# Site Reconnaissance, Preliminary Evaluation, and Opinion of Probable Cost for Dam Removal

## Old Mill Pond Dam
## West Tisbury, Massachusetts

## June 2011

*Old Mill Pond Dam from the Right Side of the Dam Impoundment*

**Prepared for**
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## PREFACE

Stantec Consulting Services Inc. (Stantec) performed preliminary site reconnaissance work to examine the potential for removal of Old Mill Pond Dam on Mill Brook in West Tisbury, Dukes County, Massachusetts. This report addresses potential beneficial and adverse impacts and challenges associated with the potential removal of this dam and alternatives and associated costs to modify or replace the existing dam spillway with a structure that would improve ecological function and continuity in Mill Brook.

Ecological function in Mill Brook adjacent to Old Mill Pond Dam is impaired by poor-to-absent continuity of the riverine and riparian habitat between the upstream and downstream reaches of the brook and degraded habitat in the dam impoundment. Removal of this dam would need to address both infrastructure issues resulting from the presence of the West Tisbury-Edgartown Road over the embankment and spillway sections of the dam, water diversion for fire-fighting purposes from the dam impoundment, and possible local opposition to alteration of the dam impoundment. The basis of the proposed approach is to initiate stakeholder discourse on these items as part of a public outreach program.

This work was performed by Stantec under contract to the Commonwealth of Massachusetts Department of Fish and Game Division of Ecological Restoration (DER). Project work included review of information prepared by others and provided to Stantec by DER, observations made during a preliminary site visit on June 7, 2011, and discussions during the site visit with Prudy Burt of West Tisbury, Kent Healy, a retired professor of civil engineering and resident of West Tisbury, and DER Priority Projects Coordinator Nick Wildman of DER.

## 1.0 SITE CONDITIONS AT OLD MILL POND DAM

This report presents information obtained as part of a preliminary site reconnaissance relevant to potential removal of the Old Mill Pond Dam (State Dam ID No. 7-4-327-1; National ID No. MA 02480) on Mill Brook in West Tisbury, Massachusetts. The dam is owned by the Martha's Vineyard Garden Club, which is interested in gifting the dam to the Town of West Tisbury.

Information presented in this section was obtained from observations made by Stantec during the site visit and information presented in a Phase I Inspection/Evaluation report prepared by Kent A. Healy, ScD (Massachusetts Professional Engineer License No. 28498), in October of 2006 (Phase 1 Report [Appendix B to this report]). All dimensions of the dam presented here were obtained from the Phase 1 Report unless otherwise noted.

### 1.1.1 Old Mill Pond Dam

The Old Mill Pond Dam is comprised of an embankment that is approximately 280 feet (ft) long with a reported height of 5.5 ft and a crest width of 50 ft. The Phase 1 Report lists the dam as a "Non

Jurisdictional" size structure with a "Significant (Class II)" hazard potential and a "Satisfactory" physical condition.

Observations by Stantec during the site visit are that the structural height of the dam is approximately 10 ft from the invert of the channel of Mill Brook immediately downstream to the center of the West Tisbury-Edgartown Road, which overlies the crest of the dam. Mill Brook discharges through a spillway structure dam adjacent to the left[1] abutment of the embankment section of the dam. This spillway structure consists of two concrete stoplog bays at the upstream end of a pair of masonry box culverts each with approximate dimensions 5 ft wide and 2.5 ft high. Stoplog boards were in place during the site visit and the measured hydraulic drop over the boards and into the two culverts was 2 ft.

Despite the presence of a temporary upstream fishpass structure constructed of wood that was observed in the left masonry box culvert during the site visit, potential for upstream fish passage under the observed conditions was marginal due to shallow (depth of approximately 0.4 ft) and fast (speed of 5 to 6 feet per second) in the downstream portion of the culvert. It is therefore expected that upstream fish passage at this dam is limited to American eel (*Anguilla rostrata*) and perhaps river herring (*Alosa spp.*) under ideal flow conditions. Indigenous brook trout (*Salvelinus fontinalis*) occur in the headwater of Mill Brook and may similarly be able to pass upstream through the fishpass under ideal conditions. The Massachusetts Division of Fisheries and Wildlife stocks various trout species in the dam impoundment (Mill Pond).

The dam is not currently used for a dedicated functional purpose, but was previously used to provide mechanical power to a former mill building located along the downstream face of the dam and West Tisbury-Edgartown Road to the right of Mill Brook. This building and the adjacent grounds are currently owned and occupied by the Martha's Vineyard Garden Club. A small (approximate 3-ft-wide, 2-ft-deep) masonry tailrace that discharges to Mill Brook is located immediately downstream from this building. Observed flow into this tailrace was minimal during the site visit suggests the presence of some seepage through the upstream section of the dam embankment and/or leakage through structures that formerly conveyed water through the building.

The tributary watershed upstream from the dam is approximately 3.1 square miles and comprised of a mix of mowed and forested residential and agricultural land overlying a sand and gravel outwash plain.

Photos 1 – 10 in Appendix A include features of the project dam, site, and Mill Brook.

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[1] The directionals "right" and "left" in this report are oriented looking downstream.

### 1.1.2 Impoundment

The Phase 1 Report lists the normal impoundment pool upstream from the dam as having a surface area of approximately 2.5 acres, a length of approximately 460 ft, an average width of approximately 250 ft, an average depth of 2 ft, and a storage volume of 5 acre-ft. The observed maximum depth was approximately 6 ft during the June 7, 2011, site visit. Emergent aquatic vegetation was observed in and along the margins of much of the impoundment, and particularly in the upstream end of the impoundment where observed depths were less than 1 ft.

A report prepared in December of 2001 by Aquatic Control Technology Inc. (ACT) for the Town of West Tisbury and titled "Mill Pond Baseline Assessment and Management Plan – West Tisbury, MA" (ACT Report [Appendix C to this report]) presents information on the dam impoundment and water quality based on field surveys performed earlier in 2006. The ACT Report describes the impoundment as a eutrophic waterbody, which is consistent with observations by Stantec during the July 7, 2011, site visit.

The objective of the ACT Report was to evaluate existing conditions in the impoundment, including water quality, and it includes a brief assessment of management options with the stated primary objectives being "restoration and maintenance of optimal fish and wildlife habitat". This report concludes that dense aquatic vegetation and shallow depths resulting from accumulation of unconsolidated organic sediments have adversely impacted the impoundment and presents a range of potential management options, including watershed management, physical techniques, mechanical techniques, chemical (herbicide) treatment, and dredging. The report recommends removal of sediment by dredging as a primary management option, but notes that ongoing management of sediment and aquatic vegetation would likely be required. The estimated cost of the recommended action (dredging) presented in the report is approximately $500,000.

The impoundment provides for limited recreational use due to it being relatively shallow. Opportunities for shoreline-based recreation (e.g., fishing) appear limited due to aquatic vegetation and an apparent lack of habitat capable of sustaining fish for a targeted recreational fishery.

Discussions with Prudy Burt and Kent Healy during the site visit indicate that the local fire department may withdraw water from the dam impoundment using a floating sump.

### 1.1.3 Impoundment Sediment

Accumulations of fine sediments were observed throughout the impoundment. The ACT Report describes this material as "organic muck" with depths of accumulation of up to 5 ft and an estimated volume of material of approximately 20,000 cubic yards (CY). While accumulated sediments are most apparent in the upper reach of the impoundment, where observed depths of water were less than 1 ft in many locations during the June 7, 2011, site visit, this material was observed in other locations at varying depths throughout the impoundment.

### 1.1.4 Mill Brook Upstream and Downstream from the Impoundment and Dam

The reach of Mill Brook adjacent to Scotchman's Lane approximately 0.5 miles upstream from the dam was visited during the site visit. The reach of the brook immediately upstream and downstream from Scotchman's Lane has a bankfull width of approximately 12 to 15 ft and substrates including gravel and sand. A complete vegetative canopy overlies this reach of the brook. Approximately 50 ft downstream from Scotchman's Lane is a small cobble and boulder diversion weir with a hydraulic height of approximately 1.5 ft that diverts approximately 10 to 20 percent of the flow in the brook through an excavated ditch that discharges to Parsonage Pond. The excavated ditch is aligned parallel to the brook (south) for approximately 0.4 miles before turning west where it flows under the West Tisbury-Edgartown Road and discharges to Parsonage Pond. The ditch is apparently in poor condition and much of its flow drains back into Mill Brook through breaches in the ditch walls, which is consistent with observed conditions during the site visit based on some flow being observed flowing into the ditch at the diversion weir but no flow entering Parsonage Pond. An annotated parcel map provided by Kent Healy that depicts some of the features described here is included as Appendix D to this report.

Mill Brook immediately downstream from the dam flows over mineral substrates including gravel and cobble-size material and has a bankfull width of 12 to 15 feet and has a complete vegetative canopy. The brook discharges to the Town Cove arm of Tisbury Great Pond approximately 0.2 miles downstream from the dam.

### 1.1.5 Maley's Pond and Fire Hydrants

Maley's Pond is located approximately 350 ft south (downstream) from the dam and is used as a fire fighting water supply source. Water is supplied to the pond from a diversion structure located adjacent to the right (west) side of the Old Mill Pond Dam that discharges to a channel immediately south of the dam and West Tisbury-Edgartown Road. The pond was apparently created by construction of a dike along its east side using material excavated from the pond. Two fire hydrants are located adjacent to the northwest corner of the pond, including a dry hydrant that is used to draw from the point and a connecting hydrant that can be used to supply water to a hydrant located approximately 0.3 miles to the west along State Road. According to Kent Healy, the local fire department uses a pump truck to draw water from the dry hydrant and feed water into the connecting hydrant that supplies water to the hydrant along State Road.

## 2.0 RESTORATION OPPORTUNTIES AND CONSTRAINTS

This section presents information on apparent opportunities and constraints on removal and other alternatives to modify or replace the existing dam spillway with a structure that would improve ecological function and continuity in Mill Brook of this dam based on visual and semi-qualitative observations and experience from other, similar projects.

Information presented here addresses various potential operational and/or structural modifications to the dam, such as temporary or permanent removal of the stoplog boards from the spillway structure, removal of the spillway structure, and removal of a larger section of the dam. Complete removal of the dam is not considered here to be a feasible or appropriate action due to the location of the West Tisbury-Edgartown Road on top of the dam. Subsequent sections of this report address modifications to the operation and/or structure of the dam that would result in lower water surface elevations in the currently impounded reach of the brook upstream from the dam.

The order of the constraints presented here is based on the apparent magnitude of their respective need for additional study as part of ongoing studies for removal of this dam in decreasing order.

### 2.1.1 Changes in Hydrologic Regime

Any operational or structural changes to the dam will affect the hydrologic regime of the pond and downstream reach of the brook. Affects on the hydrologic regime of the pond for any permanent action would include lower water surface elevations in the pond and backwatered areas upstream from the pond. Temporary operational changes, such as seasonal removal of the stoplogs, would have similar but temporary affects. Changes to the hydrologic regime could therefore affect diversion of water to Maley's Pond for fire fighting and is therefore considered here to represent a significant constraint on restoration actions at this site.

Given that much of the pond has depths of water at the normal pool elevation (e.g., top of stoplog boards) of less than 1 ft, removal of the stoplog boards, which were approximately 2 ft above the upstream invert of the spillway/masonry culvert apron during the June 7, 2011, site visit, would result in dewatering of portions of the impoundment. Observations of the impoundment from a canoe during the site visit and the bathymetric map included as Figure 4 in the ACT Report suggest that removal of the stoplogs would result initially in a stream channel along the right (west) side of most of the impoundment that would flow parallel to the dam and then into the spillway. Whether a channel would remain in this location would depend on subsequent fluvial processes.

While the dam and impoundment may result in some attenuation of peak flows in the downstream reach of the brook, the dam is not managed for flood control; an evaluation of flood control would need to consider both beneficial impacts, such as any reduction in peak flows downstream from the dam, and adverse impacts, including increased potential for flooding of the West Tisbury-Edgartown Road and impacts resulting from dam failure.

Lower water surface elevations in the impoundment would apparently result in lower water levels in the existing emergent and shrub wetland communities upstream from the current head of the impoundment.

### 2.1.2 Fire Fighting Water Supply

The invert elevation of the outlet structure that diverts water to Maley's Pond appears to be relatively shallow and lower water surface elevations in the impoundment could therefore preclude diversion of water into Maley's Pond from Mill Brook and thereby adversely affect the availability of water supply for fire fighting.

### 2.1.3 Aesthetic and Socio-Economic Factors and Community-Outreach

Aesthetic and socio-economic factors are considered to pose a substantial challenge to operational or structural modification to the dam based on the current viewshed and its proximity to the West Tisbury-Edgartown Road. While herbaceous vegetation would likely colonize exposed sediment rapidly following a drawdown of the impoundment in the spring or summer, the resulting viewshed would vary from current conditions.

A suggested community outreach approach is to present information that addresses the benefits that have resulted from other dam removal projects in Massachusetts, including photographs of conditions before and after dam removal. Given that partial dewatering of the impoundment could be achieved by removing the stoplog boards, a "trial" drawdown performed following appropriate regulatory and stakeholder notification may be an appropriate approach to initiating a process intended to foster constructive discussions on the potential long-term benefits of aquatic resource restoration at this site.

Mute swans (*Cygnus olor*) were observed on the impoundment during the site visit, and restoration of Mill Brook through the impoundment could eliminate habitat that is seasonally used by this nonnative invasive species. Potential effects on use of the impoundment by mute swans is considered here to represent an aesthetic and not biological or regulatory constraint because they are a nonnative species in North America.

### 2.1.4 Impoundment Sediments

Impoundment sediments are apparently comprised largely of fine-grained material (i.e., passing the No. 200 sieve) and organic muck, would be subject to remobilization if the impoundment water surface elevation were lowered, and should be evaluated for potential contaminants and mobility prior to implementation of actions intended to permanently alter water surface elevations in the impoundment. This work should include review of previously prepared reports that may include information on potential contaminant sources and/or locations of contaminated sediments.

Recent dam removal projects in Massachusetts and elsewhere in New England indicate that "in-stream management" (e.g., natural erosion and downstream repositioning) of sediments can be an acceptable strategy for management of sediments as part of dam removal projects. Instream sediment management appears to be a potentially appropriate approach at this site pending 1) the evaluation of the amount of material that would be remobilized following; 2) the presence of contaminated materials; and 3) evaluation of the volume of material that would be stabilized in place following colonization by rooted vegetation following a drawdown of the impoundment. This approach would necessitate review of existing information and collection and analysis of sediment samples to evaluate the nature and extent of potential contaminants. The number and location of sediment samples would need to be determined in consultation with relevant regulatory agencies. Recommended evaluations include a due-diligence review of potential sources of contamination in the upstream watershed (to inform a sediment sampling plan), field measurements to refine estimates of impounded sediment volume, and sampling and laboratory analyses of sediment in the impoundment and adjacent reaches of the brook.

#### 2.1.5 Ecological Impacts

Removal of the dam would restore free-flowing riverine conditions and reduce water quality problems (e.g., increased temperature and lower dissolved oxygen concentrations that may result from the apparently eutrophic condition of the impoundment). Resource area delineation and mapping would need to be performed in the future for dam removal permitting. Communication and coordination with the Massachusetts Natural Heritage and Endangered Species Program (NHESP) prior to implementation of any actions is recommended.

#### 2.1.6 Historic Factors

The impoundment appears to have some historical context given the presence of the former mill structure owned by the Martha's Vineyard Garden Club. Coordination and communication with local and state historical commissions (i.e., West Tisbury Local Historical Commission and Massachusetts Historical Commission) prior to implementation of any permanent actions will be required.

## 3.0 DAM REMOVAL APPROACH

This section presents a conceptual approach for actions intended to achieve goals including improved riverine connectivity and free-flowing conditions in Mill Brook at Old Mill Pond Dam. The proposed conceptual approach is based on information presented in Sections 1.0 and 2.0 of this report. The primary constraints on actions intended to achieve the stated goals are changes in the hydrologic regime of the impoundment and resulting impacts to the availability of water for fire fighting.

<u>Coordination with the local fire department is strongly recommended prior to implementation of any actions that would lower water levels in the dam impoundment or affect the supply of water to Maley's Pond.</u>

### 3.1 Conceptual Approaches to Improve Riverine Connectivity and Free-Flowing Conditions

Conceptual approaches to achieve goals, including improved riverine connectivity and free-flowing conditions in Mill Brook at Old Mill Pond Dam, could be accomplished by various means, such as temporary or permanent removal of the stoplog boards from the spillway structure, removal of the spillway structure, and removal of a larger section of the dam. As previously noted, complete removal of the dam is not considered here to be a feasible or appropriate action due to the location of the West Tisbury-Edgartown Road on top of the dam and is therefore not addressed subsequently in this report.

Maintenance of water supply to Maley's Pond as part of any of the approaches evaluated here would need to be evaluated given that the invert of the existing diversion structure is likely above the invert of the spillway structure that discharges to Mill Brook downstream from the dam. If it was determined that water supply to Maley's Pond would need to be maintained following work intended to achieve the project goals, means to maintain this diversion would need to be included in the project design. While the existing channel through the impoundment appears to be immediately adjacent to the right (west) side of the impoundment, and therefore is close to the diversion structure that supplies water to Maley's Pond, it would be necessary to ensure that that stream channel alignment was maintained following project construction. In addition, the elevation of the diversion structure would need to be set below the water surface elevation in the adjacent reach of the channel and may require installation of a new culvert under the West Tisbury-Edgartown Road. A necessary component of this work is evaluation of whether the existing ditch between the impoundment and Maley's Pond is low enough to convey water downstream based on a lower water surface elevation at the point of diversion from the impoundment.

If it were determined that flow into Maley's Pond from Mill Brook would be maintained as part of a restoration action, this would necessarily require that the horizontal and vertical alignment of the restored stream channel be relatively fixed (static) through the impoundment. While design of dam removal projects often include provisions allowing for a channel through former impoundments be allowed to naturally reform, the potential need to provide a consistent flow diversion to Maley's Pond would likely require a fixed channel alignment. This work would likely require construction of instream features, such as stone weirs and/or armored banks intended to maintain the horizontal and vertical alignment of the restored channel.

#### 3.1.1 Removal of Stoplog Boards

Removal of the stoplog boards would lower the water surface of the pond by approximately 2 ft and would result in exposure of sediment in the impoundment. Temporary implementation of this approach has the potential to achieve project goals for improved riverine continuity. This approach could be used to improve upstream passage for fauna that occur seasonally in Mill Brook, such as adult river herring and migrating American eel elver in spring, but long-term benefits of this approach should consider these benefits relative to restoration of riverine habitat by lowering of the spillway as part of removal of the dam. Information provided by Massachusetts Division of Fisheries and Wildlife and Division of Marine Fisheries staff suggests that available spawning habitat for river herring upstream from Old Mill Pond Dam is limited. Temporary removal of the stoplog boards would provide a means to evaluate potential impacts to the availability of fire fighting water from Maley's Pond, as a temporary drawdown of the impoundment is not expected to result in an immediate loss of available water for firefighting from Maley's Pond.

Some work in the brook immediately downstream from the dam may be necessary to improve upstream fish passage through the spillway system under the West Tisbury-Edgartown Road as part of this action. The need and extent of such work would best be determined based on observations by qualified individuals with relevant fish passage experience during a temporary drawdown of the impoundment performed by removing the stoplog boards.

#### 3.1.2 Partial Breaching of the Dam

A partial breach of this dam would require demolition and reconstruction of the spillway and culvert system that passes under the West Tisbury-Edgartown Road to achieve benefits in excess of those that could be achieve by removal of the stoplogs. A typical approach to dam removal is to remove the underlying and adjacent components of the dam to a minimum of at least 1 ft below the downstream channel invert. The Massachusetts Department of Conservation and Recreation (DCR) Office of Dam Safety (ODS) requires that a partial breach of a dam have the hydraulic capacity to convey the 500-year return-interval hydrologic event ("storm") without backwater affects imposed by the breach to render the structure "Non Jurisdictional." Professional judgment is that a breach that would achieve this requirement at this site would need to have a bottom width of at least 20 ft along with sloped banks, and would therefore require a set of culverts or a bridge with a span over the waterway of at least 30 ft.

Construction for dam removal and installation of a culvert system or bridge at this site would result in substantial temporary disturbance to vehicle and pedestrian traffic on the West Tisbury-Edgartown Road. As previously discussed, this work would also likely require installation of measures in the former impoundment if it was determined that flow would need to be maintained to Maley's Pond and potential for additional disturbance to the West Tisbury-Edgartown Road to install a new water diversion system under the road.

### 3.2 Proceeding Directly To Preliminary Restoration Design

Proceeding directly to preliminary restoration design does not appear to be appropriate for this site based on apparent constraints, including potential impacts to fire-fighting water supply, possible local opposition to alteration of the dam impoundment, and the potential to implement a partial drawdown of the impoundment by removing the stoplog boards. As previously noted, even temporary removal of the stoplog boards should be coordinated with the local fire department.

## 4.0 RESTORATION APPROACH, SCOPE, AND PROCESS

The following sections present a suggested approach and studies for potential future work intended to improve ecological function and continuity in Mill Brook based on observations and discussions during the June 7, 2011, site visit, review of available information, and experience with similar projects.

The suggested approach includes the following components:

Phase I. Project Management, Public Outreach, and Preliminary Drawdown Evaluation

Phase II. Preliminary Evaluations, Conceptual Design, and Regulatory Coordination;

Phase III. Preparation of Project Design Materials and Permitting; and

Phase IV. Project Implementation

The following items provide brief descriptions of each phase and specific items that comprise the suggested approach.

### 4.1 Phase I: Project Management, Public Outreach, and Preliminary Drawdown Evaluation

The suggested approach for Phase 1 is for local or municipal stakeholders to collaborate with regional groups and/or agencies (i.e., DER) with experience in dam removal.

Preparation and implementation of a public outreach plan is suggested as the basis for ongoing efforts to achieve improved ecological function and continuity in Mill Brook at Old Mill Pond Dam; this work should be performed by local residents. The goals of Phase 1 include education of local stakeholders and determination as to whether there is enough local support to initiate additional studies. Discussions with the local community, including a presentation by Ms. Beth Lambert of DER on benefits of dam removal, were initiated prior to the preparation of this report. It is recommended that this work continue, and that relevant information on stream restoration and dam removal be made readily available to interested stakeholders. This process could benefit from actions such as placement of information in public areas (e.g.; town buildings, local libraries). It is recommended that a timeline similar to that presented subsequently in this report be incorporated into public outreach work, and that this timeline include clearly defined milestones for actions such as a temporary drawdown of the impoundment.

