Planning Assistance to States

Assabet River, Massachusetts
Sediment and Dam Removal Feasibility Study

September 2010

**US Army Corps
of Engineers
New England District**

Planning Assistance to States Program

ASSABET RIVER
SEDIMENT AND DAM REMOVAL FEASIBILITY STUDY

Department of the Army
New England District
U.S. Army Corps of Engineers
Concord, MA

September 2010

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EXECUTIVE SUMMARY

This investigation was conducted by the New England District of the U.S. Army Corps of Engineers (Corps) under the Planning Assistance to States (PAS) Program as authorized in Public Law 93-251 and amended in subsequent legislation. The study was performed through a 50/50 cost sharing agreement with the Massachusetts Department of Environmental Protection (MassDEP). The MassDEP entered into a Memorandum of Understanding (MOU) with the six Assabet River Consortium communities (Westborough, Shrewsbury, Northborough, Marlborough, Hudson, and Maynard) for the sediment and dam removal study. The MOU established a Study Coordination Team (SCT) made up of twelve members, six from the communities and six selected by MassDEP including the Organization for the Assabet River (OAR), to collaborate in the study effort**.**

Purpose

The purpose of this study is to provide planning assistance (planning level engineering and scientific information) to MassDEP on the potential feasibility of sediment and dam removal to reduce internal recycling of phosphorus (sediment phosphorus flux) in the Assabet River. The first part of the study focused on reductions in internal phosphorus recycling from sediment for sediment and dam removal measures. The second part of the study focused on engineering and environmental considerations for hypothetical dam removal.

If in the future a proponent steps forward who wishes to pursue dam removal, then there would be a detailed environmental assessment and permitting process involved at all levels of government – local, state, and Federal.

The following six dams on the river, and the associated sediment behind them, were considered in the planning study:

- Aluminum City Dam, Northborough
- Allen Street Dam, Northborough
- Hudson Dam, Hudson
- Gleasondale Dam, Stow
- Ben Smith Dam, Maynard
- Powdermill Dam, Acton

Background

MassDEP in 2004 prepared a "Total Maximum Daily Load for Phosphorus" (TMDL) for the river to address the problem of eutrophication throughout the Assabet River system in response to high levels of phosphorus. The TMDL required implementation of measures to decrease phosphorus loading to the river and adopted an adaptive management approach in accordance with EPA approved procedures. The TMDL for the river can be viewed at http://www.state.ma.us/dep/water/resources/tmdls.htm#suasco.

Studies by MassDEP have determined that the Assabet River experiences the effects of eutrophication due to excessive nutrient loadings (particularly phosphorus) from wastewater treatment facilities (WWTFs), nonpoint sources, and sediment phosphors flux and that nuisance aquatic vegetation related to eutrophication impairs designated uses as defined by State Water Quality Standards including recreation, aesthetics, and fish and wildlife habitat.

Phase 1 of the TMDL required that the four WWTFs discharging to the Assabet River decrease the total phosphorus in their effluent to 0.1 mg/l (April to October) and 1.0 mg/l (November to March). The 0.1 mg/l requirement resulted in the need to add new phosphorus removal technology at the same time as doing significant facility upgrades. These upgrades are currently being implemented and paid for by the communities that own or use the WWTFs.

Phase 2 of the TMDL required additional projects be implemented to continue to decrease total phosphorus loading to the river. The MassDEP 2004 phosphorus TMDL indicated that to achieve compliance with water quality standards a 90 percent reduction in sediment phosphorus flux was needed in addition to Phase 1 WWTF improvements. Potential options identified in the 2004 TMDL to achieve the 90 percent sediment phosphorus flux reduction included sediment and/or dam removal on the Assabet River.

The Corps "Planning Assistance to States Study" study is a follow-on effort to the MassDEP 2004 TMDL to provide additional information on the feasibility of sediment and dam removal to decrease sediment phosphorus flux.

Modeling and Modeling Results

In the first part of the study the Corps contracted with the engineering firm of Camp, Dresser, and McKee (CDM) to perform data collection and computer modeling. Computer models used are listed below and an analysis is provided in the CDM "Modeling Report" dated June 2008.

- HEC-RAS model was used to examine the effect of dam removal on water surface elevations.
- HEC-6 model used to simulate the movement of sediment following dam removal, and changes to the riverbed profile following dredging.
- HSPF model was used to qualitatively assess either positive or negative changes in water quality associated with the measure (dam removal and dredging).
- A spreadsheet model, based on equations from the US-EPA QUAL2K model, was used to understand the dynamics of phosphorus flux in the system.

The following summarizes the results of that analysis.

<u>Sediment Dredging Alone</u>
Dredging of sediment from behind dams was considered to decrease sediment phosphorus flux. However, dredging alone would at best achieve only short-term (~ two to four years) reductions in sediment-phosphorus release and the increased hydraulic residence time in the impoundments would likely do more to stimulate biomass growth than the reduction in sediment phosphorus loading would inhibit it. Therefore dredging alone was not considered to be a viable control measure.

<u>Sediment Deactivation</u>
Sediment deactivation was also considered to decrease sediment phosphorus flux. This measure is generally used in lakes. The approach is to apply a chemical (aluminum, iron or calcium salts have been used) so that the chemical both scavenges inorganic phosphorus in the water column and then seal the sediment to hinder the recycling of sediment phosphorous into the water column. In the Assabet, however, it was estimated that there would be fairly rapid (2-5 years) phosphorus replenishment from the settling of biomass and in-stream phosphorus contributions to the sediment. Sediment de-activation is not considered to be a viable long-term measure.

<u>Planned WWTF Improvements</u>
Modeling results suggest that significant strides will be made toward the TMDL goal of 90% reduction in sediment phosphorus flux and overall improved water quality when the current planned improvements are in place at the WWTFs. Planned reductions in phosphorus discharges from WWTFs and the goal of a 90 percent reduction in sediment phosphorus release are not independent; the planned improvements at WWTFs are likely to collectively yield a significant reduction in sediment phosphorus flux.

Dam Removal and Planned WWTF Phosphorus Reductions

Dam removal in combination with planned reductions in WWTF was also considered. Expected water quality improvements include higher minimum dissolved oxygen levels, lower ranges of diurnal DO fluctuation, fewer and less severe occurrences of DO super-saturation, cooler water temperatures, and less nuisance aquatic vegetation.

Modeling results indicated that the potential removal of Ben Smith dam would contribute to achievement of water quality goals through reductions in sediment phosphorus flux because the biomass growth and settling that ultimately drives the sediment flux would decrease with dam removal.

Modeling results also indicated that potential removal Hudson and Gleasondale dams would also contribute incrementally to these goals. Removal of the two most upstream dams in this study, Aluminum City and Allen Street, would result in water quality improvements in stream reaches affected by the existing impoundments, but would have minimal effects on downstream water quality. Similarly, removal of Powdermill dam would have only localized benefits.

Dredging of any or all of the impoundments is suggested only to control sediment movement following dam removal; and as noted above it has no significant long term water quality benefits by itself.

Estimated Reductions in Sediment Phosphorus Flux

The modeling analysis indicated that the planned WWTF improvements would result in a 60 percent reduction in P-Load and potential dam removals would provide another 20 percent reduction. The estimated 20 percent is a conservative estimate and the percent reduction from dam removal may be greater. With both planned WWTF improvements and dam removals the sediment phosphorus flux reduction is estimated to be approximately 80 percent, near the TMDL target of 90 percent reduction.

Adaptive Management Approach

During this study additional data was collected by CDM on sediment P-flux in the Assabet River to help understand the nature of sediment phosphorus flux. Both the sediment phosphorus flux field data collected, as well as the mass balance (spreadsheet) model of sediment-phosphorous flux, led to better understanding of the seasonality associated with sediment phosphorus flux. Results indicate that the sediment response to a change in overlying water phosphorus concentration is fairly short (several seasons).

This realization supports the adaptive management approach adopted by MassDEP in the 2004 TMDL. Also as there are inherent limitations and uncertainties of predictive modeling of a dynamic physical, chemical, and biological system, the accuracy and effectiveness of target reductions could be confirmed by monitoring.

Seasonal WWTF Discharge Limit

Although consideration of lower WWTF winter P-discharge limits was not specifically part of this study, the P-flux model based on limited laboratory data indicated that winter P-loading may have an effect on summer sediment flux rates. If this is confirmed, the additional reductions in phosphorus levels in WWTF discharges during the non-growing season (below the current planned limit of 1mg/L) may make a significant contribution to achieving water quality standards, especially if only limited or no dam removal is undertaken. Further study is necessary to better understand this issue.

An additional consideration of the modeling study was that if no other improvements were implemented, further reductions in summer P discharge limits, below 0.1 mg/L, would not contribute significantly to further reduction in sediment phosphorus flux. This is because the analysis indicated that the winter instream phosphorus concentration has a strong effect on the P-flux the following summer. Therefore, if the summer P discharge limits were decreased below 0.1 mg/L without any further reduction in winter limits, the P-flux in the summer would still be "controlled" by the winter instream phosphorus concentration.

Potential Dam and Sediment Removal

The second part of the "Planning Assistance to States Study" study focused on feasibility of dam removal including engineering considerations and identification of some of the environmental impacts that would be associated with a potential dam removal project.

This study was not meant to be an Environmental Impact Assessment document of dam removal nor is it a Corps decision document. There are many permits and environmental studies at all levels of government that would apply to a dam removal project if a dam removal proponent were to step forward. Federal laws such as the National Environmental Policy Act, the Clean Water Act, the Endangered Species Act, the Fish and Wildlife Coordination Act, the National Historic Preservations Act, (to name a few) as well as Massachusetts and local laws and regulations would provide the framework for the detailed evaluation of potential projects if any are proposed in the future.

The planning study identified engineering and environmental issues related to dam removal and these are summarized below.

Sediment Quantity and Sediment Management

The Assabet River Study dams have been in place since the late 1800s and early 1900s and as a result sediments have accumulated behind these dams. If the dams are removed some of this material would reposition within the channel and some would move downstream. The quantity of sediment that would move downstream in a short period of time following dam removal was estimated using the HEC 6 computer model. Sediment volume estimates to be managed ranged from 1,300 to 67,600 cubic yards for Aluminum City and Ben Smith dams, respectively.

Also review of sediment quality data indicated that some of the sediments contain contaminants that may limit disposal options. It is suggested that additional sediment sampling and testing be performed if further studies of dam removals are undertaken. Suggested detailed sampling plans for Assabet River sediments above the dams are provided in the CDM 2008 "Assabet River Sediment Management Plan" report. These sampling plans do not address environmental or health risk assessments of sediments currently under water that could be exposed by dam removal. It is possible that these types of studies may be requested by regulatory agencies as part of future work on dam removal feasibility.

Construction Cost Estimates for Dam Removal

Construction cost estimates for hypothetical dam removal, prepared by CDM in 2008, ranged from about 1 million dollars for the Aluminum City dam to 12 million dollars for Ben Smith dam. In addition to construction costs, costs for a dam removal project would include environmental studies and public review, design, permitting, and project management. These costs are not estimated at this time and would vary depending on the entity that might implement a potential dam removal project. Also there would be real estate costs associated with implementation including items such as cost of the purchase of the dam, permanent or temporary construction easements, and purchase of land in fee as determined to be needed for a project. Also increases in sediment volumes that need to be managed and disposal constraints due to contaminants would increase construction cost estimates.

Target Fish Community Analyses

A target fish community (TFC) can be used as a guide to identify the composition of a healthy fish community for large streams and small rivers in the New England region and can guide and help evaluate river rehabilitation.

The existing fish community (EFC) in the Assabet is not consistent with the target fish community (TFC) considered for the river. Current fish species composition consists primarily of macrohabitat generalists and pollution tolerant species. The overall dominance of macrohabitat generalists and lack of fluvial specialist is directly related to the effect of the dams and the creation of impoundments in what naturally would be free flowing stretches of river.

The current fish population is dominated by more pollution tolerant species (e.g. white sucker and bluegill). It is expected that removing dams on the Assabet River and improving water quality would provide habitat that would support the increase in fluvial dependent and fluvial specialist species consistent with the considered target fish community (TFC) for this river.

Over the long term, removing dams on the Assabet would also provide for the future restoration of the migratory corridor on the Assabet and provide access to spawning grounds and nursery habitat for anadromous species when passage is provided at the Talbot Dam in Billerica.

If in the future dam removal were considered further, additional studies of fish populations on the river would be useful to assess changes that would take place.

Impact of Dam Removal on Water Surface Elevations

Computer modeling of the Assabet River included an examination of the effect of dam removals on water surface elevations. Changes were calculated using the HEC-RAS computer model developed for the study. The HEC-RAS model results indicate that dam removal significantly lowers the water surface elevations behind the dams.

Recreation

If the dams on the Assabet River were to be removed this would impact the recreational uses that rely on the impoundments and the deeper water depth provide by the impoundments. Recreational activities on the impoundments include canoeing, kayaking, fishing, ice skating, cross-country skiing and enjoyment of the open water environment. A detailed evaluation of recreational impacts was not part of this study but would be needed if dam removal is considered further. A recreational use survey would be valuable to document the many recreational uses of the river.

Water Supply

The Town of Stow relies on the Assabet River at both Gleasondale dam and the Ben Smith dam as a source of water for fire protection for the surrounding communities. Also some businesses along the river rely on the river as a source of irrigation. In addition there are fire ponds and wells adjacent to the river that would need to be considered. If dam removal were considered further then water supply uses would need to be considered in more detail to determine the impact of dam removal and mitigation plans would also need to be developed as appropriate.

Mill Pond at Clock Tower Place

If Ben Smith dam were to be removed then the Assabet River water level at the current canal intake point would drop such that water would no longer flow by gravity into the mill pond at Clock Tower Place. Options would need to be evaluated to provide water to the mill pond.

Flood Levels

Removing dams would lower water levels in the Assabet River. Storage behind the dams is small and would not be entirely lost if the dams are removed, because the dams are located at natural restrictions in the river, the effects of dam removal on downstream peak flows would be small. Future studies would be needed to determine if it is necessary to leave part of the abutments in place to further restrict flood flows such that there is no increase in downstream peak discharges; however, the elimination of the pools behind the dams would mean that the same storage as before dam removal can be achieved at a lower water level.

Wetlands Impacts

Many of the wetlands along the Assabet River exist because of the water backed up by the dams. The planning level analysis determined that there would be both changes in wetland types and a loss of wetlands as a result of dam removal. The largest changes in wetlands would occur behind Ben Smith, Gleasondale, and Hudson dams. If a potential dam removal project were to be considered further, wetlands impacts and potential mitigation would need to be assessed. Wetlands are regulated under both Federal and state laws.

Wildlife and Rare Species Habitat

Wildlife habitat includes open water areas, wetlands, and upland forest. These areas provide valuable habitat for a variety of invertebrates, amphibians, reptiles, birds, and mammals. The Massachusetts Natural Heritage Program has identified areas within the Assabet River watershed as potential habitat for rare species. Further detailed studies and assessments of wildlife resources and impacts would be needed if a dam removal project were to be considered.

Cultural Resources

All of the dams have identified cultural resource value. Ben Smith, Gleasondale, Hudson, and Allen Street dams are contributing elements to historic districts that are eligible for or listed with the National Register of Historic Places and removal would be an adverse impact and require further studies and documentation of the resources. Further study would also be required of Aluminum City to determine significance. Also, all potential removals would require further consideration of archaeological resources as areas in the vicinity of the river were used prior to European settlement by native groups dating back to 8,000 BP (before present).

All dam removal projects would be subject to consultation and review by the Massachusetts State Historic Preservation Officer and the Wampanoag Tribe of Gay Head (Aquinnah) Tribal Historic Preservation Officer (THPO), as well as the Mashpee Wampanoag THPO.

Public Review

The Corps and MassDEP held two public meetings in November of 2009 to inform local stakeholders of the study findings. Comment letters demonstrate that many in the local communities and stakeholders value the existing impoundments and dams for many reasons including: recreation, aesthetics, wetlands, fish and wildlife communities, historic and cultural significance, and as a water source for fire protection and irrigation.

Stakeholders are concerned about the potential public health risk of exposure to sediments currently under water, the cost of a dam removal project including the potential cost of sediment management, disruption during construction, potential impact on the real estate values of adjacent homes, potential impacts to business or local residents that rely on the impoundments or groundwater near the river as a source of water, potential increase in flood risk, and loss of recreation associated with the impoundments. There were many letters received opposing dam removal on the Assabet River. Stakeholders are strongly opposed to further consideration of Ben Smith dam removal.

Comment letters also raised the issues of wastewater treatment plant permitting, year round phosphorus limits, and an adaptive management approach to improve water quality in the Assabet River. Comments made at the first public meeting by several municipal officials supported an adaptive management approach that considered winter time phosphorus reductions and monitoring prior to considering additional upgrades and/or potential dam removal. Comments received on the draft and responses are included in Appendix K.

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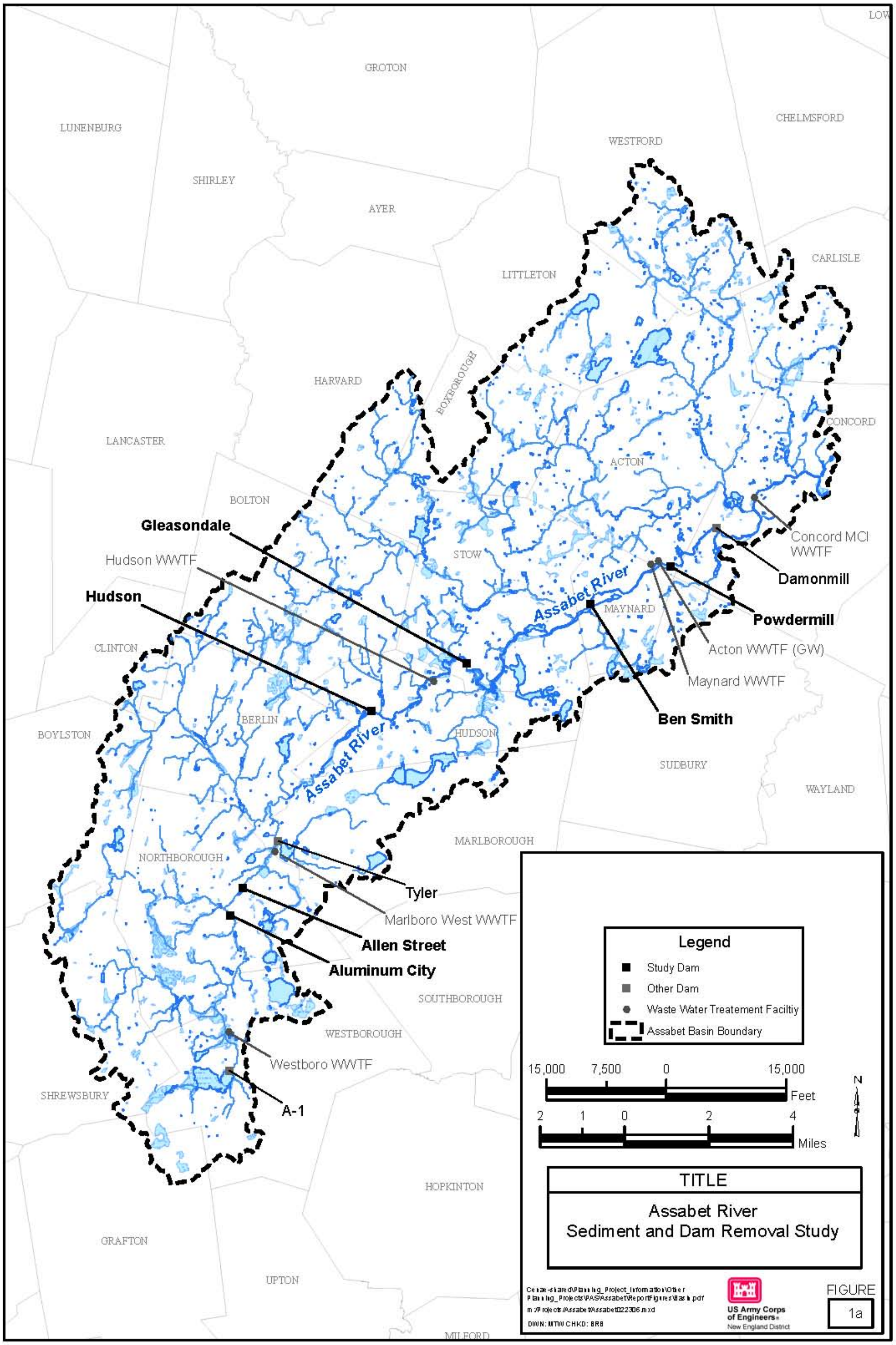
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AYER
CARLISLE
LITTLETON
HARVARD
BOXBOROUGH
CONCORD
LANCASTER
ACTON
BOLTON
Gleasondale
Concord MCI WWTF
Hudson WWTF
STOW
Damonmill
Hudson
Assabet River
MAYNARD
Powdermill
CLINTON
Acton WWTF (GW)
Maynard WWTF
Ben Smith
BERLIN
BOYLSTON
HUDSON
SUDBURY
WAYLAND
MARLBOROUGH
NORTHBOROUGH
Tyler
Marlboro West WWTF
Allen Street
Aluminum City
SOUTHBOROUGH
WESTBOROUGH
Westboro WWTF
SHREWSBURY
A-1
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GRAFTON
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Study Dam
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Assabet Basin Boundary
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Assabet River
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CDM Reports (available at: http://www.nae.usace.army.mil/projects/ma/AssabetRiver/assabetriver.htm)

Assabet River Sediment Management Plan, December 2008

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INTRODUCTION

Study Authority

This investigation was conducted by the New England District of the U.S. Army Corps of Engineers (Corps) under the Planning Assistance to States (PAS) Program as authorized in Public Law 93-251 and amended in subsequent legislation. The study was performed through a 50/50 cost sharing agreement with the Massachusetts Department of Environmental Protection (MassDEP). The MassDEP entered into a Memorandum of Understanding (MOU) with the six Assabet River Consortium communities (Westborough, Shrewsbury, Northborough, Marlborough, Hudson, and Maynard) for the sediment and dam removal study. The MOU established a Study Coordination Team (SCT) made up of twelve members, six from the communities and six selected by MassDEP including the Organization for the Assabet River (OAR), to collaborate in the study effort.

Study Purpose & Focus

The purpose of this study is to provide planning assistance (planning level engineering and scientific information) to MassDEP on the potential feasibility of sediment and dam removal to reduce internal recycling of phosphorus (sediment phosphorus flux) in the Assabet River. The first part of the study focused on predicting reductions in internal phosphorus recycling from sediment for sediment and dam removal scenarios. The second part of the study focused on engineering and environmental considerations for hypothetical dam removal. If in the future a proponent steps forward who wishes to pursue dam removal, then there would be a detailed environmental assessment and permitting process involved at all levels of government – local, state, and Federal.

Study Background

The Assabet River does not meet state requirements for water quality. Areas behind dams experience significant variations in dissolved oxygen and excessive growth of aquatic vegetation. Both factors result in degraded aquatic habitat. The primary issue is too much phosphorus input to the waterway. Phosphorus, a nutrient, when elevated above normal background levels causes excessive production of floating and rooted aquatic plants. This vegetation growth and decomposition negatively impacts water column dissolved oxygen levels. Adequate dissolved oxygen is required to support aquatic life. Phosphorus loadings originate from both point and non-point sources. Point sources include four publicly owned wastewater treatment facilities

(WWTFs)[1], while non-point sources include internal recycling of phosphorus from sediments and stormwater runoff. The four facilities are the Westborough, Marlborough Westerly, Hudson, and Maynard WWTFs.

The U.S. Environmental Protection Agency (EPA) and MassDEP have developed a Total Maximum Daily Load (TMDL) that requires seasonal reductions of phosphorous loadings from the four WWTFs that discharge to the river to 0.1 mg/l April to October and 1.0 mg/l November to March. In addition, the TMDL requires a 90 percent reduction in sediment phosphorus flux in order to achieve water quality compliance.

Restoration Goals and Objectives

Goals for the Assabet River are: 1) improved water quality to meet Massachusetts water quality standards; and 2) achievement of a sustainable and restored aquatic ecosystem. Water quality objectives for the river are improved dissolved oxygen levels, acceptable levels of biomass production, and acceptable ambient phosphorus concentrations[2]. The primary focus of this study is the goal of 90 percent reduction of phosphorus release by the sediments as specified in the nutrient TMDL for improved water quality.

Study Area

The Assabet River is located in eastern Massachusetts, approximately 20 miles west of Boston. The Assabet River has a length of about 32 miles, and drains a watershed of approximately 177 square miles, flowing through the towns of Westborough, Northborough, Marlborough, Berlin, Hudson, Stow, Maynard, Acton, and Concord, Massachusetts. The Assabet River joins the Sudbury River in Concord to form the Concord River. (See Figure 1.) The Concord River flows about 16 miles northward to the city of Lowell, where it joins the Merrimack River. The Merrimack River continues about another 40 miles to the northeast where it discharges to the Atlantic Ocean at Newburyport, Massachusetts.

The Assabet River drops 177 feet over its 32-mile length for an average slope of 5.5 feet per mile (ENSR, 2001). Generally, the river's slope is relatively flat, approximately 2 feet per mile. Several steeper sections, with gradients as great as 25 feet per mile occur in the river, often immediately below dams. (See Figure 2.)

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[1] There is a fifth small institutional wastewater treatment facility on the river at MCI Concord.

[2] MassDEP phosphorus TMDL did not establish a specific in-stream target concentration for total phosphorus instead a weight-of-evidence approach of all available information will be used to set site-specific permit limits.

Figure 1. Location Map

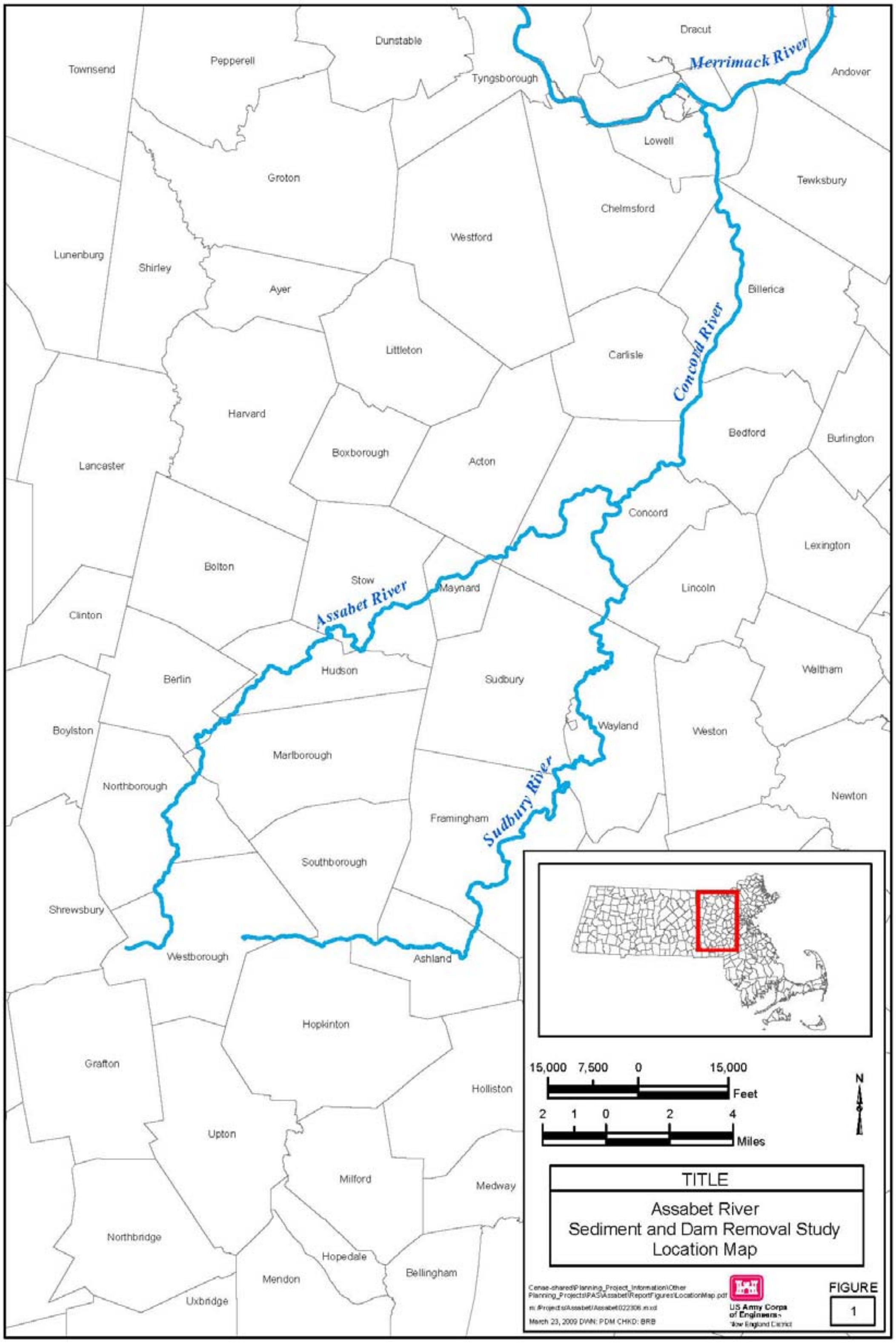

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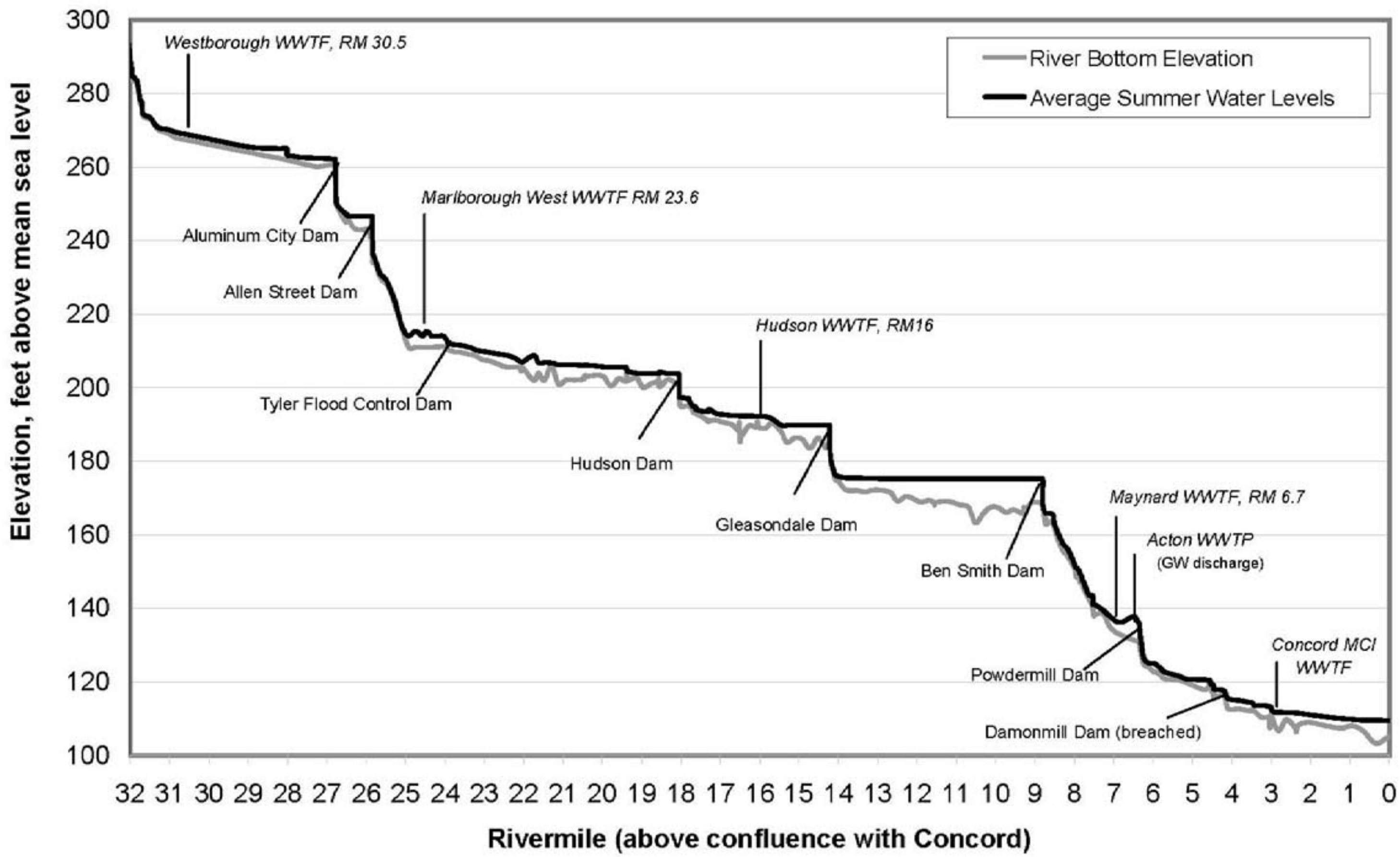
Figure 2. Assabet River Elevation Profile



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Precipitation averages 47 inches/year and average temperature ranges from 25 degrees Fahrenheit in January to 71 degrees Fahrenheit in July. (DeSimone, L.A. 2004. USGS)

Stream flow data for the Assabet River is available at a USGS stream gauge located in Maynard (river mile 7.4). Approximately 2/3 of the Assabet river watershed is upstream of the gauge. Average monthly flows at the Maynard gauge range from about 60 to 75 cubic feet per second (cfs) during low flow summer conditions to about 400 cfs during March and April (ENSR, 2001). Estimates of 7Q10 (seven day, ten year) low flow at the Maynard gauge is estimated at 15.1 cfs. Under low flow conditions, wastewater treatment plant effluent flows can account for a substantial percentage of river flow[3].

There are nine dams on the river. The Assabet River begins in Westborough at the George H. Nichols Dam, also known as the A1 site. The Assabet Reservoir is created by this dam. The dam was constructed by the National Resource Conservation Service (NRCS) in 1968 for flood prevention and fish and wildlife habitat. Downstream from this are seven old mill dams and one additional flood control dam, the Tyler Dam. The Tyler Dam is a "dry bed" flood control facility that was constructed in 1965 by NRCS. The seven old mill dams on the river are:

- Aluminum City Dam, Northborough
- Allen Street Dam, Northborough
- Hudson Dam, Hudson
- Gleasondale Dam, Stow
- Ben Smith Dam, Maynard.
- Powdermill Dam, Acton
- Damonmill Dam, Concord

The locations of these dams are shown in Figure 1 and in Plates 1 to 6 included in Appendix A. The first six dams have year round impoundments above the dams. In addition, above Ben Smith Dam, part of the river is diverted through a canal to a series of mill head ponds at Clock Tower Place (the former American Woolen Mill). This mill pond at Clock Tower Place depends on flows diverted from above the dam to maintain the pond water levels. The last dam on the river, the Damondale Dam in Concord is breached and canoe and fish passage are not blocked by the remnants of the dam.

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[3] The four WWTF discharge to the river above the USGS gage and comprise approximately 80% of the flow at the USGS gage in Maynard during low flow periods. The seven-day average low flow expected once every 10 years (7Q10) is 15.1 cubic feet per second. MassDEP 2004.

The impoundments associated with the old mill dams are generally long and narrow with depths ranging from 3 to 12 feet and widths of 100 to 300 feet. The free-flowing sections of the Assabet River are relatively narrow and shallow, typically 30 to 60 feet wide and 2 to 4 feet deep. Most of the impoundments contain significant deposits of sediments that have built up over time.

The Assabet River watershed is moderately to densely developed, with an average population density of approximately 1,000 people per square mile. Development along the impoundments varies. In urbanized areas the river channel is constrained by walls and other development, but outside of developed areas the Assabet often flows through broad riparian corridors that are buffered from development by floodplain wetlands.

There are two federally designated areas associated with the river. One is the Assabet River National Wildlife Refuge in Stow adjacent to the river and upstream of Ben Smith Dam. The second is the National Park Service, National Wild and Scenic River designated river reach. This designated reach includes a 4.4-mile segment of the Assabet River beginning 1,000 feet downstream from the Damonmill Dam in the town of Concord, to its confluence with the Sudbury River at Egg Rock in Concord.

General restoration of the river has strong, longstanding public support. Advocacy groups supporting the restoration of the river include the Organization for the Assabet River, the Sudbury Valley Trustees, and the Sudbury Assabet Concord Watershed Community Council. These groups represent a wide range of constituency.

Prior Studies and Reports

Numerous studies have investigated the Assabet River. Studies conducted prior to 2000 were summarized by ENSR (2001). These include a variety of water quality studies, stream flow, flood boundary and flood management studies, wastewater discharge studies, and biological studies conducted during the 1960's through 1990's. Water quality and modeling studies were done by ENSR in 2001 and 2004 and a TMDL was completed by MassDEP in 2004. In addition, studies have been completed by USGS including "Sediment Studies in the Assabet River, Central Massachusetts, 2003" (Zimmerman and Sorenson, 2005) and the "Simulation of Ground-Water Flow and Evaluation of Water-Management Alternatives in the Assabet River Basin" (DeSimone, 2004).

Background on Water Quality in the Assabet River

(The following summary is based on review of water quality information included in the reports noted above.)

Classification. The Assabet River is designated as a Class B water under Massachusetts water quality standards [314 CMR 4.05(3)b]. Class B waters are designated as capable of providing and supporting habitat for fish and other aquatic wildlife, and for primary and secondary contact recreation. Criteria for such waters include that dissolved oxygen (DO) shall not less be less than 5.0 mg/l in warm-water fisheries; and that surface waters shall be free from pollutants in concentrations that form nuisances, produce objectionable odor, color, taste, or turbidity, or produce undesirable or nuisance species of aquatic life. The goal for the Assabet River is to achieve these water quality standards.

Existing Water Quality Conditions. From its source at the outlet of the Assabet River Reservoir to its confluence with the Concord River, the Massachusetts Department of Environmental Protection (MassDEP) rates the Assabet River as impaired due to nutrients, and organic enrichment leading to low DO, and also to large diurnal DO fluctuations including super-saturation. Nuisance aquatic vegetation including algal mats, floating macrophytes, rooted vegetation, and phytoplankton impair designated uses including recreation, aesthetics, and fish and wildlife habitat. While the entire river is considered impaired, the main problems occur in the impoundments where nutrient-rich sediments deposit and low velocities, shallow depths, and large surface areas open to sunlight allow floating macrophytes and algae to thrive and accumulate. Decay of these plants, especially duckweed, causes odors and violations of DO standards. DO levels below 5 mg/l are mainly recorded in the larger impoundments, but they have also been observed in the river above Aluminum City and below Powdermill Dams. Excessive floating macrophyte growth is not observed in the free-flowing reaches of the Assabet; while macrophytes do exist in the sunlit free-flowing reaches, they are generally rooted species adapted to the higher velocities and generally not excessive or a nuisance.

Biomass. Excessive biomass is considered a major impairment of designated uses in the Assabet River. Decay of dying duckweed causes odors and violations of dissolved oxygen standards. Excessive growths of both floating and rooted macrophytes in the impoundments are detrimental to primary and secondary contact recreation. It also causes extreme variations in DO leading to both super-saturation and violations of the minimum criteria.

Phosphorus Loading. The water quality problems noted above are directly related to the phosphorus loading to the river that stimulates nuisance plant (biomass) growth in the impoundments. The most consistent sources of phosphorus loading to the Assabet River are the four WWTFs, which are in Westborough, Marlborough, Hudson, and Maynard. A Total

Maximum Daily Load (TMDL) for total phosphorus was prepared by MassDEP in 2004 which requires decreased phosphorus loading from WWTFs and from non-point sources, principally sediment phosphorus flux reduction.

TMDL Findings. Evaluation of nutrient loadings during intensive field surveys found that WWTFs contributed 88 to 98 percent of biologically available phosphorus, and the majority of this loading was in the dissolved form that is directly available for uptake by plants. Dissolved phosphorus that was not taken up by plants was assumed to pass through the system and not accumulate; therefore, its removal from WWTF discharges was considered only necessary during the growing season, from 1 April through 31 October. Sediment phosphorus flux was the principal non-point source during summertime low flow periods, but its contribution to overlying phosphorus concentrations was relatively minor compared to loads from the WWTFs.

However, phosphorus loadings from sediments become important when the WWTF loads are reduced. To achieve the goal of meeting state water quality standards, the TMDL study concluded that total phosphorus in WWTF discharges must be reduced to 0.1 mg/l during the growing season, and there must be a 90 percent reduction in sediment phosphorus flux.

Year-round monitoring and reporting of effluent data for total and dissolved phosphorus was required due to concerns that particulate phosphorus might be settling in the impoundments during the non-growing season and becoming available for plant growth during the growing season. The WWTFs were required to optimize the removal of particulate phosphorus during the non-growing season by going to a 1 mg/l winter limit.

PLAN FORMULATION

Modeling Studies

In order to develop plans to achieve the goal of 90 percent reduction in sediment phosphorus flux (P-flux) it was determined to develop computer simulations models of the river to provide information on the nature of the P-flux from the sediments. The modeling effort is summarized in the CDM report entitled "Assabet River Sediment and Dam Removal Study, Modeling Report" dated June 2008.

CDM Field Studies. In order to calibrate their computer models to properly predict the effects of different combinations of dredging and dam removal, CDM collected hydraulic, water quality and sediment data, and performed laboratory sediment phosphorus flux measurements. Test water was collected only at Aluminum City – downstream of Westborough which was discharging ~ 2.8 mg/ L Total Phosphorus at the time. This collection effort was to fill in data gaps from the previous studies by ENSR.

CDM laboratory flux measurements suggested that high concentrations of dissolved phosphorus were not entirely passing through the system in the winter but were being absorbed in significant amounts to the sediments. If these findings are confirmed, there are two important implications; first, it means that dredging would have only short-term benefits in reducing sediment-phosphorus release because most of the phosphorus being released was recently absorbed and not from historic deposits. Secondly, it means that consideration should be given to reducing phosphorus levels in WWTF discharges during the non-growing season.

It should be noted that the sediment phosphorus flux was complex and modeling to predict dissolved oxygen and biomass levels following specific combinations of dam removal, dredging, and reductions in phosphorus levels in WWTF discharges with the water quality model developed for the study could best be provided at a qualitative level. Further, in order to be able to provide quantitative values for sediment phosphorus flux reduction (the focus of this study) a steady state phosphorus mass balance model was developed to simulate the sediment nutrient cycle.

CDM Model Studies. ENSR developed an HSPF model to examine water quality in the Assabet River. CDM's study required refining this and supplemental models to answer questions about existing conditions and the effects of proposed dam/sediment removal and potential sediment movement with dam removal. CDM used a combination of models including HEC-RAS for river hydraulics, HEC-6 for sediment movement, and HSPF for water quality. CDM developed and used a P-flux (spreadsheet model), based on equations from QUAL2K to estimate sediment phosphorus flux for use in the HSPF model. For existing conditions, CDM's models generally matched ENSR's results well for water quality parameters; the main differences were due to changes in impoundment hydraulics due to updated bathymetry.

Modeling Scenarios. CDM modeled five scenarios using the suite of models described above: (1) existing conditions; (2) effects of planned WWTF phosphorus reductions alone; (3) removal of all 6 study dams; (4) dredging behind all 6 dams; (5) removal of Gleasondale, Hudson and Ben Smith dams. A sixth scenario, reduction in phosphorus levels in WWTF discharges during the non-growing season, was examined with the P-flux spreadsheet model. Except for the modeling of existing-conditions and reductions in winter WWTF discharges, all scenarios assumed that WWTF discharges met planned reductions to 0.1 mg/l phosphorus during the growing season and 1 mg/l during the rest of the year.

Results. Limitations of the HSPF model (See CDM Modeling Report, June 2008, Page 2-4 and 2-5) in part due to the complexity of sediment phosphorus flux behavior meant that detailed quantitative water quality predictions could not be made, and the results of implementing different scenarios could only be qualitatively assessed. Therefore, it is suggested that additional field study be undertaken should different summer and/or winter effluent permit limits be considered for the WWTFs in the future.

Modeling of dredging alone achieved limited short-term benefits at best; sediment phosphorus flux was estimated to be reduced for only a few years, and the increased hydraulic residence time in the impoundments would likely do more to stimulate biomass growth than the reduction in sediment phosphorus loading would inhibit it.

The other scenarios modeled contributed toward achieving water quality goals, with the more aggressive having the most effect. Expected improvements from reductions in WWTF phosphorus levels and dam removal include higher minimum DO levels, lower ranges of diurnal DO fluctuation, fewer and less severe occurrences of DO super-saturation, cooler water temperatures, and less nuisance aquatic vegetation.

Floating macrophytes and algal blooms would be particularly reduced. Aesthetics would improve due to reductions in algae and plants such as duckweed and due to reduced odors resulting from higher minimum DO levels and smaller amounts of biomass decay. Stream temperatures would be cooler due to a reduction in water surface areas and reduced residence times. Shading from trees and large bushes that may grow along stream banks could further reduce water temperatures.

Levels of nitrogen are not likely to change significantly, although the form of it may; as less biomass is generated and decays, more of the nitrogen would be in the form of nitrate and less of it as ammonia. Downstream loads of phosphorus and biomass to the Concord River would be reduced, but the degree of expected benefits is beyond the scope of this study. A summary of expected water quality benefits are displayed in the table below taken from the CDM 2008 report. (CDM summarized expected water quality changes as either good, fair, or poor based on the review of the HSPF model output, however as this model was not calibrated for the new hydraulic representation, only qualitative statement are made.)

Table 1. Summary of Water Quality Findings, Various Alternatives (CDM, 2008)

Dam	Base Condition (2000)	Planned Improvements	Dredging	Dam Removal
Aluminum City	🟢	🟢	*	+
Allen Street	🟢	🟢	*	+
Hudson	🟡	🟢	*	++
Gleasondale	🟡	🟢	*	++
Ben Smith	🔴	🟡	*	+++
Powdermill	🟡	🟢	*	++
Downstream Load to Concord River	🟡	🟢	*	+

Legend Existing Conditions: 🟢 = Good, 🟡 = Fair, 🔴 = Poor

Improvements: (*) = No improvement, (+) = some improvement,

(++) = good improvement, (+++) = significant improvement

Reductions in Sediment Phosphorus Flux

A potential benefit from removing dams would be reduced sediment phosphorus flux from the reduced biomass growth. Less biomass growth would produce less algae to settle and less phosphorus cycling through the sediments. Also dam removal would result in a narrower river and thus less river bed would be exposed to water.

A summary of the estimated P-flux reductions for various alternatives is shown below in Table 2. These findings are based on results from the HSPF and the P-flux model. The analysis indicated that the planned WWTF improvements would result in a 60 percent reduction in P-Load and the dam removals would provide another 20 percent reduction. The estimated 20 percent is a conservative estimate and the percent reduction from dam removal may be greater. With both planned WWTF improvements and dam removals the sediment phosphorus flux reduction is estimated to be approximately 80 percent, near the TMDL target of 90 percent reduction.

As there are inherent limitations and uncertainties of predictive modeling of a dynamic physical, chemical, and biological system, the accuracy and effectiveness of target reductions could be confirmed by subsequent monitoring.

Table 2. Summary of Anticipated P-Flux Reduction, Various Alternatives

Scenario	**P-Flux (mg P/m2-day)**	**P Flux Change**	**Sediment P[3] Load (lbs/day)**
Base Condition	D/S[1]: 21.6 U/S[1]: 12.0	No Change	28.0 [4]
Planned Improvements (WWTP TP @ 0.1 mg/l summer 1.0 mg/l winter	D/S: 8.6 U/S: 4.8	60% reduction	11.2
Dam Removal – 6 dams[2]	D/S: 4.3 U/S: 2.4	80%	4.2
Dam Removal – 3 dams (Hudson, Gleasondale, Ben Smith) [2]	D/S: 4.3 U/S: 4.8	80% (Hudson and d/s) 60% (u/s – same as planned improvements)	6.7
Dam Removal – 1 dam[2] (Ben Smith only)	Ben Smith and d/s: 6.5 Gleasondale and u/s: 4.8	70% (Ben Smith and d/s only) Gleasondale and u/s same as planned improvements	8.4
Dredging – short term[2] (less than 2 years)	D/S: 4.3 U/S: 2.4	80%	5.6
Dredging – long term[2] (more than 2 years)	D/S: 8.6 U/S: 4.8	60% (planned improvements)	11.2

Notes:

1) U/S refers to the river upstream of the Gleasondale dam. D/S refers to the river downstream of Gleasondale dam.
2) Includes Planned Improvements.
3) Sediment P Load includes reduction in P flux and reduction in sediment bed area associated with dam removal.
4) From the Assabet River MassDEP TMDL Study, September 2004, page 42. The TMDL set a goal of 90% reduction from 28.0 lbs/day of Total P to a value of 2.8 lbs/day of Total P.

Discussion of Results

Modeling results of this study suggest that significant strides will be made toward the TMDL goal of 90% reduction in sediment phosphorus flux and overall improved water quality when the current planned improvements are in place at the WWTFs. Planned reductions in phosphorus discharges from WWTFs and the goal of a 90 percent reduction in sediment phosphorus release are not independent; the planned improvements at WWTFs are likely to collectively yield a significant reduction in sediment phosphorus flux.

Modeling results indicated that potential removal of Ben Smith dam would contribute to achievement of water quality goals through reductions in sediment phosphorus flux because the biomass growth and settling that ultimately drives the sediment flux would decrease with dam removal.

Modeling results indicated that potential removal of Hudson and Gleasondale dams would also contribute incrementally to these goals. Removal of the two most upstream dams in this study, Aluminum City and Allen Street, would result in water quality improvements in stream reaches affected by the existing impoundments, but would have minimal effects on downstream water quality.

Similarly, removal of Powdermill dam would have only localized benefits. Removing the immediately upstream Ben Smith dam is the most effective option for improving water quality in the Powdermill dam impoundment. Due to its large size and long residence time, the Ben Smith impoundment is a significant contributor of biomass growth that affects the Powdermill dam impoundment and further downstream river reaches.

Dredging of any or all of the impoundments is suggested only to control sediment movement following dam removal; it has no significant long term water quality benefits by itself.

During the TMDL study the sediment phosphorus flux process was not well understood for the river. During this study additional data was collected on sediment P-flux in the Assabet River to help understand the nature of sediment phosphorus flux in the Assabet River.

Both the sediment phosphorus flux field data collected, as well as the mass balance model of sediment-phosphorous flux, led to better understanding of the seasonality associated with sediment phosphorus flux. Results indicate that the sediment response to a change in overlying water phosphorus concentration is fairly short (several seasons).

This suggests that incremental improvements in either point or nonpoint sources should yield benefits in the river in a time frame of several years, rather than a longer period of time as initially hypothesized. This realization supports the adaptive management approach adopted by MassDEP in the 2004 TMDL.

Although consideration of lower WWTF winter P-discharge limits were not part of this study, the P-flux model based on limited laboratory data indicated that winter P-loading may have an effect on summer sediment flux rates. If this is confirmed, the additional reductions in phosphorus levels in WWTF discharges during the non-growing season (below the current planned limit of 1mg/L) may make a significant contribution to achieving water quality standards, especially if only limited or no dam removal is undertaken. Further study is necessary to better understand this issue.

An additional consideration of the modeling study was that if no other improvements were implemented, further reductions in summer P discharge limits, below 0.1 mg/L, would not contribute significantly to further reduction in sediment phosphorus flux. This is because the analysis indicated that the winter instream phosphorus concentration has a strong effect on the P-flux the following summer. Therefore, if the summer P discharge limits were decreased below 0.1 mg/L without any further reduction in winter limits, the P-flux in the summer would still be "controlled" by the winter instream phosphorus concentration.

POTENTIAL DAM AND SEDIMENT REMOVAL

Dam Removal

Six dams are considered for the purpose of this study. Dam removal feasibility was considered at the request of MassDEP and as a follow on to their 2004 TMDL that identified dam removal as a potential measure to decrease sediment phosphorus flux in the river.

If in the future a proponent steps forward who wishes to pursue dam removal, then there would be a detailed environmental assessment and permitting process involved at all levels of government – local, state, and Federal.

As described above and summarized below, modeling studies indicated that four dams whose removals would most benefit water quality in the Assabet River are Ben Smith, Gleasondale, Hudson, and Powdermill Dams with Ben Smith providing the most significant water quality benefit. In consideration of localized water quality benefits removal of Aluminum City and Allen Street Dam are included. In addition, dam removal would restore the natural connectivity of the river system. Partial dam removal was not considered in this study.

> Removing all 6 dams would have a very beneficial impact on water quality. Removing a dam would have multiple benefits in water quality. First, the residence time in each impoundment would be reduced which would reduce the biomass growth in the river. Removing the dams for the larger impoundments would have the largest benefits. Removing Ben Smith dam would have the largest benefit; Hudson, Gleasondale, and Powdermill dam removals would have the next best benefits, and Aluminum City and Allen Street would have the smallest benefits. A second benefit from removing dams would be reduced sediment phosphorus flux from the reduced biomass growth. Less biomass growth would produce less algae to settle and less phosphorus cycling through the sediments. A third benefit from dam removal is increased reaeration in the shallower water depths. Increased reaeration will improve dissolved oxygen in the river.
>
> *Excerpt from Page 6-4 of the Assabet River Sediment and Dam Removal Modeling Report (CDM, June 2008)*

Sediment Removal

Sediment removal alone was also considered in the modeling studies performed by CDM, however this alternative was determined to be of little value and in some cases may have negative impacts on water quality. Sediment removal alone without dam removal was dropped from further consideration as a long term solution.

> Sediment removal/dredging with the goal of reducing the phosphorus flux will not improve water quality in the river system. This alternative was simulated in the HSPF model which predicted a negative impact on water quality. Though the phosphorus sediment flux will be reduced, the benefit will only last a few years (estimated 2 to 5 years). The phosphorus sediment flux is "driven" by the biomass growth and instream phosphorus concentrations. Additionally, up to 3 feet of sediment will need to be dredged to effectively reduce the phosphorus sediment flux based on past sediment cores by USGS. This sediment dredging increases the impoundment volumes which has several negative impacts on water quality. With the sediment removal/dredging alternative, the residence time would be longer in each impoundment, which would allow additional biomass growth, which in turn will increase sediment phosphorus flux. Also, re-aeration (transfer of oxygen from the air to the water) would be reduced in each impoundment from the deeper impoundment depths.
>
> *Excerpt from Page 6-4 of the Assabet River Sediment and Dam Removal Modeling Report (CDM, June 2008)*

Sediment Deactivation

In some cases, sediment deactivation can be an effective approach for mitigating the impacts of phosphorus enriched sediment on a water body, particularly a lake or pond where anaerobic conditions at the sediment water interface can result in release of phosphorous to the water column creating a potential significant in-lake (internal) source of phosphorus. However, sediment deactivation in rivers is not a widely used approach. See the following analysis of sediment deactivation provided by CDM for the Assabet River. Sediment deactivation for the Assabet River was determined to be ineffective and dropped from further consideration as a long term solution. (However, this does not rule out the possibility that stakeholders may wish to pursue a pilot study with USGS to gather field data to determine short-term benefits.)

Sediment deactivation is generally only used when there is good control of watershed (external) sources of phosphorus and when the historic sediments contain a significant source of phosphorus to the overlying water column. The general approach is to apply a chemical (aluminum, iron and calcium salts have been used but alum is most frequently applied) uniformly across the lake so that the chemical both scavenges inorganic phosphorus in the water column and then seals the sediment to significantly hinder the recycling of sediment phosphorous into the water column. To achieve the correct dose of the chemical it is important to understand the lake's water chemistry, particularly pH and alkalinity as these determine the potential additional need to add a buffering agent. A modified weed harvester is most frequently used for alum application.

Due to the dynamic nature of the Assabet River system, and the fact that the sediments themselves are not the sources of P-flux, sediment de-activation is not considered to be a viable option for improving water quality or meeting overall objectives of the Assabet River Sediment and Dam Removal Study as a long term solution

As discussed in detail in the Assabet River Sediment and Dam Removal Modeling Report (CDM, 2008) the major factors affecting sediment P-flux in the river system are in-stream phosphorus concentrations, resulting from both wastewater treatment plant discharge, non-point sources in the Assabet River watershed, and the characteristics of the river system itself. If sediment de-activation was performed in the Assabet River, the phosphorus in the sediment would be fairly rapidly (2-5 years) replenished from the settling of biomass and in-stream phosphorus. The effects of in-stream phosphorus and associated settling into existing sediment in the Assabet River, are further compounded due to the presence of large impoundments (e.g. Hudson, Gleasondale, Ben Smith and Powdermill), which essentially allow more time for phosphorus from the water column to be incorporated into biomass to settle into existing sediment due to significant residence times in the impoundments.

Therefore, if sediment de-activation were considered as an alternative to control P-flux from sediments in the Assabet River, and if the in-stream phosphorus concentration were to remain as is (planned improvement conditions, as discussed in Assabet River Sediment and Removal Study Modeling Report (CDM, 2008)) the source of sediment phosphorus would not change significantly.
Information Source: CDM Memo dated July 29, 2008

DESCRIPTION OF DAMS

General Characteristics

The six Assabet River dams considered in this study were originally constructed either in the 1900s or pre-1900s. Information on time frames associated with the dams is provided in Table 3 below. Although the river has been dammed for several centuries these dams changed what was once a free flowing river with ripples and pools, wetlands, and small water falls to the current system. The dams create impoundments on the river and impoundment areas vary from about 0.3 acres to 146 acres. The extent of influence of the dams is illustrated in Figure 3 and listed in Table 4. Ben Smith dam diverts some water from the river though a canal to the mill ponds in the center of Maynard. Photographs of the dams and additional information on each dam are included in Appendix B.

Table 3. Dam Information, Year Built

Dam Name	Town	DAM ID	Year Built	Dam site dates from
Aluminum City	Northborough	MA02843	1925	pre-1900
Allen Street	Northborough	MA00995	1900	1720
Hudson	Hudson	MA00447	Repaired 1987	1860
Gleasondale	Stow	MA00820	1924/1883	1750
Ben Smith	Maynard	MA00752	1850	1850
Powdermill	Acton	MA00128	1924	pre-1835

NOTES:
DAM ID - Massachusetts Conservation and Recreation, Dam Safety Bureau, DAM ID

Table 4. General Dam and Impoundment Characteristics

Dam Name/Location	Impoundment Area from USGS Report (acres)*	Impoundment Max. Water Depth, USGS report (ft.)*	Estimated Extent of Dam Influence **
Aluminum City in Northborough	0.39	4	about 0.1 mile in Northborough
Allen Street Dam in Northborough	6.9	8	about 0.6 miles to River Street in Northborough
Hudson Dam in Hudson	21.9	10	about 1.2 miles to Chapin Road in Hudson
Gleasondale Dam in Stow	13.6	11	about 1.5 miles to Cox Road in Hudson
Ben Smith Dam in Maynard	145.8	11	about 5 miles to Route 62 in Stow
Powdermill Dam in Acton	27.2	8	about 1 mile to Crane Avenue in Maynard

Notes: * Zimmerman and Sorenson, 2005. "Sediment Studies in the Assabet River, Central, Massachusetts, 2003", USGS

** Extent of influence based on modeling of water levels.

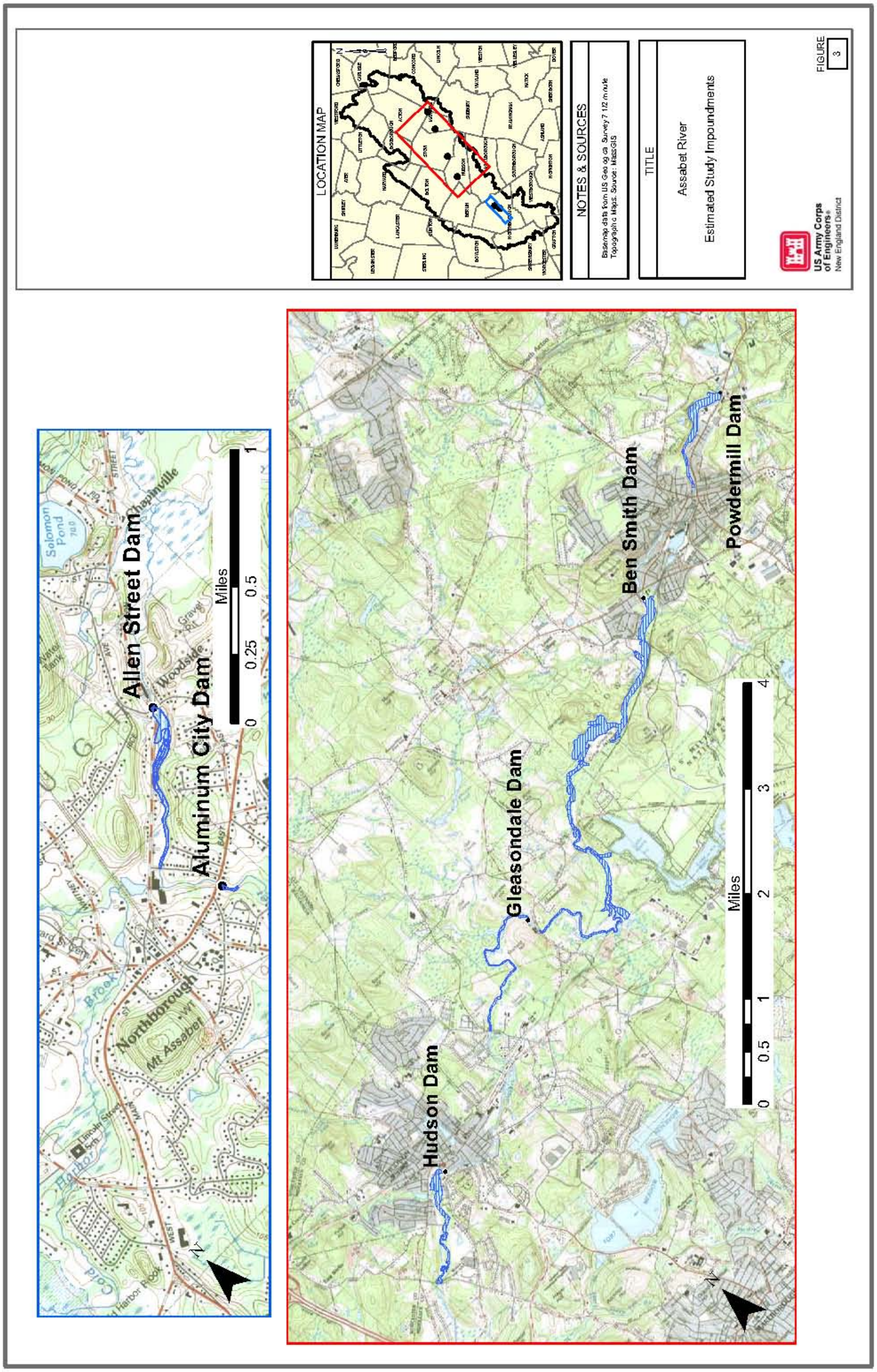


Figure 3. Assabet River Dams and Impoundments

Dam Safety

In Massachusetts, the Department of Conservation and Recreation, Office of Dam Safety maintains records of dams located throughout the Commonwealth and ensures compliance with acceptable practices pertaining to dam inspection, maintenance, operation and repair of dams.

In accordance with Massachusetts dam safety regulations, dam owners are responsible for registering, inspecting, reporting inspection results to the Office of Dam Safety and maintaining their dams in good operating condition. Owners of dams are required to hire a qualified engineer to inspect and report results every 2 years for High Hazard Potential dams, every 5 years for Significant Hazard Potential dams and every 10 years for Low Hazard Potential dams. *(Source: http://www.mass.gov/dcr/pe/damSafety/index.htm)* Reports on the condition of a dam can be requested from the Office of Dam Safety.

Potential Hazard Ratings for each of the dams were obtained from the Office of Dam Safety and are shown in Table 5 for general information purposes only.

Table 5. Dam Safety Hazard Rating

Dam Name	**Town**	**DCR DAM ID**	**DCR – Dam Hazard Rating**
Aluminum City	Northborough	MA02843	not available
Allen Street	Northborough	MA00995	S
Hudson	Hudson	MA00447	S
Gleasondale	Stow	MA00820	L
Ben Smith	Maynard	MA00752	S
Powdermill	Acton	MA00128	*

** Powdermill Dam is under jurisdiction of FERC for purposes of dam safety and hazard classification. (Source: Acton Hydro Co., Inc, comments submitted on draft report.)*

H = High Hazard Potential dam refers to dams located where failure will likely cause loss of life and serious damage to home(s), industrial or commercial facilities, important public utilities, main highway(s) or railroad(s).
S = Significant Hazard Potential dam refers to dams located where failure may cause loss of life and damage home(s), industrial or commercial facilities, secondary highway(s) or railroad(s) or cause interruption of use or service of relatively important facilities.
L= Low Hazard Potential dam refers to dams located where failure may cause minimal property damage to others. Loss of life is not expected.

Existing Uses

The dams have been in place for many years and uses have changed over time, from their original purpose as mill dams. However, the dams and impoundments are still highly valued by local stakeholders for recreation (boating, canoeing, kayaking, and fishing), the view of open water and wildlife, as a source of water for fire protection, and for business uses such as hydropower generation and irrigation. Appendix K provides comments received from stakeholders and provides extensive documentation of the important societal value of the existing impoundments to local stakeholders.

This study did not include a detailed survey of recreational uses and water supply uses. Some of the existing uses of the dams and impoundments that were identified through meetings with the dam owners and observations during field visits and are discussed below. If in the future a dam removal project were to be considered further additional studies would be needed to identify all current and potential future uses of the dams and impoundments and take into account the values and views of local stakeholders.

ALUMINUM CITY DAM

Recreation, Land Use and Viewscape. The impoundment has no developed or informal canoe or boat access. The land adjacent to the river in this area is in private ownership. Land use adjacent to the impoundment is commercial and residential. The river flows through the Juniper Hills golf course not far upstream of the impoundment. The dam is visible from the buildings adjacent to the river.

Water Supply and Hydroelectric Power. The impoundment is not currently used for water supply or hydropower generation. The potential for future use appears low.

ALLEN STREET DAM

Recreation, Land Use and Viewscape. The impoundment has no developed boat access. The river, however, is readily accessible from Hudson Street, near the Wachusett Aqueduct. Discarded lures and line indicate the site is fished to some extent. There are several private canoe launch points located upstream of the Allen Street impoundment.

The impoundment is visible from Hudson Street and Allen Street and has aesthetic appeal due to the reflection of the archways of the Wachusett Aqueduct over the impoundment. Dense growth of duckweed and mats of filamentous algae would likely detract from the aesthetic appeal of the site during summer months.

The historic mill building at the dam has been converted to an apartment complex entitled "Residence at the Falls". There may be some appeal to renters to be located adjacent to flowing waters. It is expected that improvements in water quality would benefit this asset. However, it is not currently known if a natural fall exists at the site or if dam removal would eliminate the "falls" setting.

Water Supply and Hydroelectric Power. The impoundment is not used for water supply or hydropower generation. The potential for future use appears low.

HUDSON DAM

Recreation, Land Use and Viewscape. Land use includes commercial, residential, and public properties. About 75 percent of the impoundment shoreline between the dam and the Taylor Memorial Bridge (footbridge) is privately owned. Public land along this reach includes conservation land, town park land, and the Hudson Town Library.

Between the Taylor Memorial Bridge and Chapin Road, the riparian corridor is largely owned by the Town of Hudson or private organizations (The Elks Club, Yankee Golden Retriever Rescue, and the Portuguese Club). This includes town parkland (Wood Park, Apsley Park and Riverside Park), conservation land, active and passive recreation land, and Hudson High School. The Taylor Bridge is an impressive double arch pedestrian structure and connects Wood and Apsley parks.

The Town of Hudson Recreation Department hopes to work with private organizations and owners to develop a walking trail along both sides of the river from the Taylor Memorial Bridge to Riverside Park at Chapin Street. (See Appendix A, Plate 3 to view this area)

Popular fishing sites include Taylor Memorial Bridge, Chapin St. Bridge, and Route 85 Bridge downstream of the dam. Canoe fishing is also popular. Motorboat use of the impoundment is permitted but rare. During winter the impoundment is a popular ice fishing location.

Water Supply and Hydroelectric Power. The impoundment is not used for hydropower generation. The town has no plans to use this site for hydroelectric generation in the future. At the dam, there appears to be a water intake for possible fire protection of a nearby building, however more research is needed to verify status.

GLEASONDALE DAM

Recreation, Land Use and Viewscape. Land use is a mix of industrial (at the mill), residential, recreation (Stow Acres golf course), and farmland (Orchard Hill). Nearly all of the impoundment shoreline between the dam and the Hudson town line is privately owned. Public open space is limited to a small lot on Route 62 near the Gleasondale Dam.

There is a public canoe access at the Cox Street Bridge in Hudson, about 1.5 miles upstream of Gleasondale Dam. There is no public boat access near the dam where fringing wetlands and currents pose a challenge for those trying to portage around the dam. Dense growth of duckweed and submerged aquatic vegetation may impede recreational use of the impoundment during summer months. Duck blinds located on the northern embayment suggest hunters use the site. The nearby Orchard Hill provides 100 acres of grassland habitat for bobolink (McAdow, 2000).

The river and dam are part of the view from several private homes along Route 62, the Gleasondale Mill Complex, the Orchard Hill farm, and the Stow Acres Golf Course (Lambert Hill). From the river, there are dramatic views of Orchard Hill, a steeply sloped, grassy glacial drumlin that rises 130 feet above the impoundment. Grazing horses are often visible on the hill. An impressive horse barn and farmhouse are visible from the river near the dam.

Water Supply. The artificial channel feeding from the dam to the mill complex is used for fire suppression water supply purposes by both the mill owner and the Town of Stow.

The channel feeds a cistern that has the intake for the mill sprinkler system. Water is pumped from this cistern to holding tanks. Water in these tanks is needed to feed the sprinkler system during a fire.

As reported by the Chief of the Stow Fire Department, the channel is the main source of water for the Department in case of a fire at the Gleasondale Mill building and the surrounding community. Stow does not have a public water supply system. The Fire Department backs their trucks up to the channel to fill their trucks with water. If a dam removal project were considered in the future then the design would need to consider features to supply water for the mill building fire protection system and features to allow the Stow Fire Department to continue to fill their fire trucks.

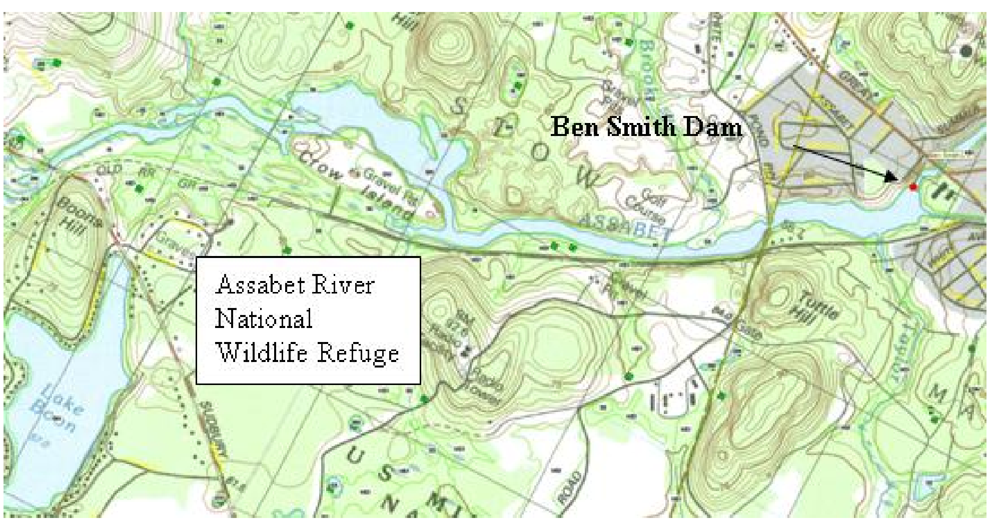
In addition, the Stow Acres Country Club has a permitted water withdrawal on a tributary to the Assabet above the Gleasondale Dam and relies on this source of water to operate its business. Further studies would be needed to determine the impact and mitigation.

Hydroelectric Power. The impoundment is not currently used for hydropower generation. The old power wheels have been removed and there are no plans to reactivate hydropower at this site.

BEN SMITH IMPOUNDMENT (INCLUDING CLOCK TOWER POND)

Recreation, Land Use and Viewscape. Land use is a mix of commercial, residential, and open space. Adjacent to the impoundment, much of the shoreline between White Pond Road and Sudbury Road is protected open space. The Assabet River National Wildlife Refuge borders the river for about 1.5 miles along this reach and the Stow Town Forest is located on the other side of the river. A general map of the refuge is included in Appendix I.

The Assabet River Rail Trail runs about parallel to the impoundment from Route 62 to Sudbury Road. Canoe access is available at Route 62, at Sudbury Road, at White Pond Road, and near the Ben Smith Dam. Maynard has a park (4 acres) and canoe launch area just upstream of the dam at Ice House Landing.

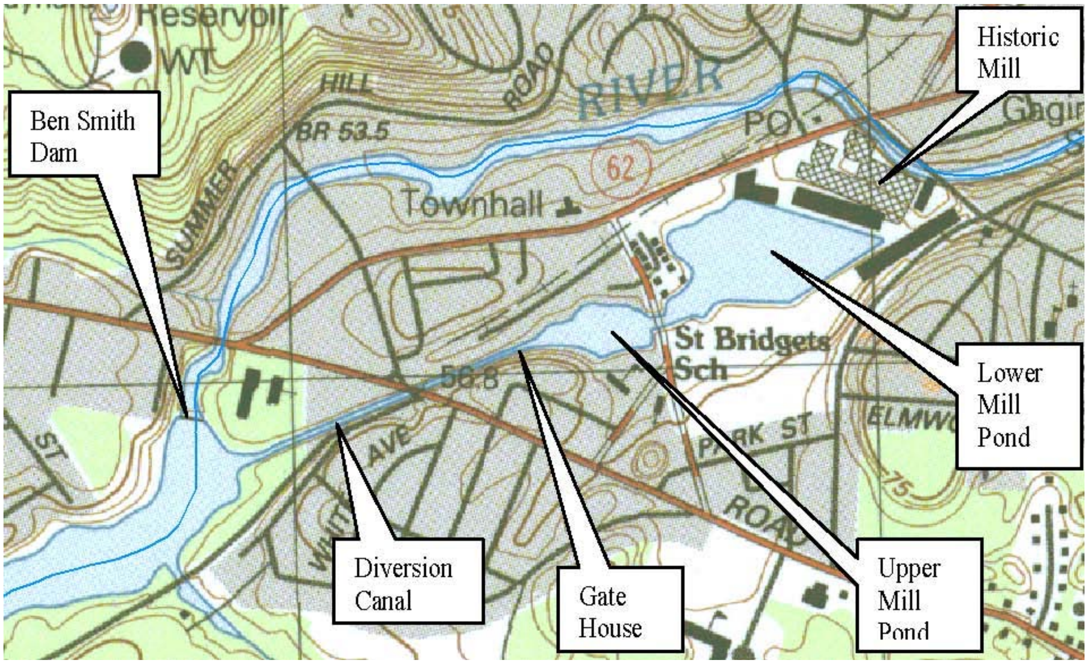


The Clock Tower mill ponds and Clock Tower Place and the dam are privately owned. The mill pond area is a central focal point in downtown Maynard. The Maynard Farmers Market occurs near the pond. Residents, office workers, and visitors stroll and relax on the banks of the pond. A large parking lot for Clock Tower Place is located adjacent to the pond.

Hydroelectric Power. There is an existing hydropower[4] project at Clock Tower Place. In 1983 the project was granted an exemption from licensing from FERC. The generator has not operated since 1998. The current owner (Wellesley Rosewood Maynard Mills L.P.) assumed ownership of the facility in 1998 and decided at that time to decommission the hydroelectric project. The surrender of the license exemption was accepted by FERC in 2004. Since 2004, the Dam owner has re-evaluated their decision and is currently considering operating a hydroelectric project at the site using the existing dam. The project proposes an installed capacity of 290 kw.

[4] The powerhouse contains a 125-kW turbine generator.

The Assabet River and the Mill Ponds. Under the 2004 FERC order new gates were installed on the diversion canal to the mill ponds that are to be operated as a fixed weir during low flow periods. For flows at or below 39 cfs in the river, no flow would go to the mill ponds.   These lower daily flows normally occur on days in the months of July through October.

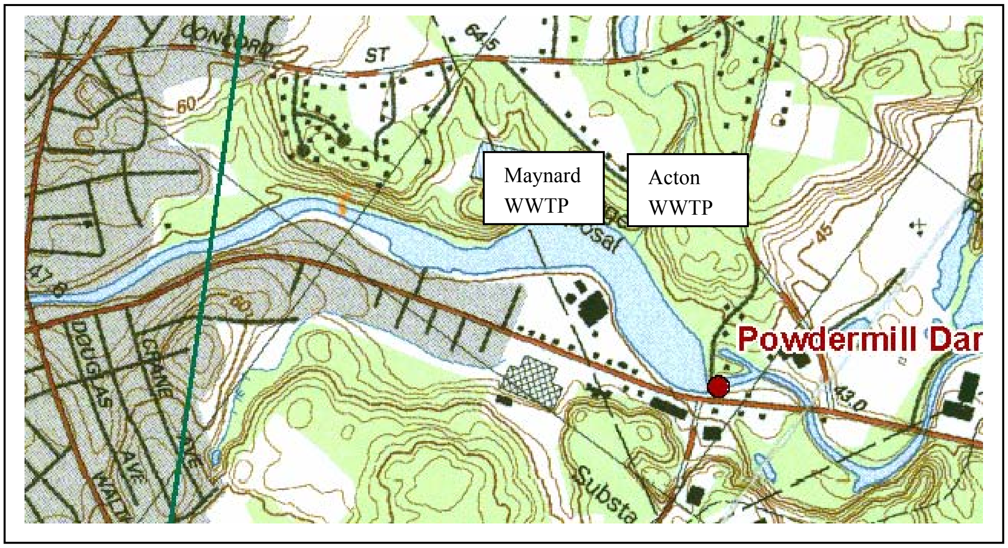


Water Supply. The lower mill pond is a source of water for the Clock Tower Place emergency sprinkler system and an emergency source of water for the Maynard Fire Department.
In addition, the Stow Fire department relies on the Assabet River impoundment above the Ben Smith Dam as a source of water for fire suppression. The Fire Chief in a letter dated November 5, 2007 expressed the concern that removal of Ben Smith dam would make the Assabet an unusable water source for the Town of Stow for fire suppression needs and also that if the Assabet is an unusable source it could endanger lives and property to the citizens and firefighters of Stow. The Town of Stow does not have a municipal water supply.

Honey Pot Orchards also reported that they use the Assabet River for frost protection in the spring and irrigation during dry spells. Honey Pot Orchard is located about 2.4 miles above the Ben Smith dam.

POWDERMILL DAM

Recreation, Land Use and Viewscape. Land use near the dam is primarily commercial. Areas upstream of the dam include residential and public uses. Public land includes a parcel of conservation land and land associated with Acton and Maynard wastewater treatment facilities. There are no public boat launches near the Powdermill Dam.



Water Supply. The impoundment is not used for water supply.

Hydroelectric Power. The dam will be used for hydropower generation. The hydropower generating unit is planned to operate as a run of river facility primarily in the fall and spring by a private owner, Acton Hydro Co., Inc. Authorized capacity is 178 kw. A FERC exemption issued for the project requires instantaneous discharge of 40 cubic feet per second, or inflow, whichever is less, and installation of fish passage facilities when anadromous fish restoration efforts reach this site. The owner has stated he plans to install a Denil fishway at the dam when required by FERC to allow for upstream passage of anadromous fish such as alewife.

ENGINEERING CONSIDERATION FOR DAM REMOVAL

Sediment Quantities

Sediment management is an important component of any dam removal project. Management of sediment accumulations behind a dam can be a significant part of the dam removal costs. In designing the dam removal project the quantity and physical and chemical characteristics of the sediment behind the dam is considered. Based on data collected a decision is then made with involved regulatory agencies as to whether it would be necessary to require removal of the sediments to prevent them from moving downstream.

The Assabet River Study dams have been in place since the late 1800s and early 1900s and as a result sediments have accumulated behind these dams. If the dams are removed some of this material would reposition within the channel and some would move downstream.

For planning purposes, the amount of sediment that would be transported downstream in a relatively short period of time following dam removal was estimated by CDM for the Assabet Study. The methodology applied is detailed in the CDM, "Assabet River Sediment Management Plan" dated December 2008, and briefly discussed below.

The sediment removal quantities associated with dam removal for the six study dams were calculated based on the results of the HEC-6 modeling conducted by CDM. (See CDM modeling report dated June 2008 for details the HEC-6 modeling conducted for the study.)

A continuous simulation of channel bed profile was modeled. Results of this simulation at different time steps (100 days, 200 days, 1-, 2-, 3-, 4- and 21-years) were plotted and the change in bed profile was analyzed over time. A comparison of the change in bed profile from the existing conditions and the post-dam removal scenarios was evaluated, and a constant slope methodology was applied.

Applying the constant slope methodology allowed for estimation of the sediment quantity that, if not removed as part of dam removal, would be transported downstream in a relatively short period of time following the dam removal. This estimated sediment quantity is the estimated sediment volume to be dredged listed in Table 6. This is not the total volume of sediment behind the dams.

For purposes of this planning study, the volum e listed in Table 6 was the am ount considered for dredging and disposal as part of the planning level dam removal construction cost estimate.

Table 6. Estimated Sediment Volumes to be Dredged*

Impoundment	Volume to be Dredged (yd^3)
Aluminum City	1,300*
Allen Street	2,230
Hudson	71,560
Gleasondale	27,860
Ben Smith	67,600
Powdermill	65,830

* Sediment quantity that, if not removed as part of dam removal, would be transported downstream in a relatively short period of time following the dam removal.

** within Aluminum City impoundment area.

Sediment Quality

In 2003, the USGS conducted a survey of sediment distribution and chemistry of the six impoundments along the Assabet River. The USGS study included, approximately 180 sediment cores collected at 57 sampling sites within the impoundments. The cores were analyzed for metals, reactive sulfide, volatile organic compounds (VOCs), polycyclic aromatic hydrocarbons (PAHs), polychlorinated biphenyls (PCBs), organochlorine pesticides, and extractable petroleum hydrocarbons (EPH). However, the analyses of VOCs were inconclusive due to matrix interference at the laboratory. The metals that were analyzed included those typically considered for sediment characterization studies with the exception of mercury[5].

For purposes of evaluating the quality of the sediments and to aid in understanding the potential sediment disposal options the USGS data and additional sieve analysis data was assessed and results are presented in the CDM "Assabet River Sediment Management Plan", dated December 2008. It was concluded that regulatory agencies would likely require additional chemical and

[5] Mercury was not analyzed by USGS due to storage and analyses requirements

physical testing of sediments that may be exposed, dredged, or mobilized as a result of removing the Assabet River dams.

It is suggested that additional sediment sampling and testing be performed if further studies of dam removals are undertaken. Suggested detailed sampling plans for Assabet River sediments above the dams are provided in the CDM 2008 report. These sampling plans do not include environmental or health risk assessments of sediments currently under water that could be exposed by dam removal, it is possible that these types of studies may be requested by regulatory agencies as part of future work on dam removal feasibility.

Table 7. Summary of RCS-1 and Landfill Reuse Exceedances

Impoundment	**Soil Category RCS-1 Exceedances**	**In-State Landfill Reuse Exceedances***
Aluminum City	Cadmium, Chromium, Nickel	Chromium (1 sample)
Allen Street	Cadmium, Chromium, Nickel	No observed exceedances
Hudson	Arsenic, Cadmium, Chromium, Lead, Nickel	Arsenic
Gleasondale	Arsenic, Cadmium, Chromium, Nickel, PCBs	Arsenic, PCBs
Ben Smith	Arsenic, Cadmium, Chromium, Lead, Nickel	Arsenic, Lead
Powdermill	Arsenic, Cadmium, Chromium, Lead, Copper, Nickel, PAHs	Arsenic, Chromium, PAHs

*Based on USGS data from 2003, data published in Zimmerman and Sorenson. 2005. "Sediment Studies in the Assabet River, Central Massachusetts, 2003."

A sampling plan for each impoundment was developed and is included in the CDM 2008 report. Table 7 above shows by impoundment where one or more samples in the proposed dredge areas were observed to exceed either the RCS – 1[6] level or the landfill reuse level.

[6]*310 CMR 40.1600 MCP Reportable Concentrations Soil Category RCS-1*. The Massachusetts Contingency Plan (MCP) does not have notification thresholds for contaminants in sediment.

Planning Level Construction Costs Estimates for Hypothetical Dam Removal

Construction Costs. Planning level construction cost estimates for dam removal were developed by CDM for this study in 2008 based on anticipated construction activities. (See Appendix B for construction activities and Appendix C for cost estimates.) A summary of the estimated construction costs are provided in Table 8 below. Estimates for dam removal and dredging include contractor overhead (16%), profit (10%), bond and insurance cost (5%) and a contingency of 25%. The hauling and disposal costs for the dredged material were also developed by CDM and were based on per ton unit cost. These are included in Appendix C.

Table 8. Estimated Dam Removal and Sediment Management Construction Cost Estimates*

Dam Name	Dam Removal Only	Dam Removal and Dredging	Add Hauling and Disposal of Dredged Material	Dam Removal, Dredging, Hauling, and Disposal
	($)	($)	($)	($)
Aluminum City	639,490	924,330	86,000	1,010,330
Allen Street	1,007,780	1,637,380	136,000	1,773,380
Hudson	1,440,640	4,677,000	4,727,000	9,404,000
Gleasondale	2,428,450	4,027,950	1,855,000	5,882,950
Ben Smith	4,559,430	7,759,300	5,081,000	12,840,300
Powdermill	1,764,890	4,841,180	6,961,000	11,802,180
Total All Six Dams	11,840,680	23,867,140	18,846,000	42,713,140
Total Hudson, Gleasondale, and Ben Smith	8,428,520	16,464,250	11,663,000	28,127,250

* Planning level information, cost estimates prepared in 2008 by CDM.

Dam removal costs do not include cost for any desired planting and or contouring of the project area above the dams. Future detailed design of dam removals should consider these features.

The planning level estimated construction cost for a “six dam removal project” is about $42.7 million, for a “Ben Smith, Gleasondale and Hudson” project at about $28.1 million, and for a “Ben Smith Dam alone” project about $12.8 million.

The percent of the estimated construction cost that applies to the sediment management costs (dredging, dewatering, hauling, and disposal) ranges from 37% for Aluminum City Dam to about 85 % of the construction cost for Powdermill and Hudson dams. (See Table 9.) Modeling at these sites demonstrated that a significant quantity of material would move downstream in a short period of time following dam removal.

Table 9. Dam Removal Construction Cost versus Sediment Management Cost

Dam Name	Dam Removal Construction Cost %	Sediment Management Cost %
Aluminum City	63%	37%
Allen Street	57%	43%
Hudson	15%	85%
Gleasondale	41%	59%
Ben Smith	36%	64%
Powdermill	15%	85%

CDM's study of the sediment identified the need for additional testing of the sediment behind the dams during design to further define the quality of the sediments and verify the extent of sediment removal that would be required by the regulatory agencies prior to dam removal. These additional studies and input from the regulatory agencies would help to better understand the sediment management costs. If more sediment can be left in the river or if less costly disposal options are identified then this could decrease the overall construction costs. If regulatory agencies were to determine that additional sediments need to be managed or that sediments currently underwater represent a risk to human health or the environment if exposed and required mitigation, then this could increase dam removal costs.

Design, Management, and Real Estate Costs. In addition to construction costs, costs for a dam removal project include environmental studies and public review, design, permitting, and project management. These costs are not estimated at this time and would vary depending on the entity that might implement a potential dam removal project. Also there would be real estate costs associated with implementation including items such as cost of the purchase of the dam, permanent or temporary construction easements, and purchase of land in fee as determined to be needed for a project.

TARGET FISH COMMUNITY ANALYSIS

A target fish community (TFC) can be used as a guide to identify the composition of a healthy fish community for large streams and small rivers in the New England region and can guide and evaluate river rehabilitation. This approach was applied to the Assabet River and is detailed and discussed in Appendix E. Appendix E also addresses the anadromous fish restoration efforts on the river.

The existing fish community (EFC) in the Assabet is not consistent with the target fish community (TFC) considered for the river. Current fish species composition consists primarily of macrohabitat generalists and pollution tolerant species. Figure 4 displays the existing fish species in the river and Table 10 compares the TFC to the EFC.

Figure 4. Assabet River Existing Fish Community

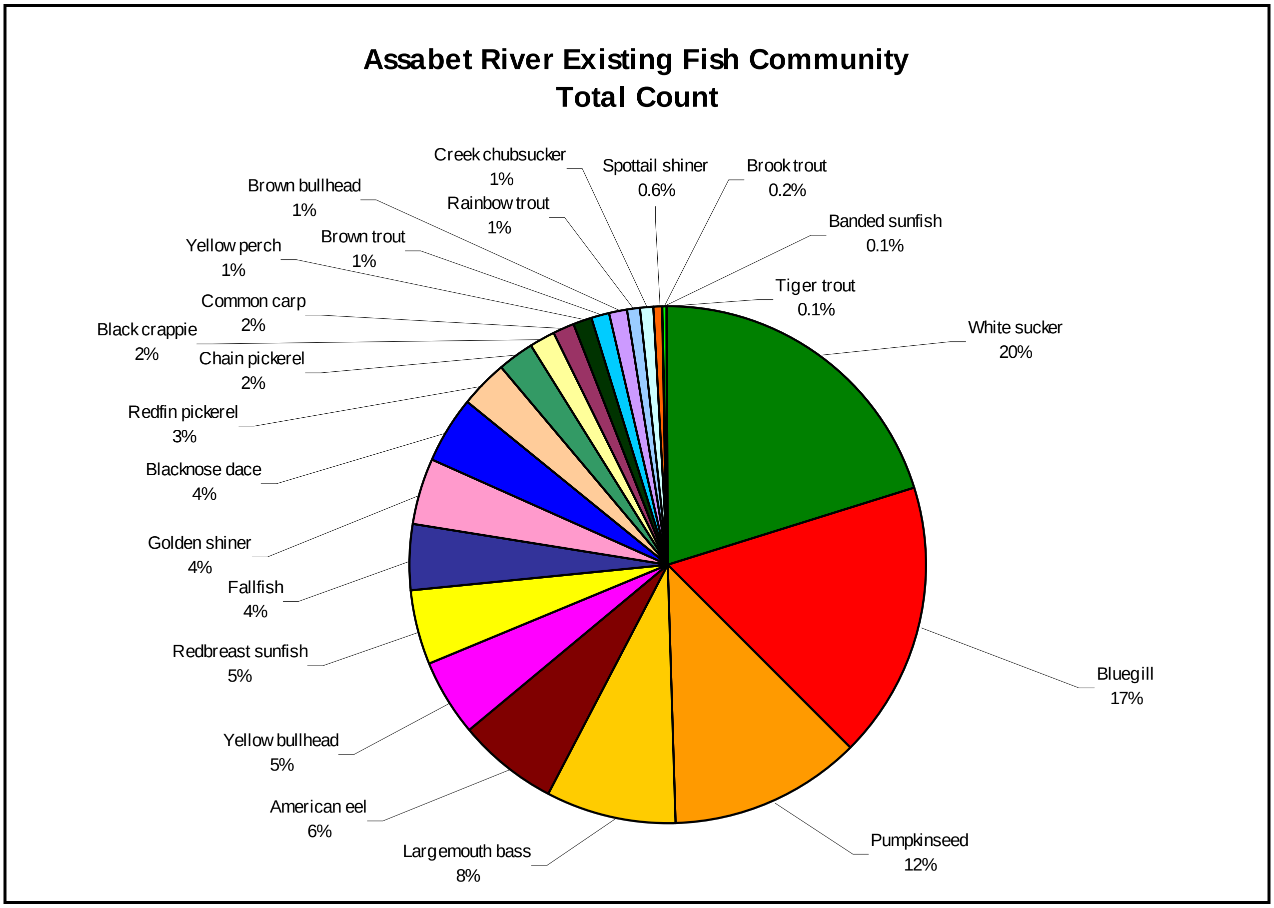


Table 10. Assabet River Fish Community Analysis

Comparison of the Target Fish Community (TFC) and Existing Fish Communities (EFC) Based on Habitat-Use and Pollution Tolerance Classification Guilds

Habitat-Use Class	% Expected TFC	% Total Existing Fish Community	% Impoundment Only	% Riverine Only
Fluvial Specialist	45.8	11.2	0	17.8
Fluvial Dependent	28	20.3	10.3	26.2
Macrohabitat Generalist	26.4	68.5	89.7	56
Pollution Tolerance	**Expected TFC**	**Total Existing Fish Community**	**Impoundment Only**	**Riverine Only**
Intolerant	7.7	2.9	0	4.6
Moderate	75.4	35.6	39.4	33.4
Tolerant	17.1	61.5	60.6	62

Habitat-Use. The overall dominance of macrohabitat generalists and lack of fluvial specialist in the EFC is directly related to the effect of the dams and the creation of impoundments in what naturally would be free flowing stretches of river.

