Revised Restoration / Management Plan for Lake Luxembourg / Core Creek Watershed, Core Creek Park, Bucks County, Pennsylvania

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Project No: 121.012

March 2005

was used to evaluate the management alternatives proposed for the original Restoration and Management Plan (Appendix B) and has been frequently used in US EPA'S Clean Lakes Program (US EPA, 1980). For this revised Restoration and Management Plan for the Core Creek watershed, the feasibility matrix factors were slightly modified and included:

1. Pollutant reduction - How substantial a decrease in nutrient and/or sediment loading can be expected from the implementation of this technique?
2. Practicality - Can the technique be realistically implemented for Lake Luxembourg and/or the Core Creek watershed?
3. Effectiveness - Based on the scientific literature, how effective is this technique in meeting desired management objectives?
4. Environmental Impacts - Are there any adverse environmental impacts associated with implementation of the technique?
5. Initial Costs - How much will it cost to design and initially implement the technique compared to the expected returns?
6. Operations and Maintenance (O/M) Costs - How much will it cost to operate and/or maintain the technique on a long-term, annual basis?

For the sake of this Feasibility Study, the BMPs identified for immediate implementation under the existing grant were evaluated separately (Table 5) from the other BMPs proposed for long-term implementation under the guidance of the TP and TSS TMDLs for the Lake Luxembourg / Core Creek ecosystem (Table 6).

Table 5 - Management Alternatives Feasibility Matrix (Proposed for Immediate Implementation)

Alternative	Pollutant Reduction	Practicality	Effectiveness	Environmental Impacts	Initial Cost	Operation and Maintenance Costs	Overall Rating
Retrofit BMPs (Catch Basins with SNOUTs)	3	4	3	4	5	2	21
Retrofit BMPs (Grate Inlet Skimmer Box)	2	4	3	4	4	2	19
Retrofit BMPs (Hydro-Cartridges)	2	4	3	4	4	2	19
Stabilization of Shoreline (1,000 ft)	3	5	4	5	3	3	23
Stabilization of Shoreline (400 ft)	3	5	4	5	3	3	23
Pocket Wetland BMP	4	3	4	5	2	4	22
Public Education	3	5	3	5	4	4	24

Table 6 - Management Alternatives Feasibility Matrix (Proposed for Future Implementation)

Alternative	Pollutant Reduction	Practicality	Effectiveness	Environmental Impacts	Initial Cost	Operation and Maintenance Costs	Overall Rating
Regional Wetland / Pool Complex BMP	4	3	4	5	2	3	21
Vegetated Buffer (Agricultural)	3	4	4	5	4	4	24
Vegetated Buffer (Urban)	3	3	3	5	3	3	20
Streambank Stabilization	2	3	4	4	3	3	19
Retrofit BMPs (Extended Detention Basins)	2	5	4	4	4	3	22
Construction of Extended Detention Basins	2	4	4	4	2	3	19
Development of a Meadow Habitat	3	4	4	5	3	4	23
Public Education	3	5	3	5	4	4	24

5.2 BMPs Proposed for Immediate Implementation

Funding was awarded to the BCCD to conduct a third implementation project for Lake Luxembourg and the Core Creek watershed. This grant was awarded by the Pennsylvania Department of Environmental Protection (PADEP) through the United States Environmental Protection Agency's (US EPA's) Non-Point Source Pollutant Program (Section 319(h) of the Clean Water Act). BMPs that will be implemented as part of this grant are shown in Figure 7 (Appendix A) and described below.

Installation of Seventeen Retrofit Stormwater BMPs (Sites 1a and 1b)

Many of the standard structural stormwater BMPs (i.e., wet ponds, retention basins, infiltration basins) tend to have large land requirements and are most effective when included in the planning phase of development. Consequently, all future development within the Core Creek watershed should incorporate Low Impact Development (LID) strategies to minimize impacts associated with both flooding and NPS pollution. Such LID strategies include, but are not limited to, vegetation and landscaping, minimizing site disturbance, time of concentration modifications, maximizing infiltration capacity and impervious area management. Once the potential and feasibility for LID has been exhausted in development planning, then the larger, structural BMPs should be considered, particularly in minimizing post-development NPS pollution. Under such a strategy, all efforts should be made to keep post-development pollutant loads and recharge capacities as close to pre-development conditions as possible.

