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May 8, 2007

To: Bill Immich, City of Plymouth

From: Steve Grumann, Earth Tech

Subject: **Mill Pond Macrophyte and Sediment Thickness Survey**

This technical memorandum summarizes the results of the macrophyte (aquatic plant) and sediment thickness survey completed by Earth Tech on July 24th and 25th, 2006 at the Mill Pond located in Plymouth, Wisconsin. Components of the macrophyte survey included field identification of macrophytes in Mill Pond, percent coverage determination of the dominant macrophyte species, field delineation and a GPS-survey of locations of macrophyte beds within Mill Pond. Components of the sediment survey included water depth to sediment, depth to native hardpan, soft sediment thickness, and GPS-surveyed locations of the survey points.

SAMPLING METHODOLOGY

Macrophyte Survey

The macrophyte community was sampled at 17 locations within Mill Pond (Figure 1, Attachment A). The sampling locations were chosen based on presence of visible macrophytes during the sampling dates. Deviations from the proposed sampling plan were made. Instead of sampling a grid throughout Mill Pond for macrophytes, the sampling was confined to locations where macrophytes were visible during the survey.

A canoe was used to paddle around Mill pond, seeking out any areas that had visible macrophytes. When a location was found, macrophytes were physically pulled from the lake and identified to species. The coordinates of each location were recorded using a hand-held GPS unit. Beds of macrophytes that were large enough to delineate were done so by paddling the canoe around the bed while logging GPS positions. Percent coverage of macrophytes was visually estimated to the nearest 5 percent in the beds.

Sediment Depth Methods

Water depth to top of sediment and depth to hardpan were measured at 13 locations through out Mill Pond (locations 5 through 17). The 13 locations were surveyed using a hand-held GPS unit (Figure 1, Attachment B). A secchi disc was used to measure the depth from the top of the water to sediment by slowly lowering the secchi disc until it rested on top of the sediment. The depth from the top of the water to the hardpan was measured by manually pushing a metal sounding pole into the sediment until it could no longer be advanced. The thickness of sediment was calculated by subtracting the depth to sediment from the depth to hardpan.

RESULTS

Macrophyte Sampling

The overall abundance of macrophytes was low during the sample period. Approximately 10 percent of the pond was covered with macrophyte beds. The dominant species were sago pondweed (*Potamogeton pectinatus*) and curly-leaved pondweed (*P. crispus*) which occur at most locations. Coontail (*Ceratophyllum demersum*) and duckweed (*Lemna minor*) accounted for the remaining species. Six macrophyte beds were identified and delineated and are shown on Figure 1 (Attachment A). The percent coverage of the macrophytes within the beds ranged from 0 to 25 percent. The beds were not densely covered, but were the only areas that had sufficient density to consider as a macrophyte bed. Table 1, in Attachment B, summarizes the macrophyte sampling results at each sample location. Photographs of the macrophyte beds are included in Attachment C.

Sediment Depth

Sediment thickness ranged from 0.5 to 5.5 feet. Table 2 in Attachment B summarizes the sediment thickness measurements. As shown in Table 2 and Figure 1, the thicker sediment was observed in the upper reach of Mill Pond. This may result from the water velocity quickly diminishing as it reaches the pond and releasing the entrained sediment from the Mullet River.

RECOMMENDATIONS

In recent years there have been reports of large algal blooms and excessive macrophyte growth in the Mill Pond contributing to low aesthetic and recreational value for users. These conditions are often the result of excess nutrient availability (nitrogen and phosphorus) to aquatic plants. In late July 2006, when field work was completed for this study, algal blooms and the presence of excessive macrophytes were not observed, suggesting that a lack of nutrients may have been limiting the growth.

Possible sources of nutrients that may influence the aquatic vegetation in Mill Pond include upstream agricultural runoff from Mullet River watershed, runoff containing fertilizer from landowners adjacent to the pond, excrement from waterfowl (geese) using the pond, and septic system leakage into the Mullet River and Mill Pond, among others.

Limiting the amount of nutrients entering a water body is an effective way to control excessive plant growth and algae blooms. Landowners adjacent to the lake should use only the recommended amount of fertilizer and apply it only in the fall. Landowners should use a no- or low-phosphorus fertilizer. A strip of un-mown, unfertilized lawn should be established on the shore of the pond to serve as a filter strip to keep fertilizers from entering the pond. Lawn clippings and fallen leaves should be collected so that they do not end up in the pond and create additional nutrient loads when they decompose. In addition, any septic system located near the pond should be checked to make sure it is operating correctly and not draining directly into the pond.

