Part II. Feasibility Study

Section 15 – Pond and Watershed Management Alternatives and Benefits

Martins Pond (segment MA92038-2004) is a Great Pond in the Commonwealth of Massachusetts and covers some 92 acres. It is a Class B water body meaning that it is designated for supporting aquatic life and recreational uses. Martins Pond is listed under the Massachusetts Year 2004 Integrated List of Waters (303d list) as an impaired water body due to **turbidity**, **noxious aquatic plants**, **exotic species** and **metals**. The desire for restoring contact recreation in Martins Pond (swimming) has been one of the driving forces for improving water quality since the beach closing at the Pond in 1988.

The water quality in Martins Pond and the Skug River, have been the focus of study since the 1970s. The relatively large number of studies focused on Martins Pond conducted to date, reflect the hydraulic, hydrologic and nutrient dynamic complexity in the pond and its watershed. One main goal of this report was to synthesize the information from previous reports and integrate it with the work conducted in 2005-2006 in order to draw some broad conclusions about the nature of this watershed.

Solutions for continued water quality improvement and increased ecological integrity of Martins Pond will be addressed in this section. In addition, some of the benefits associated with the proposed restoration actions will be discussed. Overall, an integrated program of watershed management and in-pond restoration procedures should be pursued in order to accomplish the following objectives:

(1) Effectively manage nuisance macrophyte species in Martins Pond while maintaining and enhance the ecological integrity of Martins Pond

(2) Effectively control and reduce nutrient loading into Martins Pond from watershed sources

(3) Reduce sediment inflow into Martins Pond from watershed sources

(4) Begin the process of developing a realistic and achievable sewering plan for the North Reading portion of the Martins Pond watershed to provide a long-term solution to bacterial and nutrient influx into the Pond

It is not surprising that a comprehensive watershed approach is needed to begin to address existing water quality issues in Martins Pond.

The Central Importance of Color, Turbidity and Light Limitation

Light is arguably the most important limiting factor regulating macrophyte and algae growth in Martins Pond. One of the most critical results of the current study is identifying the impact of the relatively high water color levels in Martins Pond (and in the Skug River, its tributaries and several other ponds in the watershed) on light attenuation through the water column. This is further exacerbated by the relatively high turbidity levels observed in the Pond. Combined, these factors are effectively limiting the extent of the littoral zone, reducing the spatial and temporal scale of algal blooms and consequently creating conditions unfavorable for swimming. A summary of interconnections and feedbacks between turbidity and other critical components of shallow eutrophic lakes (such as Martins Pond) are shown in Figure 53. Management efforts that alter turbidity, nutrients, macrophyte or other components shown in Figure 53, will have repercussions on the entire system. For example, any significant reductions in turbidity will likely result in increased macrophyte growth, expansion of the littoral zone and increased susceptibility to algal blooms. Such a result might ultimately be counter to the objective of improving the recreational potential of Martins Pond.

