


Pearly Pond Watershed Restoration Plan

Final Report
December 10, 2014

Prepared for:
Pearly Pond Management Advisory Council,
Pearly Pond Association
And
Franklin Pierce University

Prepared by:
Comprehensive Environmental Inc.

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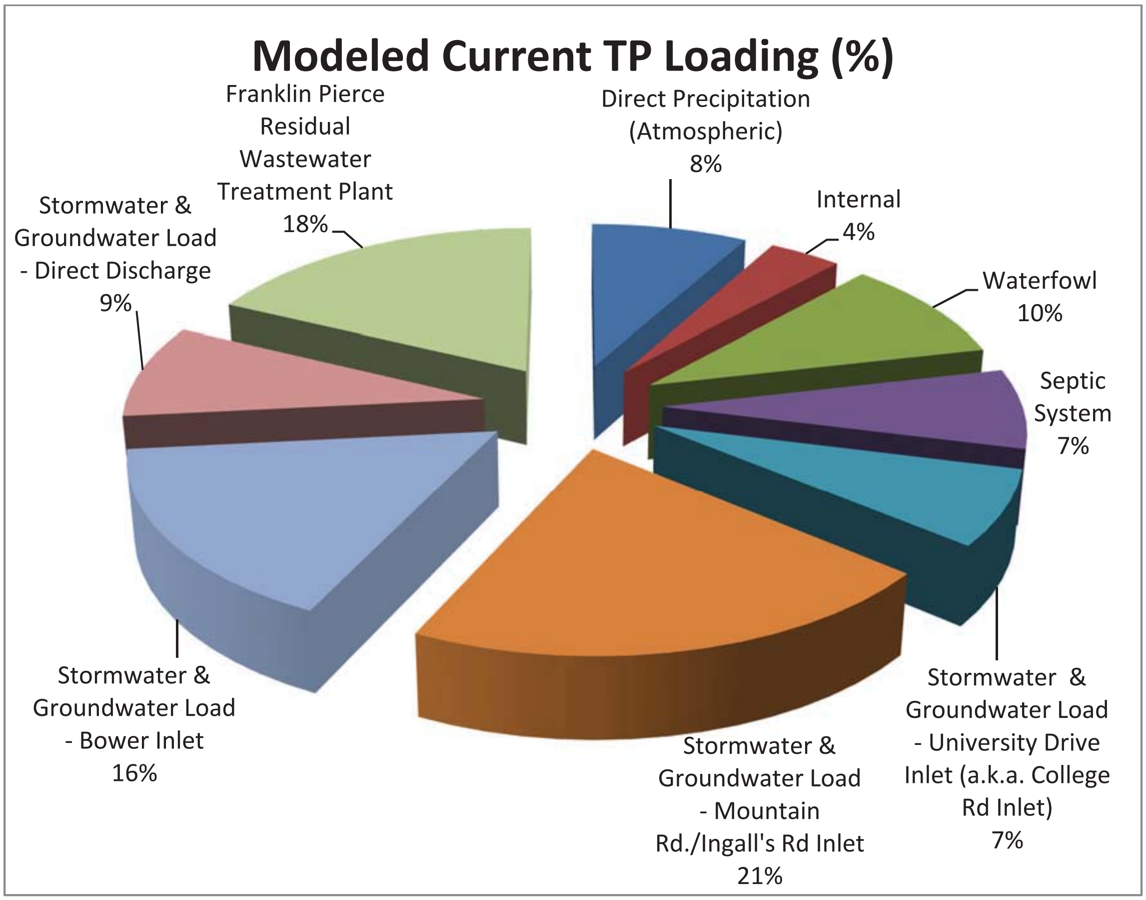
Executive Summary

This ten-year watershed restoration program was created by Franklin Pierce University (FPU) to restore the water quality of Pearly Pond located in Rindge, New Hampshire. The water quality of Pearly Pond is currently impaired, with high concentrations of chlorophyll-a and phosphorus, resulting in low levels of dissolved oxygen and resulting in cyanobacteria, which impact aquatic life and primary contact recreation uses of the pond. This plan focuses on the reduction of phosphorus loads to the pond as it is typically the limiting nutrient in a freshwater system, and excess amounts can cause severe algae growth, which in turn contribute to low DO levels. Control of phosphorus sources to the pond should therefore improve conditions related to chlorophyll-a and DO such that designated uses are supported.

Based on the desktop model (ENSR-LRM) used to estimate water flows and phosphorus loads into the pond, the following breakdown of phosphorus loads by source was estimated.



This same model was used to estimate pre-development phosphorus loads to the pond and resulting in-pond concentrations, which was established as the target water quality goal for the pond. The water quality goal considered the high background concentrations of phosphorus coming from undeveloped areas of the watershed, as noted in tributary sampling data. Best management practices (BMPs) to reduce phosphorus loads and achieve the target water quality goal were then evaluated and recommended. Based on this evaluation, a target goal of 17 micrograms per liter was selected.

The end result is a 10-year capital improvement plan (CIP) that is tied to pollutant load reductions. The capital improvement plan covers a 10-year period from 2015-2024 at a cost of $1.3 to $1.7 million dollars. These expenditures are estimated to reduce phosphorous loadings by some 87 or more kilograms per year, enough to meet the target goal of 17 micrograms per liter. Much of this cost is potentially reimbursable by grants.

The recommendations under the 10-year program are comprehensive and designed to address nearly every source of phosphorus, including widespread loadings from commercial/industrial parking lots, roadways, residential areas, internal pond loadings, and sediment sources. A summary of the 10-year CIP is provided in Table 7.1 of Section 7.0 Recommendations of this report. Several other problems, including potential sources of bacteria and suspended solids, are also addressed although not modeled. The recommendations include:

- extensive public education;
- adoption of regulatory controls for future development including a Pearly Pond Watershed Overlay District;
- installation of vegetation and maintenance of shoreline and tributary buffers;
- installation of stormwater BMPs on the FPU campus and along roadways in the watershed;
- improvements to the FPU wastewater treatment plant (WWTP) system;
- treatment of the effluent from the northern wetland, which contributes high concentrations and loads of phosphorus to the pond due to the historic discharge of FPU's WWTP effluent to the wetland network over a 40 year period before the improvements to the FPU Wastewater Treatment Facility in 2009, including construction of the rapid infiltration basins (RIBs);
- septic system improvements including promotion of maintenance for residential systems and improvements to the system at Lakeview Apartments;
- management/reduction of waterfowl populations;
- additional study of internal phosphorus loads and background levels to further calibrate the model and determine need for in-pond management techniques; and
- continuation of the long-term monitoring program.

In addition to the capital costs outlined above, operational costs will be incurred for continued monitoring of the watershed, and inspection and maintenance of the completed improvements.

After the 10-year watershed program is complete or additional data is collected to refine the source loads, the results should be revaluated and adjustments made for further improvements where possible.

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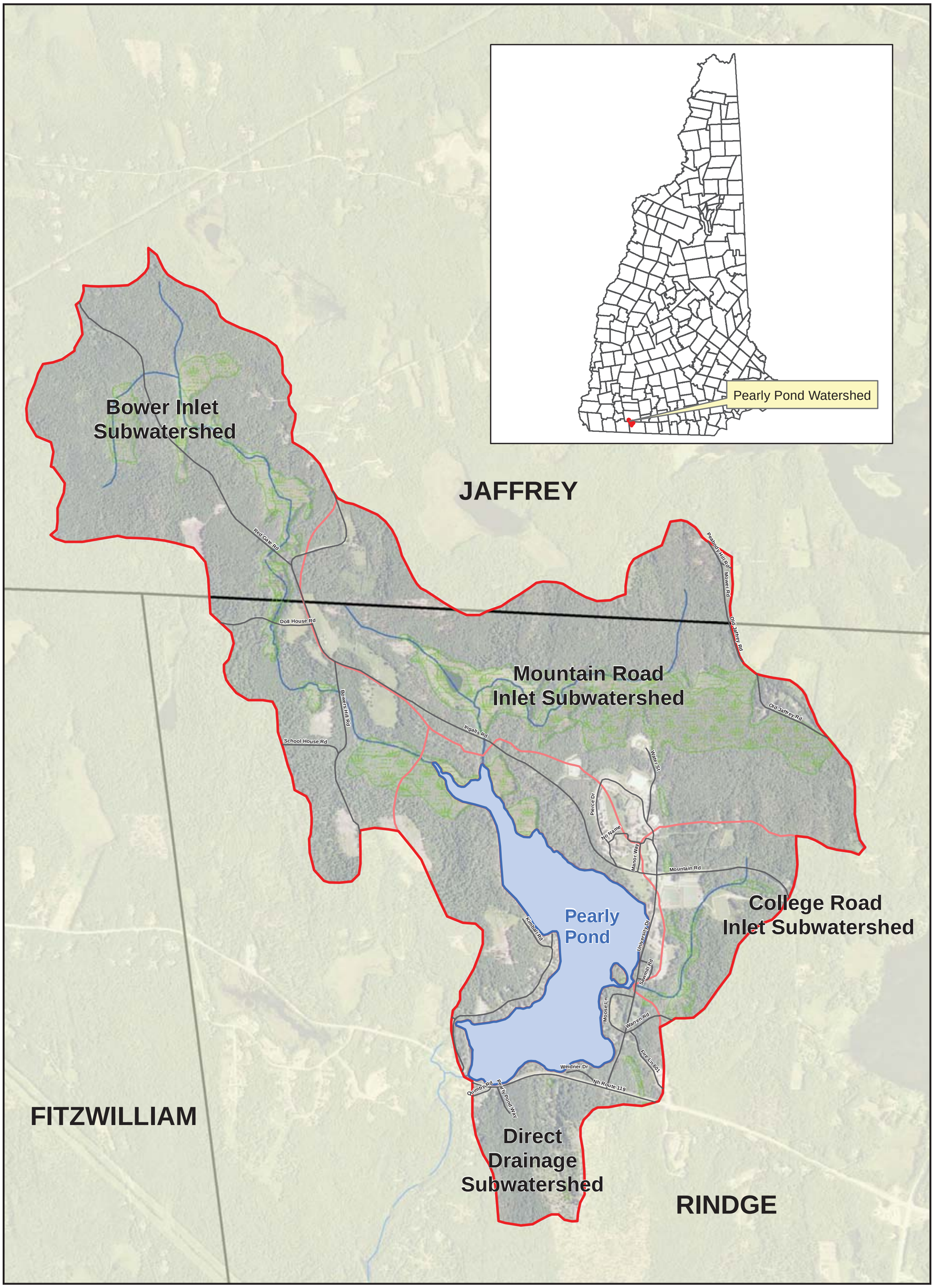
Section 1 Introduction

Pearly Lake, known locally and referenced herein as Pearly Pond, is a 191-acre pond in Rindge, NH (Figure 1-1). Despite most of the 2,128-acre watershed being undeveloped, the pond is subject to high phosphorus loads that lead to algal blooms and low dissolved oxygen concentrations. The pond has been identified on the 2012 Section 303(d) List of impaired waters for impairment of the Primary Contact Recreation use due to chlorophyll a and cyanobacteria hepatoxic microsystins (cyanobacteria), both of which are a measurement of algae production in the pond. It is also listed for impairment of the aquatic life use due to low dissolved oxygen (DO), chlorophyll-a and total phosphorus. Reducing phosphorus loads and concentrations in the pond should reduce algal growth and improve the dissolved oxygen conditions in the deep areas of the pond.

Franklin Pierce University (FPU), which represents the highest density development in the watershed, is leading efforts to protect and restore Pearly Pond and its watershed, along with its partner, the Pearly Pond Association. Together, FPU and the Pearly Pond Association sought a Section 319 Watershed Planning Grant through the New Hampshire Department of Environmental Services (NHDES) Watershed Assistance Section to prepare this Watershed Restoration Plan.

This watershed restoration plan identifies the actions and resources needed to restore the pond, focusing on phosphorus reduction, and lays out a foundation for obtaining future grant funds to complete the work. The scope of work to prepare this plan included:

- Development of a Site Specific Project Plan (SSPP) to perform modeling of pollutant loads from the watershed and reductions associated with the implementation of Best Management Practices (BMPs). Refer to Appendix D for the approved SSPP.
- Delineation and mapping of the watershed and subwatersheds using existing GIS data and field investigations, including wetlands, waterways, topography, land uses, zoning, soil types, stormwater drainage network and sewer network (refer to Section 2.0 Water Body and Watershed Description).
- Estimation and calibration of phosphorus loads under existing and buildout conditions using the ENSR-LLRM Model (Refer to Section 4.0 Pollutant Source Analysis).
- Development of realistic water quality goals and associated phosphorus reductions to achieve them (refer to Section 5.0 Restoration Goals).
- Watershed field investigations to identify potential sources of pollution to Pearly Pond, including a watershed survey (refer to Section 6.0 Stormwater BMP Evaluation).
- Identification of structural and non-structural BMP alternatives to reduce phosphorus concentrations (refer to Section 6.0 Watershed Assessment and Pollutant Analysis).
- Preparation of a Watershed Management Plan with a quantitative Capital Improvement Plan (CIP) (refer to Section 7.0 Recommendations).



Legend

- Watershed Boundary
- Subwatershed Boundary
- Road
- Town Boundary

Hydrography

- Lake
- Wetland
- Stream

Data Source: NH GRANIT, NHDES, Franklin Pierce University, Town of Rindge, and Town of Jaffrey

N
W E
S

0 0.25 0.5 Miles

0 1,750 3,500 Feet

Figure 1-1

Site Locus Map

Pearly Pond Watershed Restoration Plan

Rindge and Jaffrey, New Hampshire

Comprehensive Environmental Incorporated

Section 2 Watershed Evaluation

This section describes Pearly Pond and the contributing watershed, including its size and boundaries and characteristics such as land use and soils, which are important in estimating pollutant loads and possible measures to control these pollutant loads. It includes information collected through field investigations and a survey sent to residents along the shoreland of the pond.

2.1 Waterbody Characteristics

Pearly Pond is located in Rindge, New Hampshire within the Connecticut River Basin (Figure 1-1). The 78-hectare (ha) pond (191 acres) has a maximum depth of 4.6 meters (m) (15 ft) and a mean depth of 1.7 m (5.6 ft). The pond is weakly stratified at its deepest spot in the summer months, which means that a layer of warm water overlays a cooler layer below, resulting in limited movement of water and nutrients during summer. The pond volume is approximately 1.3 million cubic meters (m^3) with a flushing rate of approximately four to five times per year. The watershed area is 861 ha (2128 acres) and is located within the Towns of Rindge and Jaffrey.

Pearly Pond has a warm water fishery with brown bullhead (*Ictalurus nebulosus*), yellow perch (*Perca flavescens*), bluegill (*Lepomis macrochirus*), largemouth bass (*Micropterus salmoides*), chain pickerel (*Esox niger*), golden shiner (*Notemigonus crysoleucas*) and white sucker (*Catostomus commersonii*) identified during fisheries surveys (NH Fish and Game 2007, NHDES 2008c). New Hampshire Natural Heritage Bureau lists the banded sunfish (*Enneacanthus obesus*) as an endangered species in Pearly Pond (NHDES 2008c).

The non-native aquatic plant species, variable milfoil (*Myriophyllum heterophyllum*), was first identified in 1975 and continues to invade the pond. Select characteristics of Pearly Pond and its watershed are presented in Table 2-1. Figure 2-1 provides the bathymetry of the pond.

Table 0-1. Characteristics of Pearly Pond, Rindge, NH

Parameter	Value
Pond Area (ha,acres)	77.5 ha, 191.5 acres
Pond Volume (m^3)	1,295,381
Watershed Area (ha,acres)	861.2 ha, 2128.1 acres
Watershed/Pond Area	11.1 acres
Mean Depth (m, ft)	1.7m, 5.6ft
Max Depth (m, ft)	4.6m, 15ft
Flushing Rate (yr^{-1})	4 to 5
Hypolimnetic Anoxia	Yes/Weakly Stratified

2.2 Watershed Characteristics

The watershed and subwatershed areas to Pearly Pond were delineated under the development of the draft Total Maximum Daily Load (TMDL) study for Pearly Pond prepared by the environmental consulting firm, AECOM, and the New Hampshire

Department of Environmental Services (NH DES). The watershed area was delineated as 861 hectares (2,128 acres) in Rindge and Jaffrey. This was further delineated into four subwatersheds for pollutant and hydrologic modeling purposes. These include Bower Inlet, Mountain Road (a.k.a. Ingall's Road) Inlet, University Drive Inlet (a.k.a. College Road Inlet) and Direct Drainage subwatersheds. The subwatersheds represent drainage areas for each of the three major tributaries to the pond, and for the direct drainage area surrounding the pond (e.g., overland runoff into the pond). Refer to Figure 2-2 for a map showing watershed and subwatershed boundaries and key drainage system features.

2.2.1 Land Uses

Baseline land use information was obtained from the draft TMDL study and updated based on observations made during field investigations. Specifically, some land areas categorized as hayland were changed to open space as they appeared to be maintained as frequently mowed areas. Some minor adjustments were also made to reflect areas designated as forest that have since been developed and/or areas identified as residential that were actually forested. Overall, the changes did not have a significant impact on pollutant loads to the ponds.

The watershed is primarily undeveloped, with about 7% comprised of urban development, 2% as agricultural, 75% as forested (excluding forested wetlands), 15% as wetlands (including forested wetlands) and 1% as bare open space.

The majority of the urban development and impervious area within the watershed is associated with the Franklin Pierce University (FPU) campus located at the intersection of the Mountain Rd. Ingall's Rd. Inlet, University Drive Inlet (a.k.a. College Road Inlet) and Direct Drainage subwatersheds, and the residential homes located along the shoreline of the pond within the Direct Drainage subwatershed.

Figure 2-3 shows a breakdown of land uses throughout the watershed. Table 2-1 provides a breakdown of land use by subwatershed. Further description of each subwatershed and potential pollutant sources based on field investigations is provided below.

<u>University Drive Inlet (a.k.a. College Road Inlet) Subwatershed</u> – The University Drive Inlet Subwatershed, also referred to as the College Rd Inlet Subwatershed in NH DES sampling documentation, is a mix of residential, commercial, institutional/parks, wetland and forest areas. The majority of the commercial and institutional land use is associated with portions of the FPU campus facility including ball fields and associated parking areas. This subwatershed is approximately 65.6 hectares (161 acres) in size. A large dormitory complex known as Lakeview Apartments is located within this watershed. The majority of this watershed drains to College Brook which carries runoff to Pearly Pond. There are some drainage systems associated with paved roads that drain to College Brook. College Brook discharges to Pearly Pond through a culvert that crosses beneath University Drive. Some erosion was noted along the streambanks and throughout the watershed.

Table 2-2. Land Use Categories by Pearly Pond Subwatershed

	Area (Hectares)					
	Northeast Subwatershed – University Drive Inlet (a.k.a. College Rd Inlet)	**North Central Subwatershed - Mountain Rd. (Ingall's Rd.) Inlet**	**Northwest Subwatershed - Bower Inlet**	**Direct Drainage Subwatershed**	**Total**	**Percent**
Urban 1 (Residential)	0.0	0.8	1.1	10.4	12.2	1%
Urban 2 (Mixed Urban/Commercial)	2.9	10.3	0.0	6.6	19.8	2%
Urban 3 (Roads)	3.3	3.6	2.6	7.3	16.7	2%
Urban 4 (Industrial)	0.0	0.0	0.0	0.0	0.0	0%
Urban 5 (Parks, Recreation Fields, Institutional)	5.8	0.6	0.0	5.9	12.3	1%
Agric. 1 (Cover Crop)	0.0	0.0	0.0	0.0	0.0	0%
Agric. 2 (Row Crop)	0.0	0.0	0.0	0.0	0.0	0%
Agric. 3 (Grazing)	0.0	0.0	0.0	0.0	0.0	0%
Agric. 4 (Hayland-Non Manure)	0.0	11.1	0.0	2.8	13.9	2%
Forest 1 (Deciduous)	16.2	88.8	61.7	36.2	203.0	24%
Forest 2 (Non-Deciduous)	8.6	36.6	65.5	30.4	141.1	16%
Forest 3 (Mixed Forest)	22.1	83.5	122.8	70.2	298.6	35%
Forest 4 (Wetland)	5.4	41.1	18.4	5.7	70.6	8%
Open 1 (Wetland / Pond)	1.2	28.2	21.4	9.8	60.6	7%
Open 2 (Meadow)	0.0	0.0	0.0	0.0	0.0	0%
Open 3 (Bare/Open)	0.0	4.4	7.2	0.6	12.3	1%
TOTAL	65.6	309.1	300.7	185.8	861	100%

Mountain Rd. (Ingall's Rd.) Inlet Subwatershed – The Mountain Road (Ingall's Road) Inlet Subwatershed contains a large portion of the FPU campus and impervious parking areas. It is one of the largest subwatershed areas at approximately 309.1 hectares (760 acres). Stormwater runoff reaches the pond through the Mountain Road (Ingall's Road) Inlet, which is made up of two stream branches carrying runoff from a large wetland to the northeast of the pond and from undeveloped portions of the upper watershed to the northwest of the pond. Campus buildings and parking lots on the north side of the main campus (see Fig. 1-1 or 2-2) drain to the large wetland via several closed drainage systems and some overland flow. Roof drains throughout the campus discharge to a few small pervious areas which then drain onto larger impervious areas associated with the parking lots and access roadways. A majority of the closed drainage systems and sheet flow from parking areas discharge on steep slopes that lead down to the tributary, which increases erosion and potential stormwater issues. The remainder of the Mountain Rd. /Ingall's Rd. Inlet subwatershed is made up of forested and open pasture land. It was confirmed through investigations and discussions with local residents that most of the areas were historically agriculture based land use, but that activity has since ceased.

Bower Inlet Subwatershed – The Bower Inlet Subwatershed is in the upper watershed, located to the north of Mountain Road (Ingall's Road) and northwest of the pond. It is the second largest subwatershed at approximately 300.7 hectares (740 acres). The area is primarily made up of scattered low residential land uses, with a mix of forested, open space and pasture lands. Like the Mountain Rd. /Ingall's Rd. Inlet subwatershed, the pasture lands have very little agricultural use, with a few small horse farms and mowed fields. The majority of the subwatershed is forested. Runoff is primarily collected through one major tributary known as Bower Inlet, which runs nearly the entire length of the watershed and discharges to the pond to the northwest. Several gravel roads traverse the watershed and cross the Bower Inlet tributary. Erosion was noted on streambanks, at culverts and along portions of the gravel roadways.

Direct Drainage Subwatershed – The Direct Drainage Subwatershed discharges to Pearly Pond as overland flow with several small closed drainage systems that directly discharge to the pond. This subwatershed is only 185.8 hectares (460 acres), but contributes the second highest phosphorus load to the pond. It is the most developed portion of the watershed which includes the aforementioned residential areas along Kimball Road and University Drive. It also includes some residential areas and a formal drainage system that drain into the lake from the south associated with State Route 119. Portions of Route 119, Kimball Road and University Drive are located in close proximity to the pond edge, providing no buffer for stormwater runoff. Shoreline erosion was noted at these locations. The remainder of the developed portion of the subwatershed includes portions of the FPU campus. Two apartment complexes, several maintained lawns, fields and mowed areas are associated with this portion of campus; most of these areas drain to the pond through defined culverts or ditches along the north shoreline of the pond or next to the FPU boathouse. Refer to Figure 2-2 for key drainage features including culverts and drainage ditches. Several public beach areas are also located in this subwatershed. There are some very steep forested areas located to the north of the pond that are a potential large source of erosion issues in the subwatershed. Impervious surfaces, beach erosion, fertilization of lawns, erosion of open spaces (FPU campus) and steep slopes in this subwatershed area will contribute to stormwater runoff pollution.

2.2.2 Soils and Groundwater Features

Soils are typically classified into hydrologic soil groups (HSG) A through D. HSG A and B soils have the highest infiltration rates, allowing for greater stormwater recharge potential. HSG C and D soils are typically tighter soils, limiting recharge potential. This information is important when selecting stormwater best management practices (BMPs) to treat stormwater runoff, as infiltration BMPs typically offer better pollutant removal while minimizing the volume of stormwater runoff and increasing the volume of water that recharges groundwater baseflow. Infiltration BMPs also reduce the amount of warm stormwater runoff that enters the brook during the summer months, keeping the brook cooler, which is extremely important to the cold water eastern native brook trout population.

Most of the watershed contains Hydrologic Soil Group (HSG) C soils with a few areas of HSG A and B soil. HSG A and B soils percolate water quickly and are good for stormwater infiltration treatment. HSG C soils are less permeable and could pose some challenges with infiltration. There are also hydric soil layers associated with wetlands and HSA A/D soils which have a dual classification and are defined as a mix of HSA A soils in drained areas and HSA D soils in un-drained areas. This classification typically represents seasonally wet areas which have some dry sections and some standing water. These areas can infiltrate surface runoff at different times of the year, however, can eventually become saturated and experience standing water at other times of the year. The hydric and HSA D soils are usually located in constantly wet areas or under standing water and are highly unlikely to infiltrate surface water throughout the year. Refer to Figure 2-4 for soil characteristics in the watershed.

2.2.3 Stormwater and Sewer Infrastructure

The known and available mapped stormwater infrastructure throughout the watershed is shown on Figure 2-2, along with stormwater outfalls. This was used to help identify stormwater discharge areas and to prioritize potential treatment BMPs.

With the exception of some culvert crossings and minor town owned drainage systems located throughout the watershed, the majority of stormwater drainage infrastructure is associated with the FPU campus. FPU owns and maintains its own storm drain network that collects and discharges stormwater runoff from the campus to the pond or surrounding tributaries.

FPU also owns and maintains a wastewater treatment plant and collection system that handles wastewater generated from the campus dormitories and facilities. All of the FPU buildings with the exception of the Lakeview Apartments, which have a septic system, discharge wastewater to the wastewater treatment plant.

<u>FPU Wastewater Treatment Plant</u>

From 1967 through 2008 (41 years), the wastewater treatment plant discharged to a wetland network in the Mountain Road (Ingall's Road) tributary. In January 2009, the point source discharge was eliminated and treated wastewater was discharged to newly constructed wastewater rapid infiltration basins (RIBs). The RIBs provide further treatment through filtration, before the wastewater reaches groundwater. Refer to Figure 2-2 for the location of the wastewater treatment plant and RIBs.

The FPU wastewater treatment plant (WWTP) and Rapid Infiltration Beds (RIBs) were visited during field investigations. The FPU wastewater operator provided data on function, use and historical upgrades/maintenance of the wastewater treatment and collection system.

The wastewater collection system consists of over 4,000 linear feet of gravity and 5,000 linear feet of pressure main. An additional 2,500 feet of pressure line connect the outlet of the treatment facility to the RIBs. The collection system was not inspected under this project. However, through discussions with FPU staff it was determined that the gravity lines were inspected for Inflow and Infiltration (I&I) and areas were previously identified for needed repairs. FPU funded re-lining of a portion of the system, but additional areas are still in need of repairs. Currently, it is estimated that an approximate 10,000 gallons of excess water is added to the wastewater system during common rain fall events due to I&I. This is important because more water going into the system means more water has to be treated, reducing the efficiency of the WWTP.

The WWTP receives approximately 40,000 gallons per day (12-15 MGY) and consists of grit chambers, chemical feed systems and Rotating Biological Contactors (RBCs). Based on discussions with the operator, the WWTP does have issues with daily shock loading and seasonal variations associated with a student population. During summer and winter breaks the WWTP can go dormant based on lack of wastewater feeding the biological biomass in the contactors. This can make WWTP start-up a challenge and cause fluctuation in plant operation.

The RIBs are fed at different intervals via a pump system. Two sand beds make up the RIBs with feeder systems for each bed. As part of the RIB design permitting and construction, monitoring wells were installed around the perimeter. These are sampled on a routine basis and records were reviewed as part of the RIB investigation. A field investigation of the RIBs confirmed that the infiltration beds are not clogging, are maintained well and field usage is rotated on a reasonable basis. A large amount of fill was required to construct the beds and as part of the field investigation, the side slopes and embankments were inspected for signs of early break through, seepage and or slope failure. No failures were detected; however it was noted along portions of the toe of slope the ground was very saturated and pockets of standing water were noted. Additionally, interviews with FPU staff revealed historical observations of groundwater seepage in the surrounding land around the RIBs.

A portion of the RIBs also leach treated wastewater into a large wetland located to the north. The wetland drains to the pond via the Mountain Road Inlet. This is the same wetland that previously received the direct effluent discharge from the WWTP for over 40 years before the RIBs were constructed.

Residential Septic Systems

The remainder of the homes and businesses within the watershed use septic systems to handle their wastewater flows.

The general location and size of septic systems were observed around the pond during field investigations. However, a detailed investigation of residential septic systems, construction records and their function was not completed as part of this report. Results of a Resident Survey performed (refer to Section 2.3) provided some data on the age, size and type of systems, which was used in modeling pollutant loads in Section 4.0. The survey also helped identify areas where public education could be used to enhance management and maintenance of septic systems.

Lakeview Apartments Septic System

This Lakeview Apartments subsurface system is sandwiched between College Brook and Pearly Pond within 150 feet of each waterbody. The system contains several conventional septic tanks and very large subsurface drainage field. It is estimated to handle approximately 10,000 gallons per day when the apartments are fully occupied by students or for approximately 8-9 months of the year. The function of the system was not explored, but discussions with the FPU wastewater system operators and facility department provided details of the system and estimated usage for inclusion in the phosphorus load modeling discussed in Section 4.0.

2.2.4 Waterfowl

Waterfowl frequently visit Pearly Pond and FPU because of the large open green areas and easy access to the Pond. These are considered in the pollutant loadings as discussed under Section 4.0.

2.3 Resident Survey

In addition to the data collected from mapping, field surveys and discussions with the Pearly Pond stakeholder group, a survey was developed and mailed to 59 property owners within 500 feet of Pearly Pond. A total of 45 (76%) responses were received.

The purpose of the survey was to collect information on a number of environmental issues within the watershed to better understand potential phosphorus sources and to help direct future public education activities. Information was collected on perception of water quality, wastewater systems, occupancy, yard care, pets, geese, drainage issues and willingness to make property improvements to help protect the pond. A summary of the key findings is provided below, with full results provided in Appendix A.

Perception of Water Quality

Most respondents recognize that there are some water quality issues with Pearly Pond. Recognition of problems is the first step towards taking actions for improvement.

Wastewater Systems

Most of the respondents (84%) have traditional septic systems with a settling tank and leachfield. A small percentage (11%) have only holding tanks and two responded as having either a cesspool, outhouse or other type of system. While most of the homes (62%) are over 25 years old, only 29% of the wastewater systems are over 25 years old or the age of the system is unknown. The remainder is less than 25 years old, indicating that many of the systems have been replaced or upgraded since the home was constructed. Many of the homes (64%) are occupied year-round, with the remainder used seasonally.

Maintenance of septic systems typically involves pumping the solids from the holding tank for disposal. NHDES recommends pumping a septic tank out at least every two to three years. More frequent pumping may be needed depending on the size and use of the tank, including the use of garbage disposal systems. 51% of the respondents pump their tanks a minimum of once every two years, 36% pump once every three to five years and the remaining 12% pump less frequently. Only 7% or three of the respondents uses a garbage disposal.

New Hampshire regulations require a minimum distance of between 75 and 125 feet between a lake and septic system, depending on the soil type. 66% of the respondents have systems within 125 feet of the pond. Systems within 125 feet of the pond are more likely to contribute phosphorus due to their proximity and lower retention times for removal.

The use of phosphate-based detergents can also increase the phosphorus content in wastewater. NH bans the sale of high-phosphate laundry and automatic dishwasher detergents; therefore, this shouldn't be a big contributor of phosphorus to the pond.

Yard Care

Yard care can also contribute phosphorus to the pond from fertilization practices and disposal of grass clippings and leaf litter. Over half of the respondents have a grassed lawn within 100 feet of the pond. When asked how respondents disposed of their grass clippings and leaf waste, none responded that they dumped them in the pond or wet area. However, 57% didn't respond to the question pertaining to disposal of grass clippings and 71% didn't respond to the question pertaining to leaf litter disposal.

In January 2014, New Hampshire placed restrictions on the phosphorus content of fertilizers. Specifically, RSA 431:4-b states:

I. No fertilizer sold at retail that is intended for use on turf shall exceed a content level of 0.67% available phosphate unless specifically labeled for establishing new lawns, for repairing a lawn, for seeding, or for use when a soil test indicates a phosphorus deficiency.

II. No fertilizer sold at retail that is intended for use on newly established or repaired lawns, or for lawns testing deficient in phosphorus shall exceed an application rate of one pound per 1,000 square feet annually of available phosphate.

III. No natural organic turf fertilizer shall exceed a per application rate of one pound of available phosphate per 1,000 square feet when applied according to the instructions on the label.

The intent is to minimize phosphorus application on lawns, however, it can take years for such requirements to take full effect, as applicators use up their reserves and the word is spread on the new requirements. Higher phosphate content fertilizers are still allowed for establishment of new lawns and could be misused on established turf, along with the application rate.

Pets

Pets and livestock can also contribute phosphorus and other contaminants such as bacteria, through their feces if not managed. Feces left on lawns or near waters can be carried into the pond with rainfall and stormwater runoff. About half of the respondents have pets or livestock. About 13% never or seldom clean up after their pets.

Waterfowl

Waterfowl can also contribute phosphorus and bacteria to the pond through their feces. They prefer open shoreline when accessing land for nesting and breeding, as it provides clear view of potential predators and is easy to come ashore. 89% of the respondents have direct access to the shoreline, making the pond and surrounding area attractive to waterfowl such as geese. 47% of the respondents reported that waterfowl access their property from the pond.

Drainage Issues

40% of respondents indicated they have road drainage or culvert/pipes that drain onto their property and 24% indicated they have erosion issues or other drainage concerns on their property.

Willingness to Make Property Improvements to Protect Water Quality

Respondents were asked how willing they were to make improvements to their property to help protect Pearly Pond's water quality. Most indicated they would consider making improvements however, the survey did not get into the types and/or costs of improvements for consideration.

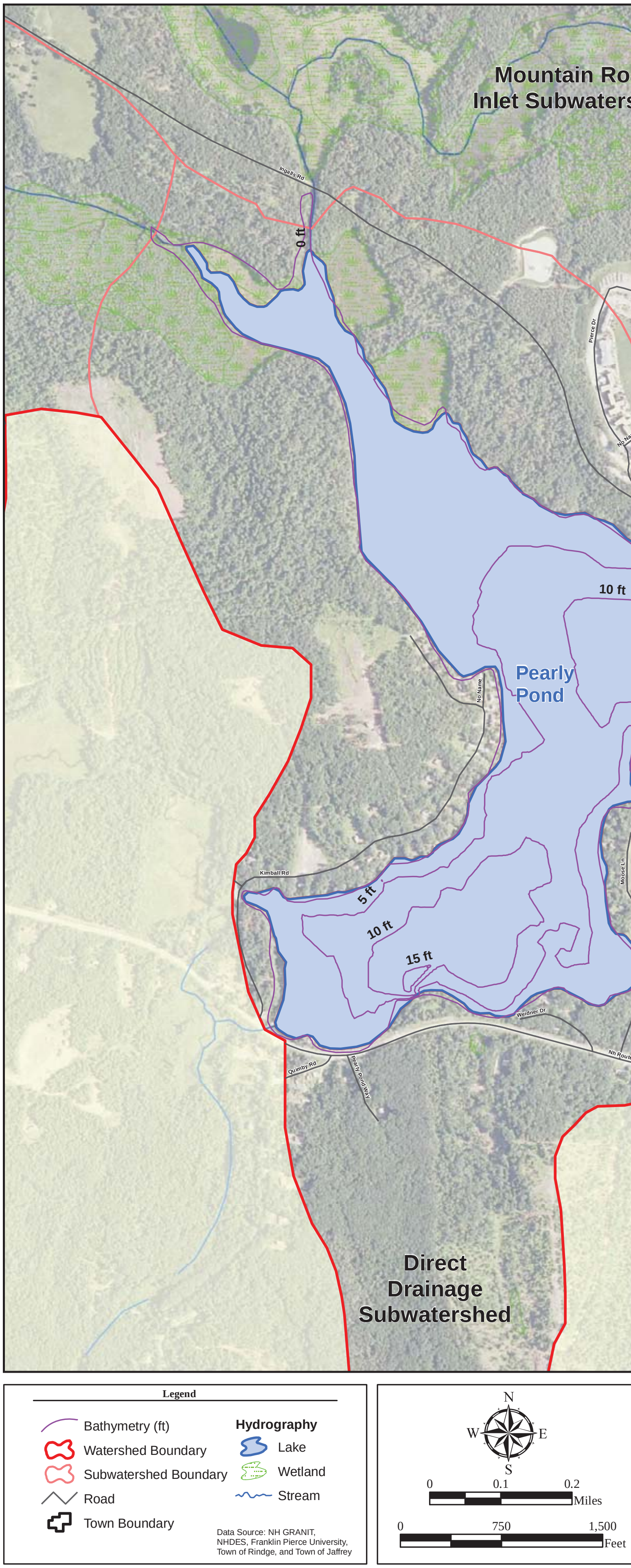


Figure 2-1

Pearly Pond Bathymetric Map

Pearly Pond Watershed Restoration Plan

Rindge and Jaffrey, New Hampshire

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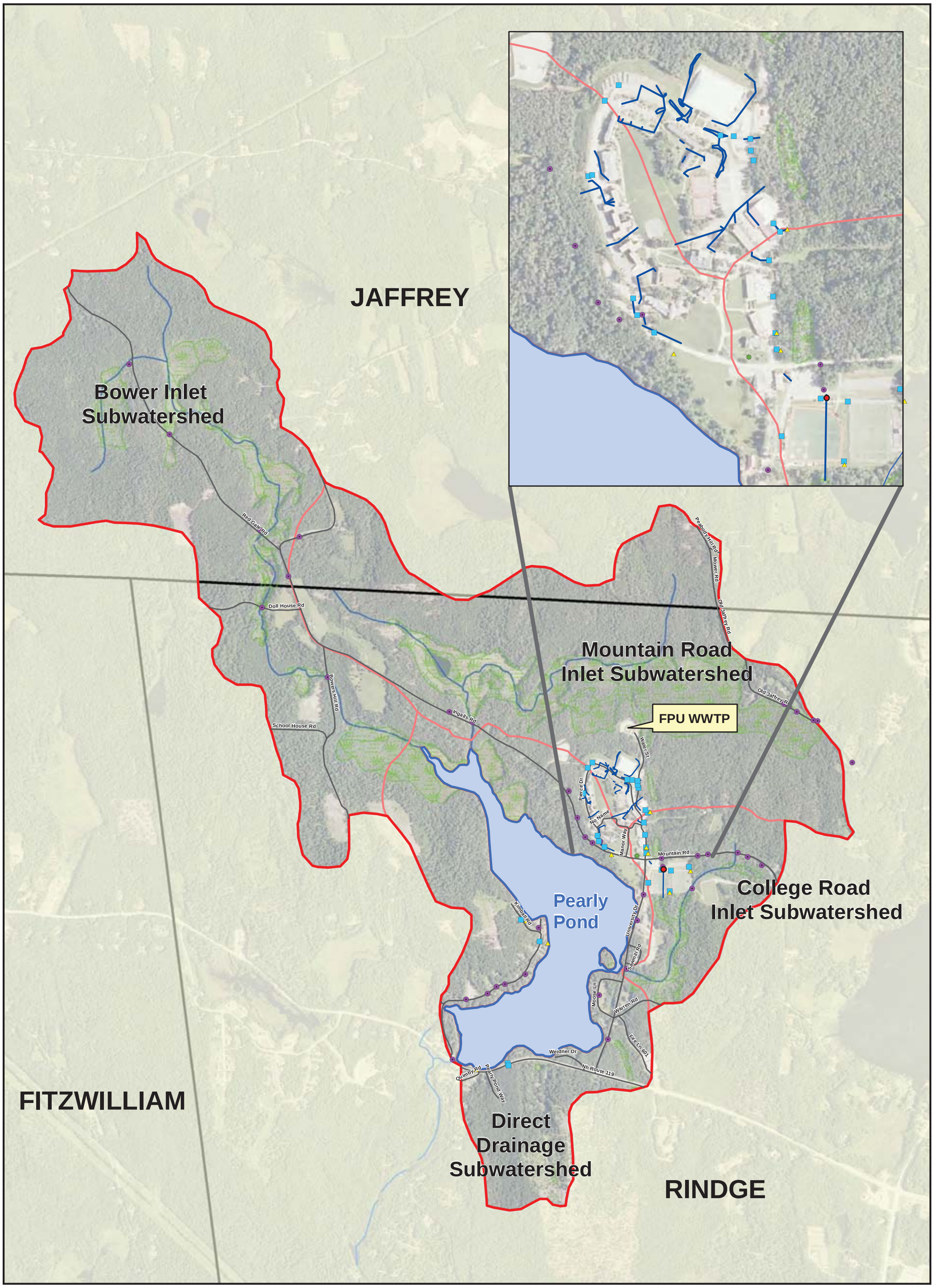


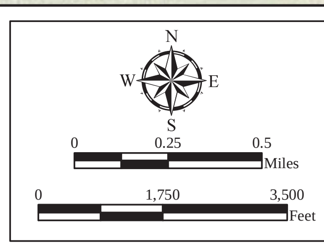
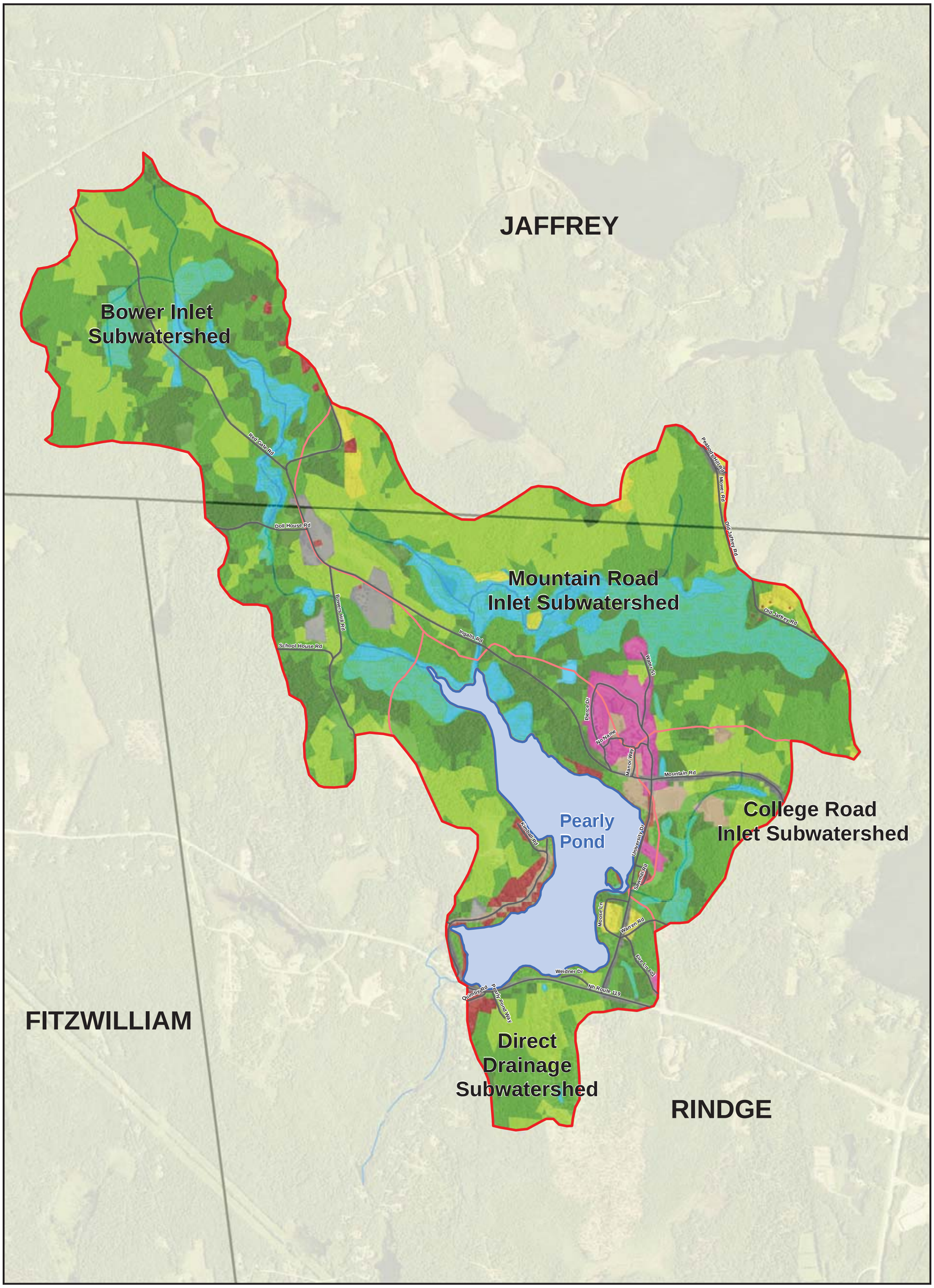


Figure 2-2
Watershed and Subwatershed Boundaries with Stormwater Infrastructure

Pearly Pond Watershed Restoration Plan

Rindge and Jaffrey, New Hampshire

Comprehensive Environmental Incorporated



Legend

Land Use
- Hayland-Non Manure
- Deciduous
- Non-Deciduous
- Mixed Forest
- Wetland
- Wetland/Pond
- Meadow
- Bare/Open
- Low Density Residential
- Mid-Density Residential
- Roads
- Industrial
- Parks, Recreational Fields, Institutional
- Watershed Boundary
- Subwatershed Boundary
- Road
- Town Boundary

Hydrography
- Lake
- Wetland
- Stream

Notes:
1) Land use polygons were updated from 2012 TMDL.

Data Source: NH GRANIT, NHDES, Franklin Pierce University, Town of Rindge, and Town of Jaffrey

N
W E
S

0 0.25 0.5 Miles

0 1,750 3,500 Feet

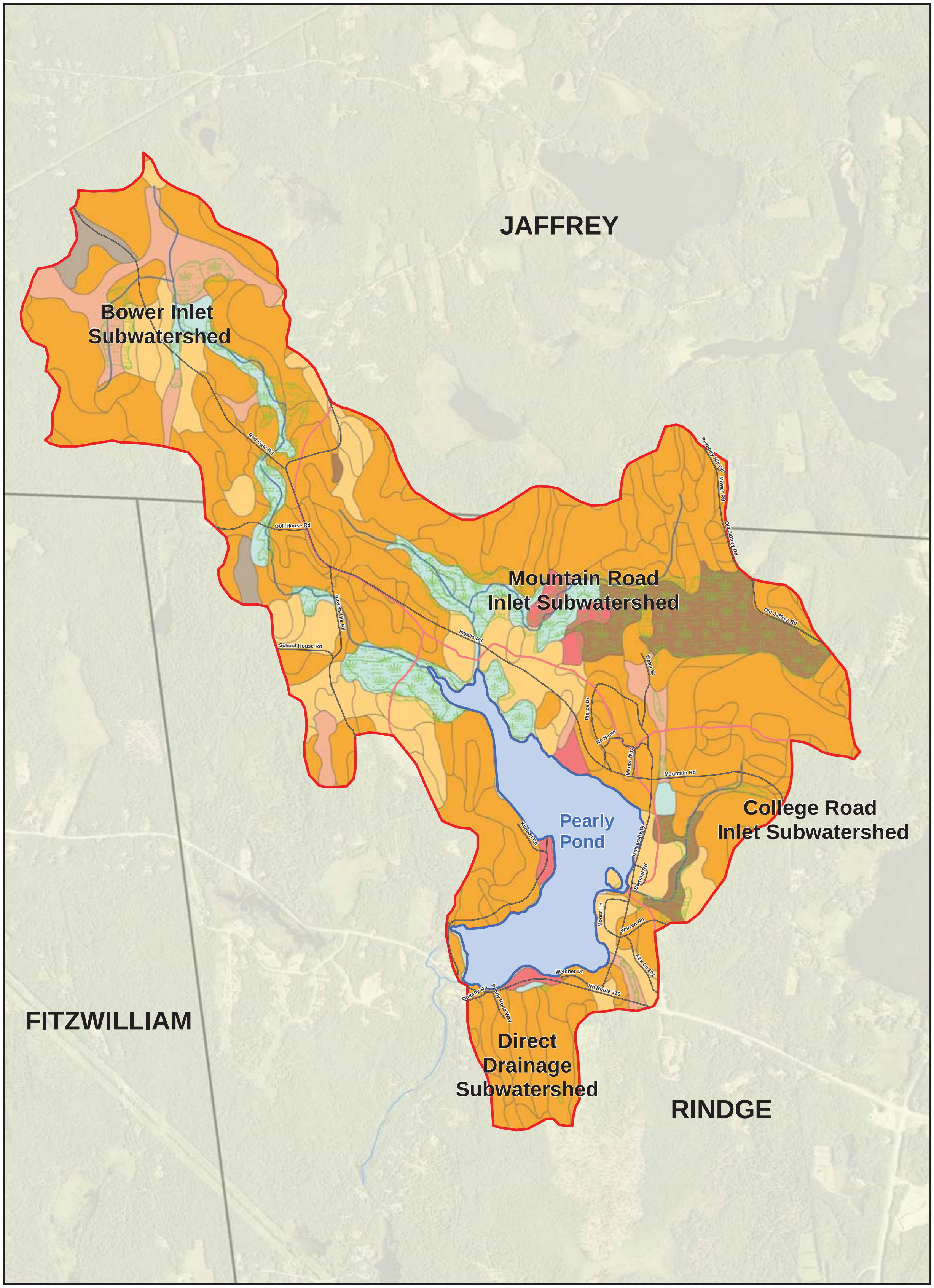
Figure 2-3

Land Use Characteristics

Pearly Pond Watershed Restoration Plan

Rindge and Jaffrey, New Hampshire

Comprehensive Environmental Incorporated



Legend

Soils
Hydrologic Soil Group
- Hydric
- A
- A/D
- B
- C
- C/D
- D

- Watershed Boundary
- Subwatershed Boundary
- Road
- Town Boundary

Hydrography
- Lake
- Wetland
- Stream

Data Source: NH GRANIT, NHDES, Franklin Pierce University, Town of Rindge, and Town of Jaffrey

N
W E
S

0 0.25 0.5 Miles

0 1,750 3,500 Feet

Figure 2-4

Soil Characteristics

Pearly Pond Watershed Restoration Plan

Rindge and Jaffrey, New Hampshire

Comprehensive Environmental Incorporated

Section 3 Water Quality

This section summarizes the available water quality data for Pearly Pond and how it impacts designated uses of the pond.

3.1 Designated Uses

Pearly Pond is assigned a surface water classification of B by the State of New Hampshire. Surface water classifications establish designated uses for a waterbody. Designated uses are desirable uses that must be protected. Water quality standards are designed to protect these designated uses. Unimpaired Class B waters will support fishing, swimming and other recreational purposes and may be used as water supplies after adequate treatment.

3.2 Pollutants of Concern

Pearly Pond, also known as Pearly Lake, (NHLAK802020103-08) is listed on the 2012 305(b)/303(d) List of Threatened or Impaired Waters (NHDES 2012a) for failure to meet the following designated uses:

Designated Use	DES Category	Impairment	Source
Aquatic Life	5-M	Chlorophyll-a	Unknown
Aquatic Life	5-M	Dissolved oxygen saturation	Package plant or other permitted small flows (FPU Wastewater treatment facility)
Aquatic Life	5-M	Phosphorus	Unknown
Aquatic Life	5-P	pH	Atmospheric deposition – naturally occurring organic
Primary Contact Recreation	5-M	Chlorophyll-a	Package plant or other permitted small flows (FPU Wastewater treatment facility)
Primary Contact Recreation	5-M	Cyanobacteria hepatotoxic microcystins	Unknown

Notes:
5-M – Parameter is a pollutant that requires a Total Maximum Daily Load (TMDL). The impairment is relatively slight or marginal.
5-P – Parameter is a pollutant that requires a TMDL. The impairment is more severe and causes poor water quality.

Pearly Lake Beach (NHLAK802020103-08-02) is listed on the 2012 305(b)/303(d) List of Threatened or Impaired Waters for failure to meet “Primary Contact Recreation”. It is DES Category “5-M” and the source of impairment is listed as “Unknown”.

Chlorophyll-a is the green pigment in plant material and its concentration is an indicator of the abundance of algae in the pond. If the chlorophyll-a concentration increases, this indicates an increase in the algal population. Chlorophyll-a levels in water are generally measured in units of micrograms per liter (ug/l) or parts per billion (ppb) and 1 ug/l is equal to 1 ppb.

For assessment purposes, as described in NHDES's Section 305(b) and 303(d) Consolidated Assessment and Listing Methodology (CALM) (NHDES 2012c) used to assess the impairment status of waters, chlorophyll-a concentrations in excess of 15 ug/L in fresh water are indicators of excessive algal growth that interferes with recreational activities. Chlorophyll-a thresholds by trophic class for aquatic life are defined by CALM as follows:

Trophic Status	Chlorophyll-a (ug/l or ppb)
Oligotrophic	<3.3
Mesotrophic	≤5
Eutrophic	≤11

Dissolved oxygen (DO) is a measure of the amount of oxygen in the water. DO levels in water are typically measured in milligrams per liter (mg/l). DO is vital to bottom-dwelling organisms, fish and amphibians that reside in the water. It gets into the water from the atmosphere, aeration of water (i.e., flowing streams) and through photosynthesis of plant material, a process that requires sunlight to occur. So, while aquatic plants and algae may produce oxygen during the day, they consume it at night. Bacteria also use oxygen both day and night when they process/break down organic matter. A significant amount of oxygen can be consumed during the decomposition of algae that sinks to the bottom of a lake or pond after it dies, leading to undesirable DO levels, and sometime fish kills. Most fish need a DO level of 5 mg/l to survive and can suffocate and die when levels fall below 2 mg/l. The process whereby DO decreases as a result of algae growth due to lake enrichment by phosphorus or nitrogen, is called cultural eutrophication. A lake that has too much nitrogen or phosphorus is known as eutrophic.

The DO assessment criteria used by CALM for Class B lakes and ponds is <5 mg/l does not support aquatic life. Greater than or equal to 6 mg/l is needed to support aquatic life.

Phosphorus is a nutrient that is essential to plants and animals. It gets into the water from the atmosphere and through stormwater runoff that picks it up as it travels across land surface. It can also enter lakes and ponds from wastewater discharges and animal feces. It is typically the limiting nutrient in a freshwater system, and excess amounts can cause excessive algae growth, which in turn contribute to low DO levels. Control of phosphorus sources to Pearly Pond should therefore improve conditions related to chlorophyll-*a* and DO such that designated uses are supported. For this reason, total phosphorus (TP) was selected as the pollutant to target in this restoration plan. Phosphorus levels in water are generally measured in units of micrograms per liter (ug/l) or parts per billion (ppb) and 1 ug/l is equal to 1 ppb.

Phosphorus thresholds by trophic class for aquatic life are defined by CALM as follows:

Trophic Status	TP (ug/l or ppb)
Oligotrophic	<8
Mesotrophic	≤12
Eutrophic	≤28

3.3 Applicable Water Quality Standards

The New Hampshire State Water Quality Standards for nutrients in Class B waters (Env-Wq 1703.14) are:

(1) **Class B** waters shall contain no phosphorus in such concentrations that would impair any existing or designated uses, unless naturally occurring.
(2) Existing discharges containing either phosphorus or nitrogen that encourage cultural eutrophication shall be treated to remove phosphorus or nitrogen to ensure attainment and maintenance of water quality standards.
(3) There shall be no new or increased discharge of phosphorus into lakes or ponds.
(4) There shall be no new or increased discharge(s) containing phosphorus or nitrogen to tributaries of lakes or ponds that would contribute to cultural eutrophication or growth of weeds or algae in such lakes and ponds.

Applicable water quality standards for DO include the following:

Env-Wq 1703.07 (b): Except as naturally occurs, or in waters identified in RSA 485-A:8, III, or subject to (c) below, Class B waters shall have a DO content of at least 75% of saturation, based on a daily mean, and an instantaneous minimum DO concentration of at least 5 mg/L.

Env-Wq 1703.07 (d): Unless naturally occurring or subject to (a) above, surface waters within the top 25 percent of depth of thermally unstratified lakes, ponds, impoundments and reservoirs or within the epilimnion shall contain a DO content of at least 75 percent saturation, based on a daily mean and an instantaneous minimum DO content of at least 5 mg/L. Unless naturally occurring, the DO content below those depths shall be consistent with that necessary to maintain and protect existing and designated uses.

3.4 Anti-degradation Policy

In addition to the above water quality standards, NHDES has anti-degradation regulations designed to preserve and protect the existing beneficial uses of New Hampshire's surface waters and to limit the degradation allowed in receiving waters. Anti-degradation regulations are included in Part Env-Wq 1708 of the New Hampshire Surface Water Quality Regulations. According to Env-Wq 1708.02, anti-degradation applies to the following:

- All new or increased activity including point and nonpoint source discharges of pollutants that would lower water quality or affect the existing or designated uses;
- A proposed increase in loading to a waterbody when the proposal is associated with existing activities;
- An increase in flow alteration over an existing alteration; and
- All hydrologic modifications, such as dam construction and water withdrawals.

This is important to prevent additional pollutant contributions and degradation of water quality from new development.

3.5 Existing Water Quality Data

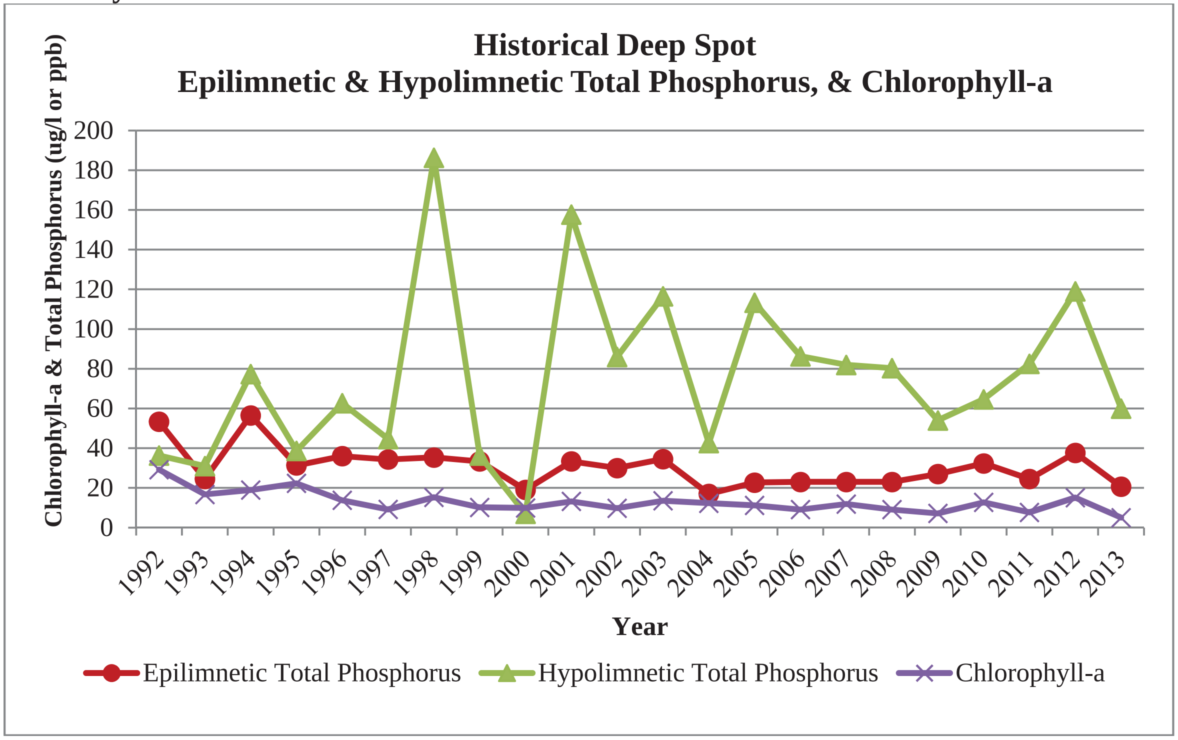
The New Hampshire Department of Environmental Services (NHDES) conducted water quality monitoring of Pearly Pond in the summers of 1977, 1990, and 2004 for Lake Trophic Studies (NHDES 1990). The Volunteer Lake Assessment Program (VLAP) began in 1992 and continues to the present day (NHDES 2012). NHDES also conducted a study of the Mountain Road (Ingall's Road) Inlet Subwatershed in 1995 (Connor and Moses, 1995).

Water quality data have been collected from tributaries to the pond and from within the pond itself. Figure 3-1 shows the tributary and in-pond monitoring locations.

3.5.1 In-Pond Water Quality

The collection of in-pond samples has focused on the deep spot of the pond, with samples collected from the upper (epilimnion), middle (metalimnion) and bottom (hypolimnion) layers of the pond under stratified and non-stratified conditions during the summer season of each year. Stratified conditions are defined by a steep temperature gradient with depth, marked by a layer above and below, in which the water is at different temperatures. This temperature gradient is also known as the thermocline and is most prevalent during the summer when surface temperatures are much warmer than bottom temperatures. TP concentrations in the bottom are typically higher than the surface due to release of phosphorus from organic material. Mixing typically occurs in the spring and fall, at which time more uniform concentrations are typically seen at various depths. Figure 3-2 provides a summary of the average chlorophyll-a, epilimnetic TP and hypolimnetic TP concentrations in the pond during the summer season between 1992 and 2013.

Figure 3-2. Historical Summer Total Phosphorus and Chlorophyll-a Concentrations in Pearly Pond



Notes:
The NH median value for chlorophyll-a in NH study lakes is 3.7 ug/l (10.5 ug/l in impaired lakes, 3.5 ug/l in unimpaired lakes) (Trowbridge 2009).
The NH median value for total phosphorus in NH study lakes is 9.1 ug/l (26.5 ug/l in impaired lakes, 11 ug/l in unimpaired lakes) (Trowbridge 2009).
The epilimnion is the top most layer of water in a thermally-stratified lake or pond.
The hypolimnion is the dense, bottom layer of water in a thermally-stratified lake or pond.

Higher TP concentrations were observed in the epilimnion layer between 1992 and 2003, with a noted decrease between 2004 and 2008, rising again in 2009, however, not as high as the historic values. There are many factors that can influence the water quality in a given year, including air and water temperatures, rainfall, water levels and stratification. A more detailed analysis of the effects of these parameters on water quality was not performed under this study. However, it is important to note that a significant source of TP to the pond was reduced in 2009, when the wastewater treatment system was upgraded at Franklin Pierce University. Prior to 2009, the wastewater effluent was discharged directly to a wetland network in the Mountain Road (Ingall's Road) Inlet Subwatershed. This wetland network ultimately drains to the pond. In 2009, rapid infiltration beds (RIBs) were constructed to accept the wastewater effluent, allowing for filtration of pollutants such as TP before reaching groundwater. This eliminated a direct point source discharge of TP to a tributary of Pearly Pond.

The mean, median and range of TP and chlorophyll-a concentration from the in-pond location between 1992 and 2013 is summarized in Table 3-1. Table 3-2 provides the same statistics for the period between 2009 and 2013 to represent average in-pond concentrations after elimination of the wastewater point source discharge. Refer to Appendix B for the full water quality data set obtained from the NHDES OneStop Environmental Monitoring Database (EMD).

Table 3-1. Pearly Pond Total Phosphorus Concentration Summer Statistics 1992-2013

Statistic	Deep Spot Epi-P (ug/l or ppb)	Deep Spot Meta-P (ug/l or ppb)	Deep Spot Hypo-P (ug/l or ppb)	Chlorophyll-a (ug/l or ppb)
Min	6	10	7	2
Mean	28	30	75	13
Max	74	52	302	43
Median	25	29	47	12
N	77	27	69	67

N = number of samples; Epi = epilimnion; Meta = metalimnion; Hypo = hypolimnion

Table 3-2. Pearly Pond Total Phosphorus Concentration Summer Statistics 2009-2013

Statistic	Deep Spot Epi-P (ug/l or ppb)	Deep Spot Meta-P (ug/l or ppb)	Deep Spot Hypo-P (ug/l or ppb)	Chlorophyll-a (ug/l or ppb)
Min	13	No Data	20	4
Mean	24	No Data	70	9
Max	52	No Data	207	28
Median	23	No Data	47	6
N	30	No Data	21	18

N = number of samples; Epi = epilimnion; Meta = metalimnion; Hypo = hypolimnion

There is a noticeable reduction in mean, maximum and median TP and chlorophyll-a concentrations between the two data sets, with generally higher concentrations when the wastewater treatment plant (WWTP) effluent was discharged to a tributary of Pearly Pond. Average and median TP concentrations in the epilimnion layer in both cases fall in the "High" category, while chlorophyll-a concentrations fall in the "More than desirable" category. The 2009-2013 data set is used to model pollutant loads to the pond (refer to Chapter 4.0) since it is most representative of current conditions (i.e., no direct wastewater discharge).

3.5.2 Tributary Water Quality

The collection of tributary samples has focused on each of the three tributaries feeding the pond and the outlet of the pond with samples collected under flowing conditions (i.e., samples are not collected when the tributary is stagnant).

The mean, median and range of TP concentrations from the inlet and outlet tributary locations between 1992 and 2013 is summarized in Table 3-3. Table 3-4 provides the same statistics for the period between 2009 and 2013 to represent average tributary concentrations after elimination of the wastewater point source discharge. Refer to Appendix B for the full water quality data set obtained from the NHDES OneStop EMD.

Table 3-3. Tributary Total Phosphorus Concentration Summer Statistics 1992-2013				
Statistic	**Bower Inlet TP (ug/l or ppb)**	**University Drive (College Road) Inlet TP (ug/l or ppb)**	**Mountain Rd (Ingall's Rd) Inlet TP (ug/l or ppb)**	**Outlet TP (ug/l or ppb)**
Min	11	32	28	14
Mean	33	72	70	28
Max	90	100	138	46
Median	27	70	68	28
N	39	8	45	59

N = number of samples

Table 3-4. Tributary Total Phosphorus Concentration Summer Statistics 2009-2013				
Statistic	**Bower Inlet TP (ug/l or ppb)**	**University Drive (College Road) Inlet TP (ug/l or ppb)**	**Mountain Rd (Ingall's Rd) Inlet TP (ug/l or ppb)**	**Outlet TP (ug/l or ppb)**
Min	11	70	28	14
Mean	24	77	56	24
Max	38	83	120	33
Median	24	77	54	24
N	13	2	12	15

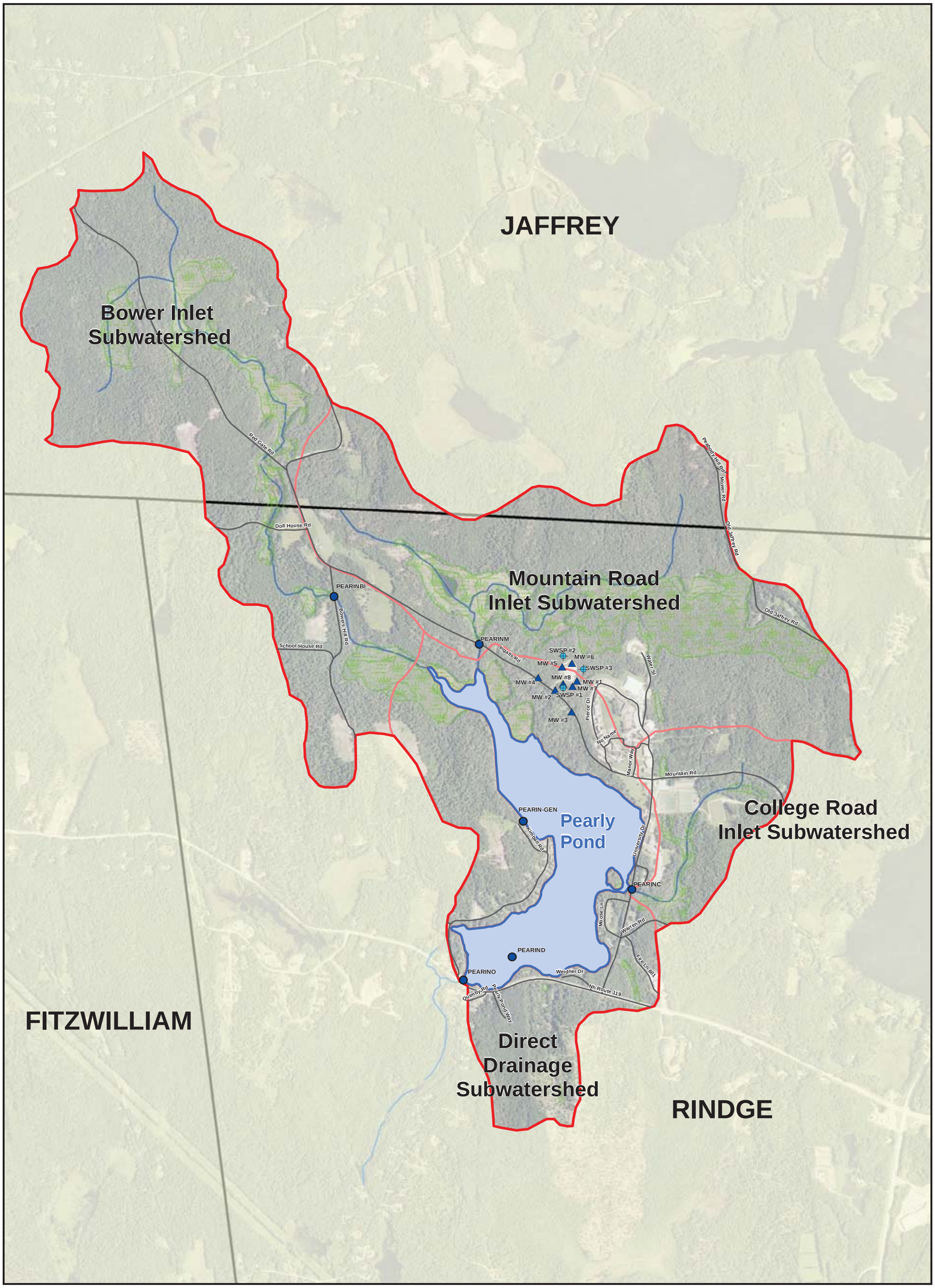
N = number of samples

The variability in concentrations can be based on a number of factors, including stream flow rate and the weather preceding the sampling event. Stream flow rates are not collected during sampling, so couldn't be used to determine the impact on TP concentrations. A comparison of the data to accumulated precipitation quantities over the seven day period, before the sampling date, show higher TP concentrations when precipitation is low and lower concentrations when precipitation is high. A summary of this analysis is shown in Table 3-5, with additional details (i.e., maximum, minimum, means, medians and number of samples for each precipitation amount) provided in Appendix C.

Table 3-5. Tributary Total Phosphorus Concentrations Correlated with Precipitation 1992-2013			
Accumulated Precipitation Over Seven Days Prior to Sampling Event (Inches)	**Average TP Concentration**		
	Bower Inlet TP (ug/l or ppb)	**Univ. Dr. (College Rd) Inlet TP (ug/l or ppb)**	**Mountain Rd (Ingall's Rd) Inlet TP (ug/l or ppb)**
<0.1	39	No Data	71
0.1-0.5	43	100	79
0.5-1	31	51	63
>1-<2	27	64	75
>2	16	70	47

The higher concentrations during dry periods (i.e., <0.5 inches of accumulated precipitation over seven days) at Mountain Road are likely associated with the release of accumulated TP in the wetland from the historic wastewater discharges. However, the high TP concentrations during dry periods in the Bower Inlet suggest a high background TP concentration in the stream baseflow. This is a mostly forested, undeveloped subwatershed, from which lower TP concentrations would be expected. The exact source of the higher concentrations (i.e., dissolved in groundwater, particulates from forested areas of the watershed) are unknown, but should be considered in TP load and reduction calculations. For example, Pearly Pond may receive naturally high loads of phosphorus from undeveloped areas, which cannot be removed and should be reflected in the load modeling and reduction goals.

The lower concentrations in both the Bower Inlet and the Mountain Road (Ingall's Road) Inlet during wetter periods appear to be associated with dilution of baseflow. The collection of flow data with future sampling events would allow for the calculation of actual phosphorus loads associated with varying stream flow rates to determine how loads vary with precipitation.



Legend

Water Sample Location

Type

- SW - Samples by VLAP/DES
- SW - Samples by FPU WWTF
- MW - Samples by FPU WWTF
- Watershed Boundary
- Subwatershed Boundary

- Road
- Town Boundary

Hydrography

- Lake
- Wetland
- Stream

Data Source: NH GRANIT, NHDES, Franklin Pierce University, Town of Rindge, and Town of Jaffrey

N W E S

0 0.25 0.5 Miles

0 1,750 3,500 Feet

Figure 3-1

Monitoring Locations

Pearly Pond Watershed Restoration Plan

Rindge and Jaffrey, New Hampshire

Comprehensive Environmental Incorporated

Section 4 Pollutant Source Analysis

Total phosphorus (TP) loadings to Pearly Pond were assessed using the ENSR-LRM methodology under existing and buildout conditions, in accordance with the Site Specific Project Plan (SSPP) in Appendix D. The ENSR-LRM model is a land use export coefficient model developed by the environmental consulting firm AECOM for use in New England and modified for New Hampshire lakes by incorporating New Hampshire land use TP export coefficients when available and adding septic system loading into the model (AECOM and NHDES 2014). This model was used in the development of the Draft Total Maximum Daily Load for Pearly Lake, Rindge, NH, prepared by AECOM in 2009 and updated by NHDES in July 2014 and updated in this restoration plan to account for site-specific water quality observations.

The direct and indirect nonpoint sources of TP to Pearly Pond evaluated within the model include:

- Atmospheric deposition (through direct precipitation to the pond);
- Surface water base flow (dry weather tributary flows, including any groundwater seepage into streams from groundwater);
- Stormwater runoff (runoff draining to tributaries or directly to the pond);
- Internal recycling (release from sediment by chemical interaction);
- Waterfowl (direct input from resident and migrating birds);
- Direct groundwater seepage including septic system inputs from shorefront residences; and
- Residual effects of a wastewater treatment plant (WWTP) surface water discharge that was eliminated in 2009 (see Section 4.1).

Temporary construction discharge and impacts are not incorporated into the model due to their variability and short-term impacts. Construction activities that disturb greater than one acre of land and convey stormwater to surface water require a federal General Permit for Stormwater Discharge from Construction Activities, which requires the use of controls to reduce pollution from these sources.

TP loads were estimated for each of the four subwatersheds, Bower Inlet, Mountain Rd. / Ingall's Rd. Inlet , University Drive Inlet (a.k.a. College Road Inlet) and Direct Drainage (refer to Figure 2-2) based on runoff and groundwater land use export coefficients. The TP loads were then attenuated as necessary to match tributary monitoring data, if available. If no current tributary data were available, then the attenuation factor was based on the slope, soils, and wetland attenuation in comparison to the other subwatersheds where tributary data was available. Loads from the watershed as well as direct sources were then used to predict in-pond concentrations of TP, chlorophyll-a, Secchi Disk Transparency (SDT), and algal bloom probability. The estimated load and in-pond predictions were then compared against measured in-pond concentrations with further adjustment of attenuation factors to achieve a close agreement between predicted in-pond TP and observed mean/median TP.

4.1 Pollutant Loads Under Existing Conditions

4.1.1 Hydrologic Inputs and Water Loading

Calculating TP loads to Pearly Pond requires estimation of the hydrologic budget or quantity of water flowing into the pond. The three primary sources of water are: 1) direct precipitation onto the pond surface; 2) stormwater runoff from the watershed, which enters tributaries to the pond and/or drains directly to the pond; and 3) baseflow, which includes all precipitation that infiltrates and is then subsequently released to surface water in the tributaries or directly to the pond (i.e., groundwater). Baseflow typically represents the minimum flows to the tributaries and pond during dry weather. In addition to these primary sources of water, effluent flow from the Franklin Pierce University (FPU) wastewater treatment plant (WWTP) was also included. The water budget is broken down into its components in Table 4-1.

- Direct Precipitation – Mean annual precipitation was assumed to be representative of a typical hydrologic period for the watershed. The annual precipitation value was derived from the USGS publication: Open File Report 96-395, “Mean Annual Precipitation and Evaporation - Plate 2”, 1996 and confirmed with precipitation data from weather stations in Epping, Durham, and Concord. For the Pearly Pond watershed, 1.07 m of annual precipitation was used (AECOM and NHDES 2014).
- Runoff – For each land use category, annual runoff was calculated by multiplying mean annual precipitation by basin area and a land use specific runoff fraction. The runoff fraction represents the portion of rainfall converted to overland flow (AECOM and NHDES 2014).
- Baseflow – The baseflow calculation was calculated in a manner similar to runoff. However, a baseflow fraction was used in place of a runoff fraction for each land use. The baseflow fraction represents the portion of rainfall converted to baseflow (AECOM and NHDES 2014).
- FPU WWTP Effluent – 2/3 of the flow from the FPU Franklin Pierce University wastewater treatment plant (WWTP) comes from water sources outside of the watershed, therefore this was added as an additional flow input in the water budget. This value is based on the average of the annual WWTP flows for the years 2009 to 2013 presented in Appendix E, Table E-8.

Table 4-1. Pearly Pond Water Budget

Water Budget	M^3/Yr.
Direct Precipitation	829,425
Watershed Runoff	2,017,859
Watershed Baseflow	2,815,243
Wastewater Treatment Plant	40,031
Total	5,662,528

Runoff and baseflow fractions from Dunn and Leopold (1978) were assumed to be representative for NH land uses and are listed in Tables E-1 and E-2 in Appendix E. The hydrologic budget was calibrated to a representative standard water yield for New England (Sopper and Lull, 1970; Higgins and Colonell 1971, verified by assessment of yield from various New England USGS flow gauging stations) and considering measured flows in the Mountain Rd. / Ingall's Rd. Inlet from the NHDES 1995 study of Pearly Pond (Connor 1995). Calibration was achieved by attenuating (reducing) the water load by 20% in all subwatersheds to achieve better agreement with the standard water yield for New England. This differs slightly from the 2014 Draft TMDL, which assumed less attenuation in the Mountain Rd. / Ingall's Rd. Inlet (15% vs. 20%) to more closely match that predicted by the standard yield. More detail on the methodology for hydrologic budget estimation and calibration is presented in Appendix F.

4.1.2 Nutrient Inputs

Land Use Export

Land uses within the watershed were determined using: (1) Geographic Information System (GIS) data; (2) analysis of aerial photographs; and (3) ground truthing (when appropriate).

The TP load for each subwatershed was calculated using export coefficients for each land use type. The subwatershed loads were adjusted based upon proximity to the pond, soil type, presence of wetlands, and attenuation provided by Best Management Practices (BMPs) for water or nutrient export mitigation. The watershed load (baseflow and runoff) was combined with direct loads (atmospheric, internal load, septic system, and waterfowl) to calculate TP loading. The generated load to the pond was then input into a series of empirical models that provided predictions of in-pond TP concentrations, chlorophyll-a concentrations, algal bloom frequency and water clarity. Details on model input parameters and major assumptions used to estimate the baseline loading (i.e., existing conditions) for Pearly Pond are described below.

- Areal land use estimates were generated from land use and land cover GIS data layers from NH GRANIT (Figure 2-3). Land area estimates were updated to account for observations made during field investigations. Specifically some agricultural hayland (12.2 hectares) was re-designated as open land (11 hectares) or forested wetland (1.2 hectares), 25.7 hectares of forested area was re-designated as open wetland (1.2 hectares) or open urban (1.5 hectares), and a one acre parcel of urban land was re-designated as forest. Land use categories were matched with the ENSR-LRM land use categories and their respective TP export coefficients. Table 4-2 lists ENSR-LRM land use categories in which the GRANIT categories were matched.
- TP export coefficient ranges were derived from values summarized by Reckhow et al. (1980), Dudley et al. (1997) as cited in ME DEP (2003) and Schloss and Connor (2000). Table E-3 (Appendix E) provides ranges for export coefficients and Table E-4 provides the runoff and baseflow export coefficient for each land use category in Pearly Pond and the sources for each export coefficient. The Urban 2 and Urban 5 TP runoff export coefficients were increased above the median export coefficient because the land within these categories was located on the Franklin Pierce College campus. These areas are likely more intensely managed and warrant a higher TP runoff export coefficient. The baseflow export coefficient (phosphorus contribution from groundwater) was also increased based on the results of phosphorus concentrations in tributary samples from the Bower

Inlet. The Bower Inlet, an undeveloped watershed, shows elevated concentrations of phosphorus during dry weather period (refer to Section 3.0), suggesting high phosphorus concentrations in groundwater baseflow.

The Bower Inlet was used to evaluate possible background phosphorus concentrations since it is the least developed watershed and most likely to represent natural conditions. The average and median phosphorus concentration in the Bower Inlet during low flow events (e.g., ~0.1 inch or less of rain over a seven to eight day period) between 2009 and 2013 is 25.8 ug/l, however, this is only based on two samples. The average concentration between 1992 and 2013, based on 5 samples was 38.7 ug/l, with a median of 30 ug/l. As described in Section 3.0, this was found to decrease with an increase in precipitation. Refer to Appendix C for correlation of phosphorus concentrations with precipitation.

Adjusting the model to reflect a groundwater baseflow concentration of 25.8 ug/l would require adjustment of the baseflow export coefficient significantly outside the documented typical range, and the data set supporting this baseflow concentration is limited. As a result, we evaluated the minimum concentration observed in the Bower Inlet over the 1992-2013 period, which was 10.7 ug/l and used this to represent a groundwater baseflow concentration. The baseflow export coefficients for forested and wetland areas were adjusted accordingly to predict a groundwater baseflow concentration of about 10 ug/l. As noted in Section 3.0, this may not be representative of an actual groundwater concentration (i.e., it could be associated with soils or phosphorus outputs from the wetland network), but accounting for it in the manner allows for it to be considered in the development of an in-pond water quality goal.

Note that this still resulted in a significant increase in the baseflow export coefficients, with forested and wetland factors falling outside of the reference range, and the remaining land use baseflow export coefficients falling on the high end of the range. The increase was made by first adjusting the undisturbed land uses (e.g., forested, wetlands and meadows) to predict P concentrations in the Bower Inlet that matched an observed concentrations of about 10 ug/l, since this is an undeveloped watershed. The natural baseflow P export coefficient was then added to the literature based baseflow P export coefficients for the other disturbed land uses to represent natural baseflow load plus the anticipated load from developed land uses.

- Annual areal loading of TP from the watershed (four subwatersheds) is estimated to be 128 kg/yr., which represents 53% of the total load to the pond.

Table 4-2. Land Use Categories by Pearly Pond Subwatersheds						
	Area (Hectares)					
	University Drive (College Rd) Inlet	**Mountain Rd. /Ingall's Rd. Inlet**	**Bower Inlet**	**Direct Drainage Subwatershed**	**Total**	**%**
Urban 1 (Residential)	0.0	0.8	1.1	10.4	12.2	1%
Urban 2 (Mixed Urban/Commercial)	2.9	10.3	0.0	6.6	19.8	2%
Urban 3 (Roads)	3.3	3.6	2.6	7.3	16.7	2%
Urban 4 (Industrial)	0.0	0.0	0.0	0.0	0.0	0%
Urban 5 (Parks, Recreation Fields, Institutional)	5.8	0.6	0.0	5.9	12.3	1%
Agric. 1 (Cover Crop)	0.0	0.0	0.0	0.0	0.0	0%
Agric. 2 (Row Crop)	0.0	0.0	0.0	0.0	0.0	0%
Agric. 3 (Grazing)	0.0	0.0	0.0	0.0	0.0	0%
Agric. 4 (Hayland-Non Manure)	0.0	11.1	0.0	2.8	13.9	2%
Forest 1 (Deciduous)	16.2	88.8	61.7	36.2	203.0	24%
Forest 2 (Non-Deciduous)	8.6	36.6	65.5	30.4	141.1	16%
Forest 3 (Mixed Forest)	22.1	83.5	122.8	70.2	298.6	35%
Forest 4 (Wetland)	5.4	41.1	18.4	5.7	70.6	8%
Open 1 (Wetland / Pond)	1.2	28.2	21.4	9.8	60.6	7%
Open 2 (Meadow)	0.0	0.0	0.0	0.0	0.0	0%
Open 3 (Bare/Open)	0.0	4.4	7.2	0.6	12.3	1%
TOTAL	65.6	309.1	300.7	185.8	861	100 %

Atmospheric Deposition

TP inputs from atmospheric deposition were estimated based on a TP coefficient for direct precipitation. The atmospheric load of 0.25 kg/ha/yr. includes both the mass of TP in rainfall and the mass in dryfall (Wetzel, 2001). The sum of these masses is carried by rainfall. As a result, the concentration calculated for use in the loading estimate (23 ug/L) is comparable to the mean concentration (25 ug/L) observed in rainfall in Concord, NH (AECOM and NHDES 2014). The coefficient was then multiplied by the pond area (ha) in order to obtain an annual atmospheric deposition TP load. The contribution of atmospheric deposition to the annual TP load to Pearly Pond was estimated to be 19.4 kg/yr. or 8% of the total load.

Internal Loading

Internal loading of TP to Pearly Pond was estimated using pond volume-weighted mass differences between late summer hypolimnetic and epilimnetic TP concentrations and

DO data. DO profiles during late summer were chosen to determine the depth of the anoxic zone. The area of the pond with potential anoxic zones was determined using GIS analysis of bathymetric maps (Figure 2-1). Internal TP loading was estimated as the difference between the hypolimnetic and epilimnetic TP concentrations in August for the most recent (2009-2013), multiplied by the volume of the hypolimnion (Table E-5 in Appendix E). Internal loading of TP to Pearly Pond was estimated to range from 0.2 kg/yr. based on the hypolimnion at a depth of 3 meters to 19 kg/yr. based on the hypolimnion at a depth of 2 meters. 2013 was the only year where fall samples were collected in September and October, with the remaining data for previous years collected over the summer months. The fall 2013 data did not show an increase in the epilimnetic TP concentrations after mixing of stratified layers occurred, indicating that the high summer concentrations in the hypolimnetic layer from internal recycling are not a significant contributor to TP concentrations in the epilimnetic layer. However, this is the only fall data available and the depth at which the hypolimnion occurs can fluctuate from year to year based on weather and water levels, such that a larger bottom surface area may be exposed to low DO levels, increasing the load to the pond. Low DO may also occur over the winter, releasing phosphorus to the water column, making it readily available for spring blooms. There isn't enough water quality data to determine whether these factors are at play in Pearly Pond. As a result, for modeling purposes, we assumed a mid-range hypolimnion depth of 2.5 meters, which would contribute 9 kg/yr. (3.7% of the total load to the pond).

<u>Septic Systems</u>

TP export loading from residential septic systems was estimated for septic systems within the 125 ft. shoreline zone. The 125 ft. zone is the minimum distance from lakes that new septic systems are allowed in New Hampshire with rapid groundwater movement through gravel soils. A shoreline survey using GIS ortho-photographs determined the number of residences within the 125 ft. zone. It was assumed that if the dwelling was within the 125 ft. zone that the septic system was also within the 125 ft. zone. Loading from the relatively large septic system serving the Lakeview apartment buildings on College Road, which house about 214 students during the school year and an average of approximately 20 people over the summer months, was also included because the leach field for this septic system is located close to the University Drive Inlet (College Road Inlet) tributary, in which high concentrations of phosphorus have been observed. The TP load was calculated by multiplying a TP export coefficient (based on literature values for wastewater TP concentrations and expected water use), the number of dwellings, the mean number of people per dwelling, the number of days occupied per year, and an attenuation coefficient (Table C6). In Pearly Pond, the TP loading from shoreline septic systems was estimated to be 6.1 kg/yr., and that from the Lakeview Apartments was estimated to be 11.9 kg/yr., which combined (18 kg/yr.) is approximately 7.5% of the TP load to Pearly Pond.

The following assumptions were used in estimating the TP load from septic systems.

- Based on the 2013 resident survey discussed in Section 2.0 and included in Appendix A, seventeen residences were estimated to be seasonal and twenty-nine residences were estimated to be year round.

- Two and a half people were estimated to reside in each dwelling. It was estimated that each resident uses 65 gallons per day for 365 days per year for year round residents and 90 days for seasonal residents.
- Two hundred and fourteen people were estimated to reside in the Lakeside Apartments during the school year (273 days/year) and an average of 20 people over the summer months (92 days) (based on correspondence with FPU).
- The TP coefficients were calculated based on mean TP concentration in domestic wastewater of 8 mg/L and mean household water uses (Metcalf & Eddy, 1991).
- All septic loads to Pearly Pond were attenuated 90% (Dudley and Stephenson, 1973; Brown and Associates, 1980) to account for TP uptake in the soil between the septic systems and the pond. There is no evidence in available watershed reports or evidence from site visits that the majority of the soils underlying the developed area immediately adjacent to Pearly Pond has severe limitations for septic systems or has poor filtration characteristics.

Residual WWTP Load

From 1967 through 2008 (41 years), the Franklin Pierce University (FPU) wastewater treatment plant (WWTP) discharged to a wetland in the Mountain Road (Ingall's Road) tributary subwatershed of Pearly Pond. The National Pollutant Discharge Elimination System (NPDES) permit number for this discharge was NH0101044. In 2009, the University eliminated this surface water discharge when it completed construction and began operation of a rapid infiltration basin (RIB) system to treat its wastewater via groundwater infiltration.

Although the surface water discharge has been eliminated, there appears to be a residual load still evident in the Mountain Road (Ingall's Road) tributary associated with the historic discharge. It is believed the capacity of the wetland to retain phosphorous was likely used up after over 40 years of receiving treated wastewater and may now be a source of phosphorous to the Mountain Road (Ingall's Road) tributary and Pearly Pond. The significantly high phosphorous concentrations in the Mountain Road (Ingall's Road) tributary compared to the nearly undeveloped Bower tributary support this theory. Both drainage areas are similar in size (300 hectares) with more wetlands and slightly more urbanized area in the Mountain Road (Ingall's Road) Inlet Subwatershed, yet data collected from 2009 through 2013 shows the average concentration of phosphorous in the Mountain Road (Ingall's Road) tributary (56 ug/L) is more than twice that of the Bower tributary (24 ug/L).

The difference in concentrations was used to estimate an additional phosphorus load associated with the wetland and historic wastewater discharge. A likely phosphorus concentration in the Mountain Road (Ingall's Road) tributary without the historic wastewater release was first estimated using the TMDL model, which predicts the concentration in the Mountain Road (Ingall's Road) tributary to be about 30% higher than the concentration in the Bower inlet due to its slightly larger drainage area and developed areas. This results in an approximate phosphorus concentration of 31.2 ug/l in the Mountain Rd. / Ingall's Rd. Inlet without the WWTP influence. A value of 31.2 ug/L seemed reasonable compared to 24.5 ug/L in the Bower tributary, which is less developed. The residual load from the former FPU WWTP discharge was then determined by subtracting the predicted concentration from the measured (observed) (56.1 ug/l – 31.2 ug/l = 24.9 ug/l), and multiplying this by the flow in the tributary. Based on this methodology, the residual WWTP load is estimated to be about 43 kg/yr. (17.8% of the total phosphorus load to the pond).

It is anticipated that over time this residual load will diminish. Continued monitoring will provide insight into the pace and extent of this anticipated reduction.

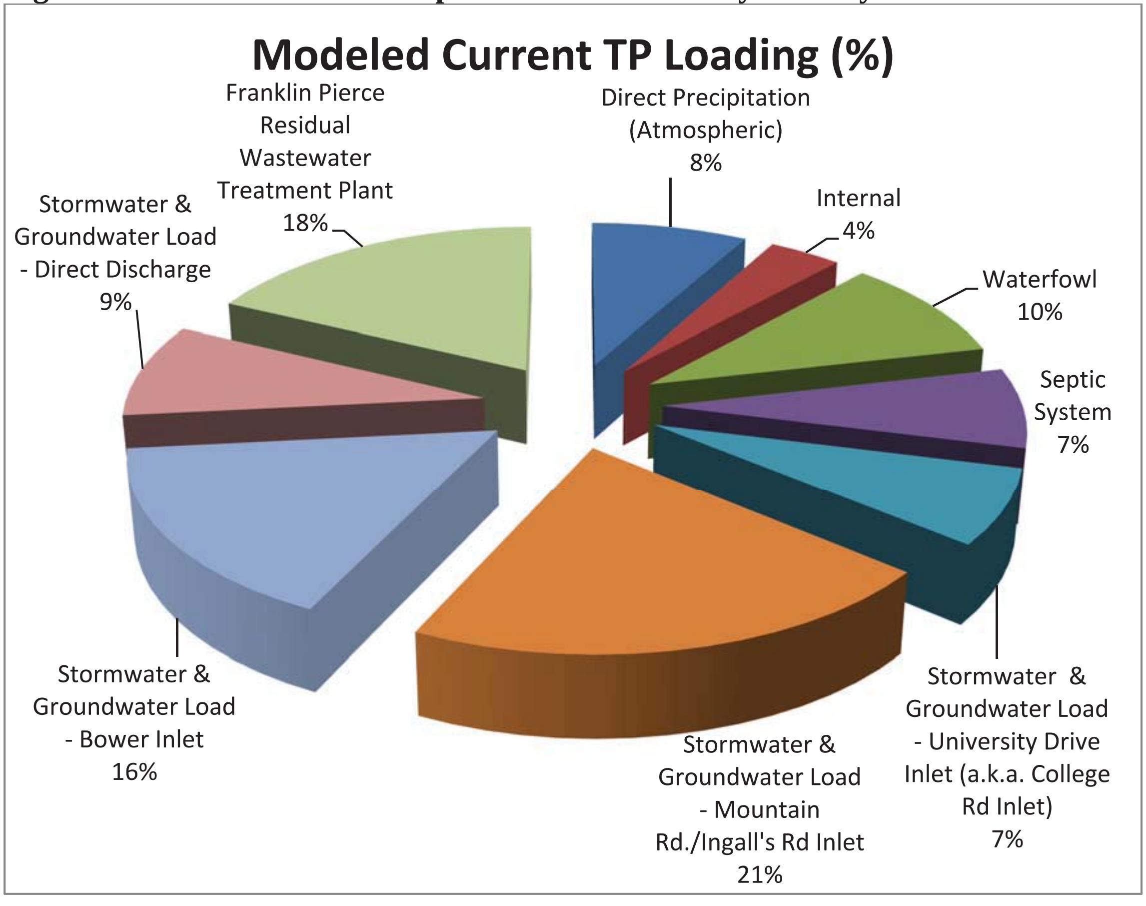
Waterfowl

Total phosphorus load from waterfowl was estimated using a TP export coefficient and an estimate of annual mean waterfowl population from data collected during a study conducted by FPU graduate Student Joshua Grey in 2011 and 2012 (Grey 2012). The mean annual waterfowl population was estimated to be 55 Canada geese. The TP export coefficient for Canada geese, 0.001526 kg/bird/day, was multiplied by 275 non-ice days and the number of waterfowl in order to obtain a TP load of 23 kg/yr. (Table E-7 in Appendix E). This equates to approximately 10% of the total TP load.

4.1.3 Phosphorus Loading Assessment Summary

The current TP load to Pearly Pond was estimated to be 240.9 kg/yr. from all sources. The breakdown by source is shown in Figure 4-1 and Table 4-3.

Figure 4-1. Modeled Total Phosphorus Loads to Pearly Pond by Source



Phosphorous loading from the watershed, which includes stormwater runoff and groundwater, was overwhelmingly the largest source at 128 kg/yr. (approximately 53% of the TP load). In particular, TP loading from the largest subwatershed (Mountain Rd. / Ingall's Rd. Inlet) was the highest at 50.6 kg/yr. (Table 4-3). This does not include the contribution from the residual WWTP load discussed in the previous section. The Bower Inlet was the second highest contributor at 39.3 kg/yr. The smallest subwatershed area is the University Drive Inlet (College Road Inlet) which contributes approximately 17 kg/yr. The Direct Drainage watershed, which is closest to the pond and contains more developed land, contributes an estimated 21.1 kg/yr.

The next largest TP source other than the watershed loads is the residual/historical WWTP load in the Mountain Road (Ingall's Road) tributary which contributes an estimated 42.9 kg/yr. or approximately 17.8% of the annual load to the pond. Since the installation of the RIBs in 2009 (see the discussion in the previous section) the surface water discharge from the FPU WWTP has been eliminated and it is expected that, over time, this residual load will diminish. Continued monitoring will provide insight into the pace and extent of this anticipated reduction.

The next three largest TP sources after the residual WWTP load are waterfowl, which contributes 23.1 kg/yr. (approximately 10%), direct precipitation, which contributes 19.4 kg/yr. (approximately 8%) and septic systems which contribute an estimated 18 kg/yr. (approximately 7.5%) of the annual TP load. Internal recycling of phosphorus was estimated at 9 kg/yr. (approximately 4%).

Table 4-3. Modeled Current TP Loading in Pearly Pond		
TP Inputs	**Modeled Current TP Loading (kg/yr.)**	**% of Total Load**
Direct Precipitation (Atmospheric)	19.4	8.1%
Internal	9.0	3.7%
Waterfowl	23.1	9.6%
Septic System	18.0	7.5%
Stormwater & Groundwater Load –University Drive Inlet (College Rd Inlet)	17.0	7.1%
Stormwater & Groundwater Load- Mountain Rd. / Ingall's Rd. Inlet	50.6	21.1%
Stormwater & Groundwater Load - Bower Inlet	39.3	16.4%
Stormwater & Groundwater Load - Direct Drainage	21.1	8.8%
Franklin Pierce Residual Wastewater Treatment Plant	42.9	17.8%
TOTAL	**240.3**	**100%**
WATERSHED TOTAL	**128.0**	**53%**

4.1.4 Pond Response to Current Loads

TP load outputs from the ENSR-LRM Methodology were used to predict in-pond TP concentrations using five empirical models. The models include: Kirchner-Dillon (1975), Vollenweider (1975), Reckhow (1977), Larsen-Mercier (1976), and Jones-Bachmann (1976). These empirical models estimate TP from system features, such as depth and detention time of the waterbody. The load generated from the export portion of ENSR-LRM was used in these equations to predict in-pond TP. The mean predicted TP concentration from these models was compared to measured (observed) values. Input factors in the export portion of the model, such as export coefficients and attenuation, were adjusted to yield an acceptable agreement between measured and average predicted TP, while continuing to maintain agreement between predicted and observed tributary concentrations. Because these empirical models account for a degree of TP loss to the pond sediments, the in-pond concentrations predicted by the empirical models are lower than those predicted by a straight mass-balance (42 ug/L) where the mass of TP entering the pond is equal to the mass exiting the pond without any retention. Also, the empirical models are based on relationships derived from many other lakes. As such, they may not apply accurately to any one lake, but provide an approximation of predicted in-lake TP concentrations and a reasonable estimate of the direction and magnitude of change that might be expected if loading is altered.

Modeling results are presented in Table 4-4. The TP load estimated using ENSR-LRM methodology translates to predicted mean in-pond concentrations ranging from 15 to 37 ug/L. The mean in-pond TP concentration of the five empirical models was 26.7 ug/L. The mean epilimnetic TP concentration from observed in-pond data from 2009 to 2013 was 24 ug/L. The slight disagreement between the model results and the in-pond data may be attributable to the time of year of sampling. Nearly all of the monitoring data are from the summer, a time when epilimnetic concentrations are typically lower than mean annual concentrations. The empirical models all predict mean annual TP concentrations assuming fully mixed conditions. Nurnberg (1996) shows summer epilimnetic concentrations as 14% lower than annual concentrations using a dataset of 82 dimictic (or stratified) lakes while Nurnberg (1998) shows a difference of 40% using a dataset of 127 stratified lakes. The mean observed summer concentration in Pearly Pond (24 ug/L) is 10% lower than the predicted annual average concentration (26.7 ug/L), a somewhat smaller difference than observed in the Nurnberg studies.

Once TP estimates were derived, annual mean chlorophyll-a and Secchi Disk Transparency (SDT) can be predicted based on another set of empirical equations: Carlson (1977), Dillon and Rigler (1974), Jones and Bachman (1976), Oglesby and Schaffner (1978), Vollenweider (1982), and Jones, Rast and Lee (1979). Algae bloom frequency (leading to an increase in chlorophyll-a in the water) was also calculated based on equations developed by Walker (1984, 2000) using a natural log mean chlorophyll-a standard deviation of 0.5. These predictions are presented in Table 4-5.

Table 4-4. Predicted In-Pond Total Phosphorus Concentration Using Empirical Models

Empirical Equation	Equation	Predicted TP (*ug*/L)
Mass Balance	TP=L/(Z(F))*1000	42
Kirchner-Dillon 1975	TP=L(1-Rp)/(Z(F))*1000	21
Vollenweider 1975	TP=L/(Z(S+F))*1000	37
Larsen-Mercier 1976	TP=L(1-Rlm)/(Z(F))*1000	29
Jones-Bachmann 1976	TP=0.84(L)/(Z(0.65+F))*1000	31
Reckhow General 1977	TP=L/(11.6+1.2(Z(F)))*1000	15
Average of Above 5 Model Values		***27***
Observed Summer Epilimnion Mean		***24***
Observed Summer Epilimnion Median		***23***

Variable	Description	Units	Equation
L	Phosphorus Load to Pond	g P/m2/yr.	
Z	Mean Depth	m	Volume/area
F	Flushing Rate	flushings/yr.	Inflow/volume
S	Suspended Fraction	no units	Effluent TP/Influent TP
Qs	Areal Water Load	m/yr.	Z(F)
Vs	Settling Velocity	m	Z(S)
Rp	Retention Coefficient (settling rate)	no units	((Vs+13.2)/2)/(((Vs+13.2)/2)+Qs)
Rlm	Retention Coefficient (flushing rate)	no units	1/(1+F^0.5)

Table 4-5: Predicted In-Pond Chlorophyll a and Secchi Disk Transparency Predictions Based on an Annual Average In-Pond Phosphorus Concentration of 27 ug/L from current modeled scenario for Pearly Pond		
Empirical Equation	**Equation**	**Predicted Value**
Mean Chlorophyll		***ug/L***
Carlson 1977	Chl=0.087*(Pred TP)^1.45	10.2
Dillon and Rigler 1974	Chl=10^(1.449*LOG(Pred TP)-1.136)	8.5
Jones and Bachmann 1976	Chl=10^(1.46*LOG(Pred TP)-1.09)	9.8
Oglesby and Schaffner 1978	Chl=0.574*(Pred TP)-2.9	12.4
Modified Vollenweider 1982	Chl=2*0.28*(Pred TP)^0.96	13.1
Average of Model Values		**10.8**
Observed Summer Mean		***8.9***
Peak Chlorophyll		***ug/L***
Modified Vollenweider (TP) 1982	Chl=2*0.64*(Pred TP)^1.05	40.2
Vollenweider (CHL) 1982	Chl=2.6*(AVERAGE(Pred Chl))^1.06	32.4
Modified Jones, Rast and Lee 1979	Chl=2*1.7*(AVERAGE(Pred Chl))+0.2	36.9
Average of Model Values		**36.5**
Observed Summer Maximum*		***28.1***
Bloom Probability		***% of Summer***
Probability of Chl >15 *u*g/L	See Walker 1984 & 2000	18.2%
Secchi Transparency		***m***
Mean: Oglesby and Schaffner 1978	Chl=10^(1.36-0.764*LOG(Pred TP))	1.9
Max: Modified Vollenweider 1982	Chl=9.77*Pred TP^-0.28	3.9
Observed Summer Mean		***1.61***
Observed Summer Maximum		***2.75***
Variable	**Description**	**Units**
"Pred TP"	The average TP calculated from the 5 predictive equation models in Table 3-4	*u*g/L
"Pred Chl"	The average of the 3 predictive equations calculating mean chlorophyll	*u*g/L
*The observed summer maximum is based on n=18 and is not necessarily the peak chlorophyll		

4.2 Pollutant Loads Under Buildout Conditions

4.2.1 Phosphorus Loadings Assessment Summary

Buildout conditions were also evaluated to determine the increase in pollutant loads that may be expected when the watershed is fully developed. Buildout land uses were estimated by converting all available forested lands into urban land (Urban 1 Low

Density Residential) after subtracting out conservation/protected lands and wetland (non-developable) buffers. Attenuation was assumed to remain the same, however, it could decrease with development. Buildout of the FPU campus was based on buildout of select areas assuming 61% of the area would be developed as Urban 2 Mixed Urban/Commercial, with the remaining 39% staying within its existing use. These percentages are based on the current development of the campus. Refer to Appendix G for proposed campus buildout areas and modeling results. The buildout scenario assumes no new septic systems will be built within 125 feet of the shoreline.

Based on these assumptions, phosphorus loads to the pond would increase by 218 kg/yr. (to 458.1 kg/yr.), resulting in an in-pond concentration of 49.8 ug/l.

4.2.2 Ordinance Review

The best way to minimize phosphorus loads from new development is to have regulations in place that require developers to implement controls and practices that prevent the discharge of phosphorus into the pond. Increases in development and impervious area increase pollutant loads carried in stormwater runoff. Given the undeveloped nature of the Pearly Pond watershed with only 7% developed urban area, a large increase in pollutant load can be expected as the watershed develops, as demonstrated with the buildout calculations above, which show an increase in phosphorus load of about 218 kg/yr., with a predicted in-pond phosphorus concentration of 49.8 ug/l, compared to the current in-pond concentration of 24 ug/l. This demonstrates the importance of having strong regulations in place to control stormwater runoff from future development projects.

Existing ordinances and regulations in Rindge and Jaffrey were reviewed to determine existing requirements for controlling stormwater runoff and water quality from new and redevelopment projects.

In Rindge, the focus of the existing ordinances is on peak control. Subdivision regulations only require peak control of stormwater runoff, which does not address water quality. Site Plan Review Regulations require peak control and water quality treatment of stormwater runoff, referencing some older NH DES and CEI manuals for design of best management practices (BMPs), however, the regulations do not specifically lay out design criteria for treatment. General standards and requirements cap the area of impervious cover on the site, with a push towards LID practices, and require on-site treatment of stormwater from all roof, canopies and paved areas.

Jaffrey requires erosion and sediment control plans for subdivisions, but does not have requirements to treat for water quality or to control peak flows from new developments (other than sizing for flows entering their drainage system). Refer to Appendix H for a detailed assessment of regulations.

Since Pearly Pond is already eutrophic and any increase in loading from new development will counteract the other restoration efforts described in this plan, CEI recommends that the Towns investigate implementation of an overlay for Pearly Pond with a requirement of no additional loading of total phosphorus from new development. The NH water quality regulation Env-Wq 1703.3(a) General Water Quality Criteria states

“The presence of pollutants in the surface waters shall not justify further introduction of pollutants from point and/or nonpoint sources”. With regard to impaired waterbodies, it is the policy of NHDES that the existing loads due to development be held constant, allowing no additional loading. In order for any future allocation of pollutant load(s) to be granted for an impaired waterbody, the load would need to be reduced elsewhere in the watershed. Regulation is needed at the local level because NHDES has no mechanism for regulation/enforcement of phosphorus export from development of single house lots that do not require a Section 401 Water Quality Certification or fall under the thresholds for alteration of terrain permits (100,000 sq.ft. of disturbance or 50,000 sq.ft. within 250 feet of a lake).

CEI also recommends that the Towns develop a separate Stormwater Management Ordinance to regulate any development that disturbs more than one acre of land, including requirements for erosion controls during construction and post-construction stormwater management practices to treat stormwater runoff from the developed site. We recommend that the ordinance require developers to meet the requirements of NH DES’s Alteration of Terrain (AoT) regulations at the one acre or lower threshold. The AoT Program requires that entities disturbing more than 100,000 sq.ft. apply for a State level permit through NHDES. Applying a lower threshold at the local level would provide better protection and is consistent with the federal NPDES Phase II requirements, which require regulation of disturbances greater than one acre.

The AoT regulations outline specific design criteria that developers must meet, including the volume of water to be recharged, the volume of water to be treated to remove pollutants, requirements to control peak flow volumes and avoid flooding, and requirements for channel protection. NH DES also developed a three volume Stormwater Manual that clearly lays out design criteria for controlling stormwater runoff, BMP design criteria and erosion and sediment control guidance, which can be referenced along with the AoT regulations.

The Regional Environmental Planning Program (REPP) developed guidance for model ordinances and regulations on a number of innovative land use techniques for municipalities to use to develop their own local ordinances, including a model ordinance for stormwater management that is consistent with state stormwater and water quality regulations described in the NH DES Stormwater Manual.

The Innovative Land Use Planning Techniques: A Handbook for Sustainable Development is available on the NHDES website at:
http://des.nh.gov/organization/divisions/water/wmb/repp/innovative_land_use.htm

A copy of the model ordinances for erosion control and post-construction stormwater management are included with the detailed assessment in Appendix H.

CEI also developed model bylaws for compliance with the NPDES Phase II Municipal Separate Storm Sewer System (MS4) Permit and to promote LID. These are also included in Appendix H, including a landscape regulation that promotes good landscaping practices during development to minimize erosion and watering requirements. CEI also recommends that Rindge and Jaffrey consider implementing landscape design standards similar to those provided in Appendix H.

4.3 Phosphorus Loading Assessment Limitations

While the analysis presented above provides a reasonable accounting of sources of TP loading to Pearly Pond, there are several limitations to the analysis:

- Precipitation varies among years and hence hydrologic loading will vary. This may greatly influence TP loads in any given year, given the importance of runoff to loading.
- Spatial analysis has innate limitations related to the resolution and timeliness of the underlying data. In places, local knowledge was used to ensure the land use distribution in the ENSR-LRM model was reasonably accurate, but data layers were not 100% verified on the ground. In addition, land uses were aggregated into classes which were then assigned export coefficients; variability in export within classes was not evaluated or expressed.
- TP export coefficients were limited as they were based on regional estimates for runoff. Although the baseflow export coefficients were modified to reflect observed background concentrations in the Bower Inlet, the adjustments are based on limited water quality data and assume that similar background conditions exist throughout the entire watershed. This should be evaluated as more data is collected.
- The TP loading estimate from septic systems was limited by the assumptions associated with this calculation (described in Section 3.2 above in the "Septic Systems" subsection) and the assumptions made about the proximity of the systems to the pond and their influence on the total loading.
- In some cases, water quality data for Pearly Pond and its tributaries are limited, restricting calibration of the model (e.g., only two TP samples were available for the University Drive Inlet (College Rd Inlet).
- The loading estimate for the waterfowl was limited by the assumptions made in Section 4.1.
- The loading estimate for the residual load from former FPU WWTP surface water discharge was limited by the assumptions made in Section 4.1.
- The internal phosphorus loading estimate was limited by the assumptions made in Section 4.1.
- The buildout loading estimate was limited by the assumptions made in Section 4.2.

Section 5 Restoration Goals

5.1 Water Quality Assessment for Impairment

The progress of the restoration of Pearly Pond and delisting from the 303(d) list of impaired waters will be based on the assessment criteria and methodology in the most recent version of the Section 305(b) and 303(d) Consolidated Assessment and Listing Methodology (CALM) (NHDES, 2012c). Specifically, concentrations of chlorophyll-a, dissolved oxygen saturation, phosphorus, pH and presence of cyanobacteria scums will be used to assess the status of the lake towards achieving water quality goals. As outlined in Section 3, CALM uses the following thresholds to assess impairment status:

Chlorophyll-a (Primary Contact Recreation) – The General Water Quality Criteria (Env-Wq 1703.03) require that surface waters be free of substances which: produce color or turbidity making the water unsuitable for the designated use, or interfere with recreational 2012 New Hampshire Consolidated Assessment and Listing Methodology (CALM) activities (Env-Wq 1703.03 (c)(1) c & e). Chlorophyll-a concentrations in excess of 15 ug/l in fresh water are indicators of excessive algal growth that interferes with recreational activities.

Dissolved Oxygen (DO) (Aquatic Life) – The DO assessment criteria used by CALM for Class B lakes and ponds is that <5 mg/l and <75% saturation does not support aquatic life. Greater than or equal to 6 mg/l and ≥85% saturation is needed to support aquatic life.

Chlorophyll-a and Phosphorus (Aquatic Life) – The acceptable levels of nutrients in surface waters are governed by Administrative Rule Env-Wq 1703.14 which requires that there be no nutrients in such quantities as to impair any designated uses in Class B waters. Therefore, assessments to determine compliance with Env-Wq 1703.14 need to consider both indicators of nutrients and nutrient-related impairments. In freshwater lakes, the indicators for nutrient levels are Chlorophyll-a and Total Phosphorus concentrations because phosphorus is the limiting nutrient in freshwaters.

In lake systems, the maintenance of a balanced, integrated, and adaptive community of organisms described in Env-Wq 1703.19 is reflected in a stable level of productivity. Phosphorus, as the limiting nutrient in lake systems, controls the ability of algae, the foundation of lake productivity, to grow and reproduce. The biomass of algae is indicated by the concentration of chlorophyll-a. Lakes are commonly categorized into productivity regimes or trophic classes. While trophic class will shift over long geologic periods, it should not shift within the modern era.

In order to assess compliance with Env-Wq 1703.14 for the freshwater lakes, the indicator of nutrients and nutrient-related impact indicator are combined using a stressor-response decision matrix. The response indicator is chlorophyll-a concentrations (a measure of algae growth). The stressor indicator is total phosphorus concentrations, because phosphorus is the limiting nutrient in freshwater lakes. Following the decision matrix, if there are both elevated nutrients and an adverse response in the same assessment unit, then that assessment unit would be considered to have excess nutrients in violation of Env-Wq 1703.14. For the purposes of assessment, a lake will be considered to have a balanced, integrated, and adaptive community described in Env-Wq 1703.19 if the summer median chlorophyll-a and total phosphorus levels are within the normal ranges as described below:

Trophic Status	Chlorophyll-a (ug/l or ppb)
Oligotrophic	<3.3
Mesotrophic	≤5
Eutrophic	≤11

Trophic Status	TP (ug/l or ppb)
Oligotrophic	<8
Mesotrophic	≤12
Eutrophic	≤28

Cyanobacteria – Cyanobacteria blooms produce scums on surface waters that can produce a human health risk. The General Water Quality Criteria (Env-Wq 1703.03) require that surface waters be free of substances which: float as foam, debris, or scum: produce odor, color, taste, or turbidity making the water unsuitable for the designated use; or interfere with recreational activities (Env-Wq 1703.03 (c)(1) b, c, & e). Surface waters cyanobacteria scums in significant amounts and for durations that significantly interfere with the primary contact recreational use are considered to be impaired for cyanobacteria.

For the purposes of developing a restoration plan and targets to achieve water quality goals, phosphorus is used since it controls the growth of algae (as measured by chlorophyll-a), which also contributes to low DO, and its concentrations and loads can be quantified, whereas chlorophyll-a and DO do not have an associated load.

5.2 Numeric Water Quality Target

A numeric water quality target (e.g., in-lake concentration) is needed to determine acceptable total phosphorus (TP) loads to the pond and appropriate actions to reduce loads to these levels. At present, numeric criteria for TP do not exist in New Hampshire's state water quality regulations. A target of 12 ug/L is typically used for most lakes unless the predicted concentration under natural (pre-development) conditions is greater. In such cases, the natural TP concentration is used as the target. This is consistent with Env-Wq 1703.14 which states that Class B waters shall contain no phosphorus in such concentrations that would impair any existing or designated uses, unless naturally occurring. The value of 12 ug/l is derived from an analysis of the observed TP concentrations from a set of impaired and unimpaired lakes in New Hampshire and is further supported by evaluation of the Trophic State Indices (TSI) developed by Carlson (1977) and a probabilistic assessment of the likelihood of blooms (Walker 1984, 2000). The "weight of evidence" suggests that 12 ug/L will support recreational and aquatic life designated uses as reflected in suitable (designated use support) measures of both Secchi Disk Transparencies (SDT) and Chlorophyll a.

In the case of Pearly Pond, modeling of natural (pre-development) conditions, indicated that the natural level of TP in Pearly Pond is 17 ug/L which exceeds the typical target of 12 ug/L.

Modeling was performed by converting all developed land uses to one of three forested land uses (i.e., deciduous, non-deciduous and mixed) based on the existing percent breakdown of each. The basin attenuation factors for phosphorus retention in each basin were then adjusted until predicted phosphorus concentrations in the tributaries matched observed median phosphorus concentrations in the Bower Inlet (22 ug/l predicted for undeveloped vs. 24 ug/l observed in the Bower Inlet). This was assumed to represent natural background concentrations in the tributary since the Bower Inlet subwatershed is undeveloped forested and wetland area with only a few residential properties in the upper reaches of the watershed.

Because it is impractical to reduce loading beyond the natural background level, the natural background scenario is used as a basis for establishing the target. Therefore, a target TP concentration of 17 ug/L, based on natural (pre-development) conditions, was selected for Pearly Pond.

Control of TP sources to Pearly Pond should improve conditions related to Chlorophyll-a, cyanobacteria and dissolved oxygen (DO). The background TP concentration of 17 ug/l corresponds to a potential risk of exceedance of 15 ug/l Chlorophyll-a in the summer of 2%, which is considered low enough to support designated uses in the pond using the CALM.