Pollution Tolerance. Data show a dominance of pollution tolerant species, 61.5 percent, in the EFC of the Assabet River versus the target in the TFC of 17.1 percent.

It is likely that removing dams on the Assabet River and improving water quality would improve the aquatic habitat and support the increase in fluvial dependent and fluvial specialist species consistent with the target fish community (TFC) considered for this river.

Over the long term, removing dams on the Assabet would also provide for the future restoration of the migratory corridor on the Assabet and provide access to spawning grounds and nursery habitat for river herring when passage is provided at the Talbot Dam in Billerica. In the short term, American eel might benefit from removal of obstructions such as dams that impede upstream and downstream passage and make their migration more difficult. American eel is the only migrating species that is currently able to access the Assabet due to their ability to pass over or around dams.

DAM REMOVAL ASSESSMENTS

Impact of Dam Removal on Water Surface Elevations

Computer modeling of the Assabet River included an examination of the effect of dam removals on water surface elevations. Effects were calculated using the HEC-RAS computer model developed for the study. (CDM, Modeling Report, June 2008.) The HEC-RAS model results indicate that dam removal significantly lowers the water surface elevations for the 7Q10, summer average flow, 10-year flood, and the 100-year flood flow conditions. The largest change in water surface elevation occurs for the lower flow conditions, 7Q10 and summer average flows, except for the Allen Street and Gleasondale sites. The change in depth behind each of the dams for the four flow conditions is presented in Table 11. Changes in depth noted in Table 11 are directly upstream of the dam. Changes decrease with distance upstream from a dam as shown in Figure 5 below.

Table 11. Change in Water Surface Elevation for Various Flows Scenarios

Flow Scenario	**7Q10**	**Summer Average**	**10 year**	**100 year**
Dam Removed	**Estimated change in WSEL in feet just upstream of dam**			
Aluminum City	-4.9	-4.8	-4.2	-0.6
Allen Street	-3.4	-3.5	-4.7	-5.6
Hudson	-7.0	-6.9	-5.4	-3.4
Gleasondale	-4.7	-4.5	-4.6	-5.1
Ben Smith	-7.4	-7.4	-5.6	-4.0
Powdermill	-7.8	-7.6	-7.2	-7.1

(Detailed data on Assabet River Water surface profiles is provided in Appendix F of the CDM Modeling Report dated June 2008.)

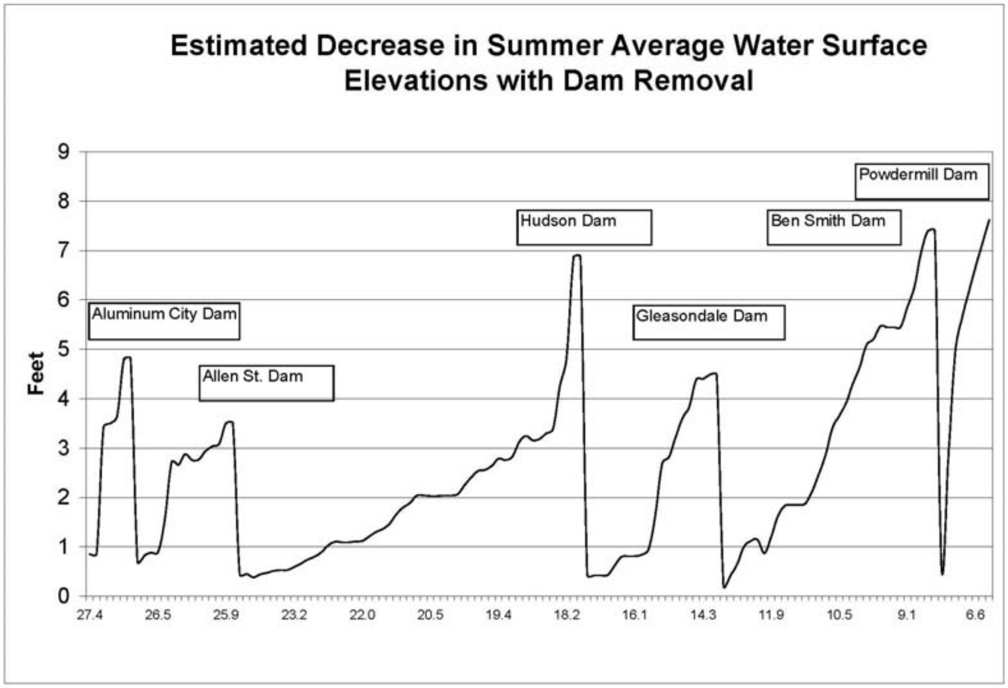


Figure 5. Assabet River Change in Water Surface Elevation[7]

Decreasing water surface elevations with dam removals would impact uses that rely on the pools (water levels) maintained by the dams. Decreased water surface elevation would result in a change in wetlands along the river (See Appendix D Figures 1 to 3) and may affect any riparian landowners that have come to depend on the impoundments as a source of water.

Impact on Recreation

If the dams on the Assabet River were to be removed this would impact the recreational uses that rely on the impoundments. Recreational activities on the impoundments include canoeing, kayaking, fishing, ice skating, cross-country skiing and enjoyment of the open water environment. There are several canoe access sites along the river as shown in Figure 6. Recreational opportunities that rely on current water depth provided by the impoundments would be impacted as water depth would be lower with dam removal. A detailed evaluation of

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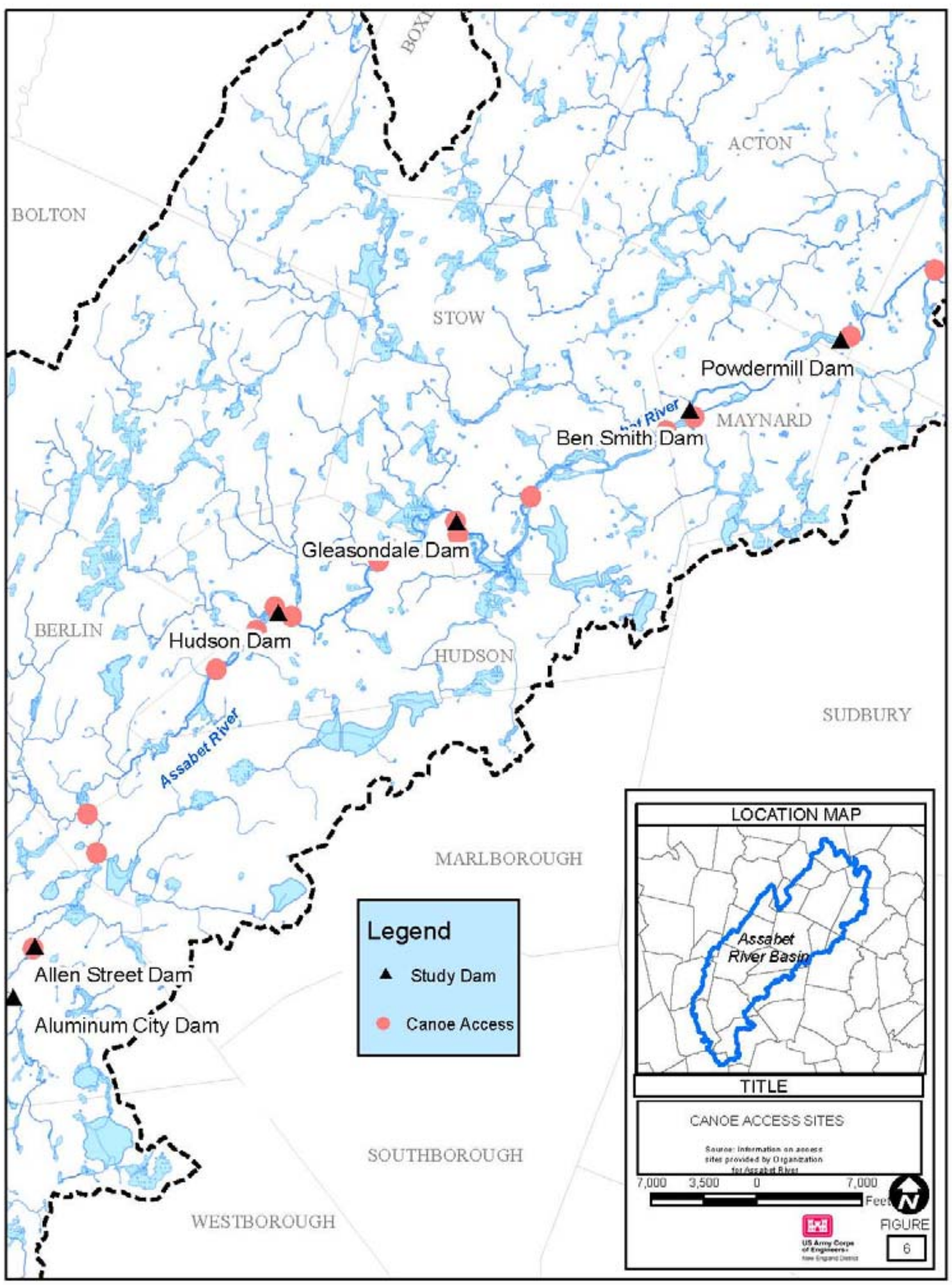
[7] Flows used for the summer average water surface elevation calculations were 13 cfs at Northborough to 64 cfs at Maynard.

recreational impacts was not part of this study but would be needed if dam removal is considered further. Based on comments received in Appendix K, it appears that Ben Smith impoundment is a highly valued local resource for recreation. A recreational use survey would be valuable to document the many uses of the river.

Figure 6. Canoe Access



Impact of Dam Removal on the Mill Ponds at Clock Tower Place

CDM reviewed the situation that would exist if Ben Smith Dam were removed and how this would affect the flow of water to the mill ponds at Clock Tower Place. CDM determined that the Assabet River water level at the current canal intake point would drop such that water would no longer flow by gravity into the Mill Ponds at Clock Tower Place. (See Appendix J.)

In order to direct water into the mill ponds by gravity, the intake location would need to be moved upstream on the Assabet (i.e., to remain higher than the mill ponds normal pool elevation). However, due to the mild slope of the river upstream of Ben Smith Dam, an intake along the Assabet River channel is likely not feasible. Another option is to pump water from the Assabet River into the mill ponds to maintain a small pool of open water. This might include allowing wetlands to fill in some of the shallower areas. It may be possible to create an open space with wetlands that would be both aesthetically pleasing and still reflect the historic mill pond function of the site. (CDM memorandum June 8, 2007.) However, community value and acceptability would need to be determined through future assessments.

Impact of Dam Removal on Groundwater Levels Adjacent to the River

Surface water levels in the river would generally be lower after dam removal. The impact of lower river water levels on the adjacent groundwater levels was not included in this study, but would be considered during future potential dam removal studies. It is expected that any localized impact to groundwater elevations adjacent to the river would decrease with distance from the river.

Impact of Dam Removal on Water Supply for Fire Protection

Initial planning level review indicated that dam removal could impact the water source for fire protection purposes for the Town of Stow at the Gleasondale Mill building, the water source for fire protection for the Town of Stow provided by the Ben Smith impoundment, and the use of the mill ponds as a water source for fire protection at Clock Tower Place in Maynard. In addition, there is a local fire protection pond near Apple Blossom Way in Stow and there may be other fire ponds near the river. If dam removal were considered further then fire protection use can be investigated and mitigation plans developed as appropriate.

Impact of Dam Removal on Local Business Water Supply

Businesses that rely on the water in the impoundments for water supply may be impacted by a dam removal project. Local businesses were not surveyed as part of this study but could be considered if further studies are undertaken for potential dam removal. The Stow Acres Country Club and the Honey Pot Orchards reported that they rely on the Assabet River for irrigation water.

Flood Levels

Summary. Removing dams would lower water levels in the Assabet River. Storage behind the dams is small and would not be entirely lost when the dams are removed, because the dams are located at natural restrictions in the river, so effects of dam removal on downstream peak flows would be small. Future studies would be needed to determine if it is necessary to leave part of the abutments in place to further restrict flood flows such that there is no increase in downstream peak discharges; however, the elimination of the pools behind the dams would mean that the same storage as before dam removal can be achieved at a lower water level. On the other hand, because storage behind the dams amounts to only a small amount of runoff from the watershed, no significant reduction in downstream peak flows can be achieved utilizing the extra storage made available by removing the dams and lowering the water levels behind them.

Surcharge Storage. That removing a dam would lower the water level behind it is intuitive, but there are concerns that the loss of surcharge storage would increase peak flows downstream and, therefore, the risk of flooding. "Surcharge storage" is that which occurs when flow increases causing the level of the water over the spillway to rise, which also causes the water level in the pool behind the dam to rise. The increased volume of water behind the dam and above the level of the spillway crest is the surcharge storage. If the pool behind the dam is large enough compared to the size of the watershed, the surcharge storage can significantly reduce peak downstream flows. However, the storage behind these dams amounts to only a small amount of runoff. Total surcharge storage behind the three dams whose removal would most benefit water quality in the Assabet River – Ben Smith, Gleasondale, and Hudson – is 3,850 acre-feet, which is equivalent to 0.6 inches of runoff from their 114 square mile drainage area. While this is not a large amount of storage, most of it would be retained through natural channel storage and the actual loss of storage would be much smaller.

Channel Storage. For practical reasons, dams are built at natural channel restrictions, and even with a dam completely removed, water can still backup behind that point with much the same effect as surcharge storage. At the Ben Smith Dam site, for example, HEC-RAS backwater analyses show that surcharge storage during the 100-year flood is 1,220 acre-feet with the dam in place and 1,140 acre-feet with it removed, a difference of 110 acre-feet, which is equivalent to less than 0.02 inches of runoff from the watershed. Total surcharge storage during the 100-year flood behind Ben Smith, Gleasondale, and Hudson Dams is 3,850 acre-feet with the dams in place and 3,560 acre-feet with them removed; the lost storage due to removal of these dams is 290 acre-feet, which is equivalent to less than 0.05 inches of runoff from the upstream watershed. By comparison, the 100-year 24-hour rainfall for this area is about 6.5 inches according to the "Rainfall Frequency Atlas of the United States" (1961), and 7 inches according to "Atlas of Precipitation Extremes for the Northeastern United States and Southeastern Canada" (1993).

Additional Studies. Although the loss of storage due to removal of three dams (Ben Smith, Gleasondale, and Hudson) is very small, it may be necessary during design of the dam removals to consider leaving part of the abutments at one or more dam sites in place to restrict high flows such that there is not even a small increase in downstream peak flood flows. Dam removal would mean that the storage below the former spillway crest would now be available for channel surcharge storage. Consequently, it would be possible to retain the full surcharge storage at a lower water elevation. For this feasibility study, only backwater analyses were performed. If dam removals are pursued then, future studies should include routings of flood hydrographs to determine if any channel restrictions are needed at the sites where dams are removed.

Wetlands

Wetlands and Riparian Vegetation

Hundreds of acres of vegetated wetlands occur along the Assabet River. The extent of wetlands along the river varies greatly. In areas where the river is affected by development there may be only a narrow fringe of vegetated wetland or none at all. In some impoundments, wetlands extend hundreds of feet from the river. Many of the wetlands along the Assabet River exist because of the water backed up by the dams.

Wetlands within the Assabet River watershed have been mapped and classified by the Massachusetts Wetlands Conservancy Program. The mapping is based on interpretation of 2001-color aerial photography. Fieldwork conducted by the Corps in 2005 indicated that these maps were accurate enough for the planning purposes of this study, except for Powdermill. As a dam safety precaution, a controlled drawdown of the Powdermill impoundment was implemented in

2004. The drawdown has continued since 2004 in order to assist repair of a sinkhole and improvements to the powerhouse intake and spillway.

The wetland plant community is adjusting to the altered hydrologic conditions. Other sources of information include maps of aquatic vegetation at impoundments prepared by ENSR (2001) and OAR (2006).

The Ben Smith impoundment supports the most wetland and open water aquatic habitat, followed by Gleasondale, Hudson, Powdermill, Allen Street, and Aluminum City dams. A description of wetland communities along the Assabet is provided in Appendix D.

Impacts of Dam Removals on Wetlands

Wetland changes following hypothetical dam removal were estimated for each impoundment. See Table 1 Appendix D. Table 1 shows existing conditions, the predicted acreage for each wetland type after dam removal, the change in the amount of each wetland type, and the amount of wetlands expected to transition to upland. The planning level analysis determined that there would be both changes in wetland types and a loss of wetlands as a result of dam removal.

Invasive Species

Invasive species are non-native plants that threaten native habitats by spreading so prolifically that they crowd out native species in sensitive forest, wetland and aquatic habitats. Common invasive emergent plants within the Assabet River study area include reed canary grass, which often forms semi-floating mats that are loosely anchored to the bottom and float up and down with changing water levels. Purple loosestrife, a ubiquitous invader, is also found in emergent wetlands and scrub-shrub wetlands along the Assabet River. Purple loosestrife would likely rapidly colonize exposed areas with saturated soils following a draw down for dam removal. Oriental knotweed could colonize exposed areas at higher elevations. Norway maple, Tree of heaven, Japanese barberry, European buckthorn, Japanese honeysuckle, and multiflora rose are also found in tree and shrub communities. Phragmites and yellow iris do not seem to be widespread in Assabet River wetlands. However, non-native invasive species are opportunistic invaders in disturbed habitats, have prolific reproductive capabilities and the ability to out-compete native vegetation. Therefore, it is prudent to develop a vegetation management plan in conjunction with dam removal to avoid the spread of these species to newly exposed areas. A post dam removal monitoring and control program could prevent initial invasion and long-term establishment of these noxious species.

Invasive aquatic plants occurring in the study area include water chestnut, fanwort, and curly pondweed. Generally, these species are associated with the lacustrine environment (sluggish flows and soft substrate) and would not survive in a riverine system due to increase water velocities and inadequate substrates.

Mitigation for Loss of Wetlands

There is a history of dam building in the eastern United States to provide water-based power for various industrial purposes, most commonly mills, as well as flood control and hydroelectric power. As noted previously, the Assabet River has nine dams on the river, starting in Westborough at the George H. Nichols Dam constructed by the Natural Resources Conservation Service (NRCS-formerly the Soil Conservation Service) in 1968 for flood prevention and fish and wildlife habitat. Downstream from this are seven old mill dams and one additional flood control dam the Tyler Dam, a “dry bed” flood control facility constructed in1965 by NRCS. Increasingly, dam removal is being considered a viable alternative to costly repairs or rehabilitation to deal with the problem of aging or unsafe dams or to address environmental degradation.

The benefits to stream or river restoration are widely recognized by the environmental community. Water movement through impounded areas is slow, allowing the retention of sediments, chemical and nutrient contamination which can lead to degraded water quality, eutrophication and warming. As well, fish passage and movement of other aquatic species up and down the river are restricted.

Massachusetts recently published guidance designed to encourage environmental improvements through potential dam removal projects. (Massachusetts Executive Office of Energy and Environmental Affairs, 2007) Under the Wetland Protection Act (310 CMR 10.53(4)), dam removal may be considered a limited project and as such, the assignment of traditional mitigation requirements is discretional for the local conservation commission (the responsible permitting board). The benefits of dam removal, such as long term water quality and wildlife habitat benefits may be recognized as mitigation as long as the net benefits of dam removal are clearly demonstrated. These inherent benefits are likely to outweigh the short term impacts to water quality (turbidity) and loss of wetland resources. The U. S. Army Corps of Engineers, (Regulatory Program) the agency responsible for the administration of Section 404 of the Clean Water Act, also has some flexibility in accounting for the benefits of river restoration projects and applying mitigation requirements. The evaluation of a “proactive project”, as referred to in the Massachusetts General Programmatic Permit (GPP), requires consultation with the Corps, State and Federal agencies "to determine that net adverse effects are not more than minimal."

Dam Removal Considerations for All Project Areas

Newly exposed riparian areas and transitional upland areas should be protected to preserve the open space, wildlife, water quality and flood storage benefits of the land. Development of transitional upland areas would be considered cumulative impacts under The Council on Environmental Quality (CEQ)[8] which defines cumulative impact as found in 40 Code of Federal Regulation (CFR) section 1508.7 as "the impact on the environment which results from the incremental impact of the action when added to other past, present and reasonably foreseeable future actions regardless of what agency (Federal or nonfederal) or persons undertakes such other acts." Transitional upland areas would need to be identified prior to dam removal and a mechanism implemented to prevent suburban/urban development of these areas in order to avoid potential cumulative impacts.

Increased water velocities within the river channel after removal of the dam would likely limit invasive species infestations, such as reed canary grass, fanwort, water chestnut, yellow flag, etc. by preventing rooting or by flushing unanchored vegetation downstream. However, the presence of purple loosestrife in many areas is of particular concern because of its ability for prolific growth and rapid reproductive capabilities in exposed wet soils and shallow aquatic sites.

Following dam removal, newly exposed banks would be highly susceptible to purple loosestrife infestation. The focus of management after dam removal should be to prevent the further spread of purple loosestrife by encouraging the growth of a healthy zone of native vegetation. A vegetation seeding plan should be implemented to provide an initially quick vegetative cover for exposed soils to prevent purple loosestrife seeds from making contact with exposed soils and the maintenance of a dense and durable vegetative cover over the long-term. This may require multiple seeding with different seed mixes depending on the time of year seeding is conducted.

[8] The Council on Environmental Quality coordinates federal environmental efforts and works closely with agencies and other White House offices in the development of environmental policies and initiatives.

Wildlife and Rare Species

The purpose of this Section is to generally describe the wildlife and rare species associated with the Assabet River and the six study dams and their impoundments to provide information on existing resources.

Habitat

Development along the Assabet River varies considerably as it passes through lightly developed riparian corridors punctuated by more heavily developed village or town centers. In many areas the river remains well buffered by broad floodplain wetlands that have precluded development. Development tends to be most extensive near dams and downstream of dams and increases markedly downstream of the Ben Smith Dam.

The river shoreline has notable protected open space. This includes a 1.5-mile reach along the Assabet River National Wildlife refuge in Stow and many smaller locally protected parcels. Non-impounded sections of the river are protected from further development by the Massachusetts River Protection Act, which provides regulatory oversight and added scrutiny for development projects within 200 feet of the normal high water level, except in urbanized areas where the protected zone may be reduced in width to 25 ft.

Hundreds of acres of vegetated wetlands occur along the Assabet River (see Wetlands discussion above). The extent of wetlands along the river varies greatly. In areas where the river is affected by development there may be only a narrow fringe of vegetated wetland or none at all. In some impoundments, expansive mosaics of floodplain wetlands extend hundreds of feet from the river. Shoreline along most impoundments is largely undeveloped. There are typically long reaches where broad areas of emergent and scrub-shrub wetland lie between open water and upland habitat. Most impoundments also contain areas with well defined banks where open water transitions abruptly to forested wetland or upland.

Wildlife

Wildlife habitat within the Assabet River riparian corridor includes shallow open water areas, emergent, scrub-shrub, and forested wetlands and upland forest. These diverse communities provide valuable habitat for a variety of invertebrates, amphibians, reptiles, birds, and mammals. The river and adjacent riparian habitat also provide travel corridors which allow wildlife to safely move between habitat areas.

Mammals strongly associated with riverine habitat and likely to occur in the Assabet study area include northern short-tailed shrew, beaver, mink, and river otter. Many other mammals utilize riparian upland or wetland habitats. These include star-nosed mole, meadow vole, bats, raccoon, weasel, muskrat, Virginia opossum, white-tailed deer, coyote, and others. Moose occur as occasional transients.

Reptiles and amphibians strongly associated with riverine habitat or impoundments include snapping turtle, painted turtle, and musk turtle. Others that inhabit riparian wetlands along the Assabet include bullfrog, leopard frog, spotted turtle, northern water snake, and ribbon snake. Vernal pools near the river provide breeding habitat for wood frogs, mole salamanders, and other amphibians.

The 1974 to1979 and 2007 to 2011 Massachusetts Breeding Bird Atlas have identified numerous breeding birds from the Assabet River watershed.
(See http://www.massaudubon.org/birdatlas/bba2/)

Many of these species are likely to utilize riparian habitat along the Assabet River. Waterfowl commonly breeding on the Assabet include mallard, wood duck, and Canada goose. Uncommon nesters include American black duck (a declining species), green and blue winged teal, and hooded merganser. The Assabet River also provides wintering habitat for American black duck, mallard, and Canada goose. The Sudbury, Assabet, Concord, Nashua, and Blackstone Rivers of central Massachusetts are designated as an "Inland River Focus Area" in the Atlantic Coast Joint Venture Waterfowl Implementation Plan (ACJV, 2005).

Riparian wetlands also provide habitat for numerous species of resident and migratory songbirds, including marsh wren, song sparrow, veery, catbird, common yellowthroat, yellow warbler, tufted titmouse, red winged blackbird, American goldfinch, and tree swallow.

Wading birds seen on the Assabet, Sudbury and Concord rivers include sora and Virginia rail, black crowned night heron, great blue heron, and bitterns (ACJV, 2005). Osprey and belted kingfisher are often seen fishing in the river or its impoundments. Mudflats and decomposing floating mats of duckweed and filamentous algae provide forging areas for migratory shorebirds such as spotted sandpiper. More than 120 species of birds are reported in the Assabet River National Wildlife Refuge (USFWS 2003), including many that may at least occasionally use riparian habitat.

Rare Species and Critical Habitat Areas

The Massachusetts Natural Heritage Program has identified numerous areas within the Assabet River watershed as potential habitat for rare species. See Figure 7. Three areas on the Assabet River are or were recently mapped as estimated habitat for rare wildlife. These include an area in Northborough mapped as blue-spotted salamander habitat, an area in Stow along the upper reaches of the Ben Smith impoundment mapped as spotted turtle habitat (note: the spotted turtle was removed from the Massachusetts rare species list as of 2007), and an area downstream of Powdermill Dam in Acton and Concord mapped as habitat for Blanding's turtle, and two freshwater mussels (triangle floater and eastern pond mussel). Blanding's turtle is a threatened species in Massachusetts. Transient bald eagles are occasionally seen along the Assabet River.

The entire reach of the Assabet River downstream of Powdermill Dam to the Concord River confluence is mapped as 'Living Waters Core Habitat" by the MA NHESP. Living Waters Core Habitat represents the lakes, ponds, rivers, and streams that provide habitat for rare freshwater species, or that are known to be exemplary aquatic habitat. The key reason for designating the Assabet as Living Waters Core Habitat is the occurrence of triangle floater and the eastern pond mussel mentioned above.

An area of the Assabet River watershed downstream of the Lake Boone in Stow is mapped as Living Waters "Critical Supporting Watershed". The area includes most of the Ben Smith impoundment and the Powdermill impoundment. "Critical Supporting Watershed" represents the area within which conservation actions, such as improved land management, decreased water use, and land protection, is likely to make the greatest contribution toward protecting the freshwater species living in the Living Waters Core Habitat.

The Massachusetts Bio-Map identifies critical upland and wetland habitat needed to maintain biodiversity. Areas classified as "Core" Bio-Map habitat consist of the most viable habitat for rare plants, animals, and natural communities. "Supporting Natural Landscape" consist of buffer areas around Core habitat and large un-fragmented areas and undeveloped watersheds.

Two areas on or near the Assabet River are designated Bio-Map habitat. A large area south of the Ben Smith impoundment, including much of the Assabet River National Wildlife Refuge, is classified as Supporting Natural Habitat. The Assabet River in Concord downstream of Route 2 is within a large Core area that provides habitat for numerous rare plants and animals, and includes examples of a rare floodplain forest community.

The SuAsCo Biodiversity Protection and Stewardship Plan (Clark 2000) identified numerous "biodiversity sites" within the Assabet watershed. The Ben Smith impoundment includes portions of three biodiversity sites: the Assabet Marshes, Crow Island and Gardner Hill, and Assabet River National Wildlife Refuge. The Assabet Marshes, located upstream of the Ben Smith dam, were noted as an excellent example of marsh habitat along the river which provides excellent habitat for migrating waterfowl, bank swallows, otter, swamp sparrow, and other wildlife.

Aquatic Invertebrates

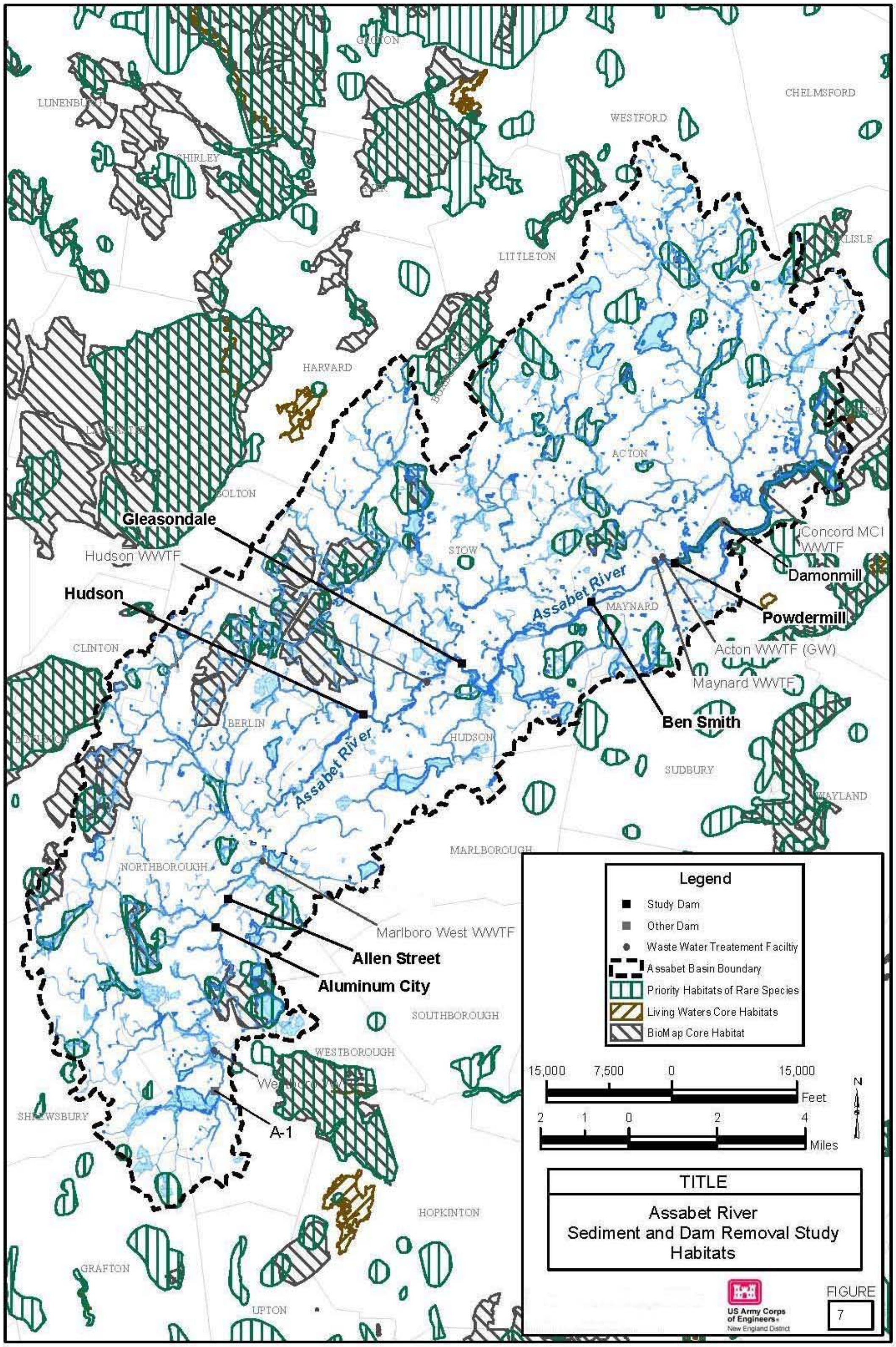
The MassDEP has sampled stream invertebrates at several locations on the Assabet River as part of a bio-monitoring program (MassDEP, 2004). Samples are collected only in riffle areas, which are uncommon in the Assabet River. Many of the Assabet River stations are located downstream of dams. The MassDEP considers all stations on the Assabet River impaired due to reduced species diversity and dominance of caddisflies, an indicator of organic enrichment.

Six of the twelve freshwater mussels occurring in Massachusetts are known to occur in the Assabet River (MA NHESP, 2004) These include three rare species which occur downstream of the Powdermill Dam. These are the triangle floater, the Eastern pond mussel, and Eastern lamp mussel. These mussels are found partially buried in sediment within moderately flowing reaches of the river (MA NHESP, 2004).

Summary Wildlife and Rare Species

None of the impoundments in the study are known to provide habitat for any federally identified rare or endangered species. Based on current information, consideration of potential dam removal and sediment removal does not appear to directly impact rare species habitat at the impoundments. However, activities could mobilize sediment and potentially adversely impact rare freshwater mussels downstream of Powdermill Dam. Work should be designed to minimize sediment transport downstream of Powdermill. Also, dam removal would change the wetlands communities and the effect of these changes on wildlife communities would need to be considered during the environmental assessment process in compliance with applicable Environmental Regulations.

Figure 7. Habitats



Cultural Resources

Prehistoric Resources

Massachusetts Historical Commission (MHC) Reconnaissance Survey Reports for each town in which the Assabet River traverses, note that these towns were known for aboriginal settlement and activity along rivers as well as ponds, and wetland areas. Prehistoric sites are most often found on terraces overlooking waterbodies. Identified sites represent all phases of New England prehistory from the PaleoIndian Period (12,500 – 10,000 BP [Before Present] to the Contact Period (450 – 300 BP/A.D. 1500 – 1620). These sites include short-term hunting or fishing stations or campsites, fish weirs, seasonal camps, and lithic production or repair sites.

The Sudbury-Assabet-Concord River drainage is an area that has been heavily studied by avocational archaeologists and has also been documented by professional cultural resource management investigations. (See Appendix F for specific site discussions.) Based on the existing documentation, it appears that the Assabet River was moderately used by prehistoric groups for resource procurement, and seasonal or short-term settlement. The potential exists for other prehistoric sites to be identified in the floodplain, on terraces or surrounding wetlands adjacent to the river. Further archaeological studies would be needed as part of environmental assessments of a potential dam removal project.

Historic Resources

The historic inventories for each town were examined for all of the dams being considered for possible removal. Some towns have very detailed, up to date inventories, while others have little or no information on the historic resources of the respective community. All of the dams are listed in the MHC Historic Inventory in their respective towns, with the exception of the Aluminum City Dam in Northborough. While National Register of Historic Places (NR) eligibility has not been determined for most of these structures, many of the dams can be considered contributing elements of larger, historic areas and potentially historic districts. NR eligibility determinations would need to be made as part of the environmental compliance process, in consultation with the Massachusetts State Historic Preservation office. More information on the Historic sites is provided in Appendix F.

Known historic structures, which may be eligible for the National Register of Historic Places were identified with a recommendation that a formal determination of eligibility should be made when an alternative is selected and that the determination be coordinated with the Massachusetts State Historic Preservation Officer (MA SHPO) for their concurrence.

The Corps conducted preliminary coordination with the MHC and received a letter dated July 25, 2008 that indicated that this is a highly sensitive area for significant historical and archaeological resources and general concurrence that additional studies and coordination would be needed for dam removals.

Dam removals would also be subject to consultation and review with the Wampanoag Tribe of Gay Head (Aquinnah) Tribal Historic Preservation Officer (THPO), as well as the Mashpee Wampanoag THPO. This coordination can be undertaken by the project sponsor/partners once a decision is made to proceed further with the investigation of dam removal.

Aluminum City Dam. The Aluminum City Dam in Northborough does not appear to be eligible for the NR. While there is a possibility that the dam is associated with an adjacent structure, the structure has been extensively modified as has the area surrounding the dam. However, dam removal, dredging, and possible staging areas all have the potential to affect archaeological resources.

An archaeological reconnaissance survey is recommended if any alternatives are chosen that would impact this site.

Allen St. Dam. The Allen Street Dam, as part of the Woodside Area appears to be potentially eligible for the NR. An intensive archaeological survey is recommended if dam removal and/or dredging are planned for this structure. There are visible stone foundations most likely relating to earlier industries at this area.

Photographic and historic documentation of the dam, factory, and surrounding village would most likely be necessary if removal of the dam is considered. An updated MHC Inventory Form would also need to be prepared in order to get concurrence with the determination of NR eligibility from the MA SHPO.

There is also the possibility that intact pre-contact archaeological resources may be present.

Hudson Dam. The Route 85 Dam in Hudson, also known as the Washington Street Dam is a contributing structure to the Silas Felton Historic District. Dam removal would have an adverse effect on the NR district.

Pre-contact and industrial archaeological resources could also potentially be affected by dam removal. Historic, photographic, and archaeological documentation may be necessary prior to any work at this site. The determination of effect would be coordinated with the SHPO and the THPOs as part of any future studies.

Gleasondale Dam. The Massachusetts Historical Commission Inventory lists the village of Gleasondale, the Gleasondale Mill, and the Gleasondale milldam and canal as historic resources within the town of Stow. Although a formal determination of eligibility has not been made for the dam, mill or surrounding village, it appears that the dam is a contributing element of a NR eligible historic district, so removal would be considered an adverse effect on the village of Gleasondale.

It is likely that archaeological resources (pre-contact and post-contact) would also be impacted by dam removal. An intensive archaeological survey is recommended prior to any work at this site. An updated MHC Inventory Form would also need to be prepared in order to get concurrence with the determination of NR eligibility from the MA SHPO.

Ben Smith Dam. The Ben Smith Dam in Maynard has been determined individually eligible for the NR as well as a contributing element of the Assabet Mills Historic District. The dam is historically important to the development of Maynard's industry as well as the development of the town itself.

Removal of the dam would constitute an adverse effect to a NR eligible historic resource and an adverse effect on the Assabet Mills Historic District, and perhaps other districts, sites or structures associated with the mills. Archaeological resources could be affected by the associated drawdown of the impoundment after dam removal. Removal of the Ben Smith Dam would have the largest negative impact on the historic industrial resources along the Assabet River.

Table 12. Cultural Resource Eligibility for National Register

Site	Findings Relative to the National Register (NR) of Historic Places	Next Steps for Dam Removal Assessment of Cultural Resources
Aluminum City Dam	Does not appear to be eligible for the NR.	Conduct archaeological reconnaissance survey of area.
Allen St. Dam	Appears to be potentially eligible for the NR.	Conduct an intensive archaeological survey of area.
Hudson Dam	Dam is a contributing structure to the Silas Felton Historic District. Dam removal would have an adverse effect on the NR district	Conduct an intensive archaeological survey of area.
Gleasondale Dam	Dam is a contributing element of a NR eligible historic district, village of Gleasondale. Dam removal would have an adverse effect on the NR eligible district	Conduct an intensive archaeological survey of area.
Ben Smith Dam	Removal of the dam would constitute an adverse effect to a NR eligible historic resource and an adverse effect on the Assabet Mills Historic District	Conduct an intensive archaeological survey of area.
Powdermill Dam	Powdermill Dam is located at the site of historic manufacturing activity, so removal of the dam could possibly impact significant historic or archaeological resource	Owner has modified dam and will be generating power at site. No further cultural resources studies are suggested as dam removal is unlikely.

Real Estate Information

Preliminary research was made into the listed owner of each dam for planning purposes. (See Appendix G.) Below is a summary of the listed dam owners based on a review of public records. Five are in private ownership and one is owned by the Town of Hudson. Dam removal would require the cooperation and willingness of these owners. The Acton Hydro Company, Inc. owner of the Powdermill Dam, has indicated that they are not interested in removing the dam as they are rebuilding the dam for hydroelectric power generation.

A dam removal project sponsor would also need to consider the land ownership of abutters along the dam impoundments and identify those areas where the project work area is on private property and obtain the appropriate right of entry or real estate interest in these properties.

Also further investigation is needed to determine ownership and access to land previously submerged that would be exposed due to dam removal.

If the Corps is involved in a dam removal project, the Corps requires that the project sponsor obtain and hold all lands, easement, and right of ways needed to proceed with dam removal. This includes the dam, construction staging areas and work areas, and sediment dewatering and upland disposal areas.

Table 13. Dam Owners on Record

Dam	**Town**	**Listed Owner**
Aluminum City Dam	Northborough	86-88 Main Street LLC.
Allen Street Dam	Northborough	Montrose Northborough LLC.
Hudson Dam	Hudson	Town of Hudson
Gleasondale Dam	Stow	F L B, Inc.
Ben Smith Dam	Maynard	Wellesley/Rosewood/Maynard Mills Limited
Powdermill Dam	Acton	Acton Hydro Company, Inc.

Depictions of Hypothetical Dam Removal

At the request of the Study Coordination Team planning level artistic depictions of dam removal projects were prepared for five of the six dams by CDM. Depictions were not prepared for Powdermill as the dam was undergoing re-construction for hydroelectric power generation during the study. Dam removal depictions are included in Appendix H. An artistic depiction of what the Ben Smith impoundment may look like after dam removal is provided below.

Figure 8. Ben Smith Impoundment Before and After Hypothetical Dam Removal

Impoundment depictions were developed from a flyover of the area in 2007. At the time of the flyover the Powdermill dam was lowered and a photograph is included below in Figure 9. These photographs are included as depictions for Powdermill dam were not developed during this study. These aerials illustrate an actual observed lower pool condition behind Powdermill dam.

Figure 9. Powdermill Impoundment, 2007

Dam Removal Permitting

There are many permits and assessments at all levels of government that would apply to a dam removal project. Federal laws such as the National Environmental Policy Act, the Clean Water Act, the Endangered Species Act, and the Fish and Wildlife Coordination Act, The National Historic Preservations Act, (to name a few) as well as Massachusetts and local laws and regulations provide the framework for project evaluation.

Below is a list of some of the processes and permits that could apply to a potential dam removal project. Many of these processes have a public review requirement.
(Source: http://www.mass.gov/dfwele/der/pdf/factsheet_permitting_final.pdf)

Local Permits
Massachusetts Wetlands Protection Act - Notice of Intent and project approval from local conservation commissions. If a project is in more than one community then permits are needed from each community.

Local building and other local permits

Massachusetts Permits
Massachusetts Environmental Policy Act (MEPA) - may require an Environmental Notification form and may require an Environmental Impact Report. More details on the MEPA regulation and review process can be found at: http://www.env.state.ma.us/mepa/

Massachusetts Chapter 91 Waterways License or permit - this permitting process is a tool for protection and promotion of public use.

Federal Clean Water Act (CWA), 401 Water Quality Certification (WQC) - The Wetlands and Waterways Program in the MassDEP administers the § 401 WQC Program. The § 401 review ensures that a proposed dredge and/or fill project that may result in the discharge of pollutants complies with Massachusetts Surface Water Quality Standards and otherwise avoids or minimizes individual and cumulative impacts to Massachusetts waters and wetlands.

Section 106 of the National Historic Preservation Act - requires Federal agencies to take into account the effects of their undertakings on cultural resources. This review process is coordinated through the Massachusetts Historical Commission and applicable the Tribal Historic Preservation Officer.

Massachusetts General Laws, Chapter 253, Permit, Office of Dam Safety - jurisdictional determination and permit applies to a project that proposes to construct, repair, materially alter, breach or remove a dam.

Massachusetts Endangered Species Act filing/permit - this process protects rare species and their habitats.

Beneficial Use of Solid Waste Permit - this permit may be needed if material from the project is being reused on site.

Federal Permits

Federal Clean Water Act (CWA), Section 404, authorizes the Corps to regulate the discharge of dredged or fill material into waters of the United States. Permitting requirements can be viewed at: http://www.nae.usace.army.mil/reg/index.htm.

Federal Energy Regulatory Commission (FERC) approval - review process is triggered if project is a hydropower dam regulated under FERC.

The National Environmental Policy Act (NEPA) requires Federal agencies to integrate environmental values into their decision making processes by assessing the environmental impacts of their proposed actions and reasonable alternatives to those actions. To meet NEPA requirements Federal agencies prepare an Environmental Assessment or a detailed statement known as an Environmental Impact Statement.

The Fish and Wildlife Coordination Act (FWCA) provides the basic authority for the U.S. Fish and Wildlife Service's involvement in evaluating impacts to fish and wildlife from proposed water resource development projects. It requires that fish and wildlife resources receive equal consideration to other project features. It also requires Federal agencies that construct, license or permit water resource development projects to first consult with the Service (and the National Marine Fisheries Service in some instances) and state fish and wildlife agency regarding the impacts on fish and wildlife resources and measures to mitigate these impacts

Endangered Species Act (ESA) provides for the conservation of species that are endangered or threatened throughout all or a significant portion of their range, and the conservation of the ecosystems on which they depend. The Act is administered by two federal agencies, the United States Fish and Wildlife Service (FWS) and the National Oceanic and Atmospheric Administration (NOAA) review projects for any ESA impacts.

PUBLIC REVIEW OF DRAFT REPORT

The draft report was prepared in September 2009 and local public informational meetings (two) held on the draft report in November 2009. Comments received on the draft and responses are included in Appendix K.

Public review of the draft report demonstrated that the local communities and stakeholders value the existing dams and impoundments for many reasons. There was strong opposition to Ben Smith Dam removal. Local stakeholders are concerned with the following potential impacts related to dam(s) removal and these impacts would require further evaluation if future studies of dam removal were considered:

- loss of the use of impoundments as a water source for fire protection
- loss of the use of the impoundments as a water source for irrigation for local business (orchards, farms, and golf courses)
- decrease in groundwater levels near the river and impacts on fire ponds and wells
- loss of the impoundments for recreation including canoeing and kayaking, bird watching, skating, and cross-country skiing
- loss of the bass sport fishery and general fishing opportunities provided by the impoundments
- loss of the aesthetically pleasing vista and lake-like peaceful environmental setting provided by Ben Smith impoundment
- loss of the wetlands associated with the impoundments
- loss of open water habitat for wildlife (waterfowl, birds of prey, migratory birds, etc.)
- loss of historic resources that contribute to the history, cultural and architectural heritage of the communities and loss of the community identity
- potential health & environmental risk with exposure to sediment currently under water
- dam removal construction costs cost much higher than considered in the study due to additional costs that might be required to "clean-up" sediments
- disruption of local neighborhoods during construction
- unpleasant odor associated with exposed sediments
- decrease in home and property values along the river due loss of the impoundment(s)
- impact to future hydroelectric power production
- increased risk of flooding with dam removal
- loss of water for the mill ponds at Clock Tower Place located in the center of Maynard

CONCLUSION

The purpose of this study is to provide planning assistance (planning level engineering and scientific information) to MassDEP on the potential feasibility of sediment and dam removal to reduce internal recycling of phosphorus (sediment phosphorus flux) in the Assabet River. The first part of the study focused on predicting reductions in internal phosphorus recycling from sediment (sediment phosphorus flux) for sediment and dam removal measures. The second part of the study focused on engineering and environmental considerations for hypothetical dam removal.

If in the future a proponent steps forward who wishes to pursue dam removal, then there would be a detailed environmental assessment and permitting process involved at all levels of government – local, state, and Federal.

The following six dams on the river, and the associated sediment behind them, were considered:

- Aluminum City Dam, Northborough
- Allen Street Dam, Northborough
- Hudson Dam, Hudson
- Gleasondale Dam, Stow
- Ben Smith Dam, Maynard
- Powdermill Dam, Acton

Modeling and Modeling Results

In the first part of the study the Corps contracted with the engineering firm of Camp, Dresser, and McKee (CDM) to perform data collection and computer modeling. Computer models used are listed below and an analysis is provided in the CDM "Modeling Report" dated June 2008.

- HEC-RAS model was used to examine the effect of dam removal on water surface elevations.
- HEC-6 model used to simulate the movement of sediment following dam removal, and changes to the riverbed profile following dredging.
- HSPF model was used to qualitatively assess either positive or negative changes in water quality associated with the measure (dam removal and dredging).
- A spreadsheet model, based on equations from the USEPA QUAL2K model, was used to understand the dynamics of phosphorus flux in the system.

The following summarizes the results of that analysis.

Sediment Dredging Alone

Dredging of sediment from behind dams was considered to decrease sediment phosphorus flux. However, dredging alone would at best achieve only short-term (~ two to four years) reductions in sediment-phosphorus release and the increased hydraulic residence time in the impoundments would likely do more to stimulate biomass growth than the reduction in sediment phosphorus loading would inhibit it. Therefore dredging alone was not considered to be a viable control measure.

Sediment Deactivation

Sediment deactivation was also considered to decrease sediment phosphorus flux. This measure is generally used in lakes. The approach is to apply a chemical (aluminum, iron or calcium salts have been used) so that the chemical both scavenges inorganic phosphorus in the water column and then seal the sediment to hinder the recycling of sediment phosphorous into the water column. In the Assabet, however, it was estimated that there would be fairly rapid (2-5 years) phosphorus replenishment from the settling of biomass and in-stream phosphorus contributions to the sediment. Sediment de-activation is not considered to be a viable long-term measure.

Planned WWTF Improvements

Modeling results suggest that significant strides will be made toward the TMDL goal of 90% reduction in sediment phosphorus flux and overall improved water quality when the current planned improvements are in place at the WWTFs. Planned reductions in phosphorus discharges from WWTFs and the goal of a 90 percent reduction in sediment phosphorus release are not independent; the planned improvements at WWTFs are likely to collectively yield a significant reduction in sediment phosphorus flux.

Dam Removal and Planned WWTF Phosphorus Reductions

Dam removal in combination with planned reductions in WWTF was also considered. Expected water quality improvements include higher minimum dissolved oxygen levels, lower ranges of diurnal DO fluctuation, fewer and less severe occurrences of DO super-saturation, cooler water temperatures, and less nuisance aquatic vegetation.

Modeling results indicated that the potential removal of Ben Smith dam would contribute to achievement of water quality goals through reductions in sediment phosphorus flux because the biomass growth and settling that ultimately drives the sediment flux would decrease with dam removal.

Modeling results indicated that potential removal of Hudson and Gleasondale dams would also contribute incrementally to these goals. Removal of the two most upstream dams in this study, Aluminum City and Allen Street, would result in water quality improvements in stream reaches affected by the existing impoundments, but would have minimal effects on downstream water quality. Similarly, removal of Powdermill dam would have only localized benefits.

Dredging of any or all of the impoundments is suggested only to control sediment movement following dam removal; and as noted above it has no significant long term water quality benefits by itself.

Estimated Reductions in Sediment Phosphorus Flux

The modeling analysis indicated that the planned WWTF improvements would result in a 60 percent reduction in P-Load and potential dam removals would provide another 20 percent reduction. The estimated 20 percent is a conservative estimate and the percent reduction from dam removal may be greater. With both planned WWTF improvements and dam removals the sediment phosphorus flux reduction is estimated to be approximately 80 percent, near the TMDL target of 90 percent reduction.

Adaptive Management Approach

During this study additional data was collected by CDM on sediment P-flux in the Assabet River to help understand the nature of sediment phosphorus flux. Both the sediment phosphorus flux field data collected, as well as the mass balance (spreadsheet) model of sediment-phosphorous flux, led to better understanding of the seasonality associated with sediment phosphorus flux. Results indicate that the sediment response to a change in overlying water phosphorus concentration is fairly short (several seasons).

This realization supports the adaptive management approach adopted by MassDEP in the 2004 TMDL. Also as there are inherent limitations and uncertainties of predictive modeling of a dynamic physical, chemical, and biological system, the accuracy and effectiveness of target reductions could be confirmed by monitoring.

Seasonal WWTF Discharge Limit

Although consideration of lower WWTF winter P-discharge limits was not specifically part of this study, the P-flux model based on limited laboratory data indicated that winter P-loading may have an effect on summer sediment flux rates. If this is confirmed, the additional reductions in phosphorus levels in WWTF discharges during the non-growing season (below the current planned limit of 1mg/L) may make a significant contribution to achieving water quality standards, especially if only limited or no dam removal is undertaken. Further study is necessary to better understand this issue.

An additional consideration of the modeling study was that if no other improvements were implemented, further reductions in summer P discharge limits, below 0.1 mg/L, would not contribute significantly to further reduction in sediment phosphorus flux. This is because the analysis indicated that the winter instream phosphorus concentration has a strong effect on the P-flux the following summer. Therefore, if the summer P discharge limits were decreased below 0.1 mg/L without any further reduction in winter limits, the P-flux in the summer would still be "controlled" by the winter instream phosphorus concentration.

Potential Dam and Sediment Removal

The second part of the "Planning Assistance to States Study" study focused on feasibility of dam removal including engineering considerations and identification of some of the environmental impacts that would be associated with a potential dam removal project.

This study was not meant to be an Environmental Impact Assessment of dam removal nor is it a Corps decision document. There are many permits and environmental studies at all levels of government that would apply to a dam removal project if a dam removal proponent were to step forward. Federal laws such as the National Environmental Policy Act, the Clean Water Act, the Endangered Species Act, the Fish and Wildlife Coordination Act, the National Historic Preservations Act, (to name a few) as well as Massachusetts and local laws and regulations would provide the framework for the detailed evaluation of potential projects if any are proposed in the future.

The planning study identified engineering and environmental issues related to dam removal and these are summarized below.

<u>Sediment Quantity and Sediment Management</u>
The Assabet River Study dams have been in place since the late 1800s and early 1900s and as a result sediments have accumulated behind these dams. If the dams are removed some of this material would reposition within the channel and some would move downstream. The quantity of sediment that would move downstream in a short period of time following dam removal was estimated using the HEC 6 computer model. Sediment volume estimates to be managed ranged from 1,300 to 67,600 cubic yards for Aluminum City and Ben Smith dams, respectively.

Also review of sediment quality data indicated that some of the sediments contain contaminants that may limit disposal options. It is suggested that additional sediment sampling and testing be performed if further studies of dam removals are undertaken. Suggested detailed sampling plans for Assabet River sediments above the dams are provided in the CDM 2008 "Assabet River Sediment Management Plan" report. These sampling plans do not address environmental or health risk assessments of sediments currently under water that could be exposed by dam removal. It is possible that these types of studies may be requested by regulatory agencies as part of future work on dam removal feasibility.

<u>Construction Cost Estimates for Dam Removal</u>
Construction cost estimates for hypothetical dam removal, prepared by CDM in 2008, ranged from about 1 million dollars for the Aluminum City dam to 12 million dollars for Ben Smith dam. In addition to construction costs, costs for a dam removal project would include environmental studies and public review, design, permitting, and project management. These costs are not estimated at this time and would vary depending on the entity that might implement a potential dam removal project. Also there would be real estate costs associated with implementation including items such as cost of the purchase of the dam, permanent or temporary construction easements, and purchase of land in fee as determined to be needed for a project. Also increases in sediment volumes that need to be managed and disposal constraints due to contaminants would increase construction cost estimates.

<u>Target Fish Community Analyses</u>
A target fish community (TFC) can be used as a guide to identify the composition of a healthy fish community for large streams and small rivers in the New England region and can guide and help evaluate river rehabilitation.

The existing fish community (EFC) in the Assabet is not consistent with the target fish community (TFC) considered for the river. Current fish species composition consists primarily of macrohabitat generalists and pollution tolerant species. The overall dominance of macrohabitat generalists and lack of fluvial specialist is directly related to the effect of the dams and the creation of impoundments in what naturally would be free flowing stretches of river. The current fish population is dominated by more pollution tolerant species (e.g. white sucker and bluegill). It is expected that removing dams on the Assabet River and improving water quality would provide habitat that would support the increase in fluvial dependent and fluvial specialist species consistent with the considered target fish community (TFC) for this river.

Over the long term, removing dams on the Assabet would also provide for the future restoration of the migratory corridor on the Assabet and provide access to spawning grounds and nursery habitat for anadromous species when passage is provided at the Talbot Dam in Billerica.

If in the future dam removal were considered further, additional studies of fish populations on the river would be useful to assess changes that would take place.

Impact of Dam Removal on Water Surface Elevations

Computer modeling of the Assabet River included an examination of the effect of dam removals on water surface elevations. Changes were calculated using the HEC-RAS computer model developed for the study. The HEC-RAS model results indicate that dam removal significantly lowers the water surface elevations behind the dams.

Recreation

If the dams on the Assabet River were to be removed this would impact the recreational uses that rely on the impoundments and the deeper water depth provide by the impoundments. Recreational activities on the impoundments include canoeing, kayaking, fishing, ice skating, cross-country skiing and enjoyment of the open water environment. A detailed evaluation of recreational impacts was not part of this study but would be needed if dam removal is considered further. A recreational use survey would be valuable to document the many recreational uses of the river.

Water Supply

The Town of Stow relies on the Assabet River at both Gleasondale dam and the Ben Smith dam as a source of water for fire protection for the surrounding communities. Also some businesses along the river rely on the river as a source of irrigation. In addition there are fire ponds and wells adjacent to the river that would need to be considered. If dam removal were considered further then water supply uses would need to be considered in more detail to determine the impact of dam removal and mitigation plans would also need to be developed as appropriate.

Mill Pond at Clock Tower Place

If Ben Smith dam were to be removed then the Assabet River water level at the current canal intake point would drop such that water would no longer flow by gravity into the mill pond at Clock Tower Place. Options would need to be evaluated to provide water to the mill pond.

Flood Levels

Removing dams would lower water levels in the Assabet River. Storage behind the dams is small and would not be entirely lost if the dams are removed, because the dams are located at natural restrictions in the river, the effects of dam removal on downstream peak flows would be small. Future studies would be needed to determine if it is necessary to leave part of the abutments in place to further restrict flood flows such that there is no increase in downstream peak discharges; however, the elimination of the pools behind the dams would mean that the same storage as before dam removal can be achieved at a lower water level.

Wetlands Impacts
Many of the wetlands along the Assabet River exist because of the water backed up by the dams. The planning level analysis determined that there would be both changes in wetland types and a loss of wetlands as a result of dam removal. The largest changes in wetlands would occur behind Ben Smith, Gleasondale, and Hudson dams. If a potential dam removal project were to be considered further, wetlands impacts and potential mitigation would need to be assessed. Wetlands are regulated under both Federal and state laws.

Wildlife and Rare Species Habitat
Wildlife habitat includes open water areas, wetlands, and upland forest. These areas provide valuable habitat for a variety of invertebrates, amphibians, reptiles, birds, and mammals. The Massachusetts Natural Heritage Program has identified areas within the Assabet River watershed as potential habitat for rare species. Further detailed studies and assessments of wildlife resources and impacts would be needed if a dam removal project were to be considered.

Cultural Resources
All of the dams have identified cultural resource value. Ben Smith, Gleasondale, Hudson, and Allen Street dams are contributing elements to historic districts that are eligible for or listed with the National Register of Historic Places and removal would be an adverse impact and require further studies and documentation of the resources. Further study would also be required of Aluminum City to determine significance. Also, all removals would require further consideration of archaeological resources as areas in the vicinity of the river were used prior to European settlement by native groups dating back to 8,000 BP (before present).

All dam removal projects would be subject to consultation and review by the Massachusetts State Historic Preservation Officer and the Wampanoag Tribe of Gay Head (Aquinnah) Tribal Historic Preservation Officer (THPO), as well as the Mashpee Wampanoag THPO.

Public Review

The Corps and MassDEP held two public meetings in November of 2009 to inform local stakeholders of the study findings. Comment letters demonstrate that many in the local communities and stakeholders value the existing impoundments and dams for many reasons including: recreation, aesthetics, wetlands, fish and wildlife communities, historic and cultural significance, and as a water source for fire protection and irrigation.

Stakeholders are concerned about the potential public health risk of exposure to sediments currently under water, the cost of a dam removal project including the potential cost of sediment management, disruption during construction, potential impact on the real estate values of adjacent homes, potential impacts to business or local residents that rely on the impoundments or groundwater near the river as a source of water, potential increase in flood risk, and loss of recreation associated with the impoundments. There were many letters received opposing dam removal on the Assabet River. Stakeholders are strongly opposed to further consideration of Ben Smith dam removal.

Comment letters also raised the issues of wastewater treatment plant permitting, year round phosphorus limits, and an adaptive management approach to improve water quality in the Assabet River. Comments made at the first public meeting by several municipal officials supported an adaptive management approach that considered winter time phosphorus reductions and monitoring prior to considering additional upgrades and/or potential dam removal. Comments received on the draft and responses are included in Appendix K.

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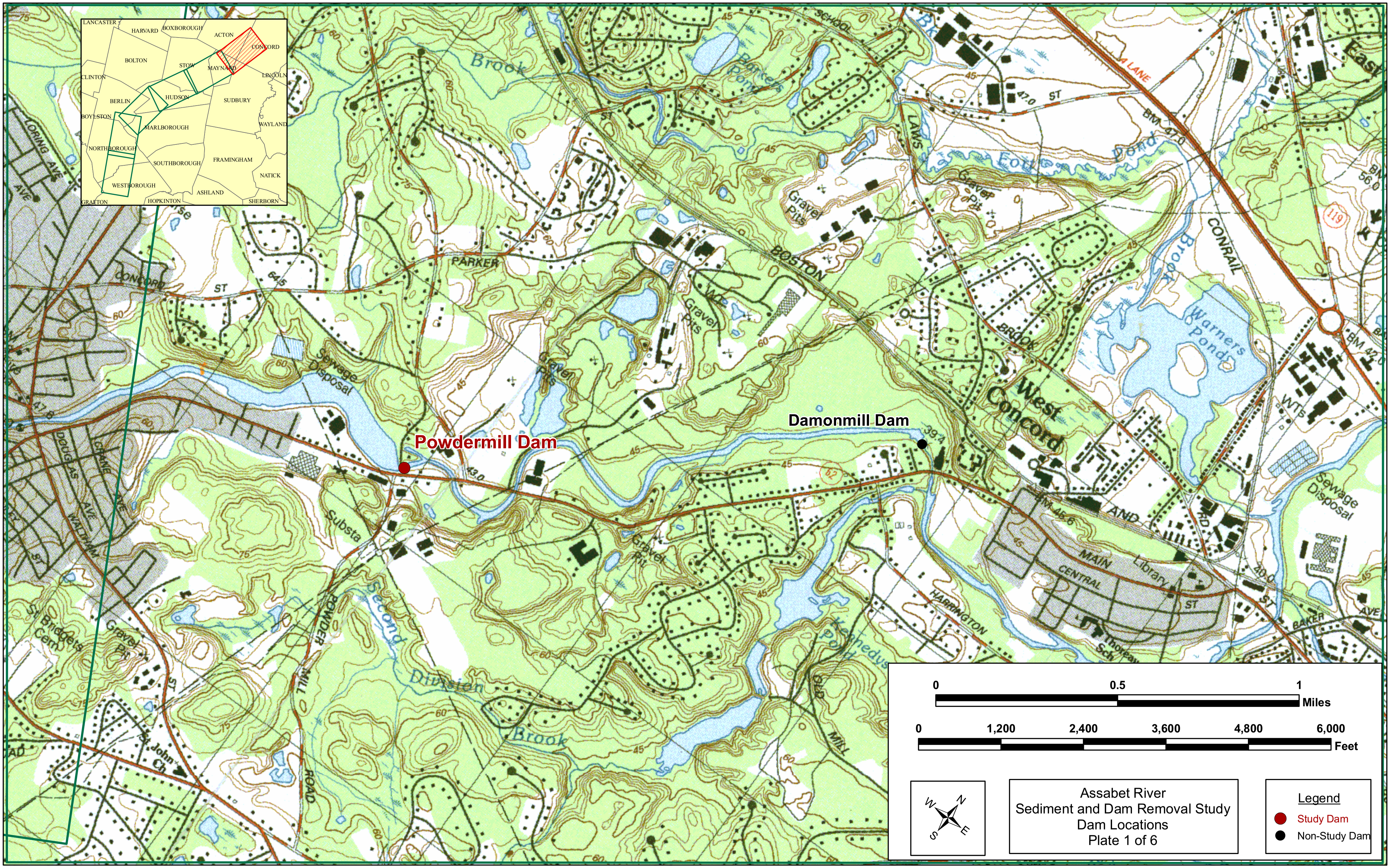
APPENDIX A

ASSABET RIVER DAM LOCATIONS


Powdermill Dam
Damonmill Dam
West Concord
Assabet River
Sediment and Dam Removal Study
Dam Locations
Plate 1 of 6
Legend
Study Dam
Non-Study Dam
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BERLIN
HUDSON
SUDBURY
WAYLAND
BOYLSTON
MARLBOROUGH
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NATICK
WESTBOROUGH
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GRAFTON
HOPKINTON
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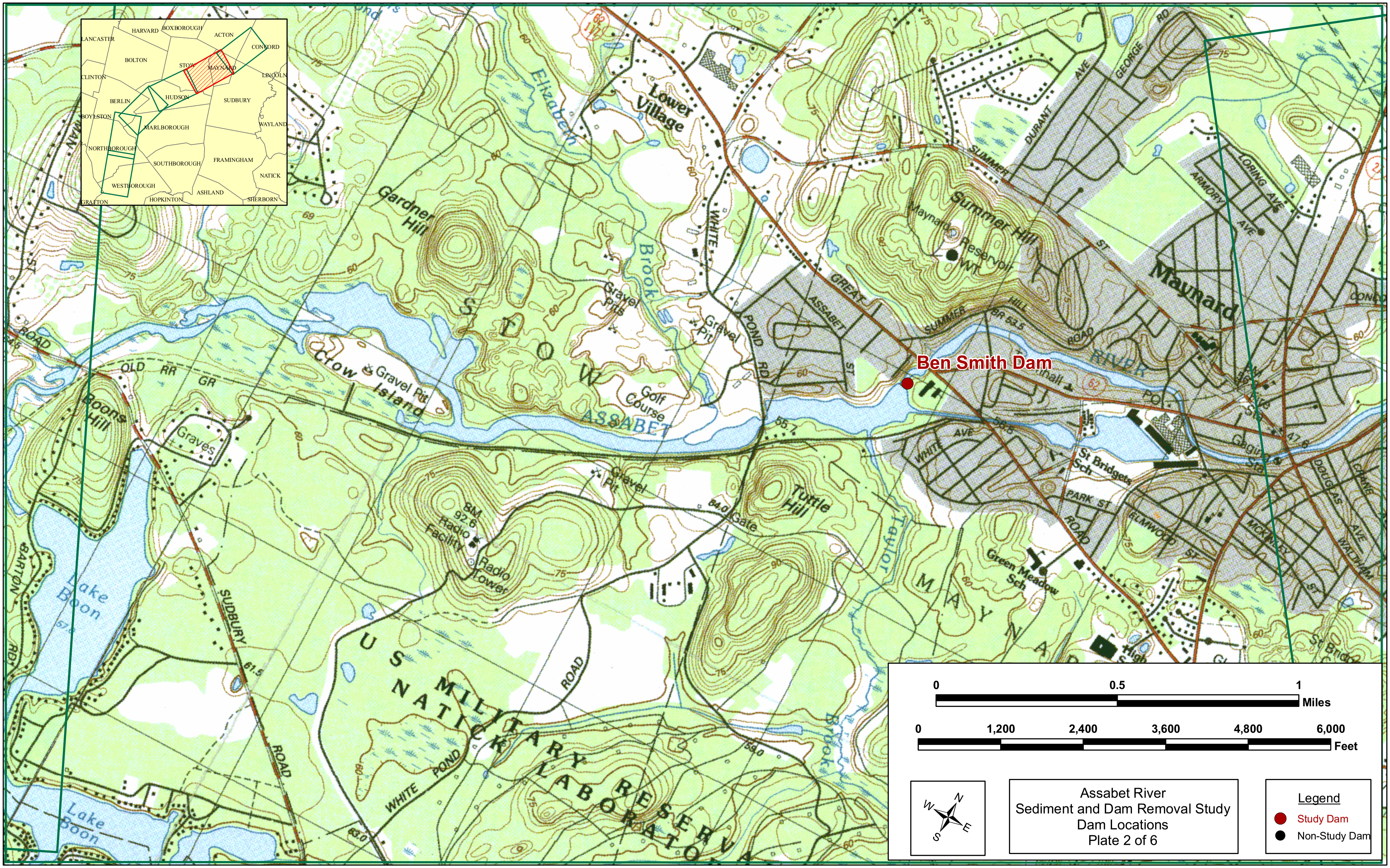

Ben Smith Dam
Maynard
Summer Hill
Maynard Reservoir
Lower Village
Gardner Hill
STOW
Crow Island
Gravel Pit
Golf Course
ASSABET
RIVER
Elizabeth Brook
Taylor Brook
Tuttle Hill
St Bridgets Sch
Green Meadow Sch
Radio Facility
Radio Tower
US MILITARY RESERVATION
NATICK LABORATORY
Boons Hill
Lake Boon
Graves
SUDBURY ROAD
WHITE POND ROAD
GREAT ROAD
OLD RR GR
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Assabet River
Sediment and Dam Removal Study
Dam Locations
Plate 2 of 6
Legend
Study Dam
Non-Study Dam
LANCASTER
HARVARD
BOXBOROUGH
ACTON
CONCORD
BOLTON
STOW
MAYNARD
LINCOLN
CLINTON
BERLIN
HUDSON
SUDBURY
BOYLSTON
MARLBOROUGH
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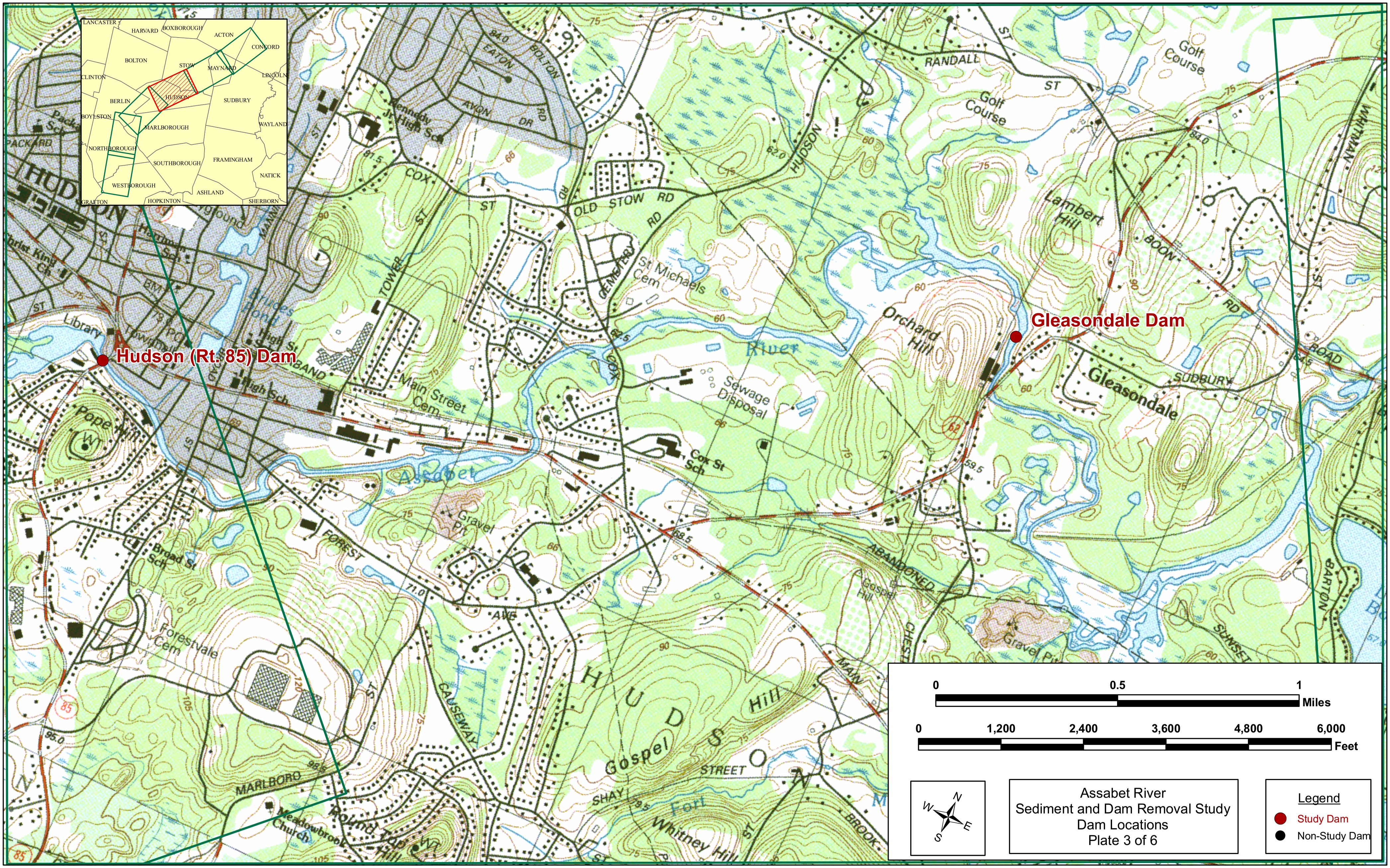
ASHLAND
SHERBORN
GRAFTON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Sediment and Dam Removal Study
Dam Locations
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Hudson (Rt. 85) Dam
Gleasondale
Orchard Hill
Lambert Hill
Golf Course
Golf Course
St Michaels Cem
Sewage Disposal
Cox St Sch
Main Street Cem
Assabet
River
Gravel Pit
Gravel Pit
Gospel Hill
Forestvale Cem
Broad St Sch
Pope Hill
Library
High Sch
Kennedy Jr High Sch
Whitney Hill
Meadowbrook Church
Round Top Hill
LANCASTER
HARVARD
BOXBOROUGH
ACTON
CONCORD
BOLTON
STOW
MAYNARD
LINCOLN
CLINTON
BERLIN
HUDSON
SUDBURY
WAYLAND
BOYLSTON
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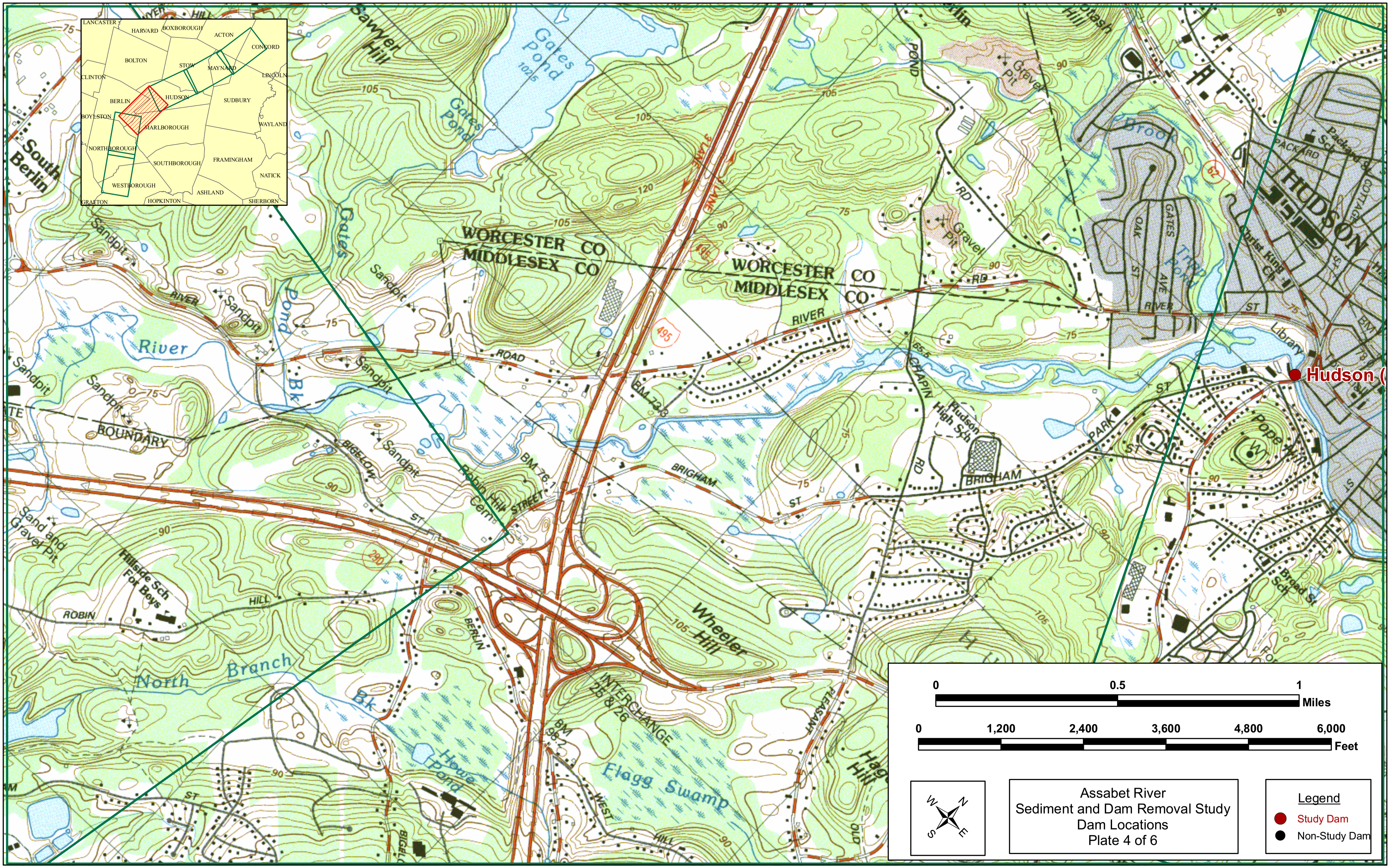
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Dam Locations
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Gates Pond
Wheeler Hill
Flagg Swamp
North Branch
Howe Pond
INTERCHANGE 25 & 26
WORCESTER CO
MIDDLESEX CO
South Berlin
Sawyer Hill
Hudson High Sch
Hillside Sch For Boys
LANCASTER
HARVARD
BOXBOROUGH
ACTON
CONCORD
BOLTON
STOW
MAYNARD
LINCOLN
CLINTON
BERLIN
HUDSON
SUDBURY
BOYLSTON
MARLBOROUGH
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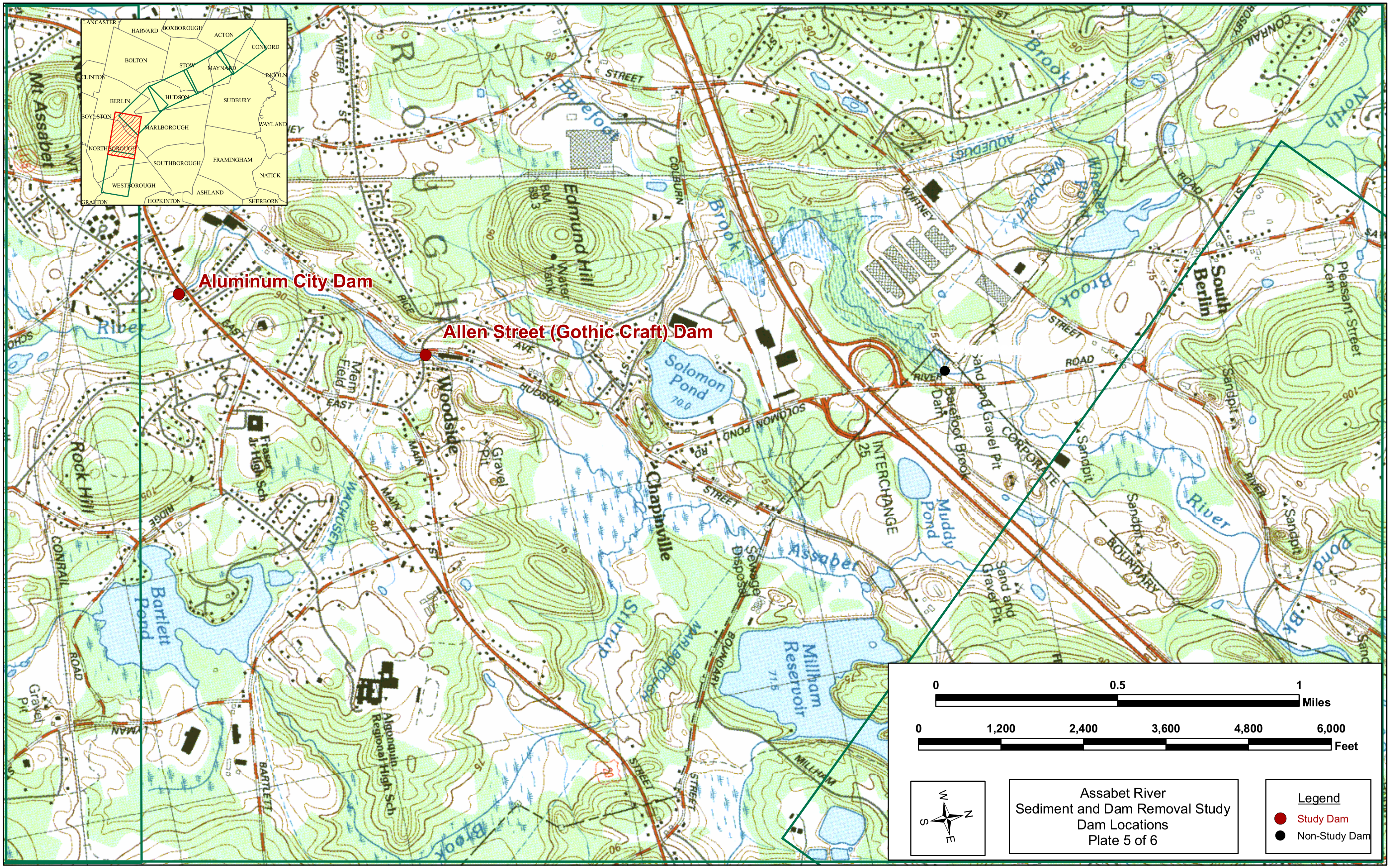

Aluminum City Dam
Allen Street (Gothic Craft) Dam
Barefoot Brook Dam
Solomon Pond
Muddy Pond
Millham Reservoir
Bartlett Pond
Wheeler Pond
South Berlin
Chapinville
Woodside
Edmund Hill
Rock Hill
Mt Assabet
Interchange 25
Algonquin Regional High Sch
Fraser Jr High Sch
Mem Field
Sewage Disposal
Sand and Gravel Pit
Pleasant Street Cem
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Assabet River
Sediment and Dam Removal Study
Dam Locations
Plate 5 of 6
Legend
Study Dam
Non-Study Dam
LANCASTER
HARVARD
BOXBOROUGH
ACTON
CONCORD
BOLTON
STOW
MAYNARD
LINCOLN
CLINTON
BERLIN
HUDSON
SUDBURY
BOYLSTON
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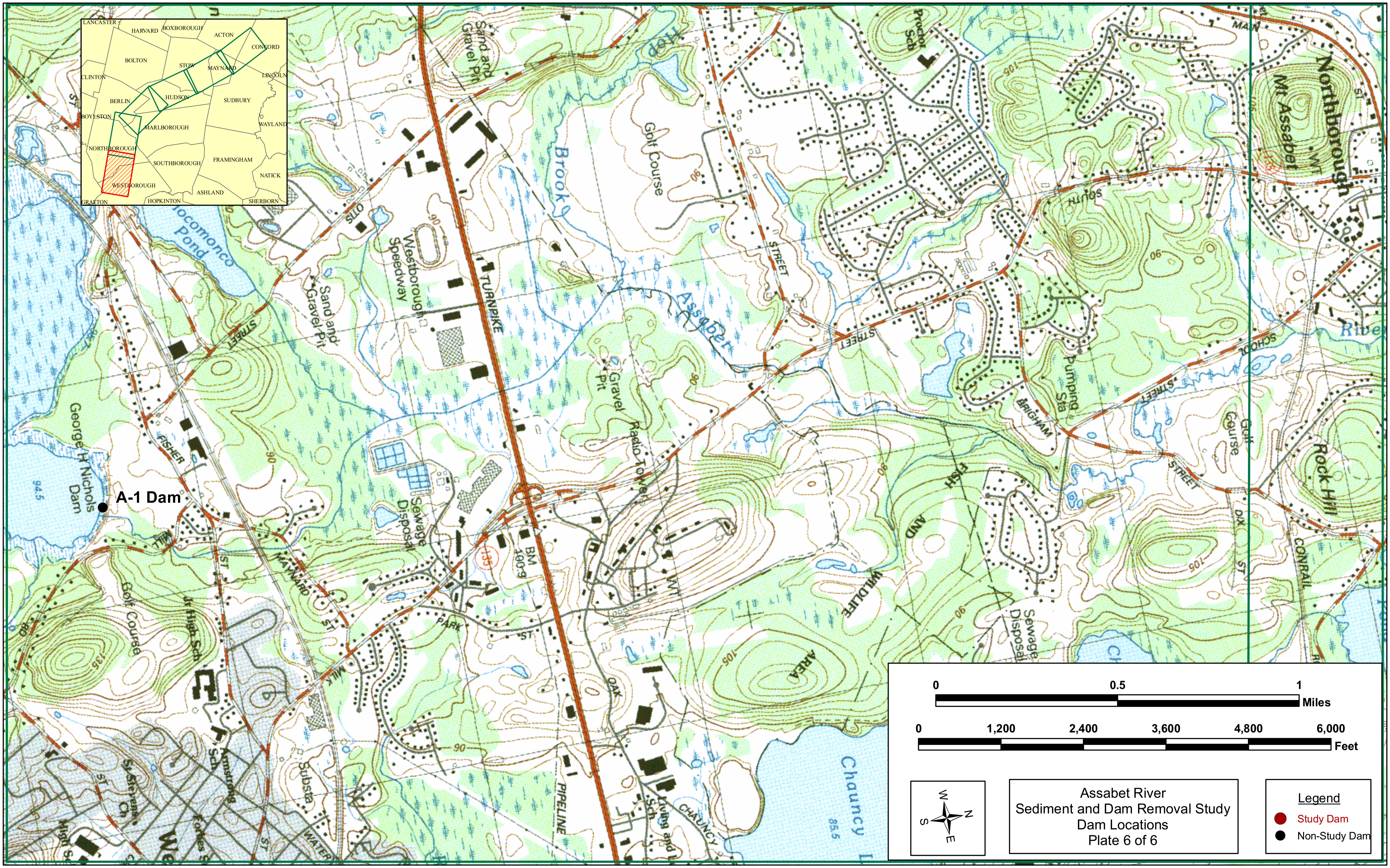

A-1 Dam
George H Nichols Dam
Northborough
Westborough Speedway
Golf Course
Sewage Disposal
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Assabet River
Sediment and Dam Removal Study
Dam Locations
Plate 6 of 6
Legend
Study Dam
Non-Study Dam

APPENDIX B

DAM REMOVAL ENGINEERING CONSIDERATIONS

Aluminum City Dam (Old Mill Pond Dam)

1.0 General Information [1]

Aluminum City Dam is situated on the southerly side of Route 20 (Main Street) in Northborough, Massachusetts. Figure 1 shows the location of Aluminum City Dam. The dam is listed in the National Inventory of Dams (NID) as ID No. MA 02843. According to the NID, the dam was constructed in 1925. According to the cultural resources review the dam site is likely to date from pre-1900.

The existing structure appears to be an earth fill dam with stone and granite masonry. The nature of the earth fill material and/or the presence of an impervious core are unknown. The dam has a structural height of 8.5[2] feet and a crest width of 60 feet. The west abutment is stone and granite block and appears to be connected to the foundation of the existing residential wood-frame building adjacent to the dam. The east abutment also appears to be stone and granite and is now part of the existing retaining wall for the parking lot at E.L Stone/Aluminum City. The foundation of the present dam and abutments is unknown, but it is assumed that it is founded on the remnants of the previous dams located within the existing channels that preceded the existing dam.

It is apparent that at one time the dam had an outlet that went under the Aluminum City parking lot, across Route 20 and under the front portion of the Stone Motorcycle Company's property. According to owner of E.L. Stone/Aluminum City, the conduit was approximately 3' x 3' and was blocked both upstream of the dam and under Route 20 in front of the Stone Motorcycle Company's building. The outlet to the Assabet River was not located, but personal communication with the owner of Stone Motorcycle Company indicates this outlet is blocked at the Assabet River.

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[1] Information provided in Sections 1, 2 and 3 on the dam and construction activities were prepared by CDM for planning purposes and provide to the Corps in CDM in memo dated March 14, 2008.

[2] Fuss & O'Neill, Letter to Dam Safety Office dated November 17, 2006.

Location of Old Mill Pond Dam (Aluminum City Dam)

Dam and Left Abutment

Route 20 Bridge Just Downstream of Dam

Support Walls Just Downstream of Route 20 Bridge

2.0 Proposed Construction Activities

The proposed hypothetical construction activities for removal of Aluminum City Dam include the following:

- Remove existing sediment upstream of the dam
- Demolition of the dam
- Channel improvements and repairs to downstream building foundation
- Channel improvements and stabilization between the dam and the bridge at Route 20 and repairs to the foundation of the downstream building
- Modifications (filling) to the existing outlet conduit as necessary
- Site restoration

2.1 Sediment Removal

Sediment removal behind the dam would be needed as part of the dam removal project. The estimated quantity of sediment, quality, and additional sediment sampling needs and dredging and dewatering are discussed in the report prepared by CDM entitled the "Assabet River Sediment Management Plan", December 2008.

For the Aluminum City impoundment, site preparation would include setting up for mechanical dredging operations. With maximum water depths of about 3.5 feet and channel widths of 30 to 65 feet, it may be possible to access the impoundment with low pressure backhoes and similar excavating equipment. If the Aluminum City dam can be removed in controlled increments, the water level in the impoundment can be lowered which would allow standard ground equipment to access the impoundment.

2.2 Dam Demolition

It is anticipated that only the spillway portion of the dam would be removed. Access and work areas for contractors for the demolition of the spillway would be primarily from the east side of the dam. Access would be from the Aluminum City parking lot. The existing residential building on the west side of the river limits access to the dam. There is limited space available in the existing parking lot. In addition to parking for customers and employees, there are several residential trailers located on the site and the rear of the parking lot is used for vehicle storage. Close coordination with the owner and tenants of E.L. Stone/Aluminum City would be required by the contractor.

Removal of the spillway portion of the dam can be accomplished using conventional construction equipment. Temporary cofferdams would be required to divert flows both upstream and downstream during a sequenced removal of the spillway. For the purposes of the planning-level cost estimate, it was assumed that prior to removal of the spillway; repairs would be required to the foundation of the adjacent residential building. Similarly, the retaining wall along the E.L. Stone/Aluminum City parking lot would be repaired and stabilized. Spillway removal would extend to the natural channel bottom or bedrock, if any. Due to the proximity of the adjacent residential building and the unknown condition of the outlet conduit, blasting is not recommended.

As part of the demolition process, all stone and granite pieces that have been either displaced from the dam, or were deposited during the dam's construction should be removed. These are all located in the channel immediately downstream of the spillway.

The stone and granite masonry should be trucked from the site. The impact of this truck traffic on the businesses located in the E.L. Stone/Aluminum City building and the impact to traffic on Route 20 should be evaluated during final design. The smaller material would be utilized as part of the final channel improvements and stabilization. Given the large size of the stone and granite masonry pieces, and the limited space, on-site crushing of these pieces into graded gravel products is not anticipated.

2.3 Channel Improvements and Repairs to Downstream Building Foundation

Downstream channel improvements would include removal of sediment and vegetation that have deposited in and along the channel over time and re-establishing a cross sectional area of the channel. The channel improvements are required to reduce the impacts of the temporary increased flows through the channel that would result as part of the construction activities. As such, it is anticipated that these improvements would be performed prior to the removal of the spillway. Temporary cofferdams and proper operation of the dam should allow work to be safely performed in the channel. Access to the channel would be from the same location as the access to the spillway.

Scour protection at the abutments to the bridge at Route 20 would be required prior to removal of the spillway. Work would be primarily repair to existing concrete. Access would be from the channel and the parking lot.

It is anticipated that repairs would be required to the Stone Motorcycle Company building's foundation. These repairs primarily would be re-pointing the stone foundation, replacing missing stones and repairing existing concrete. These repairs would extend downstream of the building to include repairs to the stone and concrete retaining wall along the building's rear parking lot.