While the LID / structural BMP strategy is appropriate for future development, it is more difficult to implement in sections of the watershed that have already been developed. As previously cited, under post-development conditions, the installation of large, structural BMPs can be costly and difficult. However, an alternative approach for developed land is to incorporate manufactured stormwater treatment devices and retrofits into the existing stormwater infrastructure.

The advantages to incorporating stormwater retrofits into the existing infrastructure include the relatively low cost, both in materials and installation; the relatively small requirements for space or land; the relative ease of installation of such devices; and the minimum or negligible amount of permitting required. The disadvantages of stormwater retrofits include their need for frequent routine maintenance and clean-outs and the limited amount of pollutants they can remove. However, when integrated into a community's routine maintenance of their existing stormwater infrastructure, retrofits can be an extremely cost-effective means of reducing the NPS pollutant loads originating from developed land.

Three specific types of retrofit devices are being proposed for the third Implementation Project for Lake Luxembourg / Core Creek. These retrofits include:

- Water quality drop (sumped) inlet with attached SNOUT device,
- Grate Inlet Skimmer Box, and
- Hydro-cartridge.

Detailed information on each of these retrofits is provided in Appendix G. The goal of this task will be to install a total of 17 of these retrofits within the Lake Luxembourg / Core Creek watershed and quantify the pollutant removal to be achieved by their installation.

Based on input provided by the local municipalities within the Core Creek watershed, as well as several site visits conducted by the BCCD, US EPA and Princeton Hydro, several sites were identified for the installation of the 17 proposed retrofit BMPs. One of these sites is Lakeview Estates, a community located in Middletown Township (Site 1a, Figure 7). This community is located on very steep slopes and the township has noted some sedimentation along the roadways. In addition, surface runoff from this community enters a small tributary which, in turn, enters Core Creek. Given the identified non-point source (NPS) pollution problems and the close proximity of the community to Lake Luxembourg, the majority of the seventeen retrofit BMPs will be installed in Lakeveiew Estates, Middletown Township.

The second site identified for the installation of a series of retrofits BMPs is located along Upper Silver Lake Road in Newtown Township (Site 1b, Figure 7). The stormwater flowing into the stormsewer basins along Upper Silver Lake Rod has been observed to be particularly turbid. Given these turbid stormwater conditions and the fact that the road runs directly into Core Creek from the west, this site was identified for the installation of retrofitted BMPs into the existing stormwater infrastructure.

To date, no verified water quality data are available on the pollutant removal effectiveness of the Grate Inlet Skimmer Box and Hydro-cartridge retrofits. However, one case study exists in Luzerne County, PA, where several Grate Inlet Skimmer Boxes were installed in the existing stormwater infrastructure surrounding Harveys Lake. Harveys Lake is another Pennsylvania TMDL watershed targeting reductions in TP and TSS loads. This installation of these retrofits was just completed in the summer of 2004, so a limited amount of stormwater data have been collected this year to quantify the pollutant load reductions associated with the Skimmer Box retrofits. A similar stormwater monitoring program will be conducted as part of the immediate Restoration Plan for Lake Luxembourg.

Some data are available for the drop inlet / SNOUT retrofit. According to information provided by the manufacturer of the SNOUT device, Best Management Practices, Inc., removal rates of 50% have been measured for TSS (Appendix G). In addition, Princeton Hydro worked with Putnam Valley and the community of Lake Peekskill, Putnam County, New York in the installation of two drop inlet / SNOUT retrofits adjacent to the lake. This small demonstration project was funded through the

County's Lake Grant Program and included the design, sizing, installation and monitoring of the retrofits. After installing the devices, Princeton Hydro instructed local volunteers on the proper collection of stormwater samples to quantify the pollutant removal capacities of these BMPs.

After some field training, the volunteers collected stormwater flowing into and out of the drop inlet structures with SNOUTS over five storm events from August through December 2003. TSS removal rates, based on concentration, varied from 0 to 76% with a mean of 53%. This mean removal rate is similar to the manufacturer's removal rate of 50%. TP removal rates, again based on concentration, varied from 0 to 77%, with a mean of 36%.