5.3 Pollutant Removal Goals

To achieve the in-pond TP water quality goal of 17 ug/l or ppb, TP loads to the pond need to be reduced by 87 kg/yr., limiting the load to 153.3 kg/yr. versus the 240.3 kg/yr. that currently enters the pond.

Successful implementation of this plan will not be based on meeting the in-lake target TP concentration of 17 ug/l or the reduction target of 87 kg/yr. Rather, compliance will be based on continued lake monitoring and assessment of monitoring results using the methods described for assessing water quality standards attainment in the most recent version of CALM for the response variables (DO, cyanobacteria, and chlorophyll-a), with the exception that the mean and peak chlorophyll-a thresholds will be 6.1 and 21.3 respectively as predicted by the model to correlate with an in-pond TP concentration of 17 ug/l.

This can be achieved through implementation of best management practices as described in Sections 6.0 and 7.0.

Section 6 BMP Evaluation

To achieve the in-pond phosphorus target concentration of 17 ug/l or ppb, 87 kg/yr. of phosphorus need to be removed from the pond. Based on the modeling results and field investigations, this plan focuses on four potential phosphorus sources to the pond, which make up about 79% of the total phosphorus loading, including:

- Stormwater runoff
- Franklin Pierce University (FPU) Wastewater Treatment Plant (WWTP), including residual loads from historic discharge to wetlands
- Septic systems
- Waterfowl

6.1 Stormwater BMP Evaluations

Stormwater runoff and groundwater baseflow is estimated to contribute nearly 53% of the total phosphorus load to the pond. It is estimated that the stormwater runoff portion of this source contributes about 107 kg/yr. or nearly 45% of the total phosphorus load entering the pond.

The following stormwater related pollutant sources within the subwatersheds were targeted for evaluation of future remedial efforts:

- Large parking lots and building on FPU campus
- Paved Roadways
- Gravel Roadways
- Residential areas
- Direct piped discharges to the pond
- Bank erosion
- Culverts & associated drainage

CEI identified potential BMPs based on approximately 100 potential pollutant sources during the stormwater field investigations. A summary of the stormwater field investigation is provided in Appendix I. A detailed BMP evaluation was completed to identify the most cost-effective and beneficial restoration efforts. Details and results of this evaluation are provided in Appendix J.

The BMP evaluation was based on identifying locations, selecting site-appropriate BMP types, ranking the feasibility of each BMP and then performing conceptual sizing of the BMPs to provide the maximum estimated removal of phosphors and other associated stormwater pollutants. Sizing of the BMPs was based on the type of BMP used and applying the Water Quality Volume (WQV) sizing criteria identified in the State of New Hampshire Department of Environmental Services (NH DES) Stormwater Design Manual. The BMP evaluation and selection process is summarized below.

CEI evaluated and selected the potential stormwater BMPs by using a two phased ranking methodology. The first phase of the ranking process was performed to determine the most feasible potential BMPs (several BMP options were evaluated per location) and the second phase was to select the most cost effective BMPs to be recommended for implementation. The purpose of this ranking was to select the most beneficial and protective BMP sites from all the potential sites that were identified during the watershed evaluation conducted in the Fall of 2013. This evaluation included field surveys and data collection provided by Franklin Pierce University, watershed residents and Comprehensive Environmental (CEI) staff. Our methodology was as follows:

1. Delineate subwatershed areas based on individual potential BMP locations;
2. For each BMP subwatershed, calculate required storage volumes for water quality, pre-treatment, recharge and multiple storm event scenarios based on New Hampshire Stormwater Standards;
3. Select BMP options and determine available space and dimensions for multiple BMP types;
4. Determine required BMP depths, sizes and phosphorus removal capabilities under each type;
5. Estimate costs for each BMP scenario based on type and size;
6. Estimate pollutant loading based on LLRM phosphorus loading coefficients and a land use breakdown for each BMP subwatershed;
7. Apply the BMP reduction estimate to the loading and determine a 10 year cost per kilogram of phosphorous removed for each BMP.

CEI conceptualized potential BMP options and alternatives for each of the study areas in order to identify and evaluate each of the specific BMP sites. Conceptual BMP locations are provided in Figure J.1 in Appendix J for the Pearly Pond Watershed. The “pool” of alternatives were selected based on existing drainage infrastructure, roadway grading, topography, potential utility conflicts, roadway structures, soil types, bedrock depths, waterways, wetland resources areas, public safety, aesthetics, land use and site specific parameters such as available space, context sensitivity, aesthetics, etc.

Once the potential BMP sites were identified, CEI compiled the data and performed the two phased ranking system to determine the most beneficial BMP sites. Based on this ranking process, some of these top sites will be selected for conceptual design and implementation to assist in improving water quality and protecting the pond from phosphorus sources. Table J.1 of Appendix J provides a summary of the potential BMPs and some of the criteria used to rank sites in order to determine the most beneficial options.

6.1.1 Stormwater BMP Identification & Alternatives

Recharge and pollutant removal can be increased through a combination of structural BMPs that provide pretreatment, infiltration and filtering, and non-structural BMPs such as educating residents and businesses on proper landscaping and maintenance practices.

Based on the pollutant loading analysis performed using the LLRM model described in Section 4.0, institutional, commercial, residential and transportation (road surfaces) development contribute the greatest phosphorus loads. These highly impervious areas were targeted for structural BMP alternatives that are designed to recharge stormwater runoff, reduce the volume of warm stormwater runoff and to treat stormwater to remove pollutants such as phosphorus and sediment.

Only a few structural BMPs were considered for the upper reaches of the watershed (subwatersheds 2 and 3) since there are no concentrated, significant areas of high imperviousness (i.e. commercial land use). Since these areas are primarily small pockets of single family residential separated by pasture land and large forested areas, distribution of public education materials and community awareness programs are recommended in these subwatersheds. Structural BMPs in these areas may be feasible as development increases but can likely be handled through the regulatory review process, making public education and regulatory controls that much more vital.

As discussed above, several field and desktop investigations were conducted throughout the watershed to identify potential phosphorus sources and stormwater BMPs. Potential BMP projects were strategically selected and located to treat several potential stormwater issues within a given area. About one hundred (100) potential stormwater issues were used to identify and generate approximately fifty (50) potential BMP sites. Several factors are considered when identifying BMP alternatives, including land availability/ownership, potential groundwater elevation, soil infiltration rates, and slopes.

Infiltration and filtration BMPs provide the greatest removal efficiencies of sediment and nutrients. The source reduction and phosphorus removal BMPs considered for the Pearly Pond watershed are shown in Table 6-1 along with their applicability.

Table 6-1. Best Management Practice (BMP) Alternatives and Applicability						
BMP Group	BMP Design	Source Reduction (Recharge)	Stormwater Attenuation (Peak Control)	Phosphorus Removal	TSS Removal	Capital Cost
Infiltration	Infiltration Trench	☒	☒	G	G	M
	Infiltration Basin	☒	☒	G	G	M
	Leaching Catch Basin	☒		G	G	L
	Permeable Pavement	☒	☒	G	G	H
	Infiltrating Parking Divider	☒	☒	G	F	L
Filters	Bioretention /Gravel Wetlands	☒		G	G	H
	Vegetated Filter Strip	☒		F	F	H
	Tree Filter	☒		G	G	H
Open Channels	Dry Swale	☒		F	F	L
	Wet Swale			F	F	L
Slope Protection	Geofabric			F	G	L
Public Education	Educational Materials			F	F	L

KEY: ☒ Appropriate BMP for intended goals
Removal efficiency: P=Poor F=Fair G=Good
Construction Cost: L=Low M=Moderate H=High

6.1.2 Stormwater BMP Alternatives Analysis

The first phase of ranking of potential structural BMPs analyzed approximately 50 total possibilities which varied in treatment type, subwatershed area, location and feasibility. Through this analysis we have identified the top 30 sites. These sites and the resultant feasibility ranking are summarized in Table J.2 in Appendix J located at the end of this report.

Eleven different criteria were used for the justification ranking to determine the prioritization of these BMPs, as seen in Table J.2. This ranking method utilized a point system for each criterion that were specifically categorized and weighted to determine a total point score for each BMP. The BMPs were ranked from the highest point score down to the lowest point score and the top thirty of those were selected for the second phase of ranking.

6.1.3 Stormwater BMP Selection

A second phase of the ranking process was used to select the final recommended BMPs using site specific cost and pollutant removal estimates for each BMP. This phase utilized specific cost data and results from the modeling analysis. The second phase of ranking is summarized in Table J.3 in Appendix J. The top ten BMPs were selected to have conceptual engineering analysis performed for future evaluations and project planning.

The top ten BMPs in ranked order are summarized in Table 6-2 along with the expected pollutant reduction, estimated ten year budgetary cost and cost per kilogram of phosphorus removed over a ten year period. The top ten BMP total costs and anticipated removals are provided in Table J.4 in Appendix J. Refer to conceptual drawings of the top ten recommended BMPs in Appendix K.

Table 6-2. Top Ten Potential Stormwater BMP Alternatives

BMP I.D.	BMP Description	Estimated Percent Removal (%)	Estimated Annual Phosphorus Removal (kg)	Estimated 10 Year Phosphorus Removal (kg)	Estimated 10 Year BMP Cost ($)	Cost Effective-ness ($ per kg TP removed)
SW-1	FPU Beach / Ball Field BMPs	65%	4.63	46.3	$271,200	$5,860
SW-2	FPU East Parking BMPs	65%	1.94	19.4	$164,800	$8,480
SW-3	Kimball Rd Beach BMPs	65%	0.61	6.1	$54,300	$8,960
SW-4	Kimball Rd Sharp Curve BMPs	65%	0.71	7.1	$71,400	$10,050
SW-5	FPU West Access Drive BMPs	65%	1.31	13.1	$131,300	$10,060
SW 6	FPU Community Center BMPs	65%	0.35	3.5	$35,800	$10,170
SW-7	Route 119 Roadway BMPs	65%	1.07	10.7	$115,600	$10,780
SW-8	Mountain Rd (Ingall’s Rd) Steep Drainage BMPs	65%	0.94	9.4	$107,900	$11,450
SW-9	Mountain Rd (Ingall’s Rd) Culvert Crossing BMPs	25%	0.58	5.8	$70,300	$12,040
SW-10	Kimball Rd Gravel Turn-around BMPs	65%	0.58	5.8	$75,400	$12,900
	Totals for Potential BMPs		**12.72**	**127.2**	**$1,098,000**	

6.2 Wastewater BMP Evaluation

It is estimated that wastewater sources contribute approximately 40 kg/year of phosphorus or nearly 17% of the total phosphorus load to the pond. This is mainly attributed to the Franklin Pierce University Wastewater system which built in the mid-1960s and as the campus has grown has experienced various upgrades including the installation of RIBs in 2009. A large contribution of the phosphorus load has been attributed to the residual wastewater remaining in the northern wetlands /groundwater as a result of direct wastewater discharge to those wetlands between mid-1960s and 2009. This contribution is estimated to be between 40-43 kg/year and is assumed to be much larger than the wastewater load from the treated wastewater effluent from the RIBs. Based on this information, the following wastewater related pollutant sources within the subwatersheds were targeted for evaluation of future remedial efforts:

- FPU wastewater collection system;
- FPU wastewater treatment plant;
- FPU wastewater rapid infiltration beds (RIBs);
- Wetland with residual phosphorus from historical & current wastewater discharge.

The BMP evaluation was based on adequately identifying potential treatment options and then meeting with FPU staff to select the most feasible options that could reasonably be funded under planned facility and operation budgets.

6.2.1 Wastewater BMP Identification & Alternatives

Identification of wastewater BMPs was based on specific concerns with the current plant operation identified by FPU staff and by focusing on general methods to remove phosphorus from wastewater streams as a whole.

Even though stormwater contributes a larger total phosphorus load, treated wastewater effluent can have high phosphorus concentrations at times which can vary based on increases in flow, the wastewater source, the time of year and the type of treatment system being employed. These high phosphorus concentrations can cause nutrient shocking of the treatment system, limiting phosphorus removal and thereby shocking the nearby groundwater and receiving surface waterbodies with phosphorus. Wastewater is sampled and monitored on a more routine basis than stormwater; however, these excessive loads might not be caught by routine wastewater /monitoring and may not be reflected in average phosphorus loading estimates making load reduction estimates somewhat unpredictable. Additionally, wastewater loads have the potential to increase over time as the treatment system ages and as the population grows. This plan focused on both holistic methods to reduce over-loading of the system and specific treatment methods to provide more buffering capacity of the system in the long-term. These alternatives were less detailed than the stormwater analysis based on a limited investigation and the potential high variability in phosphorus loading / reduction estimates associated with wastewater. It is recommended that more detailed analysis should be completed for each of the proposed alternatives prior to selection of any alternative.

The following general alternatives for each of the major phosphorus sources included:

Current Wastewater Discharge

Wastewater BMPs focused on different methods to increase phosphorus reduction by improving removal efficiencies of the treatment plant and the RIBs. This would include measures to reduce wastewater flows entering the plant, methods to provide less variation in flow/load to the plant and actions to improve the physical uptake of phosphorus in the treatment works.

Historic Wastewater Discharge

Wastewater BMPs for the historical release of phosphorus focused on methods to treat the existing phosphorus that is being released in the base flow from the northern wetland. In addition, methods to remove the phosphorus that is bound in the sediments and plant material that has reduced the wetlands ability to take up any more phosphorus added to it were also analyzed. Any projects for treating the wetland should be considered carefully due to other environmental impacts in addition to understanding that the wetland system is no longer handling direct wastewater discharges and in time could reach a healthy nutrient balance with the current loading. Additionally, implementation of other proposed stormwater BMPs within the northern wetland watershed could reduce phosphorus loading to the wetland allowing it to reach a natural nutrient balance more rapidly.

6.2.2 Wastewater BMP Alternatives Analysis

Pollution reductions for each wastewater BMP were assumed based on the estimated annual pollutant load from the LLRM model and approximations of removal rates based on the size of the annual load and using best engineering judgment. For comparison purposes, it is assumed that the current wastewater discharge from the FPU Wastewater Treatment Plant (WWTP) contributes approx. 11-12 kg of phosphorus per year and the wetland releases approx. 40-43 kg of phosphorus per year from the historical wastewater discharge into the Mountain Road (Ingall's Road) Inlet.

General cost estimates were applied to each of the proposed alternatives. A large contingency was applied to each of these alternative understanding the variability of costs and large size of the potential projects. Engineering and permitting costs were also carried for each alternative based on a percentage of the construction estimate. Construction estimates were developed using cost index references, (RS Means), historical cost data and best engineering judgment. A detailed description of the evaluated alternatives with pollutant reductions, cost assumptions and the resultant feasibility ranking are summarized in Appendix L and Table L.1 located at the end of this report.

The wastewater BMP alternatives that were evaluated are summarized and ranked in Table 6-3 along with the expected pollutant reduction, estimated ten year budgetary cost and potential cost per kilogram of phosphorus removed over a ten year period.

Table 6-3. Wastewater BMP Alternatives

BMP I.D.	BMP Description	Estimated Percent Removal (%)	Estimated Annual Phosphorus Removal (kg)	Estimated 10 Year Phosphorus Removal (kg)	Estimated 10 year BMP Cost ($)	Cost Effectiveness ($ per kg TP removed)
WW-1	*Historic* – Floating Treatment Islands	70%	2.80	280	$41,800	$150
WW-2	*Historic* – Iron Enhanced Sand Filter	60%	2.40	240	$86,250	$360
WW-3	*Current* – WWTP Improved Removal with Chemicals	50%	0.60	60	$40,990	$690
WW-4	*Historic* – Off-line Treatment Pond	65%	2.60	260	$189,800	$730
WW-5	*Historic* – Chemical TP Binding Treatment	55%	2.16	216	$165,900	$770
WW-6	*Current* – RIB Improved Removal – Iron Enhanced Sand	55%	0.70	70	$219,500	$3,100
WW-7	*Current* – WWTP Headworks Improvements	35%	0.47	47	$243,500	$5,200
WW-8	*Historic* – Wetland Restoration - Dredging	55%	2.16	216	$1,255,500	$5,810
WW-9	*Current* – Collection System Improvements (I&I)	25%	0.35	35	$253,500	$7,290
WW-10	*Current* – Reduced Water Consumption – Gray Water	25%	0.35	35	$470,000	$13,500
WW-11	*Current* – WWTP Retention Time Improvements (RBC)	35%	0.47	47	$914,950	$19,550
	Totals for Potential BMPs		**150.6**	**1,506**	**$3,881,690**	

6.2.3 Wastewater BMP Selection

Based on feedback from the Steering Committee and FPU staff, BMPs were selected that would be the most feasible and cost effective for phosphorus removal. The BMPs were ranked by selecting the lowest cost per kilogram of phosphorus removed, which was presented to the Pearly Pond Steering Committee and FPU staff. Due to the scale and potential high cost for a majority of the wastewater BMPs, some were immediately ruled out for selection despite their cost effectiveness.

FPU staff provided the final selection of recommended BMPs based on their close understanding of the wastewater system. The top two alternatives were selected for the historic discharge and the top two for the current discharge. The recommended wastewater BMPs are summarized in Section 7 of this report. The wastewater alternatives not selected for recommendation should not be ruled out for future implementation and can be included in future development of any FPU master plans if deemed feasible at that time. The proposed structural wastewater BMPs could also be implemented in conjunction with on-going public education efforts on the campus and through-out the watershed to reduce phosphorus loads and wastewater flows at the source. Source reduction could have the best long-term effect on increasing the resiliency of the treatment system and decreasing and phosphorus in the pond.

6.3 Septic System BMP Evaluation

Septic system loads were estimated to be about 18 kg/yr. However, there is a potential for this source to increase over time as residential systems get older or as more development occurs. Based on the modeling efforts, preliminary field investigations and results of the Resident Survey, the following septic system related pollutant sources within the subwatersheds were targeted for evaluation of future remedial efforts:

- Large septic system at Lakeview Apartments
- Focus on proper septic system maintenance for homes within 125 feet of the pond

For the Pearly Pond watershed, the septic system BMP evaluation focused on three major areas of concern. This included the two major residential areas around the pond with a high concentration of septic systems located within 125 feet of the shoreline. These include the area around Kimball Road and the neighborhoods along University Drive and Moose Lane. The third location focused on one large septic system located at Lakeview apartments which are a privately developed complex located on FPU land which FPU is in the process of taking over. The primary function of the apartments is to provide additional on-campus living to college students. The BMP evaluation was based on adequately identifying potential options and then meeting with FPU staff to select the most feasible options that could reasonably be funded under planned facility and operation budgets.

6.3.1 Septic System BMP Identification & Alternatives

Identification of septic system BMPs was based on data obtained for the Resident Survey and feedback from FPU staff on one large leach field located on FPU property.

Even though septic systems were shown to have small impacts on the phosphorus loads to the pond, aging and potentially failed system can have a much larger long-term impact on in-pond phosphorus concentrations in the future. Based on survey results, the systems within 125 feet of the pond were in good operating order. However, it was also noted from the survey results that by the year 2019 over 50% of the systems will be 25 years old or older and approaching the maximum expected design life. Without proper maintenance, homeowner education and necessary improvements, the loading from septic systems could increase to the pond in 5 to 10 years' time.

Septic system BMP alternatives were selected based on potential long-term growth of an area, potential for inadequate clearance to groundwater and the potential for system failure in the more densely populated locations.

These alternatives fall into the following three categories:

1. Public Education & Routine Maintenance
2. Sewering of Residential Areas
3. Small Scale Shared Community Wastewater Systems

6.3.2 Septic System BMP Alternatives Analysis

Pollution reductions for each septic system BMP were assumed based on the estimated annual pollutant load from the LLRM model, approximations of typical removal rates for properly operating septic systems and by using best engineering judgment. In some cases, the proposed BMPs would completely eliminate septic systems from the area, providing 100% removal efficiency. However, it should be noted that the phosphorus loads would not completely diminish from the total phosphorous load to the pond, in some cases it would make removal rates more efficient by moving the treated discharge farther away from the pond and out of the 125 foot buffer, In other cases, the phosphorus loads would be transferred over to the wastewater loading.

Additionally, proper maintenance and public education components can have a large effect on overall long-term phosphorus reduction, but efficiencies are somewhat un-predictable and there is very little data to support definitive removal rates. The current septic system load, including the Lakeview Apartments, contributes approximately 18 kg of phosphorus per year to Pearly Pond. This was based on 46 septic systems within the 125 foot buffer including 29 year round homes and 17 seasonal homes, each with an average of 2.5 people per system. This translates to a loading of 5.4 kg/year (0.2 kg/yr. / home) for year round homes and 0.74 kg/yr. (0.04 kg/yr./home) for seasonal homes. The Lakeview Apartment loading was approximately 11.9 kg/yr. This assumed 214 students for part of the year and an average of 20 people over the summer months. Phosphorus loading and associated reductions for each alternative will be based on the number of septic systems handled by each BMP.

General cost estimates were applied to each of the proposed alternatives. A large contingency was applied to each of these alternative understanding the variability of costs and large size of the potential projects. Engineering and permitting costs were also carried for each alternative based on a percentage of the construction estimate. Construction estimates were developed using cost index references, (RS Means), historical cost data and best engineering judgment. A detailed description of the evaluated alternatives with pollutant reductions, cost assumptions and the resultant feasibility ranking are summarized in Appendix M and Table M.1 located at the end of this report.

The septic system BMP alternatives that were evaluated are summarized and ranked in Table 6-4 along with the expected pollutant reduction, estimated ten year budgetary cost and potential cost per kilogram of phosphorus removed over a ten year period.

Table 6-4. Septic System BMP Alternatives

BMP I.D.	BMP Description	Estimated Percent Removal (%)	Estimated Annual Phosphorus Removal (kg)	Estimated 10 Year Phosphorus Removal (kg)	Estimated 10 year BMP Cost ($)	Cost Effective-ness ($ per kg TP removed)
SS-1	Public Education & Routine Maintenance – Kimball Rd	50%	4.6	46	$93,750	$2,020
SS-2	Sewering – Lakeview Apartments	90%	9.0	90	$186,950	$2,080
SS-3	Public Education & Routine Maintenance – Moose Ln	50%	0.7	7	$42,750	$6,140
SS-4	Community Wastewater – Northern Kimball Rd	95%	5.7	57	$1,486,500	$26,080
SS-5	Community Wastewater – Southern Kimball Rd	95%	1.9	19	$615,500	$32,400
SS-6	Sewering Portions of Kimball Rd	80%	3.2	32	$1,192,250	$37,260
SS-7	Community Wastewater – Moose Ln	95%	1.2	12	$436,800	$38,320
SS-8	Sewering – Moose Ln	90%	1.0	10	$564,050	$58,760
	Totals for Potential BMPs		**27.3**	**273**	**$4,618,550**	

6.3.3 Septic System BMP Selection

Based on feedback from the Steering Committee and FPU staff, BMPs were selected that would be the most feasible and cost effective for phosphorus removal. The BMPs were ranked by selecting the lowest cost per kilogram of phosphorus removed, which was presented to the Pearly Pond Steering Committee and FPU staff. Due to the scale and potential high cost for a majority of the septic system BMPs, most were immediately ruled out for short-term implementation. These BMPs should not be completely ruled out and should be considered for the future if and when septic systems become an issue in densely populated areas, if Town infrastructure is developed or as the watershed becomes more and more developed.

The Pearly Pond Steering Committee and FPU staff provided the final selection of recommended BMPs based on their close understanding of the septic systems and available funding. The recommended septic system BMPs are summarized in Section 7 of this report.

6.4 Waterfowl BMP Evaluation

It is estimated that approximately 23 kg/year of phosphorus or nearly 10% of the total loading to the pond is attributed to the presence of the Canada Geese (*Branta canadensis*). It is assumed that there are two distinct populations totaling approximately 55 geese on average at Pearly Pond which would require different management strategies to control. Based on the modeling efforts, preliminary field investigations and results of the Resident Survey, the following waterfowl related pollutant sources within the subwatersheds should be targeted for future remedial efforts:

- Breeding resident Canada Goose population on FPU campus
- Heavily used feeding locations on shorefront properties associated with migratory and breeding Canada Goose populations

6.4.1 Waterfowl BMP Identification & Alternatives

Identification of waterfowl BMPs was based on data obtained for the Resident Survey, published literature on potential geese controls (Smith 1999) and feedback from FPU staff on the breeding resident population located on FPU property. The BMP identification had to be tailored to the two different populations and focused on the best way to manage those populations through behavioral changes, both for the geese and the local shoreline residents including FPU staff. The alternatives for controlling waterfowl populations fall into the following three categories each with many potential options:

1. Physical / Behavioral Deterrents
2. Hazing / Scare Tactics
3. Landscape modifications

There are many other potential control measures that can be used that were not evaluated or recommended in this report. These measures can include, culling of the general populations, oiling of eggs, nest removal and other wildlife management controls. Hunting would not be recommended for a large portion of the waterfowl populations due to regulatory and safety concerns involved with those activities in busy populated areas. The New Hampshire Department of Fish and Game has conducted different studies and control measures for the breeding resident population. These control measures can work for the short-term, but unless activities and other proposed long-term BMPs are employed, the Geese populations can return and continue to grow into the future. These control tactics should not be ruled out, rather used in conjunction with other strategies outlined in this report to better control the population for perpetuity.

6.4.2 Waterfowl BMP Alternatives Analysis

Pollution reductions for each waterfowl BMP were assumed based on the estimated annual pollutant load from the LLRM model and by using best engineering judgment. For all waterfowl BMP cases, it is assumed that the BMPs will be tailored toward removing as many geese from the area as possible. It is understood that is not likely that all the geese will be removed for the area all the time, but certain controls could be employed to limit the amount of time they spend in the watershed or reduce the population to reasonable levels. It was assumed that BMPs tailored for the busiest areas, would have the largest phosphorus reducing effects.

For comparison purposes, it is assumed that the current waterfowl load contributes approximately 23 kg of phosphorus per year to Pearly Pond. It is assumed that the permanent breeding goose population on the FPU campus averages approximately 40 birds in a given year at a given time, while the transient population averages approximately 15 to 30 birds at any given time. These populations vary from year to year, but data gathered from FPU staff and for the Resident Survey support these estimates. Based on these assumptions and the modeling from the LLRM, a single goose could contribute approximately 0.4 kg/yr. of phosphorus to the pond. In some areas along the shoreline, residents have reported observations of 30 or more birds at times, which suggest a higher migratory population. There is not enough data to substantiate an increase in the average assumption. Based on the observation location and information from FPU staff, it is assumed that a portion of these observations could be attributed to the breeding resident population migrating from the campus area. These numbers are just estimates since bird counts can vary seasonally and currently no nests have been discovered within the watershed. If the nesting grounds are discovered, these population estimates could be confirmed.

General cost estimates were applied to each of the proposed alternatives. A large contingency was applied to each of these alternatives understanding the wide variety of options and project sizes for this type of phosphorus control. The majority of these costs included an annual fee or annual operations and maintenance (O&M) cost to continually update the BMP to ensure its effectiveness. Canada Geese can get used to different deterrents and control tactics, so it is assumed the BMP would have to be continually updated and adjusted on an annual basis. In some cases, proprietary BMPs can be employed, however no particular model or company is referenced in these recommendations and it is understood that costs and effectiveness of these types of BMPs may vary. For relevant BMPs, a construction cost was assumed and design/planning costs were also carried for each alternative based on a percentage of the construction estimate. Construction estimates were developed using cost index references, (RS Means), historical cost data and best engineering judgment. A detailed description of the evaluated alternatives with pollutant reductions, cost assumptions and the resultant feasibility ranking are summarized in Appendix N and Table N.1 located at the end of this report.

The waterfowl BMP alternatives that were evaluated are summarized and ranked in Table 6-5 along with the expected pollutant reduction, estimated ten year budgetary cost and potential cost per kilogram of phosphorus removed over a ten year period.

Table 6-5. Waterfowl BMP Alternatives						
BMP I.D.	**BMP Description**	**Estimated Percent Removal (%)**	**Estimated Annual Phosphorus Removal (kg)**	**Estimated 10 Year Phosphorus Removal (kg)**	**Estimated 10 year BMP Cost ($)**	**Cost Effective-ness ($ per kg TP removed)**
WF-1	Convert Lawn Areas to Meadow within 150' of Pond	60%	13.8	138	$1,500	$11
WF-2	Hire / Rent Border Collies	50%	8.0	80	$28,500	$356
WF-3	Visual Scares or Decoys	45%	6.6	66	$25,750	$393
WF-4	Public Education	60%	4.2	42	$19,900	$474
WF-5	Geese Fencing	40%	2.8	28	$15,520	$545
WF-6	Shoreline Buffers	70%	16.1	161	$89,500	$556
WF-7	Hire / Rent Drones	45%	6.6	66	$40,500	$617
WF-8	Purchase swan	50%	8.0	80	$52,000	$650
WF-9	Noise Makers	35%	2.2	22	$19,750	$910
WF-10	Ultrasonic Repellants	45%	2.9	29	$31,000	$1,080
WF-11	Perched Beaches	50%	11.5	115	$323,500	$2,810
	Totals for Potential BMPs		**82.7**	**827**	**$647,420**	

6.4.3 Waterfowl BMP Selection

Based on feedback from the Steering Committee and FPU staff, BMPs were selected that would be the most feasible and cost effective for phosphorus removal. The BMPs were ranked by selecting the lowest cost per kilogram of phosphorus removed, which was presented to the Pearly Pond Steering Committee and FPU staff.

The Pearly Pond Steering Committee and FPU staff provided the final selection of recommended BMPs based on their close understanding of the waterfowl issues and population history. They have worked closely with NH F&G to track and manage the populations in the past and have a good basis for making budgetary decisions associated with the most feasible BMP options. The recommended waterfowl BMPs are summarized in Section 7 of this report. In order to develop more strategic control plan, the different populations and their behaviors need to be studied very closely and for a long period of time. The BMPs recommended in this report are not necessarily a strategic control plan, rather a list of potential options to potentially pilot and study in specific areas based on an evaluation of relative costs. If specific BMPs are determined to be effective, this knowledge should be relayed throughout the watershed residents and FPU staff to ensure the populations and associated phosphorus loads are properly managed into the future.

Section 7 Recommendations

7.1 Introduction

This section describes an implementation program that will help restore water quality in Pearly Pond to support designated uses (i.e., aquatic life and primary contact recreation). As outlined in Section 5.0, the restoration goal for the Pearly Pond watershed focuses on reduction of phosphorus levels, which in turn will improve conditions related to chlorophyll-a, cyanobacteria and dissolved oxygen (DO). The goal is to remove 87 kg/yr. of the phosphorus load to the pond to achieve an in-pond concentration of 17 ug/l, which is consistent with natural background conditions.

Section 7.2 presents recommendations in a standardized format, including a description of the action, statement of its objectives, implementing partners, and costs of implementation. These recommendations are divided into three categories including: non-structural Best Management Practices (BMPs); structural BMPs that require physical installation; and other BMPs. Recommendations include:

<u>Non-structural BMPs</u>

1. Conduct Door to Door Survey & Develop Educational Community Outreach Campaign
2. Encourage Shoreline Buffer Zones and Proper Yard Maintenance
3. Encourage Proper Septic System Maintenance
4. Encourage Proper Waterfowl Management
5. Plan a Pearly Pond Cleanup Day
6. Promote Increased Infrastructure Maintenance
7. Develop a Storm Drain Marker Program
8. Adopt Regulatory Controls for Future Development

<u>Structural BMPs</u>

9. Install Stormwater Best Management Practices in Watershed
10. Install Shoreline Buffer Demonstration Projects
11. Improve Phosphorus Removal at the Franklin Pierce University (FPU) Wastewater Treatment Plant (WWTP)
12. Improve Phosphorus Removal at the FPU Rapid Infiltration Beds (RIBs) with Iron Enhanced Sand
13. Treat Northern Wetland Effluent (associated with historic Wastewater (WW) discharge) with Floating Wetlands
14. Treat Northern Wetland Effluent (associated with historic WW discharge) with Iron Enhanced Sand Filter
15. Sewer Lakeview Apartments
16. Manage Waterfowl on the Pond and on FPU Campus

Other BMPs

17. Conduct Further Studies on Internal Recycling of Phosphorus
18. Conduct Further Studies on Natural Background levels of Phosphorus
19. Continue Long-Term Monitoring Program
20. Update Watershed Plan / TMDL Model

Table 7-1 on the next two pages summarizes the recommendations, showing both capital and annual operating costs broken out by year. Figure 7-1 at the end of this section shows proposed BMP locations.

The success of the recommendations in achieving watershed quality improvements must be measurable to ensure the plan is working and to make adjustments as needed to achieve the desired results. Section 7.3 concludes this report with a discussion of the recommended monitoring program and success indicators.

Table 7-1. Pearly Pond Capital Improvement Plan & Schedule

Option	Partners	Capital Cost Range	O&M / Planning Cost	Year 1 2015	Year 2 2016	Year 3 2017	Year 4 2018	Year 5 2019	Year 6 2020	Year 7 2021	Year 8 2022	Year 9 2023	Year 10 2024	Annual Phosphorus Removal (kg/yr)	Approx. 10 Year Cost per Kilogram Removed Range ($/kg)
#1. Conduct Door to Door Surveys / Develop Educational Community Outreach Campaign	PPA, FPU, NHDES, Town of Rindge, Town of Jaffrey														
Plan and conduct a Door to Door Survey in residential neighborhoods		$ 2,000.00 - $ 2,500.00	$ -	X	X			X			X				
Develop educational community outreach campaign & program		$ 500.00 $ 1,000.00	$ -		X	X									
Develop an outreach planning committee and continue to manage outreach efforts		$ 200.00 $ 500.00	$ 200.00			X	O	O	O	O	O	O	O		
														-	$ - - $ -
#2. Shoreline Buffers, Yard Maintenance and Leaf Litter Management Outreach	PPA, FPU, NHDES, Volunteers, Private Landowners														
Develop & distribute educational materials		$ 500.00 - $ 1,000.00	$ 100.00	X	O	O	O	X	O	O	O	X	O		
Promote shoreline buffers and/or rain gardens on private properties		$ - - $ -	$ 200.00		O	O	O	O	O	O	O	O	O		
Promote proper yard maintenance & forestry management		$ - - $ -	$ 200.00		O	O	O	O	O	O	O	O	O		
														3.0	$ 1,450.00 - $ 1,470.00
#3. Septic System Maintenance Outreach	PPA, FPU, NHDES, Volunteers, Septic Haulers														
Develop & distribute educational materials		$ 200.00 - $ 500.00	$ 100.00	X	O	O	O	X	O	O	O	X	O		
Contact local septic haulers		$ 100.00 $ 200.00	$ -	X	X										
Establish a committee to educate & track maintenance with 125'		$ - $ -	$ -		X	X									
Promote and monitor maintenance within 125'		$ - $ -	$ 200.00	O	O	O	O	O	O	O	O	O	O		
Expand educational outreach through-out the watershed		$ 200.00 $ 500.00	$ 300.00						X	O	O	O	O		
														5.0	$ 790.00 - $ 800.00
#4. Waterfowl Management Outreach	PPA, FPU, NHDES, Volunteers, Private Landowners														
Develop & distribute educational materials & signage		$ 1,000.00 - $ 2,000.00	$ 100.00	X	O	O	O	X	O	O	O	X	O		
Promote proper waterfowl management techniques			$ 200.00	O	O	O	O	O	O	O	O	O	O		
														5.0	$ 560.00 - $ 580.00
#5. Pearly Pond Cleanup	PPA, FPU, Town of Rindge, Town of Jaffrey, Volunteers														
Develop a planning committee & advertise cleanup		$ 100.00 - $ 200.00	$ 200.00		X	O	O	O	O	O	O	O	O		
Pearly Pond Cleanup		$ - - $ -	$ 1,000.00		O	O	O	O	O	O	O	O	O		
														-	$ - - $ -
#6. Promote Increased Infrastructure Maintenance	PPA, FPU, NHDES, Town of Rindge														
Develop & distribute educational materials		$ 200.00 - $ 500.00			X	X									
Meet with Town and FPU maintenance staff to discuss		$ 200.00 - $ 300.00	$ -		X	X									
Promote increased maintenance & continue education		$ 200.00 - $ 500.00	$ 3,500.00		X	O	O	O	X	O	O	O	X		
														2.5	$ 8,420.00 - $ 8,450.00
#7. Develop Storm Drain Markers Education Program	PPA, FPU, Town of Rindge, Town of Jaffrey														
Develop a planning committee & solicit volunteers		$ 100.00 - $ 200.00	$ 200.00		X	O	O	O	O	O					
Develop & distribute educational materials		$ 200.00 $ 500.00	$ 100.00		X	O	O	O	O	O					
Purchase and Install Storm Drain Markers		$ 3,000.00 - $ 3,500.00				X	X		X	X					
														0.5	$ 3,660.00 - $ 3,840.00
#8. Adopt Regulatory Controls for Future Development	PPA, FPU, Town of Rindge, Town of Jaffrey	$ - - $ -	$ -		X										
Meet with Town Planners and Staff		$ 500.00 - $ 1,000.00	$ -	X	X	X	X								
Develop regulatory controls & review		$ 500.00 - $ 1,000.00	$ -			X	X								
Adopt regulatory controls		$ 100.00 - $ 200.00	$ -					X	X						
														-	$ - - $ -
#9. Install Stormwater Best Management Practices in Watershed	PPA, FPU, NHDES, NH F&G, Town of Rindge, Town of Jaffrey, Private Property Owners														
Contact and coordinate with Site Owners		$ 1,000.00 $ 1,500.00		X		X		X		X		X			
Obtain Funding		$ 1,000.00 $ 1,500.00		X		X		X		X		X			
Coordinate with Designers		$ 500.00 $ 1,000.00			X		X		X		X		X		
Design, Permit, Construction and Maintenance															
BMP-1 FPU Beach & Ball Fields		$ 220,000.00 - $ 265,000.00	$ 700.00		X	X	O	O	O	O	O	O	O	5.0	$ 4,540.00 - $ 5,440.00
BMP-2 FPU East Parking Lots		$ 120,000.00 - $ 160,000.00	$ 700.00		X	X	O	O	O	O	O	O	O	2.0	$ 6,350.00 - $ 8,350.00
BMP-3 Kimball Road Beach Access		$ 30,000.00 - $ 50,000.00	$ 700.00				X	X	O	O	O	O	O	1.0	$ 3,700.00 - $ 5,700.00
BMP-4 Kimball Road Sharp Curve		$ 50,000.00 - $ 70,000.00	$ 700.00				X	X	O	O	O	O	O	1.0	$ 5,700.00 - $ 7,700.00
BMP-5 FPU West Access Drive		$ 100,000.00 - $ 125,000.00	$ 700.00						X	X	O	O	O	1.5	$ 7,130.00 - $ 8,800.00
BMP-6 FPU Community Center		$ 15,000.00 - $ 30,000.00	$ 700.00						X	X	O	O	O	0.5	$ 4,400.00 - $ 7,400.00
BMP-7 Route 119 Roadway & Drainage		$ 80,000.00 - $ 110,000.00	$ 700.00							X	X	X	O	1.0	$ 8,700.00 - $ 11,700.00
BMP-8 Mountain Road Steep Road & Drainage		$ 80,000.00 - $ 105,000.00	$ 700.00							X	X	X	O	1.0	$ 8,700.00 - $ 11,200.00
BMP-9 Mountain Road Culvert Crossing		$ 40,000.00 - $ 65,000.00	$ 700.00									X	X	0.5	$ 9,400.00 - $ 14,400.00
BMP-10 Kimball Road Gravel Turn-around		$ 50,000.00 - $ 70,000.00	$ 700.00									X	X	0.5	$ 11,400.00 - $ 15,400.00
#10. Install Vegetated Buffers / Rain gardens	PPA, FPU, NHDES, Local Residents														
Contact Property Owners		$ 100.00 $ 200.00		X	X										
Seek Funding for Design and Construction		$ 200.00 $ 500.00			X	X		X		X					
Design, Permit and plan shoreline modifications		$ 5,000.00 - $ 7,500.00			X		X		X		X				
Install shoreline / tributary buffers and maintain		$ 5,000.00 - $ 10,000.00	$ 1,000.00		X/O	X/O	X/O	X/O	X/O	X/O	X/O	X/O	X/O		
Incorporate improvements in education outreach & distribute results		$ 500.00 - $ 1,000.00	$ 100.00					X	O	O	X	O	O		
														5.0	$ 2,100.00 - $ 2,260.00

Table 7-1. Pearly Pond Capital Improvement Plan & Schedule

Option	Partners	Capital Cost Range	O&M / Planning Cost	Year 1 2015	Year 2 2016	Year 3 2017	Year 4 2018	Year 5 2019	Year 6 2020	Year 7 2021	Year 8 2022	Year 9 2023	Year 10 2024	Annual Phosphorus Removal (kg/yr)	Approx. 10 Year Cost per Kilogram Removed Range ($/kg)
#11. Improve Phosphorus Removal at FPU WW Treatment System through Chemical Additives	PPA, FPU and NHDES														
Contact & Coordinate with FPU planners / operators		$ 100.00 $ 200.00		X											
Evaluate and pursue potential funding sources		$ 200.00 $ 500.00		X	X										
Conduct pilot study with monitoring		$ 2,000.00 - $ 5,000.00				X									
Design and plan full scale improvements/replacements		$ 10,000.00 - $ 15,000.00					X	X							
Implement full scale feeder system improvements as needed & maintain		$ 20,000.00 - $ 25,000.00	$ 1,500.00					X	X	O	O	O	O		
														5.0	$ 1,850.00 - $ 2,110.00
#12. Improve RIB Phosphorus Removal through Iron Enhanced Sand Filtration	PPA, FPU, NHDES & Contractors														
Contact & Coordinate with FPU planners / operators		$ 100.00 $ 200.00		X											
Evaluate and pursue potential funding sources		$ 200.00 $ 500.00		X			X								
Conduct pilot study with iron enhanced sand on bed 1		$ 45,000.00 - $ 55,000.00			X	X									
Implement full scale iron enhanced sand on bed 2		$ 45,000.00 - $ 55,000.00						X	X						
Continue with full scale iron enhanced sand usage on beds 1&2 (1 more time in 10 years)		$ 90,000.00 - $ 110,000.00											X		
														6.0	$ 3,010.00 - $ 3,680.00
#13. Treat Phosphorus in Effluent from Northern Wetland with Floating Treatment Islands at Mountain Rd. / Ingalls Rd. Crossing	PPA, FPU, NHDES & NH F&G														
Contact Town of Rindge & private property owners		$ 100.00 $ 200.00		X											
Discuss project with NH DES & NH F&G		$ 100.00 $ 200.00		X											
Evaluate and pursue potential funding sources		$ 200.00 $ 500.00		X											
Design and permit		$ 2,500.00 - $ 3,000.00			X										
Construct floating treatment islands		$ 5,000.00 - $ 10,000.00			X										
Remove and reset islands seasonally		$ 250.00 - $ 500.00	$ 750.00		O	O	O	O	O	O	O	O	O		
														14.0	$ 540.00 - $ 590.00
#14. Treat Phosphorus in Effluent from Northern Wetland with Iron Enhanced Sand Filter of Hodge Pond Trail Crossing	PPA, FPU, NHDES & Contractors														
Contact private property owners		$ 100.00 $ 200.00						X							
Discuss project with NH DES & NH F&G		$ 100.00 $ 200.00						X							
Seek Funding for Design and Construction		$ 200.00 $ 500.00						X							
Design and permit		$ 7,000.00 - $ 11,000.00							X						
Construct iron enhanced sand filter & maintain		$ 20,000.00 - $ 25,000.00	$ 5,000.00							X			O		
														10.0	$ 770.00 - $ 870.00
#15. Eliminate Septic Inputs by Sewering Lakeview Apartments	FPU and NHDES														
Contact & Coordinate with FPU planners / operators		$ 100.00 $ 200.00				X									
Seek Funding for Design and Construction		$ 200.00 $ 500.00				X									
Design, permit and bid sewering project		$ 25,000.00 - $ 30,000.00					X	X	X						
Install proposed tank, pump and force main improvements and maintain		$ 80,000.00 - $ 90,000.00	$ 1,500.00					X	X	O	O	O	O		
														9.0	$ 1,840.00 - $ 2,010.00
#16. Manage Waterfowl Populations using Structural Controls & Techniques	FPU, NHDES & NH F&G														
Contact & Coordinate with FPU planners / facility staff		$ 100.00 $ 200.00		X											
Evaluate and pursue potential funding sources		$ 200.00 $ 500.00		X											
Coordinate with NH F&G and conduct population study		$ 2,500.00 - $ 5,000.00			X	X									
Implement different management techniques & monitor success		$ 15,000.00 - $ 25,000.00	$ 2,100.00			X/O	X/O	X/O	X/O	X/O	X/O	X/O	X/O		
														8.0	$ 2,320.00 - $ 2,480.00
#17. Investigate Impact of Internal Phosphorus Loading & Measures to Reduce	PPA, FPU Professors, FPU students, NHDES		0												
Develop monitoring plan and study		$ 500.00 - $ 1,000.00		X	X										
Collect samples, run lab tests and process data		$ - - $ -	$ 1,000.00		O	O	O	O	O	O	O	O	O		
														-	$ - - $ -
#18. Investigate Natural Background Phosphorus Loading & Baseflow Levels in Tributaries	PPA, FPU Professors, FPU students, NHDES		0												
Develop monitoring plan and study		$ 500.00 - $ 1,000.00		X	X										
Purchase, install and maintain data loggers		$ 2,500.00 - $ 5,000.00	$ 500.00		X	O	O	O	X	O	O	O	O		
Collect samples, run lab tests and process data		$ - - $ -	$ 1,000.00		O	O	O	O	O	O	O	O	O		
														-	$ - - $ -
#19. Long-Term Monitoring Program	PPA, FPU, NHDES, NH F&G, Town of Rindge, Volunteers														
Purchase, install and maintain data loggers		$ 5,000.00 - $ 7,500.00	$ 1,000.00		X	O	O	O	X	O	O	O	O		
Continue long-term monitoring		$ - - $ -	$ 1,500.00		O	O	O	O	O	O	O	O	O		
														-	$ - - $ -
#20. Update Watershed Restoration Plan / TMDL Model	PPA, FPU, NHDES & Town of Rindge														
Update model and plan based on monitoring and implementation of BMPs		$ 30,000.00 - $ 65,000.00						X					X	-	
														-	$ - - $ -
	Totals	$ 1,217,850.00 - $ 1,637,900.00	$ 210,350.00										Removal Goal	87.0	

Capital and O&M Cost Notes:

Capital and Operation and Maintenance Cost Ranges are presented for planning and budgetary purposes. Detailed costs should be prepared for each individual implementation project at the preliminary planning stage. Costs do not reflect inflation. Capital and Annual O&M costs should be adjusted accordingly as budgets are prepared.

Annual Implementation Notes:

X = Implementation or Construction Activity

O = Operation & Maintenance Activity

7.2 Recommendations

A comparative evaluation of the feasibility and benefits of the restoration options considered led to the development of the following prioritized list of restoration recommendations.

7.2.1 Non-Structural BMPs

Public education and outreach is an important component of any watershed management program. It connects citizens and businesses to the pond and watershed. With this connection and knowledge, individuals are more likely to make good decisions regarding their habits and practices to help protect the pond. They also may be more likely to support watershed friendly policies and to cooperate with the Pearly Pond Association (PPA) and FPU in its restoration efforts (e.g., design and construction of stormwater BMPs).

To raise awareness and foster individual efforts to reduce activities that contribute to phosphorus loading, the following educational program components are proposed.

#1. Conduct a Door to Door Survey and Develop an Educational Community Outreach Program in Residential Neighborhoods

It is important that residents be targeted for education outreach to understand the value of Pearly Pond as a natural resource and how they can help protect that resource.

The most typical method of public education and outreach has historically involved generating information (e.g., brochures, fact sheets, articles) on the topic and using bulk mailings to distribute these to targeted residents. This is not always an effective means of outreach, as the material may be tossed as ‘junk mail’ or read and forgotten. In the end, it may not change a person’s behaviors to improve watershed health, and protect natural resources, which is the ultimate goal of public education.

A more direct approach would involve contacting residents within the watershed directly through a door to door effort or direct calling. This would provide opportunity to explain the value of Pearly Pond, the proposed restoration plan, identify the residents’ location in the watershed, how residents can help with restoration and obtain resident feedback on what they feel the issues may be. Such an approach is along the lines of a Community Based Social Marketing Program, which focuses on reaching out to target audiences to understand what they feel the issues are and why they may not conduct “good practices” (e.g., reduced fertilizer use, proper disposal of yard waste, water conservation, cleaning up after pets, etc.) that are protective of the environment.

The PPA and FPU could plan a door to door education outreach effort where a survey would be distributed to obtain resident feedback. This effort would be used to identify neighborhood leaders that can help with future outreach and education efforts, and to develop future public education efforts that will get people involved in watershed activities and in understanding the issues. Once residents are involved and engaged, some of the more traditional public education and outreach (e.g., brochures, fact sheets, and articles) can be used as follow-up and reminders.

Recommendation: Perform a door to door survey to discuss watershed activities, promote involvement and obtain feedback on watershed issues. Based on survey results and resident feedback, develop an Educational Community Outreach Campaign.

Actions:

1. Develop and distribute watershed survey and educational materials through door to door contact.
2. Develop an action item plan based on survey results that will detail education plan items revolving around incentives, reminders and prompts, goals and norms.
3. Implement an educational community outreach program focusing on the major areas of concern including but not limited to items listed under outreach recommendations for stormwater runoff, non-point source pollution (NPS), septic systems and waterfowl.
4. Measure and evaluate the program's success through the distribution of a follow-on resident survey.
5. Distribute follow-on survey and other educational materials at public meetings, watershed outings and through mailings. Distribution could be completed through the FPU annual wellhead protection mailings.

Objectives: Directly reach out to residents within the watershed to ensure education messages are being delivered and to engage residents in watershed protection efforts. Develop an education outreach program to include educational items listed in recommendations 2-8 and additional pertinent education materials identified during door to door surveys and follow-on surveys.

Partners: PPA, FPU, NHDES, Volunteers.

Capital Costs: Staff time and $2,000 to $2,500 in material preparation and printing costs.

Annual O&M Costs: Staff time. Assume $200 annually for planning and mailing

#2. Shoreline Buffers, Yard (Lawn) Maintenance and Leaf Litter Management Outreach

Excessive decaying plant material in the pond can contribute to phosphorus loads and have other negative impacts on an aquatic ecosystem. Although the estimated internal loads of phosphorus do not appear to be significant at present, this loading will grow over time as deposited sediments from decomposing algae and weeds continue to suppress oxygen causing a release of phosphorus from the bottom sediments of the pond. Over time, decaying plant matter will both increase the internal phosphorus recycling and fill in shallow sections of the pond, reducing natural habitats.

Based on feedback from the resident survey and other public education forums, public education efforts should also target shoreline properties to encourage the development of shoreline vegetative buffers as well as for proper yard maintenance and leaf litter management. This could include information for yard waste handling; fertilizer and pesticide use; and encouraging residents to adopt NHDES' shoreland protection best management practices for buffer plantings.

Additionally, information could be provided on methods to prevent large amounts of leaf litter from entering the pond during fall months, encourage shoreline residents to collect and compost leaves away from the shoreline, and use the compost as fertilizer instead of chemical fertilizers. Some towns set up programs where residents can buy compost bins at a reduced cost benefitting the pond residents as well as water quality. Information could also include the use proper forest management techniques and/or methods to capture leaf litter prior to it entering into the pond. These educational efforts could be tied in with other outreach efforts such as landscape modifications for waterfowl management and potential pond cleanup activities.

Recommendation: Develop and distribute educational materials to residents and FPU maintenance staff on the use of shoreline buffers, lawn maintenance and yard waste (leaf litter) management.

Actions:

1) Develop educational materials on proper yard maintenance and how yard waste and decaying plant material can impact the pond and water quality.
2) Provide the education materials to the public through mailings and by posting information on signs or kiosks located at specific heavily travelled areas.
3) Promote proper disposal of yard waste by arranging a fall cleanup or yard waste pickup day where residents can assist each other and practice proper disposal techniques.
4) Develop an outreach program to encourage local residents to install vegetated buffers along shorelines and streambanks throughout the watershed for stormwater and waterfowl benefits. Installation of these buffers will help control leaf litter in the pond as well as provide filtration of stormwater runoff.

Objectives: Increase awareness of the impact of fertilizer and yard waste on the pond and educate about alternatives that are more protective of the pond and that will minimize the amount of debris that gets into the pond. Increase awareness of the benefits of increased shoreline and streambank buffers.

Partners: PPA and FPU, NHDES and others.

Capital Costs: Staff time; $500 to $1,000 in printing, copying and mailing costs.

Annual O&M Costs: Staff time, $500 annually for costs of hauling, disposal and/or composting.

Associated Recommendations: #1. Develop Community Outreach Campaign.

#3. Septic System Maintenance Outreach

There are two major residential areas with a high concentration of septic systems located within 125 feet of the pond shoreline. These include the area around Kimball Road and the neighborhood along University Drive and Moose Lane. A high percentage of these systems are 15 years and older and have the potential to release phosphorus to the surrounding groundwater and pond as the soils beneath the leaching system lose their ability to absorb phosphorus and/or if clogging causes failure of the system. Routine septic system maintenance can help prolong the anticipated life of the system and minimize excess phosphorus loading. Public education on proper septic system function and maintenance should not only focus on these more densely populated areas near the pond, but should include all homeowners within the watershed, since septic systems located along tributaries and nearby wetlands can also contribute phosphorus loads to the pond.

It is recommended that all septic systems with 125 feet of Pearly Pond be properly maintained every two years. This includes cleaning of holding tanks and any filter systems associated with tanks. It can also include routine monitoring of the leach field to ensure proper function.

Recommendation: Develop and distribute educational materials on proper septic system function and maintenance. Expand upon the Resident Survey already sent out to residents in the two densely populated neighborhoods. This provides an opportunity to educate local residents on the importance of proper septic system maintenance and recognize the signs of a failing system early, before the issue becomes too large and costly.

Actions:

1) Follow up with respondents to the survey that was already collected, plus focus on developing mailing lists and distribution of materials to all the homeowners within the watershed, starting with those within 125 feet of a tributary or wetland.
2) Develop educational materials on proper septic system function and maintenance and distribute to residents on an annual or biennial basis. Encourage knowledgeable residents to share this education throughout the community and especially to new residents of the Pearly Pond watershed.
3) Periodically conduct a resident survey (i.e., every 3 years), expanding the original distribution list to all watershed residents, to remind residents of the importance of maintaining a healthy watershed, including topics such as septic system maintenance and to gauge responsiveness to the education outreach efforts.
4) Contact & coordinate with local septic haulers; discuss options for receiving bulk rate cleaning reductions.
5) Establish a committee to track maintenance activities within the small neighborhood areas around the pond. Provide free maintenance log books, (including the pre-packaged septic folders available from NH DES), advertise potential cost savings through bulk hauling and encourage residents to communicate their routine maintenance activities.

6) Monitor and track routine maintenance activities. Maintain records of system replacements or repairs with the 125 foot shoreland buffer of the pond. Correlate increased maintenance / replacements with any in-pond phosphorus decreases.
7) As maintenance within the 125 shoreland buffer improves, expand maintenance education and focus on systems within 125 feet of tributaries and eventually the entire watershed.

Schedule: Refer to Table 7-1.

Objectives: Increase awareness of septic system issues and proper maintenance techniques to reduce loads from this source. Prevent 5 kilograms of phosphorus per year from entering the pond through implementation of a routine maintenance program.

Partners: PPA, NHDES, Town of Rindge, Town of Jaffrey Private Property Owners and Septic Haulers.

Capital Costs: Staff time; and $200 to $500 every three to four years in costs for updating records, preparing materials, printing and copying.

Annual O&M Costs: Staff time. Assume an allowance of $100 to $300 annually for planning and additional mailing.

Associated Recommendations: #1. Develop Community Outreach Campaign.

#4. Waterfowl Management Outreach

Waterfowl feces are a source of phosphorus load to Pearly Pond from Canada Geese that populate the pond and FPU campus. There are many factors that can attract geese to the pond, including easy shoreline access, a readily accessible food source and lack of predators. Local residents, FPU staff and students can help control the geese population if armed with the knowledge on the potential impacts of geese on water quality and actions they can take to deter geese.

Recommendation: Develop and distribute educational materials on the impacts of geese on water quality and what residents can do to deter geese. This could include education on potential methods and landscape modifications to minimize waterfowl activity on individual properties in addition to how human interaction can impact waterfowl activity. Pursue funding to develop and implement a Community Outreach Program to promote the use of shoreline/landscape modifications and other deterrents designed to prevent waterfowl access onto individual properties.

Actions:

1) Develop education materials on common goose behaviors and how human interaction can affect those behaviors.
2) Provide the educational materials to the public through mailings and by posting on signs located at specific heavily travelled areas, both by geese and humans. Discourage feeding of geese and minimize human interaction.
3) Develop educational materials on potential landscape modifications, scare / hazing and other deterrent methods for keeping geese off individual properties.
4) Begin a community outreach program to educate and promote the use of different waterfowl management and deterrent techniques. These could include but are not limited to:
    a. Installation of goose fencing;
    b. Conversion of lawn areas to meadows;
    c. Installation of visual scares;
    d. Installation of shoreline vegetated buffers;
    e. Installation of perched beaches; and
    f. Use of other deterrent / hazing methods (including the use of border collies);
5) Contact property owners to discuss proposed projects and determine owner interest in participating. This should occur as soon as possible to bring property owners on board.
6) Encourage shoreline residents to assist and train each other on the installation of different shoreline deterrent methods (e.g. vegetated buffers, proper installation of goose fence). Encourage residents to track and share how goose activity on their property is affected by the different methods.
7) Pursue grant funding opportunities to design and implement BMPs.

Schedule: Refer to Table 7-1.

Objectives: Reduce the geese population at Pearly Pond. Prevent 5 kilograms of phosphorus per year from entering the pond through implementation of an educational campaign promoting the use of shoreline / land modifications and other waterfowl deterrents.

Partners: FPU, PPA, NHDES, Property Owners and others.

Capital Costs: Staff time; $1,000 $2,000 for signage and preparation of materials.

Annual O&M Costs: Staff time; costs for maintaining signage. $100 to $200 annually in printing, copying and mailing costs

Partners: PPA, FPU, NHDES, Private.

Associated Recommendations: #1. Develop Community Outreach Campaign.

#5. Pearly Pond Cleanup

In some more developed areas and along roadways surrounding Pearly Pond, trash and debris can accumulate within Pearly Pond and along the banks and shores. This trash and debris can impact the aquatic habitat by introducing contaminants and providing barriers to fish passage.

Recommendation: Organize an annual Pearly Pond clean-up event. This event provides an opportunity to publicize restoration efforts and recruit volunteers.

Actions:

1) Obtain sponsors for the cleanup event, perhaps local businesses among others.
2) Develop a fact sheet on Pearly Pond and its watershed, including background information on the Pond, its water quality resources at risk and restoration efforts.
3) Publicize the clean-up event and inform and recruit volunteers. Develop relationships with The Rindge Community Newsletter produced by the Chamber of Commerce, The Keene Sentinel's E.L.F., The Monadnock Shopper News and any other media sources.

Objectives: Increase awareness of the pond, involve the community in its protection and remove trash and debris that can be harmful to aquatic habitat.

Partners: PPA and FPU, NHDES and others.

Capital Costs: Staff time, $100 to $200 for coordination and preparation of flyers.

Annual O&M Costs: Staff time. $200 annually for costs to advertise or mail out flyers, $1,000 annually for Town hauling, disposal and recycling.

#6 Promote Increased Infrastructure Maintenance

The Direct Drainage subwatershed has major paved roadways and large impervious parking lots, partly due to the infrastructure associated with the FPU campus. There are also many gravel roads located throughout the upper watershed. Winter road and parking lot maintenance can result in significant applications of sand and salt to make these impervious surfaces safe for travel. Precipitation and snow melt will wash the sand and salt from impervious surfaces into nearby drainage infrastructure and ultimately into Pearly Pond. Additionally, gravel roads can be a large source of sediment and phosphorous loading due to erosion of the travel surface, shoulders and drainage swales during the spring and summer months.

Maintenance practices, such as sweeping and cleaning of catch basins can remove sand, sediment and attached pollutants before it is washed into the pond. Sweeping should be performed a minimum of once a year after snow melt to remove winter sanding applications, preferably twice a year to remove the accumulation of leaf litter and debris in the fall as well. Catch basin cleaning should be performed based on how quickly the basin fills with sediment. A rule of thumb proposed in recent draft stormwater permits is to maintain 50 percent sump capacity at all times.

Additionally, gravel roads that are owned and maintained by the towns should be properly graded and stormwater conveyance systems maintained on an annual basis. Gravel road maintenance and the use of Best Management Practices referenced in the New Hampshire BMPs Routine Roadway Maintenance Activities Manual and other paved/gravel road maintenance manuals should be encouraged.

An outreach program can be used to discuss sand and salt reduction and parking lot maintenance practices that are good for the environment. FPU and any private owners that potentially contract for their snow removal, sand and salt applications should be encouraged to hire certified New Hampshire Green SnowPro applicators. They should also require their existing contractors to get the certification offered through the University of New Hampshire (UNH) Technology Transfer Center (http://www.t2.unh.edu/green-snowpro-certification).

Recommendation: Contact the town Department of Public Works (DPWs) in Rindge and Jaffrey to discuss sand and salt application and good housekeeping practices to limit the amount of sand, salt and attached pollutants that discharge into the pond. Work with FPU facility staff to encourage proper parking lot and drainage system maintenance.

Actions:

1. Obtain information on sand and salt usage and current maintenance practices in Rindge, Jaffrey and FPU campus. Distribute information on sanding impacts and good maintenance practices.
2. Follow-up with DPWs annually to determine sand and salt applications and whether maintenance practices have changed.
3. Provide FPU staff and/or potential contractors with New Hampshire Green SnowPro training and certification information/opportunities and encourage participation.

Objectives: Contact local DPWs and FPU Facilities staff to increase awareness of the pond and increase drainage infrastructure maintenance.

Partners: PPA, FPU, Town of Rindge, Town of Jaffrey, Private Businesses.

Capital Costs: Staff time. $600 to $1,300 for preparation of materials, coordination of meetings, promoting education and planning.

Annual O&M Costs: Staff time. $3,500 annually for continuing education and performing proper maintenance.

#7. Develop Storm Drain Markers Education Program

There are several catch basins or storm drains within the watershed that discharge directly into Pearly Pond without treatment. These open drainage structures also introduce the potential for illegal dumping of pollutants into the storm drain system.

Storm drain marking can help prevent illegal dumping of pollutants into drains by reminding those passing by that the storm drain connects to a local water body and that dumping will pollute those waters. Storm drains can be labeled with plaques, tiles, painted or pre-cast messages warning citizens not to dump pollutants into the drain. For example, the message may state: “No Dumping. Drains to Pond” and may be accompanied by a picture to convey the message, including common aquatic fauna or a graphic depiction of the path from drain to waterbody.

Recommendation: Mark storm drains within the watershed with messages warning citizens not to dump pollutants into the drain.

Actions:

1. Identify storm drains for marking.
2. Purchase materials (e.g., stencils, paints, markers, etc.) for marking drains.
3. Coordinate volunteers to perform marking.
4. Mark storm drains.
5. Plot marked drain locations on a GIS layer and provide to the Town of Jaffrey, Town of Rindge and FPU Facilities Staff so that any re-paving or other public works projects can be informed by the data and arrangements made to re-stencil or re-plate.

Objectives: Increase awareness of connectivity between storm drains and Pearly Pond to prevent illegal dumping of pollutants into drains.

Partners: PPA, FPU, NHDES, Town of Rindge, Town of Jaffrey, NHDOT and volunteers.

Capital Costs: $3,000 to $3,500 for materials (brass plates, adhesive bolts) depending how many structures are marked and the type of markers, Staff and volunteer time for installation.

Annual O&M Costs: Staff time. $200 to $300 annually in upkeep of markers and project planning.

#8. Adopt Regulatory Controls for Future Development

Most of the Pearly Pond watershed remains undeveloped, with only 7% developed urban area. Increases in development and impervious area will increase pollutant loads carried in stormwater runoff. Given the large expanse of land that remains to be developed, this increase in pollutant load could have significant impacts to Pearly Pond. The buildout analysis performed in Section 4.0 indicates a potential increase in phosphorus load of about 213 kg/yr, resulting in an in-pond concentration of 49.3 ug/l, significantly higher than the mean concentration of 24 ug/l currently observed in the pond.

The proposed restoration efforts in this plan are targeting to remove existing phosphorus contributions to the pond. Any new loads from new development would counteract these efforts. Thus, it is important to have regulations in place to control stormwater runoff from future development projects. Ideally, an overlay district for Pearly Pond with a requirement of no additional loading of total phosphorus from new development should be implemented. This would support NHDES's anti-degradation policy with regard to impaired waters, which do not allow for any additional loading of pollutant to impaired waters. However, NHDES has no mechanism for regulation/enforcement of phosphorus export from development of single house lots that do not require a Section 401 Water Quality Certification or fall under the thresholds for Alteration of Terrain Permits (100,000 sq.ft. of disturbance or 50,000 sq.ft. within 250 feet of a lake), making local regulation more important.

CEI also recommends that the Towns of Rindge updates its Stormwater Management Ordinance and Jaffrey develops a separate one to regulate any development that disturbs more than one acre of land, including requirements for erosion controls during construction and post-construction stormwater management practices to treat stormwater runoff from the developed site. We recommend that the ordinance require developers to meet the requirements of NH DES's Alteration of Terrain (AoT) regulations at the one acre or lower threshold. The AoT Program requires that entities disturbing more than 100,000 sq.ft. apply for a State level permit through NHDES. Applying a lower threshold at the local level would provide better protection and is consistent with the federal NPDES Phase II requirements, which require regulated communities (Rindge and Jaffrey are currently not regulated NPDES Phase II Communities) disturbances greater than one acre.

The AoT regulations outline specific design criteria that developers must meet, including the volume of water to be recharged, the volume of water to be treated to remove pollutants, requirements to control peak flow volumes and avoid flooding, and requirements for channel protection. NH DES also developed a three volume Stormwater Manual that clearly lays out design criteria for controlling stormwater runoff, BMP design criteria and erosion and sediment control guidance, which can be referenced along with the AoT regulations.

CEI also recommends that Rindge and Jaffrey consider implementing landscape design standards, with an example provided in Appendix H. Refer to Appendix H for example model ordinances and regulations.

Recommendation: Coordinate with the Town of Rindge and Town of Jaffrey to:

- Encourage adoption of a Pearly Pond overlay district that provides extra protection, ideally, no additional loading of total phosphorus from new development.
- Encourage adoption of a Stormwater Management Ordinance with reference to AoT standards from NHDES.
- Encourage adoption of landscape design criteria in regulations.

Actions:

1) Contact and meet with planning boards, public works and Board of Selectmen in Rindge and Jaffrey to promote adoption of overlay district and ordinances.
2) Present the restoration plan and proposed BMP alternatives for the area to planning boards, public works and Board of Selectmen so they can incorporate restoration activities into future redevelopment projects as they occur.
3) Follow-up with Rindge and Jaffrey planning boards, public works and Board of Selectmen at least annually to discuss ongoing projects and potential collaboration.

Objectives: Adopt AoT stormwater design standards at the local level and establish an overlay district for Pearly Pond to reduce phosphorus loads to the pond and increase recharge.

Partners: PPA, FPU, Town of Rindge and Town of Jaffrey.

Capital Costs: Staff time. $1,100 to $2,200 for meetings, preparation of ordinances and attendance of public hearings.

Annual O&M Costs: Staff time.

7.2.2 Structural BMPs

#9. Install Stormwater Best Management Practices in Watershed

As described in Section 6.0, several potential stormwater treatment BMPs were investigated and the top 10 BMP sites were identified to improve water quality. Conceptual designs for improvements have been prepared as summarized in Table 7-2 and included in Appendix K. Additional data are needed to increase the success of the implementations, specifically, ownership information and cooperation, and additional data to prepare preliminary designs for the purpose of pursuing grant funds.

For the purposes of the WMP report, a range of potential project costs for the recommended alternatives is provided to add flexibility in planning and project phasing in the future. Cost ranges are provided for each BMP, understanding that the potential project can be completed using a variety of alternatives which have different cost factors (e.g. in-kind services, staff DPW assistance, hiring private contractors). As the projects are implemented it is understood that project scopes may change based on available grant funding, match funding or other feasibility issues (e.g. properties change hands, material prices go up, contractors provide higher costs). When grant applications are submitted, the projects may be modified to fit within available funding.

Several alternatives were selected for possible implementation within each subwatershed. The top ten were identified at a conceptual basis and these were broken up into phases based on a ten year planning period. The first phase includes the top four BMPs for which preliminary plans were developed. The second phase included the next three highest ranking BMPs followed by the final three BMPs to be completed in the last phase of stormwater implementation or as needed to meet water quality goals. Table J.4 in Appendix J provides a more detailed summary of the top ten ranked BMPs selected for conceptual designs. Figure 7-1 details the location of the top ten proposed stormwater BMP alternatives.

Even though not listed in the top ten most cost-effective alternatives, the next 20 most feasible BMPs should not be ruled out for future planning and implementation. The top 30 BMPs are interchangeable and can be swapped out with others as needed to accommodate possible phasing with other infrastructure improvement projects or to replace those deemed infeasible upon further investigation. These additional 20 BMPs are summarized in Tables J.2 and J.3 in Appendix J located at the end of this report. Additionally, all of the alternatives do not represent treatment of the entire impervious area in each of the four subwatersheds; rather they reflect an anticipated treatment area based on preliminary field review of grading and available space, and assuming BMP construction without entirely redeveloping a potential site.

Table 7-2. Proposed BMPs

BMP #	BMP Description	Proposed BMP Components	Estimated BMP Cost Range [1]
1	FPU Beach / Ball Field BMPs	Install gravel wetland cells on either side of access pathway connected by cross culvert. Install underground drainage piping as needed to divert drainage to gravel wetlands from roadways / parking areas and ball fields. Design treatment areas to overflow to existing outfall by connecting gravel wetland piping to existing drainage piping. Stabilize a portion of gravel parking area at the boat house with porous pavers and/or porous pavement systems. Prevent beach erosion by installing curbing / landscaping berms to capture and infiltrate sheet runoff prior to reaching beach area. Provide educational kiosk and monitoring wells for future water quality sampling, educational opportunities and case studies.	$220,000 – $265,000
2	FPU East Parking BMPs	Install tree box filters or infiltration dividers throughout large parking areas on the east side of FPU campus. Install infiltration beds or large rain gardens adjacent to tennis courts to handle runoff from nearby paved parking areas and ball fields. Install underground drainage piping as needed to divert drainage to treatment areas. Design treatment areas to overflow to existing outfalls by connecting to existing drainage piping.	$120,000 - $160,000
3	Kimball Rd Beach BMPs	Install several rain gardens at Beach access. Use existing drainage system to connect rain garden overflows to outlet piping. Install rain gardens on both sides of Kimball Road and adjacent to the beach area / existing drainage outfall. Stabilize a small section of beach access with erosion control mulch, porous pavers and/or porous pavement systems. Provide overflow system for porous pavement to prevent runoff from flowing over beach area. Connect overflow to existing drainage system. Provide educational kiosk and materials.	$30,000 - $50,000

Table 7-2. Proposed BMPs

4	Kimball Rd Sharp Curve BMPs	Install new curbing and divert flows to small treatment areas on either side of sharp curve via curb cuts. Install up-gradient catch basins and drainage piping as needed to divert drainage to a wetpond located on Town owned property. Up-gradient catch basins will reduce the amount of runoff reaching the "low spot" on the sharp curve. Re-grade sections of roadway as needed to divert runoff to treatment areas. Install roadside vegetated buffers along the pond side shoulder and create one stabilized pathway for snow mobiles to access the pond from the roadway.	$50,000 - $70,000
5	FPU West Access Drive BMPs	Install a series of curb-cuts and "bump-outs" to direct runoff to rain gardens / infiltration areas on main section of roadway. Place "bump-outs" in specific areas to promote traffic calming for busy sections of roadway and areas of heavy pedestrian traffic. Along steep sections of roadway, install infiltration swales reinforced with rounded riprap or river stone. Install checkdams to reduce runoff velocities and promote infiltration. Connect overflows for drainage system to existing drainage. Install larger rain garden / infiltration pond at the base of the steep roadway section and re-direct existing drainage outfall into treatment area.	$100,000 - $125,000
6	FPU Community Center BMPs	Install rain gardens at FPU community center to handle runoff from adjacent walkways and paths. Convert a section of existing drainage swale adjacent to Mountain Road (Ingall's Rd) to an infiltration swale by installing sub-surface crushed stone beds and riprap checkdams. Install infiltration beds/gardens around Community Center and connect existing roof leaders to infiltration beds for irrigation of vegetation. Provide educational kiosk and monitoring wells for future water quality sampling, educational opportunities and case studies.	$15,000 - $30,000

Table 7-2. Proposed BMPs			
7	Route 119 Roadway BMPs	Install plunge pools / sediment traps on pond side shoulder (westbound) of Route 119. Plunge pools will be installed where surface runoff from roadway drains onto existing paved swales. Retrofit existing drainage swale along eastbound shoulder of Route 119 by installing bio-retention or gravel treatment swale. Install rock check dams to reduce velocities and promote subsurface flows.	$80,000 - $110,000
8	Mountain Rd (Ingall's Rd) Steep Drainage BMPs	Re-grade and stabilize steep gravel roadway sections. Re-grade and reinforce drainage swales with stabilization materials and check dams to reduce runoff velocities and prevent erosion. In some very steep areas install riprap swales with reinforced shoulders. On flatter sections of roadway install vegetated swales reinforced with turf blankets. Install plunge pools and gabion level spreaders at existing outfalls to prevent erosion on steep slopes. Stabilize sections of upper roadway embankments and eroded drainage channels with bio-engineered slope treatment.	$80,000 - $105,000
9	Mountain Rd (Ingall's Rd) Culvert Crossing BMPs	Improve grading on roadway. Stabilize existing drainage swales with turf reinforcement / vegetation and install checkdams. Install series of small drainage crossings with plunge pools and infiltration areas along steep portions of roadway. Improve drainage around culvert crossing and stabilize side slopes with wing-walls and riprap drainage swales. Install level spreader and treatment BMPs near culvert if permissible by NHDES.	$40,000 - $65,000
10	Kimball Rd Gravel Turn-around BMPs	Re-grade and stabilize steep gravel roadway section of private road. Install drainage swales with check dams to reduce runoff velocities. Install underground piping and drainage structures as needed to reduce puddles and erosion at turn-around. Direct new drainage system to small wetpond and/or gravel treatment system prior to discharge into existing drainage outfall piping.	$50,000 - $70,000

[1]Costs include permitting, engineering and construction. Cost for legal agreements is not included.

The top four recommended sites were identified as the most effective towards removing phosphorus loads due to stormwater inputs. As part of the watershed management plan, preliminary designs have been completed for these top four BMPs to be used for future grant applications and discussions with potential project partners. These preliminary

designs are provided in Appendix O. These designs are based on limited topographical and property information collected from the NH Granit GIS database and Town of Rindge Tax Maps. No survey work was completed for preliminary design. Designs are based on limited site investigations conducted during the watershed / BMP evaluation. Designs assume adequate soils, clearance to groundwater and clearance to bedrock are available at the potential locations. No test pits were completed for preliminary design.
Further work is required to develop partnerships with the owners of properties within which the above listed improvements are proposed. The willingness of property owners to participate in the program will affect whether and to what degree PPA, FPU and the Town of Rindge will be able to advance these improvements.

These alternatives were selected to provide examples of pollutant removal capabilities and associated costs to help direct future BMP designs and were applied to a portion of each site, representing the area that could be treated by BMP alternatives without significantly altering the existing drainage systems or re-grading contributing areas. Treatment of a larger site area may be possible at an increased cost or alternatively could be incorporated into redevelopment efforts as they come up. A combination of stormwater treatment design standards (Recommendation #8) and example BMP alternatives will help achieve the greatest restoration benefit at the lowest cost during redevelopment.

In the meantime, PPA and FPU could pursue funding opportunities to implement some of the BMP alternatives within the lower watershed (Subwatersheds 1 through 4) to demonstrate these BMP options while increasing protection of Pearly Pond. The demonstration BMPs would serve as examples for future redevelopment projects.

Recommendation: Pursue funding to design and install structural stormwater treatment BMPs in the watershed. Begin with the top four recommended BMPs for which preliminary design plans have been completed.

Actions:

1) Discuss proposed projects and determine owner interest in participating. This should occur as soon as possible to bring property owners such as FPU Facilities, Town of Rindge DPW and the NH DOT on board.
2) Pursue grant funding opportunities to design and construct stormwater BMPs.
3) Design, permit, bid and construct BMPs for selected properties based on owner cooperation and available funding.

Objectives: Prevent about 12.0 - 14.0 kilograms of phosphorus per year from entering the pond through construction of 10 BMP installations. Prevent sediment and other pollutants associated with stormwater runoff from entering the pond. Provide storage and infiltration for stormwater.

Schedule: Refer to Table 7-1.

Partners: PPA, FPU, NHDES, New Hampshire Department of Transportation, Town of Rindge, Town of Jaffrey, Private Property Owners, Consultant.

Capital Costs: $785,000 to $1,050,000 for design, permitting and installation of BMPs over a ten year period

Annual O&M Costs: Assume an allowance of $500 to $700 per BMP per year for annual maintenance including cleanout and disposal of sediment.

#10 Install Vegetated Shoreline Buffers / Rain gardens

Installation of vegetated buffers or rain gardens along the shoreline could reduce phosphorus levels associated with both geese populations and stormwater runoff. The use of vegetation along open water bodies and tributaries could help treat pollutants associated with surface runoff from lawn areas and driveways; capture leaves and debris prior to entering the pond; limit clear access to open areas from the pond for waterfowl as well as beautify a property or shoreline. Vegetated buffers and gardens can be installed with many different layouts and a wide variety of native plant species. It is recommended that a shoreline vegetated buffer mimic conditions set forth in NH DES' Environmental Fact Sheet WD-SP-5 "Vegetation Maintenance within Protected Shoreland" and utilize vegetation outlined in NH DES's list of Native Shoreland / Riparian Buffer Plantings for New Hampshire, however there are many options to work within those parameters. A homeowner can select a more manicured garden layout, a wildflower garden or install native shrubs and trees to accomplish the same goals

Recommendation: Based on efforts of the Community Outreach Program (Recommendations # 1 and # 2) to promote the use of landscape modifications, vegetated buffers, and/or rain gardens, complete demonstration projects utilizing vegetation on individual private properties and the FPU campus along the shoreline or tributary stream banks.

Actions:

1) Contact property owners to discuss proposed projects and determine owner interest in participating.
2) Encourage residents to participate or volunteer by providing incentives such as free plant giveaways or other potential prizes.
3) Identify and plan potential shoreline buffer sites to be completed as demonstration projects.
4) Pursue grant funding opportunities to design and implement the shoreline buffers.
5) Install shoreline buffer demonstration projects based on owner cooperation and available funding.
6) Encourage shoreline residents to assist and train each other on the installation of different shoreline vegetated buffers and to promote future community based or individual private landowner installations.

Objectives: Prevent 5 kilograms of phosphorus per year from entering the pond through implementation of shoreline vegetated buffers.

Schedule: Refer to Table 7-1.

Partners: PPA, FPU, NHDES, Private Property Owners.

Capital Costs: Staff time for planning plus between $10,000 and $20,000 for design, permitting and installation depending on the type of landscape modification and how many buffers are implemented on individual properties.

Annual O&M Costs: Assume an allowance of between $100 to $1,000 per year for annual operation and maintenance depending on the type of shoreline buffer**.**

Associated Recommendations: #1. Develop Community Outreach Campaign
#2. Shoreline Buffer and Yard Maintenance Outreach
#4. Waterfowl Management Outreach

#11. Improve Phosphorus Removal at FPU Wastewater Treatment System through Chemical Additives

The FPU WWTP uses grit chambers and rotating biological contactors to treat wastewater. Phosphorus and other pollutants are removed through the use of flocculation, settling, biological removal and filtering. The flocculation process is enhanced through addition of chemicals to promote binding of particles in the waste stream, making them larger and more likely to settle or be filtered. This is done at the FPU WWTP by the addition of aluminum sulfate. Sodium hydroxide is also added to the wastewater to control the pH at a level that is adequate for flocculation. Additional dissolved phosphorus can be removed through the increase of these chemicals to promote even more flocculation, settling and filtering.

Recommendation: Pursue funding to design and implement wastewater treatment improvements for the increased removal of phosphorus at the FPU WWTP through the increase of chemical feed rates. Begin with discussions with the FPU WWTP Operators to better understand the process and what improvements can be made.

Actions:

1) Contact FPU WWTP Operators and Facilities staff to discuss proposed projects and determine interest and feasibility. This should occur as soon as possible to bring FPU staff on-board and plan for future budgetary increases.
2) Pursue funding opportunities to design and implement BMPs.
3) Conduct a pilot study and monitoring program to explore potential options and benefits.
4) Implement full-scale feed rate adjustments based on success of pilot study, owner cooperation and available funding. Install new chemical feed pumps, plumbing, chemical mixing and handling equipment as needed to support full scale chemical feed rate increase.
5) Track chemical usage, phosphorus levels in the influent and effluent to determine success.

Objectives: Prevent 5 kilograms of phosphorus per year from entering the groundwater and pond through implementation of increased chemical feed rate system.

Schedule: Refer to Table 7-1.

Partners: FPU Facilities Department, FPU WWTP Operators, Consultant and NHDES.

Capital Costs: Staff time for planning plus $30,000 to $60,000.

Annual O&M Costs: Assume an additional allowance of $500 per year for increased annual operation, maintenance and monitoring at the WWTP. Assume an additional $1,000 per year for chemical admixtures on top of the current annual chemical purchase costs.

#12. Improve RIB Phosphorus Removal through Iron Enhanced Sand Filtration

Treated effluent from the FPU WWTP is pumped to rapid infiltration beds (RIBs) that consist of sand layers used to promote the rapid infiltration of wastewater into the substrate and groundwater below. The sand material is used to filter and absorb the flocculated phosphorus from the treatment plant processes. The sand material requires mixing and eventual replacement to maintain proper function. At the time of replacement, the new sand could be mixed with iron filings, which can increase the capacity of the sand to remove dissolved phosphorus by binding the phosphorus through oxidization of the iron.

Recommendation: Pursue funding to design and implement the addition of iron enhanced sand to the existing RIBs to improve dissolved phosphorus removal. Begin with discussions with the FPU WWTP Operators to better understand the process and what improvements can be made.

Actions:

1) Contact FPU WWTP Operators and Facilities staff to discuss proposed projects and determine interest and feasibility. This should occur as soon as possible to bring FPU staff on-board and plan for future budgetary increases. Determine when the sand material in the RIBs is slotted to be removed and plan implementation around that schedule.
2) Pursue funding opportunities to implement the potential BMPs.
3) Conduct a pilot study and monitoring program to explore potential options and benefits with one of the infiltration beds. Purchase iron filings and hire a contractor to deliver materials and mix iron into the sand beds.
4) Implement full-scale iron enhanced sand installation program for the second bed and plan future usage and routine upkeep based on success of pilot study, owner cooperation and available funding.

Objectives: Prevent 6 kilograms of phosphorus per year from entering the groundwater and pond through implementation of iron enhanced sand filtration in the RIBs.

Schedule: Refer to Table 7-1.

Partners: FPU Facilities Department, FPU WWTP Operators, Consultant and NHDES.

Capital Costs: Staff time for planning plus $45,000 to $55,000 per bed replacement for sand and iron filings installation.

Annual O&M Costs: Assume an additional allowance of $500 per year for annual operation, maintenance and monitoring of the RIBs. If iron enhanced sand proves to be effective, carry an O&M cost similar to the capital cost for replacement of sand every 10 years or as needed to meet permit requirements.

#13. Treat Phosphorus in Effluent from Northern Wetland with Floating Treatment Islands at Mountain Rd. (Ingall's Rd.) Crossing

Preliminary sampling data has shown that the northern wetland in the Mountain Road (Ingall's Rd.) Inlet Subwatershed is highly eutrophic and its assimilative capacity to naturally reduce phosphorus levels through bioretention and biological means has decreased. The residual phosphorus from years of historic wastewater discharge from the FPU WWTP has overwhelmed the waterbody and phosphorus is now being released to the nearby streams and Pearly Pond. This phosphorus could be treated through the use of BMPs installed at two culvert crossings that carry base flow and stormwater from the wetland to Pearly Pond. These BMPs could be designed so they are temporary and could easily be removed after short-term implementation or until the phosphorus levels in the wetland effluent drop to reasonable levels. The first recommendation to handle the northern wetland effluent would include the installation of temporary floating treatment islands at the Mountain Rd. crossing. Based on the installation of the new wastewater discharge at the RIBs, eventually the northern wetland will self-clean by discharging the historic phosphorus load to Pearly Pond. It is assumed that this BMP could be implemented for a short-term to intercept the phosphorus discharge from the wetland and could be removed once the wetland has self-cleansed and no longer releases elevated concentrations of phosphorus to Pearly Pond.

Recommendation: Pursue funding to design, permit and implement floating treatment islands at the Mountain Rd. (Ingall's Rd.) crossing for a short-term. Begin with discussions with property owners at the crossings to determine the feasibility of access permission for implementation.

Actions:

1) Contact the Town of Rindge and abutting property owners to discuss proposed projects and determine owner interest in participating. This should occur as soon as possible to bring property owners on board.
2) Discuss the potential project with NH DES and NH Fish and Game (NH F&G) Department to make sure an in-stream BMP would be permissible at this location and identify potential special conditions that might apply.
3) Pursue grant funding opportunities to design and implement BMPs.
4) Implement BMP based on owner cooperation and available funding.
5) Purchase floating raft materials. Select specific wetland plant species that are native and will flourish on a floating raft.
6) Install plant plugs into floating rafts and place rafts in open water up-gradient of Mountain Rd. (Ingall's Rd.) crossing. Properly anchor rafts to each other and the stream banks as needed to fit available space (assistance from volunteers, FPU staff and local students could be used for installation).
7) Continue to maintain and monitor plant growth. Replace dead and overgrown vegetation as needed.

Objectives: Prevent 14 kilograms of phosphorus per year from entering the pond through implementation of floating treatment islands.

Schedule: Refer to Table 7-1.

Partners: PPA, FPU, NHDES, NH F&G, Town of Rindge, Private Property Owners and Consultant.

Capital Costs: Staff time for planning plus $10,000 to $15,000 for materials, design and labor to install floating treatment islands.

Annual O&M Costs: Assume an allowance of $750 to $1,000 per year for annual operation and maintenance which would include costs to harvest dead plants and remove islands during the winter months plus costs to purchase new plants in the spring.

#14. Treat Phosphorus in Effluent from Northern Wetland with Iron Enhanced Sand Filter at Hodge Pond Trail Crossing

Similar to Recommendations #13, the installation of filter material at the Hodge Pond crossing would provide treatment of the northern wetland effluent prior to discharge into Pearly Pond. This BMP site is located up gradient of the proposed floating treatment islands due to water depths and other site constraints. This recommendation would be a more permanent fixture compared to the floating wetlands and would be more expensive to design and install. Additionally, the installation would require work within sensitive resource areas and involve adjustments to the existing culvert and trail infrastructure. Careful environmental planning, hydraulic studies and permitting would be required. Due to the redundant nature, higher potential costs and anticipated impacts, this recommendation should only be implemented if the floating treatment islands become in-feasible or if sampling proves the treatment islands are not meeting project targets alone. This recommendation is selected for installation between years 5 and 10 of the restoration plan.

Recommendation: Pursue funding to design, permit and implement an iron enhanced sand filter at the Hodge Pond Trail crossing. Begin with discussions with property owners at the crossings to determine the feasibility of access permission for implementation.

Actions:

1) Contact property owners to discuss proposed projects and determine owner interest in participating.
2) Discuss the potential project with NH DES and NH Fish and Game Department to make sure an in-stream BMP would be permissible at this location and identify potential special conditions that might apply.
3) Evaluate hydraulic conditions associated with a culvert retrofit to determine proposed improvements and location of sand filter.
4) Pursue grant funding opportunities to design and implement BMPs.
5) Implement BMP based on owner cooperation and available funding.
6) Either retrofit the culvert crossing by installing a temporary sand filter that is sandwiched between riprap filled gabion level spreaders at the upstream / downstream end; or Install a stream diversion to a proposed offline sand filter. Ensure that the level spreader/filter or stream diversions are temporary and can be easily removed after phosphorus levels are reduced.
7) Enhance the sand filter with iron filings to improve removal efficiencies.

Objectives: Prevent an additional 10 kilograms of phosphorus per year from entering the pond through implementation of iron enhanced sand filtration system.

Schedule: Refer to Table 7-1.

Partners: PPA, FPU, NHDES, NH F&G and Private Property Owners, Consultant.

Capital Costs: Staff time for planning plus $30,000 to $50,000 for design, permitting and installation of the iron enhanced sand filter.

Annual O&M Costs: Assume an allowance of $3,000 - $5,000 per year for annual operation, maintenance and monitoring which would include costs to clean filters, mix materials, replenish iron and replace sand filters as needed. Assume sand filters should be completely replaced every five years or as needed based on monitoring results.

#15. Eliminate Septic Inputs by Sewering Lakeview Apartments

Sewering of the Lakeview Apartments would transfer wastewater and associated phosphorous loads to the WWTP, eliminating discharges to groundwater in the area of the University Drive (a.k.a. College Road) tributary and Pearly Pond.

Sewering options must consider the limited capacity of the existing sewer line. A pump station with holding tank could be installed near the apartment complex and tied to the existing pressure line on University Drive to make the final connection to the WWTP. The existing septic tanks on-site could also be used to provide storage and these would be connected to the new holding tank with pump station. This option would store wastewater and release it during low usage periods (i.e., middle of the night) to avoid upgrading the existing sewer line at this time. This would also improve function of the FPU WWTP by strategically pumping stored wastewater during times of low water consumption. This installation also provides flexibility for future phased sewer piping projects to tie in nearby neighborhoods as the sewering of those areas becomes necessary or more cost-effective.

Recommendation: Pursue funding to design and implement the sewering of Lakeview Apartments by using the existing FPU wastewater infrastructure. Begin with discussions with the FPU WWTP Operators and FPU Facility staff to better understand the existing system, anticipated flows and what improvements can be made.

Actions:

1) Contact FPU planners to discuss proposed projects and determine owner interest in participating. This should occur as soon as possible to bring property owners on board.
2) Pursue funding and loan opportunities to design and implement BMPs.
3) Implement BMP based on owner cooperation and available funding.
4) Design, permit and bid the sewering project. Properly design holding and pump system to send wastewater to treatment plant during times of low demand and store wastewater during times of high demand.
5) Install properly sized holding tank with pump system. Connect existing holding tanks to new tank and connect pump to existing 2-inch line that discharges at the FPU wastewater plant.

Objectives: Prevent 9 kilograms of phosphorus per year from entering the pond through the sewering of Lakeview Apartments.

Schedule: Refer to Table 7-1.

Partners: FPU, NHDES, Town of Rindge and Consultant.

Capital Costs: Staff time for planning plus $110,000 – $130,000 for design, permitting and installation of holding tank with pump system.

Annual O&M Costs: Assume an allowance of $1,500 to $2,000 per year for annual operation, maintenance and monitoring of the tank and pump system.

#16. Manage Waterfowl Populations using Structural Controls & Techniques

Sources of phosphorus from waterfowl at Pearly Pond include identified populations of Canada Geese. This includes the breeding resident population that permanently chooses the pond and mainly FPU campus as a seasonal nesting / feeding ground. The second includes a larger transient population of Canada Geese that visit the pond temporarily as their migration path brings them past Pearly Pond in the Spring and Fall seasons.

Actions under this recommendation would focus on minimizing the current breeding population and preventing any migrating populations from breeding / nesting around the pond in the future. Any waterfowl management techniques employed should focus on the two separate populations by identifying and implementing different methods to control excessive phosphorus loads from geese.

Recommendation: Pursue funding to plan and implement a waterfowl management plan on FPU campus and around the pond to prevent local goose families from returning to the campus and surrounding areas to nest and raise young. Begin by discussing potential management strategies with FPU planners and NH Fish and Game to establish a plan of attack and develop a budget for implementation. Build upon the education efforts developed under the Community Outreach Campaign for waterfowl management described under Recommendation #4.

Actions:

1) Coordinate with FPU Facilities staff, planners and other local shoreline land owners to identify potential pilot studies and determine funding options. This should occur as soon as possible to develop future long-term plans.
2) Pursue grant funding opportunities to implement a management plan.
3) Coordinate with New Hampshire Fish and Game to identify potential management techniques, methods to locate local nests and develop a long-term monitoring plan for the local population.
4) Based on population monitoring select different locations on campus and around the lake to focus management strategies and develop a management plan.
5) Implement several different pilot study programs based on management plan and available funding. These pilot programs could include:
    a. Rent border collies to scare and haze local breeding populations;
    b. Install different decoys and predator effigies around campus and the pond;
    c. Install goose fencing along shoreline areas;
    d. Install outdoor speaker systems to provide noise makers and/or distress calls;
    e. Conversion of manicured lawn areas to meadow on the FPU campus and private properties that are closest to the shoreline (within 150 feet).
    f. Installation of shoreline buffers and/or perched beaches.
6) Monitor the success of the different pilot projects.

Objectives: Prevent 8 kilograms of phosphorus per year from entering the pond through implementation of a waterfowl management plan on FPU campus. This would be in addition to removal estimate of 5 kilograms per year associated with additional public education and outreach for waterfowl management identified under Recommendation #4.

Schedule: Refer to Table 7-1.

Partners: PPA, FPU, NHDES, and New Hampshire Fish and Game Department.

Capital Costs: Staff time for planning plus between $15,000 and $30,000 for implementation of different deterrent / hazing methods depending on how many pilot programs are developed and for how long.

Annual O&M Costs: Assume an allowance of between $100 to $2,100 per year for annual operation, maintenance and monitoring depending on the number and type of pilot program.

Associated Recommendations: #1. Develop Community Outreach Campaign
#2. Shoreline Buffer and Yard Maintenance Outreach
#4. Waterfowl Management Outreach

7.2.3 Other BMPs

#17. Investigate Impact of Internal Phosphorus Loading and Measures to Reduce

Based on limited available sampling data and monitoring, assumptions were made to model and quantify phosphorus inputs for sources such as internal loading, septic loading and contributions due to natural background levels of phosphorus in the watershed, tributaries and wetland areas. Additional studies could be completed to evaluate and confirm quantitative phosphorus inputs to the pond that are assumed in the TMDL and watershed model. These studies could be completed by FPU professors and students with assistance from volunteers or members from the PPA. The data collected during these studies could be used to update the current model and identify reduction measures.

Recommendation: Develop collaboration between members of FPU professors, students and PPA members to develop a long-term study of internal phosphorus loadings to the pond.

Actions:

1) Develop a program to investigate the impacts of internal loading.
2) Conduct sampling programs to track phosphorus, temperature and DO levels in the pond during fall, winter and early spring months to establish more detailed turn-over data.
3) Sample sediments and pond bottom materials to quantify the amount of stored phosphorus in the pond.
4) Identify long-term trends and coordinate findings with NHDES staff and consultants to update models and management plans.
5) Develop potential reduction methods or corrective actions.

Objectives: Collect data to confirm internal loading inputs and identify potential reduction methods.

Partners: FPU (professors & students), PPA, NHDES, consultants and others.

Capital Costs: Staff time; $500 - $1,000 for costs to purchase/ rent sampling equipment.

Annual O&M Costs: Volunteer time to deploy and down load data from data loggers, calibration and maintenance of data loggers/ flow equipment, collection of samples. Assume an allowance of $1,000 annually for costs for sampling equipment up-keep and laboratory analysis.

#18. Investigate Natural Background Phosphorus Loading and Baseflow levels in Tributaries

Recommendation: Develop collaboration between members of FPU professors, students and PPA members to develop a long-term study of the natural background phosphorus loadings to the pond through tributary base flow.

Actions:

1) Develop a long-term monitoring program to investigate the natural background levels of phosphorus in the groundwater, underlying soils, wetlands and tributary base flow.
2) Conduct a sampling program of underlying soils in un-developed areas to establish natural background phosphorus levels.
3) Install shallow piezometers up gradient of tributaries and conduct groundwater sampling and monitoring.
4) Sample and monitor phosphorus levels in upper wetland areas. Sample influent and effluent for those wetland areas during both times of dry and wet weather.
5) Coordinate additional efforts with long-term tributary sampling during wet and dry weather.
6) Identify any long-term trends and coordinate findings with NHDES staff and consultants to update models and management plans.

Objectives: Collect data to confirm natural background loading inputs.

Partners: FPU (professors & students), PPA, NHDES, consultants and others.

Capital Costs: Staff time; $2,500 - $5,000 for costs to purchase/rent sampling equipment.

Annual O&M Costs: Volunteer time to deploy and down load data from data loggers, calibration and maintenance of data loggers/ flow equipment, collection of samples. Assume an allowance of $1,500 annually for costs for sampling equipment up-keep and laboratory analysis.

#19. Long-term Monitoring Program

A long-term monitoring program is recommended to document environmental/watershed trends and to evaluate the effect of watershed improvements on water quality, with a focus on phosphorus and dissolved oxygen.

Recommendation:

1. Continue the current monitoring program, which includes monitoring of water temperatures, DO, chlorophyll-a and phosphorus levels in the pond as well as tributary sampling conducted by FPU.
2. For any restoration projects that are undertaken, incorporate into them a monitoring component that includes both phosphorus levels for the influent and effluent of the BMP as well as physical monitoring (e.g. quantity of sediment removed, less erosion, stabilized drainage system, improved natural habitats, etc.) to determine their effects on the pond, water quality and the watershed as a whole.
3. Continue to implement the VLAP activities within the watershed currently conducted by volunteers from the PPA and FPU with assistance provided by NHDES staff and funding provided by FPU/DES (and seek financial support from the Towns of Rindge and Jaffrey). Monitoring stations can be added and sampling frequency increased to support specific plan objectives.

Actions:

1) Work with NH DES to continue in-pond monitoring at the deep hole over the summer.
2) Expand the monitoring program to collect in-pond samples in the fall, winter and spring to evaluate DO levels during these periods and the potential for higher internal recycling, as outlined in Recommendation # 17.
3) Continue additional annual monitoring of tributaries and surface water sources throughout the watershed during wet and dry weather to establish base flow and runoff phosphorus inputs.
4) Develop stage-discharge curves for each tributary sampling location to relate flow to water level. Purchase data loggers to continuously measure tributary water level at each of the tributary sampling locations. At a minimum, install a staff gage to record water levels during sampling events, which can then be converted to flow.
5) Develop an ongoing monitoring plan for each project performed on the pond (e.g., stormwater BMPs, northern wetland treatment and septic system controls) and include phosphorus decreases and evaluation of post-construction / implementation.
6) Use the data to develop water quality trend lines, noting when elements of the restoration plan are implemented to assess success of the program on the overall quality of Pearly Pond.

Objectives: Establish long-term environmental trends in the pond to help determine the success of the Watershed Restoration Plan.

Partners: PPA, FPU, NHDES, New Hampshire Fish and Game Department, Town of Rindge, Volunteers.

Capital Costs: $5,000 to $7,500 to purchase flow measuring equipment and/or data loggers for each potential location. It is assumed that the data loggers will be deployed and data collected by FPU or by volunteers.

Annual O&M Costs: Volunteer time to deploy and down load data from data loggers, calibration and maintenance of data loggers/ flow equipment, collection of samples. Assume an allowance of $2,500 annually for costs for sampling equipment up-keep and laboratory analysis.

#20. Update Watershed Restoration Plan / TMDL Model

As cited in Section 4.0, there are limitations with the methodology used to estimate phosphorus loads to the pond, in many cases associated with limitations in water quality data. For example, there is not enough data to accurately estimate background concentrations from the Bower Inlet and there was limited fall data to more accurately determine phosphorus loads from internal recycling. As more data is collected, the model should be updated to more accurately define phosphorus loads and target goals for restoration.

Recommendation: Update the watershed restoration plan model after additional data has been collected. The results should be used to refine the water quality and phosphorus reduction goals.

Actions:

1) Update and calibrate LLRM model with new water quality data when it becomes available, preferably after collection of five years of data.
2) Update water quality goals based on modeling results.
3) Update watershed restoration plan with new modeling results, water quality goals, and reduction allocations among contributing sources. Modify or refine recommendations for watershed-specific actions to address the new goals.

Objectives: Adjust the model and restoration plan to reflect actual water quality conditions and to establish a plan to meet water quality goals to advance the protection of the water supply. A current plan also supports future funding of recommendations through NHDES.

Schedule: Refer to Table 7-1.

Partners: PPA, FPU, NHDES & Town of Rindge.

Capital Costs: $30,000 to $65,000 for updating of TMDL model and plan.

Annual O&M Costs: None.

Associated Recommendations: #17. Further Phosphorus Input Studies.
#19. Continue Long-Term Monitoring Program.

7.3 Overall Plan Success Indicators

The success of the implementation of the BMPs must be measurable to ensure they are working and to make adjustments as needed to achieve the desired results. The following success indicators are proposed:

1) Data collected from the proposed long-term monitoring program will be used to assess long-term trend lines within the pond, with a gradual decrease in average in-pond phosphorus and chlorophyll-a levels and an increase in average DO levels anticipated over a course of years as the recommendations are implemented to decrease stormwater runoff and increase groundwater recharge.

   This will be the primary measurement of success since it reflects actual water quality and habitat improvements.

2) The amount of sediment removed from catch basin cleaning, street sweeping, gravel road maintenance and BMP maintenance should be tracked by the entity performing the activities. This will allow for prioritization of areas for more frequent cleaning to better use existing resources to achieve the greatest removal. PPA and FPU should survey the Town of Jaffrey and Town of Rindge and FPU campus maintenance staff annually to document changes in existing practices (e.g., road sanding, landscape maintenance, catch basin and BMP maintenance, street sweeping) for correlation with the restoration program and monitoring results. All accumulated sediments removed from BMPs in the watershed should be measured to determine the total sediment loads prevented from entering the pond. The sediment removal volumes recorded in the Pearly Pond watershed should be reported to the PPA and FPU and NHDES for pollutant removal tracking in New Hampshire.

3) The number of new and redevelopment projects constructed should be tracked by the watershed communities including the total and impervious acreage of the site, the "effective impervious coverage" (accounting for infiltration BMPs and disconnection practices), and the controls implemented at each site with estimated phosphorus removals. This information would provide a tally of anticipated loading reductions that can be compared with the in-pond monitoring program results to draw a correlation between structural stormwater practices improvements and water quality improvements.

4) The volume of water that is directed in the ground via newly installed Best Management Practices should be tracked.

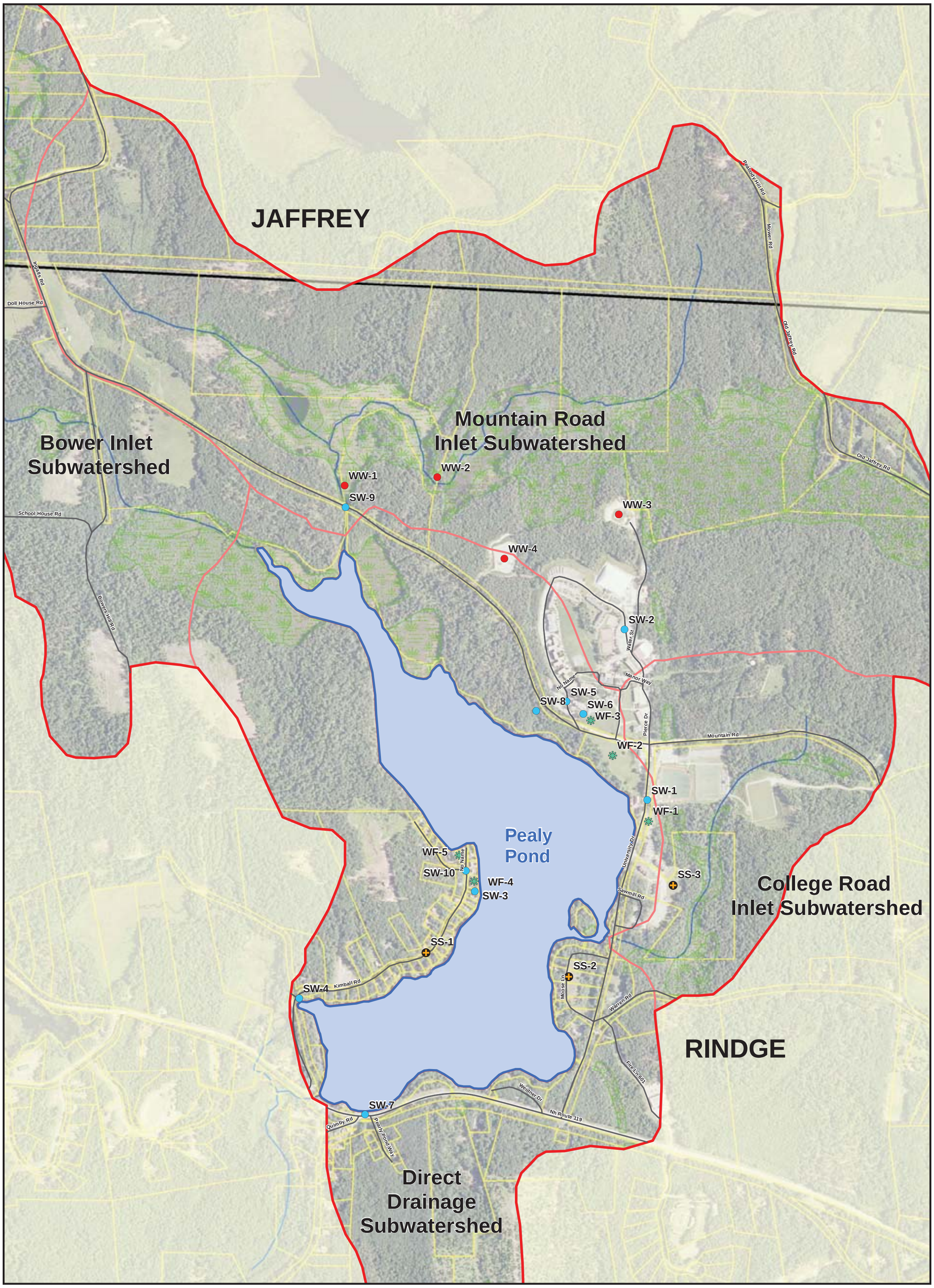
5) Phosphorus reductions associated with newly installed Best Management Practices (Table 7-2) should be tracked.

6) Track reductions in phosphorus due to implementation of wastewater improvements at the plant and rapid infiltration beds.

7) The maintenance of septic systems within the 125 foot shoreland buffer should be continually tracked through resident surveys over the ten year plan to measure the success of public outreach efforts that target proper septic system maintenance.

8) Track and monitor Canada Geese populations both on campus and individual properties to measure the success of public outreach efforts that target waterfowl deterrents and land modifications.

9) Track and document all management actions performed by PPA and FPU and others over the 10-year implementation period to allow correlation with noted water quality changes.



Legend

Type
- Stormwater (SW)
- Wastewater (WW)
- Septic (SS)
- Waterfowl (WF)

- Watershed Boundary
- Subwatershed Boundary
- Road
- Parcel Boundary
- Town Boundary

Hydrography
- Lake
- Wetland
- Stream

Data Source: NH GRANIT, NHDES, Franklin Pierce University, Town of Rindge, and Town of Jaffrey

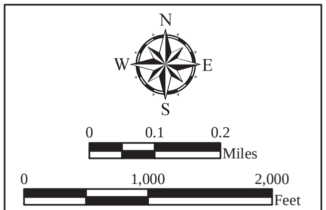


Figure 7-1

Proposed Best Management Practices (BMPs)

Pearly Pond Watershed Restoration Plan

Rindge and Jaffrey, New Hampshire

Comprehensive Environmental Incorporated

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Appendix A
Watershed Survey Results

Pearly Pond Watershed Survey

Last Name: ___________________________ Property Address: ____

Map/Lot# (if known): _______________

COMPLETE AND RETURN THIS SURVEY (POSTAGE PAID ENVELOPE PROVIDED) BY NOVEMBER 22, 2013 AND YOU WILL BE AUTOMATICALLY ENTERED INTO A RAFFLE TO WIN A $50 VISA GIFT CARD

Thank you for participating in the Pearly Pond Watershed Survey!

You are receiving this survey because you own property within 500 feet of Pearly Pond. This survey is an important part of the development of a Watershed Management Plan for Pearly Pond that is currently being developed by the Pearly Pond Management Advisory Council. This survey will assess a number of environmental issues in close proximity to Pearly Pond that can have an impact on the overall quality of your pond. Your answers will assist in developing a successful program to help restore and preserve Pearly Pond.

The survey has 26 questions and should take you about 10 minutes; we ask that you answer as many questions as possible to the best of your knowledge.

1. **On a scale of 1 to 10, where ten is the best, what is your perception of the water quality in Pearly Pond?** *(circle one)* 1 2 3 4 5 6 7 8 9 10

2. **Do you have a septic system, or other wastewater system?** *(circle one)*

   Septic System   Holding Tank   Cesspool/ Outhouse   Other ______________________

3. **How old is the septic system or other wastewater system?** *(circle one)*

   1-10 years   11-15 years   16-20 years   21-25 years   More than 25 years   I don't know

4. **How old is the house?** *(circle one)*

   1-10 years   11-15 years   16-20 years   21-25 years   More than 25 years   I don't know

5. **Is this home used year-round or seasonally?** *(circle one)*

   Year Round   More than one season (90-180 days/year)   Seasonal (less than 90 days/ year)

6. **Do you rent out your home/camp?** *(circle one)*

   Yes   No

7. **What's the average occupancy?** *(circle one)*

   1-2 people   3-4 people   5-6 people   More than 6 people

8. **What is the approximate distance of your septic system or other wastewater system from Pearly Pond?** *(circle one)*

   0-50 feet   51-125 feet   126·300 feet   301·500 feet   Greater than 500 feet   I don't know

IMPORTANT: PLEASE FILL OUT THE BACK OF THIS SURVEY!

