Mill Brook Stormwater Runoff Assessment

DRAFT

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Acknowledgements:
This project was funded by the West Tisbury Conservation Commission and the Riparian Owners of Tisbury Great Pond. Bacterial samples were analyzed at the Wampanoag tribe's Environmental Lab and nutrient and total suspended solids samples at the UMass Coastal Systems Group, New Bedford Lab. Fiona MacLean, water resource summer intern, assisted with the sampling and sample processing during 2007.

Background:
Stream flow has been measured at the spillway out of Old Mill Pond at an approximate daily average flow of 17,363 cubic meters per day (0.61 million cubic feet or 4.6 million gallons per day). Stream input (including the Tiasquam) comprises about 33% of the annual water budget of Tisbury Great Pond (Fugro-McClelland, 1992).

The stream receives runoff at numerous locations along North Road, at the point where it crosses under State Road, at the Scotchman's Lane crossing and at the Edgartown road. The goal of this project was to assess the nutrient, silt and bacterial content in the stream at the road crossings during dry whether and under runoff conditions. Sample stations from south to north were located at the downstream side of:

- The outflow from Mill Pond on the Edgartown Road (Station MB-1),
- At the Scotchman's Lane crossing (Station MB-2),
- At the State Road crossing (MB-3) and
- The North Road crossing of a small unnamed stream flowing into Priester's Pond (MB-4).

An evaluation of stormwater impacts was suggested by a consultant (ACT, 2007) as a follow up to their evaluation of the current pond condition (ACT, 2006). In addition to road crossings where runoff may impact the stream, at the suggestion of the Conservation Commission, a sampling station was added at the mid-point between stations MB-2 and MB-3 and identified as station MB-5. All sampling locations are shown in Figure 1.

Saunders Associates (1990) sampled the stream during runoff at the State Road crossing near the North Road intersection and at the Mill Pond outlet. Samples were sent out for bacterial, nutrient and metals analyses. High total and fecal coliform counts, lead and copper concentrations and total phosphorus content were found. The study concluded that the stormwater discharge was detrimental to the stream and Tisbury Great Pond and that steps should be taken to reduce the flow at the discharge points by diverting runoff into vegetated areas.

In the late 1980's, the Tisbury Great Pond Think Tank with the assistance of the USDA Natural Resource Conservation Service identified stream road crossings where diversions into buffering vegetation could be accomplished to reduce the direct input of contaminants during runoff. The Chilmark and West Tisbury Highway Departments implemented a number of the suggested plans

Figure 1
Mill Brook Sample Stations

Mill Pond Area
West Tisbury, MA

20100 200400
Feet

N

Note: This map is for planning purposes only. It is not adequate for legal boundary definition. The MVC cannot be responsible for how this data is used or interpreted by the end user.

Prepared by: The Martha's Vineyard Commission, CL Seidel, 12/11/07, www.mvcommission.org, 508-693-3453
Data: Aerial Photo - MassGIS 2005; Parcel Boundary - Full Circle 2007
Coordinate Reference: State Plane, Mass Mainland, NAD 83, Meters
File: cls_estuaries, millpond_area.mxd; original in color

and many are still in place. Diversions and runoff chutes into bordering vegetation were found to be still in place at the stream crossings at stations MB2, MB3, and MB4. Catch basins are in place west of MB1.

The Stream:

Mill Brook is a 2.4 mile long stream draining the Western Moraine with a topographic watershed of approximately 2700 acres. From its headwaters near Tea Lane, the stream flows in a northeast direction until it reaches the State Road- North Road intersection where it makes a sharp turn toward the south. It is believed that this indicates the ancient stream was a victim of "stream piracy", being captured and diverted by south flowing drainage sometime in the early post-glacial time.

The stream receives tributary flow from Witch Brook that flows into Crocker Pond and from an unnamed ephemeral stream that flows into Priester Pond and was the site of sample station MB4. The stream is dammed at numerous locations along its length including the following:

1. Fisher Pond
2. Crocker Pond
3. Priester Pond
4. Littlefield's Pond
5. Mill Pond
6. Approximately 8 other locations where small ponds have been excavated with or without a dam between the North Road and Mill Pond.
7. Parsonage Pond that receives diverted flow from Mill Brook.
8. A pond south of the Edgartown Road (Map 32 Lot 89) that receives flow from Mill Pond.

The numerous man made ponds set the stage for a complex hydrology where there may be recharge to the groundwater or seepage from groundwater to surface flow. For example, a groundwater study at a proposed subdivision on the southern shores of Priester and Crocker Ponds (Kendall & Associates, 1988), determined that both ponds received groundwater inflow on their northern shores but contributed seepage to the groundwater along part of their south shores.

North of Mill Pond and extending to north of Scotchman's Lane, the stream valley is filled with a large shrub swamp that is more than 20 acres in area. This wet area is all below the 20 foot contour on the quad sheet as is Mill Pond. It seems likely that the dam at Mill Pond has backed water up into this area to either create the swamp or to expand what may have been there naturally.

It is reported that the elevation of the stream is higher than the elevation in a groundwater well located just off Old County Road north of the intersection with Scotchman's Lane. This indicates that the stream may possibly be exfluent in its lower reaches, contributing water to the groundwater rather than receiving it from the groundwater (Healy, personal communication). The dammed water that rises behind the Mill Pond dam may well play a role in this condition. This phenomenon should be confirmed at other locations to determine the scale of the condition.

Groundwater contribution to stream flow is clearly indicated by the temperature profile at the sampling stations during the June 2007 sampling round that is significantly colder at MB4 than the other stations. In the Western Moraine, it is likely that groundwater recharge occurs at focused locations where permeable geologic formations coincide with depressions where surface runoff may contribute to recharge or in areas of level ground with permeable soil. Groundwater contributions to streamflow would occur wherever the stream intersects aquifers as well as in areas where it cuts across shallow, perched water tables.

Soil Types & Geology of the Watershed:

The geology of the upper watershed from about the North Road-State Road intersection to the headwaters is glacial moraine that developed by the direct deposition of sediment or the bulldozed redeposition of intact sections of earlier deposits by the advancing glacier to form the subgrade geology. In the low area between thrusted moraine blocks, Mill Brook formed and has deposited a wide range of fluvial sediment. The geologic deposits in the upper watershed are diverse, including materials that have widely varying characteristics from glacial till that may be compact and impermeable to stream deposits that may be sandy and permeable. From around the Town line south to Tisbury Great Pond, the stream flows in a valley where sand and gravel material supports the formation of more permeable soil types.

The soils that develop on these geologic deposits offer some insight into what lies below. The soil survey (USDA Soil Conservation Service, 1986) indicates that the stream is bordered by the Freetown-Swansea muck soil type, a wetland soil, along a good deal of its length. This soil has a continuous high water table, periodic ponding of water and moderate permeability indicating a likelihood of connection to the water in the Brook either subsurface or by surface runoff of water.

In addition, there are several more permeable soil types along the stream course that do not have standing water but have a seasonal high water table that may be at or near the surface. This combination may indicate areas where groundwater recharge is occurring that should be available to the stream's base flow as well as its seasonal higher stage flow. These include Berryland loamy sand and Pompton sandy loam, all with a seasonal high water table and sandy substrata.

Ridgebury fine sandy loam and Whitman silt loam have a seasonal high water table that is perched on clayey substrata. When bordering the stream, the perched water table in these soil types could also contribute to stream flow.

In addition to the wetter soil types described above that developed near the wet ground around the stream, the soil types further away from the stream thread also indicate subsurface geology of the stream valley. In the upper reaches of the Brook near Tea Lane the soil types beyond the bordering wetter soils described above are predominantly till soils with lower permeability that include:

1. Chilmark sandy loam that forms on red or grey clay at a depth of about 3 feet that is part glacial ice thrusted geologic material.
2. Moshup loam that develops on glacial till.

In addition, there are some relatively limited areas of East Chop loamy sand, a highly permeable soil in the Western Moraine stream valley. Generally, from the uppermost headwaters of the stream until the Chilmark-West Tisbury Town line, the lower permeability soils dominate near the Brook. These soil types are likely to contribute to stream flow mainly by contributing runoff to the wetlands that feed the Brook.

At the Town line, high permeability soil types begin to predominate including East Chop loamy sand, Haven very fine sandy loam, Riverhead sandy loam and some areas of Carver loamy coarse sand. From the area around Fisher Pond southward to Tisbury Great Pond, these four soil types are the only ones that border the wetland soil types directly adjacent to the Brook. These soil types develop on sandy glacial outwash or more recent stream deposits that are likely to support a permeable aquifer that may either contribute to stream flow or receive recharge from the stream.