Many geese were observed using the pond near the middle school. A lawn mowed directly down to the water's edge of a pond, void of surrounding shrubs and trees, is ideal goose habitat. Planting a hedge row near the shoreline or leaving an un-mown strip of grass next to the water's edge will deter geese from using the pond. These measures will not keep all geese away from the pond, but should greatly decrease the number of geese using the pond and adjacent lawns.

Preventative measures to limit aquatic macrophytes are the best way to keep aquatic macrophytes from becoming nuisance. However, once they become established at nuisance levels, various management tools can be used to keep them under control. These measures include:

Chemical herbicides: Only those chemicals registered with the U.S. EPA and Wisconsin's Department of Agriculture, Trade, and Consumer Protection (DATCP) may be used in Wisconsin. Table 3 lists the chemicals approved for use in Wisconsin. When using chemicals, it is important to correctly identify the plants and the appropriate chemical for the plant beforehand. Be certain that treatment occurs at the proper time and dosage. In order to apply chemicals in liquid form, the applicator must be licensed with the State of Wisconsin. A permit from the WDNR is also required prior to application.

Manual/Mechanical Harvesting: This includes hand-pulling, raking, or mechanically removing the plants. The WDNR may require an Aquatic Plant Management Plan before it issues a permit for these control methods. Mechanical control requires a permit*;* while manual control *may* require a permit. The local WDNR Water Management Specialist should be contacted to determine if a permit is necessary.

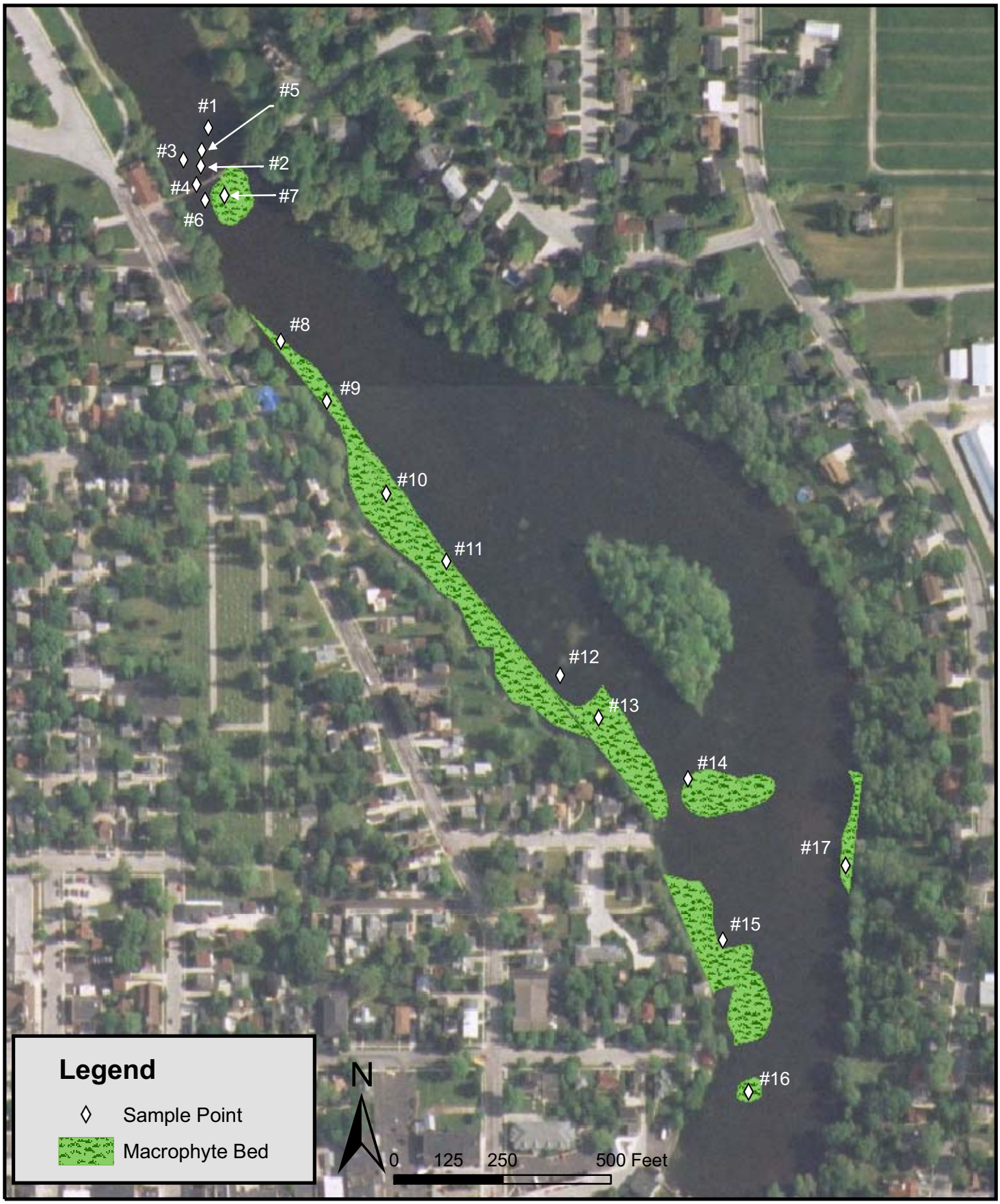
Physical: This method includes bottom plant barriers (plastic sheets, hay bails) and water level draw-downs. These methods are used only in special circumstances. Because they involve placing structures on the bed of a lake and/or affect lake water level, a Chapter 30 or 31 permit from the WDNR will most likely be needed.