Channel improvements in this area would include removal of accumulated sediment and vegetation to re-establish the channel cross-section. Access for the work within the channel and repairs to the foundation and retaining wall would be from the parking lot in the rear of the Stone Motorcycle Company building. This work would be performed prior to spillway removal.

2.4 Streambank Erosion/Stabilization Required

The locations and extent of streambank stabilization were determined based on CDM site visits in 2007 and analysis of HEC- RAS and HEC-6 model results by CDM.

1) East Main Street/Route 20 Bridge – Streambank stabilization and/or channel bed modifications would be required from downstream of the East Main Street/Route 20 Bridge for approximately 1300 feet.

2) River Street Bridge - Streambank stabilization and/or channel bed modifications would be required from downstream of the River Street Bridge for approximately 1600 feet.

2.5 Modifications to the Existing Outlet Conduit

It is anticipated that the existing outlet conduit would be filled as part of this project. As indicated earlier, currently the conduit is blocked in several locations. However, the condition of the remaining conduit is unknown. The conduit is under the parking lot and crosses under Route 20, a heavily traveled roadway in Northborough. The conduit is relatively short, approximately 200 feet long. The conduit is relatively deep and filling the conduit with a concrete fill material can be accomplished with an excavation within the Aluminum City parking lot.

2.6 Site Restoration

Site restoration would be conducted to restore the site and any areas used for temporary access or staging, to their original conditions. For purposes of the planning-level cost estimate, minimal landscaping was assumed as part of the site restoration. The extent and type of landscaping should be evaluated as part of the design phase.

2.7 Additional Considerations

It is suggested that the existing bridge at River Street be reviewed in more detail during final design. The existing bridge is located approximately 1,600 feet downstream of the Aluminum City dam. The existing bridge appears to be supported on timber columns. These should be evaluated in detail prior to any planned temporary, or permanent, increase in flow rate within the River. Also scour protection may be needed at the Route 20 Bridge just downstream of the dam.

3.0 Proposed Sequence of Construction Activities

For the purposes of developing the planning-level cost estimate, a proposed sequence of construction activities was developed. The overall construction period is estimated at 20 months. This is based on limiting construction within the Assabet River to the period May through December. It is anticipated that construction during the peak winter months and during the traditional high flow periods would not be feasible.

The major activity during the first calendar year is the sediment removal upstream of the dam. Other construction during the first calendar year would be limited to mobilization; cleaning and stabilizing the river downstream of the dam; stabilizing the existing walls and foundation of the adjacent residential building and the E.L. Stone/Aluminum City parking lot; stabilizing the walls and building foundation downstream of Route 20 and providing scour protection at the Route 20 Bridge. These later activities are performed in preparation of the dam removal.

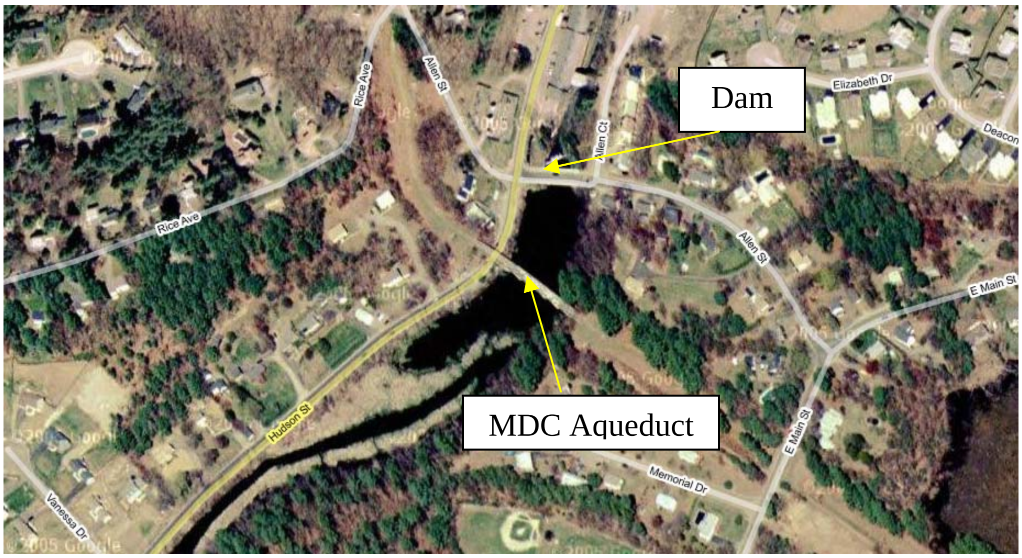
During the second calendar year, work on the demolition of the dam would be performed. Other activities would include the filling of the existing outlet conduit and site restoration.

ALLEN STREET DAM

1.0 Existing Structure Description[1]

The Allen Street Dam is located just north and approximately 30 feet downstream of Allen Street in Northborough, MA. Figure 1 shows the location of the dam. The Allen Street Dam in Northborough (also known as the Gothic Craft or Woodside Dam) is listed in the MHC Historic Inventory as the Assabet River Bridge and Dam.

The bridge and dam are part of the Woodside Area, earlier known as Davisville, which has been a mill site since c. 1720. There is an old factory building downstream that has been turned into apartments. The dam is listed in the National Inventory of Dams (NID) as ID No. MA 00995. The MDC Aqueduct is located about 100 yards upstream of the dam.



Location of Allen St. Dam

[1] Information provided in Section 1, 2 and 3 on the dam and construction activities was prepared by CDM for planning purposes and provide to the Corps in CDM memo dated March 14, 2008.

Allen Street Dam Impoundment

Allen Street Dam

Design plans and construction notes were not readily available in conducting this analysis. The discussion of proposed construction methods and the planning-level cost estimates are based on visual observations of the dam (August 2007 by CDM) and the information provided in the previous studies obtained by USACE and CDM.

The existing structure appears to be an earth fill dam with stone and granite masonry. The nature of the earth fill material and/or the presence of an impervious core are unknown.

The spillway is 70 feet long with a structural height of 12 feet. The abutments are stone and granite block. The foundation of the present dam and abutments is unknown.

The dam has a 9' x 3' foot outlet (culvert) under Allen Street, just west of the dam. The outlet discharges to an open channel immediately adjacent to Hudson Street. Flow returns to the Assabet River through a 4' wide x 6' foot concrete raceway with two vertical drops. Flow through the outlet is controlled by stop logs at the concrete raceway. The stop logs were missing at the time of CDM's site visit (August 2007).

Apartment Unit Walkway Downstream of Assabet River Dam

MDC Aqueduct Upstream of Assabet River Dam

2.0 Proposed Construction Activities

The proposed hypothetical construction activities for removal of Allen Street Dam include the following:

- Sediment removal
- Demolition of the dam
- Channel improvements and stabilization downstream the dam and repairs to the foundation of the apartment building downstream of the dam
- Modifications (filling) the existing outlet culvert, open channel and concrete raceway
- Site restoration

A proposed construction sequence is presented in Section 3.0 of this document.

2.1 Sediment Removal

Sediment removal behind the dam would be needed as part of the dam removal project. The estimated quantity of sediment, quality, and additional sediment sampling needs and dredging and dewatering are discussed in the report prepared by CDM entitled the "Assabet River Sediment Management Plan", December 2008.

For the Allen Street impoundment, site preparation would include setting up for hydraulic dredging operations, including performing a pilot study prior to full scale production. Additional site preparation includes removing oversized debris around the dam and any other areas, clearing and grubbing, establishing access and haul roads, and preparing the dewatering area.

The dredging estimate is based on hydraulic dredging using relatively small (500 gpm) equipment. If it is not possible to reach the river banks using hydraulic dredge equipment, then as suggested previously, another option would be to remove the Allen Street dam in controlled increments. This would lower the water level, which would allow standard ground equipment to access the impoundment. A 1 to 2 month lag in dewatering and disposal may be estimated based on the amount of water to be treated, time to dewater and solidify/bulk the sediment, and time to haul the sediment off site. Sediment in the Allen Street impoundment may be dredged and disposed of in one construction season.

2.2 Dam Demolition

It is anticipated that only the spillway and the east abutment of the dam will be removed. Access and work area for contractors for demolition would be primarily from Allen Court on the east side of the dam. Access would require tree removal and clearing. There appears to be adequate room for the contractor's operation. However, there is insufficient room in the area of the dam for the staging area. One possible location for the staging area is on the private property of the business at the end of Allen Court.

Removal of the spillway and abutment can be accomplished using conventional construction equipment. Temporary cofferdams would be required to divert flows both upstream and downstream during a sequenced removal of the dam. For the purposes of the cost estimate, it was assumed that repairs would be required to the foundation of the downstream apartment building and stabilization of the existing channel before any work can begin on the removal of the spillway. Removal would extend to the natural channel bottom or bedrock, if any.

It is important to note that the existing abutment of the Allen Street Bridge appears to be directly bearing on the dam's westerly abutment, which is a major concern regarding removal of the dam. The bridge has been recently rebuilt (completed in 2007), but the abutment was not modified. This must be investigated in detail prior to demolition of any portion of the dam.

As part of the dam removal process, all stone and granite pieces that either have been displaced from the dam, or were deposited during the dam's construction should be removed. These are all located in the channel immediately downstream of the dam. Existing ledge outcroppings should remain.

The stone and granite masonry should be trucked from the site. The smaller material from the dam and immediately downstream of the dam should be utilized as part of the final channel improvements and stabilization. The larger pieces of granite would be trucked from the site. Due to the limited work area at the dam site, on-site crushing of these pieces into graded gravel products is not anticipated.

2.3 Channel Improvements and Associated Structure Repairs

Downstream channel improvements would include removal of sediment and vegetation that have deposited in and along the channel over time and re-establishing the cross sectional area of the channel. The channel improvements are required to reduce the impacts of the temporary increased flows through the channel that could result as part of the construction activities. As such, it is anticipated that these improvements would be performed prior to the removal of the dam. Temporary cofferdams and proper operation of the dam should allow work to be safely performed in the channel. Access to the channel would be from Allen Court.

It is anticipated that repairs would be made to the foundation of the apartment building immediately downstream of the dam. These repairs primarily would be re-pointing the stone foundation, replacing missing stones and repairing existing concrete. Also of concern is the enclosed walkway spanning the river that connects the main building to an existing apartment unit on Allen Court. Repairs to the foundation of the apartment unit on Allen Court are anticipated.

2.4 Modifications to the Existing Outlet, Open Channel and Concrete Raceway

It is anticipated that the existing outlet culvert and open channel along Hudson Street would be filled as part of the dam removal project. Similarly, the existing concrete raceway would be removed and the land filled and re-graded as part of this project.

2.5 Site Restoration

Site restoration would be conducted to restore the site and any areas used for temporary access or staging, to their original conditions. For purposes of the planning-level cost estimate, minimal landscaping was assumed as part of the site restoration. The extent and type of landscaping should be evaluated as part of the design phase.

2.6 Additional Considerations

It is recommended that the existing bridge at Boundary Street be reviewed. A portion of the existing bridge appears to be closed to traffic indicating concerns about the safety of the existing bridge.

Steam bank stabilization and or channel bed modifications may be required downstream of the dam removal.

3.0 Proposed Sequence of Construction Activities

For the purposes of developing the planning-level cost estimate, a proposed sequence of construction activities with schedule was developed. The overall construction period is estimated to be 20 months. This is based on limiting construction within the Assabet River to the period May through December. It is anticipated that construction during the winter months and during the traditional high flow periods would not be feasible.

The major activity during the first calendar year is the sediment removal upstream of the dam. Other construction during the first calendar year would be limited to mobilization; cleaning and stabilizing the Assabet River downstream of the dam; and stabilizing the existing walls and foundation of the apartment buildings. These later activities are performed in preparation of the dam removal.

During the second calendar year, work on the demolition of the dam would be performed. Other activities would include the removal and filling of the existing outlet channel and site restoration. Depending on actual weather conditions, landscaping and planting associated with the site restoration may extend into the following calendar year.

HUDSON DAM (WASHINGTON STREET OR ROUTE 85 DAM)

1.0 Existing Structure Description [1]

Hudson Dam is situated upstream of the of Route 85 bridge in Hudson, Massachusetts. The dam exists in a narrow river channel through the downtown area. The dam is listed in the National Inventory of Dams (NID) as ID No. MA 00447.

Location of Hudson Dam

The Hudson Dam was first constructed c. 1866, and was most recently repaired in 1987. It is likely, however, that earlier dams may have been constructed at this site. A gristmill was built at

[1] Information provided in Sections 1, 2 and 3 on the dam and construction activities were prepared by CDM for planning purposes and provide to the Corps in CDM in memo dated March 14, 2008.

the natural falls at this location c. 1698, and the first bridge over the Assabet River was built just downstream of the dam by the Town of Marlborough (of which Hudson was once a part) in 1699.

Design plans and construction notes on the original dam were not readily available in conducting this analysis. The discussion of the construction methods and the planning-level cost estimates are based on visual observations of the dam (August 2007) and the information provided in previous reports obtained by the USACE and CDM.

The total extent of the existing dam is not evident from visual inspection. It appears that only the spillway portion of the dam can be seen. Development on both sides of the dam obscures the remainder of the original dam. Visual inspection also indicates that there may have been up to four buildings or mills on Washington Street in the immediate vicinity that may have used the water or water power from the dam. These building have all been replaced by existing structures. The existence of any conduits or raceways to these buildings is not evident. The existing foundation to Ace Hardware shows evident of an intake and outlet that has been blocked by concrete. The extent of that raceway and its condition are unknown, although the Phase I Inspection Report by USACE reports that there is no basement under the Ace Hardware building. The existence of any conduits to other buildings, if any, is not evident based on visual inspection.

The existing spillway structure appears to be earth fill with stone and granite masonry. The granite and stone face has mortared joints. The nature of the earth fill material and/or the presence of an impervious core are unknown. The spillway has a crest length of 66 feet with a structural height of 15 feet.

The spillway is bounded to the south by the foundation wall for the Ace Hardware building. This foundation is built of the same stone and granite block construction. The wall has several openings that have been blocked. The spillway in the vicinity of this foundation wall has a slight bend. The origin of this bend is unknown.

The spillway is bounded to the north by a concrete wall founded on a stone and granite masonry wall. This wall acts as a training wall for the spillway. The current outlet is located adjacent to this training wall. This 6’ x 8’ concrete outlet structure houses the 3’ x 4’ wood sluice gate. The gate’s operator is mounted above the gate. Adjacent to the outlet structure is a fire line intake.

Hudson Dam

Gated Outlet Works for Hudson Dam

Aerial Photograph of Hudson Dam

Immediately downstream of the dam is the Washington Street/Route 85 Bridge. The present bridge appears to be steel and concrete built over the original stone arch bridge.
The structural connection between the original dam and the stone arch bridge is a concern that would require additional investigation during the design phase. Similarly, downstream of the bridge are concrete walls which appear to be founded on stone and granite Masonry. This masonry appears consistent with the construction upstream of the dam and also needs to be evaluated in more detail during the design phase.

Hudson Bridge and Old Arch Stone Culvert Bridge

Channel Downstream of Hudson Dam

2.0 Proposed Construction Activities

The proposed hypothetical construction activities for removal of the Hudson Dam include the following:

- Sediment removal
- Demolition of the dam/spillway and outlet structure
- Channel improvements and stabilization and repairs to the foundation of the hardware building and gas station
- Repairs to the stone arch portion of the bridge, scour protection and removal of sediment in the River
- Repairs and stabilization of the walls downstream of the bridge
- Replacing the fire protection intake
- Site restoration

A proposed construction sequence is presented in Section 3.0 of this document.

2.1 Sediment Removal

Sediment removal behind the dam would be needed as part of the dam removal project. The estimated quantity of sediment, quality, and additional sediment sampling needs and dredging and dewatering are discussed in the report prepared by CDM entitled the "Assabet River Sediment Management Plan", December 2008.

For the Hudson impoundment, site preparation would include setting up for hydraulic dredging operations, including performing a pilot study prior to full scale production. Additional site preparation includes removing oversized debris around the dam and any other areas, clearing and grubbing, establishing access and haul roads, and preparing the dewatering area. The dredging would be by hydraulic dredging. If it is not possible to reach the river banks using hydraulic dredge equipment, then another option would be to remove the Hudson dam in controlled increments. This would lower the water level which would allow standard ground equipment to access the impoundment. A 1 to 3 month lag in dewatering and disposal may be estimated based on the amount of water to be treated, time to dewater and solidify/bulk the sediment, and time to haul the sediment off site. Sediment in the Hudson impoundment may be dredged and disposed of in two to three construction seasons.

2.2 Demolition of the Dam

Only the spillway of the dam is proposed for removal. It is anticipated that access for the demolition work would be from the water from the west. The best recommended access point is from the driveway and parking area of the existing gas station immediately north of the dam. The area is currently used by the existing gas station and a taxicab business. There appears to be approximately 25 feet between the retaining wall and the gas station's building. However, the presence of overhead power lines in this vicinity limits the use of this space and would make operation of heavy construction equipment extremely difficult. Thus, it is anticipated that work would proceed from the west.

Access to the water would be from the parking lot behind the town library and firehouse off Route 62. There appears to be adequate room in this parking lot for the contractor's operation and staging area. A traffic signal on Route 62 that is used by the firehouse would provide safe egress from the work site onto the busy street for all trucking activities.

For the purposes of the planning-level cost estimate, it was assumed that prior to removal of the spillway; repairs would be made to the walls both upstream and downstream of the dam and to the arch portion of the Washington Street Bridge, and stabilization of the existing channel. For the work downstream of the dam, temporary cofferdams would be required to divert flow to permit work in the dry. Work upstream of the dam would require the temporary lowering of the water level in the impoundment area. This would require opening the sluice gates in combination with the use of temporary cofferdams.

Demolition of the spillway and outlet structure can be accomplished using conventional construction equipment and techniques. Lowering of the water level in the impoundment area would be required. Depending on the resulting level of water remaining behind the spillway and the bearing capacity of the remaining soils, the equipment would be operated from temporary barges or work mats. It is anticipated that all material to be removed would be “double-handled” prior to being placed in trucks and removed from the site. Because of concerns with the condition of the walls adjacent to the spillway and the downstream bridge, blasting is not recommended.

The stone and granite masonry would be trucked from the site. The smaller material can be utilized as part of the final channel improvements and stabilization. However, the larger pieces of granite would be trucked from the site. On-site crushing of stone and granite into graded gravel products should be investigated in the future.

2.3 Channel Improvements and Stabilization and Repairs to Structures

Downstream channel improvements would include removal of sediment and vegetation that has deposited in and along the channel upstream of the dam and immediately downstream of the dam. The channel improvements are required to reduce the impacts of any temporary increase in flow rates through the channel that could result as part of the construction activities. As previously indicated, it is anticipated that these improvements would be performed prior to the removal of the spillway and that the water level in the impoundment must be lowered. Lowering of the water would require opening the sluice gate in combination with the use of temporary cofferdams. Pumping within the cofferdams is anticipated. Repairs to walls included re-pointing the stone foundation, replacing missing stones and repairing existing concrete.

2.4 Repairs to the Bridge, Scour Protection and Removal of Sediment in the River

It is anticipated that repairs to the stone arches, scour protection and removal of existing sediment at the bridge would be completed prior to demolition of the spillway and outlet structure. This work would require temporary cofferdams to control flow within the channel. The repairs to the stone arches of the Washington Street/Route 85 bridge include re-pointing and replacing missing stones. Scour protection would include repairs to existing concrete at the abutments. Removal of sediment and vegetation in the channel is also anticipated.

2.5 Repairs and Stabilization of the Walls Downstream of the Bridge

It is anticipated that while the work on the bridge and stabilization of the channel is proceeding, repairs to the existing walls downstream of the bridge can be performed. For the purposes of cost estimating, it is assumed that the concrete work above the stone/granite wall is in good condition and that the work would involve stabilizing the area in and around the remaining stone masonry.

Re-pointing and replacing missing stones are anticipated. Additional stabilization can be provided by providing a new concrete toe. This should be investigated as part of the design phase.

2.6 Replacing the Fire Protection Inlet

Following removal of the spillway and outlet structure, the fire protection inlet might be replaced if needed.

2.7 Site Restoration

Site restoration would be conducted to restore the site and any areas used for temporary access or staging, to their original conditions. For purposes of the planning-level cost estimate, minimal landscaping was assumed as part of the site restoration. The extent and type of landscaping should be evaluated as part of the design phase.

2.8 Additional Considerations

The existing bridge at Houghton Street is currently closed to traffic and in need of repair. Any work at the dam should be coordinated with efforts by Hudson and the state regarding plans to repair/replace this bridge.

The existing foundation to the former mill building off Houghton Street should be evaluated in more detail prior to any planned temporary release of waters. This building is currently used as temporary storage and appears to be well maintained.

There are other sites downstream on the river that may need scour protection once the dam is removed. Also stream bank stabilization and or channel bed modifications may also be needed downstream of the dam removal project. These items would need to be considered in design.

The existing spillway from Tripp Pond should be evaluated prior to the removal of the Hudson Dam. The pond is controlled by a 5’ wide stop log structure immediately north of Route 62. A low level outlet is provided by a gate valve. The outlet from the pond passes via an open cannel under an existing building prior to release to the Hudson Dam impoundment area. Although the elevation of the Tripp Pond outlet appears to be significantly above the level of the impoundment, the existence of any hydraulic control should be investigated further.

3.0 Proposed Sequence of Construction Activities

For the purposes of developing the planning-level cost estimate, a proposed sequence of construction activities was developed. The overall construction period is estimated at 20 months. This is based on limiting construction within the Assabet River to the period May through December. It is anticipated that construction on the spillway during the peak winter months and during the traditional high flow periods would not be feasible with the exception of the sediment removal activities.

The major activity during the first calendar year is the sediment removal upstream of the dam. It is anticipated that the first several months of sediment removal would be dedicated to providing access to the river and for preparation of the drying areas. Once sediment removal commences, it is anticipated to take approximately six months. It is important to note that several of the construction activities in and around the spillway and foundations and walls upstream of the spillway would require periodic lowering of the water levels in the river. This may have an impact on the type and size of equipment used for sediment removal.

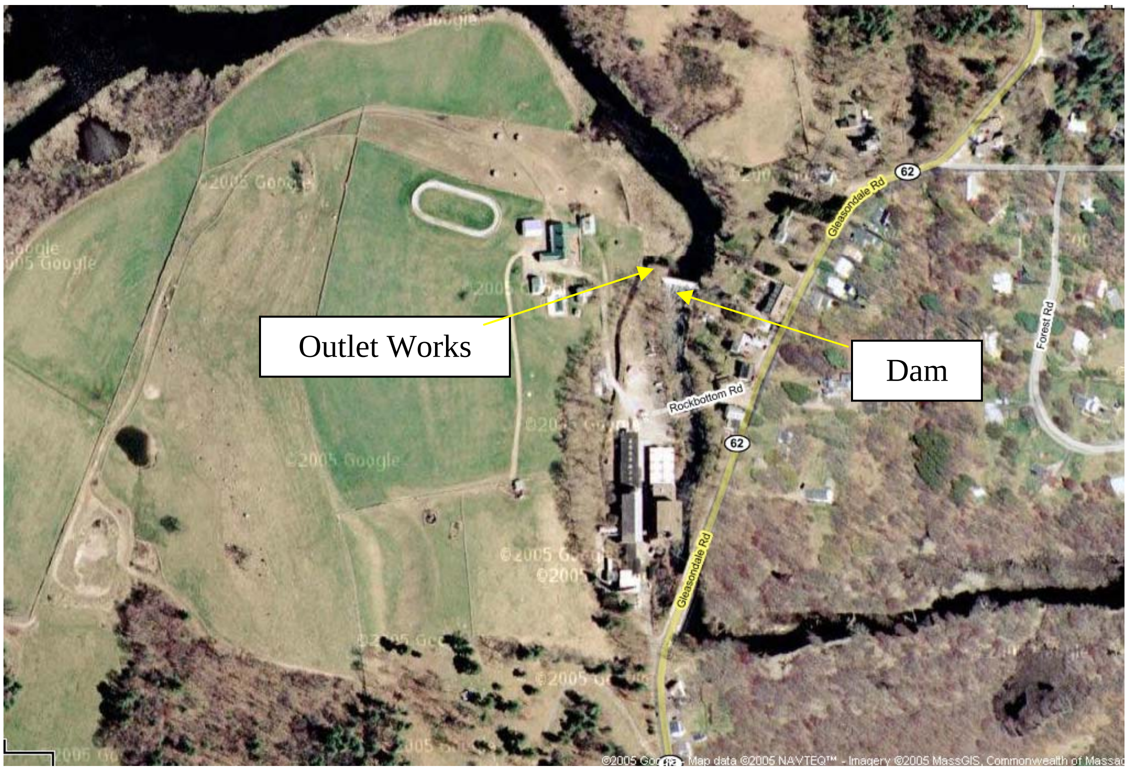
Other construction during the first calendar year would be limited to mobilization; repairing the existing sluice gate, stabilizing and repairing the Ace Hardware building's foundation and the retaining wall upstream of the dam, providing scour protection at the Washington Street bridge; cleaning and stabilizing the river downstream of the dam; and stabilizing the existing wall downstream of the dam. These later activities would be performed in preparation of the dam removal.

During the second calendar year, work on the demolition of the dam would be performed. Site restoration would proceed early in the second year and would be carried on through the remainder of the year. Depending on the weather at the end of the construction period, landscaping and planting associated with the site restoration may extend into the third construction season.

GLEASONDALE DAM

1.0 Existing Structure Description[1]

Gleasondale Dam is situated on the westerly side of Route 62 (Gleasondale Road) in Stow, Massachusetts. The dam exists in a narrow river channel and has masonry abutments on both sides. The dam is listed in the National Inventory of Dams (NID) as ID No. MA 00820.



The current dam, called the "stone dam" is the third dam at this location. The first dam constructed here was built c. 1735, and the second c. 1836 along with the canal, which extended under the mill building. The current dam was built in 1883 and connected to the existing canal, with a canal gate and overflow spillway to service the C.W. Gleason's Sons textile mill. Work on the Dam may have been done in 1924 as this is the date provided in the NID.

Design plans and construction notes were not readily available in conducting this analysis. The discussion of construction methods and the planning-level cost estimates are based on visual observations of the dam (August 2007) and the information provided in previous studies obtained by USACE and CDM.

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[1] Information provided in Section 1, 2 and 3 on the dam and construction activities was prepared by CDM for planning purposes and provide to the Corps in CDM memo dated March 14, 2008.

The existing Gleasondale dam structure appears to be an earth fill dam with stone and granite masonry. The nature of the earth fill material and/or the presence of an impervious core are unknown. The dam has a crest length of 95 feet and a structural height of 12 feet. The abutments are of similar stone and granite block construction. The foundation of the existing dam and abutments is unknown.

Gleasondale Dam

The dam has a rectangular shaped outlet channel east of the dam. The outlet channel continues south along the west side of the property via an earth open channel approximately 600 feet long. At this point the channel enters a pipe. The size of the pipe could not be determined. The pipe ends at a cistern style structure on the west side of the Mill Building. The flow passes through an opening under the building to a chase that eventually passes under the Mill building and the Mill complex's driveway before returning to the Assabet River.

Flow in the outlet pipe is controlled by a sluice gate. According to one of the dam's owners, the sluice gate has not been operated in many years. The sluice gate appears to be in poor condition. Immediately downstream of the sluice gate, there is an earth channel from the outlet channel to the Assabet River. This earth channel appears to be hand-dug and lacks a stabilized channel configuration. Early signs of erosion are visible particularly along the south face of the dam's west abutment.

Flow in the outlet channel currently serves as a critical component of the fire protection system for the Mill Complex. Presently, water is pumped from the cistern to three storage tanks located on top of the adjacent hill east of the Mill complex. Currently, only the 50,000 gallon tank is used. The tanks feed the Mill complex's building sprinkler system and yard hydrant. Since there are no existing water mains in the vicinity of the Mill Complex, this fire protection system is critical to the Mill complex and neighboring homes.

2.0 Proposed Construction Activities

The proposed hypothetical construction activities necessary for the removal of Gleasondale Dam are summarized as follows:

- Sediment removal
- Demolition of the dam
- Channel improvements and stabilization
- Scour protection and sediment removal
- Outlet channel removal
- Fire protection system replacement
- Site restoration

A proposed sequence of construction activities is included in Section 3.0 of this document.

2.1 Sediment Removal

Sediment removal behind the dam will be needed as part of the dam removal project. The estimated quantity of sediment, quality, and additional sediment sampling needs and dredging and dewatering are discussed in the report prepared by CDM entitled the "Assabet River Sediment Management Plan", December 2008.

For the Gleasondale impoundment, site preparation would include setting up for hydraulic dredging operations, including performing a pilot study prior to full scale production. Additional site preparation includes removing oversized debris around the dam and any other areas, clearing and grubbing, establishing access and haul roads, and preparing the dewatering area.
The dredging estimates are based on hydraulic dredging.

If it is not possible to reach the river banks using hydraulic dredge equipment, then another option would be to remove the Gleasondale dam in controlled increments. This would lower the water level which would allow standard ground equipment to access the impoundment. A 1 to 2 month lag in dewatering and disposal may be estimated based on the amount of water to be treated, time to dewater and solidify/bulk the sediment, and time to haul the sediment off site. Sediment in the Gleasondale impoundment may be dredged and disposed of in one to two construction seasons.

2.2 Dam Demolition

It is anticipated that only the spillway portion of the dam will be demolished and removed. The existing east abutment will remain. The existing west abutment will be stabilized and remain.

Removal of the spillway can be accomplished using conventional construction equipment. Temporary cofferdams will be required to divert flows both upstream and downstream during a sequenced removal of the dam. The flow can be diverted through the existing outlet structures and back to the Assabet River through the hand-dug channel. The hand dug channel will require stabilization prior to its use. Reuse of the entire open channel and chase under the building is not recommended due to the age and unknown condition of the portion of the chase under the building and driveway. However, the channel needs to be modified to allow flow to maintain the existing fire protection system.

For the purposes of this evaluation it is assumed that prior to removal of the spillway, repairs will be required to the foundation of the mill buildings together with removal of debris and stabilization of the river bank in this vicinity. Spillway removal will extend to the natural channel bottom or bedrock, if any.

As part of the spillway removal process, all stone and granite pieces that either have been displaced from the spillway, or were deposited during the dam's construction should be removed.

The stone and granite masonry will be trucked from the site. The smaller material from the dam and immediately downstream of the dam can be utilized as part of the final channel improvements and stabilization. However, the larger pieces of granite will be trucked from the site. On-site crushing of stone into graded gravel products should be evaluated during the design phase. Since it is anticipated that the existing abutments are to remain, blasting is not recommended.

Access and work area for contractors for the demolition will be from the open area to the rear of the Mill complex. There appears to be adequate room for the contractors' operation and staging area in this area. Some tree removal and clearing will be required. A second access to the dam is available from an existing right-of-way behind the properties to the east of the dam.

It is recommended that a new, temporary bridge be installed over the Assabet River in the same location at the existing, abandoned bridge. This temporary bridge will provide the access off Route 62 onto the site. The existing access to the area to the rear of the Mill complex off Route 62 is via the Mill's driveway. This driveway is narrow, has a dangerous traffic movement onto on Route 62, and is the only access/egress to the Mill. This driveway is also the only access to the Rock Bottom farm located to the rear of the complex. Movement of construction equipment on this driveway will be a constant impediment to the Mill's tenants. Additionally, the existing chase and the septic system for the complex are located under the driveway. The condition of both is unknown.

2.3 Channel Improvements and Stabilization

Channel improvements, together with stabilization and repairs to the foundation of the Mill buildings downstream of the dam will be required as part of removing Gleasondale Dam. Downstream channel improvements will include removal of sediment and vegetation that have deposited in and along the channel. The channel improvements are required to reduce the impacts of the temporary increased flows through the channel that could result as part of the construction activities. As such, it is anticipated that these improvements will be performed prior to the removal of the dam. Temporary cofferdams and proper operation of the dam will allow work to be safely performed in the channel. Access to the channel will be from the contractor's work area to the rear of the Mill complex.

It is also anticipated that repairs will be made to the Mill building's foundation. These repairs primarily will be re-pointing the stone foundation, replacing missing stones and repairing existing concrete.

2.4 Scour Protection and Sediment Removal

It is anticipated that scour protection and removal of existing sediment at the Route 62 bridge will be completed prior to demolition of the spillway. The existing bridge has three spans. Currently, flow in the Assabet River flows through only the center span and a limited portion of a second span. Considerable sediment and vegetation have accumulated which should be removed prior to the temporary release of additional flows. Similarly, scour protection should be provided to the two middle abutments of the existing bridge.

2.5 Outlet Channel Removal

It is anticipated that the existing outlet culvert and open channel will be removed and filled. This channel must remain in operation until the new pump station and force main are operational. This work will include removal of the stone outlet walls, removal of the concrete sluice gate structure, filling and re-grading the outlet and open channel, removal of the small bridge to the small mill building and the driveway for Rock Bottom Farm and removal of the pipe section immediately upstream of the cistern.

It is also recommended that the existing chase and outlet structure be abandoned and filled. The condition of both is unknown and they no longer serve the intended purpose. These are potential safety concerns to the building, the complex's driveway and the Town's fire fighting capabilities.

2.6 Fire Protection System Replacement

It is anticipated that a new submersible pump within a precast well will be constructed immediately adjacent to the Assabet River in the vicinity of the existing chase's outlet. The precast well will be preceded by a fabricated bar rack for protection from large solids and debris. A new force main will also be installed and connected to the existing main to the tanks.

2.7 Site Restoration

Site restoration will be conducted to restore the site and any areas used for temporary access or staging, to their original conditions. For purposes of the planning-level cost estimate, minimal landscaping was assumed as part of the site restoration. The extent and type of landscaping should be evaluated as part of the design phase.

3.0 Proposed Sequence of Construction Activities

For the purposes of developing the planning-level cost estimate, a proposed sequence of construction activities with schedule was developed. The overall construction period is estimated at 27 months. This is based on limiting construction within the Assabet River to the period May through December. It is anticipated that construction on the spillway and in the Assabet River during the peak winter months and during the traditional high flow periods will not be feasible. Construction activities off the river will continue during these periods.

The major activity during the first calendar year is the installation of the temporary bridge across the river to provide the access to the site from Route 62. The other major activity during the first year is sediment removal upstream of the dam. It is anticipated that the first several months of sediment removal will be dedicated to providing access to the river and for preparation of the drying areas. Once sediment removal commences, it is anticipated to be completed by the end of the first calendar year.

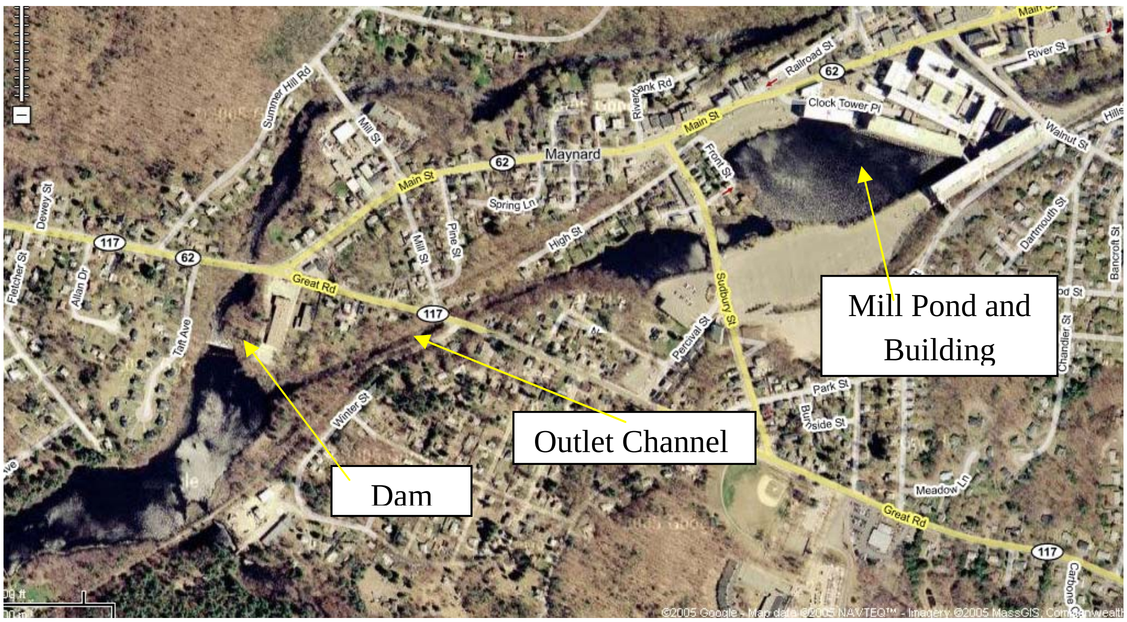
Other construction during the first calendar year will be limited to mobilization; modifications to the outlet channel to divert most of the flow back to the river while maintaining the required flow for the fire protection system; stabilizing and repairing the Mill building's foundation; cleaning and stabilizing the river downstream of the dam; and providing scour protection at the Route 62 bridge. These later activities are performed in preparation of removing the spillway.

During the second calendar year, work on the demolition of the spillway will be performed. Work on the pump station and force main will commence as will work on site remediation. Both activities will be carried on through the remainder of the year into the third calendar year. Work during the third calendar year will complete all miscellaneous, but necessary construction activities including the completion of site remediation activities.

BEN SMITH DAM

1.0 Existing Structure Description [1]

Ben Smith Dam is situated on the southerly side of Route 117 (Great Road) in Maynard, Massachusetts. The dam exists in a narrow river channel with a mix of stone and concrete abutments. The dam is listed in the National Inventory of Dams (NID) as ID No. MA 00752.



Location of Ben Smith Dam

Ben Smith Dam was constructed across the Assabet River in 1847 to establish a mill for the manufacture of carpets and carpet yarn. In order to power the mill, a canal was dug to channel a portion of the river into what is called Mill Pond. The mill changed hands several times over the years and was converted to hydroelectric power in 1902. While the mill ceased operation in 1950, the buildings remain and the mill complex, currently known as Clock Tower Place, currently houses numerous businesses. Power generation was discontinued in the early 1990s.

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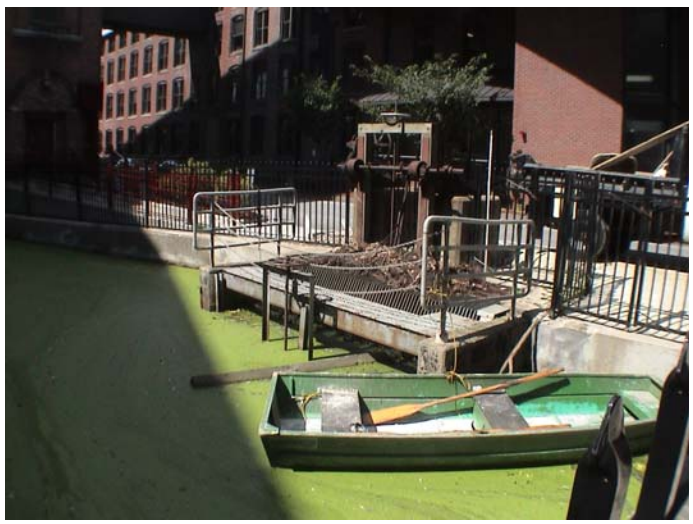
[1] Information provided in Sections 1, 2 and 3 on the dam and construction activities were prepared by CDM for planning purposes and provide to the Corps in CDM in memo dated March 14, 2008.

Ben Smith Dam



Hydropower Intakes at Mill Complex

Design plans and construction notes for Ben Smith dam were not readily available in conducting this analysis. The discussion of construction methods and the planning-level cost estimate are based on visual observations of the dam (August 2007) and the information provided in previous studies obtained by USACE and CDM.

The Ben Smith Dam was constructed in 1847 of large, dry-laid granite blocks, 1.5 to 2 ft. in depth and 4 to 6 ft. long. The Ben Smith dam is 170 feet long. The crest of the spillway is approximately two feet wide and the base of the dam is reported to be six to seven feet wide. The dam crest elevation is 174.9 feet above mean sea level. The dam varies in height from approximately three feet on the east bank to approximately nine feet on the west bank and approximately nine feet in the primary channel section.

A canal leading to the Upper and Lower Mill Ponds is located approximately 350 feet south east of the dam. The canal extends approximately 1,800 feet to the Upper Mill Pond and appears to be dug by hand with minimal horse or mule equipment. The canal begins as a 58' wide channel on the northeast shore of the Ben Smith impoundment, quickly narrowing to a relatively uniform width of approximately 40 feet . When the water level in the Ben Smith impoundment is at the crest of the dam, water depths within the canal range from 2 feet at the diversion intake to 5 feet in the narrower portion of the channel.

A gate house, located two-thirds of the way between the Ben Smith impoundment and Upper Mill Pond, controls the flow of water entering the ponds with two 6-foot wide manually controlled gates. The sluice gates are operational and were closed at the time of the August 2007 field observations to allow for work in the Lower Pond. Water exits Lower Mill Pond through the powerhouse, passing through twin tailrace tunnels before rejoining the Assabet River about 5,400 feet downstream of Ben Smith Dam.

The Lower Mill Pond is located across the bridge on Sudbury Road. The two ponds are used for aesthetic and recreational purposes for the Mill complex. The two ponds also serve as part of the fire protection system for the Mill complex.

2.0 Proposed Construction Activities

The proposed hypothetical construction activities for the removal of Ben Smith Dam are summarized as follows, and described in subsequent sections.

- Sediment removal
- Dam demolition
- Channel improvements and stabilization
- Pump station and force main (to maintain water levels in the Upper and Lower Mill Ponds)
- Remove gate house and abandon the canal to the Mill Ponds
- Site restoration

A proposed sequence of construction activities is presented in Section 3.0 of this document.

2.1 Sediment Removal

Sediment removal behind the dam would be needed as part of the dam removal project. The estimated quantity of sediment, quality, and additional sediment sampling needs and dredging and dewatering are discussed in the report prepared by CDM entitled the "Assabet River Sediment Management Plan", December 2008.

For the Ben Smith impoundment, site preparation would include setting up for hydraulic dredging operations, including performing a pilot study prior to full scale production. Additional site preparation includes removing oversized debris around the dam and any other areas, clearing and grubbing, establishing access and haul roads, and preparing the dewatering area.

The dredging cost estimate is based on hydraulic dredging. If it is not possible to reach the river banks using hydraulic dredge equipment, then another option would be to remove the Ben Smith dam in controlled increments. This would lower the water level which would allow standard ground equipment to access the impoundment. A 1 to 3 month lag in dewatering and disposal may be estimated based on the amount of water to be treated, time to dewater and solidify/bulk the sediment, and time to haul the sediment off site. Sediment in the Ben Smith impoundment may be dredged and disposed of in two to three construction seasons.

2.2 Dam Demolition

Removal of the Ben Smith dam can be accomplished using conventional construction equipment. Portable, temporary cofferdams would be required to divert flows both upstream and downstream during a sequenced removal of the dam.

The dam is assumed to be founded on the existing bedrock. Dam removal would extend to the natural channel bottom or bedrock. No blasting is anticipated. Since it is anticipated that removal of the dam would extend to bedrock, little or no permanent channel stabilization is anticipated to be required in the immediate area of the new channel bottom. Establishing new channel slopes would be required. Given the slope of the existing bank on the west, it is anticipated that the channel would resume its original pre-dam route in this area.

As part of the dam removal process, some granite pieces that either have been displaced from the dam, or were deposited during the dam's construction, should be removed. These are all located immediately downstream of the dam. All rock outcroppings that extend into the channel should remain.

The granite masonry would be trucked from the site. The smaller material would be utilized as part of the final channel improvements and stabilization. Given the large size of the granite masonry pieces, it appears unlikely that these can be used as part of the final stabilization work.

Access and work area for contractors would be primarily from the east side of the dam. Access would be from the Mill Pond Building off Route 117. The steepness of the slope makes access from Taft Avenue to the west extremely difficult and cost prohibitive. Vehicle and equipment access would be from the driveway of the Mill Pond Building. Currently, a one-way traffic pattern exists around the building with parking along the driveway. Modifications to the traffic pattern would be required during construction. There is adequate space available in the existing parking lot in the rear of the building for a staging area. Tree removal and site clearing would be required on the private property for access to the dam and to provide an adequate work area.

2.3 Channel Improvements and Stabilization

Channel improvements and stabilization would be required between the dam and the bridge at Route 117, including scour protection at the bridge at Route 117. Downstream channel improvements would include removal of sediment and vegetation that have deposited in and along the channel over the years and re-establishing a cross- sectional area of the channel. The channel improvements are required to reduce the impacts of the temporary increased flows through the channel that could result as part of the construction activities. As such, it is anticipated that these improvements would be performed prior to the removal of the dam. Temporary cofferdams and proper operation of the dam should allow work to be safely performed in the channel. Access to the channel could be from the same location as the access to the dam.

Scour protection at the abutments to the bridge at Route 117 would be required prior to removal of the dam. Work would be primarily removal of the accumulated debris in the channel bed, repair to existing concrete and improvements to the existing granite block foundation and abutments. Access could be from the channel. However, some work from Route 117 could be required. Interference to traffic should be minimal as the temporary closing of one lane to traffic is not anticipated.

2.4 Pump Station and Force Main

A critical element in removing Ben Smith dam would be maintaining the water surface elevations in the Lower and Upper Mill Pond. A previous study indicated that pumping water from the Assabet River to the Mill Ponds may be required if the Ben Smith Dam is removed. This requirement is based on the need to maintain minimum water surface elevations and maintain flow in the ponds for water quality, aesthetic and fire protection purposes. The study addressed the need for pumping only. The required rate of pumping to maintain proper flows would need to be determined with additional analyses of the Mill Pond system during future phases of this study. (See Appendix J of this report).

Construction of a pump station upstream of the present location of the Ben Smith Dam appears to be the most feasible option to supply appropriate flow to the Mill Ponds. Several locations for this pump station were evaluated including on the private property off Winter Street and on the property immediately adjacent to the Town's Public Work's yard. Both options would require a long suction line into the Assabet River and a long force main to the Upper Mill Pond.

For the purposes of this study and to prepare the planning-level cost estimate, a 400-foot long suction line and a 2,600-foot force main are anticipated. The force main route would be constructed within and along the existing bed of the canal feeding the Mill Ponds. Based on this evaluation, there do not appear to be any significant foundation or construction issues associated with the pump station, suction line and force main. It is anticipated that excavation of existing bedrock would be required.

A third potential pump station location was also evaluated. Locating the pump station within the lower level of one of the Mill buildings could also be considered as a viable option for evaluation in future phases of this study. Locating the pump station within one of the Mill buildings would significantly reduce the size of the pump station, and reduce the length of the suction line and force main. This should significantly reduce both overall construction and operation cost of the system.

It is anticipated that the pump station, suction line and force main would be constructed prior to the demolition of the dam. Temporary cofferdams would be required at the Mill Ponds and at the entrance to the canal until the work abandoning the canal is complete.

2.5 Gatehouse Removal and Canal Abandonment

The elevation of the canal feeding the Mill Ponds is very close (approximately one to two feet lower) than the elevation of the crest of the Ben Smith Dam. Upon removal of the dam, flow would no longer enter the canal from the west from the Assabet River. To assure proper operation of the Mill Ponds and to prevent water in the Mill Ponds from flowing back into the canal, it is recommended that the canal be re-graded at both the impoundment end and at the Upper Mill Pond. Similarly, it is recommended that the canal be filled and/or re-graded to prevent a new impounded area from forming in which local surface runoff could accumulate. It is also recommended that the existing gatehouse be removed since its original purpose is no longer needed.

Access for this portion of the construction could be from Route 117 and High Street along the channel and Sudbury Road from the east.

2.6 Site Restoration

Site restoration would be conducted to restore the site and any areas used for temporary access or staging, to their original conditions. For purposes of the planning-level cost estimate, minimal landscaping was assumed as part of the site restoration. The extent and type of landscaping should be reevaluated as part of the design phase.

2.7 Additional Considerations

There would be significant truck traffic associated with the construction activities required to remove Ben Smith dam. The impact of this increased traffic in this congested needs to be addressed during future phases of study if dam removal is considered further.

The three bridges along the Assabet River downstream of Ben Smith Dam all appear to be adequately sized to convey any temporary increase in flow during construction. As discussed in Section 2.3, channel improvements are suggested upstream of the bridge and scour protection is suggested for the bridge at Route 117.

More details on the extent of downstream scour protection and streambank stabilization would need to be considered in design. Channel bed improvements (e.g. drop structures) might be considered downstream of Ben Smith dam, which could minimize the extent of streambank stabilization required.

It is suggested that the existing sediment and vegetation be removed along the channel section immediately adjacent to the Mill Buildings and Route 62.

3.0 Proposed Sequence of Construction Activities

For the purposes of developing the planning-level cost estimate, a proposed sequence of construction activities was developed. The overall construction period is estimated to be 20 months. This is based on limiting construction within the Assabet River to the period May through December. It is anticipated that construction in the river during the peak winter months and during the traditional high flow periods would not be feasible. Construction activities off the river would continue during these periods.

The major activity during the first calendar is the sediment removal upstream of the dam. Other construction during the first calendar year would be limited to mobilization; cleaning and stabilizing the river downstream of the dam; and providing scour protection at the Route 62/117 Bridge. These later activities are performed in preparation of removing the spillway.

The construction on the pumping station and force main can begin during the first calendar year. Construction can continue uninterrupted over the winter and spring until completed and operational.

During the second calendar year, work on the demolition of the dam would be performed. Site restoration would also be planned for the second calendar year and should be completed by year end.

POWDERMILL DAM

1.0 Existing Structure Description [1]

Powdermill Dam is situated on the northerly side of Route 62 (Powdermill Road) in Acton, Massachusetts. The dam is part of a small hydropower facility owned by Acton Hydro Company. The dam is listed in the National Inventory of Dams (NID) as ID No. MA 00128. Based on the information provided in the previous reports, the dam was built around 1921 but has undergone repair in the past and was undergoing reconstruction at the time of this study.

The discussion of proposed construction methods and the planning-level cost estimates are based on visual observations of the dam (August 2007) and the information provided by the dam owner to USACE regarding the ongoing construction project. Note on dam removal information is provided for the purposes of this planning report only as the current owner does not plan to remove the dam.

[1] Information provided in Sections 1, 2 and 3 on the dam and construction activities were prepared by CDM for planning purposes and provide to the Corps in CDM in memo dated March 14, 2008.

The dam is built of stone masonry on a natural ledge with a timber crib structure to raise the freeboard height for hydropower purposes.

The existing dam appears to be built of stone masonry on existing ledge and till. A timber crib structure was built on the stone masonry presumably to raise the water level in the impoundment area as part of the hydroelectric plant’s operation. This timber crib structure is being removed and replaced as part of the ongoing construction. The timber crib is being replaced with hinged flashboards.

The length of the dam is approximately 450 feet. The dam has a structural height of 13. The current spillway has a crest length of 77 feet.

The intake to the power facility is located approximately 40 feet north of the spillway. The intake is twin 7 ft diameter concrete pipes. Currently, flow to the intake pipes is controlled by wood stop logs. This is being updated as part of the ongoing work.

Aerial showing lower impoundment level due to extended drawdown

Aerial view of dam prior to reconstruction

The outlet to the dam is twin 6 ft diameter corrugated metal pipes located approximately 180 feet north of the existing powerhouse. It appears that flow through the outlet pipes was controlled by wooden gates. These gates were removed prior to the August 2007 site visit. It appears that, the existing outlet would be filled and taken out of service as part of the ongoing repairs. It appears that the newly constructed hinged flashboards would be lowered to provide a temporary outlet from the impoundment when required.

Immediately upstream of the existing spillway is the Old High Street Bridge. This bridge is currently closed to traffic and appears to be abandoned. The demolition of the existing spillway would need to be coordinated with the Town of Acton and the Commonwealth regarding any plans to repair/replace the bridge.

The foundation wall for an existing building is located approximately 90 feet downstream of the spillway. This foundation is built of the same stone construction and appears to be in poor condition. The channel downstream of the spillway has evidence of significant erosion and damage. Plans for demolition of the spillway must include provisions for stabilizing the foundation and channel.

2.0 Proposed Construction Activities

The proposed hypothetical construction activities for removal of the Powdermill Dam includes the following:

- Sediment removal
- Demolition of the spillway structure
- Channel improvements and stabilization and repairs to the building foundation and channel downstream of the spillway
- Closing of the intake to the power facility
- Site restoration

2.1 Sediment Removal

Sediment removal behind the dam would be needed as part of the dam removal project. The estimated quantity of sediment, quality, and additional sediment sampling needs and dredging and dewatering are discussed in the report prepared by CDM entitled the "Assabet River Sediment Management Plan", December 2008.

For the Powdermill impoundment, site preparation would include setting up for hydraulic dredging operations, including performing a pilot study prior to full scale production. Additional site preparation includes removing oversized debris around the dam and any other areas, clearing and grubbing, establishing access and haul roads, and preparing the dewatering area.

The dredging cost estimate is based on hydraulic dredging. If it is not possible to reach the river banks using hydraulic dredge equipment, then as suggested previously, another option would be to remove the Powdermill dam in controlled increments. This would lower the water level which would allow standard ground equipment to access the impoundment. A 1 to 3 month lag in dewatering and disposal may be estimated based on the amount of water to be treated, time to dewater and solidify/bulk the sediment, and time to haul the sediment off site. Sediment in the Powdermill impoundment may be dredged and disposed of in two to three construction seasons.

2.2 Demolition of the Dam

Only the spillway structure portion of the dam would be demolished. It is anticipated that contractor access for the demolition work would be from Old High Street to the north. Old High Street appears to be capable of accommodating anticipated truck and equipment traffic. The street accesses Route 62 via High Street. The contractors' staging area would be the lower portion of Old High Street. The street is currently blocked to traffic and fenced by the current contractor. There is an existing building within the fenced area that is currently being used for the contractors' and dam operator's office. It is anticipated that similar arrangements would be available in the future.

For the purposes of the planning-level cost estimate, it is assumed that prior to removal of the spillway; repairs would be made to the existing foundation and channel downstream of the spillway. Following these repairs, the current outlet pipes need to be put back in service. Re-establishing this outlet would allow all flow to be diverted around the spillway. This would permit the construction to be performed in dry conditions.

Demolition of the dam can be accomplished using conventional construction equipment and techniques. However, because of limited space, it is anticipated that all material to be removed would be "double-handled" prior to being placed in trucks and removed from the site. Because of concerns with the condition of the adjacent dam and the dam/retaining wall along Route 62, blasting is not recommended.

The smaller material from the spillway and immediately downstream of the dam would be utilized as part of the final channel improvements and stabilization. However, the larger pieces of stone would be trucked from the site. On-site crushing of stone and granite into graded gravel products is not anticipated.

2.3 Channel Improvements and Stabilization and Repairs to the Building Foundation and Channel Downstream of the Spillway

Downstream improvements would include removal of stones, sediment and vegetation that has deposited in and along the channel downstream of the spillway. The placement of a stone and riprap channel section are required to stabilize the channel for the anticipated increase in flow during construction and to repair existing damage due to erosion. This erosion is particularly evident along the earthen channels immediately downstream of the existing outlet from dam and the tailway from the hydroelectric facility. Channel repairs are assumed to extend the entire length of the channel to the bridge at Route 62.

Repairs to the building would include the replacement of a major section of the west and north side foundation wall. Temporary support of the building would be required to replace the foundation. The building appears to be founded on the same material as the dam; therefore problems with bearing capacities are not anticipated.

The work on the foundation and within the channel would require the use of temporary cofferdams around the work areas.

2.4 Closing of the Intake to the Power Facility

Closing the intake to the dam includes the removal of the wood stop logs and intake structure and filling the twin pipes with concrete. This work should be performed during the same period that the flow in the Assabet River is being diverted through the outlet pipes.

2.5 Site Restoration

Site restoration would be conducted to restore the site and any areas used for temporary access or staging, to their original conditions. For purposes of the planning-level cost estimate, minimal landscaping was assumed as part of the site restoration. The extent and type of landscaping should be evaluated as part of the design phase.

2.6 Additional Considerations

Scour protection at the existing bridge at Route 62 downstream of the dam would need to be evaluated during the design phase.

The existing retaining wall along Route 62 should be evaluated further during the design phase. Based on the visual inspections during the August 2007 field visit, it was not completely evident whether the wall is part of the dam. If so, the impact on this retaining wall from the removal of the spillway needs to be determined.

It is assumed that the abandoned bridge on Old High Street would remain or would be removed by others. However, this assumption needs to be evaluated in terms of the final planning for the re-channelization of the Assabet River in this area. As a minimum, the old abandoned piles adjacent to the dam should be removed for visual effect and to prevent buildup of debris.

The removal of the power facility is also assumed to be performed by others and is not part of this project. That assumption needs to be re-considered as part of the future phases of this project.

3.0 Proposed Sequence of Construction Activities

For the purposes of developing the planning-level cost estimate, a proposed sequence of construction activities was developed. The overall construction period is estimated at 20 months. This is based on limiting construction within the Assabet River to the period May through December. It is anticipated that construction during the peak winter months and during the traditional high flow periods would not be feasible.

The major activity during the first calendar year is the sediment removal upstream of the dam. Other construction during the first calendar year would be limited to mobilization; replacing the existing outlet pipes; cleaning and stabilizing the river downstream of the dam; and replacing the foundation of the existing building. These later activities are performed in preparation of the removal of the spillway. Filling the existing inlet pipes to the power facility can commence in the first calendar year and be completed during the winter months.

During the second calendar year, work on the demolition of the spillway would be performed. Other activities would include site restoration.

APPENDIX C

COST ESTIMATES

APPENDIX C

APPENDIX C - PLANNING LEVEL CONSTRUCTION COST ESTIMATES

CDM developed planning level construction cost estimates for each dam removal and sediment removal. Construction activities are detailed in Appendix B and cost developed by line item and presented in the following tables.

Construction Cost Estimates include Contractor overhead (16%), profit (10%), bond and insurance cost (5%) and a contingency of 25%.

Sediment Disposal Costs were estimated based on the quantity of material to be dredged and unit disposal costs.   For each of the impoundments studied, a ball park estimate of the percent of total volume of sediment that would be suitable for either upland disposal, landfill reuse or out of state disposal was made based on results of the 2003 USGS in situ sediment program discussed in the CDM report entitled “Assabet River Sediment Management Plan”, dated December 2008.

Actual sediment disposal cost will depend on the physical and chemical quality of the dredged sediment. It was determined that additional data will be needed to determine sediment suitability for disposal and a detailed sediment sampling and analysis plan is included in the CDM report entitled “Assabet River Sediment Management Plan”, dated December 2008.

Assabet River. Planning Level Dredge Material Dispsoal Costs

	Volume of Sediment to be Dredged	Volume of Sediment to be Disposed [1]	Upland Disposal[2]		Landfill Re-use [3]		Out-of-State Landfill [4]		Subtotal - Hauling and Disposal [5]
	yd^3	yd^3	tons	Cost	tons	Cost	tons	Cost	Cost
Aluminum City	1,304	1,434	918	$ 15,606	1,377	$ 70,228	-	$ -	$ 85,834
Allen Street	2,237	2,500	2,000	$ 34,000	2,000	$ 102,000	-	$ -	$ 136,000
Hudson	71,558	79,000	50,560	$ 859,520	75,840	$ 3,867,840	-	$ -	$ 4,727,360
Gleasondale	27,856	31,000	19,840	$ 337,280	29,760	$ 1,517,760	-	$ -	$ 1,855,040
Ben Smith	67,601	75,000	33,600	$ 571,200	84,000	$ 4,284,000	2,400	$ 225,600	$ 5,080,800
Powdermill	65,833	73,000	-	$ -	93,440	$ 4,765,440	23,360	$ 2,195,840	$ 6,961,280

1) Estimated a 10% increase in volume based on solidification with additive.

2) Transportation and handling only, assumes no disposal cost, unit cost of $17 per ton for transp, handling and hauling

3) Unit cost of $51 per ton for landfill re-use (based on recent data)

4) Unit cost of $94 per ton for out of state landfill (based on recent data)

5) For each of the impoundments, % of total volume was estimated for the disposal options based on results of the 2003 USGS in situ sediment program. Estimated cost includes handling, transportation and disposal only. Actual disposal will depend on the physical and chemical quality of the dredged sediment and approval by the appropriate regulatory agencies.

Aluminum City Dam, Construction Cost for Dam Removal	
Cost Estimate developed by CDM for Assabet Study, 2008, Cost Estimate provided for Planning purposes only.	($)
General Work Items	
Mobilization/De-Mobilization	24,000
Site Access and Clearing	2,000
Landscaping - Live Staking & Rip-Rap	29,250
General Work Items - Subtotal	55,250
Dam Demolitition	
Cofferdam Equipment Mobilization - Rig Only	25,000
Install Cofferdam - 1st Area	35,700
Remove Dam - 1st area	2,520
Install Bypass Culvert	8,100
Install Bypass Culvert Fill	7,600
Install Cofferdam - Final Area	31,350
Remove Dam - Final area	5,040
Create Buttress to Support Building Foundation	13,500
Cofferdam Dewatering	10,000
Dam Demolitition - Subtotal	138,810
Channel/Foundation Improvements	
Install Temporary Shoreline (Cofferdam - 1st area)	33,750
Foundation/Wall Repairs - 1st area	24,500
Scour Protection - West Side	2,000
Install Temporary Shoreline (Cofferdam - final area)	49,500
Foundation/Wall Repairs - final area	32,000
Scour Protection	2,000
Cofferdam Dewatering	5,000
Channel/Foundation Improvements - Subtotal	148,750
Culvert and Channel Finishing	
Fill Conduit	36,850
Culvert and Channel Finishing - Subtotal	36,850
Sediment Removal	
Mechanical Dredging	64,800
Dewatering	104,080
Sediment Removal	168,880
Subtotal - Direct Costs	548,540
Indirect Costs (Contractor OH, Profit, Bond, Insurance)	191,000
Subtotal - Direct + Indirect Costs	739,540
Contingency	184,790
TOTAL Construction Costs	924,330
Estimated Sediment Disposal Cost (1,304 cy)	86,000
TOTAL with Sediment Disposal Cost	1,010,330

Allen Street Dam, Construction Cost for Dam Removal	
Cost Estimate developed by CDM for Assabet Study, 2008, Cost Estimate provided for Planning purposes only.	($)
Mobilization/De-Mobilization	38,000
Site Access and Clearing	2,500
Landscaping - Seed Mix Planting	2,900
Landscaping - Live Staking & Rip-Rap	8,500
General Work Items - Subtotal	51,900
Dam Demolitition	
Cofferdam Equipment Mobilization - Rig Only	25,000
Bridge Abutment Shoring - Concrete	42,000
Foundation Wall Repair - 1st Area	30,000
Install Cofferdam - 1st Area	117,000
Remove Dam - 1st area	6,300
Install Cofferdam - Final Area	117,000
Foundation Wall Repair - Final Area	30,000
Remove Dam - Final area	6,300
Cofferdam Dewatering	15,000
Dam Demolitition - Subtotal	388,600
Channel/Foundation Improvements	
Install Temporary Shoreline (Cofferdam - 1st area)	41,250
Foundation/Wall Repairs - 1st area	33,000
Install Temporary Shoreline (Cofferdam - final area)	22,500
Foundation/Wall Repairs - final area	12,000
Cofferdam Dewatering	5,000
Channel/Foundation Improvements - Subtotal	113,750
Culvert and Channel Finishing	
Clear Work Area	2,810
Fill Channel/Raceway	41,250
Culvert and Channel Finishing - Subtotal	44,060
Sediment Removal	
Hydraulic Dredging	58,000
Dewatering	315,640
Sediment Removal - Subtotal (does not include disposal cost)	373,640
Subtotal - Direct Costs	971,950
Indirect Costs (Contractor OH, Profit, Bond, Insurance)	338,000
Subtotal - Direct + Indirect Costs	1,309,950
Contingency	327,430
TOTAL	1,637,380
Estimated Sediment Disposal Cost (2,237 cy)	136,000
TOTAL with Sediment Disposal Cost	1,773,380

Hudson Dam, Construction Cost for Dam Removal	
Cost Estimate developed by CDM for Assabet Study, 2008, Cost Estimate provided for Planning purposes only.	($)
Mobilization/De-Mobilization	54,000
Landscaping - Live Staking & Rip-Rap	28,000
General Work Items - Subtotal	82,000
Dam Demolitition	
Cofferdam Equipment Mobilization - Rig and Barge	75,000
Install Cofferdam - 1st Area	128,250
Remove Dam - 1st area	23,100
Remove Sediment and Vegetation - 1st area	290
Install Cofferdam - Final Area	68,400
Remove Dam - Final area	23,100
Remove Sediment - Final area	79,650
Cofferdam Dewatering	20,000
Dam Demolitition - Subtotal	417,790
Channel/Foundation Improvements	
Repair Sluice Gate	4,000
Cofferdam to Divert Flow through Sluice Gate	199,500
Foundation/Wall Repairs - 1st area	68,000
Foundation/Wall Repairs - final area	24,000
Cofferdam Dewatering	5,000
Channel/Foundation Improvements - Subtotal	300,500
Sediment Removal	
Hydraulic Dredging	1,041,880
Dewatering	879,450
Sediment Removal - Subtotal (does not include disposal cost)	1,921,330
Bridge/Stone Arch Repair	
Repair Stone Arch Bridge	18,000
Bridge/Stone Arch Repair - Subtotal	18,000
Downstream Bridge Repairs	
Repairs and Stabilization of the walls	12,000
Downstream Bridge Repairs - Subtotal	12,000
Replace Fire Protection	
Replace Fire Protection Inlet	25,000
Replace Fire Protection - Subtotal	25,000
Subtotal - Direct Costs	2,776,620
Indirect Costs (Contractor OH, Profit, Bond, Insurance)	965,000
Subtotal - Direct + Indirect Costs	3,741,620
Contingency	935,380
TOTAL	4,677,000
Estimated Sediment Disposal Cost (71,558 cy)	4,727,000
TOTAL with Sediment Disposal Cost	9,404,000

Gleasondale Dam, Construction Cost for Dam Removal	
Cost Estimate developed by CDM for Assabet Study, 2008, Cost Estimate provided for Planning purposes only.	($)
General Work Items	
Mobilization/De-Mobilization	91,000
Site Access and Clearing	6,750
Landscaping - Seed Mix Planting	18,300
Landscaping - Live Staking & Rip-Rap	21,500
General Work Items - Subtotal	137,550
Dam Demolitition	
Cofferdam Equipment Mobilization - Rig and Barge	75,000
Install Cofferdam - 1st Area	48,750
Remove Dam - 1st area	16,800
Remove Abutment - 1st area	29,250
Remove Sediment and Vegetation - 1st area	5,900
Install Cofferdam - Final Area	78,000
Remove Dam - Final area	33,600
Remove Sediment - Final area	11,800
Stabilize Abutment and Dam	30,000
Cofferdam Dewatering	20,000
Dam Demolitition - Subtotal	349,100
Channel/Foundation Improvements	
Stabilize Bypass and Block Open Channel	12,500
Repair Abandoned Bridge Abutment	12,000
Foundation/Wall Repairs - 1st area	7,500
Remove Sediment and Vegetation	50,300
Add Stone Riprap	49,000
Channel/Foundation Improvements - Subtotal	131,300
Sediment Removal	
Hydraulic Dredging	393,050
Dewatering	556,560
Sediment Removal - Subtotal (does not include disposal cost)	949,610
Outlet Channel Removal	
Demolish Outlet Structure	25,000
Fill Bypass Channel and Outlet Channel	120,000
Concrete Fill - Chase under Building and Driveway	550,000
Outlet Channel Removal - Subtotal	695,000
Replace Fire Protection	
Precast Wet well - 8' diameter	40,000
Trash Rack - 20' x 4'	20,000
Submersible Pump - 200 gpm	40,000
Force Main - 6"	28,800
Replace Fire Protection - Subtotal	128,800
Subtotal - Direct Costs	2,391,360
Indirect Costs (Contractor OH, Profit, Bond, Insurance)	831,000
Subtotal - Direct + Indirect Costs	3,222,360
Contingency	805,590
TOTAL	4,027,950
Estimated Sediment Disposal Cost (27,860 cy)	1,855,000
TOTAL with Sediment Disposal Cost	5,882,950

Ben Smith Dam, Construction Cost for Dam Removal	
Cost Estimate developed by CDM for Assabet Study, 2008, Cost Estimate provided for Planning purposes only.	($)
General Work Items	
Mobilization/De-Mobilization	171,000
Site Access and Clearing	2,500
Site Access and Clearing - Paved Parking Area	30,000
Replace Parking Area	75,000
Landscaping - Seed Mix Planting	22,250
Landscaping - Live Staking & Rip-Rap	100,750
General Work Items - Subtotal	401,500
Dam Demolitition	
Cofferdam Equipment Mobilization - Rig and Barge	75,000
Install Cofferdam - 1st Area	27,000
Remove Dam - 1st area	5,040
Remove Sediment and Vegetation - 1st area	9,440
Install Temporary Culvert and Embankment	100,000
Install Cofferdam - Final Area	54,000
Remove Dam - Final area	11,760
Remove Sediment - Final area	20,060
Remove Cofferdam, Temporary Culvert and Embankment	13,500
Cofferdam Dewatering	20,000
Dam Demolitition - Subtotal	335,800
Channel/Foundation Improvements	
Install Temporary Shoreline (Cofferdam - 1st area)	75,000
Relocate Temporary Shoreline (Cofferdam)	37,500
Remove Sediment and Vegetation	47,200
Remove Large Blocks	12,600
Add Stone Riprap	60,000
Scour Protection	4,000
Cofferdam Dewatering	5,000
Channel/Foundation Improvements - Subtotal	241,300
Sediment Removal	
Hydraulic Dredging	1,042,410
Dewatering	857,180
Sediment Removal - Subtotal (does not include disposal cost)	1,899,590
Pump Station and Force Main	
Pump Staion - 4 mgd	400,000
Suction Line - 18"	86,400
Force Main - 12"	374,400
Pump Station and Force Main - Subtotal	860,800
Remove Gatehouse and Channel	
Regrade @ Former Dam and Upstream	25,000
Riprap	17,500
Fill Channel	800,000
Demolish Gatehouse and Sluice Gates	25,000
Remove Gatehouse and Channel - Subtotal	867,500
Subtotal - Direct Costs	4,606,490
Indirect Costs (Contractor OH, Profit, Bond, Insurance)	1,601,000
Subtotal - Direct + Indirect Costs	6,207,490
Contingency	1,551,810
TOTAL	7,759,300
Estimated Sediment Disposal Cost (67,600 cy)	5,081,000
TOTAL with Sediment Disposal Cost	12,840,300

Powdermill Dam, Construction Cost for Dam Removal	
Cost Estimate developed by CDM for Assabet Study, 2008, Cost Estimate provided for Planning purposes only.	($)
General Work Items	
Mobilization/De-Mobilization	66,000
Site Access and Clearing	5,000
Landscaping - Seed Mix Planting	10,000
Landscaping - Live Staking & Rip-Rap	90,000
General Work Items - Subtotal	171,000
Dam Demolitition	
Cofferdam Equipment Mobilization - Rig and Barge	75,000
Foundation Wall Repair - 1st Area	11,000
Install Cofferdam - 1st Area	90,000
Remove Sediment and Vegetation - 1st area	64,900
Install Cofferdam - Final Area	90,000
Demolish Spillway	136,000
Remove H-piles - 40'/each	18,000
Cofferdam Dewatering	20,000
Dam Demolitition - Subtotal	504,900
Channel/Foundation Improvements	
Install Temporary Bypass (Cofferdam)	45,000
Install Temporary Bypass Culvert - 72" CMP	67,500
Install Temporary Shoreline (Cofferdam - final area)	90,000
Remove Sediment and Vegetation	64,900
Remove Bypass Culvert	20,000
Cofferdam Dewatering	7,500
Channel/Foundation Improvements - Subtotal	294,900
Sediment Removal	
Hydraulic Dredging	979,590
Dewatering	846,610
Sediment Removal - Subtotal (does not include disposal cost)	1,826,200
Power Facility Intake	
Remove Stop Logs	7,000
Fill Intake Pipes	70,000
Power Facility Intake - Subtotal	77,000
Subtotal - Direct Costs	2,874,000
Indirect Costs (Contractor OH, Profit, Bond, Insurance)	999,000
Subtotal - Direct + Indirect Costs	3,873,000
Contingency	968,180
TOTAL	4,841,180
Estimated Sediment Disposal Cost (65,830 cy)	6,961,000
TOTAL with Sediment Disposal Cost	11,802,180

APPENDIX D

WETLANDS DESCRIPTION AND IMPACT IDENTIFICATION

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INTRODUCTION

The purpose of this Appendix is to describe the changes to wetland resource areas as a result of hypothetical dam removal along the Assabet River. The intent is to inform agencies, stakeholders, and decision makers on what might be expected with dam removal. Six dams and their impoundments were studied. Information contained in this report is for planning purposes only and more detailed investigations would be needed as part of dam removal design.

The Powdermill Dam impoundment located in Acton has been influenced by an extended drawdown and therefore, a description of with and without dam wetland impacts is not provided for this site. However, specific observations at the site are included.

A general description of wetlands occurring along the Assabet River is provided first, followed by a discussion of the impacts to wetland resources resulting from the hypothetical dam removals on the Assabet River and specific observations for each dam. Maps comparing wetland before and after dam removal are included as Attachment A. A list of plant species observed in the study area is included as Attachment B.

Wetlands and Riparian Vegetation

Hundreds of acres of vegetated wetlands occur along the Assabet River. The extent of wetlands along the river varies greatly. In areas where the river is affected by development there may be only a narrow fringe of vegetated wetland or none at all. In some impoundments, expansive mosaics of floodplain wetlands extend hundreds of feet from the river. Many of the wetlands along the Assabet River exist because of impoundments or are hydrological influenced by impoundments to varying degrees. Shoreline along most impoundments is largely undeveloped. There are typically long reaches where broad areas of emergent and scrub-shrub wetland lie between open water and upland habitat. Most impoundments also contain areas with well defined banks where open water transitions abruptly to forested wetland or upland**.**

Wetlands within the Assabet River watershed have been mapped and classified by the MA Wetlands Conservancy Program (MA DEP). The mapping is based on interpretation of 2001-color aerial photography. Fieldwork conducted by the Corps in 2005 indicated that these maps were accurate enough for this study, except for Powdermill Dam where the dam was partially breached in April 2004 and the wetland plant community is adjusting to new hydrologic conditions and the Ben Smith Dam where the upstream impoundment is shown as deep marsh, when it is more accurately described as open water. Other sources of information include maps of aquatic vegetation at impoundments prepared by ENSR (2001) and OAR (2006).

The Ben Smith impoundment supports the most wetland and open water aquatic habitat, followed by Gleasondale, Hudson, Powdermill, Allen Street, and Aluminum City Dams.

Open water is the dominant community type, followed by emergent, scrub-shrub, and forested wetlands. A brief description of wetland communities is provided below. A list of plant species reported at each impoundment is provided in Attachment 1 at the end of this Appendix.

Open Water: The shallow and nutrient rich Assabet River impoundments support productive communities of submerged and floating aquatic plants. Common species include filamentous green algae, floating plants (duckweed and water meal), coontail, elodea, pondweeds, and fanwort. Water chestnut is present at Ben Smith and the Clock Tower millponds. Distribution of vegetation probably depends mostly on water depth, current, and substrate. Shallow areas with slow current and soft substrate are generally most heavily vegetated with submerged aquatics. Scoured channels with hard bottom are typically sparsely vegetated. Floating plants are susceptible to currents and tend to accumulate in backwater areas, channel margins, or areas where the impoundment widens and current velocity slows. Studies by ENSR (2001) do show that plant community composition can vary considerably from year to year. There are also seasonal changes, with growth of duckweed and filamentous algae typically peaking in late summer. Under low flow conditions duckweed accumulations can be extremely heavy.

Emergent Wetland: Emergent wetlands are dominated by reed canary grass, and to a lesser extent, purple loosestrife and cattail. In the Assabet River impoundments, reed canary grass often forms semi-floating mats that are loosely attached to the bottom and float up and down with changing water levels. The mats are dense enough to be colonized by other emergent species, shrubs, and small trees. Associated species include bur-reed, pickerelweed, smartweeds, water willow, yellow flag, soft stem bulrush, smartweed, buttonbush, black willow, and red maple. Although reed canary grass dominated wetland is the most common emergent community, stands dominated by smartweeds, bur-reed cattail, and mixed emergent communities are also found.

Scrub-shrub Wetland: Common shrub and tree species in Assabet River scrub-shrub wetlands include alder, black willow, high bush blueberry, sweet gale, red maple, winterberry, northern arrow-wood, European buckthorn, and dogwoods. Herbaceous species occurring in scrub-shrub wetlands include purple loosestrife, tussock sedge, wool grass, sensitive fern, and royal fern.

Forested Wetland: Forested wetlands along impoundment shorelines are dominated by red maple. Associated species include silver maple; swamp white oak, blueberry, northern arrow-wood, and winterberry are common understory shrubs.

Forested Upland (Bank): Banks along the impoundment shorelines where open water abruptly transitions to forested upland were typically vegetated with red maples, red or white oak, and white pine. Less common tree species on the banks include hemlock, weeping willow, silver maple, tree of heaven, and common catalpa.

Methodology for Evaluating Changes to Wetlands and Riparian Habitat

The Assabet River riparian corridor is characterized by a diverse landscape; including light and heavy development as well as areas of undeveloped broad floodplain and protected open space. There are hundreds of acres of vegetated wetlands ranging from narrow fringes of vegetated wetland (or none at all) in developed areas to expansive mosaics of floodplain wetlands which extend hundreds of feet from the river. The amount (acres) and types of wetland associated with each impoundment under existing conditions are depicted on Table 1 - Estimated Change in Wetland Areas Following Dam Removal.

It is important to note that wetland acreage calculated for the existing conditions, as listed in the first column of Table 1, are wetland areas hydrologically influenced by the dams. This “area of influence” was determined using the elevation of the dam in conjunction with field observations by Army Corps of Engineers wetland specialists and includes wetland areas directly influenced by the dam and hydrologically connected contiguous wetland areas. To provide a consistent depiction of wetland changes, the same “area of influence” was used to calculate the wetland areas after dam removal.

Some wetland areas associated with the impoundments include long reaches where broad areas of emergent and scrub-shrub wetland lie between open water and upland habitat. There are also areas with well defined banks where open water transitions abruptly to forested wetland or upland**.** In order to evaluate the after dam removal conditions, predictions needed to be made as where new wetland areas will develop and where existing wetlands will transition to upland or other types of wetlands following the expected change in hydrology from an impoundment to a riverine system (over the short and long term). The development of wetlands is dependent on many physical and chemical parameters with the dominant successional force being soil moisture. Small changes in water level and elevation can greatly alter wetland structure and species composition.

No site-specific data or biological benchmarks were available that links specific elevations to the growth of different types of wetlands (shallow marsh meadow or fen, shrub swamp and wooded swamp) in the study area. As well, the available topographic maps of the area have a nine foot contour interval; a range too broad to capture topographic features associated with the development of individual categories of wetlands. To provide a prediction of future conditions (and changes to wetland areas) due to dam removal, some broad-based assumptions were developed using general observations of the existing wetlands and topography in conjunction with the professional judgment of Army Corps of Engineers wetland specialists. It was noted that when comparing the existing wetland maps relative to the available topography (9 foot contour interval), all types of vegetated wetlands (from meadow to wooded swamp) have developed (for the most part) within the first topographic contour (9 feet or less) above open water (with the exception of those areas associated with an incoming tributary, seeps or other features). This is consistent with a general expectation (professional judgment of Corps wetland biologists), that the entire range of wetland types will develop within a narrow elevation range above the newly created river's open water.

Bathymetric Data and Water Level Data used for Wetland Predictions

United States Geologic Survey (USGS) collected impoundment water depth information for each impoundment within the study area during summer and fall of 2004. These depths were measured by prope and were not tied into a specific elevation datum.   The depth measurement was used by USGS to develop one-foot depth contours of the impoundments. Although these depth contours are not static (e.g. water depth varies with flow), they can be used to provide a sense of the incremental elevation change along the river cross-section and are useful in identifying areas of wetland development after dam removal in the impoundments.

For the wetlands analysis, an estimate of the future river channel foot print in the impoundment was prepared by CDM using the HEC-RAS output for the without dam conditions and the USGS bathymetry discussed above. This would be the area of future open water.   Between the summer water level and spring high water level it is assumed that this area would be a river bank area with limited wetland vegetation. [The spring high water elevation was calculated to be 0.9 feet above the summer average flow level by Army Corps of Engineers water management specialist (i.e. the river will fluctuate approximately one foot or less between the average summer low and spring high flow)].

Adjacent to the impoundments and upstream of the impoundments decreases in water levels with dam removal were calculated based on the HEC-RAS river modeling performed by CDM for the Assabet Study.   Predicated decreases in water levels are several feet and magnitude varies depending on the river location.

Biological Assumptions Used for Wetlands Predictions

Broad-based biological benchmarks provide the basis for calculating the acreage of each type of wetland within the impoundments after dam removal. The wetland acreage figures are based on the future wetland conditions approximately several decades after dam removal. In general, after removal of the dam, it is expected that shallow marsh meadow will initially colonize exposed sediments due to the pioneering and rapid growth capabilities of emergent vegetation. However, over the long-term, water velocities and shade (as more woody vegetation becomes established) should limit herbaceous emergent vegetation to a narrow fringe landward of the spring high water level elevation along the river channel. Backwater areas located adjacent to the river channel are also expected to develop into shallow marsh meadow areas due to the repositioning of sediments into deep holes and protected (slower velocity) areas. Therefore, the shallow marsh meadow was calculated to be the area approximately one foot above the spring high flow elevation. Vegetation will then transition to scrub-shrub vegetation over the next 1-foot of elevation, then transition to wooded swamp over the next 1-foot of elevation prior to transitioning to upland.

Maps were prepared for each dam and wetland acreage figures were calculated for the future without dam condition. The prediction of the after dam removal condition was based on numerous physical landscape features and existing hydrological data in conjunction with the applied broad-based biological benchmarks as discussed in the previous paragraph. Predictions of wetland areas upstream and adjacent to the impoundments, were made based on estimated water level decreases, existing wetland vegetation type, predicted river channel development (thalwag), the movement and repositioning of sediment (based on the predicted channel configuration), the location of incoming tributaries. A detailed discussion of the predictions for individual impoundments and specific noteworthy wetlands is provided later in this section. Table 1 Estimated Change in Wetland Areas Following Dam Removal lists the predicted acreage for each wetland type after dam removal, the change in the amount of each wetland type when compared to existing conditions and the amount of wetland expected to transition to upland.

One of the recommendations of the Assabet River Sediment and Dam Removal Study, Modeling Report (CDM, 2008), is to remove sediment behind the dam prior to dam removal. The removal of sediments will minimize the transport of fine materials and potential contaminated sediments downstream subsequent to dam removal. A planning level sediment management plan (SMP) has been developed by CDM for the Corps which includes a discussion of site-specific conditions; depth of sediment, and the physical and chemical analysis of impounded sediments based on existing data. Varying scenarios for dredged material management are possible depending upon the findings of additional recommended testing detailed in the SMP; some of the dredged sediment may be removed from the site to an upland landfill (lowering the bottom profile of the river), some dredged sediment may be reused on site to create contours and terraces (potentially increasing the area available for the development of wetland floodplain species). It is expected that sediment transport processes will fill irregularities in the river channel (backwater areas and holes) over time.

It is recognized that sediment dredging will change the bathymetry of the impoundment and may alter areas predicted to support different types of wetland vegetation however, a detailed dredging plan is not available to consider at this time. Even with detailed dredging plans, the repositioning of sediments will be subject to geomorphological riverine processes over a long period of time and through a range of events (i.e. daily flows, spring high flows, and flooding events) which can not be predicted with accuracy. It is expected that the majority of wetland changes will be captured in this evaluation since the major hydrologic factor affecting wetland development, the change in water level after removal of the dam, is considered at this reconnaissance level of study. As well, the dredging of sediments from the bottom of the impoundment (located within the boundaries of the newly created river channel area) will not effect wetland development predictions because wetland vegetation is expected to develop from the spring high water level and above (not within the river channel). Reconfiguration of the river banks above the spring high water level, to create terraces for example, will change contours (and effect the development of wetlands after dam removal) but detailed information about re-contouring the river banks is not available at this time. A more detailed evaluation of wetland impacts can be accomplished during the next stage of study once a more detailed design and sediment/ bank contour plan is developed for each impoundment.

Previously, open water was the dominant community type, followed by emergent, scrub-shrub, and forested wetlands. Under the after dam removal condition, it is predicted that scrub-shrub and forested vegetation will dominate, followed by open water and emergent vegetation. These communities will not be monotypic but, mixed, overlapping and transitional. Emergent communities are likely to have a percentage of scrub-shrub inclusions; scrub-shrub communities are likely to have an herbaceous ground cover or trees in the overstory depending on the successional stage of growth, and forested wetlands are likely to have a scrub-shrub understory. A brief description of each wetland community type after dam removal is provided below.

Open Water: Currently, the shallow and nutrient rich Assabet River impoundments support productive communities of submerged and floating aquatic plants. These shallow areas with slow currents and soft substrates are dominated by filamentous green algae, floating plants, coontail, elodea, pondweeds, and fanwort. Following the removal of the dam, the impounded open water will be replaced by a smaller amount of open water associated with the river channel. Although it is likely that some sediment will be dredged at each dam to minimize downstream impacts, there will also be a transport of sediment downstream for a period of time through natural geomorphological processes. The river channel will undergo scouring and deposition until a stable and functional channel profile is reached. Riverine open water habitat will eventually be characterized by a complex of riffles and pools along the reach, the distribution of which is dependent on the gradient (more riffles with a steeper gradient) and length of restored river channel. The riffles will have a substrate of cobbles while the pools, with more quiescent waters, will have a substrate of medium sized cobble, gravel and sand.

Emergent Wetland: Semi-floating mats of reed canary grass are a dominant and unique feature of the Assabet River emergent wetland community. It is expected that initially after removal of the dam; these mats will settle down onto the exposed substrate and continue to grow. However, these mats will gradually become less dominant as more woody vegetation becomes established and increased water velocity in the river prevents the mats from expanding or forming in the river channel. Herbaceous vegetation will rapidly colonize exposed areas as seed and root stock will be readily available.

However, as was mentioned previously, it is expected over the long term that herbaceous emergent vegetation will be replaced by more woody vegetation over time, eventually limiting emergent vegetation to a narrow fringe along more quiescent waters (pools) in the river in the 1-foot elevation range above the spring high water. Purple loosestrife, bur-reed, pickerelweed, smartweeds, water willow, soft stem bulrush, and cattail currently grow on site and will likely be found in future emergent plant communities.

Table 1. Estimated Change in Wetland Areas Following Dam Removal

Impoundment	Description	*Wetlands -Existing Conditions (Acres)	After Dam Removal (Acres)	Change in Wetland Area (Acres)
Aluminum City	OPEN WATER	0.3	0.2	-0.1
	SHALLOW MARSH MEADOW OR FEN	0	0.0	0.0
	SHRUB SWAMP	0	0.0	0.0
	WOODED SWAMP DECIDUOUS	0	0.1	0.1
Allen Street	OPEN WATER	6.9	2.4	-4.5
	SHALLOW MARSH MEADOW OR FEN	2.0	1.7	-0.3
	SHRUB SWAMP	0	1.7	1.7
	TRANSITION TO UPLAND	0	0.2	-0.2
	WOODED SWAMP DECIDUOUS	0	2.9	2.9
Hudson	OPEN WATER	27.0	16.8	-10.2
	SHALLOW MARSH MEADOW OR FEN	6.9	7.6	0.7
	SHRUB SWAMP	7.4	7.3	-0.1
	TRANSITION TO UPLAND	0	6.4	-6.4
	WOODED SWAMP DECIDUOUS	4.7	7.9	3.2
Gleasondale	DEEP MARSH	3.3	0	-3.3
	OPEN WATER	14.5	10.8	-3.7
	SHALLOW MARSH MEADOW OR FEN	35.7	14.8	-20.9
	SHRUB SWAMP	18.1	13.4	-4.8
	TRANSITION TO UPLAND	0	60.1	-60.1
	WOODED SWAMP CONIFEROUS	10.4	0	-10.4
	WOODED SWAMP DECIDUOUS	56.0	39.0	-17.0
	WOODED SWAMP MIXED TREES	2.6	2.6	0.0
Ben Smith	DEEP MARSH	126.6	12.8	-113.8
	OPEN WATER	20.8	70.2	49.4
	SHALLOW MARSH MEADOW OR FEN	87.3	75.6	-11.7
	SHRUB SWAMP	76.5	81.3	4.8
	TRANSITION TO UPLAND	0	43.5	-43.5
	WOODED SWAMP DECIDUOUS	107.2	134.9	27.7
	WOODED SWAMP MIXED TREES	19.2	19.2	0.0

** Information from the Massachusetts Wetlands Conservancy Program (MA DEP) was used for the existing conditions column. This information is for general planning purposes only.*

Scrub-shrub Wetland: It is expected that scrub-shrub wetlands will develop within a 1-foot elevation range above the emergent wetland area. As scrub-shrub wetlands become established, emergent wetland areas will become less common over the long term. Species currently found in the study area, such as alder, black willow, high bush blueberry, sweet gale, winterberry, northern arrow-wood, European buckthorn, and dogwoods would likely be found in future scrub-shrub wetlands due to the availability of seed and root stock. Herbaceous species, such as tussock sedge, wool grass, sensitive fern, and royal fern may persist as ground cover as long as light and supporting hydrology are available.

Forested Wetland: Over the long term, it is expected that forested wetlands will develop within the 1-foot elevation range above the upper limit of the scrub-shrub area. Red maple will most likely remain the dominant species however, silver maple and swamp white oak may also be present with blueberry, northern arrow-wood, and winterberry as associated understory shrubs.

The existing forested wetlands will experience a major change in hydrology when the impoundment is drained. This may result in some degree of mortality initially however, red maple is categorized as a "facultative" species in the U.S. Fish and Wildlife Service National List of Plant Species That Occur In Wetlands (USFWS 1988). A "facultative" species is equally likely to occur in wetland as in nonwetlands and therefore, red maple may survive under the new drier hydrological regime. In the case of a facultative-dominated forested wetland area (such as a red maple swamp), species composition may stay relatively the same with some infusion of more upland species over the long term. However, these areas would no longer be considered forested wetlands due to lack of hydrology (and hydric soils).

Invasive Species

Invasive species are non-native plants that threaten native habitats by spreading so prolifically that they crowd out native species in sensitive forest, wetland and aquatic habitats. Common invasive emergent plants within the Assabet River study area include reed canary grass, which often forms semi-floating mats that are loosely anchored to the bottom and float up and down with changing water levels. Purple loosestrife, a ubiquitous invader, is also found in emergent wetlands and scrub-shrub wetlands along the Assabet River. Purple loosestrife would likely rapidly colonize exposed areas with saturated soils following a draw down for dam removal. Oriental knotweed could colonize exposed areas at higher elevations. Norway maple, Tree of heaven, Japanese barberry, European buckthorn, Japanese honeysuckle, and multiflora rose are also found in tree and shrub communities. Phragmites and yellow iris do not seem to be widespread in Assabet River wetlands. However, non-native invasive species are opportunistic invaders in disturbed habitats, have prolific reproductive capabilities and the ability to out-compete native vegetation. Therefore, it is prudent to develop a vegetation management plan in conjunction with dam removal to avoid the spread of these species to newly exposed areas. A post dam removal monitoring and control program could prevent initial invasion and long-term establishment of these noxious species.

Invasive aquatic plants occurring in the study area include water chestnut, fanwort, and curly pondweed. Generally, these species are associated with the lacustrine environment (sluggish flows and soft substrate) and will not survive in a riverine system due to increased water velocities and inadequate substrates.

Mitigation for Loss of Wetlands

There is a history of dam building in the eastern United States to provide water-based power for various industrial purposes, most commonly mills, as well as flood control and hydroelectric power. The Assabet River has nine dams on the river, starting in Westborough at the George H. Nichols Dam constructed by the National Resource Conservation Service (NRCS) (formerly the Soil Conservation Service) in 1968 for flood prevention and fish and wildlife habitat. Downstream from this are seven old mill dams and one additional flood control dam the Tyler Dam, a “dry bed” flood control facility constructed in1965 by NRCS. Increasingly, dam removal is being considered a viable alternative to costly repairs or rehabilitation to deal with the problem of aging or unsafe dams or to address environmental degradation.