Pearly Pond Watershed Survey

9. **How often do you have your septic tank pumped?** ***(circle one)***

Every 1 - 2 years　　Every 3 - 5 years　　Every 6 - 10 years　　More than 10 years　　I don't know

10. **When was the last time it was pumped?** _______________

11. **Which of the following water-using machines do you have in your house/camp?** *(circle all that apply)*

Washing Machine　　Garbage Disposal　　Dishwasher　　Water Softener　　Other __________

12. **When buying laundry detergents or dish detergents, do you check the labels to buy no-phosphate or low phosphate products?** (circle one)

No, not really　　Sometimes　　Always

13. **If you have a garbage disposal, how often do you use it when you are at the house?** (circle one)

Always　　Frequently　　Seldom　　Never

14. **Do you have a grassed lawn area within 100 feet of the water?** (circle one)

Yes　　No

15. **If Yes, do you use**: (circle one)

Fertilizer with Phosphorus　　Low Phosphate Fertilizer　　No-Phosphate Fertilizer　　No Fertilizer　　I don't know

16. **How do you dispose of lawn or grass clippings? (check top 2 choices)**

Picked up with my trash	Taken to recycle center for composting	Home compost bin	Dumped in pond, stream or wet area	Left on lawn	Dumped in woods	Lawn service removes them	Other
☐	☐	☐	☐	☐	☐	☐	☐

17. **How do you dispose of leaves & Spring / Fall cleanup materials? (check top 2 choices)**

Picked up with my trash	Taken to recycle center for composting	Home compost bin	Dumped in pond, stream or wet area	Left on lawn	Dumped in woods	Lawn service removes them	Other
☐	☐	☐	☐	☐	☐	☐	☐

18. **Do you have pets or livestock that are allowed outside?** (circle one)

Yes　　No

19. **If Yes, how often do you clean up pet / livestock waste from your yard?** (circle one)

Always　　Frequently　　Seldom　　Never

Pearly Pond Watershed Survey

20. Do you have a beach or direct shoreline access to the lake from your property?

Yes No

21. If Yes, do water fowl often access your property from the lake?

Yes No

22. If Yes, how many water fowl on average have been observed on your property at one time?

2-10 birds 11-20 birds 21-30 birds More than 30 birds

23. Do you have roadway drainage or culvert pipes that drain onto on your property? (circle one)

Yes No

24. Do you have erosion issues or other drainage concerns on your property? (circle one)

Yes No

25. How willing (where 10 is most willing) would you be to make improvements to your property to help protect Pearly Pond's water quality if technical assistance were provided?
(circle one) 1 2 3 4 5 6 7 8 9 10

26. Please describe any additional stormwater, erosion, septic system or other pollution / water quality related concerns or issues that you may have in the space provided below:

____

____

____

____

If you are interested in seeing the results of this survey, please fill out the information below:

- ☐ Yes, please send me the results of this survey
- ☐ I would like to receive the results by mail

OR

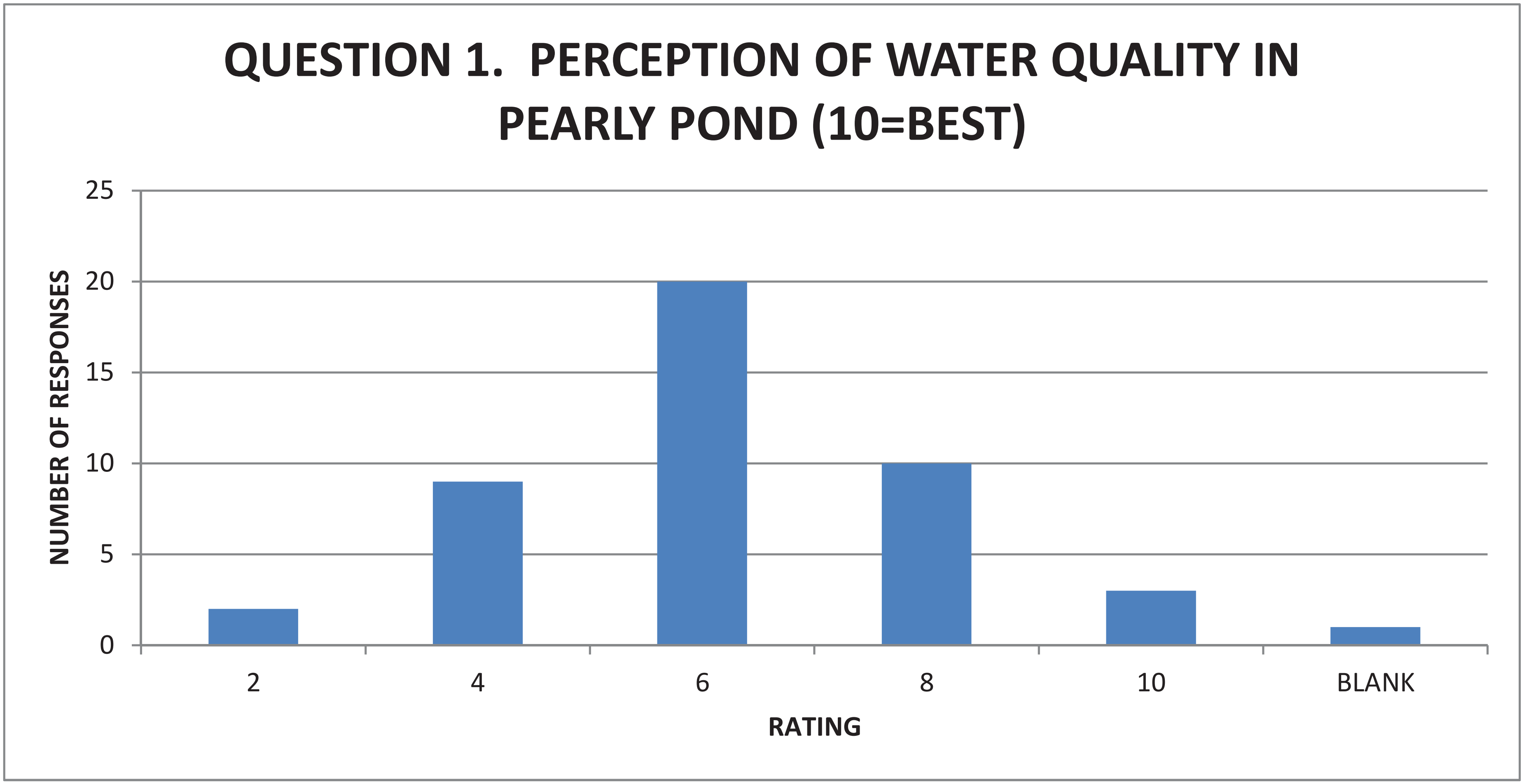
- ☐ I would like to receive the results by email and

my email address is:____

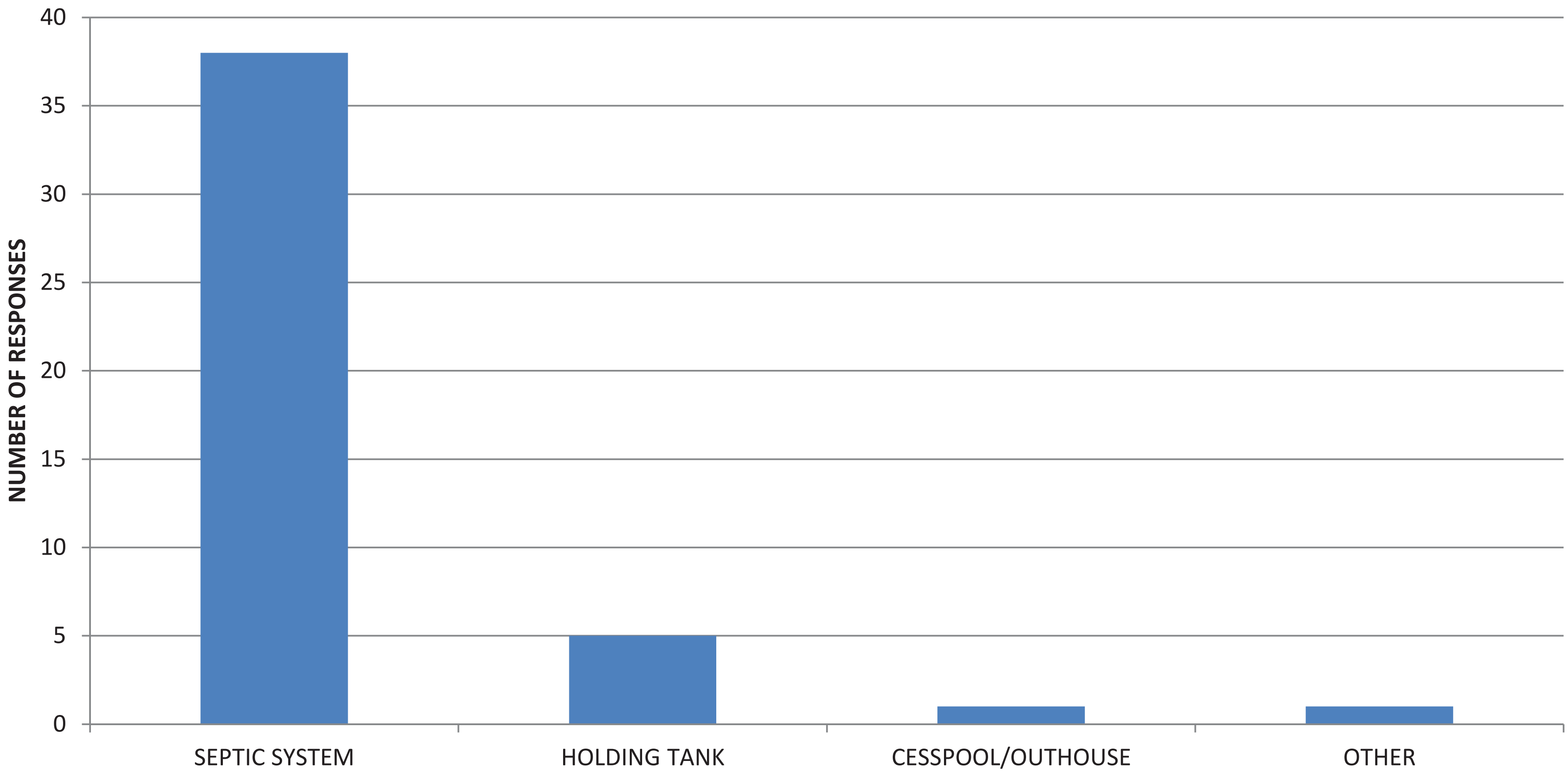
TO BE ENTERED INTO THE RAFFLE, PLEASE RETURN THE COMPLETED SURVEY IN THE PROVIDED STAMPED ENVELOPE BY:

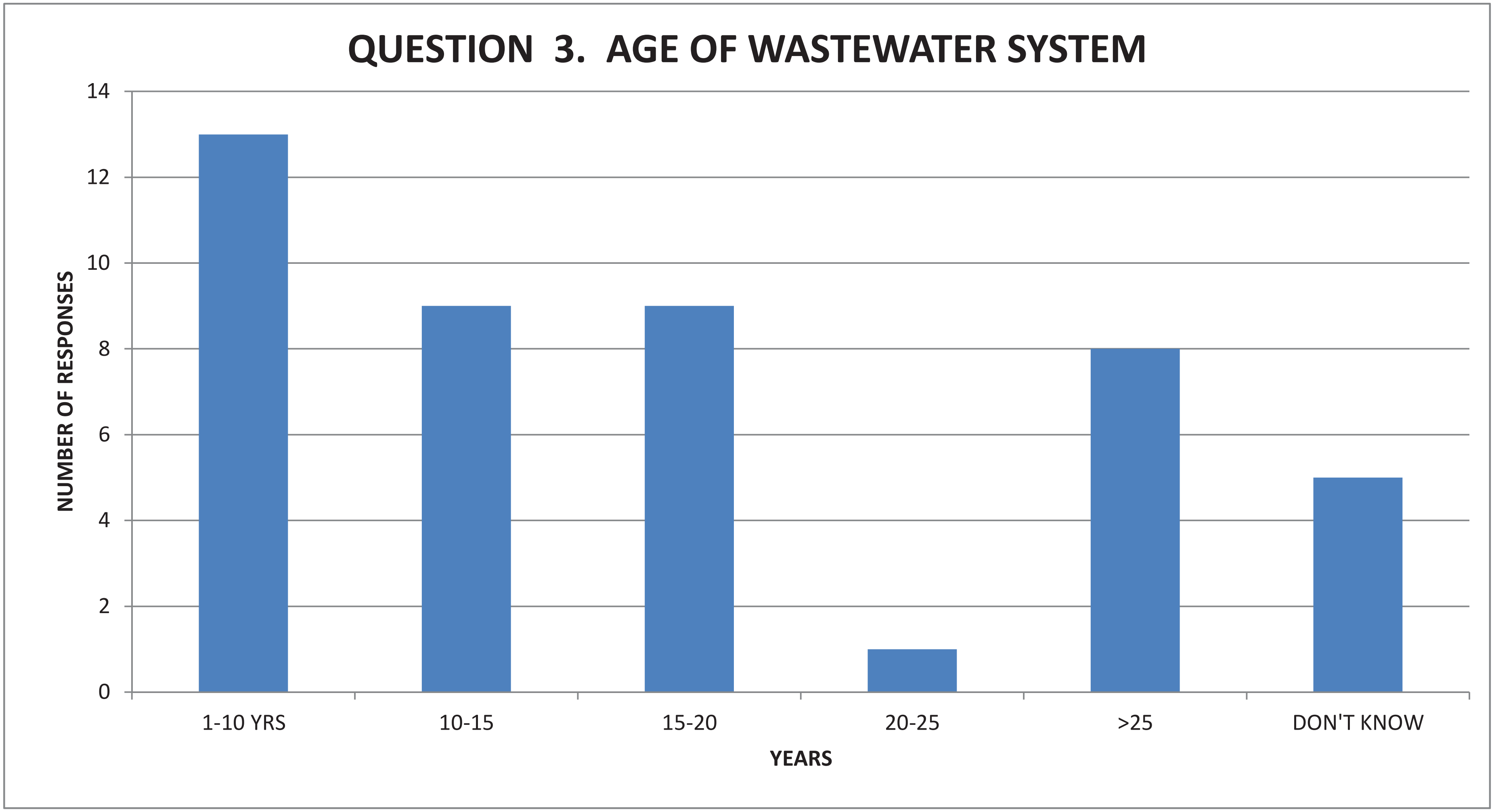
NOVEMBER 22, 2013

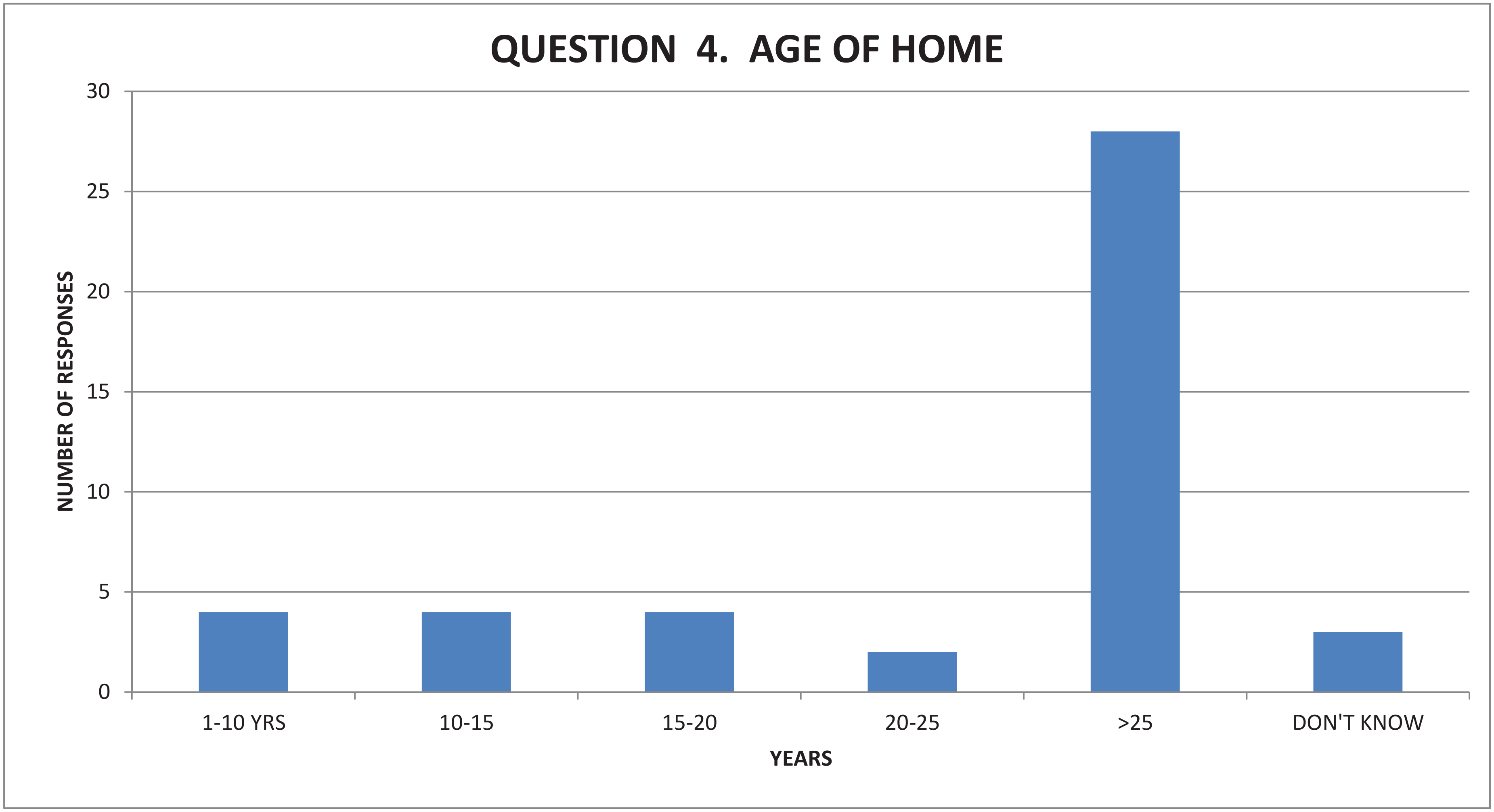
THANK YOU!

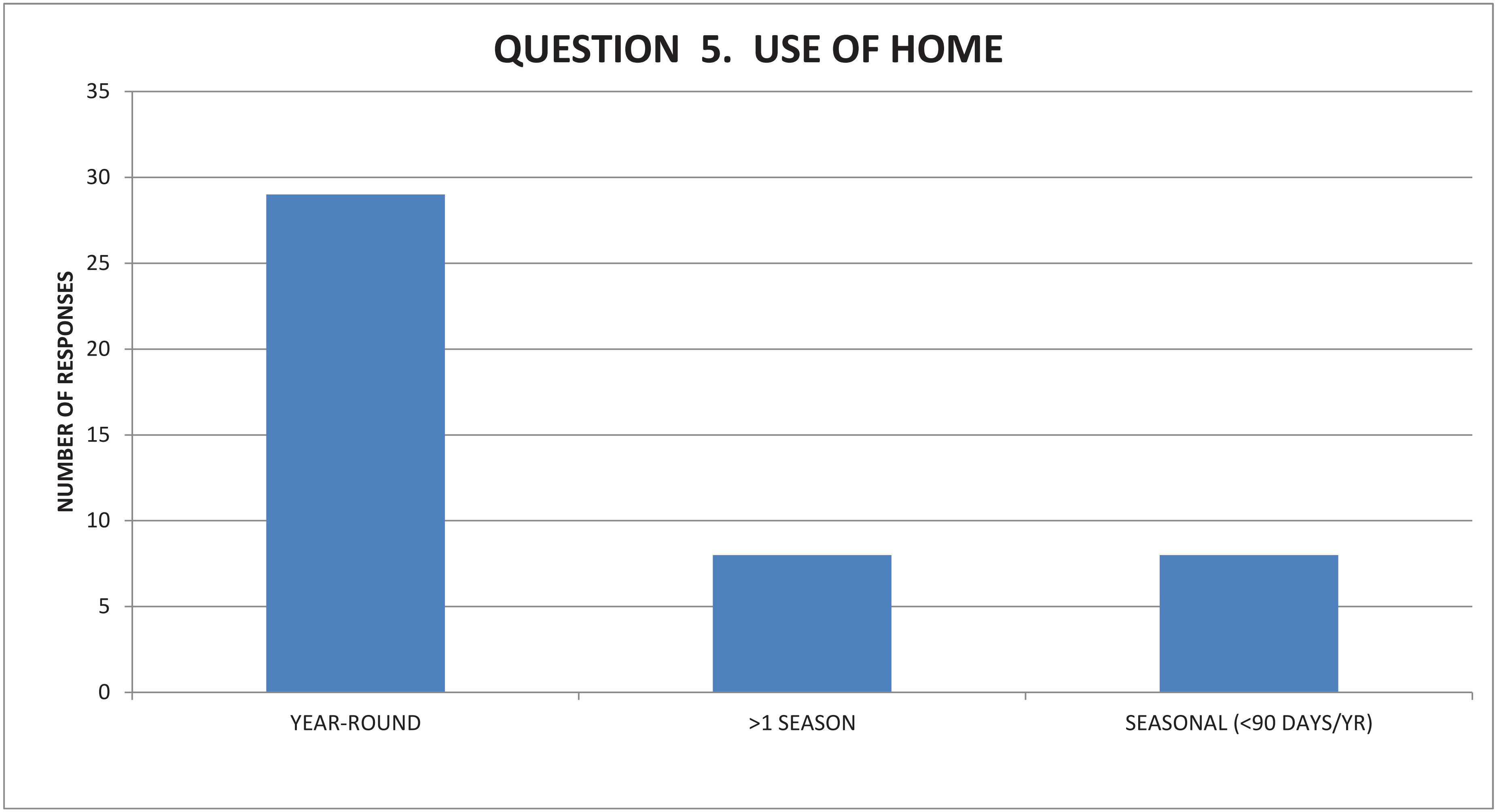

QUESTION 1. PERCEPTION OF WATER QUALITY IN PEARLY POND (10=BEST)
NUMBER OF RESPONSES
25
20
15
10
5
0
2
4
6
8
10
BLANK
RATING

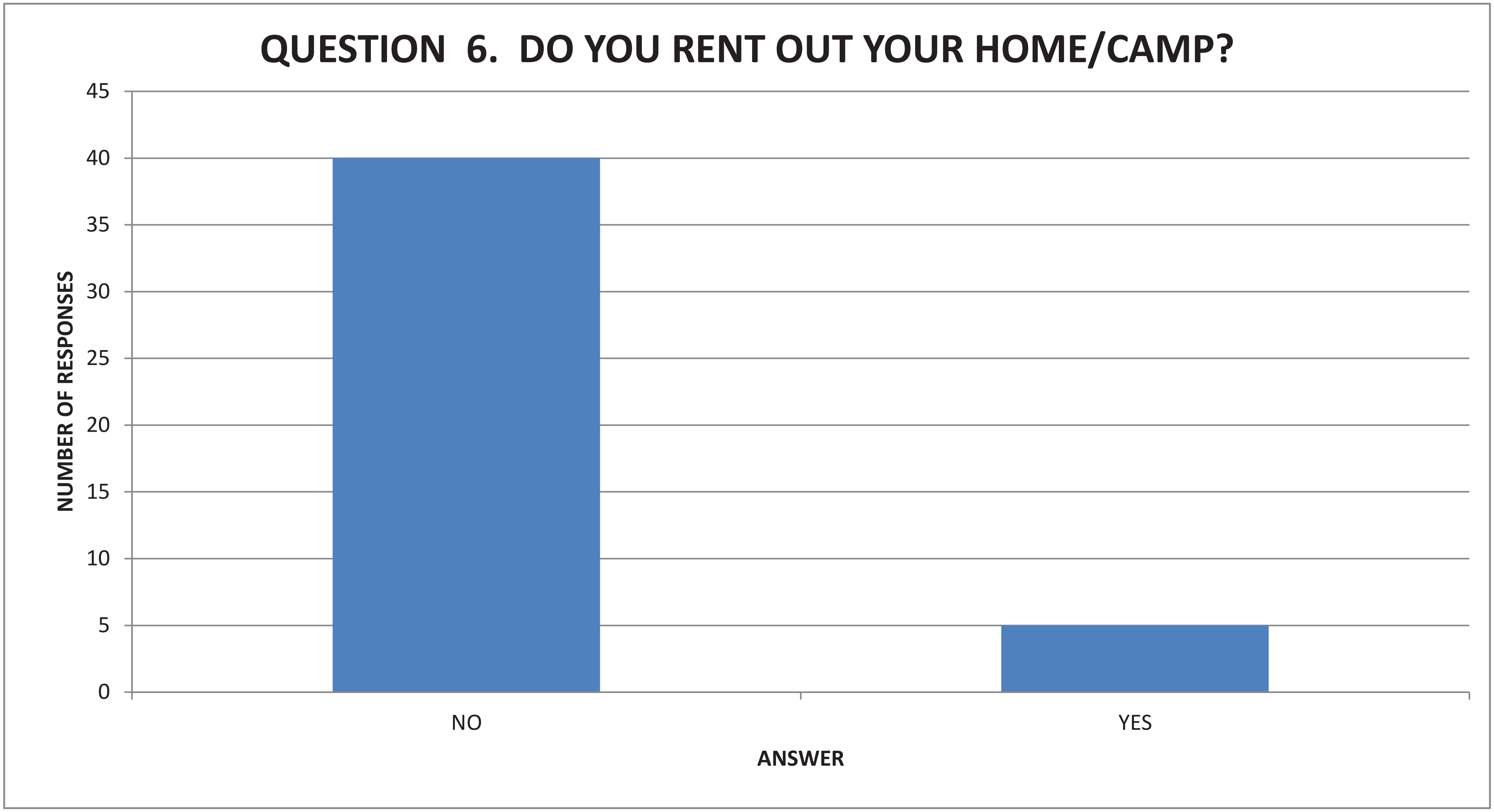
QUESTION 2. TYPE OF WASTEWATER SYSTEM

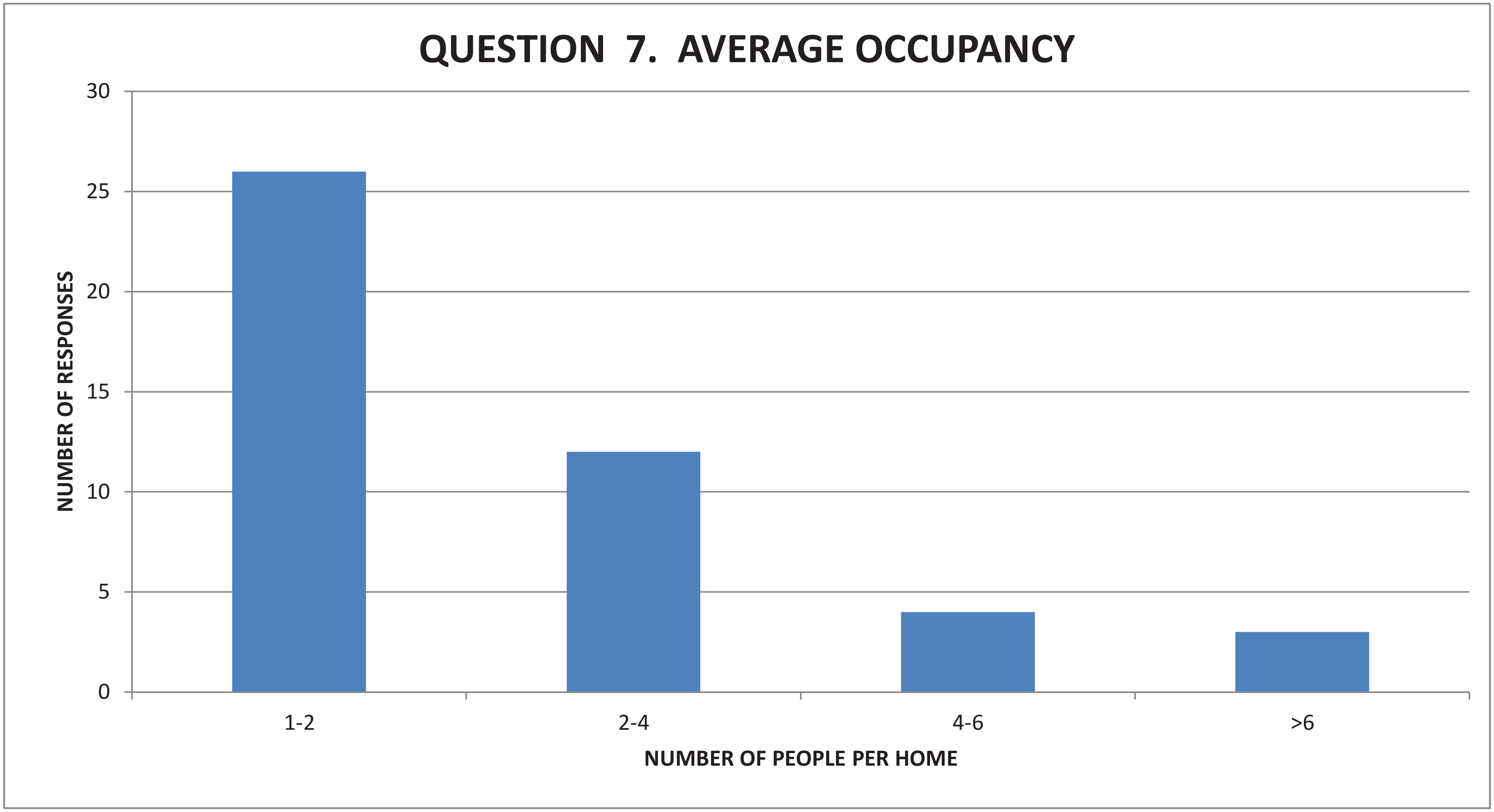



QUESTION 3. AGE OF WASTEWATER SYSTEM
NUMBER OF RESPONSES
14
12
10
8
6
4
2
0
1-10 YRS
10-15
15-20
20-25
>25
DON'T KNOW
YEARS

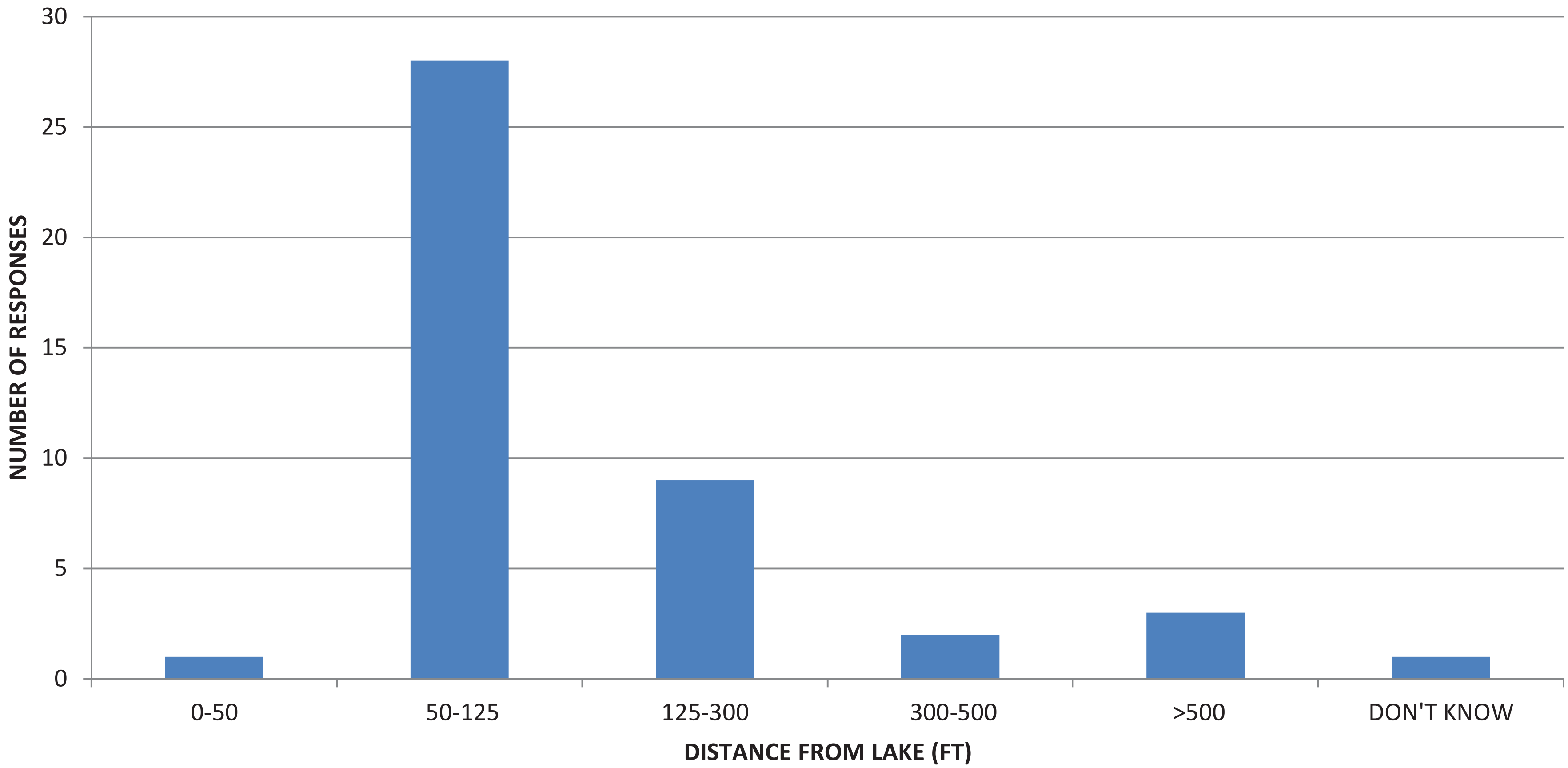

QUESTION 4. AGE OF HOME
NUMBER OF RESPONSES
30
25
20
15
10
5
0
1-10 YRS
10-15
15-20
20-25
>25
DON'T KNOW
YEARS


QUESTION 5. USE OF HOME
NUMBER OF RESPONSES
35
30
25
20
15
10
5
0
YEAR-ROUND
>1 SEASON
SEASONAL (<90 DAYS/YR)

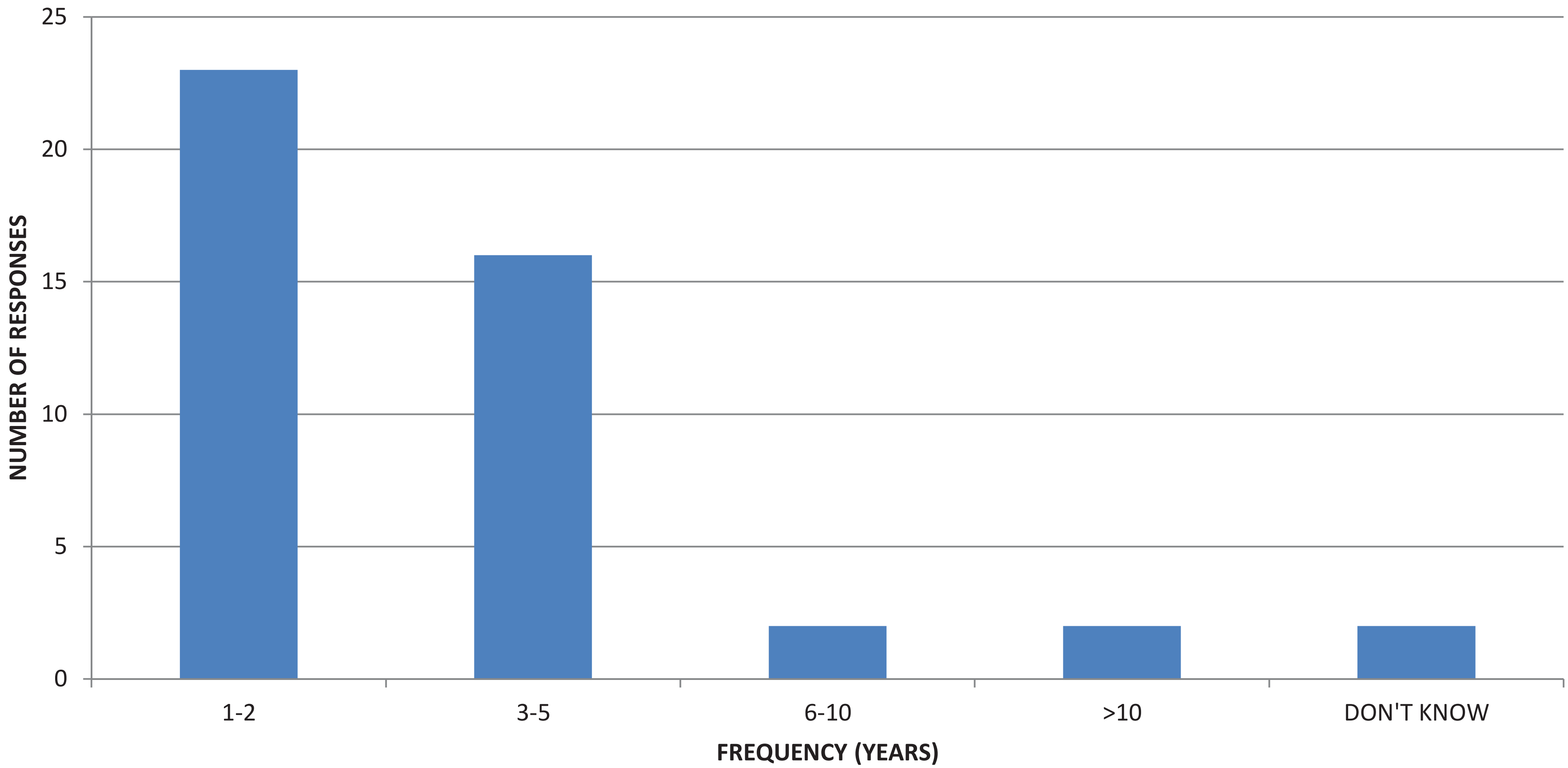

QUESTION 6. DO YOU RENT OUT YOUR HOME/CAMP?
NUMBER OF RESPONSES
45
40
35
30
25
20
15
10
5
0
NO
YES
ANSWER


QUESTION 7. AVERAGE OCCUPANCY
NUMBER OF RESPONSES
30
25
20
15
10
5
0
1-2
2-4
4-6
>6
NUMBER OF PEOPLE PER HOME

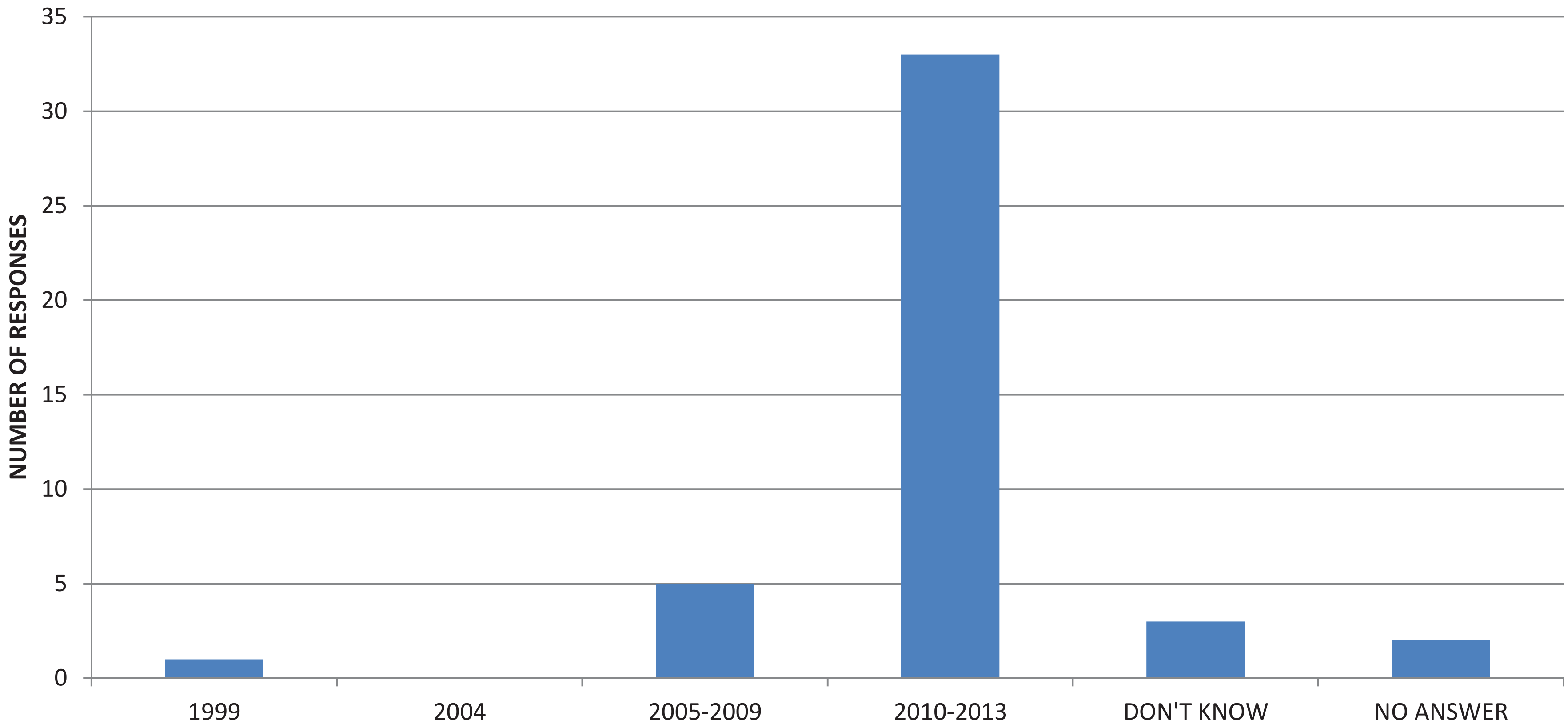
QUESTION 8. DISTANCE OF WASTEWATER SYSTEM FROM LAKE

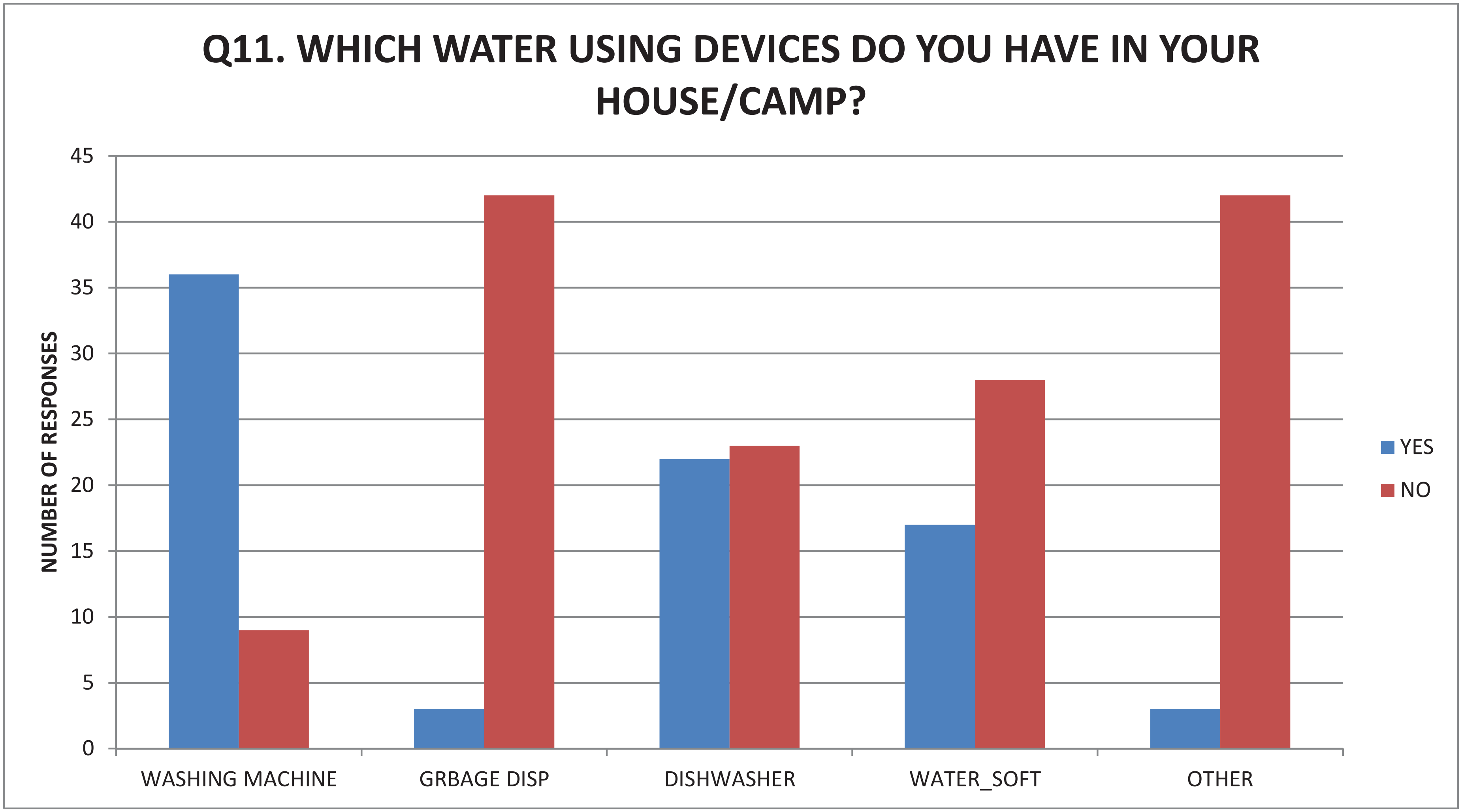


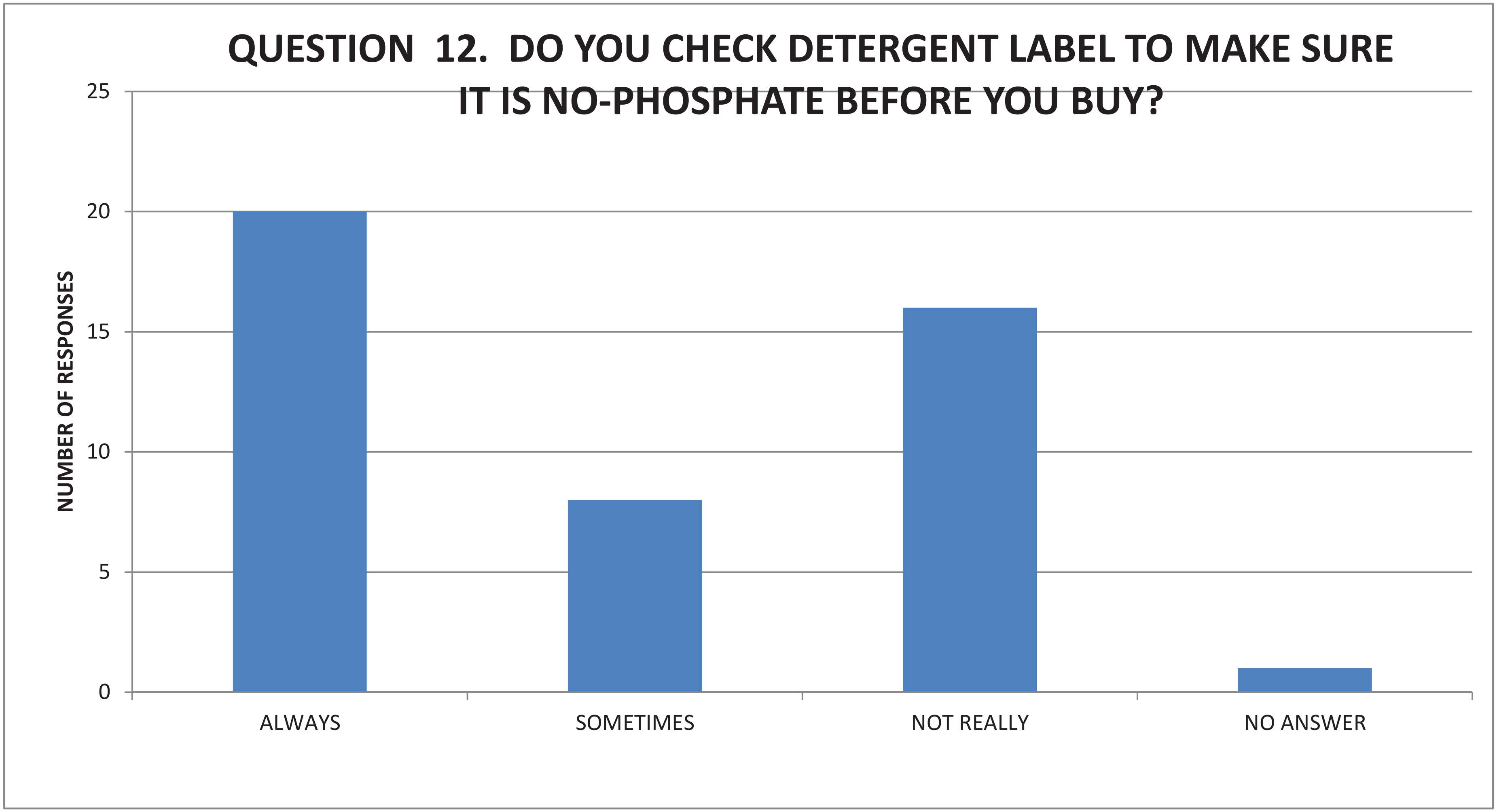
QUESTION 9. HOW OFTEN IS WASTEWATER SYSTEM PUMPED?

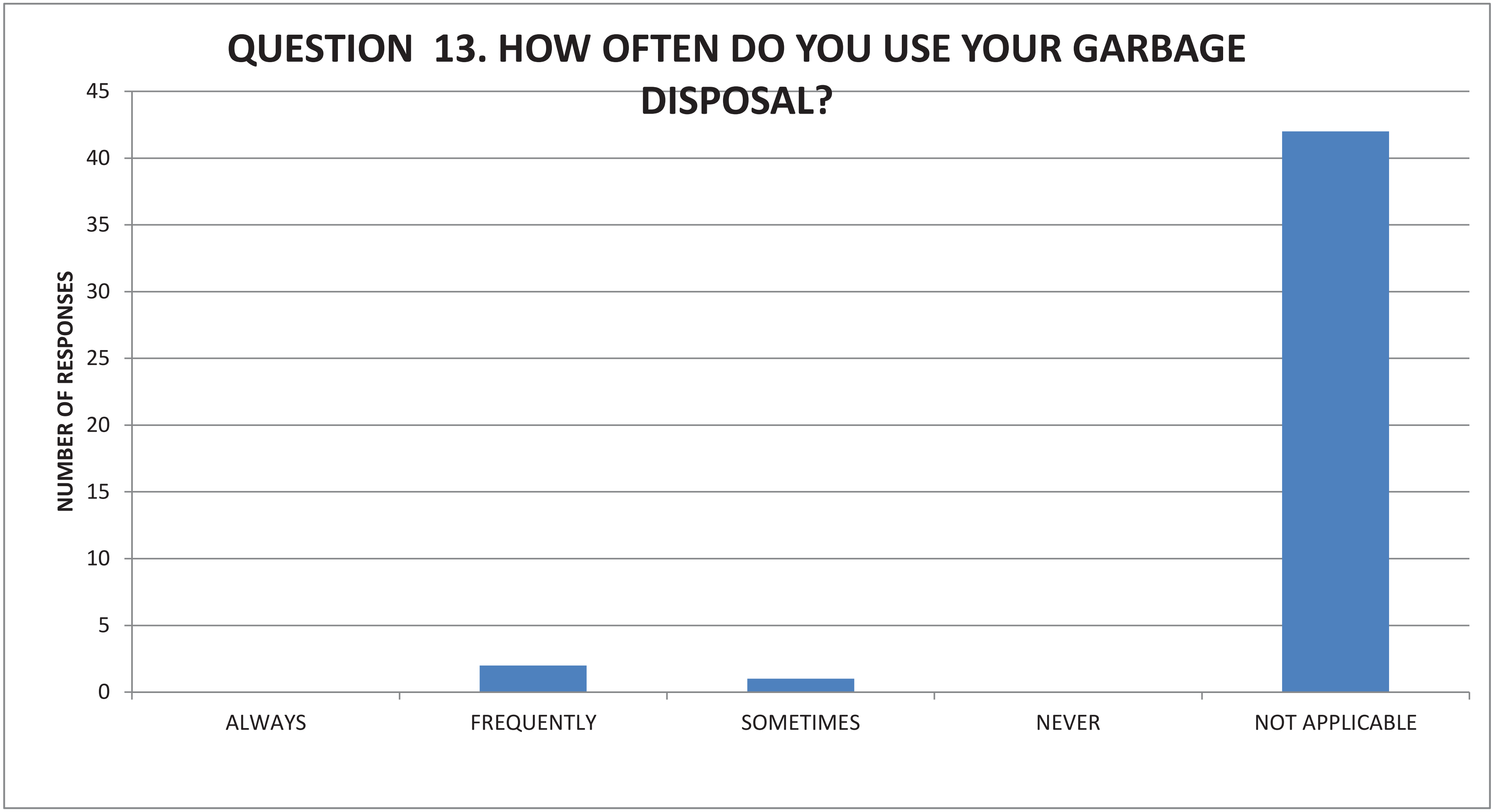


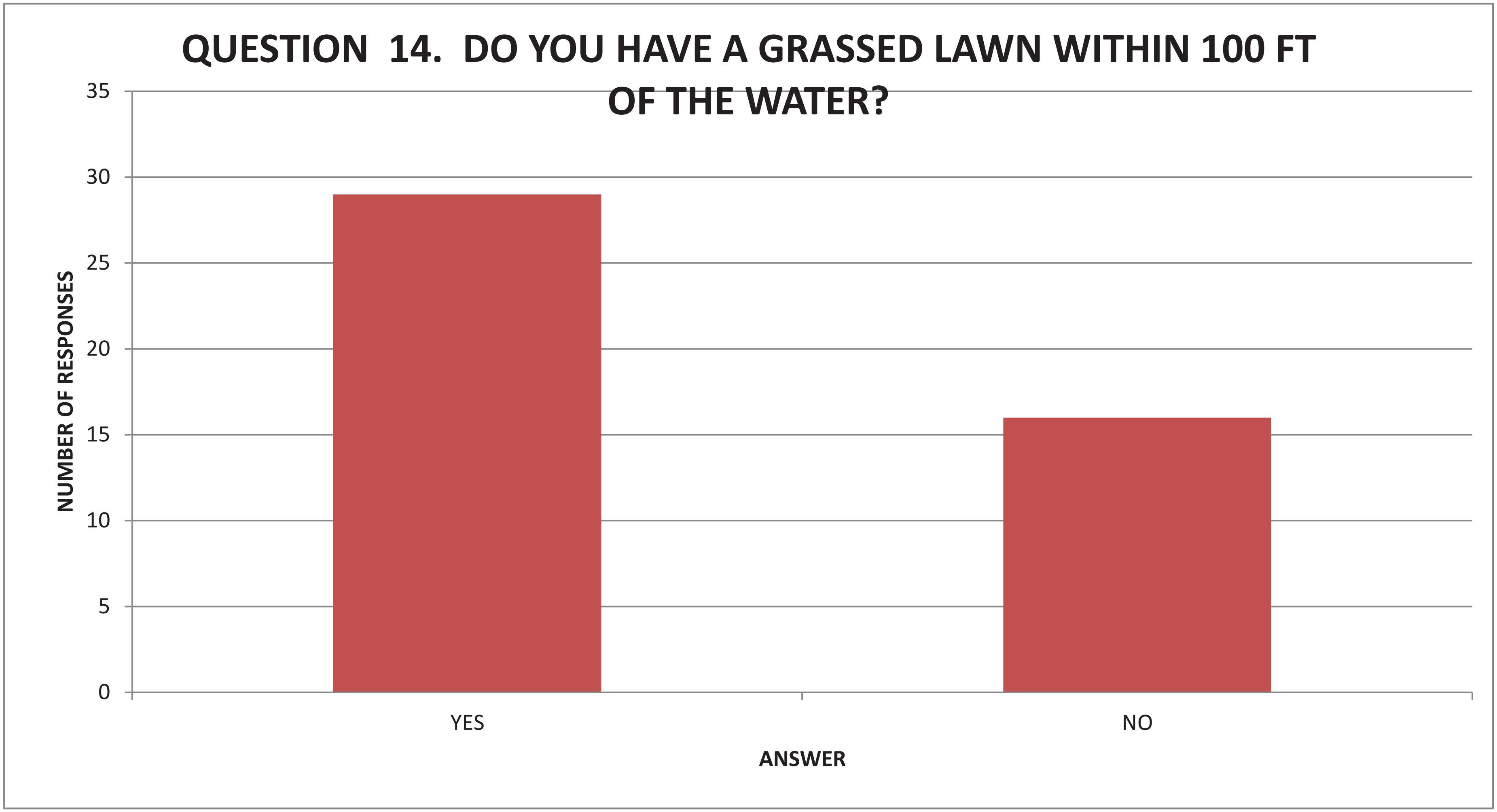
QUESTION 10. YEAR WASTEWATER SYSTEM LAST PUMPED

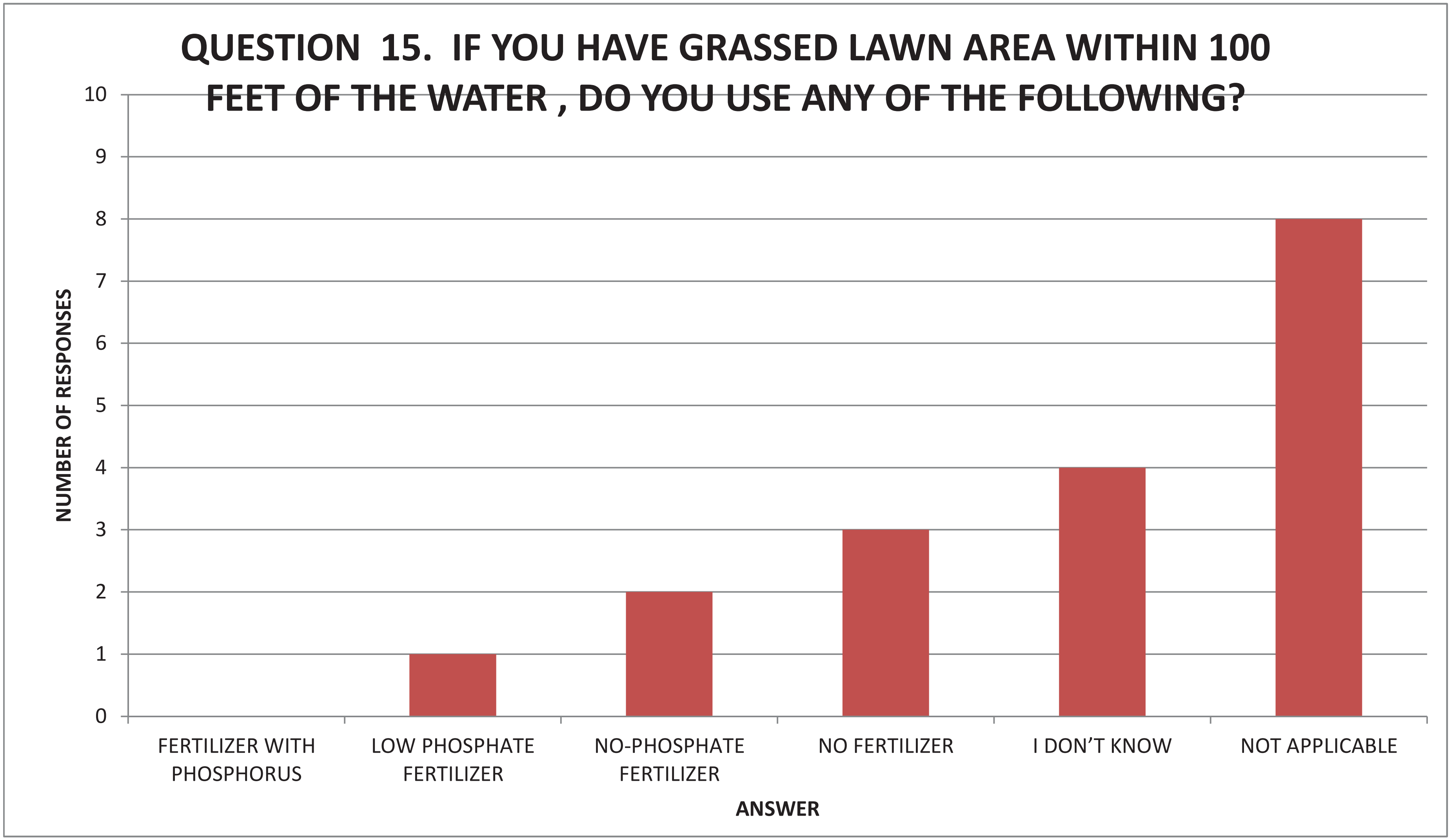



Q11. WHICH WATER USING DEVICES DO YOU HAVE IN YOUR HOUSE/CAMP?
NUMBER OF RESPONSES
45
40
35
30
25
20
15
10
5
0
WASHING MACHINE
GRBAGE DISP
DISHWASHER
WATER_SOFT
OTHER
YES
NO

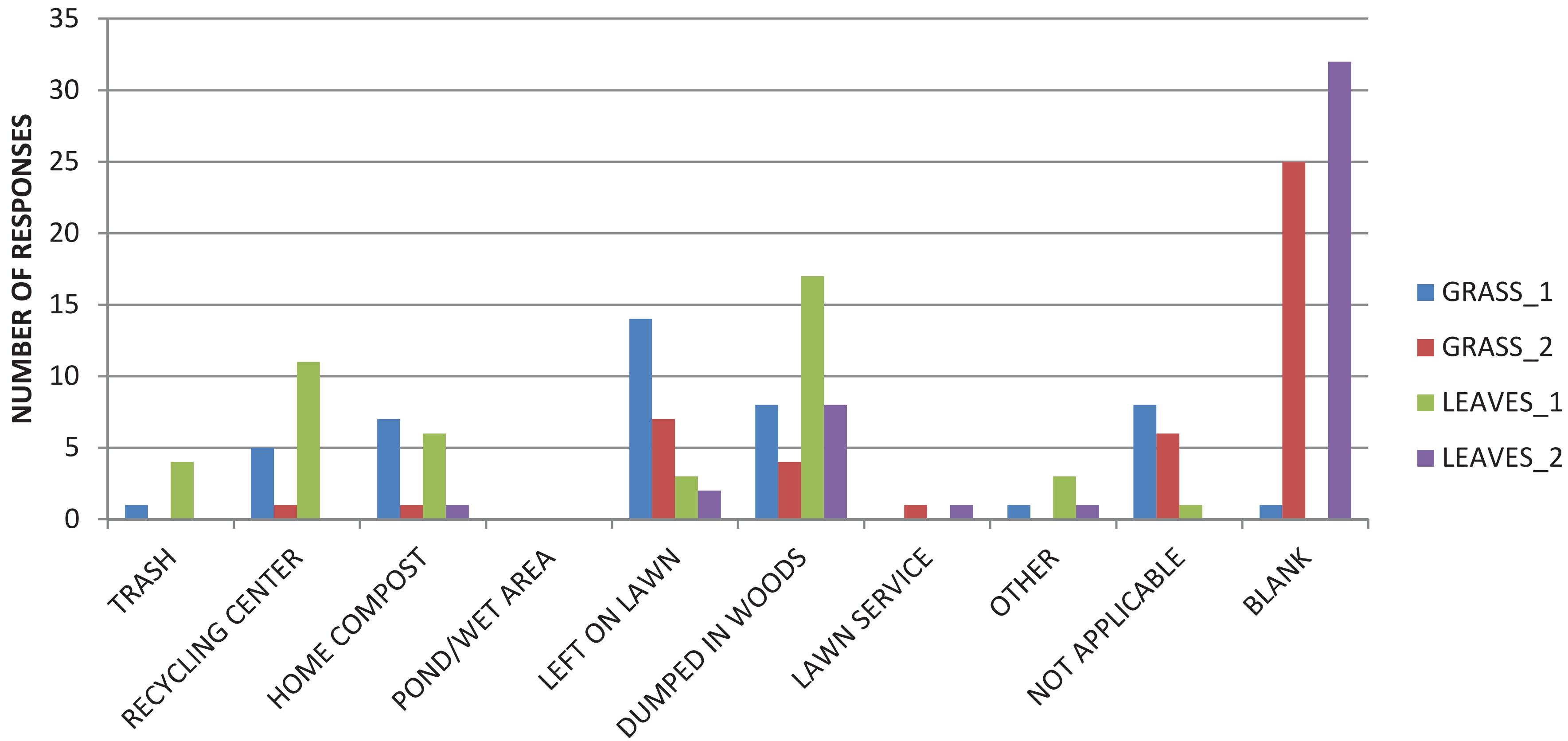

QUESTION 12. DO YOU CHECK DETERGENT LABEL TO MAKE SURE IT IS NO-PHOSPHATE BEFORE YOU BUY?
NUMBER OF RESPONSES
25
20
15
10
5
0
ALWAYS
SOMETIMES
NOT REALLY
NO ANSWER

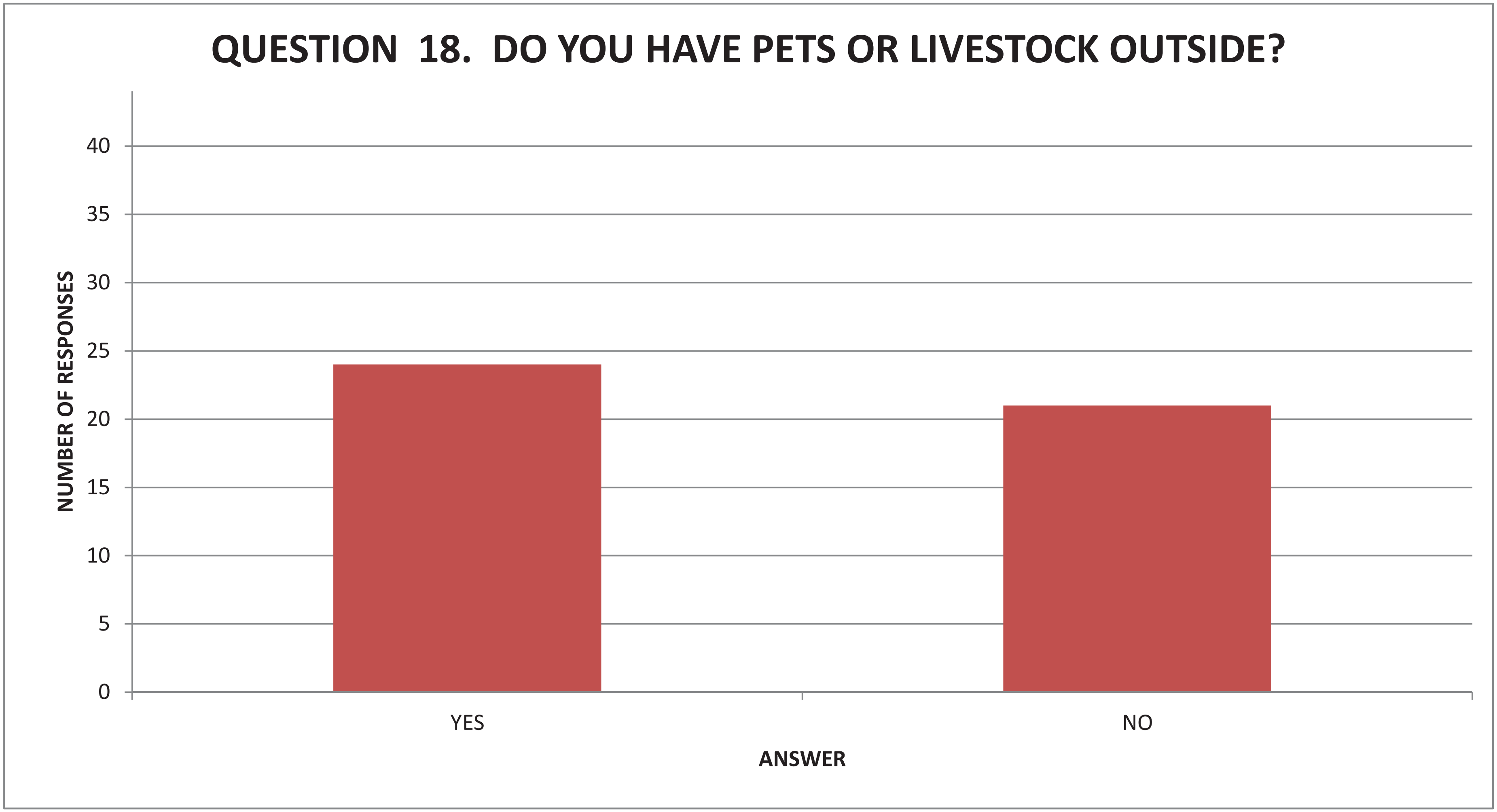

QUESTION 13. HOW OFTEN DO YOU USE YOUR GARBAGE DISPOSAL?
NUMBER OF RESPONSES
45
40
35
30
25
20
15
10
5
0
ALWAYS
FREQUENTLY
SOMETIMES
NEVER
NOT APPLICABLE


QUESTION 14. DO YOU HAVE A GRASSED LAWN WITHIN 100 FT OF THE WATER?
NUMBER OF RESPONSES
35
30
25
20
15
10
5
0
YES
NO
ANSWER

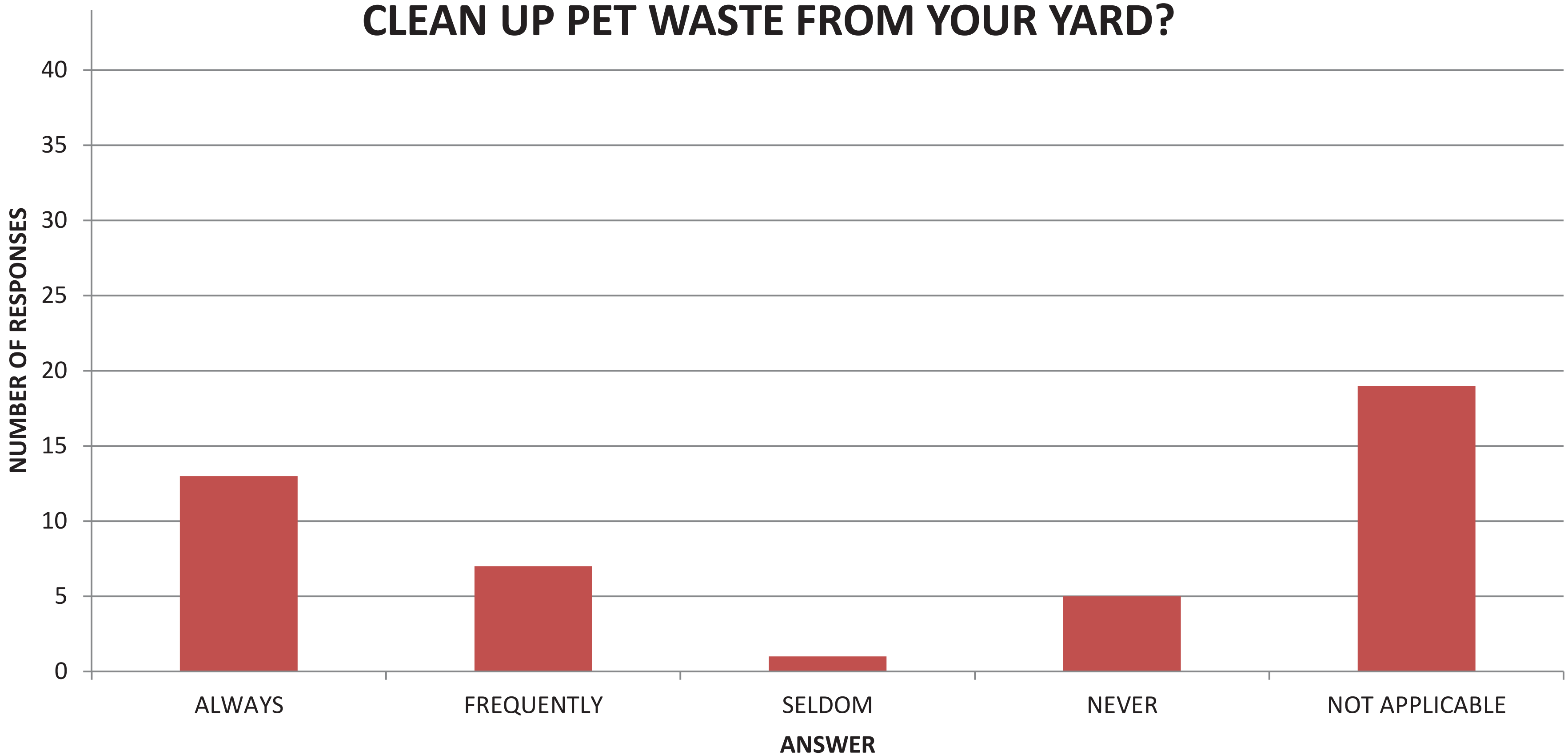

QUESTION 15. IF YOU HAVE GRASSED LAWN AREA WITHIN 100 FEET OF THE WATER , DO YOU USE ANY OF THE FOLLOWING?
NUMBER OF RESPONSES
0
1
2
3
4
5
6
7
8
9
10
FERTILIZER WITH PHOSPHORUS
LOW PHOSPHATE FERTILIZER
NO-PHOSPHATE FERTILIZER
NO FERTILIZER
I DON'T KNOW
NOT APPLICABLE
ANSWER

Q16, 17. HOW DO YOU DISPOSE OF GRASS CLIPPINGS/LEAVES? TOP TWO CHOICES

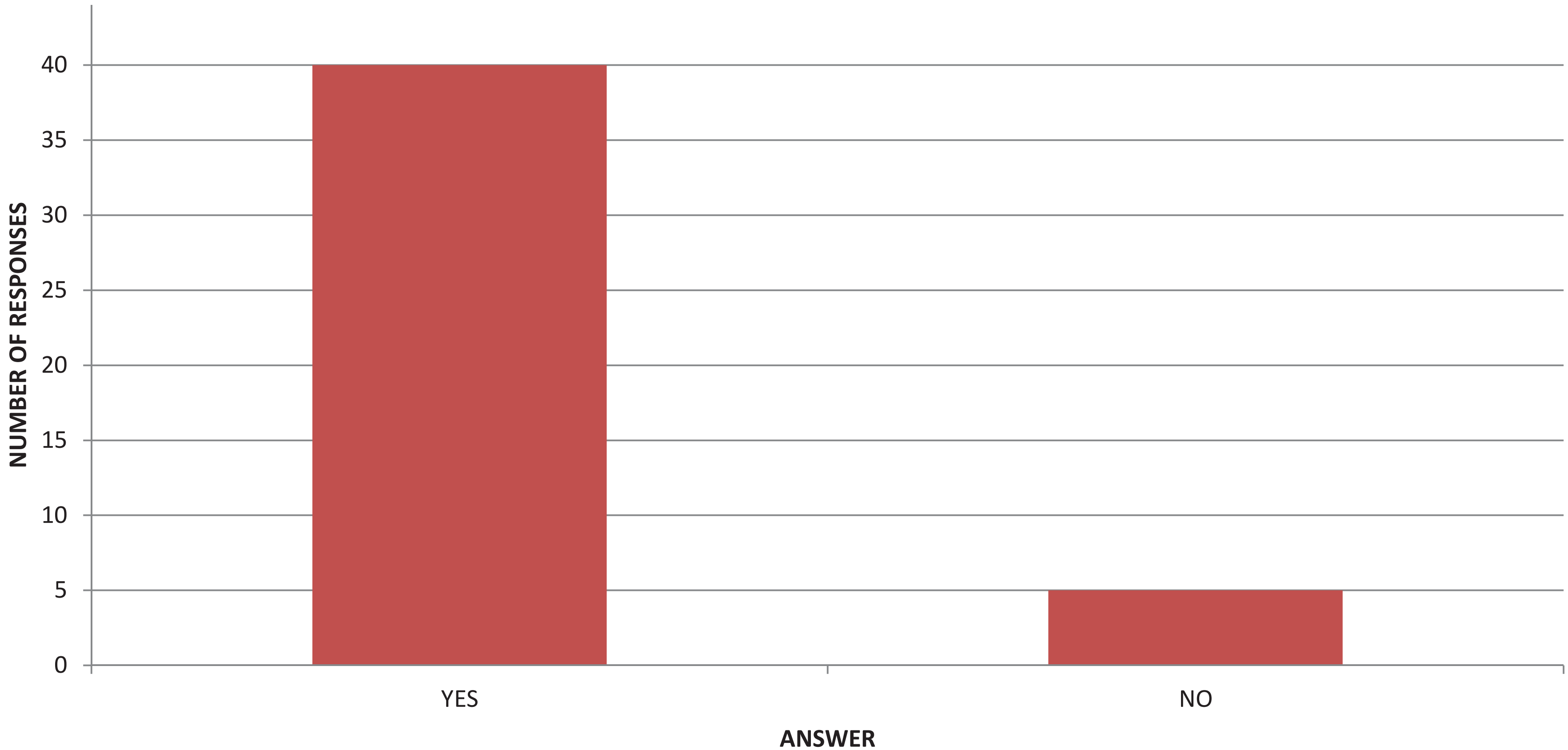



QUESTION 18. DO YOU HAVE PETS OR LIVESTOCK OUTSIDE?
NUMBER OF RESPONSES
0
5
10
15
20
25
30
35
40
YES
NO
ANSWER

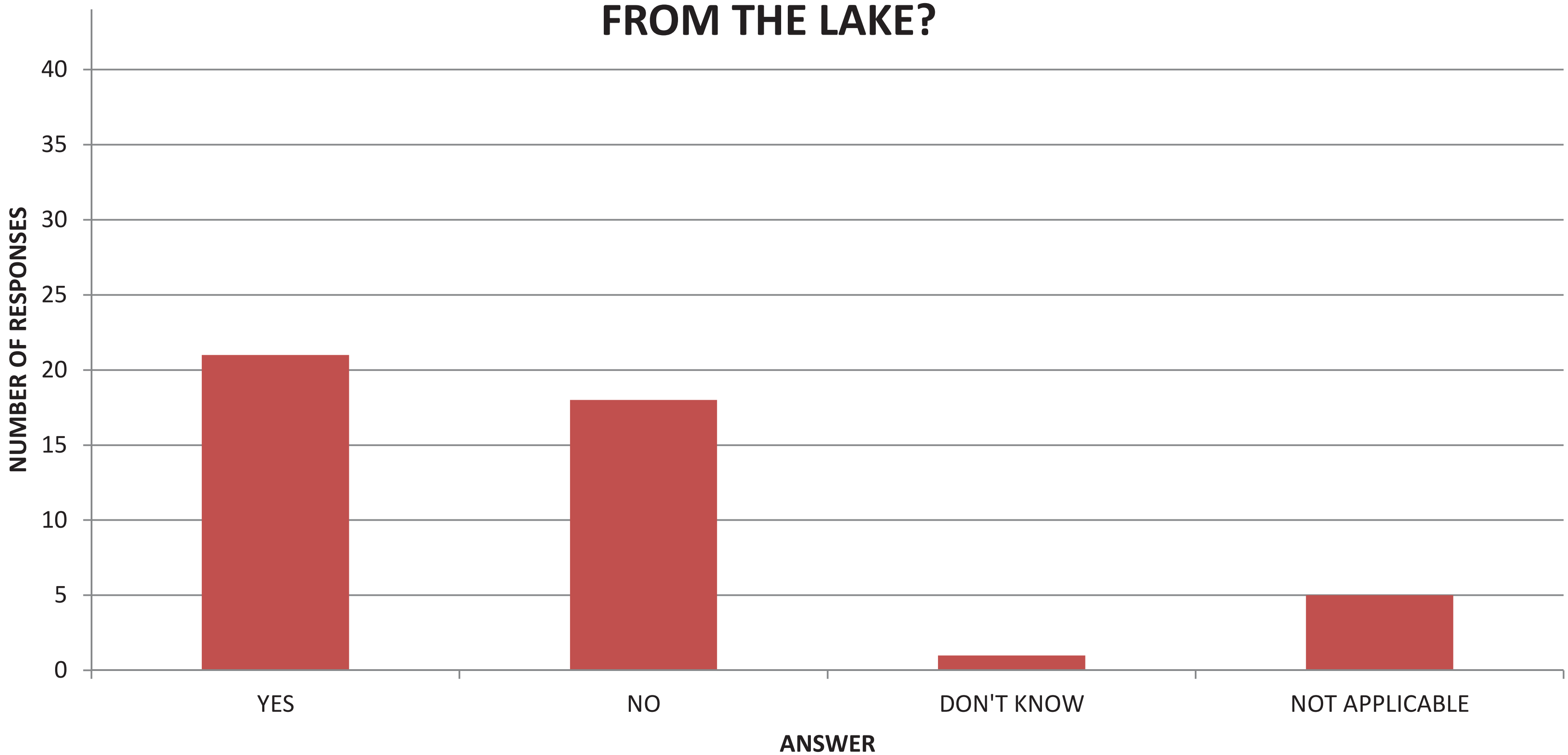
QUESTION 19. IF YOU HAVE PETS OUTSIDE, HOW OFTEN DO YOU CLEAN UP PET WASTE FROM YOUR YARD?

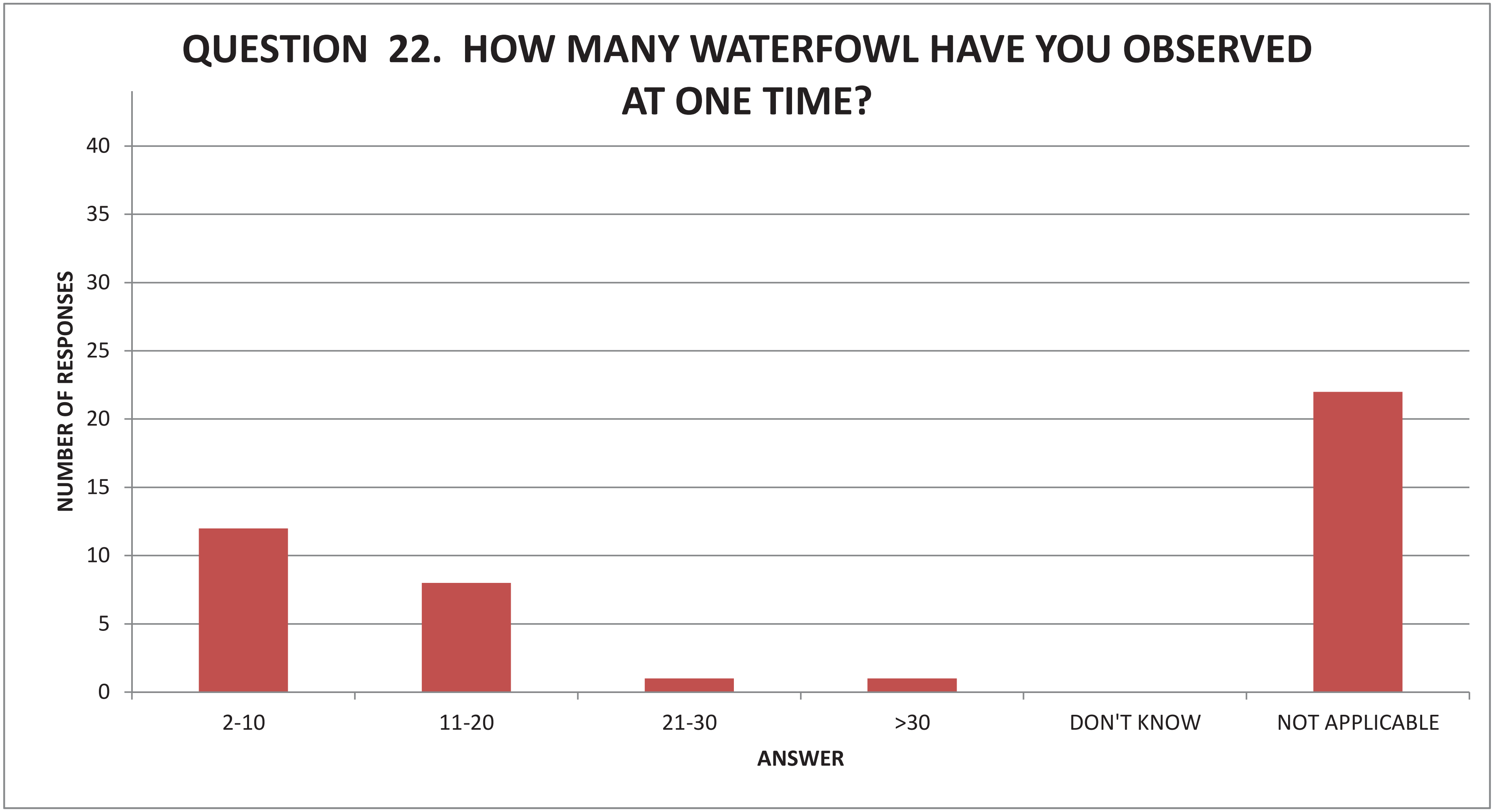


QUESTION 20. DO YOU HAVE DIRECT SHORELINE ACCESS?

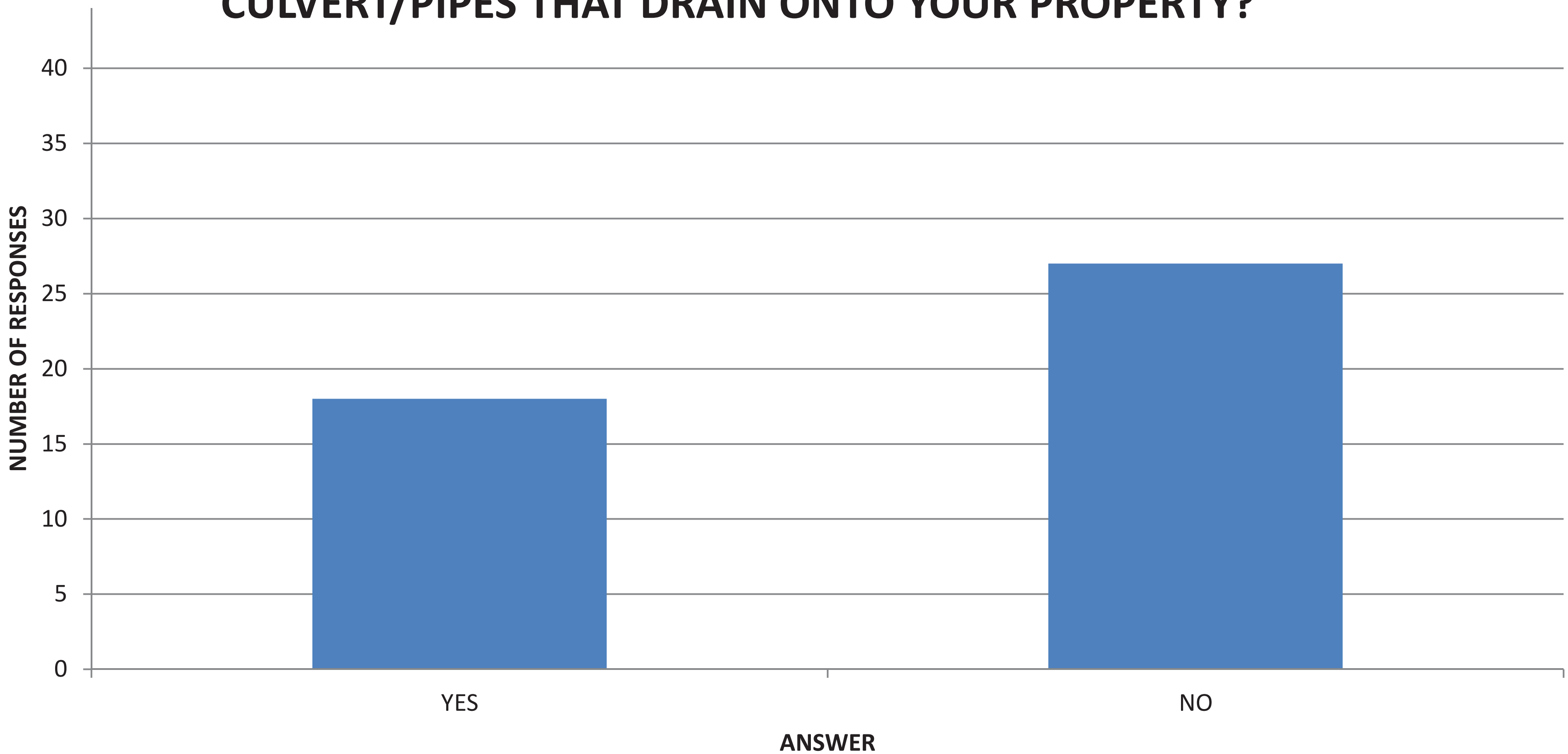


QUESTION 21. DO WATERFOWL OFTEN ACCESS YOUR PROPERTY FROM THE LAKE?

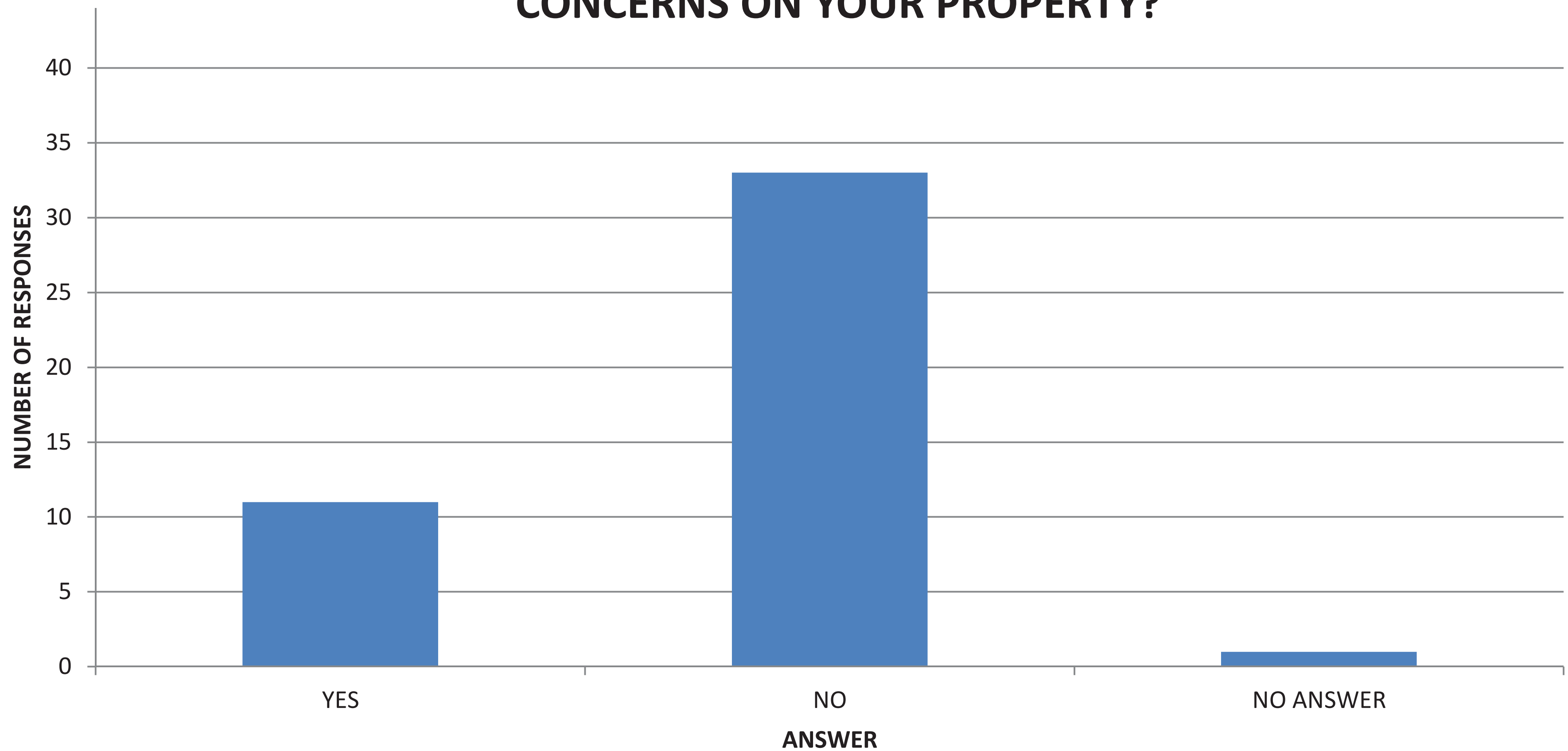



QUESTION 22. HOW MANY WATERFOWL HAVE YOU OBSERVED AT ONE TIME?
NUMBER OF RESPONSES
0
5
10
15
20
25
30
35
40
2-10
11-20
21-30
>30
DON'T KNOW
NOT APPLICABLE
ANSWER

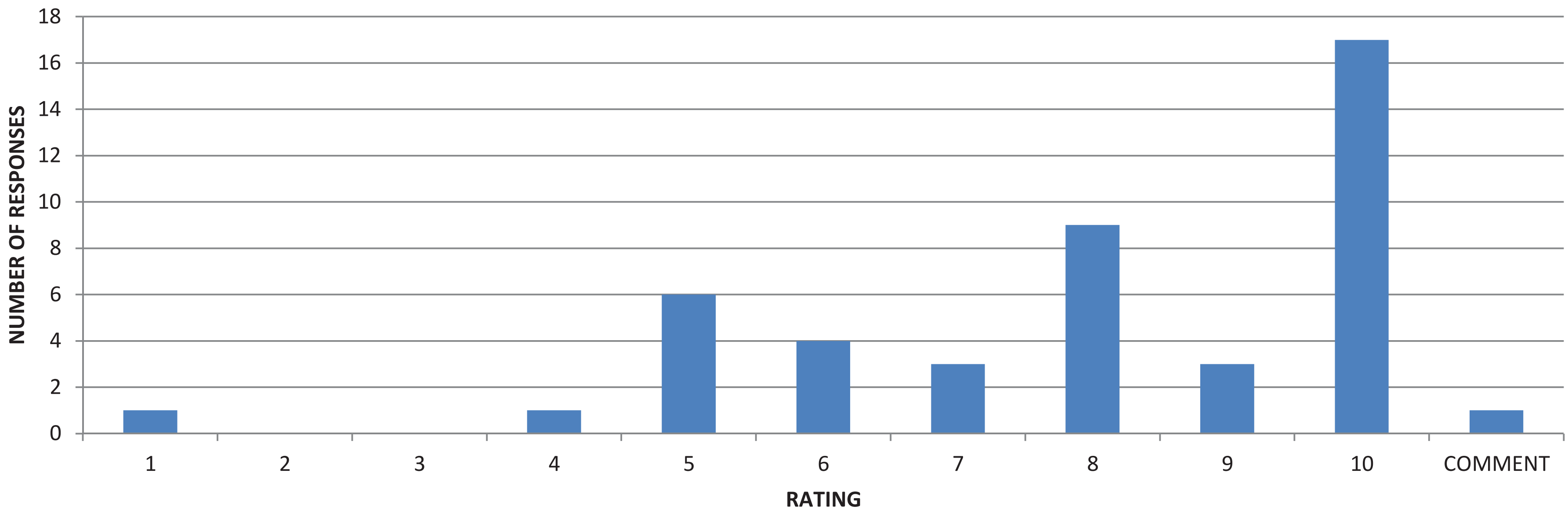
QUESTION 23. DO YOU HAVE ROAD DRAINAGE OR CULVERT/PIPES THAT DRAIN ONTO YOUR PROPERTY?



QUESTION 24. DO YOU EROSION ISSUES OR OTHER DRAINAGE CONCERNS ON YOUR PROPERTY?



Q25. HOW WILLING ARE YOU TO MAKE IMPROVEMENT TO YOUR PROPERTY TO HELP PROTECT PEARLY POND'S WATER QUALITY? (10=MOST WILLING)



Appendix B
Pearly Pond Water Quality Database from OneStop

Appendix B - Pearly Pond Water Quality Database from OneStop
In-Pond Samples

PROJECT_NAME	STATION_ID	ACTIVITY_ID	START_DATE	DEPTH ZONE	DEPTH	TOTAL PHOSPHORUS (MG/L)	CHLOROPHYLL A, UNCORRECTED FOR PHEOPHYTIN (UG/L)	DISSOLVED OXYGEN (MG/L)	DISSOLVED OXYGEN SATURATION (%)	TEMPERATURE (DEG C)	DEPTH (M)	DEPTH, BOTTOM (M)	SECCHI DISK TRANSPARENCY (M)	TOTAL MAGNESIUM (MG/L)	SODIUM (MG/L)	PH	SPECIFIC CONDUCTANCE (UMHO/CM)	ESCHERICHIA COLI (#/100ML)	MERCURY (PPM WET)	POTASSIUM (MG/L)	2,4-DICHLOROPHENOXYACETIC ACID (2,4-D) (UG/L)	VASCULAR PLANT ABUNDANCE	NITROGEN, NITRITE (NO2) + NITRATE (NO3) AS N (MG/L)	NITROGEN, NITRITE (NO2) + NITRATE (NO3) AS N QUALIFIER	GRAN ACID NEUTRALIZING CAPACITY (MG/L)
LAKE TROPHIC SURVEYS	PEARIND	WDO02159101	02/15/1991		3.50			7.6																	
LAKE TROPHIC SURVEYS	PEARIN-GEN	LB08079001	08/07/1990																						
LAKE TROPHIC SURVEYS	PEARIND	LP08079011	08/07/1990		0.10			6.6	76	23.2	3.4														
LAKE TROPHIC SURVEYS	PEARIND	LP08079012	08/07/1990		1			6.6	76	23.2	3.4														
LAKE TROPHIC SURVEYS	PEARIND	LP08079013	08/07/1990		2			6.6	76	23.2	3.4														
LAKE TROPHIC SURVEYS	PEARIND	LP08079014	08/07/1990		3			6.4	74	23.2	3.4														
LAKE TROPHIC SURVEYS	PEARIND	SP07117704	07/11/1977	COMPOSITE			22.86																		
LAKE TROPHIC SURVEYS	PEARIND	SP08079004	08/07/1990	COMPOSITE			22.75																		
LAKE TROPHIC SURVEYS	PEARIND	LC03087604	03/08/1976	UPPER	1	0.046																	0.1		
LAKE TROPHIC SURVEYS	PEARIND	LC07117702	07/11/1977	UPPER	2.50	0.068							1	0.6	6	6	51			0.6		SCATTEI	0.05	<	
LAKE TROPHIC SURVEYS	PEARIND	LC08079001	08/07/1990	UPPER	1	0.037							1	0.58	8.2	5.8	59.4			1.2		ABUNDA	0.05	<	
LAKE TROPHIC SURVEYS	PEARIND	LC08079003	08/07/1990	LOWER	2.50	0.034										5.7	60.1						0.05	<	
LAKE TROPHIC SURVEYS	PEARIND	LC02089101	02/08/1991	UPPER	1	0.032										5.1	57						0.11		
LAKE TROPHIC SURVEYS	PEARIND	LC02089102	02/08/1991	LOWER	3	0.001										5.2	67.9						0.09		
LAKE TROPHIC SURVEYS	PEARIND	VT07117702	07/11/1977		3.50			0.3																	
LAKE TROPHIC SURVEYS	PEARIND	2004-2843	07/20/2004	HYPOLIMNION	4	0.028										5.67	93.26						0.05	<	
LAKE TROPHIC SURVEYS	PEARIND	2004-2844	07/20/2004	COMPOSITE	4		10.97																		
LAKE TROPHIC SURVEYS	PEARIND	2004-2842	07/20/2004	EPILIMNION	2	0.02							1	0.616	13	5.66	91.98			0.591		COMM	0.05	<	
LAKE TROPHIC SURVEYS	PEARIND	BLP07200409	07/20/2004		0.10			7.93	95.8	24.9	5.4														
LAKE TROPHIC SURVEYS	PEARIND	BLP07200410	07/20/2004		1			7.51	90	24.4	5.4														
LAKE TROPHIC SURVEYS	PEARIND	BLP07200411	07/20/2004		2			4.71	54	22.1	5.4														
LAKE TROPHIC SURVEYS	PEARIND	BLP07200412	07/20/2004		3			3.68	41.5	21.2	5.4														
LAKE TROPHIC SURVEYS	PEARIND	BLP07200413	07/20/2004		4			0.75	8.2	19.6	5.4														
LAKE TROPHIC SURVEYS	PEARIND	BLP07200414	07/20/2004		5			0.74	7.6	16.2	5.4														
LAKE TROPHIC SURVEYS	PEARINEC01	2004-2846	07/20/2004															10							
LAKE TROPHIC SURVEYS	PEARINEC02	2004-2847	07/20/2004															10							
LAKE TROPHIC SURVEYS	PEARIND	2005-235	02/03/2005	UPPER	2	0.02										5.32	102.7						0.05	<	
LAKE TROPHIC SURVEYS	PEARIND	2005-243	02/03/2005	LOWER	4	0.022										5.42	122.7						0.05	<	
LAKE TROPHIC SURVEYS	PEARIND	2005-244	02/03/2005		5			5.5	42	3.7															
LAKE TROPHIC SURVEYS	PEARIN-GEN	LB08079004	08/07/1990																						
VOLUNTEER LAKE ASSESSMENT PROGRAM	PEARIND	VL06099208	06/09/1992		0.10			10.2	115.1	21	3.5														
VOLUNTEER LAKE ASSESSMENT PROGRAM	PEARIND	VL06099209	06/09/1992		0.50			10.1	112.9	20.5	3.5														
VOLUNTEER LAKE ASSESSMENT PROGRAM	PEARIND	VL06099210	06/09/1992		1			10.1	112.9	20.5	3.5														
VOLUNTEER LAKE ASSESSMENT PROGRAM	PEARIND	VL06099211	06/09/1992		1.50			9.6	106.2	20	3.5														
VOLUNTEER LAKE ASSESSMENT PROGRAM	PEARIND	VL06099212	06/09/1992		2			7.8	82.8	18	3.5														
VOLUNTEER LAKE ASSESSMENT PROGRAM	PEARIND	VL06099213	06/09/1992		2.50			7.2	74.8	17	3.5														
VOLUNTEER LAKE ASSESSMENT PROGRAM	PEARIND	VL06099214	06/09/1992		3			6.9	71.6	17	3.5														
VOLUNTEER LAKE ASSESSMENT PROGRAM	PEARIND	VL06099215	06/09/1992		3.50			6.1	63.1	16.8	3.5														
VOLUNTEER LAKE ASSESSMENT PROGRAM	PEARIND	VL06099227	06/09/1992	EPILIMNION	1	0.041										6.31	67.3								
VOLUNTEER LAKE ASSESSMENT PROGRAM	PEARIND	VL06099228	06/09/1992	HYPOLIMNION	3	0.033										5.86	68.6								
VOLUNTEER LAKE ASSESSMENT PROGRAM	PEARIN-GEN	VL06099234	06/09/1992			0.058										5.99	96								
VOLUNTEER LAKE ASSESSMENT PROGRAM	PEARIN-GEN	VL06099245	06/09/1992															39							
VOLUNTEER LAKE ASSESSMENT PROGRAM	PEARIND	VL06099247	06/09/1992	COMPOSITE			42.44						1												
VOLUNTEER LAKE ASSESSMENT PROGRAM	PEARIN-GEN	VL07149227	07/14/1992			0.059										5.07	66.4								
VOLUNTEER LAKE ASSESSMENT PROGRAM	PEARIND	VL07149228	07/14/1992	EPILIMNION	1	0.045										6.14	66.7								
VOLUNTEER LAKE ASSESSMENT PROGRAM	PEARIND	VL07149231	07/14/1992	HYPOLIMNION	3	0.04										5.95	68.1								
VOLUNTEER LAKE ASSESSMENT PROGRAM	PEARIND	VL07149255	07/14/1992	COMPOSITE			42.82						0.7												
VOLUNTEER LAKE ASSESSMENT PROGRAM	PEARIND	VL08309233	08/30/1992	EPILIMNION	1	0.074										6.07	66.7								
VOLUNTEER LAKE ASSESSMENT PROGRAM	PEARIND	VL08309234	08/30/1992	HYPOLIMNION	3	0.036										5.76	66.8								
VOLUNTEER LAKE ASSESSMENT PROGRAM	PEARIN-GEN	VL08309236	08/30/1992			0.039										4.89	71.5								
VOLUNTEER LAKE ASSESSMENT PROGRAM	PEARIN-GEN	VL08309250	08/30/1992															20							
VOLUNTEER LAKE ASSESSMENT PROGRAM	PEARIND	VL08309253	08/30/1992	COMPOSITE			20.52						1												
VOLUNTEER LAKE ASSESSMENT PROGRAM	PEARIND	VL06229306	06/22/1993		0.10			8.8	97	21.7	3.5														
VOLUNTEER LAKE ASSESSMENT PROGRAM	PEARIND	VL06229307	06/22/1993		1			8.8	97	21.5	3.5														
VOLUNTEER LAKE ASSESSMENT PROGRAM	PEARIND	VL06229308	06/22/1993		2			8.4	94	21.2	3.5														
VOLUNTEER LAKE ASSESSMENT PROGRAM	PEARIND	VL06229309	06/22/1993		3			7.8	83	19	3.5														
VOLUNTEER LAKE ASSESSMENT PROGRAM	PEARIND	VL06229310	06/22/1993		3.50			0.3	3	18	3.5														
VOLUNTEER LAKE ASSESSMENT PROGRAM	PEARIND	VL06229312	06/22/1993	EPILIMNION	1	0.031										5.83	68.3								
VOLUNTEER LAKE ASSESSMENT PROGRAM	PEARIND	VL06229314	06/22/1993	HYPOLIMNION	3	0.031										5.81	69.1								

Appendix B - Pearly Pond Water Quality Database from OneStop
In-Pond Samples

PROJECT_NAME	STATION_ID	ACTIVITY_ID	START_DATE	DEPTH ZONE	DEPTH	TOTAL PHOSPHORUS (MG/L)	CHLOROPHYLL A, UNCORRECTED FOR PHEOPHYTIN (UG/L)	DISSOLVED OXYGEN (MG/L)	DISSOLVED OXYGEN SATURATION (%)	TEMPERATURE (DEG C)	DEPTH (M)	DEPTH, BOTTOM (M)	SECCHI DISK TRANSPARENCY (M)	TOTAL MAGNESIUM (MG/L)	SODIUM (MG/L)	PH	SPECIFIC CONDUCTANCE (UMHO/CM)	ESCHERICHIA COLI (#/100ML)	MERCURY (PPM WET)	POTASSIUM (MG/L)	2,4-DICHLOROPHENOXYACETIC ACID (2,4-D) (UG/L)	VASCULAR PLANT ABUNDANCE	NITROGEN, NITRITE (NO2) + NITRATE (NO3) AS N (MG/L)	NITROGEN, NITRITE (NO2) + NITRATE (NO3) AS N QUALIFIER	GRAN ACID NEUTRALIZING CAPACITY (MG/L)
VOLUNTEER LAKE ASSESSMENT PROGRAM	PEARIND	VL06229327	06/22/1993	COMPOSITE			22.87						1.6												
VOLUNTEER LAKE ASSESSMENT PROGRAM	PEARIND	VL08019328	08/01/1993	EPILIMNION	1	0.018										5.51	71.9								
VOLUNTEER LAKE ASSESSMENT PROGRAM	PEARIND	VL08019329	08/01/1993	HYPOLIMNION	3	0.031										5.73	72.2								
VOLUNTEER LAKE ASSESSMENT PROGRAM	PEARIN-GEN	VL08019333	08/01/1993			0.038										4.77	233.1								
VOLUNTEER LAKE ASSESSMENT PROGRAM	PEARIND	VL08019337	08/01/1993	COMPOSITE			10.54						1.8												
VOLUNTEER LAKE ASSESSMENT PROGRAM	PEARIN-GEN	VL06199416	06/19/1994			0.105										5.38	55.3								
VOLUNTEER LAKE ASSESSMENT PROGRAM	PEARIND	VL06199418	06/19/1994	EPILIMNION	1											6.02	71								
VOLUNTEER LAKE ASSESSMENT PROGRAM	PEARIND	VL06199419	06/19/1994	METALIMNION	2	0.027										5.85	71.8								
VOLUNTEER LAKE ASSESSMENT PROGRAM	PEARIND	VL06199420	06/19/1994	HYPOLIMNION	3	0.038										5.67	72								
VOLUNTEER LAKE ASSESSMENT PROGRAM	PEARIND	VL06199429	06/19/1994	COMPOSITE			8.03						1.6												
VOLUNTEER LAKE ASSESSMENT PROGRAM	PEARIND	VL07139401	07/13/1994		0.10			9.5	114	25	4.2														
VOLUNTEER LAKE ASSESSMENT PROGRAM	PEARIND	VL07139403	07/13/1994		0.50			9.5	112	24.9	4.2														
VOLUNTEER LAKE ASSESSMENT PROGRAM	PEARIND	VL07139404	07/13/1994		1			9.3	110	24.9	4.2														
VOLUNTEER LAKE ASSESSMENT PROGRAM	PEARIND	VL07139406	07/13/1994		1.50			8.7	102	24.5	4.2														
VOLUNTEER LAKE ASSESSMENT PROGRAM	PEARIND	VL07139407	07/13/1994		2			8.3	98	24.2	4.2														
VOLUNTEER LAKE ASSESSMENT PROGRAM	PEARIND	VL07139409	07/13/1994		2.50			5.6	65	23.5	4.2														
VOLUNTEER LAKE ASSESSMENT PROGRAM	PEARIND	VL07139410	07/13/1994		3			0.3	3	21.5	4.2														
VOLUNTEER LAKE ASSESSMENT PROGRAM	PEARIND	VL07139412	07/13/1994		3.50			0.3	3	20	4.2														
VOLUNTEER LAKE ASSESSMENT PROGRAM	PEARIND	VL07139413	07/13/1994		4			0.3	3	18	4.2														
VOLUNTEER LAKE ASSESSMENT PROGRAM	PEARIND	VL07139435	07/13/1994	EPILIMNION	1	0.072										6.25	72.5								
VOLUNTEER LAKE ASSESSMENT PROGRAM	PEARIND	VL07139437	07/13/1994	HYPOLIMNION	3.50	0.15										6.05	80.1								
VOLUNTEER LAKE ASSESSMENT PROGRAM	PEARIN-GEN	VL07139439	07/13/1994			0.077										5.05	103.3								
VOLUNTEER LAKE ASSESSMENT PROGRAM	PEARIN-GEN	VL07139442	07/13/1994															20							
VOLUNTEER LAKE ASSESSMENT PROGRAM	PEARIND	VL07139445	07/13/1994	COMPOSITE			26.16						0.8												
VOLUNTEER LAKE ASSESSMENT PROGRAM	PEARIND	VL08149422	08/14/1994	EPILIMNION	1	0.041										6.03	73.7								
VOLUNTEER LAKE ASSESSMENT PROGRAM	PEARIND	VL08149426	08/14/1994	HYPOLIMNION	3.50	0.044										5.95	77.6								
VOLUNTEER LAKE ASSESSMENT PROGRAM	PEARIN-GEN	VL08149437	08/14/1994			0.098										4.53	166.9								
VOLUNTEER LAKE ASSESSMENT PROGRAM	PEARIND	VL08149440	08/14/1994	COMPOSITE			22.57						1.4												
VOLUNTEER LAKE ASSESSMENT PROGRAM	PEARIN-GEN	VL08319407	08/31/1994			0.022																			
VOLUNTEER LAKE ASSESSMENT PROGRAM	PEARIN-GEN	VL08319409	08/31/1994			0.065																			
VOLUNTEER LAKE ASSESSMENT PROGRAM	PEARIND	VL06299501	06/29/1995		0.10			9.8	113	23	4.3														
VOLUNTEER LAKE ASSESSMENT PROGRAM	PEARIND	VL06299502	06/29/1995		0.50			9.8	110	22.5	4.3														
VOLUNTEER LAKE ASSESSMENT PROGRAM	PEARIND	VL06299503	06/29/1995		1			9.7	109	22.1	4.3														
VOLUNTEER LAKE ASSESSMENT PROGRAM	PEARIND	VL06299504	06/29/1995		1.50			9.4	107	22	4.3														
VOLUNTEER LAKE ASSESSMENT PROGRAM	PEARIND	VL06299505	06/29/1995		2			6.9	76	21.5	4.3														
VOLUNTEER LAKE ASSESSMENT PROGRAM	PEARIND	VL06299506	06/29/1995		2.50			3.1	34	20	4.3														
VOLUNTEER LAKE ASSESSMENT PROGRAM	PEARIND	VL06299507	06/29/1995		3			0.7	7	18.1	4.3														
VOLUNTEER LAKE ASSESSMENT PROGRAM	PEARIND	VL06299508	06/29/1995		3.50			0.1	1	17	4.3														
VOLUNTEER LAKE ASSESSMENT PROGRAM	PEARIND	VL06299509	06/29/1995		4			0.1	1	16	4.3														
VOLUNTEER LAKE ASSESSMENT PROGRAM	PEARIN-GEN	VL06299514	06/29/1995			0.019										6.51	36.4								
VOLUNTEER LAKE ASSESSMENT PROGRAM	PEARIND	VL06299521	06/29/1995	EPILIMNION	1	0.034										6.62	73.1								
VOLUNTEER LAKE ASSESSMENT PROGRAM	PEARIND	VL06299523	06/29/1995	HYPOLIMNION	3	0.053										5.89	76.2								
VOLUNTEER LAKE ASSESSMENT PROGRAM	PEARIN-GEN	VL06299524	06/29/1995			0.068										5.21	93.2								
VOLUNTEER LAKE ASSESSMENT PROGRAM	PEARIND	VL06299526	06/29/1995	COMPOSITE			29.83						0.8												
VOLUNTEER LAKE ASSESSMENT PROGRAM	PEARIND	VL07269541	07/26/1995	EPILIMNION	1	0.028										5.95	75								
VOLUNTEER LAKE ASSESSMENT PROGRAM	PEARIND	VL07269543	07/26/1995	HYPOLIMNION	3	0.036										5.93	76.5								
VOLUNTEER LAKE ASSESSMENT PROGRAM	PEARIND	VL07269554	07/26/1995	COMPOSITE			22.23						1.5												
VOLUNTEER LAKE ASSESSMENT PROGRAM	PEARIND	VL08289540	08/28/1995	EPILIMNION	1	0.032										6.46	78								
VOLUNTEER LAKE ASSESSMENT PROGRAM	PEARIND	VL08289541	08/28/1995	HYPOLIMNION	3.50	0.027										6.03	78.4								
VOLUNTEER LAKE ASSESSMENT PROGRAM	PEARIND	VL08289586	08/28/1995	COMPOSITE			14.93						1.4												
VOLUNTEER LAKE ASSESSMENT PROGRAM	PEARIND	VL06309606	06/30/1996	METALIMNION	2	0.04										5.84	62.8								
VOLUNTEER LAKE ASSESSMENT PROGRAM	PEARIND	VL06309607	06/30/1996	EPILIMNION	1	0.032										5.75	63.3								
VOLUNTEER LAKE ASSESSMENT PROGRAM	PEARIND	VL06309609	06/30/1996	HYPOLIMNION	3	0.047										5.72	65								
VOLUNTEER LAKE ASSESSMENT PROGRAM	PEARIND	VL06309610	06/30/1996	COMPOSITE			19.98						1.2												
VOLUNTEER LAKE ASSESSMENT PROGRAM	PEARIND	VL07319603	07/31/1996		0.10			7.8	88	22.6	5.4														
VOLUNTEER LAKE ASSESSMENT PROGRAM	PEARIND	VL07319607	07/31/1996		1			7.8	88	22.6															
VOLUNTEER LAKE ASSESSMENT PROGRAM	PEARIND	VL07319610	07/31/1996		2			7.6	86	22.5															
VOLUNTEER LAKE ASSESSMENT PROGRAM	PEARIND	VL07319613	07/31/1996		3			1.3	14	21.3															
VOLUNTEER LAKE ASSESSMENT PROGRAM	PEARIND	VL07319615	07/31/1996		4			0.2	2	19.4															

Appendix B - Pearly Pond Water Quality Database from OneStop
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PROJECT_NAME	STATION_ID	ACTIVITY_ID	START_DATE	DEPTH ZONE	DEPTH	TOTAL PHOSPHORUS (MG/L)	CHLOROPHYLL A, UNCORRECTED FOR PHEOPHYTIN (UG/L)	DISSOLVED OXYGEN (MG/L)	DISSOLVED OXYGEN SATURATION (%)	TEMPERATURE (DEG C)	DEPTH (M)	DEPTH, BOTTOM (M)	SECCHI DISK TRANSPARENCY (M)	TOTAL MAGNESIUM (MG/L)	SODIUM (MG/L)	PH	SPECIFIC CONDUCTANCE (UMHO/CM)	ESCHERICHIA COLI (#/100ML)	MERCURY (PPM WET)	POTASSIUM (MG/L)	2,4-DICHLOROPHENOXYACETIC ACID (2,4-D) (UG/L)	VASCULAR PLANT ABUNDANCE	NITROGEN, NITRITE (NO2) + NITRATE (NO3) AS N (MG/L)	NITROGEN, NITRITE (NO2) + NITRATE (NO3) AS N QUALIFIER	GRAN ACID NEUTRALIZING CAPACITY (MG/L)
VOLUNTEER LAKE ASSESSMENT PROGRAM	PEARIND	VL07319617	07/31/1996		5			0.3	3	16.2															
VOLUNTEER LAKE ASSESSMENT PROGRAM	PEARIND	VL07319647	07/31/1996	METALIMNION	3	0.031										5.54	63.1								
VOLUNTEER LAKE ASSESSMENT PROGRAM	PEARIND	VL07319648	07/31/1996	EPILIMNION	1	0.033										5.78	63.8								
VOLUNTEER LAKE ASSESSMENT PROGRAM	PEARIND	VL07319650	07/31/1996	HYPOLIMNION	4.50	0.109										6.21	76.8								
VOLUNTEER LAKE ASSESSMENT PROGRAM	PEARIND	VL07319668	07/31/1996	COMPOSITE			2.1						1.4												
VOLUNTEER LAKE ASSESSMENT PROGRAM	PEARIND	VL09159632	09/15/1996	METALIMNION	2	0.045										5.74	65.8								
VOLUNTEER LAKE ASSESSMENT PROGRAM	PEARIND	VL09159633	09/15/1996	HYPOLIMNION	4	0.032										5.84	66.2								
VOLUNTEER LAKE ASSESSMENT PROGRAM	PEARIND	VL09159634	09/15/1996	EPILIMNION	1	0.043										6.52	66.2								
VOLUNTEER LAKE ASSESSMENT PROGRAM	PEARIND	VL09159642	09/15/1996	COMPOSITE			19.24						1.2												
VOLUNTEER LAKE ASSESSMENT PROGRAM	PEARIND	VL06169744	06/16/1997	EPILIMNION	1	0.019										6.03	67.5								
VOLUNTEER LAKE ASSESSMENT PROGRAM	PEARIND	VL06169752	06/16/1997	METALIMNION	2	0.017										5.65	66.2								
VOLUNTEER LAKE ASSESSMENT PROGRAM	PEARIND	VL06169766	06/16/1997	HYPOLIMNION	4	0.025										5.44	68.1								
VOLUNTEER LAKE ASSESSMENT PROGRAM	PEARIND	VL06169773	06/16/1997	COMPOSITE			4.55						1.6												
VOLUNTEER LAKE ASSESSMENT PROGRAM	PEARIND	VL07319759	07/31/1997	METALIMNION	2	0.033										5.96	65.4								
VOLUNTEER LAKE ASSESSMENT PROGRAM	PEARIND	VL07319760	07/31/1997	EPILIMNION	1	0.039										6.04	66.9								
VOLUNTEER LAKE ASSESSMENT PROGRAM	PEARIND	VL07319767	07/31/1997	HYPOLIMNION	4	0.076										6.04	70.6								
VOLUNTEER LAKE ASSESSMENT PROGRAM	PEARIND	VL07319789	07/31/1997	COMPOSITE			16.97						1.1												
VOLUNTEER LAKE ASSESSMENT PROGRAM	PEARIND	VL08259701	08/25/1997		0.10			9.2	105	22	5														
VOLUNTEER LAKE ASSESSMENT PROGRAM	PEARIND	VL08259702	08/25/1997		1			8	90	21	5														
VOLUNTEER LAKE ASSESSMENT PROGRAM	PEARIND	VL08259703	08/25/1997		2			7.7	84	20.8	5														
VOLUNTEER LAKE ASSESSMENT PROGRAM	PEARIND	VL08259704	08/25/1997		3			7.2	79	20.5	5														
VOLUNTEER LAKE ASSESSMENT PROGRAM	PEARIND	VL08259705	08/25/1997		4			5.7	62	20.1	5														
VOLUNTEER LAKE ASSESSMENT PROGRAM	PEARIND	VL08259706	08/25/1997		4.50			1.2	13	19.6	5														
VOLUNTEER LAKE ASSESSMENT PROGRAM	PEARIND	VL08259751	08/25/1997	HYPOLIMNION	4	0.033										5.95	66.9								
VOLUNTEER LAKE ASSESSMENT PROGRAM	PEARIND	VL08259753	08/25/1997	EPILIMNION	1	0.045										6.58	66.2								
VOLUNTEER LAKE ASSESSMENT PROGRAM	PEARIND	VL08259754	08/25/1997	METALIMNION	2	0.031										6.23	67.3								
VOLUNTEER LAKE ASSESSMENT PROGRAM	PEARIND	VL08259761	08/25/1997	COMPOSITE			6.04						0.7												
VOLUNTEER LAKE ASSESSMENT PROGRAM	PEARIND	VL06299815	06/29/1998	EPILIMNION	1	0.029										5.72	57.53								
VOLUNTEER LAKE ASSESSMENT PROGRAM	PEARIND	VL06299818	06/29/1998	METALIMNION	2	0.027										5.44	60.86								
VOLUNTEER LAKE ASSESSMENT PROGRAM	PEARIND	VL06299831	06/29/1998	METALIMNION	3	0.032										5.48	64.4								
VOLUNTEER LAKE ASSESSMENT PROGRAM	PEARIND	VL06299836	06/29/1998	METALIMNION	4	0.045										5.5	68.45								
VOLUNTEER LAKE ASSESSMENT PROGRAM	PEARIND	VL06299838	06/29/1998	HYPOLIMNION	5	0.113										5.51	69.36								
VOLUNTEER LAKE ASSESSMENT PROGRAM	PEARIND	VL06299846	06/29/1998	COMPOSITE			18.54						1.1												
VOLUNTEER LAKE ASSESSMENT PROGRAM	PEARIND	VL07149801	07/14/1998		0.10			6	70	23.7	5														
VOLUNTEER LAKE ASSESSMENT PROGRAM	PEARIND	VL07149803	07/14/1998		1			5.7	64	22.9	5														
VOLUNTEER LAKE ASSESSMENT PROGRAM	PEARIND	VL07149805	07/14/1998		2			4.4	49	21.7	5														
VOLUNTEER LAKE ASSESSMENT PROGRAM	PEARIND	VL07149807	07/14/1998		3			1.8	19	20.2	5														
VOLUNTEER LAKE ASSESSMENT PROGRAM	PEARIND	VL07149809	07/14/1998		4			0.3	3	17.1	5														
VOLUNTEER LAKE ASSESSMENT PROGRAM	PEARIND	VL07149811	07/14/1998		4.50			0.5	5	16.4	5														
VOLUNTEER LAKE ASSESSMENT PROGRAM	PEARIND	VL07149847	07/14/1998	METALIMNION	2.50	0.035										5.71	58.81								
VOLUNTEER LAKE ASSESSMENT PROGRAM	PEARIND	VL07149850	07/14/1998	EPILIMNION	1	0.035										5.95	58.23								
VOLUNTEER LAKE ASSESSMENT PROGRAM	PEARIND	VL07149856	07/14/1998	HYPOLIMNION	4.50	0.144										5.97	74.96								
VOLUNTEER LAKE ASSESSMENT PROGRAM	PEARIND	VL07149879	07/14/1998	COMPOSITE			11.14						1												
VOLUNTEER LAKE ASSESSMENT PROGRAM	PEARIND	VL08199860	08/19/1998	EPILIMNION	1	0.042										6.1	60								
VOLUNTEER LAKE ASSESSMENT PROGRAM	PEARIND	VL08199861	08/19/1998	METALIMNION	2.50	0.037										6.06	58.5								
VOLUNTEER LAKE ASSESSMENT PROGRAM	PEARIND	VL08199865	08/19/1998	HYPOLIMNION	4	0.302										6.09	70.6								
VOLUNTEER LAKE ASSESSMENT PROGRAM	PEARIND	VL08199873	08/19/1998	COMPOSITE			16.12						0.8												
VOLUNTEER LAKE ASSESSMENT PROGRAM	PEARIND	VL06039902	06/03/1999	METALIMNION	2.50	0.021										5.45	95.4								
VOLUNTEER LAKE ASSESSMENT PROGRAM	PEARIND	VL06039904	06/03/1999	EPILIMNION	1	0.022										5.92	96.5								
VOLUNTEER LAKE ASSESSMENT PROGRAM	PEARIND	VL06039906	06/03/1999	HYPOLIMNION	4	0.029										5.44	97.1								
VOLUNTEER LAKE ASSESSMENT PROGRAM	PEARIND	VL06039907	06/03/1999	COMPOSITE			7.49						1.7												
VOLUNTEER LAKE ASSESSMENT PROGRAM	PEARIND	VL07149901	07/14/1999		0.10			7.5	87.9	23.6	4														
VOLUNTEER LAKE ASSESSMENT PROGRAM	PEARIND	VL07149902	07/14/1999		1			6.5	75	22.8	4														
VOLUNTEER LAKE ASSESSMENT PROGRAM	PEARIND	VL07149903	07/14/1999		2			5	58.1	22.7	4														
VOLUNTEER LAKE ASSESSMENT PROGRAM	PEARIND	VL07149904	07/14/1999		3			3	34.8	22.2	4														
VOLUNTEER LAKE ASSESSMENT PROGRAM	PEARIND	VL07149905	07/14/1999		3.50			1.5	17.1	21.8	4														
VOLUNTEER LAKE ASSESSMENT PROGRAM	PEARIND	VL07149959	07/14/1999	EPILIMNION	1	0.039										6.05	94.1								
VOLUNTEER LAKE ASSESSMENT PROGRAM	PEARIND	VL07149961	07/14/1999	HYPOLIMNION	4	0.048										5.57	94.6								
VOLUNTEER LAKE ASSESSMENT PROGRAM	PEARIND	VL07149962	07/14/1999	COMPOSITE			16.75						1.3												

