approved spending \$100,000 from the Community Preservation Act for repairs of the dam, estimated to cost \$350,000. An additional \$125,000 is being sought through the State budget. The Friends of Lake Warner are attempting to raise another \$50,000 to close the funding gap. The Massachusetts Office of Dam Safety ordered Kestrel Land Trust to remove or repair the dam by December 2014.

Russellville Brook

At the confluence of the Russellville Brook and the Connecticut River is an area known as Red Rocks. A report by the Department of Environmental Management refers to this area as "the largest and most significant" of four of the fourteen important natural communities found in Hadley along the land adjacent to the Connecticut River (Massachusetts Department of Environmental Management, 1993). Most of Russellville Brook is narrow and steep sided. The brook may have once been a spawning area for salmon and brook trout. Its banks are wooded, and covered with ferns, and home to muskrats and other wetland creatures. This area, as well as

the rest of the stream, deserves more exploration and water quality testing. It is an area of town under major development. The 200-foot setback for the Riverfront Area designated under the state Wetlands Protection Act provides limited protection beyond the immediate riverbanks.

Groundwater Resources

Groundwater resources in Hadley provide base flow for the streams and rivers in the town and provide potable water for the town's residences and businesses. The town water supply is drawn from groundwater wells discussed in Chapter 3. Most Hadley residents are on the town water supply, although some farmers use private wells for irrigation and related purposes.

Floodplains

Hadley has been inundated by floodwaters several times since the turn of the 20th century. A roadside sign along Route 47 marks several flood events. Perhaps the most notable was the flood of 1936. Soon after, the town enlarged an existing earthen dike to protect the Town Center. Still, the western section of the peninsula and the area along Aqua Vitae Road remain susceptible to flooding. Nearly all of Hadley Center is mapped as being in the range of a one-hundred-year flood, a storm event that has a one percent chance of occurring in any given year.

Floodplain forests and open wet meadows are important natural resources in Hadley. Floodplain forests, dominated by silver maple (*Acer saccharinum*) and cottonwood (*Populus deltoides*), are found along the Connecticut River. Remnants also persist near Hadley Cove, along the old section of the Fort River, and on the island across from Mitch's Marina. Wet meadows are found near Hockanum Flat and Hadley Cove. Others are interspersed among the floodplain forests near the old stretch of the Fort River.

Hadley Cove is a secluded inlet along the Connecticut River, well known to bird-watchers and other naturalists. Emergent wetland vegetation in the cove supports waterfowl, shorebirds, herons and osprey. It is dominated by duck-potato (*Sagittaria latifolia*) whose starchy tuber is of considerable value to waterfowl and muskrat. A Conservation Restriction was acquired on 12 acres of predominantly silver maple floodplain forest in the Cove by The Valley Land Fund Inc. in 2002.

South of the current mouth of the Fort River lies a series of wetlands in the abandoned meanders of the Fort River. This wetland complex is composed of mature floodplain forest, forested swamp, and seasonally flooded meadows and backwater areas. The wet meadows of this area also have the potential for valuable butterfly habitat. Targeted by the state as prime land to link the Connecticut River with Skinner State Park, much of this area is now under state Department of Conservation and Recreation (DCR) protection. A state grant from the Massachusetts Highway Department occasioned by designation of Route 47 as a state "scenic byway" contributed to this protection in 2006.

Hockanum Flat, at the southernmost tip of Hadley, supports beech, black willow copses, grasslands (some of which are managed for hay), and seasonally flooded open ponds. Also, this area is adjacent to the Holyoke Range, which is labeled as a High Priority Site of Rare Species Habitat and Exemplary Natural Communities (Massachusetts Natural Heritage and Endangered Species Program 1995). DCR has acquired some of this land.

Wetlands

Hadley has a range of wetland resources, including floodplain forests, forested swamp and wet meadows. Much of the wetlands lie in heavily forested areas along the Connecticut River and its tributaries. Wet meadows are more common along the Fort River near Hockanum Flat and Hadley Cove. Many wetlands and wooded swamps in Hadley were drained for agricultural use as Hadley once had more extensive wetland areas, specifically around Lake Warner, the Fort and Mill Rivers, along the Connecticut River, and behind Stop and Shop. The remaining wetlands are a critical element in the wildlife habitat for many common and rare species, and storm water management systems of the town. Encroaching residential and commercial development threaten the important wetlands of Hadley.