An important component of Phase 1 is to evaluate the cost of approaches presented in this report relative to costs presented in the ACT Report (e.g., the estimated cost of approximately $500,000 for dredging of the impoundment).

A suggested component of the public outreach program is to implement a temporary drawdown of the impoundment by removing some or all of the stoplogs from the spillway structure. The purpose of this action would be to gain insight regarding potential effects on water supply to Maley's Pond and possible improvements to upstream fish passage at the dam and to provide stakeholders with an opportunity to view the impoundment in a drawn down condition. The timing of a drawdown should consider factors including potential beneficial and adverse impacts to flora and fauna and the expected duration to refill the impoundment if and when the stoplogs are replaced; it is suggested that consideration be given to implementing this action in spring given that flows in the brook would be relatively large, providing the potential to evaluate improvements to upstream fish passage at the dam during the period when adult river herring may be in the brook downstream from the dam.

A suggested component of this phase of work is coordination and communication with the local fire department. The objectives of this work would be to document existing use of the dam impoundment and

Maley's Pond as a water supply for fire-fighting. Information received from the local fire department on the use of these sources should be documented and used to inform latter phases of design development.

## 4.2 Phase II: Preliminary Evaluations, Conceptual Design, and Regulatory Coordination

This section presents a second phase of work presuming that there is appropriate stakeholder support for a proposed action at Old Mill Pond Dam as determined during the Phase 1 work. Suggested work includes preliminary evaluations, conceptual design, and regulatory coordination.

The preliminary evaluations described below are intended to provide information to address constraints described previously in this report.

### 4.2.1 Preliminary Evaluations

Recommended preliminary evaluations include evaluation of fire-fighting water supply from the dam impoundment and Maley's Pond, review of documentation of information obtained from the local fire department during Phase 1, evaluation of potential alternative water supply sources, and evaluation of potential contaminants in the impoundment sediment.

Costs presented in the ATC Report suggest that mechanical removal of sediment from the impoundment would be relatively expensive, and pursuing in-stream sediment management is therefore suggested as a potentially cost-effective approach for actions intended to achieve improved ecological function and continuity in Mill Brook at Old Mill Pond Dam. Given that sediment in the impoundment is largely comprised of fine material, the suggested approach is to obtain sediment samples for laboratory analysis of potential contaminants. Collection of "background" samples in the upstream and downstream reach of the river may also be appropriate. The number of samples used for laboratory analyses should be determined based on regulatory consultation. Reporting on sediment data obtained as part of this work should be prepared in a manner similar to documents prepared for small dam removal projects in Massachusetts, including comparison of laboratory results with contaminant threshold criteria in the Massachusetts Contingency Plan.

### 4.2.2 Conceptual Design Development

Preparation of conceptual design materials, including renderings of proposed actions and descriptions of impacts, such as dewatering and revegetation of portions of the impoundment, is suggested as a means to solicit feedback from stakeholders.

### 4.2.3 Regulatory Consultation

It is recommended that preliminary consultation with local, state, and federal regulatory agencies be initiated as part of this phase to identify site-specific permitting requirements. Consultation with regulatory agencies should include a request for confirmation regarding whether permits would be required for seasonal or permanent removal of stoplogs from the spillway structure.

## 4.3 Phase III: Preparation of Project Design Documents and Permitting

Phase III is for preparation of project design documents and permit applications. The scope of this work would depend upon a selected action following on Phases I and II. Brief descriptions of relevant work are described below; the actual scope of work would depend upon a selected action.

### 4.3.1 Surveying and Mapping

Topographic surveys of the dam and appurtenances would be required for project design and permitting. The suggested extents of topographic survey work is along the entire crest of the dam (approximately 350 ft) from approximately 20 ft into the impoundment on the upstream side of the dam and approximately 50 ft downstream from the dam, for a total area of approximately 1 acre. This survey should include structures that divert water to Maley's Pond. It is suggested that bathymetric data presented in the ACT Report may be appropriate for use as part of the preliminary design and that additional data need not be collected as part of this phase of work.

### 4.3.2 Hydrology and Hydraulics

Existing hydrologic data should be compiled, including data obtained by Kent Healy. Peak flow statistics should be developed using appropriate methods (e.g., regional regression equations). Hydraulic studies should be performed to evaluate the upstream limit of impacts to the waterway, potential sediment mobility following a proposed action, and sizing of a new bridge or culvert under the West Tisbury-Edgartown Road if the dam were to be removed. This work could be performed using a relatively simple, one-dimensional numerical hydraulic model (e.g., HEC-RAS).

### 4.3.3 Delineation of Regulated Natural Resources

The impoundment limit and adjacent natural resources must be delineated along with a review of existing natural resources mapped by the state (e.g., NHESP).

### 4.3.4 Historical Resource Assessment

While evaluation of historical resources does not appear to represent a critical path issue for removal of the spillway section of this dam, any associated work would need to be determined through coordination with relevant resource agencies.

### 4.3.5 Preliminary Engineering Design Plans

This work would include preliminary engineering design for the proposed action.

### 4.3.6 Permitting

Permitting requirements for this site would be similar to those encountered during other dam removal projects in Massachusetts and include local, state, and federal permits. It is assumed that initial coordination with the Town of West Tisbury Conservation Commission would have been performed as part of Phase I. Required permit applications and regulatory coordination for dam removal may include an Expanded Environmental Notification Form (EENF) under the Massachusetts Environmental Policy Act (MEPA); a Notice of Intent (NOI) under the Wetlands Protection Act and West Tisbury Wetlands Protection Bylaw; applications for 401 and 404 permits to Mass DEP and the Army Corp of Engineers, respectively; a Project Notification Form submitted to the Massachusetts Historical Commission (and any subsequent, required coordination); a Chapter 253 permit application to the Office of Dam Safety; and, potentially, a Chapter 91 Waterways Permit from Mass DEP. This work would include preparation and submittal of permit applications. If a proposed dam removal approach included disposal or reuse of concrete, bricks, asphalt or other masonry materials not exempt from requirements for solid waste regulations, a Beneficial Use Determination (BUD) permit may be required. The project is located with Massachusetts Coastal Zone and will likely require Federal Consistency Review by the Office of Coastal Zone Management.

If the dam owner intends to perform routine maintenance on the dam and/or investigate the potential to improve fish passage by removal of the stoplog boards, a Request for Determination of Applicability (RDA) would need to be submitted to the Conservation Commission, which could respond with a Positive or Negative Determination; if a Negative Determination is issued, no further action would be required for compliance with the Wetland Protection Act. If a Positive Determination is issued, the Conservation Commission will require submittal of a Notice of Intent and issuance of an Order of Conditions prior to removal of stoplog boards. If required, a Notice of Intent would need to address identified resource area impacts, including sediment quantity, quality, and expected mobility under a proposed condition.

#### 4.3.7 Final Engineering Design Plans

Suggested engineering design documents include erosion and sediment control; site access, staging and storage; existing and proposed conditions plans; and post dam-removal site restoration plans.

### 4.4 Phase IV: Implementation

Required work for project implementation will depend upon the selected alternative, including any required mitigation. Note that this work could include development of alternative water supply sources for fire-fighting.

## 5.0 PROJECT SCHEDULE, AND OPINION OF PROBABLE COST

Table 1 provides a conceptual approach, schedule, and an Opinion of Probable of Cost (OPC) for work associated with removal of the spillway structure and installation of a new culvert or small bridge. The OPC includes costs for preparation of design materials, permitting, construction bidding, construction, and construction observation and managements. The conceptual schedule assumes that funding for project studies and implementation is readily available.

## 5.1 Discussion of Expected Costs

Following is a discussion of expected costs for actions including 1) repair of the dam and ongoing maintenance and management of the impoundment; 2) removal of the dam; and 3) removal of the stoplogs.

### 5.1.1 Repair of Dam and Maintenance of the Impoundment

While the dam appears to be in reasonably good condition and therefore does not appear to be in need of imminent repair, the ACT Report presents costs for a range of options for management of the impoundment. The cost estimate presented in the ACT report for dredging of the impoundment is approximately $500,000.

### 5.1.2 Removal of Spillway Structure and Installation of a New Culvert or Small Bridge

The OPC for this action as presented in Table 1 of this report is $558,000 and is therefore similar to the estimate cost for dredging of the impoundment.

### 5.1.3 Removal of Stoplogs

Removal of the stoplogs could apparently be implemented for minimal costs (less than $25,000). This action is considered here to represent a reasonable means for evaluating subsequent potential actions intended to improve ecological function and continuity in Mill Brook.

**Table 1: Project Timeline and Opinion of Probable Cost**

| | Year/Quarter | | | | | | | | | | | | Costs | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | Year 1 | | | | Year 2 | | | | Year 3 | | | | | | |
| **Work Item** | 1 | 2 | 3 | 4 | 1 | 2 | 3 | 4 | 1 | 2 | 3 | 4 | Coordination and Design | Construction | Construction Oversight |
| **Phase I: Project Management, Public Outreach, and Preliminary Drawdown Evaluation** | | | | | | | | | | | | | | | |
| *Project Management* | | | | | | | | | | | | | $15,000 | | |
| **Phase II: Preliminary Evaluations, Conceptual Design, and Regulatory Coordination** | | | | | | | | | | | | | | | |
| *Preliminary Evaluations* | | | | | | | | | | | | | $10,000 | | |
| *Conceptual Design Development* | | | | | | | | | | | | | | | |
| *Evaluation of Fire-Fighting Water Supply* | | | | | | | | | | | | | $5,000 | | |
| *Sediment Sampling and Analyses* | | | | | | | | | | | | | $10,000 | | |
| *Regulatory Consultation* | | | | | | | | | | | | | $5,000 | | |
| **Phase III: Preparation of Project Design Materials and Permitting** | | | | | | | | | | | | | | | |
| *Surveying and Mapping* | | | | | | | | | | | | | $7,500 | | |
| *Hydrology and Hydraulics* | | | | | | | | | | | | | $7,500 | | |
| *Delineation of Regulated Natural Resources* | | | | | | | | | | | | | $8,000 | | |
| *Historic Resource Assessment.* | | | | | | | | | | | | | $10,000 | | |
| *Preliminary Engineering Design Plans* | | | | | | | | | | | | | $50,000 | | |
| *Permitting* | | | | | | | | | | | | | $40,000 | | |
| *Engineering Design Plans* | | | | | | | | | | | | | $20,000 | | |
| **Phase IV: Project Implementation** | | | | | | | | | | | | | | | |
| *Construction Bidding* | | | | | | | | | | | | | | $5,000 | |
| *Removal of Spillway and Bridge/Culvert Construction* | | | | | | | | | | | | | | $350,000 | $25,000 |
| | | | | | | | | | | | | **Subtotals:** | **$188,000** | **$355,000** | **$25,000** |
| | | | | | | | | | | | | | | | ***Total: $568,000*** |

# APPENDIX A
# Site Photographs

**Photo 1: Spillway Structure from Upstream**

**Photo 2: Left Stoplog Bay in Spillway ("fishpass" is visible on the near-side of the stoplog bay)**

**Photo 3: Spillway Culvert under West Tisbury-Edgartown Road**

**Photo 4: View Upstream through Left Spillway Culvert under West Tisbury-Edgartown Road (note "fishpass" on left side of image)**

**Photo 5: Impoundment, Dam, Overlying Roadway, and Garden Club Building from right side of the Impoundment**

**Photo 6: Impoundment from Dam**

**Photo 7: Dam (background) from Upstream Limit of Impoundment**

**Photo 8: Vegetation in Impoundment (note relatively shallow water in foreground)**

**Photo 9: Diversion Weir Downstream from Scotchman's Lane**

**Photo 10: Diversion Structure in Old Mill Pond Dam Impoundment to Maley's Pond**

# APPENDIX B
# Phase 1 Report

MILL POND DAM

PHASE I

INSPECTION / EVALUATION REPORT

Dam Name: MILL POND DAM
State Dam ID #: 7-4-327-1
NID #: MA02480
Owner: Town of West Tisbury
Owner Type: Municipal
Town: West Tisbury, Mass.
Consultant: Kent A. Healy PE
Date of Inspection: August 30, 2006 - October 30, 2006

## Executive Summary

The Mill Pond Dam in West Tisbury was inspected between August 30, 2006 and October 30, 2006 by Kent A. Healy PE. Dr. Healy is a civil engineer, a resident of West Tisbury, and has 30 years of dam engineering experience.

The Mill Pond Dam was originally constructed as an earth embankment across The Mill Brook in the seventeen hundreds. A concrete culvert bypass to Factory Brook and a main concrete sluiceway with timber plank stop logs was constructed in the 1940's, and the West Tisbury-Edgartown road along the dam crest was paved. The dam is in good condition. There is minor erosion due to road runoff at several areas on the downstream face that should be armored. The water level and stream flow have been continuously monitored since 1993 and the vegetation on the upstream face has been cut yearly. A phase 1 inspection of the dam was completed by GZA in 1995. In 2002, The Office of Dam Safety carried out a hydrologic analysis of the Mill Brook water shed for an evaluation of Priester's Pond Dam, upstream of Mill Pond. A study of the Mill Brook water shed was completed by Kent A. Healy in 2005 and additional field measurements of the elevations of the dam crest and west bank of the pond were done for this Phase 1 hydrologic analysis of Mill Pond Dam.

Measurement of rain on the water shed and monitoring of the water levels and stream flow should continue, the areas of erosion should be armored and the brush on the downstream face should be cut to facilitate inspection.

## Dam Evaluation Summary Detail Sheet

| | | |
|---|---|---|
| **1. NID ID:** MA02480 | **2. Dam Name:** MILL POND DAM | **3. Dam Location:** WEST TISBURY |
| **4. Inspection Date:** 8/30/06-10/30/06 | **5. Last Insp. Date:** 1995 | **6. Next Inspection:** 2011 |
| **7. Inspector:** Kent A. Healy | **8. Consultant:** Kent A. Healy, PE | |
| **9. Hazard Code:** Significant (Class 2) | **10. Insp. Frequency:** Significant-5 Yrs. | **11. Insp. Condition:** Satisfactory |

| | | | |
|---|---|---|---|
| **E1. Design Methodology:** | 1 | **E7. Low-Level Discharge Capacity:** | 3 |
| **E2. Level of Maintenance:** | 2 | **E8. Low-Level Outlet Physical Condition:** | 4 |
| **E3. Emergency Action Plan:** | 2 | **E9. Spillway Design Flood Capacity:** | 5 |
| **E4. Embankment Seepage:** | 5 | **E10. Overall Physical Condition of the Dam:** | 4 |
| **E5. Embankment Condition:** | 5 | **E11. Estimated Repair Cost** (in thousand $): | |
| **E6. Concrete Condition:** | 5 | | |

### Evaluation Description

**E1: DESIGN METHODOLOGY**
1. Unknown Design – no design records available
3. Some standard design features
5. State of the art design – design records available

**E2: LEVEL OF MAINTENANCE**
1. No evidence of maintenance, no O&M manual
2. Very little maintenance, no O&M manual
3. Some level of maintenance and standard procedures
4. Adequate level of maintenance and standard procedures
5. Detailed maintenance plan that is executed

**E3: EMERGENCY ACTION PLAN**
1. No plan or idea of what to do in the event of an emergency
2. Some idea but no written plan
3. No formal plan but well thought out
4. Available written plan that needs updating
5. Detailed, updated written plan available and filed with MADCR

**E4: EMBANKMENT SEEPAGE**
1. Severe piping and/or seepage with no monitoring
2. Evidence of monitored piping and seepage
3. No piping but uncontrolled seepage
4. Controlled seepage
5. No seepage or piping

**E5: EMBANKMENT CONDITION**
1. Severe erosion and/or large trees
2. Significant erosion or significant woody vegetation
3. Brush and exposed embankment soils, or moderate erosion
4. Unmaintained grass, rodent activity and maintainable erosion
5. Well maintained healthy uniform grass cover

**E6: CONCRETE CONDITION**
1. Major cracks, misalignment, discontinuities causing leaks, seepage or stability concerns
2. Cracks with misalignment inclusive of transverse cracks with no misalignment
3. Significant longitudinal cracking and minor transverse cracking
4. Spalling and minor surface cracking
5. No apparent deficiencies

**E7: LOW LEVEL OUTLET DISCHARGE CAPACITY**
1. No low level outlet
2. Outlet with insufficient drawdown capacity
3. Inoperable gate with potentially sufficient drawdown capacity
4. Operable gate with sufficient drawdown capacity
5. Operable gate with capacity greater than necessary

**E8: LOW LEVEL OUTLET PHYSICAL CONDITION**
1. Outlet inoperative needs replacement, non-existent or inaccessible
2. Outlet inoperative needs repair
3. Outlet operable but needs repair
4. Outlet operable but needs maintenance
5. Outlet and operator operable and well maintained

**E9: SPILLWAY DESIGN FLOOD CAPACITY**
1. 0 - 20% of the SDF
2. 21- 40% of the SDF
3. 41- 60% of the SDF
4. 61- 80% of the SDF
5. 81- 100% of the SDF

**E10: OVERALL PHYSICAL CONDITION OF THE DAM**
1. *UNSAFE* – Major structural, operational, and maintenance deficiencies exist under normal operating conditions
2. *POOR* - Significant structural, operation and maintenance deficiencies are clearly recognized under normal loading conditions
3. *FAIR* - Significant operational and maintenance deficiencies, no structu deficiencies. Potential deficiencies exist under unusual loading conditic that may realistically occur. Can be used when uncertainties exist as to critical parameters
4. *SATISFACTORY* - Minor operational and maintenance deficiencies. Infrequent hydrologic events would probably result In deficiencies.
5. *GOOD* - No existing or potential deficiencies recognized. Safe performa is expected under all loading including SDF

**E11: ESTIMATED REPAIR COST**
Estimation of the total cost to address all identified structural, operational, maintenance deficiencies. Cost shall be developed utilizing standard estimating guides and procedures

## Changes/Deviations to Database Information since last inspection

1. Measured 100 year rainfall event, reduced SDF from 1800 cfs to 150 cfs
2. Reevaluation of watershed, reduced area from 6.7 sq. mi. to 3.1 sq. mi.
3. Field measurments reduced dam height from 6' to 5.5' and storage from 60 ac.ft. to 30 ac.ft.
4. Spillway capacity was estimated in 1995 to be 75 cfs. Measured spillway flow indicated capacity to be 270 cfs.

# PREFACE

The assessment of the general condition of the dam is based on available data and visual inspections. Detailed investigations and analyses involving topographic mapping, subsurface exploration, testing and detailed computational evaluations are beyond the scope of this report.

The reported condition of the dam is based on observations of field conditions during the inspection, along with data available to the inspection team.

The safety of the dam depends on numerous and constantly changing internal and external conditions. It would be incorrect to assume that the present condition of the dam will continue. Only through continued care and inspections can unsafe conditions be detected.

Kent A. Healy ScD, PE Mass. #28498

Kent A. Healy PE

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FIGURES



APPENDICES



ATTACHMENTS

SECTION 1

# 1.0 DESCRIPTION OF PROJECT

## 1.1 General

### 1.1.1 Authority

The Town of West Tisbury has retained Kent A, Healy PE to perform a visual inspection and develop a report of conditions of The Mill Pond Dam on Mill Brook in West Tisbury, Massachusetts. This inspection and report were performed in accordance with MGL Chapter 253, Sections 44-50 of the Massachusetts General Laws as amended by Chapter 330 of the Acts of 2002.

### 1.1.2 Purpose of the Work

The purpose of this investigation is to inspect and evaluate the present condition of the dam and appurtenant structures in accordance with 302 CMR 10.07, to provide information that will assist in prioritizing dam repairs and planning/maintenance.

The investigation is divided into four parts, 1) obtain and review available reports, investigations and data previously submitted to the owner pertaining to the dam and appurtenant structures; 2) visually inspect the site; 3) evaluate the status of an emergency action plan and; 4) prepare a final report with an evaluation of the structure, recommendations for remedial actions, and an estimate of costs of those actions.

### 1.1.3 Definitions

Definitions of commonly used terms associated with dams are provided in Appendix D under common categories associated with dams which include 1) orientation; 2) dam components; 3) size classification ; and 4) hazard classification

## 1.2 Description of Project

### 1.2.1 Location

The Mill Pond Dam is at North 41 degrees-22.95 minutes and West 70 degrees- 40.30 to 40.40 minutes, about 500 feet east of intersection of South Road and the West Tisbury-Edgartown Road which runs along the crest of the dam. The dam impounds the water of Mill Brook to form Mill Pond.

### 1.2.2 Owner/ Operator

The West Tisbury Board of Selectmen, PO Box 278, West Tisbury, Mass. 02575, is responsible for the operation and maintenance of the dam. The daytime phone of the board is 1-508-696-0102.

### 1.2.3 Purpose of the Dam

The dam forms Mill Pond which is used for recreation.

### 1.2.4 Description of the Dam and Appurtenances

Mill Pond Dam is an earth embankment approximately 280 feet long, 5 ½ feet high and 50 feet wide with a paved roadway, the West Tisbury-Edgartown Road along it's crest. The main spillway is a double concrete sluiceway with timber stoplogs and concrete training walls that was constructed about 50 years ago upstream of the double stone culvert when the road was widened. The dam has a small spillway located near the right abutment with the water entering a 16" diameter corrugated plastic pipe feeding Factory Brook and a fire pond.

### 1.2.5 Operation and Maintenance

The West Tisbury Board of Selectmen is responsible for the operation and maintenance of the dam.
The spillways are left alone except for replacement of stoplogs as needed. The brush is cut yearly on the upstream face.

### 1.2.6 DCR Size Classification

Mill Pond Dam has a maximum structural height of approximately 5 ½ feet, as measured during this inspection, and a maximum storage capacity of 13.5 acre-feet, based on water depths measured during this inspection. Therefore, in accordance with The Department of Conservation and Recreation Office of Dam Safety classification, under Commonwealth of Massachusetts dam safety rules and regulations stated in CMR 10.00, as amended by Chapter 330 of the Acts of 2002, Mill Pond Dam is a Non Jurisdictional size structure.

### 1.2.7 DCR Hazard Classification

Mill Pond Dam is located upstream of Tisbury Great Pond. It appears that a failure of the dam at maximum pool may damage the West Tisbury-Edgartown Road, therefore in accordance with Department of Conservation and Recreation classification procedures, under Commonwealth
Of Massachusetts dam safety rules and regulations stated in 302 CMR 10.00 as amended by Chapter 330 of the Acts of 2002, Mill Pond Dam is classified as a significant hazard.