The benefits to stream or river restoration are widely recognized by the environmental community. Water movement through impounded areas can be slow, allowing the retention of sediments, chemical and nutrient contamination which can lead to degraded water quality, eutrophication and warming. Fish passage and movement of other aquatic species up and down the river can be restricted by dams.

The Massachusetts Department of Environmental Protection published guidance designed to encourage environmental improvements through dam removal projects (MA DEP 2007). Under the Wetland Protection Act (310 CMR 10.53(4)), dam removal may be considered a limited project and as such, the assignment of traditional mitigation requirements is discretional for the local conservation commission (the responsible permitting board). The benefits of dam removal, such as long term water quality and wildlife habitat benefits may be recognized as mitigation as long as the net benefits of dam removal are clearly demonstrated. The U. S. Army Corps of Engineers, the agency responsible for the administration of Section 404 of the Clean Water Act, also has some flexibility in accounting for the benefits of river restoration project and applying mitigation requirements. The evaluation of a “proactive project”, as referred to in the

Massachusetts General Programmatic Permit (GPP), requires consultation with the Corps, State and Federal agencies "to determine that net adverse effects are not more than minimal."

Dam Removal Considerations for All Project Areas (Natural Resources)

Newly exposed riparian areas and transitional upland areas should be protected to preserve the open space, wildlife, water quality and flood storage benefits of the land. Development of transitional upland areas would be considered cumulative impacts under The Council on Environmental Quality (CEQ) which defines cumulative impact as found in 40 Code of Federal Regulation (CFR) section 1508.7 as "the impact on the environment which results from the incremental impact of the action when added to other past, present and reasonably foreseeable future actions regardless of what agency (Federal or nonfederal) or persons undertakes such other acts." Real estate ownership should be clearly addressed prior to dam removal and a protection plan for transitional upland areas should be implemented prior to dam removal to avoid the potential cumulative impacts associated with urban/suburban development.

Increased water velocities within the river channel after removal of the dam will likely limit invasive species infestations, such as reed canary grass, fanwort, water chestnut, yellow flag, etc. by preventing rooting or by flushing unanchored vegetation downstream. However, the presence of purple loosestrife in many areas is of particular concern because of its ability for prolific growth and rapid reproductive capabilities in exposed wet soils and shallow aquatic sites. Following dam removal, newly exposed banks will be highly susceptible to purple loosestrife infestation. The focus of management after dam removal should be to prevent the further spread of purple loosestrife by encouraging the growth of a healthy zone of native vegetation. A vegetation seeding plan should be implemented to provide an initially quick vegetative cover for exposed soils to prevent purple loosestrife seeds from making contact with exposed soils and the maintenance of a dense and durable vegetative cover over the long-term. This may require multiple seeding with different seed mixes depending on the time of year seeding is conducted.

ALUMINUM CITY DAM

Existing Wetland and Riparian Habitat and Vegetation

The Aluminum City impoundment is approximately 300 feet long and 30 feet wide. About 70 percent of the impoundment shoreline is forested. The remainder is bordered by developed areas (retaining wall, parking lot, or lawn). Habitat maintained by the impoundment is primarily open water, vegetated with scattered submerged aquatic plants (wild celery and a narrow leaved pondweed). There is a small area of emergent and scrub-shrub vegetation on the north side of the impoundment near the dam. Reed canary grass, impatiens, Virginia creeper, and dogwood are the dominant species. Red maple, box elder, and American elm are the dominant tree species. There are several large, apparently healthy, elms growing just downstream of the dam. Some duckweed was observed growing along the margin of the impoundment. Flow through the impoundment and a short retention time likely preclude development of dense growth of duckweed, except under very low flow conditions.

Upstream of the impoundment to the railroad bridge crossing (ca. 1500 feet), the river passes through an extensive forested wetland. River flow through this reach is sluggish, with little riffle habitat. The riparian zone is largely forested with little development except for a sewer line right-of-way within 500 feet of the river.

Downstream of the dam (between route 20 and Hudson Road) the riparian corridor is moderately developed, with a narrow (<100 feet wide forested riparian zone) along most of the reach.

General Description of Impacts

Currently, the Aluminum City Dam impoundment is approximately 300 feet long by 30 feet wide with a surface area of about 0.3 acres. In general, the environmental effects of the removal of the dam will be surface water level reductions in the impoundment and along the Assabet River to an upstream riffle complex (where a sewer-line crosses the river). As stated in the introduction, decreases in water levels due to dam removal were calculated based on the HEC-RAS river modeling performed by CDM for the Assabet Study. There were only two cross-sections in the Aluminum City Dam impoundment which limits the information available to predict the effects of dam removal and distance of hydrological influence upstream by the dam. However, based on this limited data, it appears that surface water levels will decrease approximately 8 feet at the dam and 5 feet approximately 100 feet upstream of the dam. This is indicative of a steep gradient within the impoundment reach.

To determine the surface water level after dam removal, the HEC-RAS river modeling was evaluated in conjunction with the United States Geologic Survey (USGS) water depth information (bathymetric contours). Although the water level decrease at the dam and in the impoundment is sizeable, the overall appearance of open water and change in wetlands is predicted to be minimal. The amount of open water is similar in the before and post-dam condition (0.3 acres before and 0.2 acres after dam removal) due to steep bathymetric contours and a possible constriction or natural fall at the dam site, although the open water area will be more representative of a riverine pool after dam removal. Some fringing wetlands are expected to develop on the exposed river banks.

Figure 1 in Attachment A displays a map of wetlands areas predicted to develop, change or transition following dam removal. The amount of each wetland category is provided on Table 1 to provide a comparison of the existing condition versus after dam removal condition for each wetland category and a new category was added to accommodate the amount of wetland area expected to transition to upland.

Riparian Habitat and Vegetation After Dam Removal

It appears that the Assabet River will encompass more of a pool and riffle complex after the Aluminum City Dam is removed as the impoundment area will be replaced by open water more characteristic of a riverine pool. Upstream of the dam, a sluggish section of the river flows into a short section of riffle (where a sewer pipeline crosses the river), which will then flow into a riverine pool at the location of the previous impoundment which will then flows to the steep-sided rock strewn channel downstream of the former dam. Currently, there are few wetlands associated with the Aluminum City Dam impoundment; about 70 percent of the Aluminum City Dam impoundment riparian zone is upland forested and the remainder is bordered by developed areas (retaining wall, parking lot, or lawn). After dam removal, some development of fringing emergent, shrub and forested wetlands is expected on exposed banks which may be composed of impatiens, Virginia creeper, dogwood, red maple, box elder, and American elm due to the availability of seed and root stock. Open water habitat will be riverine (versus the slower flows associated with impounded water) and therefore, submerged aquatic plants (reed canary grass, wild celery, narrow leaved pondweed) will probably be limited by the higher velocity flows. Duckweed, observed growing along the margin of the impoundment, will be flushed downstream.

Invasive Species

Increased water velocities within the river channel after removal of the dam will likely limit the growth of yellow flag (noted growing along the impoundment shoreline) however, an invasive species management plan should be implemented in the project area to control the growth and spread of purple loosestrife.

ALLEN STREET DAM

Existing Wetland and Riparian Habitat and Vegetation

The Allen Street impoundment is approximately 3000 feet long, with a maximum width of about 300 feet. About one-half of the impoundment shoreline is forested and undeveloped. A narrow riparian buffer along Hudson Street borders the remainder. The most extensive wetland areas are just upstream of the Wachusett Aqueduct. Wetlands are restricted by the steep upland habitat, highway access and urban development.

Habitat maintained by the impoundment is primarily open water or emergent wetland. In August of 2005, emergent wetlands were dominated by reed canary grass, and to a lesser extent cattail, impatiens, and purple loosestrife. Other species noted included *Sparganium*, smartweed, pickerelweed, and bulrush. Scattered shrubs, mostly buttonbush, occur in the emergent wetland. Most of the emergent wetland appears to be semi floating, rising and falling with river flows. Backwater areas were heavily vegetated with duckweed (100 % cover in some locations). Open water areas were generally shallow (2 – 6 ft.) and soft bottomed, with scattered beds of Elodea and pondweeds. ENSR (2001) reported moderately productive growth of filamentous green algae.

Upstream of the impoundment to River Street Bridge, the river passes through a largely undeveloped riparian corridor. The riverbank is mostly forested, with some areas of scrub-shrub or emergent-scrub-shrub habitat fringing the river. River flow through this reach is sluggish (run or pool), with no riffle habitat. Depth ranges from 2-4 feet, with some deeper (6 – 8 ft.) pools. Beds of narrow leaf pondweed were present in some areas. The reach is generally hard bottomed sand and gravel, with cover provided by scattered boulders and large woody debris (snags). The riparian zone is largely forested with little development within 100 ft. feet of the river. Steep banks seem to have limited encroachment along the south side of the river.

Immediately downstream of the dam the riparian corridor is largely developed, with only a narrow (< 50 ft wide) vegetated riparian zone along most of the reach. An old mill building converted to apartments spans the river about 200 feet downstream of the Allen Street Bridge. Much of this reach is riffle. Approximately 1000 ft. downstream of the dam, the river enters a broad emergent and scrub-shrub wetland and flows approximately one mile to Boundary Street. A tributary brook joins the Assabet within this reach. Downstream of Boundary Street the Assabet River receives discharge from the Marlboro WWTP and flows for approximately ¾ mile through a largely undeveloped riparian corridor before it passes under Route 290 and by the Solomon Pond Mall.

General Description of Impacts

Currently, the Allen Street Dam impoundment is approximately 3000 feet long, has a maximum width of 300 feet and a surface area of about 7 acres. In general, the environmental effects of the removal of the Allen Street Dam will be surface water level reductions in the impoundment and along the Assabet River to River Street in Northborough. This will create a narrower riverine channel with a maximum width of approximately 55 feet and provide substrate for the impoundment open water to transition to a mixture of wetland community types. It is expected that a small portion of wetlands located at higher elevations will transition to upland. The change in surface water lessens along the impoundment (and river channel) further upstream; a range of approximately 3 feet at the dam to less that 1 foot above River Street in Northborough. (Based on field observation, it was thought that the dam influence was to River Street however, the area of influence may go to East Main Street. During detailed studies these areas will also need to be considered.)

Figure 1 in Attachment A displays a map of wetlands areas predicted to develop, change or transition following dam removal. The amount of each wetland category is provided on Table 1 to provide a comparison of the existing condition versus after dam removal condition for each wetland category and a new category was added to accommodate the amount of wetland area expected to transition to upland.

Riparian Habitat and Vegetation After Dam Removal

Following removal of the Allen Street dam, the width of the impoundment will decrease to approximately 30 to 55 feet with a diversity of wetland habitats developing east and west of the river (previously open water). It is expected that the existing 6.9 acres of open water will be reduced to 2.4 acres (for a difference of 4.5 acres) and shallow marsh will be reduced from 2.0

acres to 1.7 acres (for a difference of 0.3 acres). Open water and shallow marsh areas are expected to be replaced by shrub swamp (1.7 acres), wooded swamp (2.9 acres) with some transition to uplands (0.2 acres). Immediately upstream of the dam, on the east side of the river, a backwater area composed of shallow emergent vegetation is predicted to develop based on the USGS impoundment bathymetry. This area may have a small pool of open water (which may function as a vernal pool) surrounded by fringing emergent vegetation, shrubs and trees. Further upstream, another backwater area is expected to develop along the west side of the river composed of a mixture of shallow emergent vegetation, fringing shrubs and trees.

Floating beds of reed canary grass found in the existing open and shallow wetland areas are expected to float down with the water level decrease, settle and continue to grow on exposed substrates until shrubs or trees become established. Reed canary grass may also expand to newly created backwater areas but will be more susceptible in the river channel to detachment and being flushed downstream during high flows. Ribbon-leaf pondweed, duckweed, cattail, impatiens, purple loosestrife, Sparganium, smartweed, pickerelweed, and bulrush will likely populate newly created emergent wetlands due to the availability of seed and rootstock in the area with buttonbush as a volunteer shrub species. Rooted aquatic vegetation, such as Elodea, pondweeds and filamentous green algae will likely be limited due to the increase flow velocity (riverine characteristics) in open water areas.

The existing emergent vegetation in the impoundment area is expected to transition to forested wetlands over time with a small portion transitioning to upland along Hudson Street. Red maple is found in this area and as a facultative species (adapted to wetlands and upland equally) may transition to upland without notable visible mortality.

A small amount of wetlands in the upper elevation area on the west side of the impoundment is also expected to transition to upland. The river channel and backwater areas, with the diversity of wetland vegetation composition and structure, will likely provide excellent wildlife habitat value and an aesthetically pleasing viewshed.

Much of the upstream reach of the impoundment to River Street, which passes through a largely undeveloped riparian corridor, will maintain its riverine characteristics except for a narrowing of the river channel and potential development of some fringing emergent, shrub and trees on exposed sediments (at a lower elevation). River flows may increase slightly through this reach with some riffle habitat development (currently, it is primarily run or pool habitat).

No vernal pools or potential vernal pools, as mapped by the MA DFW (February 2008), are located within the area of influence of the Allen Street Dam. As stated previously, one small open water area may develop in a backwater area to the east of the river after dam removal which may function as a vernal pool. As valuable and protected resources in Massachusetts, this potential vernal pool area should be evaluated after dam removal to determine its capability for providing breeding habitat to amphibian and reptile vernal pool species.

Invasive Species

Purple loosestrife and yellow flag, noted growing along the impoundment shoreline, may still be problematic in the backwater areas expected to develop east and west of the river channel. Increased water velocities within the river channel after removal of the dam will likely limit the growth of unanchored vegetation however, an invasive species management plan should be implemented in the project area to control the growth and spread of purple loosestrife.

HUDSON DAM

Existing Wetland and Riparian Habitat and Vegetation

The lower 1200 feet of the Hudson Dam impoundment ranges in width from about 300 to 600 feet. The shoreline along this reach is moderately developed, with several businesses and about 15 homes having physical access or a view of the impoundment. Further upstream the impoundment ranges in width from about 30 to 100 feet and has riverine characteristics, which make the influence of the dam difficult to discern. Development along the upper reaches of the impoundment is sparse, with the undeveloped riparian corridor typically at least 600 ft. wide. The riparian corridor between the dam and Chapin Road includes town parkland, O'Donnell field (recreation area), and Hudson High School.

Wetland habitat maintained by the impoundment is primarily open water, emergent wetland, and scrub-shrub. In 2000, open water areas near the dam were heavily vegetated with coontail and elodea (ENSR, 2001). In September of 2005, elodea, milfoil, coontail, and filamentous green algae, including a Rhizoclonium were abundant. In riverine sections, open water was largely free of vegetation, except for scattered beds of narrow leaved Potamogeton. Backwater areas of were heavily vegetated with duckweed (100 % cover in some locations), but open water areas exposed to current were largely free of floating aquatic plants.

Emergent wetlands are strongly dominated by reed canary grass, and to a lesser extent, purple loosestrife. Associated species include cattail, Sparganium, impatiens, rice cut grass, pickerelweed, Sagitaria, soft stem bulrush, and yellow flag. Shrubs occurring in emergent wetland include buttonbush and black willow. As at the Allen Street dam, most of the emergent wetland appears to be semi floating, rising and falling with river elevation.

Species present in the scrub-shrub and scrub-shrub/forested wetlands include red maple, alder, elm, dogwoods, northern arrow-wood, sweet pepperbush, wild grape, grey birch, and white oak.

Immediately downstream of the dam the riparian corridor is heavily developed, with only a narrow vegetated riparian zone along most of the reach from Route 85 to Maning Street. Downstream of Broad Street to the Stow-Hudson town-line the riparian corridor is moderately developed.

General Description of Impacts

The Hudson Dam has an open water surface area of 22 acres and a length of about 4,000 ft.. The base of the dam is constructed on bedrock at the site of natural waterfalls. Based on field observations the main influence of the dam appears to extend about 1.2 miles upstream. (Note: wetland impacts likely extend beyond Chapin Road to approximately Rt. 290, another 2.6 miles (linear) or 3.4 river miles. During detailed studies, these additional wetland areas will also need to be considered)**.** Water level reductions will range from approximately 7.0 feet at the dam to approximately 2.6 feet Chaplin Road. It is expected that fringe wetlands in the area of the impoundment will transition to a narrow area of shallow marsh, shrubs and trees and the extensive wetlands at the inflow from Tripp Pond (Hog Brook) from the west will change in composition with some transition to upland. Further upstream, the river is bounded by emergent wetlands that are expected to change in composition with some transition to upland along the periphery.

Figure 2 in Attachment A displays a map of wetland areas predicted to develop, change or transition following dam removal. The amount of each wetland category is provided in Table 1 to provide a comparison of the existing condition versus after dam removal condition for each wetland category and a new category was added to accommodate the amount of wetland area expected to transition to upland.

Riparian Habitat and Vegetation after Dam Removal

Currently, the lower 1200 feet of the impoundment ranges in width from about 300 to 600 feet which will narrow to a range of about 100 to 250 feet following dam removal. It is expected that open water in the impoundment will change from the current 27 acres to 16.8 acres after dam removal (for a change of 10.2 acres). Since the dam is located at a natural waterfall, the pool remaining after dam removal will still maintain depths of about 5 to 6 feet and the impoundment will remain open water, however some changes to the viewshed will be observed by the businesses and homes along this shoreline. Aside from the narrowing of the impoundment, the large area of emergent and submergent vegetation associated with the inflow from Tripp Pond (Hog Brook) is expected to transition to emergent vegetation (with one small area of open water which has characteristics of a potential vernal pool), shrubs, and trees with some area transitioning to upland. The loss of open water is expected to be replaced by additional shallow marsh (an increase of 0.7 acres), an increase in wooded swamp by 3.2 acres and the transition of 6.4 acres of wetland to upland.

The narrowed impoundment will probably continue to be vegetated, although to a lesser degree, with coontail, elodea, milfoil, and filamentous green algae although some of this biomass may periodically be flushed downstream during high water events (higher velocity flows). In riverine sections, open water will remain largely free of vegetation, except for scattered beds of narrow leaved Potamogeton and duckweed in backwater areas.

There are large areas of emergent wetlands located northeast of Chapin Road on either side of the river. These areas are strongly dominated by semi-floating mats of reed canary grass, and to a lesser extent, purple loosestrife. The river is estimated to be approximately 2.5 to 3 feet lower in this area and the mats of reed canary grass are expected to float down with the water level, settle and continue to grow in quiescent backwater areas and along the shore (until higher velocity river waters scour the channel of unanchored plant materials). Seed and root stock availability from plants that currently grow in the area will promote revegetation of the riverbanks by emergent and shrub species such as impatiens, rice cut grass, soft stem bulrush, buttonbush and black willow. A large portion of these emergent wetlands will transition to shrub and forested wetlands composed of species found in the area such as red maple, alder, elm, dogwoods, northern arrow-wood, sweet pepperbush, wild grape, grey birch, and white oak with some wetland area transitioning to upland along the periphery. It is expected that the wetlands associated with an unnamed tributary on the south side of the river will remain the same as hydrological support is assumed to be derived from the tributary.

One potential vernal pool has been identified by the MA DFW (February 2008) in the project area (from the dam to Chapin Road) that may be hydrologically influenced by the Hudson Dam. This pool is located northeast of Chapin Road in an area currently delineated as emergent wetlands. Since river water levels are estimated to drop approximately 2.5 feet in this area, the vegetated wetlands in this area are expected to transition to a forested wetland community with some upland areas along the periphery. Therefore, water levels necessary for the completion of the amphibian aquatic development may not be adequate after dam removal to support vernal pool functioning in this pool. On-sight inspection is needed to fully evaluate the impact of the removal of Hudson Dam on this potential vernal pool. (In addition there are three other vernal pools between Chapin Road and Rt. 290 which will need to be considered in future detailed studies if dam removal is pursued.)

Modifications (deepening of the pool) may be considered to avoid impacts to existing resource areas. As stated previously, an area that will be isolated from the river (but may maintain a groundwater connection) after dam removal which is associated with the inflow from Tripp Pond (Hog Brook) may function as a vernal pool after dam removal and should be evaluated after dam removal to determine its function.

Invasive Species

After dam removal, the impoundment maintains a width of approximately 250 feet which may allow infestations of reed canary grass currently found in the Hudson Dam impoundment to continue to grow due to more quiescent waters in the pool. Upstream of the pool, increased water velocities within the river channel will likely reduce the infestations by flushing unanchored vegetation downstream however, an invasive species management plan should be implemented in the project area to control the growth and spread of purple loosestrife.

GLEASONDALE DAM

Existing Wetland and Riparian Habitat and Vegetation

The area behind the dam (as delineated by the USGS) is generally linear, with open water ranging in width from about 75 to 150 feet. Most of the shoreline is fringed with emergent wetland. Just upstream of the dam the impoundment is constrained between Orchard Hill to the south and Lambert Hill to the north. The river broadens about 0.4 miles upstream of the dam and receives an unnamed tributary stream from the north. A second unnamed tributary joins the Assabet River from the north about 0.8 miles upstream of the dam. The impoundment is bordered to the south by pasture and to the north by an extensive forested and scrub-shrub wetland and the Stow Acres Country Club. Upstream the river narrows and no riffle is present and any hydrological influence of the dam is difficult to discern. Development along the river is sparse until the Hudson WWTF, upstream of the dam.

Wetland habitat maintained by the impoundment is primarily open water, emergent wetland, and scrub-shrub. In the summer of 1999 and 2000, open water areas within the impoundment were heavily vegetated with coontail, elodea and floating plants (Lemma and Wolfia). (ENSR, 2001). In November of 2005, the open water areas were largely free of vegetation, except for scattered senescent beds of elodea and coontail. Open water areas were largely free of duckweed or other floating aquatic plants.

Emergent wetlands are strongly dominated by reed canary grass, and to a lesser extent, purple loosestrife and cattail. Associated emergent species include bur-reed, pickerelweed, yellow flag, and false nettle. Shrubs and small trees that occur in emergent wetland include buttonbush, black willow, and red maple. As at other Assabet River impoundments, most of the emergent wetland appears to be semi floating, rising and falling with river flows. A local resident reported grassy islands floating downstream during high flows in the fall of 2005.

Open water areas of the northern embayment contained scattered patches of coontail, elodea, and sporangium, and a few shoots of wild rice. The sediments were extremely soft and were producing gas bubbles. Sedge hummocks adjacent to the open water were vegetated with tussock sedge, purple loosestrife, sweet gale, and other species. Scrub-shrub wetland adjacent to the embayment was vegetated with sweet gale, swamp rose, red maple, alder, winterberry, blueberry, and herbaceous species. Forested wetlands near the impoundment were dominated by red maple.

There are several potential vernal pools mapped by the MA DFW that may be hydrologically influenced by the Gleasondale Dam.

Downstream of the dam, the river flows for 600 hundred feet past the Gleasondale Mill complex to Glendale Road (Route 62). The reach between the Dam and Route 62 is riffle. Downstream of Glendale Road, river velocity slows and it meanders through a broad, largely undeveloped, floodplain until it reaches Sudbury Road, the upper reaches of the Ben Smith impoundment. Flow from Lake Boon enters the Assabet about 2 miles downstream of the Gleasondale Dam, and 0.5 miles upstream of Sudbury Road.

General Description of Impacts

The Gleasondale Dam currently has an open water/deep marsh area of 17.8 acres and generally ranges in width from about 75 to 100 feet. In general, the environmental effects of the removal of the Geasondale Dam will be surface water level reduction in the impoundment and along the Assabet River to approximately Cox Street. Water level reductions will range from approximately 4.8 feet at the dam to 0.8 feet at Cox Street. The 6 feet square stone lined open box culvert on the west bank about 50 feet upstream from the dam will no longer function as a sluiceway/canal after dam removal (river surface water level will be below the box culvert invert). It is expected that fringe wetlands in the area of the impoundment will transition to a narrow area of shallow marsh, shrubs and trees. Further upstream, the river is bounded by extensive shrub and forested wetlands; a large portion of which will transition to upland due to the change in hydrology after dam removal. Fewer changes will occur to wetlands further upstream towards Cox Road as the range of water level change is reduced to about 1 to 2 feet and existing wetlands are limited to a narrow area adjacent to the river. Figure 3 in Attachment A displays a map of wetland areas predicted to develop, change or transition following dam removal. The amount of each wetland category is provided on Table 1 to provide a comparison of the existing condition versus after dam removal condition for each wetland category and a new category was added to accommodate the amount of wetland area expected to transition to upland.

Riparian Habitat and Vegetation After Dam Removal

Following the removal of the Geasondale Dam, surface water levels in the impoundment will be lowered approximately 4 to 5 feet. As a result, the width of the impoundment will be reduced to a range of about 40 to 90 feet and the reduction of 7.0 acres of open water/deep marsh. The existing fringing emergent wetlands should transition to a narrow, linear area vegetated with emergent vegetation, shrubs and trees due to the steep impoundment bathymetry (based on the 1-foot bathymetric contours) (See Figure 3.) It is expected that shallow marsh, shrub swamp, wooded coniferous swamp, and wooded deciduous swamp will all have reductions in acreages after dam removal (20.9 acres, 4.8 acres, 10.4 acres and 17.0 acres, respectively) with 60.1 acres of wetlands transitioning to upland. The aquatic vegetation, such as coontail, elodea and floating plants observed in the impoundment will be flushed downstream with increased water velocity in the river.

About 0.4 miles upstream of the dam, the river broadens and an unnamed tributary stream joins the Assabet River from the north and a second unnamed tributary joins the river from the north about 0.8 miles upstream of the dam. In this location, the river is bordered to the south by pasture and to the north by an extensive forested and scrub-shrub wetland. The river surface water levels will be reduced by approximately 3 to 4 feet in this area which is expected to result in the transition of large areas of deciduous and coniferous wooded swamp to upland. Some tree species found in these wetlands, such as red maple, are facultative species (adapted to wetland and uplands equally) and so may adapt to this hydrological change. However, some visible mortality would be expected in this area considering the large amount of area affected. It appears that the unnamed streams in this area will provide some degree of supporting hydrology to the adjacent wetland communities and therefore, the unnamed tributary riparian areas will not be altered as much (with less change the further distance upstream and away from the hydrological influence of the river).

The emergent wetlands in this area are strongly dominated by semi-floating mats of reed canary grass which are expected to float down with the water level, settle and continue to grow in quiescent backwater areas and along the shore (until higher velocity river waters scour the channel of unanchored plant materials). Seed and root stock availability from plants that currently grow in the area will promote revegetation by volunteer emergent and shrub species such a tussock sedge, purple loosestrife, bur-reed, pickerelweed, yellow flag, false nettle, buttonbush, swamp rose, alder, winterberry, blueberry, sweet gale, black willow, and red maple. It does not appear that there will be open water areas remaining in the northern embayment due to the level of surface water reduction in this area.

Water level changes resulting from dam removal become less with more distance further upstream toward Cox Road. Surface water levels are predicted to be reduced by 1 to 3 feet in this area resulting in the narrowing of the river to some degree. Existing emergent wetlands adjacent to the river will probably transition to shrubs, trees and upland and new areas of fringe emergent will develop adjacent to the river.

There are a total of 7 potential vernal pools mapped by the MA DFW (February 2008) that may be hydrologically influenced by the Gleasondale Dam; one of which is located within the impoundment area and the remaining 6 are located within the extensive wetland area located about a half mile upstream from the dam. The potential vernal pool located closest to the dam is in a backwater along the south side of the impoundment. Although water level changes are most extreme in this area, it appears that this area will still receive water to support vernal pool functions based on aerial photo interpretation. Five (5) out of the remaining 6 potential vernal pools are currently located in shrub or tree communities which are expected to transition to upland and therefore, water levels necessary for the completion of the amphibian aquatic development may not be adequate after dam removal in these pools. The remaining potential vernal pool is currently located in an area delineated as an emergent wetland and it appears based on aerial photo interpretation that this area may still receive adequate hydrology after dam removal. However, on-sight inspection is needed to fully evaluate the impact of the removal of Gleasondale Dam on these potential vernal pools and modifications (deepening of the pool) may be considered to avoid impacts.

Removal of the impoundment would not dramatically change the viewshed from Orchard Hill or Lambert Hill. For the most part the existing impoundment has riverine characteristics, and after dam removal the river would just appear narrower. Some residents along Route 62 might object to replacement of the "waterfall" created by the dam spillway with a natural river channel, most likely a section of riffle. Most of the vegetation changes would occur in the east of Hudson Road, where large tracts of forested wetland may transition to upland with some visible mortality expected.

Invasive Species

Increased water velocities within the river channel after removal of the dam will likely reduce the infestations of reed canary grass and yellow flag that are currently found in the Gleasondale Dam impoundment. However, an invasive species management plan should be implemented in the project area to control the growth and spread of purple loosestrife.

BEN SMITH IMPOUNDMENT (INCLUDING CLOCK TOWER POND)

Existing Wetland and Riparian Habitat and Vegetation

The Ben Smith Dam in located in Maynard. According to the USGS (2005) the impoundment has a surface area of 146 acres. This makes it the largest impoundment on the Assabet River, with a surface area exceeding that of all other impoundments combined. The Ben Smith dam diverts water through a 1500 feet long canal and two small ponds to Clock Tower Pond in downtown Maynard. Offices in a redeveloped mill building overlook the pond. The pond has a maximum depth of about 15 - 20 feet. Flow from the pond passes under the mill building and flows into the Assabet River at two locations, with the main flow rejoining the Assabet near Walnut Street in Maynard.

ENSR (2001, Figure 3-2) stream profile indicates the influence of the impoundment extends nearly to the Gleasondale Dam. The impoundment (as delineated by the USGS) is generally linear, with open water ranging in width from about 200 to 400 feet from the dam upstream to Crow Island. Water depth throughout this reach is typically about 6 feet, with some areas reaching 8 – 10 feet. Most of the shoreline downstream of Crow Island is fringed with a narrow band of emergent or scrub-shrub wetland vegetation.

North of Crow Island the impoundment broadens into a shallow (2 – 4 ft deep), 600 feet wide pool. The 35-acre pool is heavily vegetated. An old channel of the Assabet, now largely vegetated with scrub-shrub wetland, lies south of Crow Island. The 30-acre island is connected to land by a long wetland crossing. The island is flat and largely vegetated with grasses, with a fringe of hemlock and oak trees along the Assabet River. The privately owned island is used as an airstrip for ultra light aircraft and has an aircraft metal hangar. The island contains a 2.5 acre excavated pond that is probably hydrologically influenced by the Assabet River. Upstream of Crow Island to Sudbury Road, open water ranges from 200 to 300 feet wide. Near Sudbury Road there are broad areas of fringing emergent wetland. From Sudbury Road upstream to Route 62 the river slowly meanders for about 2 miles through a broad, largely undeveloped, floodplain. Riffles downstream of Route 62 mark the definitive end of the impoundment.

The impoundment receives inflow from several tributary streams. Flow from Lake Boon enters the Assabet River about 0.5 miles upstream of Sudbury Road. Other major tributaries to the impoundment include Taylor Brook, which enters from the south about 1000 feet upstream of the dam and Elizabeth Brook, which enters from the north upstream of White Pond Road.

The Ben Smith impoundment shoreline is largely undeveloped. There are about 15 homes on the north shore of the impoundment between the dam and White Pond Road. Upstream of White Pond Road the shoreline is almost entirely undeveloped except for a golf course east of Elizabeth Brook and Crow Island. Much of the shoreline between White Pond Road and Sudbury Road is protected open space. The Assabet River National Wildlife Refuge borders the river for 1.5 miles along this reach. To the north is Stow's Gardner Hill Conservation Area.

Of all the Assabet River dams being studied, the Ben Smith impoundment supports the most extensive wetland and aquatic habitat. Wetland habitat maintained by the impoundment is primarily open water, emergent wetland, and scrub-shrub. In the summer of 1999 and 2000, ENSR mapped aquatic vegetation from the dam to the Elizabeth Brook confluence. Plant growth was excessive and dominated by filamentous green algae, floating plants (lemna and wolfia), and coontail. Observation by OAR in 2005 found variable and occasionally heavy growth of aquatic vegetation in the impoundment from the dam to White Pond Road. Filamentous green alga and coontail were the dominant taxa (Flint, 2006).

During the summer the shallow embayment north of Crow Island is heavily vegetated with aquatic weeds, including yellow water lily, filamentous algae, coontail, elodea, duckweed, and wollfia. (Flint, pers., comm.). In November of 2005, the open water areas were largely free of vegetation, except for senescent beds filamentous algae, and scattered colonies of coontail, elodea, and water chestnut.

Downstream of Sudbury Road, emergent wetlands are dominated by reed canary grass, and to a lesser extent, purple loosestrife and cattail. Associated species include bur-reed, pickerelweed, smartweeds, water willow, yellow flag, soft stem bulrush, and smartweed. As in other Assabet River impoundments the grass-dominated wetlands are semi-floating. Even in mid November, duckweed was abundant in areas protected from the current. Scrub-shrub wetland adjacent to the river was vegetated with sweet gale, swamp rose, red maple, winterberry, blueberry, and northern arrow-wood. Herbaceous species noted in scrub-shrub wetlands included purple loosestrife, tussock sedge, and wool grass. In many areas the shoreline rises steeply to uplands, allowing only a narrow wetland fringe. Oak, white, pine and red maple were the most common trees species. Blueberry, northern arrow-wood, alder, and dogwood were common understory shrubs along the shoreline.

There are several potential vernal pools mapped by the MA DFW that may be hydrologically influence by the Ben Smith Dam.

Downstream of the Ben Smith Dam the river flows for about 1.5 through a moderately to highly developed riparian corridor before reaching the headwaters of the Powdermill Dam impoundment. The river drops in elevation about 30 feet through this high gradient reach.

The Ben Smith Dam diverts water to Clock Tower Pond through a 1600 feet long canal to two mill Ponds (known as the Upper and Lower Mill Ponds). The shoreline of the 40 feet wide canal is heavily vegetated. The canal ends at a manually operated gatehouse that controls flow into the mill ponds.

The Upper Mill Pond extends from the gatehouse downstream to Sudbury Road and has a surface area of approximately 6.5 acres. The upper pool was heavily vegetated with emergent and floating plants (duckweed and water meal) in September of 2005.

The lower millpond begins at the Sudbury Road Bridge and has a surface area of approximately 12 acres. This lower pond can be divided into a forebay pool and a main pool. The forebay pool (ca. 1 acre) is divided from the main pool by the remains of an old berm (or log boom?). The forebay consists mostly of open water habitat, with a maximum depth of 15 feet. Patches of emergent vegetation grow along the shoreline and on the log boom berm. The forebay pool was heavily vegetated with fanwort and floating leaved plants (woolfia and duckweed).

The main pool has a maximum depth of about 20 feet. The shoreline is almost entirely developed with a parking lot, old mill building, lawn, and several private homes. The southern shoreline is landscaped with weeping willow, silver maple, and other trees and shrubs. Water depth increases rapidly from shore and the pond has only a narrow, scattered, fringe of emergent vegetation. In September of 2005, percent cover of duckweed and wolfia in the pond was about 5% and the water was noticeably turbid from an algal bloom. Flow from the pond passes under the mill building and flows into the Assabet River immediately upstream of the Walnut Street Bridge approximately 7,000 feet downstream of the Ben Smith Dam.

General Description of Impacts

The Ben Smith Dam currently has a surface area of about 146 acres and generally ranges in width from about 200 to 400 feet, but broadens to 600 feet wide north of "Crow Island". In general, the environmental effects of the removal of the Ben Smith dam will be surface water level reductions in the impoundment and along the Assabet River to Route 62 in Gleasondale. This will create a narrower riverine channel approximately half the present width of the impoundment and provide substrate for the development of fringe wetland vegetation along the banks of the river. It is expected that some wetlands located at higher elevations will transition to upland. The change in surface water lessens along the impoundment (and river channel) further upstream; a range of approximately 7 feet at the dam to less that 1 foot at Route 62 in Gleasondale. Figure 4 in Attachment A displays a map of wetland areas predicted to develop, change or transition following dam removal. The amount of each wetland category is provided in Table 1 to provide a comparison of the existing condition versus after dam removal condition for each wetland category and a new category was added to accommodate the amount of wetland area expected to transition to upland.

Riparian and Habitat and Vegetation After Dam Removal

Following the removal of the Ben Smith dam, the width of the impoundment will be approximately 60 to 150 feet (downstream of Crow Island to the dam) and the steep impoundment bathymetry (predicted using the 1 foot bathymetric contours) will support the development of narrow zones of vegetated wetland areas (shallow marsh, shrubs and trees), similar to existing conditions except at a lower elevation (see Figure 4.). The amount of open water increases after dam removal; from 20.8 acres to 70.2 acres due to the transition of deep marsh to open water (deep marsh wetlands are reduced from 126.6 acres to 12.8 acres). Shallow marsh is reduced by 11.7 acres, shrub swamp gains 4.8 acres, wooded deciduous swamp gains 27.7 acres and 43.5 acres of wetland is expected to transition to upland. Since surface water level reduction is greatest in the impoundment area (approximately 7 feet at the dam), the amount of wetland expected to transition to upland is greater around the impoundment.

However, it should be noted that many wetland shrub and tree species found in the impoundment area, such as red maple, blueberry, northern arrow-wood, alder, and dogwood also grow in uplands some of the time and therefore, the transition to an upland vegetation community may be very gradual as these species may adapt to the new hydrology. Emergent wetlands will be more susceptible to the water level change and will be more likely to display abrupt and noticeable mortality with the exception perhaps of floating rafts of reed canary grass located upstream of Crow Island. It is expected that reed canary grass will float down with the water level reduction, settle and continue to grow on the newly exposed banks.

There will also be notable changes to the area north of Crow Island with water level reductions estimated to be in the range of 3 to 4 feet. A river channel (approximately 100 to 200 feet in width) will replace the broadened impoundment. The river will be flanked by large expanses of shallow marsh meadow and shrub swamps due to gradual impoundment bathymetry and repositioning of sediments in backwater areas. There will also be wetland areas transitioning to uplands along the higher elevations and in the remnant channel of the Assabet River (south of Crow Island). This area is now largely vegetated with scrub-shrub wetland and although it is fed by a perennial stream, it appears the Assabet River is the primary source of hydrology supporting this area. The 30-acre island may experience a reduction in the water level in the excavated pond (as it may be hydrologically influenced by the Assabet River) but minor changes are expected along the riverbank.

Upstream of Crow Island to Sudbury Road, the surface water level reduction becomes increasingly less, approximately 2 feet at Sudbury Road to almost no change at Route 62 (riffles downstream of Route 62 mark the definitive end of the impoundment). The width of the river should narrow to about 100 feet (from approximately 200 to 300 feet) and in general, fringing wetlands are expected to transition from shallow marsh to shrub swamp or from shrub swamp to forested wetland or change very little depending on the site-specific conditions such as species composition, other hydrological contributions, etc. Downstream of Sudbury Road, there are wide expanses of emergent wetlands which are dominated by reed canary grass. This area will be subjected to minimal water level reduction (approximately 1 foot) and therefore, it is expected that the semi-floating grass-dominated wetlands will move with water level changes. Scrub-shrub wetlands containing species that are also adapted to dried conditions, such as sweet gale, red maple, blueberry, and northern arrow-wood, may tolerate the hydrological change. A small amount of peripheral fringe wetlands in the higher elevations are expected to transition to uplands. The expansive wetlands between the Assabet River and Main Street will be generally unaffected due to the small change in water level and hydrological contributions from Fort Meadow Brook.

There are a total of 10 vernal pools (9 potential vernal pools and 1 certified vernal pool) mapped by the MA DFW (February 2008) that are located within the area of influence of the Ben Smith Dam. In the area from the dam to Crow Island, there are two potential vernal pools located in what appears to be a remnant channel of the Assabet River. Since the water level reduction in the impoundment area is the greatest, a portion of the forested wetlands are expected to transition to upland in this area and therefore, water levels necessary for the completion of the amphibian aquatic development may not be adequate after dam removal in these pools. There are 2 potential vernal pools and one certified vernal pool located in the Crow Island to Sudbury Road area. These pools are located in contiguous forested wetlands that are associated with contributing drainage and therefore, do not appear to be dependent on hydrology from the Assabet River. From Sudbury Road to Route 62, there are 5 potential vernal pools which are located in the extensive wetlands adjacent to the Assabet River. Water level reduction in this area is minimal and therefore, these vernal pools will most likely be unaffected by the dam removal project. However, vernal pools are a valuable and protected resource in Massachusetts providing breeding habitat to a variety of amphibian species, some of which are rare. Therefore, the vernal pool and potential vernal pools in this area should be evaluated prior to dam removal and modifications (deepening of the pools) may be considered should the impact of reduced hydrology associated with dam removal be determined to have a detrimental affect. An isolated pool on an exposed floodplain on the northern bank of the river upstream of Crow Island is one noteworthy potential vernal pool created as a result of the dam removal. This area is a shallow open water area surrounded by emergent and shrub wetland and appears to have characteristics of a potential vernal pool.

The impoundment and shallow embayment north of Crow Island have been heavily vegetated with aquatic weeds, including yellow water lily, filamentous algae, coontail, elodea, and duckweed. After dam removal, water velocities will exceed the tolerance range of aquatic rooted vegetation in the channel and transport floating vegetation downstream however, backwater areas will probably still support smaller populations of these aquatic weeds.

The Ben Smith Dam diverts water to Clock Tower Pond downstream through a 1600 feet long canal to two mill Ponds (known as the Upper and Lower Mill Ponds). These pools are heavily vegetated with emergent, floating plants and algae. If water is still diverted into the canal during the average summer low flow then surface water levels may not be dramatically affected in these ponds compared to the upstream impoundment. However, reduced flows may exacerbate the nuisance vegetation problem. In addition, through scouring of the river channel, some sediment may move from the former impoundment downstream to be retained in these ponds. One of the recommendations of the Assabet River Modeling Study (CDM, 2008), is to remove some sediments to minimize the transport of fine materials and potentially contaminated sediments downstream subsequent to dam removal. A sediment management plan is being developed which will include a dredging plan based on site-specific conditions; depth of sediment, and the physical and chemical analysis of impounded sediments. However, it is expected that poor water quality will be a continued problem in these ponds and will affect the Assabet River at the discharge site immediately upstream of the Walnut Street Bridge (7,000 feet downstream of the dam).

Invasive Species

Water velocities within the river channel after removal of the dam will likely reduce the infestations of yellow flag, fanwort, and water chestnut that are currently found in the Ben Smith dam impoundment and limit the growth of unanchored vegetation however, an invasive species management plan should be implemented in the project area to control the growth and spread of purple loosestrife.

Restoration Considerations (Natural Resources)

Much of the Ben Smith impoundment shoreline is undeveloped or protected open space (the Assabet River National Wildlife Refuge and Stow’s Gardner Hill Conservation Area). The protection of newly exposed riparian areas and transitional upland areas is especially important in the Ben Smith area to maintain the integrity of existing open space and conservation areas.

POWDERMILL DAM

Existing Wetland and Riparian Habitat and Vegetation

The Powdermill Dam is a stone and timber-crib dam built in the early 1920's. The dam is located in Acton. The impoundment, sometimes known as Ripple Pond, stretches into Maynard.

The impoundment has a surface area of 27 acres and extends about 1 mile to Crane Avenue in Maynard. The dam and spillway are in disrepair and the impoundment is currently drawn-down to a channel. A bridge open to only foot traffic spans the dam.

The dam's purpose is to create sufficient head to run a small hydroelectric facility at the site. In April of 2004, during high flows, a sink hole developed at the outlet work compromising the dam. As a result the impoundment is drawn-down. Currently, under high flow conditions some water is retained in the impoundment. Under low flow conditions most of the flow passes through the open outlet works.

Based on the growth of emergent vegetation and other field indicators the present influence of the impoundment is typically about 0.2 miles. Discharge from the Maynard Wastewater Treatment Plant and an unnamed tributary flow into the existing impoundment from the north. Numerous groundwater seeps on the north side of Powdermill impoundment also discharge into the Assabet River.

The width of the impoundment ranged from about 40 feet near Crane Avenue/Warren Street to about 500 feet near the dam. Route 62 parallels the south side of the impoundment and there is moderate to heavy development between Crane Avenue and the dam.

The north side of the impoundment is largely undeveloped, with about 2/3 thirds of the shoreline between the dam and Warren Street in public ownership. Upstream of Crane Avenue/Warren Street the river is about 40 feet wide.

The riparian corridor downstream of the dam is largely undeveloped and there is generally at least a 50 foot wooded buffer along the sides of the river to the Assabet River-Sudbury River confluence.

Prior to its lowering, the impoundment was primarily open water, with a minor amount of scrub-shrub wetland and fringing emergent vegetation. In 1999 and 2000, before the impoundment was lowered, open water areas were densely vegetated with submerged aquatic vegetation and floating vegetation (ENSR, 2001). Predominant species included coontail, elodea, fanwort, floating plants, and filamentous green algae.

By 2005 vegetation within the former impoundment had changed markedly in response to the new hydrologic regime. Areas that are open water or riverine habitat are primarily un-vegetated except for some elodea growing in open water areas near the dam.

The very soft, flocculent like, sediments in the residual open water area likely inhibits growth of other submerged aquatic plants. Areas that are more frequently flooded by the residual impoundment are mudflat with only scattered growth of emergents. The remaining area (approximately 1/3 thirds of the former impoundment) is vegetated primarily by herbaceous vegetation, with scattered pioneer shrubs (mostly black willow with some European buckthorn at higher elevations) and tree seedlings or saplings (mostly red maple, with some aspen and silver maple). Red maple saplings were up to three feet tall at higher elevations. Dominant species in the emergent community were purple loosestrife, smartweed, and common forget-me-not at lower elevations. Other species present include sedges, spike rush, treefoil, softrush, pickerel weed, yellowflag, reed canary grass, pale impatiens, and duckweed.

Riparian and Habitat and Vegetation After Dam Removal

The existing wetlands have changed in response to the drawdown of the impoundment, so it was not possible to provide the with and without dam analysis for this site comparable to the other dam sites.

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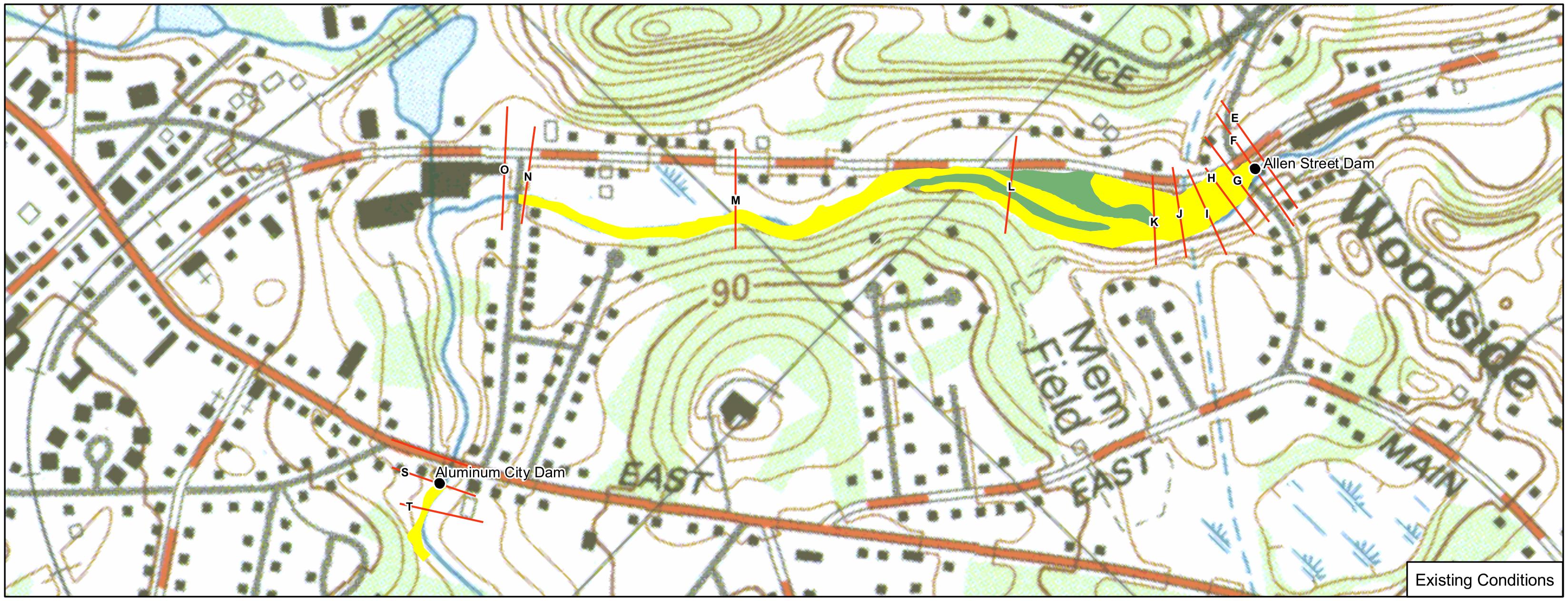
ATTACHMENT A

WETLANDS MAPS



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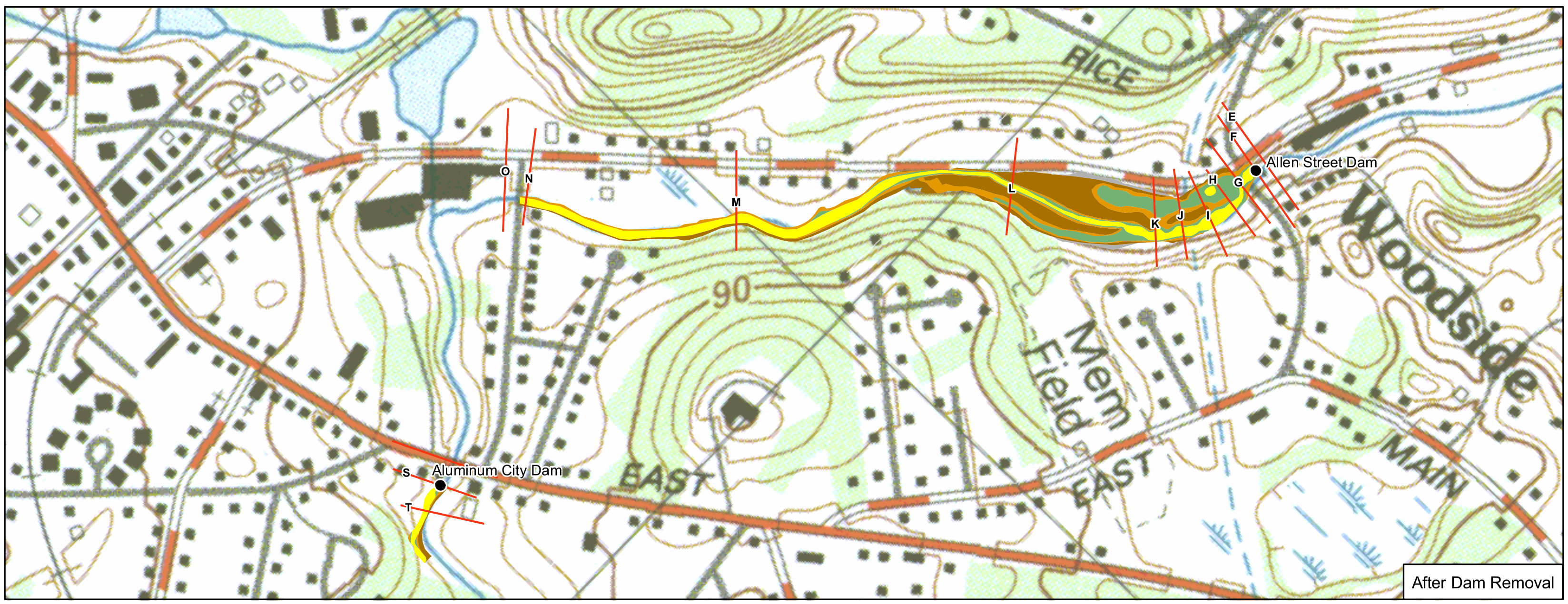


After Dam Removal

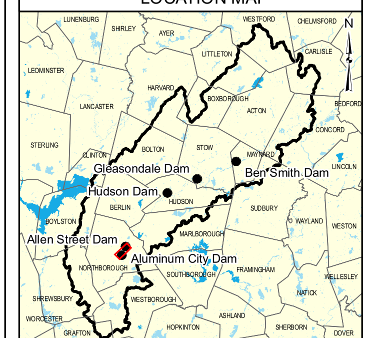
LEGEND

Wetland Types

Description

- TRANSITION TO UPLAND
- OPEN WATER
- SHALLOW MARSH MEADOW OR FEN
- DEEP MARSH
- SHRUB SWAMP
- WOODED SWAMP DECIDUOUS
- WOODED SWAMP MIXED TREES
- RIVER CROSS SECTION (from modeling)

LOCATION MAP



NOTES & SOURCES

Basemap data from US Geological Survey 7 1/2 minute Topographic Maps. Source: MassGIS
Aerial Photos: Color Digital Orthophotos:
Date Flown: 2002 Source: EarthData International

TITLE

Assabet River
Sediment and Dam Removal
Feasibility Study
Comparison of Wetlands
Before and After Dam Removal
Aluminum City and Allen Street Dams

0 500 Feet

US Army Corps of Engineers
New England District

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January 26, 2009 DWN: MTW CHKD: BRB JLJ

FIGURE 1

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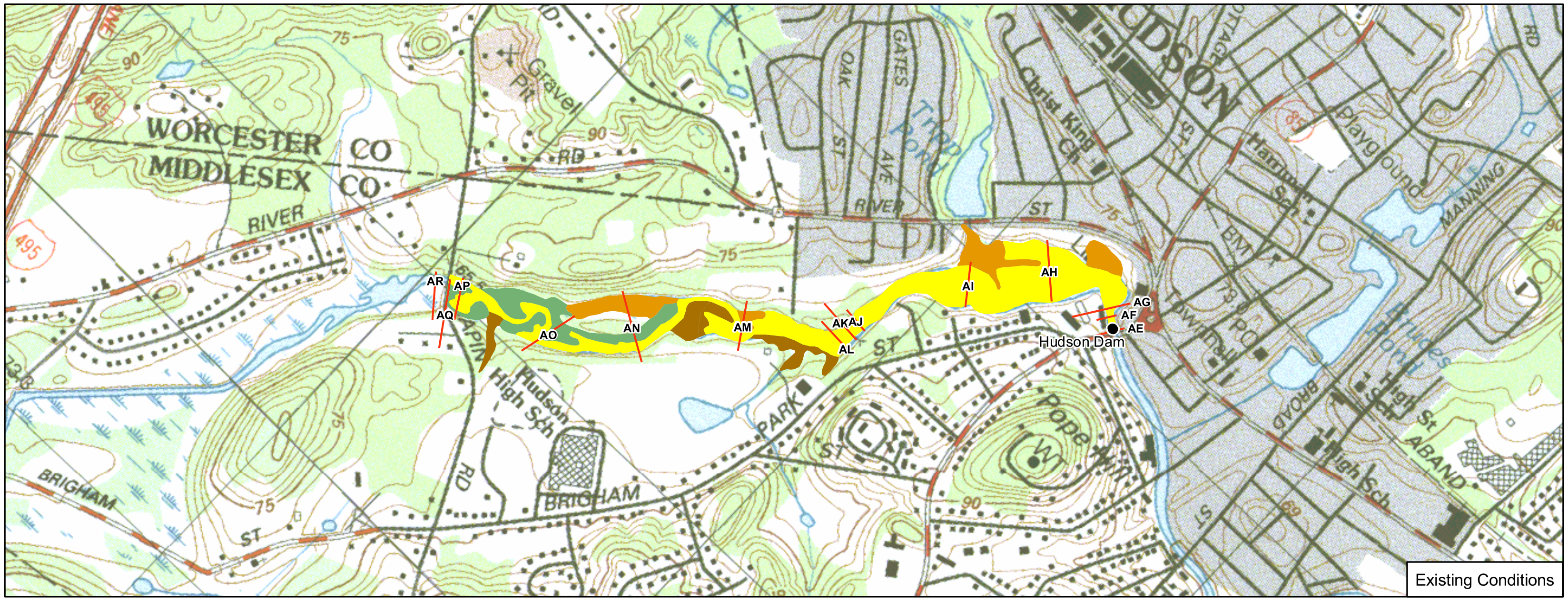
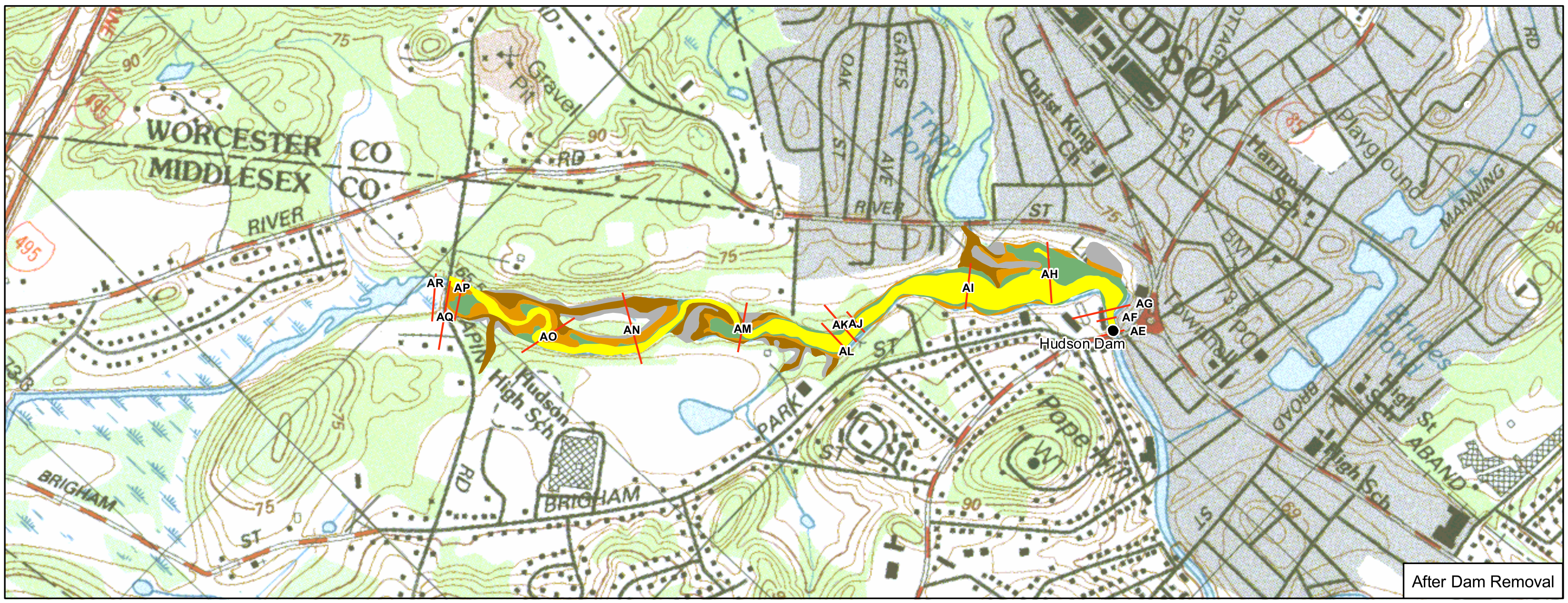




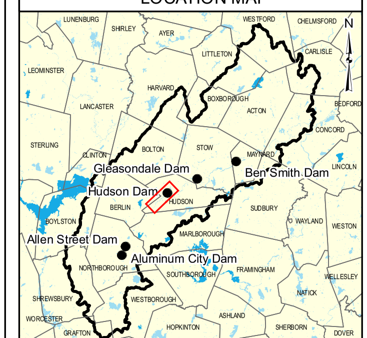
LEGEND

Wetland Types

Description

- TRANSITION TO UPLAND
- OPEN WATER
- SHALLOW MARSH MEADOW OR FEN
- DEEP MARSH
- SHRUB SWAMP
- WOODED SWAMP DECIDUOUS
- WOODED SWAMP MIXED TREES
- RIVER CROSS SECTION (from modeling)

LOCATION MAP



NOTES & SOURCES

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Date Flown: 2002 Source: EarthData International

TITLE

Assabet River
Sediment and Dam Removal
Feasibility Study
Comparison of Wetlands
Before and After Dam Removal
Hudson Dam

0 1,000 Feet

US Army Corps of Engineers New England District

FIGURE 2

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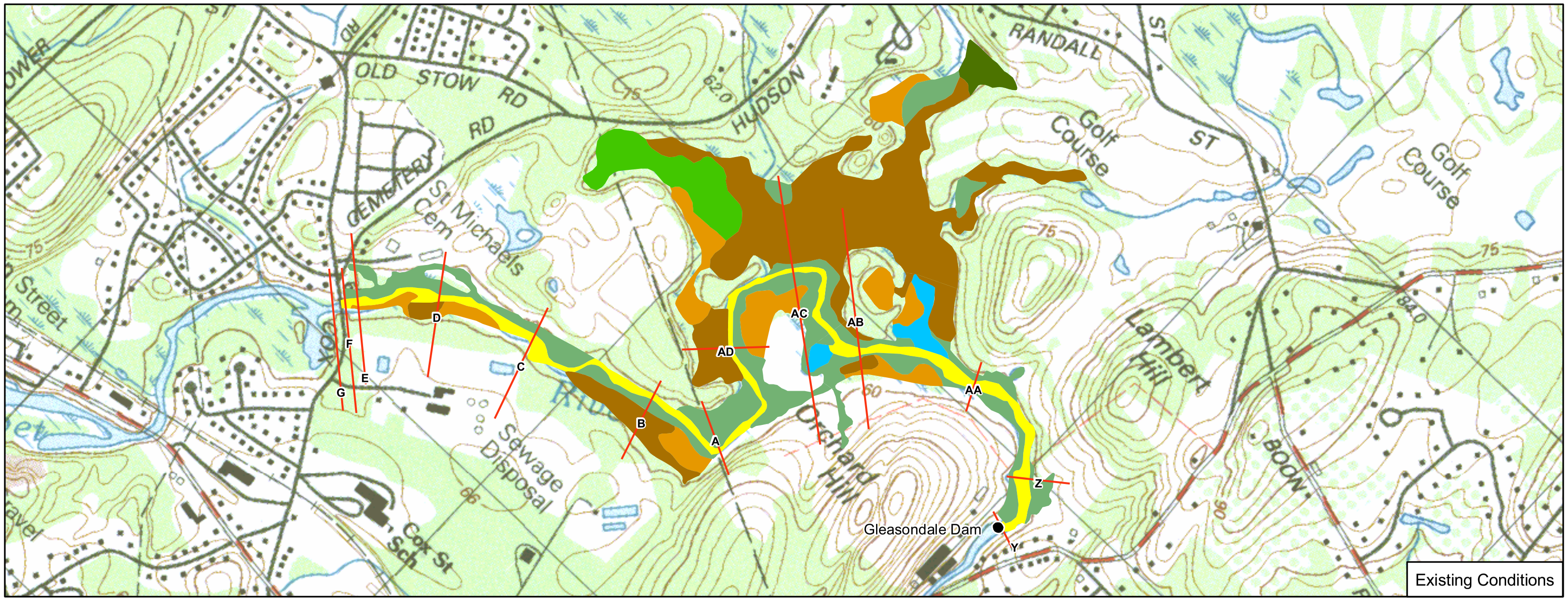
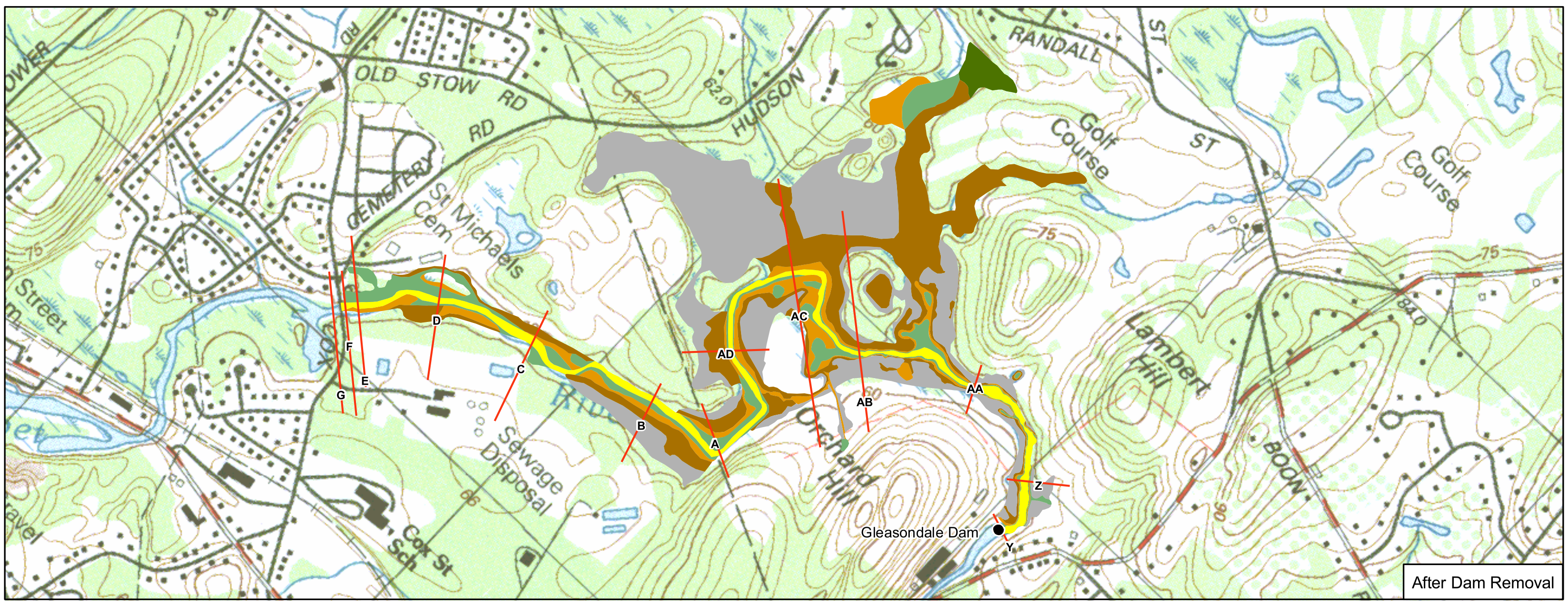




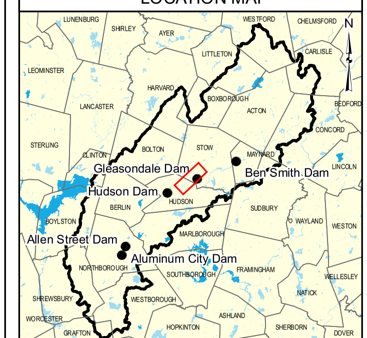
LEGEND

Wetland Types

Description

- TRANSITION TO UPLAND
- OPEN WATER
- SHALLOW MARSH MEADOW OR FEN
- DEEP MARSH
- SHRUB SWAMP
- WOODED SWAMP CONIFEROUS
- WOODED SWAMP DECIDUOUS
- WOODED SWAMP MIXED TREES
- RIVER CROSS SECTION (from modeling)

LOCATION MAP



NOTES & SOURCES

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Date Flown: 2002 Source: EarthData International

TITLE

Assabet River
Sediment and Dam Removal
Feasibility Study
Comparison of Wetlands
Before and After Dam Removal
Gleasondale Dam

0 1,000 Feet

US Army Corps of Engineers New England District

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FIGURE 3

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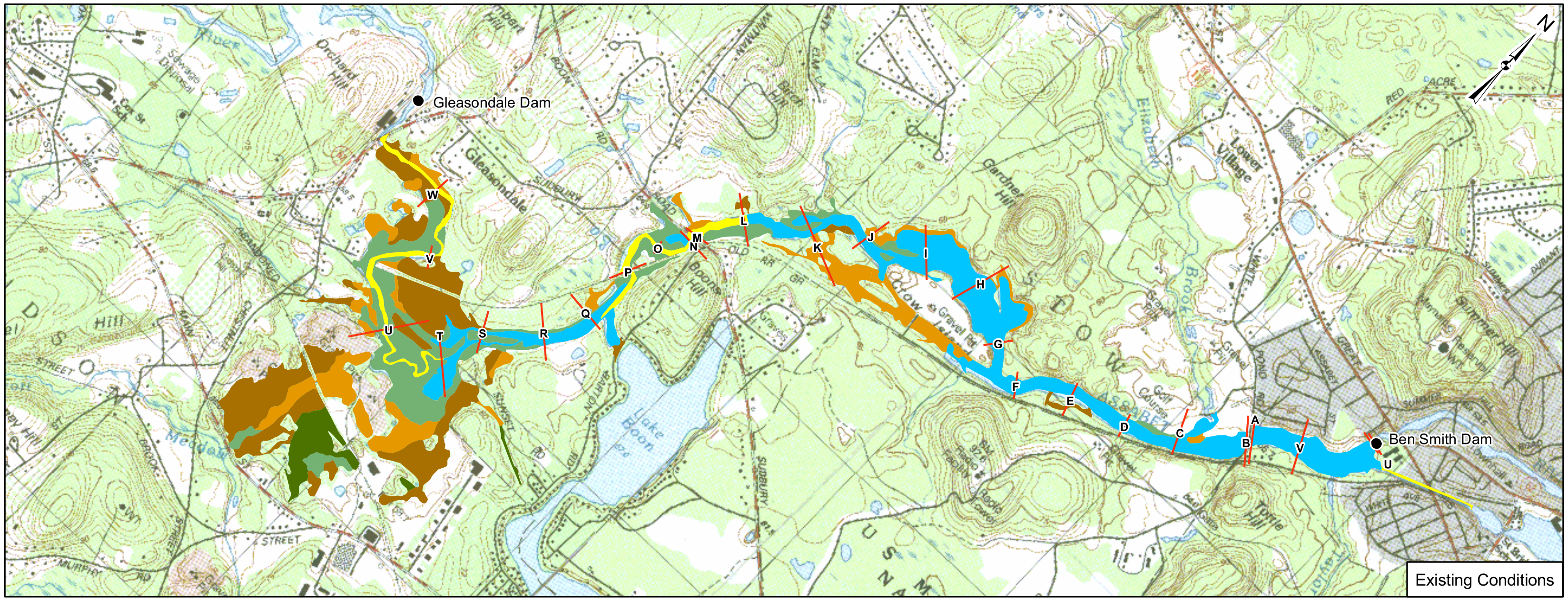
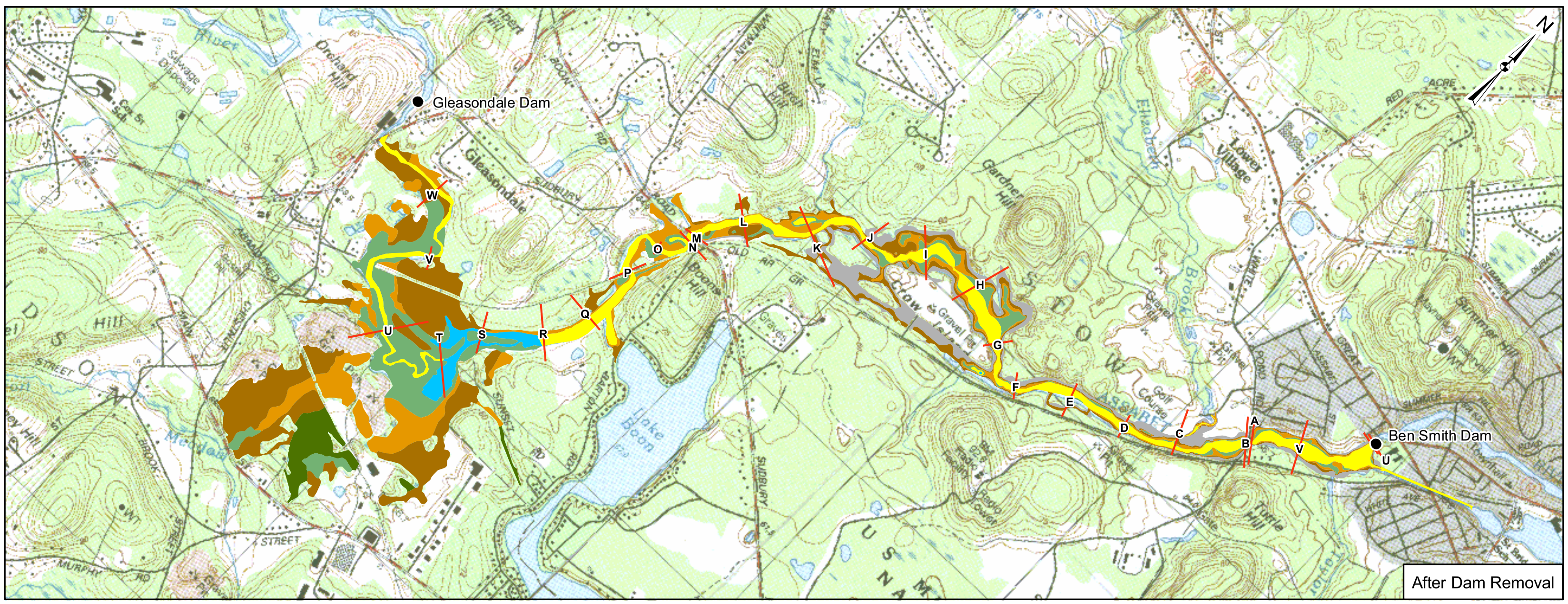




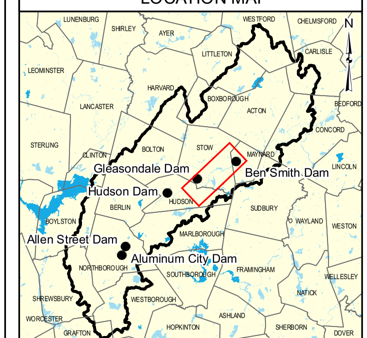
LEGEND

Wetland Types

Description

- TRANSITION TO UPLAND
- OPEN WATER
- SHALLOW MARSH MEADOW OR FEN
- DEEP MARSH
- SHRUB SWAMP
- WOODED SWAMP DECIDUOUS
- WOODED SWAMP MIXED TREES
- RIVER CROSS SECTION (from modeling)

LOCATION MAP



NOTES & SOURCES

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Date Flown: 2002 Source: EarthData International

TITLE

Assabet River
Sediment and Dam Removal
Feasibility Study
Comparison of Wetlands
Before and After Dam Removal
Ben Smith Dam

0 2,000 Feet

US Army Corps of Engineers New England District

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January 26, 2009 DWN: MTW CHKD: BRB JLJ

FIGURE 4

ATTACHMENT B

PLANT LISTS (with maps)

ATTACHMENT B

Assabet River Impoundments - Plant Community Site Observations

Impoundment	Site Location # (See maps for Site Location and Tables for Plants observed at Sites)	Classification
Aluminum City	1	Riparian
	2	SS/EM
	3	FO
Allen St	1	Riparian
	2	Riparian
	3	Riparian
	4	EM
	5	EM
Hudson	1	EM
	2	FO/SS
	3	EM
	4	FO/SS
	5	EM
	6	FO/SS
Gleasondale	1	EM/SS
	2	EM
	3	EM
	4	EM
	5	EM
	6	Riparian
Ben Smith	1	EM
	2	EM
	3	SS
	4	SS/EM

Riparian – wooded (upland)
EM – Emergent wetland
FO – Forested wetland

TABLE VALUES

Cover Code	Cover Estimate
1	< 5 %
2	5 - 25 %
3	26 - 50 %
4	51 - 75 %
5	> 75 %
◆	Observed at site

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Scientific Name	Common Name	Aluminum City			Allen St.					Hudson					
		1	2	3	1	2	3	4	5	1	2	3	4	5	6
TREES, SHRUBS AND VINES															
Acer negundo	Box elder	2		5											
Acer pensylvanicum	Striped-maple	1													
Acer platanoides	Norway maple				5										
Acer rubrum	Red maple	2				4	4				5	1	5		5
Acer saccharinum	Silver maple														
Ailanthus altissima	Tree of heavan				1										
Alnus incana rugosa	Speckled alder	2				3					2		3		3
Betula papyrifera	White birch	1													
Betula populifolia	Gray birch					1					1				1
Celastrus orbiculata	Asiatic bittersweet	2													
Cephalanthus occidentalis	Buttonbush	2			1			1		1					
Clethera alnifolia	Sweet pepperbush	2									1				
Cornus sp.	Dogwood		2		1								2		1
Fraxinus americana	White ash			1	2										
Ilex glabra	Inkberry			1			1								
Illex verticillata	Winterberry														
Juniperus virginiana	Red cedar														
Lonicera sp.	Honeysuckle			2									1		
Myrica gale	Sweet gale														
Pachysandra terminalis	Pachysandra						1								
Parthenocissus quinquefolia	Virginia creeper	2	3		1										
Picea abies	Norway spruce				1										
Pinus resinosa	Red pine				2										
Pinus strobus	Eastern white pine				2	2							1		
Populus deltoides	Cottonwood														
Populus tremuloides	Aspen														
Prunus sp.	Cherry														
Prunus virginiana	Black cherry						1								
Quercus alba	White oak						4								
Quercus bicolor	Swamp white oak					2					1				
Quercus rubra	Northern red oak	1				1					1				
Rhus radicans	Poison ivy				1										

Scientific Name	Common Name	Aluminum City			Allen St.					Hudson					
		1	2	3	1	2	3	4	5	1	2	3	4	5	6
TREES, SHRUBS AND VINES															
Rosa multiflora	Multifloa rose			3											
Rosa palustris	Swamp Rose														
Rosa rugosa	Rugosa rose				1										
Salix babylonica	Weeping willow														
Salix nigra	Black willow									1		1			
Salix sp.	Willow sp.				1										
Sambucus canadensis	Common elderberry	2													
Ulmus rubra	Slippery elm	3													1
Vaccinium corymbosum	Highbush blueberry			1		3	1								
Virburnum recognetum	Northern arrowwood			1		1	1				1				
Vitis labrusca	Fox grape			1											
Vitis sp.	Wild grape				1						2				1
HERBACEOUS															
Arisaema triphyllum	Jack in the pulpit			1											
Asclepias incarnata	Swamp milkweed														
Aster sp.	Aster sp.														
Bidens sp.	Bidens sp.														
Boehmeria cylindrica	False nettle								1						
Carex sp	Sedge														
Carex stricta	Tussock sedge														
Cuscuta sp.	Dodder								1						
Cyperus eragrostis	Umbrella sedge														
Cyperus sp.	Flatsedge														
Daucus carota	Wild carrot	1													
Dennstaedtia punctilobula	Hay-scented fern	1		3			1								
Dichanthelium clandestinum	Deer tongue grass	1													
Eleocharis sp.	Spike rush														
Equisetum sp.	Horsetail	1													
Eupatorium perfoliatum	Bonset														
Epilobium glandulosum	Purple-leaved willow herb														
Graminae	Unidentifeid grass														
Hypericum mutilium	Dwarf St. John's-wort														
Hypericum virginicum	Marsh St. John's-wort														

Scientific Name	Common Name	Aluminum City			Allen St.					Hudson					
		1	2	3	1	2	3	4	5	1	2	3	4	5	6
HERBACEOUS															
Impatiens capensis	Jewelweed	1	3	1	1		1	2	2	1					
Impatiens pallida	Jewelweed														
Iris pseudocarus	Yellow flag	1								1					
Iris versicolor	Blue flag														
Isoetes sp.	Quillwort														
Juncus effusus	Soft rush														
Lactuca canadensis	Wild lettuce														
Leersia oryzoides	Rice cut grass											1		1	
Lobelia cardinalis	Cardinal flower														
Lythrum salicaria	Purple loosestrife	1	1					1	1	2		2		2	
Onoclea sensibilis	Sensitve fern	1													
Osmunda cinnamomea	Cinnamon fern	1				1	2								
Osmunda regalis	Royal fern	1				1									
Peltandra virginica	Arrow arum								1						
Phalaris arundinacea	Reed canary grass	2	3					5	5	4		5		5	
Polygonum sp.	Smartweed							1							
Polygonum hydropiperoides	Mild water-pepper														
Polygonum persicaria	Lady's thumb														
Polygonum pensylvanicum	Pinkweed														
Pontederia cordata	Pickerelweed						1	1		1					
Sagittaria cuneata	Northern arrowhead											1		1	
Sagittaria graminea	Grass-like arrowhead							1							
Sagittaria latifolia	Broadleaf arrowhead	2	1					1	1	1					
Scirpus cyperinus	Woolgrass														
Scirpus sp.	Bullrush							1						1	
Scirpus validus	Softstem bullrush														
Scuttelaria epilobifolia	Marsh scullcap														
Solanum dulcamara	Deadly nightshade	1	2												
Sparganium sp.	Burreed							1	1	1		1		1	
Sparganium androcladum	Branching burreed														
Typha angustifolia	Narrowleaf cattail														
Typha latifolia	Broadleaf cattail							2	2						
Typha sp.	Cattail sp.									1				1	
Zinzania aquatica	Wild rice														

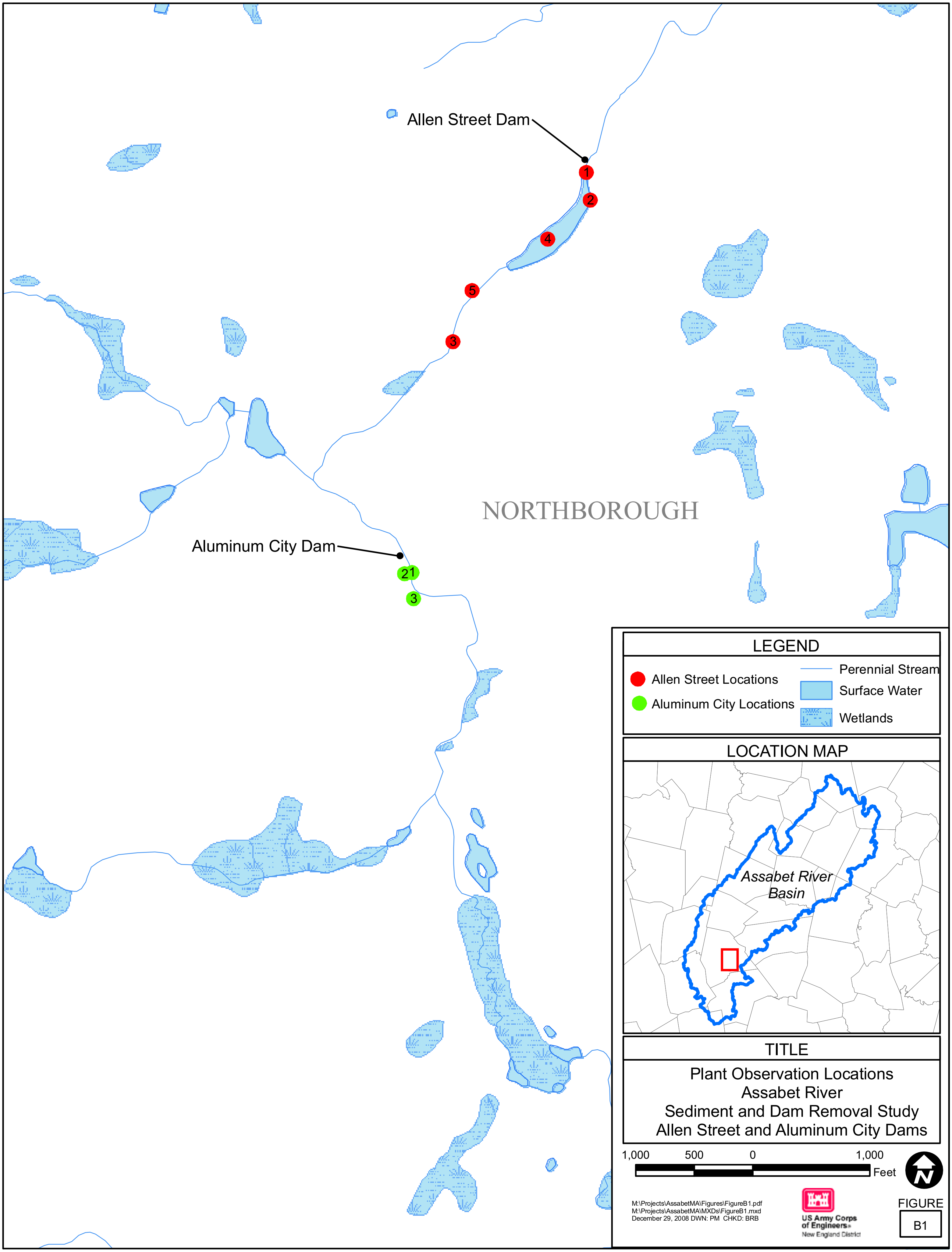
Scientific Name	Common Name	Gleasondale						Ben Smith				Clock Tower Site List	Powder Mill Site List
		1	2	3	4	5	6	1	2	3	4		
TREES, SHRUBS AND VINES													
Acer negundo	Box elder											◆	
Acer pensylvanicum	Striped-maple												
Acer platanoides	Norway maple												
Acer rubrum	Red maple	2		1	1		4				1	◆	◆
Acer saccharinum	Silver maple											◆	◆
Ailanthus altissima	Tree of heavan											◆	
Alnus incana rugosa	Speckled alder	1	1	1			1			1	2	◆	
Betula papyrifera	White birch											◆	
Betula populifolia	Gray birch												
Celastrus orbiculata	Asiatic bittersweet												
Cephalanthus occidentalis	Buttonbush				1	1						◆	
Clethera alnifolia	Sweet pepperbush											◆	◆
Cornus sp.	Dogwood						1					◆	
Fraxinus americana	White ash												
Ilex glabra	Inkberry												
Illex verticillata	Winterberry	1								2			
Juniperus virginiana	Red cedar												
Lonicera sp.	Honeysuckle												
Myrica gale	Sweet gale	2	3								2		
Pachysandra terminalis	Pachysandra												
Parthenocissus quinquefolia	Virginia creeper											◆	
Picea abies	Norway spruce												
Pinus resinosa	Red pine												
Pinus strobus	Eastern white pine												
Populus deltoides	Cottonwood												
Populus tremuloides	Aspen												◆
Prunus sp.	Cherry												
Prunus virginiana	Black cherry												
Quercus alba	White oak												
Quercus bicolor	Swamp white oak						1			1			
Quercus rubra	Northern red oak						4						
Rhus radicans	Poison Ivy												

Scientific Name	Common Name	Gleasondale 1	Gleasondale 2	Gleasondale 3	Gleasondale 4	Gleasondale 5	Gleasondale 6	Ben Smith 1	Ben Smith 2	Ben Smith 3	Ben Smith 4	Clock Tower Site List	Powder Mill Site List
TREES, SHRUBS AND VINES													
Rosa multiflora	Multifloa rose												
Rosa palustris	Swamp Rose	2	1	1							1		
Rosa rugosa	Rugosa rose												
Salix babylonica	Weeping willow											◆	
Salix nigra	Black willow					1							◆
Salix sp.	Willow sp.											◆	
Sambucus canadensis	Common elderberry												◆
Ulmus rubra	Slippery elm												
Vaccinium corymbosum	Highbush blueberry	1					1			2	2	◆	
Virburnum recognetum	Northern arrowwood						1					◆	
Vitis labrusca	Fox grape												
Vitis sp.	Wild grape											◆	◆
HERBACEOUS													
Arisaema triphyllum	Jack in the pulpit												
Asclepias incarnata	Swamp milkweed		1										
Aster sp.	Aster sp.		1										
Bidens sp.	Bidens sp.												◆
Boehmeria cylindrica	False nettle				1								◆
Carex sp	Sedge												◆
Carex stricta	Tussock sedge	2	3								1		
Cuscuta sp.	Dodder												
Cyperus eragrostis	Umbrella sedge												
Cyperus sp.	Flatsedge												◆
Daucus carota	Wild carrot												
Dennstaedtia punctilobula	Hay-scented fern												
Dichanthelium clandestinum	Deer tongue grass												
Eleocharis sp.	Spike rush												◆
Equisetum sp.	Horsetail												
Eupatorium perfoliatum	Bonset												
Epilobium glandulosum	Purple-leaved willow herb												◆
Graminae	Unidentified grass												
Hypericum mutilium	Dwarf St. John's-wort												◆
Hypericum virginicum	Marsh St. John's-wort												

Scientific Name	Common Name	Gleasondale						Ben Smith				Clock Tower Site List	Powder Mill Site List
		1	2	3	4	5	6	1	2	3	4		
HERBACEOUS													
Impatiens capensis	Jewelweed												
Impatiens pallida	Jewelweed												◆
Iris pseudocarus	Yellow flag	1	1		1	1					1	◆	
Iris versicolor	Blue flag							1					
Isoetes sp.	Quillwort												
Juncus effusus	Soft rush												◆
Lactuca canadensis	Wild lettuce												
Leersia oryzoides	Rice cut grass												
Lobelia cardinalis	Cardinal flower												◆
Lythrum salicaria	Purple loosestrife	1	3	3	2	2		4	2		1		◆
Onoclea sensibilis	Sensitve fern										1		◆
Osmunda cinnamomea	Cinnamon fern												
Osmunda regalis	Royal fern	1								1			
Peltandra virginica	Arrow arum											◆	
Phalaris arundinacea	Reed canary grass	1	1	4	4	4		2	3			◆	◆
Polygonum sp.	Smartweed		1					1					◆
Polygonum hydropiperoides	Mild water-pepper												
Polygonum persicaria	Lady's thumb												◆
Polygonum pensylvanicum	Pinkweed												◆
Pontederia cordata	Pickerelweed	3			1				1		1	◆	◆
Sagittaria cuneata	Northern arrowhead												
Sagittaria graminea	Grass-like arrowhead												◆
Sagittaria latifolia	Broadleaf arrowhead												
Scirpus cyperinus	Woolgrass		3										
Scirpus sp.	Bullrush												
Scirpus validus	Softstem bullrush	1							1				
Scuttelaria epilobifolia	Marsh scullcap												◆
Solanum dulcamara	Deadly nightshade												
Sparganium sp.	Burreed	1											
Sparganium androcladum	Branching burreed							2	1				
Typha angustifolia	Narrowleaf cattail												
Typha latifolia	Broadleaf cattail											◆	
Typha sp.	Cattail sp.				2	1		1	2				◆
Zinzania aquatica	Wild rice	1	1	1									

Scientific Name	Common Name	Impoundment						
		Aluminum City	Allen St.	Hudson	Gleasondale	Ben Smith	Clock Tower	Powdermill
Cabomba carolians	Fanwort				⌖	⌖	⌖	⌖
Ceratophyllum demersum	Coontail			⌖	⌖	⌖		⌖
Callitriche stagnalis	Water starwort		⌖					
Elodea canadensis	Waterweed		⌖	⌖	⌖	⌖		⌖
Lemna minor	Duckweed	⌖	⌖	⌖	⌖	⌖	⌖	⌖
Myriophyllum sp.	Water millfoil			⌖				
Nitella flexilis	Stonewort			⌖				
Nuphar variegata	Yellow water lily				⌖			
Nymphaea odorata	Water lily				⌖			
Potamogeton amplifolius	Large-leaved pondweed				⌖			
Potamogeton conferoides	Alga-like pondweed		⌖					
Potamogeton crispus	Curly muck-weed		⌖			⌖		⌖
Potamoogeton epihydrus	Nuttall's pondweed		⌖	⌖				⌖
Potamageton pusillus var. tenuissimus	Small pondweed		⌖		⌖	⌖		⌖
Potamogeton robbinsii	Robbin's pondweed					⌖		
Potamogeton spirillus	Spiral pondweed							⌖
Potamogeton zosteriformis	Flat-stem pondweed				⌖	⌖		⌖
Potamogeton sp.	Pondweed sp.	⌖						
Trapa natans	Water chestnut					⌖	⌖	⌖
Wolfia comubiana	Water meal	⌖	⌖	⌖	⌖	⌖	⌖	⌖

Sources: ENSR (2001), Sue Flint (2006); USGS(2005); ACOE 2005 Fieldwork



Allen Street Dam
1
2
4
5
3
NORTHBOROUGH
Aluminum City Dam
21
3
LEGEND
Allen Street Locations
Aluminum City Locations
Perennial Stream
Surface Water
Wetlands
LOCATION MAP
Assabet River Basin
TITLE
Plant Observation Locations
Assabet River
Sediment and Dam Removal Study
Allen Street and Aluminum City Dams
1,000 500 0 1,000
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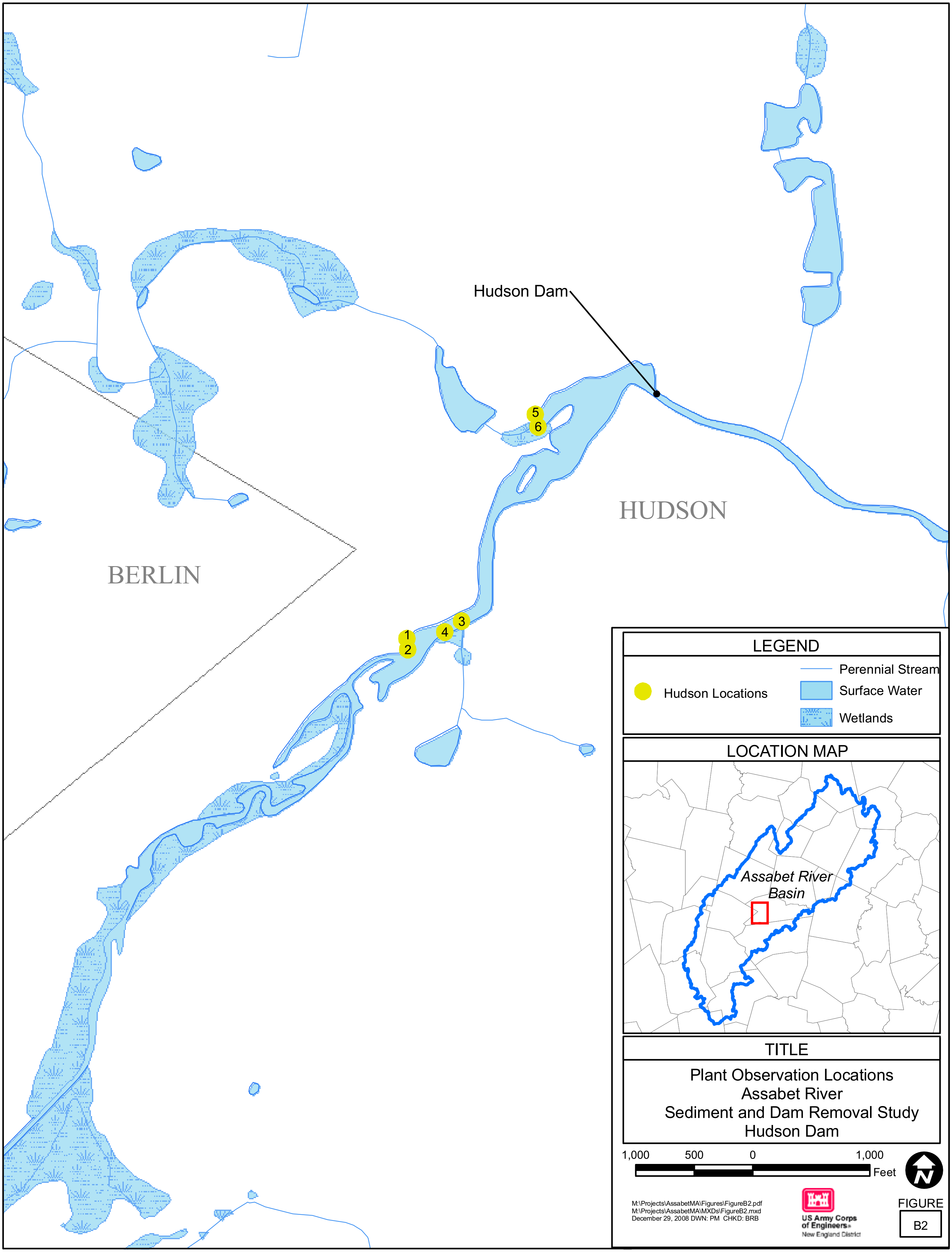
US Army Corps of Engineers
New England District
FIGURE
B1


Hudson Dam
HUDSON
BERLIN
1
2
3
4
5
6
LEGEND
Hudson Locations
Perennial Stream
Surface Water
Wetlands
LOCATION MAP
Assabet River Basin
TITLE
Plant Observation Locations
Assabet River
Sediment and Dam Removal Study
Hudson Dam
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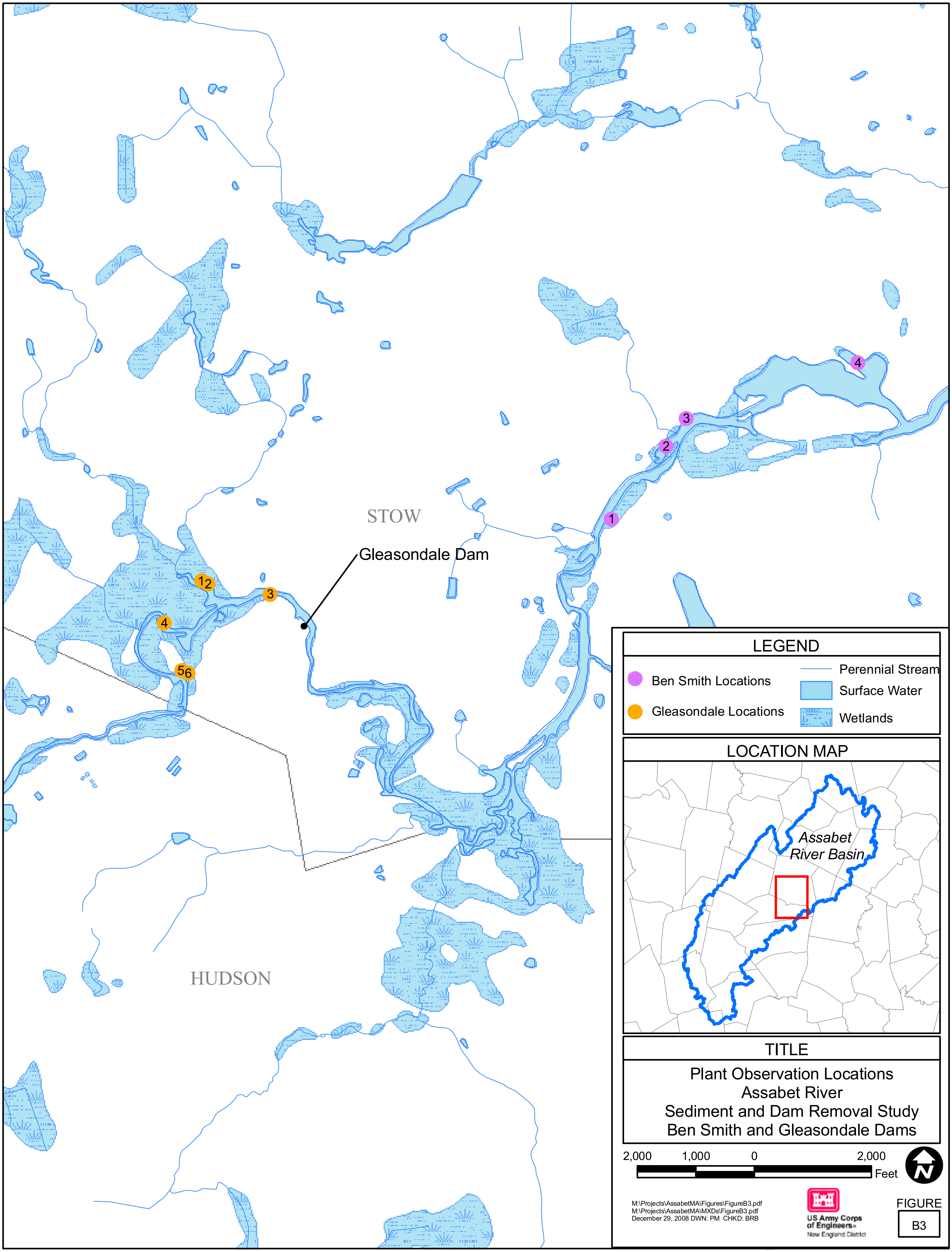
US Army Corps of Engineers
New England District
FIGURE
B2


STOW
Gleasondale Dam
HUDSON
1
2
3
4
1 2
3
4
5 6
LEGEND
Ben Smith Locations
Gleasondale Locations
Perennial Stream
Surface Water
Wetlands
LOCATION MAP
Assabet River Basin
TITLE
Plant Observation Locations
Assabet River
Sediment and Dam Removal Study
Ben Smith and Gleasondale Dams
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US Army Corps of Engineers
New England District
FIGURE
B3

APPENDIX E

TARGET FISH COMMUNITY ANALYSIS (TFC)
ASSABET RIVER

Assabet River, Massachusetts Sediment and Dam Removal Study
Assabet River Target Fish Community (TFC) Evaluation

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1. INTRODUCTION/STUDY PURPOSE

The purpose of the Assabet River Sediment and Dam Removal study is to achieve water quality compliance and a sustainable and restored aquatic ecosystem.

