FOREST STEWARDSHIP-GREEN CERTIFICATION MANAGEMENT PLAN FOR THE PROPERTY OF CITY OF HOLYOKE WATER WORKS
THE WHITING STREET RESERVOIR LANDS
Located on Westfield Road, Holyoke, Massachusetts
TOTAL FORESTED AREA 261.1 ACRES

Presented by Holyoke Water Works: Our Mission: "Providing High Quality Water to our Customers at Competitive Rates"
Manager David Conti, 20 Commercial Street, Holyoke, Massachusetts

Prepared By: Wigmore Forest Resource Management, Mary K. Wigmore (MLF 250), John W. LeBlanc (CA RPF 2324), and Technicians: Kurt P. Wigmore and Jackie Kulig
1637 West Road
Williamsburg, MA 010196
January 2016

FOREST MANAGEMENT PLAN

Submitted to: Massachusetts Department of Conservation and Recreation
For enrollment in CH61/61A/61B and/or Forest Stewardship Program

CHECK-OFFS					Administrative Box			
CH61	CH61A	CH61B	STWSHP	C-S	Case No.		Orig. Case No.	
cert. ☐	cert. ☐	cert. ☐	new ☒	EEA ☒	Owner ID		Add. Case No.	
recert. ☐	recert. ☐	recert. ☐	renew ☐	Other ☐	Date Rec'd		Ecoregion	
amend ☐	amend ☐	amend ☐	Green Cert ☒		Plan Period		Topo Name	
			Conservation Rest. ☐		Rare Spp. Hab.		River Basin	
Plan Change: ____ to ____			CR Holder ____					

OWNER, PROPERTY, and PREPARER INFORMATION

Property Owner(s): **City of Holyoke –Holyoke Water Works**
Mailing Address: **20 Commercial Street, Holyoke, MA 01040** Phone: **413.536.0442**
Email Address:

Property Location: Town(s) **Holyoke** Road(s) **Highway #202-Westfield Road**

Plan Preparer: **Mary K. Wigmore** Mass. Forester License #: **250**
Mailing Address: **1637 West Road – Williamsburg, MA 01096** Phone: **413.628.4594**

RECORDS

Assessor's Map No.	Lot/Parcel No.	Deed Book	Deed Page	Total Acres	Ch61/61A 61B *Excluded* Acres	Ch61/61A 61B **Certified** Acres	Stewshp *Excluded* Acres	Stewshp Acres
213	**006**	**xx**	**xx**	**371.8**			**118.8**	**253.0**
139	**001A**	**1703**	**321**	**5.5**			**0**	**5.5**
213	**008**	**xx**	**xx**	**2.6**			**0**	**2.6**
			TOTALS:	**379.9**			**118.8**	**261.1**

Excluded Area Description(s) **(if additional space needed, continue on separate paper)**
Map 213-Lot 006: 116.8 acres is excluded for the reservoir. An additional 2 acre is excluded which includes the earthen dam and access routes to the dam for maintenance and a small opening near the aerator house.

HISTORY

Year acquired 1800's Year management began 1970

Are boundaries marked: Yes ☐ blazed/painted/flagged/signs posted (circle all that apply)? No ☐ Partially ☒

What treatments have been prescribed, but not carried out (last 10 years if plan is a recert.)?

stand no. _____ treatment _____ reason _____
(if additional space needed, continue on separate page)

Previous Management Practices (last 10 years)

Stand #	Cutting Plan #	Treatment	Yield	Acres	Date

Remarks: (if additional space needed, continue on separate page)
Archive at City Hall missing.

Landowner Goals

Please **check** the column that best reflects the importance of the following goals:

Goal	Importance to Me			
	High	**Medium**	**Low**	**Don't Know**
Enhance the Quality/Quantity of Timber Products*	**X**			
Generate Immediate Income		X		
Generate Long Term Income	**X**			
Produce Firewood			**X**	
Defer or Defray Taxes				
Promote Biological Diversity	**X**			
Enhance Habitat for Birds	**X**			
Enhance Habitat for Small Animals	**X**			
Enhance Habitat for Large Animals	**X**			
Improve Access for Walking/Skiing/Recreation			**X**	
Maintain or Enhance Privacy	**X**			
Improve Hunting or Fishing			**X**	
Preserve or Improve Scenic Beauty	**X**			
Protect Water Quality	**X**			
Protect Unique/Special/ Cultural Areas	**X**			
Attain Green Certification Other:	**X**			

*This goal must be checked "HIGH" if you are interested in classifying your land under Chapter 61/61A.

In your own words, describe your goals for the property:

Stewardship Purpose

By enrolling in the Forest Stewardship Program and following a Stewardship Plan, I understand that I will be joining with many other landowners across the state in a program that promotes ecologically responsible resource management through the following actions and values:

1. Managing sustainably for long-term forest health, productivity, diversity, and quality.
2. Conserving or enhancing water quality, wetlands, soil productivity, carbon sequestration, biodiversity, cultural, historical and aesthetic resources.
3. Following a strategy guided by well-founded silvicultural principles to improve timber quality and quantity when wood products are a goal.
4. Setting high standards for foresters, loggers and other operators as practices are implemented; and minimizing negative impacts.
5. Learning how woodlands benefit and affect surrounding communities, and cooperation with neighboring owners to accomplish mutual goals when practical.

Signature(s): _____ Date: _____

Owner(s) (print) **City of Holyoke -Holyoke Water Works-Whiting Street Reservoir**_____ **Page __2____ of _____**

Stewardship Issues

Massachusetts is a small state, but it contains a tremendous variety of ecosystems, plant and animal species, management challenges, and opportunities. This section of your plan will provide background information about the Massachusetts forest landscape as well as issues that might affect your land. **The Stand Descriptions and Management Practices sections of your plan will give more detailed property specific information** on these subjects tailored to your management goals.

Biodiversity: Biological diversity is, in part, a measure of the variety of plants and animals, the communities they form, and the ecological processes (such as water and nutrient cycling) that sustain them. With the recognition that each species has value, individually and as part of its natural community, maintaining biodiversity has become an important resource management goal.

While the biggest threat to biodiversity in Massachusetts is the loss of habitat to development, another threat is the introduction and spread of invasive non-native plants. Non-native invasives like European Buckthorn, Asiatic Bittersweet, and Japanese Honeysuckle spread quickly, crowding out or smothering native species and upsetting and dramatically altering ecosystem structure and function. Once established, invasives are difficult to control and even harder to eradicate. Therefore, vigilance and early intervention are paramount.

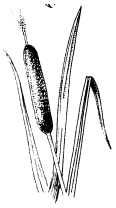
Another factor influencing biodiversity in Massachusetts concerns the amount and distribution of forest growth stages. Wildlife biologists have recommended that, for optimal wildlife habitat on a landscape scale, 5-15% of the forest should be in the seedling stage (less than 1" in diameter). Yet we currently have no more than 2-3% early successional stage seedling forest across the state. There is also a shortage of forest with large diameter trees (greater than 20"). See more about how you can manage your land with biodiversity in mind in the "Wildlife" section below. (Also refer to *Managing Forests to Enhance Wildlife Diversity in Massachusetts* and *A Guide to Invasive Plants in Massachusetts* in the binder pockets.)

Rare Species: Rare species include those that are **threatened** (abundant in parts of its range but declining in total numbers), those of **special concern** (any species that has suffered a decline that could threaten the species if left unchecked), and **endangered** (at immediate risk of extinction and probably cannot survive without direct human intervention). Some species are threatened or endangered globally, while others are common globally but rare in Massachusetts.

Of the 2,040 plant and animal species (not including insects) in Massachusetts, 424 are considered rare. About 100 of these rare species are known to occur in woodlands. Most of these are found in wooded wetlands, especially vernal pools. These temporary shallow pools dry up by late summer, but provide crucial breeding habitat for rare salamanders and a host of other unusual forest dwelling invertebrates. Although many species in Massachusetts are adapted to and thrive in recently disturbed forests, rare species are often very sensitive to any changes in their habitat.

Indispensable to rare species protection is a set of maps maintained by the Division of Fisheries

and Wildlife's Natural Heritage & Endangered Species Program (NHESP) that shows current and historic locations of rare species and their habitats. The maps of your property will be compared to these rare species maps and the result indicated on the upper right corner of the front page of the plan. Prior to any regulated timber harvest, if an occurrence does show on the map, the NHESP will recommend protective measures. Possible measures include restricting logging operations to frozen periods of the year, or keeping logging equipment out of sensitive areas. You might also use information from NHESP to consider implementing management activities to improve the habitat for these special species.



Riparian and Wetlands Areas: Riparian and wetland areas are transition areas between open water features (lakes, ponds, streams, and rivers) and the drier terrestrial ecosystems. More specifically, a **wetland** is an area that has hydric (wet) soils and a unique community of plants that are adapted to live in these wet soils. Wetlands may be adjacent to streams or ponds, or a wetland may be found isolated in an otherwise drier landscape. A **riparian area** is the transition zone between an open water feature and the uplands (see Figure 1). A riparian zone may contain wetlands, but also includes areas

with somewhat better drained soils. It is easiest to think of riparian areas as the places where land and water meet.

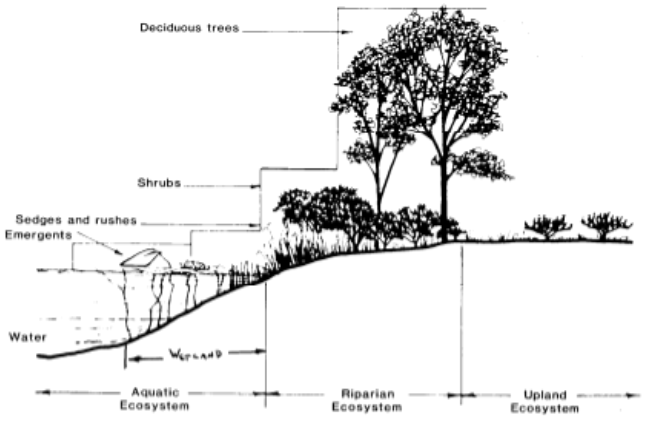


Figure 1: Example of a riparian zone.

The presence of water in riparian and wetland areas make these special places very important. Some of the functions and values that these areas provide are described below:

Filtration: Riparian zones capture and filter out sediment, chemicals and debris before they reach streams, rivers, lakes and drinking water supplies. This helps to keep our drinking water clean, and saves communities money by making the need for costly filtration much less likely.

Flood control: By storing water after rainstorms, these areas reduce downstream flooding. Like a sponge, wetland and riparian areas absorb storm water, then release it slowly over

time instead of in one flush.

Critical wildlife habitat: Many birds and mammals need riparian and wetland areas for all or part of their life cycles. These areas provide food and water, cover, and travel corridors. They are often the most important habitat feature in Massachusetts' forests.

Recreational opportunities: Our lakes, rivers, streams, and ponds are often focal points for recreation. We enjoy them when we boat, fish, swim, or just sit and enjoy the view.

In order to protect wetlands and riparian areas and to prevent soil erosion during timber harvesting activities, Massachusetts promotes the use of "Best Management Practices", or BMPs. Maintaining or reestablishing the protective vegetative layer and protecting critical areas are the two rules that underlie these common sense measures. DCR's Massachusetts Forestry Best Practices Manual (included with this plan) details both the legally required and voluntary specifications for log landings, skid trails, water bars, buffer strips, filter strips, harvest timing, and much more.

The two Massachusetts laws that regulate timber harvesting in and around wetlands and riparian areas are the Massachusetts Wetlands Protection Act (CH131), and the Forest Cutting Practices Act (CH132). Among other things, CH132 requires the filing of a cutting plan and on-site inspection of a harvest operation by a DCR Service Forester to ensure that required BMPs are being followed when a commercial harvest exceeds 25,000 board feet or 50 cords (or combination thereof).

Soil and Water Quality: Forests provide a very effective natural buffer that holds soil in place and protects the purity of our water. The trees, understory vegetation, and the organic material on the forest floor reduce the impact of falling rain, and help to ensure that soil will not be carried into our streams and waterways.

To maintain a supply of clean water, forests must be kept as healthy as possible. Forests with a diverse mixture of vigorous trees of different ages and species can better cope with periodic and unpredictable stress such as insect attacks or windstorms.

Timber harvesting must be conducted with the utmost care to ensure that erosion is minimized and that sediment does not enter streams or wetlands. Sediment causes turbidity which degrades water quality and can harm fish and other aquatic life. As long as Best Management Practices (BMPs) are implemented correctly, it is possible to undertake active forest management without harming water quality.

Forest Health: Like individual organisms, forests vary in their overall health. The health of a forest is affected by many factors, including weather, soil, insects, diseases, air quality, and human activity. Forest owners do not usually focus on the health of a single tree, but are concerned about catastrophic events such as insect or disease outbreaks that affect so many individual trees that the whole forest community is impacted.

Like our own health, it is easier to prevent forest health problems than to cure them. This preventative approach usually involves two steps. First, it is desirable to maintain or encourage a wide diversity of tree species and age classes within the forest. This diversity makes a forest less susceptible to a single devastating health threat. Second, by thinning out weaker and less desirable trees, well-spaced healthy individual trees are assured enough water

and light to thrive. These two steps will result in a forest of vigorously growing trees that is more resistant to environmental stress.

Fire: Most forests in Massachusetts are relatively resistant to catastrophic fire. Historically, Native Americans commonly burned certain forests to improve hunting grounds. In modern times, fires most often result from careless human actions.

The risk of an unintentional and damaging fire in your woods could increase as a result of logging activity if the slash (tree tops, branches, and debris) is not treated correctly.

Adherence to the Massachusetts slash law minimizes this risk. Under the law, slash is to be removed from buffer areas near roads, boundaries, and critical areas and lopped close to the ground to speed decay. Well-maintained woods roads are always desirable to provide access should a fire occur.

Depending on the type of fire and the goals of the landowner, fire can also be considered as a management tool to favor certain species of plants and animals. Today the use of prescribed burning is largely restricted to the coast and islands, where it is used to maintain unique natural communities such as sandplain grasslands and pitch pine/scrub oak barrens. However, state land managers are also attempting to bring fire back to many of the fire-adapted communities found elsewhere around the state.

Wildlife Management: Enhancing the wildlife potential of a forested property is a common and important goal for many woodland owners. Sometimes actions can be taken to benefit a particular species of interest (e.g., put up Wood Duck nest boxes). In most cases, recommended management practices can benefit many species, and fall into one of three broad strategies.

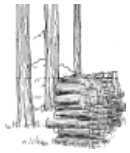
These are **managing for diversity, protecting existing habitat, and enhancing existing habitat**.