## 1.3 Pertinent Engineering Data

### 1.3.1 Drainage Area

The drainage area for the Mill Brook down to Mill Pond is approximately 3.1 square miles and extends through the communities of West Tisbury and Chilmark. The Author has, since 1990, studied the surface water and ground water contributions to Tisbury Great Pond as part of a continuing study, with The Martha's Vineyard Commission, of the hydrology of the Pond. This study involved continuous measurement of the flow of the Tiasquam River and the Mill Brook, and test holes to determine the elevation and flow direction of groundwater and ground characteristics of the water sheds. The surface water sheds and ground water sheds are shown in figure 5. As Mill Brook flows from Priester's Pond to Mill Pond across the sand and gravel outwash plain, water leaks from the brook down into the ground water and rain that falls on this area does not contribute to stream flow, no matter the antecedent weather. The stream flow derives from rain that falls on the approximately 1980 acres (3.1 square miles) upstream of Priester's Pond. This area is largely wooded with a significant portion in conservation. As a result, the runoff coefficient, as measured during the last 15 years, is quite low.

### 1.3.2 Reservoir

Normal Pool; Length - 460 feet; Width - 240 feet; Surface elevation - +12.2 USGS Datum;
Average depth – 2.0 feet; Area –2.5 acres; Storage Volume – 5.0 acre feet.

Maximum Pool; Length – 1000 feet; Width – 300 feet; Surface Elevation - +14.7 USGS Datum;
Average depth – 4.5 feet; Area – 7.0 acres; Storage Volume – 31.5 acre feet.

### 1.3.3 Discharges at the Dam Site

The largest stream flow during the last 20 years ( 1986 to 2006) occurred at about 7 AM June 14, 1998 after about 7 inches of rain fell on the Mill Brook water shed from 4 to 9 PM June 13, 1998. The peak flood flow of (main spillway 110 cfs and the Factory Brook spillway 20 cfs) about 130 cfs occurred at a pond surface elevation of +13.9 USGS Datum.

### 1.3.4 General Elevations (feet) USGS Datum.

A. Top of Dam +14.6 to +15. 7
B. Spillway Design Flood Pool –
C. Normal Pool +12.2
D. Spillway Crest +12.0
E. Upstream water at Time of Inspection +12.2
F. Streambed at Toe of the Dam +9.3
G. Low Point along the Toe of the Dam + 10

#### 1.3.5 Main Spillway

A. Type; Double Concrete Sluiceway with 2” thick plank stop logs
B. Length; two 5 feet = 10 feet
C. Invert Elevation; +10.0 USGS
D. Upstream Channel; +10.0
E. Downstream Channel; +9.3
F. Downstream Water; +9.5

#### 1.3.6 Secondary Outlet

The secondary outlet to Factory Brook is a board weir across a 16” diameter culvert pipe with the crest at +12.0

#### 1.3.7 Design and Construction Records

There are no construction records for the dam.

#### 1.3.8 Operating Records

The pond surface elevation has been recorded continuously since 1993 by Kent A. Healy PE of West Tisbury, but there are no other records available.

## SECTION 2

## 2.0 INSPECTION

### 2.1 Visual Inspection

The Mill Pond Dam was inspected in October and November of 2006. During that time the weather was generally fair with no extreme weather events. Photographs were taken and are included in Appendix A.

#### 2.1.1 General Findings

The Mill Pond Dam was found to be in satisfactory condition.

#### 2.1.2 Dam

The upstream slope is covered with rip rap at the normal pool elevation and low brush which provide protection from ice and wave damage. A walking path between the rip rap and the highway guard rail is without grass cover but is stable. The crest of the dam is a 24’ wide asphalt pavement in good condition. The downstream slope has a good grass cover. The downstream slope adjacent to the main spill way channel and the Factory Brook channel is overgrown with brush making inspection difficult. The old mill building in the middle of the downstream slope is in good condition with stable stone and brick foundation and concrete slab.

### 2.1.3 Appurtenant Structures

The main Spillway is a double concrete sluiceway with slots for wood plank spillways that was constructed more than 50 years ago up stream of the double stone culverts. The concrete and stone are in good condition and have sustained heavy traffic with no sign of distress. The secondary outlet to Factory Brook was repaired in 2000 with a new 16" plastic culvert pipe and wood spillway structure leading to the 4' diameter concrete pipe which is in good condition. The down stream channel is overgrown with brush,
The dike along the west side of the pond was constructed when the pond was dredged in the 40's and 50's and is about 30 feet wide with the top of the dike at about elevation +14.5. The top of the dike is mowed for recreation and is stable with small trees growing along the sides.

### 2.1.4 Downstream Area

The discharge channel for the main spillway is the original stream bed that meanders down through one thousand feet of wetland into Town Cove at the head of Tisbury Great Pond. The area 50 to 100 feet downstream of the dam is kept clear by The MV Garden Club and is a stable grassed area about one foot above the stream bottom. The sluice way for the under shot water wheel in the mill building was filled in many years ago and a concrete slab cast in the building floor. There are several drain pipes coming from under the building that flow to the down stream channel but there is no sign of piping or erosion. Factory Brook flows in to Maley's Pond that serves as a fire pond, then out to the Town Cove.

### 2.1.5 Reservoir Area

Mill Pond is formed by the roadway embankment across the southern end, a stable 30 foot wide berm along the western side, a 1 on 3 upslope along the eastern side and a wetland at the northern end. The pond was never very deep to start with and now has about 2 feet of water surrounded by wetland vegetation along the edges. Scotchmans Lane, a paved town road across the wetland north of the pond, is a about elevation +20, well above the pond.

## 2.2 Caretaker Interview

There is no assigned caretaker

2.3 There are no operation or maintenance procedures.

2.4 There is no emergency action plan

## 2.5 Hydrologic/Hydraulic Data

The Mill Pond Dam is 5 ½ feet high with a flood storage volume of about 32 acre feet and is non-jurisdictional in the CMR Size Classification Table. However because a secondary roadway runs along the crest of the dam and failure of the dam would interrupt roadway use, the Mill Pond Dam is significant hazard in the CMR Hazard Potential Classification Table and the spillway should carry a 100 year flood flow.

The 100 year flood flow was calculated in the 1987 and 1995 inspection reports by multiplying a drainage area taken from a USGS Quadrangle map and multiplying that area (6.7 square miles) times a preliminary guidance quantity of 1350 CFS/ square mile giving a probable maximum flood (PMF) flow of 9000 CFS. The 100 year flood flow was taken as 1/5 of the PMF. This calculation gave too large a 100 year flow for two reasons. The actual water shed area is only 3.1 square miles because of the out wash deposits, and the actual runoff is much less than 1350 CFS/square mile because of the large area of wetland and woodland in the water shed, see figure 5.

The 100 year rain fall, per the updated 1993 report from the Northeast Regional Climate Center at Cornell University, is 9.0 inches in 24 hours. A 6 hour, 100 year rainfall would be about 6.0 inches. The later would be more appropriate given the approximately 12 hour time of concentration of the Mill Pond watershed. On June 13, 1998 from 4 to 9 PM, about 6 inches of rain fell on the Mill Pond watershed, as measured by a rain gauge in Chilmark and the authors rain gauge in West Tisbury, resulting in a peak flow at 7 AM, June 14 of 110 CFS over the main spillway and 20 CFS through the Factory Brook outlet, both as measured by the author with flow velocity meter. The elevation of the pond surface a peak flow was +13.9 ft USGS datum. That flow therefore represents the 100 year flow and the existing spillway capacity is sufficient for the design flood. A photograph of the flow is shown in Appendix B. The capacity of the main spill way at a pond elevation of the lowest elevation of the dam crest (+14.6) would probably be about 250 CFS. A storm water modeling and hydrologic analysis of Mill Brook at Priester's Pond, by David Clark 1/10/02, of The DEM, indicated that the 100 year flood flow would be 164 CFS, much closer to the flow measured 6/14/98 than the 1987 and 1995 estimates.

## 2.6 Structural Stability/Overtopping Potential

### 2.6.1 Structural Stability

The low height to base width ratio (5: 50) and the flat 1:3 slope of the downstream face results in a static factor of safety of more than 5 . The long term use of this roadway by heavy trucks and equipment has vibrated the embankment enough to preclude the possibility of liquefaction. Failure of the dam would occur only from several days of overtopping and the resulting erosion of the crest.

### 2.6.2 Overtopping Potential

A significantly greater rainfall than a 100 year storm would result in overtopping of the dam at the west end near the Factory Brook outlet. At a pond elevation of +15.5, the overtopping flow would be about 100 feet x one foot of overtopping x 5 feet per second or about 500 CFS, about 4 times the 100 year flood flow or close to the maximum possible. The overtopping while certainly causing some erosion on the downstream face it would not washout the road and would not damage the old mill building.

## SECTION 3

## 3.0 ASSESSMENTS AND RECOMMENDATIONS

### 3.1 Assessments

In general the overall condition of the Mill Pond Dam is satisfactory. This is in agreement with the 1995 report rating the Mill Pond Dam in fair to good condition. The outlet to Factory Brook was repaired in 2000 and the upstream dam face has been brush cut more frequently. The foundation of the old mill building is in excellent condition and the road along the crest has been repaved.

The recommendations from the 1995 report are discussed as follows.

1. An operation and maintenance manual has not been developed but should be.
2. A seismic stability analysis has not been done but a simple one could be done using a lateral acceleration of 0.1.
3. The author thinks that the minor seepage under the old mill building is from drains that were installed when the concrete slab was constructed and the very low piping ratio of 2 feet of head over 50 feet of base width precludes failure from internal erosion.
4. The 100 year rainfall in 1998 showed that the existing spillway is adequate for that flow. Careful measurement of the dam crest show that a flow five times the 100 year flood would cause overtopping at the west end of the dam where a natural emergency spillway occurs and that only minor erosion would occur because of the flat and well vegetated downstream slope.
5. An emergency action plan showing an alternate travel route in case of flooding would be appropriate. No other downstream damage is anticipated within the extensive wetland at the head of Tisbury Great Pond.

The major recommendation of this report is that the high brush all along the downstream face of the dam be cut to allow inspection and that the areas of potential erosion from road runoff be protected with asphalt aprons. A perennial maintenance permit should be obtained from the West Tisbury Conservation Commission for this work.

### 3.2 Studies and Analysis

This report recommends that 1) A simple static and seismic stability analysis of the dam be done. 2) An operation and maintenance manual be developed and 3) An emergency action plan for an alternate travel route be prepared by The West Tisbury Emergency Planning Group. The engineering stability analysis would cost about $5000.

### 3.3 Yearly Recommendation

The brush on the upstream and downstream faces should be cut yearly and the condition of the spillway planks be determined and replaced if necessary. The annual cost would be about $2000.

### 3.4 Recommendations, Maintenance and Minor Repairs

There are no recommendations to improve the overall condition of the dam.

### 3.5 Remedial Measures

There are no recommendations for modification of the dam.

### 3.6 Probable Construction Costs

The annual cost of recommended analyses and maintenance would be $3000.

FIGURE 1.
GIS Locus Plan

MILL POND, WEST TISBURY, MASS.
1" = 800' ± 20'

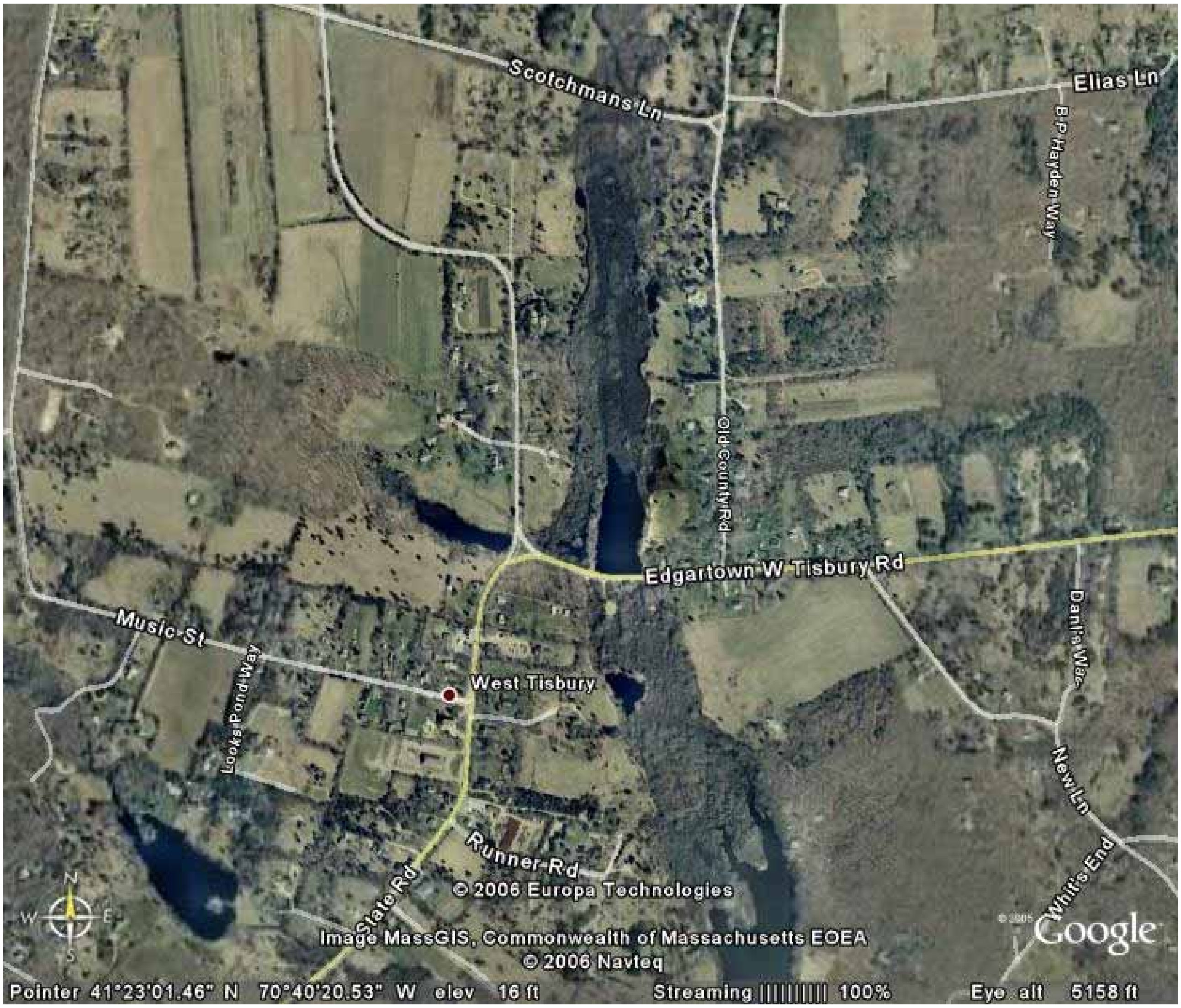

FIGURE 2
Site Plan
MILL POND, WEST TISBURY, MASS.

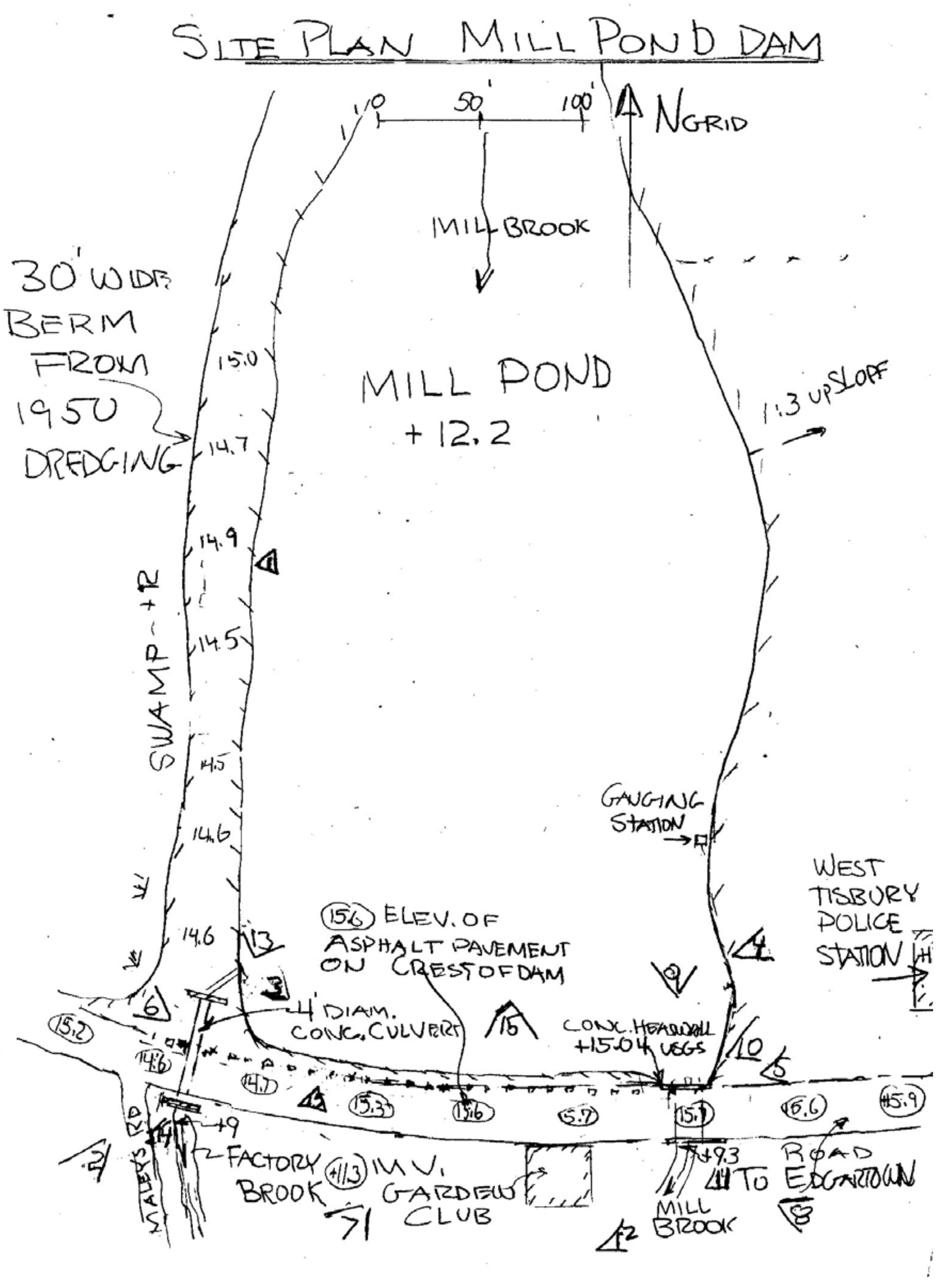

FIGURE 3
MAIN SPILLWAY, MILL POND, WEST TISBURY, MASS.