Aquatic ecosystem objectives include restoration of a combination of habitats in different portions of the Assabet River that currently support typical warm-water species (as found in the impoundment or "pond" behind each dam) or fluvial specialist species (as found in the riverine or free-flowing sections); and improvements in the migratory corridor by improving river continuity for diadromous species such as the American eel and river herring.

The TFC approach was recommended by the Massachusetts Division of Fisheries and Wildlife (MADFW) as the methodology to be used on the Assabet River to evaluate the existing fisheries community and habitat and potential fisheries community and habitat that is expected to occur as the result of hypothetical dam removal. This is accomplished by comparing the existing fish communities based on all sample collections, the impounded segments versus the free flowing or riverine segments with the TFC Model for the Concord River Watershed that includes the Sudbury, Assabet and Concord Rivers (SuAsCo) as developed by Todd Richards, MADFW Fisheries Biologist.

2. TARGET FISH COMMUNITY CONCEPT

Target Fish Community (TFC) models have been utilized within instream flow related studies on multiple rivers in Southern New England since Bain and Meixler's initial development and application of the methodology on the Quinebaug River in 2000. Successful applications of the approach to assess the status of native fish communities on the Quinebaug, Ipswich, Assabet, Charles, Housatonic, Pomperaug, Souhegan, Eightmile and Lamprey Rivers (Bain and Meixler 2000; Lang et al. 2001; Armstrong et al. 2001; Parker et al. 2004; Meixler 2005; Kearns et al. 2005; Legros 2007a & b; Parasiewicz et al. 2007a & b; Legros and Paraweicz 2007) have proven the effectiveness of TFC models as fish community assessment tools. These practical applications illustrate the ability of TFC models to assess the biological integrity of streams using an inference approach based on the biological requirements of fish species (or species groups) and a comparison of their compositions within a TFC and the existing fish community of a study stream (or stream segment). The increasing use and acceptance of this methodology, and similar methods, are indicative of the significance of using fish communities to assess the biological integrity of aquatic systems (Karr 1981, Fausch et al. 1990, Hughes 1995, Halliwell et al. 1999). The past success and recognized importance of the TFC approach has led to its adoption by the Commonwealth of Massachusetts and State of New Hampshire as a component of their water resources policy development processes regarding Protected Instream Flows (PISF) (Legros and Parasiewicz 2007).

The Target Fish Community (TFC) approach developed by Bain & Meixler (2000) evaluates the status of a river based on a comparison between the current or Existing Fish Community (EFC) and the desired TFC or Reference Fish Community. Its computational framework, accounts for spatial and temporal variations of the native community and creates a robust, interannual representation of the expected native fauna composition at the watershed scale. The Bain and Meixler paper (2000) provides the guidelines and calculations required to create a representation of what the desired species assemblage in a river should resemble. The concept is based on identifying the types of fish species and their expected proportions within the community that is as close as possible to what may have been in the ecosystem with limited human alteration and therefore a goal of natural resources management. Bain and Meixler (2000) acknowledge that finding or restoring a river community to pristine, untouched status would be impossible, especially due to widespread introduction of non-native and desired game species and the highly developed condition of some watersheds. Instead, they state that the use of the TFC or reference rivers in a mostly natural or desired state will provide a baseline community that can be used to determine where the actual community deviates from management targets (Bain and Meixler 2000).

The TFC provides a list of species as well as expected proportions that can be compared to what is actually surveyed (existing fish community) by using a similarity measurement method such as a percent affinity model (Novak and Bode 1992). The community can also be analyzed using pollution tolerance indices (i.e. intolerant, moderately tolerant and tolerant) and classifications of the habitats required by the species (i.e. fluvial dependent, fluvial specialists, or macrohabitat generalists) (Bain and Meixler 2000).

It is useful to look at the target and existing fish species in terms of these macrohabitat guilds. Fluvial specialists are species that rely entirely on rivers and flowing water throughout their life cycle. Fluvial dependents are species that require stream habitat for at least one portion of their life cycle such as spawning, migration etc. Generalists are species that can utilize multiple types of habitat and are often associated with ponded areas (Parker et al 2004). Generalists are becoming more common in rivers as dams or low flows create higher number of ponded areas. In terms of target fish communities, the general objective for rivers is to have of the fish population comprised in a large part of native, fluvial specialists and fluvial dependent species (Parker et al 2004).

The goal of developing a TFC for the main-stem Assabet River is to define the fish community that is appropriate for a natural river of this size in southern New England. Accordingly TFC assessments are used to identify the current status of a main-stem river such as the Assabet River in that the fish tell the story as they are long-lived, reflect stresses over time, and are easily recognized and identified.

The premise for the TFC is quite simple in that Rivers should have fluvial or “river” fish communities. The TFC for the SuAsCo serves as our target for river rehabilitation in the Assabet River and as an endpoint of evaluating environmental improvements such as the removal of dams. The sampled existing fish community (EFC) is compared to the target fish community (TFC) to evaluate the potential fish community resulting from the river rehabilitation objective (i.e. removal of a dam). Use of the target fish community approach can guide and evaluate environmental rehabilitation where restoration objectives cannot simply be to copy pristine, natural ecosystem properties.

3. FISHERIES HABITAT EVALUATIONS USING THE TFC APPROACH

3.1 TFC DEVELOPMENT AND METHODS

The existing fisheries data for the main-stem Assabet River used in this TFC evaluation was provided by MADFW to the USACE for subsequent data reduction and analysis in direct coordination with Todd Richards, Fisheries Biologist, MADFW. Similarly the TFC model for the Concord River Watershed used in this evaluation for the Assabet River was also provided to the USACE by Todd Richards (Richards 2008).

Sampling Protocol

Since 1998 the MADFW has sampled over 1,000 sites with over 140,000 fish records as part of their statewide fish survey using a variety of collection gear depending on the water body sampled. For each fisheries sample collected, all of the fish are identified to species and total length is measured to the nearest millimeter (mm) up to a maximum of 100 of each species if large numbers are collected, and all live fish are released except those specimens that are taken and preserved for the voucher collection.

Habitat-Use and Pollution Tolerance Classifications

The data is loaded into Excel spreadsheets and each fish record is completed by entering its respective Massachusetts Habitat Use Classification (MA HUC) and Pollution Tolerance (PT) classifications, the two most important metrics in a TFC evaluation. As described in Bain and Meixler (2000) species habitat requirements and pollution tolerances were classified using regional and state ichthyology books (Scott and Crossman 1973, Pflieger 1975, Lee et al. 1980, Trautman 1981, Becker 1983, Burr and Warren 1986, Scarola 1997, Robison and Buchanan 1988, Hartel et al. 2002, Jenkins and Burkhead 1994).

As a group, these reference books describe the North American life history of fish. Habitat requirements were summarized into three macrohabitat (water body type) classes: macrohabitat generalists (MG), fluvial dependents (FD), and fluvial specialists (FS). These groupings have been found effective in relating fish community change to river habitat alteration (Bain et al. 1988; Kinsolving and Bain 1993; Quinn and Kwak 2003).

Some adjustment was made to the classifications to accommodate regional differences in habitat requirements: three of the habitat classifications (fallfish, longnose dace, and brook trout) were changed from generalists to fluvial specialists by agreement of the project Management Committee. American eel is a catadromous fish (migrates to sea for spawning) that requires access to stream habitats to complete its life cycle. This fish was classified by MADFW as a macrohabitat generalist because the species occupies a wide range of habitats throughout its life albeit others have classified it as a fluvial dependent due to this species dependency upon fluvial conditions for migration to and from the sea.

For pollution tolerance (PT) classifications, we used the classification of Halliwell et al. (1999) for Northeast US fishes: intolerant (I), moderately tolerant (M), or tolerant (T). Finally, species were designated as native or exotic (introduced) from Schmidt (1986), Whitworth (1996) and Hartel et al. (2002) albeit this metric was not specifically analyzed in our quantitative TFC evaluation since it was not entered onto the Excel fish data sheets received from the MADFW. However, this metric is discussed from a qualitative perspective as warranted.

3.2 RESULTS

Assabet River Target Fish Community (Based on Concord Watershed TFC)

The Target Fish Community (TFC) model for the Assabet River based on the Concord River Watershed is provided in Table 1. The TFC was based on a number of riverine main-stem sampling sites in the Sudbury, Assabet and Concord Rivers (SuAsCo). The TFC for the Assabet River consist of a diverse assemblage of fifteen (15) native species representing eight (8) families.

The TFC also includes as expected the following native anadromous fish species: American shad, alewife, and blueback herring; and the sea lamprey. These species are expected providing that fish passage facilities are constructed and/or obstructions are removed in the Concord River watershed so that they can reach their historical spawning grounds. The US Fish and Wildlife Service (USFWS) and other stakeholders collaboratively began an active anadromous fish restoration program in the Concord River watershed in 2000 that continues to the present. An update of their program and results are discussed in the section on Restoration of Anadromous Fish in the Concord River Watershed after the TFC Discussion.

The top seven most abundantly expected species, comprising approximately 83% of the total, include fallfish (37.3%), common shiner (18.7%), white sucker (9.3%), redbreast sunfish (6.2%), American eel (4.1%), tessellated darter (3.7%), and brook trout (3.4%). The remaining species have expected proportions between 1.4% and 2.9% and represent almost 17% of the fauna. The species includes fluvial specialists such as fallfish, tessellated darter, brook trout and the creek chubsucker as well as fluvial dependents such as common shiner and white sucker, and macrohabitat generalists such as redbreast sunfish, American eel, bridle shiner, yellow perch, pumpkinseed, chain pickerel, brown bullhead, redfin pickerel and golden shiner.

The TFC based on habitat use classifications is composed of 45.8% fluvial specialist, 28.0% fluvial dependent, and 26.4% macrohabitat generalist species. Relative to pollution tolerances, the TFC is composed of 7.7% intolerant, 75.4% moderate, and 17.1% tolerant fish species.

The TFC based on habitat use classification guilds and pollution tolerance is graphically shown in Figures 2 and 3 in the TFC Discussion Section 3.3 and the TFC results for these two metrics are compared to the total existing fish community (EFC), and the existing fish communities in the impoundment (EFC-I) and riverine (EFC-R) habitat reaches, respectively.

Assabet River Existing Fish Community

Assabet River Sampling Locations and Collection Method

The existing fish community was surveyed primarily in 2001. Fifteen (15) locations were sampled in the Assabet River main-stem using a backpack shocker, barge shocker, boat shocker or gill net as dictated by prevailing conditions at each of the sites (Table 2). The fish sample locations ranged from approximately River-mile 31 near the headwaters in Westboro to River-mile 4 above confluence with the Sudbury River as shown in Figure 1. Nine of the locations sampled represented riverine habitats while six locations sampled represented impoundment (pond) habitats as a result of existing dams. Four of the six impoundments (Aluminum City Dam, Hudson Dam, Gleasondale Dam, and Ben Smith Dam) were sampled once while the Powdermill Dam Impoundment was sampled in two areas. No fish sample was collected in the Allen Street Impoundment. Since an assessment of water quality relative to the various wastewater treatment plants (WWTP) was also part of the overall study objectives several of the fish locations were selected to bracket the discharges of the various WWTPs (i.e. above and below the respective discharge).

Table 1. Target Fish Community (TFC) Model for the Assabet River Based on the Concord River Watershed.

Common Name	Scientific Name	Species Designation	Thermal Regime	Habitat Use	Pollution Tolerance	TFC %
Fallfish	Semotilus corporalis	Native	Eurythermal	FS	M	37.3
Common shiner	Notropis cornutus	Native	Eurythermal	FD	M	18.7
White sucker	Catostomus commersoni	Native	Eurythermal	FD	T	9.3
Redbreast sunfish	Lepomis auritis	Native	Warm	MG	M	6.2
American eel	Anguilla rostrata	Native	Eurythermal	MG(*)	T	4.1
Tesselated darter	Etheostoma olmstedi	Native	Eurythermal	FS	M	3.7
Brook trout	Savelinus fontinalis	Native	Cold	FS	I	3.4
Bridle shiner	Notropis bifrenatus	Native	Warm	MG	I	2.9
Yellow perch	Perca flavescens	Native	Eurythermal	MG	M	2.7
Pumpkinseed	Lepomis gibbosus	Native	Warm	MG	M	2.5
Chain pickerel	Esox niger	Native	Warm	MG	M	2.3
Brown bullhead	Ameiurus nebulosus	Native	Warm	MG	T	2.1
Redfin pickerel	Esox americanus	Native	Warm	MG	M	2
Golden shiner	Notemigonus crysoleucas	Native	Eurythermal	MG	T	1.6
Creek chubsucker	Erimyzon oblongus	Native	Eurythermal	FS	I	1.4
Alewife	Alosa pseudoherangus	Native	Eurythermal	FD	M	Expected
American Shad	Alosa sapidissima	Native	Warm	FD	M	Expected
Blueback Herring	Alosa aestivalis	Native	Warm	FD	M	Expected
Sea Lamprey	Petromyzon marinus	Native	Eurythermal	FD	M	Expected
Total						100.2

Native or Introduced status and Cold, Eurythermal, or Warm water thermal regime tolerances are given for each species; and following MA Habitat Use Classification Guilds: fluvial specialist (FS), fluvial dependent (FD), or macrohabitat generalist (MG); and Pollution Tolerances: intolerant (I), moderately tolerant (M), or tolerant (T).

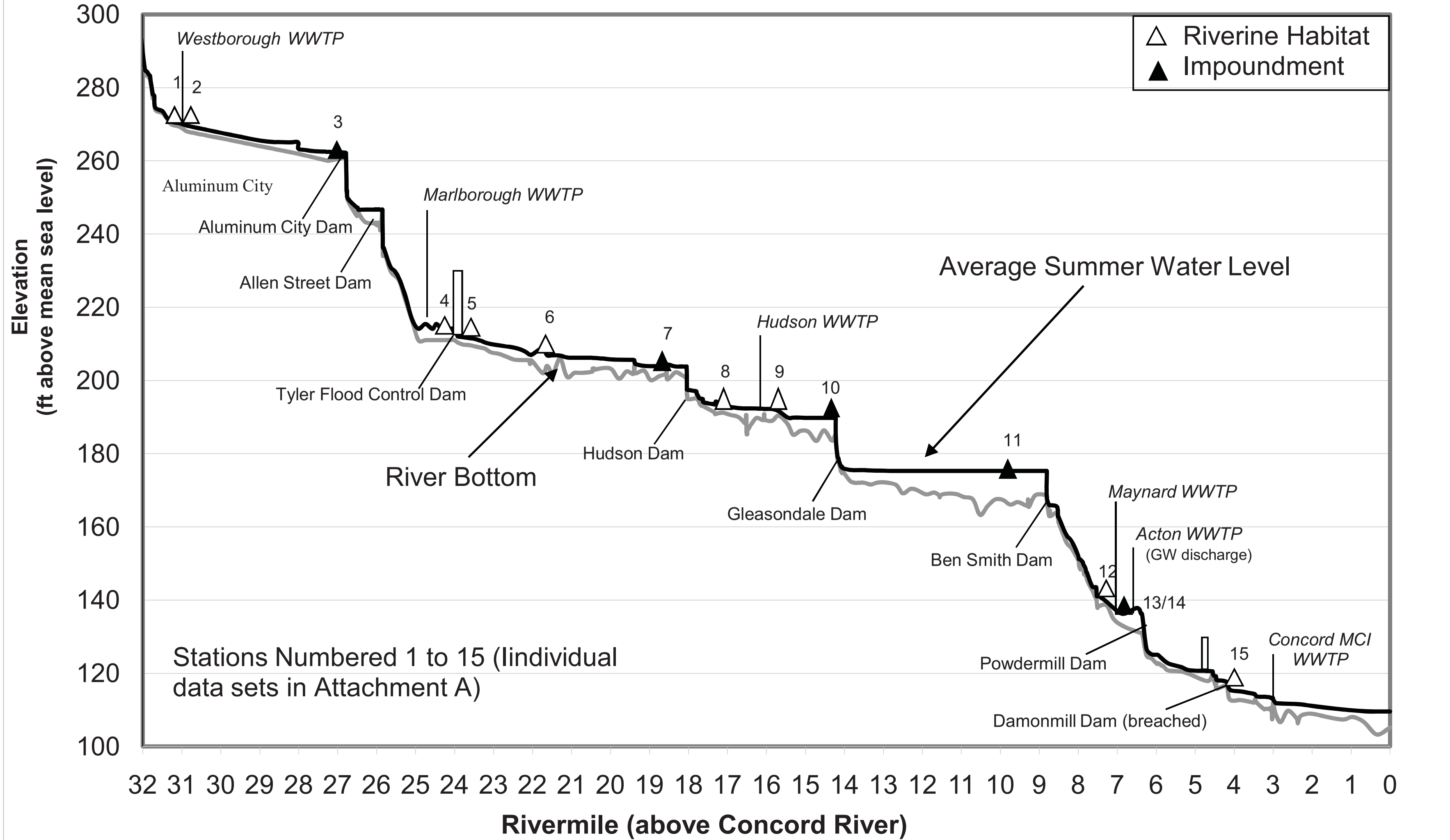
*American eel have been classified as fluvial dependent (FD) in other TFC due to this species dependency upon fluvial conditions for migration to and from the sea to complete their catadromous life-cycle.

Table 2. Assabet River Fish Data Sampling Locations, Methods and Habitat Types.

Station Number	Sample ID	Date	Town	Method	Habitat Type	Notes
1	502	7/25/2001	Westborough	Backpack Shocking	Riverine	Above Aluminum City Dam Impoundment
2	433	8/24/2001	Westboro	Barge Shocking	Riverine	Above Aluminum City Dam Impoundment
3	501	8/24/2001	Northboro	Barge Shocking	Impoundment	Within Aluminum City Dam Impoundment
4	373	6/7/2001	Northborough	Barge Shocking	Riverine	Above Hudson Dam Impoundment
5	308	6/7/2001	Northboro/Marlboro	Barge Shocking	Riverine	Above Hudson Dam Impoundment
6	91	8/31/1999	Berlin	Barge Shocking	Riverine	Above Hudson Dam Impoundment
7	498	5/18/2001	Hudson	Gillnet	Impoundment	Within Hudson Dam Impoundment
8	306	6/7/2001	Hudson	Barge Shocking	Riverine	Above Gleasondale Dam Impoundment
9	500	8/24/2001	Hudson	Barge Shocking	Riverine	Above GleasondaleDam Impoundment
10	427	5/30/2001	Hudson	Gillnet	Impoundment	Within Gleasondale Dam Impoundment
11	307	5/8/2001	Maynard	Boat Shocking	Impoundment	Within Ben Smith Dam Impoundment
12	497	7/11/2001	Maynard	Barge Shocking	Riverine	Above Powdermill Dam Impoundment
13	499	5/16/2001	Maynard	Boat Shocking	Impoundment	Within Powdermill Dam Impoundment
14	527	5/16/2001	Maynard	Boat Shocking	Impoundment	Within Powdermill Dam Impoundment
15	496	7/11/2001	Concord	Barge Shocking	Riverine	Below Breached Damonmill Dam

See Figure 1 for Assabet River sample locations and Attachment A (Tables 1-15) for individual fish sample collection data.

Figure 1. Assabet River Elevation Profile
Fish Data Sampling Locations



Assabet River Existing Fish Community (EFC) - Total Catch All Habitats

The Existing Fish Community (EFC) for the Assabet River based on the total catch by sampling the main-stem river in both impoundment and riverine habitats is provided in Table 3. A total of 1,881 fish representing 23 species were identified in the Assabet River during the fish surveys. The individual fish collection data for each of the 15 locations is provided in Attachment A.

The top ten (10) most abundantly collected species, comprising approximately 85.5% of the total, include white sucker (20.3%), bluegill (17.3%), pumpkinseed (11.7%), largemouth bass (8.1%), American eel (6.3%), yellow bullhead (4.7%), redbreast sunfish (4.7%), fallfish (4.4%), golden shiner (4.1%), and blacknose dace (3.9%). The remaining thirteen (13) species (redfin pickerel, chain pickerel, black crappie, common carp, yellow perch, brown bullhead, rainbow trout, creek chubsucker, spottail shiner, banded sunfish, brook trout, and tiger trout) comprise between 3.2% and 0.1% of the total catch and represent 14.5% of the fauna.

The EFC based on habitat use classification consisted of 11.2% fluvial specialist, 20.3% fluvial dependent, and 68.5% macrohabitat generalist fish species. Relative to pollution tolerances, the EFC consisted of 2.9% intolerant, 35.6% moderate, and 61.5% tolerant fish species. A total of 23 different fish species were sampled from the Assabet River, 14 of which were native, comprising 64% of the total catch. Eight non-native fish species, bluegill, black crappie, brown trout, largemouth bass, rainbow trout, rock bass, smallmouth bass, and yellow bullhead and one hybrid species (tiger trout) were collected and accounted for a combined 36% of the total catch.

The EFC based on habitat use classification guilds and pollution tolerances is graphically shown in Figures 2 and 3.

Assabet River Existing Fish Community for Impoundment Habitats (EFC-I)

The Existing Fish Community for the impoundments (EFC-I) in the Assabet River based on six sampling stations is provided in Table 4. A total of 698 fish representing 15 species were identified in the Assabet River during the fish surveys in the impoundments.

The top ten (7) most abundantly collected species, comprising approximately 88.3% of the total, include bluegill (34.2%), pumpkinseed (22.1%), white sucker (10.3%), largemouth bass (9.2), American eel (4.6%), common carp (4.2%), and black crappie (3.7%). The remaining eight (8) species (chain pickerel, redbreast sunfish, yellow bullhead, brown bullhead, yellow perch, redfin pickerel, golden shiner, and banded sunfish) comprise between 3.0% and 0.1% of the total catch and represent 11.7% of the fauna.

The EFC for impoundment habitats (EFC-I) consisted of 0% fluvial specialist, 10.3% fluvial dependent, and 89.7% macrohabitat generalist fish species. Relative to Pollution Tolerance, the EFC-I consisted of 0% intolerant, 39.4% moderate, and 60.6% tolerant fish species. A total of 15 different fish species were sampled from the Assabet River impoundments, ten (10) of which were native, comprising 47% of the total catch. Five non-native fish species, bluegill, largemouth bass, common carp, black crappie and yellow bullhead were collected and accounted for 53% of the total catch.

The EFC-I for impoundment habitats based on habitat use classification guilds and pollution tolerance is graphically shown in Figures 2 and 3. (See TFC Discussion Section 3.3.)

<u>Assabet River Existing Fish Community for Riverine Habitats (EFC-R)</u>

The Existing Fish Community for riverine habitat (EFC-R) in the Assabet River based on nine sampling stations is provided in Table 5. A total of 1183 fish representing 22 species were identified in the Assabet River during the fish surveys of riverine habitat.

The top eleven (11) most abundantly collected species, comprising approximately 91.0% of the total, include white sucker (26.2%), largemouth bass (7.5), American eel (7.4%), bluegill (7.3%), fallfish (7.0%), yellow bullhead (6.3%), golden shiner (6.3%), blacknose dace (6.3%), redbreast sunfish (6.1%), pumpkinseed (5.7%), and redfin pickerel (4.9%).

The remaining eleven (11) species (chain pickerel, rainbow trout, creek chubsucker, brown trout, spottail shiner, brook trout, yellow perch, brown bullhead, black crappie, banded sunfish, and tiger trout) comprise between 1.5% and 0.1% of the total catch and represent 9.0% of the fauna.

The EFC for riverine habitats (EFC-R) consisted of 17.8% fluvial specialist, 26.2% fluvial dependent, and 56.0% macrohabitat generalist fish species. Relative to pollution tolerances, the EFC consisted of 4.6% intolerant, 33.4% moderate, and 62.0% tolerant fish species. A total of 22 different fish species were sampled from the riverine habitat, fourteen (14) of which were native, comprising 75% of the total catch. Eight non-native fish species, largemouth bass, bluegill, yellow bullhead, rainbow trout, brown trout, spottail shiner, black crappies, and tiger trout accounted for 25% of the total catch.

The EFC-R for riverine habitats based on habitat use classification guilds and pollution tolerance are graphically shown in Figures 2 and 3. (See TFC Discussion Section 3.3.)

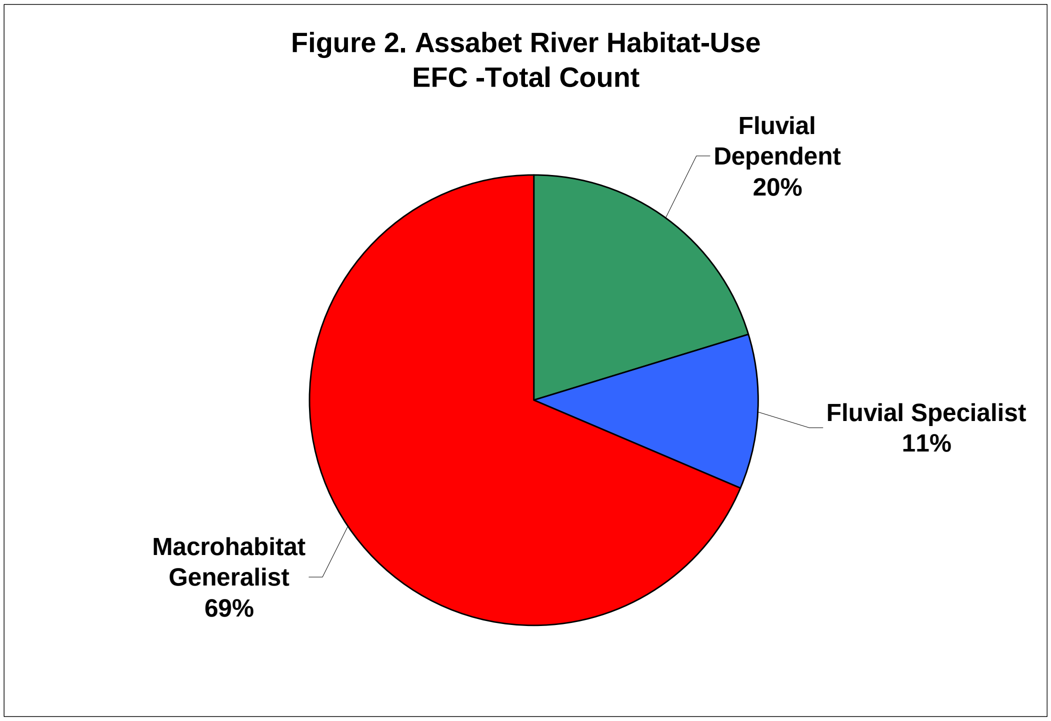


Figure 2. Assabet River Habitat-Use
EFC -Total Count
Fluvial Dependent 20%
Fluvial Specialist 11%
Macrohabitat Generalist 69%

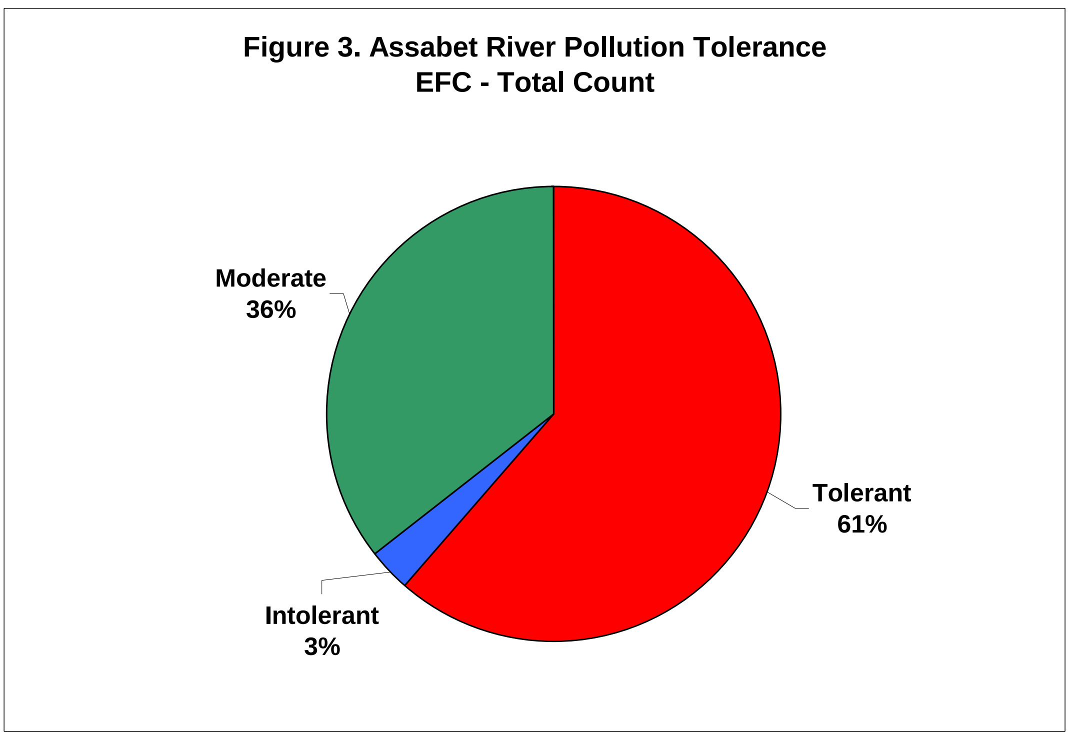


Figure 3. Assabet River Pollution Tolerance
EFC - Total Count
Moderate 36%
Tolerant 61%
Intolerant 3%

Table 3. Assabet River Existing Fish Community (EFC) - Total Catch All Habitats Relative Abundance and Species Composition of Fishes Collected.

Common Name	Scientific Name	Total	Percent Comp	Designation	Thermal Regime	MA HUC	Pollution Tolerance
White sucker	Catostomus commersoni	382	20.3	Native	Eurythermal	FD	T
Bluegill	Lepomis macrochirus	325	17.3	Introduced	Warm	MG	T
Pumpkinseed	Lepomis gibbosus	221	11.7	Native	Warm	MG	M
Largemouth bass	Micropterus salmoides	153	8.1	Introduced	Warm	MG	M
American eel	Anguilla rostrata	119	6.3	Native	Eurythermal	MG (*)	T
Yellow bullhead	Ameiurus natalis	89	4.7	Introduced	Warm	MG	T
Redbreast sunfish	Lepomis auritus	88	4.7	Native	Warm	MG	M
Fallfish	Semotilus corporalis	83	4.4	Native	Eurythermal	FS	M
Golden shiner	Notemigonus crysoleucas	78	4.1	Native	Eurythermal	MG	T
Blacknose dace	Rhinichthys atratulus	74	3.9	Native	Eurythermal	FS	T
Redfin pickerel	Esox americanus americanus	61	3.2	Native	Warm	MG	M
Chain pickerel	Esox niger	39	2.1	Native	Warm	MG	T
Black crappie	Pomoxis nigromaculatus	32	1.7	Introduced	Warm	MG	M
Common carp	Cyprinus carpio	29	1.5	Introduced	Warm	MG	T
Yellow perch	Perca flavescens	21	1.1	Native	Eurythermal	MG	M
Brown trout	Salmo trutta	20	1.1	Introduced	Cold	FS	I
Brown bullhead	Ameiurus nebulosus	19	1.0	Native	Warm	MG	T
Rainbow trout	Oncorhynchus mykiss	16	0.9	Introduced	Cold	FS	I
Creek chubsucker	Erimyzon oblongus	15	0.8	Native	Eurythermal	FS	I
Spottail shiner	Notropis hudsonius	11	0.6	Introduced	Eurythermal	MG	M
Banded sunfish	Enneacanthus obesus	3	0.2	Native	Warm	MG	T
Brook trout	Salvelinus fontinalis	2	0.1	Native	Cold	FS	I
Tiger trout	Salvelinus fontinalis X Salmo trutta	1	0.1	Hybrid	Cold	FS	I
Totals:		**1881**	**100.0**				

*American eel have been classified as *fluvial dependent* (FD) in other TFC due to this species dependency upon fluvial conditions for migration to and from the sea to complete their catadromous life-cycle.

Table 4. Assabet River EFC for Impoundments (EFC-I) - Relative Abundance and Composition of Fishes Collected within Assabet River Impoundments.

Sample Site Numbers 307, 427, 498, 499, 501, and 527 (n=6).

Common Name	Number Collected	Percent Composition	Habitat Use Class	Pollution Tolerance
Bluegill	239	34.2	MG	T
Pumpkinseed	154	22.1	MG	M
White sucker	72	10.3	FD	T
Largemouth bass	64	9.2	MG	M
American eel	32	4.6	MG	T
Common carp	29	4.2	MG	T
Black crappie	26	3.7	MG	M
Chain pickerel	21	3.0	MG	T
Redbreast sunfish	16	2.3	MG	M
Yellow bullhead	14	2.0	MG	T
Brown bullhead	12	1.7	MG	T
Yellow perch	12	1.7	MG	M
Redfin pickerel	3	0.4	MG	M
Golden shiner	3	0.4	MG	T
Banded sunfish	1	0.1	MG	T
Totals:	698	100.0		

Table 5. Assabet River EFC for Riverine Habitats (EFC-R) - Relative Abundance and Composition of Fishes Collected in Riverine Habitats.

Sample Site Numbers 91, 306, 308, 373, 433, 496, 497, 500, and 502 (n-9).

Common Name	Number Collected	Percent Composition	Habitat Use Class	Pollution Tolerance
White sucker	310	26.2	FD	T
Largemouth bass	89	7.5	MG	M
American eel	87	7.4	MG	T
Bluegill	86	7.3	MG	T
Fallfish	83	7.0	FS	M
Yellow bullhead	75	6.3	MG	T
Golden shiner	75	6.3	MG	T
Blacknose dace	74	6.3	FS	T
Redbreast sunfish	72	6.1	MG	M
Pumpkinseed	67	5.7	MG	M
Redfin pickerel	58	4.9	MG	M
Chain pickerel	18	1.5	MG	T
Rainbow trout	16	1.4	FS	I
Creek chubsucker	15	1.3	FS	I
Brown trout	12	1.0	FS	I
Spottail shiner	11	0.9	MG	M
Brook trout	10	0.8	FS	I
Yellow perch	9	0.8	MG	M
Brown bullhead	7	0.6	MG	T
Black crappie	6	0.5	MG	M
Banded Sunfish	2	0.2	MG	T
Tiger trout	1	0.1	FS	I
Totals:	**1183**	**100.0**		

3.3 TFC DISCUSSION

Comparison of Concord River (SuAsCo) Watershed Target Fish Community (TFC) Model to Assabet River Existing Fish Community–Total Catch (EFC), EFC-Impoundments (EFC-I), & EFC-Riverine Habitats (EFC-R)

As previously discussed the Target Fish Community (TFC) approach was recommended by MADFW as the methodology to be used on the Assabet River to evaluate the current or existing fisheries community for the main-stem river and those in impounded or riverine habitats and the potential fisheries community and habitat that is expected to occur as the result of dam removal.

The goal of developing a TFC for the main-stem Assabet River is to define the fish community that is appropriate for a natural river of this size in southern New England. Accordingly TFC assessments are used to identify the current status of a main-stem river such as the Assabet River in that the fish tell the story as they are long-lived, reflect stresses over time, and are easily recognized and identified.

The premise for the TFC is quite simple in that Rivers should have fluvial or "river" fish communities. In terms of target fish communities, the general objective for rivers is to have the fish population comprised in a large part of native, fluvial specialists and fluvial dependent species.

The TFC for the SuAsCo serves as our target for river rehabilitation in the Assabet River and as an endpoint of evaluating environmental improvements such as the removal of dams. The sampled existing fish community (EFC) is compared to the target fish community (TFC) to evaluate the potential fish community resulting from the river rehabilitation objective (i.e. removal of a dam). Use of the target fish community approach can guide and evaluate environmental rehabilitation where restoration objectives cannot simply be to copy pristine, natural ecosystem properties. This is accomplished by comparing the TFC Model for the Concord River (SuAsCo) Watershed to the total existing fish communities in the main-stem river (EFC), the existing fish communities in the impounded segments (EFC-I), and the existing fish community in the free flowing or riverine segments (EFC-R).

The strength in this TFC evaluation is in the comparison of the TFC or reference model community to the existing fish community (EFC) that is a composite of all main-stem samples (total catch), the existing fish community in the riverine sites (EFC-R), and to the existing fish community in all pond sites or impoundments (EFC-I) (pers. Comm. Todd Richards 2008).

The comparison of the TFC and the Existing Fish Communities (EFC) based on habitat use classification guilds and pollution tolerance is summarized in Table 6 and graphically shown in Figures 2 and 3, respectively. As per our SuAsCo Model the reference or expected TFC for the Assabet River fish population is comprised of 15 native species and based on Habitat Use-Class represents 45.8% fluvial Specialists, 28.0% fluvial Dependents, and 26.4% microhabitat generalists. Based on Pollution Tolerance Classification Guilds the TF C is comprised on 7.7% intolerant, 75.4% moderate, and 17.1% tolerant fish species.

Table 6. Comparison of the Target Fish Community (TFC) and Existing Fish Communities (EFC) Based on Habitat-Use and Pollution Tolerance Classification Guilds.

Habitat-Use Class	Expected TFC	Total Existing Fish Community	Impoundment Only	Riverine Only
Fluvial Specialist	45.8	11.2	0	17.8
Fluvial Dependent	28	20.3	10.3	26.2
Macrohabitat Generalist	26.4	68.5	89.7	56
Pollution Tolerance	**Expected TFC**	**Total Existing Fish Community**	**Impoundment Only**	**Riverine Only**
Intolerant	7.7	2.9	0	4.6
Moderate	75.4	35.6	39.4	33.4
Tolerant	17.1	61.5	60.6	62

Relative to comparisons using habitat use classes (Figure 2), the existing fish community (EFC) representing both impoundment and riverine habitats is made up of 68.5% microhabitat generalists, 20.3% fluvial dependents and only 11.2% fluvial specialists. The dramatic increase in the EFC proportion of macrohabitat generalist fish species (that are also more pollution tolerant) and subsequent decrease in the proportion of fluvial fish species to the TFC is anticipated since the continuity of the riverine habitat of the main stem Assabet is fragmented by the dams and their respective impoundments (ponds). Consequently the EFC proportion is also dominated by pollution tolerant fish species at 61.5% with decreasing proportions for moderate (35.6%) and intolerant (2.9%).

Looking at the existing fish community in the impoundments only further strengthens the observed trends in the aforementioned data and our premise that rivers should have river fish communities. The EFC-I is completely dominated by macrohabitat generalists at a proportion of 89.7% followed by only 10.3% for fluvial dependents (white sucker only) and no (0%) fluvial specialists. Consequently the EFC-I proportion is also dominated by pollution tolerant fish species at 60.6% followed by 39.4% for moderate and no (0%) intolerant fish species.

The existing fish community in the riverine reaches between the various dams and their impoundments include the presence of fluvial specialists. The EFC-R, albeit still dominated by macrohabitat generalists at 56.0%, is also comprised of 26.2 % fluvial dependents (white sucker only) and 17.8% fluvial specialists.

Seven (7) fluvial specialist fish species accounting for 17.8% of the EFC-R were collected in the riverine habitats between the dams while not one fluvial specialist was collected in any of the impoundment collections since they require riverine and not pond habitat. The fluvial species collected include fallfish (7.0%), blacknose dace (6.3%), rainbow trout (1.4%), creek chubsucker (1.3%), brown trout (1.0%), brook trout (0.8%), and tiger trout (0.1%). Fallfish, blacknose dace, creek chubsucker and brook trout are native species while rainbow trout, brown trout and tiger trout (brown X brook hybrid) are introduced species probably stocked within the watershed by the MADFW. It is interesting to note that all of the aforementioned trout species are pollution intolerant and are also classified as coldwater relative to their thermal regime (Table 3) and they were only collected in riverine habitats in the Assabet River and not in any of the impoundments.

Comparing the TFC percentage in Table 1of three native FS species (fallfish at 37.3%, brook trout at 3.4%, and creek chubsucker at 1.4%) to their percentage in Table 5 for the EFC-R (fallfish at 7.0%, brook trout at 0.8%, and creek chubsucker at 1.3%) reveals a better comparison to the TFC of the existing river fish community in these reaches on the Assabet River. However, the continuity of the overall river system is fragmented by the existing dams and impoundments that also impact the value and function of these ecosystems as shown by the EFC relative abundance and species composition in Table 3. This TFC comparison indicates that there is potential for further improvement towards achieving the TFC model commensurate upon the removal of dams.

FIGURE 4
Comparison of the Target Fish Community (TFC) and Existing Fish Communities (EFC) Based on Habitat-Use Classification Guilds

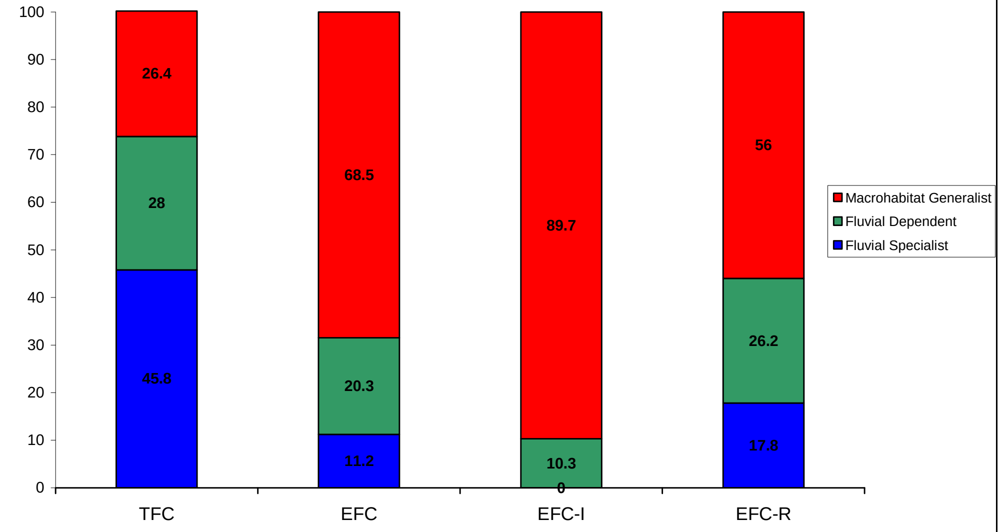
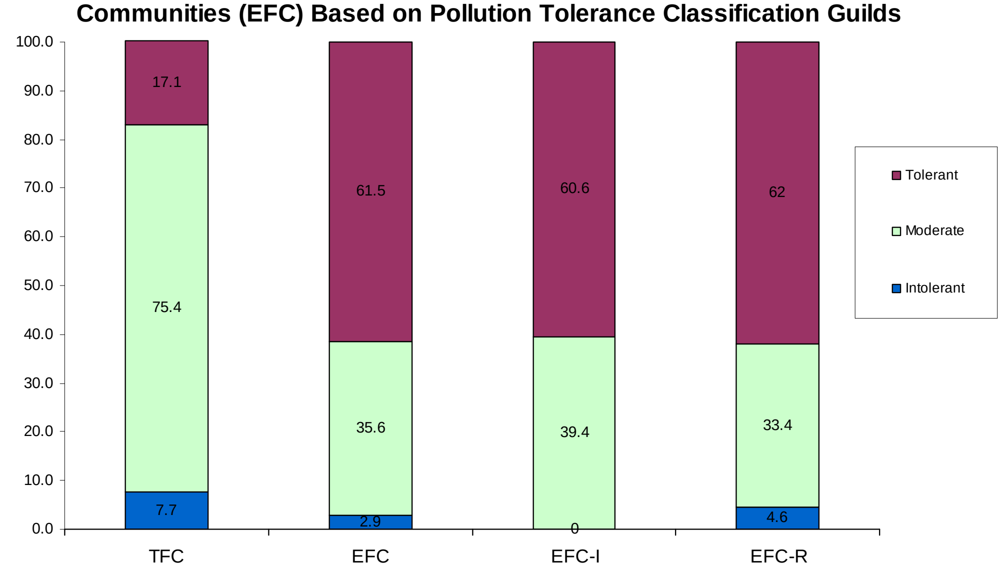


FIGURE 5
Comparison of the Target Fish Community (TFC) and Existing Fish Communities (EFC) Based on Pollution Tolerance Classification Guilds



TFC = Target Fish Community
EFC = Existing Fish Community
EFC-I = Existing Fish Community- Impoundment
EFC-R = Existing Fish Community - Riverine

4. CURRENT STATUS OF RESTORATION OF ANADROMOUS FISH

Over the long term the objective of the U.S. Fish and Wildlife Service (USFWS) is to restore anadromous fish populations in the Sudbury-Assabet-Concord River system (SUASCO). The SUASCO System is connected to the Atlantic Ocean by the Merrimack River. USFWS began the alewife restoration program in the Concord River watershed in 2000 with the transfer of 7,500 alewife from the Nemasket River in southeastern Massachusetts into four sites on the mainstem of the Concord River. Since 2000, USFWS has annually stocked between 5,000 and 7,500 alewife at various locations, progressively moving upriver and recently focused on the Sudbury River.

To access the SUASCO system for breeding the anadromous fish first need to negotiate the Essex Dam in Lawrence, Massachusetts on the Merrimack River. This dam has a fish lift, however the passage conditions here are not optimum. During the high flows that frequently exist during the passage season, competitive flow along the face of the dam (leaky flashboards and flow in excess of the hydraulic capacity) along with predation problems associated with the congregation of the alewife at the fish lift (there is a large stripe bass presence in the tailrace area that greatly impacts alewife during passage) can greatly complicate the successful passage of fish past the dam. Annual fish returns at the Essex Dam in Lawrence are shown in Table 7.

Once past the Essex Dam on the Merrimack River anadromous fish can enter the Concord River in Lowell. On the Concord River mainstem there are a number of impediments to fish passage, In the lower part of the river is the remains of the Middlesex Dam which has been extensively destroyed and is at most only a minor hindrance. Upstream from this is Massuc Falls which is a fairly extensive waterfall. During high flows the falls is mostly flooded out allowing fish passage. Further upstream is the Centennial Island Hydroelectric Facility with a Denil fish ladder.

Lastly, in Billerica is the Billerica Dam (aka Talbot Mills Dam, aka Faulkner Mills Dam). This structure is an absolute impediment to passage. Considerable effort has gone into developing a plan to address this structure with the possibility of complete dam removal.

USFWS is continuing restoration efforts from improving the migratory corridor to developing self sustaining clupeid stocks within the watershed. USFWS have successfully introduced alewife in the Concord-Sudbury system and observed successful breeding of introduced adults. It is expected that the Assabet River would also provide suitable breeding habitat if access were not an issue.

Table 7. Anadromous Fish Returns on the Merrimack River			
Year	River Herring *	American Shad	Atlantic Salmon
1982			23
1983	4,794	5,629	114
1984	1,769	5,497	115
1985	23,112	12,793	213
1986	16265	18,173	103
1987	77209	16,909	139
1988	361012	12,359	65
1989	387973	7,875	84
1990	254242	6,013	248
1991	379588	16,098	332
1992	102166	20,796	199
1993	14027	8,599	61
1994	88913	4,349	21
1995	33425	13,861	34
1996	51	11,322	76
1997	403	22,661	71
1998	1362	27,891	123
1999	7898	56,461	185
2000	24576	72,800	82
2001	1,550	76,717	83
2002	526	54,586	56
2003	10,607	55,620	147
2004	15,051	36,593	129
2005	99	6,382	34
2006	1,257	1,205	91
2007	1,169	17,529	74
2008	108	25,116	119
TOTAL	**1,809,152**	**613,834**	**3,021**
All counts were taken at the Essex Dam Fish Lift in Lawrence, Massachusetts *River Herring refers collectively to two fish species: blueback herring and alewife			

Historically American eel were very abundant in east coast streams. Eel populations appear to be declining in North America. Possible reasons for population decline include barriers to upstream and downstream migration, habitat loss and alternation, ocean conditions, over-fishing, parasitism, and contaminants. Since 2004 the USFWS and NMFS have been considering extending Federal Endangered Species Act protection to the American eel. The reasons for the sharp decline in American eel stocks across the North Atlantic remain as mysterious as its long migrations. A recent study by a NOAA scientist and colleagues in Japan and the United Kingdom says shifts in ocean-atmosphere conditions may be a primary factor in declining reproduction and survival rates (NOAA 2008).

American eel have been found recently upstream of all Assabet River mainstem dams and slow moving reaches of the Assabet River and tributary streams. Warm-water ponds in the watershed contains considerable potential eel habitat. Upstream migration of juvenile eel likely occurs from April through early summer. Juveniles can survive out of water so long as their skin is moist and they can ascend obstructions such as small dams that block movement of other fish.

5. SUMMARY

General Impacts of Dams on Aquatic Habitat

Dams can be detrimental to aquatic habitat as they fragment and block access to habitat. This ecosystem fragmentation has been linked to declines in biodiversity. Dams interrupt the migration of diadromous fish and the movement of resident aquatic species to habitat for spawning, nursery, or refuge. (MADEP, 2007) Many species such as Atlantic salmon, brook trout, river herring, and shad have generally suffered dramatic population declines, in part due to the impact of dams on migratory corridors. The removal of a dam reconnects the upstream and down stream river lengths, significantly expanding the area and quality of land under water for fisheries habitat. While the presence of additional dams upstream or downstream may limit the extent of restoration, dam removal can still provide benefits, even on limited reaches of rivers.

The re-introduction of anadromous fishes to their previous spawning grounds will also have a positive effect on the ecology of those freshwater systems such as the Assabet River (Loesch 1987). In freshwater areas where herring have been restored, studies show that resident fish populations were enhanced. The juvenile herring produced in the spawning run serve as a food supply for bass and other resident species. All life stages of anadromous herrings are important forage for many freshwater and marine fishes; in addition, birds, amphibians, reptiles, and mammals have also been documented as predators. The mortality of anadromous alewives provides an important source of nutrients for headwater ponds.

Dams transform free-flowing rivers to slow-moving water bodies and create impoundments that can become sinks for sediment. Over time impoundments may collect sediments that are contaminated with nutrients and/or urban pollutants and this will further impact the aquatic habitat.

Dams also impact water quality as impoundments increase summer water temperatures significantly by creating larger, slower moving water surface areas exposed to sun. Warmer temperatures decrease the dissolved oxygen content of the water both in the impoundment and often for some distance downstream of the dam. Dam removal eliminates these artificial impoundments and can significantly improve fisheries habitat and water quality by restoring riverine conditions that support cooler water temperatures and improved dissolved oxygen.

The Assabet TFC versus the EFC

A target fish community (TFC) can be used as a guide to identify the composition of a healthy fish community for large streams and small rivers in the New England region and can guide and evaluate river rehabilitation.

The existing fish community (EFC) in the Assabet is not consistent with the target fish community (TFC) considered for the river. Current fish species composition consists primarily of microhabitat generalists and pollution tolerant species. The overall dominance of macrohabitat generalists and lack of fluvial specialist is directly related to the effect of the dams and the creation of impoundments in what naturally would be free flowing stretches of river. The dominance of the current fish population by more pollution tolerant species (e.g. white sucker and bluegill) indicates that the Assabet River ecosystem is somewhat degraded by a combination water and/or sediment quality as a result of the six dams and their impoundments on the main stem of the Assabet River.

In conclusion, it is expected that removing dams on the Assabet River and improving water quality would provide habitat that would support the increase in fluvial dependent and fluvial specialist species consistent with the considered target fish community (TFC) for this river. Over the long term, removing dams on the Assabet would also provide for the future restoration of the migratory corridor on the Assabet and provide access to spawning grounds and nursery habitat for anadromous species when passage is provided at the Talbot Dam in Billerica. If in the future a dam removal were considered further, it is likely that additional studies of fish populations on the river would be useful to characterize changes that would result from dam removal.

6. REFERENCES

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ATTACHEMENT A

ASSABET RIVER DATA

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Site 1. Relative abundance and composition of fishes collected by backpack shocking from the Assabet River (Sample Site Number 502)

Common Name	Number Collected	Percent Composition	Habitat Use Class	Pollution Tolerance
White sucker	23	33.8	FD	T
Largemouth bass	22	32.4	MG	M
Yellow bullhead	15	22.1	MG	T
Chain pickerel	5	7.4	MG	T
Bluegill	2	2.9	MG	T
Golden shiner	1	1.5	MG	T
Totals:	**68**	**100.0**		

Site 2. Relative abundance and composition of fishes collected by barge shocking from the Assabet River (Sample Site Number 433).

Common Name	Number Collected	Percent Composition	Habitat Use Class	Pollution Tolerance
White sucker	97	44.9	FD	T
Golden shiner	53	24.5	MG	T
Redfin pickerel	30	13.9	MG	M
Pumpkinseed	14	6.5	MG	M
Chain pickerel	7	3.2	MG	T
Fallfish	4	1.9	FS	M
Brown bullhead	4	1.9	MG	T
Bluegill	3	1.4	MG	T
Largemouth bass	2	0.9	MG	M
Yellow bullhead	2	0.9	MG	T
Totals:	**216**	**100.0**		

Site 3. Relative abundance and composition of fishes collected by barge shocking from the Assabet River (Sample Site Number 501).

Common Name	Number Collected	Percent Composition	Habitat Use Class	Pollution Tolerance
White sucker	14	46.7	FD	T
Yellow bullhead	7	23.3	MG	T
American eel	5	16.7	MG	T
Pumpkinseed	1	3.3	MG	M
Redfin pickerel	1	3.3	MG	M
Brown bullhead	1	3.3	MG	T
Chain pickerel	1	3.3	MG	T
Totals:	**30**	**100.0**		

Site 4. Relative abundance and composition of fishes collected by barge shocking from the Assabet River (Sample Site Number 373).

Common Name	Number Collected	Percent Composition	Habitat Use Class	Pollution Tolerance
Blacknosed dace	72	31.6	FS	T
White sucker	46	20.2	FD	T
Bluegill	42	18.4	MG	T
Rainbow trout	13	5.7	FS	I
Fallfish	12	5.3	FS	M
Brown trout	9	3.9	FS	I
American eel	8	3.5	MG	T
Yellow bullhead	6	2.6	MG	T
Creek chubsucker	6	2.6	FS	I
Redfin pickerel	5	2.2	MG	M
Pumpkinseed	4	1.8	MG	M
Brook trout	2	0.9	FS	I
Chain pickerel	2	0.9	MG	T
Tiger trout	1	0.4	FS	I
Totals	**228**	**100.0**		

Site 5. Relative abundance and composition of fishes collected by barge shocking from the Assabet River (Sample Site Number 308).

Common Name	Number Collected	Percent Composition	Habitat Use Class	Pollution Tolerance
White sucker	12	24.0	FD	T
Bluegill	9	18.0	MG	T
American eel	9	18.0	MG	T
Brook trout	8	16.0	FS	I
Redfin pickerel	6	12.0	MG	M
Rainbow trout	3	6.0	FS	I
Pumpkinseed	3	6.0	MG	M
Totals:	**50**	**100.0**		

Site 6. Relative abundance and composition of fishes collected by barge shocking from the Assabet River (Sample Site Number 91).

Common Name	Number Collected	Percent Composition	Habitat Use Class	Pollution Tolerance
White sucker	66	31.6	FD	T
Largemouth bass	54	25.8	MG	M
American eel	17	8.1	MG	T
Yellow bullhead	17	8.1	MG	T
Redfin pickerel	14	6.7	MG	M
Redbreast sunfish	11	5.3	MG	M
Creek chubsucker	9	4.3	FS	I
Fallfish	7	3.3	FS	M
Pumpkinseed	5	2.4	MG	M
Golden shiner	4	1.9	MG	T
Blacknosed dace	2	1.0	FS	T
Brown trout	2	1.0	FS	I
Banded Sunfish	1	0.5	MG	T
Totals:	**209**	**100.0**		

Site 7. Relative abundance and composition of fishes collected by gillnet from the Assabet River (Sample Site Number 498).

Common Name	Number Collected	Percent Composition	Habitat Use Class	Pollution Tolerance
Bluegill	50	61.7	MG	T
White sucker	11	13.6	FD	T
Pumpkinseed	8	9.9	MG	M
Black crappie	5	6.2	MG	M
Chain pickerel	4	4.9	MG	T
Largemouth bass	3	3.7	MG	M
Totals:	**81**	**100.0**		

Site 8. Relative abundance and composition of fishes collected by bardge shocking from the Assabet River (Sample Site Number 306).

Common Name	Number Collected	Percent Composition	Habitat Use Class	Pollution Tolerance
White sucker	30	22.1	FD	T
Fallfish	21	15.4	FS	M
American eel	20	14.7	MG	T
Redbreast sunfish	17	12.5	MG	M
Bluegill	14	10.3	MG	T
Golden shiner	12	8.8	MG	T
Pumpkinseed	7	5.1	MG	M
Black crappie	6	4.4	MG	M
Yellow bullhead	6	4.4	MG	T
Brown bullhead	2	1.5	MG	T
Banded Sunfish	1	0.7	MG	T
Totals:	**136**	**100.0**		

Site 9. Relative abundance and composition of fishes collected by barge shocking from the Assabet River (Sample Site Number 500).

Common Name	Number Collected	Percent Composition	Habitat Use Class	Pollution Tolerance
Pumpkinseed	34	28.8	MG	M
Yellow bullhead	19	16.1	MG	T
Redbreast sunfish	16	13.6	MG	M
American eel	12	10.2	MG	T
Bluegill	9	7.6	MG	T
Largemouth bass	7	5.9	MG	M
White sucker	5	4.2	FD	T
Fallfish	5	4.2	FS	M
Golden shiner	4	3.4	MG	T
Redfin pickerel	3	2.5	MG	T
Chain pickerel	2	1.7	MG	T
Yellow perch	1	0.8	MG	M
Brown bullhead	1	0.8	MG	T
Totals:	**118**	**100.0**		

Site 10. Relative abundance and composition of fishes collected by gillnet from the Assabet River (Sample Site Number 427).

Common Name	Number Collected	Percent Composition	Habitat Use Class	Pollution Tolerance
White sucker	6	66.7	FD	T
Largemouth bass	2	22.2	MG	M
Chain pickerel	1	11.1	MG	T
Totals:	**9**	**100.0**		

Site 11. Relative abundance and composition of fishes collected by boat shocking from the Assabet River (Sample Site Number 307)

Common Name	Number Collected	Percent Composition	Habitat Use Class	Pollution Tolerance
Bluegill	142	40.5	MG	T
Pumpkinseed	110	31.3	MG	M
Largemouth bass	27	7.7	MG	M
Black crappie	15	4.3	MG	M
American eel	14	4.0	MG	T
Chain pickerel	12	3.4	MG	T
Common carp	11	3.1	MG	T
Brown bullhead	8	2.3	MG	T
Yellow bullhead	5	1.4	MG	T
White sucker	2	0.6	FD	T
Redfin pickerel	2	0.6	MG	M
Golden shiner	2	0.6	MG	T
Banded sunfish	1	0.3	MG	T
Totals:	**351**	**100.0**		

Site 12. Relative abundance and composition of fishes collected by barge shocking from the Assabet River (Sample Site Number 497).

Common Name	Number Collected	Percent Composition	Habitat Use Class	Pollution Tolerance
White sucker	18	28.1	FD	T
Redbreast sunfish	15	23.4	MG	M
American eel	14	21.9	MG	T
Fallfish	13	20.3	FS	M
Bluegill	2	3.1	MG	T
Brown trout	1	1.6	FS	I
Yellow bullhead	1	1.6	MG	T
Totals:	**64**	**100.0**		

Site 13. Relative abundance and composition of fishes collected by boat shocking from the Assabet River (Sample Site Number 499).

Common Name	Number Collected	Percent Composition	Habitat Use Class	Pollution Tolerance
White sucker	26	29.9	FD	T
Common carp	15	17.2	MG	T
Largemouth bass	13	14.9	MG	M
Redbreast sunfish	11	12.6	MG	M
Bluegill	9	10.3	MG	T
Pumpkinseed	5	5.7	MG	M
American eel	5	5.7	MG	T
Yellow perch	2	2.3	MG	M
Yellow bullhead	1	1.1	MG	T
Totals:	**87**	**100.0**		

Site 14. Relative abundance and composition of fishes collected by boat shocking from the Assabet River (Sample Site Number 527).

Common Name	Number Collected	Percent Composition	Habitat Use Class	Pollution Tolerance
Bluegill	38	27.1	MG	T
Pumpkinseed	30	21.4	MG	M
Largemouth bass	19	13.6	MG	M
White sucker	13	9.3	FD	T
Yellow perch	10	7.1	MG	M
American eel	8	5.7	MG	T
Black crappie	6	4.3	MG	M
Redbreast sunfish	5	3.6	MG	M
Brown bullhead	3	2.1	MG	T
Chain pickerel	3	2.1	MG	T
Common carp	3	2.1	MG	T
Yellow bullhead	1	0.7	MG	T
Golden shiner	1	0.7	MG	T
Totals:	**140**	**100.0**		

Site 15. Relative abundance and composition of fishes collected by barge shocking from the Assabet River (Sample Site Number 496).

Common Name	Number Collected	Percent Composition	Habitat Use Class	Pollution Tolerance
Fallfish	21	22.3	FS	M
White sucker	13	13.8	FD	T
Redbreast sunfish	13	13.8	MG	M
Spottail shiner	11	11.7	MG	M
Yellow bullhead	9	9.6	MG	T
Yellow perch	8	8.5	MG	M
American eel	7	7.4	MG	T
Bluegill	5	5.3	MG	T
Largemouth bass	4	4.3	MG	M
Chain pickerel	2	2.1	MG	T
Golden shiner	1	1.1	MG	T
Totals:	**94**	**100.0**		

APPENDIX F

CULTURAL RESOURCES IDENTIFICATION

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Assabet River Sediment Study

CULTURAL RESOURCES IDENTIFICATION

Prehistoric and historic contexts for the Assabet River Sediment Study were prepared in Phase II, as part of the "Planning Assistance to States Study". The contexts involved additional background research of town histories and archaeological investigations previously completed within each community, so that an assessment could be made of pre-contact, contact, and post-contact archaeological sensitivity for the entire Assabet River within the study area. Known historic structures, which may be eligible for the National Register of Historic Places (NR) were also identified with a recommendation that a formal determination of eligibility should be made in the future if dam removal is considered further and that the determination be coordinated with the Massachusetts State Historic Preservation Officer (MA SHPO) for their concurrence.

Potential projects would also be subject to consultation and review with the Wampanoag Tribe of Gay Head (Aquinnah) Tribal Historic Preservation Officer (THPO), as well as the Mashpee Wampanoag THPO. This information can then be used in plan formulation when the location of staging areas, access roads, or construction zones will be identified.

Pre-contact Period Land Use and Settlement Patterns

PaleoIndian Period (13,500 – 9,000 Years Before Present [BP])

The PaleoIndian period is the earliest period of occupation in New England. The retreat of the Wisconsin glacier occurred approximately 13,500 years BP in at least a portion of Massachusetts. The environment immediately after the glacier receded was characterized by a tundra environment, which was then replaced by a coniferous and hardwood forest environment. While megafauna such as mammoth and mastodon were present during part of this period, it is now considered more likely that PaleoIndian subsistence was more reliant on caribou, elk, fish, and a variety of plants and berries (Curran 1984; Dincauze 1990; Petersen (1995). PaleoIndian sites are recognized by the characteristic fluted projectile points, as well as flake knives, unifaces, drills, awls, graving tools, and biface knives (Funk 1978; Snow 1980). Many of the tools were manufactured from exotic lithic materials from sources outside New England which suggests widespread trade networks or extensive travel during this period (Holstein and Leveillee 1989).

PaleoIndian period sites are rare in the Sudbury-Assabet-Concord River drainage. Well known sites from this period include the Bull Brook Site in Ipswich, a component of the Neponset/Wamsutta site in Canton, and the Wapanucket Site (19-PL-203) in Middleborough. Isolated, diagnostic PaleoIndian projectile points and fragments have been reported from private collections from the Sudbury and Concord river drainages. The Westborough Country Club site (19- WR-680) from the Arnold Collection contained a Clovis point which is indicative of the PaleoIndian period.

Early Archaic Period (9,000 – 8,000 B.P.)

During the Early Archaic Period, the climate became warmer and drier, sea levels rose, and the environment changed to a mixed pine and deciduous forest community, which provided conditions more conducive to a more predictable and abundant food supply. The diagnostic artifact most associated with period is the bifurcate-base projectile point and stemmed or corner-notched points of the Palmer and Kirk types (Whitney et al. 2004:11). While the prevalence of sites from this period are rare in the Northeast, bifurcate points have been found in the Taunton River area and "…in every major drainage basin in eastern and central Massachusetts: in the coastal lowlands, the central uplands and the Connecticut River Valley" (Johnson 1993:48; Clements 1996:8). The megafauna of the PaleoIndian period had disappeared and the apparent seasonally available resources would have been smaller mammals. Early Archaic period sites could be found in a variety of environmental settings including large river valleys, the confluence of rivers and streams, near wetlands, as well as small brooks, ponds, and springs.

Only one possible Early Archaic period site has been identified in the vicinity of the Assabet River, the Westborough Country Club site (19-WR-680) from the Arnold Collection contained a bifurcate-base projectile point. Ten find spots or sites with these diagnostic points have been located in the middle and lower sections of the Sudbury drainage and the upper Concord River, just below the confluence of the Sudbury-Assabet Rivers. A find spot, the Taylor Brook/Tank Site in Maynard (19-MD-545), contained the base of a projectile point that could date to this period.

Middle Archaic Period (8,000 – 6,000 B.P.)

During this period, human occupation in southern New England becomes more evident. Climatic changes produced an environment very similar to the present. Mixed pine and oak forests were succeeded by oak-hemlock forests which was a better habitat for food resources such as deer and turkey. The archaeological data for this period indicates a settlement system of planned seasonal movement oriented around major rivers, streams, and marshes (Dincauze 1974). Subsistence was based on foraging, hunting of large and small mammals, migratory birds, and anadromous and freshwater fish (Whitney et al. 2004).

Diagnostic artifacts of the Middle Archaic Period include three major types of projectile points: Neville, Merrimack, and Stark. Other tools from this period include ground stone celts and gouges, as wells as grooved axes, net sinkers, adzes, and atlatls.

Four sites from this period have been identified along the Assabet River or its tributaries. The Arnold Collection (Westborough Country Club site, 19-WR-680), contained two Neville-type projectile points. In Northborough, the Algonquin High School site was a multi-component short term camp with a Middle Archaic component. The Bartlett site (19-WR-767) was a camp site that was dated by the Northborough Historical Society with Middle Archaic to Contact period cultural material. The Ironwood site (19-MD-

491) in Marlborough and the Pine Hawk site (19-MD-793) in Acton were also identified as having Middle Archaic components.

Many of the large and complex multi-component sites in the Sudbury, Assabet and Concord River drainages appear to contain evidence of recurrent occupation that began during the Middle Archaic Period.

Late Archaic Period (6,000 – 3,000 B.P.)

Late Archaic Period sites in New England are much more common than in previous periods. Modern environmental conditions were present and the wild resources available were the same as those observed by the earlier European settlers. A broad spectrum of resources was exploited during this period. Sites can be found in many diverse settings, including near falls, on the banks of large and small rivers and streams, on floodplain terraces, on lake bottom soils, margins of lakes, ponds, bogs and springs, near meadowlands, the coastal wetlands caused by the rising sea level, and in upland locations such as rock shelters and quarries (MHC 1984; Carolan et al. 1990).

There are three distinct cultural traditions that are recognized in Southern New England during the Late Archaic Period: the Laurentian Tradition, the Small-Stemmed Tradition, and the later Susquehanna Tradition. The Laurentian Tradition is characterized by Brewerton and side-notched points and appears to be more commonly found in inland sites more often than eastern coastal areas of the state, although the tradition was first identified on Martha's Vineyard and New York (Ritchie 1969).. The Small-Stemmed Tradition, also known as Mast Forest Tradition is more common in eastern Massachusetts and southern Connecticut and is present at sites with a wider range of environmental zones than other traditions (Dincauze 1975). Artifacts of this tradition consist of small, thick, stemmed or notched projectile points, most often of quartz and quartzite. These Late Archaic sites are found along wetland peripheries, with larger, "base" camps situated along major river valleys, with smaller "specialized activity" camps identified in a variety of environmental zones (McBride 1984). The Susquehanna Tradition first appears in the Late Archaic Period and extends into the Transitional or Terminal Archaic Period more fully described below. The artifacts from this tradition are characterized by several varieties of broad, side-notched and stemmed projectile points, and are arguably found more often in coastal areas rather than inland locations (Pierce and Loparto 1995).

The relationship between these three Late Archaic Period traditions remains unclear and discussion is often contentious. The Laurentian Tradition is observed most often in central and western Massachusetts, suggesting to some researchers that this either represents an interior, upland adaptation, or alternatively, that this tradition may indicate that there was a movement of settlement from the Great Lakes region, where this tradition is also identified, to New England. The Susquehanna Tradition artifacts have similarities to tools found in the southeastern United States. It has been suggested that this tradition was an intrusive population that may have coexisted with the other groups in New England (Dincauze 1974, 1975). The presence of Small-stemmed and Susquehanna points at a single site may represent either a population mixture or technological exchange (Ritchie 1969; Dincauze 1976; Snow 1980; Custer 1984; Bourque 1995; Whitney et al. 2004).

There are numerous known Late Archaic Period sites along the Assabet River. The Davenport site (19 WR-529) in Westborough is a single component, hunting/ woodworking site. The site is one of several, small riverine camps that have been found in the Assabet River floodplain. The Westborough Country Club site also has a component that dates to this period. In Northborough, the Algonquin High School and Bartlett sites (19-WR-758 and 19-WR-767) are Late Archaic sites that were used for small-scale lithic production, and functioned as small hunting camps. The Wheeler Hill, Locus 2 site (19-MD-788), Robin Hill site (19-MD-489), and the Ironwood site (19-MD-491) in Marlborough, are also small short-term sites that appear to be areas of pre-contact wetland resource exploitation in the Assabet River drainage. The Tarbell's Spring site (19-MD-148), 19-MD-158 in Concord, and the Pine Hawk site in Acton were situated on high banks overlooking the Assabet River, and could have functioned as larger base camps from which people would have set out to hunt, fish or gather.

Transitional Archaic Period (3,700 – 2,700 B.P.)

This period is characterized by the more widespread appearance of the Susquehanna Tradition, although the small-stemmed tradition also remained prevalent. During this period, vessels manufactured from steatite (soapstone) first appeared, distinguishing this period from the Early Woodland Period where ceramics were first utilized. Common diagnostic projectile points from this period include Orient Fishtail points, Atlantic-Snook Kill variant, Genesee points, and Wayland Notched points (Whitney et al. 2004).. Burials from this period are also more commonly identified, and provide evidence of complex mortuary rituals, and extensive trade networks. Subsistence during this period remained essentially the same as during the Late Archaic and included seasonal reliance on fishing, shellfishing, hunting of small and larger game, and gathering of mast-produced nuts (Snow 1980: 249; Clements 1996).

The Bartlett site (19-WR-767) in Northborough is the only known Transitional Archaic period site along the Assabet River. However, other sites such as the Pine Hawk site have been found in upland zone settings between the Sudbury and Assabet Rivers. Cremation burials have been identified within the Sudbury-Assabet-Concord drainage including the Mansion Inn site in Wayland, the Vincent site in Sudbury, and the Call site in Billerica.

Early Woodland Period (3,000 – 1,700 B.P.)

In Massachusetts, the Woodland periods are best represented in coastal regions and in the Connecticut River Valley (Carolan et al. 1990). Early and Middle Woodland period sites in the Connecticut River Valley were adapted to interior riverine resources with major settlement cores focused on the lowlands near falls and rapids Woodland sites evidence a variety of locations, sizes, and activities. Small hunting and gathering sites have been reported in Montague and Belchertown, and large fishing middens were excavated in the

Riverside District and at the WMECO site along the Connecticut River (MHC 1984). The first use of ceramics is attributed to this period, as is the introduction of horticulture with maize, beans, and squash as the major cultigens. However, hunting, fishing, and gathering remained essential subsistence activities, cultigens not being a major element of subsistence for at least 1,500 years after ceramics became established in New England (Whitney et al. 2004). The temporal periods of Woodland sites are distinguished mainly by projectile point type, and also some changes in ceramic manufacture and design. Early Woodland period sites are recognized by the presence of Meadowood, Rossville, and Adena-like projectile points and Vinette I ceramics. The quartz small-stemmed tradition also continued into the Woodland Period allowing the possibility of confusion between Late Archaic and Early Woodland sites in the absence of ceramics. Burial ceremonialism continued from the Transitional Archaic Period, with elaborate mortuary sites characterized by the presence of gorgets, birdstone, pottery pipes, copper beads, and red ocher (Ritchie and Funk 1973). These artifacts are evidence of established trade routes extending to the Midwest, where the Adena culture was firmly established (Pierce and Loparto 1995).

The Early Woodland Period in southern New England is generally underrepresented in the regional archaeological record. Settlement patterns and land use during this period appear to have been characterized by limited use of upland areas and more intensive use of coastal and estuarine resources as well as coastal habitation. There is evidence, however, of Early Woodland land use along the Assabet River found at three sites in two towns. The Robin Hill Site in Marlborough, and the Algonquin High School, and Bartlett sites in Northborough are all small, multi-component sites with evidence of Early Woodland period short-term use. Larger riverine settlement sites have been identified in the broader, Sudbury-Assabet-Concord drainage. These include the Heard Pond, Rice Farm, Sand Hill, and Weir Hill 3 sites in Wayland and Sudbury, and the Cedar Swamp 3 site in Westborough.

Middle Woodland Period (1,600 – 1,000 B.P.)

Cooler climatic conditions which began in the Early Woodland Period continued through this period as well. Site locations are much the same as the preceding period, which included riverine and coastal sites. The use of marine resources increased as indicated by large shell middens in coastal areas (Holstein and Leveillee 1989). A higher level of sedentism in settlement patterns is indicated, in addition to a population increase, the introduction of horticulture, regional trade networks, and more elaborately decorated ceramics (Whitney et al. 2004). Diagnostic artifacts from this period include, Fox Creek, Jack’s Reef Pentagonal and corner-notched, Woodland stemmed, Woodland lanceolate, Woodland corner notched, and Greene projectile points. Some argue that trade of exotic lithic materials increased during this period with the presence of jasper from Pennsylvania and chert from New York. Un-grooved adze blades, pestles, and bone and antler tools, and the introduction of the bow and arrow are also diagnostic of the later Woodland periods (Holstein and Leveillee 1985; Pierce and Loparto 1995; Whitney et al. 2004).

Only two possible Middle Woodland period sites were identified within the Assabet River area. The presence of a diagnostic projectile point in a private collection from the Honeypot Orchard site (19-MD-971 in Stow, dates this site to the Middle Woodland period. The multi-component Ironwood site (19-MD-491) in Marlborough also has a Late Woodland period presence. Other sites from this period can be found along the Sudbury River drainage.

Late Woodland Period (1,000 – 450 B.P. [AD 1500])

Late Woodland period settlement appears to have increased over the earlier periods. The population tended to gather into larger groups. Major nucleated villages located in defensible positions such as river confluence points and the heads of estuaries were favored for large base camps, while smaller camps were used for specialized activities such as farming, hunting, and harvesting shellfish. Many of the large base camp locations later became the sites of European settlement, thus many of these sites may have been destroyed.

Due to a climatic warming trend after 1,000 B.P., horticulture became a more reliable food supply, and was well established during this period with the production of corn, beans, squash, and gourds. Riverine floodplains may have been more intensively used for agriculture. Diagnostic artifacts from this period include diverse pottery styles with cord-wrapped impressions, linear stamping, and incising, as well as collared necks, castellated rims, and thinner walls (Luedtke 1985; Holstein and Leveillee 1989; Clements 1996). Diagnostic projectile points include Levanna and Madison types. Levanna projectile points, manufactured from local volcanics are widely recognized and distributed in Massachusetts, while Madison points, made from New York chert, are rarely found in eastern Massachusetts (MHC 1984).

The distribution of Late Woodland sites in upland settings is not well known in the Sudbury-Assabet-Concord River drainages. The confluence of the Sudbury and Assabet Rivers may have been a focal point of Late Woodland activity because of the presence of favorable conditions for fishing with weirs. Known sites along the Assabet River are the Marlborough Middle School site (19-MD-778) and the Bartlett site (19-WR-767 in Northborough. The Arnold Collection from the Westborough Country Club site also contained Late Woodland period projectile points.

Contact Period (AD 1500 – 1630)

The native land use and settlement pattern at the beginning of the Contact Period was essentially the same as during the Late Woodland Period. Semi-permanent camps were situated near fields, and were sometimes surrounded by palisades. Large pits were dug for storing food. Smaller sites in upland areas were used for specialized activities such as lithic procurement, hunting, trapping, or fishing. Coastal areas were heavily occupied for fishing and shellfish. Subsistence patterns consisted of seasonal hunting and gathering, with horticulture as a significant component (Holstein and Leveillee 1989). By this period native groups had established their territories and core areas of settlement. In southern New England, tribal nations included the Pequots, Wampanoags, Narragansetts, Mohegans, Nipmucs, Mohicans, Massachusetts, Nonotucks, Agawams, Pawtuckets, and Nehantics (Pierce and Loparto 1995; Whitney et al. 2004).

The Bartlett site in Marlborough purportedly contained Contact period cultural material. The Marlborough Middle School site is a Contact period habitation site. The general vicinity of this site is the area documented to be the Praying Indian town of Okommakemesit, settled by John Eliot in the seventeenth century.

Known and Expected Pre-contact Resources

Massachusetts Historical Commission (MHC) Reconnaissance Survey Reports for each town in which the Assabet River traverses, note that these towns were known for aboriginal settlement and activity along rivers as well as ponds, and wetland areas. Sites were most often found on terraces overlooking waterbodies. Identified sites represent all phases of New England prehistory from the PaleoIndian Period (12,500 – 10,000 BP [Before Present] to the Contact Period (450 – 300 BP/A.D. 1500 – 1620). These sites include short-term hunting or fishing stations or campsites, fish weirs, seasonal camps, and lithic production or repair sites.

The MHC Site Files for prehistoric sites were also checked to see where known sites for each town were located on the Assabet River from Westborough (headwaters) to Concord (confluence with Sudbury River). Five sites were identified along the Assabet River in Westborough, dating from possibly the PaleoIndian Period, through the Early to Late Archaic Periods (10,000 – 3,000 BP), with two sites also having Woodland Period components (3,000 – 450 BP). Two of the sites were located in the Assabet River floodplain, while the other three were located on terraces overlooking the river. These included small campsites as well as a locus of a larger site, and one tool-making site.

Five sites were also identified in Northborough. These sites were small, short-term campsites, and lithic re-working sites. One site was identified by artifacts eroding out of a terrace on the edge of the Assabet River.

Nine sites were identified along the Assabet River in Marlborough. Seven of the sites were represented by a few stone flakes and burnt rock, representative of a pattern of wetland resource exploitation with short-term campsites common during the Late Archaic Period (5,000 – 3,000 BP). Two of the sites were small, habitation or base campsites dating from the Late Archaic to the Early to Late Woodland Periods, with possibly a Contact Period component.

Ten sites were identified in Stow. The majority of these sites are find spots where only a small number of artifacts were found. Two were short-term camps or single event sites on elevated terraces overlooking the Assabet River that may be related to other, larger base camps along the river.

Two sites along the Assabet River were identified in Maynard, with only one site in Acton. The dearth of sites in these communities may be due to the amount of archaeological investigations or avocational collecting that was reported, rather than a true absence of prehistoric settlement in these areas.

The Sudbury-Assabet-Concord River drainage is an area that has been heavily studied by avocational archaeologists and has also been documented by professional cultural resource management investigations. It appears that the Assabet River was moderately used by prehistoric groups for resource procurement, and seasonal or short-term settlement. The potential exists for other prehistoric sites to be identified in the floodplain, on terraces or surrounding wetlands adjacent to the river.

Post-contact Period Land Use and Settlement Patterns

Historic contexts in towns within the study area are described here. The dams along the Assabet River powered industries that, in some cases, created the towns surrounding them, so their histories are described separately, from upstream to downstream.

The historic inventories for each town were examined for all of the dams being considered for possible removal. Some towns have very detailed, up to date inventories, while others have little or no information on the historic resources of the respective community. All of the dams are listed in the MHC Historic Inventory in their respective towns, with the exception of the Aluminum City Dam in Northborough. While NR eligibility has not been determined for most of these structures, many of the dams can be considered contributing elements of larger, historic areas and potentially historic districts.

Northborough

Northborough was originally part of the 1660 Marlborough grant. In 1717, the area of Northborough was set off with Westborough, and later became the second parish of Westborough in 1744. In 1766, Northborough was established as a district, and then made a town in 1775 (MHC 1983:1).

The first Colonial settler in Northborough, John Brigham, arrived around 1672, built a cabin and established a saw mill. However, the area was abandoned during King Philip's War. Increased settlement from Westborough took place after 1713. In 1726, the area became the North School District of Westborough. Thirty-seven families had settled in the Northborough area by 1744, when the area became a precinct. A meetinghouse was built in 1746. Early mill development began on Cold Harbor Brook (1711), the Assabet River (1720, with a fulling mill in 1749), and Howard Brook (1766) (MHC 1983:3). During this period, the raising of cattle, sheep and goats, and agricultural production, notably grain and fruits, were the economic base of the community.

During the Federal Period (1775-1830), water-powered mills and the network of roads continued to increase. By 1826, there were four grist mills and five saw mills. In 1814, the Northborough Manufacturing Co., producer of cotton and woolen cloth and yarn, was started at Woodside on the Assabet River. Agricultural production remained the mainstay of the economy.

The greatest decade of growth in Northborough took place from 1830 to 1840 during the Early Industrial Period (1830-1870). The Northborough Manufacturing Co. erected a second manufactory and village in 1832 at Chapinville on the Assabet River. Their two mills were able to produce 220,000 yards of cotton and woolen cloth in 1837, valued at $30,400. Other industries in Northborough at this time included the manufacture of combs, jewelry, and buttons, and the production of boots and shoes.

During the Late Industrial Period (1870-1915), Northborough had a population high of 2,104 in 1900, but that number decreased to 1,797 by 1915. The textile industry was the major industry and employer in the 1880s and 1890s. The two textile mills and two clothing manufactories provided about 75% of the manufacturing jobs, and 90% of the value of manufactured goods for the town. The comb, jewelry and button manufacture and woodworking industries continued, while several other industries, notably musical instruments, metal goods, corset stitching, rubber and elastic goods, and cameras had their start at this time. Agriculture remained vital to the economy (MHC 1983:8).

Beginning upstream on the Assabet River, the first dam being investigated for removal is the Aluminum City dam, also known as the Old Mill Pond Dam, in Northborough. The dam was built c. 1925 and was associated with a wood-frame building on the right (looking upstream) side of the stream. A local informant suggested the building was the old mill. The building now houses apartments and offices. It appears to date from the nineteenth century, which would indicate that an earlier dam was most likely present at this location. The informant also indicated that a sluiceway from the dam ran beneath the Aluminum City structure. It is hard to date this business as it has been enlarged and modified. No mention of this dam and associated industry are included in town histories reviewed to date. There is no way to tell whether there is indeed a sluiceway under the parking lot or building. The dam is unremarkable in appearance, and any associated structures appear to have been extensively modified. For this phase of the study, the determination is that this dam and surrounding area are not eligible for the NR. An archaeological reconnaissance study to determine archaeological sensitivity and the possible need for intensive archaeological investigations should be completed if removal of this dam is considered.