Wetlands and Buffering Vegetation:

The stream and its wetlands perform several important ecosystem services that are valuable to Tisbury Great Pond. The primary function is the removal of some of the nitrogen load from wastewater and fertilizer application in the upstream watershed. This highly soluble nutrient is transported in the groundwater system but wherever the groundwater flow moves into a fresh water pond or wetland there is some loss of nitrogen content. At this time, we estimate that the stream system removes 50% of the nitrogen introduced into the watershed.

The stream has an extensive natural buffer along a substantial portion of its length. Exceptions include cleared fields along the following stretches:

- South shore of Fisher Pond- with only a narrow buffer strip
- Agricultural fields and a residential property along the north shore of Crocker with only a narrow buffer strip.
- Agricultural fields along Witch Brook flowing into Crocker Pond across North Road with only a narrow wooded buffer.
- Agricultural fields or large lawn along the southwest corner of Priesters with only a narrow buffer.
- Pasture along the ephemeral stream that flows into Priesters Pond with a narrow buffer.
- Mowed fields on Map 25 lot 4 around Littlefield's Pond.
- Hillside Farm agricultural fields with only a narrow buffer strip.

- Morning Glory Farm fields with a substantial, periodically grazed field buffer and a moderate natural buffer.
- Occasional grazing land on Map 25 lot 11 with only a limited buffer.
- Mowed fields and lawns associated with residential properties between Scotchman's Lane and the Edgartown Road with variable width natural upland and wetland buffers.

The entire length of the Brook except for the residential and farmland stretch along Old Courthouse Road is within Priority Habitat for rare species as mapped by the Massachusetts Natural Heritage and Endangered Species Program.

From a larger scale view, the proximal watershed of the stream is dominated by natural vegetation and farmland along the stretch parallel to North Road. At State Road and continuing south to Scotchman's Lane, the near watershed is dominated by agricultural uses, old fields and minor residential uses. From Scotchman's Lane south to Mill Pond, residential uses become important. South of the Edgartown Road, agricultural fields become significant and residential uses are a minor component.

Watershed Land Use:

At this time, land uses have been identified only for Tisbury Great Pond watershed as a whole. Woodruff and Saunders (1989) prepared a land use summary finding that about 15% of the watershed was built, 51% was vacant and buildable and 19% was conserved in the Correllus State Forest. The report recommended redesigning the existing runoff pattern at stream crossings to take advantage of vegetative buffering services. They also recommended a natural vegetation buffer at least 100 feet in width adjacent to surface waters and no residential structures within 200 feet of surface waters.

Land use in the watershed was updated by the MVC (2000) that separated land use figures by their location in either the outwash plain area or the combined stream watersheds within the Western Moraine. This study still did not separate the land uses in the Mill Brook watershed from those in the Tiasquam watershed. This study included an interim critical nitrogen load for the Great Pond and estimated that the load at that time was within about 10% of the critical point. In the 10 years between the two studies, the number of buildings in the watershed had increased from 811 to 841, only a 4% increase.

As the Massachusetts Estuaries Project continues to completion, updated land use figures will be developed for Tisbury Great Pond on a sub-watershed basis and figures for the Mill Brook watershed will be available.

Watershed Land Use Immediately Upstream from Sampling Points
Near stream (within about 1500 feet) watershed land use beginning at the upstream sampling point is as follows:

- **Station MB4:** The immediate watershed includes a small pasture area about 6 to 7 acres that periodically holds a limited number of cattle. The watershed also includes a wooded area and part of a low density residential area. Beyond the woodland to the west is the much larger Seven Gates Farm hay field including about 35 to 40 acres.
- **Station MB3:** The sample point is downstream from the Priester's Pond spillway and includes woodland and wooded swamp and a moderate density residential area.
- **Station MB5:** This station is located near farm fields that include fallow (4 acres), hay (about 9 acres) and sweet corn (about 6 acres). There is some lightly used pasture and woodland in the proximal watershed. There are very few nearby houses.
- **Station MB2:** The watershed includes very low density residential and open and wooded land as well as the agricultural uses described for station MB5. A substantial shrub swamp is immediately to the north of the sample point.
- **Station MB1:** The immediate watershed includes low to moderate density residential land uses. A large shrub swamp is in the upstream watershed.

Features Contributing to Runoff to the Sample Sites:
Site MB1 is located on the south side of the Edgartown Road near the Garden Club building. The potential runoff contribution area extends up the Edgartown Road just past old County Road, up State Road to the north near Whiting's Gallery and to the south to near Alley's General Store. This is a large catchment area.

The installation of catch basins on State Road just north of Parsonage Pond and on the Edgartown Road just east of the triangle coincide with locations proposed in 1993 and appear to have reduced the total runoff flowing toward the Pond. Runoff to the sample collection point from the west on Edgartown Road is largely captured by a catch basin on the south side of the road, by flowage into marginal vegetation and by spilling off the road at several locations directly into Mill Pond or bordering wetland under the precipitation conditions observed. From the east, there are two catch basins on the north side of the road and there is runoff off the road into bordering vegetation on the south side of the Road before the sampling point.

During the rainfall events observed, there was limited runoff from the Road into the immediate vicinity of the sampling point in the Brook. Spillage and splashing over the edge did occur but was not significant. On the west side of the Brook there is a paved discharge chute within about 10 feet of the Brook that carried limited amounts of runoff during the rain events.

Site MB2 is located at the Scotchman's Lane bridge on the downstream side of the road. In this area, the potential catchment extends to Old County Road to the east and for a significant distance along the Lane to the west. Runoff flowing along the crowned roadway from the west is directed into wetland vegetation on both sides of the road by small ditches cut through the bordering vegetation. A substantial flow was observed flowing toward the north side wetland during the rain events. Runoff into the immediate sampling point is limited to some flowage over the bridge and water from a large puddle on the south side of the road that is swept along the road by passing vehicles. Minimal direct runoff into the stream at this point was observed.

Site MB3 is located at the crossing of State Road just south of the intersection with North Road. On the south side of the stream, a catch basin intercepts a good deal of stormwater flowing along the east side of the Road. Runoff from the road also occurs into bordering grassy vegetation on both sides of the Road. From the north, runoff is generally into the grassy roadside vegetation. During the rain events, a limited amount of runoff was observed flowing off the bridge into the Brook. Under heavy rainfall some flow through the grassy vegetation on the north side of the Road into the stream might occur. The soil in that area appeared to be quickly saturated and could allow overland flow to occur.

Site MB4 is located on North Road at the point where an ephemeral stream flows out of pasture land on the north side of the Road. In July 2007, some cattle were in this field. At this sampling location, the road is banked on the curve and runoff is toward the south side of the road and is directed into grassy bordering vegetation or into small runoff chutes that direct it into shrubs along the roadway. Under heavy rainfall conditions some runoff could occur off the road across approximately 5 feet of grass border and through another 5 feet of light shrubs and leaf litter into the sampling point that was located on the south side of the Road. In the September 2008 rain event there was some runoff that followed this path into the stream but it did not appear to be substantial during the sampling time period.

Site MB5 is located in the Brook at the southeast corner of the lot where Morning Glory Farm grew sweet corn in 2007 and 2008 (Map 25 Lot 5.1). Between the cropland and the stream there is about 100 feet of old pasture that slopes gently at first toward the stream and then dips steeply down to the stream level where the natural tree and shrub vegetation begins. It does not appear likely that there is any runoff from the cropland that could make its way to the Brook without being substantially infiltrated or filtered.

Weather record:

Sampling at a number of locations during a storm event has many pitfalls. One problem is the rainfall that stops before all stations are sampled. This was the case for the July 24, 2008 sampling round where three stations were sampled and there was no runoff after that point. Total rainfall recorded at the National Weather Service station in Edgartown (Lovewell) and at a rain gauge in West Tisbury is reported in Table 1.

Dry weather sampling rounds were completed on June 18 and August 28, 2007. As can be seen in Table 1, there was 0.2 inches of rain in the week preceding the June 18 sample date and less than 0.1 inch of rainfall overnight for that sample round and there was only a trace of rainfall for the August 28 round in the entire preceding week.