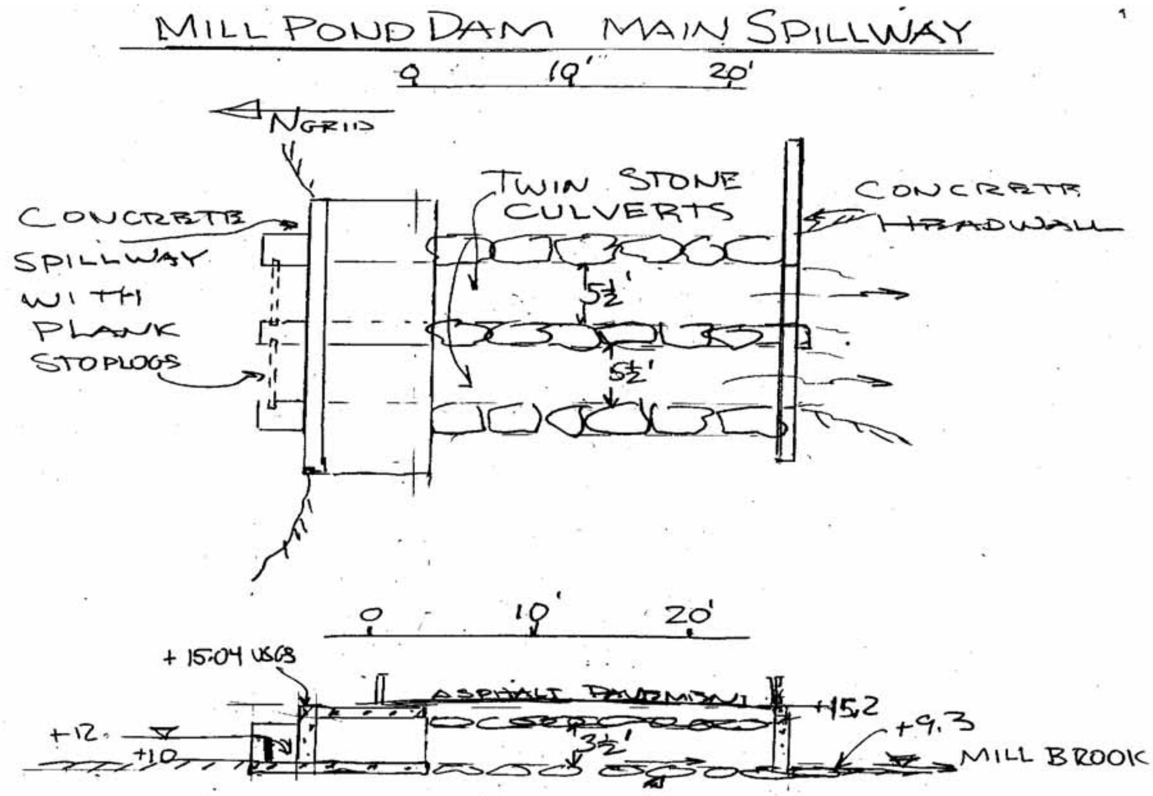

FIGURE 4
EMBANKMENT CROSS SECTIONS, MILL POND, WEST TISBURY, MASS

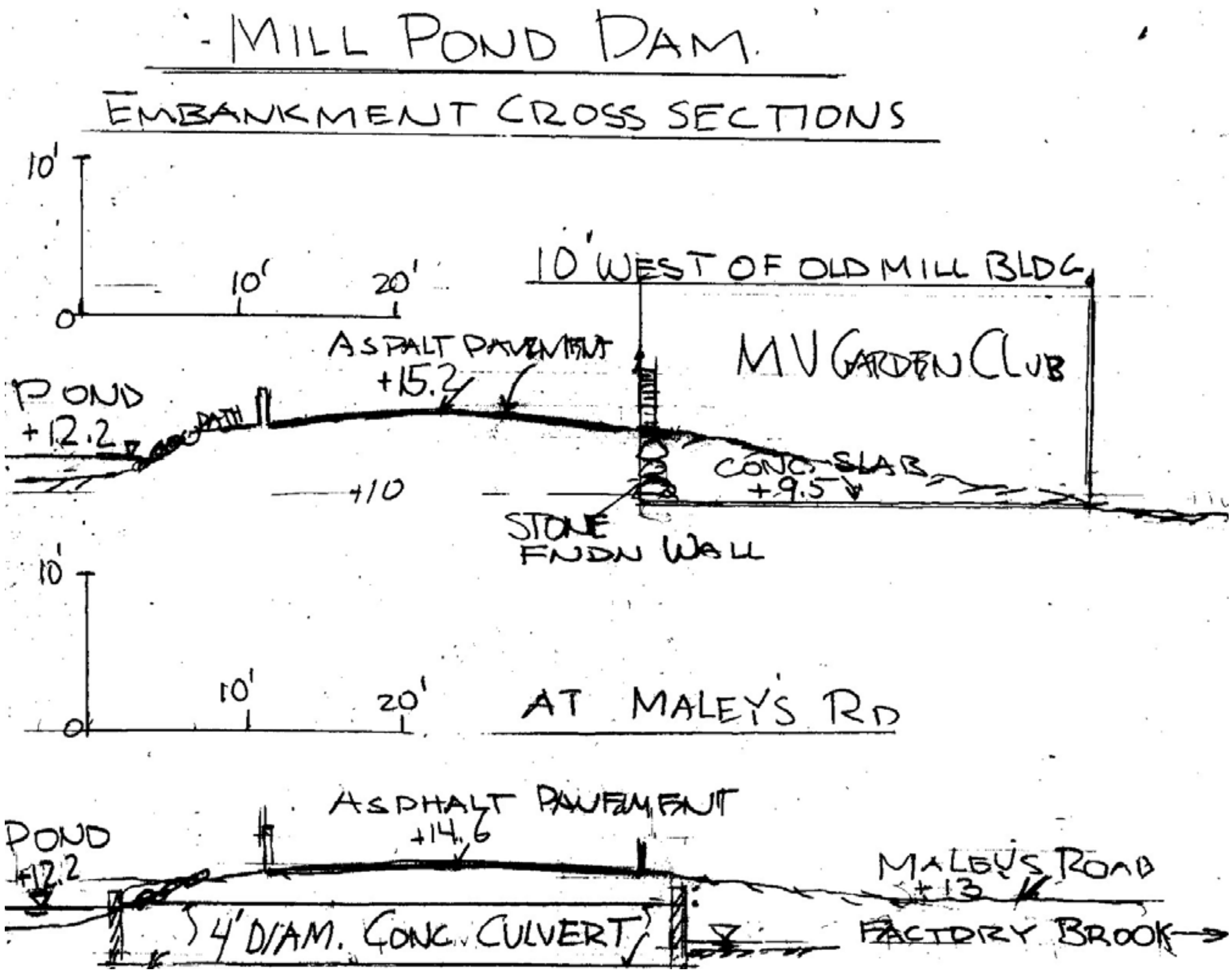

FIGURE 5
MILL BROOK WATERSHED, WEST TISBURY, MASS

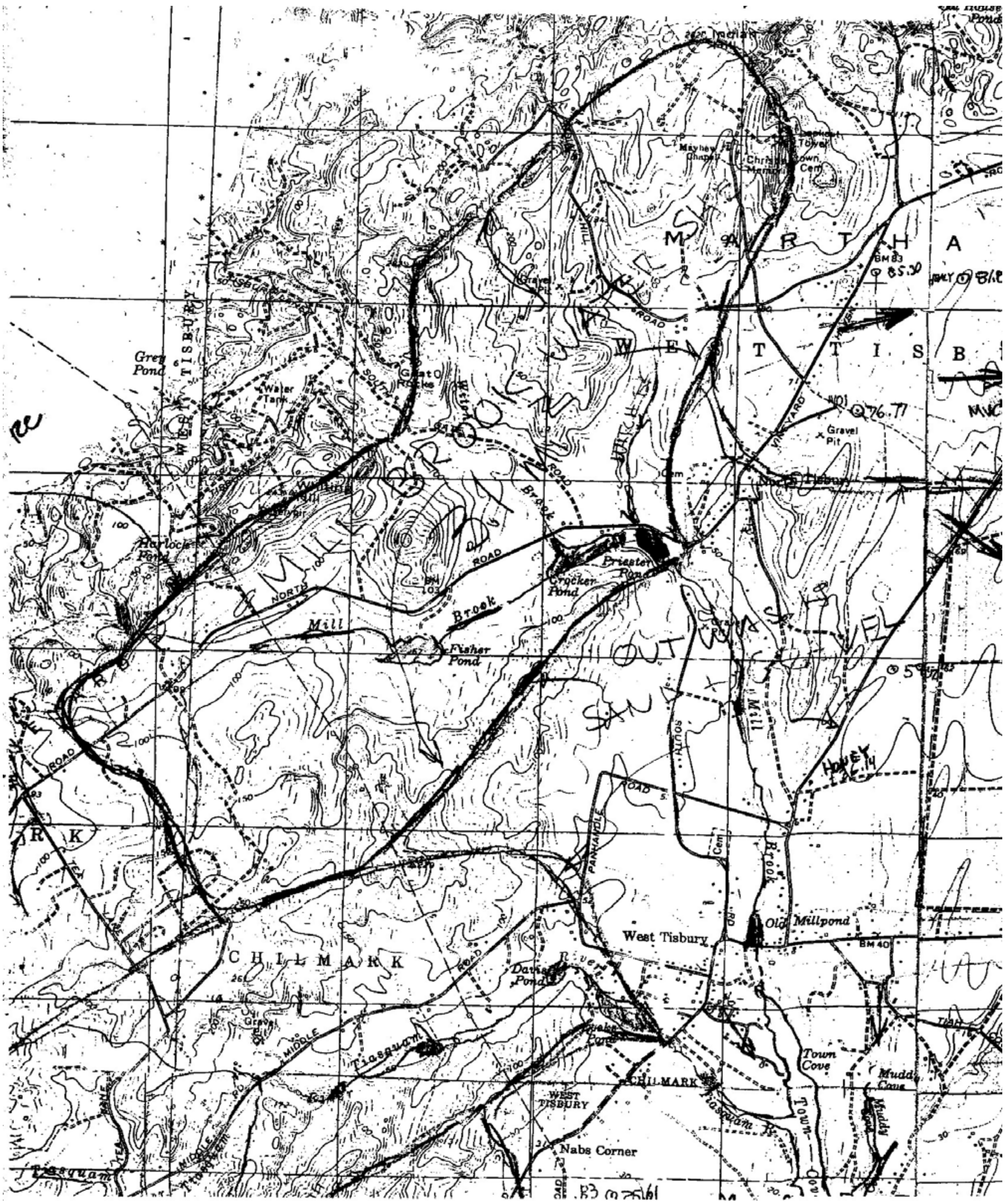

PHOTO 1 Overview of Dam from Upstream

PHOTO 2 Overview of Dam from Downstream

PHOTO 3 Overview of upstream Face from Right Abutment

PHOTO 4 Overview of up stream Face from Left Abutment

PHOTO 5 Overview of Dam Crest from Right Abutment

PHOTO 6 Overview of Dam Crest from Left Abutment

PHOTO 7    Overview of downstream Face from Right Abutment

PHOTO 8    Overview of downstream face from Left Abutment

PHOTO 9 Overview of Spillway

PHOTO 10 Overview of Weir

PHOTO 11 Overview of downstream Channel

PHOTO 12 Overview of downstream Channel

PHOTO 13 Inlet (Factory Brook)

PHOTO 14 Discharge to Factory Brook

PHOTO 15    Overview of Reservoir

PHOTO 16    June 14, 1998    Flow at 110 cfs.

# DAM SAFETY INSPECTION CHECKLIST

| | | | |
|---|---|---|---|
| NAME OF DAM: | MILL POND DAM | STATE ID #: | 7-4-327-1 |
| REGISTERED: | ☑ YES ☐ NO | NID ID #: | MA 02480 |
| STATE SIZE CLASSIFICATION: | NON-JURISDICTIONAL | STATE HAZARD CLASSIFICATION: | SIGINIFICANT II |

*LOCATION INFORMATION*

| | | | |
|---|---|---|---|
| CITY/TOWN: | WEST TISBURY | COUNTY: | DUKES |
| DAM LOCATION: | 500' EAST OF SOUTH ROAD | AKA NAME: | |
| USGS QUAD.: | VINEYARD HAVEN | LAT.: | N 41-22.95 |
| | | LONG.: | w70-40.30 |
| DRAINAGE BASIN: | MILL BROOK | RIVER: | MILL BROOK |
| IMPOUNDMENT NAME(S): | MILL POND | | |

*GENERAL DAM INFORMATION*

| | | | |
|---|---|---|---|
| TYPE OF DAM: | EARTH EMBANKMENT | OVERALL LENGTH (FT): | 280' |
| PURPOSE OF DAM: | RECREATION POND | NORMAL POOL STORAGE (ACRE-FT): | 5 |
| YEAR BUILT: | 1700's | MAXIMUM POOL STORAGE (ACRE-FT): | 31.5 |
| STRUCTURAL HEIGHT (FT): | 5.3 | EL. NORMAL POOL (FT): | 12.2' USGS |
| HYDRAULIC HEIGHT (FT): | 2 | EL. MAXIMUM POOL (FT): | 14.7' |

*FOR INTERNAL MADCR USE ONLY*

FOLLOW-UP INSPECTION REQUIRED: ☐ YES ☐ NO　　CONDITIONAL LETTER: ☐ YES ☐ NO

NAME OF DAM: MILL POND DAM

STATE ID #: 7-4-327-1

NID ID #: MA 02480

*INSPECTION SUMMARY*

DATE OF INSPECTION: 8/30/06-10/30/06

DATE OF PREVIOUS INSPECTION: June 17, 1905

TEMPERATURE/WEATHER:

ARMY CORP PHASE I: ☐ YES ☑ NO If YES, date

CONSULTANT: KENT A. HEALY

PREVIOUS DCR PHASE I: ☑ YES ☐ NO If YES, date 1995

BENCHMARK/DATUM: WEST END OF NORTH HEADWALL +15.04 USGS

OVERALL CONDITION: SATISFACTORY

DATE OF LAST REHABILITATION:

EL. POOL DURING INSP.: +12.2'

EL. TAILWATER DURING INSP.: +9.4'

*PERSONS PRESENT AT INSPECTION*

| NAME | TITLE/POSITION | REPRESENTING |
|---|---|---|
| KENT A. HEALY | | KENT A. HEALY, PE |

*EVALUATION INFORMATION*

| | | | |
|---|---|---|---|
| E1) TYPE OF DESIGN | 1 | E8) LOW-LEVEL OUTLET COND. | 4 |
| E2) LEVEL OF MAINTENANCE | 2 | E9) SPILLWAY DESIGN FLOOD | 5 |
| E3) EMERGENCY ACTION PLAN | 2 | E10) GENERAL CONDITIONS | 4 |
| E4) EMBANKMENT SEEPAGE | 5 | E11) ESTIMATED REPAIR COST ($000) | $3,000 PER YEAR |
| E5) EMBANKMENT CONDITION | 5 | ROADWAY OVER CREST | ☑ YES ☐ NO |
| E6) CONCRETE CONDITION | 5 | BRIDGE NEAR DAM | ☐ YES ☑ NO |
| E7) LOW-LEVEL OUTLET CAP | 3 | | |

SIGNATURE OF INSPECTING ENGINEER: KENT A. HEALY

| | | | |
|---|---|---|---|
| NAME OF DAM: | MILL POND DAM | STATE ID #: | 7-4-327-1 |
| | | NID ID #: | MA 02480 |

| | | | | |
|---|---|---|---|---|
| OWNER: | ORGANIZATION | TOWN OF WEST TISBURY | CARETAKER: ORGANIZATION | NONE |
| | NAME/TITLE | | NAME/TITLE | |
| | STREET | | STREET | |
| | TOWN, STATE, ZIP | WEST TISBURY, 02575 | TOWN, STATE, ZIP | |
| | PHONE | 508-696-0102 | PHONE | |
| | FAX | | FAX | |
| | EMAIL | | EMAIL | |
| | OWNER TYPE | MUNICIPAL | | |

| | | | |
|---|---|---|---|
| PRIMARY SPILLWAY TYPE | CONC. SLUCE WITH STOP LO | | |
| SPILLWAY LENGTH (FT) | 10' | SPILLWAY CAPACITY (CFS) | 250 |
| AUXILIARY SPILLWAY TYPE | 16" CULVERT | AUX. SPILLWAY CAPACITY (CFS) | 30 |
| NUMBER OF OUTLETS | | OUTLET(S) CAPACITY (CFS) | |
| TYPE OF OUTLETS | | TOTAL DISCHARGE CAPACITY (CFS) | 280 |
| DRAINAGE AREQ (SQ MI) | 3.1 | SPILLWAY DESIGN FLOOD (PERIOD/CFS) | 100 YR / 130 |
| HAS DAM BEEN BREACHED OR OVERTOPPED | ☐ YES ☑ NO | IF YES, PROVIDE DATE(S) | |
| FISH LADDER (LIST TYPE IF PRESENT) | SEASONAL WOOD | | |
| DOES CREST SUPPORT PUBLIC ROAD? | ☑ YES ☐ NO | IF YES, ROAD NAME: | WEST TISBURY / EDGARTOWN ROAD |
| PUBLIC BRIDGE WITHIN 50' OF DAM? | ☐ YES ☑ NO | IF YES, ROAD/BRIDGE NAME: | |

NAME OF DAM: MILL POND DAM

STATE ID #: 7-4-327-1

INSPECTION DATE: 8/30/06-10/30/06

NID ID #: MA 02480

## EMBANKMENT

| AREA INSPECTED | CONDITION | OBSERVATIONS | NO ACTION | MONITOR | REPAIR |
|---|---|---|---|---|---|
| CREST | SURFACE TYPE | ASPHALT PAVEMENT IN GOOD CONDITION | | | |
| | SURFACE CRACKING | | | | |
| | SINKHOLES, ANIMAL BURROWS | | | | |
| | VERTICAL ALIGNMENT (DEPRESSIONS) | | | | |
| | HORIZONTAL ALIGNMENT | | | | |
| | RUTS AND/OR PUDDLES | | | | |
| | VEGETATION (PRESENCE/CONDITION) | | | | |
| | ABUTMENT CONTACT | | | | |

ADDITIONAL COMMENTS:

Downstream Side

NAME OF DAM: MILL POND DAM

STATE ID #: 7-4-327-1

INSPECTION DATE: 8/30/06-10/30/06

NID ID #: MA 02480

## EMBANKMENT

| AREA INSPECTED | CONDITION | OBSERVATIONS | NO ACTION | MONITOR | REPAIR |
|---|---|---|---|---|---|
| D/S SLOPE | WET AREAS (NO FLOW) | | | | |
| | SEEPAGE | | | | |
| | SLIDE, SLOUGH, SCARP | | | | |
| | EMB.-ABUTMENT CONTACT | | | | |
| | SINKHOLE/ANIMAL BURROWS | | | | |
| | EROSION | | | | |
| | UNUSUAL MOVEMENT | | | | |
| | VEGETATION (PRESENCE/CONDITION) | BRUSH AT HEADWALL TO BE CUT | | | |

ADDITIONAL COMMENTS:

Upstream side

NAME OF DAM: MILL POND DAM
STATE ID #: 7-4-327-1

INSPECTION DATE: 8/30/06-10/30/06
NID ID #: MA 02480

## EMBANKMENT

| AREA INSPECTED | CONDITION | OBSERVATIONS | NO ACTION | MONITOR | REPAIR |
|---|---|---|---|---|---|
| U/S SLOPE | SLIDE, SLOUGH, SCARP | | | | |
| | SLOPE PROTECTION TYPE AND COND. | | | | |
| | SINKHOLE/ANIMAL BURROWS | | | | |
| | EMB.-ABUTMENT CONTACT | | | | |
| | EROSION | | | | |
| | UNUSUAL MOVEMENT | | | | |
| | VEGETATION (PRESENCE/CONDITION) | KEEP BRUSH CUT | | | |

ADDITIONAL COMMENTS:

NAME OF DAM: MILL POND DAM　　STATE ID #: 7-4-327-1

INSPECTION DATE: 8/30/06-10/30/06　　NID ID #: MA 02480

## EMBANKMENT

| AREA INSPECTED | CONDITION | OBSERVATIONS | NO ACTION | MONITOR | REPAIR |
|---|---|---|---|---|---|
| INSTR. | PIEZOMETERS | | | | |
| | OBSERVATION WELLS | | | | |
| | STAFF GAGE AND RECORDER | CONTINUOUS WATER LEVEL RECORDER | | | |
| | WEIRS | | | | |
| | INCLINOMETERS | | | | |
| | SURVEY MONUMENTS | | | | |
| | DRAINS | | | | |
| | FREQUENCY OF READINGS | | | | |
| | LOCATION OF READINGS | | | | |

ADDITIONAL COMMENTS:

| NAME OF DAM: | MILL POND DAM | STATE ID #: | 7-4-327-1 |
|---|---|---|---|
| INSPECTION DATE: | 8/30/06-10/30/06 | NID ID #: | MA 02480 |

**UPSTREAM AND/OR DOWNSTREAM MASONRY WALLS N/A**

| AREA INSPECTED | CONDITION | OBSERVATIONS | | | NO ACTION | MONITOR | REPAIR |
|---|---|---|---|---|---|---|---|
| D/S WALLS | WALL TYPE | | | | | | |
| | WALL ALIGNMENT | | | | | | |
| | WALL CONDITION | | | | | | |
| | HEIGHT: TOP OF WALL TO MUDLINE | min: | max: | avg: | | | |
| | SEEPAGE OR LEAKAGE | | | | | | |
| | ABUTMENT CONTACT | | | | | | |
| | EROSION/SINKHOLES BEHIND WALL | | | | | | |
| | ANIMAL BURROWS | | | | | | |
| | UNUSUAL MOVEMENT | | | | | | |
| | WET AREAS AT TOE OF WALL | | | | | | |

ADDITIONAL COMMENTS:

NAME OF DAM: MILL POND DAM

STAE ID #: 7-4-327-1

INSPECTION DATE: 8/30/06-10/30/06

NID ID #: MA 02480

**DOWNSTREAM AREA N/A**

| AREA INSPECTED | CONDITION | OBSERVATIONS | NO ACTION | MONITOR | REPAIR |
|---|---|---|---|---|---|
| D/S AREA | ABUTMENT LEAKAGE<br>FOUNDATION SEEPAGE<br>SLIDE,SLOUGH,SCARP<br>WEIRS<br>DRAINAGE SYSTEM<br>INSTRUMENTATION<br>VEGETATION<br>ACCESSIBILITY | | | | |
| | DOWNSTREAM HAZARD DESCRIPTION | | | | |
| | DATE OF LAST EAP UPDATE | | | | |

ADDITIONAL COMMENTS:

NAME OF DAM: MILL POND DAM

STATE ID #: 7-4-327-1

INSPECTION DATE: 8/30/06-10/30/06

NID ID #: MA 02480

## MISCELLANEOUS

| AREA INSPECTED | CONDITION | OBSERVATIONS | | |
|---|---|---|---|---|
| MISC. | RESERVOIR DEPTH (AVG) | 2' | | |
| | RESERVOIR SHORELINE | GOOD | | |
| | RESERVOIR SLOPES | GOOD | | |
| | ACCESS ROADS | | | |
| | SECURITY DEVICES | | | |
| | VANDALISM OR TRESPASS | YES: ☐ | NO: ☑ | WHAT: |
| | AVAILABILITY OF PLANS | YES: ☐ | NO: ☑ | DATE: |
| | AVAILABILITY OF DESIGN CALCS | YES: ☐ | NO: ☑ | DATE: |
| | AVAILABILITY OF EAP/LAST UPDATE | YES: ☐ | NO: ☐ | DATE: |
| | AVAILABILITY OF O&M MANUAL | YES: ☐ | NO: ☑ | DATE: |
| | CARETAKER/OWNER AVAILABLE | YES: ☑ | NO: ☐ | DATE: |
| | CONFINED SPACE ENTRY REQUIRED | YES: ☐ | NO: ☑ | PURPOSE: |

ADDITIONAL COMMENTS:

NAME OF DAM: MILL POND DAM

STATE ID #: 7-4-327-1

INSPECTION DATE: 8/30/06-10/30/06

NID ID #: MA 02480

## PRIMARY SPILLWAY

| AREA INSPECTED | CONDITION | OBSERVATIONS | NO ACTION | MONITOR | REPAIR |
|---|---|---|---|---|---|
| SPILLWAY | SPILLWAY TYPE | CONCRETE SLUCE WITH STOP LOGS | | | |
| | WEIR TYPE | WOOD PLANKS | | | |
| | SPILLWAY CONDITION | GOOD | | | |
| | TRAINING WALLS | CONCRETE AND STONE | | | |
| | SPILLWAY CONTROLS AND CONDITION | | | | |
| | UNUSUAL MOVEMENT | | | | |
| | APPROACH AREA | | | | |
| | DISCHARGE AREA | | | | |
| | DEBRIS | | | | |
| | WATER LEVEL AT TIME OF INSPECTION | +12.2' | | | |

ADDITIONAL COMMENTS:

NAME OF DAM: MILL POND DAM

STATE ID #: 7-4-327-1

INSPECTION DATE: 8/30/06-10/30/06

NID ID #: MA 02480

## AUXILIARY SPILLWAY

| AREA INSPECTED | CONDITION | OBSERVATIONS | NO ACTION | MONITOR | REPAIR |
|---|---|---|---|---|---|
| SPILLWAY | SPILLWAY TYPE | 16" PLASTIC CULVERT AT POND LEVEL | | | |
| | WEIR TYPE | WOOD PLANK | | | |
| | SPILLWAY CONDITION | GOOD | | | |
| | TRAINING WALLS | | | | |
| | SPILLWAY CONTROLS AND CONDITION | | | | |
| | UNUSUAL MOVEMENT | | | | |
| | APPROACH AREA | | | | |
| | DISCHARGE AREA | | | | |
| | DEBRIS | | | | |
| | WATER LEVEL AT TIME OF INSPECTION | | | | |

ADDITIONAL COMMENTS:

NAME OF DAM: MILL POND DAM

STATE ID #: 7-4-327-1

INSPECTION DATE: 8/30/06-10/30/06

NID ID #: MA 02480

## OUTLET WORKS N/A

| AREA INSPECTED | CONDITION | OBSERVATIONS | NO ACTION | MONITOR | REPAIR |
|---|---|---|---|---|---|
| OUTLET WORKS | TYPE | | | | |
| | INTAKE STRUCTURE | | | | |
| | TRASHRACK | | | | |
| | PRIMARY CLOSURE | | | | |
| | SECONDARY CLOSURE | | | | |
| | CONDUIT | | | | |
| | OUTLET STRUCTURE/HEADWALL | | | | |
| | EROSION ALONG TOE OF DAM | | | | |
| | SEEPAGE/LEAKAGE | | | | |
| | DEBRIS/BLOCKAGE | | | | |
| | UNUSUAL MOVEMENT | | | | |
| | DOWNSTREAM AREA | | | | |
| | | | | | |
| | MISCELLANEOUS | | | | |

ADDITIONAL COMMENTS:

NAME OF DAM: ______________________ STATE ID #: ______________________

INSPECTION DATE: ______________________ NID ID #: ______________________

**CONCRETE/MASONRY DAMS N/A**

| AREA INSPECTED | CONDITION | OBSERVATIONS | NO ACTION | MONITOR | REPAIR |
|---|---|---|---|---|---|
| GENERAL | TYPE<br>AVAILABILITY OF PLANS<br>AVAILABILITY OF DESIGN CALCS<br>PIEZOMETERS<br>OBSERVATION WELLS<br>INCLINOMETERS<br>SEEPAGE GALLERY<br>UNUSUAL MOVEMENT | | | | |

ADDITIONAL COMMENTS: ______________________

NAME OF DAM: ______________________ STATE ID #: ______________________

INSPECTION DATE: ______________________ NID ID #: ______________________

## CONCRETE/MASONRY DAMS N/A

| AREA INSPECTED | CONDITION | OBSERVATIONS | NO ACTION | MONITOR | REPAIR |
|---|---|---|---|---|---|
| U/S FACE | TYPE<br>SURFACE CONDITIONS<br>CONDITIONS OF JOINTS<br>UNUSUAL MOVEMENT<br>ABUTMENT CONTACTS | | | | |

ADDITIONAL COMMENTS: ______________________

Downstream Face

NAME OF DAM: ______________________ STATE ID #: ______________________

INSPECTION DATE: ______________________ NID ID #: ______________________

**CONCRETE/MASONRY DAMS N/A**

| AREA INSPECTED | CONDITION | OBSERVATIONS | NO ACTION | MONITOR | REPAIR |
|---|---|---|---|---|---|
| D/S FACE | TYPE<br>SURFACE CONDITIONS<br>CONDITIONS OF JOINTS<br>UNUSUAL MOVEMENT<br>ABUTMENT CONTACTS<br>DRAINS<br>LEAKAGE | | | | |

ADDITIONAL COMMENTS: ______________________

NAME OF DAM: ______________________ STATE ID #: ______________________

INSPECTION DATE: ______________________ NID ID #: ______________________

**CONCRETE/MASONRY DAMS N/A**

| AREA INSPECTED | CONDITION | OBSERVATIONS |
|---|---|---|
| CREST | TYPE<br>SURFACE CONDITIONS<br>CONDITIONS OF JOINTS<br>UNUSUAL MOVEMENT<br>HORIZONTAL ALIGNMENT<br>VERTICAL ALIGNMENT | |

ADDITIONAL COMMENTS: ______________________

PREVIOUS REPORTS AND REFERENCES

Inspection Report, Richard H. Slade, September 1977

Department of Environmental Management, Office of Dam Safety.
Mill Pond Dam Inspection /Evaluation Report, Prepared by Lee Pare & Assoc. 1987

Department of Environmental Management, Office of Dam Safety
Mill Pond Dam Inspection/Evaluation Report, Prepared by GZA, 1995

Department of Environmental Management, Office of Dam Safety
Priester's Pond Dam Inspection/ Evaluation Report, Prepared by DEM Office of Dam Safety 01/10/02

Atlas of Precipitation Extremes for the Northeastern United States and Southeastern Canada
Cornell University, Ithaca, New York, September 1993

# COMMON DAM SAFETY DEFINITIONS

For a comprehensive list of dam engineering terminology and definitions refer to 302 CMR10.00 Dam Safety, or other reference published by FERC, Dept. of the Interior Bureau of Reclamation, or FEMA. Please note should discrepancies between definitions exits, those definitions included within 302 CMR 10.00 govern for dams located within the Commonwealth of Massachusetts.

## Orientation

Upstream – Shall mean the side of the dam that borders the impoundment.

Downstream – Shall mean the high side of the dam, the side opposite the upstream side.

Right – Shall mean the area to the right when looking in the downstream direction.

Left – Shall mean the area to the left when looking in the downstream direction.

## Dam Components

Dam – Shall mean any artificial barrier, including appurtenant works, which impounds or diverts water.

Embankment – Shall mean the fill material, usually earth or rock, placed with sloping sides, such that it forms a permanent barrier that impounds water.

Crest – Shall mean the top of the dam, usually provides a road or path across the dam.

Abutment – Shall mean that part of a valley side against which a dam is constructed. An artificial abutment is sometimes constructed as a concrete gravity section, to take the thrust of an arch dam where there is no suitable natural abutment.

Appurtenant Works – Shall mean structures, either in dams or separate therefrom. including but not be limited to, spillways; reservoirs and their rims;low level outlet works; and water conduits including tunnels, pipelines, or penstocks, either through the dams or their abutments.

Spillway – Shall mean a structure over or through which water flows are discharged. If the flow is controlled by gates or boards, it is a controlled spillway; if the fixed elevation of the spillway crest controls the level of the impoundment, it is an uncontrolled spillway.

## Size Classification
(as listed in Commonwealth of Massachusetts, 302 CMR 10.00 *Dam Safety*)

Large – structure with a height greater than 40 feet or a storage capacity greater than 1,000 acre-feet.

Intermediate – structure with a height between 15 and 40 feet or a storage capacity of 50 to 1,000 acre-feet.

Small – structure with a height between 6 and 15 feet and a storage capacity of 15 to 50 acre-feet.

Non-Jurisdictional – structure less than 6 feet in height or having a storage capacity of less than 15 acre-feet.

## Hazard Classification
(as listed in Commonwealth of Massachusetts, 302 CMR 10.00 *Dam Safety*)

High Hazard (Class I) – Shall mean 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).

Significant Hazard (Class II) – Shall mean dams located where failure may cause loss of life and damage to home(s), industrial or commercial facilities, secondary highway(s) or railroad(s), or cause the interruption of the use or service of relatively important facilities.

Low Hazard (Class III) – Dams located where failure may cause minimal property damage to others.Loss of life is not expected.

## General

EAP – Emergency Action Plan - Shall mean a predetermined plan of action to be taken to reduce the potential for property damage and/or loss of life in an area affected by an impending dam break.

O&M Manual – Operations and Maintenance Manual; Document identifying routine maintenance and operational procedures under normal and storm conditions.

Normal Pool – Shall mean the elevation of the impoundment during normal operating conditions.

Acre-foot – Shall mean a unit of volumetric measure that would cover one acreto a depth of one foot. It is equal to
Height of Dam – Shall mean the vertical distance from the lowest portion of the natural ground, including any stream channel, along the downstream toe of the dam to the crest of the dam.

Spillway Design Flood (SDF) – Shall mean the flood used in the design of a dam and its appurtenant works particularly for sizing the spillway and outlet works, and for determining maximum temporary storage and height of dam requirements.

## Condition Rating

Unsafe - Major structural, operational, and maintenance deficiencies exist under normal operating conditions.

Poor - Significant structural, operation and maintenance deficiencies are clearly recognized for normal loading conditions.

Fair - Significant operational and maintenance deficiencies, no structural deficiencies. Potential deficiencies exist under unusual loading conditions that may realistically occur. Can be used when uncertainties exist as to critical parameters.

Satisfactory - Minor operational and maintenance deficiencies. Infrequent hydrologic events would probably result in deficiencies.

Good - No existing or potential deficiencies recognized. Safe performance is expected under all loading including SDF.

# APPENDIX C

# ACT Report

# SURVEY REPORT

## MILL POND BASELINE ASSESSMENT AND MANAGEMENT PLAN – WEST TISBURY, MA

**December 2006**

***Prepared for:***

**Town of West Tisbury**
**c/o West Tisbury Conservation Commission**
**Town Hall, P.O. Box 278**
**West Tisbury, MA 02575**

***Submitted by:***


**Aquatic Control Technology, Inc.**
**11 John Road**
**Sutton, MA 01590-2509**

AQUATIC CONTROL TECHNOLOGY, INC.
POND AND LAKE MANAGEMENT SPECIALISTS

# TABLE OF CONTENTS

## INTRODUCTION & POND DESCRIPTION

Based on concerns over accelerated sedimentation and increasing densities of aquatic vegetation within Mill Pond (West Tisbury, MA), the Town of West Tisbury, through their Conservation Commission, contracted Aquatic Control Technology, Inc. of Sutton, MA to perform a Baseline Assessment of the pond. The objective of the assessment was to document current/baseline morphometric, water quality, and vegetation growth conditions. These data were then to be used to evaluate potential near-term improvement options and outline some long-range management and maintenance strategies for the preservation of habitat diversity and passive recreational quality.

Mill Pond is a small 2.5 acre man-made impoundment of Mill Brook that was reportedly created sometime prior to the early 1800's to power a small family owned textile mill that made wool cloth called Satinet. The pond lies on the north/south axis just north of the Edgartown-West Tisbury Road, and directly west of the acting West Tisbury Police Station (see Figure 1 – Site Locus Map). The pond is fed via surface water flows from Mill Brook and direct run-off from its immediate watershed. Mill Brook originates some 3.5 miles to the north and west of the pond basin and supports three additional impoundments (Fisher Pond, Crocker Pond, and Priester Pond), which lie up gradient of Mill Pond along North Road. The primary flow of Mill Brook, however, is diverted via a man-made structure into two separate flows just south of Panhandle Road. The two created water conveyance channels then run along the extreme east and west borders of the extensive shrub swamp wetland immediately to the north of Mill Pond. The westerly inflow channel was created to provide flow into the small Parsonage Pond located just west of the intersection of Edgartown-West Tisbury Road and Vineyard Haven Road. However, at the point of a second diversion in the western channel, which is presumably intended to direct some water flow back to the Mill Pond, a sediment deposit has impeded the flow of water to Parsonage Pond. As a result all flow from Mill Brook currently flows through Mill Pond.

The pond's large earthen dam, which forms the basis for the Edgartown-West Tisbury Road, lies at the southern most end of the pond. The dam possesses two outlet structures located at the southeast and southwest limits of the pond. The primary outlet structure, located at the southeast corner, is comprised of two 4-5 ft. wide concrete spillways, which are controlled by multiple wooden flashboards. The flashboards appeared to provide sufficient control to allow complete draining of the pond. The secondary outlet, located in the southwest corner, flows uncontrolled through a large culvert under Edgartown-West Tisbury Road. Both flows remain separate as they flow south, where they eventually empty into Town Cove of Tisbury Great Pond.

Mill Pond has become quite shallow in recent years with a calculated average depth of just 1.7 ft. Despite it's current state, Mill Pond is an important feature to the environment and community alike. It provides valuable wildlife habitat, aesthetic value to the landscape, and important recreational opportunities in the form of fishing, non-motorized boating and wildlife viewing. Most ponds, especially man-made or enhanced ponds, require some level of management in order to maintain desirable conditions.

The following report will outline our field survey data as well as provide a discussion of the most appropriate and cost effective management strategies for Mill Pond.

## SURVEY METHODS

The field survey data collection was performed on September 15, 2006 by two Aquatic Control Biologists. The survey consisted of five primary tasks, vegetation inventory and mapping, bathymetry (water depth) & unconsolidated sediment measurement and mapping, water quality sampling, critical wildlife habitat assessment and general site evaluation. The procedures followed for each of these tasks are outlined in the following sections.

The pond was accessed using a 12 ft. Jon Boat from a small clearing at the southeastern corner adjacent to the primary outlet structure.

### *Vegetation Mapping & Bathymetry and Sediment Measurements*

The vegetation, sediment, and bathymetry data collection were performed at the same time, due to the similar operating procedures for each task. The above survey information was collected by first predetermining representative transect lines throughout the pond. Data sites were then chosen as points along each transect line and geo-spatially referenced using a Trimble™ Differential Global Positioning System (DGPS) (see Figure 2 – Data Point & Sample Collection Site Map) with an accuracy of +/- one meter. At each data point a flat weight was lowered on a measuring tape to gauge water depth. Sediment thickness was determined using a graduated steel rod. The rod was pushed, by hand, through the unconsolidated sediment layer to the hard inorganic refusal layer and the length of penetration was recorded. Vegetation samples were collected by dragging a long handled rake along the pond bottom. Dislodged vegetation was identified, at least to the genus level, and recorded. All the data collected was recorded under its corresponding data point and transect line and is presented in tabular format in Appendix B.


### *Water Sample Collection*

Two water sampling stations were established, one located at the inlet end of the pond and the other was located directly adjacent to the pond's primary outlet structure (see Figure 2). A single surface grab (1.0 –2.0 ft. below the surface) sample was collected from each sample site on the day of the field data collection (9/15/06). The water samples were then analyzed by an independent MA DEP certified laboratory for a suite of common water quality parameters, which included: pH, total alkalinity, turbidity, total phosphorus, Kjeldal nitrogen, nitrate nitrogen, true and apparent color, and *E. coli* bacteria.

Field testing of temperature/dissolved oxygen profiles and Secchi disk transparency were also performed during the field survey. A composite water sample was also collected for identification of dominant species of phytoplankton and count by enumeration.

### *Wildlife Habitat Features*

This task consisted of basic qualitative observation of the various resource areas associated with the pond and documenting actual wildlife utilization, if observed. Specific features potentially important to the area habitat value were also noted and classified by their typical habitat function. In addition to these field observations, rare and endangered species and pertinent fisheries information provided by the Town was also reviewed.

Aquatic Control's Senior Biologist, Keith Gazaille, met with interested Town officials following the completion of the field data collection to informally discuss initial impressions of the pond conditions and gather historic information regarding the pond, specific land use practices within the surrounding area, general pond uses, as well as the Town's particular management goals.

## SURVEY FINDINGS

Even casual observations of Mill Pond are indicative of a eutrophic, fertile waterbody. The obvious eutrophic conditions are evidenced by abundant aquatic vegetation growth and limited water depths, which are observable through the growth of depth limited emergent plants throughout most portions of the pond. These qualitative observations along with more comprehensive quantitative data collection are outlined in the following section.

**Mill Pond**

| | |
|---|---|
| **Surface Area** | 2.5 ± acres |
| **Average Water Depth** | 1.7-feet |
| **Maximum Depth** | 7.0-feet |
| **Average Sediment Thickness** | 2.8-feet |
| **Approximate Water Volume** | 4.25 acre-feet |
| **Qualitative Sediment Type** | Organic Muck |
| **Dominant Submersed Vegetation** | Ribbon-leaf pondweed; Coontail, Nitella |
| **Dominant Wetland/Shoreline Vegetation** | Bur-reed; Water willow; rushes |
| **Recommended Management Strategy** | Mechanical sediment and vegetation removal |

### *Water Quality*

A single round of two surface grab water samples were collected during the field survey. One sample was taken from the inlet end of the pond (Site 1) and the other from the outlet end (Site 2). The samples were analyzed by a certified independent laboratory for a suite of common baseline water quality parameters.

**TABLE 1 – WATER QUALITY SAMPLING RESULTS**

| Tested Parameters | Reported Units | Site 1 Results | Site 2 Results |
|---|---|---|---|
| **pH** | S.U. | 6.0 | 5.87 |
| **Total Alkalinity** | mg $CaCO_3$/l | 6.1 | 6.4 |
| **Turbidity** | NTU | 0.90 | 0.86 |
| **Total Phosphorus** | mg/l | 0.055 | 0.041 |
| **Kjeldahl Nitrogen** | mg/l | 0.8 | 0.8 |
| **Nitrate Nitrogen** | mg/l | 0.60 | 0.33 |
| **True Color** | Pt-Co | 15 | 20 |
| **Apparent Color** | Pt-Co | 35 | 33 |
| ***E. Coli*** | Org./100ml | 270 | 60 |

*Samples collected on 9/15/06*

**pH** – The pH measurement scale ranges from 0-14, where zero is extremely acidic, seven is neutral, and 14 is the most basic. pH is related to the concentration of hydrogen ions ($h^+$) in solution, which can affect many different aspects of water chemistry. A range of about 5.5-8.5 S.U. is desired for maintaining a healthy fishery. Maintaining a stable pH ($\pm$ 1 S.U.) is also important as frequent variations can have adverse effects on water chemistry and resident fisheries. The results obtained from this sampling effort are, although at the low end of the range, still within desirable limits and not uncommon for ponds on Cape Cod and the Islands.

**Total Alkalinity** - Alkalinity is a measure of the buffering capacity of a waterbody against acid additions such as acid rain and pollution, which can be detrimental to wildlife populations. Total alkalinity measures the presence of carbonates, bicarbonates and hydroxides. Values below 20 mg/l typically illustrate that the pond may be susceptible to fluctuations in pH. Alkalinity levels are generally dependent upon the make up of the surficial geology of the geographic region; therefore, the glacial deposits of Cape Cod and the Islands, generally do not support high alkalinity levels. As a result, the relatively low alkalinity levels found in Mill Pond are naturally occurring and consistent with values for the region.

**Turbidity** - Turbidity is a relative measurement of the amount of suspended material in the water. It is measured through a process involving light diffraction of the pond sample as compared to a series of prepared samples. Turbidity values can range from less than one to thousands of units; however, values in most ponds and lakes rarely rise above 5 NTU. The Mill Pond values of <1.0 NTU indicate low suspended material, which is desirable.

**Total Phosphorus** – Phosphorus is generally considered to be the limiting nutrient for plant and algae growth in freshwater systems, with concentrations of 0.03 mg/l or greater being sufficient to stimulate nuisance algae blooms. Total phosphorus analyses measure both particulate and dissolved phosphorus. Particulate phosphorus is generally not immediately biologically available for algae growth. Although not alarmingly high, the mean total phosphorus level (0.048 mg/l) for this sampling effort is above the desired threshold. It is important to understand, however, that these sample results represent a mere "snap-shot" of the ever fluctuating phosphorus levels in Mill Pond. In order to establish a more meaningful baseline value, multiple sampling rounds would be required.

Although not statistically significant due to the small data set, an interesting trend can be observed in the nutrient (phosphorus & nitrogen) sample results. The phosphorus concentrations at the inlet end of the pond are noticeably higher than those obtained from the outlet sampling station. This may likely indicate that Mill Pond is acting as a nutrient sump. This means that the elevated non-point source nutrient inputs from up-gradient in the watershed are being removed from the water through various natural processes within the pond (i.e. organic sediment deposition, uptake by resident plant and algae growth, etc.), resulting in a net reduction in phosphorus in the watercourse. This is particularly important considering the fact that Mill Brook is a primary freshwater tributary of Tisbury Great Pond, and in turn further increases the importance of responsible management of the pond, as proper management and maintenance will likely enhance the ponds nutrient retention capabilities.

**Nitrogen** – Nitrogen exists in ponds and lakes in several forms. Kjeldahl nitrogen testing results are representative of the amounts of organic or biomass nitrogen and ammonium. Nitrate Nitrogen, however, is representative of the inorganic nitrogen form that is most readily usable by plants and algae. Nitrate nitrogen, in the presence of oxygen, is the breakdown product of ammonia, which is released during the decomposition of organic material. The nitrate results from the two sampling stations indicate elevated levels of nitrogen, as it is generally thought that inorganic nitrogen levels in excess of 0.30 mg/l are sufficient to support algae blooms. As with the phosphorus levels, the nitrate results showed a net reduction from the inlet station to the outlet station.

Equally important as the sheer amount of available nitrogen is the ratio of total nitrogen to total phosphorus (N:P). The ratio of nitrogen to phosphorus is important for determining how algae growth will be limited. Systems that have N:P ratios less than 10:1 are typically nitrogen limited and those that have ratios in excess of 15:1 are considered phosphorus limited. Like most freshwater systems, Mill Pond is phosphorus limited, as the N:P ratio was in excess of 25:1.

**True Color/Apparent Color** - Apparent color is the color of the unfiltered sample water that is caused by suspended and dissolved matter. True color is the color of the filtered sample water resulting from dissolved constituents only. Water color can effect light penetration and, as a result, can limit rooted plant and algae growth. The disparity between true and apparent color can indirectly indicate the amount of suspended material in the water and lead to conclusions about the influence of stormwater or incoming water quality. The results reported for these samples indicate that the color of the water is nearly equally caused by both substances in suspension and in solution. Overall both the true and apparent color values are low and within desirable limits.

***E. coli* Bacteria** – These bacterial analyses are used to determine the probability of some type of fecal contamination. *E. coli* is a bacterium present in the digestive tract of humans and animals and is therefore the most reliable indicator of recent fecal inputs. Typical *E. coli* standards for the protection of human health in fresh, "swimmable waters" are < 235 organisms/100 ml in any one sample. Therefore the results obtained from Site 1 (inlet) are elevated and above the aforementioned threshold. Like nitrogen and phosphorus, these results represent a moment in time of a continually fluctuating parameter; therefore, additional sampling would be required to establish whether or not this was a single sample anomaly or a more chronic/consistent baseline *E. coli* value. Also, it is impossible from this particular test to determine the source of the fecal contamination; consequently, the elevated levels could be the result of waterfowl or other animal waste inputs from the watershed. Light to moderate rain was experienced prior to and during the field survey and sample collection, resulting in elevated flows that may likely have influenced these and other sample results.

**Dissolved Oxygen –** The dissolved oxygen levels at the time of the field data collection were at the saturation point at the upper level of the water column, which is expected in ponds with normal plant and algae production. A reduction in dissolved oxygen was observed near the sediment water interface, which is likely the result of normal microbial breakdown of organic material and the subsequent Biological Oxygen Demand (BOD).

Secchi disk transparency was to the bottom in most areas of the pond. This level of transparency indicates low levels of suspended materials. The low levels of suspended materials is further reflected in the low turbidity values from the water quality sampling.

## *Algae Identification & Enumeration*

Water samples were collected for microscopic identification and enumeration of planktonic or free-floating algae. The following table shows estimates of the dominant algal abundance at Mill Pond during the field survey in September of 2006. Samples were analyzed under 20X magnification in a Sedgewick-Rafter counting cell. The number of asterisks in each column represent the algal density (* present, ** common, *** abundant, **** very abundant).