In addition to quantifying pollutant removal rates, it was estimated that during one of the basin clean-outs, the community's Public Works staff removed approximately 520 lbs of material (gravel, sand, rock, soil) from each upgraded basin. This material was removed seven months after the upgraded basins with SNOUTS were installed. Based on these conditions, it was estimated that approximately 74 lbs of material are removed from each upgraded basin per month—material that would otherwise enter Lake Peekskill. The study also concluded that, barring any unusually large storm events, the upgraded basins must be cleaned out at least twice each year. It is anticipated that similar conditions will be observed when such upgraded basins are installed in the Lake Luxembourg / Core Creek watershed and the stormwater monitoring plan is implemented. The data collected can be used by the local municipalities to determine if similar structures should be installed on a broader, watershed-wide basis.

Stabilization of 1,000 Feet of Shoreline (Site 2)

As part of the second Implementation project, approximately 800 linear feet of shoreline at Lake Luxembourg was stabilized through re-grading and subsequent planting of vegetation. On 25 April 2001, students from the Neshaminy Middle School assisted the Bucks County Department of Parks and Recreation and Princeton Hydro in the installation of shoreline vegetation at this site (see Appendix D). This stabilization project was conducted along the shoreline, immediately northeast of the County Park Boat Launch.

The proposed project for immediate implementation involves extending the stabilization of this section of the lake shoreline another 1,000 linear feet toward the northeast (Site 2, Figure 7). Since shoreline conditions are similar to those experienced along the first site that was stabilized, a similar restoration approach will be employed. Specifically, a contractor will be hired to re-grade the shoreline with machinery and install geotextile and biologs. Students from the Neshaminy Middle School will assist the Bucks County Department of Parks and Recreation and Princeton Hydro in the installation of the shoreline vegetation. The entire site will be protected from grazing

Three types of small-scale retrofit projects were identified for installation in the Core Creek watershed (see Section 5.2). Based on both manufacture claims and similar projects implemented and monitored by Princeton Hydro in other watersheds, a conservative TSS removal efficiency of 50% was ascribed to all three retrofit projects. Such small-scale retrofits are generally not considered to remove a substantial amount of phosphorus from incoming stormwater. Thus, most manufactures do not provide phosphorus removal rates.

Particulate material transported through stormwater can account for a significant fraction of phosphorus entering a receiving waterway. Depending on the type of particulate material, between 80 to 90% of the total phosphorus in stormwater can be adsorbed onto particulates. Therefore, even small retrofits have the potential to remove a measurable proportion of the phosphorus in stormwater. Based on a two year monitoring program of a series of upgraded drop inlets with SNOUT structures, these retrofits removed an average of 53% of the stormwater TSS and 36% of the stormwater TP, based on measured concentrations. Since no such data were available for the other two retrofits, Grate Inlet Skimmer Box and Hydro-cartridge, the conservative removal rates of 50% for TSS and 20% for TP were selected for all three types. As part of the current Implementation Project, a stormwater monitoring program will be conducted to quantify the removal rates associated with these retrofit BMPs.

The pollutant removal efficiencies for the pocket wetland were selected from the Center of Watershed Protection (2000) and estimated that the wetland would be approximately 0.5 acres in size.

The US EPA's AVGWLF/PRedICT analysis quantified that approximately 5 miles of streambank within the Core Creek watershed requires stabilization. For the sake of the Restoration and Management Plan, it was estimated 2.5 miles of the targeted 5 miles would be readily available for streambank stabilization and/or simply require non-biological, structural stabilization measures (i.e. imbricated rip-rap, boulder revetment). Additionally, the selection of the pollutant removal efficiencies for streambank stabilization was based on an average stabilization width of 50 feet.