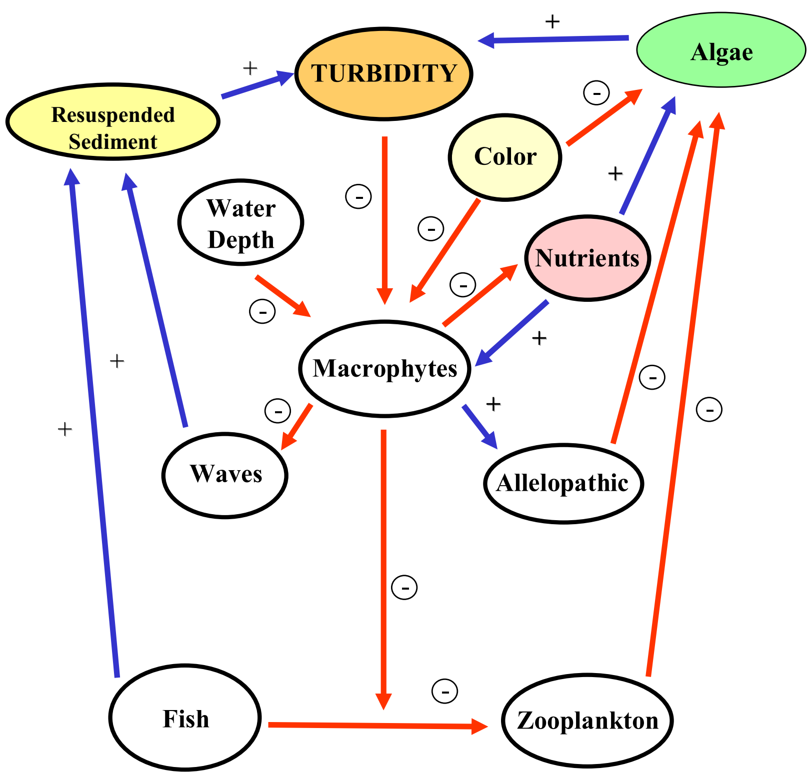

Figure 53. Positive and negative feedback patterns between turbidity, nutrients and color in shallow, eutrophic lake systems (modified from Scheffer et al. 1993).

Management Alternatives

The following sections present potential management alternatives for Martins Pond and its watershed. *The Eutrophication and Aquatic Plant Management in Massachusetts. Final Generic Environmental Impact Report* or GEIR (Mattson et al. 2004) is cited and quoted throughout this section to help inform the management alternatives. In addition, stakeholders interested in pursuing management planning should consult some of the management books focused on the restoration and management of freshwater lakes and ponds. These books provide excellent summaries and descriptions of potential management actions (Holdren et al. 2001; McComas 2003; Cooke et al. 2005).

15.1 - Doing Nothing

Given the complexity of Martins Pond and its watershed, due to the complex hydrology, high color, high turbidity and nutrient loading in the pond, efforts to slow down nutrient inputs and eutrophication will require a complex array of interrelated tasks. However, it is important for stakeholders to being the process of working on both setting realistic watershed management goals as well as in-pond goals to improve water quality. The consequences of not acting are well described in the GEIR (Mattson et al. 2004):

> *The impact of doing nothing in lakes that are already eutrophic may not be all that noticeable over a period of several years, and people may adjust their use of the lake accordingly. As habitat for some species diminishes, so will their populations, but other species may take their place until conditions become too severe (e.g., extremely low oxygen, release of toxins from algal blooms). Conditions in the absence of management can indeed get worse, and almost undoubtedly will deteriorate further over a period of years to decades, with high variability in conditions among seasons and years. Where uses have been lost, doing nothing may not have a clearly negative consequence, but the lost opportunity (along with tax revenues and biodiversity) will continue. The no management option in such cases is ineffective at restoring or rehabilitating the lake, but it may not have the obvious negative consequences of no action for a threatened lake that is not yet eutrophic.*

15.2 – Physical Management Options to Control Nuisance Macrophytes

Some of the potential physical management options for controlling nuisance macrophyte species such as fanwort (*Cabomba caroliniana*) in Martins Pond are outlined in Table 45 below. Each management option in the Table is described in more detail below. Fanwort remains the primary nuisance macrophyte species of concern in Martins Pond and this concern dates back to the 1960s.

Table 45. A Summary of Potential Physical Management Options for Managing Nuisance Macrophyte Species in Martins Pond

Management Option	Description	Advantages	Disadvantages	Systems Where Used Effectively
Dredging/ Sediment Removal	Sediment is physically removed by excavation, can be accomplished by dry, wet or hydraulic removal	Creates deeper water, can reduce nutrient reserves and sediment oxygen demand	Very expensive, must deal with dredge sediment, may negatively impact benthic invertebrates and/or fish communities	Shallow ponds and lakes, particularly those filled in by sedimentation
Drawdown	Lower the surface elevation of a lake or pond for an extended period of time; may precede dredging	Inexpensive, very effective, moderate-term control of rooted plants, allows shoreline restoration work	Can have negative impacts on wetlands, overwintering species, downstream hydrology	Only useful for artificial or regulated lakes and ponds with a dam or water control structure
Benthic Barrier	Use natural or synthetic materials to cover bottom sediments to reduce macrophyte growth	Direct and effective, may last several seasons	Expensive and small-scale, nonselective, potential negative impacts on non-targeted plant, macroinvertebrate and fish species	Around public swimming areas, docks, boat launches and/or other small-scale intensive use areas
Mechanical Harvesting with Collection	Mechanical methods of removing rooted macrophytes, includes plants cut above roots, rotovating and hydroraking	Allows for macrophyte removal at larger scales; relatively rapid short-term results	Commonly leaves fragments of targeted species which may re-root, negative impacts on non-target macrophyte species, creates substantial tubidity, may impact lack fauna	Lakes and ponds infested with dense monocultures of invasive species, removals around public swimming areas, docks, boat launches and/or other small-scale intensive use areas