Managing for Diversity – Many species of wildlife need a variety of plant communities to meet their lifecycle requirements. In general, a property that contains a diversity of habitats will support a more varied wildlife population. A thick area of brush and young trees might provide food and cover for grouse and cedar waxwing; a mature stand of oaks provides acorns for foraging deer and turkey; while an open field provides the right food and cover for cottontail rabbits and red fox. It is often possible to create these different habitats on your property through active management. The appropriate mix of habitat types will primarily depend on the composition of the surrounding landscape and your objectives. It may be a good idea to create a brushy area where early successional habitats are rare, but the same practice may be inappropriate in the area's last block of mature forest.

Protecting Existing Habitat – This strategy is commonly associated with managing for rare species or those species that require unique habitat features. These habitat features include vernal pools, springs and seeps, forested wetlands, rock outcrops, snags, den trees, and large blocks of unbroken forest. Some of these features are rare, and they provide the right mix of food, water, and shelter for a particular species or specialized community of wildlife. It is important to recognize their value and protect their function. This usually means not altering the feature and buffering the resource area from potential impacts.

Enhancing Existing Habitat – This strategy falls somewhere between the previous two. One way the wildlife value of a forest can be enhanced is by modifying its structure (number of canopy layers, average tree size, density). Thinning out undesirable trees from around large crowned mast (nut and fruit) trees will allow these trees to grow faster and produce more food. The faster growth will also accelerate the development of a more mature forest structure, which is important for some species. Creating small gaps or forest openings generates groups of seedlings and saplings that provide an additional layer of cover, food, and perch sites.

Each of these three strategies can be applied on a single property. For example, a landowner might want to increase the habitat diversity by reclaiming an old abandoned field. Elsewhere on the property, a stand of young hardwoods might be thinned to reduce competition, while a "no cut" buffer is set up around a vernal pool or other habitat feature. The overview, stand description and management practice sections of this plan will help you understand your woodland within the context of the surrounding landscape and the potential to diversify, protect or enhance wildlife habitat.



Wood Products: If managed wisely, forests can produce a periodic flow of wood products on a sustained basis. Stewardship encompasses finding ways to meet your current needs while protecting the forest's ecological integrity. In this way, you can harvest timber and generate income without compromising the opportunities of future generations.

Massachusetts forests grow many highly valued species (white pine, red oak, sugar maple, white ash, and black cherry) whose lumber is sold throughout the world. Other lower valued species (hemlock, birch, beech, red maple) are marketed locally or regionally, and become products like pallets, pulpwood, firewood, and lumber. These products and their associated value-added industries contribute between 200 and 300 million dollars annually to the Massachusetts economy.

By growing and selling wood products in a responsible way you are helping to our society's demand for these goods. Harvesting from sustainably managed woodlands – rather than from unmanaged or poorly managed forest benefits the public in a multitude of ways. The sale of timber, pulpwood, and firewood also provides periodic income that you can reinvest in the property, increasing its value and helping you meet your long-term goals. Producing wood products helps defray the costs of owning woodland, and helps private landowners keep their forestland undeveloped.

Cultural Resources: Cultural resources are the places containing evidence of people who once lived in the area. Whether a Native American village from 1,700 years ago, or the remains of a farmstead from the 1800's, these features all tell important and interesting stories about the landscape, and should be protected from damage or loss.

Massachusetts has a long and diverse history of human habitation and use. Native American tribes first took advantage of the natural bounty of this area over 10,000 years ago. Many of these villages were located along the coasts and rivers of the state. The interior woodlands were also used for hunting, traveling, and temporary camps. Signs of these activities are difficult to find in today's forests. They were obscured by the dramatic landscape impacts brought by

European settlers as they swept over the area in the 17th and 18th centuries.

By the middle 1800's, more than 70% of the forests of Massachusetts had been cleared for crops and pastureland. Houses, barns, wells, fences, mills, and roads were all constructed as woodlands were converted for agricultural production. But when the Erie Canal connected the Midwest with the eastern cities, New England farms were abandoned for the more productive land in the Ohio River valley, and the landscape began to revert to forest. Many of the abandoned buildings were disassembled and moved, but the supporting stonework and other changes to the landscape can be easily seen today.

One particularly ubiquitous legacy of this period is stone walls. Most were constructed between 1810 and 1840 as stone fences (wooden fence rails had become scarce) to enclose sheep within pastures, or to exclude them from croplands and hayfields. Clues to their purpose are found in their construction. Walls that surrounded pasture areas were comprised mostly of large stones, while walls abutting former cropland accumulated many small stones as farmers cleared rocks turned up by their plows. Other cultural features to look for include cellar holes, wells, old roads and even old trash dumps.

History of Natural Disturbance:

As noted above, the mid 19th century was the height of forestland clearing for agriculture and pasturing. The availability of richer, more productive farmland in the Midwest resulted in farm abandonment and subsequent regrowth of white pine, chestnut, and mixed hardwoods including red oak. In the early 20th century these stands, particularly white pine, were cut to supply the wood container industry. Farm activity on the newly cleared land was truncated by World Wars I and II and brought about another wave of farm abandonment and regrowth. Natural disturbances since 1900 include the Chestnut blight of 1900-1908, the hurricane of 1938, the Gypsy Moth outbreak of 1980-1982, wind events, and ice damage, most notably in December 2008.

Recreation and Aesthetic Considerations: Recreational opportunities and aesthetic quality are the most important values for many forest landowners, and represent valid goals in and of themselves. Removing interfering vegetation can open a vista or highlight a beautiful tree, for example. When a landowner's goals include timber, thoughtful forest management can be used to accomplish silvicultural objectives while also reaching recreational and/or aesthetic objectives. For example, logging trails might be designed to provide a network of cross-country ski trails that lead through a variety of habitats and reveal points of interest.

If aesthetics is a concern and you are planning a timber harvest, obtain a copy of this excellent booklet: *A Guide to Logging Aesthetics: Practical Tips for Loggers, Foresters & Landowners*, by Geoffrey T. Jones, 1993. (Available from the Northeast Regional Agricultural Engineering Service, (607) 255-7654, for $7). Work closely with your consultant to make sure the aesthetic standards you want are included in the contract and that the logger selected to do the job executes it properly. The time you take to plan ahead of the job will reward you and your family many times over with a fuller enjoyment of your forest, now and well into the future.

Invasive Species Management: Invasive species pose immediate and long-term threats to the woodlands of MA. Defined as a non-native species whose introduction does or is likely to cause economic or environmental harm or harm to human, animal, or plant health, invasives are well-adapted to a variety of environmental conditions, out-compete more desirable native species, and often create monocultures devoid of biological diversity. The websites of the Invasive Plant Atlas of New England, www.nbii-nin.ciesin.columbia.edu/ipane, and the New England Wildflower Society, www.newfs.org are excellent sources of information regarding the identification and management of invasive plants. Some of the common invasive plants found in MA are listed below.

- Oriental Bittersweet (Celastrus orbiculata)
- Glossy Buckthorn (Frangula alnus)
- Multiflora Rose (Rosa multiflora)
- Japanese Barberry (Berbis thunbergii)
- Japanese Knotweed (Fallopia japonica)
- Autumn Olive (Eleaeagnus umbellata)

Early detection and the initiation of control methods soon after detection are critical to suppressing the spread of invasive species. Selective application of the proper herbicide is often the most effective control method. See the next section for information on the use of chemicals in forest management activities.

Asian Longhorned Beetle

Pesticide Use

Pesticides such as herbicides, insecticides, fungicides, and rodenticides are used to control "pests". A pest is any mammal, bird, invertebrate, plant, fungi, bacteria or virus deemed injurious to humans and/or other mammals, birds, plants, etc. The most common forest management use of a pesticide by woodland owners is the application of herbicide to combat invasive species. MA DCR suggests using a management system(s) that promotes the development and adoption of environmentally friendly no-chemical methods of pest management that strives to avoid the use of chemical pesticides. If chemicals are used, proper equipment and training should be utilized to minimize health and environmental risks. In Massachusetts, the application of pesticides is regulated by the MA Pesticide Control Board. For more information, contact MA Department of Agricultural Resources (MDAR), Pesticide Bureau at (617) 626-1776

Please refer to FSC Pesticides Policy: Guidance on Implementation (FSC-GUI30-001 Version 2-0 EN, May 5, 2007) for information on chemicals banned from use on MA Private Lands Group Certification member properties.

This is your Stewardship Plan. It is based on the goals that you have identified. The final success of your Stewardship Plan will be determined first, by how well you are able to identify and define your goals, and second, by the support you find and the resources you commit to implement each step.

It can be helpful and enjoyable to visit other properties to sample the range of management activities and see the accomplishments of others. This may help you visualize the outcome of alternative management decisions and can either stimulate new ideas or confirm your own personal philosophies. Don't hesitate to express your thoughts, concerns, and ideas. Keep asking questions! Please be involved and enjoy the fact that you are the steward of a very special place.

Purpose of the Plan

The Holyoke Water Works (HWW) is charged with the delivery of clean, potable water to the City of Holyoke. One hundred percent of the drinking water for Holyoke comes from the Tighe Carmody Reservoir. The three in-town reservoirs are off line, reserve supplies. HWW operates under a waiver from The Massachusetts Department of Environmental Protection for the filtration requirements of the Surface Water Treatment Rules, which were established in 1986 in response to the Safe Drinking Water Act. Water quality protection is the highest priority with any activity on the watershed. HWW accepts the working hypothesis that healthy, resilient forests are the best natural filter for water.

The basic premise of this model is that with maintenance an ideal watershed forest ecosystem offers the least expensive natural filter for drinking water. The maintenance of a healthy forest requires its continual replacement through natural regeneration of its trees. This first section (The Overview) of this document explains the silvicultural techniques that HWW will apply to maintain and regenerate the watershed filtration forest upon the McLean Reservoir, Ashley Ponds Reservoir, and Whiting Street Reservoir watershed lands. Silviculture requires the harvesting of trees from the watershed, and this document explains the strategies for the protection of water quality during the necessary silvicultural projects.

The City owns a 1,350.8-acre forest ecosystem within these three watershed drainage systems. HWW plans to certify these lands under the Forest Stewardship Council Green Certification Program. Management plans are necessary for all certified acreage. HWW plans to make the management plan available in the public libraries with the expectation that community members and citizens and water rate payers of Holyoke will appreciate the valuable resource these lands bring to the City of Holyoke. Education raises awareness, which can motivate stewardship of a community's natural resources. These lands are often used unofficially for walking, hiking, nature study, and other benign activities. No official access is permitted onto these lands in order to protect water quality.

The In-Town Holyoke Reservoir System

Established in 1872, the Holyoke Board of Water Commissioners had the vision and foresight to design, plan and build one of the most reliable water systems known today. This network of reservoirs located within the City of Holyoke impounds billions of gallons of water, ensuring the City's water supply needs are met under all operating conditions. An energy efficient gravity based system conveys water from the reservoirs to a centralized treatment facility to meet all State and Federal water quality regulations. Treated water is then distributed to a series of storage tanks and pumping stations that service the five individual pressure zones within the City.

Holyoke Water Works
Mclean Reservoir, Ashley Ponds, and Whiting Street Reservoir Watersheds
Locus Map

McLean Reservoir Forest Ecosystem: 336.1 acres
Ashley Ponds Reservoir Forest ecosystem: 753.6 acres
Whiting Street Reservoir Forest Ecosystem: 261.1 acres

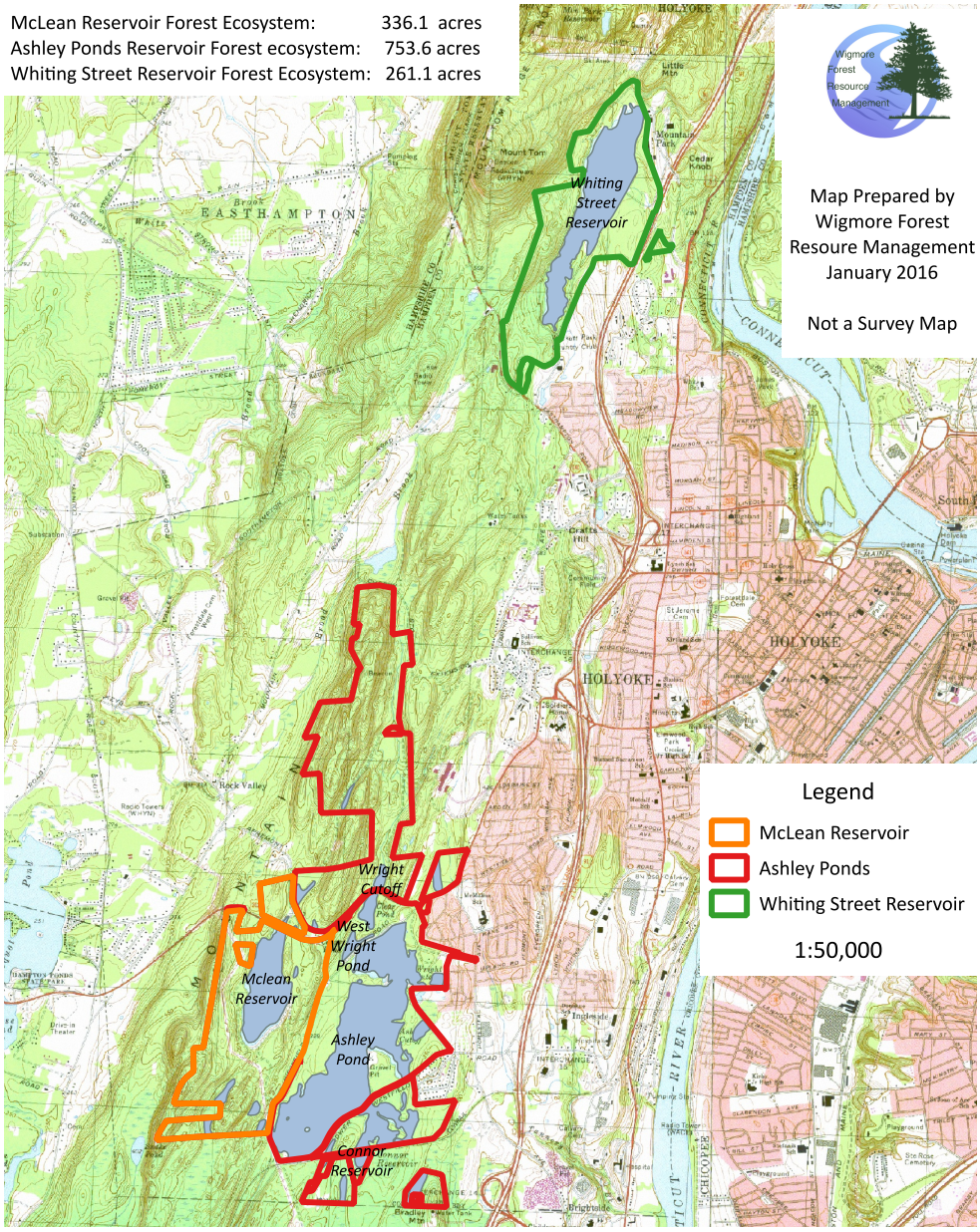


Figure #1: The 1,350.80 acre Three-Reservoir System Locus Map

The McLean Reservoir

The McLean Reservoir was constructed in 1903, and it has an impound capacity of 365 million gallons and a safe yield of 0.5 million gallons of water per day. The Reservoir drainage area is 319 acres, all of which is owned by the Holyoke Water Works. The McLean Reservoir dam is an earth fill dam with a total height of 35 feet and an approximate length of 700 feet. The Massachusetts Department of Conservation and Recreation (DCR) classifies the dam as a Large Size Structure and a Significant (Class II) Hazard Dam.