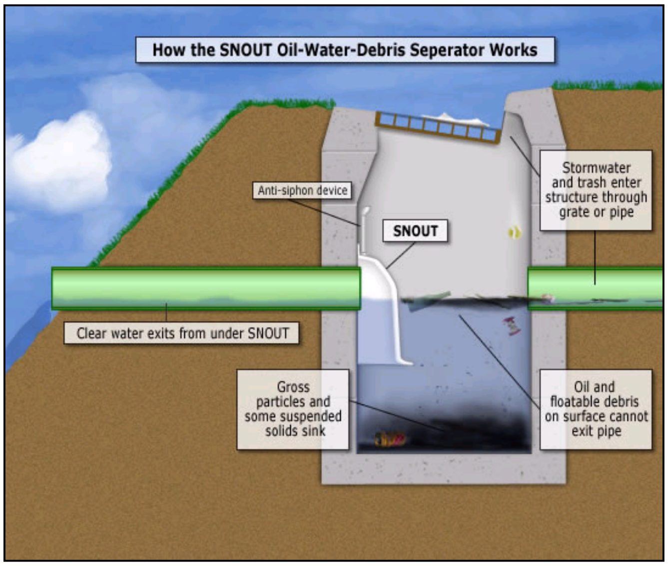
In addition to the streambank stabilization efforts, vegetative buffers were also identified as viable and applicable BMPs for the Lake Luxembourg / Core Creek watershed. Two types of vegetative buffers, agricultural and urban, were identified by the US EPA's AVGWLF/PRedICT analysis. Based on US EPA's analysis, 1.5 miles of urban land and 0.5 miles of agricultural land would benefit from vegetative plantings. For the sake of the pollutant removal efficiency analysis, it was estimated that approximately half, or 0.75 miles, of the urban vegetative buffers would be available due to limitations associated with property ownership and easement issues. In contrast, it is estimated that the entire 0.5 miles of the targeted agricultural land would be stabilized with vegetative planting. An average width of 50 feet was used to quantify the potential removal efficiency associated with both the urban and agricultural vegetative buffers.

Manufactured treatment device: the "SNOUT"

Except where otherwise noted, the information presented in this factsheet has been provided by the manufacturer, Best Management Products, Inc. <www.bestmp.com>

Manufactured treatment devices are intended to capture sediments, metals, hydrocarbons, floatables, and/or other pollutants in stormwater runoff before being conveyed to a storm sewer system, additional stormwater quality treatment measure or waterbody (NJDEP 2004). The SNOUT is a retrofit device that can be installed within an existing stormwater catch basin to provide treatment of stormwater. It consists of a fiberglass hood (trap) that fits over the outlet pipe of a sumped catch basin or other water quality structure.

The SNOUT can be adapted to filter a variety of different pollutants, but is primarily used to remove sediment, floatables and oil from stormwater.



Source: Best Management Products, Inc.

Advantages:

- Manufactured treatment devices are appropriate for small drainage areas with high impervious cover likely to contribute high hydrocarbon and sediment loadings (e.g., small parking lots and gas stations) (NJDEP 2004).
- Low cost compared to other BMPs.
- Easy to install with hand tools.
- Available in a variety of sizes and configurations; optional add-ons available (e.g., odor control filters, oil booms, custom debris screens).
- Includes "anti-siphon vent" which prevents siphon from developing and drawing surface layer pollutants downstream under full pipe flows.
- **Useful retrofit**: designed to modify existing stormwater infrastructure (catch basins).

Disadvantages:

- For larger sites, multiple devices may be necessary.
- Manufactured treatment devices are normally used for pretreatment of runoff before discharging to other, more effective stormwater quality treatment facilities (NJDEP 2004).
- May not function as effectively under low flows or in catch basins with shallow sumps (i.e., depth from beneath the invert of the outlet pipe to the bottom of the structure).
- Pollutant removal rates have not been verified by PADEP or NJDEP.

Estimated Costs:

Based on information provided by the manufacturer, the cost for materials to retrofit one catch basin ranges from approximately $200 to over $3,000 (excluding shipping and labor), depending on the size of the catch basin and the number of additional components installed (www.bestmp.com). Materials costs for most municipal catch basins would likely range from $400 to $600 per catch basin.