There are four Certified Vernal Pools and fifty-seven Potential Vernal Pools (NHESP, 2014). In addition, areas of swamps will provide habitat for vernal pool species. Clusters of vernal pools provide particularly good habitat for species that depend on vernal pools for habitat. The clusters mean that there are alternate habitats if something happens to one pool, and slightly different conditions in each may provide different habitats for pool dependent species. Along the Mill River are some small vernal pool clusters. There are more small clusters of vernal pools along the Fort River and south of the mouth of the Fort River. In order to qualify for protection under the Wetlands Protection Act, these pools must be certified by the Massachusetts Natural Heritage and Endangered Species Program (NHESP). The Hadley Conservation Commission continually seeks assistance from conservation organizations and private land owners to certify vernal pools when they are identified.

Wooded Swamps

Wooded swamps in Hadley feature a relatively rare plant association featuring tupelo (*Nyssa sylvatica*), pin oak (*Quercus palustris*) and white swamp oak (*Quercus bicolor*). Hadley represents the northernmost range of this community in the Connecticut River Valley. Many wooded swamps in Hadley, however, have been reclaimed for agricultural purposes, leaving scattered pockets of this unusual community.

The most extensive representative of this plant association in Hadley is found in the Great Swamp, located in the northeast corner of town. Other, smaller representatives of this plant community have been located near Lake Warner, along the bike path off of Maple St., and two of the three species are found near the Mill River north of the university (Searcy 1995). The Great Swamp supports the most extensive stand of the Tupelo/Pin Oak/Swamp White Oak in Hadley. Thirty acres in the Great Swamp was deeded to the conservation commission in 1972. Logging for timber management and residential development across town borders are threats in this area.

D. Vegetation

The following discussion about vegetation and the subsequent Section E. Fisheries and Wildlife are informed by information provided by the NHESP in the 2012 *BioMap2* report, and a letter dated May 16, 2014 with updated information regarding rare species, priority natural communities, and uncommon aspects of biodiversity in Hadley. *BioMap2* identifies two complementary spatial layers, Core Habitat and Critical Natural Landscape. Core Habitat identifies key areas that are critical for the long-term persistence of rare species and other Species of Conservation Concern, as well as a wide diversity of natural communities and intact

ecosystems across the Commonwealth. Protection of Core Habitats will contribute to the conservation of specific elements of biodiversity.

Critical Natural Landscape identifies large natural Landscape Blocks that are minimally impacted by development. If protected, these areas will provide habitat for wide-ranging native species, support intact ecological processes, maintain connectivity among habitats, and enhance ecological resilience to natural and anthropogenic disturbances in a rapidly changing world.

The BioMap2 components relevant to Hadley are BioMap2 Core Habitats for Species of Conservation Concern, and Natural Communities, Forest, and Aquatic Cores, and, in Critical Natural Landscape (CNL), Landscape Block and Upland Buffers of Aquatic and Wetland Cores.

Wetlands

One of the least common types of natural community in the state and globally is the Black Gum-Pin Oak-Swamp White Oak “Perched” Swamp that forms only on glacial lake sediments and is known from very few places in Massachusetts and Connecticut. Two small patches of this community remain in northeastern Hadley in BioMap2 Cores 1938 and 2943, the larger of which MassGIS shows to be on town land that continues on Amherst Conservation Commission land and includes the whole patch of the community and some additional wetlands and uplands – the sort of protection that we would recommend for maintaining the natural community.

The other uncommon type of natural community documented in Hadley is a Major-River Floodplain Forest on the Connecticut River. Major-River Floodplain Forests are dominated by silver maple along the floodplains of large rivers. The soils are enriched with nutrients brought by annual floods, resulting in a diversity of plants and insects. These are just small remnants of what would have been present in the past, with farmland having taken over large areas of the prime agricultural soils of the Connecticut’s floodplain.

Also in Hadley along the Connecticut River on the shores of a backwater are patches of Low-Energy Riverbank, a relatively common open herbaceous community that occurs on sandy or silty mineral soils of river and stream banks that do not experience severe flooding or ice scour.

Russell Cove has some exemplary examples of Wet Meadow, a relatively common type of natural community. Wet Meadows are graminoid communities similar to deep and shallow emergent marshes except that they are temporarily rather than seasonally flooded. They occur in lake basins, wet depressions, along streams, and in sloughs along rivers.

Forest Lands

The stands of mature trees on the Mount Holyoke Range and Mt. Warner include representatives of the Temperate Deciduous Forest Biome. The climax vegetation for this biome is the Appalachian Oak Forest which supports dominant tree species such as the white oak (*Quercus alba*) and northern red oak (*Quercus rubra*) and shagbark hickory (*Carya ovata*). Other common species include the American beech (*Fagus grandifolia*) and sugar maple (*Acer saccharum*).