McLean Reservoir's fill system is quite simple. A small wetland adjacent to the east side of Apremont Way pumps ground water out of springs into a small intake reservoir directly north of Route #202. System complexity manifests at its exit point. Water seeps under the dam into a web of ponds, forested wetlands, and swamps, and drains directly out of the sluiceway into a high velocity stream. This water joins the feeder system for Paucutuck Brook after working its way through the Ashley Ponds Reservoir pond matrix.

The Ashley Ponds Reservoir

The Ashley Ponds Reservoir was constructed in 1897, and it has an impound capacity of 795 million gallons and a safe yield of 2.1 million gallons of water per day. The Reservoir drainage area is 1,261 acres, 86% of which Holyoke Water Works owns. The Ashley Reservoir dam is an earthen fill dam with a total height of 12 feet and an approximate length of 640 feet. The dam is classified by the Massachusetts Department of Conservation and Recreation (DCR) as an Intermediate Size Structure and a Significant (Class II) Hazard Dam.

An aquifer recharge zone north of Cherry Street at the northern tip of the Ashley Ponds Reservoir north section drains its waters both east and west. The western flow funnels into the Broad Brook watershed, and the eastern flow drains a saddle formation into a long narrow wetland paralleling the west side of Cherry Street. This wetland surrounds a spring field through which the aquifer pumps out the headwaters of Paucutuck Brook. After about two thirds of its track through the northern Ashley Ponds watershed, it is joined by two small tributaries with origins in upslope springs. All of this water collects in a small pond that functions as an intake reservoir to Clear Pond and the Ashley Ponds matrix. Water slowly makes its way through these ponds, flowing down gradient until exiting Ashley Pond and flowing downstream to the Bearhole Watershed.

Whiting Street Reservoir

The Whiting Street Reservoir was constructed in 1888, and it has an impound capacity of 479 million gallons and a safe yield of 1.5 million gallons of water per day. The Reservoir drainage area is 897 acres, of which 42% is owned by the Holyoke Water Works. The Whiting Street Reservoir dam is a stone masonry and earthen embankment dam with a height of 19 feet and an approximate length of 1,900 feet. The dam is classified by the Massachusetts Department of Conservation and Recreation (DCR) as a Large Size Structure and a High (Class I) Hazard Dam.

Whiting Street reservoir fills with stream flow from the north and south. Water collects from the run-off on upper Mount Tom slopes and gushes down into Whiting. Spring seep flow augments this volume along the down gradient. Whiting Brook originates in a wetland near the HWW water tanks on Homestead Avenue. Here, water is pulled from the aquifer and pumped north into Whiting Street Reservoir across a series of wetlands and small ponds.

Geology

Over 200 million years ago in the Triassic Period, the North American, Eurasian, and African plates drifted towards each other and eventually collided. The collision force shoved the northern Appalachian Mountains upwards along the spine of New England. These rifts were also the sites of lava bursts onto the earth, cooling in thick slabs. This volcanic rock, basalt, is orientated in narrow

north-south columns. Erosion wore down many of these ridge tops, leaving behind the curving spur of the East Mountain formation. As time passed, the new land formation also split, which began the split of the Connecticut River peneplain.

Less than 2 million years ago, the Wisconsin Ice Sheet covered the Connecticut River valley. Its slow, grinding flow scoured the earth. Its melt water collected behind a massive dam of sand and gravel and formed a giant lake that stretched to the Canadian border. Less than 12,000 years ago, this sand dam burst and Lake Hitchcock drained, leaving the matrix of terraced floodplains above deep sands and gravels and the kettle ponds formation found today.

Terrain

East Mountain Ridge, which is part of the long, narrow spur of Metacomet Ridge, lies to the west of the Connecticut River Valley. The ridge tops stretch through the western edges of both the McLean Reservoirs and Whiting Street Reservoir lands and the central core of the northern Ashley Ponds lands. The basalt rock juts up into cliffs and exposed bedrock on the crests and upper slopes and crumbles into the richer talus lower slopes. The landscape transitions to the deep, stratified sands and gravels of the alluvial outwash plains. Another common feature is the north south orientated small hills of gravel and sands (drumlins or drumloidal hills), which alternate with the stream and run-off terraces across the Ashley Ponds area.

History

The level alluvial terraces and floodplains of the valley were frequented by native peoples, as evidenced in fishing sites and in tools found in the uplands made from basalt. The current forest structures, the dry site oak transition forest ecosystem, developed about 15,000 years ago as proven by tree pollen and seed found in the sands. European influence began on the native peoples and ecosystems around 1600. Europeans walked the trail systems of the Nashawannuck and Pascounmuck. Springfield plantation was established in 1627. It included all of West Holyoke, both ridges and floodplains. Most of the land was too wet for agriculture across the Ashley Pond area and too steep up the ridges and upper slopes. In the mid-1800's, a group of financiers planned the industrial city of Holyoke. The population grew by 400% from 1870 to 1920, primarily because of workers in the mills. Timber harvesting stretched up into the ridges and higher slopes in search of lumber and fuel for the growing valley. People moved into the urban core of the city, and the uplands to the west were reverted to forest.

History of Disturbance to the Forest

The history of disturbance on this property from the 1830's is like that of the typical woodlot in Southern New England. The mid-19th century was the height of the forestland clearing for agriculture and pasturing. The availability of richer, more productive farmland in the Midwest resulted in farm abandonment and subsequent regrowth of the forests. Industrial patterns and modes of production also shifted with the advent of the 20th century, and the factories were abandoned.

The forestland reverted to the dense mixed oak, white pine, hemlock, chestnut, and mixed hardwood cover typical on old farmlands. These forests began the successional transition toward a more diverse species composition. Wood products industry surges in the early 20th century interrupted the development of these forests. This new upswing in land clearing for wood products and reversion to open land was cut short by the World War period. The forests have been maturing into their current condition since this time.

More recent natural disturbance to the forests have been the Chestnut Blight in 1900 to 1908, the hurricane of 1938, the Gypsy Moth outbreak of 1980 to 1982, and recent severe storm events driven by climate change, including the ice storm of 2008 and the October 2011 snow storm.

The City planted areas of red pine and white pine for shoreline stability around the reservoir through the late 1950's. HWW began an active program of watershed management in the early 1970's. Timber harvests for the improvement of the growing stock were completed through the 1980's and late 1990's. Timber crop management began again in 2003 upon the reservoir lands. The forestry program renewal started on Ashley Ponds Reservoir lands in 2007 with a red pine plantation salvage operation.

Forest Soils

Time and weather eroded the once jagged, stately ridge tops into exposed basalt rocks and the crumbling talus lower slopes. The movement of water across the alluvial outwash plains and terraces constantly alters these soils. The United States Department of Agriculture – Soil Conservation Service classified all of the soils within the three watersheds into categories dependent upon their texture, depth, topography, and productivity. Many areas are designated as Highly Erodible in the soils survey. Protection measures are essential during any forest management work. Continual use of the trails and roads by illegal recreationists causes massive loss of sediment along the road and trail system.

The Rock Outcroppings - Holyoke Complex soils cover most of the three reservoir system lands. These shallow, upland soils do not grow trees very well. These soils are characterized by the talus slope formations that arise from the crumbling basalt due to erosion. The coarse texture loams lose their water quickly through evaporation and percolation. This droughtiness can kill off seedlings and discourage tree vigor. Trees are easily carried away with rainwater and wind forces. Use of these upper slopes for road construction for any management purposes is difficult, as they tend to gulley quickly without proper erosion control installations. Descending the terrain across the lower slopes and into the alluvial outwash plains, the soils deepen and sequester more fertile organic material in some areas mixed with the silts, sands and gravels. Exposed basalt rock is less common here. Tree productivity varies with the averages from poor/fair on the rocky slopes to moderately high across the outwash terraces and plains.

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Comment [1]: Or seedlings?

Table 1.: Soil Classifications and Descriptions for the Three Reservoir In-Town System

Terrain/ Topography	USDA Classification	Soil Name	Soil Description	Forest Productivity
Upper slopes, ridgeline tops, and rock outcroppings	RHD	Rock Outcroppings and Holyoke Complex	Coarse textured, shallow soils in uplands formed in a thin layer of glacial till or simply exposed bedrock. Holyoke component is excessively well-drained.	Poor to very poor for productive tree growth.
Lower slopes, and drumlin hills.	CkB, CkC, CmB, CnB, CnC, CnB, CnC	Charlton Close minor associates: Meckesville and Woodbridge.	Coarse textured, fine, stony, sandy loams, which are deep and well-drained. Tend to seepage and they are useful for earthen dams for reservoirs.	High- very productive for tree growth.
	PaB	Paxton	These soils lie along the side hills of drumlins. They have a seasonal perched water table.	High- well suited to productive tree growth.
	WgF, WgC, WgB	Wethersfield	Deep, well-drained sandy loams that formed on drumloidal hills and ridges.	High- well suited to productive tree growth.
Outwash Plains, stream terraces, and alluvial terraces.- lowlands of the system and surrounding the ponds.	En	Enfield Minor associate Freetown and Broadbrook	Nearly level, deep, well-drained silt loams.	High- well suited to productive tree growth.
	SeA	Swansea	Nearly level fine sandy loam found on the alluvial terrace formations of the central Ashley Ponds section. They are very well-drained.	Moderate to low productivity for oak and white pine.
	SrB	Sudbury	Nearly level, fine, sandy loams found on the alluvial terrace formations in the central Ashley Ponds section. They are very well-drained.	Moderate to low productivity for oak and white pine.
	HgB, HgC, HgD	Hinckley	Deep, excessively, well-drained sands that formed on the glacial outwash plains. Too dry for good tree growth.	Poor/Low Productivity.
Alluvial floodplain depressions, old lake bed deposits, and depressions on upper slopes.	Ra	Raynham	Silts and loams that formed in the glacio-lacustrine deposits of the old Lake Hitchcock bed. Water sits at surface for most of the year.	Moderate tree productivity.
	RgA, RgB	Ridgebury	A stony, moderately deep sandy loam found in the low depressions across the landscape.	Fair to Moderate tree productivity.

Figure #2. Soil Classification Map for the McLean and Ashley Ponds Reservoir Lands

Soils Classification Map for the McLean Reservoir and Ashley Ponds Reservoir Lands