Biological: This method includes herbivores and bacteria. It is illegal to transport or stock carp or crayfish in Wisconsin. Biological control of aquatic plants requires a permit form the WDNR.

Earth Tech recommends that based on the size of Mill Pond and the time and costs associated with dredging and/or manually or mechanically harvesting vegetation, chemical control of nuisance plants would be the best option to control vegetation in Mill Pond. Preventative measures should be initiated to control the growth of aquatic plants and algal blooms, but if large algal blooms and macrophyte beds still occur, treatment of the pond with the appropriate chemicals could provide a short-term solution that would be cost effective and easy to implement.

ATTACHMENT A

FIGURES



Source: USDA WI Farm Agency NAIP 2005, Earth Tech 2006

Spatial Reference: GCS_North_American_1983

Figure 1 - Sample Locations and Macrophyte Bed Delineations

Mill Pond Project
City of Plymouth
Sheboygan County, Wisconsin

November 21, 2006

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ATTACHMENT B

TABLES

TABLE 1
Mill Pond Macrophyte Survey Results
Plymouth, Wisconsin

Sample Site	Coordinates (WI State Plane)		Species Present	Percent Coverage
	Northing	Easting		
1	645989	645989	*Potamogeton pectinatus* (Sago pondweed) *Potamogeton crispus* (curly-leaved pondweed)	<10
2	2503186	645900	*Potamogeton pectinatus* (Sago pondweed) *Potamogeton crispus* (curly-leaved pondweed)	<10
3	2503146	645913	*Potamogeton pectinatus* (Sago pondweed) *Potamogeton crispus* (curly-leaved pondweed)	<10
4	2503178	645858	*Potamogeton pectinatus* (Sago pondweed) *Potamogeton crispus* (curly-leaved pondweed)	<10
5	2503187	645935	*Potamogeton pectinatus* (Sago pondweed) *Potamogeton crispus* (curly-leaved pondweed) *Ceratophyllum demersum* (coontail) *Lemna minor* (common duckweed)	<10
6	2503200	645821	*Potamogeton pectinatus* (Sago pondweed) *Potamogeton crispus* (curly-leaved pondweed) *Lemna minor* (common duckweed)	<10
7	2503244	645835	*Potamogeton pectinatus* (Sago pondweed) *Potamogeton crispus* (curly-leaved pondweed)	15
8	2503385	645504	*Potamogeton pectinatus* (Sago pondweed) *Potamogeton crispus* (curly-leaved pondweed)	15
9	2503497	645368	*Potamogeton pectinatus* (Sago pondweed) *Potamogeton crispus* (curly-leaved pondweed) *Lemna minor* (common duckweed)	20
10	2503641	645160	*Potamogeton pectinatus* (Sago pondweed)	25
11	2503786	645009	*Potamogeton pectinatus* (Sago pondweed) *Potamogeton crispus* (curly-leaved pondweed) *Lemna minor* (common duckweed)	15
12	2504058	644756	*Potamogeton pectinatus* (Sago pondweed) *Potamogeton crispus* (curly-leaved pondweed) *Lemna minor* (common duckweed) *Ceratophyllum demersum* (coontail)	Not Measured
13	644661	2504150	*Potamogeton pectinatus* (Sago pondweed) *Potamogeton crispus* (curly-leaved pondweed) *Lemna minor* (common duckweed) *Ceratophyllum demersum* (coontail)	25
14	644528	2504360	*Potamogeton pectinatus* (Sago pondweed) *Potamogeton crispus* (curly-leaved pondweed) *Ceratophyllum demersum* (coontail)	15
15	644160	2504455	*Potamogeton pectinatus* (Sago pondweed) *Potamogeton crispus* (curly-leaved pondweed) *Lemna minor* (common duckweed)	10
16	643814	2504526	*Potamogeton pectinatus* (Sago pondweed) *Potamogeton crispus* (curly-leaved pondweed) *Ceratophyllum demersum* (coontail)	20
17	644342	2504732	*Potamogeton pectinatus* (Sago pondweed) *Potamogeton crispus* (curly-leaved pondweed) *Ceratophyllum demersum* (coontail)	20