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PROJECT_NAME	STATION_ID	ACTIVITY_ID	START_DATE	DEPTH ZONE	DEPTH	TOTAL PHOSPHORUS (MG/L)	CHLOROPHYLL A, UNCORRECTED FOR PHEOPHYTIN (UG/L)	DISSOLVED OXYGEN (MG/L)	DISSOLVED OXYGEN SATURATION (%)	TEMPERATURE (DEG C)	DEPTH (M)	DEPTH, BOTTOM (M)	SECCHI DISK TRANSPARENCY (M)	TOTAL MAGNESIUM (MG/L)	SODIUM (MG/L)	PH	SPECIFIC CONDUCTANCE (UMHO/CM)	ESCHERICHIA COLI (#/100ML)	MERCURY (PPM WET)	POTASSIUM (MG/L)	2,4-DICHLOROPHENOXYACETIC ACID (2,4-D) (UG/L)	VASCULAR PLANT ABUNDANCE	NITROGEN, NITRITE (NO2) + NITRATE (NO3) AS N (MG/L)	NITROGEN, NITRITE (NO2) + NITRATE (NO3) AS N QUALIFIER	GRAN ACID NEUTRALIZING CAPACITY (MG/L)
VOLUNTEER LAKE ASSESSMENT PROGRAM	PEARIND	VL08189941	08/18/1999	METALIMNION	2	0.029										5.88	93.8								
VOLUNTEER LAKE ASSESSMENT PROGRAM	PEARIND	VL08189945	08/18/1999	HYPOLIMNION	3	0.032										5.9	94.6								
VOLUNTEER LAKE ASSESSMENT PROGRAM	PEARIND	VL08189948	08/18/1999	EPILIMNION	1	0.039										6.38	92.3								
VOLUNTEER LAKE ASSESSMENT PROGRAM	PEARIND	VL08189956	08/18/1999	COMPOSITE			6.33						1												
VOLUNTEER LAKE ASSESSMENT PROGRAM	PEARIND	VL07180068	07/18/2000	EPILIMNION	1											5.79	74								
VOLUNTEER LAKE ASSESSMENT PROGRAM	PEARIND	VL07180071	07/18/2000	METALIMNION	3											5.64	75.2								
VOLUNTEER LAKE ASSESSMENT PROGRAM	PEARIND	VL07180075	07/18/2000	HYPOLIMNION	5											5.88	86.1								
VOLUNTEER LAKE ASSESSMENT PROGRAM	PEARIND	VL071800101	07/18/2000	COMPOSITE			13.18						1												
VOLUNTEER LAKE ASSESSMENT PROGRAM	PEARIND	VL08280047	08/28/2000	METALIMNION	3	0.021										5.83	76.5								
VOLUNTEER LAKE ASSESSMENT PROGRAM	PEARIND	VL08280049	08/28/2000	EPILIMNION	1	0.019										6.16	75.6								
VOLUNTEER LAKE ASSESSMENT PROGRAM	PEARIND	VL08280053	08/28/2000	HYPOLIMNION	5	0.007										5.82	82.3								
VOLUNTEER LAKE ASSESSMENT PROGRAM	PEARIND	VL08280066	08/28/2000	COMPOSITE			9.9						1												
VOLUNTEER LAKE ASSESSMENT PROGRAM	PEARIND	VL06270163	06/27/2001	EPILIMNION	1	0.025										6.31	71.5								
VOLUNTEER LAKE ASSESSMENT PROGRAM	PEARIND	VL06270168	06/27/2001	METALIMNION	3	0.052										5.62	85.7								
VOLUNTEER LAKE ASSESSMENT PROGRAM	PEARIND	VL06270170	06/27/2001	HYPOLIMNION	4.50	0.08										5.74	86.1								
VOLUNTEER LAKE ASSESSMENT PROGRAM	PEARIND	VL06270188	06/27/2001	COMPOSITE			13.27						1.1												
VOLUNTEER LAKE ASSESSMENT PROGRAM	PEARIND	VL07180152	07/18/2001	METALIMNION	2.50	0.043										6.14	76								
VOLUNTEER LAKE ASSESSMENT PROGRAM	PEARIND	VL07180155	07/18/2001	EPILIMNION	1	0.043										6.31	77								
VOLUNTEER LAKE ASSESSMENT PROGRAM	PEARIND	VL07180161	07/18/2001	HYPOLIMNION	4	0.173										6.21	96.5								
VOLUNTEER LAKE ASSESSMENT PROGRAM	PEARIND	VL07180187	07/18/2001	COMPOSITE			12.69						1.1												
VOLUNTEER LAKE ASSESSMENT PROGRAM	PEARIND	VL08130109	08/13/2001		0.10			5.5	66.7	24.7	5														
VOLUNTEER LAKE ASSESSMENT PROGRAM	PEARIND	VL08130110	08/13/2001		1			5.6	67	24.6	5														
VOLUNTEER LAKE ASSESSMENT PROGRAM	PEARIND	VL08130111	08/13/2001		2			5.1	60.5	24.3	5														
VOLUNTEER LAKE ASSESSMENT PROGRAM	PEARIND	VL08130112	08/13/2001		3			0.2	2.1	20.9	5														
VOLUNTEER LAKE ASSESSMENT PROGRAM	PEARIND	VL08130113	08/13/2001		4			0.2	2.3	18.2	5														
VOLUNTEER LAKE ASSESSMENT PROGRAM	PEARIND	VL08130114	08/13/2001		5			0.3	2.9	17.3	5														
VOLUNTEER LAKE ASSESSMENT PROGRAM	PEARIND	VL08130123	08/13/2001	EPILIMNION	1	0.032										6.3	84.94								
VOLUNTEER LAKE ASSESSMENT PROGRAM	PEARIND	VL08130134	08/13/2001	METALIMNION	3	0.037										6.01	85.9								
VOLUNTEER LAKE ASSESSMENT PROGRAM	PEARIND	VL08130137	08/13/2001	HYPOLIMNION	5	0.22										6.33	107.6								
VOLUNTEER LAKE ASSESSMENT PROGRAM	PEARIND	VL08130147	08/13/2001	COMPOSITE			13.7						1.2												
VOLUNTEER LAKE ASSESSMENT PROGRAM	PEARIND	VL06170234	06/17/2002		0.10			7.3	76.4	17.5	5														
VOLUNTEER LAKE ASSESSMENT PROGRAM	PEARIND	VL06170235	06/17/2002		1			7.2	75.1	17.5	5														
VOLUNTEER LAKE ASSESSMENT PROGRAM	PEARIND	VL06170236	06/17/2002		2			7	72.5	16.9	5														
VOLUNTEER LAKE ASSESSMENT PROGRAM	PEARIND	VL06170237	06/17/2002		3			7	72	16.9	5														
VOLUNTEER LAKE ASSESSMENT PROGRAM	PEARIND	VL06170238	06/17/2002		4			6.8	70.5	16.9	5														
VOLUNTEER LAKE ASSESSMENT PROGRAM	PEARIND	VL06170239	06/17/2002		5			6.4	65.2	16.5	5														
VOLUNTEER LAKE ASSESSMENT PROGRAM	PEARIND	VL061702178	06/17/2002	EPILIMNION		0.021										6.05	86.26								
VOLUNTEER LAKE ASSESSMENT PROGRAM	PEARIND	VL061702181	06/17/2002	HYPOLIMNION		0.023										5.96	86.79								
VOLUNTEER LAKE ASSESSMENT PROGRAM	PEARIND	VL061702188	06/17/2002	COMPOSITE			6.94						1.1												
VOLUNTEER LAKE ASSESSMENT PROGRAM	PEARIND	VL08120249	08/12/2002	METALIMNION		0.035										5.59	89								
VOLUNTEER LAKE ASSESSMENT PROGRAM	PEARIND	VL08120255	08/12/2002	EPILIMNION		0.039										5.81	96								
VOLUNTEER LAKE ASSESSMENT PROGRAM	PEARIND	VL08120261	08/12/2002	HYPOLIMNION		0.149										5.57	104								
VOLUNTEER LAKE ASSESSMENT PROGRAM	PEARIND	VL08120275	08/12/2002	COMPOSITE			12.66						1												
VOLUNTEER LAKE ASSESSMENT PROGRAM	PEARIND	VL07140321	07/14/2003		4			1	9.7	15.4	5														
VOLUNTEER LAKE ASSESSMENT PROGRAM	PEARIND	VL07140322	07/14/2003		4.50			1.1	10.7	15.1	5														
VOLUNTEER LAKE ASSESSMENT PROGRAM	PEARIND	VL07140323	07/14/2003		0.10			6.3	73.6	23.2	5														
VOLUNTEER LAKE ASSESSMENT PROGRAM	PEARIND	VL07140324	07/14/2003		1			6.8	79.4	22.7	5														
VOLUNTEER LAKE ASSESSMENT PROGRAM	PEARIND	VL07140325	07/14/2003		2			6.5	74.9	22.4	5														
VOLUNTEER LAKE ASSESSMENT PROGRAM	PEARIND	VL07140326	07/14/2003		3			0.8	8.6	20.5	5														
VOLUNTEER LAKE ASSESSMENT PROGRAM	PEARIND	VL07140362	07/14/2003	EPILIMNION		0.033										6.03	114.4								
VOLUNTEER LAKE ASSESSMENT PROGRAM	PEARIND	VL07140369	07/14/2003	HYPOLIMNION		0.081										5.94	123.9								
VOLUNTEER LAKE ASSESSMENT PROGRAM	PEARIND	VL07140383	07/14/2003	COMPOSITE			15.36						1.1												
VOLUNTEER LAKE ASSESSMENT PROGRAM	PEARIND	VL08170345	08/17/2003	EPILIMNION		0.036										5.94	109.7								
VOLUNTEER LAKE ASSESSMENT PROGRAM	PEARIND	VL08170346	08/17/2003	HYPOLIMNION		0.152										5.87	123.3								
VOLUNTEER LAKE ASSESSMENT PROGRAM	PEARIND	VL08170349	08/17/2003	COMPOSITE			11.68						0.8												
VOLUNTEER LAKE ASSESSMENT PROGRAM	PEARIND	2004-1227	06/15/2004	EPILIMNION	1	0.006										5.7	89.35								
VOLUNTEER LAKE ASSESSMENT PROGRAM	PEARIND	2004-1228	06/15/2004	METALIMNION	3	0.01										5.48	90.63								
VOLUNTEER LAKE ASSESSMENT PROGRAM	PEARIND	2004-1229	06/15/2004	HYPOLIMNION	4.50	0.038										5.43	93.38								
VOLUNTEER LAKE ASSESSMENT PROGRAM	PEARIND	2004-1233	06/15/2004	COMPOSITE	4		12.06																		

Appendix B - Pearly Pond Water Quality Database from OneStop
In-Pond Samples

PROJECT_NAME	STATION_ID	ACTIVITY_ID	START_DATE	DEPTH ZONE	DEPTH	TOTAL PHOSPHORUS (MG/L)	CHLOROPHYLL A, UNCORRECTED FOR PHEOPHYTIN (UG/L)	DISSOLVED OXYGEN (MG/L)	DISSOLVED OXYGEN SATURATION (%)	TEMPERATURE (DEG C)	DEPTH (M)	DEPTH, BOTTOM (M)	SECCHI DISK TRANSPARENCY (M)	TOTAL MAGNESIUM (MG/L)	SODIUM (MG/L)	PH	SPECIFIC CONDUCTANCE (UMHO/CM)	ESCHERICHIA COLI (#/100ML)	MERCURY (PPM WET)	POTASSIUM (MG/L)	2,4-DICHLOROPHENOXYACETIC ACID (2,4-D) (UG/L)	VASCULAR PLANT ABUNDANCE	NITROGEN, NITRITE (NO2) + NITRATE (NO3) AS N (MG/L)	NITROGEN, NITRITE (NO2) + NITRATE (NO3) AS N QUALIFIER	GRAN ACID NEUTRALIZING CAPACITY (MG/L)
VOLUNTEER LAKE ASSESSMENT PROGRAM	PEARIND	2004-2843	07/20/2004	HYPOLIMNION	4	0.028										5.67	93.26						0.05	<	
VOLUNTEER LAKE ASSESSMENT PROGRAM	PEARIND	2004-2844	07/20/2004	COMPOSITE	4		10.97																		
VOLUNTEER LAKE ASSESSMENT PROGRAM	PEARIND	2004-2842	07/20/2004	EPILIMNION	2	0.02							1	0.616	13	5.66	91.98			0.591		COMM	0.05	<	
VOLUNTEER LAKE ASSESSMENT PROGRAM	PEARIND	2004-3176	07/26/2004	EPILIMNION	1	0.019							1.2			6.1	92.02								
VOLUNTEER LAKE ASSESSMENT PROGRAM	PEARIND	2004-3177	07/26/2004	METALIMNION	2.50	0.025										5.72	92.83								
VOLUNTEER LAKE ASSESSMENT PROGRAM	PEARIND	2004-3178	07/26/2004	HYPOLIMNION	4	0.098										5.89	97.82								
VOLUNTEER LAKE ASSESSMENT PROGRAM	PEARIND	2004-3181	07/26/2004	COMPOSITE	4		14.27																		
VOLUNTEER LAKE ASSESSMENT PROGRAM	PEARIND	BLP07200409	07/20/2004		0.10			7.93	95.8	24.9	5.4														
VOLUNTEER LAKE ASSESSMENT PROGRAM	PEARIND	BLP07200410	07/20/2004		1			7.51	90	24.4	5.4														
VOLUNTEER LAKE ASSESSMENT PROGRAM	PEARIND	BLP07200411	07/20/2004		2			4.71	54	22.1	5.4														
VOLUNTEER LAKE ASSESSMENT PROGRAM	PEARIND	BLP07200412	07/20/2004		3			3.68	41.5	21.2	5.4														
VOLUNTEER LAKE ASSESSMENT PROGRAM	PEARIND	BLP07200413	07/20/2004		4			0.75	8.2	19.6	5.4														
VOLUNTEER LAKE ASSESSMENT PROGRAM	PEARIND	BLP07200414	07/20/2004		5			0.74	7.6	16.2	5.4														
VOLUNTEER LAKE ASSESSMENT PROGRAM	PEARIND	VLP08100450	08/10/2004		0.10			7.13	83.5	23.2	5														
VOLUNTEER LAKE ASSESSMENT PROGRAM	PEARIND	VLP08100451	08/10/2004		0.10			7.22	84.7	23.3	5														
VOLUNTEER LAKE ASSESSMENT PROGRAM	PEARIND	VLP08100452	08/10/2004		1			6.72	77.6	22.5	5														
VOLUNTEER LAKE ASSESSMENT PROGRAM	PEARIND	VLP08100453	08/10/2004		1			6.37	73.6	22.5	5														
VOLUNTEER LAKE ASSESSMENT PROGRAM	PEARIND	VLP08100454	08/10/2004		2			5.74	65.6	21.9	5														
VOLUNTEER LAKE ASSESSMENT PROGRAM	PEARIND	VLP08100455	08/10/2004		2			5.83	66.7	22	5														
VOLUNTEER LAKE ASSESSMENT PROGRAM	PEARIND	VLP08100456	08/10/2004		3			5.16	58.7	21.7	5														
VOLUNTEER LAKE ASSESSMENT PROGRAM	PEARIND	VLP08100457	08/10/2004		3			5.18	58.7	21.5	5														
VOLUNTEER LAKE ASSESSMENT PROGRAM	PEARIND	VLP08100458	08/10/2004		4			0.43	4.8	20.6	5														
VOLUNTEER LAKE ASSESSMENT PROGRAM	PEARIND	VLP08100459	08/10/2004		4			2.23	25	21	5														
VOLUNTEER LAKE ASSESSMENT PROGRAM	PEARIND	VLP08100460	08/10/2004		4.50			0.27	2.9	18.7	5														
VOLUNTEER LAKE ASSESSMENT PROGRAM	PEARIND	VLP08100461	08/10/2004		4.50			0.91	9.9	19.3	5														
VOLUNTEER LAKE ASSESSMENT PROGRAM	PEARIND	2004-3973	08/10/2004	HYPOLIMNION	4	0.021										6	94.72								
VOLUNTEER LAKE ASSESSMENT PROGRAM	PEARIND	2004-3974	08/10/2004	HYPOLIMNION	4											6.07	96.55								
VOLUNTEER LAKE ASSESSMENT PROGRAM	PEARIND	2004-3972	08/10/2004	EPILIMNION	1	0.02							1.18			6.08	94.18								
VOLUNTEER LAKE ASSESSMENT PROGRAM	PEARIND	2004-3979	08/10/2004	COMPOSITE	3		11.88																		
VOLUNTEER LAKE ASSESSMENT PROGRAM	PEARIND	2005-2177	06/26/2005	EPILIMNION	1	0.016							1.75			6.09	102.3								
VOLUNTEER LAKE ASSESSMENT PROGRAM	PEARIND	2005-2178	06/26/2005	METALIMNION	2.50	0.021										5.72	104								
VOLUNTEER LAKE ASSESSMENT PROGRAM	PEARIND	2005-2179	06/26/2005	HYPOLIMNION	4	0.04										5.57	108.5								
VOLUNTEER LAKE ASSESSMENT PROGRAM	PEARIND	2005-2183	06/26/2005	COMPOSITE	5		8.39																		
VOLUNTEER LAKE ASSESSMENT PROGRAM	PEARIND	2005-2708	07/10/2005	EPILIMNION	1	0.024							1.1			6.15	95.48								
VOLUNTEER LAKE ASSESSMENT PROGRAM	PEARIND	2005-2709	07/10/2005	METALIMNION	2.20	0.023										6	96.35								
VOLUNTEER LAKE ASSESSMENT PROGRAM	PEARIND	2005-2710	07/10/2005	HYPOLIMNION	4	0.056										6.06	111.8								
VOLUNTEER LAKE ASSESSMENT PROGRAM	PEARIND	2005-2714	07/10/2005	COMPOSITE	4		11.66																		
VOLUNTEER LAKE ASSESSMENT PROGRAM	PEARIND	2005-4513	08/15/2005	COMPOSITE	4		13.53																		
VOLUNTEER LAKE ASSESSMENT PROGRAM	PEARIND	2005-4507	08/15/2005	HYPOLIMNION	4	0.244										6.27	126.2								
VOLUNTEER LAKE ASSESSMENT PROGRAM	PEARIND	2005-4508	08/15/2005	HYPOLIMNION	4											6.26	125.2								
VOLUNTEER LAKE ASSESSMENT PROGRAM	PEARIND	2005-4506	08/15/2005	EPILIMNION	1	0.028							1.25			6.24	100.3								
VOLUNTEER LAKE ASSESSMENT PROGRAM	PEARIND	VL08150506	08/15/2005		4			0.6	6.4	18	4.3														
VOLUNTEER LAKE ASSESSMENT PROGRAM	PEARIND	VL08150507	08/15/2005		3			0.5	5.6	20.1	4.3														
VOLUNTEER LAKE ASSESSMENT PROGRAM	PEARIND	VL08150508	08/15/2005		2			5.91	72.6	25.8	4.3														
VOLUNTEER LAKE ASSESSMENT PROGRAM	PEARIND	VL08150509	08/15/2005		1			5.96	73.2	25.8	4.3														
VOLUNTEER LAKE ASSESSMENT PROGRAM	PEARIND	VL08150510	08/15/2005		0.10			6.02	74	25.8	4.3														
VOLUNTEER LAKE ASSESSMENT PROGRAM	PEARIND	2006-1970	06/26/2006	EPILIMNION	1	0.02							1.7			6.07	84.92								
VOLUNTEER LAKE ASSESSMENT PROGRAM	PEARIND	2006-1971	06/26/2006	METALIMNION	2.50	0.018										5.75	87.73								
VOLUNTEER LAKE ASSESSMENT PROGRAM	PEARIND	2006-1972	06/26/2006	HYPOLIMNION	4.50	0.04										5.67	92.75								
VOLUNTEER LAKE ASSESSMENT PROGRAM	PEARIND	2006-1976	06/26/2006	COMPOSITE	4.50		7.92																		
VOLUNTEER LAKE ASSESSMENT PROGRAM	PEARIND	2006-3490	07/25/2006	EPILIMNION	1	0.025							0.9			6.06	89.39								
VOLUNTEER LAKE ASSESSMENT PROGRAM	PEARIND	2006-3491	07/25/2006	HYPOLIMNION	4	0.17										6.04	106.2								
VOLUNTEER LAKE ASSESSMENT PROGRAM	PEARIND	2006-3492	07/25/2006	HYPOLIMNION	4											6.02	96.05								
VOLUNTEER LAKE ASSESSMENT PROGRAM	PEARIND	2006-3496	07/25/2006	COMPOSITE	4		11.62																		
VOLUNTEER LAKE ASSESSMENT PROGRAM	PEARIND	2006-5316	08/30/2006	EPILIMNION	1	0.024							1.15			6.24	95.24								
VOLUNTEER LAKE ASSESSMENT PROGRAM	PEARIND	2006-5317	08/30/2006	METALIMNION	2.50	0.028										6.1	95.39								
VOLUNTEER LAKE ASSESSMENT PROGRAM	PEARIND	2006-5318	08/30/2006	HYPOLIMNION	4	0.049										6.13	97.52								
VOLUNTEER LAKE ASSESSMENT PROGRAM	PEARIND	2006-5321	08/30/2006	COMPOSITE	4		7.79																		
VOLUNTEER LAKE ASSESSMENT PROGRAM	PEARIND	VL07250601	07/25/2006		4			0.51	5.5	18.2	4.5														

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PROJECT_NAME	STATION_ID	ACTIVITY_ID	START_DATE	DEPTH ZONE	DEPTH	TOTAL PHOSPHORUS (MG/L)	CHLOROPHYLL A, UNCORRECTED FOR PHEOPHYTIN (UG/L)	DISSOLVED OXYGEN (MG/L)	DISSOLVED OXYGEN SATURATION (%)	TEMPERATURE (DEG C)	DEPTH (M)	DEPTH, BOTTOM (M)	SECCHI DISK TRANSPARENCY (M)	TOTAL MAGNESIUM (MG/L)	SODIUM (MG/L)	PH	SPECIFIC CONDUCTANCE (UMHO/CM)	ESCHERICHIA COLI (#/100ML)	MERCURY (PPM WET)	POTASSIUM (MG/L)	2,4-DICHLOROPHENOXYACETIC ACID (2,4-D) (UG/L)	VASCULAR PLANT ABUNDANCE	NITROGEN, NITRITE (NO2) + NITRATE (NO3) AS N (MG/L)	NITROGEN, NITRITE (NO2) + NITRATE (NO3) AS N QUALIFIER	GRAN ACID NEUTRALIZING CAPACITY (MG/L)
VOLUNTEER LAKE ASSESSMENT PROGRAM	PEARIND	VL07250602	07/25/2006		3			0.43	4.7	18.8	4.5														
VOLUNTEER LAKE ASSESSMENT PROGRAM	PEARIND	VL07250603	07/25/2006		2			5.27	59.7	21.5	4.5														
VOLUNTEER LAKE ASSESSMENT PROGRAM	PEARIND	VL07250604	07/25/2006		1			6.74	77.7	22.4	4.5														
VOLUNTEER LAKE ASSESSMENT PROGRAM	PEARIND	VL07250605	07/25/2006		0.10			6.91	80.6	23	4.5														
VOLUNTEER LAKE ASSESSMENT PROGRAM	PEARIND	VL07250606	07/25/2006		4			0.61	6.5	18.3	4.5														
VOLUNTEER LAKE ASSESSMENT PROGRAM	PEARIND	VL07250607	07/25/2006		3			0.44	4.8	18.8	4.5														
VOLUNTEER LAKE ASSESSMENT PROGRAM	PEARIND	VL07250608	07/25/2006		2			5.06	57.5	21.6	4.5														
VOLUNTEER LAKE ASSESSMENT PROGRAM	PEARIND	VL07250609	07/25/2006		1			6.29	72.5	22.4	4.5														
VOLUNTEER LAKE ASSESSMENT PROGRAM	PEARIND	VL07250610	07/25/2006		0.10			6.97	81.8	23.3	4.5														
VOLUNTEER LAKE ASSESSMENT PROGRAM	PEARIND	2007-1802	06/25/2007	EPILIMNION	1	0.022							1.05			6.36	87.29								
VOLUNTEER LAKE ASSESSMENT PROGRAM	PEARIND	2007-1803	06/25/2007	METALIMNION	3	0.024										5.85	87.54								
VOLUNTEER LAKE ASSESSMENT PROGRAM	PEARIND	2007-1804	06/25/2007	HYPOLIMNION	5	0.076										6.02	96.61								
VOLUNTEER LAKE ASSESSMENT PROGRAM	PEARIND	2007-1808	06/25/2007	COMPOSITE	0		13.478																		
VOLUNTEER LAKE ASSESSMENT PROGRAM	PEARIND	2007-2921	07/23/2007	EPILIMNION	1	0.025							1.2			4.61	99.34								
VOLUNTEER LAKE ASSESSMENT PROGRAM	PEARIND	2007-2922	07/23/2007	METALIMNION	2.50	0.024										6	90.05								
VOLUNTEER LAKE ASSESSMENT PROGRAM	PEARIND	2007-2923	07/23/2007	HYPOLIMNION	4	0.14										6.05	101.3								
VOLUNTEER LAKE ASSESSMENT PROGRAM	PEARIND	2007-2927	07/23/2007	COMPOSITE	4		11.159																		
VOLUNTEER LAKE ASSESSMENT PROGRAM	PEARIND	2007-4616	08/28/2007	EPILIMNION	1	0.022							1.35			6.44	90.32								
VOLUNTEER LAKE ASSESSMENT PROGRAM	PEARIND	2007-4617	08/28/2007	HYPOLIMNION	4	0.03										5.77	91.64								
VOLUNTEER LAKE ASSESSMENT PROGRAM	PEARIND	2007-4618	08/28/2007	HYPOLIMNION	4											5.92	91.63								
VOLUNTEER LAKE ASSESSMENT PROGRAM	PEARIND	2007-4619	08/28/2007	COMPOSITE	4		10.952																		
VOLUNTEER LAKE ASSESSMENT PROGRAM	PEARIND	VL08280727	08/28/2007		4			3.69	40.4	19.8	4.5														
VOLUNTEER LAKE ASSESSMENT PROGRAM	PEARIND	VL08280728	08/28/2007		3			5.05	55.8	20.2	4.5														
VOLUNTEER LAKE ASSESSMENT PROGRAM	PEARIND	VL08280729	08/28/2007		2			6.82	78.3	22.2	4.5														
VOLUNTEER LAKE ASSESSMENT PROGRAM	PEARIND	VL08280730	08/28/2007		1			7.34	85.8	23.1	4.5														
VOLUNTEER LAKE ASSESSMENT PROGRAM	PEARIND	VL08280731	08/28/2007		0.10			7.45	88.6	24	4.5														
VOLUNTEER LAKE ASSESSMENT PROGRAM	PEARIND	2008-1746	06/23/2008	COMPOSITE	4		4.721																		
VOLUNTEER LAKE ASSESSMENT PROGRAM	PEARIND	2008-1740	06/23/2008	EPILIMNION	1	0.022							2			5.76	118.1								1.3
VOLUNTEER LAKE ASSESSMENT PROGRAM	PEARIND	2008-1741	06/23/2008	HYPOLIMNION	4	0.05										5.45	120.6								
VOLUNTEER LAKE ASSESSMENT PROGRAM	PEARIND	2008-1742	06/23/2008	HYPOLIMNION	0											5.48	120.2								
VOLUNTEER LAKE ASSESSMENT PROGRAM	PEARIND	2008-3317	07/23/2008	COMPOSITE	4		12.005																		
VOLUNTEER LAKE ASSESSMENT PROGRAM	PEARIND	2008-3312	07/23/2008	EPILIMNION	1	0.025										5.8	120.5								0.9
VOLUNTEER LAKE ASSESSMENT PROGRAM	PEARIND	2008-3313	07/23/2008	HYPOLIMNION	4	0.14										6	127.4								
VOLUNTEER LAKE ASSESSMENT PROGRAM	PEARIND	2008-4884	08/24/2008	EPILIMNION	1	0.022							1			5.65	111.3								2.3
VOLUNTEER LAKE ASSESSMENT PROGRAM	PEARIND	2008-4885	08/24/2008	HYPOLIMNION	4	0.051										5.7	114.5								
VOLUNTEER LAKE ASSESSMENT PROGRAM	PEARIND	2008-4889	08/24/2008	COMPOSITE	4		10.566																		
VOLUNTEER LAKE ASSESSMENT PROGRAM	PEARIND	VL06230822	06/23/2008		4.50			0.38	4	17.1	5														
VOLUNTEER LAKE ASSESSMENT PROGRAM	PEARIND	VL06230823	06/23/2008		4			0.87	9.1	17.3	5														
VOLUNTEER LAKE ASSESSMENT PROGRAM	PEARIND	VL06230824	06/23/2008		3			4.74	52.3	20.1	5														
VOLUNTEER LAKE ASSESSMENT PROGRAM	PEARIND	VL06230825	06/23/2008		2			6.95	79.3	21.8	5														
VOLUNTEER LAKE ASSESSMENT PROGRAM	PEARIND	VL06230826	06/23/2008		1			6.77	77.8	22.2	5														
VOLUNTEER LAKE ASSESSMENT PROGRAM	PEARIND	VL06230827	06/23/2008		0.10			7.22	83.8	22.7	5														
VOLUNTEER LAKE ASSESSMENT PROGRAM	PEARIND	2009-1385	06/14/2009	EPILIMNION	1	0.019							1.5			6.03	102.6								1.5
VOLUNTEER LAKE ASSESSMENT PROGRAM	PEARIND	2009-1386	06/14/2009	HYPOLIMNION	3	0.021										5.77	104.4								
VOLUNTEER LAKE ASSESSMENT PROGRAM	PEARIND	2009-1390	06/14/2009	COMPOSITE	3		4.3868																		
VOLUNTEER LAKE ASSESSMENT PROGRAM	PEARIND	2009-2826	07/14/2009	EPILIMNION	1	0.028							1.85			6.02	90.86								2.4
VOLUNTEER LAKE ASSESSMENT PROGRAM	PEARIND	2009-2827	07/14/2009	HYPOLIMNION	4	0.068										5.84	99.56								
VOLUNTEER LAKE ASSESSMENT PROGRAM	PEARIND	2009-2828	07/14/2009	HYPOLIMNION	4											5.81	96.44								
VOLUNTEER LAKE ASSESSMENT PROGRAM	PEARIND	2009-2833	07/14/2009	COMPOSITE	4		4.4075																		
VOLUNTEER LAKE ASSESSMENT PROGRAM	PEARIND	2009-4693	08/17/2009	EPILIMNION	1	0.034							1.4			6.15	75.59								2.5
VOLUNTEER LAKE ASSESSMENT PROGRAM	PEARIND	2009-4694	08/17/2009	HYPOLIMNION	3	0.073										5.72	79.72								
VOLUNTEER LAKE ASSESSMENT PROGRAM	PEARIND	2009-4698	08/17/2009	COMPOSITE	3		12.7378																		
VOLUNTEER LAKE ASSESSMENT PROGRAM	PEARIND	VL07140901	07/14/2009		4			0.23	2.5	18	4.5														
VOLUNTEER LAKE ASSESSMENT PROGRAM	PEARIND	VL07140902	07/14/2009		3			5.2	57.8	20.5	4.5														
VOLUNTEER LAKE ASSESSMENT PROGRAM	PEARIND	VL07140903	07/14/2009		2			6.85	77.2	21.2	4.5														
VOLUNTEER LAKE ASSESSMENT PROGRAM	PEARIND	VL07140904	07/14/2009		1			6.88	77.8	21.4	4.5														
VOLUNTEER LAKE ASSESSMENT PROGRAM	PEARIND	VL07140905	07/14/2009		0.10			6.96	79	21.6	4.5														
VOLUNTEER LAKE ASSESSMENT PROGRAM	PEARIND	VL07140906	07/14/2009		4			0.08	0.9	18.2	4.5														
VOLUNTEER LAKE ASSESSMENT PROGRAM	PEARIND	VL07140907	07/14/2009		3			4.02	44.7	20.5	4.5														

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VOLUNTEER LAKE ASSESSMENT PROGRAM	PEARIND	VL07140908	07/14/2009		2			6.66	75.1	21.2	4.5														
VOLUNTEER LAKE ASSESSMENT PROGRAM	PEARIND	VL07140909	07/14/2009		1			6.82	77.2	21.4	4.5														
VOLUNTEER LAKE ASSESSMENT PROGRAM	PEARIND	VL07140910	07/14/2009		0.10			6.98	79.2	21.6	4.5														
VOLUNTEER LAKE ASSESSMENT PROGRAM	PEARIND	2010-894	06/09/2010	EPILIMNION	1	0.021							1.5			5.76	91.5								1.1
VOLUNTEER LAKE ASSESSMENT PROGRAM	PEARIND	2010-895	06/09/2010	HYPOLIMNION	3	0.021										5.55	92.6								
VOLUNTEER LAKE ASSESSMENT PROGRAM	PEARIND	2010-899	06/09/2010	COMPOSITE	4		4.6649																		
VOLUNTEER LAKE ASSESSMENT PROGRAM	PEARIND	2010-2613	07/18/2010	COMPOSITE	4		13.57																		
VOLUNTEER LAKE ASSESSMENT PROGRAM	PEARIND	2010-2610	07/18/2010	EPILIMNION	1	0.051							1.05			6.06	96								2
VOLUNTEER LAKE ASSESSMENT PROGRAM	PEARIND	2010-2611	07/18/2010	HYPOLIMNION	4	0.1										6.04	99.6								
VOLUNTEER LAKE ASSESSMENT PROGRAM	PEARIND	2010-3711	08/11/2010	EPILIMNION	1	0.025							1.25			6.83	97								1.5
VOLUNTEER LAKE ASSESSMENT PROGRAM	PEARIND	2010-3712	08/11/2010	HYPOLIMNION	4	0.073										5.79	100.4								
VOLUNTEER LAKE ASSESSMENT PROGRAM	PEARIND	2010-3714	08/11/2010	HYPOLIMNION	4											5.85	100.8								
VOLUNTEER LAKE ASSESSMENT PROGRAM	PEARIND	2010-3719	08/11/2010	COMPOSITE	4		19.91																		
VOLUNTEER LAKE ASSESSMENT PROGRAM	PEARIND	VL07141076	07/14/2010		4.50			5.3	57.4	19.2		5													
VOLUNTEER LAKE ASSESSMENT PROGRAM	PEARIND	VL07141077	07/14/2010		4			4.2	47.8	21.7		5													
VOLUNTEER LAKE ASSESSMENT PROGRAM	PEARIND	VL07141078	07/14/2010		3			5.59	66.8	24.3		5													
VOLUNTEER LAKE ASSESSMENT PROGRAM	PEARIND	VL07141079	07/14/2010		2			6.61	82.7	26.8		5													
VOLUNTEER LAKE ASSESSMENT PROGRAM	PEARIND	VL07141080	07/14/2010		1			7.36	93	27.3		5													
VOLUNTEER LAKE ASSESSMENT PROGRAM	PEARIND	VL07141081	07/14/2010		0.10			7.82	98.9	27.4		5													
VOLUNTEER LAKE ASSESSMENT PROGRAM	PEARIND	2011-938	06/19/2011	COMPOSITE	4		5.79																		
VOLUNTEER LAKE ASSESSMENT PROGRAM	PEARIND	2011-933	06/19/2011	EPILIMNION	1	0.023							1.325			6.2	97.1								1.7
VOLUNTEER LAKE ASSESSMENT PROGRAM	PEARIND	2011-934	06/19/2011	HYPOLIMNION	4	0.045										5.61	101.5								
VOLUNTEER LAKE ASSESSMENT PROGRAM	PEARIND	2011-2128	07/19/2011	EPILIMNION	1	0.026							1.65			5.99	87.22								2
VOLUNTEER LAKE ASSESSMENT PROGRAM	PEARIND	2011-2129	07/19/2011	HYPOLIMNION	4	0.12										6.07	95.05								
VOLUNTEER LAKE ASSESSMENT PROGRAM	PEARIND	2011-2130	07/19/2011	HYPOLIMNION	4											6.1	96.47								
VOLUNTEER LAKE ASSESSMENT PROGRAM	PEARIND	2011-2135	07/19/2011	COMPOSITE	4		5.34																		
VOLUNTEER LAKE ASSESSMENT PROGRAM	PEARIND	2011-3234	08/16/2011	EPILIMNION	1	0.1							1.1			5.87	102.6								1.9
VOLUNTEER LAKE ASSESSMENT PROGRAM	PEARIND	2011-3235	08/16/2011	HYPOLIMNION	4	0.035										6.11	54.7								
VOLUNTEER LAKE ASSESSMENT PROGRAM	PEARIND	2011-3239	08/16/2011	COMPOSITE	4		11.88																		
VOLUNTEER LAKE ASSESSMENT PROGRAM	PEARIND	VL07191106	07/19/2011		4			0.16	1.7	18.4		4.5													
VOLUNTEER LAKE ASSESSMENT PROGRAM	PEARIND	VL07191107	07/19/2011		3			0.22	2.5	21		4.5													
VOLUNTEER LAKE ASSESSMENT PROGRAM	PEARIND	VL07191108	07/19/2011		2			5.63	71.3	25.2		4.5													
VOLUNTEER LAKE ASSESSMENT PROGRAM	PEARIND	VL07191109	07/19/2011		1			6.1	77.6	25.5		4.5													
VOLUNTEER LAKE ASSESSMENT PROGRAM	PEARIND	VL07191110	07/19/2011		0.10			6.17	78.9	25.7		4.5													
VOLUNTEER LAKE ASSESSMENT PROGRAM	PEARIND	2012-1194	06/17/2012	COMPOSITE	4		6.44																		
VOLUNTEER LAKE ASSESSMENT PROGRAM	PEARIND	2012-1189	06/17/2012	EPILIMNION	1	0.025							1.2			5.97	97.8								2
VOLUNTEER LAKE ASSESSMENT PROGRAM	PEARIND	2012-1190	06/17/2012	HYPOLIMNION	4	0.047										5.68	101.1								
VOLUNTEER LAKE ASSESSMENT PROGRAM	PEARIND	2012-2746	07/24/2012	EPILIMNION	1	0.036							1			5.58	94								0.9
VOLUNTEER LAKE ASSESSMENT PROGRAM	PEARIND	2012-2747	07/24/2012	HYPOLIMNION	4	0.2										6.02	113								
VOLUNTEER LAKE ASSESSMENT PROGRAM	PEARIND	2012-2748	07/24/2012	COMPOSITE	4		10.81																		
VOLUNTEER LAKE ASSESSMENT PROGRAM	PEARIND	2012-4159	08/28/2012	EPILIMNION	1	0.052							1.5			5.94	108.6								1.4
VOLUNTEER LAKE ASSESSMENT PROGRAM	PEARIND	2012-4160	08/28/2012	HYPOLIMNION	4	0.11										6.33	127.7								
VOLUNTEER LAKE ASSESSMENT PROGRAM	PEARIND	2012-4161	08/28/2012	COMPOSITE	4		28.09																		
VOLUNTEER LAKE ASSESSMENT PROGRAM	PEARIND	2013-455	04/17/2013	EPILIMNION	1	0.0164							2												
VOLUNTEER LAKE ASSESSMENT PROGRAM	PEARIND	2013-456	04/17/2013	EPILIMNION	2	0.0161																			
VOLUNTEER LAKE ASSESSMENT PROGRAM	PEARIND	2013-457	04/17/2013	EPILIMNION	3	0.0166																			
VOLUNTEER LAKE ASSESSMENT PROGRAM	PEARIND	2013-458	04/17/2013	EPILIMNION	4	0.0159																			
VOLUNTEER LAKE ASSESSMENT PROGRAM	PEARIND	2013-459	04/17/2013	EPILIMNION	4.50	0.0151																			
VOLUNTEER LAKE ASSESSMENT PROGRAM	PEARIND	2013-568	05/15/2013	EPILIMNION	1	0.0177							2.75			5.68	116.6								2.1
VOLUNTEER LAKE ASSESSMENT PROGRAM	PEARIND	2013-569	05/15/2013	EPILIMNION	2	0.0188										5.76	115.9								
VOLUNTEER LAKE ASSESSMENT PROGRAM	PEARIND	2013-570	05/15/2013	EPILIMNION	3	0.0171										5.84	115.2								
VOLUNTEER LAKE ASSESSMENT PROGRAM	PEARIND	2013-571	05/15/2013	HYPOLIMNION	4	0.0201										5.54	117.4								
VOLUNTEER LAKE ASSESSMENT PROGRAM	PEARIND	2013-572	05/15/2013	HYPOLIMNION	4.50	0.0241										5.71	116.9								
VOLUNTEER LAKE ASSESSMENT PROGRAM	PEARIND	2013-578	05/15/2013	COMPOSITE	4		3.92																		
VOLUNTEER LAKE ASSESSMENT PROGRAM	PEARIND	2013-579	05/15/2013	COMPOSITE	4		4.05																		
VOLUNTEER LAKE ASSESSMENT PROGRAM	PEARIND	2013-1231	06/18/2013	HYPOLIMNION	4	0.025										5.61	93.4								
VOLUNTEER LAKE ASSESSMENT PROGRAM	PEARIND	2013-1237	06/18/2013	COMPOSITE	4		4.49																		
VOLUNTEER LAKE ASSESSMENT PROGRAM	PEARIND	2013-1239	06/18/2013	HYPOLIMNION	4											5.79	93.8								
VOLUNTEER LAKE ASSESSMENT PROGRAM	PEARIND	2013-1228	06/18/2013	EPILIMNION	1	0.0142							1.5			5.94	88.6								1.6

Appendix B - Pearly Pond Water Quality Database from OneStop
In-Pond Samples

PROJECT_NAME	STATION_ID	ACTIVITY_ID	START_DATE	DEPTH ZONE	DEPTH	TOTAL PHOSPHORUS (MG/L)	CHLOROPHYLL A, UNCORRECTED FOR PHEOPHYTIN (UG/L)	DISSOLVED OXYGEN (MG/L)	DISSOLVED OXYGEN SATURATION (%)	TEMPERATURE (DEG C)	DEPTH (M)	DEPTH, BOTTOM (M)	SECCHI DISK TRANSPARENCY (M)	TOTAL MAGNESIUM (MG/L)	SODIUM (MG/L)	PH	SPECIFIC CONDUCTANCE (UMHO/CM)	ESCHERICHIA COLI (#/100ML)	MERCURY (PPM WET)	POTASSIUM (MG/L)	2,4-DICHLOROPHENOXYACETIC ACID (2,4-D) (UG/L)	VASCULAR PLANT ABUNDANCE	NITROGEN, NITRITE (NO2) + NITRATE (NO3) AS N (MG/L)	NITROGEN, NITRITE (NO2) + NITRATE (NO3) AS N QUALIFIER	GRAN ACID NEUTRALIZING CAPACITY (MG/L)
VOLUNTEER LAKE ASSESSMENT PROGRAM	PEARIND	2013-1229	06/18/2013	EPILIMNION	2	0.013																			
VOLUNTEER LAKE ASSESSMENT PROGRAM	PEARIND	2013-1230	06/18/2013	HYPOLIMNION	3	0.0195																			
VOLUNTEER LAKE ASSESSMENT PROGRAM	PEARIND	2013-1232	06/18/2013	HYPOLIMNION	5	0.045																			
VOLUNTEER LAKE ASSESSMENT PROGRAM	PEARIND	2013-2145	07/10/2013	COMPOSITE	4.50		7.08																		
VOLUNTEER LAKE ASSESSMENT PROGRAM	PEARIND	2013-2136	07/10/2013	EPILIMNION	1	0.0297							1			6.06	93.1								2.2
VOLUNTEER LAKE ASSESSMENT PROGRAM	PEARIND	2013-2137	07/10/2013	EPILIMNION	2	0.0311										5.8	95.4								
VOLUNTEER LAKE ASSESSMENT PROGRAM	PEARIND	2013-2138	07/10/2013	HYPOLIMNION	3	0.0382										5.61	98.6								
VOLUNTEER LAKE ASSESSMENT PROGRAM	PEARIND	2013-2139	07/10/2013	HYPOLIMNION	4	0.0654										5.84	101.7								
VOLUNTEER LAKE ASSESSMENT PROGRAM	PEARIND	2013-2140	07/10/2013	HYPOLIMNION	4.50	0.129										6	107.8								
VOLUNTEER LAKE ASSESSMENT PROGRAM	PEARIND	2013-4425	08/27/2013	EPILIMNION	1	0.0266							1			6.07	100.1								2.3
VOLUNTEER LAKE ASSESSMENT PROGRAM	PEARIND	2013-4426	08/27/2013	EPILIMNION	2	0.0243										5.82	102.1								
VOLUNTEER LAKE ASSESSMENT PROGRAM	PEARIND	2013-4427	08/27/2013	HYPOLIMNION	3	0.0266										6.02	100.4								
VOLUNTEER LAKE ASSESSMENT PROGRAM	PEARIND	2013-4428	08/27/2013	HYPOLIMNION	4	0.207										6.29	121								
VOLUNTEER LAKE ASSESSMENT PROGRAM	PEARIND	2013-4432	08/27/2013	COMPOSITE	4		7.63																		
VOLUNTEER LAKE ASSESSMENT PROGRAM	PEARIND	2013-4966	09/23/2013	COMPOSITE	4		5.16																		
VOLUNTEER LAKE ASSESSMENT PROGRAM	PEARIND	2013-4961	09/23/2013	EPILIMNION	4	0.0234							1.1			5.72	98								2.1
VOLUNTEER LAKE ASSESSMENT PROGRAM	PEARIND	2013-4960	09/23/2013	EPILIMNION	1											5.79	89								2.3
VOLUNTEER LAKE ASSESSMENT PROGRAM	PEARIND	VL04171301	04/17/2013		1			8	67.3	8.3		5.4													
VOLUNTEER LAKE ASSESSMENT PROGRAM	PEARIND	VL04171302	04/17/2013		2			8.13	68.8	8.2		5.4													
VOLUNTEER LAKE ASSESSMENT PROGRAM	PEARIND	VL04171303	04/17/2013		3			7.97	66.8	8.2		5.4													
VOLUNTEER LAKE ASSESSMENT PROGRAM	PEARIND	VL04171304	04/17/2013		4			7.94	66.6	8.1		5.4													
VOLUNTEER LAKE ASSESSMENT PROGRAM	PEARIND	VL04171305	04/17/2013		4.50			8	65.8	7.9		5.4													
VOLUNTEER LAKE ASSESSMENT PROGRAM	PEARIND	VL05151301	05/15/2013		5.50			1.84	17.5	11.4		5.8													
VOLUNTEER LAKE ASSESSMENT PROGRAM	PEARIND	VL05151302	05/15/2013		5			1.9	18	11.3		5.8													
VOLUNTEER LAKE ASSESSMENT PROGRAM	PEARIND	VL05151303	05/15/2013		4			3.1	29.6	11.7		5.8													
VOLUNTEER LAKE ASSESSMENT PROGRAM	PEARIND	VL05151304	05/15/2013		3			8.03	81.4	14.3		5.8													
VOLUNTEER LAKE ASSESSMENT PROGRAM	PEARIND	VL05151305	05/15/2013		2			8.03	82	14.6		5.8													
VOLUNTEER LAKE ASSESSMENT PROGRAM	PEARIND	VL05151306	05/15/2013		1			8.18	83.7	14.8		5.8													
VOLUNTEER LAKE ASSESSMENT PROGRAM	PEARIND	VL05151307	05/15/2013		0.10			8.3	85.6	15.1		5.8													
VOLUNTEER LAKE ASSESSMENT PROGRAM	PEARIND	VL05221301	05/22/2013		1			8.63	90	18.8															
VOLUNTEER LAKE ASSESSMENT PROGRAM	PEARIND	VL05221302	05/22/2013		2			8.14	84	17.6															
VOLUNTEER LAKE ASSESSMENT PROGRAM	PEARIND	VL05221303	05/22/2013		3			7.77	77	16.3															
VOLUNTEER LAKE ASSESSMENT PROGRAM	PEARIND	VL05221304	05/22/2013		4			6.87	67	15.4															
VOLUNTEER LAKE ASSESSMENT PROGRAM	PEARIND	VL05221305	05/22/2013		4.50			5.64	54	14.5															
VOLUNTEER LAKE ASSESSMENT PROGRAM	PEARIND	VL05221306	05/22/2013		5			4.21	40	13.7															
VOLUNTEER LAKE ASSESSMENT PROGRAM	PEARIND	VL05221307	05/22/2013		5.50			2.62	24	12.3															
VOLUNTEER LAKE ASSESSMENT PROGRAM	PEARIND	VL05281311	05/28/2013		0.10			8.6	88	17.3															
VOLUNTEER LAKE ASSESSMENT PROGRAM	PEARIND	VL05281312	05/28/2013		1			8.44	83	15.9															
VOLUNTEER LAKE ASSESSMENT PROGRAM	PEARIND	VL05281313	05/28/2013		2			8.29	82	15.7															
VOLUNTEER LAKE ASSESSMENT PROGRAM	PEARIND	VL05281314	05/28/2013		3			8.02	79	15.5															
VOLUNTEER LAKE ASSESSMENT PROGRAM	PEARIND	VL05281315	05/28/2013		4			7.63	73	14.9															
VOLUNTEER LAKE ASSESSMENT PROGRAM	PEARIND	VL05281316	05/28/2013		4.50			7.61	73	14.9															
VOLUNTEER LAKE ASSESSMENT PROGRAM	PEARIND	VL06181317	06/18/2013		5			2.14	22.4	15.9		5.5													
VOLUNTEER LAKE ASSESSMENT PROGRAM	PEARIND	VL06181318	06/18/2013		4			4.56	48.4	16.4		5.5													
VOLUNTEER LAKE ASSESSMENT PROGRAM	PEARIND	VL06181319	06/18/2013		3			5.5	59	17		5.5													
VOLUNTEER LAKE ASSESSMENT PROGRAM	PEARIND	VL06181320	06/18/2013		2			7.33	82	18.9		5.5													
VOLUNTEER LAKE ASSESSMENT PROGRAM	PEARIND	VL06181321	06/18/2013		1			7.4	83.2	19.2		5.5													
VOLUNTEER LAKE ASSESSMENT PROGRAM	PEARIND	VL06181322	06/18/2013		0.10			7.64	86.9	19.7		5.5													
VOLUNTEER LAKE ASSESSMENT PROGRAM	PEARIND	VL06181323	06/18/2013		0.10			7.57	82	20.1															
VOLUNTEER LAKE ASSESSMENT PROGRAM	PEARIND	VL06181324	06/18/2013		1			7.35	79	19.4															
VOLUNTEER LAKE ASSESSMENT PROGRAM	PEARIND	VL06181325	06/18/2013		2			7.23	78	19.2															
VOLUNTEER LAKE ASSESSMENT PROGRAM	PEARIND	VL06181326	06/18/2013		3			5.94	60	17.1															
VOLUNTEER LAKE ASSESSMENT PROGRAM	PEARIND	VL06181327	06/18/2013		4			4.78	48	16.2															
VOLUNTEER LAKE ASSESSMENT PROGRAM	PEARIND	VL06181328	06/18/2013		5			3.54	35	15.5															
VOLUNTEER LAKE ASSESSMENT PROGRAM	PEARIND	VL06261301	06/26/2013		0.10			7.35	90	26.1															
VOLUNTEER LAKE ASSESSMENT PROGRAM	PEARIND	VL06261302	06/26/2013		1			6.93	82	25.4															
VOLUNTEER LAKE ASSESSMENT PROGRAM	PEARIND	VL06261303	06/26/2013		2			5.46	61	21.9															
VOLUNTEER LAKE ASSESSMENT PROGRAM	PEARIND	VL06261304	06/26/2013		3			3.12	32	17.3															
VOLUNTEER LAKE ASSESSMENT PROGRAM	PEARIND	VL06261305	06/26/2013		4			2.24	23	16.1															

Appendix B - Pearly Pond Water Quality Database from OneStop
In-Pond Samples

PROJECT_NAME	STATION_ID	ACTIVITY_ID	START_DATE	DEPTH ZONE	DEPTH	TOTAL PHOSPHORUS (MG/L)	CHLOROPHYLL A, UNCORRECTED FOR PHEOPHYTIN (UG/L)	DISSOLVED OXYGEN (MG/L)	DISSOLVED OXYGEN SATURATION (%)	TEMPERATURE (DEG C)	DEPTH (M)	DEPTH, BOTTOM (M)	SECCHI DISK TRANSPARENCY (M)	TOTAL MAGNESIUM (MG/L)	SODIUM (MG/L)	PH	SPECIFIC CONDUCTANCE (UMHO/CM)	ESCHERICHIA COLI (#/100ML)	MERCURY (PPM WET)	POTASSIUM (MG/L)	2,4-DICHLOROPHENOXYACETIC ACID (2,4-D) (UG/L)	VASCULAR PLANT ABUNDANCE	NITROGEN, NITRITE (NO2) + NITRATE (NO3) AS N (MG/L)	NITROGEN, NITRITE (NO2) + NITRATE (NO3) AS N QUALIFIER	GRAN ACID NEUTRALIZING CAPACITY (MG/L)
VOLUNTEER LAKE ASSESSMENT PROGRAM	PEARIND	VL06261306	06/26/2013		5			1.67	16	15.7															
VOLUNTEER LAKE ASSESSMENT PROGRAM	PEARIND	VL07101331	07/10/2013		0.10			6.43	79	26.6		4.5													
VOLUNTEER LAKE ASSESSMENT PROGRAM	PEARIND	VL07101332	07/10/2013		0.10			6.43	79	26.6															
VOLUNTEER LAKE ASSESSMENT PROGRAM	PEARIND	VL07101333	07/10/2013		1			6.21	76	26.4		4.5													
VOLUNTEER LAKE ASSESSMENT PROGRAM	PEARIND	VL07101334	07/10/2013		1			6.21	76	26.4															
VOLUNTEER LAKE ASSESSMENT PROGRAM	PEARIND	VL07101335	07/10/2013		2			3.27	39	25		4.5													
VOLUNTEER LAKE ASSESSMENT PROGRAM	PEARIND	VL07101336	07/10/2013		2			3.27	39	25															
VOLUNTEER LAKE ASSESSMENT PROGRAM	PEARIND	VL07101337	07/10/2013		3			0.83	9	19.4		4.5													
VOLUNTEER LAKE ASSESSMENT PROGRAM	PEARIND	VL07101338	07/10/2013		3			0.83	9	19.4															
VOLUNTEER LAKE ASSESSMENT PROGRAM	PEARIND	VL07101339	07/10/2013		4			0.79	8	16.7		4.5													
VOLUNTEER LAKE ASSESSMENT PROGRAM	PEARIND	VL07101340	07/10/2013		4			0.79	8	16.7															
VOLUNTEER LAKE ASSESSMENT PROGRAM	PEARIND	VL07101341	07/10/2013		4.50			0.93	9	16.1		4.5													
VOLUNTEER LAKE ASSESSMENT PROGRAM	PEARIND	VL07101342	07/10/2013		4.50			0.93	9	16.1															
VOLUNTEER LAKE ASSESSMENT PROGRAM	PEARIND	VL07241314	07/24/2013		0.10			7.26	89	26.8															
VOLUNTEER LAKE ASSESSMENT PROGRAM	PEARIND	VL07241315	07/24/2013		1			7.12	88	26.7															
VOLUNTEER LAKE ASSESSMENT PROGRAM	PEARIND	VL07241316	07/24/2013		2			5.65	68	25.9															
VOLUNTEER LAKE ASSESSMENT PROGRAM	PEARIND	VL07241317	07/24/2013		3			0.88	10	22.9															
VOLUNTEER LAKE ASSESSMENT PROGRAM	PEARIND	VL07241318	07/24/2013		4			0.86	9	17.2															
VOLUNTEER LAKE ASSESSMENT PROGRAM	PEARIND	VL07241319	07/24/2013		4.50			0.73	7	16.6															
VOLUNTEER LAKE ASSESSMENT PROGRAM	PEARIND	VL07311301	07/31/2013		0.10			8.46	102	25.2		5													
VOLUNTEER LAKE ASSESSMENT PROGRAM	PEARIND	VL07311302	07/31/2013		1			7.89	92	24.4		5													
VOLUNTEER LAKE ASSESSMENT PROGRAM	PEARIND	VL07311303	07/31/2013*		2					24.3		5													
VOLUNTEER LAKE ASSESSMENT PROGRAM	PEARIND	VL07311304	07/31/2013		3			3.74	42	22.1		5													
VOLUNTEER LAKE ASSESSMENT PROGRAM	PEARIND	VL07311305	07/31/2013		4			0.64	7	18.9		5													
VOLUNTEER LAKE ASSESSMENT PROGRAM	PEARIND	VL07311306	07/31/2013		4.50			0.72	7	17.5		5													
VOLUNTEER LAKE ASSESSMENT PROGRAM	PEARIND	VL08071337	08/07/2013		0.10			7	80	22.1		5													
VOLUNTEER LAKE ASSESSMENT PROGRAM	PEARIND	VL08071338	08/07/2013		1			6.83	77	22		5													
VOLUNTEER LAKE ASSESSMENT PROGRAM	PEARIND	VL08071339	08/07/2013		2			6.24	70	21.8		5													
VOLUNTEER LAKE ASSESSMENT PROGRAM	PEARIND	VL08071340	08/07/2013		3			5.38	60	21.1		5													
VOLUNTEER LAKE ASSESSMENT PROGRAM	PEARIND	VL08071341	08/07/2013		4			0.74	8	18.6		5													
VOLUNTEER LAKE ASSESSMENT PROGRAM	PEARIND	VL08071342	08/07/2013		4.50			0.87	9	17.5		5													
VOLUNTEER LAKE ASSESSMENT PROGRAM	PEARIND	2013-5116	10/22/2013	EPILIMNION	2	0.0224										5.8	96.4								
VOLUNTEER LAKE ASSESSMENT PROGRAM	PEARIND	2013-5117	10/22/2013	EPILIMNION	3	0.0277										5.81	96.4								
VOLUNTEER LAKE ASSESSMENT PROGRAM	PEARIND	2013-5118	10/22/2013	EPILIMNION	4	0.025										5.92	97.7								
VOLUNTEER LAKE ASSESSMENT PROGRAM	PEARIND	2013-5115	10/22/2013	EPILIMNION	1	0.0207							1.9			5.37	96.7								1.1
VOLUNTEER LAKE ASSESSMENT PROGRAM	PEARIND	2013-5119	10/22/2013	COMPOSITE	4		2.88																		
PESTICIDE WATER QUALITY	PEARINAP	08060319-001	06/25/2008																		4				
PESTICIDE WATER QUALITY	PEARINAP	08070105-001	07/10/2008																		4				
PESTICIDE WATER QUALITY	PEANORTH	A009688002	09/16/2010																		ND				
NH FISH STUDY	PEARIN-GEN	2003129T	07/01/2003																0.586						
NH FISH STUDY	PEARIN-GEN	2003130T	07/01/2003																0.473						

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In-Pond Samples

PROJECT_NAME	STATION_ID	ACTIVITY_ID	START_DATE	TURBIDITY (NTU)	TOTAL COLIFORM (MPN/100ML)	NITROGEN, KJELDAHL (MG/L)	APPARENT COLOR (PCU)	ALKALINITY, CARBONATE AS CACO3 (MG/L)	CHLORIDE	CALCIUM (MG/L)	SULFATE (MG/L)	TROPHIC CLASS	WEATHER COMMENTS
LAKE TROPHIC SURVEYS	PEARIND	WDO02159101	02/15/1991										
LAKE TROPHIC SURVEYS	PEARIN-GEN	LB08079001	08/07/1990		10								
LAKE TROPHIC SURVEYS	PEARIND	LP08079011	08/07/1990										RAIN
LAKE TROPHIC SURVEYS	PEARIND	LP08079012	08/07/1990										RAIN
LAKE TROPHIC SURVEYS	PEARIND	LP08079013	08/07/1990										RAIN
LAKE TROPHIC SURVEYS	PEARIND	LP08079014	08/07/1990										RAIN
LAKE TROPHIC SURVEYS	PEARIND	SP07117704	07/11/1977										
LAKE TROPHIC SURVEYS	PEARIND	SP08079004	08/07/1990										
LAKE TROPHIC SURVEYS	PEARIND	LC03087604	03/08/1976			0.32		3					
LAKE TROPHIC SURVEYS	PEARIND	LC07117702	07/11/1977	2.9		0.81	110	1	10	2.9		EUTROPI	
LAKE TROPHIC SURVEYS	PEARIND	LC08079001	08/07/1990			0.76	65	1.2	12	2	4	EUTROPI	
LAKE TROPHIC SURVEYS	PEARIND	LC08079003	08/07/1990			0.69	75	1.4	12		5		
LAKE TROPHIC SURVEYS	PEARIND	LC02089101	02/08/1991			0.58	55	0.2	9		6		
LAKE TROPHIC SURVEYS	PEARIND	LC02089102	02/08/1991			0.63	80	0.7	12		7		
LAKE TROPHIC SURVEYS	PEARIND	VT07117702	07/11/1977										
LAKE TROPHIC SURVEYS	PEARIND	2004-2843	07/20/2004			0.5	130	2.3	20		4		
LAKE TROPHIC SURVEYS	PEARIND	2004-2844	07/20/2004										
LAKE TROPHIC SURVEYS	PEARIND	2004-2842	07/20/2004			0.6	90	1.5	20	2.17	4	EUTROPI	
LAKE TROPHIC SURVEYS	PEARIND	BLP07200409	07/20/2004										SUNNY, WARM AND BREEZY
LAKE TROPHIC SURVEYS	PEARIND	BLP07200410	07/20/2004										SUNNY, WARM AND BREEZY
LAKE TROPHIC SURVEYS	PEARIND	BLP07200411	07/20/2004										SUNNY, WARM AND BREEZY
LAKE TROPHIC SURVEYS	PEARIND	BLP07200412	07/20/2004										SUNNY, WARM AND BREEZY
LAKE TROPHIC SURVEYS	PEARIND	BLP07200413	07/20/2004										SUNNY, WARM AND BREEZY
LAKE TROPHIC SURVEYS	PEARIND	BLP07200414	07/20/2004										SUNNY, WARM AND BREEZY
LAKE TROPHIC SURVEYS	PEARINEC01	2004-2846	07/20/2004										
LAKE TROPHIC SURVEYS	PEARINEC02	2004-2847	07/20/2004										
LAKE TROPHIC SURVEYS	PEARIND	2005-235	02/03/2005			0.3	95	1.6	22		6		
LAKE TROPHIC SURVEYS	PEARIND	2005-243	02/03/2005			0.3	95	2.3	27		6		
LAKE TROPHIC SURVEYS	PEARIND	2005-244	02/03/2005										
LAKE TROPHIC SURVEYS	PEARIN-GEN	LB08079004	08/07/1990		0								
VOLUNTEER LAKE ASSESSMENT PROGRAM	PEARIND	VL06099208	06/09/1992										SUNNY, SLIGHT BREEZE
VOLUNTEER LAKE ASSESSMENT PROGRAM	PEARIND	VL06099209	06/09/1992										SUNNY, SLIGHT BREEZE
VOLUNTEER LAKE ASSESSMENT PROGRAM	PEARIND	VL06099210	06/09/1992										SUNNY, SLIGHT BREEZE
VOLUNTEER LAKE ASSESSMENT PROGRAM	PEARIND	VL06099211	06/09/1992										SUNNY, SLIGHT BREEZE
VOLUNTEER LAKE ASSESSMENT PROGRAM	PEARIND	VL06099212	06/09/1992										SUNNY, SLIGHT BREEZE
VOLUNTEER LAKE ASSESSMENT PROGRAM	PEARIND	VL06099213	06/09/1992										SUNNY, SLIGHT BREEZE
VOLUNTEER LAKE ASSESSMENT PROGRAM	PEARIND	VL06099214	06/09/1992										SUNNY, SLIGHT BREEZE
VOLUNTEER LAKE ASSESSMENT PROGRAM	PEARIND	VL06099215	06/09/1992										SUNNY, SLIGHT BREEZE
VOLUNTEER LAKE ASSESSMENT PROGRAM	PEARIND	VL06099227	06/09/1992				70	3.4					
VOLUNTEER LAKE ASSESSMENT PROGRAM	PEARIND	VL06099228	06/09/1992				75						
VOLUNTEER LAKE ASSESSMENT PROGRAM	PEARIN-GEN	VL06099234	06/09/1992				75						
VOLUNTEER LAKE ASSESSMENT PROGRAM	PEARIN-GEN	VL06099245	06/09/1992										
VOLUNTEER LAKE ASSESSMENT PROGRAM	PEARIND	VL06099247	06/09/1992										
VOLUNTEER LAKE ASSESSMENT PROGRAM	PEARIN-GEN	VL07149227	07/14/1992				280						
VOLUNTEER LAKE ASSESSMENT PROGRAM	PEARIND	VL07149228	07/14/1992				90	1.5					
VOLUNTEER LAKE ASSESSMENT PROGRAM	PEARIND	VL07149231	07/14/1992				85						
VOLUNTEER LAKE ASSESSMENT PROGRAM	PEARIND	VL07149255	07/14/1992										
VOLUNTEER LAKE ASSESSMENT PROGRAM	PEARIND	VL08309233	08/30/1992				70	1.8					
VOLUNTEER LAKE ASSESSMENT PROGRAM	PEARIND	VL08309234	08/30/1992				75						
VOLUNTEER LAKE ASSESSMENT PROGRAM	PEARIN-GEN	VL08309236	08/30/1992				280						
VOLUNTEER LAKE ASSESSMENT PROGRAM	PEARIN-GEN	VL08309250	08/30/1992										
VOLUNTEER LAKE ASSESSMENT PROGRAM	PEARIND	VL08309253	08/30/1992										
VOLUNTEER LAKE ASSESSMENT PROGRAM	PEARIND	VL06229306	06/22/1993										WINDY, SUNNY
VOLUNTEER LAKE ASSESSMENT PROGRAM	PEARIND	VL06229307	06/22/1993										WINDY, SUNNY
VOLUNTEER LAKE ASSESSMENT PROGRAM	PEARIND	VL06229308	06/22/1993										WINDY, SUNNY
VOLUNTEER LAKE ASSESSMENT PROGRAM	PEARIND	VL06229309	06/22/1993										WINDY, SUNNY
VOLUNTEER LAKE ASSESSMENT PROGRAM	PEARIND	VL06229310	06/22/1993										WINDY, SUNNY
VOLUNTEER LAKE ASSESSMENT PROGRAM	PEARIND	VL06229312	06/22/1993				70	1.4					
VOLUNTEER LAKE ASSESSMENT PROGRAM	PEARIND	VL06229314	06/22/1993				70						

Appendix B - Pearly Pond Water Quality Database from OneStop
In-Pond Samples

PROJECT_NAME	STATION_ID	ACTIVITY_ID	START_DATE	TURBIDITY (NTU)	TOTAL COLIFORM (MPN/100ML)	NITROGEN, KJELDAHL (MG/L)	APPARENT COLOR (PCU)	ALKALINITY, CARBONATE AS CACO3 (MG/L)	CHLORIDE	CALCIUM (MG/L)	SULFATE (MG/L)	TROPHIC CLASS	WEATHER COMMENTS
VOLUNTEER LAKE ASSESSMENT PROGRAM	PEARIND	VL06229327	06/22/1993										
VOLUNTEER LAKE ASSESSMENT PROGRAM	PEARIND	VL08019328	08/01/1993				39	0.5					
VOLUNTEER LAKE ASSESSMENT PROGRAM	PEARIND	VL08019329	08/01/1993				46						
VOLUNTEER LAKE ASSESSMENT PROGRAM	PEARIN-GEN	VL08019333	08/01/1993				65						
VOLUNTEER LAKE ASSESSMENT PROGRAM	PEARIND	VL08019337	08/01/1993										
VOLUNTEER LAKE ASSESSMENT PROGRAM	PEARIN-GEN	VL06199416	06/19/1994				140						
VOLUNTEER LAKE ASSESSMENT PROGRAM	PEARIND	VL06199418	06/19/1994				84	1.3					
VOLUNTEER LAKE ASSESSMENT PROGRAM	PEARIND	VL06199419	06/19/1994				88						
VOLUNTEER LAKE ASSESSMENT PROGRAM	PEARIND	VL06199420	06/19/1994				84						
VOLUNTEER LAKE ASSESSMENT PROGRAM	PEARIND	VL06199429	06/19/1994										
VOLUNTEER LAKE ASSESSMENT PROGRAM	PEARIND	VL07139401	07/13/1994										CLOUDY, WARM
VOLUNTEER LAKE ASSESSMENT PROGRAM	PEARIND	VL07139403	07/13/1994										CLOUDY, WARM
VOLUNTEER LAKE ASSESSMENT PROGRAM	PEARIND	VL07139404	07/13/1994										CLOUDY, WARM
VOLUNTEER LAKE ASSESSMENT PROGRAM	PEARIND	VL07139406	07/13/1994										CLOUDY, WARM
VOLUNTEER LAKE ASSESSMENT PROGRAM	PEARIND	VL07139407	07/13/1994										CLOUDY, WARM
VOLUNTEER LAKE ASSESSMENT PROGRAM	PEARIND	VL07139409	07/13/1994										CLOUDY, WARM
VOLUNTEER LAKE ASSESSMENT PROGRAM	PEARIND	VL07139410	07/13/1994										CLOUDY, WARM
VOLUNTEER LAKE ASSESSMENT PROGRAM	PEARIND	VL07139412	07/13/1994										CLOUDY, WARM
VOLUNTEER LAKE ASSESSMENT PROGRAM	PEARIND	VL07139413	07/13/1994										CLOUDY, WARM
VOLUNTEER LAKE ASSESSMENT PROGRAM	PEARIND	VL07139435	07/13/1994				100	2.1					
VOLUNTEER LAKE ASSESSMENT PROGRAM	PEARIND	VL07139437	07/13/1994				140						
VOLUNTEER LAKE ASSESSMENT PROGRAM	PEARIN-GEN	VL07139439	07/13/1994				140						
VOLUNTEER LAKE ASSESSMENT PROGRAM	PEARIN-GEN	VL07139442	07/13/1994										
VOLUNTEER LAKE ASSESSMENT PROGRAM	PEARIND	VL07139445	07/13/1994										
VOLUNTEER LAKE ASSESSMENT PROGRAM	PEARIND	VL08149422	08/14/1994				110	1.3					
VOLUNTEER LAKE ASSESSMENT PROGRAM	PEARIND	VL08149426	08/14/1994				125						
VOLUNTEER LAKE ASSESSMENT PROGRAM	PEARIN-GEN	VL08149437	08/14/1994				140						
VOLUNTEER LAKE ASSESSMENT PROGRAM	PEARIND	VL08149440	08/14/1994										
VOLUNTEER LAKE ASSESSMENT PROGRAM	PEARIN-GEN	VL08319407	08/31/1994										
VOLUNTEER LAKE ASSESSMENT PROGRAM	PEARIN-GEN	VL08319409	08/31/1994										
VOLUNTEER LAKE ASSESSMENT PROGRAM	PEARIND	VL06299501	06/29/1995										SUNNY, WARM
VOLUNTEER LAKE ASSESSMENT PROGRAM	PEARIND	VL06299502	06/29/1995										SUNNY, WARM
VOLUNTEER LAKE ASSESSMENT PROGRAM	PEARIND	VL06299503	06/29/1995										SUNNY, WARM
VOLUNTEER LAKE ASSESSMENT PROGRAM	PEARIND	VL06299504	06/29/1995										SUNNY, WARM
VOLUNTEER LAKE ASSESSMENT PROGRAM	PEARIND	VL06299505	06/29/1995										SUNNY, WARM
VOLUNTEER LAKE ASSESSMENT PROGRAM	PEARIND	VL06299506	06/29/1995										SUNNY, WARM
VOLUNTEER LAKE ASSESSMENT PROGRAM	PEARIND	VL06299507	06/29/1995										SUNNY, WARM
VOLUNTEER LAKE ASSESSMENT PROGRAM	PEARIND	VL06299508	06/29/1995										SUNNY, WARM
VOLUNTEER LAKE ASSESSMENT PROGRAM	PEARIND	VL06299509	06/29/1995										SUNNY, WARM
VOLUNTEER LAKE ASSESSMENT PROGRAM	PEARIN-GEN	VL06299514	06/29/1995				55						
VOLUNTEER LAKE ASSESSMENT PROGRAM	PEARIND	VL06299521	06/29/1995				120	1.8					
VOLUNTEER LAKE ASSESSMENT PROGRAM	PEARIND	VL06299523	06/29/1995				140						
VOLUNTEER LAKE ASSESSMENT PROGRAM	PEARIN-GEN	VL06299524	06/29/1995				140						
VOLUNTEER LAKE ASSESSMENT PROGRAM	PEARIND	VL06299526	06/29/1995										
VOLUNTEER LAKE ASSESSMENT PROGRAM	PEARIND	VL07269541	07/26/1995				110	14.4					
VOLUNTEER LAKE ASSESSMENT PROGRAM	PEARIND	VL07269543	07/26/1995				110						
VOLUNTEER LAKE ASSESSMENT PROGRAM	PEARIND	VL07269554	07/26/1995										
VOLUNTEER LAKE ASSESSMENT PROGRAM	PEARIND	VL08289540	08/28/1995				95	14.4					
VOLUNTEER LAKE ASSESSMENT PROGRAM	PEARIND	VL08289541	08/28/1995				100						
VOLUNTEER LAKE ASSESSMENT PROGRAM	PEARIND	VL08289586	08/28/1995										
VOLUNTEER LAKE ASSESSMENT PROGRAM	PEARIND	VL06309606	06/30/1996				110						
VOLUNTEER LAKE ASSESSMENT PROGRAM	PEARIND	VL06309607	06/30/1996				110	1.4					
VOLUNTEER LAKE ASSESSMENT PROGRAM	PEARIND	VL06309609	06/30/1996				140						
VOLUNTEER LAKE ASSESSMENT PROGRAM	PEARIND	VL06309610	06/30/1996										
VOLUNTEER LAKE ASSESSMENT PROGRAM	PEARIND	VL07319603	07/31/1996										OVERCAST
VOLUNTEER LAKE ASSESSMENT PROGRAM	PEARIND	VL07319607	07/31/1996										
VOLUNTEER LAKE ASSESSMENT PROGRAM	PEARIND	VL07319610	07/31/1996										
VOLUNTEER LAKE ASSESSMENT PROGRAM	PEARIND	VL07319613	07/31/1996										
VOLUNTEER LAKE ASSESSMENT PROGRAM	PEARIND	VL07319615	07/31/1996										

Appendix B - Pearly Pond Water Quality Database from OneStop
In-Pond Samples

PROJECT_NAME	STATION_ID	ACTIVITY_ID	START_DATE	TURBIDITY (NTU)	TOTAL COLIFORM (MPN/100ML)	NITROGEN, KJELDAHL (MG/L)	APPARENT COLOR (PCU)	ALKALINITY, CARBONATE AS CACO3 (MG/L)	CHLORIDE	CALCIUM (MG/L)	SULFATE (MG/L)	TROPHIC CLASS	WEATHER COMMENTS
VOLUNTEER LAKE ASSESSMENT PROGRAM	PEARIND	VL07319617	07/31/1996										
VOLUNTEER LAKE ASSESSMENT PROGRAM	PEARIND	VL07319647	07/31/1996				140						
VOLUNTEER LAKE ASSESSMENT PROGRAM	PEARIND	VL07319648	07/31/1996				140	2.1					
VOLUNTEER LAKE ASSESSMENT PROGRAM	PEARIND	VL07319650	07/31/1996				140						
VOLUNTEER LAKE ASSESSMENT PROGRAM	PEARIND	VL07319668	07/31/1996										
VOLUNTEER LAKE ASSESSMENT PROGRAM	PEARIND	VL09159632	09/15/1996				90						
VOLUNTEER LAKE ASSESSMENT PROGRAM	PEARIND	VL09159633	09/15/1996				90						
VOLUNTEER LAKE ASSESSMENT PROGRAM	PEARIND	VL09159634	09/15/1996				90	2.3					
VOLUNTEER LAKE ASSESSMENT PROGRAM	PEARIND	VL09159642	09/15/1996										
VOLUNTEER LAKE ASSESSMENT PROGRAM	PEARIND	VL06169744	06/16/1997	0.67				1.7					
VOLUNTEER LAKE ASSESSMENT PROGRAM	PEARIND	VL06169752	06/16/1997	0.78									
VOLUNTEER LAKE ASSESSMENT PROGRAM	PEARIND	VL06169766	06/16/1997	1.8									
VOLUNTEER LAKE ASSESSMENT PROGRAM	PEARIND	VL06169773	06/16/1997										
VOLUNTEER LAKE ASSESSMENT PROGRAM	PEARIND	VL07319759	07/31/1997	1.76									
VOLUNTEER LAKE ASSESSMENT PROGRAM	PEARIND	VL07319760	07/31/1997	1.9				1.5					
VOLUNTEER LAKE ASSESSMENT PROGRAM	PEARIND	VL07319767	07/31/1997	7.6									
VOLUNTEER LAKE ASSESSMENT PROGRAM	PEARIND	VL07319789	07/31/1997										
VOLUNTEER LAKE ASSESSMENT PROGRAM	PEARIND	VL08259701	08/25/1997										
VOLUNTEER LAKE ASSESSMENT PROGRAM	PEARIND	VL08259702	08/25/1997										
VOLUNTEER LAKE ASSESSMENT PROGRAM	PEARIND	VL08259703	08/25/1997										
VOLUNTEER LAKE ASSESSMENT PROGRAM	PEARIND	VL08259704	08/25/1997										
VOLUNTEER LAKE ASSESSMENT PROGRAM	PEARIND	VL08259705	08/25/1997										
VOLUNTEER LAKE ASSESSMENT PROGRAM	PEARIND	VL08259706	08/25/1997										
VOLUNTEER LAKE ASSESSMENT PROGRAM	PEARIND	VL08259751	08/25/1997	3.4									
VOLUNTEER LAKE ASSESSMENT PROGRAM	PEARIND	VL08259753	08/25/1997	4.9				2.5					
VOLUNTEER LAKE ASSESSMENT PROGRAM	PEARIND	VL08259754	08/25/1997	5									
VOLUNTEER LAKE ASSESSMENT PROGRAM	PEARIND	VL08259761	08/25/1997										
VOLUNTEER LAKE ASSESSMENT PROGRAM	PEARIND	VL06299815	06/29/1998	0.85				1.17					
VOLUNTEER LAKE ASSESSMENT PROGRAM	PEARIND	VL06299818	06/29/1998	0.97									
VOLUNTEER LAKE ASSESSMENT PROGRAM	PEARIND	VL06299831	06/29/1998	1.3									
VOLUNTEER LAKE ASSESSMENT PROGRAM	PEARIND	VL06299836	06/29/1998	2.6									
VOLUNTEER LAKE ASSESSMENT PROGRAM	PEARIND	VL06299838	06/29/1998	4.2									
VOLUNTEER LAKE ASSESSMENT PROGRAM	PEARIND	VL06299846	06/29/1998										
VOLUNTEER LAKE ASSESSMENT PROGRAM	PEARIND	VL07149801	07/14/1998										
VOLUNTEER LAKE ASSESSMENT PROGRAM	PEARIND	VL07149803	07/14/1998										
VOLUNTEER LAKE ASSESSMENT PROGRAM	PEARIND	VL07149805	07/14/1998										
VOLUNTEER LAKE ASSESSMENT PROGRAM	PEARIND	VL07149807	07/14/1998										
VOLUNTEER LAKE ASSESSMENT PROGRAM	PEARIND	VL07149809	07/14/1998										
VOLUNTEER LAKE ASSESSMENT PROGRAM	PEARIND	VL07149811	07/14/1998										
VOLUNTEER LAKE ASSESSMENT PROGRAM	PEARIND	VL07149847	07/14/1998	0.96									
VOLUNTEER LAKE ASSESSMENT PROGRAM	PEARIND	VL07149850	07/14/1998	1.52				2.4					
VOLUNTEER LAKE ASSESSMENT PROGRAM	PEARIND	VL07149856	07/14/1998	3									
VOLUNTEER LAKE ASSESSMENT PROGRAM	PEARIND	VL07149879	07/14/1998										
VOLUNTEER LAKE ASSESSMENT PROGRAM	PEARIND	VL08199860	08/19/1998	4.7				3.9					
VOLUNTEER LAKE ASSESSMENT PROGRAM	PEARIND	VL08199861	08/19/1998	4.8									
VOLUNTEER LAKE ASSESSMENT PROGRAM	PEARIND	VL08199865	08/19/1998	9.3									
VOLUNTEER LAKE ASSESSMENT PROGRAM	PEARIND	VL08199873	08/19/1998										
VOLUNTEER LAKE ASSESSMENT PROGRAM	PEARIND	VL06039902	06/03/1999	0.75									
VOLUNTEER LAKE ASSESSMENT PROGRAM	PEARIND	VL06039904	06/03/1999	0.81				0.2					
VOLUNTEER LAKE ASSESSMENT PROGRAM	PEARIND	VL06039906	06/03/1999	1.26									
VOLUNTEER LAKE ASSESSMENT PROGRAM	PEARIND	VL06039907	06/03/1999										
VOLUNTEER LAKE ASSESSMENT PROGRAM	PEARIND	VL07149901	07/14/1999										PARLTY CLOUDY, CALM
VOLUNTEER LAKE ASSESSMENT PROGRAM	PEARIND	VL07149902	07/14/1999										PARLTY CLOUDY, CALM
VOLUNTEER LAKE ASSESSMENT PROGRAM	PEARIND	VL07149903	07/14/1999										PARLTY CLOUDY, CALM
VOLUNTEER LAKE ASSESSMENT PROGRAM	PEARIND	VL07149904	07/14/1999										PARLTY CLOUDY, CALM
VOLUNTEER LAKE ASSESSMENT PROGRAM	PEARIND	VL07149905	07/14/1999										PARLTY CLOUDY, CALM
VOLUNTEER LAKE ASSESSMENT PROGRAM	PEARIND	VL07149959	07/14/1999	1.37				2.8					
VOLUNTEER LAKE ASSESSMENT PROGRAM	PEARIND	VL07149961	07/14/1999	2.9									
VOLUNTEER LAKE ASSESSMENT PROGRAM	PEARIND	VL07149962	07/14/1999										

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PROJECT_NAME	STATION_ID	ACTIVITY_ID	START_DATE	TURBIDITY (NTU)	TOTAL COLIFORM (MPN/100ML)	NITROGEN, KJELDAHL (MG/L)	APPARENT COLOR (PCU)	ALKALINITY, CARBONATE AS CACO3 (MG/L)	CHLORIDE	CALCIUM (MG/L)	SULFATE (MG/L)	TROPHIC CLASS	WEATHER COMMENTS
VOLUNTEER LAKE ASSESSMENT PROGRAM	PEARIND	VL08189941	08/18/1999	1.88									
VOLUNTEER LAKE ASSESSMENT PROGRAM	PEARIND	VL08189945	08/18/1999	2.3									
VOLUNTEER LAKE ASSESSMENT PROGRAM	PEARIND	VL08189948	08/18/1999	3.6				1.7					
VOLUNTEER LAKE ASSESSMENT PROGRAM	PEARIND	VL08189956	08/18/1999										
VOLUNTEER LAKE ASSESSMENT PROGRAM	PEARIND	VL07180068	07/18/2000	1.84									
VOLUNTEER LAKE ASSESSMENT PROGRAM	PEARIND	VL07180071	07/18/2000	3.3									
VOLUNTEER LAKE ASSESSMENT PROGRAM	PEARIND	VL07180075	07/18/2000	6									
VOLUNTEER LAKE ASSESSMENT PROGRAM	PEARIND	VL071800101	07/18/2000										
VOLUNTEER LAKE ASSESSMENT PROGRAM	PEARIND	VL08280047	08/28/2000	1.39									
VOLUNTEER LAKE ASSESSMENT PROGRAM	PEARIND	VL08280049	08/28/2000	1.45				2.3					
VOLUNTEER LAKE ASSESSMENT PROGRAM	PEARIND	VL08280053	08/28/2000	4.3									
VOLUNTEER LAKE ASSESSMENT PROGRAM	PEARIND	VL08280066	08/28/2000										
VOLUNTEER LAKE ASSESSMENT PROGRAM	PEARIND	VL06270163	06/27/2001	1.62				2.4					
VOLUNTEER LAKE ASSESSMENT PROGRAM	PEARIND	VL06270168	06/27/2001	7.2									
VOLUNTEER LAKE ASSESSMENT PROGRAM	PEARIND	VL06270170	06/27/2001	15.4									
VOLUNTEER LAKE ASSESSMENT PROGRAM	PEARIND	VL06270188	06/27/2001										
VOLUNTEER LAKE ASSESSMENT PROGRAM	PEARIND	VL07180152	07/18/2001	1.06									
VOLUNTEER LAKE ASSESSMENT PROGRAM	PEARIND	VL07180155	07/18/2001	1.35				2.9					
VOLUNTEER LAKE ASSESSMENT PROGRAM	PEARIND	VL07180161	07/18/2001	12.7									
VOLUNTEER LAKE ASSESSMENT PROGRAM	PEARIND	VL07180187	07/18/2001										
VOLUNTEER LAKE ASSESSMENT PROGRAM	PEARIND	VL08130109	08/13/2001										COOL, OVERCAST, BREEZY
VOLUNTEER LAKE ASSESSMENT PROGRAM	PEARIND	VL08130110	08/13/2001										COOL, OVERCAST, BREEZY
VOLUNTEER LAKE ASSESSMENT PROGRAM	PEARIND	VL08130111	08/13/2001										COOL, OVERCAST, BREEZY
VOLUNTEER LAKE ASSESSMENT PROGRAM	PEARIND	VL08130112	08/13/2001										COOL, OVERCAST, BREEZY
VOLUNTEER LAKE ASSESSMENT PROGRAM	PEARIND	VL08130113	08/13/2001										COOL, OVERCAST, BREEZY
VOLUNTEER LAKE ASSESSMENT PROGRAM	PEARIND	VL08130114	08/13/2001										COOL, OVERCAST, BREEZY
VOLUNTEER LAKE ASSESSMENT PROGRAM	PEARIND	VL08130123	08/13/2001	1.13				2.7					
VOLUNTEER LAKE ASSESSMENT PROGRAM	PEARIND	VL08130134	08/13/2001	3.6									
VOLUNTEER LAKE ASSESSMENT PROGRAM	PEARIND	VL08130137	08/13/2001	7.9									
VOLUNTEER LAKE ASSESSMENT PROGRAM	PEARIND	VL08130147	08/13/2001										
VOLUNTEER LAKE ASSESSMENT PROGRAM	PEARIND	VL06170234	06/17/2002										OVERCAST, WARM, BREEZY
VOLUNTEER LAKE ASSESSMENT PROGRAM	PEARIND	VL06170235	06/17/2002										OVERCAST, WARM, BREEZY
VOLUNTEER LAKE ASSESSMENT PROGRAM	PEARIND	VL06170236	06/17/2002										OVERCAST, WARM, BREEZY
VOLUNTEER LAKE ASSESSMENT PROGRAM	PEARIND	VL06170237	06/17/2002										OVERCAST, WARM, BREEZY
VOLUNTEER LAKE ASSESSMENT PROGRAM	PEARIND	VL06170238	06/17/2002										OVERCAST, WARM, BREEZY
VOLUNTEER LAKE ASSESSMENT PROGRAM	PEARIND	VL06170239	06/17/2002										OVERCAST, WARM, BREEZY
VOLUNTEER LAKE ASSESSMENT PROGRAM	PEARIND	VL061702178	06/17/2002	1.84				2.3					
VOLUNTEER LAKE ASSESSMENT PROGRAM	PEARIND	VL061702181	06/17/2002	2.3									
VOLUNTEER LAKE ASSESSMENT PROGRAM	PEARIND	VL061702188	06/17/2002										
VOLUNTEER LAKE ASSESSMENT PROGRAM	PEARIND	VL08120249	08/12/2002	1.81									
VOLUNTEER LAKE ASSESSMENT PROGRAM	PEARIND	VL08120255	08/12/2002	3.2				2.4					
VOLUNTEER LAKE ASSESSMENT PROGRAM	PEARIND	VL08120261	08/12/2002	9.3									
VOLUNTEER LAKE ASSESSMENT PROGRAM	PEARIND	VL08120275	08/12/2002										
VOLUNTEER LAKE ASSESSMENT PROGRAM	PEARIND	VL07140321	07/14/2003										PARTLY CLOUDY, WARM, CALM
VOLUNTEER LAKE ASSESSMENT PROGRAM	PEARIND	VL07140322	07/14/2003										PARTLY CLOUDY, WARM, CALM
VOLUNTEER LAKE ASSESSMENT PROGRAM	PEARIND	VL07140323	07/14/2003										PARTLY CLOUDY, WARM, CALM
VOLUNTEER LAKE ASSESSMENT PROGRAM	PEARIND	VL07140324	07/14/2003										PARTLY CLOUDY, WARM, CALM
VOLUNTEER LAKE ASSESSMENT PROGRAM	PEARIND	VL07140325	07/14/2003										PARTLY CLOUDY, WARM, CALM
VOLUNTEER LAKE ASSESSMENT PROGRAM	PEARIND	VL07140326	07/14/2003										PARTLY CLOUDY, WARM, CALM
VOLUNTEER LAKE ASSESSMENT PROGRAM	PEARIND	VL07140362	07/14/2003	2.08				2.4					
VOLUNTEER LAKE ASSESSMENT PROGRAM	PEARIND	VL07140369	07/14/2003	9.19									
VOLUNTEER LAKE ASSESSMENT PROGRAM	PEARIND	VL07140383	07/14/2003										
VOLUNTEER LAKE ASSESSMENT PROGRAM	PEARIND	VL08170345	08/17/2003	3.44				2.5					
VOLUNTEER LAKE ASSESSMENT PROGRAM	PEARIND	VL08170346	08/17/2003	26.2									
VOLUNTEER LAKE ASSESSMENT PROGRAM	PEARIND	VL08170349	08/17/2003										
VOLUNTEER LAKE ASSESSMENT PROGRAM	PEARIND	2004-1227	06/15/2004	2.8				1					
VOLUNTEER LAKE ASSESSMENT PROGRAM	PEARIND	2004-1228	06/15/2004	1.94									
VOLUNTEER LAKE ASSESSMENT PROGRAM	PEARIND	2004-1229	06/15/2004	6.3									
VOLUNTEER LAKE ASSESSMENT PROGRAM	PEARIND	2004-1233	06/15/2004										

Appendix B - Pearly Pond Water Quality Database from OneStop
In-Pond Samples

PROJECT_NAME	STATION_ID	ACTIVITY_ID	START_DATE	TURBIDITY (NTU)	TOTAL COLIFORM (MPN/100ML)	NITROGEN, KJELDAHL (MG/L)	APPARENT COLOR (PCU)	ALKALINITY, CARBONATE AS CACO3 (MG/L)	CHLORIDE	CALCIUM (MG/L)	SULFATE (MG/L)	TROPHIC CLASS	WEATHER COMMENTS
VOLUNTEER LAKE ASSESSMENT PROGRAM	PEARIND	2004-2843	07/20/2004			0.5	130	2.3	20		4		
VOLUNTEER LAKE ASSESSMENT PROGRAM	PEARIND	2004-2844	07/20/2004										
VOLUNTEER LAKE ASSESSMENT PROGRAM	PEARIND	2004-2842	07/20/2004			0.6	90	1.5	20	2.17	4	EUTROPI	
VOLUNTEER LAKE ASSESSMENT PROGRAM	PEARIND	2004-3176	07/26/2004	7.42				2.1					
VOLUNTEER LAKE ASSESSMENT PROGRAM	PEARIND	2004-3177	07/26/2004	9.25									
VOLUNTEER LAKE ASSESSMENT PROGRAM	PEARIND	2004-3178	07/26/2004	37.6									
VOLUNTEER LAKE ASSESSMENT PROGRAM	PEARIND	2004-3181	07/26/2004										
VOLUNTEER LAKE ASSESSMENT PROGRAM	PEARIND	BLP07200409	07/20/2004										SUNNY, WARM AND BREEZY
VOLUNTEER LAKE ASSESSMENT PROGRAM	PEARIND	BLP07200410	07/20/2004										SUNNY, WARM AND BREEZY
VOLUNTEER LAKE ASSESSMENT PROGRAM	PEARIND	BLP07200411	07/20/2004										SUNNY, WARM AND BREEZY
VOLUNTEER LAKE ASSESSMENT PROGRAM	PEARIND	BLP07200412	07/20/2004										SUNNY, WARM AND BREEZY
VOLUNTEER LAKE ASSESSMENT PROGRAM	PEARIND	BLP07200413	07/20/2004										SUNNY, WARM AND BREEZY
VOLUNTEER LAKE ASSESSMENT PROGRAM	PEARIND	BLP07200414	07/20/2004										SUNNY, WARM AND BREEZY
VOLUNTEER LAKE ASSESSMENT PROGRAM	PEARIND	VLP08100450	08/10/2004										SUNNY, WARM AND BREEZY
VOLUNTEER LAKE ASSESSMENT PROGRAM	PEARIND	VLP08100451	08/10/2004										SUNNY, WARM AND BREEZY
VOLUNTEER LAKE ASSESSMENT PROGRAM	PEARIND	VLP08100452	08/10/2004										SUNNY, WARM AND BREEZY
VOLUNTEER LAKE ASSESSMENT PROGRAM	PEARIND	VLP08100453	08/10/2004										SUNNY, WARM AND BREEZY
VOLUNTEER LAKE ASSESSMENT PROGRAM	PEARIND	VLP08100454	08/10/2004										SUNNY, WARM AND BREEZY
VOLUNTEER LAKE ASSESSMENT PROGRAM	PEARIND	VLP08100455	08/10/2004										SUNNY, WARM AND BREEZY
VOLUNTEER LAKE ASSESSMENT PROGRAM	PEARIND	VLP08100456	08/10/2004										SUNNY, WARM AND BREEZY
VOLUNTEER LAKE ASSESSMENT PROGRAM	PEARIND	VLP08100457	08/10/2004										SUNNY, WARM AND BREEZY
VOLUNTEER LAKE ASSESSMENT PROGRAM	PEARIND	VLP08100458	08/10/2004										SUNNY, WARM AND BREEZY
VOLUNTEER LAKE ASSESSMENT PROGRAM	PEARIND	VLP08100459	08/10/2004										SUNNY, WARM AND BREEZY
VOLUNTEER LAKE ASSESSMENT PROGRAM	PEARIND	VLP08100460	08/10/2004										SUNNY, WARM AND BREEZY
VOLUNTEER LAKE ASSESSMENT PROGRAM	PEARIND	VLP08100461	08/10/2004										SUNNY, WARM AND BREEZY
VOLUNTEER LAKE ASSESSMENT PROGRAM	PEARIND	2004-3973	08/10/2004	3.69									
VOLUNTEER LAKE ASSESSMENT PROGRAM	PEARIND	2004-3974	08/10/2004	9.6									
VOLUNTEER LAKE ASSESSMENT PROGRAM	PEARIND	2004-3972	08/10/2004	3.56				2.3					
VOLUNTEER LAKE ASSESSMENT PROGRAM	PEARIND	2004-3979	08/10/2004										
VOLUNTEER LAKE ASSESSMENT PROGRAM	PEARIND	2005-2177	06/26/2005	1.46				2.1					
VOLUNTEER LAKE ASSESSMENT PROGRAM	PEARIND	2005-2178	06/26/2005	1.25									
VOLUNTEER LAKE ASSESSMENT PROGRAM	PEARIND	2005-2179	06/26/2005	2.37									
VOLUNTEER LAKE ASSESSMENT PROGRAM	PEARIND	2005-2183	06/26/2005										
VOLUNTEER LAKE ASSESSMENT PROGRAM	PEARIND	2005-2708	07/10/2005	2.62				2.4					
VOLUNTEER LAKE ASSESSMENT PROGRAM	PEARIND	2005-2709	07/10/2005	2.37									
VOLUNTEER LAKE ASSESSMENT PROGRAM	PEARIND	2005-2710	07/10/2005	3.41									
VOLUNTEER LAKE ASSESSMENT PROGRAM	PEARIND	2005-2714	07/10/2005										
VOLUNTEER LAKE ASSESSMENT PROGRAM	PEARIND	2005-4513	08/15/2005										
VOLUNTEER LAKE ASSESSMENT PROGRAM	PEARIND	2005-4507	08/15/2005	5.2									
VOLUNTEER LAKE ASSESSMENT PROGRAM	PEARIND	2005-4508	08/15/2005	6.01									
VOLUNTEER LAKE ASSESSMENT PROGRAM	PEARIND	2005-4506	08/15/2005	2.66				3.1					
VOLUNTEER LAKE ASSESSMENT PROGRAM	PEARIND	VL08150506	08/15/2005										OVERCAST, WARM, BREEZY
VOLUNTEER LAKE ASSESSMENT PROGRAM	PEARIND	VL08150507	08/15/2005										OVERCAST, WARM, BREEZY
VOLUNTEER LAKE ASSESSMENT PROGRAM	PEARIND	VL08150508	08/15/2005										OVERCAST, WARM, BREEZY
VOLUNTEER LAKE ASSESSMENT PROGRAM	PEARIND	VL08150509	08/15/2005										OVERCAST, WARM, BREEZY
VOLUNTEER LAKE ASSESSMENT PROGRAM	PEARIND	VL08150510	08/15/2005										OVERCAST, WARM, BREEZY
VOLUNTEER LAKE ASSESSMENT PROGRAM	PEARIND	2006-1970	06/26/2006	1.55				1.3					
VOLUNTEER LAKE ASSESSMENT PROGRAM	PEARIND	2006-1971	06/26/2006	1.2									
VOLUNTEER LAKE ASSESSMENT PROGRAM	PEARIND	2006-1972	06/26/2006	2.23									
VOLUNTEER LAKE ASSESSMENT PROGRAM	PEARIND	2006-1976	06/26/2006										
VOLUNTEER LAKE ASSESSMENT PROGRAM	PEARIND	2006-3490	07/25/2006	4.14				2.2					
VOLUNTEER LAKE ASSESSMENT PROGRAM	PEARIND	2006-3491	07/25/2006	6.83									
VOLUNTEER LAKE ASSESSMENT PROGRAM	PEARIND	2006-3492	07/25/2006	4.34									
VOLUNTEER LAKE ASSESSMENT PROGRAM	PEARIND	2006-3496	07/25/2006										
VOLUNTEER LAKE ASSESSMENT PROGRAM	PEARIND	2006-5316	08/30/2006	1.84				3.1					
VOLUNTEER LAKE ASSESSMENT PROGRAM	PEARIND	2006-5317	08/30/2006	2.21									
VOLUNTEER LAKE ASSESSMENT PROGRAM	PEARIND	2006-5318	08/30/2006	4.97									
VOLUNTEER LAKE ASSESSMENT PROGRAM	PEARIND	2006-5321	08/30/2006										
VOLUNTEER LAKE ASSESSMENT PROGRAM	PEARIND	VL07250601	07/25/2006										SUNNY, WARM AND BREEZY

Appendix B - Pearly Pond Water Quality Database from OneStop
In-Pond Samples

PROJECT_NAME	STATION_ID	ACTIVITY_ID	START_DATE	TURBIDITY (NTU)	TOTAL COLIFORM (MPN/100ML)	NITROGEN, KJELDAHL (MG/L)	APPARENT COLOR (PCU)	ALKALINITY, CARBONATE AS CACO3 (MG/L)	CHLORIDE	CALCIUM (MG/L)	SULFATE (MG/L)	TROPHIC CLASS	WEATHER COMMENTS
VOLUNTEER LAKE ASSESSMENT PROGRAM	PEARIND	VL07250602	07/25/2006										SUNNY, WARM AND BREEZY
VOLUNTEER LAKE ASSESSMENT PROGRAM	PEARIND	VL07250603	07/25/2006										SUNNY, WARM AND BREEZY
VOLUNTEER LAKE ASSESSMENT PROGRAM	PEARIND	VL07250604	07/25/2006										SUNNY, WARM AND BREEZY
VOLUNTEER LAKE ASSESSMENT PROGRAM	PEARIND	VL07250605	07/25/2006										SUNNY, WARM AND BREEZY
VOLUNTEER LAKE ASSESSMENT PROGRAM	PEARIND	VL07250606	07/25/2006										SUNNY, WARM AND BREEZY
VOLUNTEER LAKE ASSESSMENT PROGRAM	PEARIND	VL07250607	07/25/2006										SUNNY, WARM AND BREEZY
VOLUNTEER LAKE ASSESSMENT PROGRAM	PEARIND	VL07250608	07/25/2006										SUNNY, WARM AND BREEZY
VOLUNTEER LAKE ASSESSMENT PROGRAM	PEARIND	VL07250609	07/25/2006										SUNNY, WARM AND BREEZY
VOLUNTEER LAKE ASSESSMENT PROGRAM	PEARIND	VL07250610	07/25/2006										SUNNY, WARM AND BREEZY
VOLUNTEER LAKE ASSESSMENT PROGRAM	PEARIND	2007-1802	06/25/2007	3.14				2.3					
VOLUNTEER LAKE ASSESSMENT PROGRAM	PEARIND	2007-1803	06/25/2007	2.55									
VOLUNTEER LAKE ASSESSMENT PROGRAM	PEARIND	2007-1804	06/25/2007	6.94									
VOLUNTEER LAKE ASSESSMENT PROGRAM	PEARIND	2007-1808	06/25/2007										
VOLUNTEER LAKE ASSESSMENT PROGRAM	PEARIND	2007-2921	07/23/2007	2.33				-1					
VOLUNTEER LAKE ASSESSMENT PROGRAM	PEARIND	2007-2922	07/23/2007	2.3									
VOLUNTEER LAKE ASSESSMENT PROGRAM	PEARIND	2007-2923	07/23/2007	14.3									
VOLUNTEER LAKE ASSESSMENT PROGRAM	PEARIND	2007-2927	07/23/2007										
VOLUNTEER LAKE ASSESSMENT PROGRAM	PEARIND	2007-4616	08/28/2007	2.69				1.9					
VOLUNTEER LAKE ASSESSMENT PROGRAM	PEARIND	2007-4617	08/28/2007	3.54									
VOLUNTEER LAKE ASSESSMENT PROGRAM	PEARIND	2007-4618	08/28/2007	3.66									
VOLUNTEER LAKE ASSESSMENT PROGRAM	PEARIND	2007-4619	08/28/2007										
VOLUNTEER LAKE ASSESSMENT PROGRAM	PEARIND	VL08280727	08/28/2007										CLEAR, WARM
VOLUNTEER LAKE ASSESSMENT PROGRAM	PEARIND	VL08280728	08/28/2007										CLEAR, WARM
VOLUNTEER LAKE ASSESSMENT PROGRAM	PEARIND	VL08280729	08/28/2007										CLEAR, WARM
VOLUNTEER LAKE ASSESSMENT PROGRAM	PEARIND	VL08280730	08/28/2007										CLEAR, WARM
VOLUNTEER LAKE ASSESSMENT PROGRAM	PEARIND	VL08280731	08/28/2007										CLEAR, WARM
VOLUNTEER LAKE ASSESSMENT PROGRAM	PEARIND	2008-1746	06/23/2008										
VOLUNTEER LAKE ASSESSMENT PROGRAM	PEARIND	2008-1740	06/23/2008	1.14									
VOLUNTEER LAKE ASSESSMENT PROGRAM	PEARIND	2008-1741	06/23/2008	6.54									
VOLUNTEER LAKE ASSESSMENT PROGRAM	PEARIND	2008-1742	06/23/2008	6.86									
VOLUNTEER LAKE ASSESSMENT PROGRAM	PEARIND	2008-3317	07/23/2008										
VOLUNTEER LAKE ASSESSMENT PROGRAM	PEARIND	2008-3312	07/23/2008	3.44									
VOLUNTEER LAKE ASSESSMENT PROGRAM	PEARIND	2008-3313	07/23/2008	30.8									
VOLUNTEER LAKE ASSESSMENT PROGRAM	PEARIND	2008-4884	08/24/2008	2.71									
VOLUNTEER LAKE ASSESSMENT PROGRAM	PEARIND	2008-4885	08/24/2008	12.9									
VOLUNTEER LAKE ASSESSMENT PROGRAM	PEARIND	2008-4889	08/24/2008										
VOLUNTEER LAKE ASSESSMENT PROGRAM	PEARIND	VL06230822	06/23/2008										OVERCAST, WARM AND CALM
VOLUNTEER LAKE ASSESSMENT PROGRAM	PEARIND	VL06230823	06/23/2008										OVERCAST, WARM AND CALM
VOLUNTEER LAKE ASSESSMENT PROGRAM	PEARIND	VL06230824	06/23/2008										OVERCAST, WARM AND CALM
VOLUNTEER LAKE ASSESSMENT PROGRAM	PEARIND	VL06230825	06/23/2008										OVERCAST, WARM AND CALM
VOLUNTEER LAKE ASSESSMENT PROGRAM	PEARIND	VL06230826	06/23/2008										OVERCAST, WARM AND CALM
VOLUNTEER LAKE ASSESSMENT PROGRAM	PEARIND	VL06230827	06/23/2008										OVERCAST, WARM AND CALM
VOLUNTEER LAKE ASSESSMENT PROGRAM	PEARIND	2009-1385	06/14/2009	1.32									
VOLUNTEER LAKE ASSESSMENT PROGRAM	PEARIND	2009-1386	06/14/2009	1.31									
VOLUNTEER LAKE ASSESSMENT PROGRAM	PEARIND	2009-1390	06/14/2009										
VOLUNTEER LAKE ASSESSMENT PROGRAM	PEARIND	2009-2826	07/14/2009	1.56									
VOLUNTEER LAKE ASSESSMENT PROGRAM	PEARIND	2009-2827	07/14/2009	13.3									
VOLUNTEER LAKE ASSESSMENT PROGRAM	PEARIND	2009-2828	07/14/2009	5.56									
VOLUNTEER LAKE ASSESSMENT PROGRAM	PEARIND	2009-2833	07/14/2009										
VOLUNTEER LAKE ASSESSMENT PROGRAM	PEARIND	2009-4693	08/17/2009	1.96									
VOLUNTEER LAKE ASSESSMENT PROGRAM	PEARIND	2009-4694	08/17/2009	10.1									
VOLUNTEER LAKE ASSESSMENT PROGRAM	PEARIND	2009-4698	08/17/2009										
VOLUNTEER LAKE ASSESSMENT PROGRAM	PEARIND	VL07140901	07/14/2009										PARTLY CLOUDY, WARM, AND BREEZY
VOLUNTEER LAKE ASSESSMENT PROGRAM	PEARIND	VL07140902	07/14/2009										PARTLY CLOUDY, WARM, AND BREEZY
VOLUNTEER LAKE ASSESSMENT PROGRAM	PEARIND	VL07140903	07/14/2009										PARTLY CLOUDY, WARM, AND BREEZY
VOLUNTEER LAKE ASSESSMENT PROGRAM	PEARIND	VL07140904	07/14/2009										PARTLY CLOUDY, WARM, AND BREEZY
VOLUNTEER LAKE ASSESSMENT PROGRAM	PEARIND	VL07140905	07/14/2009										PARTLY CLOUDY, WARM, AND BREEZY
VOLUNTEER LAKE ASSESSMENT PROGRAM	PEARIND	VL07140906	07/14/2009										PARTLY CLOUDY, WARM, AND BREEZY
VOLUNTEER LAKE ASSESSMENT PROGRAM	PEARIND	VL07140907	07/14/2009										PARTLY CLOUDY, WARM, AND BREEZY

Appendix B - Pearly Pond Water Quality Database from OneStop
In-Pond Samples

PROJECT_NAME	STATION_ID	ACTIVITY_ID	START_DATE	TURBIDITY (NTU)	TOTAL COLIFORM (MPN/100ML)	NITROGEN, KJELDAHL (MG/L)	APPARENT COLOR (PCU)	ALKALINITY, CARBONATE AS CACO3 (MG/L)	CHLORIDE	CALCIUM (MG/L)	SULFATE (MG/L)	TROPHIC CLASS	WEATHER COMMENTS
VOLUNTEER LAKE ASSESSMENT PROGRAM	PEARIND	VL07140908	07/14/2009										PARTLY CLOUDY, WARM, AND BREEZY
VOLUNTEER LAKE ASSESSMENT PROGRAM	PEARIND	VL07140909	07/14/2009										PARTLY CLOUDY, WARM, AND BREEZY
VOLUNTEER LAKE ASSESSMENT PROGRAM	PEARIND	VL07140910	07/14/2009										PARTLY CLOUDY, WARM, AND BREEZY
VOLUNTEER LAKE ASSESSMENT PROGRAM	PEARIND	2010-894	06/09/2010	1.15									
VOLUNTEER LAKE ASSESSMENT PROGRAM	PEARIND	2010-895	06/09/2010	1.53									
VOLUNTEER LAKE ASSESSMENT PROGRAM	PEARIND	2010-899	06/09/2010										
VOLUNTEER LAKE ASSESSMENT PROGRAM	PEARIND	2010-2613	07/18/2010										
VOLUNTEER LAKE ASSESSMENT PROGRAM	PEARIND	2010-2610	07/18/2010	4.8									
VOLUNTEER LAKE ASSESSMENT PROGRAM	PEARIND	2010-2611	07/18/2010	15.2									
VOLUNTEER LAKE ASSESSMENT PROGRAM	PEARIND	2010-3711	08/11/2010	6.26									
VOLUNTEER LAKE ASSESSMENT PROGRAM	PEARIND	2010-3712	08/11/2010	11.4									
VOLUNTEER LAKE ASSESSMENT PROGRAM	PEARIND	2010-3714	08/11/2010	13.1									
VOLUNTEER LAKE ASSESSMENT PROGRAM	PEARIND	2010-3719	08/11/2010										
VOLUNTEER LAKE ASSESSMENT PROGRAM	PEARIND	VL07141076	07/14/2010										HAZY, WARM, BREEZY
VOLUNTEER LAKE ASSESSMENT PROGRAM	PEARIND	VL07141077	07/14/2010										HAZY, WARM, BREEZY
VOLUNTEER LAKE ASSESSMENT PROGRAM	PEARIND	VL07141078	07/14/2010										HAZY, WARM, BREEZY
VOLUNTEER LAKE ASSESSMENT PROGRAM	PEARIND	VL07141079	07/14/2010										HAZY, WARM, BREEZY
VOLUNTEER LAKE ASSESSMENT PROGRAM	PEARIND	VL07141080	07/14/2010										HAZY, WARM, BREEZY
VOLUNTEER LAKE ASSESSMENT PROGRAM	PEARIND	VL07141081	07/14/2010										HAZY, WARM, BREEZY
VOLUNTEER LAKE ASSESSMENT PROGRAM	PEARIND	2011-938	06/19/2011										
VOLUNTEER LAKE ASSESSMENT PROGRAM	PEARIND	2011-933	06/19/2011	1.52					24				
VOLUNTEER LAKE ASSESSMENT PROGRAM	PEARIND	2011-934	06/19/2011	3.09									
VOLUNTEER LAKE ASSESSMENT PROGRAM	PEARIND	2011-2128	07/19/2011	1.07					21				
VOLUNTEER LAKE ASSESSMENT PROGRAM	PEARIND	2011-2129	07/19/2011	4.49									
VOLUNTEER LAKE ASSESSMENT PROGRAM	PEARIND	2011-2130	07/19/2011	10.6									
VOLUNTEER LAKE ASSESSMENT PROGRAM	PEARIND	2011-2135	07/19/2011										
VOLUNTEER LAKE ASSESSMENT PROGRAM	PEARIND	2011-3234	08/16/2011	2.69					25				
VOLUNTEER LAKE ASSESSMENT PROGRAM	PEARIND	2011-3235	08/16/2011	4.82									
VOLUNTEER LAKE ASSESSMENT PROGRAM	PEARIND	2011-3239	08/16/2011										
VOLUNTEER LAKE ASSESSMENT PROGRAM	PEARIND	VL07191106	07/19/2011										HAZY, HOT, BREEZY
VOLUNTEER LAKE ASSESSMENT PROGRAM	PEARIND	VL07191107	07/19/2011										HAZY, HOT, BREEZY
VOLUNTEER LAKE ASSESSMENT PROGRAM	PEARIND	VL07191108	07/19/2011										HAZY, HOT, BREEZY
VOLUNTEER LAKE ASSESSMENT PROGRAM	PEARIND	VL07191109	07/19/2011										HAZY, HOT, BREEZY
VOLUNTEER LAKE ASSESSMENT PROGRAM	PEARIND	VL07191110	07/19/2011										HAZY, HOT, BREEZY
VOLUNTEER LAKE ASSESSMENT PROGRAM	PEARIND	2012-1194	06/17/2012										
VOLUNTEER LAKE ASSESSMENT PROGRAM	PEARIND	2012-1189	06/17/2012	1.81					24				
VOLUNTEER LAKE ASSESSMENT PROGRAM	PEARIND	2012-1190	06/17/2012	2.25									
VOLUNTEER LAKE ASSESSMENT PROGRAM	PEARIND	2012-2746	07/24/2012	5.89					22				
VOLUNTEER LAKE ASSESSMENT PROGRAM	PEARIND	2012-2747	07/24/2012	7.4									
VOLUNTEER LAKE ASSESSMENT PROGRAM	PEARIND	2012-2748	07/24/2012										
VOLUNTEER LAKE ASSESSMENT PROGRAM	PEARIND	2012-4159	08/28/2012	2.62					20				
VOLUNTEER LAKE ASSESSMENT PROGRAM	PEARIND	2012-4160	08/28/2012	5.38									
VOLUNTEER LAKE ASSESSMENT PROGRAM	PEARIND	2012-4161	08/28/2012										
VOLUNTEER LAKE ASSESSMENT PROGRAM	PEARIND	2013-455	04/17/2013										
VOLUNTEER LAKE ASSESSMENT PROGRAM	PEARIND	2013-456	04/17/2013										
VOLUNTEER LAKE ASSESSMENT PROGRAM	PEARIND	2013-457	04/17/2013										
VOLUNTEER LAKE ASSESSMENT PROGRAM	PEARIND	2013-458	04/17/2013										
VOLUNTEER LAKE ASSESSMENT PROGRAM	PEARIND	2013-459	04/17/2013										
VOLUNTEER LAKE ASSESSMENT PROGRAM	PEARIND	2013-568	05/15/2013	0.98					27				
VOLUNTEER LAKE ASSESSMENT PROGRAM	PEARIND	2013-569	05/15/2013	0.61									
VOLUNTEER LAKE ASSESSMENT PROGRAM	PEARIND	2013-570	05/15/2013	1.03									
VOLUNTEER LAKE ASSESSMENT PROGRAM	PEARIND	2013-571	05/15/2013	0.86									
VOLUNTEER LAKE ASSESSMENT PROGRAM	PEARIND	2013-572	05/15/2013	0.92									
VOLUNTEER LAKE ASSESSMENT PROGRAM	PEARIND	2013-578	05/15/2013										
VOLUNTEER LAKE ASSESSMENT PROGRAM	PEARIND	2013-579	05/15/2013										
VOLUNTEER LAKE ASSESSMENT PROGRAM	PEARIND	2013-1231	06/18/2013	1.47									
VOLUNTEER LAKE ASSESSMENT PROGRAM	PEARIND	2013-1237	06/18/2013										
VOLUNTEER LAKE ASSESSMENT PROGRAM	PEARIND	2013-1239	06/18/2013	1.54									
VOLUNTEER LAKE ASSESSMENT PROGRAM	PEARIND	2013-1228	06/18/2013	1.56					22				