The first wet weather sampling round was carried out on July 18, 2007. Precipitation was light to moderate throughout the sample collection but only a limited amount of runoff was generated near the stream sample stations. Most of the rain recorded on July 19 fell over the preceding night after the sampling round was completed.

On July 24, 2008, the second wet weather sampling round was carried out. The sampling round began in mid-afternoon but the rain was characterized by a brief downburst that did not persist and light rain dominated the storm. Once again the bulk of the precipitation recorded by the morning of July 25 fell overnight after the sampling round was completed.

TABLE 1: Precipitation Record During the Sampling Program

Dates	NWS Station rainfall- Edgartown- inches	West Tisbury rain gauge- inches
Week Preceding- DRY #1	0.2	0.0
June 16	0.0	0.0
June 17	0.0	0.0
Sample Date June 18	0.0	0.0
Total by June 19	0.09	0.0
Week Preceding- WET #1	0.09	0.0
July 16	0.0	0.0
July 17	0.0	0.0
July 18 sample date 8:00 a.m.	0.0	0.0
Total storm by 7/19	0.82	0.39
Week Preceding- DRY #2	T	0.0
August 26	0.0	0.0
August 27	0.0	0.0
August 28 sample date	0.0	0.0
2008		
Week preceding- WET #2	T	0.0
July 22	0.0	0.0
July 23	T	0.0
July 24 sample date 8:00 a.m.	0.27	0.40
Total storm by 7/25	2.47	2.89

Week preceding- WET #3	0.0	0.0
September 24	0.0	0.0
September 25	0.0	0.0
September 26 sample date	0.62	0.72*
Total storm by 9/27	2.08	2.43

Notes: rainfall totals are recorded in the morning of the date indicated and represent the **previous** 24-hour period.
*0.5" by 8:00 a.m. on 9/26
T = Trace

On September 26, rainfall began early in the morning and continued moderate to heavy throughout the sampling period. By about 8 a.m., the National Weather Observer had recorded 0.62 inches and 0.5" was recorded at my West Tisbury gauge. Rainfall continued and a second sample was collected at the outlet from Mill Pond at 9:15 a.m.

Water Quality Sample Results:
Sampling methodology is discussed in general in Appendix A and in more detail in the MVC approved sampling plan for 604B funded projects (MVC, 2008). Lab analyses results are included in Appendix C.
The primary lab results that are relevant to water quality impacts from runoff are for the following analytes:

1. **Total Suspended Solids (TSS):** These include all particulate matter retained on a glass fiber filter that is dried by heating in an oven and weighed. Particles will include silt and clay as well as plant material fragments and microscopic organisms. This measure is closely linked to turbidity. It may be increased by decay of aquatic plant material or nearby buffer zone plants, by bottom feeding fishes or soil erosion of the banks, nearby fields or the stream bed. Stormwater runoff carrying litter off the street or stream bed disturbance will be measured by this parameter. Fresh water quality criteria for this parameter are often in a narrative form, such as not reaching a level that…" would impair the benthic biota". A limit of 10 to 15 milligrams per liter (ppm) is recommended for bottom invertebrates and 80 to 100 ppm for fish (Griffiths and Walton, 1978).
2. **Particulate Organic Carbon (POC):** This parameter is included with the TSS results but is specific to the organic matter that is in the water column. It includes no mineral matter. Runoff sweeping organic fragments into a stream would be measured with this test as well as the general productivity of plants and animals growing in or near stream. There are no criteria for fresh resources for this parameter.
3. **Total Nitrogen (TN):** This is the sum of the dissolved inorganic and organic forms as well as the particulate form. This parameter is an indicator of the productivity of the water column as well as how much nitrogen is received from the groundwater, rainfall and from stormwater. While there is no criterion at this time, EPA has identified an average in

higher quality streams during the June through September time period of 0.44 ppm (EPA, 2000).

4. **Total Phosphorus (TP):** As with total nitrogen this is the total phosphorus from all sources both organic and inorganic in the water column. Runoff or suspended silt caused by stream bed disturbance would add to this test result. The State of Maine recommends a concentration of less than 15 parts per billion (ppb) for great ponds but a goal of 2 to 5 ppb for outstanding pond resources. The EPA criterion for streams and rivers indicates a standard of 0.025 ppm for higher quality systems.

At this time, the state of Massachusetts only has narrative language in the Surface Water Standards (Appendix B) for nutrient content. Suggested guidance to evaluate Mill Brook stormwater sample results are provided in Table 2.

Table 2: Guidance Concentrations for Selected Parameters

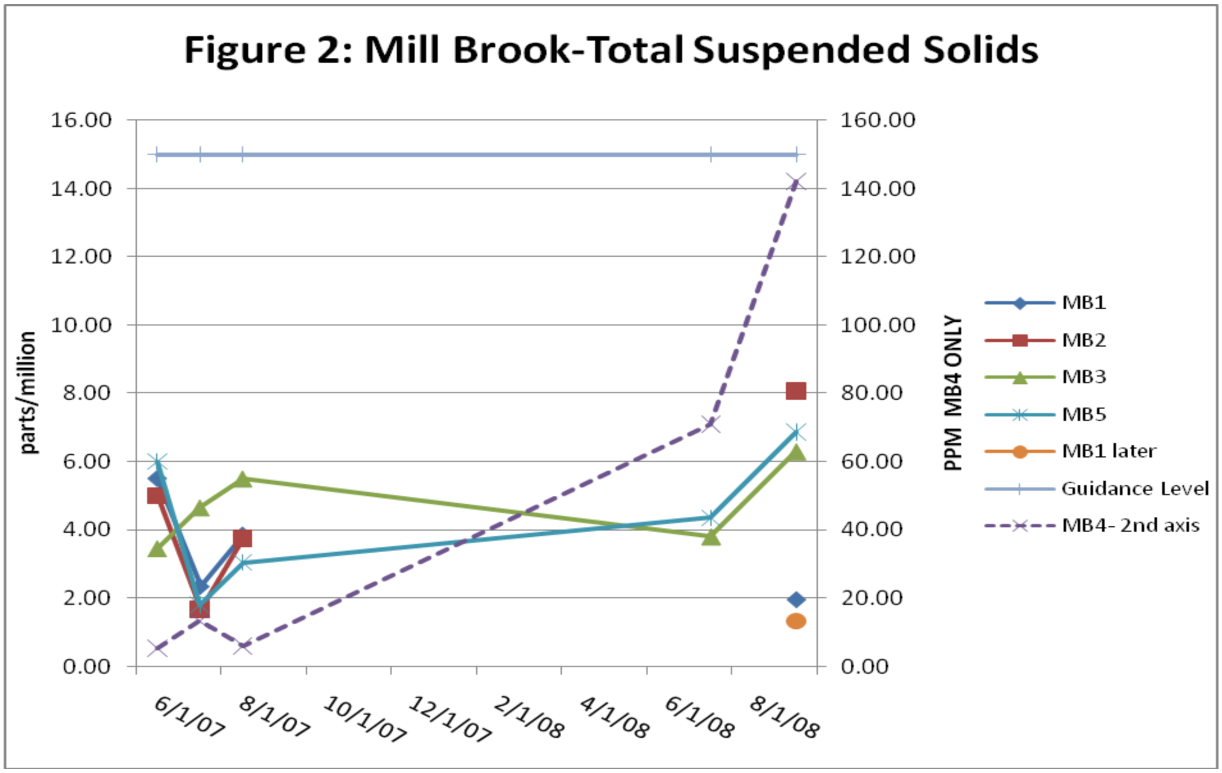
Parameter	EPA 25th percentile (upper limit) EPA, 2000	Other Guidance
Total Phosphorus (ppm)	0.025	0.005 to 0.01[1]
Total Nitrogen (ppm)	0.44	0.12[2]
Total Suspended Solids (ppm)		<15[3]
Total dissolved nitrogen (ppm)		0.1[2]

1 Maine DEP good quality lakes

2 Talbot River (Ontario) organization desired target -- http://www.talbotrivers.org/watercriteria.html

3 derived from the Chesapeake Bay Program Technical Synthesis Report for the Potomac River (Batiuk et. al. 1992)