**TABLE 2 – MICROSCOPIC ALGAE COMPOSITION**

| ALGAE TAXON | 9/15/06 |
|---|---|
| Cyanophyta (Bluegreens) | |
| - *Gloeothece* | * |
| Chlorophyta (Greens) | |
| - *Clorococcum* | ** |
| - *Closterium* | * |
| Bacillariophyta (Diatoms) | |
| - *Synedra* | * |
| - *Fragilaria* | * |
| - *Navicula* | |
| Chrysophyta & Pyrrhophyta | |
| - *Mallomonas* | |
| - *Peridinium* | |
| Algal Density Rank | 2 |
| Estimated Algal Cell Density | 2,250 cells/ml |

Water clarity was quite good during our inspection and no visible blooms of planktonic algae were observed. There was some benthic growth of filamentous algae observed, but no floating mats of algae were visible.

The planktonic algal density was low. Greens dominated the phytoplankton assemblage and the presence of some very small colonial bluegreens inflated the cell density numbers. Still, estimated algal cell densities were low and with the mix of planktonic algae seen in Mill Pond, cell densities would need to be well in excess of 10,000 cells/ml for visible algal blooms to be present.

The low algal density is likely due to the excessive vascular aquatic plant growth. Nutrients are probably utilized by the submersed and floating plant species, before they stimulate excessive algae growth.

### *Vegetation Distribution*

The Pond has well-established populations of submersed and emergent vegetation. The vegetation growth throughout much of the pond averaged between 50%-90% bottom cover, with only small pockets of open water (see Figure 3 – Vegetation Distribution Map). The plant species found throughout the pond are listed in the following table:

**TABLE 3 – DOMINANT AQUATIC PLANTS IN MILL POND (2006)**

| Scientific Name | Common Name | Field & Map Abbreviation | Plant Type | Distribution |
|---|---|---|---|---|
| *Ceratophyllum demersum* | Coontail | Cd | Submersed | Abundant – Growing at moderate to high densities throughout the southern half of the pond |
| *Potamogeton pusilis* | Thin-leaf Pondweed | Pp | Submersed | Common – Growing in shallow areas of the northern end of the pond |
| *Potamogeton epihydrus* | Ribbon-leaf Pondweed | Pe | Submersed | Abundant – most prevalent submersed plant throughout pond |
| *Lemna minor* | Duckweed | Lm | Floating | Sparse – Low densities found trapped in floating mats of submersed vegetation. |
| *Nitella* | Stonewort | Ni | Submersed Macro-Algae | Common – low to moderate density growth observed in most areas of the pond |
| --- | Filamentous Algae | FA | Floating & Submersed Mats | Scattered/Common – most prevalent in areas with lower density submersed plant growth |
| *Sparganium sp.* | Bur-reed | S | Emergent | Common/Scattered – consisted of small isolated patches throughout shallower areas |
| *Juncus sp* | Rush | R | Emergent | Sparse – isolated growth along eastern shoreline |

As a result of the extremely shallow water depths (<0.5 ft.) in the northern portion of the pond the density of the submersed growth was lower in that region than elsewhere, with an average areal coverage estimated in the range of 40%-50%. Although the shallow water depths in this region of the pond limited submersed plant densities, they facilitated widespread colonization by wetland/emergent growth, dominated by bur-reed and water willow.

The remaining two thirds of the pond harbored significantly greater densities of submersed vegetation, with scattered pockets of emergent bur-reed growth. Submersed vegetation densities in this area ranged between 70%-90% bottom cover. The dominant plant species were ribbon-leaf pondweed, coontail, and *Nitella*.

In a warm-water fishery such as Mill Pond it is generally considered optimal, for fisheries habitat, to maintain vegetation cover in the range of 20%-40%. Therefore, the current level of vegetation growth can be considered excessive. Dense contiguous plant growth can have multiple adverse impacts to the "health" of an aquatic ecosystem. For example, fisheries size classes can become stunted by limited predator/prey interaction and water quality can deteriorate from a lack of water circulation. Drastic diurnal fluctuations in dissolved oxygen can also occur, which can also be detrimental to resident fish and wildlife. Area selective management of the in-pond vegetation is, therefore, desirable for the restoration and maintenance of a more balanced warm-water aquatic ecosystem.

### *Unconsolidated Sediment Distribution*

Based on qualitative observations of the sediments attached to the sediment probe during the field survey, the unconsolidated sediments were classified as a combination of organic rich muck and inorganic sand or silt. This sediment type is typically high in nutrients and capable of supporting aquatic plant growth. Nutrient rich sediments are constantly added to an aquatic system by the annual decay of aquatic vegetation, algae and leaf litter. The unconsolidated sediment layer in Mill Pond is typical of a eutrophic waterbody suffering from excessive plant growth. The thickness of this layer ranged from 0.5 ft. to >4.0 ft. with the greatest volume of sediment located in the southeastern and northwester areas of the pond (see Figure 5 – Unconsolidated Sediment Thickness Map). The calculated average thickness of the unconsolidated sediment layer is 2.8 ft. A larger grain size or sand constituent was noted for the data points of transect A at the northern end of the pond. A higher degree of what was believed to be sand in the area of the inlets is probably the result of sediment deposition from the inlet waters. The heavier and larger sand grains settle out of suspension soon after entering the pond and the smaller and lighter silts and clay remain in suspension until flow velocities are further reduced upon entering the central and southern area of the pond; therefore, creating a distinct segregation of sediments based on grain size.

### *Wildlife Habitat Features*

Mill Pond contains a variety of different habitat features that likely provide suitable nesting, basking, and/or perching sites for resident wildlife species. Wildlife utilization of this wetland resource is likely to be diverse, however, as was mentioned previously, the weather conditions at the time of the survey were less than optimal (moderate rain and wind) for the viewing of resident wildlife. As a result, very few species were observed during our visit. Based on the habitat characteristics observed in and around Mill Pond it is likely that it supports a variety of bird species, warm-water fish species, amphibians, and reptiles.

Biotic and abiotic habitat features of specific concern that were noted at Mill Pond, along with a brief discussion of their significance to the overall ecosystem, are provided in the following section.

**Emergent Vegetation Growth** - The pond contains a significant emergent plant community dominated by bur-reed, water willow, and various rush species. Fortunately, no non-native and/or invasive species were observed colonizing this relatively diverse native plant assemblage. The current emergent growth provides desirable nesting, and perching habitat for bird species such as waterfowl and other species that prefer freshwater wetland nest sites. The native emergent growth also provides escape cover for a variety of fish species and at certain times of the year can produce valuable forage, in the form of seeds, for waterfowl.

**Deadfall Tree** - A small deadfall tree was observed along the northwestern shoreline of the pond. Deadfall trees submerged and emergent within the littoral zone provide a number of potential uses for resident wildlife. Most frequently these trees provide basking sites for turtles as well as perching sites for bird species like the Great Blue Heron and the Double-Crested Cormorant.

The submerged portion of the tree provides excellent underwater structure that is particularly important to warm-water fish species. These areas are typically utilized as ambush sites for predatory species like Largemouth Bass.

**Overhanging Vegetation** - Much of the eastern and western shores support woody shoreline growth that have limbs overhanging the water surface. This overhanging vegetation provides perching sites for piscatory bird species like the Black-Crowned Night Heron, Belted Kingfisher, and/or Osprey. The overhanging vegetation also provides cover from predatory avian species to resident fish and amphibians.

**"Edge" Habitat & Structure** - Edge habitat is particularly important to predator/prey interaction. The transition area between vegetated areas and open water ("Edge") are important feeding areas for both wading bird species and predatory fish. The dense vegetation provides excellent escape cover and desirable juvenile fish nursery habitat. Because of the important role submersed aquatic vegetation plays in the balance of an aquatic ecosystem, any proposed management should focus on the enhancement of transitional zones and not the complete eradication of plant growth.

A review of the Natural Heritage and Endangered Species Program (NHESP) data-layers for rare and endangered species and habitat indicated the presence of both

Estimated wildlife habitat (WH 512) and Priority habitat (PH 1730). Correspondence with NHESP has indicated that the state-listed rare species of specific concern for these areas are the American Brook Lamprey (*Lampetra appendix*) and the Water-willow stem borer (*Papaipema sulphurata*). Due to the presence of these state-listed species any proposed pond restoration/management project will require NHESP review under the Massachusetts Endangered Species Act (MESA) to determine if the proposed activities would result in the disturbance of or "probable take" of either of these species.

The pond does support a warm-water fishery, as several sunfish and yellow perch were observed throughout the course of our survey. In addition to the resident warm-water fish species the state Division of Fish and Wildlife reportedly stocks the pond with various size classes of rainbow trout in the early spring of each year. These trout are no doubt stocked on a "put and take" basis, as the current condition of the pond is incapable of supporting cold-water fish species, such as trout, over the hot summer months.

The Town and MV Commission have also indicated that steps are currently being taken to restore Mill Brook and Mill Pond to a viable herring run and spawning area. Although water flows have been managed to provide optimal migration conditions and a suitable fish ladder has been seasonally installed to facilitate fish passage over the Mill Pond dam, utilization of the brook by herring has reportedly been minimal. The introduction of a recruitment herring population to Mill Pond in future years is also being investigated.

Mill Pond and its surrounding area contains suitable habitat characteristics for a variety of wildlife. The in-pond submersed vegetation cover is currently in excess of the range widely recommended for the maintenance of a "healthy" warm-water fishery and certainly exceeds what would be desirable for trout species and herring. Therefore, selective management of vegetation and the restoration of more suitable water depths will improve the overall habitat value of the system. In addition, efforts should be made to prevent the introduction of non-native aquatic and wetland species, as their invasive characteristics give them the ability to out-compete native plants species and spread rapidly. In many cases this results in the development of monotypic growth, reduced plant diversity, and a net loss in overall habitat value.

## DISCUSSION OF MANAGEMENT OPTIONS

It is important when designing an aquatic management program to first identify the desired goal(s). This goal(s) should be consistent with the intended uses and natural functions of the waterbody and be realistically attainable. Selected management activities must also comply with environmental regulations that are put in place to preserve the pond's ecology and adjacent wetlands.

The primary objective of any active management at Mill Pond should be the restoration and maintenance of optimal fish and wildlife habitat value. In addition, the pond is reportedly used for common passive recreational activities such as shoreline fishing, wildlife viewing, natural aesthetics, etc. Therefore, the recommended management plan should incorporate tasks and goals that would mutually benefit all the potential uses of the pond.

In the following paragraphs we will discuss various management alternatives and provide insight and recommendations as to the best and most feasible techniques for the management of Mill Pond.

### *Watershed Management*

Mill Pond has a large watershed area, which is not uncommon for impounded waterbodies. The bulk of the watershed area is comprised predominantly of undeveloped land and low density residential development. The relatively undisturbed nature of the watershed should be beneficial for limiting the introduction of nutrients and/or pollutants to the watercourse and the subsequent transport to Mill Pond.

Because no stormwater sampling or detailed watershed investigation was performed as part of the scope of this project, it is difficult to determine to what extent external nutrient loading from the watershed contributes the eutrophication of the pond. However, based on the size of the watershed and the pond basin to drainage basin ratio it can be assumed that in-pond water quality is highly influenced by land-use and management activities within the watershed. As is the case with all pond watershed situations it is important to limit potentially high risk land-uses (industrial, commercial, and even high use agricultural) as well as residential activities that might increase the level of nutrient transport to the pond (i.e. lawn fertilization, faulty septic systems, etc.).

It does appear that Mill Brook receives direct stormwater run-off from Panhandle Road. At the time of the survey transport of small particulate matter and other debris was evident where stormwater run-off from Panhandle Road is channeled directly into Mill Brook. The introduction of these and possible other pollutants (i.e. petroleum based substances) may have a contributing effect on the nutrient loading and sedimentation of the pond.

Prior to the implementation of any focused watershed management techniques, we recommend performing a more detailed investigation, inclusive of field confirmation of the watershed delineation and current land-uses. These data will provide additional insight into the potential watershed management issues facing the pond and how best to address them.

Improving water quality and in-pond conditions through watershed management is a slow and difficult process because there are likely multiple sources contributing to the overall nutrient load to the pond. Although significant reduction of in-pond vegetation growth is unlikely as a result of even large-scale watershed management, the implementation of generic watershed improvement measures or Best Management

Practices (BMP's) are always recommended. Additional BMP and watershed management information has been provided in Appendix C.

The following list describes a selection of some commonly implemented Best Management Practices,:

**Limit impervious area** – Impervious areas such as driveways, buildings and roads interfere with the natural absorption and filtering (percolation) of stormwater through soils. Limiting impervious areas will reduce flow volumes and mitigate plug flow of nutrients into the watercourse.

**Minimize contaminant exposure** – Regulating the use of potentially hazardous chemicals and other nutrient sources on properties surrounding the waterbody will lessen the exposure to potential contamination of the waterbody and watercourse alike.

**Control of fertilization, pet & yard wastes** – It is important to encourage the proper processing of pet & yard wastes as well as the modification of fertilization practices and other activities which introduce nutrients to the watershed (i.e. car washing). In addition, establishing practices to limit nuisance non-migratory waterfowl, such as no feeding and other deterrents, can also eliminate a significant source of nutrients to the waterbody.

**Land Management** – Controlling and/or minimizing the introduction of land uses that have the potential to negatively impact the pond, such as, industrial and even agricultural uses will further limit potential sources of external nutrients and contaminants. Equally important to land management is the preservation of natural woodland areas to help prevent increases in nutrient loading and the natural processing of storm water.

**Street Cleaning** – Frequent cleaning of roadways in the watershed and maintenance of catch basins will promote cleaner stormwater runoff.

**Buffer Strips** – Vegetated buffer strips of grass and/or shrubs can act as a biofilter to mediate nutrients from non-point sources before they enter the waterbody.

**Catch Basins/Grease & Grit Traps**
**Detention Basins**
**Infiltration systems** – These more complicated watershed/storm water management techniques generally address point source runoff from drainage systems, construction or other areas with the elevated potential to introduce high levels of nutrients. The installation, improvement and/or updated design of these systems can significantly reduce the nutrient load of stormwater inflow.

**Constructed Wetlands** – The construction of simulated wetlands in areas of high stormwater flow can act as settling/detention basins and help to replicate the natural processing of nutrients from runoff that typically occurs within unaltered natural wetland systems.

These more involved nutrient transport mitigation strategies (catch basins/grease & grit traps, detention basins, infiltration systems, and constructed wetlands) are more difficult to implement because they require ownership of large portions of the watershed. General watershed management practices are always wise to implement if possible.

### *Physical Techniques*

Physical management strategies generally utilize an alteration to the physical environment to eliminate, control, or reduce nuisance aquatic vegetation populations. Several accepted methods are available and have been widely implemented; however, each technique has its particular application. Therefore, like any other management strategy, the feasibility, efficacy and potential adverse impacts should be investigated prior to use in a management program.

**Benthic Vegetation Barriers** - The use of bottom weed barriers (i.e. Aquatic Weed Net™ or Palco™) are effective for small dense patches of nuisance vegetation, but are not cost effective or feasible for large areas. Weed barriers are expensive to install and maintain at ~ \$1.00 \$1.25/$ft^2$ (1 acre expanse would cost in the range of \$43,560 - \$54,450 material & installation). Semi-annual maintenance to retrieve, clean and re-deploy the barriers would be expensive and time consuming. Also covering expansive areas of the pond bottom may also have detrimental impacts on invertebrates or other types of wildlife.

**Winter Drawdown** - Drawdown for the control of nuisance aquatic vegetation involves the lowering of the pond's water level during the fall and winter of the year to expose nuisance vegetation infestations. Exposing aquatic plant species to the elements for long periods of time (>6-8 weeks) facilitates desiccation and freezing of the plants and their root systems.

Drawdown is not a feasible management alternative at Mill Pond due to the contiguous plant growth and the shallow bottom contours of the pond. In order to expose all the areas of dense vegetation and achieve any degree of success it would be necessary to drain all of the water out of the pond, leaving insufficient water to sustain resident fish and wildlife populations.

**Hand-Pulling/Harvesting** - Hand-Pulling or hand-harvesting is an effective low-impact, non-chemical alternative to controlling a variety of unwanted vegetation species. Because hand-pulling is labor intensive on a large scale it is best suited for very low plant densities (<500 stems/acre). The current vegetation growth in Mill Pond is far too dense and widespread to be effectively or feasibly managed through manual hand-harvesting.

### *Biological Controls*

There has been a good deal of research done on stem boring weevils (*Euhrychiopsis lecontei*) for the control of invasive Eurasian watermilfoil (*Myriophyllum spicatum*). The results of their introduction to milfoil infestations have been mixed. These weevils are exclusively for the control of Eurasian watermilfoil and therefore not applicable to the management of the native plant assemblage found in Mill Pond.

Leaf eating beetles (*Galerucella* sp.) and root eating beetles (*Hylobius sp*.) have also been studied for their impacts to purple loosestrife (*Lythrum salicaria*). Reportedly these insects have been released at several sites throughout the northeast with promising results. Fortunately the emergent and adjacent wetland plant communities associated with Mill Pond do not currently support the growth of non-native and invasive purple loosestrife.

Triploid (sterile) grass carp have also been used for the management of submersed vegetation in various parts of the country. However, in the state of Massachusetts grass carp cannot be legally introduced for any purpose.

### *Mechanical Techniques*

Mechanical control techniques have proven useful in controlling nuisance aquatic vegetation. These techniques, mechanical harvesting and Hydro-Raking, benefit from area selective management and where the waterbody's morphological characteristics (i.e. depth, outlet structure, flow rates, etc.) deter the use of other techniques.

**Mechanical Hydro-Raking** - The mechanical Hydro-Rake can best be described as a "floating backhoe" with a York Rake attachment. The barge is paddle wheel driven to facilitate operation in shallow water (<2 feet) and it can effectively work to depths of about 10-12 feet. The Hydro-Rake is most effective at removing plants with well defined root systems, such as emergent species. It works from the water, thereby avoiding damage to sensitive shoreline habitat and property. This machine "rakes" the upper sediment layer collecting plants and their attached root systems.

In the case of Mill Pond the hydro-rake would be best suited for the removal of dense submersed and emergent growth throughout the pond. The selective removal of designated areas of growth will create a greater amount of valuable open water habitat, increase water circulation, improve the aesthetic quality of the area, and reduce the amount of vegetative biomass available for annual decomposition. The machine is capable of area selective management, making it possible for the removal of specific stands of growth and even specific portions of a particular infestation. This feature is particularly attractive for the management of Mill Pond, because small designated areas of plant growth can be preserved to serve as valuable fish and wildlife habitat. The removal of the vegetative biomass may subsequently cause a reduction in the dissolved nutrients/phosphorus levels that are derived from decaying organic material. Not to mention the removal of the plant root systems will likely provide multiple seasons of plant control.

Although Hydro-Raking is potentially a viable option for the area selective control of the excessive plant growth, the current bathymetry most likely precludes machine access to a large portion of the pond. In addition, the removal of plant material through mechanical Hydro-Raking does not address the existing accumulation of unconsolidated sediment, which undoubtedly contributes to the dense and widespread growth of rooted plants. The Hydro-Rake is an inefficient tool for the removal of bottom sediments on the scale that is required in Mill Pond; therefore, this technique is likely not the most appropriate initial management strategy, but is certainly well suited for future maintenance of desirable in-pond conditions.

**Mechanical Harvesting** - Mechanical cutting or harvesting on the other hand is not a recommended management technique. Mechanical harvesters have large cutting heads that cut the vegetation off just above the bottom of the pond. This technique is generally used for the control of plants that propagate exclusively through seed production. The method is to remove the vegetative portion of the plant before it has an opportunity to produce seeds. However, some of dominant plant species present in Mill Pond are perennial plants that re-grow each year from the same root system; therefore, cutting the plants and leaving the root system would provide little if any long-term control. It has been our experience that due to the rapid growth rate of many aquatic plant species multiple cuttings are often required for even season long control, thereby significantly reducing the cost effectiveness of a harvesting project. Not to mention that, like mechanical Hydro-Raking, the current water depths limit machine access to a large portion of the pond.

### *Chemical (Herbicide) Treatment*

Chemical treatment is often the most cost-effective and least disruptive means of nuisance aquatic vegetation control. Chemical treatment offers both species and area specific control, and often a longer duration of control of certain plant species. Because the Hydro-Rake is unlikely able to access all areas of the pond requiring some level of plant control, chemical treatment may be better suited to provide a short-term reduction of plant growth. The use of herbicides as a short-term or maintenance technique will reduce overall management costs and likely result in less impact to the aquatic system over the long-term.

**Reward (Diquat)** - When selecting the appropriate herbicide for a particular project it is necessary to take many outside variables into consideration. For instance, in the case of Mill Pond the two most influential factors in determining the proper herbicide are the potential for high water flows through the system and the types of vegetation that would be targeted for control. After considering all of the variables it was determined that Reward® (active ingredient diquat) is best suited for the control of the dominant plant species, ribbon-leaf pond and coontail. Reward is quickly absorbed into target plants and is therefore not as severely impaired by the flushing of high flows. It has a relatively low level of mobility in the water column allowing for area specific application, and it is extremely effective on all of the dominant submersed plants present in the pond.

We feel that Reward herbicide treatment is a viable option for the short-term control of excessive plant growth. By targeting a maximum of 60%-80% of the heaviest submersed plant growth at the southern end of the pond, open water area can be increased to provide more desirable habitat value. A single Reward treatment performed in the late spring (i.e. May/June period) of the year, when the plants are immature (not at full biomass) will not only provide season long control, but will also reduce the level of sedimentation derived from the annual decomposition of aquatic plant material. Reward, however, is a contact herbicide, killing only the vegetative portion of plant; therefore, annual or biennial (once every two years) treatment may likely be required to maintain desirable conditions.

**AquaPro (Glyphosate)** – The control of the existing emergent bur-reed growth in the central portions of the pond could be selectively controlled with a glyphosate based aquatic herbicide. AquaPro is a systemic, foliar active herbicide, which means that the active ingredient controls both the vegetative portion of the plant and the roots and is only active when it comes in direct contact with vegetation foliage. It has no activity in surrounding soil or water, so the potential for non-target impacts is further reduced. This property allows for very area selective management.

The translocation of the herbicide is partly dependent upon the plant's movement of starch to its root structures; therefore, treatment with AquaPro is most effective later in the growing season (August) when plants are preparing to over-winter by moving carbohydrate reserves down into their roots. Due to the fact that the herbicide must be in contact with the exposed plant foliage for proper control to occur, it may be necessary to perform a second follow-up treatment to insure that targeted control is achieved.

Because AquaPro is a systemic herbicide, a single season of treatment will generally provide multiple years of control. The selective control of the bur-reed growth in the central portions of the pond, while at the same time preserving desirable shoreline emergent growth, will limit the spread of this expanding plant community. Therefore, proper management of these selected stands of growth will promote the proper balance and distribution of the emergent zone. As with the submersed plant growth, reduction of the emergent plants will reduce sedimentation rates derived from annual plant decomposition.