Ashley Ponds Reservoir Forest Ecosystem: 753.6 acres

McLean Reservoir Forest Ecosystem: 336.1 acres

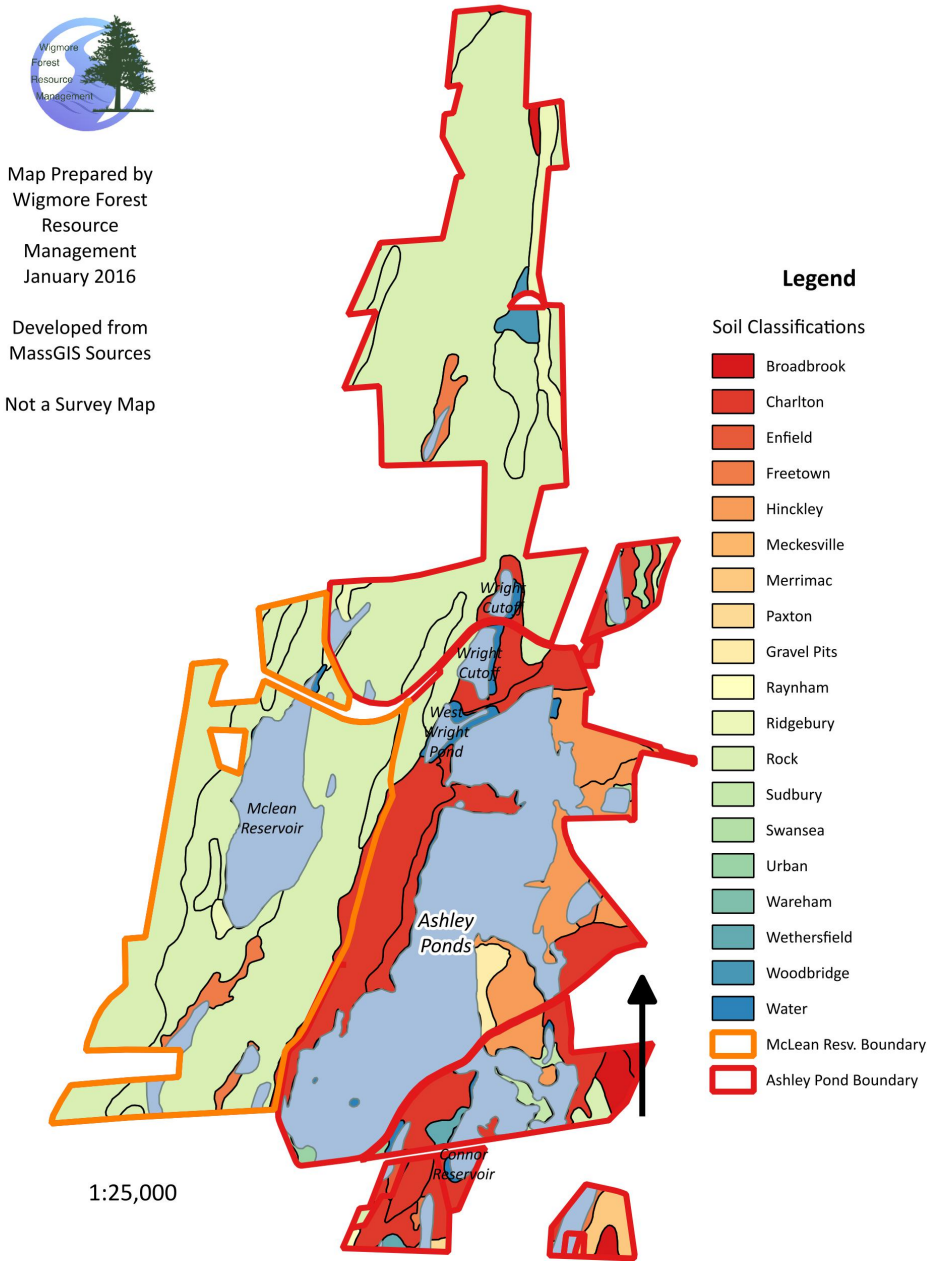
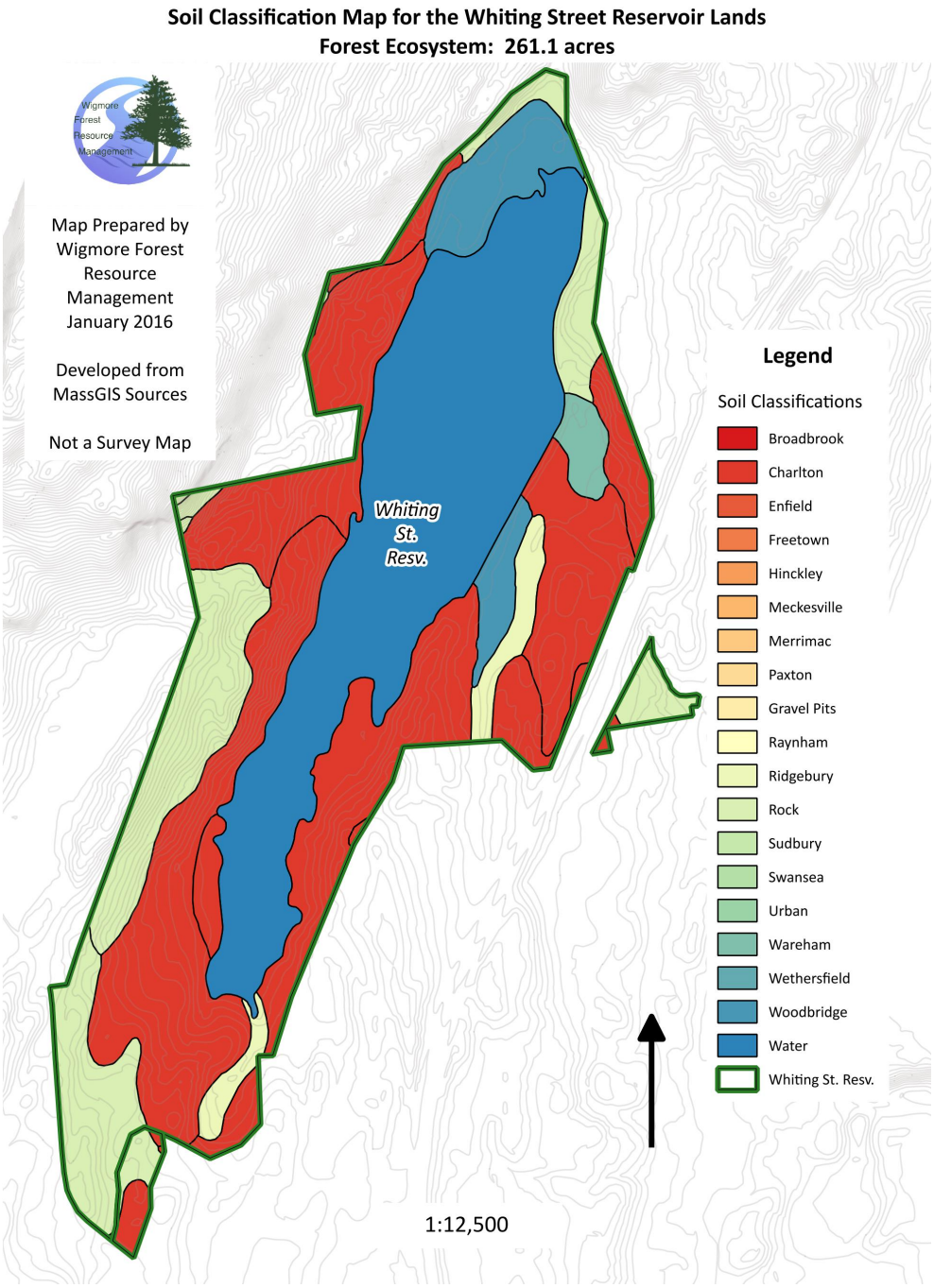


Figure #3: Soil Classification Map for the Whiting Street Reservoir Lands



Overview of Forest Ecosystem on the Whiting Street Reservoir Watershed Lands

This discussion will first examine the broad forested landscape of the three-reservoir system, and it will finish with a overview of the specific reservoir forest ecosystem. The HWW lands are nestled within a vast, continuous green band along the north-south axis of the East Mountain Ridge formation. This emerald spine offers a valuable habitat refuge deep within the urban Connecticut River valley landscape. These forests grow in the natural landscape feature know as the Berkshire Transition Forest. The vegetation here shifts between the true northern hardwood groves (beech, birches, ash, and maples) of north Berkshire and Franklin County and the oak and hickory forest of southern New England.

The forest is predominantly deciduous. Dominant trees in the upland forests are red oak, white oak, paper birch, and hickory, with some American beech, white pine, black birch, yellow birch, Eastern hemlock, sugar maple, and red maple. Along the mountaintops, chestnut oak and scarlet oak are common. Forested wetlands and lowlands consist predominantly of red maple in association with American elm, white ash, silver maple, swamp oak, yellow birch, and tulip poplar. Common understory shrubs include spicebush, highbush and low-bush blueberry, speckled alder, mountain laurel, maple-leaved viburnum, beaked hazelnut, and witch-hazel.

The forest exists in a rudimentary all-aged structure with the exception of the white pine and red pine plantation stocking. This complex, vast forest ecosystem functions as an ideal natural filter. The maturing overstory oak, mixed hardwood, white pine and hemlock trees of the main canopy range in age from 85 to 145 years and the immature, mid-canopy layer range in age from 30 to 65 years of age. Past timber harvests and natural decline opened gaps in the two upper layers for the development of seedlings and saplings (less than 30 years). Scattered old farm relics (mostly sugar maple, white oak, red oak, and hickory) and small groves of surviving hemlock may even be older than 200 years.

These forests are generally healthy, vigorous, and productive with the exception of the hemlock, white ash, and paper birch crops. The hemlock component is under attack by the elongated hemlock scale and the hemlock wooly adelgid. These pathogens are systematically destroying the genetically ancient *Tsuga* species east of the Appalachian Mountains. The full ramifications of their loss from the watershed forest ecosystem are not understood. White ash suffers environmental decline, and paper birch is a short-lived species, with many stems approaching their biological maturity across the watershed. The black birch crop suffers from minor infestation of the nectria bacteria.

Whiting Street Reservoir

The Whiting Street Reservoir sits like a blue gem at the heart of the oldest watershed system for the City of Holyoke. The terrain curves around the reservoir in a quintessential water collection basin. When the City of Holyoke bought this land in the late 1880's, the lower slopes were still open fields and farmland and a young, dry site oak and hardwood cover stretched across the upper slopes. Once the water supply was running smoothly, the City engineers turned their attention to the improvement of the watershed lands. The Whiting Reservoir Road was built for access to all areas of the shoreline. In the 1930's, forty-eight acres of predominantly white pine plantations were set along the shores of the reservoir in abandoned farmland. Red pine, scotch pine, and Norway spruce seedlings were mixed with the plantings. Although aesthetically pleasing, no one tended these stately groves, and the trees are stagnating.

The upland mixed oak and northern hardwood forests that sweep up from the gentle slopes to talus rock ledges were left to mature. The average age range of the oldest age class is 130 to 180 years of age. A few outlier red oak trees with massive trunks and crowns are close to 200 years old. Beneath this maturing overstory, a sparse layer of black birch, sugar maple, red maple, white oak, and black

oak pole and small timber sized trees has filled any canopy openings. The xeric uplands support a very dense native shrub layer with dominance in this group by eastern hophornbeam (ironwood). One 17- acre portion of these oak forests was harvested near Aerator Road in 2006. The depressions in the outwash plain support a matrix of alder and red maple swamp, which has spreads into one area of plantation south of the reservoir.

The Holyoke Water Works allowed public access into this forest with restriction to foot and bike traffic after the reservoir was decommissioned for drinking water consumption in the late 1980s. It is a very popular destination for the local community. On any given day, one will find many people enjoying the gentle 3.9-mile hike on Whiting Street Reservoir Road around the reservoir. HWW committed the upland oak hardwood forests to preservation and habitat protection during the last decade. Red oak (over 45% of the total stocking on the reservoir lands) reaches senescence well over 250 years. HWW understands the future need to reproduce these oak hardwood groves, but for the 2016 to 2026 operating period, they do not plan to start any regeneration projects.

They cannot be as long sighted with the pine plantations. These stagnating groves are beginning to show signs of suppression and decline. Without earlier thinnings for the removal of the poorly growing stems, many of the trees have small, asymmetrical crowns and spindly bole shapes. Eventually these trees will begin to fall down and possibly pose a threat with the high use recreation zone. The HWW plans to initiate a program for the regeneration of these groves to native species inclusive of white pine, black birch, sugar maple, and mixed oak from seed. The actual harvest may not happen for five years or more. A program of education and outreach will educate the stakeholders in the local community about the need for attention to these groves. Public hikes and talks will continually present the scientific data about the life cycle of white pine and the eventual condition of these declining groves. HWW does not plan to initiate a harvest until they have a consensus with the stakeholders and recreation users of the Whiting Street Reservoir.

Table #2: Forest Stand Summary By Number, Forest Type, and Area:

Reservoir Name	Stand Number	Forest Type	Stand Description	Area
Whiting Street	1	WP	Plantations of predominantly white pine with minor contributions of red pine, Norway spruce, Scotch pine and hemlock. Trees are overstocked for optimal growth of the pine crop, and serious signs of decline are evident.	48 acres
Whiting Street	2	OH	Maturing stand of red oak, white oak, black birch, red maple, sugar maple, wash, paper birch, chestnut oak, with scattered large sized pine capping the upper canopy. The quality of the red oak timber crops is very good.	184.1 acres
Whiting Street	3	RZ-RM	All of the low areas on the land where the run-off and streams drain towards the reservoir collect moisture and support a matrix of wetland shrubs, red maple, aspen, ash, elm, and scattered white pine trees. Invasive plants exploit the open like conditions of the forest floor within the riparian zone.	12 acres
Whiting Street	4	OH	This stand supports the maturing oak hardwood mix found in the upper slopes, yet it lies across a gentle, fertile plain. A timber harvest introduced a new age class beneath the maturing cover.	17 acres
			Subtotals Stewardship and Green Certified Area	**261.1 acres**

Invasive Plant Communities and Their Management

Invasive plants threaten local biodiversity with their aggressive displacement of native species. They can significantly inhibit regeneration and the future productivity of a forest stand. Invasive plants have few natural enemies, and often have little to no wildlife value. In general, preventing the spread of invasive plants is easier and less expensive than trying to control them. This plan often recommends treatment of existing invasive plants before any timber harvest work and the use of non-toxic practices to avoid their spread. Manual removal, stem cutting, application of vinegars and borax, brush cutting, and mowing in cycles reduce invasive plant stocking and prevent their spread. Retention of high crown closure uses shade as a deterrent of their spread. Scheduling and planning efforts for the treatment with natural correctives will be coordinated with income production.

These plants are found in dense volumes along all Whiting Reservoir Road, the reservoir shore, and within the riparian zones and red maple wetland forests with their lower canopy cover. Brushing maintenance along the road edges has prevented full exploitation of the road edge and movement of the plants up slope into the valuable oak groves. A 200-foot band of individual stems of the most common plants extends into the forest all along the access road. Monitoring of the white pine plantations after the proposed harvest will provide early detection and rapid response opportunity in these stands.

HWW operates on a very tight budget, and they cannot commit their financial resources to this control program. During the public outreach campaign for the pine plantation education, the invasive species problem will be discussed. HWW hopes to motivate the site users to participate in a volunteer program for simple manual removals of some of the plants. Only natural corrective measures will be considered as their program develops, so as to protect water quality.

Table #3: Invasive species plants observed across the Three-Reservoir System from a 2012 Williams College Study

Autumn Olive	Winged Euyonomous	Coltsfoot	Common Buckthorn
Japanese barberry	Glossy Buckthorn	Swallow-wort	Common Reed
Asiatic bittersweet	Bush Honeysuckle	Privet	Multiflora rose
Purple loosestrife	Climbing nightshade	Spotted nightshade	Norway Maple

Wildlife

Many groups through the years have done extensive studies of the East Mountain Ridge and reservoir plains habitat including Massachusetts Audubon, Massachusetts Division of Fisheries and Wildlife, Trustees of Reservations, The Nature Conservancy, and the Sierra Club. A summary of the most recent data is summarized in this section of the management plan. This is a rich natural heritage, and this list does not include all of the many invertebrates in the City. Because of the richness of undisturbed habitats on the East Mountain Ridge and the expansive ponds, the three-reservoir system has many more species of both plants and animals than most people realize.

Birds

Data on the bird populations is the best for the three-reservoir system land base. The Connecticut River valley is a major pathway for migratory birds. Their movement attracts a lot of enthusiasm, with special attention to hawks and birds of prey. Hawk watching is common on East Mountain Ridge during their fall migration. The large tracts of forest provide important breeding habitat for interior forest birds.

Massachusetts Audubon (2012 Count) defines these forests as a historic nesting site for Peregrine Falcons on rocky cliffs, with the potential for future nesting there. It is also an important nesting habitat for the Whip-poor-will; Worm-eating, Black-and-White, Blackburnian, Black-throated Blue and Cerulean Warblers; Louisiana Water thrush; Eastern Towhee; Eastern Wood-Pewee; Hairy Woodpecker; Baltimore Oriole; Rose-breasted Grosbeak; Scarlet Tanager; Wood Thrush; and other priority species by Partners In Flight for southern New England.