Vegetation on the Mount Holyoke Range is predominantly deciduous forest ranging in age from 50-80 years. Cleared earlier in the century, the higher elevations of the forest are now held as

public lands and are not actively managed. The north facing slopes in Hadley remain moist and cool most of the year and support hemlock (*Tsuga canadensis*), white pine (*Pinus strobus*), and many northern hard woods.

Rare and Endangered Plant Species

Of the 44 rare plant species in Hadley only 14 are considered to be current (documented in the past 25 years); of the current plant species, 9 are MESA listed, the others being on the not-regulated Plant Watch List. A complete list of rare species is included in the Appendix.

Many of the rare plants in Hadley grow in floodplains or associated wetlands along the Connecticut River. **Green Dragon** (T)¹, a relative of jack-in-the-pulpit, grows in moist floodplains with open to filtered light, usually along large rivers. **Cat-tail Sedge** (T), a perennial grass-like plant, grows in low areas of floodplain forests. **Hairy Wild Rye** (E) (historic) inhabits high terrace floodplain forests with moist alluvial soils and moist to dry rich, rocky open woods and thickets. **Sandbar Willow** (T), a low-growing, multi-stemmed shrub, is found on islands, sandbars, and beaches in the flood zone of the Connecticut River where it is subjected to annual inundation by the river. **Frank's Lovegrass** (SC), the three species of *Eleocharis* (spike-sedges and spike-rush), **Pygmyweed** (T), and **Mud Arrowhead** (WL) grow on sandy to muddy river shores.

The Holyoke Range is Hadley's other main area of biodiversity after the rivers and their shores. Many species of plant as well as some animals are currently known there, and others have been documented in the past. **Purple Clematis** (SC), a woody vine, occurs in semi-shade on sloping, circumneutral or calcareous, deciduous or mixed woodlands. **Climbing Fumitory** (SC) is an herbaceous vine of shady moist woods climbing over talus at the base of cliffs. Species no longer found in Hadley that would have been in the hills include **Drooping Speargrass** (E) which inhabits dry, rocky fertile soils on slopes and ridge crests on base-rich bedrock, within deciduous forests and woodlands and **Violet Wood-sorrel** (E), a low perennial herb that in Massachusetts inhabits dry or moist rich soils of open deciduous woodlands over circumneutral bedrock.

Some of the rare species in Hadley are those that grow best in the open without shade. **Climbing Fern** (SC) is a perennial, colonial, viney fern of low, moist woods and poorly drained, acidic to circumneutral organic rich soil. It is intolerant of shade, but can persist if forests grow over it. Other species needing open habitat have declined to the point of no longer occurring where their habitats have declined; **New England Blazing Star** (SC) is an endemic, globally rare, perennial composite of dry, sandy grasslands and clearings. In Massachusetts, New England Blazing Star inhabits open, dry, low-nutrient sandy soils of grasslands, heathlands, and barrens. It thrives in fire-influenced natural communities that are periodically disturbed and devoid of dense woody plant cover – habitats that have declined across the state.

Small whorled Pogonia (E, FT) has not been documented in Hadley since 1899. Because of the collectability of this orchid species, NHESP does not normally discuss even what towns it occurs in; however, with such an old record that has been searched for, we not only point out that it has been known from Hadley, but we would be very pleased (the botanists would be thrilled) to receive reports with photographs (no specimens, of course) of any finds in town.

¹ Key to MESA Status: E = Endangered; T = Threatened; SC = Special Concern; FE = Federally Endangered; FT = Federally Threatened; WL = unofficial Plant Watch List, not regulated; Delisted = species no longer protected under MESA

Agricultural Lands

The expansive agricultural fields in town attract ducks and geese in the spring and fall as they make their way through New England. Grassland birds, decreasing regionally, are still able to breed successfully in many hay fields throughout town. Red-tailed hawks, red fox and coyote are always on the lookout for an easy meal of meadow vole or another one of the many small mammals found in the agricultural fields in town.

Given Hadley's agricultural heritage, it is not surprising that most land has been cleared since the 1600s. Today, much of the original farmland (approximately 8,000 acres) is still actively tilled with the exception of areas that have been developed for retail or residential uses. Small abandoned fields throughout town are dominated by early succession species such as staghorn sumac (*Rhus typhina*), gray birch (*Betula populifolia*), and quaking aspen (*Populus tremuloides*).