The Allen Street Dam in Northborough (also known as the Gothic Craft or Woodside Dam) is listed in the MHC Historic Inventory as the Assabet River Bridge and Dam. The bridge and dam are part of the Woodside Area, earlier known as Davisville, which has been a mill site since c. 1720. The stone bridge (topped with later concrete repairs) spans a mid-nineteenth century millpond and the upper end of a power canal, which led to the existing early twentieth century mill building, converted to apartments. The power canal is still visible as are stone foundations that may have been associated with earlier industries. The dam is constructed of stone, topped with concrete that may have been added c. 1900, when the mill building was erected. Just upstream of the millpond, is the Wachusett Aqueduct, which is part of an historic district comprised of nineteenth century water supply structures for the metropolitan Boston area. The Wachusett Aqueduct Linear District was listed on the NR in 1990. The Woodside Area, including the Allen Street Dam appears to be eligible for the NR. The factory has been converted to housing, but remains fairly unaltered. Buildings associated with the old manufactory abut the dam. The former Northborough Manufacturing Co. had a significant impact on Northborough, turning it from primarily an agricultural community to a small industrial center. The dam is the centerpiece of this industrial village area. In addition, the power canal is still visible as are stone foundations which could have been associated with earlier mill structures. There was an industrial component at this site for over one hundred years. For this phase of the study, the determination is that this dam and the surrounding area are potentially eligible for the NR. Archaeological investigations of the surrounding area will be necessary as will documentation (possibly historic and photographic) of the dam, factory, and surrounding village if removal of this dam is considered. An updated MHC Inventory Form will also need to be prepared in order to get concurrence with the determination of NR eligibility from the MA SHPO.

Hudson

The town of Hudson was incorporated in 1866 from lands originally part of Marlborough and Stow. The current configuration resulted from the annexation of lands from Bolton in 1868 and the definition of boundaries between Hudson and Stow in 1905. The first white settler in the area was John Howe in 1656. A tavern was operating in the town by 1661 and the first meetinghouse was completed in 1666. Population at this time was approximately 200 individuals. Agriculture was the mainstay of the frontier economy.

The town was mostly destroyed during King Philip's War, and was slowly re-settled during the early eighteenth century. In 1698, John Barnes developed an acre of land on each side of the falls on the Assabet River and established a grist mill on the north side. Shortly after, Joseph Howe took over Barnes' grist mill and it is conjectured that Howe added a saw mill to the site. Jeremiah Barstow took over the mill complex in 1712. Emory Maynard also established a grist mill on the river in what is now Hudson.

By the end of the eighteenth century, "the Mills" village center had expanded. Joel Cranston built a store and public house which opened in 1794. Silas Felton, a prosperous merchant, hotelier and postmaster, helped to establish several small businesses and attracted more people to settle in the village. A tannery and saw mill were established on Tannery Brook, and the first schoolhouse opened in 1799.

Hudson witnessed continual growth throughout the nineteenth century, and became known as Feltonville by 1812. At that time, the village was made up of a small cotton mill, a fulling mill, several tanneries, and a distillery. In 1821, Daniel Stratton established a small shoemaking factory. By 1844, Silas Stuart operated a box manufacturing plant to provide shoe boxes for the growing shoe industry. Large-scale shoe manufacturing began mid-century, with at least five shoe factories. In 1847, the Fitchburg Branch Railroad was laid through the town, and in 1855 the Marlborough Branch Railroad Company opened between Marlborough and Feltonville. By 1860, the town had a population of 1800 with eight stores, two meetinghouses, 140 houses, and 17 factories employing 975 people. The Washington Street Dam provided the waterpower for the textile and shoe factories. Feltonville was officially set off from Marlborough in 1866, at which time the population was 1,900. A town vote changed the name to Hudson, after local historian and benefactor Charles Hudson.

In 1885, the Goodyear Gossamer Company was established in Hudson to manufacture materials waterproofed by rubber. Lamson's Ice Business opened in 1887, and the Knight Fuel Plant was in operation by the close of the century. A massive fire in 1894 almost completely destroyed Hudson's business district, but by the turn of the century 14 new brick and granite buildings had been built in the town's center. The importance of Hudson's historical structures as symbols of the town's industrial and architectural growth is recognized today, by the Silas Felton Historic District, of which the Washington Street Dam is a contributing element.

The Route 85 Dam in Hudson, also known as the Washington Street Dam, was first constructed c. 1866, and was most recently repaired in 1987. It is likely, however, that earlier dams may have been constructed at this site. A gristmill was built at the natural falls at this location c. 1698, and the first bridge over the Assabet River was built just downstream of the dam by the Town of Marlborough (of which Hudson was once a part) in 1699. The current bridge was built in 1864 and consists of a three-arch stone bridge with an 18-foot span. The bridge and dam are contributing elements of the Silas Fenton Historic District, an area bounded by Cox Square, Main Street, Broad Street, and the Assabet River. The Silas Felton Historic District has been listed on the NR. The dam and bridge are surrounded by modern architecture (a hardware store, gas station and McDonalds), but earlier foundations may be present closer to the water's edge. Since the dam is a contributing structure to the Silas Felton Historic District, removal would have an adverse effect on the NR district. Archaeological resources could also potentially be affected by dam removal. In addition, there may be archaeological resources of the earlier industries present. Historic, photographic, and archaeological documentation may be necessary prior to any work at this site.

Stow

European settlement in the Stow area began during the early to mid-seventeenth century in Sudbury. Hudson was the second settlement in 1666, and Stow was incorporated as a town in 1683. At that time, the area was known as Pompossitticutt. The first white settler was Matthew Boon, on the west side of Boon Hill in 1660. Additional settlements occurred along the Great Road after 1670. Subsistence agricultural and hunting was the economic base for the residents of this area.

Stow was abandoned during King Philip's War, and resettlement began around 1680. The first meetinghouse was built in 1685 in the Lower Village, with the minister's house, which was also a garrison house, being completed in 1687. A second meetinghouse was built in 1711. Settlement shifts in the eighteenth century resulted in three village centers in Stow; Stow Center where the third meetinghouse was built in 1754, the Lower Village (original settlement), and Gleasondale (Rocky Bottom), the industrial village. A saw mill and a grist mill were located at Gleasondale by 1735. Stow had somewhat less desirable topography which resulted in slower development and population growth than in adjacent towns, such as Marlborough.

An increase in population in 1810 was due mainly to the growth of mills at Rocky Bottom (Gleasondale). The Methodist Episcopal Society formed in this village in 1821. There were few exclusively commercial structures built within Stow prior to the mid-nineteenth century. There were several taverns, two stores at the Lower Village by 1816, one store at Stow Center by 1823, and a store in Gleasondale around 1830.

A fire destroyed the mill in Gleasondale in 1852, but the factory was rebuilt in brick and expanded soon after. The population remained relatively stable at around 950 to around 1,000 during the late nineteenth century to early twentieth century. There was little settlement during much of the early to mid-twentieth century with the exception of small growth as a suburb of the manufacturing town of Maynard.

Gleasondale was the only area of expansion in Stow, due to the increase in manufacturing of textiles at the Gleasondale Mill.

The MHC Historic Inventory lists the village of Gleasondale, the Gleasondale Mill, and the Gleasondale milldam and canal as historic resources within the Town of Stow. The village as listed on the Gleasondale Area Form contains over 60 buildings and structures, which date from c. 1750 to the twentieth century. The village emerged as a result of the development of the waterpower on the Assabet River at this location. The first dam to be built on this site was constructed between 1735 and 1750 by an Ebenezer Graves who also constructed a saw and gristmill. After changing hands several times, the mills were purchased in 1776 by Abraham Randall, and the village became known as Randall's Mills. In 1813, a cotton mill was built on the west side of the river, opposite the saw and gristmill. Legend had it that upon building the cotton mill, the workers hit ledge, or Rock Bottom, and the name of the village was changed to Rock Bottom c. 1820. The Randall Mills were bought by Joel Cranston, Silas Felton, and Elijah Hale between 1819 and 1822. By 1820, the mills were being operated under the name Rock Bottom Cotton and Woolen Company.

After changing hands several times again, the mills were purchased by Benjamin W. Gleason and Samuel J. Dale in 1849. The mill building burned in 1852, and the present mill building was constructed in 1854. The mill was owned by succeeding generations of the Gleason family. In 1898, the village's name was changed to Gleasondale. The mill was prosperous through the two World Wars but ended wool production after World War II. It is currently occupied by a number of light industries. The mill is a good example of a Greek Revival style of industrial architecture. The surrounding village retains its cohesiveness and character as a mill community with the Assabet River and the dam at its northern end. The current dam, called the "stone dam" is the third dam at this location. The first dam constructed here was built c. 1735, and the second c. 1836 along with the canal, which extended under the mill building. The current dam was built in 1883 and connected to the existing canal, with a canal gate and overflow spillway to service the C.W. Gleason's Sons textile mill. Although a determination of eligibility has not been made for the dam, mill or surrounding village, it appears that the dam is a contributing element of a potential NR eligible historic district. Removal of the dam would have a possible adverse effect on the village of Gleasondale. It is likely that archaeological resources (pre-contact and post-contact) would also be impacted by dam removal. An updated MHC Inventory Form will also need to be prepared in order to get concurrence with the determination of NR eligibility from the MA SHPO.

Maynard

Much of the land now included in the town of Maynard was a section of the northwest corner of the town of Sudbury added to this plantation town in 1649. The "Two Mile Grant", set aside by the General Court extended north from a line between White Pond in Stow, Willis Pond (Sudbury) and White Pond in Concord to the area just northwest of the Assabet River and Pompositticut or Summer Hill.

The New Grant or Two-Mile Grant Lots were divided and granted to individual families. Early settlement in what was called the "Northwest District" of Sudbury was limited in the late seventeenth century to a few outlying farmsteads. By 1708 only fifteen dwellings had been built in the district, and settlement was quite dispersed.

The population was quite small until the late eighteenth century, with several petitions presented to the General Court to allow the creation of a new parish on the west side of the Sudbury River. Sometime before 1820 a papermill was constructed on the Assabet River near the corner of Summer and Parker Streets and saw, grist, and cider mills had been built near Mill Street. By the early nineteenth century, some clustering of structures began to the south of the William Parker Paper Mill on the Assabet River. These manufactories were the first of many new structures that began to appear in Assabet Village. The impetus for the increase in population and structures was due primarily to the expenditure of capital by a single individual, Amory Maynard.

In 1845, Amory Maynard and William Knight began planning to build a carpet mill. They bought land in Assabet village and water privileges on both sides of the Assabet River. The men wanted to stabilize the potential source of waterpower for the new mill. In 1846, Maynard had the dam constructed across the Assabet just east of the old Ben Smith Bridge. The contract went to his good friend and advisor, Artemus Whitney. At the time Amory Maynard began to purchase land in the village for the mill, Whitney owned the site of the future millpond. Whitney built the dam, canal, the millpond, and the foundation of the mill. Artemus Whitney was one of the original petitioners to the Commonwealth for the incorporation of Maynard in 1871. He was also one of the first assessors and highway surveyors for the town. At the time of incorporation, the population of Assabet Village was twice as large as that of Sudbury or Stow.

The Assabet Manufacturing Company became insolvent in 1898, and it was acquired by the American Woolen Company in 1899. It was at that time the largest woolen mill in the nation, and continued to expand until the year immediately following the end of World War I.

The town of Maynard experienced a rapid growth in population in the late nineteenth century and again after 1900. To accommodate the increase in population, residential development in the center of Maynard expanded. Several subdivisions were built along various streets (Concord, Parker, Waltham), and the American Woolen Company built 160 tenements near its mill complex in 1901 – 1902.

There are multiple historic properties in Maynard associated with the woolen mill complex that are listed or eligible for listing on the NR. These include the Assabet Mills and appurtenant waterpower system, as well as the Sudbury Street Area, Railroad Street Area, Pine Street Area, Martin Street Area, High Street Area (all former mill worker housing areas demonstrating different styles, types and age ranges). The Maynard Downtown Historic District, Main Street Area, and Great Road Area, contain commercial and residential properties associated with the former mills. St. Bridget's Roman Catholic Church served as a house of worship for the immigrants who arrived to work.

The Ben Smith Dam is recorded as a contributing element in the MHC Historic Inventory, Assabet Mills Area Form and as a contributing feature of the Ben Smith Bridge Area. The dam is also recorded on a MHC Historic Inventory Structures Form and is recommended for individual listing on the NR. The Ben Smith Dam was constructed in 1847 of large, dry-laid granite blocks, 1.5 to 2 ft. in depth and 4 to 6 ft. long. The dam is 120 ft. long and 8 ft. high and stretches across the Assabet River.

Shortly after the water-rights were purchased by Amory Maynard in July 1846, the dam was built. This created the opportunity for water to be diverted from the river down a canal to the millpond where it would be used as power for newly constructed carpet mill (Epsilon Associates, Inc. 2006).

Not withstanding the dam's importance to the development of Maynard's industry, it is also associated with a well-known local figure. Removal of the dam would constitute an adverse effect to a NR eligible historic resource and an adverse effect on the Assabet Mills Historic District, and perhaps other districts, sites or structures associated with the mills. Archaeological resources could be affected as a result of a drawdown of the impoundment. Removal of the Ben Smith Dam would have the largest negative impact on the historic industrial resources along the Assabet River.

Acton

The present-day town of Acton was originally contained within a parcel of land granted to a Mr. Wheeler of Concord by the Massachusetts General Court in 1643. The tract was originally known as New Village or Concord Village. Acton's early economy based primarily on pasturing sheep and cattle as well as subsistence agriculture. Industries during this early period between 1660 and 1670 included Thomas Wheeler's grist mill on

Nashoba Brook, and the extraction of bog iron and charcoal production for a small iron smelting operation in West Concord.

Settlement in Acton did not begin in earnest until after King Philip's War, although dwellings continued to remain sparse throughout the eighteenth century. Acton remained a part of Concord until 1735 when it was incorporated as a separate town. The following year the first meetinghouse was built adjacent to the town common. There were two main areas of development, East Acton and South Acton. Small industry developed in South Acton along streams such as Nashoba and Fort Pond brooks and included saw, grist, and fulling mills. Coopering was another important activity. Taverns were established in Acton Center, South Acton, and along the Great Road in the mid to late eighteenth century. Acton's town center began to form at this time. Acton Center became the focus of government and religious activity while an industrial/commercial district developed in South Acton near sufficient waterpower.

The shoe and boot industry, long a cottage industry, increased with the establishment of a shoe and boot factory by John Fletcher in 1815. This industry reached its peak during the Civil War, but did remain an active component of the town's economy until the end of the nineteenth century.

The manufacture of gunpowder at mills along the Assabet River began in 1835. Nathan Pratt is credited with starting what was then known as the Acton Powder Mills when he constructed a dam across the Assabet River to power the mill's machinery. The mills were built on the former site of a saw mill. The American Powder Company, incorporated in 1842, was located adjacent to the river on the Acton/Maynard town line. The most hazardous of the powder company's processes were geographically isolated from the mill and were situated in Powder Mill Woods. Other manufacturers operating during this period were the boot and shoe factory, laundry bluing manufacturers, and a woodenware factory in West Acton. A piano stool factory and a wool shoddy mill operated in South Acton.

The American Powder Company expanded it facilities during the late nineteenth century to include the production of smokeless powder and owned several hundred acres land in the towns of Acton, Maynard, Concord, and Sudbury. A small nucleus of residential and commercial buildings called Powder Mill Village developed along the present Route 62.

The American Powder Company mills reached a peak of production during World War I with the exportation of gun-cotton to Russia. A victim of the Great Depression, the American Powder Mills closed in 1940. The facilities were purchased by American Cyanamid and Chemical Company which manufactured smokeless powder during World War II. Powder production came to an end after the war. The Dewey and Almy Chemical Company purchased the mills in 1954 and produced synthetic rubbers products.

The Powdermill Dam in Acton appears to be a historic timber-crib dam with a rock face. The first dam at this site was pre-1835. While portions of this dam could be from the original construction, it appears to have been partially reconstructed and repaired, perhaps as part of the development of hydropower at this site. There is a small, brick building adjacent to the dam, which contains a turbine. This building has the date 1923 cast into concrete in the center face of the structure.

Powdermill Dam is located at the site of historic manufacturing activity, so removal of the dam could possibly have an effect on significant historic or archaeological resources. However, the current owner holds an exemption from licensing from FERC, has repaired the dam, and is/or will soon be generating power. The current owner does not plan to remove the dam..

CONCLUSIONS

The Aluminum City Dam in Northborough does not appear to be eligible for the NR. While there is a possibility that the dam is associated with an adjacent structure, the structure has been extensively modified as has the area surrounding the dam. However, dam removal, dredging, and possible staging areas all have the potential to affect archaeological resources. An archaeological reconnaissance survey is recommended if any alternatives are chosen that would impact this site.

The Allen Street Dam, as part of the Woodside Area appears to be potentially eligible for the NR. An intensive archaeological survey is recommended if dam removal and/or dredging are planned for this structure. There are visible stone foundations most likely relating to earlier industries at this area. There is also the possibility that intact pre-contact archaeological resources may be present. Photographic and historic documentation of the dam, factory, and surrounding village will most likely be necessary if removal of the dam is considered. An updated MHC Inventory Form will also need to be prepared in order to get concurrence with the determination of NR eligibility from the MA SHPO.

The Route 85 Dam in Hudson, also known as the Washington Street Dam is a contributing structure to the Silas Felton Historic District. Dam removal will have an adverse effect on the NR district. Pre-contact and industrial archaeological resources could also potentially be affected by dam removal. Historic, photographic, and archaeological documentation may be necessary prior to any work at this site. The determination of effect will be coordinated with the SHPO and the THPOs as part of this study.

The Massachusetts Historical Commission Inventory lists the village of Gleasondale, the Gleasondale Mill, and the Gleasondale milldam and canal as historic resources within the town of Stow. Although a formal determination of eligibility has not been made for the dam, mill or surrounding village, it appears that the dam is a contributing element of a NR eligible historic district, so removal would be considered an adverse effect on the village of Gleasondale. It is likely that archaeological resources (pre-contact and post-contact) would also be impacted by dam removal. An intensive archaeological survey is recommended prior to any work at this site. An updated MHC Inventory Form will also need to be prepared in order to get concurrence with the determination of NR eligibility from the MA SHPO.

The Ben Smith Dam in Maynard has been determined individually eligible for the NR as well as a contributing element of the Assabet Mills Historic District. The dam is historically important to the development of Maynard's industry as well as the development of the town itself. Removal of the dam would constitute an adverse effect to a NR eligible historic resource and an adverse effect on the Assabet Mills Historic District, and perhaps other districts, sites or structures associated with the mills. Archaeological resources could be affected by the associated drawdown of the impoundment after dam removal. Removal of the Ben Smith Dam would have the largest negative impact on the historic industrial resources along the Assabet River.

Powdermill Dam in Acton is located at the site of historic manufacturing activity, so removal of the dam could possibly have an effect on significant historic or archaeological resources. However, the current owner holds an exemption from licensing from FERC, has repaired the dam, and is or will soon be generating power. The current owner does not plan to remove the dam.

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APPENDIX G

REAL ESTATE INFORMATION
(January 2007)

REAL ESTATE APPENDIX
ASSABET RIVER, MASSACHUSETTS

The purpose of this Appendix is to present information on ownership of the six dams of interest to the study. This research is provided for planning purposes only. If the deed did not specify that the owner of the property is also the owner of the dam (although indications are that the owner of the property is the owner of the dam), then the chain of tile was included in the research. Information from the National Inventory of Dams was also reviewed. This work was completed in January 2007.

DAM NAME	TOWN	ID	Year Completed
Aluminum City Dam	Northborough	MA02843	1925
Allen Street Dam	Northborough	MA00995	1900
Hudson Dam	Hudson	MA00447	1860
Gleasondale Dam	Stow	MA00820	1924/1883
Ben Smith Dam	Maynard	MA00752	1850
Powdermill Dam	Acton	MA00128	1921

Northborough
Aluminum City (Old Mill Pond) Dam

Location: Dam is located off Main Street, Northborough (between Assessor's Map 64, Lot 21 and Lot 20)
National Inventory of Dams: NID ID: MA02843
County: Worcester
River: Assabet River

Owner: 86-88 Main Street LLC (Map 64, Lot 21 & adjoining Lot 22)
P.O. Box 253
Southborough, MA 01772

Following is chain of title: Note: This is the parcel that has Ernest Laurence in the chain of title and NID states the owner as John F. Laurence.

Grantor/Grantee: RSJ Realty Co., Inc. to 86-88 Main Street, LLC
Worcester Registry of Deeds, Book 25203, page 336
Consideration: $520,000
Dated: November 7, 2001

This deed includes 2 parcels, parcel #21 containing 9,583 SF of land (with improvements) that runs along the river and parcel #22 containing 4,356 SF of land (with improvements) that runs west of parcel #21. There is a 12-foot wide easement on the east side and one on the west side of parcel #21 (west of Assabet River). Deed states that the dam is not to be raised above its height as it was in 1881 and the grantee, heirs, assigns, etc. has the right to enter upon land of Eames (east of Assabet River) on east side of stream to repair said dam.

Grantor/Grantee: Ronald P. Aspero to RSJ Realty Co., Inc.
Worcester Registry of Deeds, Book 12372, page 168
Consideration: $100,000
Dated: October 2, 1989
This includes 2 parcels, same as above.

Grantor/Grantee: Judith Ellis Pucci, f/k/a Judith G. Ellis to Ronald P. Aspero
Worcester Registry of Deeds, Book 11114, Page 295
Consideration: $165,000
Dated: February 5, 1988
This includes 2 parcels, same as above.

Grantor/Grantee: John L. Ellis, Jr. to Judith G. Ellis
Worcester Registry of Deeds, Book 8094 Page 1
Consideration: Less than $100
Dated: February 24, 1984
This includes 2 parcels, same as above.

Grantor/Grantee: John L. Ellis, Jr. to John L. Ellis, Jr. and Judith G. Ellis
Worcester Registry of Deeds, Book 7727, Page 18
Consideration: Less than $100
Dated: April 11, 1983
This includes 2 parcels, same as above.

Grantor/Grantee: Judith G. Ellis, f/k/a Judith G. Kwiat to John L. Ellis, Jr.
Worcester Registry of Deeds, Book 7083, Page 86
Consideration: Less than $100
Dated: September 12, 1980
This includes 2 parcels, same as above.

Grantor/Grantee: Alice Laurence, a/k/a Alice E. Laurence to
John L. Ellis, Jr. & Judith G. Swiat, as joint tenants
Worcester Registry of Deeds, Book 6782, Page 172
Consideration: Less than $42,900
Dated: July 20, 1979
This includes 2 parcels, same as above.

Grantor/Grantee: Estate of Emma L. Cranston to Ernest Laurence and Alice Laurence, as tenants by the entirety
Worcester Registry of Deeds, Book 2805, Page 571
Consideration: $1,500
Dated: January 30, 1941
This was Lot 22, 86 Main St. (the parcel not on river).

Grantor/Grantee: Hermon L. Sparrow to Ernest C. Laurence
Worcester Registry of Deeds, Book 2699, Page 583
Consideration: $1,000
Dated: July 2, 1937
This lot is upstream of river & along west side of river.

The property consists of a commercial, mixed-use structure that contains office space and residential units. The structure is very close to the river. The dam is located a short distance from the bridge.

Water Rights: The parcel located east of the Assabet River has water rights to the Assabet River. The owner of this property (Map 64, Lot 20 & Lot 19) is as follows:

Stone Euclid L. & Kelly Susan E. Trsts.
Euclid Stone Trust
94 Main Street
Northborough, MA 01532

Staging Area for Dam Removal: The property adjacent to the Assabet River, owned by Euclid Stone Trust (which also has deeded water rights to the Assabet River), has a large, unimproved area adjacent to the river that could be utilized for a contractor's staging area for dam removal.

Northborough
Allen Street Dam (Gothic Craft Dam)

Location: Dam is located at 200 Hudson Street (between Hudson & Allen Street) Northborough, Assessor's Map 46, Lot 95
National Inventory of Dams: NID ID: MA00995
County: Worcester
River: Assabet River

Owner: Montrose Northborough LLC
C/o Micozzi Management Inc.

159 Cambridge Street, 3rd floor
Allston, MA 02134

Following is chain of title:

Grantor/Grantee: MLS Associates Limited Partnership to Montrose Northborough LLC (Note: NID ID still lists MLS Associates as owners.)
Worcester Registry of Deeds, Book 2110, page 139
Consideration: $2,140,000
Dated: March 2, 1999
Grantor/Grantee: Mark L. Schmid to MLS Associates
Worcester Registry of Deeds, Book 18503, page 156
Consideration: $400,000 plus assumption of a note and mortgage
Dated: December 27, 1996

The property consists of a multi-unit apartment complex that contains 8 residential units on 1.85 acres of land. The apartment unit spans both sides of the river, with most of the units being located on Hudson Street and a few having frontage on Allen Street. The structure is very close to the river. The dam is located a short distance from the bridge.

Staging Area for Dam Removal: At this site, the contractor's staging area could be on the southwesterly portion of the property, Map 46, Lot 95, which contains 1.85 acres of land. Also, additional space for access or staging, could be obtained from the abutting commercial property owner (Richard Record & Son, Inc., Map 46, Lot 96), a 2.62 acre parcel having 52± feet of frontage on Allen Street, 271± feet of frontage on the Assabet River, and 260± feet of frontage on Allen Court. Both properties have easy access to the dam, are level flat, and have sufficient open space for a staging area.

Hudson
Hudson Dam (Washington Street, Route 85 Dam):

Location: Dam is located on Washington Street (Rt. 85), Hudson, MA and shown on Assessor's Map 29, Lot 275 and Lot 38
National Inventory of Dams: NID ID: MA00447
County: Middlesex
River: Assabet River

Owner: Town of Hudson (Light & Power Department)
Town Hall, Main Street

Hudson, MA 01749

Grantor/Grantee: Hudson Properties, Inc. to Inhabitants of the Town of Hudson
Middlesex Registry of Deeds, Book 9154, page 278
Consideration: $12,000
Dated: May 24, 1958

Grantor/Grantee: Broad's Garage Inc. to Hudson Properties, Inc.
Middlesex Registry of Deeds, Book 9154, page 273
Consideration: Less than $100
Dated: May 22, 1958
Note: According to town of Hudson, there is a question as to whether the town gave the property to Hudson Light & Power in the 1980's. Hudson Light & Power wanted to remove the dam, but the town didn't want it removed, so they transferred ownership back to the town.

The town has a letter from Anthony Monteiro (then project manager) of Notice of Project Alteration for the Washington Street Hydro Project and a copy of Environmental Notification Form, dated March 15, 1985, wherein Hudson Light & Power sets forth its ownership of the Dam. There is mention in the 1986 Annual Report of the Hudson Light & Power referencing the Department's progress for the hydro-electric project at the Washington Street Dam. There is nothing in the town records that indicate a transfer of the Washington Street Dam back to the town from the Light & Power. However, Article 33 of the Annual Town Meeting of May 5, 1980, the town opposed a study to repair the Washington Street Dam.

Staging Area for Dam Removal: The town owns property abutting the dam that might be used for construction staging areas

Stow
Gleasondale Dam

Location: Assabet River, Off Gleasondale Road, Assessor's Map U-8, Lot 4
National Inventory of Dams: NID ID: MA00820
County: Middlesex
River: Assabet River

Owner: F L B Inc.
501 Gleasondale Road
Stow, MA 01775

Following is chain of title:

Book 12601, page 82 $185,000 March 15, 1974
Assabet Realty Trust to F.L.B. Corp.

This includes 3 parcels with improvements, parcel #1 contains 15 square rods (4,083.75 square feet); parcel #2 contains 4.54 acres, and parcel #3 encompasses the 3 reservoirs that were reserved from deed of M.J. Stevens & Sons to Jennie V. McClellan on August 16, 1944 (Book 6790, page 554).

Book 11149, Page 429 $85,000 June 28, 1966
Colrow Realty Trust to Assabet Realty Trust

This includes parcel #1, #2, and #3 which covers 3 reservoirs excepted in the description of 10^{th} parcel in deed from M.T. Stevens & Sons Co. to Jennie V. McClellan (Book 6790, page 554).

Book 10058, Page 270 $77.55 in stamps June 19, 1962
L.O. Nichols et al to Colrow Realty Trust

This includes parcel 1, together with all rights to & in to land under river & canal. Parcel 2, containing 4.54± acres, of land comprising the mill property by Assabet River, over the river & canal formerly of McClellan. Parcel 3 Consists of land covered by 3 certain reservoirs excepted on description of 10^{th} parcel in deed from M.T. Stevens & Sons Co. to Jennie V. McClellan (Book 6790, page 554).

Book 6790, Page 554 $22.00 in stamps August 16,1944
M.T. Stevens & Sons Co. to Jennie McClellan

The town of Stow has a note on the deed , recorded in the South Middlesex Registry of Deeds Book 12601, Page 82, from Russell Robb III and Leslee W. Robb, Trustees of Assabet Realty Trust, that lists the address of F.L.B. Inc., as Gleasondale Industrial Park, Route 62, Stow, MA

Note: The town shows the parcel containing 4.54 acres of land (the deed states 4.63 acres plus 3 reservoirs) and is improved with industrial buildings. The previous deed mentions the dam; this previous deed also mentions all water rights appurtenant to the premises conveyed and subject to all easements of flowage. The grantor reserved the fee in the canal and the right to go upon so much of the premises conveyed as necessary for purposes of operating (etc.) the old bridge (etc.).

Staging Area for Dam Removal: There is ample, unimproved land adjacent to the dam to accommodate a staging area and access to and from the dam.

Maynard
Ben Smith Dam (Cock Tower Place)

Location: Dam is located on the Assabet River, Assessor's Map 18, Lot 201
National Inventory of Dams: NID ID: MA00752
County: Middlesex
River: Assabet River

Owner: Wellesley/Rosewood/Maynard Mills Limited Partnership
80 Waverly Street
Framingham, MA 01702

Grantor/Grantee: Wellesley/Rosewood Mills, LLC to
Wellesley/Rosewood/Maynard Mills Limited Partnership
Middlesex Registry of Deeds, Book 27896, Page 474
Consideration: Nominal
Dated: September 5, 1997

Company also owns adjoining properties (Map 19, Lot 29; Map 14, Lot 201; Map 19, Lot 266; and Map 19, Lot 272). Originally built to divert water into Mill Pond to run the mills (generate electricity). The owners recently repaired the dam and they have a FERC license to generate electricity at the ponds; the water goes from the Assabet River into a canal and then into Mill Pond. Dredging could be done at the water capture area and behind the dam (the algae that accumulates behind the dam causes an odor).

Staging Area for Dam Removal: The owners of the dam also own the adjoining land that could be utilized for access and for a staging area for either dam removal or dredging.

ACTON
Powdermill Dam

Location: Dam is located on the Assabet River, 305 & 316 Old High Street
Assessor's Map J3, Lot 41-1 and 33-2

National Inventory of Dams: NID ID: MA00128
County: Middlesex
River: Assabet River

Owner: Acton Hydro Company, Inc.
9 Mayflower Road
Northborough, MA 01532

Owner/Representative: Michael E. Coates
9 Mayflower Road
Northborough, MA 01532
Tel: 508-351-6023

Grantor/Grantee: A & D Hydro, Inc. /Acton Hydro Company, Inc.
Middlesex Registry of Deeds, Book 28063, Page 306
Consideration: $20,000
Dated: January 9, 1998

Acton Hydro Co., Inc. has filed a Notice of Intent with the Acton Conservation Commission seeking permission to remove, fill, dredge or alter an Area Subject to Protection under the Wetlands Protection Act.

They (Acton Hydro Co.) has a FERC application (FERC Project No. 7148-MA) to renovate/repair the dam and sell power to Concord Electric.

Staging Area for Dam Removal: There appears to be potential staging areas near the dam. Ownership of lands would need to be determined and appropriate construction easements obtained.

APPENDIX H

PHOTO DEPICTIONS OF DAM REMOVALS

Massachusetts Department of ENVIRONMENTAL PROTECTION

US Army Corps of Engineers®

CDM

Existing

Aluminum City Dam

Northborough, MA

September 12, 2007

Photo-Simulation
Aluminum City Dam Removal
Assabet River
Northborough, MA

Massachusetts Department of Environmental Protection
US Army Corps of Engineers®
CDM

September 12, 2007

Massachusetts Department of Environmental Protection

US Army Corps of Engineers®

CDM

Existing Impoundment

Allen Street Dam

Northborough, MA

Photo Taken October 12, 2007 by Thomas Haas Associates

Photo Simulation
Allen Street Dam Removal
Assabet River
Northborough, MA

Massachusetts Department of Environmental Protection
US Army Corps of Engineers
CDM

Massachusetts Department of Environmental Protection

US Army Corps of Engineers

CDM

Existing

Hudson Dam

Hudson, MA

September 12, 2007

Massachusetts Department of Environmental Protection

US Army Corps of Engineers®

CDM

Photo-Simulation

Hudson Dam Removal

Assabet River

Hudson, MA

September 12, 2007

Massachusetts Department of Environmental Protection

US Army Corps of Engineers®

CDM

Existing Impoundment

Hudson Dam

Hudson, MA

Photo Taken
October 12, 2007 by
Thomas Haas Associates

Massachusetts Department of ENVIRONMENTAL PROTECTION

US Army Corps of Engineers®

CDM

Photo Simulation
Hudson Dam Removal

Assabet River

Hudson, MA

Massachusetts Department of Environmental Protection

US Army Corps of Engineers®

CDM

Existing

Gleasondale Dam

Stow, MA

Photo Taken
September 12, 2007

Massachusetts Department of Environmental Protection

US Army Corps of Engineers®

CDM

Photo-Simulation
Gleasondale Dam Removal

Assabet River

Stow, MA

Photo Taken
September 12, 2007

Massachusetts Department of ENVIRONMENTAL PROTECTION

US Army Corps of Engineers®

CDM

Existing Impoundment

Gleasondale Dam

Stow, MA

Photo Taken
October 12, 2007 by
Thomas Haas Associates

Photo Simulation
Gleasondale Dam Removal
Assabet River
Stow, MA

Massachusetts Department of Environmental Protection
US Army Corps of Engineers
CDM

Massachusetts Department of ENVIRONMENTAL PROTECTION

US Army Corps of Engineers®

CDM

Existing

Ben Smith Dam

Maynard, MA

Photo Taken
September 12, 2007

Photo-Simulation
Ben Smith Dam Removal
Assabet River
Maynard, MA

Massachusetts Department of Environmental Protection
US Army Corps of Engineers
CDM

September 12, 2007

Massachusetts Department of Environmental Protection

US Army Corps of Engineers

CDM

Existing Impoundment

Ben Smith Dam

Maynard, MA

Photo Taken
October 12, 2007 by
Thomas Haas Associates

Massachusetts Department of Environmental Protection

US Army Corps of Engineers

CDM

Photo Simulation
Ben Smith Dam Removal
Assabet River
Maynard, MA

Photo Taken
October 12, 2007 by
Thomas Haas Associates

APPENDIX I

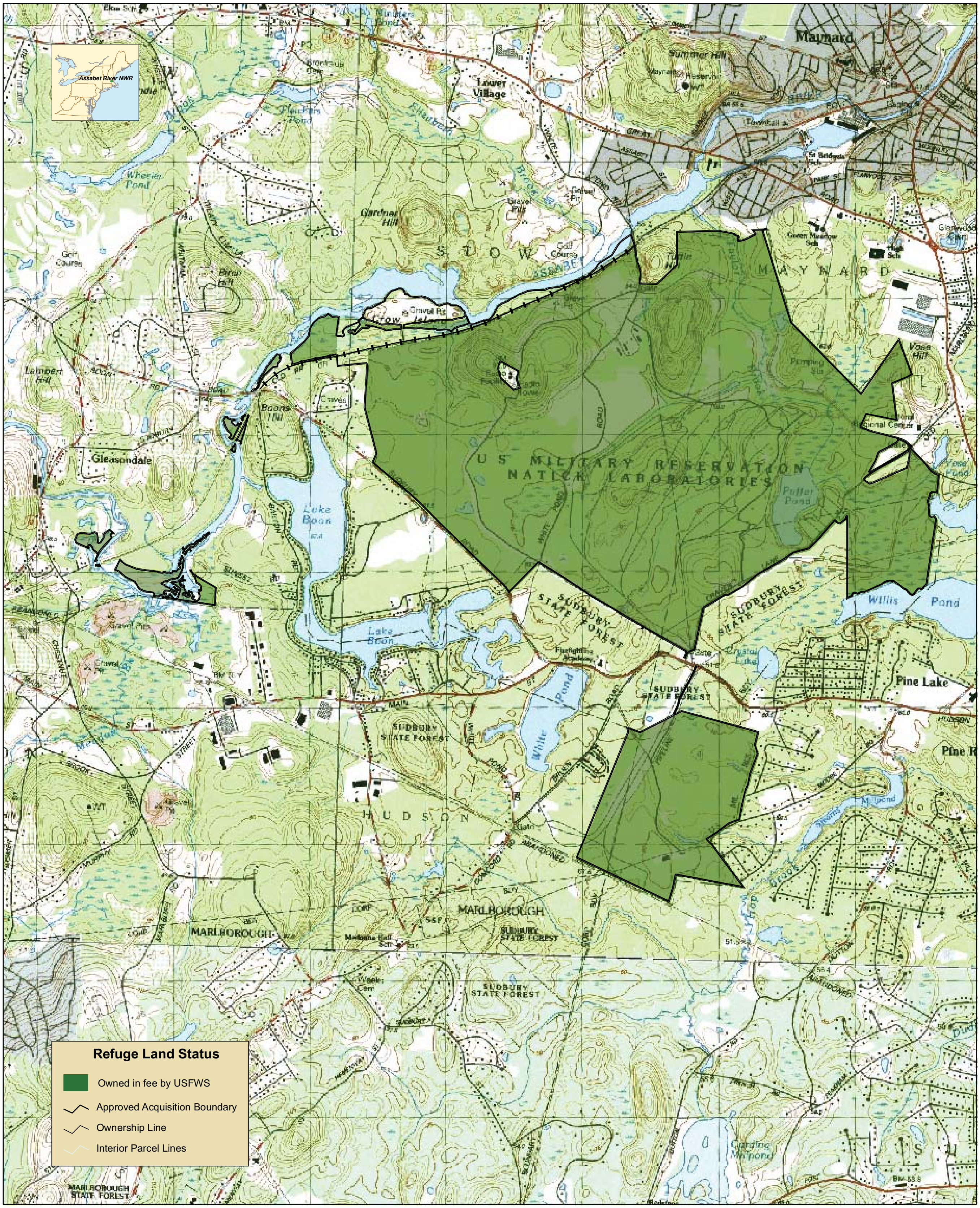
ASSABET RIVER NATIONAL WILDLIFE REFUGE

U.S. Fish & Wildlife Service

Land Status

Assabet River National Wildlife Refuge

Middlesex County, Massachusetts



Produced in the Division of Realty, Hadley, Massachusetts
Land Status Current to: Calendar Date not entered for Asr_FwsInterest
Basemap: USGS 1:24,000 topographic map
Refuge boundaries: compiled from USFWS sources
Datum & Projection: NAD_1983_UTM_Zone_19N
Map Print Date: 9/10/2008

0 0.125 0.25 0.5 0.75 1 1.25 Miles

0 0.2 0.4 0.8 1.2 1.6 2 Kilometers

1:20,016

This map is designed for refuge management.
It is not intended for use as a land survey or
as a representation of land for conveyance or tax purposes.
For more information visit the USFWS Northeast Region GIS
website at http://northeast.fws.gov/gis/

APPENDIX J

MILL PONDS AT BEN SMITH DAM

CDM

Memorandum

To: *Barbara Blumeris, USACE*

From: *Catherine Chomat and Kirk Westphal, CDM*

Date: *June 8, 2007*

Subject: *Mill Ponds at Ben Smith Dam*

Overview

The purpose of this memorandum is to provide a summary of the evaluation performed by CDM regarding the relationship of Ben Smith dam and the Mill Ponds water level. A site visit was conducted on May 23, 2007 to identify critical hydraulic control points and gather additional information to evaluate the relationship between the dam and water level in the ponds. The information gathered was used to assess potential changes in water levels in the Mill Ponds and is summarized in this memorandum.

Background Information

Ben Smith Dam was constructed across the Assabet River in 1847 to establish a mill for the manufacture of carpets and carpet yarn. In order to power the mill, a canal was dug to channel a portion of the river into what is called Mill Pond. The mill changed hands several times over the years and was converted to hydroelectric power in 1902. While the mill ceased operation in 1950, the buildings remain and the mill complex, currently known as Clock Tower Place, currently houses numerous businesses. Power generation was discontinued in the early 1990s.

The removal of six dams along the mainstem of the Assabet River is currently being evaluated. Removal of the Ben Smith dam is one option currently under consideration. However, there is concern that removing the dam would impact water level in the Mill Ponds which, in addition to aesthetic value, provide water storage for fire protection for the Town of Maynard.

Description of Mill Pond System

Ben Smith Dam and the Mill Ponds are located approximately 25 miles west of Boston in the Town of Maynard, Middlesex County, Massachusetts. Ben Smith Dam consists of a 170-foot long and 9.5-foot high granite-block dam with a crest elevation of 177.0 feet above mean sea level[1].

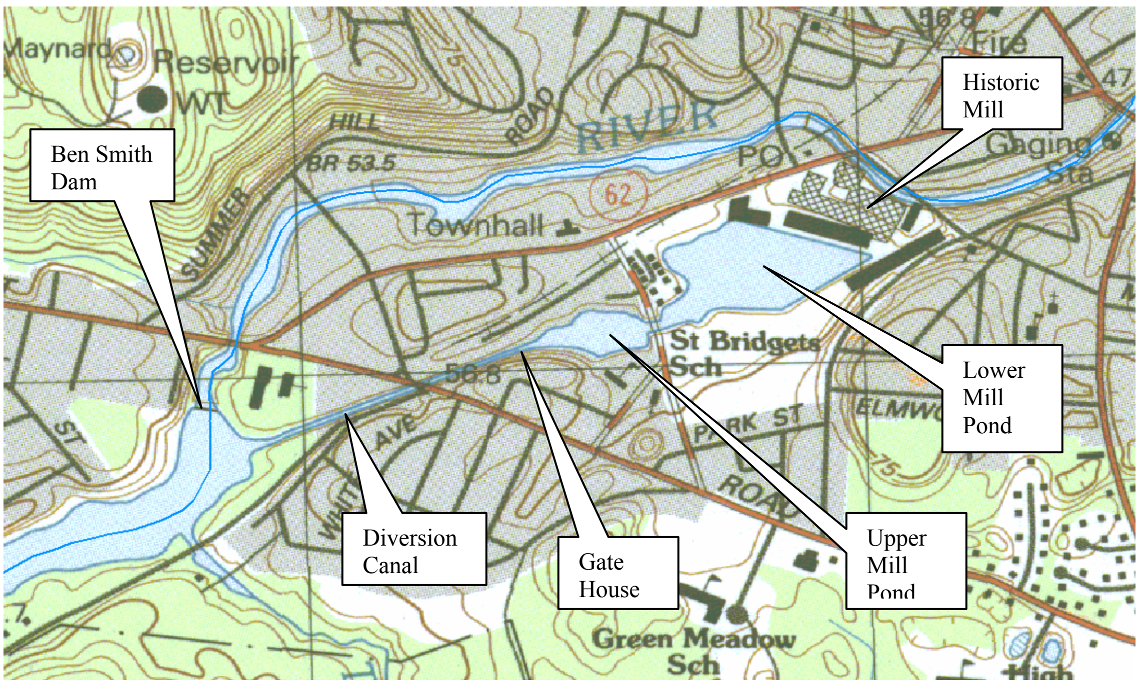


Figure 1. Ben Smith Dam and Mill Pond System

The Mill Ponds are fed with water from the 146-acre Ben Smith impoundment[2] via a 1,600 foot-long man-made canal. The canal begins as a 58-foot wide channel on the northeast shore of the Ben Smith impoundment, quickly narrowing to a relatively uniform width of approximately 40 feet[3]. When the water level in the Ben Smith impoundment is at the crest of the dam, water depths within the canal range from 2 feet at the diversion intake to 5 feet in the narrower portion of the channel[4]. A gate house, located two-thirds of the way between the Ben Smith impoundment and Upper Mill Pond, controls the flow of water entering the ponds with two 6-foot wide manually controlled gates. Water exits Lower Mill Pond through the powerhouse, passing through twin tailrace tunnels before rejoining the Assabet River about 5,400 feet downstream of Ben Smith Dam.

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[1] From 2004 FERC Report.
[2] Impoundment size was obtained from the 2003 USGS Report (Table 10).
[3] Canal widths as reported in 2004 FERC Report.
[4] Water depths based on field measurements collected on May 23, 2007. Water depths could not be collected at the center of the channel at the canal intake point and may be slightly deeper.

The Mill Pond system has a combined surface area of 18.3 acres and an estimated storage capacity of 52 million gallons[5].

Based on field measurements collected during the May 2007 site visit, there is approximately 1-foot of elevation difference between the Ben Smith Dam crest elevation and the Upper Mill Pond water surface. It is assumed that this water elevation is roughly the normal pool in the Mill Ponds.

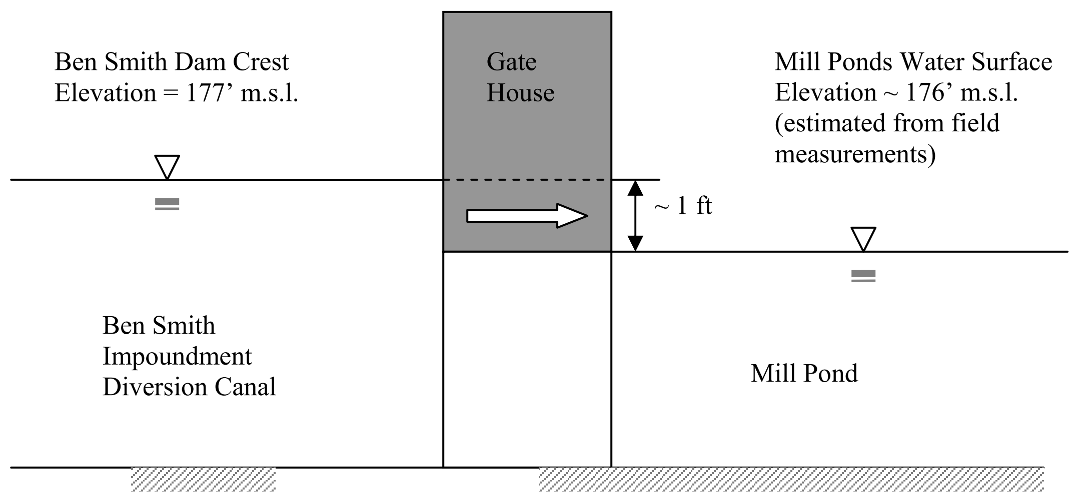


Figure 2. Mill Ponds Hydraulic Control Points

The entire system is regulated by a guideline established by the federal Fish and Wildlife Service whereby flow down the main channel of the Assabet River should be maintained at the lesser of 39 cubic feet per second (based on August 1981 median flow) or the inflow into the system. According to an Order issued April 19, 2007 by the Federal Energy Regulatory Commission (FERC), the current owner of the historical mill buildings, Wellesley Rosewood Maynard Mills, L.P. (WRMM) will be installing new gates that will function as a weir along with flow monitoring equipment to ensure that this low flow limit is maintained prior to diversion of water out of Assabet River for the Mill Ponds.

[5] From 2004 FERC Report.

Impacts of Dam Removal on Mill Pond System

If the Ben Smith Dam were removed, the Mill Ponds would no longer receive natural flow from the Assabet River. There is approximately a 1-foot difference between the Ben Smith impoundment water surface and normal pool elevation in the Mill Ponds. Therefore, lowering the dam crest by more than 1 foot would render it impossible to feed the Mill Ponds by gravity from the current diversion canal inlet point. Direct drainage into the Mill Ponds is insignificant compared to inflow from the Assabet River.

As a result, if Ben Smith Dam were to be removed, water would need to be diverted from a point further upstream or pumped into the Mill Ponds in order to maintain the current levels.

Potential Mitigation Options

Pump Water from Assabet River

USGS gage records indicate that water could be diverted out of the Assabet River, on average, on all but 64 days per year. This is based on 65 years of daily flow records from the USGS gage at Maynard (located approximately 2 miles downstream of Ben Smith Dam) and the 39 cfs minimum flow requirement for Assabet River. The distribution of low flow days is shown on Figure 3. As expected, less water could be pumped during the summer months.

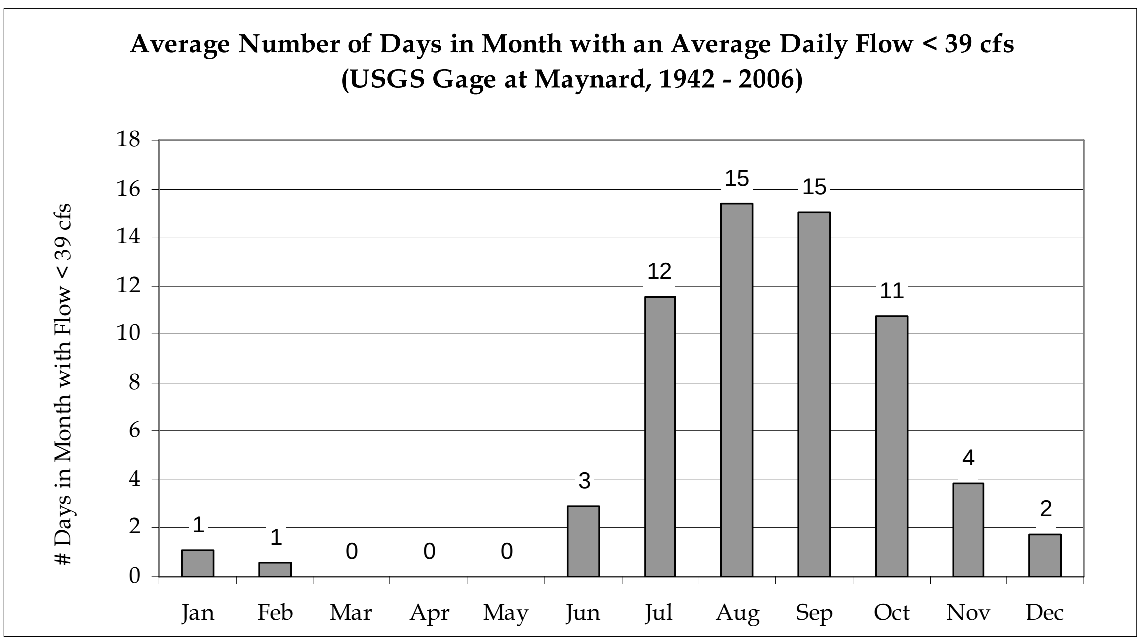


Figure 3. Distribution of Low Flow Days at Maynard USGS gage (relative to August 1981 median flow)

With Ben Smith Dam in place, water currently flows from the impoundment into the Mill Ponds. While the water may have lower quality due to stagnation within the impoundment, water is usually available and the Mill Pond system water is frequently flushed. If the dam were removed and water were to be pumped into the Mill Ponds from the Assabet River, the result could be improved water quality flowing into Mill Pond but this water would be less available, especially during the summer months. Also, during low flow periods when water could not be pumped out of the Assabet River, increased stagnation would occur within Mill Pond. Water quality impacts, such as low dissolved oxygen resulting from increased stagnation, could be offset by installing an aeration system.

Diversion of Water from an Alternate River Location

If Ben Smith Dam were removed, the Assabet River water level at the current canal intake point would drop such that in order to direct water into the Mill Ponds by gravity, the intake location would need to be modified to a point further upstream (i.e., to remain higher than the Mill Ponds normal pool elevation). Due to the mild bed slope upstream of Ben Smith Dam, an intake along the Assabet River channel may not be feasible.

References

Zimmerman, M.J. and Sorenson, J.R., *Sediment Studies in the Assabet River, Central Massachusetts, 2003,* USGS Scientific Investigations Report 2005-5131.

Order Accepting Surrender of Exemption, Federal Energy Regulatory Commission (FERC) and Wellesley Rosewood Maynard Mills, L.P. (WRMM), Project No. 5018-004, July 13, 2004.

The Maynard Web. Retrieved June 6, 2007 from:
http://web.maynard.ma.us/history/mill-history.htm
(including the Massachusetts Heritage Landscape Inventory Program's *Maynard Reconnaissance Report*)

APPENDIX K

COMMENTS AND RESPONSES

Appendix K

Comment Letters and Responses on the Draft Report

The Draft Planning Assistance to States Study "Assabet River Sediment and Dam Removal Feasibility Study" was completed in September 2009 and local public informational meetings (two) held on the draft report in November 2009 to obtain local input.

Comment letters demonstrate that the local communities and stakeholders value the existing impoundments and dams for many reasons including: recreation, aesthetics, wetlands, fish and wildlife communities, historic and cultural significance, and as a water source for fire protection and irrigation.

Stakeholders are concerned about the potential public health risk of exposure to sediments currently under water, the cost of a dam removal project including the potential cost of sediment management, disruption during construction, potential impact on the real estate values of adjacent homes, potential impacts to business or local residents that rely on the impoundments or groundwater near the river as a source of water, potential increase in flood risk, and loss of recreation associated with the impoundments. There were many letter received opposed to dam removal on the Assabet River. Stakeholders are strongly opposed to further consideration of Ben Smith dam removal.

Comment letters also raised the issues of wastewater treatment plant permitting, year round phosphorus limits, and an adaptive management approach to improve water quality in the Assabet River. Comments received on the draft and responses are included below.

List of comment letters received on the Assabet River, Massachusetts, Sediment and Dam Removal Feasibility Study, dated September 2009				
	NAME	**ORGANIZATION**	**ADDRESS**	
1	Antil, Vincent		19 Hiley Brook Road	Stow
2	Barstow, Dan & Eva		99 Pine Point Road	Stow
3	Blazar, Paul	Town of Hudson	78 Main St.	Hudson
4	Bolton, Richard & Dorothy		1 Apple Blossom Way	Stow
5	Brown, Peg	Maynard Historical Commission	195 Main Street	Maynard
6	Bunge, Kurt		72 Summer Hill Road	Maynard
7	Carstens, Kay		21 Crane Ave.	Maynard
8	Case, Karen & Andrew		57 Apple Blossom Lane	Stow
9	Chapman, Michelle		8 Shore Ave.	Stow
10	Clifford, Janet		5 Shore Ave.	Stow
11	Collings, Bob			Stow
12	Collings, Bob			Stow
13	Cutlter, Robert & Mary		461 Gleasondale Road	Stow
14	DiPietro, Alan & Beth		4 Riverside Park	Maynard
15	Dipietro, Jeri & Alan		506 Gleasondale Road	Stow

16	Dungan, Stephen	Stow Board of Selectmen	380 Great Road	Stow
17	Dwyer, John	Maynard Conservation Commission	4 Durant Avenue	Maynard
18	Field-Juma, Alison	Organization for the Assabet River	9 Damonmill Square	Concord
19	Finnila, Mildred			Maynard
20	Gavin, David	Maynard Board of Selectmen		Maynard
21	Hayden-Ruckert, Gretchen			
22	Jones, Barbara & Gregory		61 Sudbury Road	Stow
23	Lankau, Walter E.	Stow Acres Country Club	58 Randall Road	Stow
24	Martin, Richard S.	Honey Pot Hill Orchards	91 Boon Road	Stow
25	Maxfield, William		89 Walcott Street	Stow
26	McDonald, Robert C.			Stow
27	Mead, Len & Amanda		22 Taft Avenue	Maynard
28	Noone, Gerald		35 Forest Road	Stow
29	Noone, Patricia & Gerald		35 Forest Road	Stow
30	Rabaut, Susan			Hudson
31	Raskin, Melissa and Michael		12 Riverside Park	Maynard
32	Rising, Donald			Stow
33	Ross, Warren and Tammy		20 Taft Avenue	Maynard
34	Ruckert, George			Stow
35	Sangermano, John		285 Talyor Road	Stow
36	Schultz, Michael & Erica		220 Barton Road	Stow
37	Sipler, Dwight		493 Great Road	Stow
38	Sonnichsen, Dorothy		101 Packard Rd.	Stow
39	Steppacher,Lee	Sudbury, Assabet and Concord Wild and Scenic River Stewardship Council, National Park Service	15 State St.	Boston
40	Teska, Kirk		218 Sudbury Road	Stow
41	Coates, Michael	Acton Hydro Co., Inc.	316 Old High Street	Acton
42	name not provided	Westborough WWTF	238 Turnpike Road	Westborough

1. Vincent Antil, 19 Hiley Brook Road, Stow, MA

I consider myself a lifelong environmentalist (I was member of OAR and I work for a conservation organization). However, I have many concerns about the ACOE report and can not support any recommendations for removing the Ben Smith Dam.

The ACOE study focused on water quality and nutrient levels just upstream of the dam, but it did not adequately look at the many bigger picture issues which still need to be addressed. Removing the dam will not address the core water quality issues, which lie upstream with the management of the municipal water treatment plants. Removing the Ben Smith dam will just pass these problems down stream, to settle at the next dam in Maynard (only a couple miles away). Also, the ACOE report did not address the issues which will arise from a drastically altered riparian landscape including: toxic sediments, invasive species colonizing newly exposed lands, loss of wetland habitats, loss of flood control, loss of property values along the river, and possible loss of ground water recharge.

Overall, I believe dam removal will detract from the quality of our communities rather than improve it.

Below are three negative impacts which concern me personally:

1) Boating and Canoeing the Assabet is now one of the most popular activities in the Maynard-Stow area. In fact, the opportunity these activities have given people to interact with the outdoors has been the chief reasons so many people have become interested in the health of the river to begin with. I am concerned that this very recreational and educational resource will be lost with a substantially faster, lower flow.

2) Today the Assabet River actually provides one of the best recreational fisheries (for bass) in the area. Dam removal could actually lead to a river without a substantial sport-fishery, whose primary species is Chub (Fallfish). Some web-sites and articles imply that a free-flowing Assabet could sustain native trout. This is highly unlikely. The native trout requires temperatures that no large stream in eastern Massachusetts, even without dams, supports. The only sport-fishing in a free-flowing Assabet would most likely be artificial stockings which would not reproduce.

3) The Mill Pond in Maynard serves as an public amenity and scenic backdrop to the town's center. Before major changes happen to its water level, a serious plan of improvement, with funding, should be in hand. The people of Maynard, have work very hard to revitalize their former milltown, and do not want an eye-sore or nose-sore that they will have to deal with on their own.

I am excited to see what effects improved sewage treatment on the river will have. I hope that radically altering the flow and structure of the river will not proceed until other alternatives have had time to take effect and been proven inadequate.

Ironically it is the people I know who spend the most time on and care the most about the river that are most worried by dam removal.

I believe the people of the region want a cleaner Assabet, but I believe they want the river they know and love cleaner, not a radically different river.

Corps Response: Agree that water levels behind the dams would be lower if dams were removed. Many of the comment letters have noted that the existing impoundments are used for boating and kayaking. This has been added to the report. A recreational user survey was not part of the Corps study but if further studies are done in the future to assess dam removal then a survey could be included to provide additional data to assess this concern.

The existing fish community data provided by Massachusetts Division of Fisheries and Wildlife did indicate that largemouth bass are present in the Assabet River (See Appendix E, Table 3.) This is an introduced species. However, your concern is noted that Assabet is valued for this sport fishing opportunity and that removing the dams/impoundments will result in decreased fishing opportunities on the Assabet.

The Corps study identified the impact of removing the Ben Smith Dam on the Mill Ponds. Appendix J has been added to the report that includes a memo from CDM on the Mill Ponds.

If in the future a proponent steps forward who wishes to pursue dam removal, then there would be a detailed assessment and permitting process involved at all levels of government – local, state, and Federal. A section has been added to the report that lists the process that might be triggered by a dam removal project.

Also, as noted at our public meetings, this planning study was intended to look at decreasing sediment phosphorus flux from the sediment. It is the Corps understanding that major upgrades at the four wastewater treatment plants that discharge to the river are required by EPA and these facilities are under construction.

2. Dan and Eva Barstow, 9 Pine Point Rd., Stow, MA
We Oppose Removal of Ben Smith Dam

We strongly oppose removing the Ben Smith dam, for scientific, economic, ethical and cultural reasons.

From a scientific perspective, we support the more effective solution of reducing the upstream sources of the phosphorus pollution. Removing the dam does not solve the root problem, and in fact masks it by passing the pollution on to the downstream communities. We also have deep concerns about the vast amounts of underlying contaminated sediment that will be dangerously exposed by the lowered level of the Assabet River. Furthermore, the reduction of the Assabet River to a trickle will reduce the wetlands around the river with dangerous impacts on the natural habitats and ecosystems all around the river.

Economically, the removal of the dam will seriously affect those who rely on the river for their businesses, notably including farming and agriculture that are such an essential lifeblood of our local economy. The financial impact also extends to the property values of homes not just along the river, but also throughout this town that prides itself on its “rural character”.

From an ethical perspective, Stow and other downstream towns should not have to take on the consequences of the years of pollution by the upstream power plants and other sources of phosphorous.

And from a cultural perspective, the Assabet River is one the town’s most beautiful natural environments. People use it for boating, fishing, nature walks, bird watching, and simply stopping to re-connect with nature. Its seasonal changes, its winding flow through Stow, and its cultural and historical connections with other towns in the region – all demonstrate the deep and long-term value of the Assabet Rivers’ rich cultural heritage.

Corps Response: Several of the issues you mention were identified in the Corps draft report including changes to wetlands, need for additional sediment testing, and cultural and historic resource values of the dams. If in the future a proponent steps forward who wishes to pursue dam removal, then there would be a detailed assessment and permitting process involved at all levels of government – local, state, and Federal. A section has been added to the report that lists the process that might be triggered by a dam removal project.

3. Comment from Paul Blazar, Executive Assistant, Town of Hudson, 78 Main Street, Hudson, MA

More than five years ago the Town of Hudson, along with the communities of Maynard, Marlborough, Northborough, Westborough, and Shrewsbury entered into negotiations relative to the renewal of the NPDES Permits at the four municipal wastewater treatment plants on the Assabet River. The major issue of discussion was the phosphorous discharge limit that was going to be imposed on the plants. The communities ultimately agreed to a phosphorous discharge limit of 0.1 mg/l, and to assist in the preparation of, and participate in, a sediment remediation/dam removal feasibility study.

Because of agreeing to this stringent phosphorous limit, the Town of Hudson has spent over $17 million to upgrade its treatment facility. In the aggregate, the Assabet communities will spend about $100 million to upgrade their facilities.

Hudson, is now about to enter into a new round of negotiations on their NPDES permit. Some have suggested that this new permit should require that either the major dams be removed along the Assabet River, or that a much lower phosphorous discharge limit (i.e. 0.05 mg/l or less) should be required at our wastewater treatment plant. If such a requirement is established a new upgrade will be required. Although a cost has not been established to upgrade the Hudson facility, it is safe to assume that it will cost tens of millions of dollars to have all of the Assabet communities meet this stringent limit.

We do not believe that now is the best time to require the dams to be removed or for us to pursue further phosphorous removal upgrades at our treatment facility. We say this for the following reasons:

1. The first round of upgrades at the Assabet wastewater treatment facilities is not yet complete. As noted in the Feasibility Study and reiterated at the public hearings, there are many variables and uncertainties in the mathematical models used to determine the future water quality of the Assabet River (i.e. after all the current treatment plant upgrades are completed). It would be illogical to move forward with either dam removal or further upgrades at the treatment plants until the benefits of the first round of upgrades on the Assabet River's water quality can be evaluated on a factual basis.

2. As stated at the public meetings there are still a number of questions concerning the feasibility of removing the major dams on the Assabet River. Where is the money going to come from to remove the dams and who is going to manage the removal process are just two of the major issues that must be answered prior to any removals being planned. Additionally, as stated at the hearings, a number of permits are needed in order to remove the dams. The permit processes will need to address the many concerns that were raised at the public hearings on this report. This will take time.

3. Lastly, Hudson, along with the other sewered communities have, within the last few years, appropriated in the neighborhood of $100 million to upgrade our treatment plants. Gaining approval for tens of millions of dollars for further upgrades, in the current economy and before homeowners and businesses have even started to pay fully for the most recent round of upgrades will be extremely difficult. Failing to take these economic and fiscal realities into account is not a prescription for cooperation and success.

The Feasibility Study, and the accompanying Modeling Study performed by Camp Dresser and McKee gives us good information as to the affects of removing the dams and the future water quality of the Assabet River. However, more factual data and discussions are necessary prior to moving forward with any planned program. To issue us a NPDES permit requiring more stringent phosphorous discharge requirement or requiring some or all of the Assabet dams to be removed would be premature and ill-considered at this time.

MassDEP Response: The MassDEP TMDL that was developed for the Assabet River envisioned an adaptive implementation approach which will need to be discussed during the next round of NPDES permitting. An adaptive implementation approach evaluates implementation measures to determine their impact on water quality before any further actions are implemented. The TMDL that was developed for the Assabet River required that measures be implemented in order to decrease the phosphorus loading to the river and also included the adoption of an adaptive management approach in accordance with EPA procedures. This approach is particularly important given the limitations inherent in modeling as well as the uncertainties and complexity involved in accurately predicting reductions in sediment phosphorus flux.

4. Richard E. Bolton, Sr & Dorothy M. Bolton, 1 Apple Blossom Way, Stow, MA.
We own nearly one mile of river frontage on the Assabet River in Stow and would be directly impacted by the proposed draft feasibility study prepared by the Army Corps of Engineers who is recommending the possible removal of the Ben Smith Dam.

First, the study is severely flawed in many areas. Many of these flaws or inaccuracies are being addressed by other concerned citizens many of which I have reviewed in detail. In the interest of not duplicating their comments I will forego listing these in this email. However, I would like to make it extremely clear we support and agree with the comments being made by Bob Collings, Allan DiPietro and the Town of Stow to the extent that these same comments be made part of this email.

Second, we realize the Stow Fire Department has made its concerns known regarding fire safety and the concern for human life. I would like to give you one of many specific examples which directly affect our family and the five families of our children that live along the river within the fifty acres we all own that are adjacent to the river. Nearly twenty years ago before our homes were built we were required by the Planning Board under an "order of conditions" to excavate an existing pond for fire protection. In the process of this work we discovered the pond was fed by the river and its water level is exactly the same elevation of the river no matter what time of year. This pond not only services our homes but other homes in the general area. Removal of the dam would obviously leave many homes without adequate fire protection since the pond would be virtually dry.

Third, I have been an avid fisherman and a lifetime member of Trout Unlimited. I have also served on the Board of the Organization for the Assabet River representing Trout Unlimited. I appreciate the reasons for dam removal. However, the removal of the Ben Smith Dam would be a terrible decision. The idea that the volume or species attractive to fishermen would be better than at present is ill conceived. First, I have thoroughly fished the whole river between the dams and have always found great bass, pickerel and other species. I have never seen dead fish in the river except for one which had been caught and released with a deep set hook. The idea that cold water species would survive over time when a warm affluent stream coupled with the very strong possibility parts of this stream could dry up in the summer is not logical. In addition, to my knowledge, facts are lacking as to how these new species would reproduce given the drastic change in the stream bottom.

Fourth, even though there has not been a professional, comprehensive study completed regarding the impact of the dam removal it quite apparent that the information being forwarded to the DEP by your December 21st deadline should be more than sufficient to clearly eliminate further expense to the taxpayer. Obviously, the cause of the problem is the sewerage treatment plants. STOP THE CAUSE.

We do not need further studies at more expense. If there is money to burn give it to the cities and towns earmarked for compliance. Why can't the DEP put pressure on each town using these plants to adopt a moratorium on building permits until their plants are in compliance? In addition these plants should be made to comply with the same requirements in the winter as they are required to do in the summer. Once this is accomplished then look at the results. It may be very close to accomplishing the result the study is attempting to attain.

One last comment—Why wouldn't the agency responsible examine who actually owns the river bottom? This in itself may save millions of dollars of taxpayer's money, eliminating further studies.

Corps Response: The draft study did include a section on the "Impact of Dam Removal for Fire Protection". In response to yours and others comments a statement has been added that there is a local fire protection pond near Apple Blossom Way and there may be other local fire protection ponds near the river.

The Corps study did not include an assessment of fishing opportunities before and after dam removal. The Target Fish Community analyses is presented from an ecosystem restoration point of view e.g. man made impoundments versus a free flowing river. However, noted that the public values the existing impoundments for the fishing opportunities they provide.

Mass DEP Response: The issue of growth was not a part of the ACOE study but was given consideration when the Assabet River Consortium completed a Comprehensive Wastewater Management Plan in 2007 which outlined how the six Assabet River Consortium communities (Hudson, Marlborough, Maynard, Northborough, Shrewsbury and Westborough) individually and collectively would treat and dispose of sanitary sewage over a 20-year period.

This study did not perform an evaluation to determine the effects of a year round phosphorus limit of 0.1 mg/L for the wastewater treatment plants. Through the TMDL process phosphorous limits were set at 0.1 mg/L in the summer and 1.0 mg/L in the winter. However, a sediment flux study that was performed under contract by CDM for the Corps report indicated that winter P may be a part of the year round phosphorus budget. Although the evaluation by CDM did not recommend a specific permit limit the results did indicate that winter limits for phosphorus may have a beneficial impact on water quality by reducing the amount of phosphorus collected and stored in the sediment. This sediment flux study was based on very limited data, however, and should not be considered completely conclusive. Moreover, the P flux measurements that were observed by CDM are somewhat different from what was found in a study performed by ENSR in the development of the TMDL for the Assabet River which is likely a result of several factors including that the data were collected at different times of the year. In addition, the water that was used by CDM was taken from below the Westborough POTW which had an unusually high ambient phosphorus concentration which also could affect the results. Therefore, further study is necessary before any additional adjustments to the discharge limits are proposed. This issue will come under further review and consideration as the NPDES permits come up for renewal. It is also being investigated in a recent study undertaken by the USGS.

Ownership of the river bottom is a complex legal issue which would require an intensive search of all the deeds of the properties in question. This issue would need to be resolved in the future should a proponent step forward who wishes to pursue dam removal.

5. Peg Brown, Chair, Maynard Historical Commission, 195 Main Street, Maynard, MA
Your department commissioned a study to see if removal of sediment and dams from the Assabet River would improve the water quality, which is impaired primarily due to phosphorus levels in the discharges of several wastewater treatment plants along the river, the largest of them upstream of Maynard and Stow.

While your report was primarily technical in nature it did have a cursory mention of the cultural and historical aspects of the dams (and in particular the Ben Smith Dam) and it is on these points that we would like to comment.

As you know the Assabet River's runs through 8 towns and 1 city in its 31-mile course. This is a river that exists primarily in an urban context rather than undisturbed forests. Many of the towns, particularly Northborough, Hudson, and Maynard, exist because of the river and the dams that were erected on it. These are not recent constructions - many of the dams are over 150 years old and their original construction goes back to the 18th century. The effects, both positive and negative, of these dams on the geographic and cultural landscape are as intertwined with these towns as the river itself.

The Ben Smith Dam, constructed in 1847, was identified as a key "target" for removal. This was not the first dam in Maynard. In 1820 another dam, the "Papermill Dam" was the first to cross the river in what was known as "Assabet Village". The water power from these two dams sparked an industrial boom that eventually led to the Assabet Manufacturing Company and one of the largest textile mills in the United States.

Besides providing power and creating a prominent mill pond in the center of downtown Maynard, the Ben Smith Dam also raised the river level behind it, affording recreational use and was a source of ice into the early 20th century. Small steam-powered boats ferried passengers to nearby Lake Boon, a popular recreation area to this day.

Although privately owned, the Maynard Historical Commission considers the Ben Smith Dam to be a key component of our town's cultural and architectural heritage and would likely consider seeking additional protection for the dam (such as placing it on the National Register of Historic Places) should there be future indications of planning for its removal beyond this initial study.

Corps Response: Cultural Resources issues are identified in the draft report and specific information provided in Appendix F on prehistoric and historic resources associated with the Assabet River and its dams. As noted in your comments and in the Corps report Ben Smith Dam is individually eligible for the National Register as well as a contributing element of the Assabet Mills Historic District.

6. Kurt S. Bunge, 72 Summer Hill Road, Maynard, MA
My name is Kurt Bunge. My wife and I live on the Assabet River in Maynard at 72 Summer Hill Road. This letter is in regard to the possible removal of the Ben Smith Dam which is located less than a quarter mile from our home. I have read the Army Corps of Engineers report in regard to recommendations to decrease the phosphorus load in the river and supposedly improve the river's fishability and swimability.

After reading the report I was very surprised at the number of WWTFs that dump into the river. I was also surprised at Corps' opinion that the river cannot properly support wildlife habitat and people cannot use the river for recreational purposes. I have lived at this address for ten years and it's true, I have never heard anyone say the Assabet River is particularly clean but I have seen first hand that it definitely supports a wonderful array of wildlife and recreational users.

My biggest concern about removing the dam is the effect it will have on the existing wildlife habitat because of the falling water levels. My wife and I live where we live because all through the year we are able to see such wildlife as Great Blue Herons, Black-crowned Nigh-Herons, Egrets, Red-tailed Hawks, Bald Eagles, Osprey and several waterfowl species such as Canadian Geese (along with their goslings each spring), a variety of Mergansers and other duck species, turtles and more. We have a beaver living on our shoreline and we view swans upstream. We have the pleasure of watching several of these species using the river as their source for food. There never seems to be a shortage of fish for the Herons, that's for sure.

We observe the food chain in action on a daily basis and in our opinion, the Assabet River is a thriving habitat that supports our wildlife very well. The river itself is one of the major reasons why we live on the land that we live on. If that water drops as much as the research says it will if the Ben Smith Dam is removed, our fear is that all of this wonderful habitat that we enjoy so much will be destroyed, and that would be a shame for all of us, not just the wildlife that needs the river to survive.

Has the Army Corps of Engineers done an environmental impact study as a result of removing the Ben Smith Dam? Can they actually make such a recommendation without doing an impact study first?

Corps Response: This study is Corps Planning Assistance to States Study not a Corps decision document. If in the future a proponent steps forward who wishes to pursue dam removal, then there would be a detailed assessment and permitting process involved at all levels of government – local, state, and Federal to assess the impacts of the proposal. A section has been added to the report that lists the process that might be triggered by a dam removal project.

As far as recreation on the river, I am not convinced people don't use it because it's not clean enough. We see kayakers on our stretch of the river almost every weekend in the warmer months. When we travel upstream following the Rail Trail we see many boats on the water.

In closing, I suppose I just don't understand how the Army Corps of Engineers can say the river doesn't properly support wildlife and recreation when my wife and I see proof every day that the river is a thriving habitat for both wildlife and the guests (humans) that use it. Please don't change the ecosystem the river has created. If anything, we should develop strategies to change the way WWTFs dump into the river. There should be a way, with all of the global political pressure to clean up our environment, to find either federal or state funding to help WWTFs clean up THEIR acts so we can all continue to enjoy the invaluable virtues of our Assabet River.

Maynard is a unique town and part of that comes from the Assabet River. We who live here have pride in our little part of the world and all through the history of this town, long before it was Maynard, the Assabet River has been the artery that connects us to everything else. We want to keep our river and everything that comes with it.

MassDEP Response: MassDEP is responsible for monitoring the waters of the Commonwealth and identifying those waters that are impaired and not in compliance with the Massachusetts Water Quality Standards. Previously collected data and studies have shown that the Assabet River receives an excess of nutrients which results in the abundant growth of aquatic vegetation and fluctuations in dissolved oxygen. Summer-time vegetation densities in the Assabet River were observed to be at levels associated with impairment of water quality. The designated uses, such as primary and secondary contact recreation and aesthetics were adversely affected. Because the Assabet River does not meet Water Quality Standards, habitat for fish and other aquatic wildlife is impacted. This is illustrated in the section of the Corps report on "Target Fish Community Analysis" which presents information on the current fish population. Although there may be an abundant number of fish, the more pollution tolerant species are predominant indicating that the Assabet River ecosystem has been impacted.

7. Kay Carstens, 21 Crane Avenue, Maynard, MA

As a member of OAR who has spent many hours on river cleanup, I'm all for improving our river. I have attended several presentations on the study and it seems only logical to hold off on any action on the dams until we see what is accomplished by upgrading the treatment plants upstream. When the upgrades are done and we give it a year or so to let the sediment settle (and determine the intended and unintended consequences), then the issue of further work or dam removal can be revisited.

MassDEP Response: MassDEP agrees with this type of adaptive implementation approach. Please see Response to Comment Letter #3 above.

8. Karen and Andrew Case, 57 Apple Blossom Lane, Stow, MA

We would like to express our concern about the possible removal of the Ben Smith Dam on the Assabet River in Maynard. There are many acres of wetlands that would be destroyed, resulting in an extreme change to the wildlife habitat that exists upstream of the dam. We often kayak on this stretch of the river, observing the herons, turtles, swans, and other wildlife that live there. We are very concerned that their habitat would be severely damaged.

Thank you for taking this concern into consideration.

Corps Response: The Corps study did identify the wetlands behind the dams that may be impacted by dam removal. This was done at a desktop level and information is included in Appendix D of the Corps report. If in the future a proponent steps forward who wishes to pursue dam removal, then there would be a detailed assessment and permitting process involved at all levels of government – local, state, and Federal. A section has been added to the report that lists the process that might be triggered by a dam removal project.

9. Michelle Chapman, a concerned citizen, home owner, and river-dweller 8 Shore Ave, Stow, MA

I understand that there is a proposal in the works to remove the dam that is just down river from us. While I recognize there may be some short-term health benefits of this choice for the river, I am also of the opinion that removal of the dam will create other negative environmental issues and will not solve the pollution problems in the long run. I also selfishly wish for the dams to be kept in place since I know that removing the dams will greatly impact the width, depth, and flow of the water and I know that my enjoyment of the river comes from the large pools created by the dam near our house. We observe numerous boaters, enjoying the river from kayaks, motor boats, and canoes up and down the river. We have been fortunate enough to enjoy the river from our neighbor's boat as well, and it is a recreation that is highly regarded in our neighborhood. I haven't yet met a neighbor who didn't greatly appreciate their location on the river. We all hold the river in very high regards and feel very lucky to live in such a beautiful setting.

We are really fairly new to the area. We have lived in MA almost 5 years, all of that time being on the river. We don't profess to be very knowledgeable about its history, problems, or what certain actions would mean. I do have a degree in biology and have studied riparian habitats as part of my education so I have some understanding of water pollution, river health, and human contribution to both. I just don't know all of the details pertaining to this particular river.

However, we do love living on the river. We are from Utah, a land full of wide open skies and views. Since moving here, I have found New England to be terribly claustrophobic and dreary. I am not kidding in the slightest when I say that one of the greatest joys I have every day is to wake up and open my curtains and look OUT at the water in the river. The wide pond that the river makes directly in front of our house is one of the best visual assets we have. We love our area near the White Pond Road bridge just above the dam. We love the wide quiet water that the dam provides near our home. We do not yet own a boat, but we have seriously considered buying a canoe so that we can use the river waters that we can see from our living room window. Our two young daughters (ages 3 and 6) are avid bird watchers and keep track of the wildlife floating in the Assabet every day. Our enjoyment of the river is based mostly on the view of it from our home and as we take walks through the neighborhood, the birds that it attracts (swan, geese, ducks, etc...) and on its possibilities for boating recreation.

I guess that is my vision of the river. It is truly a visual treasure for us. We would want to keep its visual, emotional, and recreational qualities as close to what we see now as possible. We also want to preserve the habitats it currently provides for the wonderful waterfowl we love to watch. On another hand, I would also worry about the prospects for fire protection, should the dam be removed, as well as the loss in value of property along the river, should the river shrink to a stream.

Please do consider all voices, especially from those of us who actually LIVE on the river, before making a consideration to change the river so drastically.

Corps Response: The TMDL prepared by MassDEP in 2004 identified the options of sediment and or dam removal for phosphorus flux reduction in the Assabet River. The Corps Planning

Assistance to States study provides information on these options. If in the future a proponent steps forward who wishes to pursue dam removal, then there would be a detailed assessment and permitting process involved at all levels of government – local, state, and Federal. A section has been added to the report that lists the process that might be triggered by a dam removal project.

10, Janet Clifford, Property owner: 5 Shore Avenue, Stow, MA

My husband and I own property on Shore Avenue in Stow MA on the Assabet River (next to Russell's bridge; approximately 1/4 mile up-river from the Ben Smith dam). This property has been in my family for more than 60 years and my husband and I both grew up boating, fishing, and skating on the river and we have plans to enjoy the river in the same way in the next phase of our lives.

Attached is a photo of the Assabet River showing the beautiful serenity of the area just above the Ben Smith dam which we plan to fight to preserve for future generations to enjoy.

For the last 4+ years, we've been aware that there are some people that believe that removing the dams from the Assabet River will improve the water quality in the river; however, after all that we've read, researched, and heard (particularly at the November 19, 2009 meeting held at the Hale School in Stow, MA), we truly believe that there are other methods (other than dam removal) that could/should be implemented to improve the water quality of the Assabet River that would leave the river intact where it would continue to support wildlife, wetlands, and recreational activities, and provide critical water resources for the fire department and many businesses along the river.

The meeting held in Stow , MA (Hale School) on November 19, 2009 was attended by many people from surrounding communities who brought up numerous discrepancies in the study. In addition, many questions were raised during that meeting that should be researched, reviewed, and addressed before making a final decision on how to improve the water quality of the Assabet River . One point that continued to be brought up by attendees who spoke during that meeting was the fact that the Waste Water Treatment Plants (WWTP) have caused the poor water quality and these companies should be held accountable and be required to fix the problem. The communities, especially property and business owners along the Assabet River, should not be expected to pay for the problems caused by the WWTP.

The following comments and questions were brought up during the November 19, 2009 meeting held in Stow, MA :

•1 There are errors in the study relative to the width and length of the river and the amount of open water remaining after dam removal.

Corps Response: The Corps draft report included two measures both the visual impoundment length and the extent of influence of the dam on water levels in the river. As the first measure was confusing to most this has been removed from the Corps report and only the

impoundment area as measured by the influence of the dam on water levels retained in the final report.

•2 Removing the dams would expose acres of toxic waste.

Corps Response: The draft report does indicate that water levels will be lower if dams were to be removed. The Corps contracted with CDM to prepare a separate report entitled "Assabet River Sediment Management Plan". The CDM report suggests additional testing of the Assabet River sediments and provides detailed sampling plans if dam removal were to be considered further. Additional sampling would provide data to assess and characterize the Assabet River sediments. The study did not evaluate human health risks associated with potential exposure to sediments that are currently under water.

•3 The photos in the study showing excessive duckweed on the river don't depict the typical state of the river. There are many months during the year when the water is free of duckweed.

Corps Response: Photographs in the report are snapshots of the day they were taken. There are photographs in the report that do not include excessive vegetation.

MassDEP Response: Photographs in the slideshow were presented by MassDEP to show the extent of the duckweed coverage in the impoundments as a worse case condition. Conditions that will affect the growth and proliferation of duckweed will vary from year to year. For the past year the USGS has been documenting duckweed growth in the impoundments and will be producing a report with their findings in late 2010. The report will discuss factors that may affect the growth and distribution of duckweed including flow, weather conditions, wind, solar radiation and seasonality. Additionally, MassDEP hopes to continue with the duckweed monitoring program that was established by USGS to further document conditions over the long term.

•4 The study only researched two ways (sediment and dam removal) to address the problem. Other studies should be completed to research other options/solutions for addressing the poor water quality.

Corps Response: The scope of the study was to look at sediment and dam removal to decrease sediment phosphorus flux from the sediments.

•5 Isn't it a conflict of issue when the Army Corp of Engineers creates the study that recommends a solution that they would financially benefit from because they would get benefit from because they would get the job of removing the dams and associated projects?

Corps Response: Studies and projects that the Corps participates in are authorized by Congress through Public Laws. In this case, the study was conducted under the Corps Planning Assistance to States (PAS) Program as authorized in Section 22 of Public Law 93-251 and amended in subsequent legislation. Under this authority, the Corps can provide states, local governments, other non-Federal entities, and eligible Native American Indian tribes with water resource planning assistance. The purpose of the study was to investigate the

effects of dam removals on river water quality. The study has done that in a very factual manner. The Corps does not financially benefit from providing information to states and towns and, as just stated, is authorized by Congress to do so.

If in the future the Corps was requested by a sponsor to participate in dam removal on the Assabet River, then this participation could only occur through other Federally authorized programs (e.g. Section 206 of the Continuing Authorities Program).

•6 Why are the WWTP not being forced to apply to current standards?

MassDEP Response: When MassDEP and EPA reissued the NPDES permits, the wastewater treatment plants were given schedules to reach the 0.l mg/L total phosphorus discharge limit. To achieve the new limit, extensive and very expensive upgrades and/or replacement of the facilities were necessary. Currently the Westborough, Marlborough West and Maynard plants are under construction and work on the Hudson plant has been completed. MassDEP believes that the 0.1 mg/L total phosphorus discharge limit is the technology limit that presently can be met on a consistent basis by the wastewater treatment plants. It is very questionable if a lower limit would be consistently achievable.

•7 Why are the WWTP not adhering to the same standard throughout the year, when if they did, it would definitely improve the quality of the water?

MassDEP Response: Potential Water quality improvements associated with winter time reductions from the WWTPs was raised for the first time in this report and would need to be evaluated in greater detail. Please see Response to Letter #4 regarding phosphorous limits.

•8 Do the people who live down river from the dams, particularly residences of Billerica who get their drinking water from sources that flow from the Assabet river, know about this study, and the potential removal of the dams?

Corps Response: MassDEP placed information in the Massachusetts Environmental Monitor in October 2009 and issued News Releases for the draft Planning Assistance to States study in November 2009. The Corps placed advertisements for the public meetings in the Beacon Villager, Marlborough Enterprise/Hudson Sun, and Stow Independent. The Corps placed copies of the draft report in local libraries of Maynard, Stow, Hudson, Marlborough, Northborough, and Westborough. Public informational meetings were held on November 17 in Marlborough at the Best Western Royal Plaza Hotel and Trade Center and on November 19th in Stow at the Hale Middle School.

•9 What will be the impact to the people who live down river from the dams or along rivers that are fed from the Assabet river?

Corps Response: In the areas upstream of a dam water levels would be lower without the dam. The CDM Modeling Report dated June 2008; Appendix F provides water surface profiles and data tables for the river with and without dams.

•10 If the dams are removed, the water level of the river will drastically be reduced thus there will be less water to carry away the waste from the WWTP leaving acres of exposed toxic waste and negatively impact the health and property values of those living along the river.

Corps Response: The amount of water entering the river is based on rainfall-runoff and groundwater discharge to the river. Removing dams does not affect the amount of water entering the river. It is expected based on modeling performed by CDM for the study that removing dams will improve water quality in the river.

•11 If the dams were removed, how will that impact people's wells?

Corps Response: The impact of dam removal on groundwater levels adjacent to the river was not part of the Corps study, but could be assessed if a proponent steps forward who wishes to pursue a dam removal project.

•12 Who has input into the final decision on how to improve the quality of the river? The watershed communities? The town's conversation commission? The Commonwealth?

MassDEP Response: There are multiple parties on the federal, state and local level that are involved in working to improve the water quality of the Assabet River. In order for the dam removal project to proceed, a project proponent would have to step forward. A thorough review of the project would be performed through the Massachusetts Environmental Policy Act (MEPA) and permitting processes. Throughout these processes there will be many opportunities for public review and comment on the potential environmental impacts of the project. A section has been added to the report that lists the processes that might be triggered by a dam removal project.

•13 Water that flows over the dams adds oxygen to the water which improves the quality of the water; therefore, removing the dams would reduce the oxygen in the water.

MassDEP Response: As you point out when water flows over a dam it tends to be well oxygenated. If a dam is removed, the water will no longer be impounded but will be faster flowing which will also increase the oxygen level. One of the main causes of oxygen depletion presently is the impoundments because of low velocities, greater depth and warmer temperatures which create an environment conducive to excessive nuisance aquatic plant growth.

•14 Currently, there are numerous water ways that contribute water to the Assabet River that help to carry away waste from the WWTP. If the dams are removed these water ways will be reduced or eliminated; therefore, there will be less water to carry away the waste from the WWTP.

MassDEP Response: The amount of water that is contributed to the Assabet River through its tributaries will not be reduced or eliminated because of a lower water level in the Assabet River. Each tributary's flow is dependent upon its unique drainage area and hydrological conditions. A lowering of water levels behind the dams will not affect a tributary's flow which

is predominately controlled by conditions far afield from the confluence of the tributary with the impounded or potentially previously impounded area.

•15 We want the WWTP to sign an agreement that they will not allow communities that are outside of the Assabet River watershed to be connected to the WWTP.

MassDEP Response: This issue is outside of the scope of the Corps study. However, in 2007 the Assabet River Consortium completed a Comprehensive Wastewater Management Plan (CWMP) which outlined how the six Assabet River Consortium communities (Hudson, Marlborough, Maynard, Northborough, Shrewsbury and Westborough) individually and collectively would treat and dispose of sanitary sewage over a 20-year period. This issue was addressed under that plan.

•16 Are there chemicals that can be added to the river to combat the problem?

Corps Response: The option of adding chemicals to the sediment is discussed under the sediment deactivation section of the report. Sediment deactivation with chemicals would be a short-term solution on the order of 2 to 5 years.

•17 The original purpose of the dams was to support commerce; however, the study does not consider the impact of dam removal on businesses that rely on the Assabet River for their water needs.

Corps Response: Uses of the river for hydropower and as a source for fire protection water were identified in the study. If in the future a proponent steps forward who wishes to pursue dam removal, then there would be a detailed assessment and permitting process involved at all levels of government – local, state, and Federal. As part of this process business uses of the dams and their impoundments would be evaluated.

•18 We should lower the levels that the WWTP are allowed to pump into the river.

MassDEP Response This issue is outside of the scope of work but was addressed in the TMDL and the CWMP. Future permitting under the National Pollutant Discharge Elimination System Program (NPDES) will also address this issue.

•19 The study did not mention the use of the river for fire protection which is critical to the communities along the river.

Corps Response: This was included in the draft report under "Impact of Dam Removal on Fire Protection."

•20 The removal of dams will result in 'brown zones' of toxic wastes and does not protect wetlands.

Corps Response: The report provides information on sediment in the Assabet in the "Assabet River Sediment Management Plan" that was completed by CDM in December of 2008.

Additional studies would be required to further define the quality of the sediments and verify the extent of sediment removal that will be required should a dam removal project move forward.

The Corps study identified the wetlands behind the dams that may be impacted by dam removal. This was done at a desktop level and information is included in Appendix D of the Corps report.

If in the future a proponent steps forward who wishes to pursue dam removal, then there would be a detailed assessment and permitting process involved at all levels of government – local, state, and Federal to address these issues. A section has been added to the report that lists the process that might be triggered by a dam removal project.

•21 We need a study on ALL the negatives that would be a result of the dams being removed.

MassDEP Response: The main focus of the report was to provide planning assistance on sediment and dam removal for sediment phosphorus flux reduction. Should a dam removal project be proposed, a review will be conducted through the MEPA process. This process will include an alternatives analysis and will consider the positive and negative, short-term and long-term potential environmental impacts for all phases of the project.

•22 The study suggests that certain species of fish would return to the river if the dams were removed; however, how could fish survive if there was less water and more waste in the water?

Corps Response: Water quality is predicted to improve with dam removal and fish communities currently exist in free flowing sections of the river. See Appendix E.

•23 The river will become a stream of waste.

#22 & 23. MassDEP Response: Although the water level will be lower within former impoundments and the upstream reaches affected by the impoundments, the amount of water that is contributed to the Assabet River through various watershed sources (tributaries, rainfall, etc.) will remain the same for a given hydrological condition. The percentage composition of the river with respect to wastewater will remain the same whether the dams are removed or not for any given hydrological condition. Rather than being impounded in a certain location it will be free flowing and in more of a riverine channel. The assimilative capacity of the river will not change since the contribution of wastewater and river flow in the river will be the same.

•24 How do we know that they WWTP are complying with current standards? And if they're not complying, how are they being punished?

MassDEP Response: As a part of its Compliance and Enforcement Program, MassDEP conducts treatment plant inspections to determine if the facilities are being operated efficiently and properly. Samples of the effluent may also be taken and analyzed to determine permit compliance. The treatment plants are required under their NPDES permit to submit Discharge Monitoring Reports to MassDEP and EPA. These reports are required by law (33

U.S.C. 1318; 40 C.F.R. 125.27). Under state regulation, failure to report or failure to report truthfully can result in civil penalties not to exceed $10,000 per day of violation; or in criminal penalties not to exceed $25,000 per day of violation, or by imprisonment for not more than one year, or by both. Under federal regulation there is no maximum penalty for violations.

•25 The study lacks full details of how the river is used for recreational purposes.

Corps Response: A recreational survey of the river was not part of the Corps study. If in the future a proponent steps forward who wishes to pursue dam removal further, than a recreational user survey could be included as part of these additional studies.