### *Dredging*

The removal of nutrient rich sediments and the subsequent deepening of waterbodies is sometimes used to control rooted aquatic vegetation. When utilizing dredging as a vegetation control method there are two primary objectives. The first is to remove the organic nutrient rich sediment to eliminate an internal source of nutrients, and the second, is to increase the depth of the water to a minimum of 8-10 ft., which is typically sufficient depth to preclude adequate light from penetrating to the pond bottom. By changing these morphological features of the pond the area that can be colonized by rooted vegetation is reduced. It is also important to understand that dredging does not always eliminate nuisance aquatic vegetation problems, therefore, requiring additional in-pond management activities to maintain adequate control. Dredging of Mill Pond would be designed to optimize and enhance the ponds features through the removal of sediment in selected areas, while leaving other pond areas undisturbed.

Mill Pond would undoubtedly benefit from a dredging project. The pond has a considerable layer of unconsolidated sediment and very shallow water depths; however, in order to achieve the recommended depths of 8-10 ft. over a substantial portion of the pond, a significant portion of the ponds hard packed refusal layer (sand, gravel, and/or clay) would need to be removed. Removal of the accumulated unconsolidated sediment alone would require a significant time and financial commitment and the additional removal of a portion of the ponds consolidated refusal layer would further add to that commitment.

The two most commonly used methods of sediment removal are conventional dredging and hydraulic or suction dredging. Hydraulic dredging consists of a floating barge that is equipped with a rotary auger and a large pumping system. The auger digs and suspends the soft sediment component of the pond bottom so that it can be pumped through a pipeline, as a sediment water slurry, to a nearby containment basin. The containment basin allows the sediments and other suspended particles to settle out of the water column to the bottom. Following this process the water is decanted off the top of the basin and returned to the pond, leaving the sediment behind.

The construction of a detention basin adequate to hold the volume of removed sediment would require a significant amount of space in close proximity to the removal area (generally within a 0.25-0.50 mile). A dredging project of only two acres in Mill Pond would require a detention basin of approximately 1.5-2.0 acres and a volume of at least 40,000 cubic yards. In addition to requiring the construction of a large detention basin suction dredging is also limited to the removal of the soft unconsolidated sediment only. The advantage to this technique is that it does not require complete dewatering of the pond, and therefore imposing, significantly less impacts to adjacent wetlands and resident fish and wildlife. Although perhaps operationally possible, it is unlikely that suction dredging is the most feasible and cost effective sediment removal strategy for use at Mill Pond.

Conventional dredging on the other hand, involves the use of traditional excavation equipment after the pond has been dewatered. Excavation equipment enters the dewatered pond basin and removes bottom sediments until the desired depths are achieved. When designing such a dredging project often times the most complicated task is the complete dewatering of the waterbody and the diversion of the inlet waters. There are many different ways a pond can be drained. In the case of Mill Pond, it appears that the current flashboard controls will allow simple gravity dewatering, which consists of merely removing all of the boards to enable the impounded water to flow downstream until the pond is drained.

To facilitate a dredging project following dewatering measures must be taken to prevent the pond from filling back up. This is typically accomplished by the timing of the project (mid to late summer when flow rates are often at there lowest) and by diverting the inlet water around the pond basin. In waterbodies that have small watershed areas, and therefore less potential for high flows, refilling can often be avoided by the timing of the project and a simple pumping system to drawdown head waters when they threaten to overflow into the pond. When dealing with waterbodies that have large watershed areas and minimum downstream flows, like Mill Pond, more comprehensive diversion measures must be considered. In the case of Mill Pond it may be necessary to construct a diversion ditch around the pond or a wooden diversion channel to accommodate the significant volume of water that routinely flows through the system as well as elevated storm flows. When diverting normal flows around the pond basin using a diversion ditch it is not uncommon to experience a significant amount of erosion and scouring of the disturbed sediments. This is a concern because increased turbidity can have impacts on the remaining fish and wildlife populations as well as an increased potential for accelerated sedimentation downstream.  Therefore, lining the ditch with gravel, or constructing a wooden conveyance channel should mitigate the potential for erosion and the associated negative impacts.  In the case of Mill Pond conventional or dry dredging is likely the more feasible and cost effective strategy.

Dredging is a feasible and likely the most recommended long-term management alternative for Mill Pond.  Dredging is the only technique that will address, at least in part, both the excessive growth of rooted vegetation and the significant accumulation of sediment.  Dredging is certainly the only technique that can appreciably restore the pond's water depths.  Although dredging is likely the best initial management strategy under the current pond conditions, it does not come without potentially significant non-target environmental impacts and multiple design and operational hurdles.  In addition to potential undesirable impacts and the obvious project design considerations, dredging carries with it a complex multi-tiered permitting process with local, state and federal agencies, not to mention potentially cost prohibitive operational expenses.  We would anticipate that the design and permitting expenses alone for a conventional dredging project of this size would range between $20,000-$30,000.  The actual operational costs depend on the amount of material removed, but reasonable unit cost estimates may run between $20-$30 per cubic yard of material removed.  Therefore, removal of an average of ~5.0 ft of sediment over approximately 2.5 acres of the pond would generate approximately 20,000 cu-yds of removed spoils. The total operational dredging cost at a rate of $20-$30 /cu-yd. would be in the range of $400,000-$600,000.  Costs may also run higher, depending upon certain permit conditions and other complicating factors, such as restrictions on the disposal of the removed sediments and trucking distance to the final disposal site.

## SUMMARY

Mill Pond is significantly impacted by dense aquatic vegetation growth and shallow water depths resulting from the accumulation of unconsolidated organic sediments.  The dense vegetation, if left unmanaged, will continue to degrade water quality, impact the pond's fish and wildlife populations, and further contribute to the already seemingly accelerated sedimentation/filling in of the pond.  The pond management plan for Mill Pond should, therefore, focus on the area selective removal accumulated organic sediments, as this internal nutrient source and resulting alteration of the ponds morphology likely contribute significantly to the current unbalanced growth of aquatic vegetation and algae. The restoration of water depths in Mill Pond will not only improve in-pond habitat and recreational values, but should also enhance the waterbodies possible nutrient retention capabilities, which will further protect Tisbury Great Pond from undesirable nutrient loading.

Although dredging is the primary recommended in-pond management strategy, future sediment and vegetation management is likely to be required post-dredging.  Possible alternatives for the maintenance of desirable in-pond conditions may include mechanical Hydro-Raking and chemical treatment or an integration of both techniques.  Regardless of whether active in-pond management is required post-dredging some level of on-going monitoring should occur following the implementation of any large scale management project. Monitoring may be the most important facet of an ongoing program as it allows for the early detection of possible management issues and the timely implementation of pointed, small scale, low-impact management strategies.

The following specific management activities are suggested for consideration or inclusion in the development of a long-term management plan for Mill Pond.

- Reduce the amount of vegetation growing throughout the pond. The most appropriate techniques are dredging, mechanical Hydro-Raking, or chemical treatment. Hydro-Raking and chemical treatment are only short-term solutions under the current conditions.

- Implement annual or biannual monitoring and sampling program to document the rate of regrowth and identify the possible introduction of exotic and invasive vegetation species. Water sampling to establish baseline water quality values and identify seasonal nutrient fluctuations to aid in the timing of appropriate management measures.

- Implement Best Management Practices to address the sources and/or transport of external nutrients from the ponds surrounding watershed.

- Perform more detailed watershed investigation in order to determine potential watershed management concerns and establish baseline data that will potentially aid in the development of specific management alternatives.

An estimated cost summary for various management techniques follows. We encourage you to contact us if you have any questions or would like to discuss possible alternatives to the recommended techniques.

## COST SUMMARY

### TABLE 4 – MULTI-YEAR COST ESTIMATES FOR FEASIBLE MANAGEMENT OPTIONS

| *Feasible Management Options* | *Estimated Cost Range* | | | |
|---|---|---|---|---|
| | *Permitting & Design* | *Year 1 (2007)* | *Year 2 (2008)* | *Year 3 (2009)* |
| ▪ Mechanical Hydro-Raking for the short-term/maintenance removal of undesirable vegetation growth and accumulated organic debris. | \$2,500-\$3,000[1] | \$44,500-\$51,000[2] | ---- | \$33,000-\$40,000[2] |
| ▪ Area selective short-term control of excessive emergent and submersed vegetation growth with Reward and Rodeo herbicides. | \$2,500-\$3,000[1, 3] | \$5,000-\$5,500 | \$4,500-\$5,000 | \$4,250-\$4,500 |
| ▪ Comprehensive dredging project in order to restore water depth and limit rooted vegetation growth. | \$20,000-\$30,000[4] | \$400,000-\$600,000[5] | \$5,000-\$6,000[6] | \$5,000-\$8,000[6, 7] |

[1] - *Cost includes our preparation & filing of the necessary NOI application and supporting information as well as our attendance at one public hearing. Expenses consist of direct reimbursable costs such as filing fees, certified mailing, copying, etc…and typically do not exceed an additional \$500-\$1,000.*

[2] – *The cost of a local contractor to handle the required shore-based operations (loading, trucking, and disposal of the removed materials) are not included in the figures provided. Although these costs will vary based on the contractor selected, we generally advise our clients to assume 50%-70% of the actual Hydro-raking costs for budgeting purposes.*

[3] – *The application of pesticides to Massachusetts waters requires an additional site specific permit called a License to Apply Chemicals issued by the MA DEP – Office of Watershed Management. This permit must be filed on an annual basis. The cost for preparation, filing, and all associated fees is \$250/year.*

[4] – *Although Aquatic Control has considerable experience with dredging, a project of this magnitude would benefit from an environmental/engineering firm to complete the final project design and permitting phase.*

[5] – *This operational cost is an estimate based on typical unit costs for the dredging of associated sediment volume. Actual costs may vary significantly based on possible permit conditions and unforeseen operational complications. Also due to the relative scarcity of organic loam on the island, the operational dredging costs could possibly be partially off-set by the sale of the dredge spoils to the selected dredging contractor for future processing into saleable loam.*

[6] – *Following a dredging project of this size some level of post-dredging monitoring will likely be required by the permitting agencies. This cost estimate is based on what we would expect to be the minimum level of follow-up assessment.*

[7] – *Because it is unlikely that a sufficient areal percentage of the pond will be able to be deepened adequately to preclude the growth of rooted vegetation, some level of vegetation management may be required as soon as two years post-dredging. For this reason we have included the expense of some small scale area selective chemical treatment in year three.*

# APPENDIX A

***Figure 1 – Site Locus Map***
***Figure 2 – Data Point & Sample Collection Site Map***
***Figure 3 – Vegetation Distribution Map***
***Figure 4 – Bathymetry Map***
***Figure 5 – Unconsolidated Sediment Thickness Map***
***Figure 6 – MA DEP Wetland Resource Area Delineations***


# 2006 Mill Pond Baseline Assessment

## Site Locus Map

West Tisbury, MA

| FIGURE: | SURVEY DATE: | MAP DATE: |
|---|---|---|
| 1 | 9/15/06 | 11/10/06 |

**Legend:**

0 1,000 2,000 4,000 Feet


AQUATIC CONTROL TECHNOLOGY, INC.

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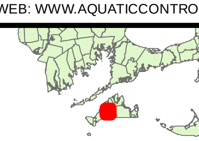


# 2006 Mill Pond Baseline Assessment

## Data Point and Sample Collection Site Map

West Tisbury, MA

| FIGURE: | SURVEY DATE: | MAP DATE: |
|---|---|---|
| 2 | 9/15/06 | 11/10/06 |

**Legend:**

Ñ Water sample collection sites

a1-f6 - DGPS recorded data points

0 60 120 240 Feet

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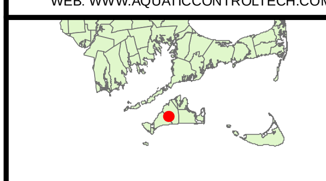

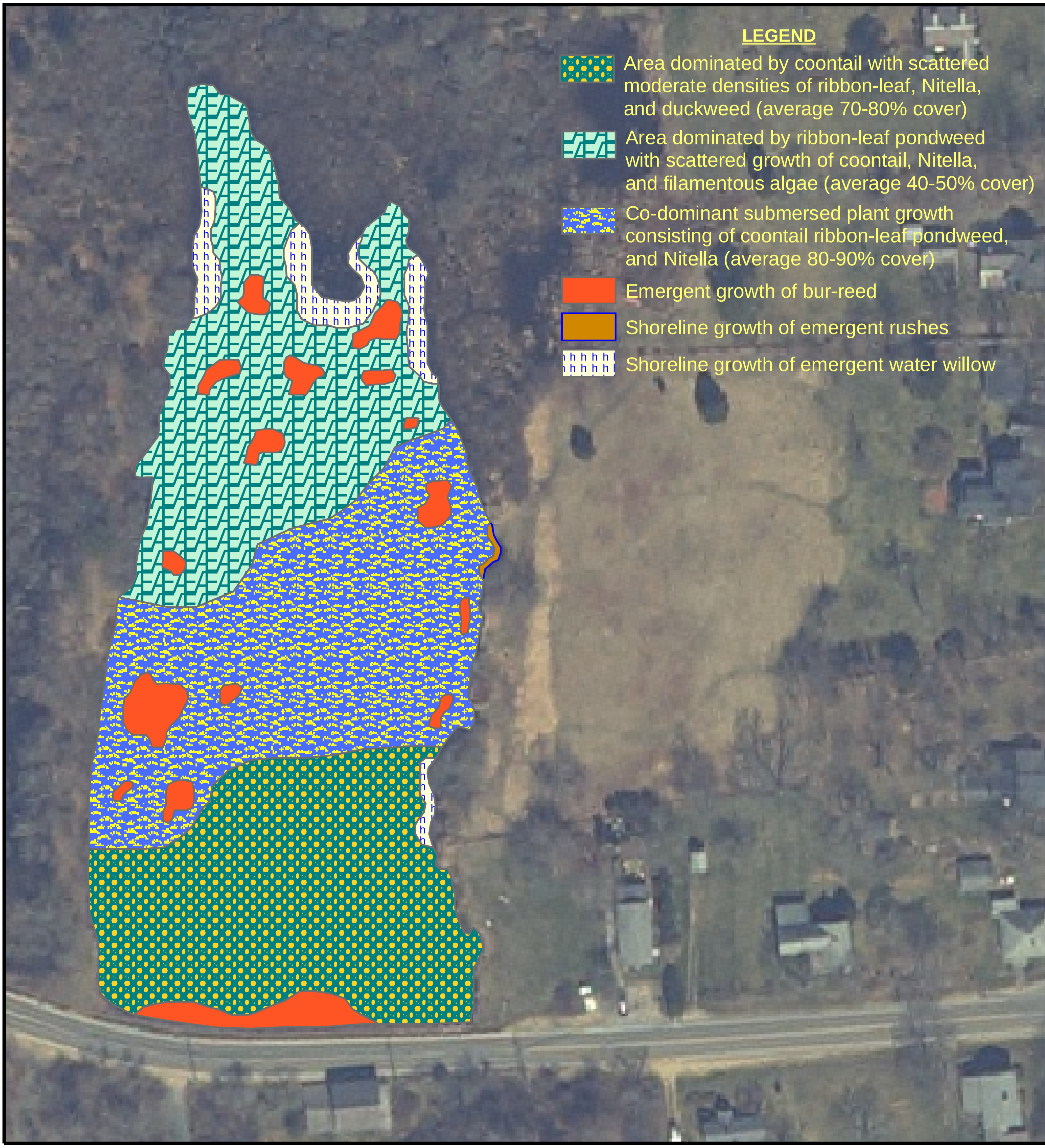


# 2006 Mill Pond Baseline Assessment

Vegetation Distribution Map

West Tisbury, MA

| FIGURE: | SURVEY DATE: | MAP DATE: |
|---|---|---|
| 3 | 9/15/06 | 11/10/06 |

0 55 110 220 Feet

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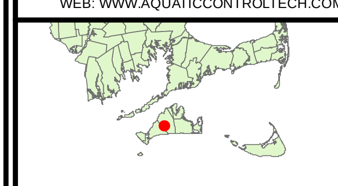

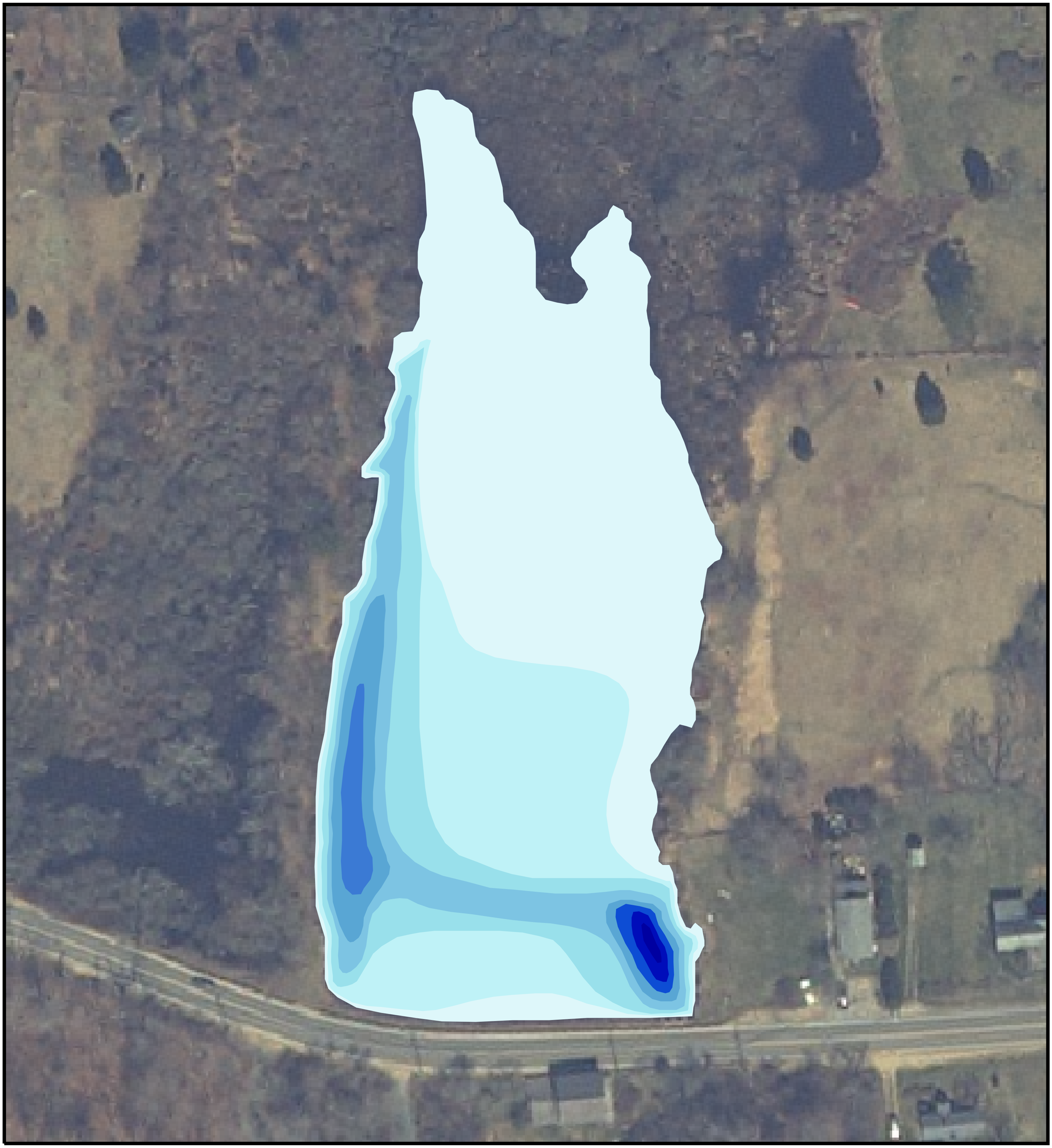

# 2006 Mill Pond Baseline Assessment

Bathymetry Map

West Tisbury, MA

| FIGURE: | SURVEY DATE: | MAP DATE: |
| --- | --- | --- |
| 4 | 9/15/06 | 11/10/06 |

**Legend:**

0-1 FT.
1-2 FT.
2-3 FT.
3-4 FT.
4-5 FT.
5 FT.
5-6 FT.
6-7 FT.
7 FT.