The low-lying agricultural fields and patches of deciduous forest in Hadley support the largest known concentration of Eastern Spadefoot toads (*Scaphiopus holbrooki*) in the Connecticut River Valley. The toads occur in areas with sandy soils and breed in seasonally flooded pools, including depressions in agricultural fields. This Core Habitat also includes habitat along small streams, including Russellville, Mohawk, and Dry Brooks. The area is criss-crossed with roads and conservation planning efforts are needed here, as these habitats are already partially fragmented and are gradually being lost to residential development (Massachusetts Natural Heritage and Endangered Species Program 2004).

E. Fisheries and Wildlife

Given its location next to the Connecticut River and the Holyoke Range, Hadley serves as a natural corridor for many species of wildlife such as migrating birds and fish as well as wandering large mammals. Situated between more heavily forested areas to the north and south, the expansive open fields and adjacent habitat provide breeding, feeding and nesting sites. The Connecticut River and its tributaries serve as water corridors for some species, and their floodplain and riparian zones serve as upland corridors for others. The Mount Holyoke Range is an extensive area of upland forest situated in an east-west position that serves as habitat and corridor for many species.

Wildlife species common to more heavily forested parts of western Massachusetts can still be found in the forests of the Mount Holyoke Range and Mt. Warner. Birds such as the northern goshawk (*Accipiter gentilis*) and ruffed grouse (*Bonasa umbellus*) as well as the wild turkey (*Meleagris gallopavo*) all thrive in these forests. White-tailed deer (*Odocoileus virginianus*) are also quite common. Thousands of migrating songbirds use the forests each spring and fall to refuel on their long flights. Sightings of black bear (*Ursus americanus*) and moose (*Alces alces*) are also becoming more common in Hadley, as are sightings of the elusive bobcat (*Felis rufus*). Fortunately a majority of the land in these two important areas is permanently protected.

The Fort and Mill River corridors provide ample habitat for a wide variety of birds, mammals, reptiles and amphibians. Commonly found near these water bodies are raccoons (*Procyon lotor*), woodchucks (*Marmota monax*), skunks (*Mephitis mephitis*), coyotes (*Canis latrans*), and occasionally black bears (*Ursus americanus*). Birds of all kinds use these narrow forested areas during the summer for breeding and during migration. Common species include: screech owl (*Otus asio*), pileated woodpecker (*Dryocopus pileatus*), great blue (*Ardea herodias*) and green herons (*Butorides striatus*), as well as barred owls (*Strix varia*). Reptiles and amphibians common to these habitats include: northern water snake (*Nerodia sipedon*), northern redbelly snake (*Storeria occipitomaculata*), common garter snake (*Thamnophis sirtalis*), painted turtle (*Chrysemys picta*), common snapping turtle (*Chelydra serpentina*), American toad (*Bufo americanus*), spring peeper (*Pseudacris crucifer*), gray tree frog (*Hyla versicolor*), green frog (*Rana clamitans*), and bull frog (*Rana catesbeiana*). Some vernal pools found in association with these wetlands support small populations of spotted salamanders (*Ambystoma maculatum*), and wood frogs (*Rana sylvatica*). Common fish inhabiting these waters are bluegills, white suckers, pickerel, and small mouth bass (Ross 1997).

Rare and Endangered Fisheries and Wildlife Species

A large number of rare and uncommon species have been observed in Hadley over the past hundred and fifty years. The 79 state listed, watch list, and delisted species known to have occurred in town reinforces the pattern of biodiversity identifying the Connecticut River Valley as one of the most biologically diverse parts of the state. Less happily, the 40 (25 MESA listed) species known only historically in Hadley (more than 25 years since last observation) often reflect the loss of habitat from degradation or changing land use. Four of the 40 species are no longer known in the state, the rest continue to be found elsewhere in Massachusetts. The rare animal species currently known from Hadley are a mix of species dependent on aquatic habitats, wetlands, a mix of wetlands and uplands, and a few others that use upland habitats.

The Connecticut River, its tributaries, and surroundings provide habitat not widespread in Massachusetts. These areas are included in the very large (because of connecting habitats)

BioMap2 Core Habitat 2943. In the aquatic habitats of the rivers, are the fish, freshwater mussels, and the nymphs of dragonflies – along with many other species, of course.