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Comment [2]: "other" is a guess here, pls confirm that it makes sense

The ranges are a migration route for large concentrations of Broad-winged, Sharp-shinned and Cooper's Hawks and American Kestrel, as well as several other species including the Northern Goshawk, Red-shouldered Hawk, Peregrine Falcon, Merlin, Osprey, and Bald Eagle. They are also a significant stopover for numerous migrant songbirds including 22 warbler species, as well as good numbers of breeding interior forest birds. Important habitat for birds includes the mixed oak habitat of the ridge tops and large continuous tracts of mature mixed oak and hardwood forests. A full list from the Massachusetts Audubon 2014 Christmas Count includes over 110 species.

Mammals, Reptiles, and Amphibians

The diversity of habitat supports a wide number of wildlife species. No conclusive species lists were found for the East Mountain Ridge and ponds area. The extensive three-reservoir system provides a corridor for large mammals and other wildlife. The Department of Conservation and Recreation (Cardoza and Mirick (2009)) conducted the most recent survey and noted the species in Table #4 as common to the three-reservoir system watershed lands.

Vernal Pools

Vernal pools are temporary bodies of fresh water that provide critical breeding habitat for many vertebrate and invertebrate wildlife species. They are defined as "basin depressions where water is confined and persists for at least two months during the spring and early summer of most years, and where reproducing populations of fish do not survive." Vernal pools may be very shallow, holding only five or six inches of water, or they may be quite deep. They range in size from fewer than 100 square feet to several acres (Natural Heritage & Endangered Species Program, Massachusetts Division of Fisheries & Wildlife, Massachusetts Aerial Photo Survey of Potential Vernal Pools, Spring 2001).

Three pools are found in the oak hardwood grove in small woodland depressions, swales, or kettle holes, which collect spring runoff or intercept seasonal high groundwater. Many species of amphibians and vertebrates are completely dependent on vernal pools to reproduce. Loss of vernal pools can endanger entire populations of these species. According to NHESP, clusters indicate particularly good habitat for species. Also, with clusters, there are alternate habitats if something happens to one pool, and slightly different conditions in each may provide different habitats for species dependent upon the pools.

Table #4: 2009 DCR Wildlife Species Lists

Reptiles:			
Snapping Turtle	Northern painted Turtle	Milk Snake	Common Garter Snake
American Mud Turtle	Eastern Race Turtle	Brown Snake	Copperhead
Pond Turtle	Ring Necked Snake	Northern Water Snake	Timber Rattler Snake
Wood Turtle	Eastern Rat Snake	Red Bellied Snake	
Eastern Box Turtle	Eastern Hog Nosed Snake	Eastern Ribbon Snake	

Amphibians:			
Mudpuppy	Marble Salamander	Spring Salamander	Fowler's Toad
Jefferson Salamander	Eastern Newt	Northern Two Lined Salamander	Green Frog
			Bullfrog
Blue Spotted Salamander	Redbacked Salamander	Spadefoot Salamander	Wood Frog
Spotted Salamander	Four Toed Salamander	American Toad	Pickerel Frog

Mammals:				
Feral Cat	Mink	Beaver	Northern Shrew	Porcupine
Bobcat	Striped Skunk	Jumping Mouse	Smoky Shrew	Snowshoe Hare
Coyote	Raccoon	Meadow Vole	American water Shrew	Eastern Cottontail
Mountain Lion	Moose	Woodlands Vole	Mole	New England Cottontail
Gray Fox	White Tailed Deer	Common Muskrat	Red Squirrel	
Red Fox	Virginia Opossum	Deer Mouse	Woodchuck	Woodchuck
American Black Bear	Gray Squirrel	Rat	Northern Flying Squirrel	Fisher
North American Otter	Ermine	Northern Flying Squirrel	Chipmunk	Longtailed Weasel
Brown Bat	Eastern Red Bat	Tri-Color Bat	Silver Bat	Myotis

Biodiversity:

The Massachusetts Division of Fish and Game through its Natural Heritage and Endangered Species Program designates these lands as Priority Habitat and Core Habitat, which is essential for the long-term health of native communities. Priority Habitat is land desirable for habitat use by the rare and special concern plant and animal species in western Massachusetts. The ecosystem provides high quality wetlands, vernal pools, habitat, and range for rare and vulnerable or uncommon animals, birds, reptiles, amphibians, invertebrates, and plants. Much of the area is also designated as Critical Natural Landscape, which provides good habitat for wide ranging species, nurtures intact ecosystems, and protects habitat integrity. The protection of both Priority Core Habitat and Critical Natural Landscapes (especially their overlap zones) assures healthy ecosystem functioning and rich biodiversity. The continuous acreage provides connectivity for species to cross the landscape.

Massachusetts Audubon designated this area as an Important Bird Area (IBA), which provide essential habitat to migrating birds for mating and roosting. Twenty-seven state-listed birds whose population is decreasing were noted here. Habitat is variable across the three-reservoir system from the upland oak talus slopes, rocky outcrops, and the alluvial floodplains. Peregrine falcons have been seen soaring above East Mountain, and many documented wood turtle observations exist. A few rare plants grow on the ridge tops and rocky outcroppings. Massachusetts DFG, The Nature Conservancy, and Massachusetts Audubon support the use of this area for the protection of many habitats of species of greatest need of conservation. The entire three-reservoir system provides both resiliency (the capacity of an ecosystem to recover from stress) and resistance (the ability of an ecosystem to stay stable) to the climate crisis.

Biodiversity Protection:

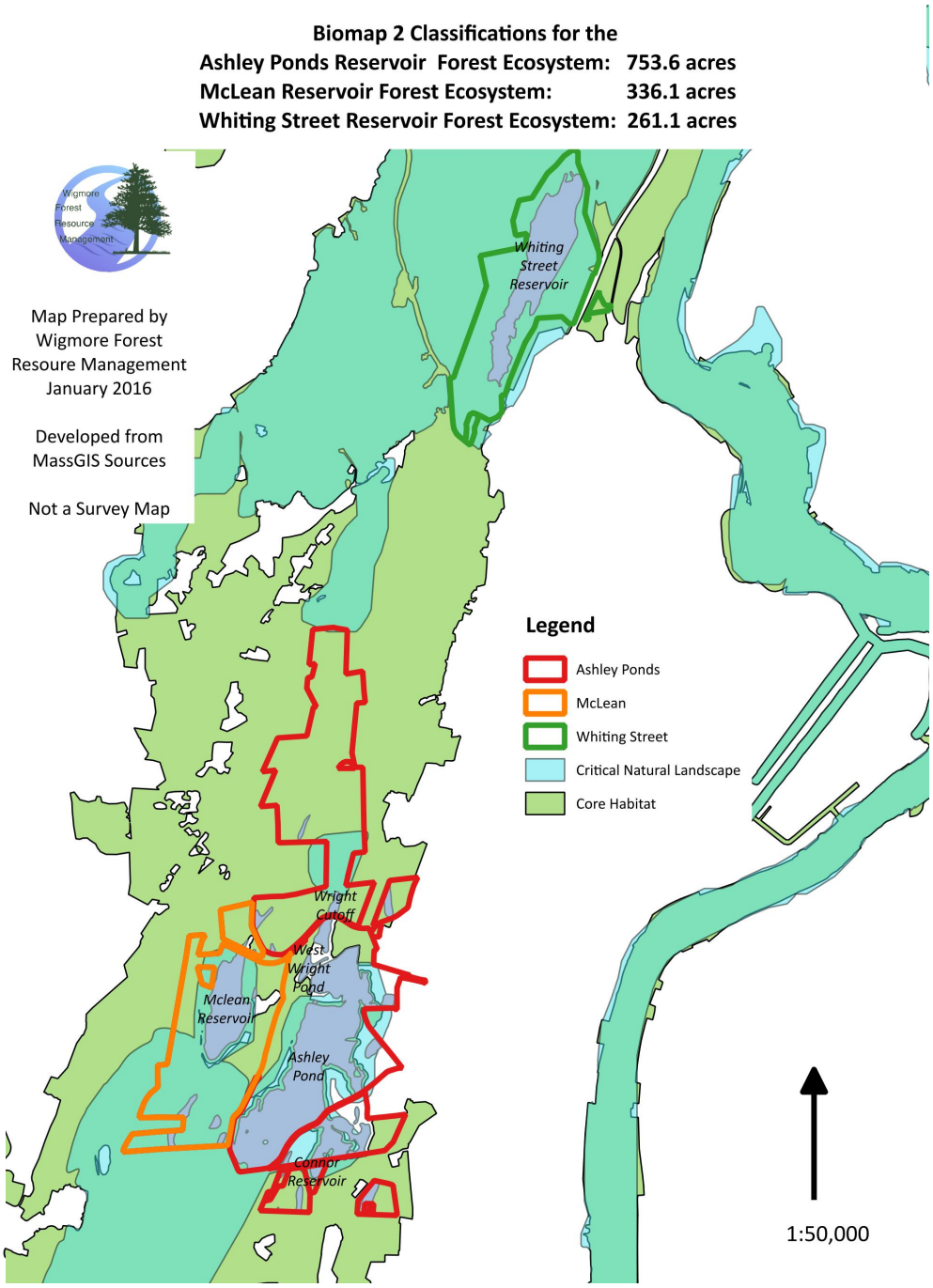
Holyoke is remarkably rich in rare plant and animal species. The East Mountain Ridge and glacial ponds are cited by the Massachusetts Natural Heritage and Endangered Species Program (NHESP) as one of the most important and ecologically significant rare species localities within the Commonwealth. It is a high priority Special Focus Area for protection given the rare species habitat, the extent of contiguous habitat types, and the habitat for migratory land birds available.

All projects within Priority Habitats undergo a review by DFG NHESP. Most of the watershed area is designated as a sensitive resource not suitable for timber harvest or silviculture work. No access is encouraged to the vernal pool zones on the southern watershed. Holyoke Water Works supports the diligent use of Forest Conservation Management Practices. All CMPs published by the DFG NHESP will be followed during the one proposed timber harvest project within the white pine plantations.

Conservation Management Practices (CMPs) are specific, science-based guidelines for conservation of rare species during forest harvesting. CMPs are somewhat analogous to Forestry Best Management Practices (BMPs), except whereas BMPs focus mainly on protection of water resources, CMPs specialize in protection of rare wildlife. The primary objective of CMPs is to guide harvesting activities such that rare species listed under the Massachusetts Endangered Species Act (MESA) are not impacted in a way that jeopardizes long-term viability of local populations. CMPs first identify and describe potential impacts of forest harvesting to state-listed species, whether impacts may be direct (e.g., physical injury or death of individual animals) or indirect (e.g., alteration of habitat in a way that reduces overall reproductive success of a local population). Then, CMPs provide specific guidelines to avoid or minimize impacts that would be considered negative or potentially detrimental to a local population. The guidelines are based on scientific knowledge of the habitat requirements, reproductive strategy, dispersal ability, survivorship, and other ecological factors that influence population dynamics of the species.

CMPs aim to maintain adequate opportunity for sustainable management of timber products in Massachusetts. To this end, CMPs tend to focus forest harvesting restrictions on the critical areas

Figure #4: Priority habitat and natural Critical Landscape Map from the BioMap2 Project for the McLean Reservoir, Ashley Ponds Reservoir, and Whiting Street Reservoir lands



within known habitat of state-listed species, thereby allowing timber management to proceed with fewer restrictions over as large an area as possible. This strategy is based, in part, on the recognition that forest harvesting typically results in temporary habitat change or sometimes even habitat improvement rather than permanent habitat loss. Thus, the CMP strategy is designed to help maximize the protection of state-listed species and the ability of Massachusetts landowners to manage their forests for timber and other wood products.

Principles Guiding Forest Watershed Management

The science of watershed management continues to evolve, although many basic principles are long established and are now widely accepted as the precedent for the stewardship of watershed lands. This section is presented as the scientific defense synopsis for the City of Holyoke's watershed forest management program. The focus is on water quality, which can be directly impacted by active silviculture work. Although water yield is important to watershed management, the proposed silvicultural program restricts harvest levels to a less than 20% threshold, which is not significant enough to impact yield.

Watershed Protection

- Forested watersheds generally yield higher water quality than non-forested cover types.
- Maintaining vigorously growing forests across a watershed provides the best regulation of nutrients in a watershed.
- Watershed management activities depend upon an adequate, well-designed, and well-maintained watershed road system.

Water Quality

- Surface water collected from fully forested watersheds with minimal exposed soils generally carries low turbidity.
- In actively managed forests, correctly designed and effectively applied Best Management Practices will protect water sources from sediment/nutrient losses otherwise associated with forest management work.
- The most common sources of water quality degradation by timber harvesting are intersections in harvesting roads and staging areas near water sources. Disconnecting roads/staging areas from water sources prevents this degradation.
- To prevent contamination of surface or ground waters, petroleum products on water supply watersheds must be tightly regulated.
- Maintaining a species and age/size diverse forest cover may increase the forest's resistance to natural disturbance. Active forest management can increase size and species diversity of forest cover.

The Water Protection Forest: A Working Hypothesis

- The ideal watershed protection forest has the capacity to recover from natural disturbances with or without active forest management.
- Healthy, well-distributed diverse age groups and size classes across the watershed increase the forest's ability to withstand environmental stress and disturbance.
- Research has shown that harvesting less than 25% of the forested watershed in any given ten year period can minimize the loss of nutrients or sediments.

- Separation of the roads and staging areas from water resources is the first rule to protecting these resources from any negative impact due to logging.
- Roads should be designed to minimize stream crossings, and storm water drainage structures need to be properly designed and managed.
- Staging areas must be remote from water resources.

Forest Management Objectives/Strategies:

- To maintain the ability of the forest to regenerate itself;
- To encourage the development of the ideal all-aged, species diverse natural filtration forest structure on the forest stand suitable for silviculture treatment;
- To continually regenerate these lands in order to maintain multi-age structure and diverse species composition;
- Strict adherence with Best Management Practices as stated the Department of Conservation and Recreation Best Management Practices Manual (2103) with compliance with both the mandatory and suggested practices;
- To limit harvesting to no more than 20% of the total stocking on any given forest stand over a 15 to 20 year cutting cycle; and
- Delineation and marking of the boundaries of the entire reservoir lands with documentation of all monumentation for archive purposes.

Water Quality Objectives/Strategies for 2016 to 2026

Silvicultural practices, as described in this management plan, are employed to bring about ideal filtration forest conditions. These practices require the cutting and removal of overstory trees to diversify structural and species compositions and to maintain the vigor of the residual overstory. The process of removing trees disturbs the forest and the watershed soils, which are essential to protecting water quality. The areas of greatest concern are the hauling roads for timber products and log landings. Proper location of these in relation to streams, rivers, reservoirs, ponds, vernal pools, springs, and vegetated wetlands is important to prevent soil loss.