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PROJECT_NAME	STATION_ID	ACTIVITY_ID	START_DATE	TURBIDITY (NTU)	TOTAL COLIFORM (MPN/100ML)	NITROGEN, KJELDAHL (MG/L)	APPARENT COLOR (PCU)	ALKALINITY, CARBONATE AS CACO3 (MG/L)	CHLORIDE	CALCIUM (MG/L)	SULFATE (MG/L)	TROPHIC CLASS	WEATHER COMMENTS
VOLUNTEER LAKE ASSESSMENT PROGRAM	PEARIND	2013-1229	06/18/2013										
VOLUNTEER LAKE ASSESSMENT PROGRAM	PEARIND	2013-1230	06/18/2013										
VOLUNTEER LAKE ASSESSMENT PROGRAM	PEARIND	2013-1232	06/18/2013										
VOLUNTEER LAKE ASSESSMENT PROGRAM	PEARIND	2013-2145	07/10/2013										
VOLUNTEER LAKE ASSESSMENT PROGRAM	PEARIND	2013-2136	07/10/2013	2.72					22				
VOLUNTEER LAKE ASSESSMENT PROGRAM	PEARIND	2013-2137	07/10/2013	2.46					21				
VOLUNTEER LAKE ASSESSMENT PROGRAM	PEARIND	2013-2138	07/10/2013	4.48									
VOLUNTEER LAKE ASSESSMENT PROGRAM	PEARIND	2013-2139	07/10/2013	8.71									
VOLUNTEER LAKE ASSESSMENT PROGRAM	PEARIND	2013-2140	07/10/2013	16.2									
VOLUNTEER LAKE ASSESSMENT PROGRAM	PEARIND	2013-4425	08/27/2013	1.72					26				
VOLUNTEER LAKE ASSESSMENT PROGRAM	PEARIND	2013-4426	08/27/2013	1.82					26				
VOLUNTEER LAKE ASSESSMENT PROGRAM	PEARIND	2013-4427	08/27/2013	1.79									
VOLUNTEER LAKE ASSESSMENT PROGRAM	PEARIND	2013-4428	08/27/2013	4.56									
VOLUNTEER LAKE ASSESSMENT PROGRAM	PEARIND	2013-4432	08/27/2013										
VOLUNTEER LAKE ASSESSMENT PROGRAM	PEARIND	2013-4966	09/23/2013										
VOLUNTEER LAKE ASSESSMENT PROGRAM	PEARIND	2013-4961	09/23/2013	1.75					13				
VOLUNTEER LAKE ASSESSMENT PROGRAM	PEARIND	2013-4960	09/23/2013	1.13					14				
VOLUNTEER LAKE ASSESSMENT PROGRAM	PEARIND	VL04171301	04/17/2013										CLEAR, COOL, BREEZY
VOLUNTEER LAKE ASSESSMENT PROGRAM	PEARIND	VL04171302	04/17/2013										CLEAR, COOL, BREEZY
VOLUNTEER LAKE ASSESSMENT PROGRAM	PEARIND	VL04171303	04/17/2013										CLEAR, COOL, BREEZY
VOLUNTEER LAKE ASSESSMENT PROGRAM	PEARIND	VL04171304	04/17/2013										CLEAR, COOL, BREEZY
VOLUNTEER LAKE ASSESSMENT PROGRAM	PEARIND	VL04171305	04/17/2013										CLEAR, COOL, BREEZY
VOLUNTEER LAKE ASSESSMENT PROGRAM	PEARIND	VL05151301	05/15/2013										CLEAR, COOL, BREEZY
VOLUNTEER LAKE ASSESSMENT PROGRAM	PEARIND	VL05151302	05/15/2013										CLEAR, COOL, BREEZY
VOLUNTEER LAKE ASSESSMENT PROGRAM	PEARIND	VL05151303	05/15/2013										CLEAR, COOL, BREEZY
VOLUNTEER LAKE ASSESSMENT PROGRAM	PEARIND	VL05151304	05/15/2013										CLEAR, COOL, BREEZY
VOLUNTEER LAKE ASSESSMENT PROGRAM	PEARIND	VL05151305	05/15/2013										CLEAR, COOL, BREEZY
VOLUNTEER LAKE ASSESSMENT PROGRAM	PEARIND	VL05151306	05/15/2013										CLEAR, COOL, BREEZY
VOLUNTEER LAKE ASSESSMENT PROGRAM	PEARIND	VL05151307	05/15/2013										CLEAR, COOL, BREEZY
VOLUNTEER LAKE ASSESSMENT PROGRAM	PEARIND	VL05221301	05/22/2013										OVERCAST, BREEZY
VOLUNTEER LAKE ASSESSMENT PROGRAM	PEARIND	VL05221302	05/22/2013										OVERCAST, BREEZY
VOLUNTEER LAKE ASSESSMENT PROGRAM	PEARIND	VL05221303	05/22/2013										OVERCAST, BREEZY
VOLUNTEER LAKE ASSESSMENT PROGRAM	PEARIND	VL05221304	05/22/2013										OVERCAST, BREEZY
VOLUNTEER LAKE ASSESSMENT PROGRAM	PEARIND	VL05221305	05/22/2013										OVERCAST, BREEZY
VOLUNTEER LAKE ASSESSMENT PROGRAM	PEARIND	VL05221306	05/22/2013										OVERCAST, BREEZY
VOLUNTEER LAKE ASSESSMENT PROGRAM	PEARIND	VL05221307	05/22/2013										OVERCAST, BREEZY
VOLUNTEER LAKE ASSESSMENT PROGRAM	PEARIND	VL05281311	05/28/2013										OVERCAST, BREEZY
VOLUNTEER LAKE ASSESSMENT PROGRAM	PEARIND	VL05281312	05/28/2013										OVERCAST, BREEZY
VOLUNTEER LAKE ASSESSMENT PROGRAM	PEARIND	VL05281313	05/28/2013										OVERCAST, BREEZY
VOLUNTEER LAKE ASSESSMENT PROGRAM	PEARIND	VL05281314	05/28/2013										OVERCAST, BREEZY
VOLUNTEER LAKE ASSESSMENT PROGRAM	PEARIND	VL05281315	05/28/2013										OVERCAST, BREEZY
VOLUNTEER LAKE ASSESSMENT PROGRAM	PEARIND	VL05281316	05/28/2013										OVERCAST, BREEZY
VOLUNTEER LAKE ASSESSMENT PROGRAM	PEARIND	VL06181317	06/18/2013										OVERCAST, WARM, CALM
VOLUNTEER LAKE ASSESSMENT PROGRAM	PEARIND	VL06181318	06/18/2013										OVERCAST, WARM, CALM
VOLUNTEER LAKE ASSESSMENT PROGRAM	PEARIND	VL06181319	06/18/2013										OVERCAST, WARM, CALM
VOLUNTEER LAKE ASSESSMENT PROGRAM	PEARIND	VL06181320	06/18/2013										OVERCAST, WARM, CALM
VOLUNTEER LAKE ASSESSMENT PROGRAM	PEARIND	VL06181321	06/18/2013										OVERCAST, WARM, CALM
VOLUNTEER LAKE ASSESSMENT PROGRAM	PEARIND	VL06181322	06/18/2013										OVERCAST, WARM, CALM
VOLUNTEER LAKE ASSESSMENT PROGRAM	PEARIND	VL06181323	06/18/2013										CLOUDY
VOLUNTEER LAKE ASSESSMENT PROGRAM	PEARIND	VL06181324	06/18/2013										CLOUDY
VOLUNTEER LAKE ASSESSMENT PROGRAM	PEARIND	VL06181325	06/18/2013										CLOUDY
VOLUNTEER LAKE ASSESSMENT PROGRAM	PEARIND	VL06181326	06/18/2013										CLOUDY
VOLUNTEER LAKE ASSESSMENT PROGRAM	PEARIND	VL06181327	06/18/2013										CLOUDY
VOLUNTEER LAKE ASSESSMENT PROGRAM	PEARIND	VL06181328	06/18/2013										CLOUDY
VOLUNTEER LAKE ASSESSMENT PROGRAM	PEARIND	VL06261301	06/26/2013										HAZY-HUMID
VOLUNTEER LAKE ASSESSMENT PROGRAM	PEARIND	VL06261302	06/26/2013										HAZY-HUMID
VOLUNTEER LAKE ASSESSMENT PROGRAM	PEARIND	VL06261303	06/26/2013										HAZY-HUMID
VOLUNTEER LAKE ASSESSMENT PROGRAM	PEARIND	VL06261304	06/26/2013										HAZY-HUMID
VOLUNTEER LAKE ASSESSMENT PROGRAM	PEARIND	VL06261305	06/26/2013										HAZY-HUMID

Appendix B - Pearly Pond Water Quality Database from OneStop
In-Pond Samples

PROJECT_NAME	STATION_ID	ACTIVITY_ID	START_DATE	TURBIDITY (NTU)	TOTAL COLIFORM (MPN/100ML)	NITROGEN, KJELDAHL (MG/L)	APPARENT COLOR (PCU)	ALKALINITY, CARBONATE AS CACO3 (MG/L)	CHLORIDE	CALCIUM (MG/L)	SULFATE (MG/L)	TROPHIC CLASS	WEATHER COMMENTS
VOLUNTEER LAKE ASSESSMENT PROGRAM	PEARIND	VL06261306	06/26/2013										HAZY-HUMID
VOLUNTEER LAKE ASSESSMENT PROGRAM	PEARIND	VL07101331	07/10/2013										HAZY, WARM, BREEZY
VOLUNTEER LAKE ASSESSMENT PROGRAM	PEARIND	VL07101332	07/10/2013										PARTLY CLOUDY
VOLUNTEER LAKE ASSESSMENT PROGRAM	PEARIND	VL07101333	07/10/2013										HAZY, WARM, BREEZY
VOLUNTEER LAKE ASSESSMENT PROGRAM	PEARIND	VL07101334	07/10/2013										PARTLY CLOUDY
VOLUNTEER LAKE ASSESSMENT PROGRAM	PEARIND	VL07101335	07/10/2013										HAZY, WARM, BREEZY
VOLUNTEER LAKE ASSESSMENT PROGRAM	PEARIND	VL07101336	07/10/2013										PARTLY CLOUDY
VOLUNTEER LAKE ASSESSMENT PROGRAM	PEARIND	VL07101337	07/10/2013										HAZY, WARM, BREEZY
VOLUNTEER LAKE ASSESSMENT PROGRAM	PEARIND	VL07101338	07/10/2013										PARTLY CLOUDY
VOLUNTEER LAKE ASSESSMENT PROGRAM	PEARIND	VL07101339	07/10/2013										HAZY, WARM, BREEZY
VOLUNTEER LAKE ASSESSMENT PROGRAM	PEARIND	VL07101340	07/10/2013										PARTLY CLOUDY
VOLUNTEER LAKE ASSESSMENT PROGRAM	PEARIND	VL07101341	07/10/2013										HAZY, WARM, BREEZY
VOLUNTEER LAKE ASSESSMENT PROGRAM	PEARIND	VL07101342	07/10/2013										PARTLY CLOUDY
VOLUNTEER LAKE ASSESSMENT PROGRAM	PEARIND	VL07241314	07/24/2013										SUN, VERY WINDY
VOLUNTEER LAKE ASSESSMENT PROGRAM	PEARIND	VL07241315	07/24/2013										SUN, VERY WINDY
VOLUNTEER LAKE ASSESSMENT PROGRAM	PEARIND	VL07241316	07/24/2013										SUN, VERY WINDY
VOLUNTEER LAKE ASSESSMENT PROGRAM	PEARIND	VL07241317	07/24/2013										SUN, VERY WINDY
VOLUNTEER LAKE ASSESSMENT PROGRAM	PEARIND	VL07241318	07/24/2013										SUN, VERY WINDY
VOLUNTEER LAKE ASSESSMENT PROGRAM	PEARIND	VL07241319	07/24/2013										SUN, VERY WINDY
VOLUNTEER LAKE ASSESSMENT PROGRAM	PEARIND	VL07311301	07/31/2013										SUNNY, CALM
VOLUNTEER LAKE ASSESSMENT PROGRAM	PEARIND	VL07311302	07/31/2013										SUNNY, CALM
VOLUNTEER LAKE ASSESSMENT PROGRAM	PEARIND	VL07311303	07/31/2013*										SUNNY, CALM
VOLUNTEER LAKE ASSESSMENT PROGRAM	PEARIND	VL07311304	07/31/2013										SUNNY, CALM
VOLUNTEER LAKE ASSESSMENT PROGRAM	PEARIND	VL07311305	07/31/2013										SUNNY, CALM
VOLUNTEER LAKE ASSESSMENT PROGRAM	PEARIND	VL07311306	07/31/2013										SUNNY, CALM
VOLUNTEER LAKE ASSESSMENT PROGRAM	PEARIND	VL08071337	08/07/2013										CLOUDY, CALM
VOLUNTEER LAKE ASSESSMENT PROGRAM	PEARIND	VL08071338	08/07/2013										CLOUDY, CALM
VOLUNTEER LAKE ASSESSMENT PROGRAM	PEARIND	VL08071339	08/07/2013										CLOUDY, CALM
VOLUNTEER LAKE ASSESSMENT PROGRAM	PEARIND	VL08071340	08/07/2013										CLOUDY, CALM
VOLUNTEER LAKE ASSESSMENT PROGRAM	PEARIND	VL08071341	08/07/2013										CLOUDY, CALM
VOLUNTEER LAKE ASSESSMENT PROGRAM	PEARIND	VL08071342	08/07/2013										CLOUDY, CALM
VOLUNTEER LAKE ASSESSMENT PROGRAM	PEARIND	2013-5116	10/22/2013	1.11					18				
VOLUNTEER LAKE ASSESSMENT PROGRAM	PEARIND	2013-5117	10/22/2013	1.33					19				
VOLUNTEER LAKE ASSESSMENT PROGRAM	PEARIND	2013-5118	10/22/2013	1.47					19				
VOLUNTEER LAKE ASSESSMENT PROGRAM	PEARIND	2013-5115	10/22/2013	1.09					18				
VOLUNTEER LAKE ASSESSMENT PROGRAM	PEARIND	2013-5119	10/22/2013										
PESTICIDE WATER QUALITY	PEARINAP	08060319-001	06/25/2008										
PESTICIDE WATER QUALITY	PEARINAP	08070105-001	07/10/2008										
PESTICIDE WATER QUALITY	PEANORTH	A009688002	09/16/2010										
NH FISH STUDY	PEARIN-GEN	2003129T	07/01/2003										
NH FISH STUDY	PEARIN-GEN	2003130T	07/01/2003										

Appendix B - Pearly Pond Water Quality Database from OneStop
Tributary Samples

STATION_ID	STATION_NAME	START_DATE	PH RESULTS	SPECIFIC CONDUCTANCE RESULTS (UMHO/CM)	ESCHERICHIA COLI RESULTS (#/100ML)	PHOSPHORUS (MG/L)	TURBIDITY RESULTS (NTU)	APPARENT COLOR RESULTS (PCU)
PEARINM	PEARLY LAKE-MOUNTAIN RD	06/09/1992	5.18	60.4		0.082		180
PEARINO	PEARLY LAKE-OUTLET	06/09/1992	6.17	67.2		0.045		70
PEARINM	PEARLY LAKE-MOUNTAIN RD	07/14/1992	5.2	48.8		0.055		190
PEARINO	PEARLY LAKE-OUTLET	07/14/1992	5.94	67		0.046		85
PEARINM	PEARLY LAKE-MOUNTAIN RD	08/30/1992	5.33	64.5		0.1		260
PEARINO	PEARLY LAKE-OUTLET	08/30/1992	5.66	67.5		0.027		65
PEARINC	PEARLY LAKE-COLLEGE RD INLET	06/22/1993	5.19	85.5				140
PEARINC	PEARLY LAKE-COLLEGE RD INLET	06/22/1993			50			
PEARINM	PEARLY LAKE-MOUNTAIN RD	06/22/1993	5.9	86.4		0.101		140
PEARINM	PEARLY LAKE-MOUNTAIN RD	06/22/1993			10			
PEARINO	PEARLY LAKE-OUTLET	06/22/1993	5.6	69		0.037		65
PEARINO	PEARLY LAKE-OUTLET	08/01/1993	4.75	71		0.019		42
PEARINC	PEARLY LAKE-COLLEGE RD INLET	06/19/1994				0.100		
PEARINO	PEARLY LAKE-OUTLET	06/19/1994	5.74	72.8		0.027		88
PEARINC	PEARLY LAKE-COLLEGE RD INLET	07/13/1994	4.96	73.5		0.070		140
PEARINC	PEARLY LAKE-COLLEGE RD INLET	07/13/1994			10			
PEARINM	PEARLY LAKE-MOUNTAIN RD	07/13/1994	5.24	82.3		0.138		140
PEARINO	PEARLY LAKE-OUTLET	07/13/1994	5.92	72.2		0.046		100
PEARINC	PEARLY LAKE-COLLEGE RD INLET	08/14/1994	4.5	60.4		0.051		140
PEARINM	PEARLY LAKE-MOUNTAIN RD	08/14/1994	5.2	117.9		0.09		140
PEARINO	PEARLY LAKE-OUTLET	08/14/1994	5.76	76.1		0.037		108
PEARINM	PEARLY LAKE-MOUNTAIN RD	08/31/1994				0.06		
PEARINM	PEARLY LAKE-MOUNTAIN RD	06/29/1995	5.45	57.3		0.085		140
PEARINO	PEARLY LAKE-OUTLET	06/29/1995	6.17	75.6		0.034		70
PEARINM	PEARLY LAKE-MOUNTAIN RD	07/26/1995	5.74	57.2		0.1		140
PEARINO	PEARLY LAKE-OUTLET	07/26/1995	5.95	75.2		0.038		100
PEARINO	PEARLY LAKE-OUTLET	08/28/1995	6.11	78.5		0.028		95
PEARINO	PEARLY LAKE-OUTLET	06/30/1996	5.8	64.1		0.034		100
PEARINM	PEARLY LAKE-MOUNTAIN RD	07/31/1996	5.28	73.8		0.041		140
PEARINO	PEARLY LAKE-OUTLET	07/31/1996	5.9	63		0.037		140
PEARINO	PEARLY LAKE-OUTLET	09/15/1996	5.94	65.5		0.034		90
PEARINM	PEARLY LAKE-MOUNTAIN RD	06/16/1997	5.46	66.9		0.068	1.1	
PEARINO	PEARLY LAKE-OUTLET	06/16/1997	5.73	55.8		0.02	0.81	
PEARINO	PEARLY LAKE-OUTLET	07/31/1997	6.03	61.5		0.04	1.5	
PEARINM	PEARLY LAKE-MOUNTAIN RD	08/25/1997	5.2	98.1		0.03	0.42	
PEARINO	PEARLY LAKE-OUTLET	08/25/1997	6.14	68.3		0.035	3.4	
PEARINM	PEARLY LAKE-MOUNTAIN RD	06/29/1998	5.31	48.23		0.048	0.47	
PEARINO	PEARLY LAKE-OUTLET	06/29/1998	5.53	59.71		0.029	1.02	
PEARINM	PEARLY LAKE-MOUNTAIN RD	07/14/1998	5.21	54.32		0.057	0.46	
PEARINBI	PEARLY LAKE-BOWER INLET	07/14/1998	5.29	18.12		0.04	0.51	
PEARINO	PEARLY LAKE-OUTLET	07/14/1998	5.75	58.2		0.018	0.95	
PEARINM	PEARLY LAKE-MOUNTAIN RD	08/19/1998	6.09	49.3		0.065	2.6	
PEARINBI	PEARLY LAKE-BOWER INLET	08/19/1998	5.57	20.8		0.048	2.9	
PEARINO	PEARLY LAKE-OUTLET	08/19/1998	6.13	59.3		0.036	6.3	
PEARINM	PEARLY LAKE-MOUNTAIN RD	06/03/1999	5.56	77.5		0.069	0.81	
PEARINBI	PEARLY LAKE-BOWER INLET	06/03/1999	5.37	20.8		0.044	1.02	
PEARINO	PEARLY LAKE-OUTLET	06/03/1999	5.69	96.6		0.023	0.69	
PEARINM	PEARLY LAKE-MOUNTAIN RD	07/14/1999	5.4	82.8		0.082	1.09	
PEARINBI	PEARLY LAKE-BOWER INLET	07/14/1999	5.31	24.9		0.043	1.09	
PEARINO	PEARLY LAKE-OUTLET	07/14/1999	5.76	95.1		0.041	1.67	
PEARINBI	PEARLY LAKE-BOWER INLET	08/18/1999	5.81	25.1		0.104	1.99	
PEARINM	PEARLY LAKE-MOUNTAIN RD	07/18/2000	5.24	75.3			0.57	
PEARINO	PEARLY LAKE-OUTLET	07/18/2000	5.7	74.4			1.78	
PEARINBI	PEARLY LAKE-BOWER INLET	08/28/2000	5.25	21.3		0.047	1.14	
PEARINO	PEARLY LAKE-OUTLET	08/28/2000	5.88	75.2		0.022	1.03	
PEARINM	PEARLY LAKE-MOUNTAIN RD	06/27/2001	5.62	67		0.064	0.59	
PEARINBI	PEARLY LAKE-BOWER INLET	06/27/2001	5.28	20.2		0.058	1.09	
PEARINO	PEARLY LAKE-OUTLET	06/27/2001	6.14	80		0.031	1.8	
PEARINM	PEARLY LAKE-MOUNTAIN RD	07/18/2001	5.73	80.1		0.068	0.57	
PEARINBI	PEARLY LAKE-BOWER INLET	07/18/2001	5.53	18.8		0.065	1.21	
PEARINO	PEARLY LAKE-OUTLET	07/18/2001	6.14	82.1		0.043	1.03	
PEARINC	PEARLY LAKE-COLLEGE RD INLET	08/13/2001	6.04	87.75		0.100	1.2	
PEARINBI	PEARLY LAKE-BOWER INLET	08/13/2001	6.13	26.64		0.09	1.81	
PEARINO	PEARLY LAKE-OUTLET	08/13/2001	6.16	85.53		0.04	1.33	
PEARINC	PEARLY LAKE-COLLEGE RD INLET	06/17/2002	5.85	73.31		0.032	0.82	
PEARINBI	PEARLY LAKE-BOWER INLET	06/17/2002	5.28	16.01		0.019	3.21	
PEARINO	PEARLY LAKE-OUTLET	06/17/2002	6.04	86.07		0.02	2.24	
PEARINM	PEARLY LAKE-MOUNTAIN RD	08/12/2002	5.83	98		0.072	1.25	
PEARINBI	PEARLY LAKE-BOWER INLET	08/12/2002	5.16	26		0.068	1.65	
PEARINO	PEARLY LAKE-OUTLET	08/12/2002	6.12	87		0.036	3.3	
PEARINBI	PEARLY LAKE-BOWER INLET	07/14/2003	5.4	21.1		0.053	2.01	
PEARINO	PEARLY LAKE-OUTLET	07/14/2003	5.95	114.3		0.03	1.32	
PEARINM	PEARLY LAKE-MOUNTAIN RD	08/17/2003	5.5	91.99		0.058	0.58	
PEARINBI	PEARLY LAKE-BOWER INLET	08/17/2003	5.19	22.69		0.031	0.71	
PEARINO	PEARLY LAKE-OUTLET	08/17/2003	6.03	109.6		0.033	3.44	
PEARINM	PEARLY LAKE-MOUNTAIN RD	06/15/2004	5.56	102		0.057	1.2	
PEARINBI	PEARLY LAKE-BOWER INLET	06/15/2004	5.14	17.56		0.016	0.94	
PEARINO	PEARLY LAKE-OUTLET	06/15/2004	5.75	90.3		0.015	3.2	
PEARINBI	PEARLY LAKE-BOWER INLET	07/26/2004	5.45	2		0.03	2.43	
PEARINO	PEARLY LAKE-OUTLET	07/26/2004	6.07	92.39		0.019	7.28	
PEARINM	PEARLY LAKE-MOUNTAIN RD	08/10/2004	6.23	151.2		0.071	3.34	
PEARINBI	PEARLY LAKE-BOWER INLET	08/10/2004	5.71	21.37		0.03	0.89	
PEARINO	PEARLY LAKE-OUTLET	08/10/2004	6.12	94.37		0.018	2.96	
PEARINO	PEARLY LAKE-OUTLET	08/10/2004	6.08	94.43			3.05	
PEARINM	PEARLY LAKE-MOUNTAIN RD	06/26/2005	5.63	83.76		0.106	1.46	
PEARINBI	PEARLY LAKE-BOWER INLET	06/26/2005	5.31	17.93		0.037	0.71	
PEARINO	PEARLY LAKE-OUTLET	06/26/2005	6.01	102.6		0.02	1.39	
PEARINM	PEARLY LAKE-MOUNTAIN RD	07/10/2005	5.66	100.8		0.055	0.7	
PEARINBI	PEARLY LAKE-BOWER INLET	07/10/2005	5.34	17.09		0.023	0.75	
PEARINO	PEARLY LAKE-OUTLET	07/10/2005	6.05	96.68		0.024	2.18	
PEARINM	PEARLY LAKE-MOUNTAIN RD	08/15/2005	5.87	113.7		0.108	1.48	
PEARINBI	PEARLY LAKE-BOWER INLET	08/15/2005	5.63	22.79		0.035	0.97	
PEARINO	PEARLY LAKE-OUTLET	08/15/2005	6.19	100.4		0.03	2.08	

Appendix B - Pearly Pond Water Quality Database from OneStop Tributary Samples

STATION_ID	STATION_NAME	START_DATE	PH RESULTS	SPECIFIC CONDUCTANCE RESULTS (UMHO/CM)	ESCHERICHIA COLI RESULTS (#/100ML)	PHOSPHORUS (MG/L)	TURBIDITY RESULTS (NTU)	APPARENT COLOR RESULTS (PCU)
PEARINO	PEARLY LAKE-OUTLET	08/15/2005	6.22	100.2			1.91	
PEARINM	PEARLY LAKE-MOUNTAIN RD	06/26/2006	5.56	99.86		0.08	0.99	
PEARINBI	PEARLY LAKE-BOWER INLET	06/26/2006	5.44	17.22		0.021	1.06	
PEARINO	PEARLY LAKE-OUTLET	06/26/2006	5.79	87.05		0.023	1.33	
PEARINC	PEARLY LAKE-COLLEGE RD INLET	07/25/2006	5.61	121.5		0.069	1.22	
PEARINBI	PEARLY LAKE-BOWER INLET	07/25/2006	5.32	18.33		0.025	0.58	
PEARINO	PEARLY LAKE-OUTLET	07/25/2006	5.96	85.64		0.023	3.53	
PEARINM	PEARLY LAKE-MOUNTAIN RD	08/30/2006	5.62	157.7		0.087	0.9	
PEARINBI	PEARLY LAKE-BOWER INLET	08/30/2006	5.47	22.33		0.021	0.48	
PEARINO	PEARLY LAKE-OUTLET	08/30/2006	6.05	95.59		0.03	1.81	
PEARINM	PEARLY LAKE-MOUNTAIN RD	06/25/2007	5.73	115.8		0.081	1.09	
PEARINBI	PEARLY LAKE-BOWER INLET	06/25/2007	5.4	16.26		0.025	1.21	
PEARINO	PEARLY LAKE-OUTLET	06/25/2007	5.8	87.35		0.022	2.83	
PEARINM	PEARLY LAKE-MOUNTAIN RD	07/23/2007	5.64	170.2		0.081	1.27	
PEARINBI	PEARLY LAKE-BOWER INLET	07/23/2007	5.55	18.4		0.027	0.83	
PEARINO	PEARLY LAKE-OUTLET	07/23/2007	6.09	89.35		0.033	5.79	
PEARINM	PEARLY LAKE-MOUNTAIN RD	06/23/2008	5.52	110.9		0.077	1.71	
PEARINBI	PEARLY LAKE-BOWER INLET	06/23/2008	5.02	17.14		0.025	1.84	
PEARINO	PEARLY LAKE-OUTLET	06/23/2008	5.69	118.1		0.02	1.21	
PEARINM	PEARLY LAKE-MOUNTAIN RD	07/23/2008	5.55	142.7		0.065	1.25	
PEARINBI	PEARLY LAKE-BOWER INLET	07/23/2008	4.93	17.77		0.029	1.3	
PEARINO	PEARLY LAKE-OUTLET	07/23/2008	6.06	120.3		0.025	2.69	
PEARINM	PEARLY LAKE-MOUNTAIN RD	08/24/2008	5.39	81.99		0.071	1.16	
PEARINBI	PEARLY LAKE-BOWER INLET	08/24/2008	5.13	17.23		0.02	0.7	
PEARINO	PEARLY LAKE-OUTLET	08/24/2008	5.82	111.5		0.023	2.42	
PEARINM	PEARLY LAKE-MOUNTAIN RD	06/14/2009	5.34	102.2		0.061	0.86	
PEARINBI	PEARLY LAKE-BOWER INLET	06/14/2009	5.16	15.54		0.016	1.06	
PEARINO	PEARLY LAKE-OUTLET	06/14/2009	5.98	101.9		0.024	1	
PEARINM	PEARLY LAKE-MOUNTAIN RD	07/14/2009	5.42	73.26		0.079	0.84	
PEARINBI	PEARLY LAKE-BOWER INLET	07/14/2009	5.44	15.9		0.022	0.57	
PEARINBI	PEARLY LAKE-BOWER INLET	07/14/2009	5.39	16.4			0.56	
PEARINO	PEARLY LAKE-OUTLET	07/14/2009	5.89	91.01		0.027	1.41	
PEARINM	PEARLY LAKE-MOUNTAIN RD	08/17/2009	5.11	61.9		0.12	1.61	
PEARINBI	PEARLY LAKE-BOWER INLET	08/17/2009	5.46	16.45		0.027	0.54	
PEARINO	PEARLY LAKE-OUTLET	08/17/2009	6.08	74.69		0.028	1.41	
PEARINC	PEARLY LAKE-COLLEGE RD INLET	06/09/2010	5.69	113		0.083	1.31	
PEARINBI	PEARLY LAKE-BOWER INLET	06/09/2010	5.53	12.5			1.02	
PEARINO	PEARLY LAKE-OUTLET	06/09/2010	5.9	90.7		0.021	1.29	
PEARINO	PEARLY LAKE-OUTLET	07/18/2010	6.04	95.9		0.033	4.44	
PEARINC	PEARLY LAKE-COLLEGE RD INLET	08/11/2010	5.76	89.8		0.070	1.53	
PEARINC-DUP	PEARLY LAKE-COLLEGE RD INLET	08/11/2010	5.79	88.5			1.56	
PEARINBI	PEARLY LAKE-BOWER INLET	08/11/2010	5.71	25.6		0.037	1.38	
PEARINO	PEARLY LAKE-OUTLET	08/11/2010	6.1	97		0.029	5.34	
PEARINM	PEARLY LAKE-MOUNTAIN RD	06/19/2011	5.29	106.4		0.053	1.38	
PEARINBI	PEARLY LAKE-BOWER INLET	06/19/2011	5.52	17.43		0.024	0.84	
PEARINO	PEARLY LAKE-OUTLET	06/19/2011	6.02	97.2		0.021	1.02	
PEARINM	PEARLY LAKE-MOUNTAIN RD	07/19/2011	5.51	73.92		0.055	2.24	
PEARINM	PEARLY LAKE-MOUNTAIN RD	07/19/2011	5.49	73.98			1.26	
PEARINBI	PEARLY LAKE-BOWER INLET	07/19/2011	5.63	15.9		0.038	0.81	
PEARINO	PEARLY LAKE-OUTLET	07/19/2011	5.95	87.55		0.028	0.75	
PEARINM	PEARLY LAKE-MOUNTAIN RD	08/16/2011	5.28	110.6		0.064	2.85	
PEARINBI	PEARLY LAKE-BOWER INLET	08/16/2011	5.39	19.6		0.024	1.12	
PEARINO	PEARLY LAKE-OUTLET	08/16/2011	5.9	106.1		0.028	1.61	
PEARINM	PEARLY LAKE-MOUNTAIN RD	06/17/2012	5.28	67.9		0.043	1.84	
PEARINBI	PEARLY LAKE-BOWER INLET	06/17/2012	5.34	15.41		0.019	1.04	
PEARINO	PEARLY LAKE-OUTLET	06/17/2012	6.13	96.8		0.021	1.88	
PEARINM	PEARLY LAKE-MOUNTAIN RD	05/15/2013	5.5	117.3		0.0285	0.37	
PEARINBI	PEARLY LAKE-BOWER INLET	05/15/2013	5.49	15.6		0.0136	0.65	
PEARINO	PEARLY LAKE-OUTLET	05/15/2013	5.95	114.5		0.014	0.47	
PEARINO	PEARLY LAKE-OUTLET	05/15/2013	5.96	114.5			0.54	
PEARINM	PEARLY LAKE-MOUNTAIN RD	06/18/2013	5.21	51.5		0.028	0.73	
PEARINBI	PEARLY LAKE-BOWER INLET	06/18/2013	5.23	18.52		0.0107	0.31	
PEARINO	PEARLY LAKE-OUTLET	06/18/2013	5.85	89		0.0135	0.75	
PEARINM	PEARLY LAKE-MOUNTAIN RD	07/10/2013	5.39	99.5		0.0768	0.86	
PEARINBI	PEARLY LAKE-BOWER INLET	07/10/2013	5.47	19.92		0.0309	0.65	
PEARINO	PEARLY LAKE-OUTLET	07/10/2013	6.08	93.6		0.028	0.9	
PEARINM	PEARLY LAKE-MOUNTAIN RD	08/27/2013	5.8	66.6		0.0307	1.03	
PEARINBI	PEARLY LAKE-BOWER INLET	08/27/2013	5.58	20.6		0.0246	0.77	
PEARINO	PEARLY LAKE-OUTLET	08/27/2013	6.1	96.9		0.0242	1.07	
PEARINM	PEARLY LAKE-MOUNTAIN RD	09/23/2013	5.25	104.6		0.0338	0.55	
PEARINBI	PEARLY LAKE-BOWER INLET	09/23/2013	5.23	19.1		0.0234	0.41	
PEARINO	PEARLY LAKE-OUTLET	09/23/2013	5.86	88.7		0.0214	0.82	

Appendix C
Tributary Total Phosphorus Concentrations Correlated with Precipitation

Appendix C - Tributary Total Phosphorus Concentrations Correlated with Precipitation

<0.1 inch (1992-2013)				
	Bower Inlet - PHOSPHORUS (UG/L)	College Rd - PHOSPHORUS (UG/L)	Mountain Rd- PHOSPHORUS (UG/L)	Outlet - PHOSPHORUS (UG/L)
Average	38.7	No Data	71	28
Minimum	24.6	No Data	31	18
Maximum	68.0	No Data	120	40
Median	30.0	No Data	70	28
N	5.0	No Data	8	9

<0.1 inch (2009-2013)				
	Bower Inlet - PHOSPHORUS (UG/L)	College Rd - PHOSPHORUS (UG/L)	Mountain Rd- PHOSPHORUS (UG/L)	Outlet - PHOSPHORUS (UG/L)
Average	25.8	No Data	75	26
Minimum	24.6	No Data	31	24
Maximum	27.0	No Data	120	28
Median	25.8	No Data	75	26
N	2.0	No Data	2	2

0.1-0.5 inch (1992-2013)				
	Bower Inlet - PHOSPHORUS (UG/L)	College Rd - PHOSPHORUS (UG/L)	Mountain Rd- PHOSPHORUS (UG/L)	Outlet - PHOSPHORUS (UG/L)
Average	43	100	79	30
Minimum	24	100	41	20
Maximum	65	100	106	43
Median	43	100	81	29
N	7	1	11	

0.1-0.5 inch (2009-2013)				
	Bower Inlet - PHOSPHORUS (UG/L)	College Rd - PHOSPHORUS (UG/L)	Mountain Rd- PHOSPHORUS (UG/L)	Outlet - PHOSPHORUS (UG/L)
Average	24	No Data	53	21
Minimum	24	No Data	53	21
Maximum	24	No Data	53	21
Median	24	No Data	53	21
N	1	No Data	1	1

0.5-1 inch (1992-2013)				
	Bower Inlet - PHOSPHORUS (UG/L)	College Rd - PHOSPHORUS (UG/L)	Mountain Rd- PHOSPHORUS (UG/L)	Outlet - PHOSPHORUS (UG/L)
Average	31	51	63	27
Minimum	16	51	34	15
Maximum	53	51	90	46
Median	30	51	57	26
N	8	1	7	

0.5-1 inch (2009-2013)				
	Bower Inlet - PHOSPHORUS (UG/L)	College Rd - PHOSPHORUS (UG/L)	Mountain Rd- PHOSPHORUS (UG/L)	Outlet - PHOSPHORUS (UG/L)
Average	31	No Data	55	26
Minimum	23	No Data	34	21
Maximum	38	No Data	77	28
Median	31	No Data	55	28
N	3	No Data	3	3

>1-<2 inch (1992-2013)				
	Bower Inlet - PHOSPHORUS (UG/L)	College Rd - PHOSPHORUS (UG/L)	Mountain Rd- PHOSPHORUS (UG/L)	Outlet - PHOSPHORUS (UG/L)
Average	31	71	75	29
Minimum	16	32	43	20
Maximum	90	100	138	46
Median	25	70	71	29
N	16	5	12	

>1-<2 inch (2009-2013)				
	Bower Inlet - PHOSPHORUS (UG/L)	College Rd - PHOSPHORUS (UG/L)	Mountain Rd- PHOSPHORUS (UG/L)	Outlet - PHOSPHORUS (UG/L)
Average	24	83	61	26
Minimum	16	83	43	21
Maximum	37	83	79	33
Median	21	83	61	26
N	4	1	3	6

>2 inch (1992-2013)				
	Bower Inlet - PHOSPHORUS (UG/L)	College Rd - PHOSPHORUS (UG/L)	Mountain Rd- PHOSPHORUS (UG/L)	Outlet - PHOSPHORUS (UG/L)
Average	16	70	47	27
Minimum	11	70	28	14
Maximum	24	70	82	45
Median	14	70	30	28
N	3	1	5	

>2 inch (2009-2013)				
	Bower Inlet - PHOSPHORUS (UG/L)	College Rd - PHOSPHORUS (UG/L)	Mountain Rd- PHOSPHORUS (UG/L)	Outlet - PHOSPHORUS (UG/L)
Average	16	70	40	19
Minimum	11	70	28	14
Maximum	24	70	64	28
Median	14	70	29	14
N	3	1	3	3

Appendix D
Site Specific Project Plan

SITE SPECIFIC PROJECT PLAN FOR:
DEVELOPMENT OF THE PEARLY LAKE WATERSHED PLAN
(NHDES Project # RP-13-CT-02)

Under the New Hampshire Section 319 Nonpoint Source Grant Program QAPP
RFA# 08262
August 29, 2013

Final
October 3, 2013

Prepared by:
Comprehensive Environmental Inc.
21 Depot Street
Merrimack, NH 03054

For Review:

Project Manager/Grantee: 10/10/13
Signature/Date
Dr. Catherine Owen Koning, Franklin Pierce University

Technical Project Manager: 10/9/13
Signature/Date
Ben Lundsted, P.E., CEI

Technical Review: 10/9/13
Signature/Date
Matthew Lundsted, P.E., CEI

QA Officer: 10/9/13
Signature/Date
David Nyman, P.E., CEI

Project Engineer: 10/7/13
Signature/Date
Rebecca Balke, P.E., CEI

NHDES Project Manager:

Signature/Date
Jeffrey Marcoux, NHDES

Program Quality Assurance Coordinator:

Signature/Date
Jillian E. McCarthy, NHDES

NHDES Quality Assurance Manager:

Signature/Date
Vincent Perelli, NHDES

For Receipt:

EPA Nonpoint Source Program Coordinator:

Signature/Date
Erik Beck, EPA Region 1

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Tables

Figures

1- Distribution List

Table 1 lists people who will receive copies of the approved Site Specific Project Plan (SSPP) under the *New Hampshire Section 319 Nonpoint Source Grant Program Quality Assurance Project Plan* dated October 17, 2008.

Table 1. SSPP Distribution List

SSPP Recipient Name	Project Role	Organization	Telephone number and e-mail address
Dr. Catherine Owen Koning	Project Manager/Grantee	Franklin Pierce University	koningc@franklinpierce.edu 603-899-4322
Ben Lundsted	Technical Project Manager	Comprehensive Environmental Inc.	blundsted@ceiengineers.com 603-424-8444
Matthew Lundsted	Technical Review	Comprehensive Environmental Inc.	mlundsted@ceiengineers.com 603-424-8444
David Nyman	QA Officer	Comprehensive Environmental Inc.	dnyman@ceiengineers.com 603-424-8444
Rebecca Balke	Project Engineer	Comprehensive Environmental Inc.	rbalke@ceiengineers.com 603-424-8444
Curt Busto	Technical Team-GIS	Comprehensive Environmental Inc.	cbusto@ceiengineers.com 800-725-2550
Natalie Koncki	Technical Team-GIS/Land Use Modeling	Comprehensive Environmental Inc.	nkoncki@ceiengineers.com 800-725-2550
Jeffrey Marcoux	NHDES Project Manager	NHDES, Watershed Management Bureau	Jeffrey.Marcoux@des.nh.gov 603-271-5334
Jillian McCarthy	Program QA Coordinator	NHDES, Watershed Management Bureau	jillian.mccarthy@des.nh.gov 603-271-8475
Vincent Perelli	NHDES QA Manager	NHDES, Planning, Prevention, & Assistance Unit	vincent.perelli@des.nh.gov 603-271-8989
Erik Beck	USEPA Project Manager	USEPA New England	beck.erik@epa.gov 617-918-1606

2- Project Organization

Franklin Pierce University (FPU) in Rindge, New Hampshire received funding under Section 319 of the Clean Water Act from the NH Department of Environmental Services (NHDES) to develop a Watershed Management Plan (WMP) for the Pearly Lake, also known as Pearly Pond, Watershed.

Comprehensive Environmental Inc. (CEI) was selected as the technical consultant to help complete the scope of services for FPU. CEI Technical Project Manager Ben Lundsted will provide project oversight, technical expertise, and serve as the main point of contact for the Pearly Lake Watershed Plan stakeholder group. He will work closely with FPU and the Steering Committee to ensure that the project stays on time and budget. Ben is in charge of managing key project personnel and coordination of tasks with the project engineer, Rebecca Balke. Ben will also oversee field efforts, BMP matrix preparation, preliminary BMP designs and BMP reduction calculations.

Matthew Lundsted will provide technical review of the project, as well as cost estimation and construction services consulting. He will provide QA/QC for the BMP conceptual designs.

Rebecca Balke will provide technical expertise and oversight for key modeling tasks including the land use modeling, in-lake phosphorus and assimilative capacity analysis, buildout analysis, and pollutant load reduction estimates. Rebecca will also conduct the water quality analysis. Natalie Koncki and Curt Busto will provide technical support for lake modeling tasks.

David Nyman will serve as QA Officer and provide QA/QC for the BMP reduction calculations and the land use modeling. As the QA officer, David will ensure that survey results and modeling results have been reviewed and double-checked for potential inconsistencies.

Figure 1 outlines the organization structure of the project personnel.

Figure 1. Project Organizational Chart

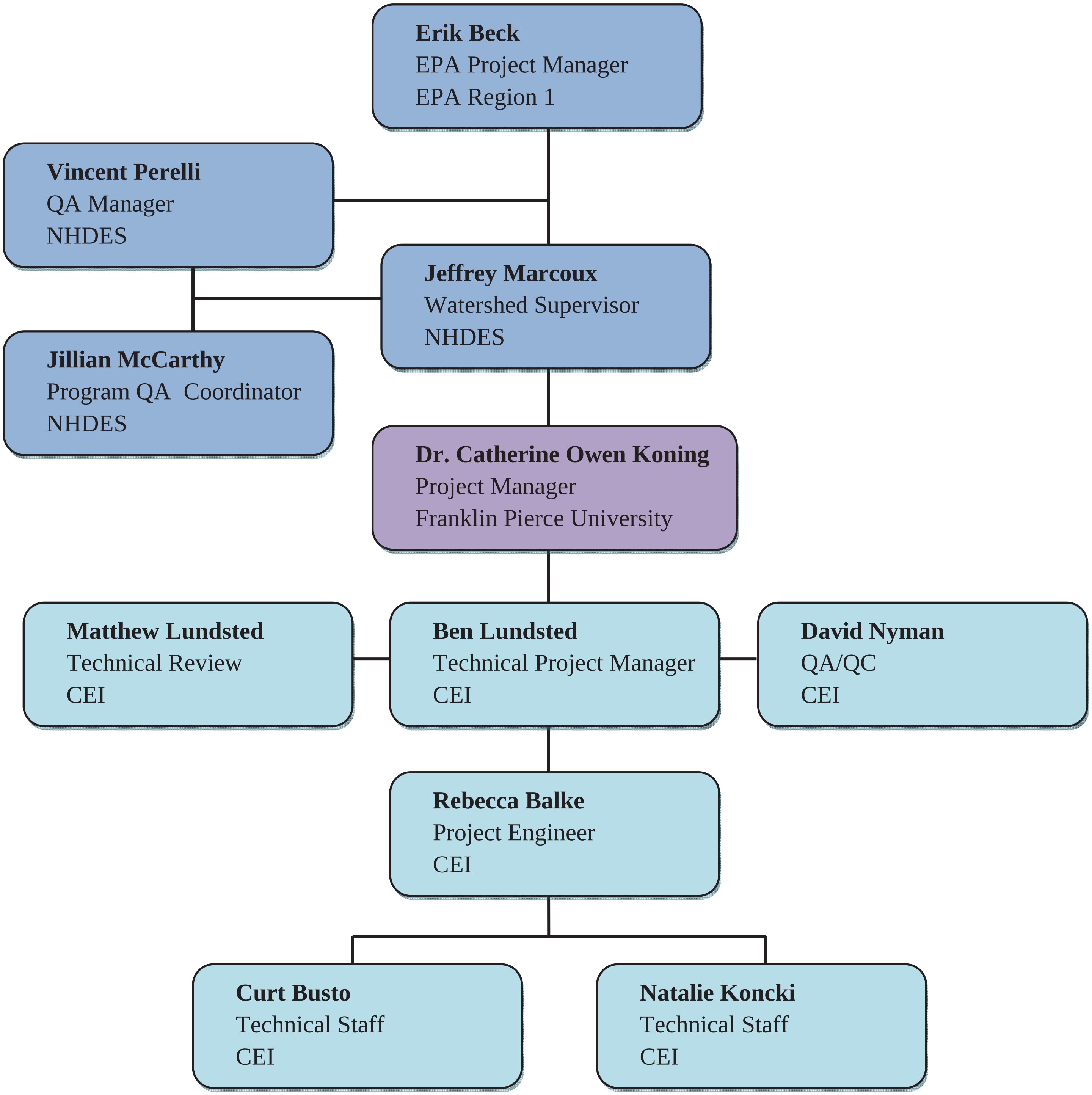

Table 2. Personnel Responsibilities and Qualifications

Name and Affiliation	Responsibilities	Qualifications
Dr. Catherine Owen Koning Franklin Pierce University	Project Manager	On file at FPU
Ben Lundsted Comprehensive Environmental Inc.	Project Manager	On file at CEI
Matthew Lundsted Comprehensive Environmental Inc.	Technical Review	On file at CEI
David Nyman Comprehensive Environmental Inc.	QA Officer	On file at CEI
Rebecca Balke Comprehensive Environmental Inc.	Project Engineer	On file at CEI
Jeffrey Marcoux, NHDES Watershed Management Bureau	Reviews and oversees development of the Pearly Lake WMP	On file at NHDES
Jillian McCarthy, NHDES Watershed Management Bureau	Reviews QAPP preparation and other QA/QC activities	On file at NHDES
Vincent Perelli, NHDES Planning Prevention & Assistance Unit	Reviews and approves QAPPs	On file at NHDES
Erik Beck US EPA Region I	EPA Project Manager	On file at US EPA

3- Site Information

Pearly Lake is listed in the final EPA 2012 303(d) list as impaired by chlorophyll-a, dissolved oxygen, total phosphorus, pH and cyanobacteria hepatotoxic microcystins. The Pearly Lake Beach is also listed as impaired for cyanobacteria hepatotoxic microcystins. A draft Total Maximum Daily Load (TMDL) targeting phosphorus was prepared in July 2009 and revised in October 2012.

The project area is located in the Pearly Lake watershed in the towns of Rindge and Jaffrey, New Hampshire, located in the Connecticut River Basin. The watershed area is about 2,128 acres and is primarily forested with some residential, urban/commercial and agricultural land uses. Most of the residential land use is along the shoreline of the lake with wastewater treatment through septic systems. The FPU campus is also on the lake, and until 2009, discharged its treated wastewater effluent directly to Pearly Lake. In 2009, a rapid infiltration system was put into operation at the Franklin Pierce Wastewater Treatment Plant (WWTP), essentially eliminating the surface water discharge basins discharge to the lake.

Pearly Lake is 193 acres and has a maximum depth of 11.2 feet and a mean depth of 5.2 feet. The lake volume is about 1.3 million cubic meters with a flushing rate of about five times per year. There are three year-round tributary streams to the Lake. The lake has a warm water fishery with brown bullhead (*Ictalurus nebulosus*), yellow perch (*Perca flavescens*), blue gill (*Lepomis macrochirus*), largemouth bass (*Micropterus salmoides*), chain pickerel (*Esox niger*), golden shiner (*Notemigonus crysoleucas*) and white sucker (*Catostomus commersonii*) identified during fisheries surveys (NH Fish and Game 2007, NHDES 2008c). New Hampshire Natural Heritage Bureau lists the banded sunfish (*Enneacanthus obesus*) as an endangered species in Pearly Lake (NHDES 2008c).

4- Project Rationale

Pearly Lake (NHLAK802020103-08) is on the 2012 305(b)/303(d) Surface Water Quality Assessment for failure to meet the following designated uses:

1. Aquatic Life (5-M) – Chorophyll-a
2. Aquatic Life (5-M) – Dissolved Oxygen
3. Aquatic Life (5-M) – Total Phosphorus
4. Aquatic Life (5-P) – pH
5. Primary Contact Recreation (5-M) – Chlorophyll-a
6. Primary Contact Recreation (5-M) – Cyanobacteria hepatotoxic microcystins

Pearly Lake Beach (NHLAK802020103-08-02) is on the 2012 305(b)/303(d) Surface Water Quality Assessment for failure to meet the following designated uses:

1. Primary Contact Recreation (5-M) – Cyanobacteria hepatotoxic microcystins

A draft TMDL targeting phosphorus was prepared in July 2009 and revised in October 2012. The goal of this project is to develop a watershed-based management plan that will build on the estimated loadings of phosphorus from the TMDL report, to identify the most cost-effective and useful strategies to reduce phosphorus inputs. Part of this project involves evaluating and updating the TMDL pollutant load model to reflect any identified variations found during the study and to estimate the impacts of proposed best management practices (BMPs) on the water quality of the lake.

The modeling will estimate total phosphorus loading to Pearly Lake, assess loading from major tributaries and subwatersheds, predict loading from future development, and help establish water quality goals.

5- Project Approach/Study Design

On-the-ground surveys, combined with in-depth water quality analysis and computer modeling, will be used to identify sources of pollution and to estimate pollutant load reductions needed to meet water quality goals and accommodate future watershed development. Several different tools, techniques and models will be used to complete this component of the watershed management plan.

A. Water Quality Analysis

Historical water quality monitoring data will be used for determining the median phosphorus values, the indirect phosphorus load to Pearly Lake, the internal load, the assimilative capacity, and for determining the water quality goal for the lake.

Monitoring results will be collected and reviewed from in-lake sources, inlet and outlet flows, and tributaries to calibrate modeling efforts. The New Hampshire Volunteer Lake Assessment Program (VLAP) is the primary volunteer group collecting water quality data on the lake. Data from the VLAP is available through the New Hampshire Department of Environmental Services Environmental Monitoring Database (EMD). Only data that is flagged as “Final” in the EMD will be used.

Phosphorus and flow data (where available) for the major streams flowing into Pearly Lake will be used to assess pollutant levels entering and leaving the lake and to provide an assessment of inputs by subwatershed. An initial analysis of water quality data will be conducted to determine median Total Phosphorus (TP) based on all samples regardless of whether it was a grab or epilimnetic core (EC) sample. Minimum, maximum and median TP values will be determined, sorted by epilimnion, metalimnion and hypolimnion. Data will be further refined using EC data only to calculate the median EC value (where more than one sample was collected on the same day, a mean will be used for that day). In the event that EC data are limited, grab samples taken on the same day at multiple depths near the surface may be used in conjunction with the EC samples. Similar methodology will be used to calculate average Chl *a* and Secchi disk transparency (SDT).

B. Water Quality Goal Setting

The Draft TMDL for Pearly Lake set a water quality goal for Total Phosphorus such that algal growth and bloom formation would no longer impair primary contact recreation. This goal will be revisited and revised as necessary depending on the site-specific findings for the lake and watershed discovered during this study. Existing and historic water quality data, along with predicted lake concentrations under an undeveloped watershed scenario, and feasibility of achieving pollutant reductions will be evaluated and considered in setting water quality goals.

Any changes to the water quality goal established under the Draft TMDL will be discussed with the Pearly Lake Stakeholder Committee and the New Hampshire Department of Environmental Services.

C. Loading Models

Watershed Loading Model

Geographical Information Systems (GIS) data will be obtained by CEI to assist with the land use assessment and specifically for determining the total land use area by land use type (in acres) for input into the watershed loading model (see below for model selection criteria). CEI will use the Land Use Map developed by ENSR/AECOM in the October 2012 Draft TMDL as its baseline. This was compiled from Land Cover raster data and national Wetlands Inventory (NWI) data obtained from NHGRANIT, and from windshield survey information. CEI and FPU will ground-truth land use coverage in the field to ensure and/or update the model to use the best land use coverages. CEI will develop a standard form and map for this purpose that identifies the parcel location, existing mapped GIS land use, and observed land use.

The Lake Loading Response Model (LLRM) (also called SHEDMOD or ENSR-LRM) used in the Draft TMDL will be updated as necessary to assess current nutrient loads from the watershed, and the load reductions that would result from the implementation of different best management practices (BMPs). The model was developed by AECOM for use in New England and modified for New Hampshire lakes by incorporating New Hampshire land use total phosphorus (TP) export coefficients and adding septic system loading into the model (AECOM, 2009). This model provides the best fit for the watershed and has already been used in the Draft TMDL for Pearly Lake and extensively for more than 30 recent Lake TMDLs in New Hampshire. The LLRM model used in the Draft TMDL will be obtained from NHDES. CEI will also obtain a recently completed and NHDES-approved LLRM model version, such as the one used in Lake Wentworth in 2012, to update the phosphorus loading and reduction analysis. The LLRM User Guide contained in the *Total*

Maximum Daily Load for Robinson Pond, Hudson, NH (AECOM and NHDES, 2011) will serve as the primary documentation on the model.

Data needed for input into the LLRM include: water quality monitoring data (TP, Chl *a*, and Secchi) for the lake; physical characteristics such as lake surface area, volume and flushing rate; tributary monitoring data including discharge; corrected GIS land use data; subwatershed land area; soils data including steepness of slope; precipitation data; septic system data (from the 2011 survey). Natalie Koncki of CEI will be running the model with assistance from Curt Busto. Natalie is proficient in the use of running watershed loading models, including direct experience with AVGWLF and desktop models based on The Simple Method, as well as lake response models. CEI Project Engineer Rebecca Balke will provide technical oversight and confirm that the information used for the model is correct. Natalie will make edits to the model based on feedback from Rebecca and the Steering Committee and final modeling results will be reviewed by Rebecca. Rebecca has expertise in water resources modeling and design including experience with Eutromod, STEPL, The Simple Method, GWLF, lake response models, HydroCAD, StormCAD, WaterCAD and SWMM.

The LLRM model estimates total phosphorus loading from the watershed, and predicts in-lake concentrations of TP, Chl *a*, SDT and algal bloom probability based on runoff and groundwater land use export coefficients. Attenuation factors such as porous soils, wetlands or existing BMPs that would decrease loading will be accounted for in order to reach a close agreement between predicted in-lake TP and observed median TP. The estimated watershed load (runoff and base flow) will be combined with direct loads (atmospheric, internal load and septic systems) to calculate total phosphorus loading and will be compared to observed in-lake concentrations.

In-Lake Total Phosphorus Concentrations

Results of the total phosphorus modeling will be input into a series of empirical models that provide predictions of in-lake TP concentrations, Chl *a* concentrations, algal bloom frequency and water clarity. Also referred to as total phosphorus retention modeling, the model estimates in-lake phosphorus concentrations based on physical and chemical lake characteristics including lake volume, mean depth, watershed area, flushing rate, and estimated watershed phosphorus loading. Because of the imperfect nature of any model to predict processes within natural systems, the model will compare six different in-lake phosphorus models including: Kirchner-Dillon (1975), Vollenweider (1975), Larsen-Mercier (1976), Jones-Bachman (1976), Reckhow General (1977), and Nürnberg (1998). The average of the six empirical models will be used as the predicted TP value for each of the lakes with some exceptions (it may be determined that one of the models is most representative, or a model could be eliminated as inapplicable). The predicted in-lake TP concentration will be compared to actual data in-lake water quality data analysis (see 5A, above). Additional predictions (Chl *a*, water clarity and bloom probability) will be determined based on the average in-lake TP concentration.

Future Loading Model/Build-Out Analysis

CEI will conduct a buildout analysis for analyzing the effects of new development on Pearly Lake. The buildout analysis utilizes GIS zoning data to estimate future development within the watershed. The analysis will combine current zoning restrictions and a host of development constraints (conservation lands, steep slopes, wetlands) in order to determine the extent of buildable area in the watershed. Future phosphorus loading will be estimated under full buildout and an assessment of the potential effects of future development as it relates to water quality goals. The buildout analysis will be conducted by Natalie Koncki with oversight by Rebecca Balke.

Load Reduction Estimates

The 'Simple Method' load reduction model (CWP, 2005) will be used to estimate load reductions from select BMPs identified through on-the-ground surveys, and can be fed back through the LLRM to evaluate lake response to proposed reductions. This method provides empirical estimates of phosphorus, nitrogen, chemical oxygen demand and biochemical oxygen demand as well as for metals. Load reduction estimates using the "Simple Method" will be conducted by Ben Lundsted with QA/QC by Rebecca Balke of Comprehensive Environmental Inc. Observations, trends, conclusions, significant QA/QC findings, and limitations in the pollutant load reduction data will be documented and reported in the final report to be submitted in hard copy and electronic format.

6- Quality Control

Quality control checks will be performed at various levels throughout the project. CEI Project Manager Ben Lundsted will provide quality control checks of the information collected during field surveys of the watershed and ensure the information is entered accurately into the spreadsheets. QA/QC checks will be conducted on a series of random field survey forms, and the spreadsheets will be reviewed for inconsistencies. If errors are identified, Ben will review the input values, and identify and correct the error to ensure the correct information is entered into the spreadsheets.

CEI Project Engineer Rebecca Balke will review all modeling inputs, calculations, and outputs for the purpose of QA/QC. She will perform these tasks for the LLRM Model and the 'Simple Method' load reduction model.

Final QA/QC will be performed by CEI QA Officer David Nyman. David will ensure that all of the information collected from field surveys and for use in the model have been reviewed and double-checked for potential inconsistencies. He will also provide final review of modeling results and calibrations to ensure that calibration adjustments are realistic and representative of the data collected.

All QA/QC issues identified will be properly documented, along with the appropriate steps taken to resolve the issues.

7- Project Schedule

Project components are scheduled to be completed at different stages throughout the planning process. Below is a list of targets for completion of individual tasks.

Task 1: Final Site Specific Project Plan – October 2013
Task 2: Revised TMDL Spreadsheet, build-out scenario results and septic system data – January 2014
Task 3: Documentation of water quality goals – February 2014

Task 4: Pollutant loading and reduction results – March 2014
Task 5: Management recommendations, BMP matrices, costs prioritizations, load reductions, schedule – July 2014
Task 6: Outreach strategy and public education materials – April 2014
Task 7: Draft and Final Watershed Management Plan – November 2014
Task 8: Draft BMP Designs – November 2014

8- Final Products and Reporting

Final products for this project include the following:

- Approved Site Specific Project Plan under the New Hampshire Section 319 Nonpoint Source Grant Program QAPP for the Septic and Stormwater Survey (RFA# 08262, 10/17/08).
- Revised draft TMDL spreadsheet for existing and buildout conditions.
- Documentation of water quality target.
- Matrix of Best Management Practices with load reduction estimates and costs.
- Draft and final watershed plans.

9- References

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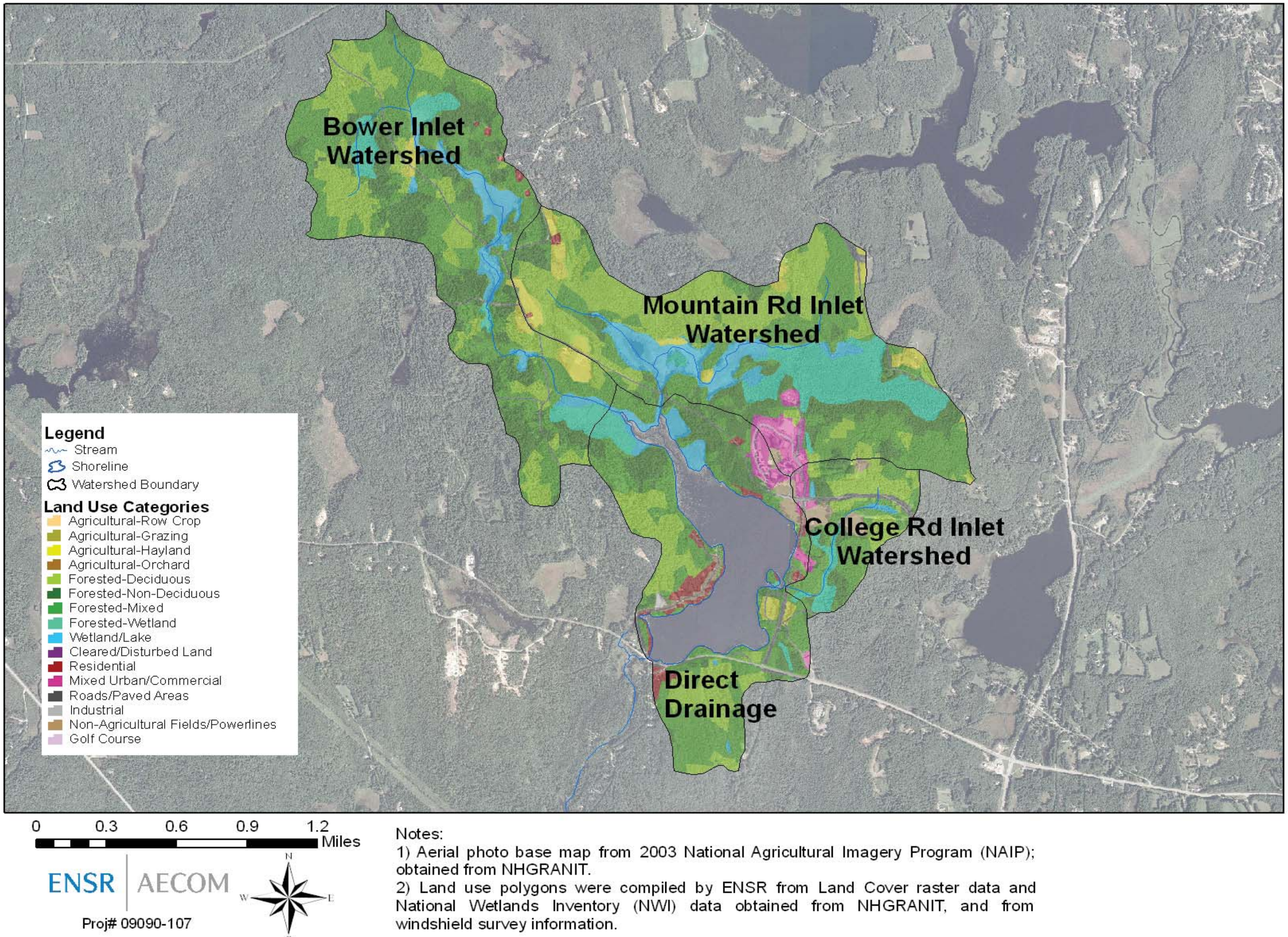
NH GRANIT. www.granit.unh.edu.

Appendix A- Pearly Lake Watershed Map



Notes:
1) Aerial photo base map from 2003 National Agricultural Imagery Program (NAIP); obtained from NHGRANIT.
2) Land use polygons were compiled by ENSR from Land Cover raster data and National Wetlands Inventory (NWI) data obtained from NHGRANIT, and from windshield survey information.

Source: AECOM, 2012. Draft Total Maximum Daily Load for Pearly Lake, Rindge, NH. Document Number: 09090-107-21.

Appendix E
Land Use Categories, Export Coefficients and Additional Calculations

Appendix E - Land Use Categories, Export Coefficients and Additional Calculations

Table E-1. Runoff and baseflow fraction ranges

	Low	Med	High
Baseflow fraction	0.01	0.20	0.40
Runoff fraction	0.10	0.40	0.95

Table E-2. Runoff and baseflow factions used in the model for Pearly Pond

Landuse Category	Runoff Fraction	Baseflow Fraction
Urban 1 (Residential)	0.40	0.25
Urban 2 (Mixed Urban/Commercial)	0.50	0.15
Urban 3 (Roads)	0.60	0.05
Urban 4 (Industrial)	0.60	0.05
Urban 5 (Parks, Recreation Fields, Institutional)	0.30	0.30
Agric 1 (Cover Crop)	0.15	0.30
Agric 2 (Row Crop)	0.30	0.30
Agric 3 (Grazing)	0.30	0.30
Agric 4 (Hayland-Non-Manure)	0.30	0.30
Forest 1 (Deciduous)	0.30	0.40
Forest 2 (Non-Deciduous)	0.30	0.40
Forest 3 (Mixed Forest)	0.30	0.40
Forest 4 (Wetland)	0.05	0.40
Open 1 (Wetland / Pond)	0.05	0.40
Open 2 (Meadow)	0.15	0.30
Open 3 (Cleared/Disturbed Land)	0.30	0.30

Table E-3. Land use categories from used in Pearly Pond ENSR-LRM

ENSR-LRM LAND USE	Land Cover Code[1]	Land Cover Description	NWI code[2]	Windshield Survey
Urban 1 (Residential)	110	Residential/Commericial/Industrial	not wetland area	
Urban 2 (Mixed Urban/Commercial)	110	Residential/Commericial/Industrial	not wetland area	
Urban 3 (Roads)	140	Transportation/Roads		
Urban 4 (Industrial)	110	Residential/Commericial/Industrial		
Urban 5 (Parks, Recreation Fields, Institutional)	790			X
Agric 1 (Cover Crop)	211			X
Agric 2 (Row Crop)	211	Row Crops		X
Agric 3 (Grazing)	212	Hay/Pasture		X
Agric 4 (Hayland-no manure)	212	Hay/Pasture		X
Agric 5 (Orchard)	221	Fruit Orchard		
Forest 1 (Deciduous)	412	Beech/oak		
	414	Paper birch/aspen		
	419	Other hardwoods		
Forest 2 (Non-Deciduous)	421	White/red pine		
	422	Spruce/fir		
	423	Hemlock		
	424	Pitch pine		
Forest 3 (Mixed)	430	Mixed forest		
Forest 4 (Wetland)	610	Forested wetlands	PF___	
Open 1 (Wetland / Lake)	500	Water		
	620	Open Water/Wetland	PSS_, L1_, PEM__	
Open 2 (Meadow)	212	Hay/Pasture		X
Open 3 (Cleared/Disturbed Land)	790	Cleared/other open		X
	710	Disturbed		X

[1] Land cover data created by GRANIT using Lansat 5 and 7 imagery and other available raster and vector data.

[2] National Wetlands Inventory (NWI) data is used to improve the accuracy of wetland areas that are either not delineated in the land use and land cover data or poorly represented by raster cells.

Priority ranking is given to the Land Use data set for all non-wetland areas, NWI data for wetland areas, and Land cover for forest type areas.

Table E-4. Land use export coefficients (kg/ha/yr) used in Pearly Pond TMDL*

ENSR-LRM Land Use	Runoff P export coefficient range	Runoff P export coefficient used[1]	Source	Baseflow P export coefficient range	Baseflow P export coefficient used[2]	Source
Urban 1 (Residential)	0.11-8.42	0.9	Reckhow et al. 1980, Schloss et al. 2000-Table 5	0.001-0.05	0.05	ENSR Unpublished Data; Mitchell et al. 1989
Urban 2 (Mixed Urban/Commercial)	0.11-8.42	2	Reckhow et al. 1980	0.001-0.05	0.05	"
Urban 3 (Roads)	0.60-10	1.5	Dudley et al. 1997	0.001-0.05	0.05	"
Urban 4 (Industry)	0.11-8.42	1.5	Reckhow et al. 1980	0.001-0.05	0.05	"
Urban 5 (Park/Institutional/Recreation/Cemetery)	0.19-6.23	2	Reckhow et al. 1980	0.001-0.05	0.05	"
Agric 1 (Cover Crop)	0.10-2.90	0.8	Reckhow et al. 1980	0.001-0.05	0.05	"
Agric 2 (Row Crop)	0.26-18.26	2.2	Reckhow et al. 1980	0.001-0.05	0.05	"
Agric 3 (Grazing)	0.14-4.90	0.8	Reckhow et al. 1980	0.001-0.05	0.05	"
Agric 4 (Hayland-No Manure)	0.35	0.35	Dennis and Sage 1981	0.001-0.05	0.05	"
Forest 1 (Deciduous)	0.034-0.973	0.15	Schloss et al. 2000- Table 4	0.001-0.010	0.04	"
Forest 2 (Non-Deciduous)	0.01-0.138	0.093	Schloss et al. 2000- Table 4	0.001-0.010	0.04	"
Forest 3 (Mixed)	0.01-0.138	0.093	Schloss et al. 2000- Table 4	0.001-0.010	0.04	"
Forest 4 (Wetland)	0.003-0.439	0.082	Schloss et al. 2000-Table 4	0.001-0.010	0.04	"
Open 1 (Wetland / Pond)	0.009-0.25	0.065	Schloss et al. 2000-Table 5	0.001-0.010	0.04	"
Open 2 (Meadow)	0.02-0.83	0.8	Reckhow et al. 1980	0.001-0.010	0.04	"
Open 3 (Bare Open)	0.25-1.75	0.8	Reckhow et al. 1980	0.001-0.010	0.05	"

Notes:

[1]Shaded values are not a median

[2]Baseflow P export coefficient was calculated based on background P concentrations observed in Bower Inlet under low flow conditions. Land uses that represent undisturbed conditions (e.g., forested, wetlands and meadows) were adjusted to predict P concentrations in the Bower Inlet that matched observed concentrations under dry weather conditions, since the Bower Inlet watershed is an undeveloped watershed. This natural baseflow P export coefficient was then added to literature based baseflow P export coefficients for other disturbed land uses (e.g., urban, agricultural) to represent natural baseflow load plus anticipated load from developed land uses.

Table E-5. Internal loading calculations in Pearly Pond model

	Value	Unit
TP Difference August Hypolimnion-Epilimnion (2009-2013)	0.078	mg/L
Sample Size	5	
Hypolimnion Volume (Below 2.5 m)	115,411,690	L
Internal TP Load	9.0	kg/yr
Surface Area of Anoxic Zone	23.74	ha
Internal TP Coefficient	0.38	kg/ha/yr

Table E-6. Septic system calculations in Pearly Lake model

Category	# of Dwellings in 125 ft Buffer	People/ Dwelling	TP Atten Factor	Mean TP Conc (mg/L)	P Load (kg/person/yr)	P Load (kg/yr)	Water (gal/day)	# of Days	Water Load (m^3/yr)
Year Round Residential	29	2.53	0.1	8	0.72	5.4	65	365	6689
Seasonal Residential	17	2.53	0.1	8	0.18	0.7	65	90	928
Total Septic System Loading						18.0			7617

Table E-7. Waterfowl loading calculations in Pearly Pond model

Bird Type	# of Birds	P Load (kg/bird/day)	Non-Ice Days (days)	P Load (kg/yr)	Coefficient Source	Bird Count Source
Canada Geese	55	0.001526	275.00	23	Scherer et al. 1995	Grey 2012

Table E-8. Franklin Pierce Annual Waste Water Treament Plant Phosphorus and Water Load Calculations[1]

Year	Monthly Average (MGD)	Average Discharge (m3/day)	Average Yearly Discharge (m3/yr)	Daily Mean TP (lbs/day)	Average Annual TP (kg/yr)		lbs/m3	mg/L
2001	0.044	166	60,448	0.069	**11.5**		0.000381	0.17
2002	0.040	153	55,769	0.094	**15.5**		0.000517	0.23
2003	0.043	162	59,136	0.052	**8.6**		0.000335	0.15
2004	0.040	151	55,267	0.023	**3.9**		0.000174	0.08
2005	0.042	159	57,915	0.037	**6.1**		0.000239	0.11
2006	0.043	162	59,182	0.092	**15.2**		0.000616	0.28
2007	0.042	159	58,030	0.088	**14.6**		0.000578	0.26
2008	0.047	178	64,929	0.129	**21.4**		0.000728	0.33
2009	0.047	177	64,609	0.113	**18.7**		0.000639	0.29
2010	0.045	171	62,437	0.079	**13.1**		0.000463	0.21
2011	0.047	177	64,571	0.105	**17.4**		0.000595	0.27
2012	0.040	150	54,648	0.069	**11.5**		0.000463	0.21
2013	0.039	148	53,965	0.072	**11.9**		0.000485	0.22

[1] Source- NPDES Permit NH0101044 Required Monitoring Results- DMR Data from NH DES Wastewater Engineering Bureau.

Appendix F
ENSR-LRM Methodology Documentation

Appendix F – ENSR-LRM Methodology Documentation
LLRM – Lake Loading Response Model Users Guide (also called SHEDMOD or ENSR-LRM)

Model Overview

The Lake Loading Response Model, or LLRM, originated as a teaching tool in a college course on watershed management, where it was called SHEDMOD. This model has also been historically called ENSR-LRM. The intent was to provide a spreadsheet program that students could use to evaluate potential consequences of watershed management for a target lake, with the goal of achieving desirable levels of phosphorus (TP), nitrogen (N), chlorophyll a (Chl) and Secchi disk transparency (SDT). For the NH Lake TMDLs only TP, Chl and SDT were simulated. As all cells in the spreadsheet are visible, the effect of actions could be traced throughout the calculations and an understanding of the processes and relationships could be developed.

LLRM remains spreadsheet based, but has been enhanced over the years for use in watershed management projects aimed at improving lake conditions. It is still a highly transparent model, but various functions have been added and some variables have been refined as new literature has been published and experience has been gained. It is adaptable to specific circumstances as data and expertise permit, but requires far less of each than more complex models such as SWAT or BASINS. This manual provides a basis for proper use of LLRM.

Model Platform

LLRM runs within Microsoft Excel. It consists of three numerically focused worksheets within a spreadsheet:

1. Reference Variables – Provides values for hydrologic, export and concentration variables that must be entered for the model to function. Those shown are applicable to the northeastern USA, and some would need to be changed to apply to other regions.
2. Calculations – Uses input data to generate estimates of water, N and TP loads to the lake. All cells shaded in blue must have entries if the corresponding input or process applies to the watershed and lake. If site-specific values are unavailable, one typically uses the median value from the Reference Variables sheet.
3. Predictions – Uses the lake area and inputs calculated in the Calculations sheet to predict the long-term, steady state concentration of N, TP and Chl in the lake, plus the corresponding SDT. This sheet applies five empirical models and provides the average final results from them.

Watershed Schematic

Generation of a schematic representation of the watershed is essential to the model. It is not a visible part of the model, but is embodied in the routing of water and nutrients performed by the model and it is a critical step. For the example provided here, the lake and watershed shown in Figure 1 is modeled. It consists of a land area of 496.5 hectares (ha) and a lake with an area of 40 ha. There are two defined areas of direct drainage (F and G), from which water reaches the lake by overland sheetflow, piped or ditched stormwater drainage, or groundwater seepage (there are no tributaries in these two drainage basins). There is also a tributary (Trib 1) that is interrupted by a small pond, such that the corresponding watershed might best be represented as two parts, upstream and downstream of that pond, which will provide some detention and nutrient removal functions. There is another tributary (Trib 2) that consists of two streams that combine to form one that then enters the lake, the classic "Y' drainage pattern. With differing land uses associated with each of the upper parts of the Y and available data for each near the confluence, this part of the watershed is best subdivided into three drainage areas. As shown in Figure 2, the watershed of Figure 1 is represented as the lake with two direct drainage units, a tributary with an upper and lower drainage unit, and a tributary with two upper and one lower drainage units. The ordering is important on several levels, most notably as whatever nutrient loading attenuation occurs in the two lower tributary basins will apply to loads generated in the corresponding upper basins. Loads are generated and may be managed in any of the drainage basins, but how they affect the lake will be determined by how those loads are processed on the way to the lake. LLRM is designed to provide flexibility when testing management scenarios, based on watershed configuration and the representation of associated processes.

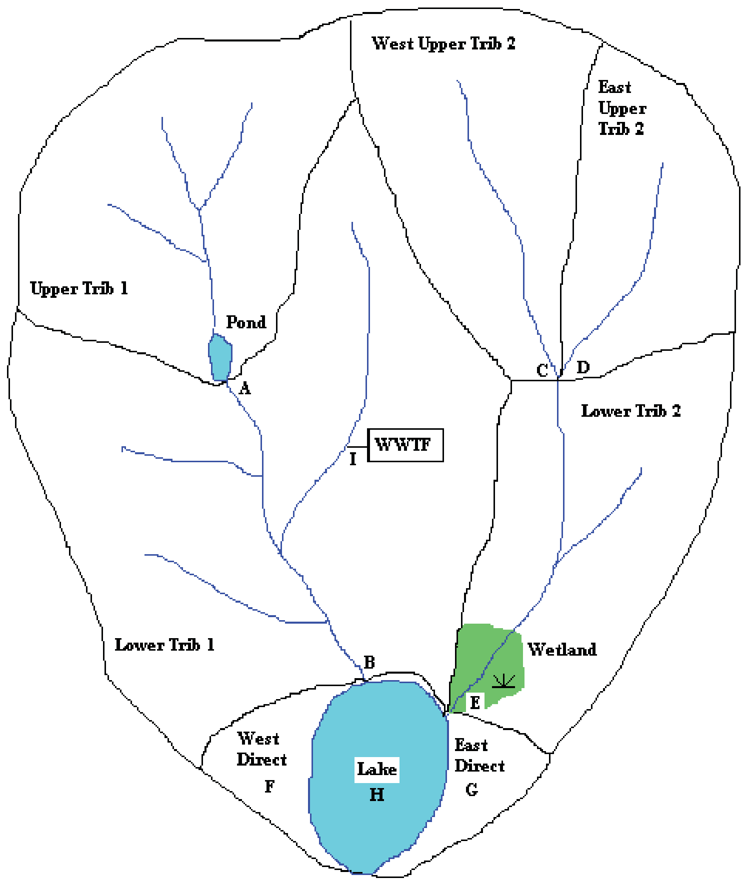


Figure 1. Watershed Map for Example System

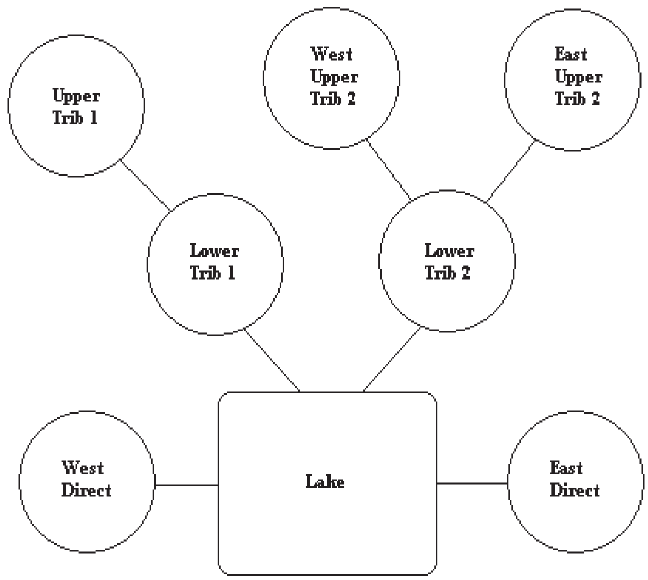


Figure 2. Watershed Schematic for Example System

Model Elements

There are three main types of inputs necessary to run LLRM:

1. Hydrology inputs – These factors govern how much water lands on the watershed and what portion is converted to runoff or baseflow. The determination of how much precipitation becomes runoff vs. baseflow vs. deep groundwater not involved in the hydrology of the target system vs. loss to evapotranspiration is very important, and requires some knowledge of the system. All precipitation must be accounted for, but all precipitation will not end up in the lake. In the northeast, runoff and baseflow may typically account for one to two thirds of precipitation, the remainder lost to evapotranspiration or deep groundwater that may feed surface waters elsewhere, but not in the system being modeled. As impervious surface increases as a percent of total watershed area, more precipitation will be directed to runoff and less to baseflow. There are two routines in the model to allow "reality checks" on resultant flow derivations, one using a standard areal water yield based on decades of data for the region or calculated from nearby stream gauge data, and the other applying actual measures of flow to check derived estimates.
2. Nutrient yields – Export coefficients for N and TP determine how much of each is generated by each designated land use in the watershed. These export values apply to all like land use designations; one cannot assign a higher export coefficient to a land use in one basin than to the same land use in another basin. Differences are addressed through attenuation. This is a model constraint, and is imposed partly for simplicity and partly to prevent varied export assignment without justification. Where differing export really does exist for the same land uses in different basins of the watershed, attenuation can be applied to adjust what actually reaches the lake. Nutrient export coefficients abound in the literature, and ranges, means and medians are supplied in the Reference Variables sheet. These are best applied with some local knowledge of export coefficients, which can be calculated from land area, flow and nutrient concentration data. However, values calculated from actual data will include attenuation on the way to the point of measurement. As attenuation is treated separately in this model, one must determine the pre-

attenuation export coefficients for entry to initiate the model. The model provides a calculation of the export coefficient for the "delivered" load that allows more direct comparison with any exports directly calculated from data later in the process.

3. Other nutrient inputs – five other sources of N and TP are recognized in the model:
   a. Atmospheric deposition – both wet and dry deposition occur and have been well documented in the literature. The area of deposition should be the entire lake area. Choice of an export coefficient can be adjusted if real data for precipitation and nutrient concentrations is available.
   b. Internal loading – loads can be generated within the lake from direct release from the sediment (dissolved TP, ammonium N), resuspension of sediment (particulate TP or N) with possible dissociation from particles, or from macrophytes ("leakage" or scenescence). All of these modes have been studied and can be estimated with a range, but site specific data for surface vs. hypolimnetic concentrations, pre-stratification whole water column vs. late summer hypolimnetic concentrations, changes over time during dry periods (limited inflow), or direct sediment measures can be very helpful when selecting export coefficients.
   c. Waterfowl and other wildlife – Inputs from various bird species and other water dependent wildlife (e.g., beavers, muskrats, mink or otter) have been evaluated in the literature. Site specific data on how many animals use the lake for how long is necessary to generate a reliable estimate.
   d. Point sources – LLRM allows for up to three point sources, specific input points for discharges with known quantity and quality. The annual volume, average concentration, and basin where the input occurs must be specified.
   e. On-site wastewater disposal (septic) systems – Septic system inputs in non-direct drainage basins is accounted for in baseflow export coefficients, but a separate process is provided for direct drainage areas where dense housing may contribute disproportionately. The number of houses in two zones (closer and farther away, represented here as <100 ft and 100-300 ft from the lake) can be specified, with occupancy set at either seasonal (90 days) or year round (365 days). For the NH lake nutrient TMDLs, one zone of 125 feet from the lake was used. The number of people per household, water use per person per day, and N and TP concentrations and attenuation factors must be specified. Alternatively, these inputs can be accounted for in the baseflow export coefficient for direct drainage areas if appropriate data are available, but this module allows estimation from what is often perceived as a potentially large source of nutrients.

LLRM then uses the input information to make calculations that can be examined in each corresponding cell, yielding wet and dry weather inputs from each defined basin, a combined total for the watershed, a summary of other direct inputs, and total loads of TP and N to the lake, with an overall average concentration for each as an input level. Several constraining factors are input to govern processes, such as attenuation, and places to compare actual data to derived estimates are provided. Ultimately, the lake area and loading values are transferred to the Prediction sheet where, with the addition of an outflow TP concentration and lake volume, estimation of average in-lake TP, N, Chl and SDT is performed. The model is best illustrated through an example, which is represented by the watershed in Figures 1 and 2. Associated tables are directly cut and pasted from the example model runs.

Hydrology

Water is processed separately from TP and N in LLRM. While loading of water and nutrients are certainly linked in real situations, the model addresses them separately, then recombines water and nutrient loads later in the calculations. This allows processes that affect water and nutrient loads differently (e.g., many BMPs) to be handled effectively in the model.

Water Yield

Where a cell is shaded, an entry must be made if the corresponding portion of the model is to work. For the example watershed, the standard yield from years of data for a nearby river, to which the example lake eventually drains, is 1.6 cubic feet per square mile (cfsm) as shown below. That is, one can expect that in the long term, each square mile of watershed will generate 1.6 cubic feet per second (cfs). This provides a valuable check on flow values derived from water export from various land uses later in the model.

COEFFICIENTS	
STD. WATER YIELD (CFSM)	1.6
PRECIPITATION (METERS)	1.21

Precipitation

The precipitation landing on the lake and watershed, based on years of data collected at a nearby airport, is 1.21 m (4 ft, or 48 inches) per year, as shown above. Certainly there will be drier and wetter years, but this model addresses the steady state condition of the lake over the longer term.

Runoff and Baseflow Coefficients

Partitioning coefficients for water for each land use type have been selected from literature values and experience working in this area. Studies in several of the drainage basins to the example lake and for nearby tributaries outside this example system support the applied values with real data. It is expected that the sum of export coefficients for runoff and baseflow will be <1.0; some portion of the precipitation will be lost to deep groundwater or evapotranspiration.

	RUNOFF EXPORT COEFF.			BASEFLOW EXPORT COEFF.		
	Precip Coefficient	P Export Coefficient	N Export Coefficient	Precip Coefficient	P Export Coefficient	N Export Coefficient
LAND USE	(Fraction)	(kg/ha/yr)	(kg/ha/yr)	(Fraction)	(kg/ha/yr)	(kg/ha/yr)
Urban 1 (Residential)	0.30	0.65	5.50	0.15	0.010	5.00
Urban 2 (Roads)	0.40	0.75	5.50	0.10	0.010	5.00
Urban 3 (Mixed Urban/Commercial)	0.60	0.80	5.50	0.05	0.010	5.00
Urban 4 (Industrial)	0.50	0.70	5.50	0.05	0.010	5.00
Urban 5 (Parks, Recreation Fields, Institutional)	0.10	0.80	5.50	0.05	0.010	5.00
Agric 1 (Cover Crop)	0.15	0.80	6.08	0.30	0.010	2.50
Agric 2 (Row Crop)	0.30	1.00	9.00	0.30	0.010	2.50
Agric 3 (Grazing)	0.30	0.40	5.19	0.30	0.010	5.00
Agric 4 (Feedlot)	0.45	224.00	2923.20	0.30	0.010	25.00
Forest 1 (Upland)	0.10	0.20	2.86	0.40	0.005	1.00
Forest 2 (Wetland)	0.05	0.10	2.86	0.40	0.005	1.00
Open 1 (Wetland/Lake)	0.05	0.10	2.46	0.40	0.005	0.50
Open 2 (Meadow)	0.05	0.10	2.46	0.30	0.005	0.50
Open 3 (Excavation)	0.40	0.80	5.19	0.20	0.005	0.50
Other 1	0.10	0.20	2.46	0.40	0.050	0.50
Other 2	0.35	1.10	5.50	0.25	0.050	5.00
Other 3	0.60	2.20	9.00	0.05	0.050	20.00

Setting export coefficients for the division of precipitation between baseflow, runoff and other components (deep groundwater, evapotranspiration) that do not figure into this model is probably the hardest part of model set-up. Site specific data are very helpful, but a working knowledge of area hydrology and texts on the subject is often sufficient. This is an area where sensitivity testing is strongly urged, as some uncertainly around these values is to be expected. There is more often dry weather data available for tributary streams than wet weather data, and some empirical derivation of baseflow coefficients is recommended. Still, values are being assigned per land use category, and most basins will have mixed land use, so clear empirical validation is elusive. As noted, sensitivity testing by varying these coefficients is advised to determine the effect on the model of the uncertainty associated with this difficult component of the model.

Nutrient Yields for Land Uses

Phosphorus and Nitrogen in Runoff

The values applied in the table above are not necessarily the medians from the Reference Variables sheet, since there are data to support different values being used here. There may be variation across basins that is not captured in the table below, as the same values are applied to each land use in each basin; that is a model constraint. Values for “Other” land uses are inconsequential in this case, as all land uses are accounted for in this example watershed without creating any special land use categories. Yet if a land use was known to have strong variation among basins within the watershed, the use of an “Other” land use class for the strongly differing land use in one or another basin could incorporate this variability.

Phosphorus and Nitrogen in Baseflow

Baseflow coefficients are handled the same way as for runoff coefficients above. While much of the water is likely to be delivered with baseflow, a smaller portion of the TP and N loads will be delivered during dry weather, as the associated water first passes through soil. In particular, TP is removed effectively by many soils, and transformation of nitrogen among common forms is to be expected.

The table above is commonly adjusted to calibrate the model, but it is important to justify all changes. Initial use of the median TP export value for a land use may be based on a lack of data or familiarity with the system, and when the results strongly over- or under-predict actual in-lake concentrations, it may be necessary to adjust the export value for one or more land use categories to achieve acceptable agreement. However, this should not be done without a clear understanding of why the value is probably higher or lower than represented by the median; the model should not be blindly calibrated, and field examination of conditions that affect export values is strongly recommended.

Other Nutrient Inputs

Atmospheric Deposition

Both wet and dry deposition nutrient inputs are covered by the chosen values, and are often simple literature value selections. Where empirical data for wet or dry fall are available, coefficients should be adjusted accordingly. Regional data are often available and can be used as a reality check on chosen values. Choices of atmospheric export coefficients are often based on dominant land use in the contributory area (see Reference Variables sheet), but as the airshed for a lake is usually much larger than the watershed, it is not appropriate to use land use from the watershed as the sole criterion for selecting atmospheric export coefficients. Fortunately, except where the lake is large and the watershed is small, atmospheric inputs tend not to have much influence on the final concentrations of TP or N in the lake, so this is not a portion of the model on which extreme investigation is usually necessary.

For the example system, a 40 ha lake is assumed to receive 0.2 kg TP/ha/yr and 6.5 kg N/ha/yr, the median values from the Reference Variables sheet. The model then calculates the loads in kg/yr to the lake and uses them later in the summary.

AREAL SOURCES										
	Affected Lake Area (ha)	P Export Coefficient (kg/ha/yr)	N Export Coefficient (kg/ha/yr)	P Load (from coeff) (kg/yr)	N Load (from coeff) (kg/yr)	Period of Release (days)	P Rate of Release (mg/m2/day)	N Rate of Release (mg/m2/day)	P Load (from rate) (kg/yr)	N Load (from rate) (kg/yr)
Direct Atmospheric Deposition	40	0.20	6.50	8	260					
Internal Loading	20	2.00	5.00	40	100	100	2.00	5.00	40	100

Internal Loading

Internal release of TP or N is generally described as a release rate per square meter per day. It can be a function of direct dissolution release, sediment resuspension with some dissociation of available nutrients, or release from rooted plants. The release rate is entered as shown in the table above, along with the affected portion of the lake, in this case half of the 40 ha area, or 20 ha. The period of release must also be specified, usually corresponding to the period of deepwater anoxia or the plant growing season. The model then calculates a release rate as kg/ha/yr and a total annual load as shown in the table above.

For the NH lake nutrient TMDLs, the release rate from internal loading was calculated using water quality data (pre-stratification vs. late summer hypolimnetic TP concentrations or late summer hypolimnetic vs. late summer epilimnetic TP concentrations) and dividing by the anoxic area of the lake.

Waterfowl or Other Wildlife

Waterfowl or other wildlife inputs are calculated as a direct product of the number of animal-years on the lake (e.g., 100 geese spending half a year = 50 bird-years) and a chosen input rate in kg/animal/yr, as shown in the table below. Input rates are from the literature as shown in the Reference Variables sheet, while animal-years must be estimated for the lake.

NON-AREAL SOURCES										
	Number of Source Units	Volume (cu.m/yr)	P Load/Unit (kg/unit/yr)	N Load/Unit (kg/unit/yr)	P Conc. (ppm)	N Conc. (ppm)	P Load (kg/yr)	N Load (kg/yr)		
Waterfowl	50		0.20	0.95			10	47.5		
Point Sources										
PS-1		45000			3.00	12.00	135	540		
PS-2		0			3.00	12.00	0	0		
PS-3		0			3.00	12.00	0	0		
Basin in which Point Source occurs (0=NO 1=YES)										
	BASIN 1	BASIN 2	BASIN 3	BASIN 4	BASIN 5	BASIN 6	BASIN 7	BASIN 8	BASIN 9	BASIN 10
PS-1	0	0	0	1	0	0	0	0	0	0
PS-2	0	0	0	0	0	0	0	0	0	0
PS-3	0	0	0	0	0	0	0	0	0	0

Point Source Discharges

LLRM allows for three point source discharges. While some storm water discharges are legally considered point sources, the point sources in LLRM are intended to be daily discharge sources, such as wastewater treatment facility or cooling water discharges. The annual volume of the discharge must be entered as well as the average concentration for TP and TN, as shown in the table above. The model then calculates the input of TP and TN. It is also essential to note which basin receives the discharge, denoted by a 1 in the appropriate column. As shown in the table above, the example system has a discharge in Basin 4, and no discharges in any other basin (denoted by 0).

On-Site Wastewater Disposal Systems

While the input from septic systems in the direct drainage areas around the lake can be addressed through the baseflow export coefficient, separation of that influence is desirable where it may be large enough to warrant management consideration. In such cases, the existing systems are divided into those within 100 ft of the lake and those between 100 and 300 ft of the lake, each zone receiving potentially different attenuation factors. For the NH lake TMDLs, a single 125 foot zone was used. A further subdivision between dwelling occupied all year vs. those used only seasonally is made. The number of people per dwelling and the water use per person per day are specified, along with the expected concentrations of TP and TN in septic system effluent, as shown in the table below. The model then calculates the input of water, TP and TN from each septic system grouping. If data are insufficient to subdivide systems along distance or use gradients, a single line of this module can be used with average values entered.

DIRECT SEPTIC SYSTEM LOAD												
Septic System Grouping (by occupancy or location)	Days of Occupancy/Yr	Distance from Lake (ft)	Number of Dwellings	Number of People per Dwelling	Water per Person per Day (cu.m)	P Conc. (ppm)	N Conc. (ppm)	P Attenuation Factor	N Attenuation Factor	Water Load (cu.m/yr)	P Load (kg/yr)	N Load (kg/yr)
Group 1 Septic Systems	365	<100	25	2.5	0.25	8	20	0.2	0.9	5703	9.1	102.7
Group 2 Septic Systems	365	100 - 300	75	2.5	0.25	8	20	0.1	0.8	17109	13.7	273.8
Group 3 Septic Systems	90	<100	50	2.5	0.25	8	20	0.2	0.9	2813	4.5	50.6
Group 4 Septic Systems	90	100 - 300	100	2.5	0.25	8	20	0.1	0.8	5625	4.5	90.0
Total Septic System Loading										31250	31.8	517.0

Subwatershed Functions

The next set of calculations addresses inputs from each defined basin within the system. Basins can be left as labeled, 1, 2, 3, etc., or the blank line between Basin # and Area (Ha) can be used to enter an identifying name. In this case, basins have been identified as the East Direct drainage, the West Direct drainage, Upper Tributary #1, Lower Tributary #1, East Upper Tributary #2, West Upper Tributary #2, and Lower Tributary #2, matching the watershed and schematic maps in Figures 1 and 2.

Land Uses

The area of each defined basin associated with each defined land use category is entered, creating the table below. The model is set up to address up to 10 basins; in this case there are only seven defined basins, so the other three columns are left blank and do not figure in to the calculations. The total area per land use and per basin is summed along the right and bottom of the table. Three "Other" land use lines are provided, in the event that the standard land uses provided are inadequate to address all land uses identified in a watershed. It is also possible to split a standard land use category using one of the "Other" lines, where there is variation in export coefficients within a land use that can be documented and warrants separation.

Land use data is often readily available in GIS formats. It is always advisable to ground truth land use designation, especially in rapidly developing watersheds. The date on the land use maps used as sources should be as recent as possible.

BASIN AREAS											
	BASIN 1	BASIN 2	BASIN 3	BASIN 4	BASIN 5	BASIN 6	BASIN 7	BASIN 8	BASIN 9	BASIN 10	TOTAL
	E. Direct	W. Direct	Upper T1	Lower T1	W. Upper T2	E. Upper T2	Lower T2				
LAND USE	AREA (HA)	AREA (HA)	AREA (HA)	AREA (HA)	AREA (HA)	AREA (HA)	AREA (HA)	AREA (HA)	AREA (HA)	AREA (HA)	AREA (HA)
Urban 1 (Residential)	12.0	8.5	8.4	47.4	6.7	4.5	18.1				105.5
Urban 2 (Roads)	3.7	5.5	0.0	5.9	0.8	0.6	2.3				18.8
Urban 3 (Mixed Urban/Commercial)	3.6	5.8	0.0	5.9	0.8	0.6	2.3				19.0
Urban 4 (Industrial)	0.0	0.0	0.0	23.5	0.0	0.0	0.0				23.5
Urban 5 (Parks, Recreation Fields, Institutional)	0.0	3.2	0.0	0.0	0.0	0.0	0.0				3.2
Agric 1 (Cover Crop)	0.0	0.0	0.0	0.8	12.3	0.0	0.0				13.1
Agric 2 (Row Crop)	0.0	0.0	0.0	0.0	16.2	0.0	0.0				16.2
Agric 3 (Grazing)	0.0	0.0	0.0	0.0	4.0	0.0	0.0				4.0
Agric 4 (Feedlot)	0.0	0.0	0.0	0.0	0.5	0.0	0.0				0.5
Forest 1 (Upland)	7.7	17.5	50.3	90.3	9.2	32.0	33.6				240.6
Forest 2 (Wetland)	0.0	0.2	0.0	14.5	0.0	0.0	1.9				16.6
Open 1 (Wetland/Lake)	2.5	0.6	2.0	0.1	0.0	0.1	14.2				19.4
Open 2 (Meadow)	2.0	1.3	0.0	10.2	0.1	0.0	0.2				13.8
Open 3 (Excavation)	0.1	0.1	0.0	2.3	0.0	0.0	0.0				2.5
Other 1											0.0
Other 2											0.0
Other 3											0.0
TOTAL	31.6	42.6	60.7	200.9	50.6	37.7	72.4	0	0		496.5

Load Generation

At this point, the model will perform a number of calculations before any further input is needed. These are represented by a series of tables with no shaded cells, and include calculation of water, TP and TN loads from runoff and baseflow as shown below. These loads are intermediate products, not subject to attenuation or routing, and have little utility as individual values. They are the precursors of the actual loads delivered to the lake, which require some additional input information.

WATER LOAD GENERATION: RUNOFF											
	BASIN 1	BASIN 2	BASIN 3	BASIN 4	BASIN 5	BASIN 6	BASIN 7	BASIN 8	BASIN 9	BASIN 10	TOTAL
	E. Direct	W. Direct	Upper T1	Lower T1	W. Upper T2	E. Upper T2	Lower T2				
LAND USE	(CU.M/YR)	(CU.M/YR)	(CU.M/YR)	(CU.M/YR)	(CU.M/YR)	(CU.M/YR)	(CU.M/YR)	(CU.M/YR)	(CU.M/YR)	(CU.M/YR)	(CU.M/YR)
Urban 1 (Residential)	43560	30855	30492	172056	24182	16277	65563	0	0	0	382985
Urban 2 (Roads)	18005	26457	0	28676	4030	2713	10927	0	0	0	90808
Urban 3 (Mixed Urban/Commercial)	26136	42108	0	43014	6045	4069	16391	0	0	0	137763
Urban 4 (Industrial)	0	0	0	142175	0	0	0	0	0	0	142175
Urban 5 (Parks, Recreation Fields, Institutional)	0	3872	0	0	0	0	0	0	0	0	3872
Agric 1 (Cover Crop)	0	0	0	1387	22325	0	0	0	0	0	23712
Agric 2 (Row Crop)	0	0	0	0	58806	0	0	0	0	0	58806
Agric 3 (Grazing)	0	0	0	0	14520	0	0	0	0	0	14520
Agric 4 (Feedlot)	0	0	0	0	2723	0	0	0	0	0	2723
Forest 1 (Upland)	9325	21175	60863	109263	11126	38720	40600	0	0	0	291073
Forest 2 (Wetland)	0	150	0	8746	0	0	1153	0	0	0	10049
Open 1 (Wetland/Lake)	1494	334	1210	56	0	37	8591	0	0	0	11722
Open 2 (Meadow)	1210	768	0	6199	38	0	122	0	0	0	8336
Open 3 (Excavation)	593	454	0	10991	0	0	0	0	0	0	12038
Other 1	0	0	0	0	0	0	0	0	0	0	0
Other 2	0	0	0	0	0	0	0	0	0	0	0
Other 3	0	0	0	0	0	0	0	0	0	0	0
TOTAL (CU.M/YR)	100323	126173	92565	522564	143794	61816	143347	0	0	0	1190582
TOTAL (CFS)	0.11	0.14	0.10	0.59	0.16	0.07	0.16	0.00	0.00	0.00	1.33

WATER LOAD GENERATION: BASEFLOW											
	BASIN 1	BASIN 2	BASIN 3	BASIN 4	BASIN 5	BASIN 6	BASIN 7	BASIN 8	BASIN 9	BASIN 10	TOTAL
	E. Direct	W. Direct	Upper T1	Lower T1	W. Upper T2	E. Upper T2	Lower T2				
	(CU.M/YR)	(CU.M/YR)	(CU.M/YR)	(CU.M/YR)	(CU.M/YR)	(CU.M/YR)	(CU.M/YR)	(CU.M/YR)	(CU.M/YR)	(CU.M/YR)	(CU.M/YR)
Urban 1 (Residential)	21780	15428	15246	86028	12091	8139	32781	0	0	0	191492
Urban 2 (Roads)	4501	6614	0	7169	1008	678	2732	0	0	0	22702
Urban 3 (Mixed Urban/Commercial)	2178	3509	0	3585	504	339	1366	0	0	0	11480
Urban 4 (Industrial)	0	0	0	14218	0	0	0	0	0	0	14218
Urban 5 (Parks, Recreation Fields, Institutional)	0	1936	0	0	0	0	0	0	0	0	1936
Agric 1 (Cover Crop)	0	0	0	2775	44649	0	0	0	0	0	47424
Agric 2 (Row Crop)	0	0	0	0	58806	0	0	0	0	0	58806
Agric 3 (Grazing)	0	0	0	0	14520	0	0	0	0	0	14520
Agric 4 (Feedlot)	0	0	0	0	1815	0	0	0	0	0	1815
Forest 1 (Upland)	37301	84700	243452	437052	44504	154880	162402	0	0	0	1164291
Forest 2 (Wetland)	0	1203	0	69969	0	0	9220	0	0	0	80393
Open 1 (Wetland/Lake)	11953	2672	9680	450	0	294	68728	0	0	0	93777
Open 2 (Meadow)	7260	4605	0	37192	226	0	732	0	0	0	50016
Open 3 (Excavation)	297	227	0	5496	0	0	0	0	0	0	6019
Other 1	0	0	0	0	0	0	0	0	0	0	0
Other 2	0	0	0	0	0	0	0	0	0	0	0
Other 3	0	0	0	0	0	0	0	0	0	0	0
Point Source #1	0	0	0	45000	0	0	0	0	0	0	45000
Point Source #2	0	0	0	0	0	0	0	0	0	0	0
Point Source #3	0	0	0	0	0	0	0	0	0	0	0
TOTAL (CU.M/YR)	85270	120894	268378	708932	178122	164330	277961	0	0	0	1803888
TOTAL (CFS)	0.10	0.14	0.30	0.79	0.20	0.18	0.31	0.00	0.00	0.000	2.02

LOAD GENERATION: RUNOFF P											
	BASIN 1	BASIN 2	BASIN 3	BASIN 4	BASIN 5	BASIN 6	BASIN 7	BASIN 8	BASIN 9	BASIN 10	TOTAL
	E. Direct	W. Direct	Upper T1	Lower T1	W. Upper T2	E. Upper T2	Lower T2				
LAND USE	(KG/YR)	(KG/YR)	(KG/YR)	(KG/YR)	(KG/YR)	(KG/YR)	(KG/YR)	(KG/YR)	(KG/YR)	(KG/YR)	(KG/YR)
Urban 1 (Residential)	7.8	5.5	5.5	30.8	4.3	2.9	11.7	0.0	0.0	0.0	68.6
Urban 2 (Roads)	2.8	4.1	0.0	4.4	0.6	0.4	1.7	0.0	0.0	0.0	14.1
Urban 3 (Mixed Urban/Commercial)	2.9	4.6	0.0	4.7	0.7	0.4	1.8	0.0	0.0	0.0	15.2
Urban 4 (Industrial)	0.0	0.0	0.0	16.5	0.0	0.0	0.0	0.0	0.0	0.0	16.5
Urban 5 (Parks, Recreation Fields, Institutional)	0.0	2.6	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	2.6
Agric 1 (Cover Crop)	0.0	0.0	0.0	0.6	9.8	0.0	0.0	0.0	0.0	0.0	10.5
Agric 2 (Row Crop)	0.0	0.0	0.0	0.0	16.2	0.0	0.0	0.0	0.0	0.0	16.2
Agric 3 (Grazing)	0.0	0.0	0.0	0.0	1.6	0.0	0.0	0.0	0.0	0.0	1.6
Agric 4 (Feedlot)	0.0	0.0	0.0	0.0	112.0	0.0	0.0	0.0	0.0	0.0	112.0
Forest 1 (Upland)	1.5	3.5	10.1	18.1	1.8	6.4	6.7	0.0	0.0	0.0	48.1
Forest 2 (Wetland)	0.0	0.0	0.0	1.4	0.0	0.0	0.2	0.0	0.0	0.0	1.7
Open 1 (Wetland/Lake)	0.2	0.1	0.2	0.0	0.0	0.0	1.4	0.0	0.0	0.0	1.9
Open 2 (Meadow)	0.2	0.1	0.0	1.0	0.0	0.0	0.0	0.0	0.0	0.0	1.4
Open 3 (Excavation)	0.1	0.1	0.0	1.8	0.0	0.0	0.0	0.0	0.0	0.0	2.0
Other 1	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
Other 2	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
Other 3	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
TOTAL	15.6	20.6	15.7	79.4	147.1	10.2	23.6	0.0	0.0	0.0	312.2

LOAD GENERATION: RUNOFF N											
	BASIN 1	BASIN 2	BASIN 3	BASIN 4	BASIN 5	BASIN 6	BASIN 7	BASIN 8	BASIN 9	BASIN 10	TOTAL
	E. Direct	W. Direct	Upper T1	Lower T1	W. Upper T2	E. Upper T2	Lower T2				
LAND USE	(KG/YR)	(KG/YR)	(KG/YR)	(KG/YR)	(KG/YR)	(KG/YR)	(KG/YR)	(KG/YR)	(KG/YR)	(KG/YR)	(KG/YR)
Urban 1 (Residential)	66.0	46.8	46.2	260.7	36.6	24.7	99.3	0.0	0.0	0.0	580.3
Urban 2 (Roads)	20.5	30.1	0.0	32.6	4.6	3.1	12.4	0.0	0.0	0.0	103.2
Urban 3 (Mixed Urban/Commercial)	19.8	31.9	0.0	32.6	4.6	3.1	12.4	0.0	0.0	0.0	104.4
Urban 4 (Industrial)	0.0	0.0	0.0	129.3	0.0	0.0	0.0	0.0	0.0	0.0	129.3
Urban 5 (Parks, Recreation Fields, Institutional)	0.0	17.6	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	17.6
Agric 1 (Cover Crop)	0.0	0.0	0.0	4.6	74.8	0.0	0.0	0.0	0.0	0.0	79.4
Agric 2 (Row Crop)	0.0	0.0	0.0	0.0	145.8	0.0	0.0	0.0	0.0	0.0	145.8
Agric 3 (Grazing)	0.0	0.0	0.0	0.0	20.8	0.0	0.0	0.0	0.0	0.0	20.8
Agric 4 (Feedlot)	0.0	0.0	0.0	0.0	1461.6	0.0	0.0	0.0	0.0	0.0	1461.6
Forest 1 (Upland)	22.0	50.1	143.9	258.3	26.3	91.5	96.0	0.0	0.0	0.0	688.0
Forest 2 (Wetland)	0.0	0.7	0.0	41.3	0.0	0.0	5.4	0.0	0.0	0.0	47.5
Open 1 (Wetland/Lake)	6.1	1.4	4.9	0.2	0.0	0.1	34.9	0.0	0.0	0.0	47.7
Open 2 (Meadow)	4.9	3.1	0.0	25.2	0.2	0.0	0.5	0.0	0.0	0.0	33.9
Open 3 (Excavation)	0.6	0.5	0.0	11.8	0.0	0.0	0.0	0.0	0.0	0.0	12.9
Other 1	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
Other 2	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
Other 3	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
TOTAL	139.9	182.0	195.0	796.6	1775.2	122.5	261.0	0.0	0.0	0.0	3472.2

LOAD GENERATION: BASEFLOW P											
	BASIN 1	BASIN 2	BASIN 3	BASIN 4	BASIN 5	BASIN 6	BASIN 7	BASIN 8	BASIN 9	BASIN 10	TOTAL
	E. Direct	W. Direct	Upper T1	Lower T1	W. Upper T2	E. Upper T2	Lower T2				
LAND USE	(KG/YR)	(KG/YR)	(KG/YR)	(KG/YR)	(KG/YR)	(KG/YR)	(KG/YR)	(KG/YR)	(KG/YR)	(KG/YR)	(KG/YR)
Urban 1 (Residential)	0.12	0.09	0.08	0.47	0.07	0.04	0.18	0.00	0.00	0.00	1.06
Urban 2 (Roads)	0.04	0.05	0.00	0.06	0.01	0.01	0.02	0.00	0.00	0.00	0.19
Urban 3 (Mixed Urban/Commercial)	0.04	0.06	0.00	0.06	0.01	0.01	0.02	0.00	0.00	0.00	0.19
Urban 4 (Industrial)	0.00	0.00	0.00	0.24	0.00	0.00	0.00	0.00	0.00	0.00	0.24
Urban 5 (Parks, Recreation Fields, Institutional)	0.00	0.03	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.03
Agric 1 (Cover Crop)	0.00	0.00	0.00	0.01	0.12	0.00	0.00	0.00	0.00	0.00	0.13
Agric 2 (Row Crop)	0.00	0.00	0.00	0.00	0.16	0.00	0.00	0.00	0.00	0.00	0.16
Agric 3 (Grazing)	0.00	0.00	0.00	0.00	0.04	0.00	0.00	0.00	0.00	0.00	0.04
Agric 4 (Feedlot)	0.00	0.00	0.00	0.00	0.01	0.00	0.00	0.00	0.00	0.00	0.01
Forest 1 (Upland)	0.04	0.09	0.25	0.45	0.05	0.16	0.17	0.00	0.00	0.00	1.20
Forest 2 (Wetland)	0.00	0.00	0.00	0.07	0.00	0.00	0.01	0.00	0.00	0.00	0.08
Open 1 (Wetland/Lake)	0.01	0.00	0.01	0.00	0.00	0.00	0.07	0.00	0.00	0.00	0.10
Open 2 (Meadow)	0.01	0.01	0.00	0.05	0.00	0.00	0.00	0.00	0.00	0.00	0.07
Open 3 (Excavation)	0.00	0.00	0.00	0.01	0.00	0.00	0.00	0.00	0.00	0.00	0.01
Other 1	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Other 2	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Other 3	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Point Source #1	0.00	0.00	0.00	135.00	0.00	0.00	0.00	0.00	0.00	0.00	135.00
Point Source #2	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Point Source #3	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
TOTAL	0.25	0.33	0.35	136.42	0.46	0.22	0.48	0.00	0.00	0.00	138.50

LOAD GENERATION: BASEFLOW N											
	BASIN 1	BASIN 2	BASIN 3	BASIN 4	BASIN 5	BASIN 6	BASIN 7	BASIN 8	BASIN 9	BASIN 10	TOTAL
	E. Direct	W. Direct	Upper T1	Lower T1	W. Upper T2	E. Upper T2	Lower T2				
LAND USE	(KG/YR)	(KG/YR)	(KG/YR)	(KG/YR)	(KG/YR)	(KG/YR)	(KG/YR)	(KG/YR)	(KG/YR)	(KG/YR)	(KG/YR)
Urban 1 (Residential)	60.00	42.50	42.00	236.99	33.31	22.42	90.31	0.00	0.00	0.00	527.53
Urban 2 (Roads)	18.60	27.33	0.00	29.62	4.16	2.80	11.29	0.00	0.00	0.00	93.81
Urban 3 (Mixed Urban/Commercial)	18.00	29.00	0.00	29.62	4.16	2.80	11.29	0.00	0.00	0.00	94.88
Urban 4 (Industrial)	0.00	0.00	0.00	117.50	0.00	0.00	0.00	0.00	0.00	0.00	117.50
Urban 5 (Parks, Recreation Fields, Institutional)	0.00	16.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	16.00
Agric 1 (Cover Crop)	0.00	0.00	0.00	1.91	30.75	0.00	0.00	0.00	0.00	0.00	32.66
Agric 2 (Row Crop)	0.00	0.00	0.00	0.00	40.50	0.00	0.00	0.00	0.00	0.00	40.50
Agric 3 (Grazing)	0.00	0.00	0.00	0.00	20.00	0.00	0.00	0.00	0.00	0.00	20.00
Agric 4 (Feedlot)	0.00	0.00	0.00	0.00	12.50	0.00	0.00	0.00	0.00	0.00	12.50
Forest 1 (Upland)	7.71	17.50	50.30	90.30	9.20	32.00	33.55	0.00	0.00	0.00	240.56
Forest 2 (Wetland)	0.00	0.25	0.00	14.46	0.00	0.00	1.91	0.00	0.00	0.00	16.61
Open 1 (Wetland/Lake)	1.23	0.28	1.00	0.05	0.00	0.03	7.10	0.00	0.00	0.00	9.69
Open 2 (Meadow)	1.00	0.63	0.00	5.12	0.03	0.00	0.10	0.00	0.00	0.00	6.89
Open 3 (Excavation)	0.06	0.05	0.00	1.14	0.00	0.00	0.00	0.00	0.00	0.00	1.24
Other 1	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Other 2	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Other 3	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Point Source #1	0.00	0.00	0.00	540.00	0.00	0.00	0.00	0.00	0.00	0.00	540.00
Point Source #2	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Point Source #3	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
TOTAL	106.60	133.54	93.30	1066.71	154.61	60.06	155.54	0.00	0.00	0.00	1770.36

Load Routing Pattern

The model must be told how to route all inputs of water, TP and TN before they reach the lake. Since attenuation in an upstream basin can affect inputs in an upstream basin that passes through the downstream basin, the model must be directed as to where to apply attenuation factors and additive effects. In the table below, each basin listed on the lines labeled on the left that passes through another basin labeled by column is denoted with a 1 in the column of the basin through which it passes. Otherwise, a 0 appears in each shaded cell. All basins pass through themselves, so the first line has a 1 in each cell. Basins 1 and 2 go direct to the lake, and so all other cells on the corresponding lines have 0 entries. Basin 3 passes through Basin 4 (see Figure 2), and so the line for Basin 3 has a 1 in the column for Basin 4. Likewise, Basins 5 and 6 pass through Basin 7, so the corresponding lines have a 1 entered in the column for Basin 7.