In Massachusetts **Shortnose Sturgeons** (E, FE) are river fish that spawn in fast-flowing, rocky areas of rivers and move to deeper, slower waters during the winter. These federally endangered fish do not mature until they are 5 to 10 years old and can live into their 20s - or longer. In the Connecticut River, they are blocked from migrating to estuaries, but move around between the dams. **Eastern Silvery Minnow** (SC), a small fish of shallow backwaters and oxbows of large rivers, is in the Connecticut River in Hadley, but in very different aquatic habitats from those needed by the Shortnose Sturgeons. **Longnose Sucker** (SC) previously known in the Connecticut River in Hadley, is a torpedo-shaped fish is found mainly in cool upper sections of streams and rivers with rocky to gravel substrates. These fish may swim miles to deposit their eggs on clean and well oxygenated gravel substrates. The Fort River supports **Burbot** (SC), a species of freshwater cod with an elongate body that grows to about a foot and a half long that are generally found in deep lakes and cool streams that have shelter such as rock slabs and trees in which they can hide in areas with dense aquatic plants. Burbot have spawning migrations that average about 20 km upstream, up tributaries, or from deep areas to inshore areas. **Bridle Shiners** (SC) are small (<5 cm) minnows that are found in schools swimming in and out of vegetation along the edges of open, clear water in lakes and ponds and slack areas of streams and rivers. They feed on small insects and other aquatic animals.

Also found in the Connecticut and Fort Rivers in the very large, connected, BioMap2 Core 2943, are freshwater mussels. Hadley is a hotbed of diversity of freshwater mussels, including three state-listed species and another that was recently removed from the list and continues to be of conservation interest. Hadley also has an historic occurrence of the small (<2" long) **Dwarf Wedgemussel** (E, FE) that inhabits very shallow water along stream banks of a variety of sized rivers and streams. All freshwater mussels are sedentary filter feeders that spend most of their lives partially burrowed into the bottoms of rivers and streams; they can move in the substrate as water levels fluctuate. However, as sedentary filter feeders they are vulnerable to alterations of their water bodies with stability of flow and substrate critical for these species. **Yellow Lampmussels** (E), usually less than 5 1/4 in. long, have been found to be more abundant in shallow sandbars than in nearby areas that were deeper and had a rocky or muddy substrate. **Eastern Pondmussels** (SC), large freshwater mussels inhabit streams, rivers, and small to large lakes and ponds. **Creepers** (SC) inhabit low-gradient reaches of small to large rivers with sand or gravel substrates: cool to warm-water with diverse fish assemblages best support Creepers. **Triangle Floaters** (delisted) are commonly found in low-gradient river reaches with sand and gravel substrates and low to moderate water velocities, although they are found in a wide range of substrate and flow conditions.

Five listed and one recently delisted species of **dragonflies** are known in Hadley, also primarily found along the Connecticut and Fort Rivers in BioMap2 Core 2943. Although each has its own distinct habitat, the nymphs (young) of all are aquatic and burrow in the bottom sediments of the wetland types they prefer. Maintaining clean, free flowing water is important for maintaining the species. Young adults of all of the species make use of surrounding upland forests for protection while they reach sexual maturity, one of the many reasons for maintaining a forested buffer around streams and rivers.

Orange Sallow Moths (SC) inhabit dry, open oak woodlands on rocky uplands. Their eggs are laid on false foxgloves (*Aureolaria* spp.) where the larvae feed on flowers, seeds, and foliage. In Hadley they occur in the Holyoke Range section of BioMap2 Core 2943.

The state-listed rare bird species known in Hadley include **Bald Eagles** (T) which require large trees in floodplains to hold their nests along the Connecticut River. Hadley's **Peregrine Falcons** (E) are also associated with the Connecticut River, but in this case because a nesting platform was built on the Coolidge Bridge – and they found and use the facility there.

The other rare birds known from Hadley are associated with grasslands, with each species using somewhat different aspects of grassland habitat. **Vesper Sparrows** (T) are species of upland grasslands, such as old fields and pastures. Although considered secure globally, they have declined significantly in eastern North America due to changes in land use. **Grasshopper Sparrows** (T) nest in dry grasslands. Natural situations include sandplain grasslands, but they have adapted well to anthropogenic habitats such as airports and landfills. They are very sensitive to changes in plant composition and respond well to the effects of fire management. In Massachusetts **Upland Sandpipers** (E) inhabit open expanses of grassy fields, hay fields, and mown grassy strips adjacent to runways and taxiways of airports and military bases. **Barn Owls** (SC) require grassy habitats for foraging, such as marshes and agricultural fields. They rarely occur apart from populations of meadow voles, a primary food source, and avoid areas of deep snow and prolonged cold, which can preclude successful foraging. The Barn Owl is resourceful in making use of such nesting sites as hollow trees, cavities in cliffs or riverbanks, and artificial structures such as nest boxes, old barns, and bridges. **Sedge Wrens** (E) nest in large wet meadows. They are sensitive to changes in hydrology and seral succession.