1) Prevent the movement of sediments into the water system and the reservoirs from the the silviculture work in the white pine plantations.

2) The compliance with the best BMP's (Explicitly described in the Massachusetts Forestry best Management Practices2013 Manual) for harvest techniques in order to minimize the risks of sediment and nutrient loading into the water system. The timber harvest work would be conducted during frozen ground conditions.

3) Establish a program of public outreach to the local community users about erosion prevention and trail use.

4) Conduct a detailed survey of the trail and road system condition and record and document high erosion concern areas.

5) Establish a community partnership for volunteer maintenance projects on erosion control and site monitoring and a forum for discussion about adaptive watershed management.

Biodiversity Objectives/Strategies for 2016 to 2026

1) Protect and encourage native plant communities through the study and control of the invasive plant infestations across the reservoir lands.
2) Seek grant funding for analysis and control measures against the invasive plants.
3) Establish non-disturbance preservation areas within each reservoir property for the conservation and development of intact natural communities and the diverse species within each area.
4) Monitoring for forest health, which poses a threat to biodiversity if a species is threatened by a pathogen.
5) Strict adherence to all CMP's as published by Massachusetts NHESP during any silviculture work.

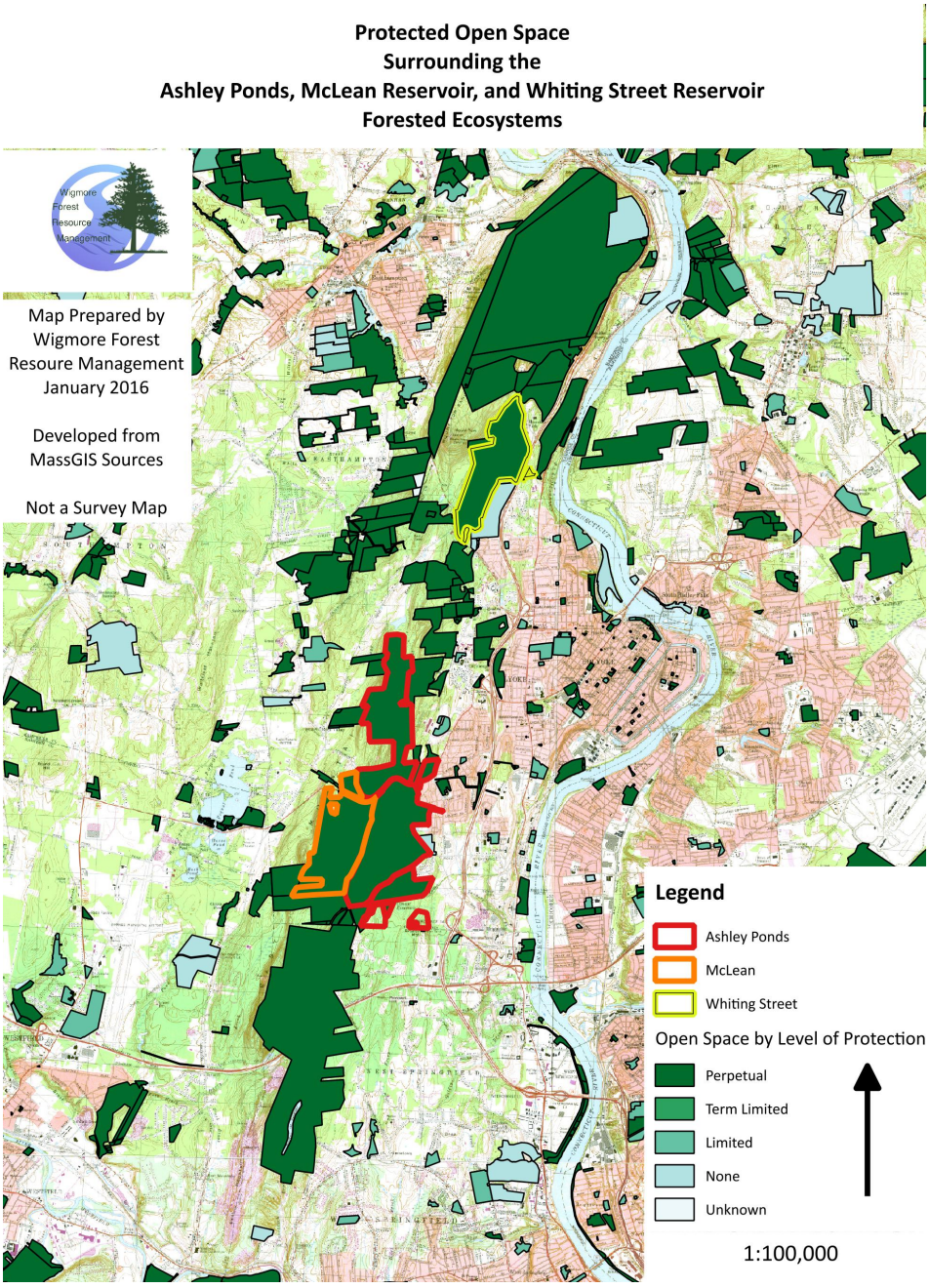
The Role of the Forest in the Landscape and Local Economy

The three-reservoir system stretches on a north-south axis over more than three miles of the East Mountain Ridge. It provides a unifying corridor for a vast habitat and forest core. Most is in municipal or state ownership, though 800 acres are in private hands. Much of the Protected Open Space lies within a matrix of forested vegetation that, while unprotected, is barely distinguishable from the adjacent protected spaces. Protected properties include the Mount Tom Reservation State lands, the Trustees of Reservations Little Mount Tom Reservation, Division of Fish and Game lands, and the Bearhole watershed lands owned by the City of West Springfield to the south.

Protected open space is important in the maintenance of individual populations, species richness, and biological diversity. Population viability of many wildlife species within a regional context is reported to be dependent on large tracts of contiguous habitat that are minimally isolated from similar habitats. Often, area-sensitive species are not present or do not breed successfully in isolated, small, or fragmented tracts of land. The landscape context in relation to a given habitat can have an important effect on wildlife reproductive success and population health. Diversity of habitats and microhabitats within an area influences wildlife species richness and presence/absence of individual species. The three-reservoir watershed increases the ecological resiliency and biodiversity of the regional landscape.

The active silvicultural program on these three watershed areas will produce moderate volumes of merchantable timber products over ten years. Local and regional forest products businesses will complete the physical management work on these lands. They rely on local small businesses for the necessary materials and tools for the production and processing of these timber products. The City of Holyoke relies on the timber revenues from their silvicultural program for the funding of special water related projects and maintenance needs. Their use of the forest as a natural filtration system saves the City millions of dollars in the costs of construction and maintenance of a water filtration plant.

Figure #5: Protected Open Space in and around the McLean Reservoir, Ashley Ponds Reservoir, and Whiting Street Reservoir lands



The Role of Silviculture

Applying ecological principles to a forest stand to enhance growth of desirable species or native plant communities or to promote regeneration is termed silviculture. Silvicultural treatments are generally divided into procedures designed to reproduce forest stands, and intermediate treatments that maintain vigor and desired composition and stand structure. All of the tree species growing within the three-reservoir properties are biologically immature. The oak species might approach senescence near 275 years. However, some red oak can live for over 400 years, and some white pine have been recorded at well over 300 years. The average age range of trees across these properties is 85 to 180 years, with anomalies in all species. These trees are mid-way through their life cycles. If a tree is not under stress from a pathogen or environmental hardships, it is likely to continue growing.

The forest stands upon the three reservoir properties were assessed for their suitability for silviculture. Suitability depends upon the ability of a given forest stand to support the main objectives for water quality and biodiversity of this management plan. Therefore, forest stands upon steep slopes with a high erosion factor were not deemed suitable, nor were forest stands that function solely for the filtration, collection, or transfer of water (wetlands, swamps, or stream banks). Some areas were deemed not suitable for silviculture because of their support function for habitat and their important values for ecological resiliency, such as biodiversity or habitat value.

Only the 48- acre white pine plantations (18% of the total reservoir holding) are suitable for silviculture during the 2016 to 2026 period upon the Whiting Street Reservoir forest. This stand is at its mid-point in the lifecycle. Regeneration of the site is the long-term goal of the silviculture work, yet full site occupation by over 2,000 seedlings per acre of all native species is not mandatory for several decades. The silvicultural system appropriate for this objective is the Irregular Shelterwood Harvest System.

Shelterwood Harvests reproduce a new forest beneath the cover and shelter of the maturing crops. The Irregular Shelterwood System retains portions of the overstory crop, called legacy trees, for their lifespan. This approach is executed over several decades in a stand of trees. The first phase of this system, known as the Preparatory Harvest, removes an estimated 25% to 30% of the stocking with the objective of removing the worst stems, releasing the best trees for improved growth and increased seed production. The retention of over 66% of the growing stock will marginalize the disturbance to this stand, and introduce the aesthetic changes in the stand gradually.

Invasive Plant Management:

Invasive plants, like Japanese barberry, Asiatic bittersweet, and multiflora rose can significantly inhibit regeneration and the future productivity of a forest stand. Usually escaped ornamentals, they have few natural enemies, and often have little to no wildlife value. In general, preventing the spread of invasive plants is easier and less expensive than trying to control them. This plan recommends treatment of existing invasive plants with natural correctives prior to the proposed timber harvest and after the work. Treatment will be necessary along the reservoir shoreline, along the Whiting Street Reservoir Road, and into the interior of the plantations. Throughout the rest of the forest ecosystem without any reduction in crown closure, shade should prevent the spread of these plants.

Annual monitoring inspections of the pine plantation conditions post harvest for detection of spread of the plants into the regeneration areas can motivate future control work. Some of the removal work can be done manually with the removal of the plants from the soils. Brush cutting and mowing along the Whiting Reservoir Road by the HWW will continue to reduce their spread. Toxic methods and the use of chemicals will not be permitted on the Whiting Street Reservoir lands. HWW's management philosophy subscribes to the opinion that invasive plants, although a threat to the native ecosystem, should not introduce a more dangerous threat to water quality in their treatment. Other natural corrections include propane torch application, stem cutting and vinegar and borax application, and direct plant removal by tool or hand.

Hazard Tree Removals

Whiting Street Reservoir Road is lined with stately, tall hardwoods and conifers. Recent severe storm events damage trees and create hazardous circumstances for the public users. Adaptive watershed management allows for new decision making if a hazardous tree event arises. Amendments would be made to the management plan after review by all stakeholders, which would include the development of a prudent plan for hazard tree removal.

Mary Wigmore 1/25/2016 4:06 PM

Comment [3]: This sentence should be rephrased for greater clarity. Don't have enough specific knowledge to do so myself.

Adaptive Watershed Management

Adaptive resource management (ARM) is a structured, iterative process of robust decision making in the face of uncertainty, with an aim to reducing uncertainty over time via system monitoring. In this way, decision making about the use and management of the forest resources on the Whiting Street Reservoir simultaneously meets one or more resource management objectives and, either passively or actively, accrues information needed to improve future management. Adaptive management is a tool that will be used not only to change the watershed management system, but also to learn about the system.

Because adaptive management is based on a learning process, it improves long-run management outcomes. The challenge in using the adaptive management approach lies in finding the correct balance between gaining knowledge to improve management in the future, and achieving the best short-term outcome based on current knowledge. The use of these lands as a primary biodiversity protection area is a new direction for HWW. The reproduction of the forest tree species is essential to the maintenance of the forest's filtration function. Diligent monitoring, documentation, and analysis will inform the watershed manager and all stakeholders about the effectiveness of this approach for the achievement of HWW stated Forest Stewardship and Green Certification Goals. This approach allows for the flexibility to evaluate the forest when a new threat to forest health, ecosystem function, or habitat condition develops in the future, and to change direction when necessary.

Methodology

Inventory Methodology: A sampling system was devised that used probability parameters proportional to the size of the trees sampled and the relationship between basal area and volume. The "double point" sampling system relies on the measurement of the basal area in all trees with a 20 basal factor gauge and the measurement of the tree metrics (diameter, height, and condition class) of a sub-set of these trees with a 40 basal area factor gauge. Its core is the method known as variable plot sampling work, which assigns chance of measurement of trees on each sample plot based upon its relative size with larger trees, which have a greater chance of measurement. Fifty five points were taken across the watershed on a systematic grid design that was executed with a GPS field system throughout all three compartments of the watershed. The placement on the plots on the grid was generated by a random plot function in QGis. The DS Cruiser computer program calculated the stand volumes, basal areas, and stand structure metrics. The raw field data is stored in an electronic file, as well as the computed reports on each stand's condition.

Site Index Methodology: Site index for each stand was estimated using data from Natural Resources Conservation Service, United States Department of Agriculture Web Soil Survey. This survey is available online at http://websoilsurvey.nrcs.usda.gov/. Site index by species was determined by weighted average based on the estimated percentage of the soil types within a stand.

Soils Methodology: Soils data were obtained from MassGIS, Office of Geographic Information, and Commonwealth of Massachusetts from the layer GISDATA_SOILS_POLY_SV_MUNAME. Stand maps were geo-referenced to the soils layer to delineate soil types.

Mapping Methodology: GIS data was obtained from MassGIS, Office of Geographic Information, and Commonwealth of Massachusetts. Layers included the following and the appropriate aerial imagery from the same source.

GISDATA_L3_TAXPAR_POLY_ASSESS

GISDATA_EOTROADS_ARC

GISDATA_HYDRO25K_ARC

GISDATA_HYDRO25K_POLY

GISDATA_SOILS_POLY_SV_MUNAME

Stand maps, developed from aerial imagery and further refined during field investigation using GPS were geo-referenced to a base layer that covered the watershed. Forest Stands were numbered as a decimal (.01 – .15) within a watershed so that they can be sorted correctly. For example, the Hemlock Hardwood stand in the Manhan sub-watershed is numbered 3.08 – stand # 8 in watershed # 3.

Growth Rate Methodology: Growth rates were determined using the method by which the state determines Chapter 61 tax valuations, using an expected volume increase of 162 board feet per acre per year calculated from state Forest Inventory Analysis (FIA) data. The total expected average volume increase was determined by multiplying the total acreage of the stand by 162 board feet per acre.

Mary Wigmore 1/25/2016 2:35 PM

Comment [4]: Mary – I had to guess with this word insertion, pls make sure it makes sense

Simple Regeneration Metric: Regeneration is described at different points in the inventory data and the management plan in the following manner using a simple metric.

A – High – very dense regeneration.

B – Moderate – intermediate level of stocking.

C – Low – low to negligible stocking.

Simple Invasive Plant Metric: The stocking level of invasive plants is described using a simple metric.