ROUTING PATTERN										
	(Basin in left hand column passes through basin in column below if indicated by a 1)									
1=YES 0=NO XXX=BLANK	BASIN 1	BASIN 2	BASIN 3	BASIN 4	BASIN 5	BASIN 6	BASIN 7	BASIN 8	BASIN 9	BASIN 10
	E. Direct	W. Direct	Upper T1	Lower T1	W. Upper T2	E. Upper T2	Lower T2			
	(CU.M/YR)	(CU.M/YR)	(CU.M/YR)	(CU.M/YR)	(CU.M/YR)	(CU.M/YR)	(CU.M/YR)	(CU.M/YR)	(CU.M/YR)	(CU.M/YR)
INDIVIDUAL BASIN	1	1	1	1	1	1	1	1	1	1
BASIN 1 OUTPUT	XXX	0	0	0	0	0	0	0	0	0
BASIN 2 OUTPUT	0	XXX	0	0	0	0	0	0	0	0
BASIN 3 OUTPUT	0	0	XXX	1	0	0	0	0	0	0
BASIN 4 OUTPUT	0	0	0	XXX	0	0	0	0	0	0
BASIN 5 OUTPUT	0	0	0	0	XXX	0	1	0	0	0
BASIN 6 OUTPUT	0	0	0	0	0	XXX	1	0	0	0
BASIN 7 OUTPUT	0	0	0	0	0	0	XXX	0	0	0
BASIN 8 OUTPUT	0	0	0	0	0	0	0	XXX	0	0
BASIN 9 OUTPUT	0	0	0	0	0	0	0	0	XXX	0
BASIN 10 OUTPUT	0	0	0	0	0	0	0	0	0	XXX
CUMULATIVE DRAINAGE AREAS										
	(Total land area associated with routed water and nutrients)									
1=YES 0=NO XXX=BLANK	BASIN 1	BASIN 2	BASIN 3	BASIN 4	BASIN 5	BASIN 6	BASIN 7	BASIN 8	BASIN 9	BASIN 10
	E. Direct	W. Direct	Upper T1	Lower T1	W. Upper T2	E. Upper T2	Lower T2			
	(CU.M/YR)	(CU.M/YR)	(CU.M/YR)	(CU.M/YR)	(CU.M/YR)	(CU.M/YR)	(CU.M/YR)	(CU.M/YR)	(CU.M/YR)	(CU.M/YR)
INDIVIDUAL BASIN	31.6	42.6	60.7	200.9	50.6	37.7	72.4	0.0	0.0	0.0
BASIN 1 OUTPUT	XXX	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
BASIN 2 OUTPUT	0.0	XXX	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
BASIN 3 OUTPUT	0.0	0.0	XXX	60.7	0.0	0.0	0.0	0.0	0.0	0.0
BASIN 4 OUTPUT	0.0	0.0	0.0	XXX	0.0	0.0	0.0	0.0	0.0	0.0
BASIN 5 OUTPUT	0.0	0.0	0.0	0.0	XXX	0.0	50.6	0.0	0.0	0.0
BASIN 6 OUTPUT	0.0	0.0	0.0	0.0	0.0	XXX	37.7	0.0	0.0	0.0
BASIN 7 OUTPUT	0.0	0.0	0.0	0.0	0.0	0.0	XXX	0.0	0.0	0.0
BASIN 8 OUTPUT	0.0	0.0	0.0	0.0	0.0	0.0	0.0	XXX	0.0	0.0
BASIN 9 OUTPUT	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	XXX	0.0
BASIN 10 OUTPUT	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	XXX
TOTALS	31.6	42.6	60.7	261.6	50.6	37.7	160.7	0.0	0.0	0.0

The model then combines the appropriate watershed areas as shown above, generating larger sub-watersheds that are used later to calculate overall export coefficients, comparative water yields, and related checks for model accuracy.

Load Routing and Attenuation

With the loads calculated previously for each basin under wet and dry conditions and the routing of those loads specified, the model can then combine those loads and apply attenuation values chosen to reflect expected losses of water, TP or TN while the generated loads are on their way to the lake.

Water

Water is attenuated mostly by evapotranspiration losses. Some depression storage is expected, seepage into the ground is possible, and wetlands can remove considerable water on the way to the lake. In general, a 5% loss is to be expected in nearly all cases, and greater losses are plausible with lower gradient or wetland dominated landscapes. In the example system, only the lower portion of Tributary 2 is expected to have more than a 5% loss, with a 15% loss linked to the wetland associated with this drainage area and tributary (see Figure 1).

WATER ROUTING AND ATTENUATION										
	BASIN 1	BASIN 2	BASIN 3	BASIN 4	BASIN 5	BASIN 6	BASIN 7	BASIN 8	BASIN 9	BASIN 10
	E. Direct	W. Direct	Upper T1	Lower T1	W. Upper T2	E. Upper T2	Lower T2			
SOURCE	(CU.M/YR)	(CU.M/YR)	(CU.M/YR)	(CU.M/YR)	(CU.M/YR)	(CU.M/YR)	(CU.M/YR)	(CU.M/YR)	(CU.M/YR)	(CU.M/YR)
INDIVIDUAL BASIN	185594	247067	362153	1231497	321916	226145	421308	0	0	0
BASIN 1 OUTPUT	XXX	0	0	0	0	0	0	0	0	0
BASIN 2 OUTPUT	0	XXX	0	0	0	0	0	0	0	0
BASIN 3 OUTPUT	0	0	XXX	344045	0	0	0	0	0	0
BASIN 4 OUTPUT	0	0	0	XXX	0	0	0	0	0	0
BASIN 5 OUTPUT	0	0	0	0	XXX	0	305820	0	0	0
BASIN 6 OUTPUT	0	0	0	0	0	XXX	214838	0	0	0
BASIN 7 OUTPUT	0	0	0	0	0	0	XXX	0	0	0
BASIN 8 OUTPUT	0	0	0	0	0	0	0	XXX	0	0
BASIN 9 OUTPUT	0	0	0	0	0	0	0	0	XXX	0
BASIN 10 OUTPUT	0	0	0	0	0	0	0	0	0	XXX
CUMULATIVE TOTAL	185594	247067	362153	1575542	321916	226145	941966	0	0	0
BASIN ATTENUATION	0.95	0.95	0.95	0.95	0.95	0.95	0.85	1.00	1.00	1.00
OUTPUT VOLUME	176314	234714	344045	1496765	305820	214838	800671	0.0	0.0	0.0
Reality Check from Flow Data				1500000.0			800000.0			
Calculated Flow/Measured Flow	#DIV/0!	#DIV/0!	#DIV/0!	0.998	#DIV/0!	#DIV/0!	1.001	#DIV/0!	#DIV/0!	#DIV/0!
Reality Check from Areal Yield X Basin Area	174638.7	235450.8	335258.2	1444750.2	279386.8	208035.3	887509.1	0.0	0.0	0.0
Calculated Flow/Flow from Areal Yield	1.010	0.997	1.026	1.036	1.095	1.033	0.902	#DIV/0!	#DIV/0!	#DIV/0!

The resulting output volume for each basin is calculated in the table below, and two reality check opportunities are provided. First any actual data can be added for direct comparison; average flows are available for only two points, the inlets of the two tributaries, but these are useful. In many cases no flow data may be available. The model therefore generates an estimate of the expected average flow as a function of all contributing upstream watershed area and the water yield provided near the top of the Calculations sheet (covered previously). While this flow estimate is approximate, it should not vary from the modeled flow by more than about 20% unless there are unusual circumstances.

In the example, the ratio of the calculated flow from the complete model generation and routing to the estimated yield from the contributing drainage area ranges from 0.902 to 1.095, suggesting fairly close agreement. As some ratios are lower than 1 and others are higher than 1, no model-wide adjustment is likely to bring the values into closer agreement. Slight changes in attenuation for each basin could be applied, but are not necessary when the values agree this closely.

Phosphorus

The same approach applied to attenuation of water is applied to the phosphorus load, as shown in the table below. Here attenuation can range from 0 to 1.0, with the value shown representing the portion of the load that reaches the terminus of the basin. With natural or human enhanced removal processes, it is unusual for all of the load to pass through a basin, but it is also unusual for more than 60 to 70% of it to be removed. What value to pick depends on professional judgment regarding the nature of removal processes in each basin. Infiltration, filtration, detention and uptake will lower the attenuation value entered below, and knowledge of the literature on Best Management Practices is needed to make reliable judgments on attenuation values.

LOAD ROUTING AND ATTENUATION: PHOSPHORUS										
	BASIN 1	BASIN 2	BASIN 3	BASIN 4	BASIN 5	BASIN 6	BASIN 7	BASIN 8	BASIN 9	BASIN 10
	E. Direct	W. Direct	Upper T1	Lower T1	W. Upper T2	E. Upper T2	Lower T2			
	(KG/YR)	(KG/YR)	(KG/YR)	(KG/YR)	(KG/YR)	(KG/YR)	(KG/YR)	(KG/YR)	(KG/YR)	(KG/YR)
BASIN 1 INDIVIDUAL	15.8	20.9	16.3	215.8	147.6	10.4	24.1	0.0	0.0	0.0
BASIN 1 OUTPUT	XXX	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
BASIN 2 OUTPUT	0.0	XXX	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
BASIN 3 OUTPUT	0.0	0.0	XXX	12.2	0.0	0.0	0.0	0.0	0.0	0.0
BASIN 4 OUTPUT	0.0	0.0	0.0	XXX	0.0	0.0	0.0	0.0	0.0	0.0
BASIN 5 OUTPUT	0.0	0.0	0.0	0.0	XXX	0.0	118.1	0.0	0.0	0.0
BASIN 6 OUTPUT	0.0	0.0	0.0	0.0	0.0	XXX	7.8	0.0	0.0	0.0
BASIN 7 OUTPUT	0.0	0.0	0.0	0.0	0.0	0.0	XXX	0.0	0.0	0.0
BASIN 8 OUTPUT	0.0	0.0	0.0	0.0	0.0	0.0	0.0	XXX	0.0	0.0
BASIN 9 OUTPUT	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	XXX	0.0
BASIN 10 OUTPUT	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	XXX
CUMULATIVE TOTAL	15.8	20.9	16.3	228.0	147.6	10.4	149.9	0.0	0.0	0.0
BASIN ATTENUATION	0.90	0.90	0.75	0.85	0.80	0.75	0.70	1.00	1.00	1.00
OUTPUT LOAD	14.2	18.8	12.2	193.8	118.1	7.8	104.9	0.0	0.0	0.0

In the example system, the direct drainage basins were assigned values of 0.90, representing a small amount of removal mainly by infiltration processes. Upper Tributary #1 has a small pond and was accorded a value of 0.75 (25% removal); a larger pond might have suggested a value closer to 0.5. Lower Tributary #1 has an assigned value of 0.85 based on channel processes that favor uptake and adsorption. West and East Upper Tributary #2 have value based on drainage basin features as evaluated in the field, while the wetland associated with Lower Tributary #2 garners it the lowest load pass-through at 0.7. A more extensive wetland with greater sheet flow might have earned a value near 0.5. Resulting output loads are then calculated.

Nitrogen

The same process used with water and TP attenuation applies to TN, but attenuation of TN is rarely identical to that for TP. Nitrogen moves more readily through soil, and while transformations occur in the stream, losses due to denitrification require slower flows and low oxygen levels not commonly encountered in steeper, rockier channels. However, losses from uptake and possibly denitrification are possible in wetland areas, such as that associated with Lower Tributary #2. Accordingly, attenuation values are assigned as shown in the table below, with generally lower losses for TN than for TP. As with TP attenuation, choosing appropriate values does require some professional judgment.

LOAD ROUTING AND ATTENUATION: NITROGEN										
	BASIN 1	BASIN 2	BASIN 3	BASIN 4	BASIN 5	BASIN 6	BASIN 7	BASIN 8	BASIN 9	BASIN 10
	E. Direct	W. Direct	Upper T1	Lower T1	W. Upper T2	E. Upper T2	Lower T2			
	(KG/YR)	(KG/YR)	(KG/YR)	(KG/YR)	(KG/YR)	(KG/YR)	(KG/YR)	(KG/YR)	(KG/YR)	(KG/YR)
BASIN 1 INDIVIDUAL	246.5	315.6	290.1	1863.3	1929.8	182.6	416.6	0.0	0.0	0.0
BASIN 1 OUTPUT	XXX	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
BASIN 2 OUTPUT	0.0	XXX	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
BASIN 3 OUTPUT	0.0	0.0	XXX	232.1	0.0	0.0	0.0	0.0	0.0	0.0
BASIN 4 OUTPUT	0.0	0.0	0.0	XXX	0.0	0.0	0.0	0.0	0.0	0.0
BASIN 5 OUTPUT	0.0	0.0	0.0	0.0	XXX	0.0	1543.8	0.0	0.0	0.0
BASIN 6 OUTPUT	0.0	0.0	0.0	0.0	0.0	XXX	146.0	0.0	0.0	0.0
BASIN 7 OUTPUT	0.0	0.0	0.0	0.0	0.0	0.0	XXX	0.0	0.0	0.0
BASIN 8 OUTPUT	0.0	0.0	0.0	0.0	0.0	0.0	0.0	XXX	0.0	0.0
BASIN 9 OUTPUT	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	XXX	0.0
BASIN 10 OUTPUT	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	XXX
CUMULATIVE TOTAL	246.5	315.6	290.1	2095.4	1929.8	182.6	2106.4	0.0	0.0	0.0
BASIN ATTENUATION	0.95	0.95	0.80	0.90	0.80	0.80	0.75	1.00	1.00	1.00
OUTPUT LOAD	234.2	299.8	232.1	1885.8	1543.8	146.0	1579.8	0.0	0.0	0.0

Load and Concentration Summary

Water

Water loads were handled to the extent necessary in the previous loading calculations, and are used in this section only to allow calculation of expected TP and TN concentrations, facilitating reality checks with actual data.

Phosphorus

Using the calculated load of TP for each basin and the corresponding water volume, an average expected concentration can be derived, as shown in the table below. Where sampling provides actual data, values can be compared to determine how well the model represents known reality. Sufficient sampling is needed to make the reality check values reliable; it is not appropriate to assume that either the data or the model is necessarily accurate when the values disagree. However, with enough data to adequately characterize the concentrations observed in the stream, the model can be adjusted to produce a better match. Estimated and actual concentrations are used to generate a ratio for easy comparison.

The TP loads previously calculated represent the load passing through each basin, but do not represent what reaches the lake, as not all basins are terminal input sources. The model must be told which basins actually drain directly to the lake, and for which the exiting load is part of the total load to the lake.

LOAD AND CONCENTRATION SUMMARY: PHOSPHORUS											
	BASIN 1	BASIN 2	BASIN 3	BASIN 4	BASIN 5	BASIN 6	BASIN 7	BASIN 8	BASIN 9	BASIN 10	
	E. Direct	W. Direct	Upper T1	Lower T1	W. Upper T2	E. Upper T2	Lower T2				
OUTPUT (CU.M/YR)	176314	234714	344045	1496765	305820	214838	800671	0	0	0	
OUTPUT (KG/YR)	14.2	18.8	12.2	193.8	118.1	7.8	104.9	0.0	0.0	0.0	
OUTPUT (MG/L)	0.081	0.080	0.035	0.129	0.386	0.036	0.131	#DIV/0!	#DIV/0!	#DIV/0!	
REALITY CHECK CONC. (FROM DATA)	0.078	0.076	0.040	0.150	0.325	0.035	0.125				
CALCULATED CONC./MEASURED CONC.	1.035	1.056	0.886	0.863	1.188	1.038	1.049	#DIV/0!	#DIV/0!	#DIV/0!	
BASIN EXPORT COEFFICIENT	0.45	0.44	0.20	0.74	2.33	0.21	0.65	#DIV/0!	#DIV/0!	#DIV/0!	
TERMINAL DISCHARGE?	1	1	0	1	0	0	1	1	1	1	
(1=YES 2=NO)											
LOAD TO RESOURCE											TOTAL
WATER (CU.M/YR)	176314	234714	0	1496765	0	0	800671	0	0	0	2708464
PHOSPHORUS (KG/YR)	14.2	18.8	0.0	193.8	0.0	0.0	104.9	0.0	0.0	0.0	331.8
PHOSPHORUS (MG/L)	0.081	0.080	0.000	0.129	0.000	0.000	0.131	#DIV/0!	#DIV/0!	#DIV/0!	0.123

For the example system, the ratio of the calculated concentration to average actual values derived from substantial sampling (typically on the order of 10 or more samples representing the range of dry to wet conditions) ranges from 0.886 to 1.188, or from 11% low to 19% high, within a generally acceptable range of $\pm$20%. This is not a strict threshold, especially with lower TP concentrations where detection limits and intervals of expression for methods can produce higher percent deviation with very small absolute differences. Yet in general, <20% difference between observed and expected watershed basin output values is considered reasonable for a model at this level of sophistication.

That some values are higher than expected and others lower suggests that now model-wide adjustment will improve agreement (such as an export coefficient change), but attenuation values for individual basins could be adjusted if there is justification.

For the example system, Basins 1, 2, 4 and 7 contribute directly to the lake, and are so denoted by a 1 in their respective columns on the line for terminal discharge. These loads will be summed to derive a watershed load of TP to the lake.

Nitrogen

The model process followed for TN is identical to that applied to TP loads from basins. For TN in the example system, comparison of expected vs. observed values yields a range of ratios from 0.929 to 1.188, representing 7% low to 19% high. Only one out of seven values is lower than 1, so perhaps some adjustment of the TN export coefficients is in order, but most individual basin values are within 8% of each other, so without clear justification, the judgment exercised in the original choices for export coefficients and attenuation is not generally overridden. The same basins denoted as terminal discharges for TP are so noted for TN, allowing calculation of the total watershed load of TN to the lake.

LOAD AND CONCENTRATION SUMMARY: NITROGEN											
	BASIN 1	BASIN 2	BASIN 3	BASIN 4	BASIN 5	BASIN 6	BASIN 7	BASIN 8	BASIN 9	BASIN 10	
	E. Direct	W. Direct	Upper T1	Lower T1	W. Upper T2	E. Upper T2	Lower T2				
OUTPUT (CU.M/YR)	176314	234714	344045	1496765	305820	214838	800671	0	0	0	
OUTPUT (KG/YR)	234.2	299.8	232.1	1885.8	1543.8	146.0	1579.8	0.0	0.0	0.0	
OUTPUT MG/L	1.328	1.277	0.675	1.260	5.048	0.680	1.973	#DIV/0!	#DIV/0!	#DIV/0!	
REALITY CHECK CONC. (FROM DATA)	1.430	1.240	0.650	1.180	4.250	0.650	1.830				
CALCULATED CONC./MEASURED CONC.	0.929	1.030	1.038	1.068	1.188	1.046	1.078	#DIV/0!	#DIV/0!	#DIV/0!	
BASIN EXPORT COEFFICIENT	7.41	7.03	3.82	7.21	30.52	3.88	9.83	#DIV/0!	#DIV/0!	#DIV/0!	
TERMINAL DISCHARGE?	1	1	0	1	0	0	1	1	1	1	
(1=YES 2=NO)											
LOAD TO RESOURCE											TOTAL
WATER (CU.M/YR)	176314	234714	0	1496765	0	0	800671	0	0	0	2708464
NITROGEN (KG/YR)	234.2	299.8	0.0	1885.8	0.0	0.0	1579.8	0.0	0.0	0.0	3999.7
NITROGEN (MG/L)	1.328	1.277	0.000	1.260	0.000	0.000	1.973	#DIV/0!	#DIV/0!	#DIV/0!	1.477

Grand Totals

The final portion of the Calculation sheet is a summary of all loads to the lake and a grand total load with associated concentrations for TP and TN, as shown below. The breakdown of sources is provided for later consideration in both overall target setting and in consideration of BMPs. For the example system, the watershed load is clearly dominant, and would need to be addressed if substantial reductions in loading were considered necessary. The loads of water, TP and TN are then transferred automatically to the Prediction sheet to facilitate estimation of in-lake concentrations of TP, TN and Chl and a value for SDT. The derived overall input concentration for TP is also transferred; the in-lake predictive models for TN do not require that overall input concentration, but the comparison of TP and TN input levels can be insightful when considering what types of algae are likely to dominate the lake phytoplankton.

LOAD SUMMARY			
DIRECT LOADS TO LAKE	P (KG/YR)	N (KG/YR)	WATER (CU.M/YR)
ATMOSPHERIC	8.0	260.0	484000
INTERNAL	40.0	100.0	0
WATERFOWL	10.0	47.5	0
SEPTIC SYSTEM	31.8	517.0	31250
WATERSHED LOAD	331.7	3998.4	2707372
TOTAL LOAD TO LAKE	421.5	4922.9	3222622
(Watershed + direct loads)			
TOTAL INPUT CONC. (MG/L)	0.131	1.528	

Water Quality Predictions

Prediction of TP, TN, Chl and SDT is based on empirical equations from the literature, nearly all pertaining to North American systems. Only a few additional pieces of information are needed to run the model; most of the needed input data are automatically transferred from the Calculations sheet. As shown below, only the concentration of TP leaving the lake and the lake volume must be entered on the Prediction sheet. If the outflow TP level is not known, the in-lake surface concentration is normally used. If the volume is not specifically known, an average depth can be multiplied by the lake area to derive an input volume, which will then recalculate the average depth one cell below. The nature of the TN prediction models does not require any TN concentration input.

IN-LAKE MODELS FOR PREDICTING CONCENTRATIONS: Current Conditions					
THE TERMS					
	PHOSPHORUS				
SYMBOL	**PARAMETER**	**UNITS**	**DERIVATION**	**VALUE**	
TP	Lake Total Phosphorus Conc.	ppb	From in-lake models	To Be Predicted	
KG	Phosphorus Load to Lake	kg/yr	From export model	422	
L	Phosphorus Load to Lake	g P/m2/yr	KG*1000/A	1.054	
TPin	Influent (Inflow) Total Phosphorus	ppb	From export model	131	
TPout	Effluent (Outlet) Total Phosphorus	ppb	From data, if available	75	Enter Value (TP out)
I	Inflow	m3/yr	From export model	3222622	
A	Lake Area	m2	From data	400000	
V	Lake Volume	m3	From data	1625300	Enter Value (V)
Z	Mean Depth	m	Volume/area	4.063	
F	Flushing Rate	flushings/yr	Inflow/volume	1.983	
S	Suspended Fraction	no units	Effluent TP/Influent TP	0.573	
Qs	Areal Water Load	m/yr	Z(F)	8.057	
Vs	Settling Velocity	m	Z(S)	2.330	
Rp	Retention Coefficient (settling rate)	no units	((Vs+13.2)/2)/(((Vs+13.2)/2)+Qs)	0.491	
Rlm	Retention Coefficient (flushing rate)	no units	1/(1+F^0.5)	0.415	
	NITROGEN				
SYMBOL	**PARAMETER**	**UNITS**	**DERIVATION**	**VALUE**	
TN	Lake Total Nitrogen Conc.	ppb	From in-lake models	To Be Predicted	
KG	Nitrogen Load to Lake	kg/yr	From export model	4923	
L1	Nitrogen Load to Lake	g N/m2/yr	KG*1000/A	12.31	
L2	Nitrogen Load to Lake	mg N/m2/yr	KG*1000000/A	12307	
C1	Coefficient of Attenuation, from F	fraction/yr	2.7183^(0.5541(ln(F))-0.367)	1.01	
C2	Coefficient of Attenuation, from L	fraction/yr	2.7183^(0.71(ln(L2))-6.426)	1.30	
C3	Coefficient of Attenuation, from L/Z	fraction/yr	2.7183^(0.594(ln(L2/Z))-4.144)	1.85	

Phosphorus Concentration

TP concentration is predicted from the equations shown below. The mass balance calculation is simply the TP load divided by the water load, and assumes no losses to settling within the lake. Virtually all lakes have settling losses, but the other equations derive that settling coefficient in different ways, providing a range of possible TP concentration values. Where there is knowledge of the components of the settling calculations, a model might be selected as most representative or models might be eliminated as inapplicable, but otherwise the average of the five empirical models (excluding the mass balance calculation) is accepted as the predicted TP value for the lake.

THE MODELS				
	PHOSPHORUS	**PRED.**	**PERMIS.**	**CRITICAL**
		CONC.	**CONC.**	**CONC.**
NAME	**FORMULA**	**(ppb)**	**(ppb)**	**(ppb)**
Mass Balance	TP=L/(Z(F))*1000	131		
(Maximum Conc.)				
Kirchner-Dillon 1975	TP=L(1-Rp)/(Z(F))*1000	67	18	36
(K-D)				
Vollenweider 1975	TP=L/(Z(S+F))*1000	101	27	55
(V)				
Larsen-Mercier 1976	TP=L(1-Rlm)/(Z(F))*1000	76	21	41
(L-M)				
Jones-Bachmann 1976	TP=0.84(L)/(Z(0.65+F))*1000	83	22	45
(J-B)				
Reckhow General (1977)	TP=L/(11.6+1.2(Z(F)))*1000	50	13	27
(Rg)				
Average of Model Values		75	20	41
(without mass balance)				
Measured Value		75		
(mean, median, other)				
From Vollenweider 1968				
Permissible Load (g/m2/yr)	Lp=10^(0.501503(log(Z(F)))-1.0018)	0.28		
Critical Load (g/m2/yr)	Lc=2(Cp)	0.57		

The predicted in-lake TP concentration can be compared to actual data (an average value is entered in the shaded cell as a reality check) and to calculation of the permissible and critical concentrations as derived from Vollenweider's 1968 work. For the example lake, the predicted TP level of 75 ug/L is an exact match for the measured value of 75 ug/L, but both are well above the critical concentration.

The permissible concentration is the value above which algal blooms are to be expected on a potentially unacceptable frequency, while the critical concentration is the level above which unacceptable algal growths are to be expected, barring extreme flushing, toxic events, or light limitation from suspended sediment.

Use of the range of values derived from these empirical equations provides some sense for the uncertainty in the analysis. Changing input loads, lake volume, or other key variables allows for sensitivity analysis.

Nitrogen Concentration

Prediction of TN is based on three separate empirical equations from the same work, each calculating settling losses differently. A mass balance equation is applied as well, as with the prediction of TP. An actual mean value is normally entered in the shaded cell as a reality check. For the example system, the actual mean TN value is within the range of predicted values, but is about 5.6% lower than the average of predicted values. One might consider adjusting export coefficients or attenuation rates in the Calculations sheet, to bring these values closer together, but the discrepancy is relatively minor.

	NITROGEN	
Mass Balance	TN=L/(Z(F))*1000	1528
(Maximum Conc.)		
Bachmann 1980	TN=L/(Z(C1+F))*1000	1011
Bachmann 1980	TN=L/(Z(C2+F))*1000	923
Bachmann 1980	TN=L/(Z(C3+F))*1000	789
Average of Model Values		908
(without mass balance)		
Measured Value		860
(mean, median, other)		

Chlorophyll Concentration, Water Clarity and Bloom Probability

Once an average in-lake TP concentration has been established, the Predictions sheet derives corresponding Chl and SDT values, as shown below. Five different equations are used to derive a predicted Chl value, and an average is derived. Peak Chl is estimated with three equations, with an average generated. Average and maximum expected SDT are estimated as well. Bloom frequency is based on the relationship of mean Chl to other threshold levels from other studies, and the portion of time that Chl is expected to exceed 10, 15, 20, 30 and 40 ug/L is derived.

A set of shaded cells are provided for entry of known measured values for comparison. For the example lake, the average and peak Chl levels predicted from the model are slightly higher than actual measured values, while the average and maximum SDT from the model are slightly lower than observed values, consistent with the Chl results. Agreement is generally high, however, with differences between 10 and 20%. There were not enough data to construct a dependable actual distribution of Chl over the range of thresholds provided for the example lake.

There are other factors besides nutrients that can strongly affect the standing crop of algae and resulting Chl levels, including low light from suspended sediment, grazing by zooplankton, presence of heterotrophic algae, and flushing effects from high flows. Consequently, close agreement between predicted and actual Chl will be harder to achieve than for predicted and actual TP. Knowledge of those other potentially important influences can help determine if model calibration is off, or if closer agreement is not rationally achievable.

PREDICTED CHL AND WATER CLARITY			
MODEL	**Value**	**Mean**	**Measured**
Mean Chlorophyll (ug/L)			
Carlson 1977	45.9		
Dillon and Rigler 1974	38.4		
Jones and Bachmann 1976	44.7		
Oglesby and Schaffner 1978	40.4		
Modified Vollenweider 1982	35.5	41.0	37.5
Peak Chlorophyll (ug/L)			
Modified Vollenweider (TP) 1982	119.7		
Vollenweider (CHL) 1982	133.1		
Modified Jones, Rast and Lee 1979	139.5	130.8	118.1
Secchi Transparency (M)			
Oglesby and Schaffner 1978 **(Avg)**	0.8		1.0
Modified Vollenweider 1982 **(Max)**	2.9		3.1
Bloom Probability			
Probability of Chl >10 ug/L **(% of time)**	99.5%		
Probability of Chl >15 ug/L **(% of time)**	96.1%		
Probability of Chl >20 ug/L **(% of time)**	88.2%		
Probability of Chl >30 ug/L **(% of time)**	64.6%		
Probability of Chl >40 ug/L **(% of time)**	42.0%		

Evaluating Initial Results

LLRM is not meant to be a "black box" model. One can look at any cell and discern which steps are most important to final results in any give case. Several quality control processes are recommended in each application.

Checking Values

Many numerical entries must be made to run LLRM. Be sure to double check the values entered. Simple entry errors can cause major discrepancies between predictions and reality. Where an export coefficient is large, most notably with Agric4, feedlot area, it is essential that the land use actually associated with that activity be accurately assessed and entered.

Following Loads

For any individually identified load that represents a substantial portion of the total load (certainly >25%, perhaps as small a portion as 10%), it is appropriate to follow that load from generation through delivery to the lake, observing the losses and transformations along the way. Sometimes the path will be very short, and sometimes there may be multiple points where attenuation is applied. Consider dry vs. wet weather inputs and determine if the ratio is reasonable in light of actual data or field observations. Are calculated concentrations at points of measurement consistent with the actual measurements? Are watershed processes being adequately represented? One limitation of the model involves application of attenuation for all loads within a defined basin; loads may enter at the distal or proximal ends of the basin, and attenuation may not apply equally to all sources. Where loading and attenuation are not being properly represented, consider subdividing the basin to work with drainages of the most meaningful sizes.

Reality Checks

LLRM can be run with minimal actual water quality data, but to gain confidence in the predictions it is necessary to compare results with sufficient amounts of actual data for key points in the modeled system. Ideally, water quality will be tested at all identified nodes, including the output points for all basins, any point source discharges, any direct discharge pipes to the lake, and in the lake itself. Wet and dry weather sampling should be conducted. Flow values are highly desirable, but without a longer term record, considerable uncertainty will remain; variability in flow is often extreme, necessitating large data sets to get representative statistical representation. Where there are multiple measurement points, compare not just how close predicted values are to observed values, but the pattern. Are observed values consistently over- or underpredicted? A rough threshold of ±20% is recommended as a starting point, with a mix of values in the + or – categories.

Sensitivity Testing

The sensitivity of LLRM can be evaluated by altering individual features and observing the effect on results. For any variable for which the value is rather uncertain, enter the maximum value conceivable, and record model results. Then repeat the process with the minimum plausible value, and compare to ascertain how much variation can be induced by error in that variable. Which variables seem to have the greatest impact on results? Those variables should receive the most attention in reality checking, ground truthing, and future monitoring, and would also be the most likely candidates for adjustment in model calibration, unless the initially entered values are very certain.

For example, the runoff coefficients for TP from the various land uses were set below the median literature values, based on knowledge of loads for some drainage areas from actual data for flow and concentration. However, it is possible that the actual load generated from various land uses is higher than initially assumed, and it is the attenuation that should be adjusted to achieve a predicted in-lake concentration that matches actual data. If the median TP export for runoff is entered into the Calculations sheet, substituting the unshaded values for the shaded values in the table below, the resulting in-lake TP prediction is 89 ug/L, much higher than the 75 ug/L from real data.

	Original P Export Coefficient	New P Export Coefficient
LAND USE	(kg/ha/yr)	(kg/ha/yr)
Urban 1 (Residential)	0.65	1.10
Urban 2 (Roads)	0.75	1.10
Urban 3 (Mixed Urban/Commercial)	0.80	1.10
Urban 4 (Industrial)	0.70	1.10
Urban 5 (Parks, Recreation Fields, Institutional)	0.80	1.10
Agric 1 (Cover Crop)	0.80	0.80
Agric 2 (Row Crop)	1.00	2.20
Agric 3 (Grazing)	0.40	0.80
Agric 4 (Feedlot)	224.00	224.00
Forest 1 (Upland)	0.20	0.20
Forest 2 (Wetland)	0.10	0.20
Open 1 (Wetland/Lake)	0.10	0.20
Open 2 (Meadow)	0.10	0.20
Open 3 (Excavation)	0.80	0.80
Other 1	0.20	0.20
Other 2	1.10	1.10
Other 3	2.20	2.20

To get a closer match for the known in-lake value, attenuation would have to be adjusted (reduction in the portion of the generated load that reaches the lake) by about 0.1 units (10%), as shown below. This would result in a predicted in-lake TP concentration of 77 ug/L, not far above the measured 75 ug/L. It is apparent that choice of export coefficients is fairly important, but that error in those choices can be compensated by adjustments in attenuation that are not too extreme to be believed. Yet those choices will affect the results of management scenario testing, and should be made carefully. The intent is to properly represent watershed processes, both loading and attenuation, not just the product of the two.

	BASIN 1 E. Direct	BASIN 2 W. Direct	BASIN 3 Upper T1	BASIN 4 Lower T1	BASIN 5 W. Upper T2	BASIN 6 E. Upper T2	BASIN 7 Lower T2
ORIGINAL BASIN ATTENUATION	0.90	0.90	0.75	0.85	0.80	0.75	0.70
NEW BASIN ATTENUATION	0.80	0.80	0.65	0.75	0.70	0.65	0.60

Aside from changes in all export coefficients, one might consider the impact of changing a single value. As that value applies to all areas given for the corresponding land use, its impact will be proportional to the magnitude of that area relative to other land uses. A change in forested land use exports may be very influential if most of the watershed is forested. A much larger change would be necessary to cause similar impact for a land use that represents a small portion of the watershed.

Model Calibration

Actual adjustment of LLRM to get predicted results in reasonable agreement with actual data can be achieved by altering any of the input data. The key to proper calibration is to change values that have some uncertainty, and to change them in a way that makes sense in light of knowledge of the target watershed and lake. One would not change entered land use areas believed to be correct just to get the predictions to match actual data. Rather, one would adjust the export coefficients for land uses within the plausible range (see Reference Variables sheet), and in accordance with values that could be derived for selected drainage areas (within the target system or nearby) from actual data. Or one could adjust attenuation, determining that a detention area, wetland, or other landscape feature had somewhat greater or lesser attenuation capacity that initially estimated. Justification for all changes should be provided; model adjustment should be transparent and amenable to scrutiny.

For the example system, it may be appropriate to adjust either TN export coefficients or attenuation to get the average of the three empirical equation results for TN (see Predictions sheet) to match the observed average more closely. In the example, a predicted TN concentration of 908 ug/L was derived, while the average of quite a few in-lake samples was 860 ug/L. With a difference of <6%, this is not a major issue, but since all but one of the individual basin predictions for TN concentration were also overpredictions, adjustment can be justified.

If all the TN export coefficients in the Calculations sheet are reduced by 10%, an entirely plausible situation, the new TN prediction for the lake becomes 861 ug/L, a very close match for the observed 860 ug/L. Export coefficients were not changed selectively by land use; all were simply adjusted down a small amount, well within the range of possible variation in this system. Alternatively, if the TN attenuation coefficient for each basin is reduced in the Calculations sheet by 0.05 (representing 5% more loss of TN on the way to the lake), the new predicted in-lake TN concentration becomes 842 ug/L, not far below the observed 860 ug/L. Attenuation in each basin was adjusted the same way, showing no bias. Either of these adjustments (export coefficients or attenuation values) would be reasonable within the constraints of the model and knowledge of the system.

The only way to change the export coefficient for land use in a single basin is to split off that land use into one of the “Other” categories and have it appear in only the basins where a different export coefficient is justified. This is hardly ever done, and justification should involve supporting data. Likewise, if one basin had a particularly large load and a feature that might affect that load, one might justify changing the attenuation for just that one basin, but justification should be strong to interject this level of individual basin bias.

Model Verification

Proper verification of models involves calibration with one set of data, followed by running the model with different input data leading to different results, with data to verify that those results are appropriate. Where data exist for conditions in a different time period that led to different in-lake conditions, such verification is possible with LLRM, but such opportunities tend to be rare. If the lake level was raised by dam modification, and in-lake data are available for before and after the pool rise, a simple change in the lake volume (entered in the Predictions sheet) can simulate this and allow verification. If in-lake data exist from a time before there was much development in the watershed, this could also allow verification by changing the land use and comparing results to historic TP and TN levels in the lake. However, small changes in watershed land use are not likely to yield sufficiently large changes in in-lake conditions to be detectable with this model. Additionally, as LLRM is a steady state model, testing conditions in one year with wetter conditions against another year with drier conditions, with no change in land use, is really not a valid approach.

Model verification is a function of data availability for at least two periods of multiple years in duration with different conditions that can be represented by the model. Where available, use of these data to verify model performance is strongly advised. If predictions under the second set of conditions do not reasonably match the available data, adjustments in export coefficients, attenuation, or other features of the model may be needed. Understanding why conditions are not being properly represented is an important aspect of modeling, even when it is not possible to bring the model into complete agreement with available data.

Scenario Testing

LLRM is meant to be useful for evaluating possible consequences of land use conversions, changes in discharges, various management options, and related alterations of the watershed or lake. The primary purpose of this model is to allow the user to project possible consequences of actions and aid management and policy decision processes. Testing a conceived scenario involves changing appropriate input data and observing the results. Common scenario testing includes determining the likely "original" or "pre-settlement" condition of the lake, termed "Background Condition" here, and forecasting the benefit from possible Best Management Practices (BMPs).

Background Conditions

Simulation of Background Conditions is most often accomplished by changing all developed land uses to forest, wetland or water, whichever is most appropriate based on old land use maps or other sources of knowledge about watershed features prior to development of roads, towns, industry, and related human features. Default export coefficients for undeveloped land use types are virtually the same, so the distinction is not critical if records are sparse.

For the example system, all developed land uses were converted to forested upland, although it is entirely possible that some wetlands were filled for development before regulations to protect wetlands were promulgated, and some may even have been filled more recently. The resulting land use table, shown below, replaces that in the original model representing current conditions. The watershed area is the same, although in some cases diversions may change this aspect as well. Many lakes have been created by human action, such that setting all land uses to an undeveloped state would correspond to not having a lake present, but the assumption applied here is that the user is interested in the condition of the lake as it currently exists, but in the absence of human influences.

BASIN AREAS

LAND USE	BASIN 1 E. Direct AREA (HA)	BASIN 2 W. Direct AREA (HA)	BASIN 3 Upper T1 AREA (HA)	BASIN 4 Lower T1 AREA (HA)	BASIN 5 W. Upper T2 AREA (HA)	BASIN 6 E. Upper T2 AREA (HA)	BASIN 7 Lower T2 AREA (HA)	BASIN 8 AREA (HA)	BASIN 9 AREA (HA)	BASIN 10 AREA (HA)	TOTAL AREA (HA)
Urban 1 (Residential)											0.0
Urban 2 (Roads)											0.0
Urban 3 (Mixed Urban/Commercial)											0.0
Urban 4 (Industrial)											0.0
Urban 5 (Parks, Recreation Fields, Institutional)											0.0
Agric 1 (Cover Crop)											0.0
Agric 2 (Row Crop)											0.0
Agric 3 (Grazing)											0.0
Agric 4 (Feedlot)											0.0
Forest 1 (Upland)	27.1	40.6	60.7	176.0	50.5	37.6	56.2				448.7
Forest 2 (Wetland)	0.0	0.2	0.0	14.5	0.0	0.0	1.9				16.6
Open 1 (Wetland/Lake)	2.5	0.6	0.0	0.1	0.0	0.1	14.2				17.5
Open 2 (Meadow)	2.0	1.3	0.0	10.2	0.1	0.0	0.2				13.8
Open 3 (Excavation)											0.0
Other 1											0.0
Other 2											0.0
Other 3											0.0
TOTAL	31.6	42.7	60.7	200.8	50.6	37.7	72.5	0	0		496.6

Also altered in this example, but not shown explicitly here, are the internal load (reduced to typical background levels of 0.5 mg TP/m2/d and 2.0 mg TN/m2/d), point source (removed), septic system inputs (removed), and attenuation of TP and TN (values in cells lowered by10%, representing lesser transport to the lake through the natural landscape).

Resulting in-lake conditions, as indicated in the column of the table below labeled “Background Conditions,” include a TP concentration of 16 ug/L and a TN level of 366 ug/L. Average Chl is predicted at 5.7 ug/L, leading to a mean SDT of 2.7 m. Bloom frequency is expected to be 8.6% for Chl >10 ug/L and 1.5% for Chl >15 ug/L, with values >20 ug/L very rare. While the example lake appears to have never had extremely high water clarity, it was probably much more attractive and useable than it is now, based on comparison with current conditions in the table. If this lake was in an ecoregion with a target TP level of <16 ug/L, it is expected that meeting that limit would be very difficult, given apparent natural influences.

SUMMARY TABLE FOR SCENARIO TESTING	Existing Conditions		Background Conditions	Complete Build-out	WWTF Enhanced	Feasible BMPs
	Calibrated Model Value	Actual Data	Model Value	Model Value	Model Value	Model Value
Phosphorus (ppb)	75	75	16	83	49	24
Nitrogen (ppb)	861	860	366	965	745	540
Mean Chlorophyll (ug/L)	40.7	37.5	5.7	46.7	23.3	9.3
Peak Chlorophyll (ug/L)	130.0	118.1	20.1	148.5	76.1	31.6
Mean Secchi (m)	0.8	1.0	2.7	0.8	1.2	2.0
Peak Secchi (m)	2.9	3.1	4.5	2.8	3.3	4.0
Bloom Probability						
Probability of Chl >10 ug/L	99.5%		8.6%	99.8%	92.6%	34.4%
Probability of Chl >15 ug/L	96.0%		1.5%	97.8%	73.6%	11.3%
Probability of Chl >20 ug/L	87.9%		0.3%	92.6%	52.3%	3.7%
Probability of Chl >30 ug/L	64.1%		0.0%	73.8%	22.5%	0.5%
Probability of Chl >40 ug/L	41.5%		0.0%	52.5%	9.2%	0.1%

Changes in Land Use

Another common scenario to be tested involves changes in land use. How much worse might conditions become if all buildable land became developed? For the example system, with current zoning and protection of some undeveloped areas, a substantial fraction of currently forested areas could still become low density residential housing. Adjusting the land uses in the corresponding input table to reflect a conversion of forest to low density urban development, as shown below, and adding 28 septic systems to that portion of the loading analysis (not shown here) an increase in TP, TN and Chl is derived, and a decrease in SDT are observed (see summary table above). TP rises to 83 ug/L and TN to 965 ug/L, but the change in Chl and SDT are not large, as the lake would already be hypereutrophic.

BASIN AREAS

LAND USE	BASIN 1 E. Direct AREA (HA)	BASIN 2 W. Direct AREA (HA)	BASIN 3 Upper T1 AREA (HA)	BASIN 4 Lower T1 AREA (HA)	BASIN 5 W. Upper T2 AREA (HA)	BASIN 6 E. Upper T2 AREA (HA)	BASIN 7 Lower T2 AREA (HA)	BASIN 8 AREA (HA)	BASIN 9 AREA (HA)	BASIN 10 AREA (HA)	TOTAL AREA (HA)
Urban 1 (Residential)	16.0	18.5	23.4	87.4	6.7	12.5	38.6				203.1
Orginal Urban 1	12.0	8.5	8.4	47.4	6.7	4.5	18.1				
Urban 2 (Roads)	3.7	5.5	0.0	5.9	0.8	0.6	2.3				18.8
Urban 3 (Mixed Urban/Commercial)	3.6	5.8	0.0	5.9	0.8	0.6	2.3				19.0
Urban 4 (Industrial)	0.0	0.0	0.0	23.5	0.0	0.0	0.0				23.5
Urban 5 (Parks, Recreation Fields, Institutional)	0.0	3.2	0.0	0.0	0.0	0.0	0.0				3.2
Agric 1 (Cover Crop)	0.0	0.0	0.0	0.8	12.3	0.0	0.0				13.1
Agric 2 (Row Crop)	0.0	0.0	0.0	0.0	16.2	0.0	0.0				16.2
Agric 3 (Grazing)	0.0	0.0	0.0	0.0	4.0	0.0	0.0				4.0
Agric 4 (Feedlot)	0.0	0.0	0.0	0.0	0.5	0.0	0.0				0.5
Forest 1 (Upland)	3.7	7.5	35.3	50.3	9.2	24.0	13.0				143.0
Original Forest 1	7.7	17.5	50.3	90.3	9.2	32.0	33.6				240.6
Forest 2 (Wetland)	0.0	0.2	0.0	14.5	0.0	0.0	1.9				16.6
Open 1 (Wetland/Lake)	2.5	0.6	2.0	0.1	0.0	0.1	14.2				19.5
Open 2 (Meadow)	2.0	1.3	0.0	10.2	0.1	0.0	0.2				13.8
Open 3 (Excavation)	0.1	0.1	0.0	2.3	0.0	0.0	0.0				2.5
Other 1											0.0
Other 2											0.0
Other 3											0.0
TOTAL	31.6	42.7	60.7	200.9	50.6	37.8	72.5				496.8

Changes in Wastewater Management

Managing wastewater is often a need in lake communities. In LLRM, wastewater treatment facilities (WWTF) are represented as point sources, with flow and concentration provided. On-site wastewater disposal (septic) systems are part of the baseflow of drainage areas with tributaries, and can be represented that way for direct drainage areas as well, but the option exists to account separately for septic systems in the direct drainage area. Changes to point sources or septic systems can be made in LLRM to simulate possible management actions.

In the example system, there is one small WWTF that discharges into Lower Tributary #1 and 250 residential units that contribute to septic system inputs in the two defined direct drainage areas (see Figure 1). If the units now served by septic systems were tied into the WWTF via a pumping station, the flow through the WWTF would increase from 45,000 cu.m/yr under current conditions to 71,953 cu.m/yr, the amount of wastewater calculated to be generated by those 250 residential units. If WWTF effluent limits for TP and TN were established at 0.1 and 3.0 mg/L, respectively, the concentration in the discharge would be reduced from 3.0 and 12.0 mg/L (current values from monitoring) to the new effluent limits. The result would be a higher flow from the WWTF with lower TP and TN levels, and an elimination of septic system inputs in the model, both simple changes to make, as shown in the table below.

NON-AREAL SOURCES												
	Number of Source Units	Volume (cu.m/yr)	P Load/Unit (kg/unit/yr)	N Load/Unit (kg/unit/yr)	P Conc. (ppm)	N Conc. (ppm)	P Load (kg/yr)	N Load (kg/yr)				
Waterfowl	50		0.20	0.95			10	47.5				
Point Sources												
PS-1		71953			0.10	3.00	7.2	215.9				
PS-2		0			3.00	12.00	0	0				
PS-3		0			3.00	12.00	0	0				
Basin in which Point Source occurs (0=NO 1=YES)												
	BASIN 1	BASIN 2	BASIN 3	BASIN 4	BASIN 5	BASIN 6	BASIN 7	BASIN 8	BASIN 9	BASIN 10		
PS-1	0	0	0	1	0	0	0	0	0	0		
PS-2	0	0	0	0	0	0	0	0	0	0		
PS-3	0	0	0	0	0	0	0	0	0	0		
DIRECT SEPTIC SYSTEM LOAD												
Septic System Grouping (by occupancy or location)	Days of Occupancy/Year	Distance from Lake (ft)	Number of Dwellings	Number of People per Dwelling	Water per Person per Day (cu.m)	P Conc. (ppm)	N Conc. (ppm)	P Attenuation Factor	N Attenuation Factor	Water Load (cu.m/yr)	P Load (kg/yr)	N Load (kg/yr)
Group 1 Septic Systems	365	<100	0	2.5	0.25	8	20	0.2	0.9	0	0.0	0.0
Group 2 Septic Systems	365	100 - 300	0	2.5	0.25	8	20	0.1	0.8	0	0.0	0.0
Group 3 Septic Systems	90	<100	0	2.5	0.25	8	20	0.2	0.9	0	0.0	0.0
Group 4 Septic Systems	90	100 - 300	0	2.5	0.25	8	20	0.1	0.8	0	0.0	0.0
Total Septic System Loading										0	0.0	0.0

The result, shown in the summary table for scenario testing above, is an in-lake TP concentration of 49 ug/L and a new TN level of 745 ug/L. These are both substantial reductions from the current levels, but continued elevated Chl (mean = 23.3 ug/L, peak = 76.1 ug/L) and a high probability of algal blooms is expected. Water clarity improves slightly (from 0.8 to 1.2 m on average), but at the cost of the sewerage and treatment, this is unlikely to produce a success story.

Best Management Practices

The application of BMPs is generally regarded as the backbone of non-point source pollution management in watershed programs. Considerable effort has been devoted to assessing the percent removal for various pollutants that can be attained and sustained by various BMPs. BMPs tend to fall into one of two categories: source controls and pollutant trapping. Source controls limit the generation of TP and TN and include actions like bans on lawn fertilizers containing TP or requirements for post-development infiltration to equal pre-development conditions, and would be most likely addressed in LLRM by a change in export coefficient. Pollutant trapping limits the delivery of generated loads to the lake and includes such methods as detention, infiltration, and buffer strips, and is most often addressed in LLRM by changes in attenuation values.

There are limits on what individual BMPs can accomplish. While some site specific knowledge and sizing considerations help modify general guidelines, the following table provides a sense for the level of removal achievable with common BMPs.

Range and Median for Expected Removal (%) for Key Pollutants by Selected Management Methods, Compiled from Literature Sources for Actual Projects and Best Professional Judgment Upon Data Review.

	TSS	Total P	Soluble P	Total N	Soluble N	Metals
Street sweeping	5-20	5-20	<5	5-20	<5	5-20
Catch basin cleaning	5-10	<10	<1	<10	<1	5-10
Buffer strips	40-95	20-90	10-80	20-60	0-20	20-60
	(50)	(30)	(20)	(30)	(5)	(30)
Conventional catch basins	1-20	0-10	0-1	0-10	0-1	1-20
(Some sump capacity)	(5)	(2)	(0)	(2)	(0)	(5)
Modified catch basins (deep	25	0-20	0-1	0-20	0-1	20
sumps and hoods)	(25)	(5)	(0)	(5)	(0)	(20)
Advanced catch basins	25-90	0-19	0-21	0-20	0-6	10-30
(sediment/floatables traps)	(50)	(10)	(0)	(10)	(0)	(20)
Porous Pavement	40-80	28-85	0-25	40-95	-10-5	40-90
	(60)	(52)	(10)	(62)	(0)	(60)
Vegetated swale	60-90	0-63	5-71	0-40	-25-31	50-90
	(70)	(30)	(35)	(25)	(0)	(70)
Infiltration trench/chamber	75-90	40-70	20-60	40-80	0-40	50-90

	(80)	(60)	(50)	(60)	(10)	(80)
Infiltration basin	75-80	40-100	25-100	35-80	0-82	50-90
	(80)	(65)	(55)	(51)	(15)	(80)
Sand filtration system	80-85	38-85	35-90	22-73	-20-45	50-70
	(80)	(62)	(60)	(52)	(13)	(60)
Organic filtration system	80-90	21-95	-17-40	19-55	-87-0	60-90
	(80)	(58)	(22)	(35)	(-50)	(70)
Dry detention basin	14-87	23-99	5-76	29-65	-20-10	0-66
	(70)	(65)	(40)	(46)	(0)	(36)
Wet detention basin	32-99	13-56	-20-5	10-60	0-52	13-96
	(70)	(27)	(-5)	(31)	(10)	(63)
Constructed wetland	14-98	12-91	8-90	6-85	0-97	0-82
	(70)	(49)	(63)	(34)	(43)	(54)
Pond/Wetland Combination	20-96	0-97	0-65	23-60	1-95	6-90
	(76)	(55)	(30)	(39)	(49)	(58)
Chemical treatment	30-90	24-92	1-80	0-83	9-70	30-90
	(70)	(63)	(42)	(38)	(34)	(65)

While BMPs in series can improve removal, the result is rarely multiplicative; that is, application of two BMPs expected to remove 50% of TP are unlikely to result in 0.5 X 0.5 = 0.25 of the load remaining (75% removal) unless each BMP operates on a different fraction of TP (particulates vs. soluble, for example). This is where judgment and experience become critical to the modeling process. In general, BMPs rarely remove more than 2/3 of the load of P or N, and on average can be expected to remove around 50% of the P and 40% of the N unless very carefully designed, built and maintained. The luxury of space is not often affordable, forcing creativity or greater expense to achieve higher removal rates.

In the example system, setting attenuation for all basins to 0.5 for P and 0.6 for N is viewed as a practical level of BMP application for a first cut at what BMPs might be able to do for the lake. Careful consideration of which BMPs will be applied where in which basins is in order in the final analysis, but to set a reasonable approximation of what can be achieved, these are supportable attenuation values. Note that values are not set at 0.5 or 0.6 of the value in place in the calibrated model, but rather a low end of 0.5 or 0.6. If, as with Basin 7 (Lower Tributary #2) in the example system, the attenuation values for P and N under current conditions are 0.70 and 0.75, the practical BMP values of 0.5 and 0.6, respectively, represent less of a decline through BMPs than for the direct drainage areas, which have current condition attenuation values of 0.9 for P and 0.95 for N.

In addition to setting P attenuation at 0.5 for P in all basins and 0.6 for N in all basins in the example system, the WWTF has been routed to a regional WWTF out of the watershed, and the all areas within 300 ft of the lake have been sewered, with that waste also going to the regional WWTF. Consequently, the WWTF and direct drainage septic system inputs have been eliminated. Finally, internal loading has been reduced to 0.5 mg P/m/day and 2.0 mg N/m^2/day, achievable with nutrient inactivation and lowered inputs over time.

The results, as indicated in the summary table for scenario testing above, include an in-lake P concentration of 24 ug/L and an N level of 540 ug/L. The predicted mean Chl is 9.3 ug/L, with a peak of 31.6 ug/L. SDT would be expected to average 2.0 m and have a maximum of 4.0 m. While much improved over current conditions, these are marginal values for supporting the range of lake uses, particularly contact recreation and potable water supply. As a first cut assessment of what BMPs might do for the system, it suggests that more extreme measures will be needed, or that in-lake maintenance should be planned as well, since algal blooms would still be expected. Further scenario testing with the model, combined with cost estimation for potential BMPs, may shed light on the cost effectiveness of rehabilitating the example lake.

Appendix G
Buildout Model Results

Appendix G - Buildout Model Results

Table G-1. Pearly Pond water budget at buildout

WATER BUDGET	M^3/YR
Atmospheric	829,425
Wastewater Treatment Plant[1]	40,031
Watershed Runoff	2,585,531
Watershed Baseflow	2,419,604
Total	5,874,592

[1] 2/3 of the flow from the WWTF comes from water sources outside of the watershed, therefore was added as an additional flow input in the water budget.

Table G-2. Land use categories at buildout by Pearly Pond subwatershed

	Area (Hectares)			
	Northeast Subwatershed	North Central Subwatershed	Northwest Subwatershed	Direct Drainage Subwatershed
Forest 1 (Deciduous)	28.2	141.8	152.1	88.6
Forest 2 (Non-Deciduous)	8.7	27.1	0.0	9.1
Forest 3 (Mixed Forest)	3.3	3.6	2.6	7.3
Forest 4 (Wetland)	0.0	0.0	0.0	0.0
Open 1 (Wetland / Pond)	5.8	0.7	0.0	5.9
Open 2 (Meadow)	0.0	0.0	0.0	0.0
Open 3 (Bare/Open)	0.0	0.0	0.0	0.0
Other 1:	0.0	0.0	0.0	0.0
0.0	0.0	11.1	0.0	2.8
TOTAL	1.2	26.6	21.1	10.8
% Wetland	3.7	8.4	31.1	13.2
Forest	8.1	16.1	46.8	32.1
Decrease in forested area from ex	5.4	41.1	18.4	5.7
WATER LOAD GENERATION: RU	1.2	28.2	21.4	9.8
0.0	0.0	0.0	0.0	0.0
0.0	0.0	4.5	7.2	0.6
Urban 2 (MDR)	65.6	309.1	300.7	185.8

Table G-3. Modeled Buildout TP loading in Pearly Pond

TP INPUTS	Modeled Current TP Loading (kg/yr)	% of Total Load
Atmospheric	19.4	4.23%
Internal	0.2	0.04%
Waterfowl	23.1	5.04%
Septic System	18.0	3.92%
Watershed Load- College Rd Inlet	35.3	7.70%
Watershed Load- Mountain Road Inlet	144.1	31.46%
Watershed Load- Bower Inlet	130.1	28.40%
Watershed Load- Direct Drainage	41.3	9.01%
Franklin Pierce Residual Wastewater Treatment Plant	46.7	10.20%
TOTAL	**458.1**	**100%**

Pearly Lake- Modeled Buildout Conditions

Table G-4. Predicted total phosphorus in-Pond concentrations from buildout modeled scenario for Pearly Pond

Empirical Equation	Equation	Predicted TP (*u* g/L)
Mass Balance	TP=L/(Z(F))*1000	78
Kirchner-Dillon 1975	TP=L(1-Rp)/(Z(F))*1000	40
Vollenweider 1975	TP=L/(Z(S+F))*1000	70
Larsen-Mercier 1976	TP=L(1-Rlm)/(Z(F))*1000	53
Jones-Bachmann 1976	TP=0.84(L)/(Z(0.65+F))*1000	57
Reckhow General 1977	TP=L/(11.6+1.2(Z(F)))*1000	29
Average of Above 5 Model Values		***50***
Observed Summer Epilimnion Mean		***0***
Observed Summer Epilimnion Median		***0***

Variable	Description	Units	Equation
L	Phosphorus Load to Pond	g P/m2/yr	
Z	Mean Depth	m	Volume/area
F	Flushing Rate	flushings/yr	Inflow/volume
S	Suspended Fraction	no units	Effluent TP/Influent TP
Qs	Areal Water Load	m/yr	Z(F)
Vs	Settling Velocity	m	Z(S)
Rp	Retention Coefficient (settling rate)	no units	((Vs+13.2)/2)/(((Vs+13.2)/2)+Qs)
Rlm	Retention Coefficient (flushing rate)	no units	1/(1+F^0.5)

Table G-5: Predicted in-Pond chlorophyll a and Secchi transparency from current modeled scenario for Pearly Pond

Empirical Equation	Equation	Predicted Value
Mean Chlorophyll		***u* g/L**
Carlson 1977	Chl=0.087*(Pred TP)^1.45	25.2
Dillon and Rigler 1974	Chl=10^(1.449*LOG(Pred TP)-1.136)	21.1
Jones and Bachmann 1976	Chl=10^(1.46*LOG(Pred TP)-1.09)	24.5
Oglesby and Schaffner 1978	Chl=0.574*(Pred TP)-2.9	25.7
Modified Vollenweider 1982	Chl=2*0.28*(Pred TP)^0.96	23.9
Average of Model Values		**24.1**
Observed Summer Mean		***8.9***
Peak Chlorophyll		***u* g/L**
Modified Vollenweider (TP) 1982	Chl=2*0.64*(Pred TP)^1.05	77.6
Vollenweider (CHL) 1982	Chl=2.6*(AVERAGE(Pred Chl))^1.06	75.7
Modified Jones, Rast and Lee 1979	Chl=2*1.7*(AVERAGE(Pred Chl))+0.2	82.0
Average of Model Values		**78.4**
Observed Summer Maximum*		***28.1***
Bloom Probability		***% of Summer***
Probability of Chl >15 *u* g/L	See Walker 1984 & 2000	75.7%
Secchi Transparency		***m***
Mean: Oglesby and Schaffner 1978	Chl=10^(1.36-0.764*LOG(Pred TP))	1.2
Max: Modified Vollenweider 1982	Chl=9.77*Pred TP^-0.28	3.3
Observed Summer Mean		***1.61***
Observed Summer Maximum		***2.75***

Variable	Description	Units
"Pred TP"	The average TP calculated from the 5 predictive equation models in Table 3-4	*u* g/L
"Pred Chl"	The average of the 3 predictive equations calculating mean chlorophyll	*u* g/L

*The observed summer maximum is based on n=18 and is not necessarily the peak chlorophyll

Appendix H
Regulatory Review

MEMORANDUM

TO:	Catherine Owen Koning, Franklin Pierce University
FROM:	Rebecca Balke, CEI
SUBJECT:	Pearly Pond – Regulatory Review
JOB NUMBER:	308-1
DATE:	September 15, 2014

CEI performed a review of existing ordinances and regulations in Rindge and Jaffrey to determine existing requirements for controlling stormwater runoff and water quality from new and redevelopment projects and to provide recommendations to help maintain and improve water quality.

Increases in development and impervious area increase pollutant loads carried in stormwater runoff. Given the undeveloped nature of the Pearly Pond watershed with only 7% developed urban area, a large increase in pollutant load can be expected as the watershed develops. A comparison of existing development to buildout conditions, assuming no stormwater controls on new development, shows an increase in phosphorus load of about 305 pounds per year, with a predicted in-pond phosphorus concentration of 41 ppb, compared to the current in-pond concentration of 25 ppb. This demonstrates the importance of having strong regulations in place to control stormwater runoff from future development projects.

Existing Requirements – Rindge

The following regulations were reviewed for requirements pertaining to controlling stormwater runoff from development projects:

- Subdivision Regulations, Effective: December 6, 1976, Last Amended September 20, 2011
- Site Plan Review Regulations, Adopted May 13, 1987, Last Amended February 15, 2005
- Planned Unit Residential Development Regulation, Adopted March 24, 1987, Last Amended October 20, 2009
- Zoning Ordinance, Adopted and Effective March 14, 1961, Last Amended March 11, 2014
- Regulations Governing Earth Excavations, Adopted August 12, 1991
- Aquifer Protection District Ordinance, Adopted March 12, 1991, Last Amended March 11, 2014
- Wetlands Conservation District Ordinance, Adopted March 11, 1986, Last Amended March 11, 2014

<u>Subdivision Regulations, Effective: December 6, 1976, Last Amended September 20, 2011</u>

- Major subdivisions are required to submit documents concerning proposed streets, including:
    - Identification and location of proposed soil erosion and sediment control and stormwater control measures and structures
    - Drawings and specifications for each proposed soil erosion and sediment control measure and structure in accordance with guidelines of the town and Best Management Practices (BMPs)
    - Drawings, details, and specifications for proposed stormwater control measures and structures and for proposed stormwater retention and/or detention basins
    - A complete drainage analysis of the site following the Roadway Construction Standards, including a description of the proposed treatment methods and methods of reducing stormwater runoff and pre- and post-development drainage calculations
    - Roadway Construction Standards require that the post-development rate of runoff does not exceed the pre-development rate of runoff for the 10-, 25-, and 50-year / 24-hour storm events
    - Sediment in run-off must be trapped during construction
    - Disturbed areas must be kept to a minimum and duration of exposure shall be under six months with temporary seeding and/or mulching used to protect exposed critical areas during development

<u>Site Plan Review Regulations, Adopted May 13, 1987, Last Amended February 15, 2005</u>
Applies to all non-residential uses of land, multi-family structures, condominiums or Planned Unit Residential Developments involving construction, demolition or removal, land clearing, building development. All plans for site development including land clearing and grading, buildings, structures and appurtenances shall include the following:

- Provisions for control of erosion and sedimentation both permanent and temporary. The recommended guidance document is the "Best Management Practices to Control Non-Point Source Pollution" Citizen's Guide, NH DES, January, 2004.
- A stormwater management plan showing:
    - Stormwater management plan showing:
        - Existing and proposed methods of handling stormwater runoff
        - For major site plans (>40,000 sq.ft.), provide engineering calculations to show post-development peak discharge rate is less than or equal to pre-development peak discharge rate (based on a 2-, 10, 25- and 50- year, 24-hour storm). The stormwater system shall be sized to treat and store the 2-year storm and infiltrate the 1-inch storm.

- The stormwater management system design shall follow the "Best Management Practices Manual for Innovative Stormwater Treatment Technologies", NH Department of Environmental Services, May 2002 and "Design Guidelines and Criteria for Stormwater Management", Comprehensive Environmental Inc., November 2003, including any future amendments to these documents.

- The applicant may be required to submit a soil erosion and sediment control plan in keeping with the provisions of the "Stormwater Management and Erosion and Sediment Control Handbook for Urban and Developing Areas in New Hampshire", August 1992, as amended; and the Best Management Practices to Control Nonpoint Source Pollution: A guide for Citizens and Town Officials, NHDES, January 2004.

General standards and requirements include:

- The area of impervious cover shall be limited to 50% of the entire site, except in the Aquifer Protection District, which limits total impervious area to 20% of the site. Site design shall be consistent with Low Impact Design (LID) practices.
- Stormwater shall be removed from all roof, canopies and paved areas, and treated directly on site.
- Every effort shall be made to use pervious parking surfaces for overflow parking.

Planned Unit Residential Development Regulation, Adopted March 24, 1987, Last Amended October 20, 2009

The Planned Unit Residential Development Regulation (PURD) allows for flexibility in the design and development of land, to promote preservation of natural features and open space and provide opportunities for a diverse mix of housing unit types. These developments are treated as a subdivision for review and public hearing purposes. The regulation requires adequate provisions for stormwater drainage based on a minimum 25-year storm frequency, using on-site absorption and/or temporary detention. A minimum landscaped buffer of 50 feet is required along the entire perimeter of the PURD.

Zoning Ordinance, Adopted and Effective March 14, 1961, Last Amended March 11, 2014

The zoning ordinance does not include any provisions for the management of stormwater runoff.

Regulations Governing Earth Excavations, Adopted August 12, 1991

These regulations do not include any provisions for the management of stormwater runoff, however, do include restriction on the proximity of development to waters and requirements to maintain drainage points and flow proportions as part of reclamation.

Aquifer Protection District Ordinance, Adopted March 12, 1991, Last Amended March 11, 2014

Applies to the outer edge of the surficial extent of all aquifer deposits presently designated at or above 2000 Transmissivity. Standards for development include that the proposed development will not detrimentally affect the quality of the groundwater in the aquifer and the use of BMPs to maximize infiltration, and recharge to the aquifer will not be inhibited or prevented.

Wetlands Conservation District Ordinance, Adopted March 11, 1986, Last Amended March 11, 2014

The Wetlands Conservation District includes all surface waters and wetlands, including a zone of minimal disturbance of 150 feet around all surface waters and 50 feet around all Vegetated Wetlands greater than 3,000 square feet in area.

The following restrictions are in place pertaining to stormwater runoff:

- No building or impervious surface in or within 50 feet of the Ordinary High Water Mark of surface waters or within 50 feet of vegetated wetlands.
- No net increase in peak flow of stormwater runoff into surface waters or vegetated wetlands. Calculations to be based on a 25-year storm event.
- No establishment or expansion of salt storage yards, automobile junk yards or solid or hazardous waste facilities shall take place in or within 250 feet of Surface Waters or within 250 feet of vegetated wetlands.
- No underground or above ground storage of hazardous materials shall take place in or within 125 feet of the Ordinary High Water Mark of surface waters or within 125 feet of vegetated wetlands.
- No dumping, disposal or storage of snow and ice collected from off-site roadways or parking areas outside the Wetlands Conservation District shall take place in or within 250 feet of the Ordinary High Water Mark of surface waters or within 250 feet of vegetated wetlands.
- No fertilizer, except limestone, shall be used within 25 feet of the Ordinary High Water Mark of surface waters or within 25 feet of vegetated wetlands. Low phosphate, slow release nitrogen fertilizer or limestone, may be used in the buffer zone between 25 and 250 feet from these resource areas.

Best Management Practices for stormwater management are referred to “Model Storm Water Management and Erosion Control Regulation”, February, 1997, NH Association of Conservation Districts, Water Quality and Urban Conservation Committee”.

Existing Requirements – Jaffrey

The Jaffrey Land Use Code, Amended March 11, 2014 was reviewed for requirements pertaining to controlling stormwater runoff from development projects, including the following sections/regulations:

- Rules and Regulations to Control Subdivisions, Adopted August 11, 1992, Last Amended December 14, 2010
- Site Plan Review Regulations, Adopted May 13, 1980, and as Amended
- Zoning Ordinance, Effective March 10, 1981, Last Amended March 11, 2014
  - Section XIII: Innovative Land Use Plan, Last Amended March 2008
  - Section XIX: Shoreland Overlay District
  - Section XX: Wetlands Conservation District
- Regulations Governing Earth Excavations, Dated March 30, 2008

<u>Rules and Regulations to Control Subdivisions, Adopted August 11, 1992, Last Amended December 14, 2010</u>

- The Planning Board may require as a condition of approval for a subdivision or site plan that development shall be so designed and so executed as to preclude runoff onto public or private ways or adjacent properties to include wetlands. In this connection, the Planning Board recommends that new development or changes to existing development adhere to the best management practices as published in the NH Department of Environmental Services booklet "Nonpoint Source Pollution" dated January 2004.
- Applications must include a plan for the control of sedimentation and erosion.

<u>Site Plan Review Regulations, Adopted May 13, 1980, and as Amended</u>

Applies to the development or change or expansion of use of tracts for nonresidential uses or multifamily dwelling units.

- Applicants are required to submit a storm drainage plan, including plans for the retention and slow release of storm water where necessary, and plans for snow removal and/or storage.
- Where the existing drainage system to which the site drains is inadequate, provisions shall be made for retention and gradual release of stormwater in order to meet the 25-year flood demand.
- The Planning Board may require that development be designed to preclude runoff onto public or private ways or adjacent properties. In this connection, the Planning Board recommends that new development or changes to existing development adhere to the BMPs as published in the NH DES "Nonpoint Source Pollution" dated January 2004.
- Groundwater and wellhead protection areas require approval of a stormwater management and pollution protection plan consistent with the standards for industrial operators contained in the *New Hampshire Stormwater Manual Volumes I-III*, New Hampshire Department of Environmental Services…demonstrating minimization of the release of regulated substances into stormwater and best available technology in any infiltration or discharge of stormwater to the ground to mitigate all contaminants.

Zoning Ordinance, Effective March 10, 1981, Last Amended March 11, 2014
Provisions for the management of stormwater runoff were found in the following sections of the Zoning Ordinance:

Section XIII: Innovative Land Use Plan, Last Amended March 2008
The Innovative Land Use Plan allows for flexibility in the design and development of land, to promote preservation of natural features and open space and provide opportunities for a diverse mix of housing unit types. These developments come before the board for a Preliminary Conceptual Consultation or a Design Review Phase, both provided for in the Subdivision Regulations.

Section XIX: Shoreland Overlay District
These regulations only apply to certain waters within Jaffrey, so do not apply to Pearly Pond.

Section XX: Wetlands Conservation District
The Wetlands Conservation District comprises all ponds, rivers, intermittent and perennial streams, ephemeral ponds, and wetlands; including the upland area within 75 feet of these features.

No primary building, impervious cover, or driveway shall be located within the Wetlands Conservation District. Minimal disturbance is promoted for any activities within this district and no activities that can contaminate, pollute or harm waters are allowed.

Regulations Governing Earth Excavations
These regulations do not include any provisions for the management of stormwater runoff, however, do include restriction on the proximity of development to waters and requirements to maintain drainage points and flow proportions as part of reclamation.

Recommendations
In Rindge, the focus of the existing ordinances is on peak control. Subdivision regulations only require peak control of stormwater runoff, which does not address water quality. Site Plan Review Regulations require peak control and water quality treatment of stormwater runoff, referencing some older NH DES and CEI manuals for design of best management practices (BMPs), however, do not specifically lay out design criteria for treatment. General standards and requirements cap the area of impervious cover on the site, with a push towards LID practices, and require on-site treatment of stormwater from all roof, canopies and paved areas.

Jaffrey requires erosion and sediment control plans for subdivisions, but does not have requirements to treat for water quality or to control peak flows from new developments (other than sizing for flows entering their drainage system).

As previously outlined, any new development can contribute additional phosphorus loads to Pearly Pond if stormwater runoff is not adequately controlled, worsening existing water quality. CEI recommends that the Towns investigate implementation of an overlay district for Pearly Pond with a requirement of no additional loading of total phosphorus from new development meeting the disturbance threshold criteria outlined above. The NH water quality regulation Env-Wq 1703.3(a) General Water Quality Criteria states "The presence of pollutants in the surface waters shall not justify further introduction of pollutants from point and/or nonpoint sources". With regard to impaired waterbodies, it is the policy of NHDES that the existing loads due to development be held constant, allowing no additional loading. In order for any future allocation of pollutant load(s) to be granted for an impaired waterbody, the load would need to be reduced elsewhere in the watershed. Regulation is needed at the local level because NHDES has no mechanism for regulation/enforcement of phosphorus export from development of single house lots that do not require a Section 401 Water Quality Certification or fall under the thresholds for alteration of terrain permits (100,000 sq.ft. of disturbance or 50,000 sq.ft. within 250 feet of a lake).

CEI also recommends that the Towns develop a separate Stormwater Management Ordinance to regulate any development that disturbs more than one acre of land, including requirements for erosion controls during construction and post-construction stormwater management practices to treat stormwater runoff from the developed site. We recommend that the ordinance require developers to meet the requirements of NH DES's Alteration of Terrain (AoT) regulations at the one acre or lower threshold. The AoT Program requires that entities disturbing more than 100,000 sq.ft. apply for a State level permit through NHDES. Applying a lower threshold at the local level would provide better protection and is consistent with the federal NPDES Phase II requirements, which require regulation of disturbances greater than one acre.

The AoT regulations outline specific design criteria that developers must meet, including the volume of water to be recharged, the volume of water to be treated to remove pollutants, requirements to control peak flow volumes and avoid flooding, and requirements for channel protection. NH DES also developed a three volume Stormwater Manual that clearly lays out design criteria for controlling stormwater runoff, BMP design criteria and erosion and sediment control guidance, which can be referenced along with the AoT regulations.

The Regional Environmental Planning Program (REPP) developed guidance for model ordinances and regulations on a number of innovative land use techniques for municipalities to use to develop their own local ordinances, including a model ordinance

for stormwater management that is consistent with state stormwater and water quality regulations described in the NH DES Stormwater Manual. The Innovative Land Use Planning Techniques: A Handbook for Sustainable Development is available on the NHDES website at:
http://des.nh.gov/organization/divisions/water/wmb/repp/innovative_land_use.htm
A copy of the model ordinances for erosion control and post-construction stormwater management are attached.

CEI also developed model bylaws for compliance with the NPDES Phase II Municipal Separate Storm Sewer System (MS4) Permit and to promote LID. These are also attached for review, including a landscape regulation that promotes good landscaping practices during development to minimize erosion and watering requirements. CEI also recommends that Rindge and Jaffrey consider implementing landscape design standards similar to those provided in the attached example.

MODEL SUBDIVISION & SITE PLAN REGULATION

EROSION & SEDIMENT CONTROL DURING CONSTRUCTION

BY THE REGIONAL ENVIRONMENTAL PLANNING PROGRAM

Model Language and Guidance for Implementation

The following regulation is based on several existing models and handbooks, including those prepared by DES and the N.H. Association of Conservation Districts. Model language for pre-application land disturbance was derived from a presentation entitled “Storm Water Phase II-Developing Construction & Post Construction Programs Fees and Funding” given by attorney Stephen C. Buckley, Hodes, Buckley, McGrath & LeFevre, PA, in the spring of 2005 at a workshop hosted by the US EPA, Region 1.

MODEL SUBDIVISION AND SITE PLAN REGULATION

EROSION AND SEDIMENT CONTROL DURING CONSTRUCTION

I. TITLE AND AUTHORITY

A. **Title**
The title of this Site Plan and Subdivision Regulation for the Town/City of [NAME], shall be known as the “Erosion and Sediment Control During Construction.”

B. **Authority**
This regulation is adopted pursuant to RSA 674:16, Grant of Power, RSA 674:17, Purposes of Zoning Ordinance, and RSA 674:21, Innovative Land Use Controls, Environmental Characteristics. The corresponding section of the Zoning Ordinance is found at section [_______].

Towns adopting these regulations should add a section to the zoning ordinance authorizing the adoption of stormwater regulations during construction based on the RSA sections listed above. The findings listed in this regulation should be considered for addition to the master plan natural resources chapter.

II. PURPOSE

Based on the findings above, the purpose of this regulation is to develop standards for design, installation, and maintenance of stormwater management measures during construction for the following reasons:

- To control the quantity and quality of runoff.
- To prevent soil erosion and sedimentation resulting from site construction and development.
- To prevent the pollution of runoff from construction sites.
- To protect natural resources including wildlife habitat.
- To protect other properties from damage that could be caused by erosion and sedimentation or the quantity or quality of runoff.
- To reduce public expenditures in maintenance of stormwater drainage systems such as removing sediment from systems, repairing or replacing failed systems, restoring degraded natural resources, and to prevent damage to town infrastructure caused by inadequate controls.

III. FINDINGS

The planning board has made the following findings concerning the need to address sediment and erosion control during construction.

A. **Land development alters hydrologic response.**
   Land development projects and other land use conversions and their associated changes to land cover can alter the hydrologic response of local watersheds and increase stormwater runoff rates and volumes, which in turn increase flooding, stream channel erosion, and sediment transport and deposition, and decrease groundwater recharge by creating impervious surface such as pavement and buildings, and compacting pervious surfaces.

B. **Small storms account for 90 percent of runoff.**
   Over 90 percent of runoff and associated pollutants loads result from very small storms, thus traditional methods of preparing stormwater control plans must be revisited take into consideration not only larger, less frequent storms, but also small storms to ensure that water supplies do not become polluted by these small storms and that designs for larger, less frequent storms resulting in large downstream flows can be reduced so as not to cause significant stream channel erosion and other environmental damage.

C. **Cumulative effects.**
   The cumulative effects of several storms on a particular project, and the erosion and sediment contributions from several projects create a significant cumulative effect on water quality, hydrologic response of local watersheds, and alter or destroy wildlife habitat.

D. **Land development contributes to increased nonpoint source pollution.**
   Land development projects and other land use conversions contribute to increased nonpoint source pollution and degradation of receiving waters due to the addition of petroleum products, fertilizers and pesticides, construction waste, and other substances to runoff from construction sites.

E. **Land development causes significant environmental damage to wildlife and wildlife habitat.**
   Land development projects cause significant damage to trees and other wildlife habitat through compaction of soils due to construction vehicle traffic, stripping of vegetation during grading and other site preparation activities, and increased turbidity in water supplies that may damage the habitat of aquatic species.

F. **Stormwater runoff related to development adversely affects health, safety, welfare, and the environment.**
   The impacts of stormwater runoff related to development can adversely affect public safety, public and private property, surface water supplies, groundwater resources, drinking water, aquatic and non-aquatic wildlife habitats, fish and other aquatic life, property values, and the potential for other uses of land and water.

G. **Best management practices can minimize adverse impacts.**
   These adverse impacts can be controlled and minimized through the application of best management practices during construction activities, low impact development practices post construction, and periodic inspections before, during and after construction to ensure that erosion and sediment control practices are functioning effectively.

H. **Federal law requires regulations to manage stormwater runoff from construction sites.**

Federal law requires small MS4 operators to develop, implement, and enforce a program to reduce pollutants in any storm water runoff from construction activities that result in a land disturbance of greater than or equal to one acre. Reduction of storm water discharges from construction activity disturbing less than one acre must be included in the program if that construction is part of a large common plan or development or sale that would disturb one acre or more.

It is therefore in the public interest of health, safety, welfare, and environmental protection to minimize the impacts associated with land development and to regulate stormwater runoff during construction in order to address the adverse impacts to public health, safety, welfare, and the environment detailed in the above section.

IV. APPLICABILITY

The requirements of this regulation shall apply to land disturbance, development, and or any construction activities in all zoning districts where the disturbance, development, or construction activity will disturb greater than 20,000 square feet or that is within a critical area as defined below.

V. DEFINITIONS

Best Management Practice (BMP): A proven or accepted managerial, structural, non-structural, or vegetative measure to prevent or reduce increases in stormwater volumes or flow; to reduce erosion, sediment, peak storm discharge, and point-source and non-point-source pollution; and to improve stormwater quality and protection of the environment.

Critical Areas: Disturbed areas of any size within 75 feet of stream, intermittent stream, bog, water body, or poorly or very poorly drained soils; disturbed areas of any size within 50 feet of a property line; disturbed areas exceeding 2,000 square feet in highly erodible soils; or disturbed areas containing slope lengths exceeding 25 feet on slopes greater than 15 percent.

Developer: Any person or legal entity that undertakes or proposes to undertake activities that cause land disturbance.

Development: Any activity involving land grading, or alteration of terrain or landscape, other than for agricultural purposes or silvicultural purposes where best management practices for agriculture or timber harvesting as defined by New Hampshire law are utilized.

Disturbed area: An area where the natural vegetation has been removed exposing the underlying soil or where vegetation has been covered by soil.

Drainage Area: A geographic area within which stormwater, sediments, or dissolved materials drain to a particular receiving waterbody or to a particular point along a receiving waterbody.

Effective Impervious Cover: Impervious surfaces that contribute to stormwater runoff leaving a site. Effective impervious cover can be reduced by capturing and directing stormwater runoff generated by the impervious surface to an on-site retention, treatment and infiltration management device or practice.

Erosion: The detachment and movement of soil or rock fragments by water, wind, ice, or gravity.

Highly Erodible Soils: Any soil with an erodibility class (K factor) greater than or equal to 0.43 in any layer or listed below or as found in Table 3-1 of the “Stormwater Management and Erosion and Sediment Control Handbook for Urban and Developing Areas in New Hampshire” Rockingham County

Conservation District, 1992.

Impervious Surface: Land surface with a low capacity for soil infiltration, including but not limited to pavement, roofs, roadways, or other structures, paved parking lots, sidewalks, driveways (compacted gravel or paved) and patios. Total impervious surface cover shall be calculated by determining the total area of all impervious surfaces on a site as described above, regardless of whether the impervious surfaces are contiguous or non-contiguous.

Land Disturbance or Land Disturbing Activity: For the purposes of this regulation, refers to any exposed soil resulting from activities such as clearing of trees or vegetation, grading, blasting, and excavation.

Low Impact Development Techniques: Alternative designs for the treatment and management of stormwater that minimize disturbance to the natural drainage patterns on the landscape and require high standards for water quality discharge and recharge. These techniques include treatment of stormwater runoff on residential lots using low-maintenance methods such as vegetated swales, rain gardens and subsurface infiltration devices.

Openness Ratio: A ratio calculated by dividing a culvert's cross-sectional area by its length (OR = cross sectional area / length).

Owner: A person with a legal or equitable interest in a property.

Pervious Surface: Any material of structure on or above the ground that permits water to infiltrate into the underlying soil. Naturally pervious surfaces may become less pervious through the process of compaction.

Qualified Professional: A person knowledgeable in the principles and practice of stormwater management and erosion and sedimentation control, including Certified Professional in Erosion and Sediment Control (CPESC), Certified Professional in Storm Water Quality (CPSWQ), licensed soil scientist, licensed engineer, or someone with experience in the principles and practices of stormwater management and erosion and sedimentation control working under the direction and supervision of a licensed engineer and in consultation with a person qualified to construct a project as per design and in compliance with regulatory requirements.

Recharge: The amount of water from precipitation that infiltrates into the ground and is not evaporated or transpired.

Redevelopment: The reuse of a site or structure with existing man-made land alterations. A site which currently has 35 percent or more of existing impervious surface, calculated by dividing the total existing impervious surface by the size of the parcel and converted to a percentage before the project begins would be considered a redevelopment. [*Note: This definition is distinct from other requirements a town may have as to maximum impervious surface allowed in the completed project.*]

Regulated Substance: Oil, as defined pursuant to RSA 146-A or a substance listed in 40 CFR 302, with the following exclusions: ammonia, sodium hypochlorite, sodium hydroxide, acetic acid, sulfuric acid, potassium hydroxide, and potassium permanganate.

Sediment: Solid material, either mineral or organic, that is in suspension, is transported, or has been moved from its site of origin.

Sensitive Area: For the purposes of this regulation, lakes, ponds, perennial and intermittent streams, vernal pools, wetlands, floodplains, floodways and areas with highly erodible soils.

Sheet flow: Runoff that flows or is directed to flow across a relatively broad area at a depth of less than 0.1 feet for a maximum distance of 100 feet.

Site: The lot or lots upon which development is to occur or had occurred.

Stabilization: The condition in which all soil-disturbing activities at a site have been completed and a uniform, perennial vegetative cover with a density of 85 percent has been established or equivalent stabilization measures (such as the use of mulches or geotextiles) have been employed on all unpaved areas and areas not covered by permanent structures.

Stormwater: Water resulting from precipitation (including rain and snow) that runs off the land's surface, is transmitted to the subsurface, or is captured by separate storm sewers or other man-made or natural drainage facilities.

Stormwater runoff: The water from precipitation that is not absorbed, evaporated, or otherwise stored within the contributing drainage area.

Stream: Areas of flowing water that occur for sufficient time to develop and maintain defined channels but which may not flow during dry portions of the year. Includes but is not limited to all perennial and intermittent streams located on U.S. Geological Survey Maps.

Turbidity: A condition of water quality characterized by the presence of suspended solids and/or organic material.

Undisturbed Cover: A land surface that has not been significantly altered by human activity.

Vegetation: Is defined to include a tree, plant, shrub, vine, or other form of plant or fungal growth.

Water Supply Intake Protection Area: Designated protection area for a surface water intake used a source by a public water system.

Well Head Protection Area: As defined in RSA 485-C:2, the surface and subsurface area surrounding a water well or well field, supplying a public water system, through which contaminants are reasonably likely to move toward and reach such well or well field.

VI. CONSTRUCTION INSPECTIONS, PHASING, AND THE PLANNING PROCESS

A. **Inspections/Frequency.** Periodic inspections of stormwater management structures or techniques shall be conducted periodically by the town's engineering consultant or a qualified professional; the cost of such inspections shall be included in the escrowed funds paid by the developer for the purpose of reimbursement to the town for the payment of fees to town engineering and planning consultants reviews and inspections. At a minimum, inspections shall be conducted at the site prior to commencement of land clearing activities, after every storm event during construction, periodically during construction, at the completion of construction activities and removal of any temporary BMPs, and as specified thereafter in an agreed-upon inspection schedule proposed by the developer in consultation with either the contractor who will build the project or a consulting contractor and approved by the planning board and the planning board's consulting engineer, to insure that stormwater management structures or techniques are performing effectively.

B. **Inspections/documentation.** All inspections shall be documented and written reports prepared by the town's compliance officer or compliance consultant that contain the following information:

1. Date and location of the inspection.
2. Date of last storm event.
3. Whether construction is in compliance with the approved stormwater management plan.
4. Variations from approved construction specifications.
5. Photographic documentation of each erosion and sediment control BMP and any other site level techniques employed pursuant to this regulation, such as but not limited to seeding of fill piles, marking of root zone areas of trees, disposal of construction debris, and implementation of any state or federal level record-keeping or reporting procedures related to erosion and sediment control.
6. Recommended actions for replacement, repair, or substitution of BMPs, that are not functioning properly.

Copies of reports and labeled photographs shall be provided to the planning board.

C. **Phases of Inspection.** The schedule for inspections should include the following phases:

1. **Initial site inspection** prior to plan approval, which shall include a site walk by the developer or developer's engineer and contractor, the town's consulting engineer and/or compliance officer, and a member of the planning board.
2. **Erosion control inspection t**o ensure erosion control techniques or structures have been properly installed, and are in accord with the developer's submitted plan.
3. **During and post-storm event inspection.** The town's consultant shall inspect the site during and within 48 hours after the first storm event and subsequent storm events to ensure that erosion and sediment control techniques and drainage structures are functioning properly.
4. **Stormwater management system inspection.** This inspection will include inspection of temporary measures to be employed only during construction, as well as semi-permanent and permanent measures designed to remain for some time period after construction is completed but which may be completed before all construction of the site is completed. The inspector will also note whether construction debris is being disposed of properly and whether other erosion and sediment control measures in addition to those in the approved plan must be instituted by the developer to protect water resources.
4. **Final inspection and storm performance inspection.** The town's consultant shall inspect the system after the system has been constructed and before the surety has been released. This inspection shall also evaluate the effectiveness of the system during and after the first actual storm. No surety will be released until the inspector certifies both the final inspection and the storm performance inspection.

D. **Phasing.** The developer shall submit a phasing plan to the planning board to be reviewed by the town's engineering consultant to ensure compliance with all applicable federal and state level laws and regulations pertaining to stormwater management. The phasing plan shall specify areas of the development to be completed in sequence and shall specify that all necessary infrastructure to support each phase shall be in place prior to the issuance of permits for certificates of occupancy for that phase.

E. **The Planning Process.** All developers must adhere to the four-step process as set forth below and demonstrate this in writing in developing their stormwater management plan during construction and thereafter.

Step 1: Planning. Plan the development to fit the existing site features, including topography, soils, drainage ways, and natural vegetation.

Step 2: Scheduling of Operations. Schedule grading and earthmoving operations to expose the smallest practical area of land for the shortest possible time.

Step 3: Soil Erosion Control. Apply soil erosion control practice and any other techniques as specified in the stormwater management plan to achieve the purposes set forth in this regulation.

Step 4: Inspections and Maintenance. Implement a thorough maintenance program and schedule inspections in conjunction with the town's consultant, to be reviewed by the planning board.

VII. PROCEDURES FOR CONSIDERATION OF INFORMATION SUBMITTED BY THE PUBLIC

A. The planning board shall consider any information submitted by the public concerning the stormwater management plan or site conditions or erosion and sediment control measures before and during construction. The board shall develop a short form to allow citizens to submit information concerning these measures. The board shall consider such information at a properly noticed public hearing even if the application to which the information relates has already been closed. All such information shall be either submitted in writing or as testimony in a properly noticed public hearing.

> This section relates to federal law requirements for small MS4 operators to develop procedures to receive public input. Municipalities may wish to develop a standard form for such information.

VIII. DESIGN STANDARDS

A. **Strategies to Be Employed**

To ensure that all sources or soil erosion and sediment on the construction site are adequately controlled, the following strategies shall be employed:

1. **Minimize the areas of disturbed soil.** Limit site preparation activities such as grading and clearing to where they are absolutely necessary and consistent with the phasing plan and the daily schedule of construction activities.

2. **Maximize the protection and on-site use of native vegetation.** Protect all vegetation not intended for removal by adequately marking, fencing around the drip line of trees, protectively wrapping and temporarily transplanting as necessary.

3. **Reduce the time that soil is left disturbed.** Utilize construction management and by phasing; soil disturbed by construction activities shall be stabilized within 14 days of ceasing disturbance.

4. **Stabilize soil** with seeding and mulch as soon as possible after disturbance. Minimize soil disturbance between October 15 and May 1.

5. **Control water at upslope site perimeters.** Prevent stormwater from entering areas of disturbed soil from outside the site and from other parts of the site. Utilize diversion swales and vegetated strips to reduce the amount of water entering a construction site.
6. **Control water on-site.** On the site water must be controlled and kept to low velocities so that erosion is minimal. This can be achieved through immediate seeding and mulching or the application of sod, as well as the use of structural measures including silt fences, check dams, mulch filter socks, and mechanical tracking of hillsides.
7. **Control sediment on site.** Reduce the amount of sediment produced from areas of disturbed soils, and control the sediment produced on site through seeding and mulching and structural measures.
8. **Control sediment at the down slope site perimeters.** Prevent the off-site transport of all sediment produced on the construction site using vegetated strips, diversion dikes, and swales, sediment traps and basins, stabilized construction entrances, and silt fences or mulch filter socks.
9. **Utilize biological or recyclable materials.** To the extent possible, developers should utilize natural biological materials or recyclable materials as temporary measures that can remain on-site after the completion of construction such as mulch berms or other methods as opposed to silt fences, which must be removed and disposed after the completion of construction activities in order to reduce waste and reduce costs of removal.

B. **Design Standards**

The following standards shall be applied in planning for stormwater management and erosion control:

1. Stormwater management and erosion control designs shall not conflict with minimum N.H. Department of Environmental Services requirements for Alteration of Terrain or other environmental permits required.
2. Measures shall be designed and installed to control the post-development peak rate of runoff so that it does not exceed pre-development runoff for the two-year, 10-year, and 25-year/24-hour storm event and for additional storm event frequencies as specified in the design criteria of the N.H. Stormwater Management Manual.
3. Emergency spillways and down slope drainage facilities shall have capacity to accommodate a 100-year/24-hour storm.
4. All measures in the plan shall meet as a minimum the best management practices set forth in the N.H. Stormwater Management Manual.
5. Stormwater management practices shall be selected to accommodate the unique hydrologic and geologic conditions of the site.
6. The use of low impact development techniques are preferred to intercept, treat, and infiltrate runoff from developed areas distributed throughout the site, as are techniques that restore, enhance, or protect natural areas such as riparian areas, stream channels, wetlands, and forests.
7. Stormwater management systems shall not discharge to surface waters, ground surface, subsurface, or groundwater within 100 feet of surface water within a water supply intake protection area.
8. Any contiguous area of disturbance, not associated with the installation of a roadway, shall be

limited to 20,000 square feet.

9. Contiguous areas of disturbance shall be separated by at least 20 feet of area maintained at natural grade and retaining existing, mature vegetated cover that is at least 20 feet wide at its narrowest point.

10. Roadway and driveway crossings over streams shall meet the following design criteria to accommodate high flows, minimize erosion, and support aquatic habitat and wildlife passage:

    a. Natural stream bottoms.

    b. Sized for 1.2 times bank-full stream width, i.e. the width of the stream during the 1.5-year flow event.

    c. Bridges and culverts shall have an openness ration of greater than or equal to 0.25 (calculated in meters) for perennial streams.

    d. Passageways under roads shall be designed to maintain water velocity at a variety of flows that is comparable to flows in upstream and downstream segments of the natural stream.

    e. Culverts shall have a trough or narrow channel in the bottom running the full length of the culvert to maintain sufficient water depth during low-flow periods to support fish passage.

    f. Round culverts must be imbedded at least 25 percent.

> The above section is intended to provide some overlap with the chapter on Permanent (Post-Construction) Stormwater Management given that the use of techniques designed for the construction phase may overlap with other techniques that remain after construction activities are completed.
>
> In some cases, design of culverts or other wildlife crossings that may be impacted by temporary or permanent stormwater control methods will require the review of such practices by a wildlife biologist who can assess the site's wildlife habitat and recommend practices that will minimize the adverse impact of stormwater control methods on existing wildlife crossing areas. The town may wish to add a provision allowing this limited review and providing for reimbursement of this expense by the developer. Alternatively, the Conservation Commission may appropriately provide information on the natural resources inventory of a town as well as site-level characteristics.

IX. CONSTRUCTION SITE METHODS

A. **Responsibility of the applicant.** The applicant shall bear final responsibility for the installation, construction, inspection, and disposition of all stormwater management and erosion control measures required by the provisions of this regulation.

B. **Daily log of installations, inspections, modifications, rainfall, and repairs or reinstallations.** Construction site operators shall be responsible to ensure erosion and sedimentation control measures approved for the site are installed as designed. A daily log of erosion control measures, inspections, modifications required, rainfall events and erosion observed shall be submitted weekly to the town's engineering consultant, or public works department, or the planning board, at the discretion of the planning board.

C. **Estimate required.** A detailed estimate including unit pricing of temporary and permanent erosion control methods in a form acceptable to the planning board shall be submitted for review by the town's engineering consultant prior to any construction work.

D. **Construction site inspections.** In addition to the general inspections outlined above, the qualified professional serving as the town's consultant shall verify proposed limits of site disturbance and limits of tree removal, including the marking of root zones of trees to be retained, the location of temporary parking of construction vehicles, the location of stockpiles of construction materials, the location of earth stockpiles, and the proposed methods for daily removal of construction waste and debris from the site.

E. **Test upgradient and downgradient waters for turbidity levels**. Both to ensure they meet allowable state and federal standards and to compare these levels in order to evaluate sediment capture through the site.

F. **Pre-construction meeting.** A pre-construction meeting shall take place in which the applicant, town's consultant, site engineer, site contractor, road agent, and any other key town personnel as necessary attend to discuss the site, the development plans, and all aspects of site construction.

G. **Pre-winter meeting.** A pre-winter meeting shall be held not later than September 15 of each year prior to the acceptable completion of site work, in order that town staff, the applicant, the contractor, the site engineer, the town's consultant, and other involved parties specify measures to secure the site for the winter season.

H. **Documentation.** Copies of all required permits and permit applications relative to the site, such as Site Specific Permit, and the Stormwater Pollution Prevention Plan shall be provided to the planning board and shall be considered as necessary for any conditional approval.

I. **Installation of erosion and sediment control devices**. Erosion and sedimentation control devices shall be installed prior to site disturbance or tree removal that would create erosion and sediment control issues.

J. **Certification.** No building permit shall be issued by the town until the town's consultant has certified that the site construction has proceeded in accordance with stormwater management and erosion and sedimentation control standards, plans, and specifications, and that the relevant portion of the site has been reasonably stabilized, and until the town's consultant has certified that all utilities, drainage and stormwater management measures and roadway base course of paving have been satisfactorily installed on the site.

K. **Surety.** An estimate shall be developed for the construction period, which shall include all erosion control costs. The applicant may request periodic release of such surety for work completed and verified by the town's consultant. At the completion of the construction and final acceptance by the town, the applicant may request up to 85 percent of escrow funds. The remaining escrow shall be held for two years after the completion of construction and acceptance by the town at which time the town's consultant will certify all temporary erosion controls that should be removed have been removed and all permanent measures have been installed and are functioning and have been maintained as intended. The site engineer shall develop and submit a maintenance plan for permanent erosion control and sedimentation and an estimate of annual maintenance costs. The plan shall include any necessary easements or other legal documents necessary to allow periodic inspection for a period of two years after completion of the project. Upon receipt of the certification and maintenance plan and legal review of easements or other legal documents as described herein, the town shall release the remaining funds.

X. CONSTRUCTION PRACTICES

A. Natural vegetation shall be retained, protected or supplemented to the extent practical. The stripping of vegetation shall be done in a manner that minimizes soil erosion.

B. Excavation equipment shall not be placed in the base of an infiltration area during construction. Excavation or other construction vehicles shall not be placed in the root zone areas of trees to be retained during construction.

C. Construction equipment and materials shall be stored at a distance greater than 25 feet from drainage channels, streams, lakes or wetlands.

D. Onsite wastes generated during the course of construction, including, but not limited to discarded building materials, concrete truck washout, chemicals, litter, and sanitary waste shall be removed from the site daily to the extent feasible or at a regular interval as specified in the construction sequence and schedule of daily activities for the project and disposed of properly.

E. No ground disturbed as a result of site construction and development shall be left as exposed bare soil. All areas exposed by construction, with the exception of finished building, structure, and pavement footprints, shall be decompacted (aerated) and covered with a minimum thickness of six inches of non-compacted topsoil, and shall be subsequently planted with a combination of living vegetation such as grass, groundcovers, trees, and shrubs, and other landscaping materials such as mulch, loose rock, gravel or stone. Native, non-invasive species as defined or listed on the New Hampshire DES Shoreland Protection List of Native Shoreland and Riparian Buffers Plantings in New Hampshire.

XI. REQUIRED SUBMISSIONS IN STORMWATER MANAGEMENT PLANS FOR APPLICATION REVIEW

A. In addition to any information generally required by the town for subdivision or site plan application, the applicant must submit the following items to the planning board for review:

1. Existing and proposed conditions including the following elements

    a. Local map showing property boundaries.
    b. North arrow, scale, and date of plan and plan amendments.
    c. Surveyed property lines.
    d. Structures, roads, utilities, earth stockpiles, equipment storage, and stump disposal.
    e. Records of any timbering activities within the past five years.
    f. Topographic contours at two-foot intervals.
    g. Critical areas relating to natural resources as defined at a regional level, state level, or local level by a regional, state, or local level natural resource inventory.
    h. Stockpile areas, and staging areas.

i. Within the project area, within 400 feet of project boundary, and upgradient within the watershed or appropriate portions thereof, all surface waters, waterbodies, streams, intermittent streams, ephemeral streams, wetlands, vernal pools, and drainage patterns and watershed boundaries.

j. Identified wildlife corridors if referenced in a local, regional, or state level natural resources plan

k. Vegetation, including description of species.

l. Extent of the 100-year flood plain when applicable.

m. Soil information from a National Cooperative Soils Survey soil series map or a High Intensity Soil Map.

n. Easements or covenants.

o. Areas of soil disturbance or remediation areas.

p. Areas of cut and fill.

q. Areas of poorly or very poorly drained soils, including any portion to be disturbed or filled.

r. Location of all structural, non-structural, and vegetative stormwater management and erosion control BMPs.

s. Detail sheet showing each BMP.

t. Phasing plan.

u. Inspection schedule.

v. Construction schedule.

w. Earth movement and grading schedule.

x. Construction Erosion and Sediment Control Plan that complies with the provisions of this regulation.

y. An operations and maintenance plan.

z. Spill prevention plan and emergency management plan for spills of potentially hazardous materials.

aa. Surety.

bb. Identification of alternatives in the drainage system design that provide for contingencies during storm events, for instance, and alternative for water flow in case a critical culvert becomes blocked by debris.

cc. Design calculations for all temporary and permanent BMPs and a narrative description of each measure, its purpose, construction sequence, and installation timing.

dd. Drainage report with inclusion of more frequent small storms as well as traditional calculations.

ee. Landscaping Plan (unless required by other sections of the regulations).

ff. Notation of soil types (unless required by other sections of the regulations).

XII. PRE-CLEARING

The applicant shall provide pre and post development peak flow rates in stormwater calculations. Any site that was wooded in the last five years must be considered undisturbed woods for the purposes of calculating pre-development peak flow rates.

XIII. ENFORCEMENT

The planning board may pursue any remedies authorized in the New Hampshire Revised Statutes Annotated for non-compliance with the specifications of an approved plan including revocation of the recorded plan.

PERMANENT (POST-CONSTRUCTION) STORMWATER MANAGEMENT MODEL ORDINANCE

BY THE REGIONAL ENVIRONMENTAL PLANNING PROGRAM

Model Language and Guidance for Implementation

PERMANENT (POST-CONSTRUCTION) STORMWATER MANAGEMENT MODEL ORDINANCE

I. PURPOSE

To protect, maintain and enhance the public health, safety, environment, and general welfare by establishing minimum requirements and procedures to control the adverse affects of increased post-development stormwater runoff, decreased groundwater recharge, and non-point source pollution associated with new development and redevelopment.

II. AUTHORITY

The provisions of this Article are adopted pursuant to RSA 674:16, Grant of Power, RSA 674:17, Purposes of Zoning Ordinance, and RSA 674:21, Innovative Land Use Controls.

III. APPLICABILITY

The requirements of this Article shall apply to land disturbance, development, and/or construction activities in all zoning district(s).

IV. DEFINITIONS

> Communities should review existing definitions sections prior to the adoption of any of the following definitions to avoid duplication or conflicting definitions.

Best Management Practice (BMP): Structural, non-structural and managerial techniques that are recognized to be the most effective and practical means to prevent and/or reduce increases in stormwater volumes and flows, reduce point source and non-point source pollution, and promote stormwater quality and protection of the environment.

Curve Number (CN): A numerical representation used to describe the stormwater runoff potential for a given drainage area based on land use, soil group, and soil moisture, derived as specified by the U.S. Department of Agriculture, Natural Resources Conservation Service (USDA/NRCS).

Developer: A person who undertakes or proposes to undertake land disturbance activities.

Development: For the purposes of this article, development refers to alterations to the landscape that create, expand or change the location of impervious surfaces or alters the natural drainage of a site.

Disconnected Impervious Cover: Impervious cover that does not contribute directly to stormwater runoff from a site, but directs stormwater runoff to on-site pervious cover to infiltrate into the soil or be filtered by overland flow so that the net rate and volume of stormwater runoff from the disconnected impervious cover is not greater than the rate and volume from undisturbed cover of equal area.

Drainage Area: Means a geographic area within which stormwater, sediments, or dissolved materials drain to a particular receiving waterbody or to a particular point along a receiving waterbody.

Effective Impervious Cover: Impervious cover that is not disconnected impervious cover.

Erosion: The detachment and movement of soil, rock, or rock fragments by water, wind, ice or gravity.

Impervious Cover: A structure or land surface with a low capacity for infiltration, including but not limited to pavement, roofs, roadways, and compacted soils, that has a Curve Number of 98 or greater.

Infiltration: The process by which water enters the soil profile (seeps into the soil).

Land Disturbance or Land Disturbing Activity: For the purposes of this Article, refers to any exposed soil resulting from activities such as clearing of trees or vegetation, grading, blasting, and excavation.

Owner: A person with a legal or equitable interest in a property.

Pervious Cover: A land surface with a high capacity for infiltration.

Recharge: The amount of water from precipitation that infiltrates into the ground and is not evaporated or transpired.

Redevelopment: The reuse of a site or structure with existing man-made land alterations. A site is considered a redevelopment if it has 35 percent or more of existing impervious surface, calculated by dividing the total existing impervious surface by the size of the parcel and convert to a percentage.

Regulated Substance: A "regulated substance" as defined in Env-Ws 421.03(f) or successor rule, Env-Wq 401.03(h).

Sediment: Solid material, mineral or organic, that is in suspension, is being transported, or has been moved from its site of origin by air, water or gravity as a product of erosion.

Sensitive Area: For the purpose this Article include lakes, ponds, perennial and intermittent streams, vernal pools, wetlands, and highly erodable soils.

Sheet flow: Runoff that flows or is directed to flow across a relatively broad area at a depth of less than 0.1 feet for a maximum distance of 100 feet in such a way that velocity is minimized.

Site: The lot or lots on upon which development is to occur or has occurred.

Stormwater: Water resulting from precipitation (including rain and snow) that runs off the land's surface, is transmitted to the subsurface, or is captured by separate storm sewers or other drainage facility.

Stormwater Runoff: Water flow on the surface of the ground or in storm sewers, resulting from precipitation.

Total Impervious Cover: The sum of Disconnected Impervious Cover plus Effective Impervious Cover.

Undisturbed Cover: A natural land surface whose permeability has not been altered by human activity.

Vegetation: Is defined to include a tree, plant, shrub, vine or other form of plant growth.

Wellhead Protection Area: As defined in RSA 485-C:2, XVIII, the surface and subsurface area surrounding a water well or well field, supplying a public water system, through which contaminants are reasonably likely to move toward and reach such water well or well field.

V. STORMWATER MANAGEMENT PLAN

All developments disturbing greater than 20,000 square feet of area shall submit a permanent (post-construction) Stormwater Management Plan (SMP) with an application for subdivision or site plan review. The permanent SMP, which shall be prepared by a licensed New Hampshire, professional engineer, shall address and comply with the requirements set forth herein and as specified by the planning board.

Each community should decide whether it wants to require a separate management plan and, if so, what size development or disturbed area is subject to this requirement. A community might also decide to restrict the applicability of additional provisions from this model ordinance to larger developments or developments in more sensitive areas.

VI. PERMANENT STORMWATER MANAGEMENT REQUIREMENTS

All development activity must comply with the following provisions to reduce and properly manage stormwater post-construction:

A. Maximum effective impervious cover shall not exceed 10 percent of a site. Impervious cover may be disconnected from the stormwater drainage network, to reduce total effective impervious cover, through such techniques as infiltration or sheet flow over a pervious area.

As noted in the definitions, Effective Impervious Cover is different from Impervious Cover. For example, to comply with this section, a site that creates 50 percent impervious cover must provide ample opportunities to capture and infiltrate stormwater to reduce the amount of stormwater leaving the site to be equivalent to having just 10 percent impervious cover (i.e., the site has 10 percent effective impervious cover).

B. BMP techniques shall be used to meet the conditions below for control of peak flow and total volume of runoff, water quality protection, and maintenance of on-site groundwater recharge.

1. Stormwater management practices shall be selected to accommodate the unique hydrologic and geologic conditions of the site.

An example of a site condition that should be factored into the stormwater management approach is soil type. The areas of a site with the best soils for infiltration should be preserved to maintain natural infiltration or set aside to be used for infiltrating stormwater generated elsewhere on the site.

2. The use of nontraditional and/or nonstructural stormwater management measures, including site design approaches to reduce runoff rates, volumes, and pollutant loads, are preferred and shall be implemented to the maximum extent practical. Such techniques include, but are not limited to, minimization and/or disconnection of impervious surfaces; development design that reduces the rate and volume of runoff; restoration or enhancement of natural areas such as riparian areas, wetlands, and forests; and use of practices that intercept, treat, and infiltrate runoff from developed areas distributed throughout the site (e.g. bioretention, infiltration dividers or islands, or planters and raingardens). Applicants shall demonstrate why the use of nontraditional

and/or nonstructural approaches are not possible before proposing to use traditional, structural stormwater management measures (e.g., stormwater ponds, vegetated swales).

3. The applicant shall demonstrate how the proposed control(s) will comply with the requirements of this ordinance, including the control of peak flow and total volume of runoff, protection of water quality, and recharge of stormwater to groundwater. The applicant must provide design calculations and other back-up materials necessary.
4. At the discretion of the planning board, stormwater management systems shall incorporate designs that allow for shutdown and containment in the event of an emergency spill or other unexpected contamination event.

Communities may wish to include a provision to require emergency shutdown and containment, particularly in commercial and industrial areas or in drinking water supply areas, as an added protection against contamination of surface waters or groundwaters.

5. Stormwater management systems shall not discharge to surface waters, ground surface, subsurface, or groundwater within 100 feet of a surface water within a water supply intake protection area.
6. Stormwater management systems shall not discharge within the setback area for a water supply well as specified in the following table:

The NHDES Alteration of Terrain program provides for exemptions to the above standards (5) and (6) for stormwater management systems that discharge stormwater form areas less than 0.5 acres and that do not and will not receive stormwater from high-load area. The exemption is designed to encourage low impact development.

Well Type	Well Production Volume (gallons per day)	Setback from Well (feet)
Private Water Supply Well	Any Volume	75
Non-Community Public Water Supply Well	0 to 750	75
	751 to 1,440	100
	1,441 to 4,320	125
	4,321 to 14,400	150
Community Public Water Supply Well	0 to 14,400	150
Non-Community and Community Public Water Supply Well	14,401 to 28,800	175
	28,801 to 57,600	200
	57,601 to 86,400	250
	86,401 to 115,200	300
	115,201 to 144,000	350
	Greater than 144,000	400

7. BMPs shall be designed to convey a minimum design storm event, as described in the table below, without overtopping or causing damage to the stormwater management facility.

Treatment Practice	Design Storm Event
Stormwater Pond	50-year, 24-hour storm
Stormwater Wetland	50-year, 24-hour storm
Infiltration Practices	10-year, 24-hour storm
Filtering Practices	10-year, 24-hour storm
Flow through Treatment Swales	10-year, 24-hour storm

C. Protection of natural hydrologic features and functions.

1. Site disturbance shall be minimized. Vegetation outside the project disturbance area shall be maintained. The project disturbance area shall be depicted on site plans submitted as part of the site plan review process. The project disturbance area shall include only the area necessary to reasonably accommodate construction activities. The applicant may be required to install construction fencing around the perimeter of the proposed project disturbance area prior to commencing land disturbance activities.

2. Soil compaction on site shall be minimized by using the smallest (lightest) equipment possible and minimizing travel over areas that will be revegetated (e.g., lawn areas) or used to infiltrate stormwater (e.g., bioretention areas). In no case shall excavation equipment be placed in the base of an infiltration area during construction.

3. Development shall follow the natural contours of the landscape to the maximum extent possible. A grading plan shall be submitted as part of the site plan review process showing both existing and finished grade for the proposed development.

4. Cut and fill shall be minimized. The maximum height of any fill or depth of any cut area, as measured from the natural grade, shall not be greater than 10 feet.

5. Any contiguous area of disturbance, not associated with the installation of a roadway, shall be limited to 20,000 square feet for residential development and to 100,000 square feet for other types of development. Contiguous areas of disturbance shall be separated by an area maintained at natural grade and retaining existing, mature vegetated cover that is at least 20 feet wide at its narrowest point.

Communities may decide to allow a larger contiguous area of disturbance overall or in certain areas where appropriate, such as in areas zoned for larger-scale commercial or industrial use.

6. No ground disturbed as a result of site construction and development shall be left as exposed bare soil at project completion. All areas exposed by construction, with the exception of finished

building, structure, and pavement footprints, shall be decompacted (aerated) and covered with a minimum thickness of six inches of non-compacted topsoil, and shall be subsequently planted with a combination of living vegetation such as grass, groundcovers, trees, and shrubs, and other landscaping materials (mulch, loose rock, gravel, stone).

7. Priority shall be given to maintaining existing surface waters and systems, including, but not limited to, perennial and intermittent streams, wetlands, vernal pools, and natural swales.

    a. Existing site hydrology shall not be modified so as to disrupt on-site and adjacent surface waters. The applicant must provide evidence that this standard can be achieved and maintained over time.

    b. Existing surface waters, including lakes, ponds, rivers, perennial and intermittent streams, wetlands, vernal pools, and natural swales, shall be protected by a 50 foot no disturbance, vegetated buffer.

> The 50 foot buffer requirement under 7.b-. is meant as a bare-minimum standard for communities that do not have more specific buffer requirements. While a 50 foot buffer will provide some water quality benefits, it will not be adequate in all situations (e.g., particularly steep slopes) or sufficient to meet all the natural resource protection goals of a community. Communities should determine whether a broader buffer requirement is appropriate for their community to provide additional water quality and other benefits, such as wildlife habitat and corridor protection and human recreation opportunities. Other chapters in this series, particularly those pertaining specifically to the protection of surface water resources and habitat, provide additional information on appropriate buffer widths and protections to achieve various natural resource protection goals.

    c. BMPs shall not be located within the 50 foot no disturbance, vegetated buffer or within 50 feet of steep banks (greater than 15 percent slope).

    d. Where roadway or driveway crossings of surface waters cannot be eliminated, disturbance to the surface water shall be minimized, hydrologic flows shall be maintained, there shall be no direct discharge of runoff from the roadway to the surface water, and the area shall be revegetated post-construction.

    e. Stream and wetland crossings shall be eliminated whenever possible. When necessary, stream and wetland crossings shall comply with state recommended design standards to minimize impacts to flow and animal passage. (See NH Fish and Game Department, 2008.)

D. Post-development peak flow rates and total runoff volumes.

1. The applicant shall provide pre- and post-development peak flow rates. Any site that was wooded in the last five years must be considered undisturbed woods for the purposes of calculating pre-development peak flow rates.

2. The two-year, 24-hour post-development peak flow rate shall be (a) less than or equal to 50 percent of two-year, 24-hour storm pre-development peak flow rate or (b) less than or equal to the one-year, 24-hour storm pre-development peak flow rate.

3. The 10-year, 24-hour post-development peak flow rate shall not exceed the 10-year, 24-hour pre-

development peak flow rate for all flows off-site.

4. The 50-year, 24-hour post-development peak flow rate shall not exceed the 50-year, 24-hour pre-development peak flow rate for all flows off-site.

> The NHDES Alteration of Terrain program provides for exemptions to the standards D.2, D.3, and D.4 for projects that directly discharge to a stream, waterbody, estuary, or tidal water and where the applicant has provided supporting off-site drainage calculations for the 10-year and 50-year, 24-hour storm showing that at a point immediately downstream from the project site the post-development peak flow rate from the site and the off-site contributing area does not exceed the pre-development peak flow rate at that point.

5. Measurement of peak discharge rates shall be calculated using point of discharge or the down-gradient property boundary. The topography of the site may require evaluation at more than one location if flow leaves the property in more than one direction. Calculations shall include runoff from adjacent up-gradient properties.

6. An applicant may demonstrate that a feature beyond the property boundary is more appropriate as a design point.

7. The applicant shall provide pre- and post-development total runoff volumes. Any site that was wooded in the last five years shall be considered undisturbed woods for the purposes of calculating pre-development total runoff volumes.

8. The post-development total runoff volume shall be equal to 90 to 110 percent of the pre-development total runoff volume (based on a two-year, 10-year, 25-year, and 50-year, 24-hour storms). Calculations shall include runoff from adjacent up-gradient properties.

E. Water Quality

1. If more than 35 percent of the total area of the site will be disturbed or the site will have greater than 10 percent effective impervious cover, the applicant shall demonstrate that their stormwater management system will:

   a. Remove 80 percent of the average annual load of total suspended solids (TSS), floatables, greases, and oils after the site is developed.

   b. Remove 40 percent of phosphorus.