Wood Turtles (SC) are known from several areas in Hadley, particularly along the Fort River where they co-occur with many state-rare freshwater mussels and dragonflies in BioMap2 Core 2943. Wood Turtle habitat is streams and rivers preferably with long corridors of undeveloped, connected uplands extending on both sides of the waterways. Wood Turtles nest in sandy upland areas and are susceptible to becoming road kill when they move among parts of their habitats if there are there. Loss of only a few adults annually can cause populations to decline because of their having low replacement rates due to low nest and juvenile survivorship. **Eastern Box Turtles** (SC) are more terrestrial than Wood Turtles, inhabiting many dry and moist woodland habitats. Strong populations of **Spotted Turtles** (Delisted) in good habitat - large, unfragmented, protected open space - continue to be of interest to conservation. This small, dark-colored turtle with yellow spots on its carapace inhabits wetlands year-round and nests in nearby uplands during spring.

Eastern Spadefoot (T) is a short-legged, squat, big-headed toad with unmistakable cat-like, vertically elliptical pupils. This burrowing amphibian requires dry, sand or sandy loam soils interspersed with temporary ponds. It prefers areas with leaf litter, and may be found in farmland areas. In the warmer months, from April to September, the Spadefoot comes up from its burrows to breed in vernal pools after prolonged warm and heavy rains.

Vernal Pool Habitat

Vernal pools are increasingly rare wetlands that provide critical breeding sites for several species of amphibians. Because of their temporary nature, vernal pools are often overlooked when a site is considered for development. They are not protected under the Wetlands Protection Act unless: 1) they are located within the 100 year flood plain or in some cases "isolated land subject to flooding" and 2) their existence and location has been certified by the Massachusetts Division of Fisheries and Wildlife. There are presently two certified vernal pools and 57 potential vernal pools in Hadley, as determined by the NHESP. The small number of certified pools is due in part to lack of conservation staff time and funding, and partly to the concern about access to private lands for verification and certification.

F. Scenic Resources and Unique Environments

Hadley is a scenic gem of the Connecticut River Valley. In a region where farmland is being lost at an alarming rate, Hadley's working landscapes are truly a resource for the entire area. The Connecticut River is also designated as one of only fourteen American Heritage Rivers, and the one and only American Heritage River. Hadley's extensive frontage on the river contains dramatic views and priceless ecosystems.

Approximately 75 percent of Hadley is classified as either Noteworthy or Distinctive in the Massachusetts Scenic Landscape Inventory (MA DCR, 1982). The Holyoke Range, Hadley's most prominent geologic feature rising over 900 feet above the flood plain, is considered Distinctive along with the acres of open farmland stretching north from the foot of the range. The mountain peaks provide a striking contrast with the valley floor below, and the range runs in east-west direction unusual in New England. Consequently its vegetation encompasses both northern and southern forest. The expansive fields lining the Connecticut River in North Hadley are also identified as Distinctive. Agricultural fields along the winding Connecticut River inspired several of the great 19th century landscape paintings by such artists as Thomas Cole and William Henry Bartlett. In addition, Route 47, which follows the Connecticut River for several miles, is labeled Noteworthy, and has been designated a National Scenic Byway from South Hadley into Vermont.

The Holyoke Range offers a network of hiking trails, and from the historic Summit House of Skinner State Park, a breathtaking view up the Connecticut Valley. Categorized as Distinctive in the state's scenic inventory, this trap rock ridge is one of the town's most important natural resources. The Department of Conservation and Recreation has already acquired a sizable block of land along the range, underlining its statewide significance.

Great Meadow Project

The Great Meadow of Hadley is an agricultural area that stands out, not only for its extremely productive agricultural soils and its sweeping views of the Mount Holyoke and Mount Tom Ranges and the Berkshires, but also for its historic roots dating back to this country's earliest colonial settlements. Located along the banks of the Connecticut River in Hadley, the "Great Meadow" was the town's first agricultural field, allotted to residents of West Street in 1661. In the 1990s the Great Meadow was included on the National Register of Historic Places as part of the historic town center of Hadley. More recently, Preservation Mass, a statewide historic preservation organization, named the Great Meadow as one of the "10 Most Endangered Historic Resources" of 2004.