TABLE 2
Mill Pond Sediment Survey Results
Plymouth, Wisconsin

Sample Site	Coordinates (WI State Plane		Depth to sediment (ft)	Depth to hardpan (ft)	Sediment Thickness (ft)
	Northing	Easting			
5	2503187	645935	1.7	4.8	3.1
6	2503200	645821	1.3	5.9	4.6
7	2503244	645835	1.3	5.8	4.5
8	2503385	645504	1.2	6.7	5.5
9	2503497	645368	1.5	6.3	4.8
10	2503641	645160	1.7	4.4	2.7
11	2503786	645009	1.7	4.0	2.3
12	2504058	644756	1.9	4.5	2.6
13	2504150	644661	1.9	5.0	3.1
14	2504360	644528	2.0	5.3	3.3
15	2504455	644159	2.3	6.9	4.6
16	2504526	643814	2.8	3.3	0.5
17	2504732	644342	1.7	3.3	1.6

TABLE 3

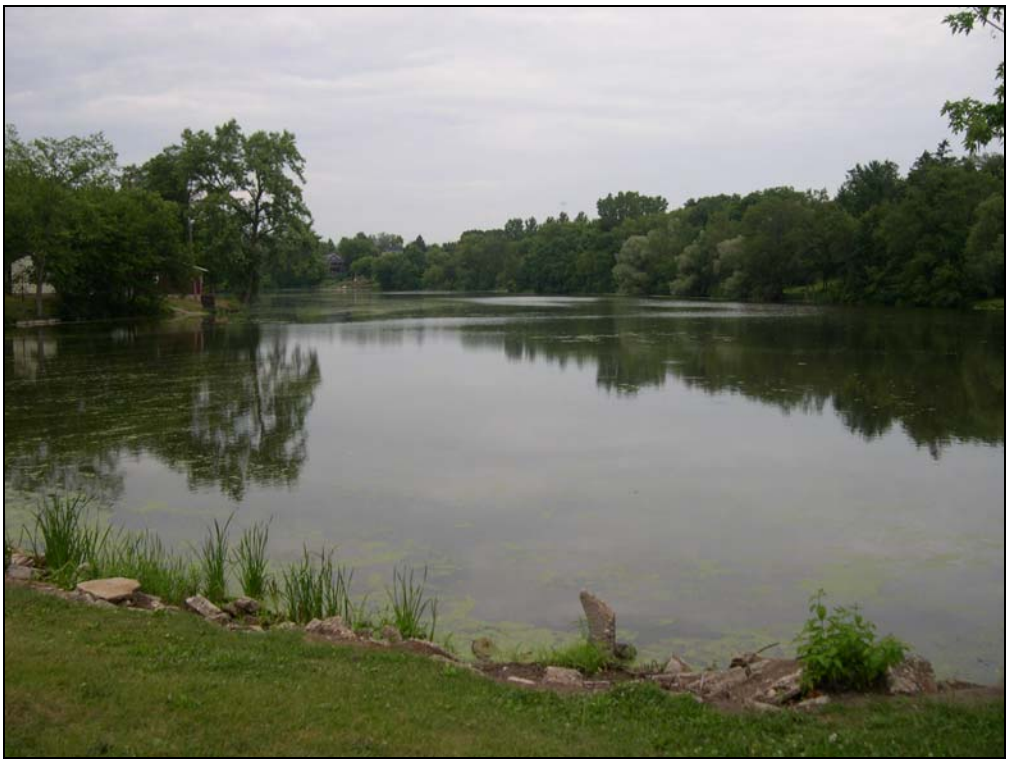
Aquatic Herbicides Approved for Use in Wisconsin[1]
Plymouth, Wisconsin