> Depending on the existing water quality of downstream receiving waters, in particular if a waterbody is impaired or designated as an "outstanding resource water," development projects requiring an Alteration of Terrain Permit or a 401 Water Quality Certification from the state may be subject to more stringent pollutant removal requirements than specified in Sections E. 1. a. and b.

2. Compliance with the recharge requirements under Section F, consistent with the pre-treatment and design requirements in Sections F.2 and F.3, shall be considered adequate to meet the treatment standards specified in VI.E.1.

3. Applicants not able to employ Section F must provide suitable documentation, including a pollutant loading analysis from an approved model, that the treatment standards specified in VI.E.1 will be met.

F. Recharge to Groundwater

Except where prohibited, stormwater management designs shall demonstrate that the annual average pre-development groundwater recharge volume (GRV) for the major hydrologic soil groups found on-site are maintained.

1. For all areas covered by impervious cover, the total volume of recharge that must be maintained shall be calculated as follows:

   a) REQUIRED GRV =
   (Total Impervious Cover) x (Groundwater Recharge Depth)

   Where Total Impervious Cover is the area of proposed impervious cover that will exist on the site after development.

   And where Groundwater Recharge Depth is expressed as follows:

USDA/NRCS Hydrologic Soil Group (HSG)	Groundwater Recharge Depth (inches)
A	0.40
B	0.25
C	0.10
D	not required

Example: Applicant proposes 30,000 square foot parking lot over C soils.
REQUIRED GRV = 30,000 X 0.10
REQUIRED GRV= 250 ft3

   b. Where more than one hydrologic soil group is present, a weighted soil recharge factor shall be computed.

2. Pre-Treatment Requirements

   a. All runoff must be pretreated prior to its entrance into the groundwater recharge device to remove materials that would clog the soils receiving the recharge water.

   b. Pretreatment devices shall be provided for each BMP, shall be designed to accommodate a minimum of one-year's worth of sediment, shall be designed to capture anticipated pollutants, and be designed and located to be easily accessible to facilitate inspection and maintenance.

> The use of below-ground pre-treatment devices should be discouraged because of the added difficulty in assessing their function and performing regular inspections and maintenance.

3. Sizing and design of infiltration (recharge) BMPs

   a. All units shall be designed to drain within 72 hours from the end of the storm.

> This design requirement addresses concerns about infiltration BMPs contributing to mosquito problems. Requiring such facilities to drain within 72 hours will prevent mosquitoes from successfully breeding.

   b. The floor of the recharge device shall be at least three feet above the seasonal high water table and bedrock.

   c. Soils under BMPs shall be scarified or tilled to improve infiltration.

   d. Infiltration BMPs shall not be located in areas with materials or soils containing regulated or hazardous substances or in areas known to DES to have contaminants in groundwater above ambient groundwater quality standards or in soil above site-specific soil standards.

4. Infiltration may be prohibited or subject to additional pre-treatment requirements under the following circumstances:

   a. The facility is located in a well-head protection area or water supply intake protection area; or

   b. The facility is located in an area where groundwater has been reclassified to GAA, GA1 or GA2 pursuant to RSA 485-C and Env-Dw 901; or

   c. Stormwater is generated from a "high-load area," as described under Section G.

G. Land Uses with Higher Potential Pollutant Loads

1. The following uses or activities are considered "high-load areas," with the potential to contribute higher pollutant loads to stormwater, and must comply with the requirements set forth in subsections 2, 3, and 4 below:

   a. Areas where regulated substances are exposed to rainfall or runoff; or

   b. Areas that typically generate higher concentrations of hydrocarbons, metals, or suspended solids than are found in typical stormwater runoff, including but not limited to the following:

      i. Industrial facilities subject to the NPDES Multi-Sector General Permit (MSGP); not including areas where industrial activities do not occur, such as at office buildings and their associated parking facilities or in drainage areas at the facility where a certification of no exposure will always be possible [see 40CFR122.26(g)].

      ii. Petroleum storage facilities.

      iii. Petroleum dispensing facilities.

      iv. Vehicle fueling facilities.

      v. Vehicle service, maintenance and equipment cleaning facilities.

      vi. Fleet storage areas.

      vii. Public works storage areas.

viii. Road salt storage and loading facilities.

ix. Commercial nurseries.

x. Non-residential facilities having uncoated metal roofs with a slope flatter than 20 percent.

xi. Facilities with outdoor storage, loading, or unloading of hazardous substances, regardless of the primary use of the facility.

xii. Facilities subject to chemical inventory under Section 312 of the Superfund Amendments and Reauthorization Act of 1986 (SARA).

xiii. Commercial parking areas with over 1,000 trips per day.

c. If a high-load area demonstrates, through its source control plan, the use of best management practices that result in no exposure of regulated substances to precipitation or runoff or release of regulated substances, it shall no longer be considered a high-load area.

> Information on the Multi-Sector General Permit for commercial and industrial sites is available at http://cfpub.epa.gov/ npdes/stormwater/swppp-msgp.cfm.
>
> The uses listed under 1.b.ii – 1.b.xiii are generally not subject to the MSGP, unless associated with another use or specific activity that is covered under the MSGP. A municipality may decide not to regulate one or more of these types of uses, or to cover additional types of uses that may represent a threat to water quality in their community (e.g., auto recyclers/salvage yards; marina service areas).

2. In addition to implementation of BMPs for designing site-specific stormwater management controls, uses included under subsection G.1 shall provide a stormwater pollution prevention plan (SWPPP, see margin note below), describing methods for source reduction and methods for pretreatment.

> Example Stormwater Pollution Prevention Plans (SWPPP) are available at http://cfpub.epa.gov/npdes/ stormwater/ swppp-msgp. cfm.

3. Infiltration of stormwater from high-load areas, except commercial parking areas, is prohibited. Infiltration, with appropriate pre-treatment (e.g., oil/water separation) and subject to the conditions of the SWPPP, is allowed in commercial parking areas and others areas of a site that do not involve potential “high-load” uses or activities (e.g., where a certification of “no exposure” under the MSGP will always be possible).
4. For high-load areas, except commercial parking areas, filtering and infiltration practices, including but not limited to, sand filters, detention basins, wet ponds, gravel wetlands, constructed wetlands, swales or ditches, may be used only if sealed or lined.

H. Parking

1. Snow may not be plowed to, dumped in, or otherwise stored within 15 feet of a wetland or waterbody, except for snow that naturally falls into this area. Snow storage areas shall be shown on the site plan to comply with these requirements.
2. At the discretion of the planning board, parking spaces may be allowed, or required, to be constructed of a pervious surface (i.e. grass, pervious asphalt, pervious pavers).
3. Infrequently used emergency access points or routes shall be constructed with pervious surfaces (i.e. grass, pervious asphalt, pervious pavers).

I. Redevelopment or Reuse

1. Redevelopment or reuse of previously developed sites must meet the stormwater management standards set forth herein to the maximum extent possible as determined by the planning board. To make this determination the planning board shall consider the benefits of redevelopment as compared to development of raw land with respect to stormwater.
2. Redevelopment or reuse activities shall not infiltrate stormwater through materials or soils containing regulated or hazardous substances.
3. Redevelopment or reuse of a site shall not involve uses or activities considered “high-load areas” unless the requirements under Section G. are met.

J. Easements

1. Where a site is traversed by or requires construction of a watercourse or drainageway, an easement of adequate width may be required for such purpose.
2. There shall be at least a ten foot wide maintenance easement path on each side of any stormwater management system element. For systems using underground pipes, the maintenance easement may need to be wider, depending on the depth of the pipe.

K. Performance Bond

1. To ensure that proposed stormwater management controls are installed as approved, a performance bond shall be provided as a condition of approval in an amount determined by the planning board.
2. To ensure that stormwater management controls function properly, a performance bond shall be required, as a condition of approval, which may be held after final certificate of occupancy is issued.

L. Operation and Maintenance Plan

1. All stormwater management systems shall have an operations and maintenance (O&M) plan to ensure that systems function as designed. This plan shall be reviewed and approved as part of the review of the proposed permanent (post-construction) stormwater management system and incorporated in the Permanent Stormwater Management Plan, if applicable. Execution of the O&M plan shall be considered a condition of approval of a subdivision or site plan. If the stormwater management system is not dedicated to the city/town pursuant to a perpetual offer of dedication, the planning board may require an applicant to establish a homeowners association or

similar entity to maintain the stormwater management system. For uses and activities under Section G, the O&M plan shall include implementation of the Stormwater Pollution Prevention Plan (SWPPP).

2. The stormwater management system owner is generally considered to be the landowner of the property, unless other legally binding agreements are established.

3. The O&M plan shall, at a minimum, identify the following:

    a. Stormwater management system owner(s), (For subdivisions, the owner listed on the O&M plan shall be the owner of record, and responsibilities of the O&M plan shall be conveyed to the party ultimately responsible for the road maintenance, i.e. the Town should the road be accepted by the Town, or a homeowners association or other entity as determined/required under Section VI.L.1 above.)

    b. The party or parties responsible for operation and maintenance and, if applicable, implementation of the Stormwater Pollution Prevention Plan (SWPPP).

    c. A schedule for inspection and maintenance.

    d. A checklist to be used during each inspection.

    e. The description of routine and non-routine maintenance tasks to be undertaken.

    f. A plan showing the location of all stormwater management facilities covered by the O&M plan.

    g. A certification signed by the owner(s) attesting to their commitment to comply with the O&M plan.

4. Recording:

    a. The owner shall provide covenants for filing with the registry of deeds in a form satisfactory to the planning board, which provide that the obligations of the maintenance plan run with the land.

    b. The owner shall file with the registry of deeds such legal instruments as are necessary to allow the city/town or its designee to inspect or maintain the stormwater management systems for compliance with the O&M plan.

5. Modifications:

    a. The owner shall keep the O&M plan current, including making modifications to the O&M plan as necessary to ensure that BMPs continue to operate as designed and approved.

    b. Proposed modifications of O&M plans including, but not limited to, changes in inspection frequency, maintenance schedule, or maintenance activity along with appropriate documentation, shall be submitted to the planning board for review and approval within thirty days of change.

    c. The owner must notify the planning board within 30 days of a change in owner or party responsible for implementing the plan.

    d. The planning board may, in its discretion, require increased or approve decreased frequency of inspection or maintenance or a change in maintenance activity. For a reduced frequency of inspection or maintenance, the owner shall demonstrate that such changes will not compromise the long-term function of the stormwater management system.

e. The planning board shall notify the owner of acceptance of the modified plan or request additional information within 60 days of receipt of proposed modifications. No notification from the planning board at the end of 60 days shall constitute acceptance of the plan modification. The currently approved plan shall remain in effect until notification of approval has been issued, or the 60 day period has lapsed.

M. Record Keeping

1. Parties responsible for the operation and maintenance of a stormwater management system shall keep records of the installation, maintenance and repairs to the system, and shall retain records for at least five years.

2. Parties responsible for the operation and maintenance of a stormwater management system shall provide records of all maintenance and repairs to the [______ *i.e. Code Enforcement Officer, Board of Selectmen*], during inspections and/or upon request.

N. Enforcement

When the responsible party fails to implement the O&M plan, including, where applicable, the SWPPP, as determined by the Code Enforcement Officer or Board of Selectmen, the municipality is authorized to assume responsibility for their implementation and to secure reimbursement for associated expenses from the responsible party, including, if necessary, placing a lien on the subject property.

VII. AUTHORIZATION TO ISSUE A SPECIAL USE PERMIT

A. Authority is hereby granted to the planning board, as allowed under RSA 674:21 II, to issue a special use permit to allow variations from the requirements and restrictions set forth in this section upon the request of the applicant provided the development design and proposed stormwater management approach satisfy the following conditions:

1. Such modifications are consistent with the general purpose and standards of this section and shall not be detrimental to public health, safety or welfare;

2. The modified design plan and stormwater management approach shall meet the performance standards under sections VI.D-VI.F of this ordinance; and

3. The modified design plan and stormwater management approach shall satisfy all state and/or federal permit requirements, as applicable.

VIII. ENGINEERING REVIEW

A. The applicant shall submit a fee, as determined by the planning board, with their application for subdivision or site plan review to cover the cost of outside engineering review of their proposed permanent post-construction stormwater management system(s), and the separate Permanent Post-Construction Stormwater Management Plan (SMP) and Stormwater Pollution Prevention Plan

(SWPPP), if applicable.

B. Additional copies of all plans, engineering studies, and additional information as requested by the planning board describing the proposed permanent post-construction stormwater management system shall be provided as necessary to allow for a thorough outside engineering review.

> Municipalities have the option of granting the planning board the authority to issue a special use permit (also known as a conditional use permit) as a means of giving the planning board and applicants greater flexibility to meet the requirements of this section. The advantage of allowing a special use permit option is that the planning board can work with an applicant to modify a plan when it is in the best interest of the community, while still ensuring compliance with the intent of the ordinance, without forcing the applicant to pursue a zoning variance.

MODEL ORDINANCE FOR ZONING

LANDSCAPING

BY THE REGIONAL ENVIRONMENTAL PLANNING PROGRAM

Model Language and Guidance for Implementation

When considering the impacts of development on the environment, preservation of the existing landscape may be generally desirable, but is not always a practical or an available option. Most new, expanded or re-development construction projects require buildings, pavement, and, if required, at least some new landscaping. The model language below is designed to assist communities with striking a balance between preserving existing resources (i.e. vegetation, topography, and soil) and establishing requirements for selection, design, installation, and maintenance of new landscaping features. The model language addresses a combination of landscaping functions that provide a variety of environmental, economic, and social benefits to communities.

Due to the unique characteristics presented with each site, the applicability of landscaping standards should be considered on a site-specific basis. Including comprehensive landscaping requirements within a community's subdivision and site plan regulations, rather than the zoning ordinance, provides greater flexibility for considering the unique characteristics of each site.

A model zoning ordinance and model subdivision and site plan review regulations are presented below.

MODEL ORDINANCE FOR ZONING

ARTICLE __: LANDSCAPING

I. PURPOSE

The purpose of this article is to protect, enhance and promote the economic, ecological and aesthetic environment and protect and conserve the water resources of the Town/City of _____ through the use of certain landscape elements.

II. AUTHORITY

The provisions of this Article are adopted pursuant to RSA 674:16, Grant of Power and RSA 674:21, Innovative Land Use Controls.

III. APPLICABILITY

The requirements of this Article shall apply to ________ zoning district(s), and are consistent with the goals of the Town/City of ____ Master Plan (adopted on _____) including _________________________.

IV. DEFINITIONS

Arboriculture: The planting and care of woody plants (trees, shrubs, vines, and groundcovers).

Caliper: Diameter of a tree at 6 inches from the ground for trees 4 inches and under in caliper, and measured at 12 inches from the ground for trees measuring over 4 inches in caliper.

Damage: In reference to landscaping, includes any intentional, negligent, or accidental act that will cause vegetation to decline or die within a period of two years, including but not limited to, injury by heavy equipment; soil compaction by vehicular or pedestrian overuse; natural grade changes (cuts or fills); snow plow or snow load injury; fire injury or secondary infections through disease or pest infestation.

Dripline: An imaginary vertical plumb line that extends downward from the tips of the outermost tree branches and intersects the ground.

Drought Tolerant or Drought Resistant: A tree, shrub, or other plant that once established, will require limited or no regular irrigation for adequate appearance, growth and disease resistance.

Ground Cover: Low plants which generally form a continuous cover over time that are typically 3 feet or less in height.

Impervious Surface: Land surface with a low capacity for soil infiltration, including but not limited to pavement, roofs, roadways, human structures, paved parking lots, sidewalks, driveways (gravel and paved), and patios. Total impervious cover shall be calculated by determining the total of all impervious surfaces on a site as described above, regardless of whether the impervious surfaces are contiguous or non-contiguous.

Invasive (Plant) Species: Any plant species included on the most current list of prohibited invasive species prepared by the New Hampshire Invasive Species Committee.

Landscaped Area or Landscaping: That area within the boundaries of a given lot that is devoted to, and consists of, landscaping material, including but not limited to, trees, shrubs, perennials, vines, grasses, or other groundcovers, and annual flower beds. Hardscape materials may be included such as planters, brick, stone, placed rocks or boulders, water forms, and aggregates.

Landscape Plan: Graphic and written specifications for design, planting, and maintenance as well as detailed plans to create, arrange, and modify natural and man-made features.

Maintain, Maintenance: In reference to landscaping includes mulching, mowing, spraying, irrigating, fertilizing, propping, bracing, treating for disease or injury, snow removal, proper pruning techniques based on current arboriculture standards, and any other similar acts which promote the life, growth, health, safety, or beauty of the landscape vegetation.

Mulch: An organic material such as tree bark, wood chips, pine needles, leaf litter, grass clippings, or seed hulls used to control weed growth, reduce soil erosion and reduce water loss.

Native (Plant) Species – Plants that currently (or historically) grow as part of natural ecosystems that have co-evolved within the same planting zone.

New Development: Any construction or land disturbance of a parcel of land that removes or alters the vegetation or soil.

Parking Lot: Any off-street, unenclosed ground level facility used for the purpose of temporary storage of motor vehicles. Enclosed parking facilities, such as single or multi-story garages or parking facilities constructed within the confines of a larger building or structure, or parking facilities associated with single-family and duplex residential development are not included within this definition.

Parking Lot Island: A planting island contained completely within the confines of a parking lot.

Redevelopment: The reuse of a site or structure with existing man-made land alterations. A site is considered a redevelopment if it has 35 percent or more of existing impervious surface, calculated by dividing the total existing impervious surface by the size of the parcel and converting to a percentage.

Sediment: Solid material, mineral or organic, that is in suspension, is being transported, or has been moved from its site of origin by air, water or gravity as a product of erosion.

Shrub: A bushy, woody-stemmed plant, usually with several permanent stems usually less than 15-20 feet at maturity.

Site: The area, lot, or lots upon which development is to occur or has occurred.

Stormwater: Water resulting from precipitation (including rain and snow) that runs off the land's surface, is transmitted to the subsurface, or is captured by separate storm sewers or other sewage or drainage facilities, or conveyed by snow removal equipment.

Tree: Any self-supporting woody perennial plant which normally attains an overall height of at least ten 10 feet at maturity, either with one main stem or trunk or multiple stems or trunks as commonly grown in the nursery industry.

Vegetated Buffer: Land area used to visibly separate one use from another or to shield or block, noise, light or other nuisances. Vegetated buffers may include such things as fences or berms as well as all forms of plant growth, whether planted or naturally occurring.

Vegetation: Includes trees, plants, shrubs, vines, groundcovers, grasses, herbaceous perennials, or other forms of plant growth whether naturally occurring or planted.

V. SPECIAL PROVISIONS

A. Site disturbance shall be minimized and existing vegetation and undisturbed soil shall be retained whenever possible. When site disturbance is necessary, top soil shall be stock-piled and stabilized for on-site redistribution within new landscaped areas. Stock-piled soil shall remain covered to prevent soil loss and sedimentation of nearby surface waters.

B. Existing non-invasive vegetation shall be preserved wherever possible. Maximum effort should be made to preserve small stands of trees, rather than individual trees, to minimize the potential for serious damage due to wind, grade changes and soil compaction. No construction materials, equipment, vehicles, or temporary soil deposits shall be located within the dripline of existing trees. Protective barriers shall be installed around each plant or group of plants that are to remain on site. Snow fence installed around the dripline of the tree canopy is an example of an acceptable barrier.

C. Development shall follow the natural contours of the landscape to the maximum extent possible to minimize grading.

D. Cut and fill shall be minimized, with the maximum height of any fill or depth of any cut area, as measured from the natural grade, not greater than 10 feet and preferably limited to four to six feet.

E. Any contiguous area of disturbance, not associated with the installation of a roadway, shall be limited to 20,000 square feet for residential development and to 100,000 square feet for other types of development. Contiguous areas of disturbance shall be separated by at least 20 feet of area maintained at natural grade and retaining existing, mature vegetated cover.

F. Lawn or grass covered areas may comprise no more than ___ percent or ____ square feet of the total vegetated area. A minimum of 2 different grass species with three or more preferred shall make up the seed or sod.

G. Plants shall be selected based on consideration of site conditions and plant function. Use of native species is encouraged; hybrid varieties of native plants, and plants that are non-native and non-invasive are also permitted. Use of invasive species included on the N.H. Invasive Species Committee's most current list of prohibited invasive species, is not permitted in accordance with New Hampshire Agricultural Rule NH AGR 3800 (see Figure 3.6.4).

> As an alternative to exclusively requiring native species plantings, communities should consider requiring non-invasive species that provide ecological and wildlife values consistent with the site conditions and plant functions. For example, if the site design includes frontage along a state highway and retaining natural vegetation is not an option, drought and salt-tolerant plant species should be selected. The New Hampshire Invasive Species Committee maintains a list of invasive plants prohibited from sale, transport, distribution, propagation or transplantation in New Hampshire, which can be found on the NH Department of Agriculture, Markets and Food website www.agriculture.nh.gov. Information about the Invasive Species Committee is also available on that website. The UNH Cooperative Extension's "Alternatives to Invasive Landscape Plants" identifies plants with similar aesthetic and functional attributes for suggested use in place of invasive species, and is available at www.extension.unh.edu.

NH AGR 3800 states that “no person shall knowingly collect, transport, sell, distribute, propagate, or transplant any living or viable portion of any listed prohibited invasive species including all of their cultivars, varieties and specified hybrids.”

H. Layered plantings of trees, shrubs, vines, perennials, groundcovers and leaf litter are encouraged to promote biological diversity in the landscape (see Figure 3.6.5).

I. Low maintenance landscapes are encouraged.

J. The type and location of vegetation shall not interfere with utilities and the safe and efficient flow of street traffic or pedestrians.

K. Nothing herein shall affect in any way the present or future acquired rights of any public utility or the Town/City of ___ to clear trees and/or other growth from lands used by the public utility or town/city. Using current arboriculture standards when pruning within public rights-of-way is strongly encouraged, as well as leaving a vegetated understory to prevent erosion.

L. No ground disturbed as a result of site construction and development shall be left exposed to bare soil at the conclusion of construction. All areas, including landscape islands and strips, exposed by construction, with the exception of finished building, structure, and pavement footprints, shall be decompacted (aerated) and covered with a minimum thickness of 6 inches of non-compacted topsoil, and shall be subsequently planted with a combination of living vegetation such as grass, groundcovers, trees, and shrubs, and other landscaping materials. After planting, areas between plants where exposed soil remains shall be mulched at a depth no greater than 3 inches.

M. Tree Coverage

1. To promote the replacement of trees removed during site construction and development:

    a. Developments serving single-family homes and duplexes must plant and maintain at least 1 tree for every 35 feet of frontage, with a minimum of one tree per lot. Trees shall have a minimum caliper of 2 inches when planted.

    b. Developments serving uses other than single-family homes and duplexes must plant and maintain at least one tree for every 35 feet of frontage, with a minimum of one tree per lot, or at a density of one tree for every 400 square feet of paved area for non-street surfaces. Trees shall have a minimum caliper of 2-21/2 inches when planted. To foster biological diversity when more than 10 trees are planted at the same time the “10-20-30 Rule” shall be used. (No more than 10% of the trees shall be of the same species, no more than 20% in the same genus, and no more than 30% in the same family.)

    c. Trees shall be planted in locations that provide site value such as aesthetics, shading, and cooling of buildings or parking areas for energy efficiency, wildlife habitat, and stabilization of soils in disturbed areas. Trees shall not be planted in locations that block safe sight lines for vehicles and pedestrians entering and exiting the site.

N. All trees and shrubs shall be planted, maintained, or transplanted in accordance with accepted nursery and horticulture standards such as those specified by International Society of Arboriculture or the American Nursery and Landscape Association (See Figure 3.6.6).

Communities that adopt landscaping standards may also want to consider adopting screening standards in order to encourage screening of visually undesirable features from public view, protect the privacy of residents, and promote the community as one that cares about its appearance.

VI. ENFORCEMENT

Any landscaping installed in accordance with the requirements of this Article or the Town/City _____ Subdivision or Site Plan Regulations shall be maintained in good order in perpetuity to achieve the objectives of this Article and applicable Subdivision and/or Site Plan Review Regulations. Failure to install, maintain or replace dead, diseased or damaged landscaping as required shall be considered a violation of this ordinance.

Communities will need to consider enforcement of landscaping standards. Communities with limited enforcement resources may choose to enforce these requirements on a complaint-driven basis, while communities with more advanced enforcement mechanisms may choose to regularly inspect all sites or all non-residential sites, for example. To ensure that applicants for building permits are familiar with local landscaping requirements, communities should consider amending building permit applications to include a note calling attention to such requirements and/or adding an item to a building permit checklist that identifies landscaping requirements.

MODEL SUBDIVISION REGULATIONS

SECTION _______: LANDSCAPING

A landscaping plan designed to preserve existing resources and features, promote wildlife habitat, conserve water resources, and support on-site stormwater control shall be submitted with all applications for subdivision. The landscaping plan shall be prepared by a licensed landscape architect, professional landscape designer, or nursery professional. The landscaping plan must address and comply with the requirements set forth herein:

I. PRESERVATION

Existing vegetation shall be preserved wherever possible. Existing natural features of special interest, such as large trees or those having historic relevance, shall be delineated and located on the landscaping plan. Proposed lot lines shown on a subdivision plan shall consider the location of identified features, and such features shall be preserved whenever possible. A note should be added to the site plan indicating that identified feature(s) shall be protected during site clearing and construction through the use of construction fencing or other adequate protective barriers. Maximum effort should be made to preserve small stands of trees rather than individual trees to minimize the potential for serious damage due to wind, grade changes and soil compaction. No construction materials, equipment, vehicles, or temporary soil deposits shall be located within the dripline of existing trees. Protective barriers shall be installed around each plant and/or groups of plants that are to remain on site. Snow fence installed around the drip line of the tree canopy is an example of an acceptable barrier.

II. BUFFERS

Subdivisions shall provide a vegetated buffer along the street or right-of-way providing frontage to the existing lot of record (see Figure 3.6.7).

A. The buffer shall be a minimum of 20 feet in width and comprised of preserved natural non-invasive vegetation.

B. As an alternative to II.A, the buffer may be designed in accordance with one or more of the following options. If existing vegetation in the buffer is predominantly comprised of lawn or grass, the buffer shall be designed in accordance with one or more of the following options:

   1. A minimum of one tree per 35 linear feet or portion thereof excluding curb cuts, densely planted with a combination of shrubs, perennials, vines, and groundcovers planted en masse to form a year-round dense screen at least 6 feet high within 3 years. A combination of both deciduous plants and evergreens are encouraged.

   2. A fence or wall of uniform appearance no more than 6-feet high (cannot be concrete block) may be used in conjunction with plant materials with a minimum 10 foot buffer between the fence and the street. A minimum of one tree per 35 linear feet, or portion thereof excluding curb cuts, with a combination of shrubs, perennials, vines, and groundcovers planted en masse per 35 linear feet. A combination of both deciduous plants and evergreens are encouraged.

   3. Spacing between individual trees shall not be more than 35 feet, not more than 6 feet for individual shrubs, and not more than 3 feet between individual perennials and groundcovers.

III. SIDEWALKS

Where sidewalks are required, a minimum four-foot buffer shall be provided between the street edge and a paved sidewalk or walkway area. It is strongly recommended that the buffer area be vegetated with perennials, groundcovers, and shrubs (30 inches or less at maturity). If grass is used, it shall be a mix of at least two different species with three or more preferred.

IV. CUL-DE-SACS

Where cul-de-sacs are permitted, the island or center area of the cul-de-sac shall remain in a natural vegetated state, with any invasive species removed. If it will be used as a biofilter for stormwater treatment, the area shall be vegetated with a combination of living plant material including trees, shrubs, and groundcovers. Non-living landscape material may cover up to 20 percent of the island or center area. When planting of vegetation is required, cul-de-sac landscaping shall be installed after construction of the street is complete.

V. STREET TREES

When new streets are proposed as part of the subdivision, new streets shall be bordered with trees on both sides. To avoid damage to trees during construction, street trees shall be installed upon completion of the street construction, and street trees shall conform to the following standards:

A. Trees shall be salt and drought-tolerant, native or non-invasive species, and have a structure and growth form which prevents them from obstructing sidewalks and walkways.

B. Trees shall have a caliper of no less than 2-21/2 inches when planted.

C. Trees located under utility wires should be a low-growing species.

D. To foster biological diversity trees planted along a given street shall use the “10-20-30 Rule” (No more than 10% of the trees shall be of the same species, no more than 20% in the same genus, and no more than 30% in the same family.)

E. Trees shall be located no more than 35 feet apart.

F. Trees should be located to avoid obstruction for driver visibility, and to avoid interference between root systems and utilities. Trees may be planted individually or clustered.

G. All newly planted trees, shrubs and other vegetation shall have a watering plan during the establishment period (for trees, one-year-per-inch in caliper at planting, shrubs and other vegetation generally establish within one growing season). Mulching trees, shrubs, and plants helps retain soil moisture, moderates temperature fluctuations, provides protection from mechanical damage by mowers and trimmers, and serves as temporary covering of exposed soil until understory plants and ground covers fill in. However, thick applications of mulch (such as “volcano mulching”) will kill trees and other vegetation. Mulch shall be no greater than 3 inches in depth and shall not be in contact with the bark or stems of plants.

H. Incentive Bonuses:

1. Two existing healthy and non-invasive trees, with a caliper of 3 inches or greater, preserved using proper protection methods within the required planting area, may be substituted for one required tree, to be determined by the planning board.

2. Where an applicant proposes leaving a significant portion of healthy trees within the construction area, alternative landscaping designs will be considered.

VII. VEGETATION

Vegetation planted in accordance with the requirements of this section shall be native or non-invasive species selected for their adaptability to the climatic, geologic and topographical conditions of the site.

A. Shrubs and hedges shall be a minimum of 24 inches in height when measured immediately after planting. Groundcovers and perennials may be less.

VIII. DOCUMENTATION

A note should be added to the plan indicating that "Development of lots shown on an approved subdivision plan shall comply with the landscaping requirements set forth in the Town/City of ____ Zoning Ordinance and Subdivision Regulations."

IX. PERFORMANCE GUARANTEE

A. To ensure that landscaping is installed in accordance with the final approved landscaping plan, a performance guarantee shall be provided as a condition of approval in an amount determined by the planning board. The performance guarantee shall be released following an inspection by the Town of [*Name*] Code Enforcement Officer.

B. To ensure that landscaping functions as designed and all plants remain healthy, a performance guarantee shall be required, as a condition of approval, which will be held a minimum of 24 months after an approved inspection as required in Section __.IX.1.

X. MAINTENANCE

A. If the street is to be a private street, cul-de-sac landscaping, street trees and other landscaping as required shall be maintained by a property owners association that is responsible, in perpetuity, for maintaining all landscaping in good condition and replacing as necessary to the standards herein, and to keep landscaped areas free of refuse and debris. The legal instrument establishing this requirement as part of the homeowners association shall be submitted to the planning board for review and comment by town counsel prior to the planning board taking final action on the application.

B. If the street is to be dedicated to and accepted by the Town/City of ____, the town/city shall be responsible for maintaining street trees and cul-de-sac landscaping.

MODEL SITE PLAN REVIEW REGULATIONS

SECTION ______: LANDSCAPING

A landscaping plan designed to preserve existing resources and features, promote wildlife habitat, and support on-site stormwater control shall be submitted with an application for site plan review. Due to the variation of each site, creativity and diversity in landscaping is encouraged. The landscaping plan shall be prepared by a licensed landscape architect, professional landscape designer, or nursery professional.

The landscaping plan must address and comply with the requirements set forth herein:

I. GENERAL REQUIREMENTS

A. Existing vegetation shall be preserved wherever possible. Existing natural features of special interest, such as those having historic relevance, shall be delineated and located on the landscaping plan. A note should be added to the site plan indicating that identified feature(s) shall be protected during site clearing and construction through the use of construction fencing or other adequate protective barriers. Maximum effort should be made to preserve small stands of trees, rather than individual trees, to minimize the potential for serious damage due to wind, grade changes and soil compaction. No construction materials, equipment, vehicles, or temporary soil deposits shall be located within the dripline of existing trees. Before commencement of work, protective barriers shall be installed and maintained around each plant and/or groups of plants that are to remain on site until completion. Snow fence installed around the dripline of the tree canopy is an example of an acceptable barrier.

B. Vegetation planted in accordance with the requirements of this section shall be non-invasive species selected for their adaptability to the climatic, geologic and topographical conditions of the site.

C. Shrubs and hedges shall be a minimum of 24 inches in height when measured immediately after planting. Groundcovers and perennials may be less.

D. Effective use and preservation of natural berms, existing topography and existing vegetation is encouraged.

E. Landscaped beds shall be used to separate parking areas from the portion of a building providing access to the building (see Figure 3.6.8).

F. Vegetated Buffer: Plants or a combination of plants and other landscaping material shall be used to form a buffer between non-residential and residential uses. The buffer shall be at least 20 feet wide, densely planted (or equivalent natural growth), and form a year-round dense screen at least 6 feet high within 3 years. A minimum of one tree per 35 feet or portion thereof, with a combinations of shrubs, perennials, vines, and groundcovers shall be planted enmasse among the trees. Spacing between individual trees shall not be more than 35 feet, not more than 6 feet apart for individual shrubs, and not more than 3 feet between individual perennials and groundcovers. A combination of evergreens and deciduous plants are encouraged. As an alternative, a fence or wall of uniform appearance not more than 6-feet high (concrete block cannot be used) and extending to within six inches of ground level may be used in conjunction with the above plant materials with a minimum 15 foot vegetative buffer.

G. Plants, or a combination of plants and a solid visual barrier such as wooden fencing, or berms, shall be used to screen loading, waste disposal, material storage and other areas that are likely to generate noise, dust, or other potentially disruptive conditions.

H. Landscaping shall be used to establish and/or maintain an attractive streetscape adjacent to roadways. A minimum of one tree per 35 linear feet or portion thereof.

I. To promote on-site water retention and filtration, landscaped areas shall be designed in a manner that guides stormwater from on-site impervious streets, parking areas, sidewalks and walkways to vegetated areas or approved retention areas.

See the stormwater management chapter for more detailed requirements addressing water quality.

J. Curbing or equivalent barriers shall be required to protect vegetation from vehicular damage. Barriers shall be designed with openings that allow stormwater to flow into vegetated areas (see Figure 3.6.9).

K. The type and location of vegetation shall not interfere with utilities or the safe and efficient flow of street traffic.

L. No trees or shrubs shall obstruct the view between the street and the access drives and parking aisles near entries and exits. Plantings within 25 feet of an intersection shall not exceed a maximum mature height of 30 inches.

M. When irrigation systems are proposed, a temporary watering plan/ schedule, or low volume (drip) irrigation system shall be required. Permanent irrigation systems are prohibited, except as noted below. Temporary irrigation systems shall be designed and installed for efficient and effective water use to the landscaped area for a limited period of time determined by the plant material and site conditions. (See margin note.) For those exceptions when permanent irrigation is considered necessary, such as an athletic field, permanent irrigation shall utilize water saving technologies, including rain sensors, flow meters, and management systems that monitor current weather conditions.

N. A maintenance plan shall be provided with the site plan application. All landscaped areas shall receive regular maintenance and upkeep. Severely injured, diseased, or dead plant material shall be replaced in kind in perpetuity (avoid replacing landscape materials in the period from November to March.) Best practices to minimize environmental impacts such as the use of low phosphorous fertilizer and slow release nitrogen, shall be included in the management plan. If ownership of a site is conveyed to a new property owner the new owner shall be responsible for maintaining all landscaping in accordance with the approved final landscaping plan.

When developing local landscaping regulations, communities should consider adding criteria that specify circumstances to include a temporary low volume watering system (i.e. drip irrigation) as part of a landscaping plan until plants become established. Providing adequate water during the establishment period is critical to the long-term success of the landscape. The establishment period for trees is one-year-per-inch in caliper at planting. Shrubs and other vegetation will generally establish within one growing season. Permanent irrigation systems are generally not essential and may create inefficient water use if not properly maintained.

II. PARKING LOTS

A. Interior landscaped beds shall be required for all parking lots with multiple adjacent parallel parking rows. Required interior landscaping shall be a minimum of 10 percent of the total area of driveways and parking. The maximum number of continuous parking spaces permitted shall be twenty. Interior landscaping shall be in addition to any required perimeter landscaping as specified below, and shall include trees, along with shrubs, perennials, and/or groundcovers planted enmasse among the trees. Plant materials shall be suitable for site conditions including location, soil conditions, and exposure to environmental factors.

B. Bare soil is not acceptable. The introduction of groundcovers and/or perennials planted enmasse and the use of mulch as a soil covering is acceptable. However, no more than 20 percent of the minimum landscaped area may be covered with non-living landscaping material such as bark mulch, woodchips, or leaf litter.

C. In order to break up the visual expansiveness of parking lots, interior landscaped beds shall be installed in the form of landscape strips and/or landscape islands. Depressed vegetated landscaped beds are encouraged to infiltrate stormwater (see Figure 3.6.10).

D. Landscape strips shall be a minimum of 15 feet in width.

E. Landscape islands shall be a minimum of 20 feet in width.

F. Parking lots with more than 50 parking spaces shall have landscape islands serving as end-caps to each row.

G. The interior of parking lots shall have no less than one tree for every 10 parking spaces. The trees may be clustered together in landscape islands with shrubs, perennials, and ground covers planted enmasse among the trees. This requirement is in addition to any trees required in Article __.V.J.b of the Town of _____ Zoning Ordinance.

H. Snow storage shall not be permitted on any landscape area.

I. **Incentive Bonuses:**

1. Each existing healthy and native or non-invasive tree, with a caliper of three inches or greater, preserved using proper protection methods within the interior parking lot area may be substituted for one tree required for every 10 parking spaces.
2. Where an applicant proposes leaving a significant portion of healthy non-invasive trees and other vegetation within the proposed construction area, the planning board will consider alternative landscaping designs.

J. **Perimeter Landscaping for Parking Areas:** Along the perimeter of parking lots with ten or more spaces a buffer of perimeter landscaping is required along at least 75% of the length of right-of-way. The buffer width shall be a minimum of 20 feet, though the planning board may require a wider buffer when the use, building or site conditions dictate that a larger buffer would better serve the intent of these regulations. The vegetated buffer shall include existing non-invasive plant material, where appropriate, in combination with new trees, shrubs, perennials and groundcovers of suitable type, characteristics to meet site-specific requirements in order to provide longevity of the landscape (see Figure 3.6.11). The buffer shall include one or more of the following options:

1. A minimum of one tree per 35 linear feet or portion thereof excluding curb cuts, with a combination of shrubs, perennials, vines, and groundcovers planted en masse. The trees may be clustered together with shrubs, perennials, and groundcovers planted enmasse among the trees. A combination of both deciduous plants and evergreens are encouraged.
2. A wall, or fence of uniform appearance 6 feet high of brick, stone or finished concrete (cannot be concrete block) may be used in conjunction with plant materials with a minimum 10 foot-buffer between the fence and the street. A minimum of one tree per 35 linear feet or portion thereof with a combination of shrubs, perennials, vines, and groundcovers planted en masse per 35 linear feet excluding curb cuts. A combination of both deciduous plants and evergreens are encouraged.
3. Spacing between individual trees shall not be more than 35 feet, not more than 6 feet apart for individual shrubs, and not more than 3 feet between individual perennials and groundcovers.
4. If the area abutting the street is existing woodland, a 25-foot woodland buffer may be left in lieu of landscaping if approved by the planning board.

The planning board may want to consider establishing provisions for existing parking lots, for example requiring existing lots to comply with this Section (re: Parking) only if new spaces are added..

III. TREES

A. Trees shall be salt and drought-tolerant, native or non-invasive species, and have a structure and growth form which prevents them from obstructing sidewalks and walkways.

B. Trees shall have a caliper of no less than 2-21/2 inches when planted.

C. Trees located under utility wires should be a low-growing species.

D. To foster biological diversity trees planted along a given street shall use the “10-20-30 Rule” (No more than 10% of the trees shall be of the same species, no more than 20% in the same genus, and no more than 30% in the same family.)

E. Trees shall be located no more than 35 feet apart.

F. Trees should be located to avoid obstruction for driver visibility, and to avoid interference between root systems and utilities. Trees may be planted individually or clustered.

G. All newly planted trees, shrubs and other vegetation shall have a watering plan during the establishment period (for trees, one-year-per-inch in caliper at planting, shrubs and other vegetation generally establish within one growing season). Mulching trees, shrubs, and plants helps retain soil moisture, moderates temperature fluctuations, provides protection from mechanical damage by mowers and trimmers, and serves as temporary covering of exposed soil until understory plants and ground covers fill in. However, thick applications of mulch (such as “volcano mulching”) will kill trees and other vegetation. Mulch shall be no greater than 3 inches in depth and shall not be in contact with the bark or stems of plants.

H. **Incentive Bonuses:**

1. Each existing healthy and non-invasive tree, with a caliper of 3 inches or greater, preserved using proper protection methods within the required planting area may be substituted for one required tree.
2. Where an applicant proposes leaving a significant portion of healthy trees within the construction area, alternative landscaping designs will be considered.

IV. PLAN REQUIREMENTS

A. Landscaping plans shall include dimensions and distances and clearly delineate the existing and proposed parking spaces, or other vehicular uses, access, aisles, driveways, and the location, and description of all landscape materials, including the quantity and common and botanical names of all plants.

B. Landscape plans shall be provided at the same scale as the engineering drawings unless otherwise required by the planning board for review purposes.

C. Snow storage areas shall be clearly shown on the plan and are not permitted on any landscaped areas. In accordance with NH DES Best Management Practices snow storage areas and snow dumps shall be located so that snow melt runoff is directed to vegetated swales or filter strips created for that purpose.

D. A planting plan shall provide specifications regarding the plant placement, type, size and spacing, and other features as required by this section. Trees and shrubs shall be specified according to the American Standard for Nursery Stock by the American Nursery and Landscape Association.

E. Depending on the nature and scale of the proposed use, a temporary watering plan, or low volume (drip) irrigation system shall be required. When required, irrigation systems shall be designed and installed for efficient and effective use of water to the landscaped area. Permanent irrigation systems are generally prohibited.

F. A maintenance plan shall be provided with the site plan application. All landscaped areas shall receive regular maintenance and upkeep. Severely injured, diseased, or dead plant material shall be replaced in kind in perpetuity (avoid replacing landscape materials in the period from November to March.) Best practices to minimize environmental impacts such as the use of low phosphorous fertilizer and slow release nitrogen, shall be included in the management plan.

G. The Planning Board may seek an advisory opinion regarding the submitted landscape plan at the expense of the applicant.

H. The Planning Board will seek an advisory opinion of the conservation commission or other municipal board or committee regarding the landscape plan, if deemed necessary.

V. SECURITY/PERFORMANCE BOND

A. To ensure that landscaping is installed in accordance with the final approved landscaping plan, a performance guarantee shall be provided as a condition of approval in an amount determined by the planning board. The performance guarantee shall be released following and inspection by the Town of ____ Code Enforcement Officer.

B. To ensure that landscaping functions as designed and all plants remain healthy, a performance guarantee shall be required, as a condition of approval, which will be held a minimum of 24 months after an approved inspection as required in Section __.IX.1.

VI. MAINTENANCE

A. The property owner, or owners association if applicable, is responsible, in perpetuity, for maintaining all landscaping in good condition. Landscaping shall be kept free of refuse and debris, and shall be replaced as necessary to the standards herein.

B. If the ownership of a site is conveyed to a new property owner, the new owner shall be responsible for maintaining all landscaping in accordance with the approved final landscaping plan.

C. Proposed modifications of an approved landscaping plan shall be submitted to the planning board for review and approval. The planning board shall notify the owner of acceptance of the modified plan or request additional information within 60 days of receipt of proposed modifications. The currently approved plan shall remain in effect until notification of approval has been issued, or the 60 day period has lapsed.

> Communities may want to consider requiring that a legal maintenance agreement be established to address all aspects of maintenance including vegetation replacement; pruning, fertilizing and insect and disease protection; litter or debris clean-up; and, drainage and tree protection if the proposed landscaping will create a change in the existing grade.

VII. ENFORCEMENT

A. An inspection of all plantings to ensure compliance with the submitted landscape plan shall be conducted prior to the issuance of a certificate of occupancy.

B. Ongoing inspections of landscapes shall be conducted to ensure compliance of landscape maintenance in perpetuity.

FIGURE 3.6.4

Winterberry holly, (Ilex verticillata) *a native with red berries that persist into winter, attracts birds and is showy against snow.*

FIGURE 3.6.5

Landscapes that include many layers and varieties of plants begin to mimic natural ecosystems. These landscapes require less maintenance resulting in reduced energy use and lower energy costs.

FIGURE 3.6.6

Planting trees and shrubs at proper depth is critical to their survival. Look for the trunk flare, the point where the trunk widens and roots begin to branch from the trunk. Remove any soil that covers the trunk flare. The trunk flare should be even with the surface of the ground. Take time to measure the rootball and dig the hole no deeper than this measurement. Illustration by Lauren Chase-Rowell, Outdoor Rooms Sustainable and Ecological Landscape Design Services.

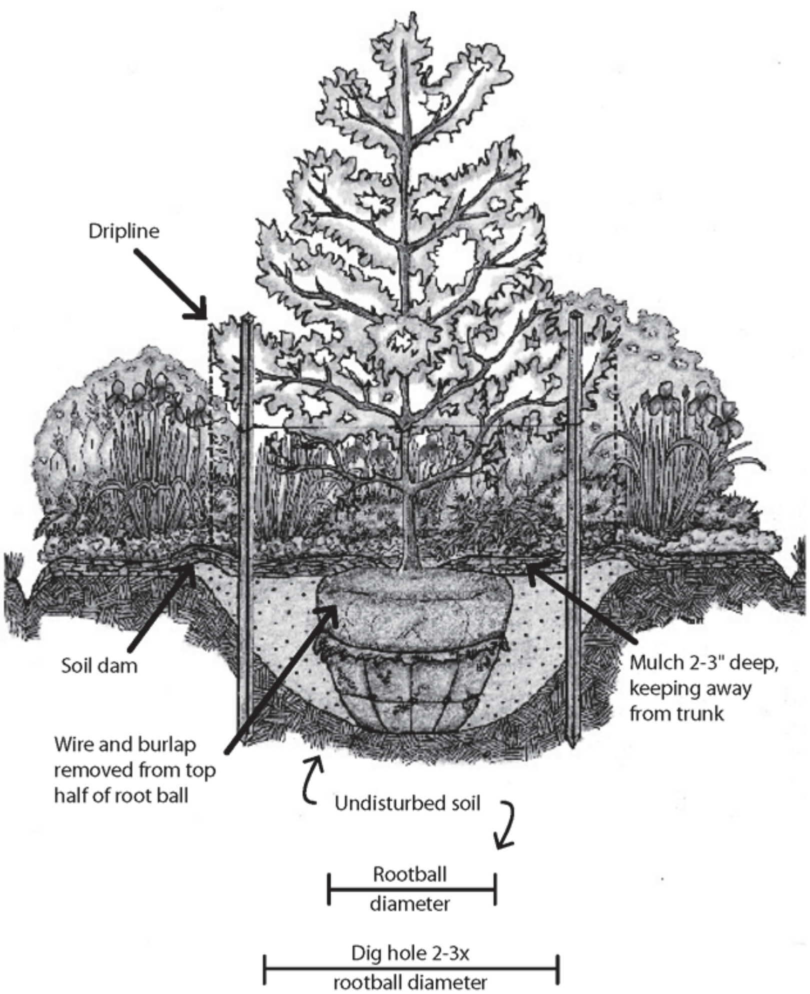


FIGURE 3.6.7

Design vegetative buffers with a variety of layers that include both deciduous plants and evergreens. These buffers blend with natural landscapes and have more aesthetic appeal than the commonly planted row of Arborvitae.

FIGURE 3.6.8
Adding landscape plantings to separate uses provides a visual transition, and can increase property value.

FIGURE 3.6.9

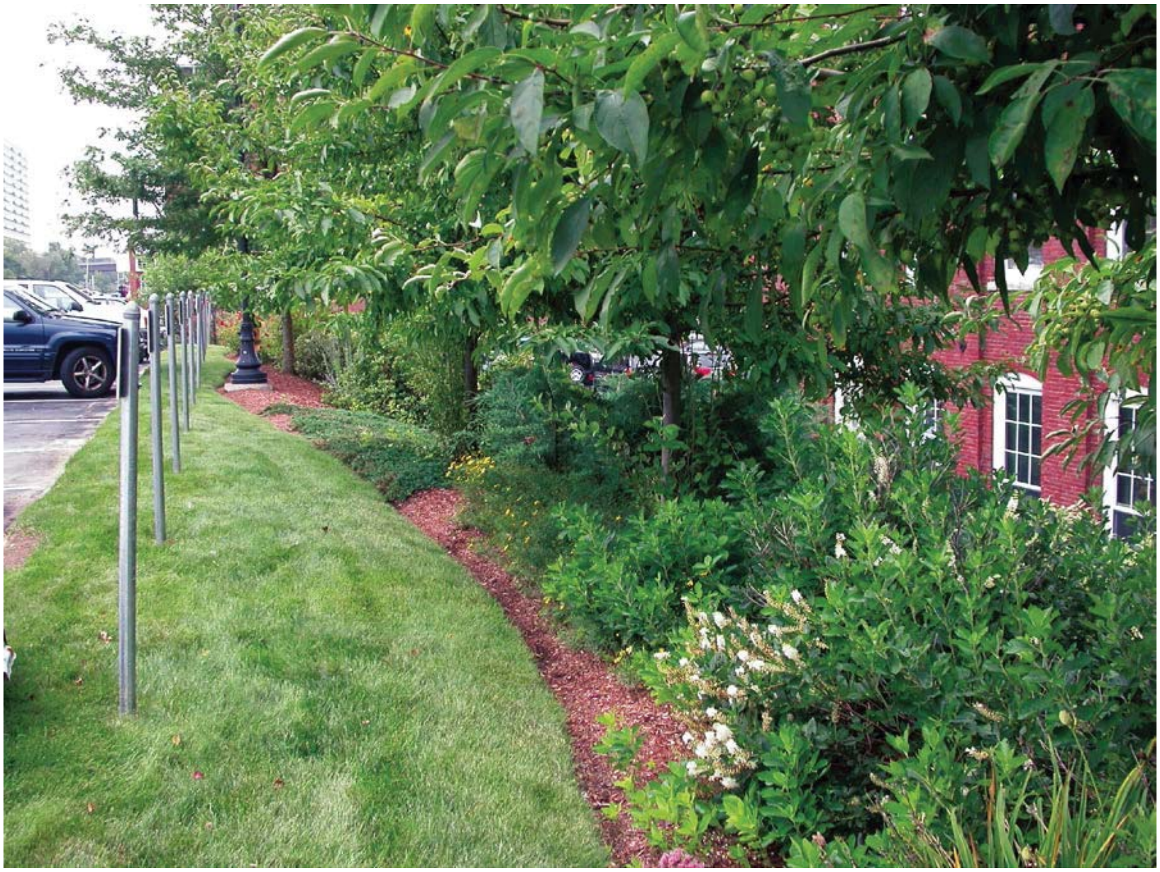
Openings in curbed-areas allow vegetation to filter, slow, and retain stormwater.

FIGURE 3.6.10

Shrubs, perennials, and groundcovers planted among trees in landscape strips or islands minimize soil compaction from pedestrian foot traffic, and can capture and filter stormwater.

FIGURE 3.6.11

This vegetative buffer serves several purposes: It shades cars in the parking lot, provides nice views for office workers, creates habitat for wildlife, reduces the amount of lawn maintenance required, and decreases stormwater runoff coming from the roof.



MODEL STORMWATER BYLAWS

BY COMPREHENSIVE ENVIRONMENTAL INC.

Comprehensive Environmental Inc.

MODEL BYLAWS

To Achieve Phase II Stormwater Compliance and Promote Low Impact Development

JUNE 2005

Comprehensive Environmental Inc.
Milford, MA • Merrimack, NH • N. Kingstown, RI
1-800-725-2550
www.ceiengineers.com

Stormwater Management & Erosion Control Bylaw

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Stormwater Management & Erosion Control Bylaw

1. Purpose

A. Increased volumes of stormwater, contaminated stormwater runoff from impervious surfaces, and soil erosion and sedimentation are major causes of:
   1. impairment of water quality and decreased flow in lakes, ponds, streams, rivers, wetlands and groundwater;
   2. contamination of drinking water supplies;
   3. erosion of stream channels;
   4. alteration or destruction of aquatic and wildlife habitat;
   5. flooding; and,
   6. overloading or clogging of municipal catch basins and storm drainage systems.

The United States Environmental Protection Agency has identified sedimentation from land disturbance activities and polluted stormwater runoff from land development and redevelopment as major sources of water pollution, impacting drinking water supplies, natural habitats, and recreational resources. Regulation of activities that result in the disturbance of land and the creation of stormwater runoff is necessary for the protection of the *(Town of ______)* water bodies and groundwater resources, to safeguard the health, safety, and welfare of the general public and protect the natural resources of the Town.

B. The **objectives** of this Bylaw are to:
   1. protect water resources;
   2. require practices that eliminate soil erosion and sedimentation;
   3. control the volume and rate of stormwater runoff resulting from land disturbance activities in order to minimize potential impacts of flooding;
   4. require practices to manage and treat stormwater runoff generated from new development and redevelopment;
   5. protect groundwater and surface water from degradation or depletion;
   6. promote infiltration and the recharge of groundwater;
   7. prevent pollutants from entering the municipal storm drain system;
   8. ensure that soil erosion and sedimentation control measures and stormwater runoff management practices are incorporated into the site planning and design process and are implemented and maintained;
   9. ensure adequate long-term operation and maintenance of stormwater best management practices;
   10. require practices to control waste such as discarded building materials, concrete truck washout, chemicals, litter, and sanitary waste at construction sites that may cause adverse impacts to water quality;
   11. comply with state and federal statutes and regulations relating to stormwater discharges; and
   12. establish the *(Town of __________)* legal authority to ensure compliance with the provisions of this Bylaw through inspection, monitoring and enforcement.

2. Definitions

ABUTTER: The owner(s) of land abutting the land disturbance site.

AGRICULTURE: The normal maintenance or improvement of land in agricultural or aquacultural use, as defined by the Massachusetts Wetlands Protection Act (M.G.L. c. 131 § 40) and its implementing regulations (310 CMR 10.00).

ALTERATION OF DRAINAGE CHARACTERISTICS: Any activity on an area of land that changes the water quality, or the force, quantity, direction, timing or location of runoff flowing from the area. Such changes include: change from distributed runoff to confined, discrete discharge; change in the volume of runoff from the area; change in the peak rate of runoff from the area; and change in the recharge to groundwater on the area.

APPLICANT: Any "person" as defined below requesting a land disturbance permit for proposed land-disturbance activity.

AUTHORIZED ENFORCEMENT AGENCY: *(_________________)(Planning Board, Conservation Commission, Board of Health or other duly authorized Town entity that has the authority to administer, implement, and enforce this Stormwater Bylaw)* and its employees or agents will be in charge of enforcing the requirements of this bylaw.

BEST MANAGEMENT PRACTICE (BMP): An activity, procedure, restraint, or structural improvement that helps to reduce the quantity or improve the quality of stormwater runoff.

CONSTRUCTION AND WASTE MATERIALS: Excess or discarded building or construction site materials that may adversely impact water quality, including but not limited to concrete truck washout, chemicals, litter and sanitary waste.

CLEARING: Any activity that removes the vegetative surface cover. Clearing activities generally include grubbing activity as defined below.

DESIGN STANDARDS: The (*Town of ______*) Design Standards for Development and Redevelopment.

DEVELOPMENT: The modification of land to accommodate a new use or expansion of use, usually involving construction.

DISTURBANCE OF LAND: Any action, including clearing and grubbing, that causes a change in the position, location, or arrangement of soil, sand, rock, gravel, or similar earth material.

ENVIRONMENTAL SITE MONITOR: A Professional Engineer, or other trained professional selected by the (*Stormwater Authority)* and retained by the holder of a Land

Disturbance Permit to periodically inspect the work and report to the *Stormwater Authority).*

EROSION: The wearing away of the land surface by natural or artificial forces such as wind, water, ice, gravity, or vehicle traffic and the subsequent detachment and transportation of soil particles.

EROSION AND SEDIMENTATION CONTROL PLAN: A document containing narrative, drawings and details developed by a qualified professional engineer (PE) or a public land surveyor (PLS), which includes best management practices, or equivalent measures designed to control surface runoff, erosion and sedimentation during pre-construction and construction related land disturbance activities.

ESTIMATED HABITAT OF RARE WILDLIFE AND CERTIFIED VERNAL POOLS: Habitats delineated for state-protected rare wildlife and certified vernal pools for use with the Wetlands Protection Act Regulations (310 CMR 10.00) and the Forest Cutting Practices Act Regulations (304 CMR 11.00).

GRADING: Changing the level or shape of the ground surface.

GRUBBING: The act of clearing land surface by digging up roots and stumps.

IMPERVIOUS SURFACE: Any material or structure on or above the ground that prevents water infiltrating the underlying soil. Impervious surface includes without limitation roads, paved parking lots, sidewalks, and roof tops. Impervious surface also includes soils, gravel driveways, and similar surfaces with a runoff coefficient (Rational Method) greater than 85.

LAND-DISTURBING ACTIVITY or LAND DISTURBANCE: Any activity, including clearing and grubbing, that causes a change in the position or location of soil, sand, rock, gravel, or similar earth material.

LANDSCAPE DESIGN STANDARDS: The *(Town of _____)* Landscape Design Standards.

LOT: An area or parcel of land or any part thereof, in common ownership, designated on a plan filed with the administration of the Zoning Bylaw by its owner or owners as a separate lot.

MASSACHUSETTS ENDANGERED SPECIES ACT: (M.G.L. c. 131A) and its implementing regulations at (321 CMR 10.00) which prohibit the "taking" of any rare plant or animal species listed as Endangered, Threatened, or of Special Concern.

MASSACHUSETTS STORMWATER MANAGEMENT POLICY: The Policy issued by the Department of Environmental Protection, as amended, that coordinates the requirements prescribed by state regulations promulgated under the authority of the

Massachusetts Wetlands Protection Act MGL c. 131 s. 40 and the Massachusetts Clean Waters Act MGL c. 21, ss. 23-56. The Policy addresses stormwater impacts through implementation of performance standards to reduce or prevent pollutants from reaching water bodies and control the quantity of runoff from a site.

MUNICIPAL STORM DRAIN SYSTEM or MUNICIPAL SEPARATE STORM SEWER SYSTEM (MS4): The system of conveyances designed or used for collecting or conveying stormwater, including any road with a drainage system, street, gutter, curb, inlet, piped storm drain, pumping facility, retention or detention basin, natural or man-made or altered drainage channel, reservoir, and other drainage structure that together comprise the storm drainage system owned or operated by the *(Town of ________)*.

OPERATION AND MAINTENANCE PLAN: A plan describing the functional, financial and organizational mechanisms for the ongoing operation and maintenance of a stormwater management system to ensure that it continues to function as designed.

OUTFALL: The point at which stormwater flows out from a discernible, confined point source or discrete conveyance into waters of the Commonwealth.

OUTSTANDING RESOURCE WATERS (ORWs): Waters designated by Massachusetts Department of Environmental Protection as ORWs. These waters have exceptional sociologic, recreational, ecological and/or aesthetic values and are subject to more stringent requirements under both the Massachusetts Water Quality Standards (314 CMR 4.00) and the Massachusetts Stormwater Management Standards. ORWs include vernal pools certified by the Natural Heritage Program of the Massachusetts Department of Fisheries and Wildlife and Environmental Law Enforcement, all Class A designated public water supplies with their bordering vegetated wetlands, and other waters specifically designated.

OWNER: A person with a legal or equitable interest in property.

PERMITTEE: The person who holds a land disturbance permit and therefore bears the responsibilities and enjoys the privileges conferred thereby.

PERSON: An individual, partnership, association, firm, company, trust, corporation, agency, authority, department or political subdivision of the Commonwealth or the federal government, to the extent permitted by law, and any officer, employee, or agent of such person.

POINT SOURCE: Any discernible, confined, and discrete conveyance, including but not limited to, any pipe, ditch, channel, tunnel, conduit, well, discrete fissure, or container from which pollutants are or may be discharged.

PRE-CONSTRUCTION: All activity in preparation for construction.

PRIORITY HABITAT OF RARE SPECIES: Habitats delineated for rare plant and animal populations protected pursuant to the Massachusetts Endangered Species Act and its regulations.

REDEVELOPMENT: Development, rehabilitation, expansion, demolition or phased projects that disturb the ground surface or increase the impervious area on previously developed sites.

RESPONSIBLE PARTIES: owner(s), persons with financial responsibility, and persons with operational responsibility.

RUNOFF: Rainfall, snowmelt, or irrigation water flowing over the ground surface.

SEDIMENT: Mineral or organic soil material that is transported by wind or water, from its origin to another location; the product of erosion processes.

SEDIMENTATION: The process or act of deposition of sediment.

SITE: Any lot or parcel of land or area of property where land-disturbing activities are, were, or will be performed.

SLOPE: The incline of a ground surface expressed as a ratio of horizontal distance to vertical distance.

SOIL: Earth materials including duff, humic materials, sand, rock and gravel.

STABILIZATION: The use, singly or in combination, of mechanical, structural, or vegetative methods, to prevent or retard erosion.

STORMWATER: Stormwater runoff, snow melt runoff, and surface water runoff and drainage.

STORMWATER COMMITTEE: A Committee of the *(Town of ______)* consisting of the *(list appropriate stormwater committee members).*

STORMWATER MANAGEMENT PLAN: A document containing narrative, drawings and details prepared by a qualified professional engineer (PE) or a professional public land surveyor (PLS), which includes structural and non-structural best management practices to manage and treat stormwater runoff generated from regulated development activity. A stormwater management plan also includes an Operation and Maintenance Plan describing the maintenance requirements for structural best management practices.

STORMWATER MANAGER: *(Storwater Authority)* or its agent, will serve in this capacity.

STRIP: Any activity which removes the vegetative ground surface cover, including tree removal, clearing, grubbing, and storage or removal of topsoil.

TSS: Total Suspended Solids. Material, including but not limited to trash, debris, soils, sediment and sand suspended in stormwater runoff.

VERNAL POOLS: Confined basin depression which, at least in most years, holds water for a minimum of two continuous months during the spring and/or summer, and which is free of adult fish populations, as well as the area within 100 feet of the mean annual boundary of such a depression, regardless of whether the site has been certified by the Mass. Division of Fisheries and Wildlife.

WATERCOURSE: A natural or man-made channel through which water flows, including a river, brook, or stream.

WETLAND RESOURCE AREA: Areas specified in the Massachusetts Wetlands Protection Act M.G.L. c. 131, s.40 and in the *(Town of ____)* Wetland Protection By-law.

WETLANDS: Wet meadows, marshes, swamps, bogs, areas where groundwater, flowing or standing surface water or ice provide a significant part of the supporting substrate for a plant community for at least five months of the year; emergent and submergent communities in inland waters; that portion of any bank which touches any inland water.

3. Authority

This Bylaw is adopted under authority granted by the Home Rule Amendment of the Massachusetts Constitution, the Home Rule statutes, and pursuant to the regulations of the federal Clean Water Act found at 40 CFR 122.34.

4. Applicability

This Bylaw shall apply to all land-disturbing activities within the jurisdiction of the *(Town of ____)*. Except as permitted by the *(Stormwater Authority)* in a land disturbance permit or as otherwise provided in this Bylaw, no person shall perform any activity that results in land disturbance of 40,000 square feet or more or disturbs land with 15% or greater slope and where the land disturbance is greater than or equal to 200 square feet within the sloped area.

A. Regulated Activities. Regulated activities shall include, but not be limited to:

1. Land disturbance of greater than 40,000 square feet, associated with construction or reconstruction of structures,
2. Development or redevelopment involving multiple separate activities in discontinuous locations or on different schedules if the activities are part of a larger common plan of development that all together disturbs 40,000 square feet or more of land,
3. Paving or other change in surface material over an area of 40,000 square feet or more causing a significant reduction of permeability or increase in runoff,

4. Construction of a new drainage system or alteration of an existing drainage system or conveyance serving a drainage area of more than 40,000 square feet,
5. Any other activity altering the surface of an area exceeding 40,000 square feet that will, or may, result in increased stormwater runoff flowing from the property into a public way or the municipal storm drain system, OR
6. Land disturbance where there is a 15% or greater slope and where the land disturbance is greater than or equal to 200 square feet within the sloped area.

B. **Exempt Activities.** The following activities are exempt from the requirements of this Bylaw:
1. Normal maintenance and improvement of Town owned public ways and appurtenances.
2. Normal maintenance and improvement of land in agricultural use.
3. Repair of septic systems when required by the Board of Health for the protection of public health.
4. Normal maintenance of existing landscaping, gardens or lawn areas associated with a single family dwelling provided such maintenance does not include the addition of more than 100 cubic yards of soil material, construction of any walls, alteration of existing grades by more than one foot in elevation, or alteration of drainage patterns.
5. The construction of fencing that will not alter existing terrain or drainage patterns.
6. Construction of utilities other than drainage (gas, water, electric, telephone, etc.) that will not alter terrain or drainage patterns.

5. Administration

A. The *(Stormwater Authority)* shall administer this bylaw. The *(Stormwater Authority)* shall consist of the *(insert appropriate Stormwater Authority members)*. The *(Town of). (Storwmater Authority)* shall designate the Chair of the *(Authority)*.

B. The *(Stormwater Authority)* and its agents shall review all applications for a land disturbance permit, conduct inspections, issue a final permit and conduct any necessary enforcement action. Following receipt of a completed application the *(Stormwater Authority)* shall seek review and comments from the Planning Board, Conservation Commission and the DPW. The *(Stormwater Authority)* shall not make a decision on the Land Disturbance Permit until it has received comments from the Conservation Commission and Planning Board or until the Conservation Commission and Planning Board have allowed fourteen (14) days to elapse after receipt of the application materials without submission of comments thereon.

C. The *(Authority)* may adopt and periodically amend Stormwater Regulations relating to receipt and content of Land Disturbance applications; review time periods, permit terms, conditions, additional definitions, enforcement, fees (including application, inspection, and/or consultant fees), procedures and administration of this Bylaw by majority vote of the *(Stormwater Authority)*, after conducting a public hearing to receive comments on any proposed revisions. Such hearing dates shall be advertised in a newspaper of general local circulation, at least seven (7) days before the hearing date. After public notice and hearing, the *(Stormwater Authority)* may promulgate rules and regulations to effectuate the purposes of this Bylaw. Failure by the *(Stormwater Authority)* to promulgate such rules and regulations shall not have the effect of suspending or invalidating this Bylaw.

D. The *(Stormwater Authority)* will refer to the policy, criteria and information including specifications and standards of the latest edition of the Massachusetts Stormwater Management Policy or the latest edition of *(Town of ____)* Design Standards and Landscape Design Standards, whichever is more stringent in the protection of the town's environmental and infrastructure resources, for execution of the provisions of this Bylaw.

E. The Applicant will publish a notice in the local newspaper that the (*Stormwater Authority)* is accepting comments on the Land Disturbance Permit. The Land Disturbance Permit shall be available for inspection by the public during normal business hours at the Town Hall for 5 business days from the notice. A public hearing is not required. The public may submit their comments within the time that the Land Disturbance Permit is available for inspection. Comments may be submitted to the *(Stormwater Authority)* during business hours.

F. Filing an application for a land disturbance permit grants the *(Stormwater Authority)* or its agent, permission to enter the site to verify the information in the application and to inspect for compliance with permit conditions.

G. The *(Stormwater Authority)* may:

i. Approve the Application and issue a permit if it finds that the proposed plan will protect water resources and meets the objectives and requirements of this Bylaw;
ii. Approve the Application and issue a permit with conditions, modifications, requirements for operation and maintenance requirements of permanent structural BMPs, designation of responsible party, or restrictions that the *(Stormwater Authority)* determines are required to ensure that the project will protect water resources and will meet the objectives and requirements of this Bylaw; or
iii. Disapprove the application and deny a permit if it finds that the proposed plan will not protect water resources or fails to meet the objectives and requirements of this Bylaw. If the *(Stormwater Authority)* finds that the applicant has submitted insufficient information to describe the site, the work, or the effect of the work on water quality and runoff volume, the *(Stormwater Authority)* may disapprove the application, denying a permit.

H. No permit shall be issued by the *(Stormwater Authority)* for projects that are actively under review or pending decisions from the Conservation Commission or the Planning Board until those decisions have been concluded.

I. The (*Stormwater Authority)* shall take final action on an Application within 30 days if review from Conservation Commission or Planning Board is not required. Failure to take action shall be deemed to be approval of said Application. Upon certification by the Town Clerk that the allowed time has passed without the *(Stormwater Authority's)* action, the Land Disturbance Permit shall be issued by the *(Stormwater Authority)*.

J. The *(Stormwater Authority)* shall take final action on an Application within 10 days of final decision(s) from Conservation Commission and/or Planning Board if the project was under review by the Conservation Commission and/or the Planning Board. Failure to take action shall be deemed to be approval of said Application. Upon certification by the Town Clerk that the allowed time has passed without the *(Stormwater Authority's)* action, the Land Disturbance Permit shall be issued by the *(Stormwater Authority)*.

K. Appeals of Action by the *(Stormwater Authority)*. A decision of the *(Stormwater Authority)* shall be final. Further relief of a decision by the *(Stormwater Authority)* made under this Bylaw shall be reviewable in the Superior Court in and action filed within 10 days thereof. The remedies listed in this Bylaw are not exclusive of any other remedies available under any applicable federal, state or local law.

6. Permits & Procedures

Permit Procedures and Requirements shall be defined and included as part of any rules and regulations promulgated as permitted under Section 4 of this Bylaw.

7. Fees

The *(Stormwater Authority)* shall establish fees to cover expenses connected with application review and monitoring permit compliance. The fees shall be sufficient to cover Town secretarial staff and professional staff. The *(Stormwater Authority)* is also authorized to retain and charge the applicant fees to cover a Registered Professional Engineer or other professional consultant to advise the *(Stormwater Authority)* on any or all aspect of the project. The applicant for a Land Disturbance Permit may be required to establish and maintain an escrow account to cover the costs of said consultants. Applicants must pay review fees to the *(Stormwater Authority)* before the review process may begin.

8. Surety

The *(Stormwater Authority)* may require the permittee to post before the start of land disturbance activity, a surety bond, irrevocable letter of credit, cash, or other acceptable security. The form of the bond shall be approved by town counsel, and be in an amount deemed sufficient by the *(Stormwater Authority)* to insure that the work will be completed in accordance with the permit. If the project is phased, the *(Stormwater Authority)* may release part of the bond as each phase is completed in compliance with the permit but the bond may not be fully released until the *(Stormwater Authority)* has received the final report as required in the Regulations and issued a certificate of completion.

9. Waivers

A. The *(Stormwater Authority)* may waive strict compliance with any requirement of this by-law or the rules and regulations promulgated hereunder, where such action:
   1. is allowed by federal, state and local statutes and/or regulations,
   2. is in the public interest, and
   3. is not inconsistent with the purpose and intent of this by-law.

B. Any applicant may submit a written request to be granted such a waiver. Such a request shall be accompanied by an explanation or documentation supporting the waiver request and demonstrating that strict application of the by-law does not further the purposes or objectives of this bylaw.

C. All waiver requests shall be discussed and a decision will be made by the *(Stormwater Authority)* within 30 days of receiving the waiver request.

D. If in the *(Stormwater Authority)* opinion, additional time or information is required for review of a waiver request, the *(Stormwater Authority)* may continue a consideration of the waiver request to a date certain announced at the meeting. In the event the applicant objects to a continuance, or fails to provide requested information, the waiver request shall be denied.

10. Enforcement

A. The *(Stormwater Authority)* or its authorized agent shall enforce this Bylaw, its regulations, orders, violation notices, and enforcement orders, and may pursue all civil and criminal remedies for such violations.

B. Orders. The *(Stormwater Authority)* or its authorized agent may issue a written order to enforce the provisions of this Bylaw or the regulations thereunder, which may include:
   1. a requirement to cease and desist from the land-disturbing activity until there is compliance with the Bylaw or provisions of the land-disturbance permit;
   2. maintenance, installation or performance of additional erosion and sediment control measures;
   3. monitoring, analyses, and reporting;
   4. remediation of erosion and sedimentation resulting directly or indirectly from the land-disturbing activity;
   5. compliance with the Operation and Maintenance Plan.

   6. If the enforcing person determines that abatement or remediation of erosion and sedimentation is required, the order shall set forth a deadline by which such abatement or remediation must be completed. Said order shall further advise that,

should the violator or property owner fail to abate or perform remediation within the specified deadline, the (Town of ______) may, at its option, undertake such work, and the property owner shall reimburse the Town's expenses.

7. Within thirty (30) days after completing all measures necessary to abate the violation or to perform remediation, the violator (if different than the property owner) and the property owner shall be notified of the costs incurred by the (Town of ____), including administrative costs. The violator or property owner may file a written protest objecting to the amount or basis of costs with the (Stormwater Authority) within thirty (30) days of receipt of the notification of the costs incurred. If the amount due is not received by the expiration of the time in which to file a protest or within thirty (30) days following a decision of the (Stormwater Authority) affirming or reducing the costs, or from a final decision of a court of competent jurisdiction, the costs shall become a special assessment against the property owner and shall constitute a lien on the owner's property for the amount of said costs. Interest shall begin to accrue on any unpaid costs at the statutory rate, as provided in G.L. Ch. 59, § 57, after the thirty-first day following the day on which the costs were due.

8. Criminal Penalty. Any person who violates any provision of this Bylaw, regulation, order or permit issued there under, shall be punished by a fine of not more than $ 300.00. Each day or part thereunder that such violation occurs or continues shall constitute a separate offense.

9. Non-Criminal Disposition. As an alternative to criminal prosecution or civil action, the (Town of ________) may elect to utilize the non-criminal disposition procedure set forth in G.L. Ch. 40, §21D, which has been adopted by the Town in Sec. 19 of the general bylaws, in which case the (Stormwater Authority) or authorized agent shall be the enforcing person. The penalty for each violation shall be $300.00. Each day or part thereof that such violation occurs or continues shall constitute a separate offense.

10. Tax Liens. The (Town of ______) shall require the repayment of services provided to the responsible party which the responsible party was obligated to perform as put forth in the Operation and Maintenance Plan. Such services may include but are not limited to the following: removing sediment from stormwater devices, repairing stormwater devices or revegetating stormwater devices. The Town will send the responsible party a bill for services provided. If the bill is not paid the Town may impose a tax lien on the responsible party or parties' property.

11.Severability

If any provision, paragraph, sentence, or clause of this Bylaw shall be held invalid for any reason, all other provisions shall continue in full force and effect.

Comprehensive Environmental Inc.

MODEL STORMWATER REGULATIONS

To Achieve Phase II Stormwater Compliance and Promote Low Impact Development

JUNE 2005

Comprehensive Environmental Inc.
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Stormwater Management & Erosion Control Regulations

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Stormwater Management and Erosion Control Regulations

1. Purpose

Increased volumes of stormwater, contaminated stormwater runoff from impervious surfaces, and soil erosion and sedimentation are major causes of:

1. impairment of water quality and decreased flow in lakes, ponds, streams, rivers, wetlands and groundwater;
2. contamination of drinking water supplies;
3. erosion of stream channels;
4. alteration or destruction of aquatic and wildlife habitat;
5. flooding; and,
6. overloading or clogging of municipal catch basins and storm drainage systems.

The United States Environmental Protection Agency has identified sedimentation from land disturbance activities and polluted stormwater runoff from land development and redevelopment as major sources of water pollution, impacting drinking water supplies, natural habitats, and recreational resources. Regulation of activities that result in the disturbance of land and the creation of stormwater runoff is necessary for the protection of the *(Town of _____)* water bodies and groundwater resources, to safeguard the health, safety, and welfare of the general public and protect the natural resources of the Town. These regulations address the issues mentioned above and as referenced in the Stormwater Management and Erosion Control Bylaw of the *(Town of _________)*.

2. Authority

A) The Regulations contained herein have been adopted by the *(Stormwater Authority)* in accordance with the *(Town of _______)* Stormwater Management and Erosion Control Bylaw.

B) Nothing in these Regulations is intended to replace or be in derogation of the requirements of the *(Town of _______)* Wetlands Protection Bylaw or any Rules and Regulations adopted thereunder unless these regulations are more stringent.

C) These Stormwater Regulations may be periodically amended by the *(Stormwater Authority)* in accordance with the procedures outlined in Section 5.0 of the *(Town of ________)* Stormwater Management and Erosion Control Bylaw

3. Administration

The *(Stormwater Authority)* shall administer, implement and enforce these Regulations. Projects and activities approved by the *(Stormwater Authority)* shall be deemed in compliance with the intent and provisions of these Stormwater Management and Erosion Control Regulations.

4. Procedures

Major Land Disturbance Permit issuance is required prior to any activity disturbing 40,000 square feet or more of land or as listed in Section 4 of the Stormwater and Erosion Control Bylaw except for Section 4.A.6, which requires a Minor Land Disturbance Permit. In either case the site owner or his Agent shall file for the permit with the *(Stormwater Authority)*. While application may be made by a representative, the permittee must be the owner of the site.

A. **Applications**: An application shall be made to the *(Stormwater Authority)* in a form and containing information as specified in the Regulations adopted by the *(Stormwater Authority)* respectively and shall be accompanied by payment of the appropriate application and review fees. The fee shall be collected by the *(Stormwater Authority)* prior to any review. Applicants shall submit an additional complete application to the Board and/or Commission which is currently reviewing other permits for the same project.

1. Major Land Disturbance Permit Application package shall include:

    a. a completed Application Form with original signatures of all owners;
    b. a list of abutters, certified by the Assessors Office;
    c. three (3) copies of the Erosion and Sediment Control Plan as specified in Section 4.0(E) of these regulations;
    d. three (3) copies of the Stormwater Management Plan as specified in Section 4.0(F) of these regulations;
    e. three (3) copies of the Operation and Maintenance Plan as specified in Section 4.0(G) of these regulations,
    f. payment of the application and review fees; and,

2. One (1) copy each of the Application Form, the Stormwater Management Plan, the Operation & Maintenance Plan and the list of abutters must be filed with the Town Clerk for all Land Disturbance Permits. The Major Land Disturbance Permit Application Package will also be submitted to any other Boards or Commissions reviewing the project.

3. Minor Land Disturbance Permit Application is required for, land disturbance where there is a 15% slope or greater and where the land disturbance is greater than or equal to 200 square feet within the sloped area. An application for a Minor Land Disturbance Permit will include, at a minimum, a sketch of the parcel or parcels on which the activity is to take place, drawn so as to include soil erosion and sediment control practices, planned and existing roadways, waterways, building or buildings to be constructed, topography, a stabilization construction entrance, a Minor Land Disturbance Permit Application and any other information requested by the *(Stormwater Authority)* or their Agent. The plot plan will be drawn to scale. The above information will be submitted to the Town Clerk as well as the *(Stormwater Authority)*. Minor Land Disturbance Permits

have all of the same requirements as the Major Land Disturbance Permits except for the submittal requirements stated above or where stated in the regulations.

B. **Information Requests:** The *(Stormwater Authority)* may request such additional information as is necessary to enable the *(Stormwater Authority)* to determine whether the proposed land disturbance activity will protect water resources and meet the objectives of the Stormwater Management and Erosion Control Bylaw and Regulations.

C. **Determination of Completeness.** The *(Stormwater Authority)* shall make a determination as to the completeness of the application and adequacy of the materials submitted within 5 business days. No review shall take place until the application has been found to be complete.

D. **Project Changes.** The permittee, or their Agent, must notify the Agent of the *(Stormwater Authority)* in writing of any change or alteration of a land-disturbing activity before the change or alteration occurs. If the Agent of the *(Stormwater Authority)* determines that the change or alteration is significant, based on the design requirements listed in Section 4.0(E) and Section 4.0(F) of the Regulations the Agent of the *(Stormwater Authority)* may require that an amended application or a full application be filed in accordance with this Section. If any change or alteration from the Land Disturbance Permit occurs during land disturbing activities, including significant changes in schedule, the Agent of the *(Stormwater Authority)* may require the installation of interim erosion and sedimentation control measures before considering the change or alteration.

E. Erosion and Sediment Control Plan. The Erosion and Sediment Control Plan shall contain sufficient information to describe the nature and purpose of the proposed development, pertinent conditions of the site and the adjacent areas, and proposed erosion and sedimentation controls. The applicant shall submit such material as is necessary to show that the proposed development will comply with the design standards and contain the information listed below.

a. Standards. The Erosion and Sediment Control Plan shall be designed to meet the Massachusetts Stormwater Management Policy or the latest edition of *(Town of _____)* Design Standards (Appendix A) and Landscape Design Standards (Appendix B), whichever is more stringent in the protection of the town's environmental and infrastructure resources, for execution of the provisions of this Bylaw.

b. Contents.

The Erosion and Sediment Control Plan shall contain the following information:

1. Names, addresses, and telephone numbers of the owner, applicant, and person(s) or firm(s) preparing the plan.
2. Title, date, north arrow, names of abutters, scale (1"=20' or 1"=40'), legend, and locus map (1"=800').
3. Location and description of natural features including:

a. Watercourses and water bodies, wetland resource areas, riparian zones and all floodplain information, including the 100-year flood elevation based upon the most recent Flood Insurance Rate Map, or as calculated by a professional engineer for areas not assessed on these maps;
b. Existing vegetation of various kinds including tree lines, shrub layer, ground cover and herbaceous vegetation, and trees with a caliper twelve (12) inches or larger, noting specimen trees and forest communities;
c. Habitats mapped by the Massachusetts Natural Heritage & Endangered Species Program as Endangered, Threatened or of Special Concern, Estimated Habitats of Rare Wildlife and Certified Vernal Pools, Potential Vernal Pools, and Priority Habitats of Rare Species within five hundred (500) feet of any construction activity.

4. Lines of existing abutting streets showing drainage and driveway locations and curb cuts.
5. Existing soils (type, hydrologic group, erodibility) and the volume and nature of imported soil materials.
6. Topographical features including existing and proposed contours at intervals no greater than two (2) feet with spot elevations provided when needed.
7. Steep slopes for pre-development and post-development conditions, delineated by 0%-15%, 15%-25%, and over 25%.
8. Surveyed property lines showing distances and monument locations, all existing and proposed easements, rights-of-way, and other encumbrances, the size of the entire parcel, and the delineation and number of square feet of the land area to be disturbed.
9. Drainage patterns, watersheds and subwatersheds, with calculations of proposed land disturbance within each subwatershed and areas of soil to be disturbed in each watershed throughout the duration of the proposed land disturbance activity.
10. Location and details of erosion and sediment control measures with a narrative of the construction sequence/phasing of the project, including both operation and maintenance for structural and non-structural measures, interim grading, and material stockpiling areas.
11. Path and mechanism to divert uncontaminated water around disturbed areas, to the maximum extent practicable.
12. Location and description of and implementation schedule for temporary and permanent seeding, vegetative controls, and other temporary and final stabilization measures.
13. A description of construction and waste materials expected to be stored on-site. The Plan shall include a description of controls to reduce pollutants from these materials, including storage practices to minimize exposure of the materials to stormwater, and spill prevention and response.
14. A description of provisions for phasing the project where 40,000 square feet of contiguous area or greater is to be altered or disturbed.
15. Plans, reports, and calculations must be stamped and certified by a qualified professional as defined in Section 2 of the Stormwater Management and Erosion Control Bylaw.
16. Such other information as is required by the *(Stormwater Authority)*.

F. Stormwater Management Plan. The Stormwater Management Plan shall contain sufficient information to describe the nature and purpose of the proposed development, pertinent conditions of the site and the adjacent areas, and proposed best management practices for the permanent management and treatment of stormwater. The Stormwater Management Plan shall contain sufficient information for the *(Stormwater Authority)* to evaluate the environmental impact, effectiveness, and acceptability of the measures proposed by the applicant for reducing adverse impacts from stormwater. The Plan shall be designed to meet the Massachusetts Stormwater Management Policy or the latest edition of *(Town of ________)* Design Standards (Appendix A) and Landscape Design Standards (Appendix B), whichever is more stringent in the protection of the town's environmental and infrastructure resources, for execution of the provisions of this Bylaw. The Stormwater Management Plan shall fully describe the project in drawings, and narrative. The applicant shall submit such material as is required below.

a. Standards. The Stormwater Management Plan shall be prepared in accordance Massachusetts Stormwater Management Policy or the latest edition of *(Town of __)* Design Standards (Appendix A) and Landscape Design Standards (Appendix B), whichever is more stringent in the protection of the town's environmental and infrastructure resources.

b. Stormwater Management Plan Requirements. The Stormwater Management Plan shall contain the following information:

1. A locus map, at a scale of 1"=800'.
2. The existing zoning, and land use at the site.
3. The proposed land use.
4. The location(s) of existing and proposed easements.
5. The location of existing and proposed utilities.
6. The site's existing & proposed topography with contours at 2 foot intervals.
7. The existing site hydrology.
8. A description & delineation of existing stormwater conveyances, impoundments, and wetlands on or adjacent to the site or into which stormwater flows.
9. A delineation of 100-year flood plains, if applicable.
10. An estimate made by a Licensed Soil Evaluator of seasonal high groundwater elevation in each area to be used for stormwater retention, detention, or infiltration.
11. The existing and proposed vegetation and ground surfaces with runoff coefficient for each.
12. A drainage area map showing pre and post construction watershed boundaries, drainage area and stormwater flow paths.
13. A description and drawings of all components of the proposed drainage system including:
    a. locations, cross sections, and profiles of all brooks, streams, drainage swales and their method of stabilization,
    b. all measures for the detention, retention or infiltration of water,

   c. all measures for the protection of water quality,
   d. the structural details for all components of the proposed drainage systems and stormwater management facilities,
   e. notes on drawings specifying materials to be used, construction specifications, and typicals, and
   f. expected hydrology with supporting calculations.
14. The proposed improvements including location of buildings or other structures, impervious surfaces, and drainage facilities, if applicable.
15. The Timing, schedules, and sequence of development including clearing, stripping, rough grading, construction, final grading, and vegetative stabilization.
16. A maintenance schedule for the period of construction.
17. Any other information requested by the *(Stormwater Authority)*.

G. Operation and Maintenance Plans

An **Operation and Maintenance Plan** (O&M Plan) for the permanent storm water management system is required at the time of application for all projects. The maintenance plan shall be designed to ensure compliance with this Bylaw and that the Massachusetts Surface Water Quality Standards contained in 314 CMR 4.00 are met in all seasons and throughout the life of the system. The *(Stormwater Authority)* shall make the final decision of what maintenance option is appropriate in a given situation. The *(Stormwater Authority)* will consider natural features, proximity of site to water bodies and wetlands, extent of impervious surfaces, size of the site, the types of stormwater management structures, and potential need for ongoing maintenance activities when making this decision. Once approved by the *(Stormwater Authority)* the Operation and Maintenance Plan shall be recorded at the *(_________ County Registry of Deeds)* by the permittee, shall remain on file with the *(Stormwater Authority)* and shall be an ongoing requirement. The Operation and Maintenance Plan shall conform to the requirements listed below. Stormwater management easements shall be provided by the property owner(s) and shall be sufficient in location and extent to carry out the required maintenance.

a. Operation and Maintenance Plan Requirements. An Operation and Maintenance Plan shall include:

1. The name(s) of the owner(s) for all components of the system
2. Maintenance agreements that specify:
   a. The names and addresses of the person(s) responsible for operation and maintenance
   b. The person(s) responsible for financing maintenance and emergency repairs.
   c. A Maintenance Schedule for all drainage structures, including swales and ponds.
   d. A list of easements with the purpose and location of each.
   e. The signature(s) of the owner(s).

b. **Stormwater Management Easement(s)**.

1. Stormwater management easements shall be provided by the property owner(s) as areas are necessary for:
   a. access for facility inspections and maintenance,
   b. preservation of stormwater runoff conveyance, infiltration, and detention areas and facilities, including flood routes for the 100-year storm event; and
   c. direct maintenance access by heavy equipment to structures requiring regular cleanout maintenance.
2. The purpose of each easement shall be specified in the maintenance agreement signed by the property owner.
3. Stormwater management easements are required for all areas used for off-site stormwater control, unless a waiver is granted by the *(Stormwater Authority)*.
4. Easements shall be recorded with the *(_______ County Registry of Deeds)* prior to issuance of a Certificate of Completion by the *(Stormwater Authority)*.

c. Changes to Operation and Maintenance Plans

1. The owner(s) of the stormwater management system must notify the *(Stormwater Authority)* or its Agent of changes in ownership or assignment of financial responsibility.
2. The maintenance schedule in the Maintenance Agreement may be amended to achieve the purposes of this Stormwater Management and Erosion Control Bylaw and Regulations by mutual agreement of the *(Stormwater Authority)* and the Responsible Parties. Amendments must be in writing and signed by all Responsible Parties. Responsible Parties shall include owner(s), persons with financial responsibility, and persons with operational responsibility. Once the amended Plan is signed the *(Stormwater Authority)* shall file it at the Registry of Deeds at the expense of the current owner(s).

d. Annual Report Submittal

The Responsible Parties must submit annual reports regarding the inspection and maintenance of the BMPs for which they are responsible. The reports must include:

1. Descriptions of the condition of the BMPs,
2. Descriptions of maintenance performed and,
3. Receipts for maintenance performed.

H. Review Fee Schedule

The following fee schedules are minimum fees. The *(Stormwater Authority)* may require higher fees if deemed necessary for proper review of an application or to ensure compliance.

Lot Area	Professional Review Fee	Application Fee
Less Than 3 Acres	$ _____.__	$ ___.__
3 to 10 Acres	$ _____.__	$ ___.__
Greater than 10 Acres	$ _____.__ each acre	$ ___.__

Resubmittal/Amendment
Filing Fee $_____ Review Fee $___

5. Inspection and Site Supervision

All inspections will be conducted by an Agent of the *(Stormwater Authority)*.

A. Preconstruction Meeting. Prior to clearing, excavation, construction, or any land disturbing activity requiring a permit, the applicant, the applicant's technical representative, the general contractor, pertinent subcontractors, and any person with authority to make changes to the project, shall meet with the *(Stormwater Authority)* or its designated Agent to review the permitted plans and proposed implementation.

B. ***(Stormwater Authority)*** **Inspection**. The *(Stormwater Authority)* or its designated Agent shall make inspections as hereinafter required and shall either approve that portion of the work completed or shall notify the permittee wherein the work fails to comply with the approved plans and any conditions of approval. One copy of the permit plans and conditions of approval signed by the *(Stormwater Authority)* shall be maintained at the site during the progress of the work. A copy of the NPDES Construction General Permit and Stormwater Pollution Prevention Plan (if applicable) shall be kept on site as well. In order to obtain inspections, the permittee shall notify the Agent of the *(Stormwater Authority)* at least three (3) working days before each of the following events:

1. Erosion and sediment control measures are in place and stabilized;
2. Rough Grading has been substantially completed;
3. Final Grading has been substantially completed;
4. Bury Inspection: prior to backfilling of any underground drainage or stormwater conveyance structures.
5. Close of the Construction Season; and
6. Final Landscaping (permanent stabilization) and project final completion.

C. Final Inspection. After the stormwater management system has been constructed and before the surety has been released, the applicant must submit a record plan detailing the actual stormwater management system as installed. The applicant must submit an explanation detailing any differences between the plans approved with the permit and the as-built plans. This explanation must be stamped by a Professional Engineer. The *(Stormwater Authority)* or its Agent shall inspect the system to confirm its "as-built" features. This inspector shall also evaluate the effectiveness of the system in an actual storm. If the inspector finds the system to be adequate he shall so report to the *(Stormwater Authority)* which will issue a Certificate of Completion.

If the system is found to be inadequate by virtue of physical evidence of operational failure, even though it was built as called for in the Stormwater Management Plan, it shall be corrected by the permittee before the performance guarantee is released. If the permittee fails to act the *(Town of______)* may use the surety bond to complete the work. Examples of inadequacy shall be limited to: errors in the infiltrative capability, errors in the maximum groundwater elevation, failure to properly define or construct flow paths, or erosive discharges from basins.

D. Permittee Inspections. The permittee or his/her Agent shall conduct and document inspections of all control measures no less than weekly or as specified in the permit, and prior to and following anticipated storm events. The purpose of such inspections will be to determine the overall effectiveness of the Erosion and Sedimentation Control Plan, and the need for maintenance or additional control measures. The permittee or his/her Agent shall submit monthly reports to the *(Stormwater Authority)* or designated Agent in a format approved by the *(Stormwater Authority)*. The *(Stormwater Authority)* may require, as a condition of approval, that an Environmental Site Monitor, approved by the *(Stormwater Authority)*, be retained by the applicant to conduct such inspections and prepare and submit such reports to the *(Stormwater Authority)* or its designated Agent.

E. Access Permission. To the extent permitted by state law, and as authorized by the owner at the time of the application or other party in control of the property, the *(Stormwater Authority)*, its Agents, officers, and employees may enter upon privately owned property for the purpose of performing their duties under this Bylaw and may make or cause to be made such examinations, surveys or sampling as the *(Stormwater Authority)* deems reasonably necessary to determine compliance with the permit.

6. Final Reports

Upon completion of the work, the permittee shall submit a report (including certified as-built construction plans) from a Professional Engineer (P.E.), surveyor, certifying that all erosion and sediment control devices, and approved changes and modifications, have been completed in accordance with the conditions of the approved permit. Any discrepancies should be noted in the cover letter. Minor Land Disturbance Permits are not required to have a P.E. or surveyor certify as built plans.

7. Certificate of Completion

The *(Stormwater Authority)* will issue a letter certifying completion upon receipt and approval of the final reports and/or upon otherwise determining that all work of the permit has been satisfactorily completed in conformance with this Bylaw. The Certificate of Completion shall be recorded at the Registry of Deeds by the Owner(s).

Application
Land Disturbance Permit

GENERAL INSTRUCTIONS

An applicant for a land disturbance plan review must file with the *(Stormwater Authority)* a completed application package, in accordance with the requirements of the Stormwater Management and Erosion Control Bylaw and Regulations. Timelines concerning the review process will not begin until the *(Stormwater Authority)* has determined that the application is complete and decisions from other Boards and Commissions have been concluded.

1. Any application not accompanied by the appropriate fee shall be deemed incomplete. Payment must be made to the *(Town of ______, Stormwater Authority)* in cash, money order, bank or certified check payable to the *(Town of ______)*.

2. An Applicant's failure to pay any additional review or inspection fee within five business days of receipt of the notice that further fees are required shall be grounds for disapproval.

3. The Applicant will publish the public notice. The applicant is responsible for sending abutter notification, by certified mail-return receipt requested. Copies of the certified mail receipts must be submitted to the *(Stormwater Authority)* for verification prior to the Public Review. The applicant shall pay all costs associated with the publication and notification requirements.

Professional review fees include engineering review, legal review, and clerical fees associated with the public review and permit processing. A fee estimate may be provided by the *(Stormwater Authority's)* consultant. The applicant may be required to establish an escrow account with the Town to cover the review fees. If the escrow account becomes depleted, the applicant will be required to renew the escrow account in order to continue the review of the application.

Applicant's Name ____
Applicant's Address ____
____
Applicant's Phone ____

Owners' Names(s) ____
Owners' Address ____
____
Owner's Phone ____

The Land Disturbance involves property where owner's title to the land is derived under deed from____________________, dated_________ ,
and recorded in the *(________ County Registry of Deeds)*, Book_______, Page________, or Land Court Certificate of Title No_____________, Registered in____________________District, Book_________, Page_______. The project is located on the parcel shown on Assessors Map_______, Parcel________. Project street address ___________________________________

Give a brief summary of the nature of the project.

The property (building) is described as being located at
_____________________________________; It is currently used as
____,

The changes proposed are
____
____
_____
Planned start date:____________________, Planned completion date:___________________
Total area to be disturbed? _________________ square feet..
Total area of the site (lot) _______________ square feet
Will there be disturbance of any slope greater than 15%?_________Yes __________No
If yes, give the area of the slope disturbance. ________________square feet.

Please list other narratives and plans (graphics) submitted with this application.
1.____
2.____
3.____
4.____
5.____
6..____

Attach application fee and supporting documents.

Certification
I, the undersigned, hereby certify that I have read and understand the requirements and conditions of the *(Town of _________)* Stormwater Management and Erosion Control Bylaw and Regulations and that the information included in the application materials is accurate and truthful to the best of my knowledge. (sign and print name and date)

Owner Signature:______________________________________ Date:____________________
Name____
(please print)

Applicant Signature: ____________________________________Date: ____________________
Name:____
(please print)

Full Land Disturbance application page 2 of 2

Comprehensive Environmental Inc.

APPENDIX A: STORMWATER TECHNICAL DESIGN CRITERIA

To Achieve Phase II Stormwater Compliance and Promote Low Impact Development

JUNE 2005

Comprehensive Environmental Inc.
Milford, MA • Merrimack, NH • N. Kingstown, RI
1-800-725-2550
www.ceiengineers.com

Appendix A:

Stormwater Management Design Criteria

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Appendix A:

Stormwater Technical Design Criteria

Introduction

Why use design criteria at all? Early subdivisions and other developments were built with no protective design criteria at all – there were no design criteria – and when the land is cleared for development, runoff characteristics change dramatically for the worse. More runoff at higher velocities is discharged. The result of these developments was flooding, environmental damage, and economic losses where development became dense enough to affect people downstream.

In roughly the mid 1950s, engineers working for communities and design engineers for developments began using crude peak flow criteria such as designing for the 10-year storm. These criteria helped a little, but to a large degree just made people feel like they were controlling the impacts of development on flooding in particular. Storms smaller than the 10-year, which almost all of them are, passed untreated, undetained through the detention basins that were typically used to meet this minimal criteria. Larger storms also were not controlled.[1]

In the late 1980s and 1990s, stormwater quality became the focus of engineers and scientists trying to protect water quality. Many improvements were made in stormwater treatment, and proprietary units proliferated. The focus on quality improved the situation and added considerable costs to many projects, but also left the quantity side somewhat unregulated. Today, recognition of the quantity/quality link and the affects of stormwater losses on groundwater levels, streamflows and general dewatering of urban areas has brought the focus back to the quantity issue but with a different twist. Instead of trying to control only flooding, engineers are now trying to control smaller and smaller storms since over 90% of the runoff and its associated pollutant loads is in very small storms. A new recognition has also dawned that using peak criteria only results in sustained flows downstream – flows that over time cause significant channel and environmental damage.

Today, Low Impact Development or LID is the new buzzword, and many people are excited at the opportunity to better control the impacts of development that have become well recognized in the last 20 years. But there are no real design criteria to achieve LID, and without design criteria, the impacts of development will be difficult to control and most communities will have trouble identifying exactly what makes up LID and whether a development is actually going to achieve the best outcome possible.

[1] Note that stormwater management techniques that control small storms, recharge and other factors affect water quantity and quality significantly. Using peak discharge rates of 25, 50 and 100-year storms typically leaves the smaller storms untouched and addresses only the hydraulic impact of massive amounts of rain on downstream flooding, a somewhat rarer event.

Controlling the smallest storms and providing better, low impact development and drainage design has been done only rarely. Methods and data to measure its success are not yet perfected. So actually accomplishing LID will be slow and erratic, with potentially many more mistakes than successes until design criteria are established. This document is a working document meant to provide the first steps towards implementing better drainage design and Low Impact Development. Typically the use of these criteria will not add significantly to the cost of the development, but the long-term economic benefits to host communities could be substantial. Granted, developers and their engineers may not jump right into using the new criteria without encouragement -- no one likes change – but their use will help communities and designers provide better protection for abutters, the environment and the community's infrastructure.

These criteria update an earlier version of CEI's stormwater design criteria (CEI, 2002) to reflect recent improvements in methods to measure and control stormwater impacts[2]. In some cases, they provide more than one method to reach similar performance benchmarks, so that communities and design engineers can choose the best fit method for achieving the similar goals.[3] The criteria include:

1. **Stormwater Recharge**: an additional option has been added to the 1 inch infiltration found in CEI's 2002 criteria. The purpose is to address sites where soils are less conducive to infiltration while still providing hydrologic protection.

2. **Pretreatment**: more criteria for sizing pretreatment have been added to the 2002 criteria.

3. **Flood Protection**: More options are added to reflect the level of urbanization.

4. **Channel Protection**: this is a new criteria designed to protect downstream channels from the damage caused by sustained flows that would occur if only peak discharge was applied.

5. **Water Quality Volume:** Additional methods to compute water quality volume have been added. The purpose of this criteria is to ensure that stormwater runoff is treated, even if recharge is not an option.

6. **Erosion Control:** This is a new criteria from 2002, added because erosion control is crucial and an often overlooked or underutilized practice that may result in tons and tons of sediment released into waterways.

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[2] Some of CEI's 2002 criteria have been combined together where it made sense for simplification, and others have been modified to add more options for calculating the results. There are also three new criteria.

[3] Communities may choose to allow the use of any of the methods as alternates or may identify the one they are most comfortable with and allow only that method to be used. The criteria are listed from most conservative and protective of receiving waters to least conservative.

7. **Detention Basins:** This is a new criteria that if used will result in more naturalized detention basins being built, with better performance.

1. Stormwater Recharge[4]

Impervious and disturbed surfaces from development alter the natural hydrologic cycle by discharging stormwater directly to streams, rather than allowing it to infiltrate through the soils and into groundwater as it did before development. This increases flooding and reduces the baseflow to streams that is needed in the summer months when there is little precipitation. The increased runoff from impervious surfaces also increases stream temperatures, since pavement and other impervious surfaces absorb substantial amounts of heat in the summer due to their dark coloring and lack of shade, which is transferred to runoff passing over the surface. The result is runoff that is dramatically warmer than natural groundwater inflow would have been under a natural hydrologic cycle. The purpose of this criteria is to maintain existing recharge rates to preserve existing groundwater levels and stream baseflows. Two different methods to achieve better recharge are shown below. The first method is more conservative and protective of receiving waters than the second method.

<u>Method 1</u>
All storms up to 1-inch must be retained on site for post-development conditions. The volume of water to be retained can be calculated using the following equation:

Infiltration required per storm (ft^3) = impervious surfaces (ft^2) X 1.0 (inch) / 12 (inches per foot)

The following criteria also apply:

- Initial exfiltration during the design storm shall not be accounted for during the unit/device sizing, with the exception of roof runoff devices, which may account for exfiltration in sizing calculations.

- All units/devices shall be designed to drain within 48 hours from the end of the storm.

- Recharge shall not be concentrated to one area. It shall be distributed to multiple areas throughout the site.

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[4] The appropriate local review authority may alter or eliminate the recharge volume requirement if the site is situated on unsuitable soils (i.e., marine clays). In this situation the water quality volume must still be treated through other BMPs designed to remove pollutants. Underdrained soil filters using a highly organic material are the preferred alternative in these cases, as they most closely mimic the benefits of infiltration.

Redevelopment projects may not be able to achieve the one inch recharge criteria due to site layout and limited space. These projects must recharge or treat a minimum of one half inch of precipitation over the impervious surface.

- The recharge volume criteria does not apply to any portion of a site designated as a stormwater hotspot. Hotspots are defined as sites with higher potential pollutant loads, including:

  - Auto salvage yards (auto recycler facilities)
  - Auto fueling facilities (gas stations)
  - Fleet storage areas (cars, buses, trucks, public works)
  - Vehicle service and maintenance areas
  - Vehicle and equipment cleaning facilities
  - Commercial parking lots with average trip generation rates of 1,000 or greater per day, such as fast-food restaurants, convenience stores, high-turnover (chain) restaurants, shopping centers, and supermarkets
  - Road salt storage and loading areas (if exposed to rainfall)
  - Commercial nurseries
  - Flat metal (galvanized metal or copper) rooftops of industrial facilities
  - Outdoor storage and loading/unloading areas of hazardous substances
  - SARA 312 generators (if materials or containers are exposed to rainfall)
  - Marinas (service, repainting, and hull maintenance areas)

Method 2

The volume of water to be recharged shall be based on the site soils. The volume of water to be retained from the developed site should be calculated using the following equation:

$Re_v = [(S)(Rv)(A)(43{,}560)]/12$, *where*

Re_v = *recharge volume* (ft^3)

$R_v = 0.05 + 0.009(I)$ *where I is the percent impervious cover*

A = *site area in acres*

S = *Soil Specific Recharge Factor*

Hydrologic Group	*Soil Specific Recharge Factor*
A	*0.40*
B	*0.25*
C	*0.10*
D	*0.07*

The following criteria also apply:

- Initial exfiltration during the design storm shall not be accounted for during the unit/device sizing, with the exception of roof runoff devices, which may account for exfiltration in sizing calculations.

- All units/devices shall be designed to drain within 48 hours from the end of the storm.

- Recharge shall not be concentrated to one area. It shall be distributed to multiple areas throughout the site.

- The soil group classification used to determine the CN value shall be based on an on-site percolation test and the table below:

Soil Group	**A**	**B**	**C**	**D**
Infiltration rate when wet (inches/hour)	> 0.3	0.15 – 0.3	0.05 – 0.15	0 – 0.05

- If more than one soil type is present at the site, a composite soil specific recharge factor shall be computed based on the proportion of total site area within each soil type. The recharge volume provided at the site shall be directed to the most permeable soil available.

- The recharge volume criteria does not apply to any portion of a site designated as a stormwater hotspot. Hotspots are defined as sites with higher potential pollutant loads, including:

    - Auto salvage yards (auto recycler facilities)
    - Auto fueling facilities (gas stations)
    - Fleet storage areas (cars, buses, trucks, public works)
    - Vehicle service and maintenance areas
    - Vehicle and equipment cleaning facilities
    - Commercial parking lots with average trip generation rates of 1,000 or greater per day, such as fast-food restaurants, convenience stores, high-turnover (chain) restaurants, shopping centers, and supermarkets
    - Road salt storage and loading areas (if exposed to rainfall)
    - Commercial nurseries
    - Flat metal (galvanized metal or copper) rooftops of industrial facilities
    - Outdoor storage and loading/unloading areas of hazardous substances
    - SARA 312 generators (if materials or containers are exposed to rainfall)
    - Marinas (service, repainting, and hull maintenance areas)

2. Pretreatment

To prevent premature failure, the design of stormwater treatment devices shall include a pre-treatment device or method that will trap sand and sediments to avoid clogging the treatment mechanism. Infiltration of stormwater from the treatment device into underlying soils and eventually groundwater aquifers is an important beneficial component of the device. Pre-treatment basins must be designed and located to be easily inspected and accessible to facilitate maintenance. Pre-treatment devices must also be sized to accommodate a minimum of one-year's worth of sediment and debris.

The following standards shall be followed to ensure that the device will permit sufficient treatment to treat stormwater and allow for a reasonable required maintenance frequency for the BMP:

- Pre-treatment devices shall be provided for each BMP; ***and***

- Pre-treatment devices shall be designed to accommodate a minimum of one-year's worth of sediment; ***and***

- Pre-treatment devices shall be designed to capture anticipated pollutants, such as oil and grease; ***and***

- Pre-treatment devices shall be designed and located to be easily accessible to facilitate inspection and maintenance; ***and***

- The Revised Universal Soil Loss Equation (RUSLE)[5] shall be used to calculate sediment deposits that would occur from pervious areas adjacent to the BMP; ***and***

- Pretreatment structures shall be sized to hold an annual sediment loading. An annual sediment load shall be calculated using a sand application rate of 500[6] lbs/acre for sanding of roadways, parking areas and access drives within the subcatchment area, a sand density of 90 lbs per cubic foot and assuming a minimum frequency of ten sandings per year. To obtain an annual sediment volume, perform the following calculation:

  $$\text{Area to be sanded (acres)} \times 500\,\frac{\text{pounds}}{\text{Acre-storm}} \div 90\,\frac{\text{pounds}}{ft^3} \times 10\,\frac{\text{storms}}{\text{year}} = \frac{\text{cubic feet of}}{\text{sediment/yr}}$$

- The developer shall maintain any BMPs used to trap sediment during construction to prevent sediment from leaving the site, and shall remove all sediment from all BMPs when construction is finished and the site is stabilized.

Sanding rates and numbers of storms may need to be adjusted downward for southern New England and upward for northern New England.

3. Flooding Protection

Impervious and disturbed surfaces from development cause an increase in the volume, velocity and flowrates of stormwater leaving sites and entering surface waters. This in

[5] Developed by the Natural Resources Conservation Service, USDA to predict soil erosion to due water.
[6] Municipalities may wish to adjust the sanding rate for roadways based on actual sanding rates for their Town or City. Sanding rates for private parking lots and facilities should assume the 500 lbs/acre.

turn causes flooding of the receiving waters during storms, which damages the streambanks. This can be controlled through the use of flow controls to prevent post-development peak discharges from exceeding pre-development peak discharges. It is important to control various size storms. Even the smaller storms warrant control as these occur more frequently and can be damaging to streambanks as the frequency and magnitude of flooding increases. Larger storms, such as the 100-year storm should also be controlled to prevent flood damage and maintain the 100-year flood plain boundaries.

The following standards should be followed to control peak discharge rates and improve the overall effectiveness of the BMPs. These are minimum design standards.

- The post-development peak discharge rate shall be equal to or less than the pre-development peak discharge rate (based on a 1-year, 2-year, 10-year, 25-year, 24-hour storm); ***and***

- Control the peak discharge rate from the 100-year storm to pre-development levels within the 100-year floodplain; ***and***

- The site shall be designed to ensure that all runoff from the site up to the maximum design storm (i.e., 100-year storm) enters the control structure. For example, the drainage system may only be sized to handle a ten-year storm, with larger storms flooding the distribution system and traveling overland. This overland flow, or overflow, must be directed into the peak control structure; ***and***

- The applicant shall account for all run-on and run-off (including off-site impacts) in both pre- and post-development conditions; ***and***

- The applicant shall prepare hydrographs for pre- and post-development conditions; ***and***

- The pre-developed condition shall be a forested land cover in good condition. Post development should assume a worst case condition (i.e., poor vegetated cover) for disturbed areas; ***and***

- Any site that was wooded within the last five years must be considered undisturbed woods for all pre-construction runoff conditions, regardless of clearing or cutting activities that may have occurred on the site during that pre-application period; ***and***

- Use TR-55 to develop hydrographs and peak flow rates for the proposed development site. Make sure all areas are accounted for in the pre/post runoff calculations. The total tributary area that contributes flow from the proposed site, including runoff entering the site through piped drainage or surface runoff from off-site sources, must be included even if a portion does not contribute flow to the BMP. The objective is for the development's storm drain design to account for total runoff leaving the site; ***and***

- Off-site areas should be modeled as "present land use condition" in good hydrologic condition for the 2 and 10-year storm events for both pre and post development calculations; ***and***

- The length of overland sheet flow used in t_c calculations shall be limited to no more than 50 feet for pre- and post-development conditions.

4. Channel Protection

Many storm water management practices focus on controlling peak flow rates for larger storms, including the 2-year, 10-year and 100-year storms. This does not address the increased duration at which those high flows occur because of the increased *volume* of water from development compared to pre-development. For example, although the peak flows are kept the same, there is a much greater volume of water leaving the site under developed conditions and the streams have higher flows for longer durations than they did under predevelopment conditions. In addition, because the impervious development has limited recharge, base flow during non-storm event times is lower. The purpose of this criterion is to limit the total amount of time that a receiving stream exceeds an erosion-causing threshold based on pre-developed conditions. Two methods to achieve better channel protection are shown below, with the more conservative and protective provided first.

Method 1
24 hours extended detention of the post-development 1-year, 24-hour return frequency storm event shall be provided.

Method 2
12 hours extended detention of the post-development 1-year, 24-hour return frequency storm event shall be provided.

5. Water Quality Volume[7]

Development also impacts the water quality of streams, ponds, lakes and wetlands. As impervious area increases, the volume and velocities of stormwater increase, often resulting in erosion of soils. Pollutant deposits on the land surface also increase as the intensity of land use increases. These materials are then washed off by rain and runoff, increasing the pollutant load to receiving waters. Thus, it is important that BMPs are used to handle water quantity as well as treat water quality. The water quality volume should include the first flush of storms, as this is where the majority of pollutants are collected and discharged. Two different methods for calculating water quality volumes are

[7] Redevelopment projects may not be able to treat the full water quality volume as estimated above due to site layout and limited space. These projects must treat a minimum of one half inch of precipitation over the impervious surface.

presented below. The first is more conservative and protective of receiving waters than the second.

Method 1

The water quality volume required to be treated shall be calculated as:

Water Quality Volume (ft^3)= [(P)(R_v)(A)(43,560)]/12, *where*
P = rainfall depth in inches – use 1”
R_v *= 0.05 + 0.009(I) where I is the percent impervious cover*
A = site area in acres

- At a minimum use 0.2 inches per acre at sites with less than 15% impervious cover.

Method 2

The water quality volume required to be treated shall be calculated as:

Water Quality Volume (ft^3) *= impervious surfaces* (ft^2) *X 1.0 (inch) / 12 (inches per foot)*

6. Erosion Control

Land clearing and grading for construction purposes leaves soils susceptible to erosion. If not controlled, eroded soils may reach streams and lakes, filling them in and adding pollutants attached to the soil particles. It is important to have controls in place to prevent and control the erosion of disturbed lands. The following standards shall be met for erosion control:

- Prior to any land disturbance activities commencing on the site, the developer shall physically mark limits of no land disturbance on the site with tape, signs, or orange construction fence, so that workers can see the areas to be protected. The physical markers shall be inspected daily.

- Appropriate erosion and sediment control measures shall be installed prior to soil disturbance. Measures shall be taken to control erosion within the project area. Sediment in runoff water shall be trapped and retained within the project area. Wetland areas and surface waters shall be protected from sediment.

- Sediment shall be removed once the volume reaches ¼ to ½ the height of the silt fence or hay bale.

- Divert offsite runoff from highly erodible soils and steep slopes to stable areas.

- Land disturbance activities exceeding two acres in size should not be disturbed without a sequencing plan that requires stormwater controls to be installed and the soil stabilized, as disturbance beyond the two acres continues. A construction phasing plan shall be submitted to the Planning Department prior to any construction on the site. Mass clearings and grading of the entire site shall be avoided.

- Soil stockpiles must be stabilized or covered at the end of each workday. Stockpile side slopes shall not be greater than 2:1. All stockpiles shall be surrounded by sediment controls.

- The area of disturbance shall be kept to a minimum. Disturbed areas remaining idle for more than 14 days shall be stabilized.

- For active construction areas such as borrow or stockpile areas, roadway improvements and areas within 50 feet of a building under construction, a perimeter sediment control system shall be installed and maintained to contain soil.

- A tracking pad shall be constructed at all entrance/exist points of the site to reduce the amount of soil carried onto roadways and off the site.

- Dust shall be controlled at the site.

- On the cut side of roads, ditches shall be stabilized immediately with rock rip-rap or other non-erodible liners, or where appropriate, vegetative measures such as sod.

- Permanent seeding shall be undertaken in the spring from March through May, and in late summer and early fall from August to October 15. During the peak summer months and in the fall after October 15, when seeding is found to be impractical, an appropriate temporary mulch shall be applied. Permanent seeding may be undertaken during the summer if plans provide for adequate mulching and watering.

- All slopes steeper than 3:1 (h:v, 33.3%), as well as perimeter dikes, sediment basins or traps, and embankments must, upon completion, be immediately stabilized with sod, seed and anchored straw mulch, or other approved stabilization measures. Areas outside of the perimeter sediment control system must not be disturbed.

- Monitoring and maintenance of erosion and sediment control measures throughout the course of construction shall be required. The applicant shall submit an Operation and Maintenance Plan for temporary and permanent erosion control measures as part of the application package.

- Temporary sediment trapping devices must not be removed until permanent stabilization is established in all contributory drainage areas. Similarly, stabilization must be established prior to converting sediment traps/basins into permanent (post-construction) stormwater management facilities. All facilities used as temporary measures shall be cleaned prior to being put into final operation.

- All temporary erosion and sediment control measures shall be removed after final site stabilization. Disturbed soil areas resulting from the removal of temporary measures shall be permanently stabilized within 30 days of removal.

7. Naturalized Detention Basins

Naturalized basins are attractively landscaped basins that fit better into a natural landscape. Naturalized planting themes incorporate native plants and use an informal pattern to mimic the natural environment. They have several advantages over traditional basins, including:

- The deeper root systems of the native plant materials encourage infiltration, recharging groundwater tables and increasing base flows.
- The plants trap pollutants, increasing the water quality of the discharge.
- The vegetation serves to cool water temperatures and slow storm water velocities.
- They are visually more attractive and can help beautify a neighborhood, increasing property values.
- They require less maintenance. Generally annual mowing and periodic trimming of trees and plants is sufficient.

Minimum Design Standards

Naturalized basins shall be used in lieu of conventional detention basins wherever feasible. The following design standards shall be followed to achieve the maximum benefit:

1. The basin shall be easily accessible for maintenance.

2. Construct basin with a sediment forebay at the inlet, sized to hold a minimum of one year's worth of sediment accumulation if no other pre-treatment is proposed.