Dredging

Several mechanical dredging methods are available. They all involve sediments being physically removed from either a lake/pond or river channel. Mattson et al. (2004) summarize the methods in the GEIR as follows:

> ***Dry excavation**, in which the lake is drained to the extent possible, the sediments are dewatered by gravity and/or pumping, and sediments are removed with conventional excavation equipment such as backhoes, bulldozers, or draglines.*
>
> ***Wet excavation**, in which the lake is not drained or only partially drawn down (to minimize downstream flows), with excavation of wet sediments by various bucket dredges mounted on cranes or amphibious excavators.*
>
> ***Hydraulic dredging**, requiring a substantial amount of water in the lake to float the dredge and provide a transport medium for sediment. Hydraulic dredges are typically equipped with a cutterhead that loosens sediments that are then mixed with water and transported as pumped slurry of 80 to 90% water and 10 to 20% solids through a pipeline that traverses the lake from the dredging site to a disposal area.*
>
> ***Pneumatic dredging**, in which air pressure is used to pump sediments out of the lake at a higher solids content (reported as 50 to 70%). This would seem to be a highly desirable approach, given containment area limitation in many cases and more rapid drying with higher solids content. However, few of these dredges are operating within North America, and there is little freshwater experience upon which to base a review. Considerations are much like those for hydraulic dredging, and pneumatic dredging will not be considered separately from hydraulic dredging for further discussion.*
>
> ***Reverse layering**, which is grouped with dredging because it involves the movement of sediment, but differs in that the sediment is not actually removed from the lake. Sandy substrates beneath layers of muck are pumped upward and spread over the muck, burying the nutrient-rich material and creating a new top layer of presumably low-nutrient sand.*

Due to the complex hydrology of the Martins Pond watershed and the influence of downstream obstructions along Martins Brook, it would be extremely difficult to create conditions for an effective drawdown for any dry dredging. Thus limited wet dredging or hydraulic dredging would be the only feasible options. However, removal of sediments is not recommended for Martins Pond. While dredging can potentially lower in-pond nutrient concentrations by removing a key source of nutrients – sediments, the long-term impacts are more complex and do not reduce watershed sources of N and P. Given the high color and turbidity in the pond, dredging could potentially decrease the size and extent of the littoral zone. This could further increase turbidity by having more sediments outside the macrophyte rooting zone thereby exposing more sediment to potential resuspension. This is especially true given the relatively high level of inherent color in the pond. Deepening of Martins Pond and increasing its holding capacity would also decrease flushing times and increase residence times in the Pond. The ramifications of this remain unknown, but it would increase the potential and likelihood of stratification or at least partial stratification during the summer. This would considerably change the nutrient dynamics in the Pond and increase the potential for anoxic releases of P during prolonged stratification periods.

In addition, the cost of removing sediments can be high. An estimate of $10/cubic yard is suggested as a rough estimator for estimating the general cost of a potential project under initial consideration (GEIR). Based on the two scenarios mentioned in the 1985 D/F Study (Anderson Nichols and Lycott 1985), dredging the southern Pond area immediately adjacent to the beach to a depth of 15 ft and dredging the entire Pond to the same depth, corresponds to some 160,000 cubic yards and 1,220,000 cubic yards, respectively. Thus an estimated cost for the two scenarios would be $1.6 million and $12.2 million for the southern scenario and whole-pond scenario, respectively.

Drawdown

Drawdown is not a feasible options given the hydraulic constraints downstream and the complex hydrology of the watershed. Even with new bridges at Route 62 along Martins Brook or at Route 28 on the Skug River, this would not help in any sort of meaningful drawdown. This also means that any efforts at dilution or flushing are also likely to be limited in their impact.