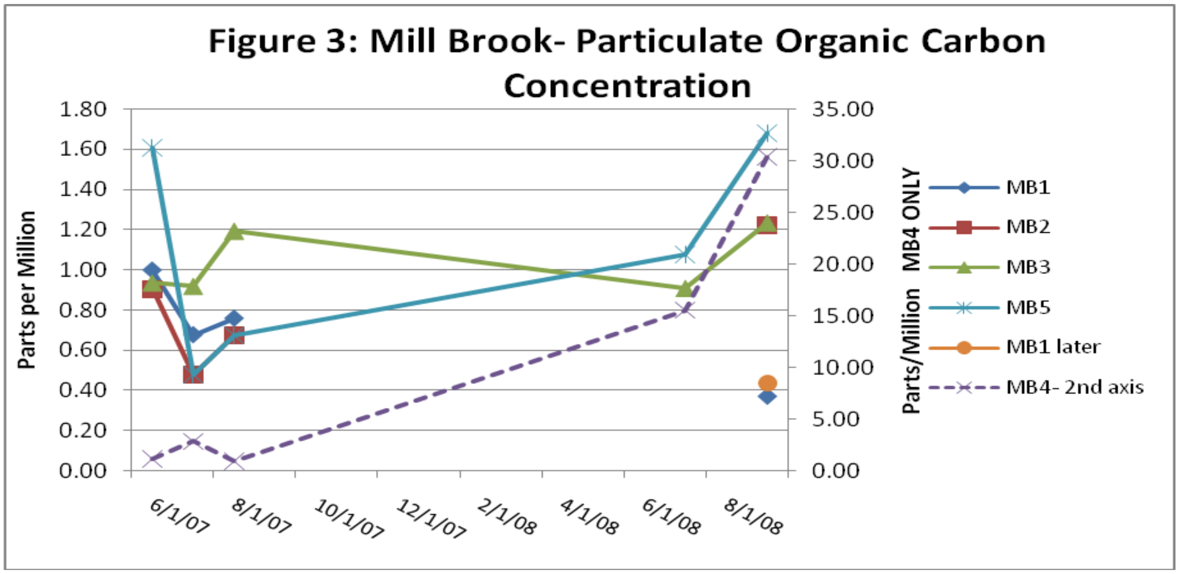
TSS results are shown in Figure 2. ***In this figure, the results for MB4 only are plotted on the right hand vertical axis***. Between the July 24, 2008 and the September 26, 2008 dates, all stations except the Mill Pond outlet (MB1) show increased TSS probably in part as a response to the heavier rainfall during the September sampling although vegetative decay might add to the total at that time of year (however note that particulate carbon increases proportionally to TSS implying that a vegetative decay source has not increased dramatically). The extremely high TSS value at station MB4 at the North Road crossing on September 26 may indicate that there was some streambed disturbance during sampling as it is doubtful that the runoff from the road alone would result in this much suspended material.



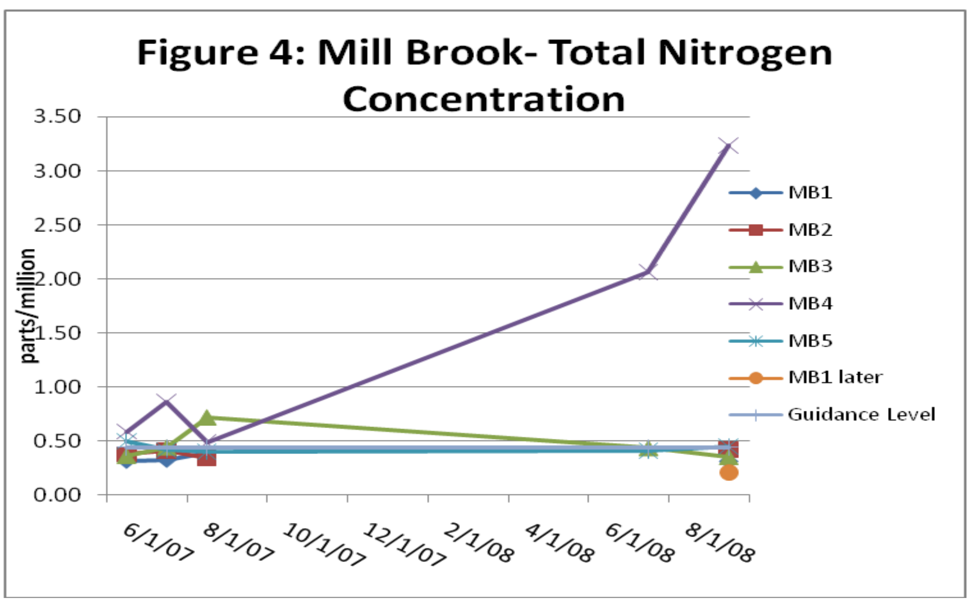
NOTE: All data and guidance level plotted on left vertical axis except MB4.

There is little indication of runoff influence on TSS at station MB1 but stations MB2, 3 and 5 do show an increase over the dry weather measurements. With the possible exception of station MB4 during 2008, sampling point TSS concentration is increased by stormwater runoff but does not approach the guidance level. The September 26 TSS concentrations represent about a 50% increase over the previous concentrations. TSS concentrations are below guidance levels at all stations except MB4 during both dry and wet weather.

Particulate carbon (POC) is included in the TSS results and shows a very similar pattern to TSS, increasing in concentration during the September 26 wet weather sampling over the dry weather or previous wet weather sampling events. In Figure 3, the results for station MB4 only are plotted on the right axis. Once again, station MB4 has a very high result that may have been influenced by stream bottom disturbance. The concentration of POC at MB4 on September 26 is about 30 ppm indicating organic matter represented about 20% of the TSS content measured. Generally, this percentage holds for all the samples with a margin of about plus or minus 5 percent.



The pattern continues in Figure 4 for Total Nitrogen at station MB4. There is little change in TN between dry and wet weather sampling for the other stations. TN concentrations are at the guidance level for stations MB1, MB2 and MB5 during nearly all sampling rounds. In fact, at station MB1 further into the rain event, the TN concentration had decreased. Station MB4 is above the criteria for all rain events but is near that guidance level during dry weather.

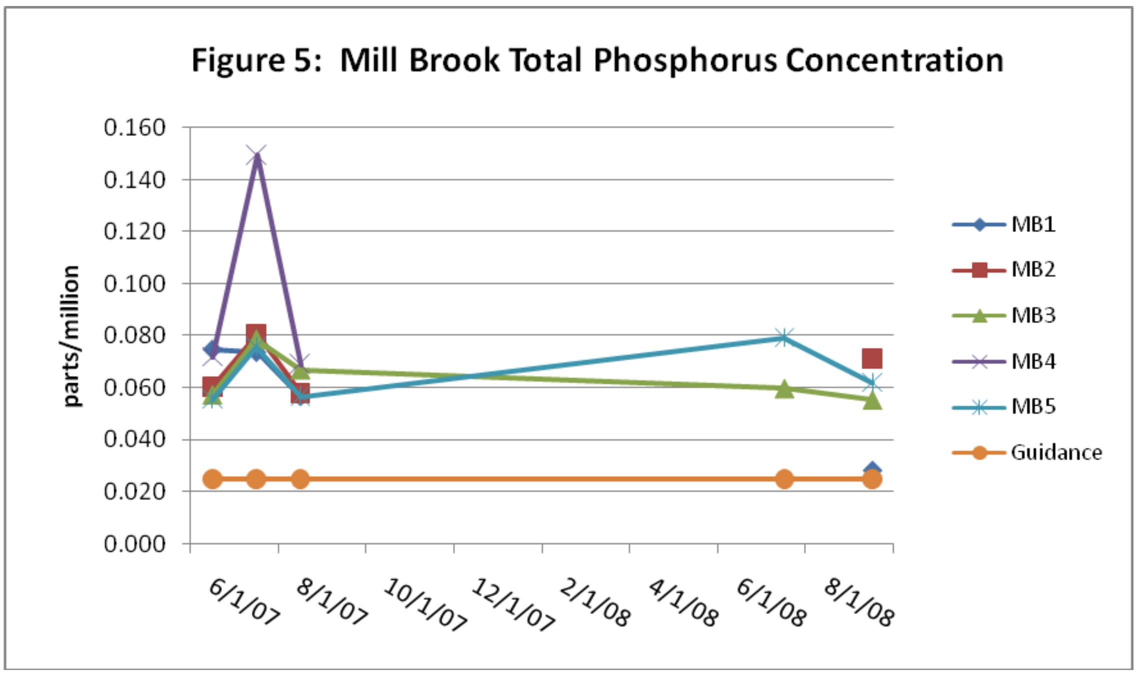


Station MB3 is above the guidance level in late August 2007 during dry weather and may be influenced from the seasonal die-off of high density aquatic plants population in Priesters Pond that is immediately upstream (particulate carbon also increases during the August 2007 round).