0 50 100 200 Feet

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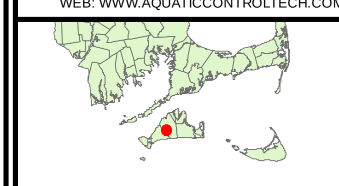

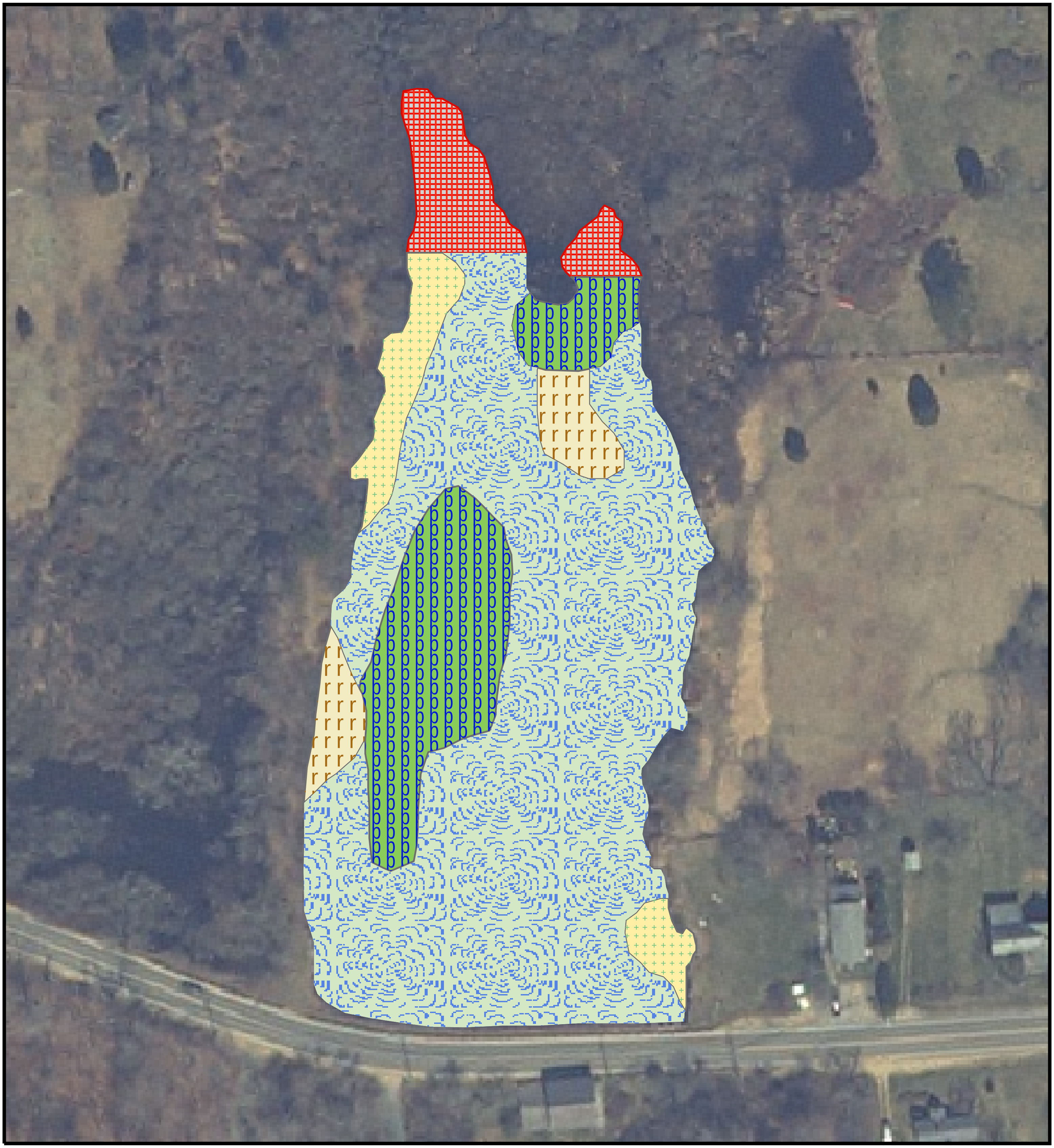

# 2006 Mill Pond Baseline Assessment

Unconsolidated Sediment Thickness Map

West Tisbury, MA

| FIGURE: | SURVEY DATE: | MAP DATE: |
|---|---|---|
| 5 | 9/15/06 | 11/10/06 |

## Legend

- 0.5-2.0 FT
- 2.5-3.0 FT
- 3.5-4.0 FT
- >4.0 FT
- Area not surveyed - inaccessible by boat or foot

0 50 100 200 Feet


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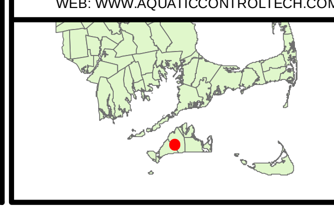

# 2006 Mill Pond Baseline Assessment

MA DEP Wetland Resource Area Delineations

West Tisbury, MA

| FIGURE: | SURVEY DATE: | MAP DATE: |
|---|---|---|
| 6 | 9/15/06 | 11/10/06 |

**Legend:**

- SHRUB SWAMP
- OPEN WATER
- WOODED SWAMP DECIDUOUS

*Wetland resource area delineations provided by June 2006 MA DEP Wetlands datalayer from MassGIS*

0 150 300 600 Feet


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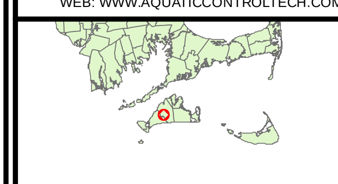


# APPENDIX B

***Vegetation Survey Data***
***Water Quality Analysis Lab Sheets***

| | | 9/15/06 Survey Data | | | | |
|---|---|---|---|---|---|---|
| **Transect** | **Data Point** | **Water Depth** | **Sediment Thickness** | **Vegetation** | **Percent Vegetation Cover** | **Biomass Index** |
| A | 1 | 0.3 | 4.0 | Pe, S, Lm | 50 | 4 |
| A | 2 | 0.2 | 3.0 | Pe, S, Lm | 100 | 4 |
| A | 3 | 0.3 | 3.5 | Pe, Lm | 50 | 4 |
| A | 4 | 0.3 | 2.0 | Pe, S, Ni | 75 | 4 |
| A | 5 | 0.4 | 1.5 | S, Lm | 5 | 4 |
| B | 1 | 0.6 | 2.5 | Pe, Lm, Ni, Cd | 100 | 4 |
| B | 2 | 0.6 | 3.5 | Pe, Cd, Ni, FA | 25 | 4 |
| B | 3 | 0.2 | 3.0 | Pe, FA | 25 | 3 |
| B | 4 | 0.2 | 3.5 | Pe, FA, S, Pp | 25 | 4 |
| B | 5 | 0.8 | 2.5 | Pe, Cd, FA, Lm | 75 | 4 |
| B | 6 | 3.5 | 6.5 | Lm, FA, Cd | 15 | 4 |
| C | 1 | 3.5 | 3.0 | Pe, Lm, Cd, S | 40 | 4 |
| C | 2 | 1.0 | 2.0 | Pe, Cd, Ni | 100 | 4 |
| C | 3 | 1.0 | 2.0 | Cd, Pe, Ni, S, Lm | 100 | 4 |
| C | 4 | 1.0 | 2.5 | Pe, Cd, Ni, S, Lm | 100 | 4 |
| C | 5 | 1.0 | 2.5 | Cd, Ni, Pe, S | 100 | 4 |
| C | 6 | 1.0 | 3.0 | Cd, Pe, S | 100 | 4 |
| C | 7 | 1.0 | 3.0 | Cd, Pe, S, Ni | 100 | 4 |
| D | 1 | 1.0 | 3.0 | Cd, Pe, Lm, S | 80 | 4 |
| D | 2 | 1.5 | 2.5 | Cd, Pe, Ni | 80 | 3 |
| D | 3 | 1.5 | 2.5 | Cd, Ni | 100 | 4 |
| D | 4 | 1.5 | 2.0 | Cd, Pe, FA | 100 | 4 |
| D | 5 | 1.5 | 1.5 | S, Cd, Pe, Ni | 100 | 4 |
| D | 6 | 3.0 | 1.0 | S, FA, Lm | 30 | 4 |
| D | 7 | 5.0 | 3.5 | S, Cd, FA | 30 | 4 |
| E | 1 | 5.5 | 2.5 | FA, S, Lm | 10 | 2 |
| E | 2 | 2.5 | 0.5 | S, Cd, Pe, FA, Lm | 100 | 4 |
| E | 3 | 1.5 | 3.0 | Cd, Pe | 100 | 4 |
| E | 4 | 1.5 | 2.5 | Cd, Ni, Pe | 75 | 4 |
| E | 5 | 1.5 | 2.5 | Cd, Pe | 40 | 4 |
| E | 6 | 1.0 | 3.0 | Cd, Pe | 60 | 4 |
| F | 1 | 7.0 | 5.0 | Cd | 40 | 3 |
| F | 2 | 2.0 | 3.0 | Cd, Pe, Ni | 100 | 4 |
| F | 3 | 1.5 | 2.5 | Cd, Pe, S, Ni | 100 | 4 |
| F | 4 | 1.5 | 2.5 | Cd, Pe, S, Ni | 100 | 4 |
| F | 5 | 2.0 | 2.5 | Cd, S | 50 | 3 |
| F | 6 | 4.0 | 3.0 | Cd, S | 50 | 3 |
| | **Averages** | **1.7** | **2.8** | | **68.38** | **3.81** |

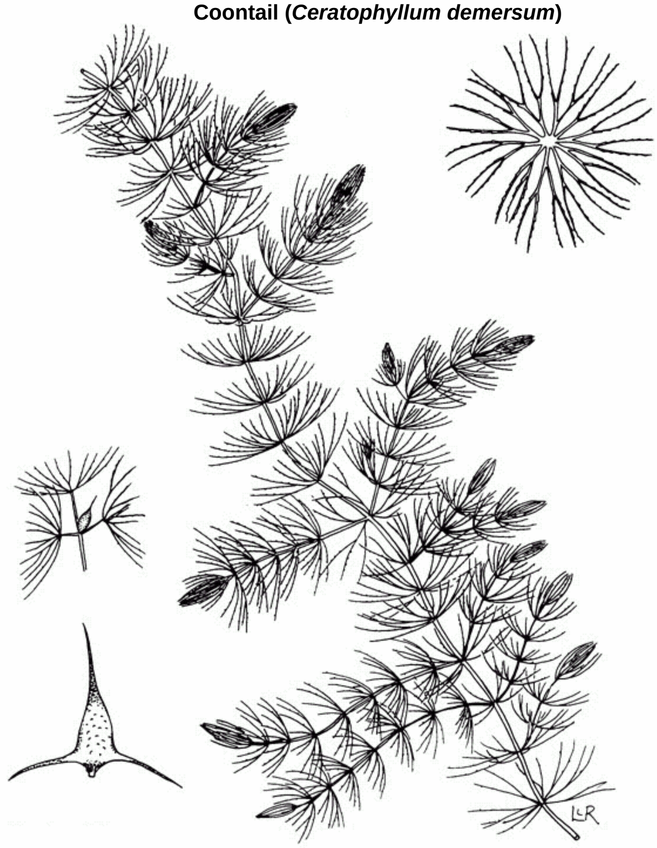
# APPENDIX C

***BMP – Best Management Practices Information***

# APPENDIX D

*Mill Pond Dominant Plant Line Drawings*

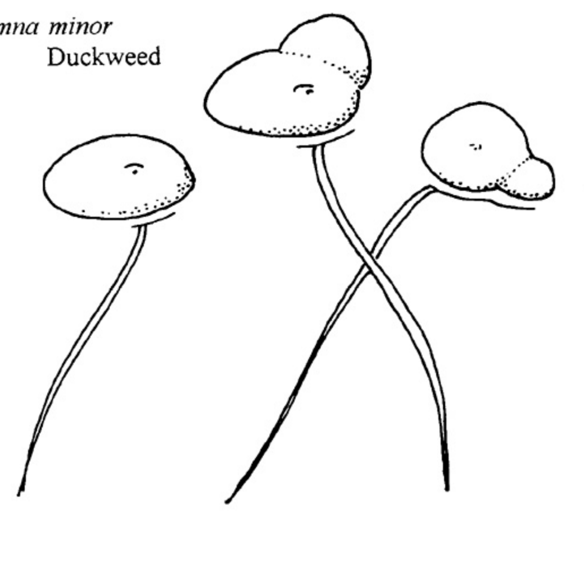
**Coontail (*Ceratophyllum demersum*)**

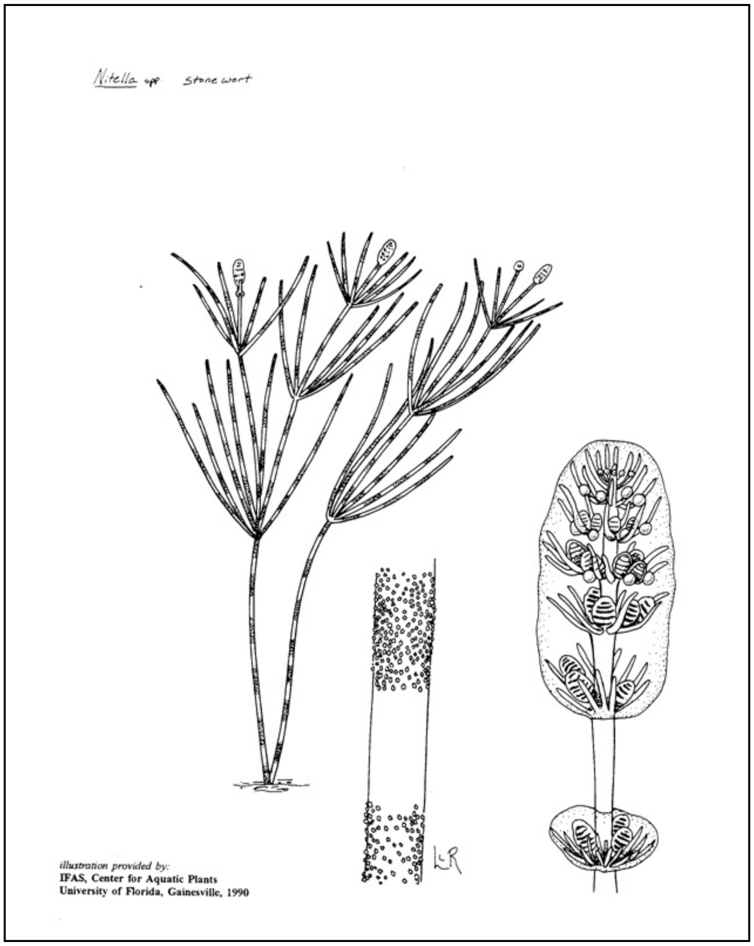


**Thin-leaf Pondweed (*Potamogeton pusilis*)**

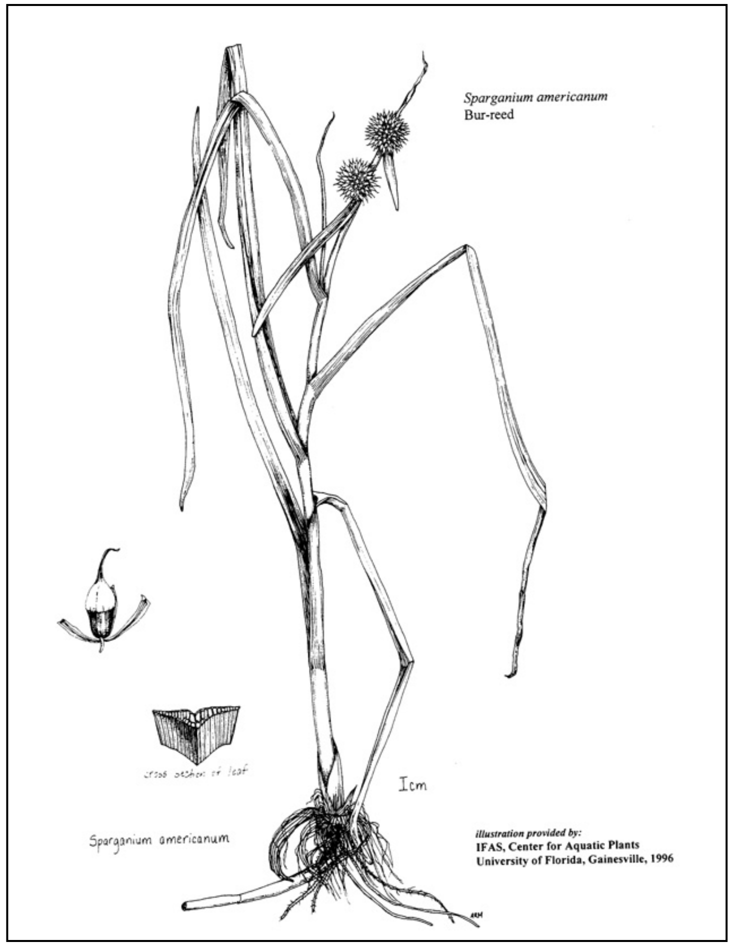

**Ribbon-leaf Pondweed (*Potamogeton epihydrus*)**


*Lemna minor*
Duckweed

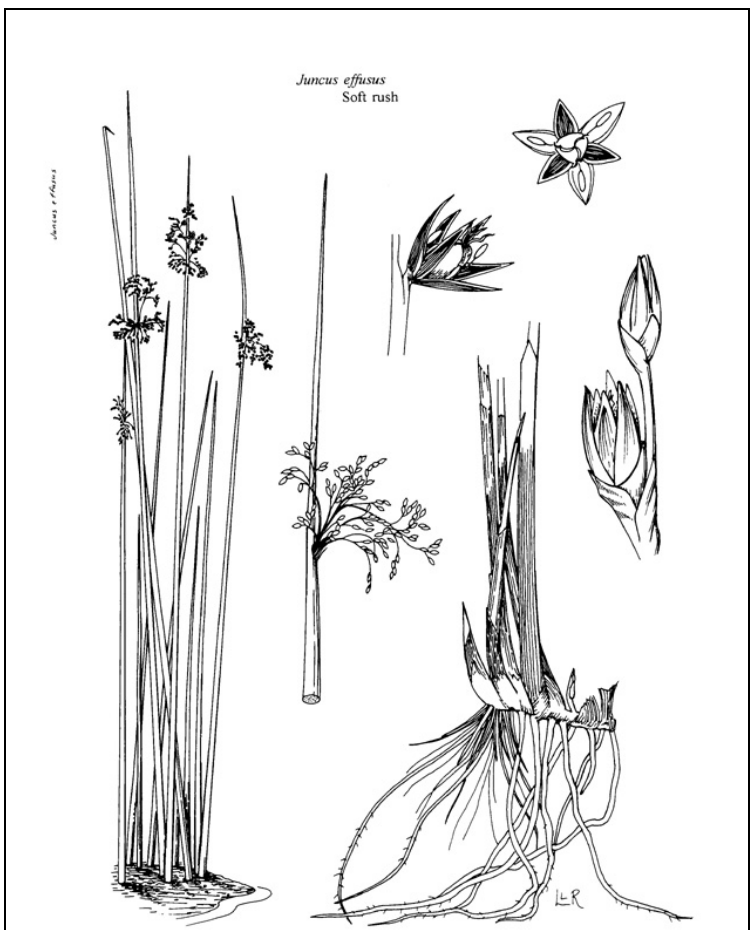




Nitella spp stonewort
illustration provided by:
IFAS, Center for Aquatic Plants
University of Florida, Gainesville, 1990

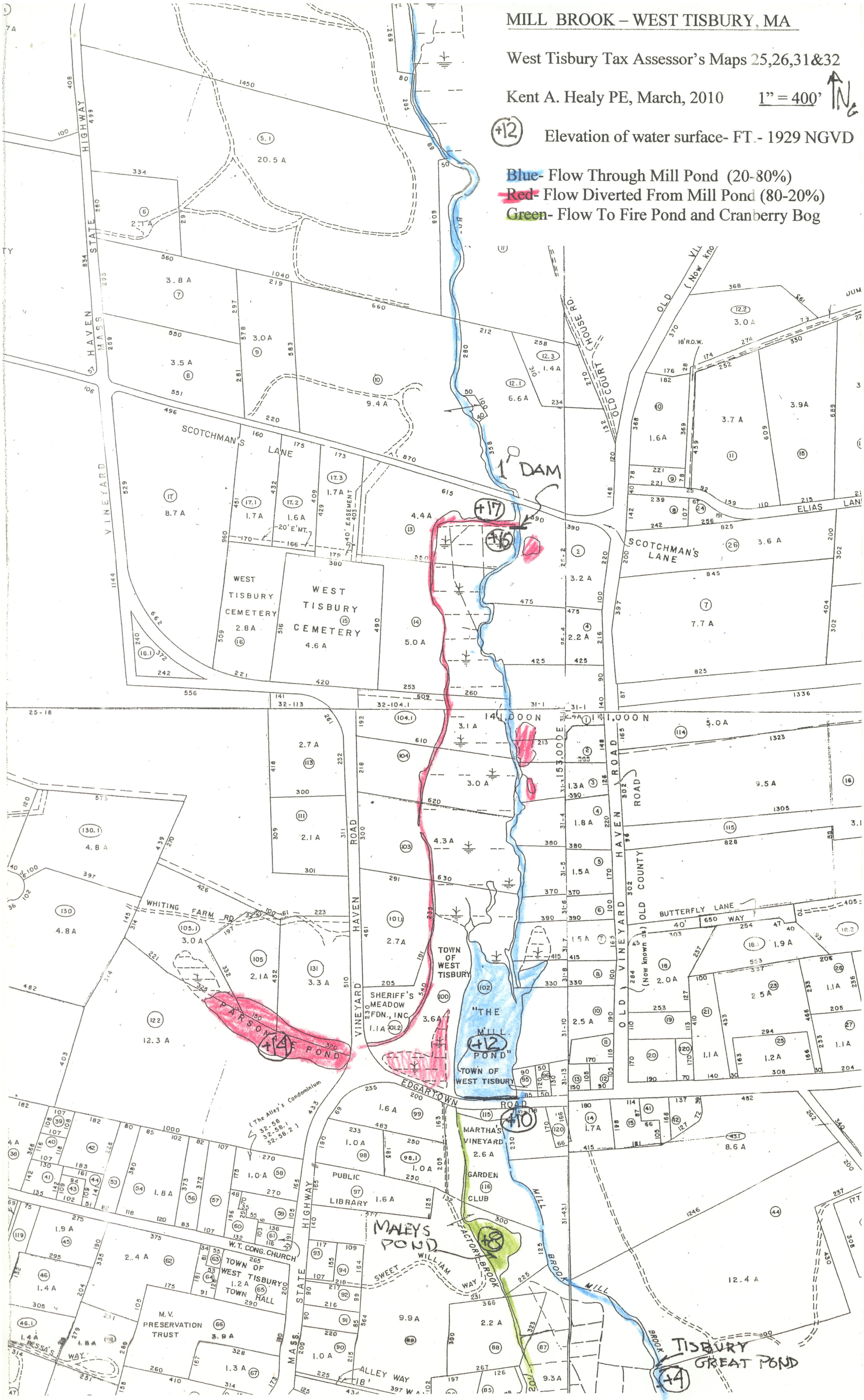



Sparganium americanum
Bur-reed
cross section of leaf
1cm
Sparganium americanum
illustration provided by:
IFAS, Center for Aquatic Plants
University of Florida, Gainesville, 1996

Juncus effusus
Soft rush

# APPENDIX D
# Annotated Parcel Map


MILL BROOK – WEST TISBURY, MA
West Tisbury Tax Assessor's Maps 25,26,31&32
Kent A. Healy PE, March, 2010
1" = 400'
N
(+12) Elevation of water surface- FT.- 1929 NGVD
Blue- Flow Through Mill Pond (20-80%)
Red- Flow Diverted From Mill Pond (80-20%)
Green- Flow To Fire Pond and Cranberry Bog
1' DAM
+17
+16
"THE MILL POND"
+12
+10
PARSONS POND
+14
MALEYS POND
+8
TISBURY GREAT POND
+4
MILL BROOK
FACTORY BROOK
VINEYARD HAVEN ROAD
OLD VINEYARD HAVEN ROAD
OLD COUNTY ROAD
EDGARTOWN ROAD
MASS. STATE HIGHWAY
SCOTCHMAN'S LANE
WEST TISBURY CEMETERY
TOWN OF WEST TISBURY
SHERIFF'S MEADOW FDN., INC.
MARTHA'S VINEYARD GARDEN CLUB
PUBLIC LIBRARY
W.T. CONG. CHURCH
TOWN OF WEST TISBURY TOWN HALL
M.V. PRESERVATION TRUST
WHITING FARM RD
BUTTERFLY LANE
ELIAS LANE
OLD COURT HOUSE RD.
SWEET WILLIAM WAY
ALLEY WAY