A – High – very dense stocking of invasive plants.

B – Moderate – intermediate level of stocking.

C – Low – low to negligible stocking.

Boundary Consideration:

The archives in the City of Holyoke –Holyoke Water Works are not complete. Deeds and old property maps have been misplaced or lost. Some of the old surveys of the Whiting Street lands were found and used during the management plan project. A boundary research and delineation project is underway for these lands with an anticipated completion date of December 2016. The record of the deed transfers is also incomplete. The City engineer is working with WFRM on the deed review. Revised Assessor records will be added to the management pan upon completion of this research.

Combination Forest Stand Descriptions and Management Practices for 2016 to 2026 by Stand

For the purposes of this report, a forest stand is an easily defined area that is relatively uniform in composition and structure. If a stand is suitable for silviculture, the management data was presented directly after the stand descriptions. Specific stand attributes that support the value of its habitat are mentioned in the stand description narratives.

Objective	Stand #	Forest Type	Stand Area (acres)	MSD or Size Class (inches)	Basal Area (sq.ft./ac)	Volume Per Acre	Site Index	DCR/FIA Growth Rate (MBF/yr.)
Stewardship Green Cert.	3.01	WP	48.0	16.2	265	28.650 MBF 12 cords	WP:55 RO:55	7.250

Water Quality Concerns: The goal for water quality protection on these watershed lands is the prevention of the movement of sediment and nutrients from the upland forests through the soils and streams into the Whiting Street Reservoir. Application of all BMP's for water quality protection and scheduling of the harvest during winter months with frozen ground minimizes the risk of sediment movement.

Silviculture Status: Suitable.

Terrain/Topography: This stand wraps itself around the reservoir on the gentle level sites.

Soils: The deep Broadbrook and Raynham alluvial outwash sands and gravels support this stand.

Timber Harvesting: Harvest work on the gentle terrain will not cause sediment loss. Scheduling of the proposed harvest during the winter with frozen ground conditions will protect the soils' integrity.

Overstory: The overstocked white pine plantations (with minor stocking of red pine, scotch pine, and Norway spruce) have an average age of 95 years. The trees have small, asymmetrical crowns, excessive sap flow from the knots on the main boles, and sign of weevil damage. Many roots heaved upward from high winds, and the trees appear ready to blow over. An estimated 30% of the stems have good form and high value.

Understory

Regeneration: Whenever an opening occurred in the canopy, black birch, red maple, sugar maple and hemlock seeded into the spots. These young trees are less than two inches in diameter and less than ten feet in height.

Shrub and Herbaceous Cover: Despite the overstory shade a healthy herbaceous and shrub layer grows in clusters and patches beneath the pine crop. Plants cited include wintergreen, Christmas fern, tree club moss, Christmas fern, partridgeberry, running cedar, and hay scented fern. A moderate stocking of native shrubs were also found here. Most prominent shrubs include witch-hazel, , low bush blueberry, and maple leaved viburnum. Two small native trees, ironwood and musclewood, grow prolifically in this stand.

Invasive Plants: The edges of the stand along Whiting Street Reservoir Road have been infiltrated with invasive plants. The plants grow in dense thickets on the road edge, and they are consistently

found in individual stems for a distance of 200 feet from the road. Species include Japanese barberry, common buckthorn, winged euyonomous, and Asiatic bittersweet. Their density rating is variable with an average of B.

Habitat: White pine provides terrestrial habitat elements across the New England landscape in ways that other large conifer species are unable to duplicate. As a food source, white pine provides seeds, needles and buds, bark, and the insects that can be gleaned from white pine substrates. White pine seed provides a food source for bird species such as red-breasted nuthatch, pine warbler, common grackle, and evening grosbeak. The black capped chickadee and the pine warbler glean insects from pine needles and bark. White pine seed is an important food for chipmunk, gray squirrel, voles, and an emergency food for white tailed deer. Porcupines will also forage in pine groves looking for carpenter ants. Large white pine stems usually > 18 inches in diameter having a decaying central core are very valuable habitat elements to large-bodied cavity excavators such as pileated woodpecker and other cavity dwellers such as the barred owl, woodpeckers, and red-breasted nuthatches.

Fire Protection: This stand is accessible from Whiting Street Reservoir Road with a four-wheel drive pumper truck for fire management. Water is readily available from the reservoir. No fire events have occurred across this area for decades.

Desired Future Condition: The white pine crop is aging and suffering from stagnation. The development of an all-aged grove of mixed species with a proportion of mature white pine towering above the hardwoods in the upper canopy will provide the best long-term protection to water quality in the reservoir.

Recommended Management Practices: 1. Initiation of a public outreach campaign within the local community to prepare the site users and stakeholders for the preservation of the East Mountain ridge native ecosystems about the necessity of this harvest work amongst the overstocked pine groves. 2. Delineation and mapping of the invasive plant communities, and the initiation of a control program before any harvest work and its continuance after any harvest. 3. Application of the Preparatory Harvest within a Shelterwood Harvest System with the objectives of stand regeneration over thirty years or more, improvement of the vigor and growth of the legacy pine and seed bearing pine trees, and the removal of any potential hazard trees along the edges of the stands.

Stand Number	Forest Type	Silviculture Practice	Stand Area (acres)	Basal Area Removal (sq.ft/ac)	Volume Removal (MBF)	Firewood Removal (Cords)	Pulpwood Removal (Cords)	Timing
3.01	WP	Irregular Shelterwood Harvest-Preparatory Harvest	48	<=100	280	--	300	2019-2024

Management Practice Objective: The long-term objective for this stand is the conversion of the declining plantation to a species diverse, un-even aged forest capable of resistance to pathogens, disease and climate change and natural water filtration and purification. The Preparatory Harvest of a Shelterwood System removes an estimated one third of the growing stock in the stand. This approach retains another one third of the growing stock through its biological lifespan for seed production, aesthetic appeal, and the habitat benefit of the mature pine.

Trees to be removed and retained: The application of the complete regeneration of this stagnant pine grove will require several decades, therefore the criteria for designated crop trees include the largest live crown ratio, secure rooting systems, minimal sap streaking, and crack free lower boles. It is advisable to retain small groups or rings of these superior genotype trees for wind firmness. These trees have grown closely for almost a century, and their release might leave even the best trees prone to windfall or snapping. The crop trees will be expected to produce seed for regeneration and support the stand for another thirty years with many surviving another one hundred years. Once the crop and legacy trees have been chosen, the trees for harvest will be the smaller diameter stems with tiny, asymmetrical crowns, excessive black knot defects along the main bole, and fissures on the base of the trunk.

Regeneration Concerns: Despite full canopy closure, seedlings of black birch, sugar maple, and red oak sprouted across the forest floor. Seedling establishment will be easy, yet the shrub layer may also thrive with the increased sunlight.

Soil Considerations: These fine-grained sand and gravel soils drain directly into Whiting Street reservoir restricting the natural filtration process to a short period. Scheduling of all harvest work during stale ground conditions in the winter months prevents undue disturbance to the roads and soils. Priority habitat zones require frozen ground scheduling of all management work under Massachusetts Endangered Species regulations.

Invasive Plant Management: Treatment of the plants scattered through the stand interior, along the roadside, and on the edges of the stand with the riparian zones is recommended to prevent their spread. Annual monitoring inspections of the forest conditions post harvest for detection of spread into the regeneration zones will direct the use of resources for plant removals. The removal work can be done manually with the removal of the plants from the soils and with mowing and brushing along the road.

Habitat Considerations: The proposed harvest will increase the vertical stratification within this stand and enhance biodiversity. The legacy pine trees will provide excellent perching and roosting opportunities near the water. The silviculture practices will incorporate the guidelines of existing Conservation Management Practices from Massachusetts Division of Fish and Game NHESP publications.

Objective	Stand #	Forest Type	Stand Area (acres)	MSD or Size Class (inches)	Basal Area (sq.ft./ac)	Volume Per Acre	Site Index	DCR/FIA Growth Rate (MBF/yr.)
Stewardship Green Cert.	3.02	OH	184.1	16 RO: 22	133	8.750 MBF 6 cords	WP: 55 RO: 55	25.255

Water Quality Concerns: The goal for water quality protection on these watershed lands is the prevention of the movement of sediment and nutrients from the upland forests through the soils and streams drain water across the upper slopes into the Whiting Street Reservoir. Retention of full canopy cover protects the soil structure and precludes any sediment loss off the upper slopes.

Silviculture Status: Suitable but not relevant during the 2016 to 2026 operating period.

Terrain/Topography: This stand clings to the upper talus rock slope in the northern section of the watershed. As one moves south through the property, the pitch lessens, and terrain broadens out

across a wide alluvial plain. Several small streams drain water eastward across the slopes into the reservoir.

Soils: Bedrock outcroppings and exposed basalt are common amongst the Rock Outcropping Holyoke Complex soils along the upper slopes. The stand grows above the fertile Broadbrook sandy loams on the lower slopes. Small boulder and rock fields dot the mid-slopes in the northern section of the stand.

Timber Harvesting: Not applicable.

Overstory: The stand has a two-storied structure with large sized (>=23 inches) red oak trees sharing the upper canopy with sugar maple, hickory, white oak, black oak, and scattered white pine trees, and a moderate stocking level of slightly younger, well-formed, vigorous 14 to 16 inches red oak, black birch, white ash, sugar maple, and red maple timber crop trees beneath them in the middle canopy. The maturing red oak crop (average age 150 years) has excellent quality. The hemlock crop declined and died out of these stands over the last decade. The oak crowns suffered damage from the recent storm events, yet the stand was in general healthy with the exception of declining paper birch and white ash trees.

Understory

Regeneration: The older crowns spread wide across the upper canopy and prevent full sunlight into the lower layers for seed germination and seedling development. The shade tolerant species such as black birch and sugar maple are seeding into the stand, and white pine prolifically seeds along the edges of the pine plantation or adjacent to the scattered legacy white pine stems. Hemlock seedlings are present, yet most of them show serious needle dieback.

Shrub and Herbaceous Cover: The upper slope acidic rock cliff communities are the least diverse of local habitats. They support low nutrient demanding plants such as blueberry, lycopodium, Virginia creeper, polypoda, and harebell. Moving across the convex slopes towards the reservoir, the native shrub stocking explodes. Common species include witchazel, blueberry, beaked hazelnut, and flowering dogwood. Maple leaved viburnum and ironwood, a small native tree, exploited the available growing space on the forest floor. These shade tolerant plants contribute over 65% of the shrub cover. Their stocking levels prevent adequate seedling development.

Invasive Plants: Individual stems of Japanese barberry, multiflora rose, and Asiatic bittersweet dot the stand's interior, but their stocking levels rise along the Whiting Street Reservoir Road edge and the edges of the riparian zones. Their stocking rating overall is a C, with ratings of A in the hot spot zones. These plants pose no threat to native plant community throughout this dry site oak hardwood stand.

Habitat: Small caves provide denning and nesting opportunities for porcupine, and small mammals up on the high talus slopes. The small ridge top site on the western bound had caches of acorn shards scattered over the rocks. Small niches of beech trees provide diversity with the mast crop. Pileated woodpecker damage was noted in most of the white ash trees. Three vernal pools lie close to the western bound. Abundant fine and coarse woody material clutters the forest floor from the storm damage. This material supports the lifecycle of invertebrates and fungi and provides burrowing and nesting sites form small mammals. The oldest red oak and sugar maple trees have plenty of cavities and holes for denning.

Fire Protection: This stand is accessible in most sections with a four-wheel drive pumper truck for fire management with the exception of the rocky, upper slopes. Water is readily available from the reservoir. No evidence of a recent fire event was noted.

Desired Future Condition: The long-term objective for this stand is its development into a mature all-aged species diverse forest community. The reproductive class is deficient at this time, yet the dense shrub cover provides soil stability. Seedlings will continue to establish themselves beneath

the canopy shade. Since red oak crops live for a longtime, the regeneration of this stand will be addressed in the future.

Special Stewardship Considerations: A small waterfall cascades across the exposed talus slope in the northern tip of the property. A trail into the Mountain Park lands passes this waterfall.

Objective	Stand #	Forest Type	Stand Area (acres)	MSD or Size Class (inches)	Basal Area (sq.ft./ac)	Volume Per Acre	Site Index	DCR/FIA Growth Rate (MBF/yr.)
Stewardship Green Cert.	3.03	RZ-RM	12	RO and WP: 18 RM in swamps: 7	95	3.975 MBF 4 cords	WP: 55 RO: 55	2.754

Water Quality Concerns: The goal for water quality protection on these watershed lands is the prevention of the movement of sediment and nutrients from the upland forests through the soils and streams into the Whiting Street Reservoir. These sites are the last barrier for filtration of sediment and toxins. Retention of full canopy and shrub cover will protect the forest soils from displacement.

Silviculture Status: Not suitable.

Terrain/Topography: This stand lies in the depression and swales across the landscape and in the small inlets along the reservoir shoreline.

Soils: The small patches of this type grow above a matrix of the fine sandy Broadbrook loams and the hydric Swansea and Raynham soils. Water collects in these soils from run-off and spring effusion.

Timber Harvesting: Not applicable.

Narrative: Riparian areas are lands that occur along watercourses and water bodies. On this property they include forested wetlands, red maple swamps, and shrub swamps along the reservoir shoreline. The pattern of vegetation placement expands from the core of each small area of the riparian zone with a stream or watercourse (spring seep flow or stream flow) in the center, red maple and shrub swamp habitat directly adjacent to the water, and the forested wetlands more removed from the water.

In the southern tip of the reservoir lands this pattern is evident. A saturated red maple sapling and pole wetland (with scattered red oak timber trees) lies due east of the access road from Easthampton Road. Associated hardwood trees in this wetland include aspen, elm, white ash, and paper birch. A rare 22-inch elm tree grows in this area. Run-off and spring seep flow moves north through this small strip and drains in a defined channel towards the reservoir. East of the drainage, the water table is rising and flooding a small section of a white pine grove. These trees are dying and developing into excellent snag and cavity stems. The eastern portion of this site drains a small stream with a picturesque waterfall near the property bound.

A long, narrow band of red maple and shrub swamp habitat extends along the length of a depression from the southern bound near the Wyckoff Golf Course up to and crossing Aerator Road. Sapling and pole sized red maple growing in stump sprout clusters tower about thickets of native wetland shrubs inclusive of spicebush, speckled alder, witchazel, grey dogwood, and illex. Despite the soil moisture, white pine seedlings dot the understory in this strip.