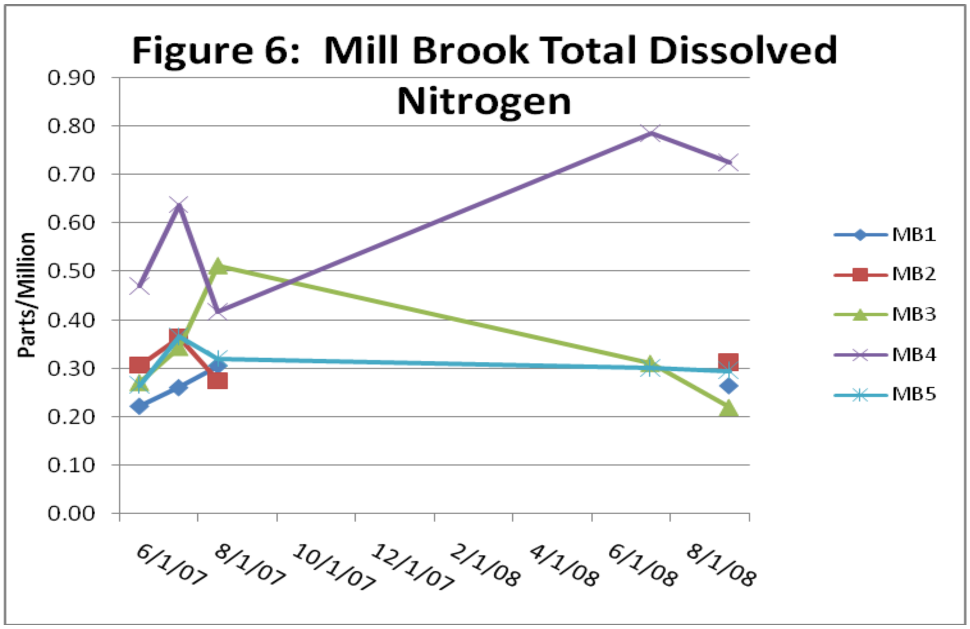
Nearby residential wastewater may have played a role in total nitrogen content at this location in late August (see Figure 6 where dissolved nitrogen peaks at 0.5 ppm on August 28 2007). During both 2008 rain events, this location has a relatively low TN concentration.

The Total Phosphorus test results are reported in parts per million in Figure 5. The guidance level for rivers and streams available for this parameter from EPA is 0.025 ppm although the state of Maine reports outsanding quality ponds having a total phosphorus content of 0.002 to 0.005 ppm (Maine DEP wesbsite).

In Figure 5, all stations except MB1 respond to the rain event on July 18, 2007 with an increase in total phosphorus. TP concentrations decrease from the July 2008 sampling to the September 2008 wet weather event. The sampling results are above both guidance criteria for both dry and wet weather sampling.



Total dissolved nitrogen is a subset of total nitrogen that consists of nitrite, nitrate, ammonium and dissolved organic nitrogen and is plotted in Figure 6. This parameter is analyzed from a filtered sample. Precipitation or sources of nitrogen that have been filtered by movement through the groundwater like septic systems as well as decay of vegetative matter in the stream or nearby wetlands are likely sources for these parameters. Dissolved nitrogen values are generally above the guidance value that is suggested for a river in Ontario. The dissolved fraction appears to comprise about 60% or more of the total nitrogen in Mill Brook.



In Figure 6, the concentrations for station MB4 do not follow the pattern of an extremely higher value on September 26, 2008 seen for the other parameters. For this parameter, the concentration is highest on July 24, 2008.

Bacteria:

Bacterial samples have strict requirements for holding times between collection and lab processing. Samples were collected on July 18 2007, during a light to moderate rainfall and on August 28 2007, during a dry weather period and are reported in Table 3 below.

Table 3: Mill Brook Bacterial Analyses, July 24 and August 28, 2007

Station	Date	Time	Total coliform	E. coli	Fecal coliform
MB1	18 July'07	14:55	>2419	28.9	136
MB1	28 Aug'07	9:30	>2419	275.5	48
MB2	18 July'07	15:10	>2419	73.8	49
MB2	28 Aug'07	9:20	>2419	261.3	29
MB3	18 July'07	15:45	>2419	365.4	182
MB3	28 Aug'07	8:45	>2419	27.9	36
MB4	18 July'07	16:00	>2419	49.7	129
MB4	28 Aug'07	8:30	>2419	248.9	84
MB5	18 July'07	15:30	>2419	125	104
MB5	28 Aug'07	9:00	>2419	410.6	122

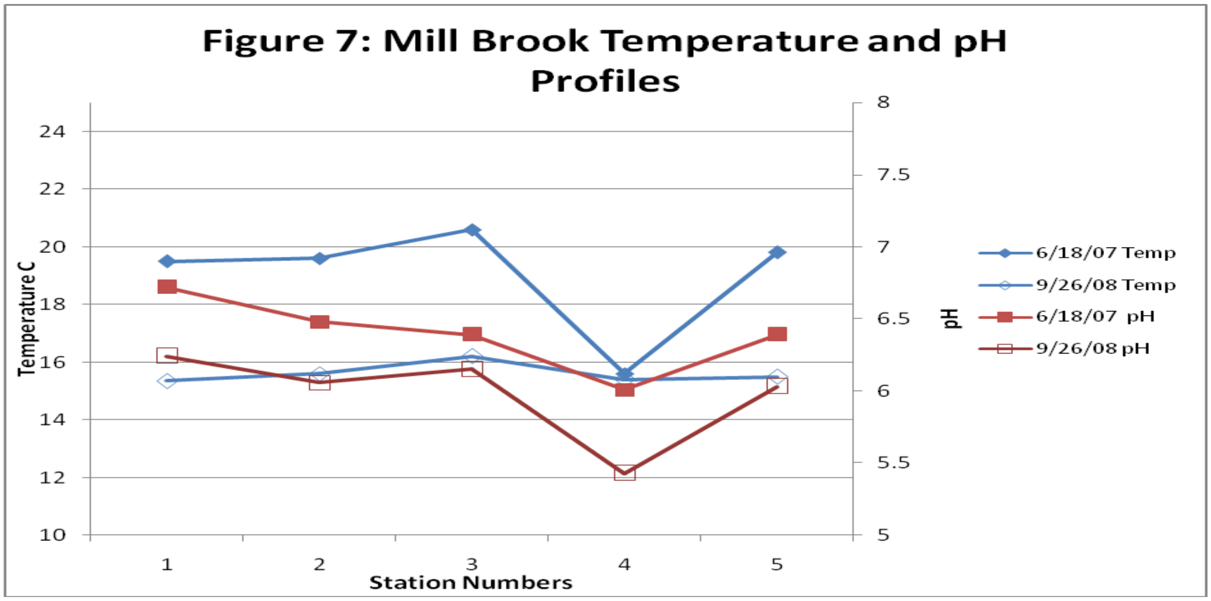
Total coliform bacteria include 16 species of bacteria found in the soil, on plants as well as those from the gut of warm-blooded and cold-blooded animals. Most of these are harmless. Fecal coliform is the group of 6 species that is added to the environment from the feces of warm blooded animals and is a subset of total coliform. Their presence indicates the possibility of presence of disease causing organisms. *Escherichia coli* (*E. coli*) is a sub-group of the fecal coliform group that is not capable of surviving in the environment. Most *E. coli* bacteria are harmless and are found in great quantities in the intestines of people and warm-blooded animals. It is probably the best indicator of fecal contamination that may include disease-causing viruses and bacteria and some strains of *E. coli* themselves can cause illness. Neither fecal coliform nor *E. coli* is exclusive indicators of human sewage presence. The Massachusetts standard for other waters (not used for drinking and applying to swimming waters during the off season) are no more than 126 *E. coli* colonies per 100 ml of water during 5 consecutive sampling rounds with no more than 235 in any sampling.

During the wet weather sampling, the fecal coliform test results are higher than the dry weather results at all stations except MB5 where the two are almost the same. The *E. coli* results are high during August at all stations except MB3. They are generally lower during the rain event except at station MB3 at the State Road stream crossing. During the July rain event, all stations meet the standard except for MB3.

Field data:
Parameters recorded in the field with an YSI-85 multi-parameter meter include specific conductance, temperature and dissolved oxygen saturation. The pH was measured on sample remainder in the office using a Thermo Orion A+ portable pH meter. Not all sample rounds were analyzed.