•26 If the dams were removed, the level of the river would be so low that people would no longer be able to use the river for kayaking, canoeing, fishing, etc.

Corps Response: Detailed data on decreases in water surface elevations in the river if dams were removed is provided in the Corps report and in the CDM modeling report.

•27 There is a definite difference between earlier studies on dam removal and the current 'draft' study. For example, the current 'draft' study lacked details on winter discharge from WWTP and how the water quality could be greatly improved if the WWTP were required to comply to lower standards all year.

MassDEP Response: This study was not designed nor did it perform an evaluation to determine the effects of a year round phosphorus limit of 0.1 mg/L for the wastewater treatment plants. It only noted that winter limits may have potential to address some of the nutrient related problems being observed. Please see Response to Comment Letter #4 regarding year round phosphorus limits.

•28 Watershed communities need a system for planning for growth that affects WWTP; specifically, how and when will WTTP be allowed to expand to address growth within watershed communities?

MassDEP Response: In 2007 the Assabet River Consortium completed a Comprehensive Wastewater Management Plan (CWMP). Projections of economic and population growth in conjunction with land use planning were considered in that process.

•29 The cost to remove the dams, clear and remove the sediment, and complete all other related projects would far exceed the estimates mentioned in study.

Corps Response: Estimates presented in the report are planning level construction cost estimates. Construction costs and other project costs including real estate costs would need to be refined during more detailed studies and design of particular dam removal project.

11. Comment from Bob Collings of Stow, MA

Question #1

- "The WWTF's contribute 88-98% of biological available phosphorus and the majority of this loading was in the dissolved form that is directly available for uptake by plants." (pg8)
- CDM modeled six scenarios including number (6) reduction in phosphorus levels in WWTF discharges during the non-growing season. (pg10)
- Conclusion

"Additional reductions in phosphorus levels in WWTF discharges during the non-growing season may make a significant contribution to achieving water quality standards, especially if only limited dam removal is undertaken." Pg 13

Question: What is your best estimate of the impact of reducing the discharge level from 1.0 mg/l to .1 mg/l (a 90% reduction) during the 5 month winter period?

(If answer is that they can't estimate the impact – remind them that they did make a quantitative estimate for Ben Smith dam removal (10%) despite "the sediment – phosphorus flux was too complex to allow the modeling to predict actual DO and biomass levels following specific combinations of dam removal, dredging, and reductions in phosphorus levels in WWTF discharges" Pg 9

Corps Response: CDM modeling for scenario 6 was done with the P-flux spreadsheet model only. This exercise examined the sensitivity of reducing the winter limit below the planned 1.0 mg/l and not the effect of explicit winter limits.

Question #2

CONCERN

There are many errors and omissions in the Assabet River, Mass Sediment & Dam Removal Feasibility Study (SDRFS) that need to be corrected before any final recommendations and conclusions are reached.

EXAMPLES

A. Impoundment Areas & Length

	SDRFS(p19)	DAM influence	USGS[1] (p40)
1) Ben Smith Dam Impoundment Area	146AC	454ac	3.1X

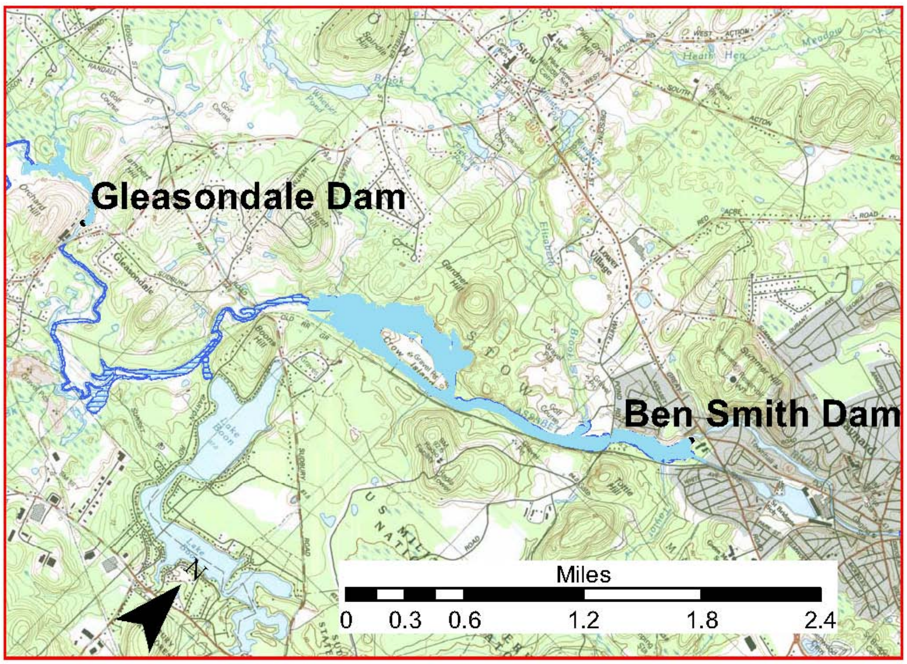
Corps Response: In the USGS 2005 report "Entitled Sediment Studies in the Assabet River, Central Massachusetts, 2003 page 40 Table 10 the Ben Smith Dam is listed as 590,000 m^2. This converts to 145.739 acres and agrees with the Corps Table 4 page 19 of 145.8. For the final report the area has been rounded to 146 acres. The USGS report page 40 does not list 454 acres anywhere on this page.

2) Ben Smith Dam Impoundment Length	2.15 miles	5miles to Rt 62	6.8 miles	3.2X

The river profile confirms the impoundment area goes from the Ben Smith Dam all the way to the Gleasondale Dam. (Fig 2 & Pg 38)

Corps Response: The extent of influence of the Ben Smith Dam based on CDM modeling is approximately 5 miles. The new Figure 3 was added to report illustrates the extent of influence of the dam The USGS report Page 40 list the length of the Ben Smith impoundment as 11,000 meters which converts to 6.8 miles. The Corps has no information to indicate that the 5 miles should be changed to 6.8 miles at this time in Table 4.

The impoundment length column in the Corps draft report Table 4 refers to the length of the impoundment as shown below. In the case of Ben Smith dam this is from the dam to just west of Crow Island about 2.15 miles. This length is shown below in solid blue. However, agree that presenting two different lengths e.g. impoundment length of 2.15 miles and extent of dam influence of 5 miles was confusing to the reader. Only the extent of dam influence of 5 miles is included in the final report.



B. Open Water

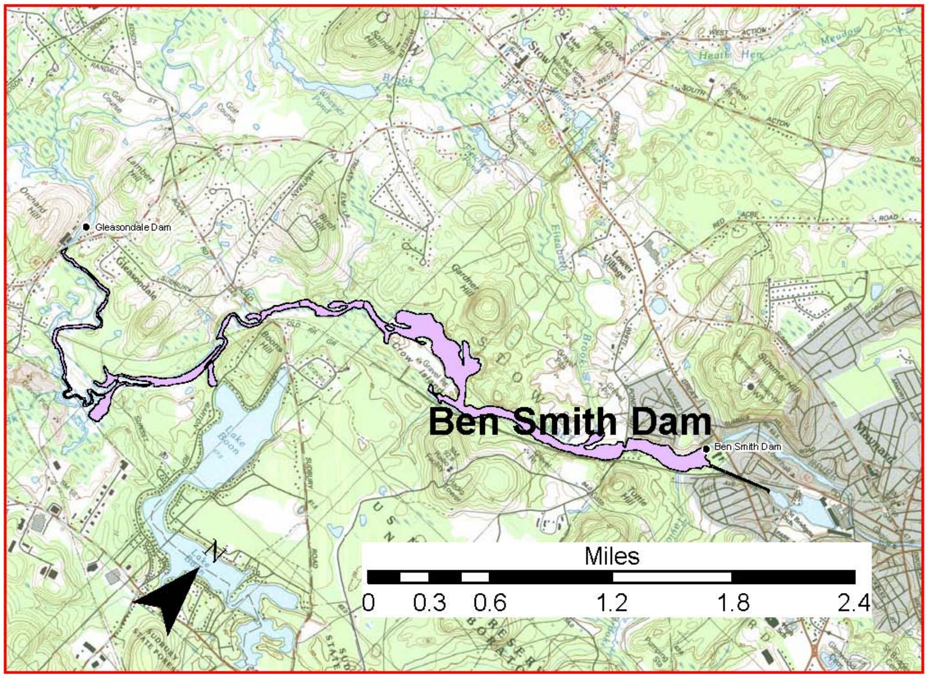
1) "The amount of open water increases after dam removal; from 20.8ac to 70.2ac" (Apx D, Pg 29, and Pg 9)

a) This conflicts with the renderings of a 30ft wide river replacing in many areas 200-600 ft wide open water expanses.

b) This conflicts with your Change in Impoundment Vol <u>EXISTING</u> <u>REDUCTION</u>
411 acft =>22acft 95%

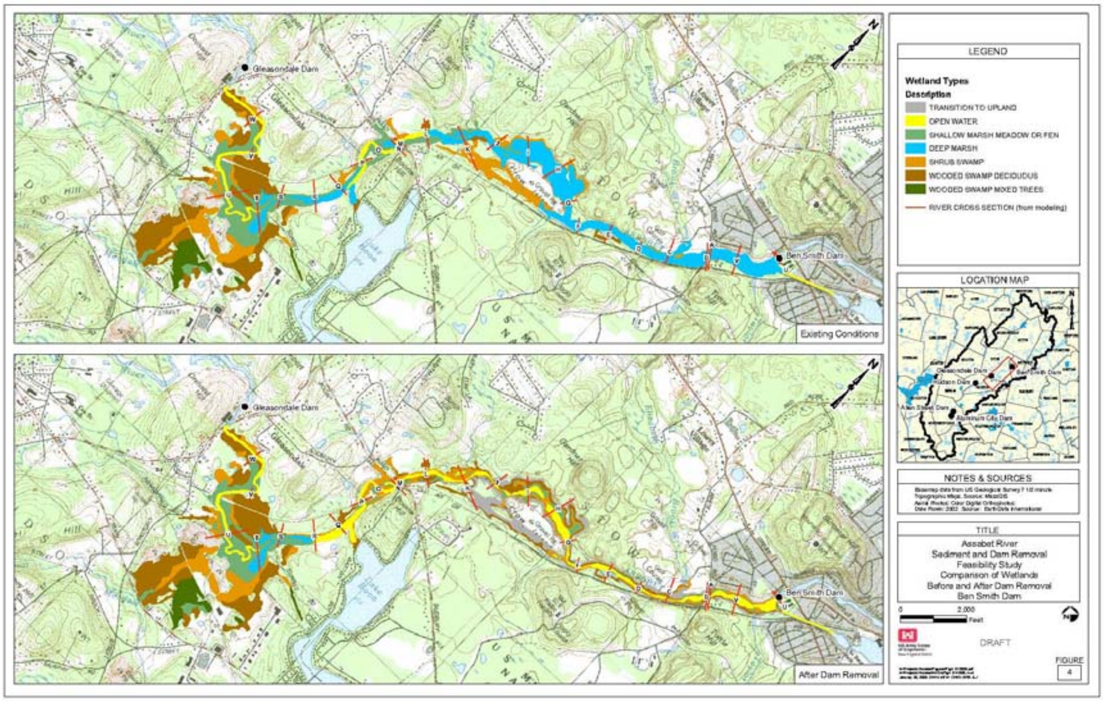
c) A river 30ft wide X 5.5miles = 20.6 ac vs 70.2ac an error of 50 acres.

Corps Response: Appendix D page 29 and page 9. The "open water" term in Appendix D is a type of wetland as mapped by the Massachusetts Wetland Conservancy Program (MassDEP). The "open water" and "deep marsh" wetland areas as mapped by the Massachusetts Wetland Conservancy program are shown below in Lilac. Both types of wetlands can have standing water.



The intent of Appendix D is to perform a planning level desktop analysis to show potential changes in wetland types that may occur if the dam were to be removed. Table 1 Appendix D summarizes these changes. The desktop analysis shows the potential change in wetland type and transition to upland of some areas with dam removal. In the case of the Ben Smith Dam removal the "deep marsh" is estimated to decrease while the wetland type "open water" is estimated to increase. The total area of existing wetland behind Ben Smith Dam is estimated at about ~ 438 acres (437.6 acres) and the wetlands are shown in the table and figure below.

		Acres		
Impoundment	**Description**	**Wetlands - Existing Conditions**	**After Dam Removal**	**Change in Wetland Area**
Ben Smith	DEEP MARSH	126.6	12.8	-113.8
	OPEN WATER	20.8	70.2	49.4
	SHALLOW MARSH MEADOW OR FEN	87.3	75.6	-11.7
	SHRUB SWAMP	76.5	81.3	4.8
	TRANSITION TO UPLAND	0	43.5	-43.5
	WOODED SWAMP DECIDUOUS	107.2	134.9	27.7
	WOODED SWAMP MIXED TREES	19.2	19.2	0.0



C. Sediment Removal

1) Ben Smith Dam volume to be dredged is estimated to be 68kyd^3 (pg 31) (amount of sediment that would be transferred downstream in a relatively short period of time).

2) The Assabet River has been a dump site for toxic materials for 159 years. The report cites 5 metals that exceed RCS-1 levels and two, arsenic and lead which exceed landfill reuse criteria. In addition, there is Mercury, VOC's & PCB's.

3) Reducing the open water to 21 acres and reducing the impoundment volume by 95% of the previous 146ac or more correct 454 ac will <u>expose/create hundreds of acres</u> of "brown field" toxic area. What happens if a clean up is required? Maynard, Concord, Acton, and Billerica (who uses the river for drinking water) are not going to want to see Arsenic, Mercury, and other toxic material come down the river.

4) The sediment volume in the Ben Smith impoundment is estimated to be 759kyd$^{3(1)pg40}$. If the volume of sediment were to be 759kyd^3 vs 68kyd^3 the cost of Ben Smith dam removal could be over $100M!!

Corps Response: Removing a dam would result in less area being under water. The Sediment Management Plan prepared by CDM (December 2008) for the study recognizes this issue and additional sampling is proposed if further efforts were to occur. The sampling plan for Ben Smith is discussed in Section 3 of the CDM report, page 32 and 33. The Corps draft report

references the CDM report and notes that additional sampling and analysis will likely be required by regulatory agencies.

The sediment removal quantities associated with dam removal for the six study dams were calculated based on results of the HEC-6 modeling conducted for the study. In general the HEC-6 model allowed for estimation of the sediment quantity that if not removed as part of the dam removal would be transported downstream in a relatively short period of time following the dam removal. The estimated volume to be removed for Ben Smith based on this analysis is 67,600 cubic yards.

The USGS report page 40 lists the sediment volume behind Ben Smith dam as 580,000m^3 (758,611 cubic yards). This appears to be a volume estimated based on probe depths to greater than 15 feet (page 24 of USGS report). The USGS reports states that the greatest sediment depths are near Crow Island. The figure on Page 19 of the USGS report confirms this statement. As noted above the Corps sediment quantity is the amount that would move downstream in a relatively short time. It is not expected that the deep sediments near Crow Island would move downstream.

The Corps study did not investigate the issue of clean-up of exposed sediment previously under water. If regulatory agencies were to determine that additional volumes of sediment behind the dams need to be "cleaned-up" for public health or environmental reasons then this would result in costs not considered in this study.

QUESTION

Given that your estimate of a 10% P Flux change by the removal of the Ben Smith Dam was based upon "phosphorus flux modeling which was too complex to handle specific combinations of dam removal, dredging and reduced levels of WWTF discharges.", and given that there are numerous substantial omissions and errors in this analysis: and given that the catastrophic impacts on the Town of Stow & its residents have not be evaluated – How could you recommend the removal of the Ben Smith Dam?

(1) U.S.G.S. Sediment Studies in the Assabet River Central Massachusetts 2003, U.S. Dept of Justice, U.S. Geological Survey.

Corps Response: The intent of the study is to provide planning assistance on sediment and dam removal for sediment phosphorus flux reduction. Many of the issues discussed in your comments are identified in the Corps draft report. The concept of dam removal on the Assabet to improve water quality is not new. The TMDL prepared by MassDEP in 2004 (page 3) identified dam removal as a measure to improve water quality in the river. The SuAsCo TMDL can be viewed at: http://www.mass.gov/dep/water/resources/tmdls.htm#suasco.

12. Comment from Bob Collings, Stow MA

Lowering the Assabet River level by 7.4 ft by removing the Ben Smith Dam resulting in a 25-30 ft wide 1-2 ft deep river has huge consequences including:

- Loss of Public Safety water source for both towns of Stow & Maynard.

Corps Response: The draft report on page 39 indicated that dam removal could impact the water supply for fire protection purposes. If a potential dam removal project were to be considered in the future, then mitigation plans would need to be developed to address this need as appropriate.

- Loss of critical water source for orchards, farming, golf courses, etc.

Corps Response: A survey of water users of the river and impoundments was not a part of the scope of work for the study. This issue would need to be addressed further should a dam removal project move forward.

- Lowering the water table impacts ponds, wells, and perhaps the entire watershed.

Corps Response: The Corps draft report page 39 indicated that groundwater levels were not included in the study but could be considered in future studies.

- Destroys year round recreational uses of canoeing, kayaking, fishing, motor boating, bird watching, etc.

Corps Response: A recreational use survey of the river was not part of the Corps study. However, a statement has been added to the report that recreational opportunities that rely on the current water depths would be impacted as water depths will be lower with dam removal.

- Would destroy the most beautiful and scenic part of the Assabet River in exchange for a 25-30 ft wide stream with huge "brown fields" of toxic material quickly overgrown with loosestrife such that the river wouldn't even be visible in 2-3 years.

Corps Response: The Corps study did not investigate the issue of clean-up of exposed sediment previously under water. Regulatory agencies will determine if additional volumes of sediment behind the dams need to be "cleaned-up" for public health or environmental reasons. The report includes a section on invasive species and indicated that a vegetation management plan should be developed in conjunction with dam removal to avoid the spread of invasive species to newly exposed areas.

- Substantial negative impact on the value of the homes and property along the Assabet.

Corps Response: The issue of property values is outside of the scope of work for the Corps Study.

- Reduction in impoundment volume (411acft =>22acft) or 95% would have enormous impact on 454 ac of impoundment area affecting wetlands, wildlife, and water recharge.

Corps Response: Planning level information was presented in the report on these issues.

If in the future a proponent steps forward who wishes to pursue dam removal, these issues would be addressed through a detailed assessment and the permitting process. A section has been added to the report that lists the processes that might be triggered by a dam removal project.

- Exposing a 159 yr old toxic and trash dump site would result in hundreds of acres of “brown field” with 5 metals exceeding RCS levels, and two, arsenic and lead which exceed acceptable landfill reuse. In addition, there is mercury, VOC’s & PCB’s, and who know what else.

Corps Response: The report provides information on sediment in the Assabet River in the “Assabet River Sediment Management Plan” that was completed by CDM in December of 2008. Additional studies would be required to further define the quality of the sediments and verify the extent of sediment removal that would be required should a dam removal project move forward.

- The study estimates clean up costs including sediment removal of 68kyd^3 at $12M. It ignores the Sediment Study of The Assabet River estimate of 759kyd^3 of sediment which could result in a cost of greater than **$100,000,000!!!** (759kyd^3 is approximately 42,000 10 wheeler dump truckloads). Removing large amounts of material would create a lake or series of ponds or impoundment areas, Stow’s very own “Big Dig” and who would pay for it?

RESOLUTION
Given that the estimate of a 10% P. Flux change by the removal of the Ben Smith Dam was based upon “phosphorus flux modeling which was too complex to handle specific combinations of dam removal, dredging and reduced levels of WWTF discharges”; (Pg 9) and given that there are numerous substantial omissions and errors in this analysis; and given that the catastrophic impacts on the Town of Stow and their residents have not been evaluated – “The removal of the Ben Smith Dam and Gleasondale Dam cannot be justified, and should not even be considered due to the horrific impact on and costs to the town of Stow and our residents.”

13. Robert J. and Mary E. Cutler, 461 Gleasondale Road, Stow, MA 01775

Thank you for the presentations offered both at Clock Tower Place in Maynard and in Stow to clarify the goals and possible solutions to the current and future pollution scenarios on the Assabet River.

I have lived on the banks of the Assabet since 1940 as a girl in Maynard when Assabet Woolen Mills and everyone else was using it as a dumping ground for God knows what, and my husband and I bought our Gleasondale house from my grandparents in 1964 when he returned from an army tour in Germany.

We have seen it both at its worst and at it’s best when, together with the Stow Board of Health and John Devine, their consultant, we caught Hudson dumping raw sewage into the river during the night. We live on the Gleasondale Dam, and my young children had a sandbox about 25 feet from the river bank, so I was out early in the morning supervising them when I saw the results of Hudson's action floating past us!! This report to the Stow Board of Health resulted in a comprehensive evaluation of the river and the resultant cleanup and enforcing of the regulations kept the river clean for many years. A huge variety of wildlife and water birds now populates the river to the delight of all of us.

I was astonished to learn when this study began that it was even necessary. The river is again being polluted by the treatment plants; and there seem to be no regulations in place to require proactive planning to prevent this scenario from repeating every few years. I can find no reason the towns can't come up with a formula to predict the point of growth at which planning and funding for increasing capacity of the treatment plants in time to handle the addition pollutants before impacting the river is the only solution!

This river is not just a beautiful natural resource in it's current form. It is a crucial resource for the towns it flows through. I hope any thought of removing dams has been shown to be not only ridiculously expensive, but would irrevocably damage innumerable critical functions to both public safety, farming and recreation currently enjoyed by citizens of the towns it impacts. These include:

- Loss of critical water for firefighting, especially Stow which has no public water supply and uses tankers and direct pumping from the rivers and ponds to fight fires.

Corps Response: The draft report indicated that dam removal could impact the water supply for fire protection purposes. Additional concerns regarding fire ponds adjacent to the river gathered through the public participation process has been added to the section in the report on "Impact of Dam Removal on Water Supply for Fire Protection". If a potential dam removal project were to be considered in the future, then further mitigation plans would need to be developed to address this need.

- Loss of critical water source for two golf courses, orchards, farms and gardens.

Corps Response: A survey of water users of the river and impoundments was not a part of the scope of work for the study. This issue would need to be considered further should a dam removal project move forward.

- Loss would lower the water table, negatively impacting ponds, wells and the levels of the entire watershed.

Corps Response: The Corps report indicates that groundwater levels were not included in the study but could be considered in future studies.

- Impact power generation for both municipal and private purposes already existing in Hudson and Maynard.

Corps Response: The impact on power generation was not a part of the Corps studies. Should any dams be proposed for removal, this issue could be addressed in future studies.

In addition to these losses, removal would:

- Expose old toxic and trash dumpsites

Corps Response: If dam removal were pursued further then additional information would need to be obtained in the area above the dam to identify any potential historic dump sites.

- Cost enormous amounts of money for cleanup or removal

MassDEP Response: Appendix C of the report presents planning level construction cost estimates for dam and sediment removal. These estimate range from one to over twelve million dollars. It should also be noted that communities with wastewater treatment plants have also spent large sums of money upgrading and/or replacing those facilities in order to meet their NPDES permit limits.

- Eliminate the recreational uses (limited boating, ice skating and other recreational activities (no more cub scout river trips and camping out on the banks)

Corps Response: A statement has been added to the report that recreational opportunities that rely on the current water depths would be impacted as water depths will be lower with dam removal.

- Destroy the adjacent wetlands and their inhabitants

Corps Response: In Appendix D a planning level desktop analysis was performed to show potential changes in wetland types that may occur if dams were to be removed. Table 9 Appendix D summarizes these changes. The desktop analysis shows the potential change in wetland type and transition to upland of some areas with dam removal.

- Make the current fans and abutters of the river extremely unhappy!!

A few years ago, our septic system failed. Ours is a 4-apartment townhouse, and when we applied for a permit to replace it, current regulations required a mini processing plant with five manholes in our back driveway, removal of all the trees and flowering shrubs from our back yard, a mound that makes it difficult for us to walk down to the river, and a cost of $75,000 to implement it. This did not include costs like having Astrocrane move the gazebo from the water's edge to the top of the current lawn.

The important point here is that we had no wiggle room around meeting the regulations, and the idea that towns can use cost or time to avoid compliance is a double standard of the worst type.

We take exception to the idea that there is difference in the amount of pollution allowable in winter and summer, since the wildlife inhabiting the river use it in all seasons, and there is no evidence that winter pollutants do not contribute to the problems at other times.

MassDEP Response: Please see the Response to Comment letter #4 regarding year round phosphorus limits.

We believe that no permit to increase contaminants should be issued to Marlboro, and the fact that they are not in compliance will help spur the correction of this problem and inspire prevention of future scenarios!

MassDEP Response: This issue is not a part of the Corps study but is being handled through the NPDES permitting process.

We also believe that your report will impact future river scenarios and we urge you to carefully consider this possibility when filing your final report.

Corps Response: Many of the issues in your bulleted list have been identified in the Corps draft report in pages 37 to 50. The subject of this study was reducing phosphorus flux from the sediment. Phosphorus is found in wastewater but it is also used as fertilizer. In the Assabet impoundments phosphorus is also released to the water column from the sediment. MassDEP requested the Corps look at sediment and dam removal to decrease phosphorus flux from the sediments. This information in the report is to inform the process for improving water quality in the river. If in the future a proponent steps forward who wishes to pursue dam removal, then there would be a detailed assessment and permitting process involved at all levels of government – local, state, and Federal.

<u>14. Alan and Beth DiPietro, 4 Riverside Park, Maynard Massachusetts</u>

As abutters to the Ben Smith Impoundment and the Assabet River, the proposal to remove the historic Ben Smith Dam will have a direct impact on our family, our home, our community and the history that reminds us of who we are, and how and why we happen to be here in Maynard and Stow.

Our family has lived alongside the Assabet River for multiple generations as have many of our neighbors. We have seen great floods. We have seen the river run multi-colored from dyes that were dumped directly into the water. We have seen duckweed so thick you could walk on it. We have seen this river used as a dump site for household waste, tires, cars etc. We have made great strides over the years to clean up the river. However, the Assabet River's pollution problems are still here, just not as obviously as before. But should we throw out the baby with the bath water?

We believe that the negative impact of removing the Ben Smith Dam on the recreational value alone would be enough to oppose this plan. But the loss of history, culture, and community identity could not be remediated.

As we have researched more, we realize that the claims of environmental improvement will actually result in a loss of 100 acres of wetlands. In addition our entire neighborhood would have to be dug up for multiple years to remove sediment. All this so that waste water treatment facilities (WWTFs) can continue to pollute the Assabet River. No, thank you.

The Ben Smith Dam is in excellent shape. It is properly maintained and is not at risk of failing. However, removing it has many risks and consequences.

If this plan were to go forward it would mean the loss of water for recreation, agriculture and fire protection, and loss of critical water sources for area businesses such as orchards, farming, golf courses, etc. It would also cause a multi-year disturbance of hundreds more acres of our neighborhood – a plan that would require the removal of 42,000 truck loads of sediment, that can not be disposed of anywhere in New England. We also would loose the recreational value of the area for most, if not all, of the year. Canoeing, kayaking, and fishing will be greatly impacted if not outright lost. Additionally, shallow wells will obviously be affected by this drop in the water table, however people with artisian wells need also be concerned. The loss of hundreds of cubic acres of impounded water will have a significant impact on groundwater recharge as well as deep aquifer recharge.

Corps Response: Many of the issues raised above have been identified in the Corps draft report. The Corps report notes that water levels will be lower without the dams and Appendix F of the CDM Modeling Report dated June 2008 provides water surface elevations with and without the dams. Sediment behind the dams were considered and discussed in the CDM Sediment Management Plan dated December 2008. Impacts on wetlands were also identified in the Corps draft report page 41 and Appendix D. Specific shallow wells adjacent to the river were not identified in the study but could be included in future studies. If in the future a proponent steps forward who wishes to pursue dam removal, issues associated with dam removal would be addressed through a detailed assessment and the permitting process. A section has been added to the report that lists the processes that might be triggered by a dam removal project.

In addition, the function of flood control can not be glossed over, as more and more development has occurred in historic floodplain areas protected by dam. All dams, even ones that have been converted to fixed weir, provide flood control. It is a natural consequence of restricting the river. Most of the Town of Maynard is down stream of the Ben Smith Dam. And therefore will be at greater risk of flooding if this dam is removed.

Corps Response: As explained in the draft report (page 39 and 40), a detailed flood-routing study would be required to determine if dam removal will pose a risk of increased downstream flood damages. Dams are typically sited at natural channel restrictions, which would continue to provide surcharge storage during floods. As an alternative, dams can be partially breached, rather than entirely removed, so as to obtain the environmental benefits of dam removal during normal flows and the flood-damage reduction benefits of surcharge storage during high flows. Currently there is no project proponent for dam removal and if one were to step forward in the future then detailed studies of this and other issues would be required by Federal, State, and local stakeholders.

The historic mill complex and its associated structures, like the dam and the impoundments, are resources that must be protected. Without the physical reminders of our history, we will quickly fall victim to the allure of revisionist history. Tearing down buildings and changing the names of streets or removing the vestiges of industrialization besmirches the memory of all those hardworking people who made it possible. Out of sight is out of mind, and out of the history books.

Corps Response: The report contains a section on "Cultural Resources" which indicates that many of the dams can be considered contributing elements of larger, historic areas and potentially historic districts. An eligibility determination under the National Register of Historic Places will need to be made as part of the environmental compliance process in consultation with the Massachusetts State Historic Preservation office. "Appendix F Cultural Resources Identification" contains more details including what information would be required should any dams be proposed for removal.

This proposal and all it entails, will only allow WWTFs to continue to pollute the Assabet River. Dam removal only relocates the problem down stream. We are very concerned that this is the same water that ultimately finds its way into the Billerica public drinking water supply. And as if all that were not enough, this proposal does not meet the TMDL Phase II requirement of a 90 percent reduction in sediment phosphorus flux, and is repugnant to the myriad concerns acknowledged in the report.

We must fix this problem at the source. The WWTFs are the cause of the phosphorous issues in the Assabet. It seems clear that the best solution for all involved is tighter winter limits on phosphorous discharge, followed by a plan to discontinue the practice of surface water discharge entirely.

MassDEP Response: Please see the Response to Comment Letter #4 regarding winter limits.

The current practice of discharging wastewater into the river is unsustainable and it must ultimately be stopped. Phosphorous is only the tip of the iceberg - nitrogen, pharmaceuticals, etc., are also being dumped into our river. The towns operating these WWTFs are pumping water from the ground and local surface sources and then dumping the majority of it out of the recharge areas of their water supplies. These towns need to keep their water local to recharge their local ground water sources.

MassDEP Response: These issues are outside of the scope of work for this project and are best addressed under the NPDES permitting program and the CWMP.

Why is the Marlboro facility being allowed an increase of discharge into the river instead of utilizing groundwater disposal, like the Acton WWTF? While at the same time the current TMDL can not be met. Any increases in discharge are in direct contradiction to reducing total phosphorous levels in the Assabet.

MassDEP Response: The proposed increase to the Marlborough facility discharge is not a part of the Corps study but is being handled through the NPDES permitting process. In making permitting decisions MassDEP and EPA must consider individual situations. The utilization of groundwater disposal would likewise be handled through the permitting process. This issue was addressed in the CWMPs prepared for both the City of Marlborough and the Town of Northborough.

The recommendation to remove the Ben Smith Dam must be stricken from the US Army Corps of Engineers' "*Assabet River, Massachusetts Sediment and Dam Removal Feasibility Study*." The data in the report does not support the conclusion. The scope of this study was so limited as to exclude the obvious option of tighter winter limits. Fortunately CDM had to model this scenario anyway. It is the baseline condition for all of their models. Unfortunately we have not been given a straight answer as to what the appropriate winter limit is to get us the "magic" 90% reduction in P Flux. The recommendation to remove the Ben Smith Dam can not possibly be drawn from this report. There are so many contraindictions to this plan that further study would be good money after bad. It is clear from the report that the conclusion must be tighter winter limits on phosphorous discharge.

MassDEP Response: The possibility of stricter winter limits will be discussed during the next round of NPDES permitting. Also please see the Response to Comment Letter #4 regarding year round phosphorus limits.

This report and its executive summary must be altered to recommend that, based on the CDM modeling results, phosphorous discharge levels of no greater than 0.1mg/l must be mandated for any and all discharges into the Assabet River with no exceptions. Towns that are currently discharging into the Assabet River need to start allocating open space in their own communities for groundwater discharge sites or they will have to curtail their development plans.

MassDEP Response: This study identified the potential benefits of winter time phosphorus reductions but did not perform an evaluation to determine the water quality effects on the river of a year round phosphorus limit of 0.1 mg/L for the wastewater treatment plants. Please see the Response to Comment Letter #4. This evaluation was beyond the scope of this report.

The above abutter objections must be clearly outlined in the report, in the conclusion and in the executive summary.

Thank you. We are happy that are voices can be heard in this great democracy. We have faith that the peoples voices will be heard and reflected in the actions of our elected representatives.

Corps Response: The Corps study looked at sediment and dam removal to reduce sediment phosphorus flux. As part of this study issues associated with dam removal were identified such as existing uses, wetlands, water levels, fire protection, flood levels, and cultural resources, see pages 37 to 50 of the draft report. This study is not intended to be an Environmental Impact Statement of dam removal. It is noted that many abutters in Stow appear to value the existing higher water levels provided by the Ben Smith Dam for recreation, aesthetic value, and water supply uses. If in the future a proponent steps forward who wishes to pursue dam removal, then there would be a detailed assessment and permitting process involved at all levels of government – local, state, and Federal.

15. Jeri and Alan Dipietro, 506 Gleasondale Rd., Stow, MA

My name is Jeri Dipietro my husband Alan and I have lived on the Assabet river in Stow for almost 40 years. We are concerned about the recommendation to remove the Ben Smith Dam. We feel that the US Army Corps of Engineers report has provided a lot of valuable information, however we strongly feel that there is not sufficient information contained in the report to recommend removal of any dams.

Any recommendations must be supported by the study and its report, as it will have a major impact on the policy makers on all levels. This study investigated the very narrow impact of dam removal on P loading. It also listed but did no more than list some of the negative impacts and conflicting interests. The conclusion of this report can only comment on the possible impact of P loading if the dam were removed. In addition we feel that the conclusion must also stress, that based on new information uncovered by this study, year round phosphorous discharge levels would better accomplish the same goals.

There has been a lot of talk about the WWTFs and the cost involved to update and operate. How about those of us in Stow who have paid until it hurts! We've personally installed two septic systems, the first in 1971 and again in 2001, which also required us to dig a new water, to meet new tighter requirements. (My story is not unique other residents in town have had to do the same.) Stow is doing what is right, not contributing to the problem but we are the ones being affected.

We realize this study was only to determine if water quality could be improved by dam removal. How ever the feasibility of dam removal cannot be established unless all areas of impact are looked at. This report does not include enough information on the negative impacts of the proposed removal. Therefore the following should be noted in detail in your report.

1- Water tables - if the dam is removed the water tables will drop. The report states this could be a problem but a study has not been done on it. Lowering of the water table would be an increased expense for Stow residents who will need to dig a new well.

Corps Response: The Corps draft report page 39 indicates that groundwater levels were not included in the study but could be considered in the future. If in the future a proponent steps forward who wishes to pursue dam removal, then there would be a detailed assessment and permitting process involved at all levels of government – local, state, and Federal.

2- Fire - Stow has no public water supply and a volunteer Fire department. With a two to three foot deep narrow river will not be enough water to pump from and protect us with. There will be an increase in our homeowners insurance for fire coverage, one more expense for Stow residents. What price do you put on personal safety?

Corps Response: The draft report on page 39 indicated that dam removal could impact the existing use of the river as a source of water for fire protection purposes. If a potential dam removal project were to be considered further in the future, then this use could be investigated further and mitigation plans developed to address this need as appropriate.

3 - Irrigation - What about farms and other businesses that use the river as a source of water? Will they be allowed to renew their withdrawal permits? There will not be enough water for them to draw from in the summer which is imperative for their livelihoods. This further demand for a limited supply of water will further impact fire safety and wells.

Corps Response: A survey of water users of the river and impoundments was not a part of the scope of work for the study. If in the future a proponent steps forward who wishes to pursue dam removal, then there would be a detailed assessment and permitting process involved at all levels of government – local, state, and Federal

4 - Flood - Our property is in the flood plain but our house is not. This is based on the 100 year flood zone. Now what happens? Who was here before the dams to say which land will flood. Most of the structures that exist along the river today were build after the dams. Some of us who do not presently need flood insurance will have yet another expense. Not to mention greater risk to our personal safety. The report noted the possibility of a partial dam removal helping with flood waters, therefore this must be of some concern. Who will guarantee our safety?

Corps Response: As explained in the draft report (page 39 and 40), a detailed flood-routing study would be required to determine if dam removal will pose a risk of increased downstream flood damages. Dams are typically sited at natural channel restrictions, which would continue to provide surcharge storage during floods. As an alternative, dams can be partially breached, rather than entirely removed, so as to obtain the environmental benefits of dam removal during normal flows and the flood-damage reduction benefits of surcharge storage during high flows. If in the future a proponent steps forward who wishes to pursue dam removal then detailed studies of this and other issues would be required by Federal, State, and local stakeholders.

5 - Historic Sites - Where is the protection for the preservation of historic sites? There is tremendous history involving the river the mills and the dams. Many of the riverfront structures did not exist before the dams were build, but were build because the dams existed. These dams are the history and reason for the existence of our current communities.

Corps Response: The report contains a section on "Cultural Resources" which indicates that many of the dams can be considered contributing elements of larger, historic areas and potentially historic districts. An eligibility determination under the National Register of Historic Places would need to be made as part of the environmental compliance process in consultation with the Massachusetts State Historic Preservation office. "Appendix F Cultural Resources Identification" contains more details including what information would be required should any dams be proposed for removal.

6 - Recreation - As I stated I've lived on the river for almost 40 years I grew up on the river in Hudson as my father did before me in Maynard. He taught me to respect the water and enjoy all it had to offer, to just sit and listen, relax, and watch the wildlife. He taught me to row, to paddle, to fish, to camp, in the winter to skate, snowshoe, cross country ski, to ice fish. These simple pleasures were passed on to my children. But what about the next generation? While the thought of padding the river without getting out at the dams sounds good; how often do you think you'll get out and walk through mud because you cannot paddle in such shallow waters? There will be no coves for ice skating, skiing, or snowshoeing in the winters. With a narrow swift current the ice won't freeze safe for ice fishing. The river is presently used for recreation in many areas by

an enormous number of people. Artists who spend endless hours capturing fabulous views of the Assabet on canvas and film will have to go elsewhere.

Corps Response: A recreational use survey of the river was not part of the Corps study. However, a statement has been added to the report that recreational opportunities that rely on the impoundments would be impacted as water depths will be lower with dam removal.

7 - Property Values - Dam removals would eliminate the incredible views that we are blessed with. Dam removals would increase financial expense to the property owners. Dam removals would increase flood risks to people and property. It would increase fire safety risks to our residents and to our fire fighters. Dam removal would decrease our property values!

MassDEP Response: The issue of property values is outside of the scope of work for this project. Please see bullet #2 in this letter above which addresses the issue of fire protection.

Stow does not discharge waste into the river but Stow would bear the impact. Dam removal is not feasible when personal safety concerns and negative impact out weigh the benefits. Dam removal is a backwards approach to the problem. This project is a very expensive band-aid. Dam removal will not eliminate the phosphorus problem. We will still have phosphorus in the water, unless the source WWTFs are dealt with. Hold the WWTFs to a consistent year round phosphorous discharge limit. Why are they allowed to discharge in the river in the first place? If we really want to help the environment and ourselves we would restore these dams to functioning hydroelectric power plants and utilize the resources that we already have. It is time to do what's right and really clean up the Assabet River. Take the millions proposed for dam removal and upgrade and operate the WWTFs so they don't pollute in the first place.

MassDEP Response: The potential benefits associated with year-round phosphorus removal were identified for the first time through this report and will require further discussion and evaluation during the next round of NPDES permitting. The present study however did not perform a detailed water quality evaluation to determine the effects of a year round phosphorus limit of 0.1 mg/L for the wastewater treatment plants. Please see the Response to Comment Letter #4 regarding this issue. The other wastewater treatment plant issues raised are outside of the scope of work for this project and would be handled under the NPDES permitting process and CWMP.

Corps Response: Many of the issues identified above are also identified in the Corps report page 37 to 50 of the draft report. Property values are not discussed in the report, however based on comments received it does appear that riparian landowners have come to rely on the higher water levels provided by the dams. If in the future a proponent steps forward who wishes to pursue dam removal, then there would be a detailed assessment and permitting process involved at all levels of government – local, state, and Federal. A section has been added to the report that lists the process that might be triggered by a dam removal project
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16. Stephen M. Dungan, Chairman, Stow Board of Selectmen, 380 Great Road, Stow, MA

The Town of Stow appreciates the opportunity to comment on the Draft Assabet River, Massachusetts, Sediment and Dam Removal Feasibility Study (the "Study"). In preparing these comments, the Town conducted a Joint Boards meeting and solicited public comments. Comments were received from the Board of Selectmen, the Planning Board, the Conservation Commission, and the Board of Health, as well as from interested citizens. They have been collected and summarized in this letter.

The Town of Stow has been an active participant in the activities and studies associated with the Assabet River over the past few years. The Town of Stow Conservation Commission held a very well-attended public meeting on November 5, 2007 at which the U.S. Army Corps of Engineers, New England District and its consultant, Camp Dresser & McKee (CDM), presented the initial findings of the Draft Modeling Report for the Study. Also in 2007, the Town requested and was invited to participate in the Consortium as a non-voting member. While this was at the end of the process, the Town appreciated the opportunity to be involved. We have also been engaged for the past few years in reviewing and commenting on the 2007 MEPA Environmental Impact Reports, the 2008 Assabet River Sediment and Dam Removal Study: Modeling Report, and the 2008 draft permit modification to allow the City of Marlborough to discharge an additional 1.26 mgd of effluent from the Marlborough Westerly Waste Water Treatment Facility (WWTF) to the Assabet River.

The health of the Assabet River has been a major concern to the residents of Stow for many years. The fact that four municipal WWTFs discharge significant quantities of effluent into the river every year cannot be good for the Assabet River or for the residents of Stow. Although the content of the effluent is regulated by DEP/EPA NPDES discharge permits, the river is not achieving its Total Maximum Daily Load (TMDL) goal as a swimmable, fishable waterway. The 2004 Assabet River TMDL report[1] indicates as much. The Assabet River is designated as a Class B waterway under the Massachusetts water quality standards, indicating that the river should be capable of providing and supporting habitat for fish and other aquatic wildlife, and for primary and secondary contact recreation. The analyses that went into the development of the Study were conducted to evaluate the feasibility of one of the potential means of achieving the goals of a fishable, swimmable river: the potential that sediment and/or dam removal will allow the Assabet River to achieve water quality standards[2].

The Town values its stretch of the river. It provides a base condition for current land uses, specifically private drinking water supply, fire protection, agriculture, and groundwater levels that dictate land planning activities. It also provides a major recreational area for Stow. Its slow moving wide expanses of water provide a navigable environment for canoeists, kayakers and boaters, and the current planning for a bikeway revolves in part around the river. Additionally, the Assabet is federally designated as a Wild and Scenic River.

Overall the studies prepared by the U.S. Army Corps of Engineers over the past few years, and the presentations made by the Corps and its consultant, CDM, have been very useful in understanding the dynamics of phosphorus in the Assabet River. Of most interest has been the recognition that winter discharge from the WWTFs affects phosphorus flux the following summer, and specifically, that phosphorus introduced in the winter can contribute over 50% of the summer phosphorus flux. In addition, the studies have found that a reduction in winter phosphorus loading from point sources, including the WWTFs, could reduce phosphorus sediment flux loading[3]. This information will be useful in the issuance to future NPDES permits to the WWTFs. The information is also useful to the Town: the results of the Study regarding non-point source contributions to the phosphorus loading to the river and remedial actions are being discussed as part of the Town's Master Planning process.

Several items of concern to the Town were not evaluated and should be included in future studies if dam removal continues to be considered as an option. There are many remaining questions that unfortunately result in the inability to fully understand the impacts associated with dam removal. The following comments address these concerns:

- The Study does not estimate the impact of a year-round reduction in P discharge by the WWTFs to 0.1 mg/l. Therefore, the resulting effect on P levels in the river and its sediments cannot be evaluated in conjunction with dam removal. The Study also does not address the potential to reduce discharge limits to levels below 0.1, an option that has been raised in previous documents[4] as part of Phase 2 NPDES permit limits.

MassDEP Response: This issue is outside of the scope of work for this project. Please see the Response to Comment Letter #4 regarding year round phosphorus limits. Future discharge limits will be addressed under the NPDES permitting program and the potential benefits and impacts associated with winter time reductions are identified in this report to inform further discussion during the permitting process.

- The Town believes that prior to considering dam removal, the WWTFs need to be at or below their required discharge P concentrations. Cities and towns that are downstream simply can't be expected to be responsible for cleaning up P that should be removed at the source.

MassDEP Response: MassDEP and EPA have issued NPDES permits requiring the wastewater treatment plants to reach the 0.l mg/L total phosphorus discharge limit. Currently the Westborough, Marlborough West and Maynard plants are under construction and work on the Hudson plant has been completed. MassDEP believes that the 0.1 mg/L total phosphorus discharge limit is the technology limit that presently can be met on a consistent basis by the wastewater treatment plants.

- Table 14 of the Study does not include a cost estimate to further upgrade the WWTFs and therefore, a comparison to the costs to remove dams and clean up the impoundments is unavailable. It may be that the upgrade costs are less.

MassDEP Response: It is not possible at this time to compare these costs because detailed design and cost information is not available for further upgrades to the wastewater treatment plants beyond those already being implemented which are considered the limit of present day technology.

- The dams are privately owned, and the feasibility of their removal by a public sponsor is an important question. In fact, the Study discounted the removal of the Powdermill Dam because of the stated interest in hydropower by the dam's owner, and there are similar plans for another dam.

- Stow is projected to incur significant negative impacts if the Ben Smith and Gleasondale dams are removed. These will involve private drinking water supplies, fire protection resources, agricultural uses, property values for those homes adjacent to the river, and golf courses that rely on the river for irrigation. The Study did not evaluate impacts to these uses, and therefore, the Town is unable to fully evaluate the potential effect of dam removal. The evaluation of direct and indirect impacts on these important uses of the river is recommended in future studies.

Corps Response: The study was meant to provide information on a planning level basis. Future studies and detailed assessments would need to be conducted should a dam removal project be proposed to move forward. A section has been added to the report that lists the processes that might be triggered by a dam removal project.

- The Assabet River is suffering from an excess of phosphorus loading, as documented in the Study. Instead of discharging phosphorus into the river, there is an opportunity for the 35 WWTFs to recover phosphates as part of their treatment process. Phosphorus is a crucial plant nutrient, mainly available to plants as phosphate. As seen in many Massachusetts rivers, it becomes a pollutant when present in excessive quantities. However, loss of phosphorus from the nutrient cycle over time also creates problems. Unlike nitrogen, which can be recovered from the geobiosphere through nitrogen fixation, phosphates mainly end up in the ocean after moving through ground and surface waters. Both food and fuel crops eventually will have to compete for this dwindling essential nutrient unless effective methods are established to either conserve terrestrial phosphates or reclaim them from the ocean [Abelson, 1999[5]]. The Town suggests that the municipal waste treatment plants that are not recovering this important nutrient are wasting a valuable resource. Through use of algal and/or other fast growing aquatic plant species in tertiary retention ponds, both N and P are readily removed and sequestered from waste effluents prior to discharge into our waterways. The subsequent algae or plant material can be recovered and used as fertilizers. This is a win-win sustainable solution to this problem, and the MA DEP should consider phosphate recovery as part of future NPDES permitting.

MassDEP Response. Although this issue is not a part of the current study, your comment on the recovery of phosphorus has been noted.

- The Study does not address water level changes that may impact Lake Boon, a dammed great pond that drains into the Assabet River. All residences around Lake Boon rely on private wells (many of which are shallow) and on-site septic disposal systems.

MassDEP Response: The Corps report indicates that groundwater levels were not addressed in the study. If in the future a proponent steps forward who wishes to pursue dam removal, the impact of water level changes in the river on Lake Boon would need further assessment. A section has been added to the report that lists the processes that might be triggered by a dam removal project.

- Has the Study evaluated the "safe yield" of the Assabet River watershed with dam removal? Although the final definition of safe yield is still evolving, it is reasonable to assume that the greatly reduced flow following dam removal would put the river below the safe yield threshold.

Corps Response: The amount of flows from the Assabet River watershed into the Assabet River would not change as a result of dam removal. The question of the Assabet River Basin "safe yield" as defined by the Massachusetts Water Management Act was not part of this study. For more information on the definition of safe yield under the Water Management Act please refer to: http://www.mass.gov/dep/water/resources/isymethod.htm.

- It is difficult to put a price tag on the aesthetic and recreational values of the river, but for Stow they are significant.

- Stow has raised comments in the past on the planning approach that continues to allow growth in communities relying on the WWTFs without evaluating the cost to manage the resulting increased waste load. If communities continue to permit more and more development, it should be their responsibility to treat the waste. They must not be allowed to dump additional amounts into the Assabet and expect those towns downstream to deal with it. One of the most important points noted in the Study is that the WWTFs are the main source of P in the river. Logic dictates that the WWTFs should also be the main source of the solution. In its 2007 comments on the Draft Environmental Impact Report, the town questioned the planning and projections behind the requested increases in flow and nutrient loading. Land use planning should be a part of any municipal study that depends upon continued and increased reliance on centralized WWTFs). As stated in 2007, "In the current climate of increased sustainability and low impact development, combined with the need to maintain stream base flows, ground water recharge, and maintenance of overall watershed health, it is difficult to understand the apparent narrow approach to expansion of centralized waste water treatment."

MassDEP Response: The issues of development and land use planning were not a part of the ACOE study and are best addressed under a Comprehensive Wastewater Management Plan.

- In addition to the comments mentioned above, the 100-year floodplain and floodway will change dramatically with dam removal.

MassDEP Response: Your comment is noted. This issue will need to be addressed in the future by the proper agency, such as the Federal Emergency Management Agency (FEMA).

Detailed Comments on the Study:

- Page 5, bottom paragraph: Please define how the Study defines the term "impoundment" behind the dams, or the "visual impoundment", which in some cases (e.g. Ben Smith Dam) is smaller than the length of the river that is affected by the dam. See for example Figure 2 which shows a much larger length of river affected by the dam than the estimated impoundment length and area shown on Table 4, General Dam and Impoundment Characteristics.

Corps Response: This has been rewritten in report to clarify numbers presented. A new Figure 3 has been added showing the extent of dam influence.

Dam	Extent of Dam Influence Estimated based on Modeling by CDM	Impoundment area shown in Figure 3 (acres)
Aluminum City Dam	about 0.1 mile in Northborough	0.34
Allen Street Dam	about 0.6 miles to River Street in Northborough	6.9
Hudson Dam	about 1.2 miles to Chapin Road in Hudson	26.9
Gleasondale Dam	about 1.5 miles to Cox Road in Hudson	14.4
Ben Smith Dam	about 5 miles to Route 62 in Stow	146
Powdermill Dam	about 1 mile to Crane Ave in Maynard	27

- Page 10, discussion regarding the qualitative nature of the Study: Here it states that "Modeling limitations due to the complexity of sediment-phosphorus flux behavior meant that quantitative predictions of DO (dissolved oxygen) and biomass levels could NOT be made, and the results of implementing different scenarios could only be qualitatively assessed." Because new permits are expected to be issued in 2010 and there may be changes in permit limits as stated on page 10, we agree that future field studies should be undertaken for different summer and /or winter effluent permit limits.

MassDEP Response: MassDEP has stated in the TMDL that it supports an adaptive management approach. EPA policy allows for this type of approach to implementation. Details related to how this would occur will be discussed and decided during the next round of NPDES permit reissuance. Please see Response to Comment Letter #3 above regarding this issue.

- Page 13: Here it states that consideration of lower WWTF winter P-discharges was not part of the Study. That is an important point in balancing the management of P at its source versus removal of dams and associated dredging (and disposal of dredged materials) downstream. We agree with the conclusion that "Additional reductions in phosphorus levels in WWTF discharges during the non-growing season may make a significant contribution to achieving water quality standards, especially if only limited dam removal is undertaken." While not a criticism of the Study because it was outside the scope of the work, the absence of data on further source point P reductions makes it impossible to fully evaluate the pros and cons of dam removal.

MassDEP Response: This is an issue that will need to be addressed in the future through the NPDES permitting program as permits come up for renewal. It is also being investigated in a study undertaken by the USGS. Please see Comment Letter #4 for more information on phosphorus limits.

- Starting on page 38, the Study addresses the impacts on water surface elevations. Projected drops in water levels immediately behind the dams are significant in many cases, and the impact as one moves upstream, especially during the summer months, can be significant. For example, the drop of 4.5 ft for the Gleasondale dam and 7.4 feet for the Ben Smith dam behind the dams will result in much shallower water elevations as one moves upstream. This is of great concern to the residents of Stow, with potential negative effects on fisheries and wildlife during low flows, and recreational uses during the summer months when low flow conditions would render the river unnavigable.

Corps Response: Recreation was noted as an existing use in the draft report. Many comments have been received concerning the potential loss of boating during the summer. A statement has been added to the report that recreational opportunities that rely on the current water depths would be impacted as water depths will be lower with dam removal.

- The Study notes potential impacts on private drinking water wells, fire ponds, and agricultural intake pipes, specifically as the river flows through Stow, but acknowledges that the impact of lower river water levels on the adjacent groundwater levels was not included and "could be considered during future dam removal studies" (page 39). A full understanding of this impact to the Town of Stow is critical, as most private water supplies, fire protection and agricultural uses are fully dependent on groundwater levels, quantity, and quality. Therefore, the Study is inadequate in this area.

Corps Response: If in the future a proponent steps forward who wishes to pursue dam removal, the issue of groundwater levels could be addressed through a detailed assessment and the permitting process. A section has been added to the report that lists the processes that might be triggered by a dam removal project.

- The Study indicates that the owner of the Powdermill Dam is not interested in removing the dam (page 57). Can the Study identify how the other dam owners responded to the feasibility of dam removal? We understand that the owner of the Ben Smith dam may be considering hydroelectric options, which would render the removal of the dam unlikely. The Study should be updated to reflect current changes to ownership goals. In addition, the Study should include a brief discussion regarding the process of dam removal. For example, is a formal, legally-posted public hearing required prior to any dam removal? Who makes the final decision on removing a given dam? The owner? The town? Is there a process of condemnation?

Corps Response: The Corps has no additional information on the position of dam owners on the Assabet River regarding dam removal. For information on permitting for dam removal projects in Massachusetts suggest you contact the Massachusetts Department of Fish and

Game, Division of Ecological Restoration. Their web site is: http://www.mass.gov/dfwele/der/index.htm.

- On page 59, the Study compares planning level construction costs for the Reduction in P-Load (Table 15). Did the Corps do any benchmarking to determine the costs of upgrading other WWTFs in New England?

Corps Response: The Corps did not look at the costs of wastewater treatment facility upgrades to treat for phosphorus and this information was not available for this study. The intent of the section was to compare the dam removal scenarios looked at in the report to each other. Although agree it would be useful to have information on the cost for the upgrades and annual operation cost for phosphorus treatment. This section has been deleted from final report.

- The Study did not consider partial dam removal, and this option may be beyond its scope. If possible, can the Study briefly address the pros and cons of partial removal, and note, it appropriate, that a study of the impacts of partial removal is beyond the scope?

Corps Response: A sentence was added to report to indicate partial dam removal was not considered in the Corps study. The Corps has no specific information on how partial dam removal could impact the river and thus did not include a discussion of pros and cons in the report.

- The Study addressed additional associated costs; e.g. control of invasive species in former wetlands, restoration, etc. The Study, on page 57, briefly addressed the need for additional information on private land ownership and how land ownership typically changes with dam removal. This information will be necessary, especially for the Town of Stow.

MassDEP Response: It is our understanding that in order to determine land ownership under a dam removal scenario a historical investigative study would need to be performed of all deeded property abutting each impounded area. Such an effort is costly and was deemed necessary only if a formal proposal was made to remove a dam which presently does not exist.

- Appendix B provides engineering considerations for the dam removals. Within Appendix B, there is a discussion of sediment removal for each dam, which makes reference to the 2008 Assabet River Sediment Management Plan prepared by CDM. In order to make the information more accessible to the reader of the Study, perhaps a brief discussion can be included to summarize how CDM developed the volume of sediment necessary for removal at each dam. This will assist the Town in reviewing the costs associated with sediment removal compared to the costs associated with upgrading the WWTFs. One resident expressed a serious concern that the Study drastically underestimated both the volume of sediment that would need to be removed and the associated cost. He also noted that reduced river flow would expose potentially toxic beds that would require extra disposal costs.

Corps Response: The Corps will add a section to report under "Sediment Quantities" that discusses how the sediment volumes were estimated. The sediment removal quantities associated with dam removal for the six study dams were calculated based on results of the HEC-6 modeling conducted for the study. In general that approach allowed for estimation of the sediment quantity that if not removed as part of the dam removal would be transported downstream in a relatively short period of time following the dam removal.

If regulatory agencies determine that exposed sediments represent a health risk and require clean-up then costs and responsibility for clean up would need to be considered. The CDM Sediment Management Plan does identify the need for additional sampling of the sediments if a project were to be considered further.

We recognize that a sponsor for this project is not yet identified, and many of these questions will be raised and discussed as part of the permitting and design process that such a sponsor would be required to undertake. However, additional information in the Final Study would be useful to a future sponsor and to the future regulatory process, as well as to Town planning efforts and management of resources.

As one of our citizens indicated during the Joint Boards meeting, The Town of Stow is not against cleaning up the river. Our primary reservation is that the Study does not provide enough information or a convincing argument that dam removal is going to get the river any closer to achieving state TMDL goals. Therefore, many questions remain regarding the feasibility of dam removal.

In summary,

- The Town is pleased that the Study was able to provide updated information, not available at the time the TMDL was published, regarding winter phosphorus discharges.
- The Study, while thorough in the areas within its scope, was not able to provide critical information necessary for Stow to fully understand impacts associated with dam removal, including, for example, changes to groundwater levels and water supply.
- The Study was unable to show that dam removal would successfully assist in meeting TMDL goals.
- There was not enough assessment of greater improvement to upstream WWTFs.
- There was not enough comparative data regarding costs associated with dam removal versus costs associated with upgrades to WWTFs.

Thank you for the opportunity to comment on the Study.

[1] Assabet River Total Maximum Daily Load for Total Phosphorus, Report Number MA82B-01-2004-01, Control Number CN 201.0 prepared by the Commonwealth of Massachusetts (Assabet TMDL)
[2] Page 8 of 104 of Assabet TMDL
[3] Assabet River Sediment and Dam Removal Study: Modeling Report. June 2008. Camp Dresser & McKee
[4] Letter to Nancy Stevens, Donald Cowles, Paul Blazar and Walter Sokolowski from Ira Leighton, EPA and Robert Golledge, DEP, dated April 28, 2005.
[5] P. H. Abelson, A potential phosphate crisis, *Science*. 1999, *283(5410)*, 2015.

17. Comment from John Dwyer, 4 Durant Avenue

There are still too many unresolved issues to even consider dam removal. The dams maintain extensive wetlands habitat, keep a higher water table that supports wells, and is needed for fire control. Phosphorous is only one of many issues to be addressed.

In addition, the Ben Smith dam supports the mill ponds in downtown Maynard. They are a central feature of the town, a historical landmark, and necessary for fire suppression for the mill complex. If the dam was removed, flow to the mill ponds would stop.

Need to have a discussion of removing more phosphorous from the input to the waste treatment plants. For example, stop sale of any household products containing phosphorous in area stores and educate citizens not to buy products with phosphorous.

Corps Response: Wetlands, water levels, fire protection, the impact on the mill ponds in Maynard and cultural resource issues are identified in the Corps study. If in the future a proponent steps forward who wishes to pursue dam removal, then there would be a detailed assessment and permitting process involved at all levels of government – local, state, and Federal. A section has been added to the report that lists the process that might be triggered by a dam removal project.

18. Organization for the Assabet River -Comments on Assabet River Sediment and Dam Removal Feasibility Study, Draft, September 2009, Alison Field-Juma.

Thank you for the opportunity to comment on this final draft of the above referenced study prepared by the Army Corps of Engineers for the Mass. Department of Environmental Protection. We have reviewed the draft and our comments follow.

Our first comment is in regard to the language used in the Draft Study that draws on the conclusions of the Modeling Report completed by CDM in 2008 which is a central element of this study. The CDM Report (*Assabet River Sediment and Dam Removal Modeling Report*, June 2008) provides valuable technical information to be used in guiding policy-makers and other stakeholders in how to ensure that the Assabet River meets its water quality standard, as laid out in the TMDL for the river.

We are concerned, however, that in several cases the Draft Study's interpretation of the CDM Report inaccurately portrays the conclusions of the CDM Modeling Report and goes beyond the terms of the Study. We raised these concerns in our comments to the ACOE in our comment letter on an earlier draft in June 2009, but they have not been addressed.

The Executive Summary (P. ES-2) states: "This finding *appears* to *indicate* that lower winter limits on WWTFs discharge of phosphorus *may* contribute significantly to reducing sediment phosphorus flux and *might* be another control measure …" (emphasis added).

The CDM Report is far less equivocal, stating: "Based on results of this modeling effort, it was concluded that winter limits for the WWTFs, below the current planned limit of 1 mg/L would contribute significantly to the reduction in sediment phosphorus flux." It goes on to state that: "If no other improvements were implemented, further reductions in summer P discharge limits, below 0.1 mg/L, would not contribute significantly to further reduction in sediment phosphorus flux. *This is because the winter instream phosphorus concentration has such a strong effect on the P flux the following summer*." (CDM Report p. 6-7, emphasis added) The Draft Study's conclusions should reflect the conclusions of the technical report.

***Corps Response:* The sentences you reference were prefaced in the CDM Modeling Report by suggestion for further efforts to better understand the nature of the sediment-water interface, and the influence of the sediment phosphorus flux rates on instream water quality and suggestions for an adaptive management approach. Page 6-7 CDM Modeling Report is included below for clarification.**

During the TMDL study, and even during the outset of this study, the sediment phosphorus flux process was not well understood for the river. This study helped gain an understanding of the dynamic nature of sediment phosphorus flux in the Assabet River. Further efforts should be undertaken to better understand the nature of the sediment-water interface, and the influence of sediment phosphorus flux rates on instream water quality.

Both the sediment phosphorus flux field data collected, as well as the mass balance model of sediment flux, led to better understanding of the seasonality associated with sediment phosphorus flux. Results of the study indicate that the sediment response to a change in overlying water phosphorus concentration is fairly short (several seasons). This suggests that incremental improvements in either point or nonpoint sources should yield benefits in the river in a time frame of several years, rather than a longer period of time as initially hypothesized.

This realization suggests that an adaptive approach would be advantageous. That is, the planned improvements at the WWTFs could be instituted and their impacts measured within a few years to see how extensive further improvements may need to be. This can be concurrent to the feasibility studies for dam removal. Study findings suggest further efforts should focus on the influence of nonpoint sources in this watershed, and the potential associated improvements in sediment phosphorus flux and water quality associated with nonpoint source reductions.

This study also resulted in significant findings regarding the seasonality of sediment phosphorus flux. An additional consideration to meet the TMDL target of 90% reduction in sediment phosphorus flux is winter phosphorus discharge limits for at WWTFs. Based on results of this modeling effort, it was concluded that winter limits for the WWTFs, below the current planned limit of 1 mg/l would contribute significantly to the reduction in sediment phosphorus flux.

If no other improvements were implemented, further reductions in summer P discharge limits, below 0.1 mg/L, would not contribute significantly to further reduction in sediment phosphorus flux. This is because the winter instream phosphorus concentration has such a strong effect on the P flux the following summer. Therefore, if the summer P discharge limits were decreased below 0.1 mg/L without any further reduction in winter limits, the P flux in the summer would still be "controlled" by the winter instream phosphorus concentration.

OAR also strongly objects to the conclusion in the Draft Study that monitoring of the impact of the planned improvements to the WWTFs should be done “before selecting the appropriate option(s) for making the necessary sediment flux reductions and verifying the model predictions.” (ES-2) Further, the Draft Study states that the conclusions of the modeling are limited due to the complexity of sediment-phosphorus flux behavior, and recommends that “additional field study be undertaken should different summer and/or winter effluent permit limits be considered for WWTFs in the future.” (P. 10) These are subjective conclusions that relate more to upcoming permitting decisions than to the data in the technical study. It is beyond the purview of the Draft Study to comment on the timing of wastewater treatment plant discharge limits.

Corps Response: Agree, the Corps is not involved in permitting the wastewater treatment facilities on the river. Revised wording in Executive Summary.

We also note that the biomass data referred to on page 7 were collected in 1999 and 2000 for the TMDL (not by OAR), and data from 2005, 2006 and 2007 were collected by OAR. No biomass data were collected from the Powdermill Dam impoundment in recent years due to the drawdown of the impoundment for dam repair; biomass levels are otherwise generally very high in that impoundment.

Corps Response: The Corps removed this reference from the report.

Lastly, OAR is concerned regarding the recommendation for dam removal. As part of the interim (Phase 1) WWTF permits issued in 2005, the Sediment and Dam Removal Feasibility Study was initiated to explore two possible alternative ways to reduce phosphorus in the Assabet River. The primary source of phosphorus is known to be the four municipal wastewater treatment plants that discharge into the river. In conjunction with the study, OAR convened two River Restoration Workshops to inform the community—and ourselves—about how dam removal could affect river water quality, river ecology, and the watershed as a whole. In these workshops we learned that although dam removal can have a positive impact on river water quality and provide better habitat by allowing free fish passage, among other benefits, it is an extremely complicated process and requires, at minimum, willing dam owners, a supportive river community, and lengthy regulatory review.

Since the initiation of the study, and more recently with the release of the draft findings, a number of items have come to light:

- The CDM Report shows that phosphorus entering the water column during the winter months is being taken up by sediments in the river and then released in warmer months, as noted above. The Report points to lower winter limits as likely to have a significant effect on lowering phosphorus uptake by biomass in the growing season.

- The Draft Study focused on the removal of a single, privately-owned dam, the Ben Smith Dam in Maynard, whose removal by itself could yield a relatively small improvement in water quality while likely having significant impacts on public safety, wells, and current recreational use.

- Most of the dams on the Assabet are privately owned and the owners have economic interests in several them. The Powdermill Dam in Acton is operated as a hydro-electric facility and the owner of the Ben Smith Dam in Maynard has applied for grants to explore the generation of hydropower there, and has applied for and received a Preliminary Permit from FERC in 2008 to generate hydro-electricity.

- Members of the public who would be directly affected by dam removal expressed strong negative reactions and posed many questions that the study had not been able to answer at the public informational meetings held on the Draft Study.

Given the great uncertainty in the cost estimates of the dam removals and accompanying site restoration, the lack of support of the largest dam owners, and objections by communities affected by some of the larger dams, OAR believes that removing dams, either singly or in combination, is not a viable option for achieving water quality standards for the Assabet River for Phase 2 NPDES permitting. As discussed above, the CDM Report shows that lower winter phosphorus limits, in combination with the planned WWTF upgrades mandated by Phase 1 permits, would offer immediate and achievable water quality improvements. We believe that this approach would benefit the river, the wildlife that lives in and around the river, and the communities that have grown up along it.

We hope these comments will be reflected in the text of the final study. We appreciate the large amount of work that has gone into the study to provide a greater understanding of the pollution problems of the Assabet River and how to solve them. Please don't hesitate to contact us if you would like further clarification.

Corps Response. Many comments and concerns have been received regarding dam removal and are included in this Appendix. The Corps study looked at six dams, although agree many of the comments received were in opposition to the removal of the Ben Smith dam. The Corps appreciates your participation in this study as a member of the Study Coordination Team.

19. Mildred Finnila, Maynard, MA

I have grown up in Maynard so did my mother, grandmother and children. We have used the river for teaching my children to fish and had many family canoeing trips with stops along the way for lunch. This body of water also would be a benefit if there was a fire along the river. It is a source of fresh water for the Stow or Maynard firefighters. I would strongly recommend not removing the dam.

Corps Response: The draft report page 39 indicates that dam removal could impact water supply for fire protection purposes. Removal of dams would result in lower water levels and this would impact the existing recreational uses that rely on the deeper water levels in the impoundments. If in the future a proponent steps forward who wishes to pursue dam removal, then there would be a detailed assessment and permitting process involved at all levels of

government – local, state, and Federal for all aspects of a dam removal project. A section has been added to the report that lists the process that might be triggered by a dam removal project.

<u>20. David D. Gavin, Chair, Maynard Board of Selectmen</u>

The Maynard Board of Selectmen appreciates the recent meeting with Barbara Blumeris from the Army Corps of Engineers and Mass DEP representatives, Alice Rojko and Bryant Firman. As a result of that presentation and a thorough review of the Assabet River Feasibility Study, the board has some concerns.

The board wholeheartedly agrees with the conclusion articulated in the Executive Summary. *"Given the inherent difficulty in predicting the impact of sediment flux under the water quality conditions present at the time the TMDL was developed, it is reasonable from a scientific standpoint to monitor the effectiveness of the present wastewater treatment facility (WWTFs) upgrades before selecting the appropriate option(s) for making the necessary sediment flux reductions and verifying the model predictions."*

Modeling is not an exact science. Only one of the 4 upgraded Waste Water Treatment Plants is presently on-line. It is premature to draw conclusions about river sediment without the hard science of at least one full year of data reflecting summer and winter mandated phosphorus limits at all 4 plants.

The Board realizes that a feasibility study is not a directive. Clearly further studies are necessary before arriving at any directive regarding removal of the Ben Smith Dam. Some points for your consideration are as follows:

> 1. The study states, "consideration should be given to reducing phosphorus levels in WWTF discharges during the non-growing season."
> The board agrees with this recommendation. It is difficult to understand that dam removal would be considered given the expense and unknown issues with sediment toxicity, prior to exploring the merits of reducing winter phosphorus levels at all Waste Water Treatment Facilities.

MassDEP Response: Please see the Response to Comment Letter #4 regarding year round phosphorus limits.

> 2. The study fails to highlight the recreational importance of the impoundment behind the Ben Smith Dam. Trails in the adjacent properties are mentioned but not the value of the river itself. Maynard invested conservation funds to create a park and canoe launch, Ice House Landing, just upstream of the dam. The section on either side of the White Pond Road bridge is a popular kayak, fishing and family canoe area. That stretch of slow moving river is spectacular in all seasons and is heavily used by residents of both Stow and Maynard.

Corps Response: Recreation was identified in the report as an existing use of the river. However, a detailed recreation survey of the river was not part of the Corps scope of work. If in the future a proponent of dam removal steps forward then loss or changes to recreational use would need to be considered as part of the environmental impact assessment.

3. The study thoroughly articulates the historic significance of the Ben Smith Dam and we appreciate that. Maynard in fact would not exist if not for the Ben Smith Dam. Further, the Mill Pond is a central focal point in the downtown district. The popular Farmer's Market is located next to the mill pond. Residents stroll, fish and relax on the banks of the pond. And perhaps most importantly, the Mill Pond is a critical fire protection source for the adjacent historic mill buildings. One can scarcely imagine the town without this important resource.

Corps Response: There is a section in the report, "Impact of Dam Removal on the Mill Ponds at Clock Tower Place", that recognizes the importance of the Mill Pond and presents some preliminary information on the options that are available. Appendix J has been added to the report which provides a summary of the evaluation performed by CDM regarding the relationship of Ben Smith dam and the Mill Ponds water level. If in the future dam removal is pursued, this issue would need to be further addressed.

4. The report documents each dam owner and the current status of each dam. To reiterate, Wellesley Rosewood Maynard Mills LP has a preliminary permit with FERC to once again generate electricity from the Ben Smith Dam. As recently as April 2009, a progress report was submitted to FERC. In that report, Wellesley Rosewood states *"We at Wellesley Rosewood Maynard Mills L have worked hard over a number of years to get to this very exciting point in our studies and work associated with the realization of a hydropower electrical generation plant at historic Clock Tower Place. Our motivation is extremely high to see this installation complete, for we realize that this achievement will benefit, not only the Permittee, but also the objectives of the National Administration in not only reducing our reliance on foreign oil but also reducing the high carbon emissions from fossil fuels."* The report then articulates the detailed progress thus far. Clearly the owner is committed to restoring the dam for its originally intended purpose.

5. The study discusses a targeted fish community (TFC) that may find its way to the river should the dams be removed. The study mentions shade trees and bushes presumed to flourish along the newly exposed shores as well. However, according to the study *"under low flow conditions, wastewater treatment plant effluent flows can account for a substantial percentage of river flow"*.
It is indeed difficult to imagine alewife thriving in a river that is primarily effluent in the summer months. It is equally difficult to imagine shade trees having much of a chance to flourish given the aggressive nature of invasive species such as purple loosestrife. There is an ecosystem flourishing now. It is 160 years old. It is comprised of wetlands and supports a variety of wildlife. The board is quite familiar with the law of unintended consequences. There is a concern that in the efforts to clean the river, more may be lost than gained.

Corps Response: The target fish community approach was suggested by Massachusetts Division of Fisheries and Wildlife as the methodology to use for this planning study. If in the future a proponent were to consider dam removal further detailed fisheries predictions could be developed as appropriate.

In conclusion, the board understands and generally supports the goals for the Assabet River; improved water quality to meet Massachusetts water quality standards and achievement of a sustainable and restored aquatic ecosystem. However, Maynard is at a severe disadvantage in that the community lies downstream of three WWTFs, two of which are quite large. The burden for a cleaner river needs to be shared equally between all communities responsible for its demise. The merits of a restored aquatic ecosystem must also be balanced with historic, recreational, economic and social impacts within our human communities.

According to your own conclusion, the flux was too complex to allow modeling to predict outcomes of various combinations of dam removal, dredging and reductions in phosphorus levels in WWTF discharges. The board urges further study AFTER reduced phosphorus limits have been implemented for a full year at ALL Waste Water Treatment Facilities.

MassDEP Response: MassDEP has stated in the TMDL that it is in support of an adaptive management approach. EPA policy allows for this type of approach to implementation. Details related to how this would occur will be discussed and decided during the next round of NPDES permit reissuance. Please see Response to Comment Letter #3 above.

Further, the stated goal is to reach 90% P Flux reduction in river sediment. The study concludes that removal of the Ben Smith Dam would reach 80%. Given that dam removal is not projected to meet the stated objective and is in fact an extremely challenging avenue to pursue, the board concludes that dam removal is in fact not the best approach for reaching your stated goal.

Corps Response: We anticipate that the comments and concerns raised by the communities and landowners in this Appendix regarding dam removal will be useful to decision makers.

21. Gretchen Hayden-Ruckert, Artistic Director, Chhandika Institute of Kathak Dance, Part-time Lecturer, Tufts University and Wellesley College

I am adding my voice to those against the Corps' dam removal proposal. Dam removal is NOT the best solution. I'm aware that many have written letters more eloquently—some with greater knowledge of the details. I join them in saying that removing the dams would have more of a negative than a positive impact on the Assabet River.

I have attended three meetings presented by the Army Corps of Engineer during the past two years. From the beginning, the studies and viewpoints seemed to me to be distorted (mostly one-sided) and disingenuous. There were no details put forth initially on the impact dam removal would have on certain areas of the Assabet (such as in Stow). No study was done on the environmental impact. If some portions of the river are all but "disappeared" what happens to those areas, the water supply, the residential and business wells, the water-life, wild-life, recreational use, etc. as a result?

It also seems to me:

Allowing the destruction of some of the most beautiful, vibrant, and useful portions of the Assabet River and surroundings should NOT be allowed.

- o These areas are used and enjoyed by many, including kayakers, hikers, canoers, hunters, fishermen, families—as well as treasured abutters and those living in towns near the Assabet.
- o Not only is the Assabet a source of beauty and a haven for wildlife, we in Stow depend on it as a source of water (wells) and fire protection (from the river water).

- A great part of the solution lies in holding the water treatment plants responsible for higher standards; towns with water treatment plants pouring their waste into the river should be held accountable for better treatment facilities; for educating their residents and businesses to use less-polluting substances that end up in the Assabet; to cut back on the waste amount they can put into the river.

My husband I have been abutters to the Assabet River since moving to the Gleasondale area of Stow in 2001. It was the magnificent beauty, the wildlife, and the serenity of this portion of the river that drew us here. "A "pocket of peace!" is how a visiting friend from Holland refers to it. Not a day goes by without us counting our blessings and good fortune to have our home by this sweet and semi-wild Assabet River! Daily we celebrate the abundant wildlife that inhabit these environs: red-tailed hawk, heron, owls, frogs, a variety of fish species, turtles, muskrats, otter, fisher-cat, river snakes, several duck species, to name just some. As one neighbor down the road put it, "we don't even have to drive to Maine for this!"

We are aware that over the years many have put in immense effort in cleaning up the river (such as OAR) and bringing it to its current standard. As this is our "back yard" we not naturally want to protect this, and we also feel a responsibility to do whatever we can to protect the Assabet River and wetlands for the future. Once gone, it will not come back.

Finally—as I consider proposed "solution" of dam removal, I cannot help but wonder: **Who is getting to decide (an how) which portions of the Assabet River to possibly destroy in order to "save" the river?**

Corps Response: The concept of dam removal on the Assabet to improve water quality is not new. The TMDL prepared by MassDEP in 2004 (page 3) identified possible dam removal as a measure to improve water quality in the river. The SuAsCoTMDL can be viewed at: http://www.mass.gov/dep/water/resources/tmdls.htm#suasco.

The Corps study is a follow on to this TMDL and is done under the Corps "Planning Assistance to States Program" and is not an Environmental Impact Statement. The purpose of the Corps study was to evaluate sediment and dam removal to reduce sediment phosphorus flux and included identification of impacts associated with this measure. As you are aware, the presence of dams on the river result in higher than natural water levels and without dams the water levels would be lower. The study recognizes the existing natural resources above the dams and includes Appendix D that provides a desktop review of wetlands behind the dams and potential changes to wetlands for informational purposes.

If in the future a proponent steps forward who wishes to pursue dam removal, then there would be a detailed assessment and permitting process involved at all levels of government – local, state, and Federal. A section has been added to the report that lists the process that might be triggered by a dam removal project.

22. Barbara and Gregory Jones, 61 Sudbury Road, Stow, MA

My husband and I have lived along the Assabet River in Stow since 1982. During that time, we have canoed and kayaked along the beautiful waters of the Assabet River many, many times, in all seasons. We have introduced our three children to the beauties of the undeveloped wetlands that surround the river, particularly in the stretch between the dam in Gleasondale, and the Sudbury Road bridge in Stow. Although this is not a long stretch of water, you can quickly lose sight of any houses, and feel as if you are completely on your own. Wild life abounds as the river snakes slowly along this undisturbed stretch.

One of the most memorable sights was coming upon a pair of swans. When we approached in our canoe, they took flight. They are enormous birds that require a lot of effort to get aloft. Having them achieve flight within arm's length of our canoe was a sight we will never forget.

Many, many residents use this stretch of water to refresh their spirits and regain a sense of nature. We have watched as the quality of water in the Assabet River has improved considerably during the nearly 30 years we have been using the river. Occasionally, when we have a particularly cold winter, we have joined others to skate to Maynard, or cross-country ski over the frozen water.

Removing the Ben Smith Dam in Maynard will reduce our beautiful river to a bog, source of mosquitoes and other undesirable insects, and take from us an irreplaceable natural source of renewal.

Please consider the good of all the citizens and residents of the communities, like Stow that will be greatly affected by the lose of this beautiful resource.

Corps Response: If in the future a proponent steps forward who wishes to pursue dam removal, then there would be a detailed assessment and permitting process involved at all levels of government – local, state, and Federal. A section has been added to the report that lists the process that might be triggered by a dam removal project.

23. Walter E. Lankau, Jr., Owner, Stow Acres Country Club,
58 Randall Rd., Stow, MA

Thank you for giving Stow residents and business owners a chance to present our concerns at the public hearing on Nov 19, 2009.

As I mentioned during the meeting, I am very concerned that the impact on local businesses of dam removal was not addressed in the report. The dams in the river were constructed decades ago for the primary purpose of supporting local commerce. The river, in its current state, continues to support many local businesses including golf courses and fruit orchards. In my particular case, the river has served as the primary and essentially only source of irrigation water since it was first built in the 1920's. Our usage has been registered and approved ever since registration and reporting were mandated in the late 1980's or early 1990's.

We are totally dependent on the river and its current height and flow and would be faced with an extreme hardship or the demise of our business if the Ben Smith Dam were to be removed. We employ over 100 people in our peak months and provide significant open space and recreation for residents of the surrounding communities.

We respectfully ask that you include the impact on local businesses in your report and urge you to leave the dams in place.

Corps Response: The study did not include a survey of water users of the river/impoundments behind the dams. Some uses were noted under the "Existing Uses" section of the report and the decrease in water level was identified in the "Impact of Dam Removal on Water Levels" section.

We checked with MassDEP and the location of the Stow Acres Country Club permitted withdrawal #2286009-01G is located on a tributary to the Assabet above Gleasondale Dam. This information has been included in the existing uses section for Gleasondale Dam.

If in the future a proponent steps forward who wishes to pursue dam removal, then there would be a detailed assessment and permitting process involved at all levels of government – local, state, and Federal. A section has been added to the report that lists the process that might be triggered by a dam removal project.

24. Richard S. Martin, Honey Pot Hill Orchards, 91 Boon Road, Stow, MA

The Assabet River must be policed to stop pollutants entering into it. Removing the dams along the Assabet River solves nothing and takes away a lot. There will still be pollutants coming into the river. The low river will virtually eliminate its recreational value and probably eliminate the availability of water for our 200 acre farm. We draw water for frost protection in the spring and irrigation during dry spells. This can mean the difference between profit and loss at the orchard. Nature will clean up the river if we eliminate the pollutants. Spend our money on eliminating the pollutants source.

Corps Response: Based on a GIS map of the area Honey Pot Orchards appears to be located near Sudbury Road about 2.4 miles above Ben Smith Dam. The report will note in the existing uses section that the Orchard has reported they withdraw water from the river upstream of Ben Smith Dam.

25. William Maxfield, 89 Walcott Street, Stow, MA 01775

I have attended two public meetings over the past two years regarding this study and both times I came away with the same three comments.

First, with all the analysis of Dam Removal and its effect on phosphorus in your draft, the concept of controlling the P-discharge limits at the source is mentioned, but no further study has taken place between your presentation in 2007 and the one a month ago.

Your study makes the statement "Although consideration of lower WWTF winter P-discharge limits were not part of this study, the P-flux model based on limited laboratory data indicated that winter P-loading may have an effect on summer sediment flux rates. Additional reductions in phosphorus levels in WWTF discharges during the non-growing season may make a significant contribution to achieving water quality standards, especially if only limited dam removal is undertaken."

I understand that Marlborough does not even meet the P-discharge limits that are already in place with 1.0 mg/l during the winter and 0.1 mg/l during the summer. If the limits were enforced by the MassDEP, and then altered to 0.1 mg/l for all twelve months, we could see how much the nutrient loadings are affected over a two to three year period. All of the treatment plants that discharge into the Assabet River are required to implement procedures to limit P-discharge to 0.1 mg/l for the summer months so I assume the same system will work during the winter months. So the technology is available and should be in place SOON, we hope, so the impact on the river could be sampled over a two to three year period. The cost of these measurements should not be a burden and should be place now if we want to be able to report any progress in controlling the P-discharge with the existing limits, let alone with the 0.1 mg/l limits all year that I am suggesting.

My second comment concerns the removal of the Ben Smith Dam. Over the past two years the private owner of the Powder Mill Dam has been installing a new hydroelectric generator at their dam site and I believe they are very close to bringing it online. For the past two years the

Powder Mill dam has not been filling its catchment basin until sometime in the past few months. Now the basin is full and one would assume they are generating electricity or will be very soon.

The reason I mention this is if the Ben Smith dam were to be removed, even with all the sediment that has accumulated behind it, the Powder Mill dam is only about two miles downstream and I doubt if the owners of the newly renovated dam will want to consider removing their dam. I consider the cost of removing the Ben Smith dam way out of line if the same problem exists behind the Powder Mill dam, just a few miles downstream.

The last comment I have concerns the dams that are being considered for removal. One of the issues, as I understand it, is the buildup of sediment behind the dams. This is a problem for all dams that let the excess water flow over the top of the dam. There are dams that are built with discharge pipes close to the bottom of the dam that allow for both water and sediment to pass through the dam and not accumulate as much behind the dam. The renovation of any dam to install such discharge pipes is not cheap, but it might allow the dams to stay in place and still facilitate the reduction of sediment and its P-loading concerns.

I am a member of the Open Space Committee in the Town of Stow and we have discussed the Assabet River Study and several of the comments by other committees in town that have much more clout with concerns of dam removal. One of our missions has been to evaluate parcels that are considered 'open space' but not protected from development. If a parcel has been under Chapter 61 and the owner has an offer to sell the parcel to a developer, the town only has 120 days to decide whether to meet the contractual offer. The town has used our evaluations to aid in the decision process of the right of first refusal. We are very aware of some of the parcels in Stow that boarder the Assabet River that are larger than five acres and are not developed. There is no doubt that if the Ben Smith dam were to be removed, the property values, residential, commercial and public will be affected.

Corps Response: The Corps study looked at sediment and dam removal to decrease sediment phosphorus flux. The Corps recognized the issue of sediment movement that can occur with dam removal and as a part of the study CDM developed a sediment management plan for dam removal "Assabet River Sediment Management Plan" CDM 2008. The study did not investigate creating a bottom discharge pipe from a dam to allow sediment to pass downstream. Moving sediment downstream would create an issue at the next downstream impoundment.

MassDEP Response: MassDEP and EPA reissued the NPDES permits with compliance schedules for the wastewater treatment plants to reach the 0.l mg/L total phosphorus discharge limit. To achieve the new limit, extensive and very expensive upgrades and/or replacement of the facilities are necessary. Currently the Westborough, Marlborough West and Maynard plants are under construction and work on the Hudson plant has been completed. The permitting limits for the wastewater treatment plants, including any consideration for year round phosphorus limits of 0.1 mg/L total phosphorus, are outside of the scope of work for this project and are being handled under the NPDES permitting program. Please also see Response to Comment Letter #4 for further information regarding year round phosphorus limits.

26. Robert C. McDonald, Stow, MA

1.0 Adverse Consequences of dam removal

1.1 Summer dry periods will result in the river carrying a majority flow consisting of sewer plant effluent. Maintaining low phosphorus will have minimal benefit, because the high biological and chemical oxygen demand will destroy aquatic animal communities. Chlorine oxide, the product of sunlight catalyzed oxidation of treatment plant chlorine will contribute to the loss of animal life in the river.

Corps Response: Removing dams does not change the portion of flow due to the wastewater treatment facilities in the river.

1.2 Long periods of drought in the region will result in long term loss of fish and riparian species of bird, mammals, amphibians and reptiles.

1.3 Long stretches of the River will drop to pre-industrial flows with reduced navigability for recreational and sports boating.

Corps Response: Agree, water levels in the river behind the dams will be lower if the dams are removed and this is shown in Table 11 and Figure 5 in the Corps report. In addition, the CDM "Modeling Report", June 2008, Appendix F provides water surface elevations for 7Q10, Summer Average , 10-year, and 100- year flow scenarios for the river for base conditions and dam removal conditions.

1.4 After 160 years of accumulation of sediment behind the dams, a sudden release of this solid material to down stream communities will have a potential effect on public health, not only for users of the river but also for the communities of Billerica and Tewkesbury the obtain their drinking water from the Concord river which lies down stream. Portals installed at the base of the dams would permit controlled release of the fine sediment particles to minimize the impact on downstream life.

Corps Response: Releasing sediments from portals at the base of a dam was not investigated as part of this study but does not appear to have any benefit as the sediment would move to the next impoundment. It should also be noted that discharging water from the base of the dam can also have negative impacts if there are low oxygen levels above the dam. Low oxygen releases can impact fish resources downstream.

1.5 The return of the river to its pre-industrial level will alter several hundred acres of floodplain which was created by the seven dams. Though unintentional at the time, the expanses of flooded land led to the expansion of aquatic habitat for many species of wild life thriving in the resulting vigorous food chain: black duck, otter, beaver and mammals breeding in isolated upland islands like coyote, deer,

1.6 The large areas of formal floodplain will have the be remapped to determine the new 100-year floodplain boundaries as will be required by landowners and developers of commercial and residential property. Areas of scenic landscape which were created by the dams will be altered and replaced by industrial, commercial and residential land uses.

Corps Response: The Corps study does provide planning level information on the wetlands behind the dams that might be changed by a dam removal project. (See Appendix D) and discusses the need to protect riparian lands.

2.0 Recommendations for completion of study

2.1 The Commonwealth and the Corp of Engineers must do the following to complete the study of dam removal:

2.2 Develop a model of the chemical, biological, wildlife and human health consequences of a low flow, effluent-rich river which passing through seven towns. The chemical modeling should to include not only the phosphate loading but the effects of sunlight and warmer temperatures on the interaction of nitrates, chlorine, phosphates and the population of organic solvents, pharmaceutics, and petroleum products which enter the river from the communities using the treatment plants

Mass DEP Response: Your recommendation has been noted. If in the future a proponent steps forward who wishes to pursue dam removal, then there would be a detailed assessment involving many of the issues that were raised with dam removal.

2.3 Examine the relative costs and effectiveness of creating a series of periodic drainage features in each dam (similar to the one currently in use at the Powder Mill dam in Acton) which can parse out sediment during periods which are safe for down stream communities.

Mass DEP Response: Your recommendation has been noted.

2.4 Commit to halting the practice of adding new communities, not located in the river's watershed to the Assabet's treatment plants. Massachusetts rivers should be treated with equal care and consideration.   Since the Assabet has a disproportionate number of treatment plants per mile of river length, it receives a high level of   septic haulage from towns outside the watershed.

Mass DEP Response: This issue was not a part of the ACOE study but was given consideration when the Assabet River Consortium completed a Comprehensive Wastewater Management Plan in 2007 which outlined how the six Assabet River Consortium communities (Hudson, Marlborough, Maynard, Northborough, Shrewsbury and Westborough) individually and collectively would treat and dispose of sanitary sewage over a 20-year period.

2.5 Develop a revised model for down-stream flooding as dams are removed from the river. The current models on which the flow-control projects are based assumes a large square area of flood storage. A post-dam river is likely to like in its pre-industrial recess which banks in many areas which will funnel and accelerated river flow during the 100 and 500 year floods.

Corps Response: As explained in the draft report (page 39 and 40), a detailed flood-routing study would be required to determine if dam removal will pose a risk of increased downstream flood damages. If in the future a proponent steps forward who wishes to pursue dam removal then a detailed study of this issue would likely be required by Federal, State, and local stakeholders.

2.6 Work with all communities to develop long range planning for sustainable growth with advanced planning works water resources and waste treatment. Build-out limits must be defined in terms of what the water supply and removal systems can safely support.

Mass DEP Response: As noted above this issue would best be addressed under a Comprehensive Wastewater Management Plan.

2.7 Determine what need to be done to upgrade Billerica and Tewkesbury drinking water treatment plants to tolerated the deteriorating water quality in the Concord from the expanded effluent from the Marlborough plant, especially in low-flow conditions during drought.

Mass DEP Response: The proposed increase to the Marlborough facility discharge is being handled through the NPDES permitting process which will consider many factors in making its permitting decision.

27. Len and Amanda Mead, 22 Taft Ave, Maynard, MA.

I have read through the detailed Army Corps of Engineers report which analyzes the Assabet River pollutant levels and the idea that removing the Ben Smith dam in Maynard will solve the problem. We object to this suggestion and urge you not to remove the Ben Smith dam for a number of reasons, but two stand out

1) Demolishing dams does not address the issue of upstream towns dumping pollutants into the river. That should be the core issue and it is not going to be solved by simply altering the flow patterns in the river.
2) Of all the dams being considered for removal, none will cause greater aesthetic and cultural damage than the Ben Smith dam. Not only is it the oldest and most historically significant dam being evaluated, but its removal would cause the most obvious change to the appearance of our town. Maynard is a relatively tiny town, surely one of the smallest on the river, and the river itself and the ponds which shoot off of the Ben Smith dam are visible to a high percentage of people who live and work in Maynard.