Maintenance Requirements:

Monthly for the first year: Monitor to ensure proper functioning of device

As needed: clean out sump when half full (usually requires vacuum truck)

Four times/year and after every storm <0.5 in.: inspect all device components expected to receive and/or trap debris for clogging and excessive debris and sediment accumulation; dispose of debris, sediment and other waste material at suitable disposal/recycling sites and in compliance with applicable waste regulations

Once/year: Inspect all structural components for cracking, subsidence and deterioration; flush anti-siphon vent and open and close access hatch

Ascribed Pollutant Removal Efficiencies (estimates provided by Best Management Products, Inc.):

TSS reduction in postconstruction runoff: up to 50%

Total phosphorus removal rate: mean of 36% (Princeton Hydro, unpublished data for Lake Peekskill, New York).

Total nitrogen removal rate: not provided

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Appendix H

Calculations used to Quantify the Amount of Pollutants Removed as a Result of the Implemented and Future BMPs

APPENDIX H

Details on the Calculations Used to Quantify the Amount of Pollutants Removed through the Implementation of the Identified BMPs.

For the sake of this analysis, the average, watershed-wide pollutant loading rates were calculated for the entire Core Creek watershed. That is, the watershed's existing total annual pollutant loads (as calculated by USEPA) were divided by watershed's total area. The resulting average, annual, watershed-wide total phosphorus (TP) and total suspended solids (TSS) loading rates were 0.48 and 603 lbs per acre, respectively.

The average loading rates (see above) were multiplied by the area designed to be treated by each BMP to calculate the average annual pollutant loads (third column in Pollutant Tables). In turn, these average annual pollutant loads were multiplied by the identified BMP pollutant removal efficiencies (fourth column in Pollutant Tables) to quantify the annual amount of each pollutant removed by each BMP (fifth column in Pollutant Tables).

Calculations Used to Quantify the Amount of Total Phosphorus Removed Through the Proposed BMPs

Identified BMP	Area Treated By BMP	Average Annual Pollutant Load for Treated Area	Removal Efficiency for TP	Annual TP Removed by BMP (lbs)
Implemented BMPs				
Two lake shore Stabilization projects	1.6 acres	0.8 lbs	30 %	0.3 lbs
Two retrofit Installation projects	75 acres	36.2 lbs	20 %	7.2 lbs
Pocket Wetland	50 acres	24.1 lbs	57 %	13.7 lbs
Future BMPs				
Streambank Stabilization	15.2 acres	7.3 lbs	30 %	2.2 lbs
Urban Vegetative Buffers (half of targeted areas vegetated)	1.8 acres	0.9 lbs	22 %	0.2 lbs
Agricultural Vegetative Buffers	3 acres	1.5 lbs	22 %	0.3 lbs
Retrofitted Detention Basins	574 acres	276.5 lbs	20 %	55.3 lbs
Created Meadow	0.5 acres	0.2 lbs	30 %	0.1 lbs
Conservation Pool – Wetland Complex	3,602 acres	1,671.2 lbs	39 %	652.0 lbs

Calculations Used to Quantify the Amount of Total Suspended Solids (TSS) Removed Through the Proposed BMPs

Identified BMP	Area Treated By BMP	Average Annual Pollutant Load for Treated Area	Removal Efficiency for TSS	Annual TSS Removed by BMP (lbs)
Implemented BMPs				
Two lake shore Stabilization projects	1.6 acres	969 lbs	60 %	581 lbs
Two retrofit Installation projects	75 acres	45,219 lbs	50 %	22,609 lbs
Pocket Wetland	50 acres	30,146 lbs	57 %	17,183 lbs
Future BMPs				
Streambank Stabilization	15.2 acres	9,136 lbs	60 %	5,482 lbs
Urban Vegetative Buffers (half of targeted areas vegetated)	1.8 acres	1,096 lbs	27 %	296 lbs
Agricultural Vegetative Buffers	3 acres	1,827 lbs	67 %	1,224 lbs
Retrofitted Detention Basins	574 acres	345,833 lbs	40 %	138,333 lbs
Created Meadow	0.5 acres	301 lbs	70 %	211 lbs
Conservation Pool – Wetland Complex	3,602 acres	2,010,911 lbs	57 %	1,146,220 lbs