STORMWATER RETROFIT OF LONG LAKE, LITTLETON, MA – USING LOW IMPACT DEVELOPMENT APPROACHES

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ABSTRACT

Long Lake in Littleton, Massachusetts has experienced rapid eutrophication as a result of conversion of summer cottages to year-round housing, on-site wastewater disposal on small lots, and an extensive network of stormwater collection and conveyance piping with direct discharge to the Lake. A network of stormwater catch basins and conveyance piping currently directs the vast majority of stormwater immediately into Long Lake through over 18 piped discharge points. The current stormwater conveyance system provides minimal opportunity for stormwater to come in contact with soils and vegetation, settle solids, and remove nutrients and other pollutants.

This Section 319 comprehensive stormwater retrofit project for the restoration of Long Lake, the first of its kind in Massachusetts, employs a Low Impact Development (LID) approach that will include: selected disconnection of the existing stormwater collection system; design and site location of infiltration swales, and a wetland treatment cell, bioretention cells, depression storage, porous pavement, and parking lot storage; homeowner involvement through education including: installation of rain barrels, lawn care education, water conservation, and other management practices. In addition to the Section 319 grant, the Town recently received a $300,000 State Lake and Pond Demonstration Grant to help implement many of the controls. The new grant will support economic incentives to encourage homeowners to purchase no phosphorus lawn fertilizer under a rebate program.

This paper will describe the comprehensive and innovative approach that Littleton is using to retrofit this area, improve water quality in this recreational lake, involve residents, and help to meet the local Stormwater Phase II requirements and provide a pilot project for similar lakeshore communities developing Phase II programs.

INTRODUCTION

Long Lake is a 99-acre recreational (i.e., swimming and fishing) kettle pond in Massachusetts with over 600 houses on small lots, that has been subject to a deterioration of water quality and recreation use caused by a proliferation of nuisance aquatic macrophytes (Figure 1). Results of a water quality study conducted as part of a Diagnostic/Feasibility Study in 1990 and further
documented through a current S.319 project indicate that Long Lake is undergoing cultural eutrophication, mainly due to nutrient inputs from its 1.5 square mile watershed. Phosphorus is considered the most important limiting nutrient for primary production (plant growth) in the lake. The phosphorus arrives principally through the surface tributaries, storm drainage runoff from road surfaces and the groundwater. An updated phosphorus budget was completed for the S.319 Project (Figure 2). A network of stormwater catch basins and conveyance piping currently directs the vast majority of stormwater immediately into Long Lake and quickly discharges stormwater through over 18 piped discharge points. The current stormwater conveyance system provides minimal opportunity for stormwater from impervious source areas to come in contact with soils and vegetation, settle solids, and remove nutrients and other pollutants (Figure 3). Stormwater is the major source of pollutants to the lake and accordingly a program has been developed to address this source through retrofit of the existing stormwater collection system with grass and vegetated swales, a constructed wetland, boat ramp and parking area redesign, and distributed controls on private residential lots in the watershed. Current S.319 funding is limited and will only help to implement a portion of the required controls.

Figure 1. Noxious Aquatic Macrophytes and Emergents at Long Lake

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Long Pond is identified on the Massachusetts 303(d) list for noxious aquatic plants, and water quality may be threatened by high phosphorous loading. Long Pond is in the Fort Pond Brook Tributary Basin and serves as the headwaters into the Assabet River, which is also identified on the Massachusetts 303 (d) list. The Assabet River is currently undergoing a “Total Maximum Daily Load” analysis. Eutrophication has led to extremely dense macrophyte growth along the shoreline of the pond, with subsequent degradation of the recreational utility of this water body. Storm events bring flooding and direct discharge of sediment, nutrient, and pollutants directly into the Lake (Figure 4), causing rapid buildup of sediment along the shoreline of the Lake.
Figure 4. Flooding and direct discharges of sediment into Long Lake during March 21, 2001 storm event.

The water quality impacts of storm drains and septic systems in the Long Pond watershed are also a concern. Restoration of recreational activities and mitigation of present and future influences are desired.

Figure 5. Stormwater Outfall at Town Beach

Figure 6. Dye Testing To Determine Stormwater Drainage
RESTORATION PLANS

The Littleton Lakes Coalition (LLC), and the Long Lake Neighborhood Association (LLNA) have become active participants with the Town of Littleton to restore and protect the many lakes in the Town and promote cooperation among individual lake and pond associations. Many improvements and institutional changes in the Long Lake watershed have been accomplished over the last year. The community has agreed to promote the design and installation of a range of Low Impact Development (LID) controls within the watershed to Long Lake. LID controls are stormwater management techniques designed to reduce stormwater volume and improve the level of pollutant removal through distributed control techniques, including disconnection of flow paths, infiltration, retention, and biological uptake.