The Great Meadow lies adjacent to the Hadley Common, a spacious green on West Street surrounded with historic houses, and the burying ground, also laid out in 1661. This type of village with clustered house lots and outlying fields was typical of Seventeenth Century New England. This arrangement was also not only a familiar pattern brought from England, but one that served the settler's defensive needs and helped build the tightly knit communities they valued. The Great Meadow also appears to be the best surviving example of a rare seventeenth century "open field," a pattern of slender, unfenced, elongated parcels that was once common in medieval Europe. Open fields, lying just outside village centers, typically consisted of long, parallel, strip parcels tilled by village residents. The elongated lots were designed to be efficiently plowed with oxen and heavy plows with moldboards that were difficult to turn at the ends of rows. Such fields were also considered "common fields" because they were enclosed by a cooperatively maintained fence and the town's grazing animals were loosed in the field after

harvest in the fall. Hadley's Great Meadow is remarkable because the original pattern of slender lots is still visible in stripes of different plantings and the lots remain in the possession of many owners. Even across the Atlantic, this field archetype, dating back to medieval times, is exceedingly rare in Britain today. That such a field should still exist in the "New World" is a notable example of cultural endurance.

Today the future of the 350-acre Great Meadow is in jeopardy. For the first time in almost 350 years, much of this land is in danger of being valued more for its development potential than for farming. A floodplain zoning district barring new residential development temporarily protects part of the Great Meadow. However, the entire 165-acre area east of the dike is zoned residential and commercial, providing no long-term protection for agricultural use. If any one parcel is developed in this area, all the other parcels will be impacted, greatly harming the meadow's agricultural, scenic, wildlife, and historic values.

To secure a sustainable future for this historic farmland, in 2004 a cooperative initiative was launched with a local land trust, the Kestrel Land Trust, taking the lead. The goal is for the town, landowners, state agencies, and land trusts to work together to conserve the Great Meadow for farming with a series of agricultural preservation restrictions (APR). Reflecting historic land use patterns, there are about 40 different long and narrow parcels in the Great Meadow, which are owned by separate individuals or families. Most of the strips are only 3 or 4 acres in size—some are smaller. Protecting 40 of such strips one at a time is challenging work for all the parties. This collaborative approach to land conservation continues today.

Three historic districts on the state registry exemplify and preserve the town's rural flavor. They are the North Hadley, Hadley Center, and Hockanum Rural Historic Districts. Particular points of historic interest within the town include the Porter-Phelps Museum, the Farm Museum and the Summit House in Skinner State Park.

G. Environmental Challenges

Development pressure represents a significant environmental problem. Hadley is situated between the two larger communities of Amherst and Northampton and has been experiencing significant residential and commercial growth. Development has consumed acres of productive farmland; compromised wetlands, watercourses, and wildlife habitat; and threatened the rural town character of Hadley. Although agricultural uses are traditionally assumed to be large contributors to non-point source pollution, this seems to be less the case in Hadley. Local farmers have adopted model farming techniques that use fewer pesticides and thus decrease the impact of agricultural pollution on the water supply. Development along Route 9, where the soils are incapable of absorbing the increased stormwater runoff, significantly degrades the water quality of the local water resources. Paved and otherwise impervious surfaces are important sources of non-point source pollution, especially to the Mill and Fort Rivers and their tributaries.

Hadley is also faced with chronic flooding. As a sign along Route 47 testifies, water can inundate key roadways and the homes of many residents. Following the 1936 flood, the earthen dike was substantially improved to protect town center. While the dike protects much of town center, land in the Honey Pot and Aqua Vitae Road areas and along the Connecticut's tributaries is still threatened by high water. The Conservation Commission attempts to lessen the impact on dwellings by encouraging homeowners to elevate existing homes above the one hundred-year flood level. Projects that are permitted must provide compensatory storage for floodwaters and be constructed in accordance with FEMA standards for elevations and utilities. More

importantly, the town has zoned some of the most flood-prone land for agriculture use only; no new non-agricultural building is allowed. The Commission has identified land within the floodplain overlay district as a critical resource area and will attempt to acquire partial interests on portions of land in this area to protect critical floodwater staging areas from development.

Many of the existing natural resources in Hadley are challenged or under threat from various sources. For example, the sixty-five acre Lake Warner is a significant habitat, however, it is gradually being taken over by nonnative species and eutrophication as a result of increasing water temperatures and pollution. In addition, the large privately owned swamp running from behind the Stop and Shop on Route 9 to Rocky Hill Road is contaminated from storm water runoff from Route 9 and other paved surfaces. A strategy for prioritizing and protecting these remaining resources is highly supported by the citizens of Hadley. However, the town has not the resources or ability to protect every acre of undeveloped land. A comprehensive prioritization of existing open space, based on sound ecological principles, agricultural sustainability, and the values and priorities of the people should be a key strategy as the town moves forward with protecting these remaining resources.