Chemical (Trade Names)	Management Summary	Management Implications
Copper Compounds (multitude of trade names)	Broad spectrum algaecides used to control both planktonic and filamentous algae. No weekly carryover benefits.	Non-selective and will kill algae within 72 hours. Some algae are resistant. Algae can return within 10 days.
Diquat Dibromide (Reward®, Diquat)	Broad spectrum, contact herbicides that are effective on submersed aquatic plants. No carryover benefits.	Non-selective and will kill plants within 10-14 days. Not effective in turbid waters. Consumption restrictions apply.
Endothal Acid (Aquathol®, Hydrothol®)	Broad spectrum, contact herbicides that are effective on many submersed aquatic plants. No carryover benefits.	Non-selective and will kill plants within 10-14 days. Fish consumption, drinking, and irrigation restrictions apply.
Glyphosate (Rodeo®)	Broad spectrum and systemic (will kill roots). Herbicides used with a surfactant to control emergent and floating plants.	Non-selective and requires the use of a surfactant to ensure uptake by plants. Commonly used for control of purple loosestrife.
2,4-D (Aquakleen, Aquacide, Navigate®, Weedtrine, among others)	Controls only dicotyledons (broad leaf plants such as water lilies, watershield, and water milfoil) with some potential for multiple year control.	Does not control the majority of aquatic plant species found in Wisconsin. Commonly used for control of Eurasian water milfoil. Drinking and irrigation restrictions apply.
Fluridone (Sonar®)	Broad spectrum herbicide that may be dosed selectively for some plants. May have some multiple year control.	Very water soluble and works best when entire pond is treated. Kills plants slowly (20-60 days). Most useful for duckweed control. Irrigation restrictions apply.

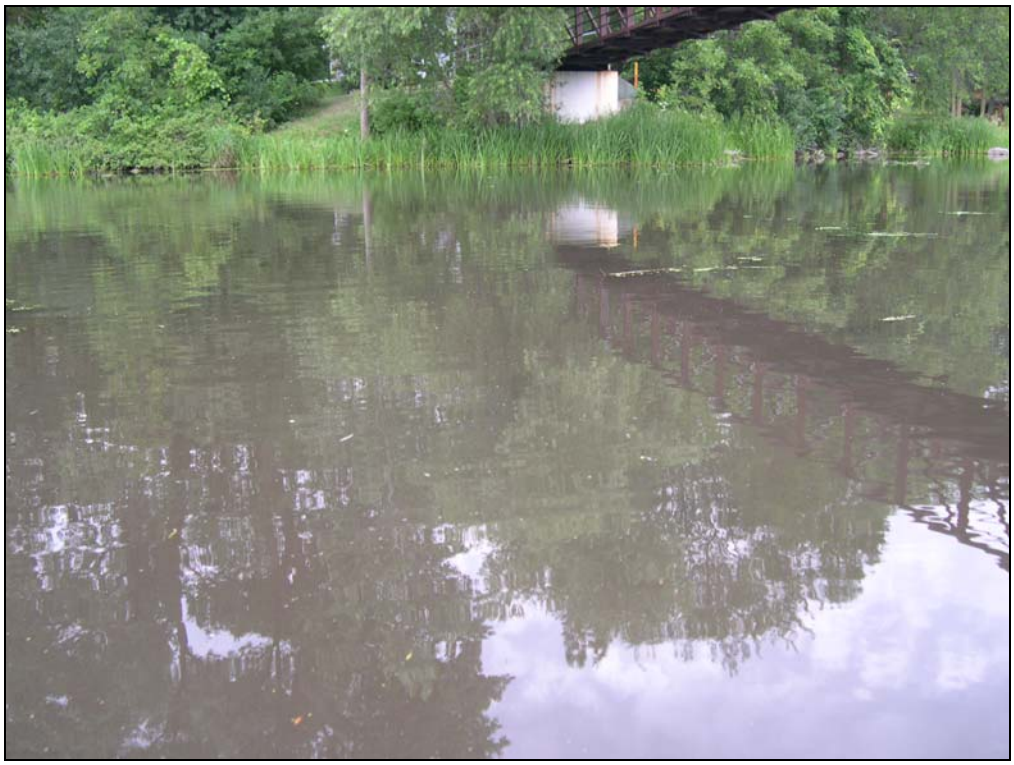
Notes:
[1]Modified from the WDNR.