Another small section of the stand lies in a broad swale that surrounds the confluence of two small drainages immediately north of Aerator Road (the road from the gate on Mountain Park Road into the earthen dam site). The water drains through this stand in two cement-lined canals. A mix of white pine, Norway spruce red and white oak, and immature red maple, white ash, aspen, pin cherry, and paper birch sapling and pole trees share this small wetland. A high stocking of invasive plants dominates the forest floor. Some of species include multiflora rose, japans barberry, Asiatic bittersweet, glossy buckthorn, and winged euyonomous. Bittersweet vines aggressively climb and topple over larger trees and shrubs.

A small shrub swamp follows the drainage channel from Mountain Park into the reservoir at the northern tip of the lands. Statuesque mature red oak trees line the drainage, and a small waterfall borders the wetland and the upland oak site.

Invasive Plants: The invasive plant community spread into these small niches. Their stocking rating is a B+ to A throughout each of the sites. They expanded into the edges of the pine plantation and oak hardwood stand. The filtration function of the riparian areas would be threatened if chemical control were used for these plants. A monitoring program within the white pine stand can initiate an early detection and rapid response program for protection of the regeneration beds beneath the pine. Natural corrective measures would be used for plant removal on the edges of the silviculturally suitable stands. Retention of full canopy and shrub cover throughout the riparian zones will prevent further growing site exploitation.

Habitat: Dense shrub cover provides forage and breeding sites for woodcock, ruffed grouse, and wetland songbirds such as the Canadian warbler. Sign of use of these areas by raccoon, white tailed deer, pileated woodpecker, and coyote were noted during the field inventory. Migrating birds use red maple swamps as they pass the Connecticut River valley. All of the native shrubs produce palatable fruit crops each year.

Fire Protection: This stand is accessible from the Whiting Street Reservoir Road with a four-wheel drive pumper truck for fire management. Water is readily available from the reservoir for protection in the event of a fire. No fire events have occurred across this area for decades.

Desired Future Condition: These sites function as core habitat and water filtration strips across the landscape. No disturbance is recommended in these sites.

Objective	Stand #	Forest Type	Stand Area (acres)	MSD or Size Class (inches)	Basal Area (sq.ft./ac)	Volume Per Acre	Site Index	DCR/FIA Growth Rate (MBF/yr.)
Stewardship Green Cert.	3.04	OH	17.0	17.5	95	3.974 MBF 4 cords	WP: 65 RO: 65	2.754

Water Quality Concerns: The goal for water quality protection on these watershed lands is the prevention of the movement of sediment and nutrients from the upland forests through the soils and streams into the Whiting Street Reservoir. Full retention of the canopy cover will protect soil integrity in this stand.

Silviculture Status: Suitable but not applicable during the 2016 to 2026 operating period.

Terrain/Topography: This stand lies upon a gentle, level outwash plain along the eastern property bound with the Wyckoff Golf Course.

Soils: The productive deep Broadbrook sandy loams support this stand.

Timber Harvesting: Not applicable.

Overstory: This stand is similar to Stand 3.02, but the area was harvested for timber products over six years ago. Consequently, this stand has developed more of an all aged structure. Maturing red oak (52% of stand stocking) trees share the site with white oak, black birch, red maple, black oak, and scattered white pine timber sized trees. The quality of these trees is fair to good. Many of the red oak trees sprouted epicormic branches from the exposure to sunlight that degrade the future lumber value.

Understory

Regeneration: A dense seedling and sapling layer developed post harvest with dominance by black birch and white pine. These young trees are vigorous; many stems reached heights close to six feet in a few growing seasons.

Shrub and Herbaceous Cover: The rich soils support a dense mat of ferns, herbaceous plants and shrubs. Common species include Christmas fern, partridgeberry, hay scented fern, witchazel, blueberry, beaked hazelnut, maple leaved viburnum, and musclewood. Mountain laurel covers about 30% of the forest floor.

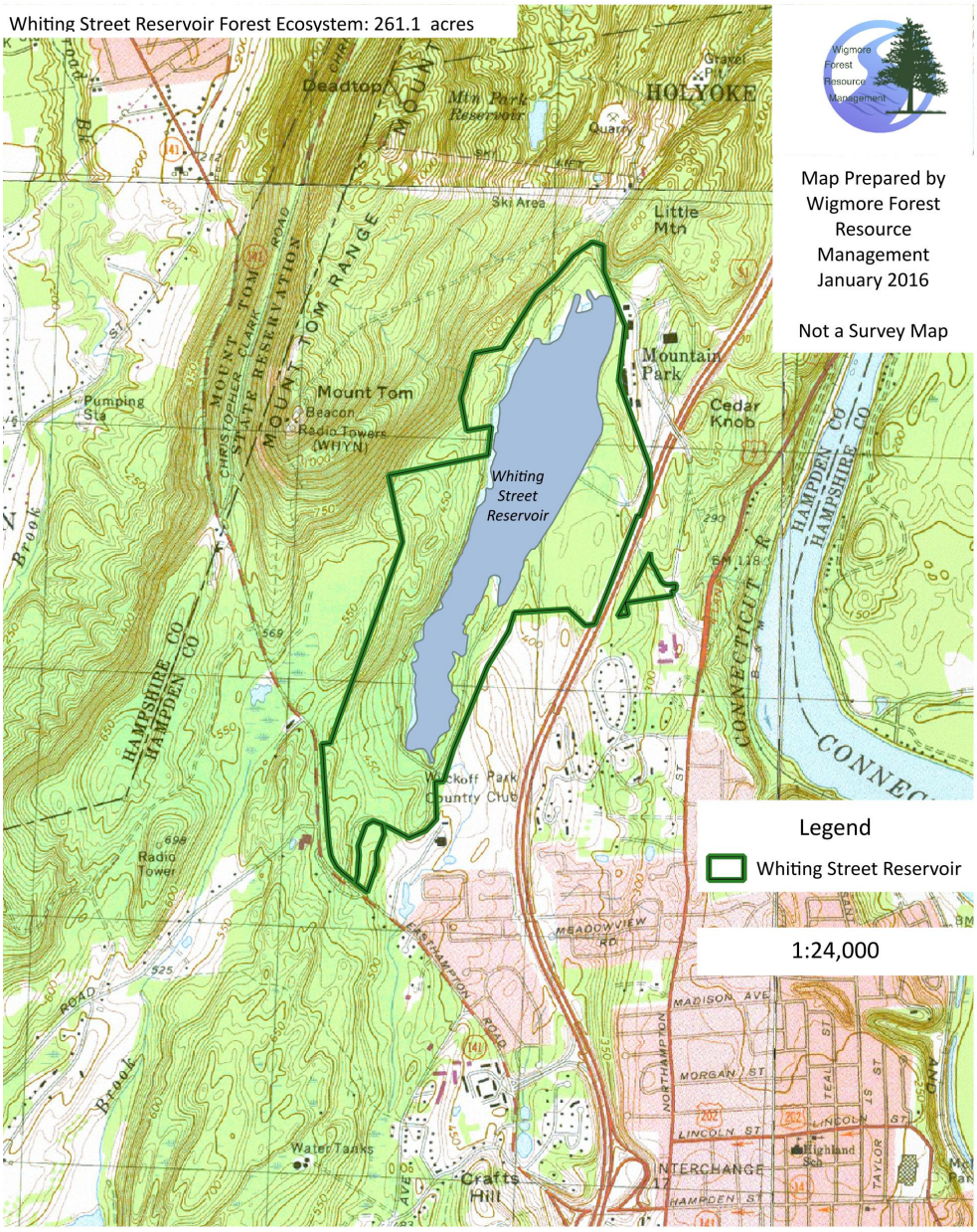
Invasive Plants: Individual stems of Japanese barberry, multiflora rose, and Asiatic bittersweet dot the stand's interior, but their stocking level rating is a C. More plants were found near the property bound. The dense laurel cover prevents their exploitation of the recently opened forest canopy. These plants do not pose a threat to the native plant community.

Habitat: A dense shrub layer offers foraging, breeding, and nesting cover for small mammals and songbirds. Some of the maturing red oak trees have cavities for denning, and they set ample mast crops each fall.

Fire Protection: This stand is accessible with a four-wheel drive pumper truck for fire management. Water is readily available from the reservoir. No evidence of a recent fire event was noted.

Desired Future Condition: The long-term objective from this stand is its development into a mature all-aged species diverse forest ecosystem capable of water filtration and purification. No silviculture work is necessary during the operating period 2016 to 2026.

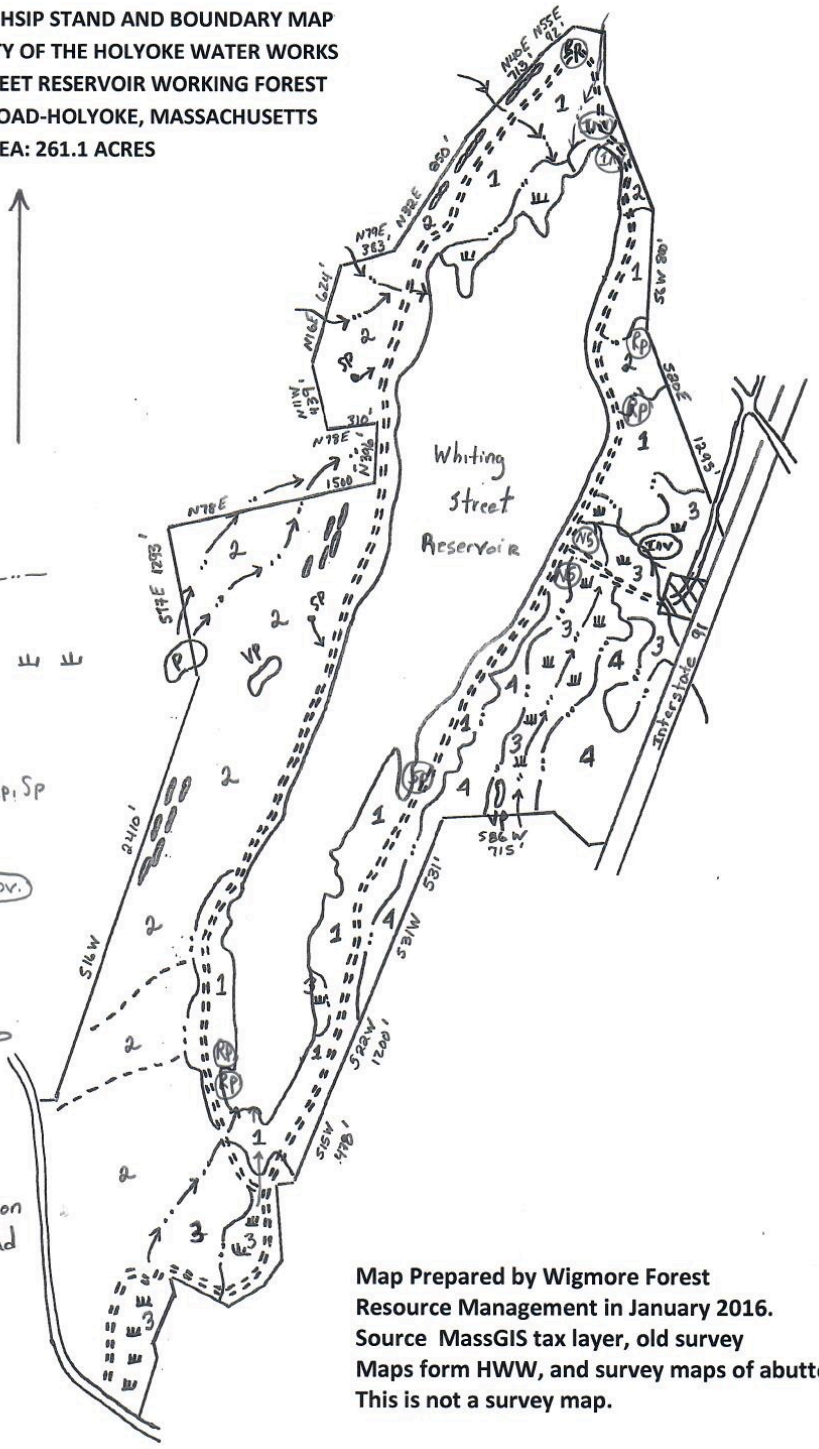
Holyoke Water Works
Whiting Street Reservoir Watershed
Locus Map



FOREST STEWARDHSIP STAND AND BOUNDARY MAP
FOR THE PROPERTY OF THE HOLYOKE WATER WORKS
THE WHITING STREET RESERVOIR WORKING FOREST
EASTHAMPTON ROAD-HOLYOKE, MASSACHUSETTS
STEWARDSHIP AREA: 261.1 ACRES

Map Scale
1 inch = 1,075 feet

True North



Physical Feature Legend

- Forest Stand Boundary
- Forest Stand Number 1
- Hydric Soils/Wetland Site
- Excluded sites
- Gravel Road
- Groves of red pine and spruce trees Rp, Sp
- Hiking Trail
- Invasive Plant Hotspot Inv.
- Paved Road
- Pond P
- Large Rock Outcroppings
- Spring Seep SP
- Stream
- Vernal Pool VP

Map Prepared by Wigmore Forest Resource Management in January 2016.
Source MassGIS tax layer, old survey Maps form HWW, and survey maps of abutters.
This is not a survey map.

Signature Page Please check each box that applies.

☐ **CH. 61/61A Management Plan** I attest that I am familiar with and will be bound by all applicable Federal, State, and Local environmental laws and /or rules and regulations of the Department of Conservation and Recreation. I further understand that in the event that

I convey all or any portion of this land during the period of classification, I am under obligation to notify the grantee(s) of all obligations of this plan which become his/hers to perform and will notify the Department of Conservation and Recreation of said change of ownership.

☒ **Forest Stewardship Plan.** When undertaking management activities, I pledge to abide by the management provisions of this Stewardship Management Plan during the ten year period following approval. I understand that in the event that I convey all or a portion

of the land described in this plan during the period of the plan, I will notify the Department of Conservation and Recreation of this change in ownership.

☒ **Green Certification.** I pledge to abide by the FSC Northeast Regional Standards and MA private lands group certification for a period of five years. To be eligible for Green Certification you must also check the box below.

☐ **Tax considerations.** I attest that I am the registered owner of this property and have paid any and all applicable taxes, including outstanding balances, on this property.

Signed under the pains of perjury:

Owner(s)_____Date_____

Owner(s)_____Date_____

I attest that I have prepared this plan in good faith to reflect the landowner's interest.

Plan Preparer_____Date_____

I attest that the plan satisfactorily meets the requirements of CH61/61A and/or the Forest Stewardship Program.

Approved, Service Forester_____Date_____

Approved, Regional Supervisor_____Date_____