Benthic Barriers

Benthic barriers basically are bottom covers for the pond that act as physical barriers to prevent plant growth or the release of nutrients. Natural barriers (usually clay, silt or sand) can be used or artificial barriers such as polyethylene, polypropylene, fiberglass or nylon sheeting have been used to cover bottom sediments. Benthic barriers have been in use since the 1960s to cover sediments/hydrosoils in efforts to limit and/or prevent the growth of nuisance macrophyte species (Engel 1984). While effective in limiting certain target macrophyte species, the barriers can also have negative impacts on more desirable macrophyte species and macroinvertebrates (Ussery et al. 1997).

Because light is a limiting factor in Martins Pond, there is no long-term need to control the extent of the littoral zone, especially given the yearly fluctuations in macrophyte abundance and spatial distribution. Benthic barriers would likely limit resuspension but that could be a 'double-edged sword'. The benthic barrier would need to be maintained or expanded to limit macrophyte growth if water clarity increased. In addition, barriers could increase anoxia at the sediment-water interface, interfere with benthic invertebrates or inhibit fish feeding and/or spawning if placed in key habitats.

When considering the potential deployment of benthic barriers, the GEIR notes:

> *The use of benthic barriers, or bottom covers, is predicated upon the principles that rooted plants require light and cannot grow through physical barriers… In theory, benthic barriers should be a highly effective plant control technique, at least on a localized, area-selective scale. In practice, however, there have been difficulties with the deployment and maintenance of benthic barriers, limiting their utility over the broad range of field conditions.*

The following guidelines are also noted in the GEIR:

- *Porous barriers will be subject to less billowing, but will allow settled plant fragments to root and grow; annual maintenance is therefore essential.*
- *Solid barriers will generally prevent rooting in the absence of sediment accumulations, but will billow after enough gases accumulate; venting and strong anchoring are essential in most cases.*
- *Plants under the barrier will usually die completely after one to two months, with solid barriers more effective than porous ones in killing the whole plant; barriers of sufficient tensile strength can then be moved to a new location, although continued presence of solid barriers restricts recolonization.*

Given the constraints and the potential negative ecological impacts, any large-scale benthic barrier deployment is not recommended. However, in small-scale applications such as at the public boat landing off Travelled Way and at the North Reading Town Beach, a limited deployment of benthic barriers might be a viable and cost-effective method to control unwanted macrophyte growth (including fanwort).

Mechanical Harvesting with Collection

Employed in 2005, this remains an option in the future, but should be used very judiciously. Limited mechanical harvesting for maintenance of boat channels and/or high use recreational is a viable management option, but only on a very limited basis and preceded by a quantitative survey of both the composition and spatial extent of existing macrophyte species. Post-harvesting impacts must also be monitored before any new harvesting is considered. Damage to non-target macrophyte species diversity and rhizomatous pond lilies is problematic.

As noted in the GEIR:

> *Harvesting of nuisance aquatic plants includes a suite of techniques that vary in sophistication and cost from simply hand pulling of weeds to large-scale mechanical cutting and collection of plants. Harvesting can be an effective short-term treatment to control the growth of aquatic plants. With repeated application at appropriate intervals, it can produce long-term shifts in the plant community, but it is unlikely to reduce long-term plant density substantially.*

Based on the work conducted as part of the current 2005-06 study, the following are conclusions and recommendations regarding the control of fanwort in Martins Pond:

- Given the exceptionally high turbidity and color in Martins Pond, many of the macrophyte spatial and temporal abundance patterns observed in this study need to be interpreted in the context of the severe turbidity constraints on macrophyte growth and littoral zone extension.
- Following mechanical harvesting in 2005, there was a dramatic decrease in both the extent and abundance of fanwort in Martins Pond relative to the pre-harvest conditions. The percent occurrence of fanwort on all sample points in 2006, the year after mechanical harvesting, was only 6.5%, compared to 38.9% in 2005, suggesting that harvesting was successful in reducing the overall level of occurrence of fanwort in Martins Pond.
- The abundance of fanwort in the non-harvested Area A (see Figure 45 for location) also showed dramatic decreases despite not being harvested. This suggests that fanwort abundance may have been in a decline cycle despite the harvesting effort. Variability in species abundance of both fanwort and other species was clearly evident over the past five and even 40 years, regardless of any harvesting or mechanical management activities.
- The 2006 macrophyte survey results showed decreases in all three measures of diversity. It is hard to decipher the relative contribution of harvesting to these declines, but clearly harvesting did not have any positive impact on the abundance and distribution of aquatic plant diversity in Martins Pond. The reduction in species richness is particularly of interest and needs to be monitored closely if any additional harvesting activities are proposed. Fanwort control must be balanced with full consideration of the ecological integrity of the native aquatic plant communities in Martins Pond.