ATTACHMENT C

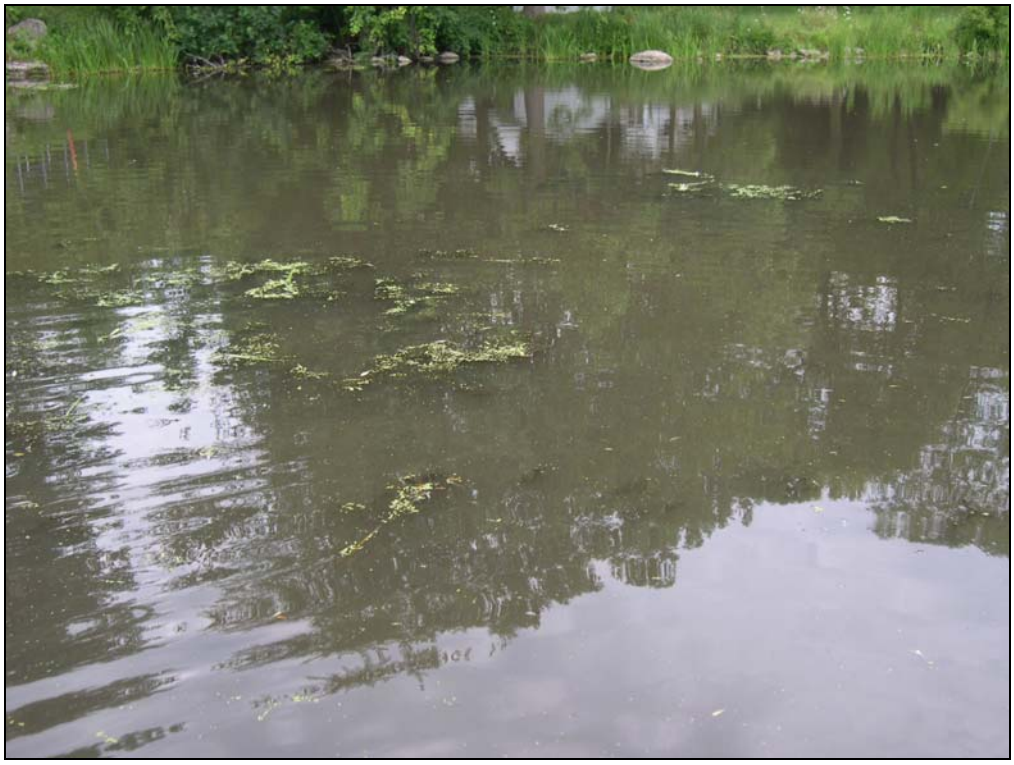
PHOTOGRAPHS



Mill Pond, looking northeast from southern end of the pond.