For us personally, we live on Taft Avenue in Maynard and our decision to purchase this house was driven significantly by the beauty of the river in our backyard. We canoe on it, we watch the wildlife swimming through it (otters, beavers, ducks, swans, herons, etc) with our children, and we cherish the conservation land which exists in the land between our home and the river. As we look at photos of the “after” look once the Ben Smith dam is removed, it appears we would essentially be bordering a swamp. You will have taken this home’s most appealing and unique asset and turned it into a negative. I know ours is not the only house that will be effected in this manner.

Please feel free to speak with us if you believe we are misguided in our understanding of this issue. Otherwise, we wish to loudly object to any plans to remove the Ben Smith dam.

Corps Response: As a point of clarification the study assumes the waste water treatment plants are upgraded to reduce phosphorus discharges to the NPDES permit limits as prescribed by MassDEP and EPA. Dam removal and sediment dredging were considered in this study in addition to planned upgrades to reduce the phosphorus loading from the sediment. This measure was identified in the TMDL prepared by MassDEP and EPA in 2004. The SuAsCo TMDL can be viewed at:
http://www.mass.gov/dep/water/resources/tmdls.htm#suasco

There are many concerns associated with dam removal that would need to be considered further. If in the future a proponent steps forward who wishes to pursue dam removal, then there would be a detailed assessment and permitting process involved at all levels of government – local, state, and Federal. A section has been added to the report that lists the process that might be triggered by a dam removal project.

28. Gerald P. Noone, 35 Forest Road, Stow, MA

I am writing regarding the recent study by the Army Corp of Engineers concerning the Assabet River. I am an abutter in Stow and have lived here for 19 years. I am concerned that Stow will bear the brunt of the destruction of a natural resource if the Ben Smith Dam and Gleasondale Dam are removed. It appears to me that DEP and the towns upriver that are discharging pollutants are looking for the easy and cheap way out at the expense of the abutters in Stow. There does not appear to be any valid reason, short of expense to those towns, for the removal of the aforementioned dams. While the phosphorous levels may be reduced, there is no guarantee and further, it does not appear that any thought has been given to the resulting brownfields if the water levels of the river go down as much as predicted. Who will pay for the removal of this new problem? Who will pay for the need for new wells to be dug for the abutters. (I happen to have a well.) Who will pay for the loss in value of my home due to the exposed, toxic, polluted riverbank and marsh areas? This will in essence be a taking by eminent domain without just compensation in violation of the Fifth Amendment. The river has an occasional smell in the summer when water levels are lower, it will be much worse if the dams are removed and the water level is reduced to a stream.

Those towns upriver who have been cutting a deal with DEP, without input from Stow, are the only ones who will benefit. The six miles of river and the hundreds (400 plus) of exposed acreage will be permanently damaged and for what? If those upriver towns want to keep expanding, then make them pay for their discharge. DEP shouldn't be in bed with these towns and their consultants who only have their own selfish interests at heart not the interests of Stow or nature lovers. If the water level is reduced, you will drive off all of the wildlife that I can see from my deck! This includes, beaver, heron, fishers, fox, deer, coyotes, ducks, geese, hawks, turtles, fish, etc. The exposed muck will reek during the hot summer months. And I'm sure that this muck is equally as bad for the environment as the phosphorous being discharged by Hudson, Marlborough, Northborough.

I am urging you and the DEP to find other ways to reduce the phosphorous discharge levels by these towns. Their expansion should not be at the expense of a beautiful natural resource. The resulting damage will be irrevocable. I will be demanding that the Stow Conservation Commission and the federal governmental agencies that have an interest in this process, find a way to stop your plan. If necessary, I will seek legal action myself to stop the DEP from permanently harming my property as well as the Assabet River. The process so far does not pass the proverbial "smell test". It smacks of corruption and collusion between the upriver towns and the DEP.

I respectfully request the DEP put a halt to this planned removal of the Ben Smith Dam and any other dams which will impact the water levels on the Assabet River.

MassDEP Response: It appears that some clarification is necessary as to the intent of this study. This investigation was commissioned to identify key issues associated with dam and or sediment removal if and when a future proponent requested that action. MassDEP's request to the ACOE to investigate these possibilities was a result of prior water quality investigations to determine the impacts of phosphorus on water quality and what levels are needed to achieve Class B water quality standards. Through that process it was found that although significant upgrades at the wastewater treatment plants (to the limit of technology) was necessary and mandated in their last round of permits it would likely not be sufficient to achieve long-term water quality goals. Thus additional phosphorus reduction sources and techniques needed to be evaluated. It should also be noted that the cost of upgrades to the upstream communities is approximately $80 to $100 million and is not considered a cheap nor easy way out to meet water quality goals. MassDEP does agree with the commenter that there are many issues raised by the ACOE report that would need to be investigated and addressed before any proposed dam removal could take place. If in the future a proponent steps forward who wishes to pursue dam removal, then there would be a detailed assessment and permitting process involved at all levels of government – local, state, and Federal. A section has been added to the report that lists the process that might be triggered by a dam removal project.

29. Patricia G. and Gerald P. Noone, 35 Forest Rd, Stow, MA

We are opposed to the request from the towns of Marlboro and Northborough to increase the amount of sewage that their sewage treatment plans currently dump into the Assabet River and we request your assistance in helping to stop this proposal.

The Assabet River is finally coming back to life after years of abusive dumping and years of state taxpayer money for cleanup. It is inconceivable that after all these efforts and costs, these towns wish to return to the disgusting and shameful ways of old. Stow, whose homeowners pay for private septic systems, should not become the human waste- water dumping ground for the upriver towns simply because those towns choose not to supply appropriate solutions to their waste disposal.

In addition to dumping more sewage into the Assabet, a proposed solution to helping the Assabet become clean has been to remove the Ben Smith dam in Maynard. This solution is proposed by the Army Corps of Engineers, an agency which did such a fine job destroying the Mississippi River basin. This solution will leave human waste lying in the mud flats, spreading odor and disease, and relegate the Assabet to a mere trickle of water. If this happens, we will look to the towns of Marlboro and Northborough, as well as the state, for cleanup costs and related medical costs which may arise.

Corps Response: The Corps is not involved in permitting the wastewater treatment facilities on the river. The purpose of the "Planning Assistance to States" study was to look at sediment and dam removal to reduce sediment phosphorus flux. This possible solution was proposed in the TMDL issued by MassDEP in 2004.

If in the future a proponent steps forward who wishes to pursue dam removal, then there would be a detailed assessment and permitting process involved at all levels of government – local, state, and Federal. A section has been added to the report that lists the process that might be triggered by a dam removal project.

MassDEP Response: The issue of the Marlborough wastewater treatment plant is outside of the scope of the study and is being handled under the NPDES permitting program. Further clarification on why this study was commissioned is included in Response #28 above.

30. Dr. Susan Rabaut, Hudson

I am much opposed to the removal of the dam on the Assabet River potentially affecting water levels in and around the Hudson, Maynard and Northboro area. I use the river frequently to paddle my kayak. take my dog swimming and just enjoy walking by. I live just up the hill from the Hudson High School. I have friends and acquaintances in the Maynard and Stow areas that are equally concerned. From what we can read there are missing and incorrect facts being said.

Having paddled much of the Assabet the area that may be affected by the dam removal is the most beautiful section of the river.

I ask you to reconsider this decision. I think much more research and thought needs to go into making such a serious decision.

You can't take it back later and say "we goofed" or we didn't really consider this or that issue.

Corps Response: If in the future a proponent steps forward who wishes to pursue dam removal, then there would be a detailed assessment and permitting process involved at all levels of government – local, state, and Federal. A section has been added to the report that lists the process that might be triggered by a dam removal project.

31. Comment from Melissa and Michael Raskin, 12 Riverside Park, Maynard MA

As an abutter to the Ben Smith Impoundment in Maynard MA, the proposal to remove the Historic Ben Smith Dam will have a direct impact on my family and my home. We believe that the negative impact on the recreational value alone would be enough to oppose this plan. But the loss of history, culture, and community identity could not be remediated. As we have researched more, we realize that the claims of environmental improvement will actually result in a loss of 100 acres of wetlands. In addition we are to have our entire neighborhood dug up for multiple years. All this so that WWTFs can continue to pollute the Assabet River. Dam removal only relocates the problem down stream. It seems clear that the best solution for all involved is tighter winter limits on phosphorous discharge.

We request that the recommendation to remove the Ben Smith Dam be stricken from the US Army Corps of Engineers "Assabet River, Massachusetts Sediment and Dam Removal Feasibility Study". We feel that this proposal does not meet the TMDL Phase II requirement of a 90 percent reduction in sediment phosphorus flux and is repugnant to the myriad concerns acknowledged in the report.

We request that instead the report should be altered to recommend that, based on the CDM modeling results, phosphorous discharge levels of no greater than 0.1mg/l should be mandated for any and all discharges into the Assabet River with no exceptions.

We also request that the above abutter objections are clearly outlined in the report and in the conclusion.

Corps Response: This study is a Corps "Planning Assistance to States" study intended to provide information to decision makers and stakeholders on the measure of sediment and dam removal to reduce sediment phosphorus flux. The TMDL prepared by MassDEP in 2004 (page 3) identified possible dam removal as a measure to improve water quality in the river. The SuAsCo TMDL can be viewed at:
http://www.mass.gov/dep/water/resources/tmdls.htm#suasco.

As part of the study the Corps contracted with CDM to perform data collection and modeling in order to assess the p-flux reduction and water quality benefits of dam removal. The findings of the CDM modeling study included findings on phosphorus flux reductions for planned wastewater treatment plant improvements, dam removal scenarios, and identification of the sensitively of the system to winter limits. The Study Conclusions section at the end of the Corps report has been expanded to include the findings of the CDM modeling study.

MassDEP Response: This study did not perform an in-depth evaluation to determine the effects of a year round phosphorus limit of 0.1 mg/L for the wastewater treatment plants. Through the TMDL process phosphorous limits were set at 0.1 mg/L in the summer and 1.0 mg/L in the winter. However, a sediment flux study that was performed under contract by CDM for the Corps report indicated that winter P may be a part of the year round phosphorus budget. This sediment flux study was based on very limited data and should not be considered completely conclusive but does provide new insight about the possible benefits of winter time reductions. This issue will come under further review and consideration as the NPDES

permits come up for renewal. Please see the Response to Comment Letter #4 regarding year round phosphorus limits.

<u>32. Donald B. Rising, Stow, MA</u>

I am a resident of Stow with substantial frontage on the Assabet River downstream of the Sudbury Road bridge. I am opposed to consideration of any proposal to remove the Gleasondale dam in Stow and/or the Ben Smith dam in Maynard. You are already well aware of the Town of Stow's dependence on the river for fire fighting, and of golf courses and a major orchard for irrigation purposes. The river is also a major recreational resource for the area. And what will happen to all the waterfowl that now breed in the marshes along the river, if a dam is removed?

We are told that the sediments in the dam impoundments contain many toxic materials in addition to the phosphorus, some of which have been identified. In a conversation at the recent meeting in Marlborough, a DEP representative stated that they did not have the capability to test for all the possible toxic materials in the sediments. I believe that any attempt to remove any portion of the sediment in an impoundment is bound to stir up the toxic materials and release some of it downstream, no matter how carefully it is done. Furthermore, it is unclear where any removed sediment can be taken for disposal.

The financial implications are enormous, but it is unclear who would be responsible for the costs of dam removal. Would the dam owners have to pay for the work? Would abutters to the river pay for sediment removal along the banks?

Other than four community wells, Stow is totally dependent on individual wells for potable water and has no public sewerage, but would be impacted the most by any dam removal. Yet the source of the phosphorus in the river is reportedly the municipal sewage treatment plants. To remove phosphorus from the river, the emphasis should be on those treatment plants. The total phosphorus discharge of each treatment plant should be limited to an amount that will allow the river to clean up. There no doubt are other contaminants discharged that should be controlled as well. Our rivers can no longer be used as our sewers.

Corps Response: Existing sediment quality data from USGS "Sediment Studies in the Assabet River, Central Massachusetts, 2003, Scientific Investigations Report 2005-5131" was reviewed by CDM and this information included in the "Sediment Management Plan" prepared by CDM in 2008. The CDM study suggested additional testing of sediment if a dam removal project is considered further and this was stated on page 32 of the Corps draft report.

Table 9 in the Corps draft report identifies sediment management as a significant portion of the dam removal costs. The discussion following Table 9 has been edited to indicate that additional sampling and testing would be part of a dam removal study and depending on findings and regulatory requirements this can increase costs associated with sediment management. The Corps "Planning Assistance to States" study considers sediment management to minimize downstream movement of sediment. The Corps study did not

include environmental or health risks assessments of exposed sediments but as noted above more testing of sediment is suggested.

33. Warren and Tammy Ross, 20 Taft Avenue, Maynard, MA

I live directly on the Assabet River in Maynard, MA, 150 yards upriver from the Ben Smith Dam, the largest dam on the Assabet River. It has been brought to my attention that the US Army Corps of Engineers (ACoE) has recently completed a draft report in conjunction with your organization regarding the reduction of phosphate content in the Assabet River. The primary set of recommendations from this draft report includes the removal of dams on the Assabet River and sediment dredging and removal in an attempt to reduce phosphate levels. The removal of the Ben Smith Dam specifically has been identified as among the highest recommended items. My letter to you is intended to outline my concerns and requests regarding this report. I would be appreciative if you could please reply to my letter. In your reply, I would also appreciate understanding how these concerns are being tracked.

CONCERNS & QUESTIONS:

1. I have serious concerns about the integrity and credibility of the referenced report in question. If the objective of this report to improve the water quality of the river why is the report titled, “Assabet Sediment and Dam Removal Feasibility Study” vs. “Improving Assabet River Water Quality.” It appears that the answer to the question is assumed and not in question. What other alternatives were studied? Alternative methods were to improving water quality were not studied or researched to anywhere the same degree as dam removal.

Corps Response: The focus of the study was to investigate the feasibility of sediment and dam removal to decrease sediment phosphorus flux. This study was not an analysis of all alternatives to improve water quality in the river. MADEP and EPA have a process for examining water quality measures necessary to meet water quality standards. This process includes development of a “Total Maximum Daily Load” for a pollutant. The phosphorus TMDL for the Assabet River prepared by MassDEP can be found at: http://www.mass.gov/dep/water/resources/tmdls.htm#suasco.

The TMDL considers various sources of phosphorus to the river. One measure to reduce sediment phosphorus flux identified in the TMDL was possible sediment and dam removal measures and this is the focus of the Corps study effort.

2. There may be a conflict of interest in the ACoE submitting a report with recommendations if the ACoE will direct, supervise and/or participate in completion of the work to remove the dams.
3. As an abutter, I would like to better understand the relationship between the Massachusetts DEP and ACoE, as it is possible there is a conflict of interest here too. I also want to understand if MA DEP will direct, supervise and/or participate in completion of the work to remove the dams.

Corps Response: Studies and projects that the Corps participates in are authorized by Congress through Public Laws. In this case, the study was conducted under the Corps Planning Assistance to States (PAS) Program as authorized in Section 22 of Public Law 93-251 and amended in subsequent legislation. Under this authority, the Corps can provide states, local governments, other non-Federal entities, and eligible Native American Indian tribes with water resource planning assistance.

If in the future the Corps was requested by a sponsor to participate in dam removal on the Assabet River, then this participation could only occur through other Federally authorized programs.

4. During public meetings held on 17 and 19 November 2009, nearly every picture of the river shown of the Ben Smith Dam shows duckweed and presents the river as "polluted" yet this condition exists for 3 weeks per year the past two years (I know as I live on the river and look at it every day). Yet, one would not know this if one did not live on the river. This drives misperceptions in communities.

MassDEP Response: These pictures were presented by MassDEP to show the extent of the duckweed coverage in the impoundments as a worse case condition. Conditions that will affect the growth and proliferation of duckweed will vary from year to year. For the past year the USGS has been documenting duckweed growth in the impoundments and will be producing a report with their findings in late 2010. The report will discuss factors that may affect the growth and distribution of duckweed including flow, weather conditions, wind, solar radiation and seasonality. Additionally, MassDEP hopes to continue with the duckweed monitoring program that was established by USGS to further document conditions over the long term.

5. The Ben Smith Dam removal only is, as of today, estimated at $13 Million but is likely to increase upwards of $50Million – especially if heavy metals and PCB's are found in higher quantities than identified in sediments that were identified by samples taken by USGS in 2003, and this is likely given the river was heavily used during industrialization). We need to see an independent third party estimate and a study of the health effects on abutters from sediment removal with more samples taken given the impact the industrial heavy metals identified as being present (arsenic, cadmium, chromium, nickel and lead) and PCB's. It is often safer to leave these substances where they are.

Corps Response: Existing sediment quality data from USGS "Sediment Studies in the Assabet River, Central Massachusetts, 2003, Scientific Investigations Report 2005-5131" was reviewed by CDM for the Corps study and this information included in the "Sediment Management

Plan" prepared by CDM in 2008. The CDM study suggested additional testing of sediment if a dam removal project is considered further and this was stated on page 32 of the Corps draft report.

Table 9 in the Corps draft report identifies sediment management as a significant portion of the dam removal costs. The discussion following Table 9 has been edited to indicate that additional sampling and testing would be part of a dam removal study and depending on findings and regulatory requirements this can increase costs associated with sediment management. The Corps "Planning Assistance to States" study considers sediment management to minimize downstream movement of sediment. The Corps study does not include environmental or health risks assessments of exposed sediment but as noted above more testing of sediment is suggested.

6. Phosphorous reduction of the river can be accomplished by requiring waste water treatment plants that currently discharge into the river to comply with already existing regulations of 0.1mg/l phosphorous discharge. I quote from the report on page 15, para. II, "The Primary issue is too much phosphorous input to the waterway." Communities upriver from Maynard are being allowed to discharge above this rate during the winter months causing externalities downstream. If the recommendations of the report are followed, downriver communities will unfairly and unjustly pay for the externalities of these upriver communities and not just in dollar terms. The cost of treatment to reduce winter discharge rates at waste water treatment plants is never outlined in the report which calls into question the credibility of the report. I quote again from the report on page 24, para. II "field surveys found that waste water treatment plants contributed 88 to 98 percent of the biologically available phosphorous…"

Corps Response: The study scope was to look at sediment and dam removal to reduce sediment phosphorus flux. Changes in wastewater treatment facility discharge limits are addressed in the TMDL prepared by MassDEP in 2004 and also through the EPA and MassDEP NPDES permitting process.

MassDEP Response: It should also be noted that all the wastewater treatment facilities received new permits in 2004 requiring them to upgrade the processes to achieve 0.1 mg/l in their discharges. At the time this was done there was not sufficient evidence to support the conclusion that year-round reductions could be beneficial. The 88 to 98 % values that were cited are based on the prior technology at the treatment facilities before new upgrades are constructed. The potential benefits of winter time phosphorus reductions came to light for the first time as a result of this present study and will need additional discussion during the next round of NPDES permit negotiations. It is also important to note that, based on existing water quality model results; the technology to achieve those limits may be limiting and will likely not

be sufficient in the long term to achieve state water quality standards. As such other potential sources such as the sediment needed to be evaluated as well.

7. How much would it cost for upriver communities, who have four point sources at waste water treatment plants, to improve waste water discharge compared to the cost of removal of dams at a today estimate of $42.7M (and this dam removal cost is very likely to be larger, potentially 5 to 8 times more)?

Corps Response: An analysis of wastewater treatment technology and costs would be needed to and this was not part of the Corps study.

8. If the removal of aquatic vegetation up river from dams was accomplished, without removal of the dams, how much would dissolved oxygen be improved?

Corps Response: The concentration of dissolved oxygen in the river is affected by many factors. Removal (harvesting) of vegetation is normally considered as a temporary measure to reduce nuisance growth. This is usually a short term measure as vegetation can re-grow.

9. In 2005 several upriver communities visited Washington, D.C. in a search for monetary aid to clean up the Assabet River without success. Several upriver towns, due to budget constraints have imposed moratoriums on sewer connections. They know they are in violation of effluent discharge rates, and are discharging greater than 0.1mg/l phosphorous rate. It appears that their work with ACoE and their influence to get the report drafted will reduce moneys they otherwise would have had to spend to fully update their waste water treatment plants to meet the standard all year long. Why are these communities being allowed to discharge above the legal limit and why are they being given waivers? And why is there now a report from the ACoE to remove dams? It appears that the upriver community strategy today is for downriver communities to remove dams so upriver communities do not have to pay to improve phosphorous effluent (especially during the winter, which is where the highest quantity of phosphorous problem lies as outlined in the report).

MassDEP Response: When MassDEP and EPA reissued the NPDES permits, the wastewater treatment plants were given schedules to reach the 0.l mg/L total phosphorus discharge limit. To achieve the new limit, extensive and very expensive upgrades and/or replacement of the facilities are necessary ($80-100 million total.) Construction on the Hudson Wastewater Treatment Plant has been completed. The other treatment plants are at various stages of construction and are under mandate to meet their compliance schedules. Although none of the wastewater treatment plants has been given a waiver, two plants have been received modified compliance schedules to complete the necessary work as the result of permit appeals.

As noted in the response to your comment #6 above, there is some concern that the existing upgrades may not be sufficient to meet water quality standards given that the new upgrades are at the limit of technology as it is known today. As such the evaluation of options to further reduce phosphorus loadings to the river, including sediment removal/treatment and dam removal/modification, was identified as being necessary.

10. Even if dams are removed, phosphorous would merely be moved downstream to more communities if upriver waste water treatment plants will not fully comply with legal limits. In other words, the source of the problem will not be fixed!

MassDEP Response: Please see our response to your comment #9 above.

11. In the 330 page report, there is little mention of how abutters will be affected. There will be a 20 month construction period with significant noise and smells and traffic (at 67,600 estimated cubic yards of sediment to be removed from Ben Smith dam alone, traffic will be a factor) and loss of quality of life from construction, smells from muck at the bottom of the river, potential health effects and other effects. This work must be done during non-winter months further aggravating abutters' quality of life. My back yard is the river. How will quality of life for abutters be compensated?

Corps Response: If a proponent steps forward to pursue dam removal, then there would be a detailed assessment and permitting process involved at all levels of government – local, state, and Federal. A section has been added to the report that lists the processes that might be triggered by a dam removal project. Construction impacts and traffic and noise issues would be considered as part of an impact analysis for a dam removal.

12. I live at a section of the river that is approximately 500 feet in width. If the Ben Smith dam is removed, the width of the river will be reduced to approximately 15 yards, an over 90% reduction in width (see page 58 of the report for a before and after computer generation of how the width of the river will be affected). This computer generation is likely to depict a season with maximum flow and hence width. During the summer, it would not be surprising to see the width to lessen to 10 feet or less and may be 1/3 the width of what is depicted when the dam is removed. It is hard to understand how recreationally valuable the river will be then.

Corps Response: A recreational use survey of the river was not part of the Corps study. However, a statement has been added to the report that recreational opportunities that rely on the current impoundments would be impacted with dam removal. If a proponent steps forward to pursue a dam removal project then a recreational use survey of impoundments would be useful in the Environmental Assessment process.

13. The property value of the 18 homes located directly on the river (direct waterfront homes only counted) and upriver from the Ben Smith Dam to the White Pond Road Bridge, a distance of approximately 2000 feet, will be forever deleteriously affected. Who will pay for the serious and negative reduction in the value of me and my neighbor's property and reimburse me for the incremental property taxes I have paid over 15 years from what my property was worth to what it will be worth if the Ben Smith Dam is removed? The market value of these homes will deeply decline.

Corps Response: Your concern is noted but an analysis of decline in property values was not part of the Corps study.

14. When one reads the report, it is inferred that the Assabet as a highly polluted river, further inferring it has little natural beauty or recreational value. In the 330 page report, there is very little mention of how the public will lose this valuable and beautiful resource. As I live on this river, I know, because I see it every day, that this is a most beautiful, bucolic river. Every day there are walkers. Every day there are canoeists, kayakers and boaters and those who fish the river. The serious reduction in water quantity acreage will destroy this resource forever. Yes, there is some duck weed and algae that can be seen in August/September for two to three weeks, however this has been significantly improving as phosphorous levels in the past 10 years have improved and is getting better. Is this enough to radically and forever change this resource? We need a study done to determine the recreational value that the river has today, just as we need a study to determine how to reduce phosphorous loading other than just dam and sediment removal. For an example of a study that was undertaken for the Minnesota River reference http://ideas.repec.org/p/ags/umaesp/13771.html where recreational value is compared to phosphorous reduction cost.

Corps Response: A recreational use survey of the river was not part of the Corps study. However, a statement has been added to the report that recreational opportunities that rely on the current water depths would be impacted as water depths will be lower with dam removal. As you suggest if a proponent steps forward to pursue a dam removal project then a recreational use survey of existing uses of the river would be useful in the Environmental Assessment process. Also economic value of recreation could be considered in future studies.

15. It would appear that the ACoE is attempting to change the classification of wetlands upriver of the Ben Smith dam to open water (see page 165 of the report, under "Table 1, Estimated Change in Wetland Areas Following Dam Removal."). Regardless, the loss of valuable wetlands will be significant to wildlife which we see on a daily basis. It is conservatively estimated that we will lose 125 acres of wetlands.

Corps Response: The intent of the footnote in this Table was misinterpreted by readers. The Corps used GIS files downloaded from the Massachusetts Wetlands Conservancy program (MassDEP) for existing wetland types. The notation in the Corps Table was added to reflect a concern raised by a reviewer from Stow on an early study draft regarding the wetland type in the GIS file. However, as this notation was confusing to readers and added little value to the analysis, it has been removed from the Table.

16. Dredging upriver from the Ben Smith Dam will leave a dirt pit at a size of 145.8 acres. What is the plan to revegetate these ~146 acres? How long will we be looking at a mud pit (and how long will it smell)? This is not addressed in the report. Also, the area size of 146 acres is in question and may be as large as 450 acres.

Corps Response: The dredge area in the Ben Smith impoundment as identified in the Assabet study is shown in Figure 4-5 of the CDM Sediment Management Plan, December 2008 and is about 22 acres. However you are correct in that sediment previously under water will be exposed with dam removal beyond the proposed dredging area and additional testing would likely be required. (This was noted on page 32 of the draft report.) If future studies of dam removal occur, suggested post-construction vegetation plans could be considered for newly exposed areas. (This was identified on page 44 of the draft report.) Generally, vegetation moves into exposed areas relatively quickly on the order of one to three growing seasons. A vegetation plan would help to control the types of species that could colonize the exposed area and provide for more desirable types of vegetation.

Page 32 of draft report: "For purposes of evaluating the quality of the sediments and to aid in understanding the potential sediment disposal options the USGS data and additional sieve analysis data was assessed and results are presented in the CDM "Assabet River Sediment Management Plan", dated December 2008. Based on the assessment, it was concluded that regulatory agencies will likely require additional chemical and physical testing of sediments that may be exposed, dredged, or mobilized as a result of removing the Assabet River dams."

Page 44 of draft report: "Following dam removal, newly exposed banks will be highly susceptible to purple loosestrife infestation. The focus of management after dam removal should be to prevent the further spread of purple loosestrife by encouraging the growth of a healthy zone of native vegetation. A vegetation seeding plan should be implemented to provide an initially quick vegetative cover for exposed soils to prevent purple loosestrife seeds from making contact with exposed soils and the maintenance of a dense and durable vegetative cover over the long-term. This may require multiple seeding with different seed mixes depending on the time of year seeding is conducted."

17. We are likely to lose most of the river trees behind my home and this will forever open my home up to views and we will lose privacy. This is not addressed in the report. Also not addressed is the fact that walking lanes are likely to open up behind my home that were previously not there, further impacting our privacy in ways that we could have never imagined when we purchased our home. It is also possible that homes could be built on what was previously river.

Corps Response: This issue is recognized in the report under "Dam Removal Considerations for All Project Areas" page 43.

Page 43 of draft report: "Newly exposed riparian areas and transitional upland areas should be protected to preserve the open space, wildlife, water quality and flood storage benefits of the land. Development of transitional upland areas would be considered cumulative impacts under The Council on Environmental Quality (CEQ) which defines cumulative impact as found in 40 Code of Federal Regulation (CFR) section 1508.7 as "the impact on the environment which results from the incremental impact of the action when added to other past, present and reasonably foreseeable future actions regardless of what agency (Federal or nonfederal) or persons undertakes such other acts." Transitional upland areas will need to be identified prior to dam removal and a mechanism implemented to prevent suburban/urban development of these areas in order to avoid potential cumulative impacts."

18. Current waste water treatment plants (WWTP) are just now beginning to come online after having spent approximately $100 Million. We need time to see the impact and effect of this monetary spending and resultant reduction in phosphate loading. The report uses as a base period the year 2000 for phosphate levels. Base lining phosphate levels in the river from the year 2000 (in order to reduce TMDL by 90%, the stated goal of the report) is misrepresentative at best and does not take into account the new WWTP's coming online nor improvements from the past 9 years.

MassDEP Response: The MassDEP TMDL envisioned an adaptive implementation approach which will need to be discussed during the next round of NPDES permitting. The TMDL that was developed for the Assabet River required that measures be implemented in order to decrease the phosphorus loading to the river and also included the adoption of an adaptive management approach in accordance with EPA procedures. This approach is particularly important given the limitations inherent in modeling as well as the uncertainties and complexity in accurately predicting reductions in sediment phosphorus flux.

19. The participation and charter of the ACoE and MA DEP is not to make recommendations, which was clearly stated during public meetings, yet when one reads the report in question -- and if a policy maker reads the report -- it is clear that the recommendation is to remove dams, especially the Ben Smith Dam.

Corps Response: The purpose of this study is to provide planning assistance (planning level engineering and scientific information) to MassDEP on the potential feasibility of sediment and dam removal to reduce internal recycling of phosphorus (sediment phosphorus flux) in the Assabet River. The first part of the study focused on reductions in internal phosphorus recycling from sediment for sediment and dam removal measures. The second part of the study focused on engineering and environmental considerations for "hypothetical" dam removal.

20. By the ACoE's own admission, the "Simple Mass Balance Model" used to model hydrology and phosphorous loading of the river is a new model, just recently being published by a Tufts professor with no real world data behind it. This calls into question the credibility of the "recommendations" and calls for alternate data modeling at best.

Corps Response: The best available method was combined with sediment flux core evaluation to model the P-flux reductions in this study.

21. Waivers of current WWTP's discharging effluent into the river are wrongly being granted. WWTP's should be held accountable for maintaining legal limits not greater than .01 mg/l year round. In addition, the report does not model what would happen if WWTP's were required to do so as an alternative to the set of recommendations given (further hampering integrity and credibility).

MassDEP Response: As indicated in the response to your comment #9 above, when MassDEP and EPA reissued the NPDES permits, the wastewater treatment plants were given schedules to reach the 0.l mg/L total phosphorus discharge limit. Construction on the Hudson Wastewater Treatment Plant has been completed. The other treatment plants are at various stages of construction and are under mandate to meet their compliance schedules. Although none of the wastewater treatment plants has been given a waiver, two plants have been received modified compliance schedules to complete the necessary work as the result of permit appeals.

22. The town of Wayland recently signed an agreement with the US EPA in August 2009, limiting discharge of effluent to not greater than .01mg/l phosphorous year round on the Sudbury River.

MassDEP Response: In making permitting decisions MassDEP and EPA must consider individual situations based on the type and size of the facilities in question as well as the type of receiving stream. The Town of Wayland has a very small wastewater treatment plant that discharges into a wetland area whereas the Assabet POTWs are much larger but discharge to a free flowing river which is impounded several times. It is for this reason the Department

develops detailed water quality models that are used to predict water quality conditions under different discharge and flow scenarios. One situation cannot be directly compared to another.

23. There are serious concerns about the health impacts from the removal of sediment from the river, 15 yards behind my house. The Assabet River was heavily used during industrialization and it is likely that sediments blocked by the dam will have high levels of heavy metals, such as cadmium, chromium, lead, arsenic, etc., and also PCB's. What will happen to the safety and health of my family when exposed to these materials? The area behind my home will be turned into a brown field. Is that really what communities' desire?

Corps Response: Existing sediment quality data from USGS "Sediment Studies in the Assabet River, Central Massachusetts, 2003, Scientific Investigations Report 2005-5131" was reviewed by CDM for the Corps study and this information is included in the "Sediment Management Plan" prepared by CDM in 2008. CDM study suggested additional testing of sediment if a dam removal project is considered further. Health risk assessments of exposure to Assabet River sediments were not conducted as part of the Corps study.

24. Citizens learned during open meetings that communities upstream who discharge effluent into the Assabet have allowed other cities to hook into their sewage treatment plants to discharge additional effluent into the river. This will have a significant impact on water quality, even if discharge rates are lowered and should be outlawed.

MassDEP Response: This issue was not a part of the ACOE study but was given consideration when the Assabet River Consortium completed a Comprehensive Wastewater Management Plan in 2007.

REQUESTS:

1. I request that a study be undertaken to better understand the health effects from removals of sediments from behind dams relative to exposure to heavy metals and PCB's.

MassDEP Response: The Corps "Planning Assistance to States" study considers sediment management to minimize downstream movement of sediment. The Corps study did not include environmental or health risks assessments of exposed sediments but as noted above more testing of sediment is suggested. This task is beyond the present scope of work and would require additional funding if and when a formal proposal is made.

2. I request that the recommendation to remove the Ben Smith Dam be stricken from the US Army Corps of Engineers report "Assabet River, Massachusetts Sediment and Dam Removal Feasibility Study." The proposal in the report does not meet the TMDL Phase II requirement of a 90 percent reduction in sediment phosphorus flux.

Corps Response: Changed wording in Conclusions to "Modeling results indicated that removal of Ben Smith dam would contribute to achievement of water quality goals through reductions in sediment phosphorus flux because the biomass growth and settling that ultimately drives the sediment flux would decrease with dam removal. Modeling results indicated that removing Hudson and Gleasondale dams would also contribute incrementally to these goals. Removal of the two most upstream dams in this study, Aluminum City and Allen Street, would result in water quality improvements in stream reaches affected by the existing impoundments, but would have minimal effects on downstream water quality. Similarly, removal of Powdermill dam would have only localized benefits". Note these statements are not Corps recommendations but simply stating the findings of the modeling analysis performed for the study.

3. I request that the report should be altered to recommend that, based on the CDM modeling results, phosphorous discharge levels of no greater than 0.1 mg/l should be mandated for any and all discharges into the Assabet River with no exceptions. Waste Water Treatment plants should not be allowed to discharge over legal limits.

MassDEP Response: All major wastewater treatment plants have already been issued permits to construct facilities to meet the 0.1 mg/l phosphorus limitation. Construction on the Hudson plant has been completed and the others are now under construction. The issue of achieving these limits during the winter months will be discussed during the next round of NPDES permitting.

4. I request that all abutter objections, including those in this letter, are clearly outlined in the ACoE report.

MassDEP Response: All comments with responses have been included in this Appendix.

5. I request that a cost study be undertaken to understand the cost of upriver towns reducing phosphorous effluent to the legal limit of 0.1mg/l (especially during the winter when effluent discharge regularly is greater than 0.1mg/l), and that this be placed in the ACoE report for comparison to the cost of dam and sediment removal.

MassDEP Response: Your request has been noted.

6. For the record, I want to know the relationship between the MA DEP and ACoE.

Corps Response: Studies and projects that the Corps participates in are authorized by Congress through Public Laws. In this case, the study was conducted under the Corps Planning Assistance to States (PAS) Program as authorized in Section 22 of Public Law 93-

251 and amended in subsequent legislation. Under this authority, the Corps can provide states, local governments, other non-Federal entities, and eligible Native American Indian tribes with water resource planning assistance. PAS studies are cost shared 50 % Federal and 50 % non-Federal sponsor. The non-Federal sponsor for the study is MassDEP.

7. For the record, I want to know if the ACoE or MA DEP is going to manage, supervise and/or do the actual work for dam removal. It is important to understand this potential conflict of interest.

MassDEP Response: Presently there is no formal sponsor for this project. The present study was commissioned by MassDEP to the Corps under the "Planning Assistance to States" program in an effort to determine the feasibility of such an action if it were proposed in the future and to identify the many important issues associated with such an action.

Corps Response: If in the future the Corps was requested by a sponsor to participate in a potential dam removal project on the Assabet River, then this participation could only occur through a Federally authorized program and in compliance with applicable laws and regulations.

8. I request that a study of "human factors and considerations" and recreational value be undertaken such that all constituencies understand the human side of the loss of the river and its dams and that this be placed in the ACoE report or incorporated by reference.

Corps Response: A recreational use survey of the river was not part of the Corps study and the Corps is not pursuing additional studies at this time. However, an assessment of the potential loss of recreation with dam removal and other social impacts could be included in future assessments of dam removal.

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9. I request that a study be done to determine the effectiveness of sediment deactivation as an alternative to dam removal, and that this study include sediment deactivation be done every 5 years and the cost of this compared to dam removal. In addition, the report should clearly outline other methods and combination of methods so that if decisions are made, trade-offs can be holistically understood.

MassDEP Response: Sediment deactivation involves the application of a chemical so the phosphorus in the water column is scavenged and then the sediment is sealed to hinder the recycling of sediment phosphorus into the water column. Due to the dynamic nature of the Assabet River system this was not considered to be a viable long-term option since phosphorus in the sediment would be rapidly replenished from the settling of biomass and in-stream

phosphorus. A section in the report on Dam and Sediment Removal Alternatives provides information on this subject.

10. I request that a study of real estate values for homes directly on the Assabet River upriver from the Ben Smith dam be undertaken, indicating pre and post dam removal values and that this be placed in the ACoE report or incorporated by reference.

MassDEP Response: This issue is beyond the scope of work for this study. Your request has been noted and would be addressed if and when a formal proposal was made to pursue dam removal.

11. I request that an independent comparison of costs to remove dams be undertaken and compared to an independent estimate of costs to reduce phosphate effluent from upriver communities and that this be placed in the ACoE report or incorporated by reference.

MassDEP Response: It is not possible at this time to compare these costs because detailed design and cost information is not available for further upgrades to the wastewater treatment plants beyond those already being implemented which are considered the limit of present day technology.

12. I request that a study be taken to determine the effects on abutter's privacy from walking lanes that are likely to be opened up and trees that will be forever lost.

MassDEP Response: Your request has been noted.

13. I request that all alternatives and solutions for reducing phosphorous in the Assabet River be included in subject report.

MassDEP Response: Your request is beyond the scope of this project which was focused on the feasibility of dam and sediment removal. Various alternatives were previously evaluated during the MassDEP TMDL development process. It is this process that resulted in the required treatment facility upgrades and identified that sediment phosphorus reduction was necessary to meet water quality goals.

The ACoE report appears to be heavily one sided in the favor of removing dams on the river and little if any attention paid to represent competing views or alternatives. I can testify that this is a beautiful river worthy of keeping as is. Removing the dams, especially the Ben Smith dam, will significantly reduce water acreage (by at least 90%) and river width and depth. Those with whom I have spoken on my street, Taft Avenue in Maynard, agree with the view that it would be wrong to lose this resource. Please do not allow our way of life and the loss of a valuable recreational resource to be forever lost. We welcome a dialogue and reply to these requests and concerns.

34. George Ruckert, Sr. Lecturer, MIT
I wish to state my opposition to the dam removal project proposed by the Army Corps of Engineers.

The many letters of protest that the proposal has generated iterate most of my ideas: the ridiculous ecological disaster of the dam removal, the irreparable damage to the environment, the prohibitive costs, the problems of fire protection, the possible damage to local wells, and the biased financial interests of the current polluters, the "water-treatment" facilities. I have been to two of the hearings on this proposal, and the many people who speak seem universally appalled by the whole procedure as well as the proposal itself.

My voice represents a small neighborhood of abutters to the river in the Marlboro Road district of Gleasondale (Stow). We have gathered together and discussed the proposal, and we look with alarm on those outsiders who apparently think they act in our behalf. Furthermore, at one of the meetings, the Army Corps representative smiled smugly and implied that the protesters were common "tree-huggers," i.e., disillusioned and romantic wild–life lovers who stand in the way of progress. With this kind of "dispassionate" and biased opinions running the show, we who are citizens feel steamrollered by a machine which has no particular feeling for the area they seek to destroy.

My tax money indirectly paid for the survey. Our tax money pays the salaries of the Corps of Engineers and the Massachusetts Conservation Corps. Why, then, do they conveniently pocket the Stow protestors as a group to whom they are not directly responsible?

The proposal to remove the dams is environmentally faulty and financially ridiculous. Kindly hear the many voices of reason and pursue a more rational course of action.

Corps Response: This study is a Corps "Planning Assistance to States" requested by MassDep and intended to provide information to stakeholders on the measure of sediment and dam removal to reduce sediment phosphorus flux. This is not a Corps Decision document. The TMDL prepared by MassDEP in 2004 (page 3) identified possible dam removal as a measure to improve water quality in the river. The SuAsCo TMDL can be viewed at: http://www.mass.gov/dep/water/resources/tmdls.htm#suasco.

If in the future a proponent steps forward who wishes to pursue dam removal, then there would be a detailed assessment and permitting process involved at all levels of government – local, state, and Federal. A section has been added to the report that lists the process that might be triggered by a dam removal project.

35. John Sangermano, 285 Taylor Rd., Stow, MA (Member of the Stow Recreation Commission, Associate Member of the Stow Rail Trail)
Comments on the Dam Removal discussion. I did attend one of the information sessions at the Stow Town Hall and have read about the topic in the local newspapers.

I wanted to register an opinion to maintain the Ben Smith Dam in Maynard, as a measure to allow water recreation in Stow, and all the water habitat that this impoundment creates.

I am a Member of the Stow Recreation Commission, writing as an individual from Stow. The section of the Assabet River in Stow is a terrific recreational space. With increased ownership of kayaks and canoes, and viewable access to the river from the adjoining Gardner Hill Conservation Area and Track Road 'Rail Trail' there is a constituency of users in place to protect the resource.

I have considered the benefits of an Assabet River without dams - and the ability of the water to 'flush' the sediments over time - benefits to fish migration and river health. But I fear the loss of both habitat and more to my recreation background, to the lost of recreational space. I believe there are benefits to having motivated users in place to protect the shoreline and water.

So my opinion is that the Ben Smith Dam should remain in place, and allow the continued use of the Assabet River in Stow for Recreational use.

Thanks for considering my comments. I am aware that these comments are close to the comment period deadline.

Corps Response: If in the future a proponent steps forward who wishes to pursue dam removal, then there would be a detailed assessment and permitting process involved at all levels of government – local, state, and Federal. A section has been added to the report that lists the process that might be triggered by a dam removal project.

36. Michael and Erica Schultz, 220 Barton Road, Stow, MA

It would be terrible if you removed the Ben Smith dam. Please count my voice and my wife's as strong opposition.

Corps Response: If in the future a proponent steps forward who wishes to pursue dam removal, then there would be a detailed assessment and permitting process involved at all levels of government – local, state, and Federal. A section has been added to the report that lists the process that might be triggered by a dam removal project.

37. Comment from Dwight Sipler, 493 Great Road, Stow, MA

The Army Corps of Engineers has proposed removal of dams along the Assabet River to reduce phosphorus loading to improve water quality. Their fact sheet (http://www.nae.usace.army.mil/projects/ma/assabetriver/assabetriverfact.pdf) states "In addition to wastewater treatment plant improvements, the P-flux from the sediment needs to be decreased. Without implementation of measures to decrease sediment P-flux, it is likely that communities will be required to achieve even lower P limits that are technically challenging and will add considerably to the already expensive wastewater treatment plant upgrades."

While it may be desirable to reduce P-flux from sediments, the removal of dams is not going to accomplish this task. A simplified model of the river, attached below, shows that the removal of a dam will have no long term effects on P-flux, and will probably increase the P-flux in the short term.

This is essentially a flow problem. If there are no phosphorus sinks in a given segment of the river (e.g. sequestration of phosphorus by sediments behind a dam), there cannot be any reduction of phosphorus loading downstream. Erosion of existing sediments behind a removed dam will be a phosphorus source and will therefore increase the phosphorus loading downstream. Further, erosion of existing sediments will increase the downstream loading of all other materials currently sequestered by the sediments, to the detriment of water quality.

While it is true that in some seasons the sediments act as a source of phosphorus, the very fact that the sediments contain the phosphorus means that the integrated flow of phosphorus has been reduced downstream of the dam. The plants in the river take up the phosphorus and store it in the sediments. They do not generate any phosphorus that was not already present in the river. Storage of phosphorus in the sediments means that the integrated flow of phosphorus must be lowered downstream.

Want to reduce the phosphorus flow downstream? Build more dams. Enlarge the impoundments. Make the river flow more slowly to retain more sediment. Most importantly, reduce the sources of phosphorus entering the river.

In addition to the above comments, removal of the dam is removal of an important resource enjoyed by many of the residents of the towns abutting the river. Recreation is important to many people, but the rivers are also an important source of water for agriculture along the river. A restricted river will make it more difficult to extract irrigation water. In summary, removal of the dams along the Assabet River will deprive the area of an important resource and will not provide the desired result.

Dam Removal

The removal of a dam from a river has been proposed as a way to reduce phosphorus loading downstream of the dam. Here is a simplified model of the process, which concludes that this will in fact not reduce the phosphorus loading, but will increase it, at least in the short term.

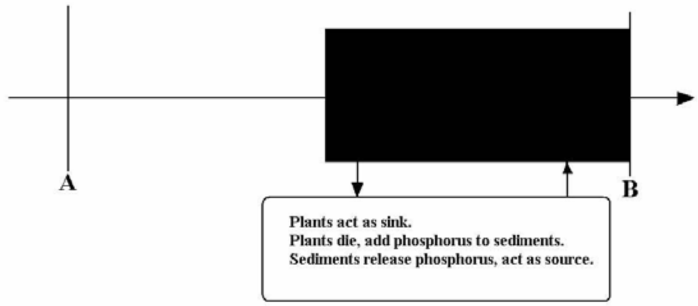

Figure 1

Figure 1 shows a segment of a river. At point A on the river, upstream of the dam, we have a flow f_a and phosphorus concentration p_a. The total amount of phosphorus that flows past point A can be found by integrating over the total time the river flows, or $P_a = \int_{t_0}^{T} f_a p_a dt$, and similarly $P_b = \int_{t_0}^{T} f_b p_b dt$ is the total amount of phosphorus that flows past the dam. Downstream of point A we have a dam at point B and between points A and B we find an impoundment. Since this is a simplified model, we assume no sources of phosphorus between points A and B. In the case of Stow, there are no point sources, but there can be nonpoint sources along the river. Additional tributaries, leading to $f_a < f_b$ will dilute the phosphorus, but will be a constant of the problem and are not considered here.

Plants take up phosphorus during the growing season. When the plants die in the fall, they add phosphorus to the sediments, which then release the phosphorus back to the river. Downstream of the dam, the concentration of phosphorus is modulated by the uptake by plants and release by sediments. The concentration of phosphorus at point B will be smaller than at point A during the growing season, and larger when the sediments are releasing the phosphorus back to the river. However, since the plants do not create phosphorus, the total integrated quantity of phosphorus flowing past point B (P_b) cannot be larger than P_a. In fact, since some phosphorus remains in the sediments, P_b must be smaller than P_a. This assumes that the integration to time T takes place over some integral multiple of a year, so the cyclic nature of the phosphorus is cancelled out. It further assumes that differences between years are averaged out over the integral (i.e. that the integral multiplier of T is large).

Without the dam at point B, there will still be some areas on the river in which seasonal vegetation sinks phosphorus and adds it to the sediments, but without the large impoundment area, these areas will be smaller so the uptake of phosphorus will be correspondingly smaller.

If the dam at point B exists for some period of time, but is removed, the river will be narrowed and will flow faster within its channel. This will erode the existing sediments and carry the phosphorus (and everything else in the sediments) downstream. During this process, the phosphorus concentration downstream will be increased beyond the concentration upstream. This will continue until the stream erodes through the sediment containing the phosphorus, after which the quantity of phosphorus that makes it through this segment of the river will be $P_b = P_a$ – (sinks due to vegetation) + (sources due to sediments). But since the river covers a smaller footprint and is flowing faster, the sinks and sources will be significantly smaller than prior to dam removal, and $P_b \approx P_a$. Thus dam removal will increase the total flow of phosphorus downstream.

Corps Response: Suggest you review the information in the phosphorus TMDL for the Assabet River prepared by MassDEP (2004) that identifies impoundments as areas of impaired water quality. The SuAsCoTMDL can be viewed at: ***http://www.mass.gov/dep/water/resources/tmdls.htm#suasco***

MassDEP response: We have reviewed the attached simplified model and make the following observations.

It is important to note the difference between P-flux and P loadings. Sediment P-flux is a rate of release (or uptake) in terms of mass/area/time (as used in the TMDL model, mg/m^2/day) and is primarily a function of sediment and pore water concentrations, overlying water P concentrations, dissolved oxygen, and temperature. With the dams in place, the potential contributing area in the impoundments is substantial; removal of the dams would result in a greatly reduced area of potential contribution and would, via channelization and increased water velocity, minimize further any depositional areas that might contribute to sediment P-flux as well as exposure time.

The short-term increase alluded to would most likely occur during and after dam removal but as a transitory loading (pounds/day, for instance) from sediment transport.

The simplified model does not address P-flux but rather P loadings, does not account for various rates of P uptake (plants) nor P release (sediment flux), nor does it focus on the seasonality that the TMDL was addressing – water quality protection during summer low flows.

As you point out flow is a definite factor. However, in order to achieve the TMDL goals, other dynamics which are often related to flow must be taken into account. The TMDL was developed to be protective during low flow summertime flows which represent the greatest stress (dissolved oxygen) and macrophyte (plant) production. Sediment P-flux becomes significant during times of low flow especially due to the longer exposure and growing times in the impoundments; conversely, during periods of high flow less sediment P is released for a given quantity of water (less exposure time) and higher flushing rate does not allow accumulation of duckweed.

While on its face it is true that if there are no phosphorus sinks there cannot be any reduction of phosphorus loading downstream, the complexities of the Assabet River system which does involve both dams and impounded sediments to which both the TMDL and this report are concerned must be taken into consideration.

While the comments that are made on the contributions by "erosion" are true, this is a short term transitory effect for which steps would be taken to minimize sediment (and any material including P) transport during a dam removal process. This is a separate issue from P-flux. The MassDEP publication "Dam Removal and Wetland Regulations" (www.mass.gov/dep/water/resources/dampol.pdf) provides guidance on sediment management and transport.

One of the goals of the TMDL was to reduce plant coverage, especially duckweed, in the impoundments. The model identified sediment P-flux as a source needing to be controlled. Sediment P-flux released into the impoundments, especially during the summer growing season, is responsible for unacceptable coverage in the impoundments, according to the model, even as P from the POTWs is reduced. The recycling of P from the sediments was best reduced, as presented in this report, by the effects accruing from dam removal.

38. Dorothy Sonnichsen, 101 Packard Rd., Stow, MA

I would like to express my alarm over the prospect of increased sewage output from Marlboro and Northborough's sewage treatment plants. Rather than spend the money to upgrade their facilities, they want to dump and additional 40% of output, which would travel through Stow in the Assabet River.

Back in the 1960's, an oil slick was visible across the entire width of the river and as far upstream as could be viewed in the Gleasondale area. Human waste could also be seen floating past. Stow's then Board of Health agent, John DeVine, determined that Hudson's treatment plant was dumping their overflow of raw sewage directly into the river during the night. He initiated the cleanup process with regular river monitoring. As a result, the state mandated that Hudson upgrade their sewage treatment plant to provide for the additional housing growth they had experienced. In addition, the state patrolled upriver through Hudson, Marlboro, and Northborough and found that many of the businesses and houses adjacent to the river had no sewage connections and were unknowingly dumping their sewage directly into the river. For many years following, the water was tested regularly by the state taking samples from the Gleasondale dam upwards. Because of these actions, the river came back to life with abundant wildlife and waterfowl, including swans and the blue heron fishing daily at the bottom of that dam. The river is now a joy to the people who see it, canoe and kayak on it, and fish in it. This local treasure should not be allowed to backslide to unacceptable quality again.

It is beyond comprehension why any community could be granted a waiver of the regulations to satisfy the needs of their increased population, thereby adversely impacting other communities. If a community's facilities cannot handle their waste load, the only options should be a moratorium on future building until those facilities are upgraded, or new homes and businesses be built on lots which can accommodate the necessary septic systems, just as we all do in Stow. I have no sympathy for a community which cannot adjust their tax rate to provide the required services when private homeowners downstream must pay the entire bill for their personal treatment systems themselves.

I am also opposed to the removal of the Ben Smith dam in Maynard which would turn Stow's portion of the Assabet into a small stream with unsightly and odoriferous mudflats. Our river would become unsuitable for fishing or traversing by canoe or kayak and radically changed from what we all now enjoy.

MassDEP Response: The issue of growth was not a part of the ACOE study but was given consideration when the Assabet River Consortium completed a Comprehensive Wastewater Management Plan in 2007 which outlined how the six Assabet River Consortium communities (Hudson, Marlborough, Maynard, Northborough, Shrewsbury and Westborough) individually

and collectively would treat and dispose of sanitary sewage over a 20-year period. It should also be noted that all the wastewater treatment facilities are in fact being required to upgrade their facilities to achieve a limit of 0.1 mg/l and all of the facilities are presently under construction to do so.

39. Lee Steppacher, Project Coordinator, Sudbury, Assabet and Concord Wild and Scenic River Stewardship Council, National Park Service, 15 State Street, Boston, MA

As you know, twenty nine miles of the Sudbury, Assabet and Concord rivers have been nationally recognized as wild and scenic rivers, including 4 miles of the Assabet River downstream of Damon Mill. The National Park Service as the administering agency of the wild and scenic river has been very engaged with water quality issues on the Assabet River, specifically implementation of the phosphorus Total maximum Daily Load (TMDL). It is in this context that I am sending these comments on the Draft Assabet River Sediment and Dam Removal Feasibility Study authored by the Army Corps of engineers.

While others may focus on the science and technical aspects of the study, my comments focus primarily on the conclusions and the Executive Summary (ES) – those pieces of the report that water quality managers and the public will read most closely. It would be very helpful if the Conclusions section was straightforward and substantial, and the Executive Summary could be a stand-alone document. It is very important that the results of this study provide information that can help to move the process of implementing the TMDL forward. To do that, concluding statements should be as clear and far reaching (within the realm of the science) as possible.

For example, one of the important findings of this study is that winter P limits do have an impact on the sediment phosphorus flux. Language in the ES and the conclusions should more strongly bring this point out. Phrases like 'may contribute' and 'might be another control measure' should be more strongly stated. While the model cannot quantify the impact of winter phosphorus limits without more monitoring, the fact that winter limits have a positive impact should not be understated.

It would be helpful to include Table 2, which presents each modeling scenario and the resulting reduction in sediment flux in the ES. The TMDL is focused on reducing the sediment flux by 90%, so including these results upfront would reinforce the need to move towards this goal.

Any other recommendations that the authors can make to help move implementation of the TMDL forward would be helpful. There are always additional important questions requiring more studies and monitoring that could be pursued. However, more monitoring and studies will only delay implementation of the TMDL, and the question becomes whether there is enough information to move forward to help restore water quality in the river.

Corps Response: The Corps has reviewed and reworded the Executive Summary and Conclusions Section to highlight the finding of the PAS study. The TMDL for phosphorous prepared in 2004 by MassDEP does suggest an adaptive management approach to phosphorus control that includes monitoring. As improvements are implemented at the Wastewater

Treatment Plants it is practical to gather new data to document the resulting water quality change in the river.

<u>40. Kirk Teska, 218 Sudbury Road, Stow, MA</u>

Horrible idea. I kayak, boat, fish and hunt on the Assabet. You are attempting to "save" the river by basically eliminating it. Address the real problem at its source – re water treatment plants up-stream. Leave our river alone and the way it is which is a whole lot better than the way it would be if you removed the dam. Removing the dam would adversely affect my property value and could leave me and my family liable for clean-up.

Just because a thing can be done doesn't mean it should be. There are likely numerous unintended consequences associated with removing this dam.

Corps Response: If in the future a proponent steps forward who wishes to pursue dam removal, then there would be a detailed assessment and permitting process involved at all levels of government – local, state, and Federal. A section has been added to the report that lists the process that might be triggered by a dam removal project.

41. Comment from Acton Hydro Co., Inc.

General Comments

The whole report, and especially the Executive Summary, suffers from the tendency to state opinion as fact. It is similar to what occurs late in the news cycle of a current event on TV. When first reported in the news, factual information seems paramount but as each successive reporting occurs, reporters have such a strong desire to report something new that each telling of the event is embellished, stating the next plausible conjecture as likelihood and opinion as fact. Each successive reporter never seems satisfied to simply report on what is actually known, it must seem new. I t seems that each report on the Assabet River assumes that all previously reported speculations and opinions have become facts.

In the case of this report, a number of things are stated as if they are factual when they are not. For example the report states that the river is impaired but a more accurate description is that the DEP has rated it as impaired, which is an opinion which has become a position, a position which has objectives and goals and policies, policies which have the force of full-time champions and taxpayer funding. Other opinions exist but they don't have the luxury of funding and champions, nor the weight of previous publication. One of the responsibilities of governmental agencies such as DEP, EPA, and the Corps is to accurately represent factual information even if it is rereported factual information and to keep opinions in a different category even if the opinions are reported from previous documents.

MassDEP Response: Under the provisions of the Clean Water Act MassDEP is responsible for monitoring the waters of the Commonwealth and identifying those waters that are impaired and not in compliance with the Massachusetts Water Quality Standards. There are established procedures and protocols in place to ensure that data is evaluated and assessed in a scientific manner. Section 305(b) of the Clean Water Act has established a water quality reporting process by which EPA, Congress and the public can evaluate existing water quality, assess progress made in maintaining and restoring water quality and determine the extent of remaining problems. Guidelines are provided by EPA for making the determination under section 303(d) of that Act as to whether or not a water body supports each of its designated uses and meets water quality standards. This is a function of the type(s), quality and quantity of available current information.

The availability of appropriate and reliable scientific data and technical information is fundamental to both the 303(d) and 305(b) reporting process. It is EPA policy that a quality system be established to support the development, review, approval, implementation and assessment of data collection operations. To this end, MassDEP describes its Quality System in an EPA-approved Quality Management Plan to ensure that environmental data collected or compiled are of known and documented quality and are suitable for their intended use.

For more detailed information on the assessment methodology that is used by MassDEP please see the "SuAsCo Watershed 2001 Water Quality Assessment Report". This report is available for download at: http://www.mass.gov/dep/water/resources/wqassess.htm#wqar

If the study report is to be a report of factual findings, one significant modification should be to scan the entire report for the occurrence of definitive verbs and replace them with conditional verbs. For example, the verb “will” is used extensively but should more accurately be modified to “might”, “could” or “may”. The report should not be allowed to stand as is because it presents a tone of certainty to dam removal when the report’s stated purpose is to provide planning assistance, not to predict the future.

Another criticism of the report is that its tone, direction, limited scope, and conclusions all indicate a pre-conceived preference for dam removal regardless of cost or other influences. The agencies and scientists should have a preference for reduced phosphorus, which is clearly reported as being the most significant cause of the river being rated as impaired, regardless of the means which accomplish this. The costs estimated for dam removal and dredging are enormous and the impacts are large, too. The costs and impacts are so extensive that a cautious approach to phosphorus reduction seems mandatory. Think of it this way, can the owners have the dams back if removal doesn’t meet phosphorus reduction expectations? Can the taxpayers have their money back if dam removal and dredging doesn’t meet expectations? One section of the report describes vegetation changes that might occur over decades in the exposed impoundment bottoms if dams were removed. It’s presented as if long-term transition is expected and acceptable. So, to avoid irresponsible use of taxpayer funds and private property, shouldn’t the steps to reduce phosphorus be implemented in a cautious and measurable fashion and without a preference at the start for a particular method?

Gleaning the report, the clearest approach to successful phosphorus reduction seems to be:

1. Require all WWTF to implement DEP’s planned limits of 0.1mg/l in summer and 1.0mg/l in winter followed by collection of actual phosphorus loading results in the river for several years.
2. Compare results to the phosphorus modeling estimates and revise the model. (It is ludicrous to charge ahead to further restrictions on the WWTF or costly physical projects without a measurement of results and verification of the model.)
3. If phosphorus loading is still too high, require all WWTF to implement 0.1mg/l year round followed by collection of actual phosphorus loading results in the river for several years.
4. Compare results to the phosphorus modeling estimates and revise the model.
5. Re-estimate the potential impact and costs of dredging, dam removal, and other alternatives, including zero-discharge WWTF requirements.
6. Report on results, future impacts, estimated costs, and alternatives to reduce phosphorus.

Detailed comments on report sections follow, but some summary comments are included here:
• The report accurately infers that biochemical and biological modeling of natural systems is very inexact and requires verification. Each of the proposed and planned steps should be verified by field data collection over a sufficient time to allow modification of the model and revision of predictions.
• The report states that modeling at this point only provides qualitative, not quantitative predictions of changes in phosphorus flux in the water column. This should be stated as a foundational finding of the study in the Executive Summary. It should also compel DEP to implement its plans in a stepwise fashion, with step by step verification and model modification

until the model can produce quantitative results. There should be a limit on how much plan implementation can be required without verification and quantitative modeling.

▪ The report seems to make light of aesthetic influences other than the sight of floating vegetation. This visual aesthetic impact should be more correctly be described in the perspective of the entire calendar year and the spatial impact compared to the entire length of the river. If the floating vegetation is visible only in impoundments, as indicated in the report, then the extent of the impoundment which is impacted should also be described, especially as a percentage of river length. The report should also indicate how often the floating vegetation becomes an extensive negative aesthetic at each impoundment; certainly not every year at every impoundment. Plus, other aesthetic values should be studied and reported.

• Recreation is mentioned more than once as a recognized resource of the river yet there is no data to support these statements other than one anecdote about lost fishing lures. Dam removal is implied to have minor impact on recreation yet there is no data to support these implications. If statements about recreation are to be included as adding weight to an argument for dam removal, then all forms of recreation on or near the river should be studied, quantified, classified, and modeled.

▪ Though the purpose of the study is stated to be to describe feasibility of dredging or dam removal to reduce phosphorus loading in the river, a huge amount of report space is devoted to building a case for the ancillary benefits of dam removal. These sections of the report should more clearly be indicated as ancillary benefits and the tone of the information and conclusions presented should be modified to keep this information supplemental to the main purpose of the study and report.

• The study, and report, is severely lacking in the sense that it only considered two possible alternatives to accomplish phosphorus reduction and yet the report presents conclusions as if one of those alternatives is the only possible solution. The report should be modified, especially the Executive Summary, to state that this study is limited to only two of all possible solutions and that no others were considered. The report should also list some alternatives which were not considered, such as zero-discharge WWTF, vegetation harvesting, overflow gate installation at dams, and aquaculture, to reduce phosphorus loading.

▪ The report has a major omission. No cost of WWTF improvements was included and no cost of year-round reduction of limits to 0.1mg/l was included. These are the two most significant costs which must be compared to the estimated costs of dam removal.

• No discussion was presented in any section of the legal ramifications of dam removal recommendations. There is no mention as to whether such recommendations constitute a government taking of property or whether such recommendations affect the value of dam owner properties or products, particularly with the two dams where electric power generation is a near-term possibility.

• No discussion was presented of the value of renewable energy as an aesthetic, economic, or environmental benefit and how dam removal or recommendation of dam removal might have a negative impact on these values.

Corps Response on General Comments above: The Corps report was written and prepared to provide a summary of gathered/background information and details on analyses conducted for the study. The report was prepared in a direct, technical writing style. However, the report was revised to make it clear that this is a "Planning Assistance to States Study" and to make it clear that dam removal is hypothetical. If in the future a proponent steps forward to pursue

dam removal, then there would be a detailed assessment and permitting process involved at all levels of government – local, state, and Federal. A section has been added to the report that lists the processes that might be triggered by a dam removal project. Suggested studies of renewable energy as an aesthetic, economic, or environmental benefit can be considered by a future dam removal proponent and/or regulatory agencies as part of an EIS.

The Corp agrees that the water quality assessments and TMDL discussed in the report were prepared by MassDEP. This has been noted more frequently in the report. Please note references to previous reports were included on page 6 of the draft report entitled "Prior Studies and Reports".

The limited scope of the study is appropriate for a "Planning Assistance to States" Study. The scope and study focused on the measure of sediment/dam removal for sediment phosphorus flux reduction in the Assabet River.

The Corps notes that the author suggests a cautious approach to implementing actions to improve water quality in the river due to the uncertainty associated with phosphorus flux modeling and the costs and impacts of dam removal. Many of the authors concerns are included in the Corps report and in the CDM modeling report.

The Corps did not collect any additional information on the extent of floating vegetation in the river and thus cannot provide any new information on this topic.

> *Additional MassDEP Response: For the past year the USGS has been documenting duckweed growth in the impoundments and will be producing a report with their findings in late 2010. The report will discuss factors that may affect the growth and distribution of duckweed including flow, weather conditions, wind, solar radiation and seasonality. Additionally, MassDEP hopes to continue with the duckweed monitoring program that was established by USGS to further document conditions over the long term.*

Recreation was noted in the Corps report, but the study scope did not include a recreational use survey. If in the future a proponent steps forward to remove a dam then a recreational use survey can be considered by the proponent and/or regulatory agencies as part of an Environmental Assessment or Environmental Impact Scope (EIS) of work.

The TMDL previously prepared by MassDEP identified dam removal as a potential measure to decrease sediment phosphors flux and this planning study was a follow on to the TMDL to provide additional information on this measure.

The Corps does not have information on potential costs of further WWTF upgrades. This was noted in Table 14 page 56 of the draft report.

The Corps has no information to add on the legal aspects of dam removal on the Assabet River. It is noted on page 57 of the draft report that if the Corps is involved as a partner in a

dam removal project, then the Corps requires the project proponent to acquire all real estate including land, easements, rights-of-way, relocation, and disposal areas needed to proceed with a dam removal project.

Title
Should be called "Sediment Dredging and Dam Removal Study"

Corps Response: This was the title requested by MassDEP and has not been changed. Although agree that other titles could be used.

Executive Summary

PgES-1, PP2, S1: Please either state the particular effects that the Assabet "suffers" or substitute the word "experiences" for the phrase "suffers from the effects of". The report body does not support a description of suffering, but feasibility of dredging or dam removal.

Corps Response: The statement has been reworded to "experiences".

PgES-1, PP2, S2: Please only state that fish and wildlife habitat is impaired due to nuisance vegetation if it is supported in the report. If the report is not a study of impairment, then this statement is an assumption or a conclusion from another study and should be either removed or stated as an assumption or referenced conclusion.

Corps Response: Revised. Past studies by MassDEP have determined that the Assabet River experiences the effects of eutrophication due to nutrient loadings (particularly phosphorus) from wastewater treatment facilities (WWTFs), nonpoint sources, and sediments and that nuisance aquatic vegetation related to eutrophication impairs designated uses including recreation, aesthetics, and fish and wildlife habitat.

PgES-1, PP2, S3: Please only state that fish and aquatic organisms are threatened by varying dissolved oxygen levels if the body of the report supports this statement. If it does, then the body should cite specific fish survival data (not calculations) due to varying dissolved oxygen in the Assabet.

MassDEP Response: The scientific literature has shown that varying dissolved oxygen levels can have a negative effect on organisms within an aquatic ecosystem. Abrupt changes in dissolved oxygen induce stress and subsequently make fish more susceptible to disease. Organisms that are intolerant to these conditions tend to be replaced by ones that are more pollution tolerant. The SuAsCo Watershed Water Quality Assessment Report (http://www.mass.gov/dep/water/resources/wqassess.htm#wqar) indicates that the fish community in the Assabet River is dominated by species that are tolerant or moderately tolerant to pollution. This is further evidenced in a section of the Corps report on "Target Fish Community Analysis" which also indicates that the current fish population is dominated by the more pollution tolerant species.

PgES-1, PP2, S5: Does the body of the report really support that the effects of vegetation are most evident in impoundments because nutrients settle or because of some other factor, such as lower velocity, higher temperature, or shallow overflow depth? Nutrients may settle in impoundments and can be summarized if the body of the report demonstrates that, but that doesn't mean that there is a cause and effect relationship between nutrient settling and evidence of nuisance vegetation.

MassDEP Response: All the factors that you mention are interrelated and this issue is addressed in the TMDL (http://www.mass.gov/dep/water/resources/anuttmdl.doc) which indicates that the primary locations where biomass accumulates are the impoundments where conditions most suitable for excessive macrophyte growth exist. These include low velocity, shallow depths, large surface area open to sunlight, and nutrient enrichment. The impoundments provide the physical setting while the four major treatment plants and sediment in the impoundments provide the nutrients that result in the observed excessive macrophyte growth. In the free flowing reaches of the river excessive floating macrophyte growth is not observed. While macrophytes do exist, they are generally rooted species adapted to the higher velocities and do not appear to be excessive or a nuisance.

PgES-1, PP2: This whole paragraph seems less a summary of the report than it is a background to justify certain conclusions. If it is background, it should be clearly identified as such in the Executive Summary and it should be clear which portions of the background are assumptions and which are derived from other works.

Corps Response: Revised text in ES.

PgES-1, PP5, S2: Would not this sentence be more accurate if it substituted the words "implementing Phase 1 of the TMDL" instead of "decreasing the WWTF's effluent to 0.1 mg/l"? As presently worded, it makes it seem like there is a year-round requirement for the WWTF's to discharge at 0.1 mg/l, which contradicts the previous paragraph.

Corps Response: Revised. Phase 1 of the TMDL required that the four WWTFs discharging to the Assabet River decrease the total phosphorus in their effluent to 0.1 mg/l (April to October) and 1.0 mg/l (November to March). These upgrades are currently being implemented and paid for by the communities that own or use the WWTFs.

PgES-2, PP3, S1: An additional sentence should be inserted immediately following the first sentence which states that the scope of this study was limited by direction of DEP and that no other options for decreasing sediment phosphorus flux were considered. It should further state in this paragraph what some unconsidered options might be, such as vegetation harvesting, aquaculture, etc.

Corps Response: Revised. The Corps study is a follow-on effort to the TMDL to provide additional information on the option of sediment and dam removal identified in the TMDL. Although not included in the Corps study vegetation harvesting is usually considered as a short term measure to control nuisance vegetation and is generally an on-going maintenance requirement.

PgES-3, PP1, S2: Please substitute the words “It is estimated that dam removal would” for “Dam removal will”. As presently worded it far oversells the certainty of dam removal at any site as well as implies certainty to an unverified mathematical model.

Corps Response: Revised text in ES.

PgES-3, PP3, S1: Please remove the first use of “the” in the sentence and please substitute the word “impoundment” for the word “river”.

Corps Response: Deleted “the” and changed to “water levels behind dams”.

PgES-3, PP3, S3: Please reword this sentence to say, “The largest changes in wetlands communities would occur if the Ben Smith, Gleasondale, and Hudson dams were removed.” These dam removal projects are far from certain and the wording should refrain from this assumption.

Corps Response: Revised. Removing dams would change existing water levels behind dams. Many of the wetlands along the Assabet River exist because of the water backed up by the dams. The largest changes in wetlands communities would occur if the Ben Smith, Gleasondale, and Hudson dams were removed.

Introduction

Pg6, PP3, S2: This is an incomplete sentence.

Corps Response: Revised sentence.

Pg6, PP3, S3: Either Damonmill Dam (Pg 5) or Damon Mill Dam should be used throughout the report, but not both.

Corps Response: Revised to Damonmill Dam on page 6.

Pg6, PP4, S1: Who recognizes the Assabet as a significant recreational and natural area? How many people endorse this opinion? And in what publications is this conclusion documented? I will concede that at least two government offices and one special interest group desire this to be so, but that doesn’t mean that the river already holds this valued status in wide recognition. I recommend rewording this sentence so that it does not overstate the actual recognition of the river in its current state by the majority of the people who are aware of its existence. Consider the recognition of the Deerfield, the Millers, the Green, or the Connecticut Rivers in comparison to the awareness that the people who utilize those rivers as recreational and natural areas have of the Assabet. The Assabet has value but it shouldn’t be overstated like this

Corps Response: Revised. There are two federally designated areas associated with the river. One is the Assabet River National Wildlife Refuge in Stow adjacent to the river and upstream of Ben Smith Dam. The second is the National Park Service, National Wild and Scenic River designated river reach. This designated reach includes the a 4.4-mile segment of the Assabet

River beginning 1,000 feet downstream from the Damonmill Dam in the town of Concord, to its confluence with the Sudbury River at Egg Rock in Concord.

Restoration of the river has strong, longstanding public support. Advocacy groups supporting the restoration of the river include the Organization for the Assabet River, the Sudbury Valley Trustees, and the Sudbury Assabet Concord Watershed Community Council. These groups represent a wide range of constituency.

.
Pg8, PP1, S1: Please insert the word "to" after the word "related".

Corps Response: Revised.

Pg8, PP1, S3: The logic of this sentence doesn't seem to make sense. The factors mentioned are contributors, but the seasonality of eutrophication is most directly related to the natural growing season (temperature, sunlight), combined with low flow and phosphorous loading. Logic says that phosphorus is present year-round and water records show that low flows occur at many times during the year, but biomass growth doesn't happen year-round, it happens during the natural growing season. If the point of the sentence is to draw attention to the WWTF contribution to aquatic growth, then it should state that the WWTF's exacerbate aquatic growth by making phosphorus readily available during the natural growing season.

Corps Response: Revised paragraph.

Plan Formulation for Water Quality Improvements

Pg9, PP3, S4: This statement about the inability of the model to adequately predict quantitative results is one of the most significant findings of the study and should be included in the Executive Summary. Also, the entire report should be edited to be sure that no ambiguity remains that the model only provides qualitative indications rather than quantitative estimates.

Corps Response: State of the art modeling techniques were used to evaluate the problems on the Assabet. Paragraph 9 has been changed in the report.

Pg10, PP3, S1: This statement should be reworded to be consistent with the conclusion about qualitative indications of benefits. Something like, "Models of dredging alone indicated that it would achieve limited short-term benefits..."

Corps Response: Revised.

Pg10, PP4, S1: To be consistent with qualitative indications, this statement should be reworded as, "The other scenarios modeled indicated that they would contribute toward..."

Corps Response: Revised.

Pg10, PP4, S2: Wording consistent with qualitative results: "Expected improvements...might include..."

Pg10, PP5: The verbs in these sentences should be changed to be consistent with qualitative results; use "may," "could," "might," instead of "will".

PG10, PP6: Ditto.

Pg11, PP1: Ditto. Substitute "could possibly" or "would likely" for "is". These conclusions sound far too definitive to be consistent with qualitative judgements and analysis. Wording should be consistent with the findings and the report's disclaimers.

Pg12, PP1: This wording is better, but still carries the force of certainty. "Might" should be substituted for "will" each time it occurs.

Pg13, PP3, S1: Substitute "indicates" for "will have".

Pg13, PP3, S2: Substitute "might be" for "is".

Pg13, PP4, S1: Substitute "would be" for "is". Substitute "may have" for "has".

Pg13, PP5: This paragraph is well written and its conclusions should be made pointedly clear in the Executive Summary.

Pg14, Bullet 3: This bullet should be stricken. It is a conclusion that is outside the scope of the study purpose and direction.

Corps Response: Revised section, but disagree in concept. Dams transform a river into a lake-like habitat with slower water flow and block or hinder passage along the river.

Dam and Sediment Removal Alternatives

Pg15, PP2, S2: If this statement must stay in the report it should substitute the words "DEP's goal" for the words "the second goal".

Corps Response: Revised. In addition, dam removal would restore the natural connectivity of the river system and provide for a more sustainable riverine ecosystem. In consideration of potential ecological benefits and also localized water quality benefits removal of Aluminum City and Allen Street Dam are included. All six dams are retained for consideration for study purposes.

Pg15: The information in the box is redundant; it does not clarify anything nor add any new information. It's purpose is unclear.

Corps Response: Inserted text box included as not all readers will have read the CDM report.

Description of Dams Considered for Removal

Pg18, PP1: This paragraph should include a statement that cites the total percentage of river length that is impounded (15.25%), and total percentage of river length that dams influence (29.4%), for perspective. As it stands, the reader is left with the impression that the full length of the river is impounded, which is misleading.

Corps Response: Referred reader to Figure 3 that illustrates the effect of dams.

Pg20, Table: Both Ben Smith Dam and Powdermill Dam are under jurisdiction of FERC for purposes of dam safety and not the MA ODS. FERC's definitions of Hazard Classification are slightly different than MA ODS. I'm not sure how to suggest improving the information listed here, but it's not correct as stated.

Corps Response: Based on your input the Corps added a note that Powdermill Dam is under jurisdiction of FERC for purposes of dam safety and hazard classification. At Ben Smith the jurisdiction appears to have been transferred to the ODS with the surrender of the FERC exception in 2004. (Source: Letter from ODS to Mr. Mullin dated March 28, 2006.) The Corps has no additional information on this issue.

Pg22, PP1, 2: This wording makes it sound like dense growth of nuisance vegetation is a common occurrence. If this is documented to be common, fine, but otherwise please insert the Acton Hydro Co., Inc. 7 of 12 12/21/09 word "would" before the work "likely". Periods of extreme low flows such as drought conditions in 2002 and 2003 are not common and these are the occasions when dense growth has occurred.

Corps Response: The Corps has added the word "would".

Pg24, PP2, S2: Is the Maynard town park really the correct designation in this sentence? Or does this paragraph really belong under the description of the Ben Smith Dam?

Corps Response: This information has been moved to the Ben Smith dam.

Pg25, PP1, S1: I believe that the correct term for the canal described is "head race" not "tail race".

Corps Response: The Corps agrees with the commenter, however, as the purpose implied by a headrace no longer exists, we revised the report to describe it as an artificial channel.

Pg29, PP1, S1: The correct owner name is "Acton Hydro Co., Inc.".

Corps Response: Revised.

Engineering Consideration for Dam Removals
No comments

Target Fish Community Analysis

Pg36, PP1, S2: Characterizing the river as degraded assumes that it does not meet the expectations of either a theoretical river or historic river for which exists no record of the fish communities. This sentence should be clarified so that it states to what the present river community is being compared.

Corps Response: Revised. Data indicate a dominance of pollution tolerant species in the current fish population.

Pg36, PP2, S1: Wouldn't "theorized" be a more accurate word than "expected". Earlier in the study, the word "expected" was used to convey some close link between a single cause and a single effect. Here, there are many assumptions of causes and many possible effects, too many to say what could be "expected". It should be proposed as a theory that may or may not have a tight cause and effect relationship to fish communities desired by DEP.

Corps Response: Revised. …. it is likely that replacing impounded river areas with free flowing river area.

Pg36, PP3, S2: Is there any evidence that the American Eel is not thriving in the Assabet River? This statement seems inconsistent with reports of eel surveys. Dam removal might make life easier for the American Eel but they seem to be doing just fine as is. No evidence that I've seen indicates that eel migration is impeded on the Assabet as implied by this sentence.

Corps Response: As we do not have a study on the success rate of current eel migration on the Assabet we have revised the language to "might" benefit. However, review of literature on American eel does include suggestions for specialized eel ladders, by-pass cannels, and dam removal. See link for general information on this topic.
http://www.wildlife.state.nh.us/marine/marine_PDFs/American_Eels_GulfOfMaine.pdf

Dam Removal Assessments

Pg37, PP1, S3: Back to my strong suggestion to use conditional verbs like "might" or "could" instead of "will".

Corps Response: Revised. The HEC-RAS model results indicate that dam removal significantly lowers the water surface elevations for the 7Q10, summer average flow, 10-year flood, and the 100-year flood flow conditions. The largest change in water surface elevation occurs for the lower flow conditions, 7Q10 and summer average flows, except for the Allen Street and Gleasondale sites.

Pg38, PP1: Ditto, and through the rest of the report.

Pg39, PP3: Was there no consideration of how dam removal might affect town water supplies from ground wells, such as Acton's well pumps immediately northeast of Powdermill Dam? If it wasn't considered, even that should be mentioned.

Corps Response: This issue was noted on page 39 of the draft report. A groundwater analysis was not conducted for the planning study. This is an evaluation that might be included in a scope of work for an Environmental Impact Statement if a proponent steps forward to remove a dam. USGS has done a general study of ground water in the Assabet River Basin entitled "Simulation of Ground-Water Flow and Evaluation of Water Management Alternatives in the Assabet River Basin, Eastern Massachusetts SIR 2001-5114, This study can be downloaded at http://pubs.usgs.gov/sir/2004/5114. One of the purposes of this study was to examine the impact of water supply withdrawals on stream flows. This reference was previously included in the Corps list of references.

Pg41, PP3, S3: This statement is inaccurate. Powdermill Dam was not partially breached. As a dam safety precaution, a controlled drawdown of the impoundment was implemented. The drawdown has continued since 2004 in order to assist repair of a sinkhole and improvements to the powerhouse intake and spillway.

Corps Response: The statement has been revised.

Pg42, PP1, S5: Shouldn't all of these be species names use proper nouns (capitalization of both terms)?

Corps Response: Botanists generally reject the practice of capitalizing the common names of plants, though individual words of plant names may be capitalized as in this section.

Pg43, PP1, S4: Why introduce the term "obsolete" in a discussion of wetlands? If the report needs to make a case that dams are obsolete, then do so convincingly in an independent section. To include the term here just seems like a crude slam that adds nothing to the wetlands mitigation discussion. Please remove this adjective.

Corps Response: The word has been deleted.

Pg46, PP3: Also seen are Snowy Egrets, White Swans, and Green Herons.

Corps Response: If in the future a dam removal project were undertaken a bird survey might be incorporated in the environmental studies.

Pg53, Table 12: ...removal of the dam could possibly "affect"significant...

Corps Response: Revised.

Additional Information
Pg55, Last Sentence: This is so much of an overstatement that it's wishful thinking. There is no measurable difference between \$6.2M/RPL and \$6.1M/RPL in a non-quantitative model. This statement should be revised to state that the last two rows in the table are effectively equivalent in cost per RPL, since the determination of RPL was qualitative.

Corps Response: Deleted.

Pg56, Table 14: For purposes of an informed decision-making process, it is a major omission to leave out an estimate of the cost to implement the Planned WWTF Improvements. It is also a major omission to leave out the cost to implement a change at WWTF to lower the winter phosphorus loading to 0.1mg/l. The relative value of these dam removal and dredging costs cannot be evaluated without those two figures.

Corps Response: As noted in Table 14 in the draft report these cost are not available to the Corps so we can not include them. Agree that in the future someone may wish to develop information on the initial construction costs and annual operation cost to treat for phosphorous in wastewater.

Conclusion
Pg59, S1: Substitute the words "could possibly" for "will" in the introductory clause and all succeeding bullets.

Corps Response: Revised Conclusions.

Pg60, PP5, S1: This is an understatement. This should be reworded to more accurately reflect that there would be a significant negative effect on canoe and kayak recreation in reaches where dams are removed.

Corps Response: Revised Conclusions.

Appendix B
PgB-41, PP2: The dam length is 450 ft. The spillway crest is 77 ft.

Corps Response: Revised.

PgB-42, PP1: There never were gate valves at the flood conduits at the left of the earthen dam. There were two wooden gates.

Corps Response: The text has been edited to indicate there were wooden gates at the conduits. However, note the text in the draft report said that there "appeared to have been gate valves".

Throughout this section of Appendix B, please substitute the word "would" for the word "will" and utilize other conditional verbs as needed to be consistent. The current owner does not plan to remove the dam so the certainty of the word "will" must be tempered.

Corps Response: The verb tense has been edited in Appendix B to respond to comments. However, it is not unusual in Engineering Documents to use the word will when discussing future events that may or may not occur.

Appendix D

PgD-2, PP2: Powdermill Dam was not breached, as stated in earlier comments. There has been an extended drawdown which caused the conditions observed. Please change the wording to reflect this.

Corps Response: The text has been edited.

PgD-7, PP2, S4: Use “affect” not “effect” here.

Corps Response: The text has been edited.

PgD-8, Line 1: I believe that “...depending on the...” should be substituted for “...depending of the...”

Corps Response: The text has been edited.

Pg10, PP3, S3: Shouldn’t “drier” be substituted for “dryer”?

Corps Response: The text has been edited.

Pg11, PP1, S1: Shouldn’t “out-compete” be substituted for “out-complete”?

Corps Response: The text has been edited.

Pg11, PP2, S2: Shouldn’t “increased” be substituted for “increase”?

Pg11, PP3: This is the third time in the report that this paragraph has been included. It adds nothing to the discussion of mitigation and takes up space. This is poor writing practice.

Corps Response: This is general information that provides MADEP guidance and discussed mitigation which is appropriate to this section of the report.

Pg11, PP2: This is the second time in the report that this paragraph has been included, except for the misspelled verb in the first sentence and the incorrect assumption that there is general recognition of benefits. Again, it doesn’t contribute to the discussion of mitigation and should be removed.

Corps Response: Revised. The benefits to stream or river restoration are widely recognized by the environmental community. Water movement through impounded areas can be slow, allowing the retention of sediments, chemical and nutrient contamination which can lead to degraded water quality, eutrophication and warming. Fish passage and movement of other aquatic species up and down the river can be restricted by dams.

Pg11, PP3: Ditto.
Pg12, PP1: Ditto.

Pg12, PP2: Ditto.

Pg32, PP3: The penstocks are plastic-lined concrete and there is no sluiceway downstream of the powerhouse. Water doesn't pass through a generator, it passes through a turbine. The water exiting the powerhouse rejoins the river immediately downstream of the powerhouse.

Corps Response: The text has been deleted.

Pg33, PP5, S1: The words "drawdown of the impoundment" should be substituted for "breach of the dam".

Corps Response: The text has been edited.

Appendix E

PgE-1: Shouldn't the title at the top of the page be "APPENDIX E"?

Corps Response: Deleted the text "Appendix TFC" to avoid confusion.

PgE-6, PP4, S1: "Excel" should be substituted for "excel".

Corps Response: The text has been edited.

PgE-13, PP6, S3: Why is a sentence included here that states what was found in impoundments?

Corps Response: This should read "riverine" and the text has been edited.

PgE-19, PP3, S1: This is a very revealing statement. It contradicts earlier statements that the comparison of EFC to TFC was for evaluation only. The statement indicates a pre-disposed antagonism to impoundments: "...rivers should be for river fish...". To what extent did this predisposition influence the conduct of the study? I can agree that there may be a premise that fluvial species would be found in riverine sections and non-fluvial species would be found in impoundments, but this is sentence is clearly an indication of a study aimed to support a predisposition. That's bad science.

Corps Response: The Target Fish Community approach is explained at the start of the Appendix.

PgE-20, PP1, S1: What data shows that the EFC populations were worse than they are now? If we don't have data, how could there be a "recovery"? This word should probably be changed to indicate that they show signs that are encouraging or signs that they are relatively healthy without consideration of sediment dredging or dam removal.

Corps Response: Revised. The existing fish community in the riverine reaches between the various dams and their impoundments include the presence of fluvial specialists. The EFC-R,

albeit still dominated by macrohabitat generalists at 56.0%, is also comprised of 26.2 % fluvial dependents (white sucker only) and 17.8% fluvial specialists.

PgE-20, PP2, S3: Is there no coordination of the state fish-stocking program with the other programs like the TFC and the restoration programs? Why is it tolerated within the state agencies to introduce non-native species into rivers when private introduction of non-native species is probably a criminal offense? This should be addressed in this report as well as an indication of the direction the future stocking programs to assist restoration programs. What about other non-native species? How did they get past the dams? This should be described. There is plenty of other speculation in this report about how conditions came to be as currently observed, so speculation about how the fish arrived could be included.

Corps Response: Your comment has been noted but is not part of study and likely something that is better discussed by watershed stakeholders with the MADFW.

PgE-20, PP3, S1: Again, inclusion of the word "recovery" indicates a collection of at least two data sets, one worse than the most recent. It is encouraging that the riverine portions of the river support expected populations, but the case hasn't been made that a recovery is in progress.

Corps Response: The text has been edited.

PgE-20, PP3, S2: I may have a challenge to the math used in this EFC/TFC comparison. Are the "total population" percentages based on the total of the samples? If so, it may not accurately represent the river. For instance, 6 of 15 sample sets (40%) were taken in impoundments but impoundments only comprise 15.25% of river length. So extrapolation to "total population" from the data sets should be weighted for total river length since the TFC assumes a riverine habitat throughout its length. In any case, the basis for extrapolating from data set to total population percentage should be stated for reference.

Corps Response: Attachment A to Appendix E includes the data used to calculate the percentages and this is noted in the report.

PgE-22, PP2, S3: Wording should be changed to "...there is a large striped bass presence...".

Corps Response: The text has been edited

PgE-24, PP2, S5: This statement is unfounded, as mentioned before. American Eel populations in the Assabet are healthy and no study has been conducted to prove that their populations would increase with either ladders or dam removal.

Corps Response: The Corps agrees that a study was not done on the Assabet to evaluate eel passage on the Assabet. This is a study that could be considered as part of future environmental studies of the river. The sentence was deleted.

PgE-25, PP2, S2: Omit the first occurrence of "for".

Corps Response: The text has been edited

PgE-25, PP4, S1: This sentence is awkward. Should "River" be changed to "the river"?

Corps Response:. The text has been edited

PgE-25, PP4, S2: This sentence is an overstatement. The extrapolation of total population either as performed or as corrected by river length weighting does not support this overarching statement. This statement is an accurate summary of impoundment conditions, not total river conditions.

Corps Response: See response to next comment.

Pg3-25, PP4, S2&S3: These two sentences are overstated, as was the second sentence. They may be close to summarizing the impoundment condition, but impoundments only comprise 15.25% of river length. Please correct these mis-statements.

Corps Response: Revised. In conclusion, it is expected that removing dams on the Assabet River and improving water quality would provide habitat that would support the increase in fluvial dependent and fluvial specialist species consistent with the considered target fish community (TFC) for this river. Over the long term, removing dams on the Assabet would also provide for the future restoration of the migratory corridor on the Assabet and provide access to spawning grounds and nursery habitat for anadromous species when passage is provided at the Talbot Dam in Billerica. If in the future a dam removal were considered further, it is likely that additional studies of fish populations on the river would be useful to characterize changes that would result from dam removal.

Appendix F

PgF-2, PP4, S2: I've never heard an atlatl described as a weight for a spear. Is that an accurate archaeological description or should it be described as a throwing lever for a spear?

Corps Response: Your comment has been noted.

PgF-13, PP4, S2: Should "paper mail" be "paper mill"?

Corps Response: The text has been edited.

PgF-14, PP4, S4: Shouldn't the location be northwest of the canal entrance?

Corps Response: The text has been edited.

PgF-16, PP1: "1923" cast into concrete, not brick. The hydroelectric development does not have a FERC license; it holds an exemption from licensing by FERC. The name of the company is Acton Hydro Co., Inc.

Corps Response: The text has been edited.

PgF-16, PP2, S2: The owner holds an active exemption from licensing, not a license.

Corps Response: The text has been edited.

PgF-17, PP3, S2: The owner holds an exemption from licensing. These terms are not semantic, nor synonymous.

Corps Response: The text has been edited.

Appendix G

PgG-1, PP1: This paragraph is completely redundant and serves no useful purpose in this appendix. It should be omitted.

Corps Response: The text has been edited.

PgG-8: Owner is located at 9 Mayflower Road.

Corps Response: The text has been edited.

42. Comment from Westborough Wastewater Treatment Facility, 238 Turnpike Road, Westborough, MA 01581

The Westborough Wastewater Treatment Board agrees with the sediment removal and dam removal project. The Board is aware that based upon the results of the TMDL Study, the best long-term solution for the nutrient issue is to have the treatment plants along the river treat to levels of 0.1 to 0.2 mg/l phosphorous in their effluents, and to remove the sediment along with the dams that promote the accumulation of the sediment.

However, in light of that, we are opposed to any lower limits for phosphorous in our NPDES Discharge Permit including lower winter limits. Limits lower than 0.1 were shown to be not effective in addressing the nutrient issue of the Assabet.

Instead of looking further into point source discharges, the owners of which are spending significant sums of money to treat at the low level of 0.1 mg/l, the WTPB respectfully request that the regulatory agencies focus on non-point sources. Prior to the start of the CWMP and TMDL studies, non-point sources constituted about 40% of the phosphorous discharge to the river. Once the four municipal treatment plants along the Assabet River have their phosphorous treatment units operational, the non-point portion of phosphorous should significantly increase.

Corps Response: Your comments are included for consideration by MassDEP and EPA.