The specific goals of the Long Lake restoration project are to restore the value of the lake to the community through the implementation of in-lake and out-of-lake controls. The techniques being implemented are aimed at reducing or removing factors leading to pond degradation rather than merely treating pond conditions in isolation. These techniques include macrophyte chemical treatment (conducted in June of 2001) hydroraking of rooted macrophytes, stormwater treatment (i.e., LID controls), increased street sweeping, and education of watershed residents.

LID CONTROLS

Over 20,000 linear feet of drainage swales are designed and in the process of installation. Using a parcel-by-parcel and right-of-way analysis based on the Town’s geographic information system (GIS). The design and layout of wet and dry drainage swales was accomplished. In this highly developed watershed, encroachment upon the roadway right-of-way was significant. Mailboxes, trees, shrubs, walls, fences, were all identified using the GIS. Where obstacles could be removed or avoided, a swale was designed. In Massachusetts, infiltrating stormwater control measures must have a setback of 100 feet from septic systems. Achieving this setback was almost impossible in this watershed. In response, the design of the swales was modified to include impervious membranes such that they will function as wet swales.

A constructed wetland cell (Figure 7) was designed to treat a 40-acre drainage area to Long Lake. The parcel is owned by the Town and is currently considered a non-buildable lot due to wetlands. Over 90% of the stormwater volume will flow through this constructed wetland resulting in a significant reduction in sediment and nutrient loading to the Lake. In addition, recreational opportunities for wildlife observation were incorporated into the project by including a porous paver walkway.
Other proposed LID controls include: the disconnection of roof drains that are directly connected to pervious surfaces; installation of rain barrels to capture roof drainage; installation of raingardens to hold small volumes of runoff on site; installation of several bioretention cells on public parcels throughout the watershed; creation of a watershed interpretative Low Impact Development walking trail in the watershed with a map, field signage, and pamphlet; and economic incentives to promote the use of low phosphorus lawn fertilizers and natural lawn care products.

This last LID control involves providing watershed homeowners with rebates to purchase no phosphorus lawn care products. Excessive amounts of nutrients from lawn care activities are common sources of nutrient loading to lakes. Public educational materials were supplied to residents on alternative lawn care products that are low in phosphorus. There is considerable interest in using these products; however, their cost is slightly higher than commercial brands of lawn fertilizers. Corn gluten meal (10-0-0) is a commercially available lawn care product having no phosphorus and consisting entirely of dried protein separated from corn during the manufacture of starch in the food industry. Corn gluten also has properties that reduce weed seed germination, serving as a pre-emergent natural herbicide. This and other natural products are available locally at hardware stores and lawn care supply stores. The approach is to provide a $25 per bag rebate to homeowners in the watershed that purchase these products rather than fertilizer high in phosphorus. Rebates such as this have worked exceptionally well in the electric power industry (low-wattage light bulb coupons) and in the water conservation field (low-flow
toilet retrofit rebates). This innovative approach to use economic incentives to change behavior in the purchasing of fertilizers can significantly reduce phosphorus loading from lawn care in the watershed. The rebates will be directly available to the consumer at the time of purchase. The retailer will be reimbursed for all rebate coupons accepted.

NPDES STORMWATER PHASE II COMPLIANCE

In 1999, the U.S. Environmental Protection Agency (EPA) instituted the NPDES Phase II Storm Water Regulations. Phase II affects 189 Massachusetts communities by expanding the NPDES program to include these municipal separate small sewer systems [MS4s] and small construction site activities (1-5 acres). Included in the MS4 category are municipal systems, state and federal departments of transportation, public universities, local sewer districts, public hospitals, military bases and prisons. Under the stormwater rule, all regulated small municipal separate storm sewer systems must develop, implement, and enforce a stormwater management program designed to reduce the discharge of pollutants to the "maximum extent practicable" utilizing best management practices (BMPs). The program require the development and implementation of 6 minimum control measures including:

- Public education and outreach on storm water impacts
- Public involvement/participation in the development of the plan
- Illicit discharge detection and elimination including infrastructure mapping
- Construction site storm water runoff control
- Post-construction storm water management in new development and redevelopment
- Pollution prevention/good housekeeping for municipal operations

The Long Lake stormwater restoration project in Littleton will assist the community develop a stormwater control program for most of these minimum measures. Public education and involvement has been achieved. Infrastructure mapping is completed. Post-construction stormwater controls have been designed and several installed. Pollution prevention through street sweeping and catchbasin cleaning is a regular maintenance item in the watershed.

CONCLUSION

Over the next three years all of the stormwater control measures discussed above will be implemented. A water quality monitoring program will be conducted to measure the nutrient and sediment loading reductions from these distributed LID control measures. It is anticipated that the cost of the LID controls will be significantly less than the cost of a regional stormwater control facility. In addition to the water quality benefits, community involvement and aesthetic improvements through plantings in the bioretention cells, raingardens and swales will help to create vegetated buffers between the small residential lots. LID controls in a retrofit setting of high density lakeshore development holds the promise of achieving improved stormwater quality control while involving residents and improving aesthetics.