During the June 2007 sampling round, a relatively strong temperature gradient was found from nearest to the headwaters at station MB4 (coldest) to furthest from the headwaters at station MB1 (warmest). The gradient amounted to 4 degrees C on June 18, 5° on July 18 and 4.7° on August 28, 2007. This temperature gradient probably reflects a combination of the relative proportion of groundwater input to the sampling point compared to upstream surface flow and the proximity of upstream water features where residence time and solar input may warm the water. For example, the temperature at station MB4 on June 18 was 15.6° C while within 500 feet at station MB3 the temperature was 20.6°. Priester's Pond intervenes between the two stations with an average depth of 1 to 1.5 feet. During the September 2008 sampling round, the temperature gradient is not pronounced (see Figure 7). This is interpreted as a result of lower water tables contributing less cold water at the previously colder station (MB4), slower flow in the stream and warmer air temperature during September compared to June.

The pH profile during the June 2007 sampling round follows the temperature pattern. However, the lower pH value at station MB4 remains in the September 2008 round. The pH values are somewhat below the desired goal for surface waters that range from 6.5 to 8.3 (Mass. Surface Water Standards in Appendix B).



Specific conductivity remained in a narrow range during the sampling rounds being between 80 and 93 μS (microSeimens) at all stations with the exception of MB4 described below. Specific conductivity measures the quantity of dissolved chemicals that affect electrical conductivity in the water. An influx of road salt or a septic system effluent plume would raise the values. It increased slightly downstream from 83.7at MB4 to 89.2 μS at MB1 on June 18. SC increased by less than 10% in the downstream stations in July and August 2007 over the June 2007 values. Conductivity remained about the same at station MB4.

During the September 2008 sampling round, values were lower at all stations and at MB4 the value decreased to 65 μS at station MB4.

Over the course of the summer, the stream was initially well oxygenated at all stations but decreased significantly in the August 2007 sampling round. The desired value is generally over 70% saturated. Oxygen saturation ranged from 80 to 94% on June 18; 73% to 86% on July 18 and 59% to 77% in late August during 2007. The higher dissolved oxygen levels seem to correlate with the higher flow (MB1, MB2, MB3 and MB5) areas and/or areas with heavy aquatic vegetation (MB5). In 2008, the meter performance was affected by the precipitation and data is not available for all stations.

Comparison to Previous Data:
Previous data is limited and is briefly described below.

The University of Massachusetts School of Marine Science Estuaries Project data collected at weekly intervals during 2005 and 2006 has not yet been released. The large number of samples collected at the Mill Pond outlet (MP1) over a year should allow a more detailed assessment of baseline stream water quality and response to rainfall.

The National Park Service lab found a total phosphorus concentration of 0.06 ppm and a total dissolved nitrogen concentration of 0.32 ppm in August 2003 in Mill Pond. That TDN value is close to those found at station MB1 that ranged from 0.22 to 0.31 ppm.

In late October 2001, a sample collected at the Mill Pond outlet (Station MB1) had a total nitrogen concentration of 0.23 ppm and total phosphorus content of 0.04 ppm (Wilcox unpublished). At that time, near the intersection with North Road the total nitrogen was 0.22 and the total phosphorus was 0.06 ppm. These values are somewhat lower than the values found in this study but were collected during dry weather. The availability of only 1 sample at each location makes a conclusion difficult.

During 1994, a survey of nitrogen loading to Tisbury Great Pond found total nitrogen values that ranged between 0.18 and 0.43 ppm over the course of a year at a sampling point below the MB1 station at the Mill Pond outlet (Wilcox, 1994). The average concentration was 0.3 ppm from 8 samples collected over a year.

Saunders Associates sampling reported a total phosphorus concentration of 0.49 ppm and a total nitrogen concentration of 2.8 ppm at station MB3 and 0.42 ppm total phosphorus and 2.1 ppm total nitrogen at station MB1 (Saunders Associates, 1990). At that time, considerable direct discharge of stormwater was observed and that appears to be the sample source, not the stream itself. This would account for the substantially higher values of total nitrogen.

Poole (1986) found total coliform at 230 colonies and fecal at 77 with a fecal coliform to fecal streptococcus ratio of 1.83 in the upper part of Town Cove. That ratio was interpreted to indicate a mix of human and animal sources. A follow up survey in July found a ratio of 3.3 at both outlets from Mill Pond indicating some huuman source bacteria. These sites would be linked to station MB1 in the current study.

Discussion:
The data collected during 2007 and 2008 provide a limited baseline for water quality parameters in Mill Brook during wet and dry periods.

Total suspended solids concentrations are below guidance values throught the sampling program under both wet and dry conditions. The exception is station MB5 where during the rain event in July 2007 it is at the guidance limit and during both sampling rounds in 2008, it is well above the guidance value. It appears that modifications made to drainage off the road system have been successful in greatly reducing direct discharge of stormwater into the Mill Brook under conditions of the type of precipitation events that were sampled.

Total nitrogen concentrations are very near the 0.44 ppm guidance limit for streams much of the time but do exceed the limit during both wet (MB5: 7/18/07, 7/28/08 and 9/26/08 in Figure 5) and dry periods (MB3, August 28,2007 in Figure 5). Generally the growth of algae and microscopic algae blooms are **not** limited by the availability of nitrogen in freshwater environments. However, when phosphorus is abundant, higher levels of available nitrogen can magnify the vegetative growth.

Based on the limited data available, the total nitrogen content in the stream averages about 0.5 ppm. Combining this with the approximate annual stream flow yields an annual nitrogen load from the Mill Brook watershed of about 3200 kilograms. This is approximately 20% of the estimated annual nitrogen load to Tisbury Great Pond from the entire watershed. Wilcox (1994) concluded that the nitrogen load from Mill Brook was on the order of 590 kilograms (from the inorganic nitrogen alone) and 1270 kilograms based on average total nitrogen of 0.3 ppm. The load was also based on a total annual streamflow that is about one third less than the latest estimate. At the more recent annual flow, the annual load implied from the 1994 total nitrogen data would be about 1900 kilograms per year, still well below the load estimate based on the recent data. It is possible that the latest estimate of annual nitrogen load from Mill Brook represents a real increase in nitrogen loading from this subwatershed over the 14 years between the two studies but the wide range in estimates emphasizes the need to refine this load by the Estuaries Project.

Total phosphorus values recorded during both wet and dry periods are higher than guidance levels for streams, ranging between 0.06 and 0.08 ppm. The current sample results agree reasonably with previous data where samples were collected in the stream or a pond in the Mill Brook system. The Saunders data reflects stormwater runoff concentration rather than the diluted in-stream concentration and shows that the phosphorus concentration in the stormwater itself is on the order of 8 times the concentration found in the Brook. The TP concentration spikes up during the rainfall on July 18, 2007 sampling at all stations except Mill Pond. The greatest response is seen at station MB4 at the North Road stream crossing. No response was detected at the MB1 station at the outlet to Mill Pond.

In lakes, a total phosphorus concentration of 0.024 to 0.048 ppm is typical of eutrophic systems (Carlson, 1977). The ratio of total nitrogen to total phosphorus indicates whether there is excess nitrogen and, as a result, phosphorus limits growth or the reverse. In ponds, phosphorus appears to become limiting to growth when the ratio is over 10 to 1 (Carlson, 1992). Averaged over all samples in this study, the ratio for Mill Brook is 14.9 indicating that the system is limited by the availability of phosphorus despite the fact that the phosphorus concentrations exceed the guidance levels. While these indicators for lakes may not apply directly to Mill Brook, the streamflow into the chain of ponds along the Brook is a major component of their hydrologic budget and very likely has a strong negative influence on water quality in the ponds.

Potential phosphorus sources include:

- The bottom sediment stores phosphorus particularly in the ponds and under the right conditions, anoxia can alter the chemistry that locks the phosphorus in the sediment releasing it into the water column. Release can be rapid and is self perpetuating.
- Farmland, large gardens and lawns where applications of fertilizer include phosphorus particularly if applied in an area that can contribute runoff to the system due to limited width buffers.
- Other land development that disturbs the soil increasing runoff within the watershed particularly if buffers are not adequate (increasing loads with steepening slope). The amount of phosphorus exported is related to the soil hydrologic group, being higher for the denser soils and lower for the sandier soil types (Maine DEP, 1992).
- On site wastewater disposal, particularly when located within about 300 feet of the surface water.
- Atmospheric dry deposition was significant at Walden Pond (USGS, 2001).