- No additional harvesting should occur without conducting a pre-harvesting survey to determine if fanwort abundance and distribution warrant control efforts. It should also be noted that great care must be taken when cleaning the harvester of plant fragments and/or seeds to prevent new species from entering Martins Pond and/or existing species leaving the pond and infesting new areas.

Hydroraking and Rotovation

Neither of these macrophyte mechanical control options are recommended for Martins Pond. The physical disturbance created would be extremely disruptive to pond sediments that are already susceptible to resuspension. Hydroraking and/or Rotovation, would likely increase resuspension of sediment, increase turbidity and damage non-target species. They would only be an option along Martins Brook to help clear the natural channel of that waterway from vegetation that is overgrowing or has overgrown the channel, namely water willow (*Decodon verticillatus*) and purple loosestrife (*Lythrum salicaria*). It should be noted that hydroraking has been used in recent years to control fanwort in Foster's Pond in Andover, MA.

15.3 - Chemical Controls of Algae and Macrophytes

Chemical Control of Algae

Several types of chemical control agents are available, including contact algaecides such as copper compounds (e.g., $CuSO_4$), endothall and diquat. Chemical treatments offer potentially rapid control of algae, however the chemicals may be toxic to non-target species of plants and/or animals, they may impair uses of the pond and killing of algae may release cellular contents of the algae. Given that algae require both light and nutrients for growth, the high turbidity and color in Martins Pond means that light is a key factor limiting algal growth. Relatively high light attenuation due to turbidity and color are what now keep algal blooms from being more pronounced as well as preventing rooted macrophytes from expanding out of the current littoral zone. Given that algae are a minor component of turbidity, it does not make sense to expect their control will dramatically improve water clarity. Thus, chemical control of algae is not recommended.

Chemical Control of Macrophytes

As noted earlier, fanwort remains the main species of concern in Martins Pond and this concern dates back to the 1960s. Given the current suite of macrophyte species found in Martins Pond, fanwort is the sole aquatic macrophyte species attracting potential management attention. One of the most common forms of control of nuisance aquatic plants, such as fanwort, is the use of herbicides. There are basically six types of chemical herbicides that are available for use corresponding to six different active compounds. There are three types of contact herbicide that basically kill macrophytes at the immediate point of contact. The three types are (1) various formulations of **endothall** (7-oxabicyclo [2.2.1] heptane-2, 3-dicarboxylic acid); (2) forms of **diquat** (6,7-dihydropyrido [1,2-2',1'-c] pyrazinediium dibromide) ; and (3) **glyphosate** (N phosphonum ethyl glycine). There are also three systemic herbicides available for controlling macrophytes. The three systemic herbicides are: (4) forms of **2,4-D** (2,4-dichlorophenoxy acetic acid); (5) forms of **fluridone** (1-methyl-3-phenyl-5-[-3-{tripluoromethyl}phenyl]-4[1H]-pyridinone); and (6) forms of **triclopyr** (3,5,6-trichloro-2-pyridinyloxyacetic acid).

Pilot herbicide and research studies were originally proposed for the current study using fluridone. However, due to the pursuit of the mechanical harvesting option by the Town of

North Reading, coupled with public concerns about the use of chemical control, no small-scale, pilot herbicide application was made in Martins Pond for the control of fanwort.

The abundance of fanwort in Martins Pond has fluctuated dramatically over the previous four decades. Calls for control of this species become more pronounced in years when fanwort abundance peaks and it is both more likely to impair recreational opportunities in the pond and become an ecologically dominant species. However, it is not uncommon for fanwort to dramatically increase or decrease on a yearly basis so preparations for management that seem urgent in one year may be more or less so in the following year. These yearly fanwort fluctuations are linked, in part, to the high color and turbidity in the pond in that light levels during any winter and spring can play a large role in the growth rate and extent of fanwort and other macrophyte species. Yearly shifts in the extent of the littoral zone are expected and thus management plans must be flexible and take a long-term perspective.