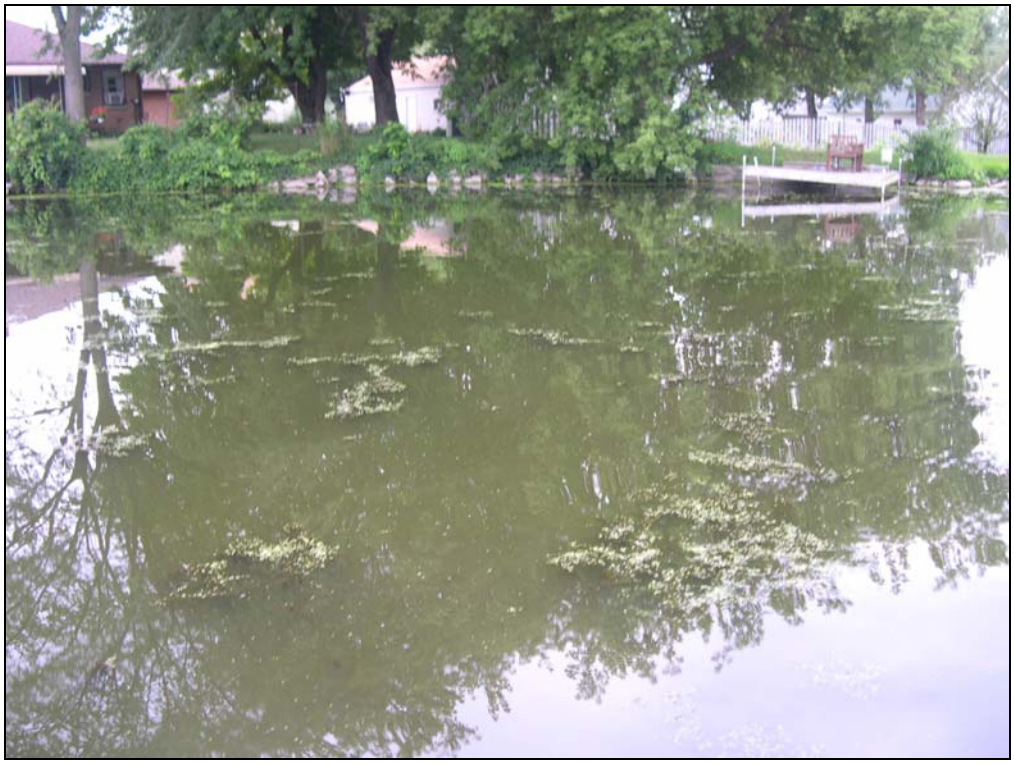


Mill Pond, near the pedestrian foot bridge.

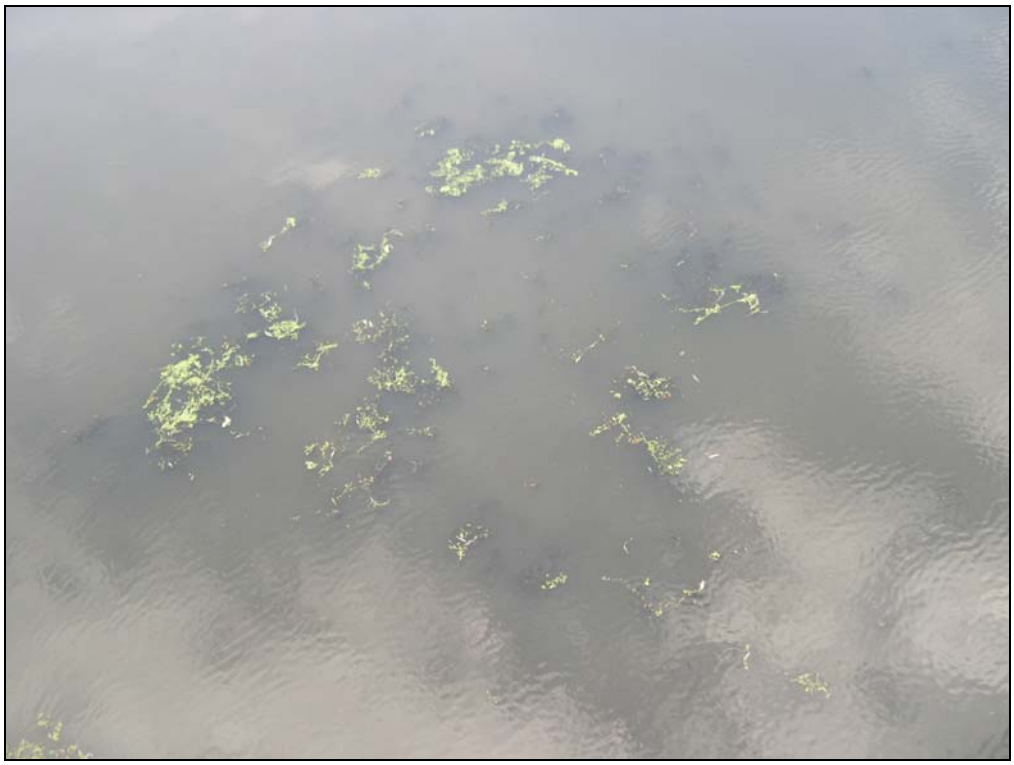


Macrophytes near the pedestrian foot bridge.

Duckweed floating near southwest end of Mill Pond.



Macrophytes on west side of Mill Pond.



Macrophyte bed, looking down from pedestrian foot bridge.