Mt. Warner Well Contamination and Callahan Wells Treatment Plant

The Mt. Warner wells are contaminated by perchlorate, nitrates, and DCPA (Dimono-acid degredate). The Environmental Protection Agency has set a permissible level of nitrates and has listed DCPA as a candidate for regulation; and the state has established a 2 ppb limit for perchlorate. The town has closed well #2 at Mt. Warner and is currently using the water well #1 (top capacity 800,000 gpd) augmented by water from the Callahan wells low levels for summer use. The town also is trying to determine the source of the pollutants. The technology needed to treat the Callahan wells is proven and readily available. The town has no intention to abandon or ignore the Mt. Warner wells. The Mt. Warner wells will require treatment by more complex, newer methods, and it makes sense to wait until standards are set.

The Callahan wells have excessive amounts of manganese. This metal is not considered a “regulated contaminant” but does cause problems with drinking water. Manganese builds up in pipelines, pressure tanks, water heaters and water softeners and the damage results in economic costs to homeowners and businesses alike. Manganese can permanently stain clothes when you wash them and affect the flavor and taste of food and water.

The Callahan wells have been treated using a chemical called Aqua-Mag, which does not take the manganese out of the water but keeps it “in solution.” However, the best way to fix the problem is to use “ultrafiltration membrane technology” which eliminates the manganese. The filter membranes also screen out viruses and bacteria without the use of chlorine, so the technology offers additional protection. A new water treatment plant came online in 2007. The Water Division of the Hadley DPW is developing an update to the 2004 master plan, evaluating future capital costs and needs.

Existing Protection for Water Resources

Several federal, state and local environmental regulations protect freshwater resources against filling, inappropriate development, and other forms of alteration. The state Wetlands Protection Act (General Laws Ch. 131, s. 40) is administered by the town Conservation Commission to prevent the alteration of wetlands and riverbanks and to assure treatment of storm water before it flows into wetlands and streams. The town adopted a local Wetlands Bylaw in 2010 to regulate disturbance within 35 feet of a wetland or stream.

Hadley's Aquifer Protection District is divided into two zones: Zone I and Zone II. Zone I is the protective 400-foot radius around public groundwater wells, and by state law, must remain in public control and undeveloped. Zone II is the primary groundwater recharge area for the public wells, and includes areas that contribute water to the public wells under the most severe pumping conditions. The average permitted usage was exceeded in 2001 in the North Hadley Mt. Warner wells; however, water use has since been reduced. The town currently enforces a water restriction policy in the summer months where residents alternate watering on odd and even days. Furthermore, the town has adjusted water rates to promote water conservation.

Elevated E. coli Bacteria Levels in Mill and Fort Rivers

The Pioneer Valley Planning Commission (PVPC), in partnership with the Connecticut River Watershed Council (CRWC) and the UMASS Water Resources Research Center (WRRC), conducted monitoring for E. coli bacteria in the main stem of the Connecticut River and fourteen tributaries to the river between June and October 2010, and April to June 2011. The Mill and Fort Rivers in Hadley were included in the study and found to have elevated levels of E. coli bacteria during dry weather sampling.

The Mill River in Hadley was evaluated to assess potential sources of sediment and nutrient loading to Lake Warner. The lower Mill River in Hadley at Mill Site Road and North Hadley Road had three dry weather exceedances. Meadow Street, draining a tributary coming from the northwest corner of Hadley and Sunderland) also had elevated level. The study concluded that due to multiple potential sources of bacteria within this watershed including agriculture, the UMASS campus, and the Amherst Waste Water Treatment Plant, further source tracking activity is needed to identify a potential source. Data collected from this study is included in the Appendices.

The Fort River in Hadley was included in the study because of high E. coli counts collected by MA DEP at Route 47 above the Callahan Well Water Treatment Facility in September, 2009. High E. coli levels were found in the Fort River, and very high levels in the tributary to Hart's Brook along Bay Road in Hadley on October 12th and 26th, 2010. Harts Brook has several tributaries that collect water from the Bay Road area and Chmura Road and the Holyoke Range. Additional sampling was performed to better determine the source identified a potential source located along Bay Road, east of the Hartsbrook School entrance and west of the Hampshire College Physical Plant. Field observations noted cows and well-grazed pasture abutting Harts Brook. In addition, homes along this road are not serviced by a public sewer and are on private septic systems. Outreach to property owners in this area is recommended regarding septic system condition and farm management practices for water quality protection.