15.4 – Chemical Sediment Treatments

Phosphorus Inactivation – Alum

Nuisance algal blooms and/or macrophyte growth can be reduced in phosphorus-limited systems, if phosphorus concentrations can be effectively lowered. Aluminum salts, in the form of aluminum sulfate (alum) or sodium aluminate or polyalumium chloride, can be used to bind phosphorus under a wide range of limnological conditions thus inactivating the phosphorus. Phosphorus can be removed from the water column (precipitation) or the release of mobile phosphorus from lake sediments can be retarded (inactivation). The aluminum binds both with free phosphate forming aluminum phosphate and with hydroxide forming a colloidal aluminum hydroxide floc. The latter can bind with many forms of phosphorus. In some cases, calcium hydroxide, ferric chloride and/or ferric sulfate can also be used as substitutes for alum but each of these can alter pH in undesirable ways, especially in water bodies with limited acid neutralizing capacity (ANC).

Alum treatments have been tried previously in Martins Pond (1985 and 1987). However, no short and/or long-term benefit was documented based on these treatments. Given the large proportion of watershed inputs of phosphorus (89.7%), watershed-wide treatments would be needed which would be both impractical and undesirable. In addition, if nitrogen is sometimes limiting rather than phosphorus in Martins Pond, phosphorus inactivation will not address that problem. Given the high external (watershed) loading of P, in-pond P inactivation would have a limited impact on reducing P levels. The slightly acidic pH of Martins Pond and its inflow, and relatively low ANC also means the Pond is more susceptible to pH changes.

15.5 - Septic Conversion to Sewering

Since the IEP Study (1977), there has been evidence that septic systems are a likely contributor to both fecal coliform levels and nutrient loading (particularly N and to a lesser extent P) into Martins Pond, other surface waters and into the Skug River and its tributaries. Converting wastewater disposal from septics to sewering should be part of a long-term management plan to reduce bacterial contamination and help reverse the trend of increasing eutrophication in Martins Pond by reducing N and P inflows. While not the only solution to the eutrophication problems of Martins Pond, sewering is an essential step on the road to ensuring the long-term recreational use potential of the pond and part of a broader watershed plan to begin reductions in sources of nutrient loadings to the pond. Sewering will not dramatically decrease P inputs because the main source are watershed loadings (89.7%), but sewering would decrease P and N inputs and be one part of a multi-pronged program to decrease P and N influx. In addition, bacterial contamination, particularly during storm events, needs to be addressed if contact recreation and swimming are going to be long-term use options for Martins Pond.

Recommendations to consider sewering around Martins Pond are not new. The IEP Study (1977) noted:

"...sewering of residences within the watershed of Martins Pond in North Reading will substantially reduce the annual phosphorus loading and supply to the Pond."

The 1985 D/F Study recommendations included:

"The significant source of nutrients around the pond is the subsurface disposal of wastewater. The recommended methods of combating this source is the construction of a shoreline pressure sewer for most of the developed areas around the pond"

Thus, it is highly recommended that the Town of North Reading and all Martins Pond stakeholders set a timeline for the development of a feasible and implementable sewering program.

15.6 - Watershed Management to Reduce Sediment and Nutrient Input

This will be essential and the most complex management goal to achieve. Water quality in Martins Pond is heavily influenced by watershed-based non-point source pollution as evidenced by high watershed loadings of N, P and TSS. Therefore, effective management plans need effectively address the source of impairment.

Controlling Sediments

Efforts at managing and/or reducing sediment inflows will be complex in Martins Pond and in the Skug River watershed. Some 91.2% of the sediment load into Martins Pond is from watershed sources. In addition, a 78.9% fraction of the sediments (TSS) entering Martins Pond are organic. Runoff and erosion control BMPs will need to be implemented watershed wide to combat the influx of TSS into Martins Pond, including a focus on stormwater conveyance inputs, stream bank and/or shoreline erosion and landscaping practices. Shoreline and stream bank stabilization can have dramatic impacts on reducing the inorganic fraction of TSS and are highly encouraged.