In general, during the most substantial rain event sampled in late September 2008, the stream water quality was not adversely impacted by stormwater at most stations with the possible exception of the tributary stream crossing under North Road. Total phosphorus concentration was actually lower at most stations during this rain event than during the lighter rainfall on July 28, 2008.

The **pH** values found are lower than the desirable range for higher quality inland surface waters according to the Massachusetts Surface Water Standards (pH of 6.5 to 8.3). This is to be expected in our area where the soil and surface water have limited ability to buffer the effect of acid precipitation and natural release of acidic water from boggy soils.

The **bacterial** results do indicate the presence of fecal bacteria during the sampling rounds but it is not clear from the limited dataset what are the implications. From the settings where the samples are collected, the most likely source is animal. Further testing at station MB1 and MB3 where there are nearby houses is warranted.

Recommendations:

The following are recommended follow up steps and suggested priority:

1. Detailed watershed-wide land use and vegetation mapping and coverage determination for the Mill Brook valley. This should not wait for the Massachusetts Estuaries Project study of Tisbury Great Pond. HIGH
2. Qualitative identification of possible phosphorus sources to the stream including an evaluation of wastewater disposal, residential development and agricultural fields in addition to revisiting the stormwater discharges to gather more data. HIGH
3. Examination of deeper water ponds along the stream that might experience anoxia and add phosphorus to the system from the bottom sediment. HIGH
4. Identify the length of stream that is accompanied by natural buffers and their width as well as the portion of the stream that has narrow buffers separating it from actively managed lands. HIGH
5. Sampling at station MB4 several times during a rain event to confirm the high levels of TSS, particulate carbon and total phosphorus found during the 2008 sampling. Other time series sampling at stations MB1, MB2 and MB3 to assure an accurate characterization of stormwater runoff impacts. HIGH
6. Further assessment to identify the influent- exfluent portions of the stream valley. This kind of study would involve driving some well points and surveying in the well head and the stream to a common datum to allow a comparision of their water elevations at several points along the length of the stream. Existing private wells may be used. MODERATE/LOW
7. When available, the Estuaries Project data from station MB1 should be scrutinized to identify the range of total nitrogen and phosphorus concentration and compared with precipitation records to identify any clear effects. HIGH
8. GPS field survey of stormwater management features near the MB1 station have been collected but need to be further field checked and examined under heavy rainfall conditions to further clarify the discharge of runoff into wetlands, Mill Pond and the stream. This data should be utilized to calculate the impervious road contribution areas. While it appears that the runoff impact on the stream is not significant in terms of nutrients, this may not be the case under heavier precipitation than was observed during this study. There may be simple steps that can be taken to even better protect the resource. MODERATE
9. Similar GPS field survey should be carried out at the Scotchman's and State Road crossings. MODERATE
10. Further bacterial testing at stations MB1 and MB3. LOW

Other study that would be useful in developing a stream management plan include:

11. Close observation of the flow of stormwater at the Mill Pond, Scotchman's and State Road crossings under higher intensity rainfall to identify any additional stormwater diversions or infiltration systems that could further protect stream water quality. This step may require

engineering design and participation of both Mass Highways and the Highway Department.

12. A survey of both plants and animals in the stream to identify any rare/endangered populations that require protective steps and to assess stream habitat quality. Approaches to habitat assessment include EPA's Rapid Bioassessment Protocols or the Index of Biological Integrity. An in-the-field assessment of the riparian buffer and the aquatic ecosystem condition should be accomplished in this assessment.
13. If potential sources of nutrients or sediment are identified in #2 above, carry out a more detailed upstream/downstream water sample analysis at suspected sites to confirm sources.
14. Stream flow measurement at locations other than the Mill Pond spillway to determine changes in volume along the length of the stream. Possible sites include the spillways at Priester's Pond, Littlefield's Pond, Mill Pond and possibly Crocker and Fisher ponds. For simultaneous data collection at these points, purchase water level loggers and at least monthly stream flow measurements are required at each station.
15. Determination of soft sediment thickness has been made for Mill Pond and there is some data for Priesters Pond but additional information including bathymetric data in some or all of the other ponds may be desirable to better assess sediment removal implications.

The fifteen tasks identified represent a significant level of effort and expertise and discussion how to procede in completing these tasks should follow.

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APPENDIX A

Summary of Sampling Methodology

Note:
The general sampling methodology follows the approved Sampling and Analysis Plan for the DEP 604(b) sampling program in our coastal ponds as far as sample collection, processing and handling, YSI85 meter calibration and use and record keeping.

Sampling Methodology

The goal of the sampling project was to collect samples during dry weather with little or no rainfall in the prior week to identify background levels of the parameters to be tested. The desired storm event sampling was conceptualized as occurring about 30 minutes into a heavy precipitation when substantial runoff was observed flowing into the stream above the sampling points. Unfortunately, rainfall over the planned course of the sampling project (June 15 to September 30, 2007) was uncooperative, occurring only as light showers during weekdays when samples could be delivered to the lab (Monday through Thursday). As a result only a moderate rainfall/runoff event was sampled and no heavy rainfall event sampling was accomplished and the project was halted until 2008 for the desired rain event.

Samples were collected at all 5 stations on June 18, 2007 to establish dry weather, background values for the parameters to be analyzed. On July 18, light to moderate rainfall generated limited runoff during the sampling time period that ranged from 20 minutes after rainfall initiation to 90 minutes after. A second dry weather data set was collected on August 28.

All samples were collected from the Brook itself while standing on dry land to avoid bottom sediment stirrup. No samples were collected of the stormwater discharge itself in order to assess stream water quality impacts. The bacterial samples were collected in the provided, sterilized bottles by plunging the bottle into the water to a depth of 2 to 4 inches with the open end facing up stream. Samples for nutrient and total suspended solids were collected using a dipstick to plunge a lab-clean, 1 liter bottle in to a depth of about 4 inches below the surface at station MB1and MB4 and by hand at the other stations where the water depth was too shallow. To collect this sample by hand the bottle was pointed upstream and submerged to a point where the neck was submerged as near to 4 inches below the surface as possible without the side of the bottle contacting the sediment.

From the 1 liter samples, dissolved nutrient samples were filtered through a 0.22 micron, cellulose acetate filters into 60 milliliter lab clean bottles. The total phosphorus sample was not filtered. The 1 liter bottle was then refilled for the TSS analysis. All samples were placed into a Styrofoam cooler with ice and shipped to the lab via fast ferry for analyses. In the case of the samples collected in late afternoon on July 18 2007, the samples were held overnight in a refrigerator and shipped the following morning.

APPENDIX B

Massachusetts standards for surface water quality.

314 CMR 4.00: MASSACHUSETTS SURFACE WATER QUALITY STANDARDS

(3) Inland Water Classes.

(a) Class A. These waters include waters designated as a source of public water supply and their tributaries. They are designated as excellent habitat for fish, other aquatic life and wildlife, including for their reproduction, migration, growth and other critical functions, and for primary and secondary contact recreation, even if not allowed. These waters shall have excellent aesthetic value. These waters are protected as Outstanding Resource Waters.

1. Dissolved Oxygen. Shall not be less than 6.0 mg/l in cold water fisheries and not less than 5.0 mg/l in warm water fisheries. Where natural background conditions are lower, DO shall not be less than natural background conditions. Natural seasonal and daily variations that are necessary to protect existing and designated uses shall be maintained.

2. Temperature.

a. Shall not exceed 68° F (20° C) based on the mean of the daily maximum temperature over a seven day period in cold water fisheries, unless naturally occurring. Where a reproducing cold water aquatic community exists at a naturally occurring higher temperature, the temperature necessary to protect the community shall not be exceeded and natural daily and seasonal temperature fluctuations necessary to protect the community shall be maintained. Temperature shall not exceed 83°F (28.3°C) in warm water fisheries. The rise in temperature due to a discharge shall not exceed 1.5°F (0.8°C); and

b. natural seasonal and daily variations that are necessary to protect existing and designated uses shall be maintained. There shall be no changes from natural background conditions that would impair any use assigned to this Class, including those conditions necessary to protect normal species diversity, successful migration, reproductive functions or growth of aquatic organisms.

3. pH. Shall be in the range of 6.5 through 8.3 standard units but not more than 0.5 units outside of the natural background range. There shall be no change from natural background conditions that would impair any use assigned to this Class.