Reducing sediment loadings will improve water clarity to an extent. However, Martins Pond is inherently colored and at relatively high levels. The combination of dissolved organic material coupled with dissolved Fe and Mn means that a background level of color will always be present. While not considered a component of turbidity *per se*, water color negatively impacts water penetration in the water column thus creating a background condition where some 1/3rd of the light may be attenuated due to this color alone. Because of the color, sediment loading reductions may reduce turbidity but it will not address light attenuation due to color. Thus if one management goal is to control turbidity in Martins Pond to meet the water clarity standard for swimming, in will be essential to factor in the influence of color in order to meet management goals.

Nutrient Loading

Nutrient loading remains a major challenge for Martins Pond. Watershed loadings account for 98.7% of P input into the pond and 58.3% of N input. The impact of sewering on reducing nutrient inflows has already been discussed. Sewering might have a greater impact on N than P given the watershed loadings of those nutrients relative to internal inputs. However, any efforts to control and reduce nutrient inputs need to have a strong watershed-based component. Martins Pond is thus challenged with a classic non-point source pollution problem. An integrated suite of BMPs will need to be implemented watershed-wide to reduce the watershed influx of nutrients into Martins Pond. Examples of BMPs to achieve nutrient reductions include fertilizer controls, landscaping management, controlling pet wastes, septic system maintenance and stormwater conveyance alterations. Implementation of BMPs should begin with the subwatersheds noted in this study exhibiting the highest loadings of nutrients. The Towns of North Reading, Andover and North Andover will have to coordinate their efforts to maximize efficiency and effectiveness.

15.7 – Restoring the Swimming Potential of Martins Pond

Martins Pond is a Class B water meaning that it is designated as a habitat for aquatic life, and wildlife, and for primary and secondary contact recreation. One long-term management objective since the Town Beach was closed in 1988 was to have the Pond once again meet the water quality standards to allow swimming. The Minimum Standards for Bathing Beaches established by the Massachusetts Department of Public Health which state that swimming and bathing are not permitted at public beaches when: 105CMR 445.10

> (2b) A black disk, six inches in diameter, on a white field placed at a depth of at least 4 feet of water is not readily visible from the surface of the water; or when, under normal usage, such disk is not readily visible from the surface of the water when placed on the bottom where the water depth is less than four feet….

Given the high turbidity and color in Martins Pond, having swimming again will need to balance the goal of improving turbidity to the point where swimming is allowed, but not to the point where light is no longer limiting in the Pond and eutrophication will become even more accelerated. At present, swimming and contact recreation in Martins Pond is not advised during or immediately after rainfall events. Fecal coliform levels spike during rain events and residents around Martins Pond and other users should be fully aware of the potential health risks of swimming under these impaired water conditions.

In order to resume swimming in the pond in the short-term, one option that the Town of North Reading should consider implementing is the use of a 'barrier curtain' during the summer swimming season could achieve the clarity requirements of Massachusetts Department of Public Health. The barrier could be temporarily installed each season. This would allow contact recreation in the pond and be a solution to the complex and inherent problem of high natural turbidity and water clarity issues in this stained pond and allow for treatment of bacteria within the confines of the barrier curtain. Such a barrier could result in producing Secchi depths greater than the 4 ft minimum standard. This represents a relatively low cost and immediate solution to the lack of contact recreation in the pond. Barrier curtains have been deployed along the Charles River and at other locations in the northeast.

15.8 - Biological Control of Purple Loosestrife

The goal of biological control of purple loosestrife (*Lythrum salicaria*) using *Galerucella* beetles is not just to reduce loosestrife cover and biomass, but to move in the direction of restoring the cover and abundance of native wetland species. The results of the biological control project have been modest to date. As shown in this report, the surface water level has exceeded the critical threshold for beetle over wintering survival in 2003, 2005 and 2006. This is likely correlated to the extreme reduction in reduced beetle herbivory noted. The concerns surrounding surface water elevations in the Martins Brook wetland complex south of Martins Pond and influenced by flow restrictions further downstream.

Given these important constraints, any future beetle releases should be in more elevated portions of the Martins Brook release site. There is micro-topographical variation in the wetlands and release sites should be shifted to areas of higher elevation to help avoid the negative impacts of high seasonal water levels. It is recommended that with these adjustments, the biological control program should continue until 2010.