4. Bacteria.

a. At water supply intakes in unfiltered public water supplies: either fecal coliform shall not exceed 20 fecal coliform organisms per 100 ml in all samples taken in any six month period, or total coliform shall not exceed 100 organisms per 100 ml in 90% of the samples taken in any six month period, If both fecal coliform and total coliform are measured, then only the fecal coliform criterion must be met. More stringent regulations may apply under the Massachusetts Drinking Water regulations, 310 CMR 22.00 (*see* 314 CMR 4.06(1)(d)1.);

b. at bathing beaches as defined by the Massachusetts Department of Public Health in 105 CMR 445.010: where E. coli is the chosen indicator**,** the geometric mean of the five most recent samples taken during the same bathing season shall not exceed 126 colonies per 100 ml and no single sample taken during the bathing season shall exceed 235 colonies per 100 ml; alternatively, where enterococci are the chosen indicator, the geometric mean of the five most recent samples taken during the same bathing season shall not exceed 33 colonies per 100 ml and no single sample taken during the bathing season shall exceed 61 colonies per 100 ml;

c. for other waters and, during the non bathing season, for waters at bathing beaches as defined by the Massachusetts Department of Public Health in 105 CMR 445.010: the geometric mean of all E. coli samples taken within the most recent six months shall not exceed 126 colonies per 100 ml typically based on a minimum of five samples and no single sample shall exceed 235 colonies per 100 ml; alternatively, where enterococci are the chosen indicator, the geometric mean of all enterococci samples taken within the most recent six months shall not exceed 33 colonies per 100 ml typically based on a minimum of five samples, and no single sample shall exceed 61 colonies per 100 ml. These criteria may be applied on a seasonal basis at the discretion of the Department; and

d. consistent with Massachusetts Department of Public Health regulations for bathing beaches, the single sample maximum values in the primary contact recreation bacteria criteria in 314 CMR 4.05(3)(a)4.b. and 4.05(3)(a)4.c. also are for use in the context of notification and closure decisions.

5. Solids. These waters shall be free from floating, suspended and settleable solids in concentrations or combinations that would impair any use assigned to this class, that would cause aesthetically objectionable conditions, or that would impair the benthic biota or degrade the chemical composition of the bottom.

314 CMR 4.00: DIVISION OF WATER POLLUTION CONTROL

4.05: continued

1. Color and Turbidity. These waters shall be free from color and turbidity in concentrations or combinations that are aesthetically objectionable or would impair any use assigned to this class.
2. Oil and Grease. These waters shall be free from oil and grease, petrochemicals and other volatile or synthetic organic pollutants.
3. Taste and Odor. None other than of natural origin.

APPENDIX C

Lab Analyses

KEY

SiO4	Silica
PO4	Orthophosphate
NH4	Ammonium
NOX	Nitrate plus nitrite
DIN	Dissolved inorganic nitrogen (sum of NH4 and NOX)
DON	Dissolved organic nitrogen
TSS	Total suspended solids (or sediment)
POC	Particulate organic carbon
PON	Particulate organic nitrogen
TN	Total nitrogen (sum of DIN, DON and PON)
TP	Total phosphorus
µM	Micromoles – the concentration of the parameter indicated based on its molecular weight. Conversion to ppm depends on the weight of the cation. For example, nitrogen with atomic weight 14 is converted by multiplying the uM concentration by 0.014 while carbon is converted by multiplying by 0.012 and phosphorus by 0.031.

Sample ID	Date	RAIN?	SiO4 (uM)	PO4 (uM)	NH4 (uM)	NOX (uM)	DIN (uM)	DON (uM)	TSS mg/L	POC (uM)	PON (uM)	TN (uM)	TP (uM)
Mill Pond Outlet	6/18/07	NO	46.6	0.7	0.6	0.68	1.26	14.63	5.50	83.07	6.55	22.45	2.4
Scotchman's crossing	6/18/07	NO	36.0	0.8	1.1	1.41	2.48	19.38	5.00	75.51	5.44	27.30	1.9
State Road near Priester's	6/18/07	NO	19.5	0.5	1.3	0.54	1.83	17.57	3.45	77.94	6.88	26.27	1.9
North Road crossing	6/18/07	NO	26.4	1.3	7.4	9.66	17.04	16.54	5.25	94.23	8.34	41.92	2.3
MVLB	6/18/07	NO	30.6	1.0	0.4	0.87	1.32	17.62	6.00	133.92	16.59	35.53	1.8
Mill Pond Outlet	7/18/07	Moderate	28.0	0.8	1.4	1.72	3.15	15.45	2.35	56.31	4.52	23.13	2.4
Scotchman's crossing	7/18/07	Light/mod	38.5	1.4	2.2	4.88	7.09	18.94	1.68	39.99	3.55	29.59	2.6
State Road near Priester's	7/18/07	Light steady	27.2	1.3	2.4	1.64	4.07	20.50	4.65	76.50	7.20	31.77	2.5
North Road crossing	7/18/07	Light steady	18.4	1.9	10.2	12.77	22.93	22.68	13.30	234.81	16.21	61.82	4.8
MVLB	7/18/07	Light/mod	57.8	1.6	2.4	4.23	6.61	19.54	1.80	39.70	3.56	29.71	2.5
Mill Pond Outlet	8/28/07	NO	20.5	0.6	0.7	0.68	1.39	20.41	3.85	63.13	6.14	27.95	1.8
Scotchman's crossing	8/28/07	NO	27.9	0.7	1.4	3.77	5.13	14.46	3.75	56.31	5.17	24.77	1.9
State Road near Priester's	8/28/07	NO	49.3	0.6	3.5	1.91	5.45	31.17	5.50	99.42	14.75	51.38	2.2
North Road crossing	8/28/07	NO	23.9	1.4	5.0	6.74	11.75	18.02	6.05	74.20	4.93	34.71	2.2
MVLB	8/28/07	NO	34.4	1.0	2.7	4.71	7.43	15.44	3.05	56.06	5.66	28.53	1.8
Mill Pond Outlet	7/24/08												
Scotchman's crossing	7/24/08												
State Road near Priester's	7/24/08	Yes	25.06	1.0	2.18	0.76	2.93	19.29	3.80	75.66	9.15	31.37	1.93
North Road crossing	7/24/08	Light	22.04	2.0	12.11	10.64	22.76	33.40	70.80	1292.28	91.22	147.38	NS
MVLB	7/24/08	Yes	36.31	1.5	1.56	3.72	5.28	16.21	4.35	89.69	7.69	29.18	2.56
Mill Pond Outlet	9/26/08	Mod steady	26.97	0.6	0.19	0.16	0.35	18.53	1.97	30.77	3.24	22.12	0.90
Scotchman's crossing	9/26/08	Mod/heavy	20.47	1.4	1.10	2.59	3.69	18.63	8.07	101.98	8.05	30.37	2.29
State Road near Priester's	9/26/08	Mod/heavy	26.03	0.7	1.00	1.02	2.02	13.69	6.30	102.90	9.77	25.48	1.79
North Road crossing	9/26/08	heavy steady	8.15	2.3	6.34	9.65	15.99	35.81	142.00	2529.92	179.55	231.35	NS
MVLB	9/26/08	heavy steady	33.72	1.1	0.67	2.20	2.87	18.25	6.87	140.02	10.74	31.86	2.00
Mill Pond Outlet	9/26/08	Light/mod	26.42	0.6	0.05	0.16	0.21	11.71	1.33	36.40	3.30	15.21	1.00

Lab Analyses by Wampanoag Tribal Laboratory

Lab ID	Results TC	Results E. coli	esults Fecal Colifor	Location	Time	Date
7172	>2419.6	28.9	136	MB-1	14:55	18-Jul
7173	>2419.6	73.8	49	MB-2	15:10	18-Jul
7174	>2419.6	365.4	182	MB-3	15:45	18-Jul
7175	>2419.6	49.7	129	MB-4	16:00	18-Jul
7176	>2419.6	125	104	MB-5	15:30	18-Jul
7329	>2419.6	275.5	48	MB-1	9:30	8/28/07
7330	>2419.6	261.3	29	MB-2	9:20	8/28/07
7331	>2419.6	27.9	36	MB-3	8:45	8/28/07
7332	>2419.6	248.9	84	MB-4	8:30	8/28/07
7334	>2419.6	410.6	122	MB-5	9:00	8/28/07

NOTES:

All results are colonies per 100 ml of water

TC: Total coliform bacteria