3. Construct basin to have a natural low flow channel with turf reinforcement material to remove pollutants and prevent erosion.

4. Incorporate a naturally landscaped area at the ground surface. The ground surface around the basin shall be large enough to be in scale with the overall landscaped area. The purpose is to filter and soften views from residential areas.

5. Plant all areas of the naturalized basin, including basin floors, side slopes, berms, impoundment structures, or other earth structures, with suitable vegetation such as naturalized meadow plantings or lawn grass specifically suited for storm water basins. Suggested plants include:

    a. Grasses: Big Blue Stem, Switchgrass and wildflower mixes. In wet areas, plant Sweetflag, Yellow Iris and Soft Rush for color and texture.

   b. Shrubs: Red Chokeberry (Aronia arbutifolia), Silky Dogwood (Cornus ammomum), Arrowwood (Viburnun Dentatum), Cranberrybush (Viburnum trilobum).
   c. Trees: Red Maple (Acer rubrum), River Birch (Betula nigra), Sweetgum (Liquidambar styraciflua), various Willows.

6. Trees may not be planted below the pool area of the basin. If shrubs are used, they must be adapted to wet or moist soils conditions.

7. Mulch all shrub beds located within the pool area with a non-floating type mulch over a weed barrier material.

8. Group trees or shrubs to avoid a spotty effect.

9. Provide access to the basin for maintenance. Blend access area in with the surrounding landscape to the extent feasible.

10. The forebay/sediment trap shall be at least 10 feet long and sized to hold at least the annual sediment loading.

11. Maintenance access shall be planted with grass and at least 10 feet wide with a maximum slope of 15% and a maximum cross slope of 3%.

12. Provide a means to prevent soil compaction on the floor of the basin during construction.

13. Size treatment storage area to hold the water quality volume.

14. The perimeter of all basins shall be curvilinear so that from most edges of the basin, the whole basin will not be in view. A more traditionally shaped (oval or rectangular) basin may be permitted when conditions such as topography, parcel size, or other site conditions warrant. Basins shall follow natural landforms to the greatest extent possible or be shaped to mimic a naturally formed depression.

15. Place inlets and outlets to maximize the flow path through the facility. At a minimum, the flow path shall be twice as long as wide. Baffles, pond shaping or islands can be added within the permanent pool to increase the flow path. If there are multiple inlets, the length-to-width ratio shall be based on the average flow path length for all inlets.

16. Minimum 1 foot of freeboard above the 25-year storm elevation.

17. The interior slopes of the basin within the pool area shall not exceed a slope of four horizontal to one vertical.

18. A minimum of six inches of topsoil with at least 6% organic content shall be provided for all planting ground cover beds or lawn areas.

19. Low flow outlets shall be designed to prevent clogging.

20. For basins that cannot infiltrate the water quality volume, use a soil filter conforming to the following:

    a. Impoundment Depth – Peak storage depth within the filter area for water quality volume may not exceed 18 inches.

    b. Pipe layout and spacing – Layout of the pipe underdrain system must be sufficient to effectively drain the entire filter area. There must be at least one line of underdrain pipe for every 8 feet of the filter area's width. The slope of the pipe must be 1% or greater.

    c. Pipe bedding – Minimum 12 inches over top of drainage pipe, 6" thick at sides, and 6 inches below drainage pipe of clean well-graded gravel.

    d. Filter bed – The soil must consist of loamy, coarse sand. The soil filter must extend across the bottom of the entire filter area. The soil must be at least 18" deep and underlain by a gravel bedding. A nonwoven filter fabric shall be installed between the soil and gravel with sufficient permeability rates to drain the water quality volume.

    e. Surface Cover – The top of the underdrain system must be covered with a 4 inch layer of sandy loam and then covered with plantings consisting of species tolerant of frequent inundation.

    f. Underdrain outlet – Each system must discharge to an area capable of withstanding concentrated flows and saturated conditions without eroding.

8. Hydrologic and Hydraulic Criteria for All Designs

- Impervious cover is measured from the site plan and includes any material or structure on or above the ground that prevents water from infiltrating through the underlying soil. Impervious surface is defined to include, without limitation: paved parking lots, sidewalks, roof tops, driveways, patios, and paved, gravel and compacted dirt surfaced roads.

- Determination of flooding and channel erosion impacts to receiving streams due to land development projects shall be measured at each point of discharge from the development project and such determination shall include any runoff from the balance of the watershed which also contributes to that point of discharge.

- The specified design storms shall be defined as a 24-hour storm using the rainfall distribution recommended by the United States Department of Agriculture (USDA) Natural Resources Conservation Service (NRCS).

- Proposed residential, commercial, or industrial subdivisions shall apply these stormwater management criteria to the land development as a whole. Individual lots in new subdivisions shall not be considered separate land development projects, but rather the entire subdivision shall be considered a single land development project. Hydrologic parameters shall reflect the ultimate land development and shall be used in all engineering calculations.

Comprehensive Environmental Inc.

APPENDIX B:
LANDSCAPE DESIGN STANDARDS FOR STORMWATER TREATMENT

MARCH 2005

Comprehensive Environmental Inc.
Milford, MA • Merrimack, NH • N. Kingstown, RI
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www.ceiengineers.com

Appendix B

Landscape Design Standards for Stormwater Treatment

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Appendix B:

Landscape Design Standards for Stormwater Treatment

General Standards

Soil and landscaping play an important role in stormwater impacts and treatment results. From a quantity standpoint, the loss of good quality topsoil from many sites during construction results in significant increases in runoff quantities that are often not calculated in the models such as TR-55 typically used for runoff assessment. In terms of quality, high organic content of soils absorbs and adsorbs many pollutants. In fact peat and compost have been shown to provide considerable pollutant removal and are sometimes used in various treatment strategies.

Landscaping also affects stormwater quality and quantity. Grassed areas, while not totally undesirable, may have considerably more runoff due to compaction and more pollutant contribution due to the frequently-occurring overuse of fertilizers and pesticides. Alternatively, a tiered landscape containing an overstory (typically large shade trees), understory trees, shrubs groundcovers provides the most absorption and natural uptake of rainfall. Some grass may be included but typically not an expansive monoculture. A more desirable landscape is diverse and provides wildlife habitat, shade, and beauty along with strips of grass for open areas.

Tiered landscapes, like natural landscapes, tend to require less maintenance and chemical input once established. These landscapes, including a highly organic soil profile, absorb and cleanse rainfall and runoff so that the quantity and quality are more reflective of a natural hydrology. By using these specifications, water, pesticide and fertilizer use will be minimized and vegetation will thrive with little but spring and fall cleanup.

Soil Preparation

1. Compacted soils restrict root penetration, impede water infiltration, and contain few macropore spaces needed for adequate aeration. In addition, compacted soils have a higher runoff coefficient and should be avoided. Preventing construction activities on parts of the site will help prevent compaction. In areas where this is not practical, methods to compensate for the compaction must be employed. Landscape areas should be deep tilled to a depth of at least 12 inches to facilitate deep water penetration and soil oxygenation. Use of soil amendments is encouraged to improve water drainage, moisture penetration, soil oxygenation, and/or water holding capacity. Soil amendments are organic matter such as compost, sewer biosolids, and forestry by-products, but do not include topsoil or any mix with soil as an element.

2. For all newly landscaped areas, including single-family residences, organic matter (three to four cubic yards of organic matter per 1,000 square feet of landscape area) should be incorporated to a depth of four to six inches. Organic content of landscaped soils shall not be less than 18% by volume in the top six inches of the finished topsoil.

3. For newly landscaped areas where topsoil is limited or nonexistent, or where soil drainage is impeded due to subsurface hardpan or bedrock, 6 to 24 inches of sandy loam topsoil should be spread in all planting and turf areas, in addition to the incorporation of organic matter into the top horizon of the imported soil. Organic content of landscaped soils shall not be less than 18% by volume in the top six inches of the finished topsoil.

4. Soil analysis of new or renovated turf areas should include a determination of soil texture, including percentage of organic matter; an approximated soil infiltration rate; and a measure of pH value.

Mulching

Mulch should be applied regularly to, and maintained in all, planting areas to assist soils in retaining moisture, reducing weed growth, and minimizing erosion. Mulches include organic materials such as wood chips, compost and shredded bark and inert organic materials such as decomposed lava rock, coble, and gravel. If weed barrier mats are used, the use of inert organic mulches is recommended. Non-porous materials, such as plastic sheeting, are not recommended for use in any area of the landscape because of down-slope erosion, potential soil contamination from herbicide washing and increased runoff coefficients. Mulches should be applied to the following depths: three inches over bare soil, and two inches where plant materials will cover. Mulches for stormwater management areas should be heavier and not of a type that will float away.

Compatible Water Use Design

Trees and plants having similar climatic, water, soil, and maintenance requirements should be grouped in distinct and compatible planting areas as follows: (1) plants which, at maturity, require moist soils and supplemental water in addition to natural rainfall to survive; (2) plants which, at maturity, survive on natural rainfall with supplemental water during seasonal dry periods that are unusual due to their length, high temperature, or lack of moisture; and (3) plants which, at maturity, survive on natural rainfall without supplemental water. Grouping/zoning of plantings should coordinate with the irrigation hydrozoning plan as well as topographic features in the landscape so that plantings benefit from collected precipitation, run-off, or water harvesting. Group 3 plantings should be preferred over Group 2 or 1 plantings.

Site Features and Layout

1. Landscaping should be designed to remain functional and attractive during all seasons of the year through a thoughtful selection of deciduous, evergreen, flowering and non-flowering plant varieties.

2. Prominent natural or man-made features of the landscape such as mature trees, surface waters, natural rock outcrops, roadways or stonewalls should be retained and incorporated into the landscape plan where possible. The addition of ornamental rocks, fencing and other features new to the landscape are encouraged.

3. Existing natural vegetation should be retained where possible. Existing trees and shrubs to be retained may be substituted for any compatible required plantings.

4. Lawn areas should be kept to a minimum. Natural re-growth, mulched planting beds and alternative groundcover plant varieties are preferred. Lawn areas should not be planted in strips of less than six feet in width, especially adjacent to roads or parking areas, since such areas require watering but have little utility and are less likely to thrive.

5. Native plant species, or plant species that have been naturalized in the area or the surrounding region should be used to meet the minimum requirements of this section. Plant varieties selected should be hardy, drought and salt resistant, and require minimal maintenance. Less hardy, exotic or higher maintenance plant varieties may be used to supplement minimum landscaping requirements where appropriate, but are not encouraged. Species listed on the current Invasive Species List for Massachusetts shall not be used.

Use of Compost

Incorporation of organic matter such as compost improves the structure (tilth) of the till and any other soil types, with the exception of soils that are already highly organic. In sandy soils, compost increases the water holding capacity and nutrient retention. The physical and chemical properties of most New England soils can be significantly improved by blending in compost.

Compost-amended soil has many potential benefits when instituted with establishment of turf and landscaping, including: (1) increased water conservation, (2) increased nutrient retention, (3) better turf aesthetics, (4) reduced need for chemical use, (5) improved stormwater retention, and (6) cost-savings to the private landowner, and the Town of ____________.

Compost shall be a stable, humus-like organic material produced by the biological and biochemical decomposition of source separated compostable materials, separated at the point of generation, that may include, but are not limited to, leaves and yard trimmings, food scraps, food processing residuals, manure and/or other agricultural residuals, forest residues and bark, and soiled or non-recyclable paper. Compost shall not be altered by the addition of materials such as sand, soil or glass. Compost shall contain no substances toxic to plants and shall not contain more than 0.1 percent by dry mass of man-made foreign matter. Compost shall pose no objectionable odor and shall not closely resemble the raw material from which it was derived. Compost shall have a minimum organic matter content of 30 percent dry unit weight basis as determined by loss on ignition in accordance with ASTM D 2974. Compost shall be loose and friable, not dusty, have no visible free water and have a moisture content of 35 - 60 percent in accordance with ASTM D 2974. The particle size of compost shall be 100 percent less than 25 mm in accordance with AASHTO T27 and shall be free of sticks, stones, roots or other objectionable elongated material larger than 50 mm in greatest dimension. The pH of compost shall be in the range of 5.5 - 8.0. The maturity of the compost shall be tested and reported using the Solvita Compost Maturity Test and must score 6 or higher to be acceptable. The soluble salt content of compost shall not exceed 4.0 mmhos/cm as determined by using a dilution of 1 part compost to 1 part distilled water.

The quantity of compost to be incorporated into a site is determined by the final organic content goal for the soil and is dependent on its existing organic content. Organic content of landscaped soils shall not be less than six percent.

Low Impact Development Landscaping

Landscaping that incorporates Low Impact Development (LID) strategies for stormwater management should serve to meet the requirements of the Town of ________'s stormwater management plan by absorbing and treating stormwater runoff to the greatest extent possible onsite. Low Impact Development landscaping includes the use of biofilters, raingardens, shallow swales, drywells and other features that use soil and landscaping to mimic natural hydrologic features and functions. The high organic content of the soils encourages healthy growth and absorbs and retains rainwater on site as soil moisture, minimizing irrigation needs and runoff quantities.

Landscape areas shall include all areas on the site that are not covered by buildings, structures, paving or impervious surface. The selection and location of turf, trees, ground cover (including shrubs, grasses, perennials, flowerbeds and slope retention), pedestrian paving and other landscaping elements shall be used to absorb rainfall, prevent erosion and meet the functional and visual purposes such as defining spaces, accommodating and directing circulation patterns, managing hardscape impacts, attracting attention to building entrances and other focal points, and visually integrating buildings with the landscape area. Where possible, the landscaping design should combine form and function, incorporating drainage features invisibly into the landscape such as through shallow detention areas, parking lot islands that provide for infiltration of parking lot runoff and sheet flow.

Neighboring Properties

Landscape Design Plans shall mitigate the impact to neighboring properties. The rear elevations of buildings, loading docks, and refuse collection areas must also be addressed in the Landscape Design Plan. It is required that rear elevations adjacent to non-commercial zoned parcels will be screened to the full height of the structure within seven (7) years of occupancy of the retail space.

Parking Lots

Parking lots with more than fifty (50) parking spaces shall have curbed planting areas. Planting areas shall be placed at each end of a parking row. No parking row shall contain 30 contiguous parking spaces without a curbed planting area.

Curbs around parking lot planting areas shall have a shallow descending cut that is a minimum of five feet wide to allow drainage to flow from the parking lot into the curbed planting areas for infiltration. Such planting areas shall be underlain by a suitable layer of crushed stone or other water holding reservoir, with an overlay of filter fabric to minimize clogging by fines. Topsoil depths and minimum organic content shall be as above for other landscaped areas for the maximum absorption of rainfall.

Vegetation

Any landscape element that dies, or is otherwise removed, shall be promptly replaced with the same, if not similar to, height or texture element as originally intended.

A split rail or picket fence, not less than two feet in height and not more than four feet in height, shall be provided between or to the rear of the trees to serve as a back drop and support for the shrubs and other planting, to serve as a unifying architectural element, and to protect against damage cause by pedestrian "cut-through" traffic. Shrubs and other smaller plantings should be placed between the fence and the street or on both sides where the fence is placed toward the center of the landscaped strip.

Landscape strips should be mulched or planted with hardy groundcover plant varieties rather than planted as lawn areas. Where landscape strips are used as part of the drainage system, plantings shall be tolerant of periodic wet conditions and shall be shallowly sloped to allow infiltration and storage.

Wheel stops should be provided in all parking areas abutting landscaped strips to avoid accidental damage.

Collector Roads: A deciduous shade tree and accompanying understory shrubs and groundcovers shall be planted in groupings along the front property line of all sites adjoining the collector road at a rate of not less than 1 tree per 25 linear feet of property frontage. Where larger shade trees may interfere with overhead utilities, minor shade or ornamental tree varieties should be used.

Maintenance

Low maintenance, drought, insect and disease resistant plant varieties are encouraged so that buffer areas and other required landscaping can be maintained with minimal care and the need for watering, pesticide or fertilized use is minimized. For these reasons, native species and species that have long thrived within the region are preferred since such plant species are well adapted to the local environment.

To avoid maintenance problems, soil testing should be conducted prior to planting to ensure that the appropriate plant varieties are selected for various portions of a site.

To avoid maintenance problems and excessive watering, organic matter such as compost or peat should be added to the soil before planting as appropriate to increase the water holding capacity of the soil and to provide nutrients.

Where used, irrigation systems should be installed with moisture meters or other devices designed to avoid unnecessary or excessive watering. Alternatively, irrigation systems should be manually activated.

Informal, Re-growth and Peripheral Landscape Areas

Disturbed areas intended for natural re-growth should be, at a minimum, graded, loamed and seeded with wildflowers, perennial rye grass or similar varieties. The planting of native trees, shrubs and other plant varieties is encouraged. The planting of blueberry, rhododendron, winterberry, bayberry, shrub dogwoods, cranberry bush, spicebush, native viburnums and other hardy shrubs along the edge of cleared woodlands provides for an attractive transition between natural woodland and more formally landscaped portions of a site. Where woodland areas are intended to serve as buffers, such plantings can fill in voids by rapidly reestablishing undergrowth. Perennial flowerbeds are also encouraged.

Plant Specifications and Definitions

1. <u>Trees and shrubs – installation size requirements</u>

    a) Minimum size for shade or canopy trees shall be 3 inches in diameter measured at a point six inches above grade with a height of not less than 12 feet.
    b) Minimum size for small or minor shade trees shall be 2.5 inches in diameter measured at a point six inches above grade with a height of not less than nine feet.
    c) Minimum size for ornamental or flowering fruit trees shall be 2 inches in diameter measured at a point six inches above grade with a height of not less than seven feet.
    d) Minimum size for evergreen trees shall be six feet in height.
    e) Minimum size for shrubs shall be 1.5 feet in height.

2. Planting Specifications

   a) Areas intended as planting beds for shrubs or hedges shall be cultivated to a depth of not less than 18 inches. All other planting beds shall be cultivated to a depth of not less than 12 inches.
   b) Pits for planting trees or shrubs shall be generally circular in outline with vertical sides. Pits for trees or shrubs shall be deep enough to allow one-eighth of the ball of the roots to be the existing grade. Pits for trees shall be wide enough to allow for at least 9 inches between the ball of the tree and the sides of the pit on all sides.
   c) Cultivated areas shall be covered with not less than a two to three inch deep layer of mulch after planting.
   d) All trees and shrubs shall be appropriately pruned after planting with all broken or damaged branches removed.
   e) All plants shall be nursery grown.

3. Retention of Existing Vegetation

The boundary of areas to be cleared should be well defined in the field with tree markings, construction fencing or silt fencing as appropriate to avoid unnecessary cutting or removal. Care should be taken to protect root systems from damage from excavation or compaction. Individual trees, rock formations and other landscape features to be retained should also be clearly marked and bounded in the field.

Recommended Plant Varieties

See Attachment A

Definitions

1. Berm: a linear earthen mound designed to block views, noise or other potentially objectionable circumstances.
2. Deciduous: a plant with foliage that is shed annually.
3. Evergreen: a plant with foliage that is retained and remains green throughout the year.
4. Mulch: nonliving organic or synthetic matter spread over cultivated ground to retain moisture, limit weed growth and control erosion.
5. Ornamental tree: a deciduous tree, generally smaller than a shade tree, that is planted primarily for its aesthetic or ornamental value.
6. Shade tree: a large deciduous tree with a high crown of foliage or overhead canopy.
7. Shrub: A self-supporting woody plant, smaller than a tree, which consists of several small stems or branches from a base at or about the ground.

Appendix I
Stormwater Fieldwork Summary Table

Date	Source ID	Major Road/Street	Type of Potential Source (Erosion / Roadway Drainage/ Septic / Lawn Area)	Drainage System or Culvert (Y/N and What Type)	Size	Material	Waterway (Y/N) (Type e.g. swale, ditch, brook, river, stream)	Sediment (Y/N)	Erosion (major /minor)	Surrounding Land Use	IMG # Photos	Notes	Potential Type of BMP	Accessability	Sediment Accumulation	Deposits	Drainage Structural or Culvert Condition	Erodibility	Vegetation	Direct Runoff to Waterbody	Proximity to Waterbody	Constraints
9/25/2013	C-1	Rt 119	Outlet- no issues	2 culverts	48"	RCP					0	Direct roadway runoff	__ Bioretention Area __ Plunge Pool __ Treatment Swale __ Infiltration Trench / Basin __ Wet Pond / Constructed Wetlands __ Filter Strip __ Leaching CBs / Sub-Chambers	__ Easy __ Moderate Difficult	__ None __ Slight build up __ Heavy build up Approx. Depth _________ Inches	__ None __ Grease/Oil __ Grass Clippings __ Compost __ Trash/Debris __ Algae/ Blooms __ Other*	Circle One or both: Drainage Structure / Pipe __ N/A __ Good __ Corroded __ Cracked __ Exposed Steel __ Other*	__ N/A __ None __ Channeling __ Depressions __ Bank Erosion __ Displaced Riprap __ Other*	__ N/A __ No Distress __ Distressed __ Sparse __ Undesirable Woody __ Invasive Plants	__ None __ At Crossing __ Overland Flow __ Drainage Outfall	Approx. Distance: __________ Feet Name of Waterbody:	Available Space: __ Yes __ No Slope: __ Slight __ Moderate __ Steep Obstructions: __ Trees __ Boulders __ Other*
9/25/2013	S-1	Rt 119	Drainage from roadway	paved waterway	1-2'	Asphalt		Y	minor	Roadway	2318-2320	Direct runoff, major sediment	__ Bioretention Area __ Plunge Pool _X_ Treatment Swale _X_ Infiltration Trench / Basin __ Wet Pond / Constructed Wetlands __ Filter Strip __ Leaching CBs / Sub-Chambers	_X_ Easy __ Moderate Difficult	__ None _X_ Slight build up __ Heavy build up Approx. Depth ___6______ Inches	__ None _X_ Grease/Oil _X_ Grass Clippings __ Compost _X_ Trash/Debris __ Algae/ Blooms __ Other*	Circle One or both: Drainage Structure / Pipe _X_ N/A __ Good __ Corroded __ Cracked __ Exposed Steel __ Other*	__ N/A _X_ None __ Channeling __ Depressions __ Bank Erosion __ Displaced Riprap __ Other*	__ N/A __ No Distress _X_ Distressed __ Sparse __ Undesirable Woody __ Invasive Plants	__ None __ At Crossing _X_ Overland Flow __ Drainage Outfall	Approx. Distance: _____30_____ Feet Name of Waterbody:	Available Space: _X_ Yes __ No Slope: __ Slight _X_ Moderate __ Steep Obstructions: __ Trees __ Boulders __ Other* None
9/25/2013	S-2	Rt 119	Drainage from roadway	paved waterway	2-3'	Asphalt		Y	major	Roadway	2321-2322	Direct roadway runoff	__ Bioretention Area __ Plunge Pool _X_ Treatment Swale _X_ Infiltration Trench / Basin __ Wet Pond / Constructed Wetlands __ Filter Strip __ Leaching CBs / Sub-Chambers	_X_ Easy __ Moderate Difficult	__ None _X_ Slight build up __ Heavy build up Approx. Depth ___6______ Inches	__ None _X_ Grease/Oil _X_ Grass Clippings __ Compost _X_ Trash/Debris __ Algae/ Blooms __ Other*	Circle One or both: Drainage Structure / Pipe _X_ N/A __ Good __ Corroded __ Cracked __ Exposed Steel __ Other*	__ N/A _X_ None __ Channeling __ Depressions __ Bank Erosion __ Displaced Riprap __ Other*	__ N/A __ No Distress _X_ Distressed __ Sparse __ Undesirable Woody __ Invasive Plants	__ None __ At Crossing _X_ Overland Flow __ Drainage Outfall	Approx. Distance: _____30_____ Feet Name of Waterbody:	Available Space: _X_ Yes __ No Slope: __ Slight _X_ Moderate __ Steep Obstructions: __ Trees __ Boulders __ Other* None
9/25/2013	I-1	Rt 119	Drainage swale with CB	catch basin	N/A	Brick		Y	minor	Roadway	2323-2324	Eroded swale no outlet, maybe leaching? Additional info required	__ Bioretention Area __ Plunge Pool _X_ Treatment Swale _X_ Infiltration Trench / Basin __ Wet Pond / Constructed Wetlands __ Filter Strip __ Leaching CBs / Sub-Chambers	_X_ Easy __ Moderate Difficult	__ None _X_ Slight build up __ Heavy build up Approx. Depth ___Unknown______ Inches	__ None _X_ Grease/Oil __ Grass Clippings __ Compost _X_ Trash/Debris __ Algae/ Blooms _X_ Other* Sediment	Circle One or both: Drainage Structure / Pipe __ N/A __ Good __ Corroded _X_ Cracked __ Exposed Steel __ Other* Brick Built	__ N/A __ None _X_ Channeling __ Depressions __ Bank Erosion __ Displaced Riprap __ Other*	__ N/A __ No Distress _X_ Distressed __ Sparse __ Undesirable Woody __ Invasive Plants	__ None __ At Crossing _X_ Overland Flow __ Drainage Outfall	Approx. Distance: ______50____ Feet Name of Waterbody: No outlet	Available Space: _X_ Yes __ No Slope: __ Slight _X_ Moderate __ Steep Obstructions: __ Trees __ Boulders _X_ Other*
9/25/2013	S-3	Rt 119	Drainage swale pull-off	eroded swale, bare earth	N/A	Veg	swale	N	minor	Roadway	2325-2327	Pull-off good distance from pond + 75	__ Bioretention Area __ Plunge Pool _X_ Treatment Swale _X_ Infiltration Trench / Basin __ Wet Pond / Constructed Wetlands __ Filter Strip __ Leaching CBs / Sub-Chambers	_X_ Easy __ Moderate Difficult	_X_ None __ Slight build up __ Heavy build up Approx. Depth ___0______ Inches	__ None __ Grease/Oil _X_ Grass Clippings __ Compost _X_ Trash/Debris __ Algae/ Blooms _X_ Other* Sediment	Circle One or both: Drainage Structure / Pipe _X_ N/A __ Good __ Corroded __ Cracked __ Exposed Steel __ Other*	__ N/A __ None _X_ Channeling __ Depressions _X_ Bank Erosion __ Displaced Riprap __ Other*	__ N/A __ No Distress __ Distressed _X_ Sparse __ Undesirable Woody __ Invasive Plants	__ None __ At Crossing _X_ Overland Flow __ Drainage Outfall	Approx. Distance: ____75______ Feet Name of Waterbody:	Available Space: _X_ Yes __ No Slope: __ Slight __ Moderate __ Steep Obstructions: __ Trees __ Boulders __ Other*
9/25/2013	O-1	Rt 119	Drainage crossing from Pearly/Quimby	culvert	24"	RCP		N	minor	Roadway	2328-2329	Large culvert drainaging direct watershed partially submerged	__ Bioretention Area __ Plunge Pool __ Treatment Swale __ Infiltration Trench / Basin __ Wet Pond / Constructed Wetlands __ Filter Strip __ Leaching CBs / Sub-Chambers	__ Easy __ Moderate Difficult	__ None __ Slight build up __ Heavy build up Approx. Depth _________ Inches	__ None __ Grease/Oil __ Grass Clippings __ Compost __ Trash/Debris __ Algae/ Blooms __ Other*	Circle One or both: Drainage Structure / Pipe __ N/A __ Good __ Corroded __ Cracked __ Exposed Steel __ Other*	__ N/A __ None __ Channeling __ Depressions __ Bank Erosion __ Displaced Riprap __ Other*	__ N/A __ No Distress __ Distressed __ Sparse __ Undesirable Woody __ Invasive Plants	__ None __ At Crossing __ Overland Flow __ Drainage Outfall	Approx. Distance: __________ Feet Name of Waterbody:	Available Space: __ Yes __ No Slope: __ Slight __ Moderate __ Steep Obstructions: __ Trees __ Boulders __ Other*
9/25/2013	S-4	Rt 119	Drainage swale from roadway	vegetated swale	2-3'	Veg	swale	Y	minor	Roadway	2330-2333	Large swale good condition	__ Bioretention Area __ Plunge Pool _X_ Treatment Swale _X_ Infiltration Trench / Basin __ Wet Pond / Constructed Wetlands __ Filter Strip __ Leaching CBs / Sub-Chambers	_X_ Easy __ Moderate Difficult	__ None _X_ Slight build up __ Heavy build up Approx. Depth ___2-3______ Inches	__ None _X_ Grease/Oil __ Grass Clippings __ Compost _X_ Trash/Debris __ Algae/ Blooms _X_ Other* Sediment	Circle One or both: Drainage Structure / Pipe __ N/A __ Good __ Corroded _X_ Cracked __ Exposed Steel __ Other*	__ N/A __ None _X_ Channeling __ Depressions __ Bank Erosion __ Displaced Riprap __ Other*	__ N/A __ No Distress _X_ Distressed __ Sparse __ Undesirable Woody __ Invasive Plants	__ None __ At Crossing _X_ Overland Flow __ Drainage Outfall Pipe	Approx. Distance: ______100____ Feet Name of Waterbody:	Available Space: _X_ Yes __ No Slope: __ Slight _X_ Moderate __ Steep Obstructions: __ Trees __ Boulders __ Other*
9/25/2013	I-2	Rt 119	Drainage system CB	catch basin	N/A	Brick		Y	minor	Roadway	2334-2335		__ Bioretention Area __ Plunge Pool _X_ Treatment Swale _X_ Infiltration Trench / Basin __ Wet Pond / Constructed Wetlands __ Filter Strip __ Leaching CBs / Sub-Chambers	_X_ Easy __ Moderate Difficult	__ None _X_ Slight build up __ Heavy build up Approx. Depth ___Unknown______ Inches	__ None _X_ Grease/Oil __ Grass Clippings __ Compost _X_ Trash/Debris __ Algae/ Blooms _X_ Other* Sediment	Circle One or both: Drainage Structure / Pipe __ N/A __ Good __ Corroded _X_ Cracked __ Exposed Steel __ Other* Brick Built	__ N/A __ None _X_ Channeling __ Depressions __ Bank Erosion __ Displaced Riprap __ Other*	__ N/A __ No Distress _X_ Distressed __ Sparse __ Undesirable Woody __ Invasive Plants	__ None __ At Crossing _X_ Overland Flow __ Drainage Outfall	Approx. Distance: ______50____ Feet Name of Waterbody: No outlet	Available Space: _X_ Yes __ No Slope: __ Slight _X_ Moderate __ Steep Obstructions: __ Trees __ Boulders _X_ Other*
9/25/2013	C-10	University Dr	Drainage swale	culvert crossing	24"	CMP		Y	minor	Wooded Roadway	2336-2339	Drainage swale discharge to wetland -> crossings	__ Bioretention Area __ Plunge Pool _X_ Treatment Swale __ Infiltration Trench / Basin __ Wet Pond / Constructed Wetlands _X_ Filter Strip __ Leaching CBs / Sub-Chambers	_X_ Easy __ Moderate Difficult	__ None __ Slight build up _X_ Heavy build up Approx. Depth ___6-12______ Inches	__ None __ Grease/Oil _X_ Grass Clippings __ Compost _X_ Trash/Debris __ Algae/ Blooms _X_ Other* Sediment	Circle One or both: Drainage Structure / Pipe __ N/A _X_ Good __ Corroded __ Cracked __ Exposed Steel __ Other*	__ N/A __ None _X_ Channeling __ Depressions _X_ Bank Erosion __ Displaced Riprap __ Other*	__ N/A __ No Distress __ Distressed _X_ Sparse __ Undesirable Woody __ Invasive Plants	__ None _X_ At Crossing __ Overland Flow __ Drainage Outfall	Approx. Distance: _____50_____ Feet Name of Waterbody:	Available Space: __ Yes __ No Slope: __ Slight _X_ Moderate __ Steep Obstructions: __ Trees _X_ Boulders __ Other*

Date	Source ID	Major Road/Street	Type of Potential Source (Erosion / Roadway Drainage/ Septic / Lawn Area)	Drainage System or Culvert (Y/N and What Type)	Size	Material	Waterway (Y/N) (Type e.g. swale, ditch, brook, river, stream)	Sediment (Y/N)	Erosion (major /minor)	Surrounding Land Use	IMG # Photos	Notes	Potential Type of BMP	Accessability	Sediment Accumulation	Deposits	Drainage Structural or Culvert Condition	Erodibility	Vegetation	Direct Runoff to Waterbody	Proximity to Waterbody	Constraints
9/25/2013	S-5	Warren Rd	Warren Road drainage	Swale/ditch	1-2'	Veg	drainage ditch	Y	major	Wooded Roadway	2340-2345	ditch filled with sediment/eroded gravel dtich	__ Bioretention Area __ Plunge Pool _X_ Treatment Swale __ Infiltration Trench / Basin __ Wet Pond / Constructed Wetlands __ Filter Strip _X_ Leaching CBs / Sub-Chambers	_X_ Easy __ Moderate Difficult	__ None __ Slight build up _X_ Heavy build up Approx. Depth ___6-12______ Inches	__ None _X_ Grease/Oil __ Grass Clippings __ Compost _X_ Trash/Debris __ Algae/ Blooms _X_ Other* lots of sediment	Circle One or both: Drainage Structure / Pipe _X_ N/A __ Good __ Corroded __ Cracked __ Exposed Steel __ Other*	__ N/A __ None _X_ Channeling _X_ Depressions _X_ Bank Erosion __ Displaced Riprap __ Other*	__ N/A __ No Distress _X_ Distressed _X_ Sparse __ Undesirable Woody __ Invasive Plants	__ None __ At Crossing __ Overland Flow __ Drainage Outfall	Approx. Distance: __100+________ Feet Name of Waterbody:	Available Space: __ Yes _X_ No Slope: __ Slight __ Moderate _X_ Steep Obstructions: __ Trees __ Boulders __ Other*
9/25/2013	C-11	Moose Lane	Culvert in gravel rd (low lying area)	Drainage crossing	12"	CMP		Y	major	Grass/Residential	2346-2348	Gravel rd erosion	__ Bioretention Area __ Plunge Pool __ Treatment Swale __ Infiltration Trench / Basin __ Wet Pond / Constructed Wetlands __ Filter Strip __ Leaching CBs / Sub-Chambers	__ Easy __ Moderate Difficult	__ None __ Slight build up __ Heavy build up Approx. Depth _________ Inches	__ None __ Grease/Oil __ Grass Clippings __ Compost __ Trash/Debris __ Algae/ Blooms __ Other*	Circle One or both: Drainage Structure / Pipe __ N/A __ Good __ Corroded __ Cracked __ Exposed Steel __ Other*	__ N/A __ None __ Channeling __ Depressions __ Bank Erosion __ Displaced Riprap __ Other*	__ N/A __ No Distress __ Distressed __ Sparse __ Undesirable Woody __ Invasive Plants	__ None __ At Crossing __ Overland Flow __ Drainage Outfall	Approx. Distance: __________ Feet Name of Waterbody:	Available Space: __ Yes __ No Slope: __ Slight __ Moderate __ Steep Obstructions: __ Trees __ Boulders __ Other*
9/25/2013	S-6	Sawmill rd	Parking lot drainage				drainage ditch	Y	major	College Parking	2349-2351	Parking lot sediment accumulation/erosion	__ Bioretention Area _X_ Plunge Pool _X_ Treatment Swale __ Infiltration Trench / Basin __ Wet Pond / Constructed Wetlands __ Filter Strip __ Leaching CBs / Sub-Chambers	_X_ Easy __ Moderate Difficult	__ None __ Slight build up _X_ Heavy build up Approx. Depth ____6-12_____ Inches	__ None _X_ Grease/Oil __ Grass Clippings __ Compost _X_ Trash/Debris __ Algae/ Blooms _X_ Other* lots of sediment	Circle One or both: Drainage Structure / Pipe _X_ N/A __ Good __ Corroded __ Cracked __ Exposed Steel __ Other*	__ N/A __ None _X_ Channeling __ Depressions __ Bank Erosion __ Displaced Riprap __ Other*	__ N/A __ No Distress _X_ Distressed __ Sparse __ Undesirable Woody __ Invasive Plants	__ None __ At Crossing _X_ Overland Flow __ Drainage Outfall	Approx. Distance: __100________ Feet Name of Waterbody: wetland	Available Space: _X_ Yes __ No Slope: __ Slight _X_ Moderate __ Steep Obstructions: __ Trees __ Boulders __ Other* None
9/25/2013	C-12	University Dr	Roadway drainage	culvert	42"	CMP	stream (college trib)	N	major	Wooded Roadway	2352-2356	Erosion at headwall direct roadway discharge, trash rack fell over	__ Bioretention Area _X_ Plunge Pool _X_ Treatment Swale __ Infiltration Trench / Basin __ Wet Pond / Constructed Wetlands __ Filter Strip __ Leaching CBs / Sub-Chambers	_X_ Easy __ Moderate Difficult	_X_ None __ Slight build up __ Heavy build up Approx. Depth _________ Inches	__ None _X_ Grease/Oil __ Grass Clippings __ Compost _X_ Trash/Debris __ Algae/ Blooms __ Other*	Circle One or both: Drainage Structure / Pipe __ N/A _X_ Good __ Corroded __ Cracked __ Exposed Steel __ Other*	__ N/A __ None __ Channeling __ Depressions _X_ Bank Erosion __ Displaced Riprap __ Other*	__ N/A _X_ No Distress __ Distressed __ Sparse __ Undesirable Woody __ Invasive Plants	__ None _X_ At Crossing __ Overland Flow __ Drainage Outfall	Approx. Distance: ______@Pearly____ Feet Name of Waterbody:	_X_ Yes __ No Slope: _X_ Slight __ Moderate __ Steep Obstructions: __ Trees __ Boulders _X_ Other* roadway/water
9/25/2013	C-13	University @ saw mill rd	Roadway drainage	direct discharge 12"	12"	CMP		Y	minor	Residential Road	2357-2362	Discharge of driange system	__ Bioretention Area __ Plunge Pool __ Treatment Swale __ Infiltration Trench / Basin _X_ Wet Pond / Constructed Wetlands __ Filter Strip _X_ Leaching CBs / Sub-Chambers	_X_ Easy __ Moderate Difficult	__ None _X_ Slight build up __ Heavy build up Approx. Depth __2-3_______ Inches	__ None _X_ Grease/Oil _X_ Grass Clippings __ Compost _X_ Trash/Debris __ Algae/ Blooms __ Other*	Circle One or both: Drainage Structure / Pipe __ N/A __ Good __ Corroded __ Cracked _X_ Exposed Steel __ Other*	__ N/A __ None __ Channeling __ Depressions __ Bank Erosion __ Displaced Riprap _X_ Other* at outfall some erosion direct	__ N/A __ No Distress __ Distressed _X_ Sparse __ Undesirable Woody __ Invasive Plants	__ None _X_ At Crossing _X_ Overland Flow __ Drainage Outfall	Approx. Distance: _____50_____ Feet Name of Waterbody:	Available Space: _X_ Yes __ No Slope: _X_ Slight __ Moderate __ Steep Obstructions: _X_ Trees __ Boulders _X_ Other* Road
9/25/2013	S-7	University Dr	Eroded accessway, boat launch?	N/A	N/A	N/A		Y	major	Roadway	2363-2364	Large eroded between road and pond	__ Bioretention Area __ Plunge Pool __ Treatment Swale __ Infiltration Trench / Basin __ Wet Pond / Constructed Wetlands _X_ Filter Strip __ Leaching CBs / Sub-Chambers X bank access stabilization	_X_ Easy __ Moderate Difficult	__ None _X_ Slight build up __ Heavy build up Approx. Depth _________ Inches	__ None __ Grease/Oil __ Grass Clippings __ Compost _X_ Trash/Debris __ Algae/ Blooms _X_ Other* sediment eroded	Circle One or both: Drainage Structure / Pipe _X_ N/A __ Good __ Corroded __ Cracked __ Exposed Steel __ Other*	_X_ N/A __ None __ Channeling __ Depressions __ Bank Erosion __ Displaced Riprap __ Other*	__ N/A __ No Distress _X_ Distressed __ Sparse __ Undesirable Woody __ Invasive Plants X displaced	__ None __ At Crossing _X_ Overland Flow __ Drainage Outfall	Approx. Distance: _____@Pearly_____ Feet Name of Waterbody:	Available Space: _X_ Yes __ No Slope: _X_ Slight __ Moderate __ Steep Obstructions: _X_ Trees _X_ Boulders _X_ Other* Road/Pond
9/25/2013	S-8	University Dr	Eroded accessway, foot traffic access	N/A	N/A	N/A		Y	major	Roadway	2365-2366	Large eroded between road and pond	__ Bioretention Area __ Plunge Pool __ Treatment Swale __ Infiltration Trench / Basin __ Wet Pond / Constructed Wetlands _X_ Filter Strip __ Leaching CBs / Sub-Chambers X bank access stabilization	_X_ Easy __ Moderate Difficult	__ None _X_ Slight build up __ Heavy build up Approx. Depth _________ Inches	__ None __ Grease/Oil __ Grass Clippings __ Compost _X_ Trash/Debris __ Algae/ Blooms _X_ Other* sediment eroded	Circle One or both: Drainage Structure / Pipe _X_ N/A __ Good __ Corroded __ Cracked __ Exposed Steel __ Other*	_X_ N/A __ None __ Channeling __ Depressions __ Bank Erosion __ Displaced Riprap __ Other*	__ N/A __ No Distress _X_ Distressed __ Sparse __ Undesirable Woody __ Invasive Plants X displaced	__ None __ At Crossing _X_ Overland Flow __ Drainage Outfall	Approx. Distance: _____@Pearly_____ Feet Name of Waterbody:	Available Space: _X_ Yes __ No Slope: _X_ Slight __ Moderate __ Steep Obstructions: _X_ Trees _X_ Boulders _X_ Other* Road/Pond
9/25/2013	S-9	Sawmill parking	Parking lot drainage	2 curb breaks draing to trib	N/A	N/A	veg swale to trib	Y	minor	Parking/Residential	2367-2369	Untreated drainage paths to trib	_X_ Bioretention Area __ Plunge Pool __ Treatment Swale __ Infiltration Trench / Basin _X_ Wet Pond / Constructed Wetlands __ Filter Strip __ Leaching CBs / Sub-Chambers	_X_ Easy __ Moderate Difficult	__ None _X_ Slight build up __ Heavy build up Approx. Depth ___>1"______ Inches	__ None _X_ Grease/Oil __ Grass Clippings __ Compost _X_ Trash/Debris __ Algae/ Blooms __ Other*	Circle One or both: Drainage Structure / Pipe _X_ N/A __ Good __ Corroded __ Cracked __ Exposed Steel __ Other*	__ N/A __ None _X_ Channeling __ Depressions __ Bank Erosion __ Displaced Riprap __ Other*	__ N/A __ No Distress _X_ Distressed __ Sparse __ Undesirable Woody _X_ Invasive Plants	__ None __ At Crossing _X_ Overland Flow __ Drainage Outfall	Approx. Distance: ___+100______ Feet Name of Waterbody: tributary to Pearly	Available Space: _X_ Yes __ No Slope: _X_ Slight __ Moderate __ Steep Obstructions: __ Trees __ Boulders __ Other*
9/25/2013	S-10	Sawmill parking	Parking lot drainage outfall	1 culvert under walking path	12"	HDPE		Y	minor	Parking/Residential	2370-2371	Untreated drainage pipe to wetland	_X_ Bioretention Area __ Plunge Pool __ Treatment Swale __ Infiltration Trench / Basin _X_ Wet Pond / Constructed Wetlands __ Filter Strip __ Leaching CBs / Sub-Chambers	_X_ Easy __ Moderate Difficult	__ None _X_ Slight build up __ Heavy build up Approx. Depth ___>1"______ Inches	__ None _X_ Grease/Oil __ Grass Clippings __ Compost _X_ Trash/Debris __ Algae/ Blooms __ Other*	Circle One or both: Drainage Structure / Pipe _X_ N/A __ Good __ Corroded __ Cracked __ Exposed Steel __ Other*	__ N/A __ None _X_ Channeling __ Depressions __ Bank Erosion __ Displaced Riprap __ Other*	__ N/A __ No Distress _X_ Distressed __ Sparse __ Undesirable Woody _X_ Invasive Plants	__ None __ At Crossing _X_ Overland Flow __ Drainage Outfall	Approx. Distance: ___+100______ Feet Name of Waterbody: tributary to Pearly	Available Space: _X_ Yes __ No Slope: _X_ Slight __ Moderate __ Steep Obstructions: __ Trees __ Boulders __ Other*

Date	Source ID	Major Road/Street	Type of Potential Source (Erosion / Roadway Drainage/ Septic / Lawn Area)	Drainage System or Culvert (Y/N and What Type)	Size	Material	Waterway (Y/N) (Type e.g. swale, ditch, brook, river, stream)	Sediment (Y/N)	Erosion (major /minor)	Surrounding Land Use	IMG # Photos	Notes	Potential Type of BMP	Accessability	Sediment Accumulation	Deposits	Drainage Structural or Culvert Condition	Erodibility	Vegetation	Direct Runoff to Waterbody	Proximity to Waterbody	Constraints
9/25/2013	C-14	University @ boathouse	Field runoff roadway drainage	road culvert/ wetland area drainage	12"	RCP		Y	minor	Field Parking	2372-2376	Wet area drians to boat house-erosion road runoff	_X_ Bioretention Area __ Plunge Pool __ Treatment Swale __ Infiltration Trench / Basin _X_ Wet Pond / Constructed Wetlands __ Filter Strip __ Leaching CBs / Sub-Chambers	_X_ Easy __ Moderate Difficult	__ None _X_ Slight build up __ Heavy build up Approx. Depth _____?____ Inches	__ None __ Grease/Oil __ Grass Clippings __ Compost _X_ Trash/Debris __ Algae/ Blooms __ Other*	Circle One or both: Drainage Structure / Pipe __ N/A __ Good __ Corroded __ Cracked __ Exposed Steel _X_ Other* headwall bad no outfall found	__ N/A __ None _X_ Channeling __ Depressions __ Bank Erosion __ Displaced Riprap __ Other*	__ N/A __ No Distress _X_ Distressed __ Sparse __ Undesirable Woody _X_ Invasive Plants	__ None __ At Crossing _X_ Overland Flow __ Drainage Outfall	Approx. Distance: ______75____ Feet Name of Waterbody: Pearly	Available Space: _X_ Yes __ No Slope: __ Slight _X_ Moderate __ Steep Obstructions: __ Trees __ Boulders _X_ Other* roadway
9/25/2013	S-11	University @ boathouse	roadway runoff onto beach	N/A	N/A	N/A		Y	major	Beach	2377-2380	Eroded beach from road runoff/ formal boat access	_X_ Bioretention Area __ Plunge Pool __ Treatment Swale __ Infiltration Trench / Basin __ Wet Pond / Constructed Wetlands __ Filter Strip __ Leaching CBs / Sub-Chambers X drainage diversion fomal boat stabilization	_X_ Easy __ Moderate Difficult	__ None __ Slight build up __ Heavy build up Approx. Depth _________ Inches N/A Beach	__ None _X_ Grease/Oil __ Grass Clippings __ Compost _X_ Trash/Debris __ Algae/ Blooms _X_ Other* sediment	Circle One or both: Drainage Structure / Pipe __ N/A __ Good __ Corroded __ Cracked __ Exposed Steel __ Other* N/A	__ N/A __ None _X_ Channeling __ Depressions __ Bank Erosion __ Displaced Riprap __ Other*	__ N/A __ No Distress __ Distressed _X_ Sparse __ Undesirable Woody __ Invasive Plants	__ None __ At Crossing _X_ Overland Flow __ Drainage Outfall	Approx. Distance: _____@Pearly_____ Feet Name of Waterbody:	Available Space: _X_ Yes __ No Slope: __ Slight _X_ Moderate _X_ Steep Roadway Obstructions: _X_ Trees _X_ Boulders _X_ Other* Parking Area/
9/25/2013	S-12	Campus Center	roof/roadway runoff/erosion				grassed ditch	N	minor	Building/Grassed	2381-2386	Erosion runoff puddle, potential student rain garden location	_X_ Bioretention Area __ Plunge Pool __ Treatment Swale __ Infiltration Trench / Basin __ Wet Pond / Constructed Wetlands __ Filter Strip __ Leaching CBs / Sub-Chambers	_X_ Easy __ Moderate Difficult	__ None _X_ Slight build up __ Heavy build up Approx. Depth _________ Inches	__ None __ Grease/Oil _X_ Grass Clippings __ Compost __ Trash/Debris __ Algae/ Blooms _X_ Other* goose poop	Circle One or both: Drainage Structure / Pipe __ N/A __ Good __ Corroded __ Cracked __ Exposed Steel __ Other* N/A	__ N/A __ None _X_ Channeling _X_ Depressions __ Bank Erosion __ Displaced Riprap __ Other*	__ N/A __ No Distress _X_ Distressed __ Sparse __ Undesirable Woody __ Invasive Plants	__ None __ At Crossing _X_ Overland Flow __ Drainage Outfall	Approx. Distance: _____250_____ Feet Name of Waterbody: Pearly	Available Space: _X_ Yes __ No Slope: __ Slight _X_ Moderate __ Steep Obstructions: __ Trees __ Boulders __ Other*
9/25/2013	O-2	Ingalls Rd	Drainage outfall	drainage outfall	15"	CMP	swale eroded	Y	major	Roadway Gravel	2387-2390	Erosion/steep slope	__ Bioretention Area _X_ Plunge Pool _X_ Treatment Swale __ Infiltration Trench / Basin __ Wet Pond / Constructed Wetlands __ Filter Strip __ Leaching CBs / Sub-Chambers	__ Easy _X_ Moderate __ Difficult	__ None _X_ Slight build up __ Heavy build up Approx. Depth _________ Inches	__ None __ Grease/Oil _X_ Grass Clippings __ Compost _X_ Trash/Debris __ Algae/ Blooms _X_ Other* sediment	Circle One or both: Drainage Structure / Pipe __ N/A __ Good __ Corroded __ Cracked __ Exposed Steel __ Other* N/A	__ N/A __ None _X_ Channeling __ Depressions _X_ Bank Erosion __ Displaced Riprap __ Other*	__ N/A __ No Distress _X_ Distressed __ Sparse __ Undesirable Woody __ Invasive Plants	__ None _X_ At Crossing __ Overland Flow __ Drainage Outfall	Approx. Distance: ______100____ Feet Name of Waterbody:	Available Space: _X_ Yes __ No Slope: __ Slight __ Moderate _X_ Steep Obstructions: _X_ Trees _X_ Boulders __ Other*
9/25/2013	S-13	Ingalls Rd Theater Parking	Drainage outfall overflow from parking	outfall pipe	18"	RCP	eroded bank	Y	minor, stone	Parking Roadway	2391-2395	steep slope drains into wetland	__ Bioretention Area __ Plunge Pool __ Treatment Swale _X_ Infiltration Trench / Basin __ Wet Pond / Constructed Wetlands __ Filter Strip _X_ Leaching CBs / Sub-Chambers	_X_ Easy __ Moderate Difficult	__ None __ Slight build up _X_ Heavy build up Approx. Depth _________ Inches	__ None __ Grease/Oil __ Grass Clippings __ Compost _X_ Trash/Debris __ Algae/ Blooms _X_ Other* sediment	Circle One or both: Drainage Structure / Pipe __ N/A __ Good __ Corroded _X_ Cracked __ Exposed Steel _X_ Other* collapsed outfall, erosion	__ N/A __ None _X_ Channeling _X_ Depressions _X_ Bank Erosion __ Displaced Riprap _X_ Other* sediment on parking lot above	__ N/A __ No Distress _X_ Distressed __ Sparse __ Undesirable Woody __ Invasive Plants	__ None _X_ At Crossing _X_ Overland Flow __ Drainage Outfall	Approx. Distance: __________ Feet Name of Waterbody:	Available Space: _X_ Yes _X_ No Slope: __ Slight __ Moderate _X_ Steep Obstructions: _X_ Trees __ Boulders _X_ Other* Fence
9/25/2013	I-3	Ingalls Rd	Erosion/Lawn Area	Drainage Outfall	10"	HDPE		N	minor	Lawn	2396-2397	eroded outfall into CB	__ Bioretention Area _X_ Plunge Pool _X_ Treatment Swale _X_ Infiltration Trench / Basin __ Wet Pond / Constructed Wetlands __ Filter Strip __ Leaching CBs / Sub-Chambers	__ Easy _X_ Moderate __ Difficult	__ None _X_ Slight build up __ Heavy build up Approx. Depth _________ Inches	__ None __ Grease/Oil _X_ Grass Clippings __ Compost _X_ Trash/Debris __ Algae/ Blooms _X_ Other* sediment lots of runoff and erosion	Circle One or both: Drainage Structure / Pipe X_ N/A __ Good __ Corroded __ Cracked __ Exposed Steel __ Other*	__ N/A __ None _X_ Channeling _X_ Depressions _X_ Bank Erosion __ Displaced Riprap __ Other*	__ N/A __ No Distress _X_ Distressed __ Sparse __ Undesirable Woody __ Invasive Plants	__ None __ At Crossing _X_ Overland Flow __ Drainage Outfall	Approx. Distance: __+200________ Feet Name of Waterbody:	Available Space: _X_ Yes __ No Slope: __ Slight __ Moderate _X_ Steep Obstructions: _X_ Trees __ Boulders _X_ Other* Roadway
9/25/2013	C-15	Ingall Rd Entrance	Paved swale eroded culvert	culvert at end of paved swale	12"	CMP		N	major	Paved Parking	2398-2400	steep paved swale no treatment	__ Bioretention Area __ Plunge Pool __ Treatment Swale __ Infiltration Trench / Basin __ Wet Pond / Constructed Wetlands __ Filter Strip __ Leaching CBs / Sub-Chambers	__ Easy __ Moderate Difficult	__ None __ Slight build up __ Heavy build up Approx. Depth _________ Inches	__ None __ Grease/Oil __ Grass Clippings __ Compost __ Trash/Debris __ Algae/ Blooms __ Other*	Circle One or both: Drainage Structure / Pipe __ N/A __ Good __ Corroded __ Cracked __ Exposed Steel __ Other*	__ N/A __ None __ Channeling __ Depressions __ Bank Erosion __ Displaced Riprap __ Other*	__ N/A __ No Distress __ Distressed __ Sparse __ Undesirable Woody __ Invasive Plants	__ None __ At Crossing __ Overland Flow __ Drainage Outfall	Approx. Distance: __________ Feet Name of Waterbody:	Available Space: __ Yes __ No Slope: __ Slight __ Moderate __ Steep Obstructions: __ Trees __ Boulders __ Other*
9/25/2013	I-4	Ingall Rd Entrance	Catch basin lots of sediment	drainage inlet				Y	minor	Paved Parking	2401-2402	Parking lot sediment	__ Bioretention Area _X_ Plunge Pool _X_ Treatment Swale _X_ Infiltration Trench / Basin __ Wet Pond / Constructed Wetlands __ Filter Strip __ Leaching CBs / Sub-Chambers	__ Easy _X_ Moderate __ Difficult	__ None _X_ Slight build up __ Heavy build up Approx. Depth _________ Inches	__ None __ Grease/Oil _X_ Grass Clippings __ Compost _X_ Trash/Debris __ Algae/ Blooms _X_ Other* sediment lots of runoff and erosion	Circle One or both: Drainage Structure / Pipe X_ N/A __ Good __ Corroded __ Cracked __ Exposed Steel __ Other*	__ N/A __ None _X_ Channeling _X_ Depressions _X_ Bank Erosion __ Displaced Riprap __ Other*	__ N/A __ No Distress _X_ Distressed __ Sparse __ Undesirable Woody __ Invasive Plants	__ None __ At Crossing _X_ Overland Flow __ Drainage Outfall	Approx. Distance: __+200________ Feet Name of Waterbody:	Available Space: _X_ Yes __ No Slope: __ Slight __ Moderate _X_ Steep Obstructions: _X_ Trees __ Boulders _X_ Other* Roadway
9/25/2013	S-14	Ingall Rd Entrance	Eroded area from drainage onto gravel	possible outfall from MH				Y	major	parking grassed	2403-2404	large gullies steep-erosion	__ Bioretention Area _X_ Plunge Pool _X_ Treatment Swale _X_ Infiltration Trench / Basin __ Wet Pond / Constructed Wetlands __ Filter Strip __ Leaching CBs / Sub-Chambers	__ Easy _X_ Moderate __ Difficult	__ None _X_ Slight build up __ Heavy build up Approx. Depth _________ Inches	__ None __ Grease/Oil _X_ Grass Clippings __ Compost _X_ Trash/Debris __ Algae/ Blooms _X_ Other* sediment lots of runoff and erosion	Circle One or both: Drainage Structure / Pipe X_ N/A __ Good __ Corroded __ Cracked __ Exposed Steel __ Other*	__ N/A __ None _X_ Channeling _X_ Depressions _X_ Bank Erosion __ Displaced Riprap __ Other*	__ N/A __ No Distress _X_ Distressed __ Sparse __ Undesirable Woody __ Invasive Plants	__ None __ At Crossing _X_ Overland Flow __ Drainage Outfall	Approx. Distance: __+200________ Feet Name of Waterbody:	Available Space: _X_ Yes __ No Slope: __ Slight __ Moderate _X_ Steep Obstructions: _X_ Trees __ Boulders _X_ Other* Roadway

Date	Source ID	Major Road/Street	Type of Potential Source (Erosion / Roadway Drainage/ Septic / Lawn Area)	Drainage System or Culvert (Y/N and What Type)	Size	Material	Waterway (Y/N) (Type e.g. swale, ditch, brook, river, stream)	Sediment (Y/N)	Erosion (major /minor)	Surrounding Land Use	IMG # Photos	Notes	Potential Type of BMP	Accessability	Sediment Accumulation	Deposits	Drainage Structural or Culvert Condition	Erodibility	Vegetation	Direct Runoff to Waterbody	Proximity to Waterbody	Constraints
9/25/2013	C-16	Ingalls Rd	eroded gravel roadway culvert	drainage outfall	12"	CMP	drainage ditch	Y	major	woods/ gravel road	2405-2411	large gully downstream steep slopes-gravel/road swale	__ Bioretention Area _X_ Plunge Pool __ Treatment Swale __ Infiltration Trench / Basin __ Wet Pond / Constructed Wetlands __ Filter Strip __ Leaching CBs / Sub-Chambers X stabilize steep swale	__ Easy __ Moderate _X_ Difficult	__ None __ Slight build up _X_ Heavy build up Approx. Depth ____+6_____ Inches	__ None __ Grease/Oil __ Grass Clippings __ Compost __ Trash/Debris __ Algae/ Blooms _X_ Other* sediment	Circle One or both: Drainage Structure / Pipe __ N/A _X_ Good __ Corroded __ Cracked __ Exposed Steel __ Other*	__ N/A __ None __ Channeling _X_ Depressions _X_ Bank Erosion __ Displaced Riprap _X_ Other* very deep erosion >5ft	__ N/A __ No Distress _X_ Distressed __ Sparse __ Undesirable Woody __ Invasive Plants	__ None _X_ At Crossing _X_ Overland Flow __ Drainage Outfall	Approx. Distance: _____100_____ Feet Name of Waterbody:	Available Space: _X_ Yes __ No Slope: __ Slight __ Moderate _X_ Steep Obstructions: _X_ Trees _X_ Boulders _X_ Other* hard access
9/25/2013	C-17	Ingalls Rd	eroded gravel roadway culvert	drainage outfall	12"	CMP	very eroded ditch	Y	major	woods/ gravel road	2412-2415	large gully downstream steep slopes-gravel/road swale	__ Bioretention Area _X_ Plunge Pool __ Treatment Swale __ Infiltration Trench / Basin __ Wet Pond / Constructed Wetlands __ Filter Strip __ Leaching CBs / Sub-Chambers X stabilize steep swale	__ Easy __ Moderate _X_ Difficult	__ None __ Slight build up _X_ Heavy build up Approx. Depth ____+6_____ Inches	__ None __ Grease/Oil __ Grass Clippings __ Compost __ Trash/Debris __ Algae/ Blooms _X_ Other* sediment	Circle One or both: Drainage Structure / Pipe __ N/A _X_ Good __ Corroded __ Cracked __ Exposed Steel __ Other*	__ N/A __ None __ Channeling _X_ Depressions _X_ Bank Erosion __ Displaced Riprap _X_ Other* very deep erosion >5ft	__ N/A __ No Distress _X_ Distressed __ Sparse __ Undesirable Woody __ Invasive Plants	__ None _X_ At Crossing _X_ Overland Flow __ Drainage Outfall	Approx. Distance: _____100_____ Feet Name of Waterbody:	Available Space: _X_ Yes __ No Slope: __ Slight __ Moderate _X_ Steep Obstructions: _X_ Trees _X_ Boulders _X_ Other* hard access
9/25/2013	C-18	Ingalls Rd	eroded gravel roadway culvert	drainage outfall	12"	CMP	very eroded ditch	Y	major	woods/ gravel road	2416-2417	large gully downstream steep slopes-gravel/road swale	__ Bioretention Area _X_ Plunge Pool __ Treatment Swale __ Infiltration Trench / Basin __ Wet Pond / Constructed Wetlands __ Filter Strip __ Leaching CBs / Sub-Chambers X stabilize steep swale	__ Easy __ Moderate _X_ Difficult	__ None __ Slight build up _X_ Heavy build up Approx. Depth ____+6_____ Inches	__ None __ Grease/Oil __ Grass Clippings __ Compost __ Trash/Debris __ Algae/ Blooms _X_ Other* sediment	Circle One or both: Drainage Structure / Pipe __ N/A _X_ Good __ Corroded __ Cracked __ Exposed Steel __ Other*	__ N/A __ None __ Channeling _X_ Depressions _X_ Bank Erosion __ Displaced Riprap _X_ Other* very deep erosion >5ft	__ N/A __ No Distress _X_ Distressed __ Sparse __ Undesirable Woody __ Invasive Plants	__ None _X_ At Crossing _X_ Overland Flow __ Drainage Outfall	Approx. Distance: _____100_____ Feet Name of Waterbody:	Available Space: _X_ Yes __ No Slope: __ Slight __ Moderate _X_ Steep Obstructions: _X_ Trees _X_ Boulders _X_ Other* hard access
9/25/2013	S-15	Ingalls Rd	very steep drainage	runoff on steep slope	12"	CMP		Y	major	woods/ gravel road	2418-2419	large gully downstream steep slopes-gravel/road swale	__ Bioretention Area __ Plunge Pool __ Treatment Swale __ Infiltration Trench / Basin __ Wet Pond / Constructed Wetlands __ Filter Strip __ Leaching CBs / Sub-Chambers	__ Easy __ Moderate Difficult __	__ None __ Slight build up __ Heavy build up Approx. Depth _________ Inches	__ None __ Grease/Oil __ Grass Clippings __ Compost __ Trash/Debris __ Algae/ Blooms __ Other*	Circle One or both: Drainage Structure / Pipe __ N/A __ Good __ Corroded __ Cracked __ Exposed Steel __ Other*	__ N/A __ None __ Channeling __ Depressions __ Bank Erosion __ Displaced Riprap __ Other*	__ N/A __ No Distress __ Distressed __ Sparse __ Undesirable Woody __ Invasive Plants	__ None __ At Crossing __ Overland Flow __ Drainage Outfall	Approx. Distance: __________ Feet Name of Waterbody:	Available Space: __ Yes __ No Slope: __ Slight __ Moderate __ Steep Obstructions: __ Trees __ Boulders __ Other*
9/25/2013	C-19	Ingalls Rd	seepage from infiltration into swale	eroded swale	12"	CMP	flowing a lot GW or stream	N	major	woods/ gravel road	2420-2421	near MW-3 dam seepage source	__ Bioretention Area __ Plunge Pool __ Treatment Swale __ Infiltration Trench / Basin __ Wet Pond / Constructed Wetlands __ Filter Strip __ Leaching CBs / Sub-Chambers	__ Easy __ Moderate Difficult __	__ None __ Slight build up __ Heavy build up Approx. Depth _________ Inches	__ None __ Grease/Oil __ Grass Clippings __ Compost __ Trash/Debris __ Algae/ Blooms __ Other*	Circle One or both: Drainage Structure / Pipe __ N/A __ Good __ Corroded __ Cracked __ Exposed Steel __ Other*	__ N/A __ None __ Channeling __ Depressions __ Bank Erosion __ Displaced Riprap __ Other*	__ N/A __ No Distress __ Distressed __ Sparse __ Undesirable Woody __ Invasive Plants	__ None __ At Crossing __ Overland Flow __ Drainage Outfall	Approx. Distance: __________ Feet Name of Waterbody:	Available Space: __ Yes __ No Slope: __ Slight __ Moderate __ Steep Obstructions: __ Trees __ Boulders __ Other*
10/10/2013	C-40	Ingalls Rd	road runoff	culvert	48"	CMP	stream	N	minor	Woods	2422-2427	Sediment island on outlet end directing flows in two directions. No significant overland erosion. Good vegetative cover. Some sediment depostits in adjacent wooded area. (dirt road)	__ Bioretention Area _X_ Plunge Pool __ Treatment Swale __ Infiltration Trench / Basin __ Wet Pond / Constructed Wetlands _X_ Filter Strip __ Leaching CBs / Sub-Chambers	_X_ Easy __ Moderate Difficult __	_X_ None __ Slight build up __ Heavy build up Approx. Depth _________ Inches	__ None __ Grease/Oil __ Grass Clippings __ Compost _X_ Trash/Debris __ Algae/ Blooms _X_ Other* sediment	Circle One or both: Drainage Structure / Pipe __ N/A __ Good _X_ Corroded (Bottom rusted out) __ Cracked __ Exposed Steel __ Other*	__ N/A __ None __ Channeling __ Depressions _X_ Bank Erosion __ Displaced Riprap __ Other*	__ N/A __ No Distress _X_ Distressed __ Sparse __ Undesirable Woody __ Invasive Plants	__ None __ At Crossing _X_ Overland Flow __ Drainage Outfall	Approx. Distance: _______0___ Feet Name of Waterbody: Inlet to Pearly	Available Space: _X_ Yes __ No Slope: _X_ Slight __ Moderate __ Steep Obstructions: __ Trees __ Boulders __ Other*
10/10/2013	C-41	Ingalls Rd	Roadway drainage	culvert	12"	CMP		Y	minor	Woods	2428-2429	flowing away from lake, dirt road	__ Bioretention Area __ Plunge Pool __ Treatment Swale __ Infiltration Trench / Basin __ Wet Pond / Constructed Wetlands __ Filter Strip __ Leaching CBs / Sub-Chambers X stabilization	_X_ Easy __ Moderate Difficult __	__ None _X_ Slight build up __ Heavy build up Approx. Depth __1-2_______ Inches	_X_ None __ Grease/Oil __ Grass Clippings __ Compost __ Trash/Debris __ Algae/ Blooms __ Other*	Circle One or both: Drainage Structure / Pipe __ N/A __ Good __ Corroded __ Cracked __ Exposed Steel _X_ Other* Upstream partially buried	__ N/A __ None __ Channeling __ Depressions _X_ Bank Erosion __ Displaced Riprap __ Other*	__ N/A _X_ No Distress __ Distressed __ Sparse __ Undesirable Woody __ Invasive Plants	_X_ None __ At Crossing __ Overland Flow __ Drainage Outfall	Approx. Distance: ___300-400_______ Feet Name of Waterbody: Trib to Pearly	Available Space: _X_ Yes __ No Slope: _X_ Slight __ Moderate __ Steep Obstructions: __ Trees __ Boulders __ Other*
10/10/2013	C-42	Dollhouse Rd	Roadway Drainage, beavers	culvert	Unknown	Unknown	stream	Unknown	minor	Wooded	2432-2434	Major beaver activity, flooded roadway, need to unclog culvert, dirt road	__ Bioretention Area __ Plunge Pool __ Treatment Swale __ Infiltration Trench / Basin __ Wet Pond / Constructed Wetlands __ Filter Strip __ Leaching CBs / Sub-Chambers	__ Easy _X_ Moderate __ Difficult	__ None __ Slight build up __ Heavy build up Approx. Depth _________ Inches Unknown	__ None __ Grease/Oil __ Grass Clippings __ Compost __ Trash/Debris __ Algae/ Blooms _X_ Other* wood/stick from beavers	Circle One or both: Drainage Structure / Pipe __ N/A __ Good __ Corroded __ Cracked __ Exposed Steel _X_ Other* clogged/flooded	_X_ N/A Unknown __ None __ Channeling __ Depressions __ Bank Erosion __ Displaced Riprap __ Other*	__ N/A __ No Distress _X_ Distressed __ Sparse __ Undesirable Woody __ Invasive Plants	__ None _X_ At Crossing __ Overland Flow __ Drainage Outfall	Approx. Distance: ____0______ Feet Name of Waterbody: Trib to Pearly	Available Space: _X_ Yes __ No Slope: _X_ Slight __ Moderate __ Steep Obstructions: _X_ Trees __ Boulders _X_ Other* beaver dam
10/10/2013	C-20	Ingalls Rd	Roadway drainage	culvert	12"	CMP	drainage ditch	Y	major	Wooded	2435-2436	Upstream pipe buried, erosion on upstream, scoring @ outlet, 4" off bottom, erosion along road, dirt road	__ Bioretention Area _X_ Plunge Pool _X_ Treatment Swale _X_ Infiltration Trench / Basin __ Wet Pond / Constructed Wetlands __ Filter Strip __ Leaching CBs / Sub-Chambers	_X_ Easy __ Moderate Difficult __	__ None __ Slight build up _X_ Heavy build up downstream Approx. Depth ______6-12___ Inches	__ None __ Grease/Oil __ Grass Clippings __ Compost __ Trash/Debris __ Algae/ Blooms _X_ Other* sediment	Circle One or both: Drainage Structure / Pipe __ N/A _X_ Good buried upstream end __ Corroded __ Cracked __ Exposed Steel __ Other*	__ N/A __ None _X_ Channeling __ Depressions __ Bank Erosion __ Displaced Riprap __ Other*	__ N/A __ No Distress __ Distressed _X_ Sparse @ outlet __ Undesirable Woody __ Invasive Plants	__ None __ At Crossing _X_ Overland Flow __ Drainage Outfall	Approx. Distance: ______150-200____ Feet Name of Waterbody:	Available Space: _X_ Yes __ No Slope: _X_ Slight __ Moderate __ Steep Obstructions: __ Trees __ Boulders __ Other*

Date	Source ID	Major Road/Street	Type of Potential Source (Erosion / Roadway Drainage/ Septic / Lawn Area)	Drainage System or Culvert (Y/N and What Type)	Size	Material	Waterway (Y/N) (Type e.g. swale, ditch, brook, river, stream)	Sediment (Y/N)	Erosion (major /minor)	Surrounding Land Use	IMG # Photos	Notes	Potential Type of BMP	Accessability	Sediment Accumulation	Deposits	Drainage Structural or Culvert Condition	Erodibility	Vegetation	Direct Runoff to Waterbody	Proximity to Waterbody	Constraints
10/10/2013	C-21	Red Barn Rd	road drainage	culvert	48"x36" boxed culvert	stone/granite	stream	N	minor	Wooded	2437-2440	Box culvert, white foam on downstream end, dirt road is in good shape	__ Bioretention Area __ Plunge Pool _X_ Treatment Swale __ Infiltration Trench / Basin __ Wet Pond / Constructed Wetlands __ Filter Strip __ Leaching CBs / Sub-Chambers	_X_ Easy __ Moderate Difficult	_X_ None __ Slight build up __ Heavy build up Approx. Depth ________ Inches	_X_ None __ Grease/Oil __ Grass Clippings __ Compost __ Trash/Debris __ Algae/ Blooms __ Other*	Circle One or both: Drainage Structure / Pipe __ N/A _X_ Good __ Corroded __ Cracked __ Exposed Steel __ Other*	__ N/A _X_ None __ Channeling __ Depressions __ Bank Erosion __ Displaced Riprap __ Other*	__ N/A _X_ No Distress __ Distressed __ Sparse __ Undesirable Woody __ Invasive Plants	__ None _X_ At Crossing __ Overland Flow __ Drainage Outfall	Approx. Distance: ____0______ Feet Name of Waterbody:	Available Space: _X_ Yes __ No Slope: _X_ Slight __ Moderate __ Steep Obstructions: __ Trees __ Boulders __ Other*
10/10/2013	C-22	Ingalls Rd	road drainage	culvert	12"	CMP	Upstream wetland, downstream no water	Y	minor	Wooded	2441-2444	Upstream end wetland, downsteam end no water, slight sediment build-up from dirt roadway	__ Bioretention Area _X_ Plunge Pool __ Treatment Swale __ Infiltration Trench / Basin __ Wet Pond / Constructed Wetlands __ Filter Strip __ Leaching CBs / Sub-Chambers	_X_ Easy __ Moderate Difficult	__ None _X_ Slight build up __ Heavy build up Approx. Depth ______1-2___ Inches	__ None _X_ Grease/Oil __ Grass Clippings __ Compost __ Trash/Debris __ Algae/ Blooms __ Other*	Circle One or both: Drainage Structure / Pipe __ N/A _X_ Good __ Corroded __ Cracked __ Exposed Steel __ Other*	__ N/A _X_ None __ Channeling __ Depressions __ Bank Erosion __ Displaced Riprap __ Other*	__ N/A _X_ No Distress __ Distressed __ Sparse __ Undesirable Woody __ Invasive Plants	__ None __ At Crossing _X_ Overland Flow __ Drainage Outfall	Approx. Distance: _____0_____ Feet Name of Waterbody: wetland upstream	Available Space: _X_ Yes __ No Slope: _X_ Slight __ Moderate __ Steep Obstructions: __ Trees __ Boulders __ Other*
10/10/2013	S-16	Ingalls Rd	road drainage	ditch	N/A	N/A		Y	major	Wooded	2445-2451	Road erosion, sediment on side of road-slight berm seperating it from wetland, right upgradient lots of erosion along dirt road	__ Bioretention Area __ Plunge Pool _X_ Treatment Swale __ Infiltration Trench / Basin __ Wet Pond / Constructed Wetlands __ Filter Strip __ Leaching CBs / Sub-Chambers X Stabilization	_X_ Easy __ Moderate Difficult	__ None __ Slight build up _X_ Heavy build up Approx. Depth ___Unknown______ Inches	__ None __ Grease/Oil __ Grass Clippings __ Compost __ Trash/Debris __ Algae/ Blooms _X_ Other* Sediment	Circle One or both: Drainage Structure / Pipe _X_ N/A __ Good __ Corroded __ Cracked __ Exposed Steel __ Other*	__ N/A __ None _X_ Channeling __ Depressions __ Bank Erosion __ Displaced Riprap __ Other*	__ N/A __ No Distress __ Distressed _X_ Sparse __ Undesirable Woody __ Invasive Plants	__ None __ At Crossing _X_ Overland Flow to wetland area __ Drainage Outfall	Approx. Distance: _____~400_____ Feet Name of Waterbody: wetland	Available Space: _X_ Yes __ No Slope: __ Slight __ Moderate __ Steep Obstructions: __ Trees __ Boulders __ Other*
10/10/2013	C-23	Red Gate Rd	road drainage, road washout, erosion	culvert	36"x24" boxed culvert	stone/granite		Y	major	Wooded	2452-2458	Sediment delta downstream, boxed culvert, dirt road washout, heavy sediment, upstream culvert buried	__ Bioretention Area _X_ Plunge Pool _X_ Treatment Swale __ Infiltration Trench / Basin __ Wet Pond / Constructed Wetlands __ Filter Strip __ Leaching CBs / Sub-Chambers	_X_ Easy __ Moderate Difficult	__ None __ Slight build up _X_ Heavy build up Approx. Depth ___6-12______ Inches	__ None __ Grease/Oil __ Grass Clippings __ Compost __ Trash/Debris __ Algae/ Blooms _X_ Other* sediment	Circle One or both: Drainage Structure / Pipe __ N/A __ Good __ Corroded __ Cracked __ Exposed Steel _X_ Other* upstream buried	__ N/A __ None _X_ Channeling __ Depressions __ Bank Erosion __ Displaced Riprap _X_ Other* Road erosion	__ N/A __ No Distress _X_ Distressed __ Sparse __ Undesirable Woody __ Invasive Plants	__ None _X_ At Crossing __ Overland Flow __ Drainage Outfall	Approx. Distance: ___0_______ Feet Name of Waterbody: Trib to Pearly	Available Space: _X_ Yes __ No Slope: _X_ Slight __ Moderate __ Steep Obstructions: __ Trees __ Boulders __ Other*
10/10/2013	C-24	Red Gate Rd	roadway drainage	culvert	24"	HDPE	stream	Y	minor	Wetland	2459-2462	Mislabeled land use on map, should be wetland pipe slightly crushed on one side	__ Bioretention Area __ Plunge Pool __ Treatment Swale __ Infiltration Trench / Basin __ Wet Pond / Constructed Wetlands __ Filter Strip __ Leaching CBs / Sub-Chambers	_X_ Easy __ Moderate Difficult	__ None _X_ Slight build up __ Heavy build up Approx. Depth _____<1____ Inches	_X_ None __ Grease/Oil __ Grass Clippings __ Compost __ Trash/Debris __ Algae/ Blooms __ Other*	Circle One or both: Drainage Structure / Pipe __ N/A _X_ Good __ Corroded __ Cracked __ Exposed Steel __ Other*	__ N/A _X_ None __ Channeling __ Depressions __ Bank Erosion __ Displaced Riprap __ Other*	__ N/A _X_ No Distress __ Distressed __ Sparse __ Undesirable Woody __ Invasive Plants	__ None _X_ At Crossing __ Overland Flow __ Drainage Outfall	Approx. Distance: ___0_______ Feet Name of Waterbody:	Available Space: _X_ Yes __ No Slope: __ Slight __ Moderate __ Steep Obstructions: __ Trees __ Boulders __ Other*
10/10/2013	C-25	Bowers Rd	runoff from road and erosion	culvert	36"X48" boxed culvert	stone	stream	Y	Minor	Wooded	2463-2468	Erosion and sediment deposits on up stream portion of culvert, runoff from road both sides, waterfall, upstream sediment deposits, swale stabilization	__ Bioretention Area _X_ Plunge Pool __ Treatment Swale __ Infiltration Trench / Basin __ Wet Pond / Constructed Wetlands __ Filter Strip __ Leaching CBs / Sub-Chambers X swale stabilization	_X_ Easy __ Moderate Difficult	__ None _X_ Slight build up __ Heavy build up Approx. Depth __2_______ Inches	__ None __ Grease/Oil __ Grass Clippings __ Compost __ Trash/Debris __ Algae/ Blooms _X_ Other* Sediment	Circle One or both: Drainage Structure / Pipe __ N/A __ Good __ Corroded __ Cracked __ Exposed Steel _X_ Other* boxed culvert	__ N/A __ None __ Channeling __ Depressions _X_ Bank Erosion __ Displaced Riprap __ Other*	__ N/A __ No Distress __ Distressed _X_ Sparse __ Undesirable Woody __ Invasive Plants	__ None _X_ At Crossing __ Overland Flow __ Drainage Outfall	Approx. Distance: ____0______ Feet Name of Waterbody:	Available Space: _X_ Yes __ No Slope: __ Slight __ Moderate __ Steep Obstructions: __ Trees __ Boulders __ Other*
10/11/2013	C-26	Old Jaffrey Rd (by 172 N. Side)	roadway drainage, erosion	culvert	12"	CMP		N	Minor	Wooded/LD Residential	2476-2478	~60' swale collecting runoff from side slopes. Slight erosion of swale bank on hillside. East side of road by 172 Old Jaffrey. Discharges to wetland area.	__ Bioretention Area _X_ Plunge Pool _X_ Treatment Swale __ Infiltration Trench / Basin __ Wet Pond / Constructed Wetlands __ Filter Strip __ Leaching CBs / Sub-Chambers	_X_ Easy __ Moderate Difficult	_X_ None __ Slight build up __ Heavy build up Approx. Depth ________ Inches	_X_ None __ Grease/Oil __ Grass Clippings __ Compost __ Trash/Debris __ Algae/ Blooms __ Other*	Circle One or both: Drainage Structure / Pipe __ N/A _X_ Good __ Corroded __ Cracked __ Exposed Steel __ Other*	__ N/A __ None __ Channeling __ Depressions _X_ Bank Erosion __ Displaced Riprap __ Other* minimal	__ N/A _X_ No Distress __ Distressed __ Sparse __ Undesirable Woody __ Invasive Plants	_X_ None __ At Crossing __ Overland Flow __ Drainage Outfall	Approx. Distance: ______Unknown____ Feet Name of Waterbody:	Available Space: _X_ Yes __ No Slope: __ Slight __ Moderate __ Steep Obstructions: __ Trees __ Boulders __ Other*
10/11/2013	C-27	Old Jaffrey Rd (by 172 E. Side)	swale, roadway drainage	culvert	18"	CMP		Y	Minor	Forest/LD Residential	2479-2481	Roadside swale (east) South side of 172 to woods on West side	__ Bioretention Area _X_ Plunge Pool _X_ Treatment Swale __ Infiltration Trench / Basin __ Wet Pond / Constructed Wetlands __ Filter Strip __ Leaching CBs / Sub-Chambers	_X_ Easy __ Moderate Difficult	_X_ None __ Slight build up __ Heavy build up Approx. Depth ________ Inches	_X_ None __ Grease/Oil __ Grass Clippings __ Compost __ Trash/Debris __ Algae/ Blooms __ Other*	Circle One or both: Drainage Structure / Pipe __ N/A __ Good __ Corroded _X_ Cracked (upstream) __ Exposed Steel __ Other*	__ N/A __ None __ Channeling __ Depressions _X_ Bank Erosion __ Displaced Riprap __ Other*	__ N/A _X_ No Distress __ Distressed __ Sparse __ Undesirable Woody __ Invasive Plants	_X_ None __ At Crossing __ Overland Flow __ Drainage Outfall	Approx. Distance: __________ Feet Name of Waterbody:	Available Space: _X_ Yes __ No Slope: __ Slight __ Moderate __ Steep Obstructions: __ Trees __ Boulders __ Other*
10/11/2013	C-28	Old Jaffrey	swale, roadway drainage	culvert	12"	CMP		N	Minor	Forest/ ~200' South of Resident	2482-2484	Discharge to woods on West side. Drainage from hillside. Swale contains branches. Swale ~60' (N & S of culvert)	__ Bioretention Area _X_ Plunge Pool _X_ Treatment Swale __ Infiltration Trench / Basin __ Wet Pond / Constructed Wetlands __ Filter Strip __ Leaching CBs / Sub-Chambers	_X_ Easy __ Moderate Difficult	_X_ None __ Slight build up __ Heavy build up Approx. Depth ________ Inches	_X_ None __ Grease/Oil __ Grass Clippings __ Compost __ Trash/Debris __ Algae/ Blooms __ Other*	Circle One or both: Drainage Structure / Pipe __ N/A _X_ Good __ Corroded __ Cracked __ Exposed Steel __ Other*	__ N/A _X_ None __ Channeling __ Depressions __ Bank Erosion __ Displaced Riprap __ Other*	__ N/A _X_ No Distress __ Distressed __ Sparse __ Undesirable Woody __ Invasive Plants	_X_ None __ At Crossing __ Overland Flow __ Drainage Outfall	Approx. Distance: __________ Feet Name of Waterbody:	Available Space: _X_ Yes __ No Slope: _X_ Slight __ Moderate __ Steep Obstructions: __ Trees __ Boulders __ Other*

Date	Source ID	Major Road/Street	Type of Potential Source (Erosion / Roadway Drainage/ Septic / Lawn Area)	Drainage System or Culvert (Y/N and What Type)	Size	Material	Waterway (Y/N) (Type e.g. swale, ditch, brook, river, stream)	Sediment (Y/N)	Erosion (major /minor)	Surrounding Land Use	IMG # Photos	Notes
10/11/2013	C-29	Old Jaffrey	Erosion	culvert	Unknown	Unknown	wetland	Y	Major	Wetland/LD Residential	2485-2487	Culvert buried in front of driveway of 148 Old Jaffrey Rd. Erosion on downstream side and erosion further up the road
10/11/2013	C-30	Old Jaffrey	Erosion, roadway drainage	culvert	12"	CMP		Y	Minor	Wetland/Wooded	2488-2490	Downstream buried. Banks are steep on south side and slightly eroded. Iron colored water, a lot of water upstream. Bank stabilization. (Outside watershed)
10/11/2013	C-32	Mountain Rd	Erosion, roadway runoff	culvert	12"	CMP		Y	Minor	Wooded	2493-2495	Upstream headwall eroding. Downstream erosion under headwall. Overland flow around both headwalls, better stabilization needed. At gate farm property. Drainage Ditch
10/11/2013	C-33	Mountain Rd	Bank erosion, roadway runoff	culvert	12"	CMP		Y	Minor	Wooded	2496-2499	Sediment deposits on stream side coming from hill. Bank erosion alaong headwall. Headwall only downstream side.
10/11/2013	C-34	Mountain Rd	roadway runoff, bank erosion	culvert	12"	CMP		Y	Minor	Wooded	2500-2506	Headwall bothsides. Significant flow, sediment deposits in front but not in pipe. Washout on sides/slight sediment. Defined channel. Swale is a few feet wide carrying flow. Erosion up ditch but doesn't carry down to culvert. 190' long swale, erosion along upstream bank
10/11/2013	C-35	Mountain Rd	swale, roadway drainage	culvert	12"	CMP	swale	Y	Minor	Wooded	2507-2509	70ft N &S of upstream culvert runoff to swale, slight sediment deposits from washout along headwall. Headwall on both sides, culvert gets runoff from swale, smelly water and erosion
10/11/2013	C-36	Mountain Rd	roadway runoff	culvert	12"	CMP		Y	Minor	Wooded	2510-2511	Erosion near upstream pipe. Sediment in pipe from upstream erosion. Slight sediment deposit @outfall. Headwall falling apart.
10/11/2013	C-37	Mountain Rd	parking lot runoff	culvert	12"	CMP	wetland	N	Minor	Wetland/Roadway/ Parking lot	2512-2514	Drainage from parking lot and wetland. Runoff along road to outfall histroic stabilization. Rocks put in place to stabilize.
10/11/2013	C-38	Franklin Pierce Athletic Fields	parking lot runoff	culvert	Parallel Pipes 24"	RCP	wetland	N	Minor	Parking lot/Athletic Field	2516	Drains parking lot and wetland from culvert C-37

Source ID	Potential Type of BMP	Accessability	Sediment Accumulation	Deposits	Drainage Structural or Culvert Condition	Erodibility	Vegetation	Direct Runoff to Waterbody	Proximity to Waterbody	Constraints
C-29	__ Bioretention Area _X_ Plunge Pool _X_ Treatment Swale __ Infiltration Trench / Basin __ Wet Pond / Constructed Wetlands __ Filter Strip __ Leaching CBs / Sub-Chambers	_X_ Easy __ Moderate Difficult	__ None __ Slight build up _X_ Heavy build up Approx. Depth _____4____ Inches	__ None __ Grease/Oil __ Grass Clippings __ Compost __ Trash/Debris __ Algae/ Blooms _X_ Other* Sediment	Circle One or both: Drainage Structure / Pipe __ N/A __ Good __ Corroded __ Cracked __ Exposed Steel _X_ Other* buried	__ N/A __ None __ Channeling __ Depressions _X_ Bank Erosion __ Displaced Riprap __ Other*	__ N/A __ No Distress _X_ Distressed __ Sparse __ Undesirable Woody __ Invasive Plants	__ None __ At Crossing _X_ Overland Flow __ Drainage Outfall	Approx. Distance: _________ Feet Name of Waterbody: wetland	Available Space: _X_ Yes __ No Slope: _X_ Slight __ Moderate __ Steep Obstructions: __ Trees __ Boulders __ Other*
C-30	__ Bioretention Area _X_ Plunge Pool _X_ Treatment Swale __ Infiltration Trench / Basin __ Wet Pond / Constructed Wetlands __ Filter Strip __ Leaching CBs / Sub-Chambers	_X_ Easy __ Moderate Difficult	__ None _X_ Slight build up __ Heavy build up Approx. Depth _________ Inches	_X_ None __ Grease/Oil __ Grass Clippings __ Compost __ Trash/Debris __ Algae/ Blooms __ Other*	Circle One or both: Drainage Structure / Pipe __ N/A __ Good __ Corroded __ Cracked __ Exposed Steel _X_ Other* buried	__ N/A __ None __ Channeling __ Depressions _X_ Bank Erosion __ Displaced Riprap __ Other*	__ N/A __ No Distress _X_ Distressed __ Sparse __ Undesirable Woody __ Invasive Plants	__ None _X_ At Crossing __ Overland Flow __ Drainage Outfall	Approx. Distance: __0_______ Feet Name of Waterbody:	Available Space: _X_ Yes __ No Slope: __ Slight _X_ Moderate __ Steep Obstructions: __ Trees __ Boulders __ Other*
C-32	__ Bioretention Area _X_ Plunge Pool __ Treatment Swale __ Infiltration Trench / Basin __ Wet Pond / Constructed Wetlands __ Filter Strip __ Leaching CBs / Sub-Chambers	_X_ Easy __ Moderate Difficult	__ None _X_ Slight build up __ Heavy build up Approx. Depth ___<1______ Inches	_X_ None __ Grease/Oil __ Grass Clippings __ Compost __ Trash/Debris __ Algae/ Blooms __ Other*	Circle One or both: Drainage Structure / Pipe __ N/A _X_ Good __ Corroded __ Cracked __ Exposed Steel __ Other*	__ N/A __ None _X_ Channeling __ Depressions __ Bank Erosion __ Displaced Riprap __ Other* eroding under headwall	__ N/A __ No Distress _X_ Distressed __ Sparse __ Undesirable Woody __ Invasive Plants	__ None __ At Crossing _X_ Overland Flow __ Drainage Outfall	Approx. Distance: _____Unknown_____ Feet Name of Waterbody:	Available Space: _X_ Yes __ No Slope: _X_ Slight __ Moderate __ Steep Obstructions: __ Trees __ Boulders __ Other*
C-33	__ Bioretention Area _X_ Plunge Pool _X_ Treatment Swale (improve existing treatment swale) __ Infiltration Trench / Basin __ Wet Pond / Constructed Wetlands __ Filter Strip __ Leaching CBs / Sub-Chambers	_X_ Easy __ Moderate Difficult	__ None _X_ Slight build up __ Heavy build up Approx. Depth ____1-2_____ Inches	_X_ None __ Grease/Oil __ Grass Clippings __ Compost __ Trash/Debris __ Algae/ Blooms __ Other*	Circle One or both: Drainage Structure / Pipe __ N/A _X_ Good __ Corroded __ Cracked __ Exposed Steel __ Other*	__ N/A __ None __ Channeling __ Depressions _X_ Bank Erosion __ Displaced Riprap __ Other*	__ N/A __ No Distress _X_ Distressed __ Sparse __ Undesirable Woody __ Invasive Plants	__ None __ At Crossing _X_ Overland Flow __ Drainage Outfall	Approx. Distance: _____Unknown_____ Feet Name of Waterbody:	Available Space: _X_ Yes __ No Slope: _X_ Slight __ Moderate __ Steep Obstructions: __ Trees __ Boulders __ Other*
C-34	__ Bioretention Area _X_ Plunge Pool _X_ Treatment Swale __ Infiltration Trench / Basin __ Wet Pond / Constructed Wetlands __ Filter Strip __ Leaching CBs / Sub-Chambers	_X_ Easy __ Moderate Difficult	__ None _X_ Slight build up __ Heavy build up Approx. Depth __1-2_______ Inches	__ None __ Grease/Oil __ Grass Clippings __ Compost __ Trash/Debris __ Algae/ Blooms _X_ Other* sediment	Circle One or both: Drainage Structure / Pipe __ N/A _X_ Good __ Corroded __ Cracked __ Exposed Steel __ Other*	__ N/A __ None _X_ Channeling __ Depressions __ Bank Erosion __ Displaced Riprap __ Other*	__ N/A __ No Distress _X_ Distressed __ Sparse __ Undesirable Woody __ Invasive Plants	_X_ None __ At Crossing __ Overland Flow __ Drainage Outfall	Approx. Distance: _____0_____ Feet Name of Waterbody:	Available Space: _X_ Yes __ No Slope: _X_ Slight __ Moderate __ Steep Obstructions: __ Trees __ Boulders __ Other*
C-35	__ Bioretention Area _X_ Plunge Pool _X_ Treatment Swale __ Infiltration Trench / Basin __ Wet Pond / Constructed Wetlands __ Filter Strip __ Leaching CBs / Sub-Chambers	__ Easy _X_ Moderate __ Difficult	__ None _X_ Slight build up __ Heavy build up Approx. Depth _________ Inches	_X_ None __ Grease/Oil __ Grass Clippings __ Compost __ Trash/Debris __ Algae/ Blooms __ Other*	Circle One or both: Drainage Structure / Pipe __ N/A _X_ Good __ Corroded __ Cracked __ Exposed Steel __ Other*	__ N/A __ None __ Channeling __ Depressions _X_ Bank Erosion __ Displaced Riprap __ Other*	__ N/A __ No Distress _X_ Distressed __ Sparse __ Undesirable Woody __ Invasive Plants	__ None __ At Crossing _X_ Overland Flow __ Drainage Outfall	Approx. Distance: _________ Feet Name of Waterbody:	Available Space: _X_ Yes __ No Slope: __ Slight _X_ Moderate __ Steep Obstructions: _X_ Trees __ Boulders _X_ Other* steep terrain
C-36	__ Bioretention Area _X_ Plunge Pool _X_ Treatment Swale __ Infiltration Trench / Basin __ Wet Pond / Constructed Wetlands __ Filter Strip __ Leaching CBs / Sub-Chambers	_X_ Easy __ Moderate Difficult	__ None _X_ Slight build up __ Heavy build up Approx. Depth _________ Inches	_X_ None __ Grease/Oil __ Grass Clippings __ Compost __ Trash/Debris __ Algae/ Blooms __ Other*	Circle One or both: Drainage Structure / Pipe __ N/A _X_ Good __ Corroded __ Cracked __ Exposed Steel __ Other*	__ N/A __ None __ Channeling __ Depressions _X_ Bank Erosion __ Displaced Riprap __ Other*	__ N/A __ No Distress _X_ Distressed __ Sparse __ Undesirable Woody __ Invasive Plants	__ None __ At Crossing _X_ Overland Flow __ Drainage Outfall	Approx. Distance: ____100-200______ Feet Name of Waterbody:	Available Space: _X_ Yes __ No Slope: _X_ Slight __ Moderate __ Steep Obstructions: __ Trees __ Boulders __ Other*
C-37	__ Bioretention Area _X_ Plunge Pool _X_ Treatment Swale __ Infiltration Trench / Basin __ Wet Pond / Constructed Wetlands __ Filter Strip __ Leaching CBs / Sub-Chambers X stabilization	_X_ Easy __ Moderate Difficult	_X_ None __ Slight build up __ Heavy build up Approx. Depth _________ Inches	_X_ None __ Grease/Oil __ Grass Clippings __ Compost __ Trash/Debris __ Algae/ Blooms __ Other*	Circle One or both: Drainage Structure / Pipe __ N/A _X_ Good __ Corroded __ Cracked __ Exposed Steel __ Other*	__ N/A __ None __ Channeling __ Depressions _X_ Bank Erosion slight along bank __ Displaced Riprap __ Other*	__ N/A __ No Distress _X_ Distressed __ Sparse __ Undesirable Woody __ Invasive Plants	__ None _X_ At Crossing __ Overland Flow __ Drainage Outfall	Approx. Distance: _____0_____ Feet Name of Waterbody: wetland	Available Space: _X_ Yes __ No Slope: __ Slight _X_ Moderate __ Steep Obstructions: _X_ Trees _X_ Boulders __ Other*
C-38	__ Bioretention Area __ Plunge Pool __ Treatment Swale __ Infiltration Trench / Basin __ Wet Pond / Constructed Wetlands __ Filter Strip __ Leaching CBs / Sub-Chambers	_X_ Easy __ Moderate Difficult	_X_ None __ Slight build up __ Heavy build up Approx. Depth _________ Inches	_X_ None __ Grease/Oil __ Grass Clippings __ Compost __ Trash/Debris __ Algae/ Blooms __ Other*	Circle One or both: Drainage Structure / Pipe __ N/A _X_ Good __ Corroded __ Cracked __ Exposed Steel __ Other*	__ N/A _X_ None __ Channeling __ Depressions __ Bank Erosion __ Displaced Riprap __ Other*	__ N/A _X_ No Distress __ Distressed __ Sparse __ Undesirable Woody __ Invasive Plants	__ None _X_ At Crossing __ Overland Flow __ Drainage Outfall	Approx. Distance: _____0_____ Feet Name of Waterbody:	Available Space: __ Yes _X_ No Parking lot Slope: __ Slight __ Moderate __ Steep Obstructions: __ Trees __ Boulders __ Other*

Date	Source ID	Major Road/Street	Type of Potential Source (Erosion / Roadway Drainage/ Septic / Lawn Area)	Drainage System or Culvert (Y/N and What Type)	Size	Material	Waterway (Y/N) (Type e.g. swale, ditch, brook, river, stream)	Sediment (Y/N)	Erosion (major /minor)	Surrounding Land Use	IMG # Photos	Notes	Potential Type of BMP	Accessability	Sediment Accumulation	Deposits	Drainage Structural or Culvert Condition	Erodibility	Vegetation	Direct Runoff to Waterbody	Proximity to Waterbody	Constraints
10/11/2013	O-3	Franklin Pierce Athletic Fields	athletic field runoff	outfall pipe	15"	HDPE	BMP	N	Minor	Athletic Fields	2517-2519	outfall to bioretention BMP, existing BMP and ripap	__ Bioretention Area __ Plunge Pool __ Treatment Swale __ Infiltration Trench / Basin __ Wet Pond / Constructed Wetlands __ Filter Strip __ Leaching CBs / Sub-Chambers	_X_ Easy __ Moderate Difficult	_X_ None __ Slight build up __ Heavy build up Approx. Depth ________ Inches	_X_ None __ Grease/Oil __ Grass Clippings __ Compost __ Trash/Debris __ Algae/ Blooms __ Other*	Circle One or both: Drainage Structure / Pipe __ N/A _X_ Good __ Corroded __ Cracked __ Exposed Steel __ Other*	__ N/A _X_ None __ Channeling __ Depressions __ Bank Erosion __ Displaced Riprap __ Other*	__ N/A _X_ No Distress __ Distressed __ Sparse __ Undesirable Woody __ Invasive Plants	__ None __ At Crossing _X_ Overland Flow __ Drainage Outfall	Approx. Distance: _____0_____ Feet Name of Waterbody: BMP	Available Space: _X_ Yes __ No Slope: _X_ Slight __ Moderate __ Steep Obstructions: __ Trees __ Boulders __ Other*
10/11/2013	I-6	Franklin Pierce Athletic Fields	parking lot runoff	inlet	N/A	N/A		N/A	N/A	Athletic Fields	2515	grate takes runoff from parking lot	__ Bioretention Area __ Plunge Pool __ Treatment Swale __ Infiltration Trench / Basin __ Wet Pond / Constructed Wetlands __ Filter Strip __ Leaching CBs / Sub-Chambers	_X_ Easy __ Moderate Difficult	__ None __ Slight build up __ Heavy build up Approx. Depth ________ Inches	__ None __ Grease/Oil __ Grass Clippings __ Compost __ Trash/Debris __ Algae/ Blooms __ Other*	Circle One or both: Drainage Structure / Pipe _X_ N/A __ Good __ Corroded __ Cracked __ Exposed Steel __ Other*	_X_ N/A __ None __ Channeling __ Depressions __ Bank Erosion __ Displaced Riprap __ Other*	_X_ N/A __ No Distress __ Distressed __ Sparse __ Undesirable Woody __ Invasive Plants	_X_ None __ At Crossing __ Overland Flow __ Drainage Outfall	Approx. Distance: __________ Feet Name of Waterbody: wetland (doesn't drain to it)	Available Space: __ Yes __ No limited space in parking lot Slope: _X_ Slight __ Moderate __ Steep Obstructions: __ Trees __ Boulders __ Other*
10/11/2013	C-39	Franklin Pierce Athletic Fields	football field, inlet from upper parking lot	culvert	15"	HDPE	wetland, stream	N	Minor	Athletic fields	2523-2528	Runoff from inlet from upper parking lot. Headwall presence and culvert discharges to wetland	__ Bioretention Area __ Plunge Pool __ Treatment Swale __ Infiltration Trench / Basin __ Wet Pond / Constructed Wetlands __ Filter Strip __ Leaching CBs / Sub-Chambers	_X_ Easy __ Moderate Difficult	_X_ None __ Slight build up __ Heavy build up Approx. Depth ________ Inches	_X_ None __ Grease/Oil __ Grass Clippings __ Compost __ Trash/Debris __ Algae/ Blooms __ Other*	Circle One or both: Drainage Structure / Pipe __ N/A _X_ Good __ Corroded __ Cracked __ Exposed Steel __ Other*	__ N/A _X_ None __ Channeling __ Depressions __ Bank Erosion __ Displaced Riprap __ Other*	__ N/A _X_ No Distress __ Distressed __ Sparse __ Undesirable Woody __ Invasive Plants	__ None __ At Crossing __ Overland Flow _X_ Drainage Outfall	Approx. Distance: _____0_____ Feet Name of Waterbody:	Available Space: __ Yes __ No Slope: _X_ Slight __ Moderate __ Steep Obstructions: __ Trees __ Boulders __ Other*
10/11/2013	I-7	Franklin Pierce Athletic Fields	athletic field runoff	inlet	N/A	N/A		N/A	N/A	Athletic Fields	2529	Inlet on side of soccer field, riprap around cover	__ Bioretention Area __ Plunge Pool __ Treatment Swale __ Infiltration Trench / Basin __ Wet Pond / Constructed Wetlands __ Filter Strip __ Leaching CBs / Sub-Chambers	_X_ Easy __ Moderate Difficult	__ None __ Slight build up __ Heavy build up Approx. Depth ________ Inches	_X_ None __ Grease/Oil __ Grass Clippings __ Compost __ Trash/Debris __ Algae/ Blooms __ Other*	Circle One or both: Drainage Structure / Pipe __ N/A _X_ Good __ Corroded __ Cracked __ Exposed Steel __ Other*	__ N/A _X_ None __ Channeling __ Depressions __ Bank Erosion __ Displaced Riprap __ Other*	_X_ N/A __ No Distress __ Distressed __ Sparse __ Undesirable Woody __ Invasive Plants	__ None __ At Crossing __ Overland Flow _X_ Drainage Outfall	Approx. Distance: __________ Feet Name of Waterbody:	Available Space: _Y_ Yes __ No Slope: _X_ Slight __ Moderate __ Steep Obstructions: __ Trees __ Boulders __ Other*
10/11/2013	O-4	Franklin Pierce Athletic Fields	athletic field runoff	drainage outfall	24" parallel pipes	HDPE		Y	Minor	Athletic Fields	2531	Parallel pipes, outfall of 2 parallel pipes off of mountain road	__ Bioretention Area _X_ Plunge Pool __ Treatment Swale __ Infiltration Trench / Basin __ Wet Pond / Constructed Wetlands __ Filter Strip __ Leaching CBs / Sub-Chambers	_X_ Easy __ Moderate Difficult	__ None _X_ Slight build up __ Heavy build up Approx. Depth ________ Inches	_X_ None __ Grease/Oil __ Grass Clippings __ Compost __ Trash/Debris __ Algae/ Blooms __ Other*	Circle One or both: Drainage Structure / Pipe __ N/A _X_ Good __ Corroded __ Cracked __ Exposed Steel __ Other*	__ N/A _X_ None __ Channeling __ Depressions __ Bank Erosion __ Displaced Riprap __ Other*	__ N/A _X_ No Distress __ Distressed __ Sparse __ Undesirable Woody __ Invasive Plants	__ None __ At Crossing _X_ Overland Flow __ Drainage Outfall	Approx. Distance: ____Unknown______ Feet Name of Waterbody:	Available Space: _X_ Yes __ No Slope: _X_ Slight __ Moderate __ Steep Obstructions: __ Trees __ Boulders __ Other*
10/11/2013	S-17	Baseball field	baseball field material		N/A	N/A		Y	N/A	Baseball field	2532-2533	Piles of baseball field material laying around, easily able to runoff	__ Bioretention Area __ Plunge Pool __ Treatment Swale __ Infiltration Trench / Basin __ Wet Pond / Constructed Wetlands __ Filter Strip __ Leaching CBs / Sub-Chambers	__ Easy __ Moderate Difficult	__ None __ Slight build up __ Heavy build up Approx. Depth ________ Inches	__ None __ Grease/Oil __ Grass Clippings __ Compost __ Trash/Debris __ Algae/ Blooms __ Other*	Circle One or both: Drainage Structure / Pipe __ N/A __ Good __ Corroded __ Cracked __ Exposed Steel __ Other*	__ N/A __ None __ Channeling __ Depressions __ Bank Erosion __ Displaced Riprap __ Other*	__ N/A __ No Distress __ Distressed __ Sparse __ Undesirable Woody __ Invasive Plants	__ None __ At Crossing __ Overland Flow __ Drainage Outfall	Approx. Distance: __________ Feet Name of Waterbody:	Available Space: __ Yes __ No Slope: __ Slight __ Moderate __ Steep Obstructions: __ Trees __ Boulders __ Other*
10/11/2013	I-8	University Dr/Athletic Fields	roadway and parking lot runoff	inlet	N/A	N/A		N/A	N/A		2534-2535	Inlet from riprap drainage swale	__ Bioretention Area __ Plunge Pool __ Treatment Swale __ Infiltration Trench / Basin __ Wet Pond / Constructed Wetlands __ Filter Strip __ Leaching CBs / Sub-Chambers	__ Easy __ Moderate Difficult	__ None __ Slight build up __ Heavy build up Approx. Depth ________ Inches	__ None __ Grease/Oil __ Grass Clippings __ Compost __ Trash/Debris __ Algae/ Blooms __ Other*	Circle One or both: Drainage Structure / Pipe __ N/A __ Good __ Corroded __ Cracked __ Exposed Steel __ Other*	__ N/A __ None __ Channeling __ Depressions __ Bank Erosion __ Displaced Riprap __ Other*	__ N/A __ No Distress __ Distressed __ Sparse __ Undesirable Woody __ Invasive Plants	__ None __ At Crossing __ Overland Flow __ Drainage Outfall	Approx. Distance: __________ Feet Name of Waterbody:	Available Space: __ Yes __ No Slope: __ Slight __ Moderate __ Steep Obstructions: __ Trees __ Boulders __ Other*
10/11/2013	I-9	Pierce Dr.	road/parking lot runoff	inlet	N/A	N/A		N/A	N/A	parking lot/ roadway	2536	Inlet collecting road and parking lot runoff	__ Bioretention Area __ Plunge Pool __ Treatment Swale __ Infiltration Trench / Basin __ Wet Pond / Constructed Wetlands __ Filter Strip __ Leaching CBs / Sub-Chambers	__ Easy __ Moderate Difficult	__ None __ Slight build up __ Heavy build up Approx. Depth ________ Inches	__ None __ Grease/Oil __ Grass Clippings __ Compost __ Trash/Debris __ Algae/ Blooms __ Other*	Circle One or both: Drainage Structure / Pipe __ N/A __ Good __ Corroded __ Cracked __ Exposed Steel __ Other*	__ N/A __ None __ Channeling __ Depressions __ Bank Erosion __ Displaced Riprap __ Other*	__ N/A __ No Distress __ Distressed __ Sparse __ Undesirable Woody __ Invasive Plants	__ None __ At Crossing __ Overland Flow _X_ Drainage Outfall	Approx. Distance: __________ Feet Name of Waterbody:	Available Space: __ Yes __ No Slope: __ Slight __ Moderate __ Steep Obstructions: __ Trees __ Boulders __ Other*
10/11/2013	O-5	Pierce Dr.	road runoff	outfall pipe	15"	HDPE		N	Minor	parking lot/ roadway	2537-2539	Outfall to wetlands, exposed pipe, scouring, could perform bank stabilization	__ Bioretention Area __ Plunge Pool __ Treatment Swale __ Infiltration Trench / Basin __ Wet Pond / Constructed Wetlands __ Filter Strip __ Leaching CBs / Sub-Chambers X bank stabilization	__ Easy _X_ Moderate __ Difficult	_X_ None __ Slight build up __ Heavy build up Approx. Depth ________ Inches	_X_ None __ Grease/Oil __ Grass Clippings __ Compost __ Trash/Debris __ Algae/ Blooms __ Other*	Circle One or both: Drainage Structure / Pipe __ N/A _X_ Good __ Corroded __ Cracked __ Exposed Steel __ Other*	__ N/A __ None __ Channeling __ Depressions __ Bank Erosion __ Displaced Riprap _X_ Other* outlet scouring	__ N/A __ No Distress _X_ Distressed __ Sparse __ Undesirable Woody __ Invasive Plants	__ None __ At Crossing _X_ Overland Flow __ Drainage Outfall	Approx. Distance: __100-200_______ Feet Name of Waterbody: wetland	Available Space: _X_ Yes __ No Slope: __ Slight __ Moderate _X_ Steep Obstructions: _X_ Trees __ Boulders __ Other*

Date	Source ID	Major Road/Street	Type of Potential Source (Erosion / Roadway Drainage/ Septic / Lawn Area)	Drainage System or Culvert (Y/N and What Type)	Size	Material	Waterway (Y/N) (Type e.g. swale, ditch, brook, river, stream)	Sediment (Y/N)	Erosion (major /minor)	Surrounding Land Use	IMG # Photos	Notes	Potential Type of BMP	Accessability	Sediment Accumulation	Deposits	Drainage Structural or Culvert Condition	Erodibility	Vegetation	Direct Runoff to Waterbody	Proximity to Waterbody	Constraints
10/11/2013	I-10	Pierce Dr.	road/parking lot runoff	inlet	N/A	N/A		N/A	N/A	parking lot/ roadway	2540-2541	inlet behind speed bump	__ Bioretention Area __ Plunge Pool __ Treatment Swale __ Infiltration Trench / Basin __ Wet Pond / Constructed Wetlands __ Filter Strip _X_ Leaching CBs / Sub-Chambers	_X_ Easy __ Moderate Difficult	_X_ None __ Slight build up __ Heavy build up Approx. Depth __________ Inches	_X_ None __ Grease/Oil __ Grass Clippings __ Compost __ Trash/Debris __ Algae/ Blooms __ Other*	Circle One or both: Drainage Structure / Pipe __ N/A _X_ Good __ Corroded __ Cracked __ Exposed Steel __ Other*	__ N/A _X_ None __ Channeling __ Depressions __ Bank Erosion __ Displaced Riprap __ Other*	_X_ N/A __ No Distress __ Distressed __ Sparse __ Undesirable Woody __ Invasive Plants	__ None __ At Crossing __ Overland Flow _X_ Drainage Outfall	Approx. Distance: __________ Feet Name of Waterbody:	Available Space: _X_ Yes behind speed bump __ No Slope: __ Slight __ Moderate __ Steep Obstructions: __ Trees __ Boulders __ Other*
10/11/2013	O-6	Pierce Dr.	road/parking lot runoff	drainage outfall	15"	HDPE		N	Major	parking lot/ roadway	2542	Tons of erosion from road to outall. Overland and pipe erosion	__ Bioretention Area __ Plunge Pool __ Treatment Swale __ Infiltration Trench / Basin __ Wet Pond / Constructed Wetlands __ Filter Strip _X_ Leaching CBs / Sub-Chambers additional room to construct BMP in shoulder	__ Easy __ Moderate _X_ Difficult	_X_ None __ Slight build up __ Heavy build up Approx. Depth __________ Inches	_X_ None __ Grease/Oil __ Grass Clippings __ Compost __ Trash/Debris __ Algae/ Blooms __ Other*	Circle One or both: Drainage Structure / Pipe __ N/A _X_ Good __ Corroded __ Cracked __ Exposed Steel __ Other*	__ N/A __ None __ Channeling __ Depressions _X_ Bank Erosion __ Displaced Riprap __ Other*	__ N/A __ No Distress _X_ Distressed __ Sparse __ Undesirable Woody __ Invasive Plants	__ None __ At Crossing _X_ Overland Flow __ Drainage Outfall	Approx. Distance: __________ Feet Name of Waterbody:	Available Space: __ Yes __ No Maybe Slope: __ Slight __ Moderate _X_ Steep Obstructions: __ Trees __ Boulders __ Other*
10/11/2013	I-11	Pierce Dr.	road/parking lot runoff	inlet	N/A	N/A		N/A	N/A	parking lot/ roadway	2543-2544	Opprotunity to put in BMP infiltration, inlet outfalls to wetland, car access outfall heavily vegetated and steep	__ Bioretention Area __ Plunge Pool __ Treatment Swale __ Infiltration Trench / Basin __ Wet Pond / Constructed Wetlands __ Filter Strip _X_ Leaching CBs / Sub-Chambers	_X_ Easy __ Moderate Difficult	__ None __ Slight build up __ Heavy build up Approx. Depth __________ Inches	__ None __ Grease/Oil __ Grass Clippings __ Compost __ Trash/Debris __ Algae/ Blooms __ Other*	Circle One or both: Drainage Structure / Pipe __ N/A __ Good __ Corroded __ Cracked __ Exposed Steel __ Other*	__ N/A __ None __ Channeling __ Depressions __ Bank Erosion __ Displaced Riprap __ Other*	__ N/A __ No Distress __ Distressed __ Sparse __ Undesirable Woody __ Invasive Plants	__ None __ At Crossing __ Overland Flow __ Drainage Outfall	Approx. Distance: __________ Feet Name of Waterbody:	Available Space: _Y_ Yes __ No Slope: __ Slight __ Moderate _X_ Steep Obstructions: __ Trees _X_ Boulders __ Other*
10/11/2013	I-12	Pierce Dr.	road/parking lot runoff	2 inlets	N/A	N/A		N/A	N/A	parking lot/ roadway	2545-2546	Opprotunity to put in BMP infiltration, inlet outfalls to wetland, car access outfall heavily vegetated and steep	__ Bioretention Area __ Plunge Pool __ Treatment Swale __ Infiltration Trench / Basin __ Wet Pond / Constructed Wetlands __ Filter Strip _X_ Leaching CBs / Sub-Chambers	_X_ Easy __ Moderate Difficult	__ None __ Slight build up __ Heavy build up Approx. Depth __________ Inches	__ None __ Grease/Oil __ Grass Clippings __ Compost __ Trash/Debris __ Algae/ Blooms _X_ Other* Mulch	Circle One or both: Drainage Structure / Pipe __ N/A _X_ Good __ Corroded __ Cracked __ Exposed Steel __ Other*	__ N/A __ None __ Channeling __ Depressions __ Bank Erosion __ Displaced Riprap _X_ Other* cracked pavement	_X_ N/A __ No Distress __ Distressed __ Sparse __ Undesirable Woody __ Invasive Plants	__ None __ At Crossing __ Overland Flow _X_ Drainage Outfall	Approx. Distance: __________ Feet Name of Waterbody:	Available Space: __ Yes __ No Slope: _X_ Slight __ Moderate __ Steep Obstructions: __ Trees __ Boulders __ Other*
10/11/2013	O-7	Pierce Dr.	road/parking lot runoff	drainage outfall	8" (off plans)	CMP		Y	Y	parking lot/ roadway	2547-2548	Outfall has bank erosion, steep bank	__ Bioretention Area __ Plunge Pool __ Treatment Swale __ Infiltration Trench / Basin __ Wet Pond / Constructed Wetlands __ Filter Strip __ Leaching CBs / Sub-Chambers X bank stabilization	__ Easy __ Moderate _X_ Difficult	__ None __ Slight build up _X_ Heavy build up Approx. Depth _____Unknown____ Inches	__ None __ Grease/Oil __ Grass Clippings __ Compost _X_ Trash/Debris __ Algae/ Blooms __ Other*	Circle One or both: Drainage Structure / Pipe _X_ N/A (can't see) __ Good __ Corroded __ Cracked __ Exposed Steel __ Other*	__ N/A __ None __ Channeling __ Depressions _X_ Bank Erosion __ Displaced Riprap __ Other*	__ N/A __ No Distress _X_ Distressed __ Sparse __ Undesirable Woody __ Invasive Plants	__ None __ At Crossing _X_ Overland Flow __ Drainage Outfall	Approx. Distance: __________ Feet Name of Waterbody:	Available Space: __ Yes _X_ No Slope: __ Slight __ Moderate _X_ Steep Obstructions: _X_ Trees __ Boulders __ Other*
10/11/2013	I-13	Water St	road/parking lot runoff	inlet	N/A	N/A		Y	Y	parking lot/ roadway	2549-2551	Buried structure, covered with debris and sediment, collects runoff from parking lot and road	__ Bioretention Area __ Plunge Pool __ Treatment Swale __ Infiltration Trench / Basin __ Wet Pond / Constructed Wetlands __ Filter Strip _X_ Leaching CBs / Sub-Chambers	_X_ Easy __ Moderate Difficult	__ None __ Slight build up _X_ Heavy build up Approx. Depth ____4-6_____ Inches	_X_ None __ Grease/Oil __ Grass Clippings __ Compost __ Trash/Debris __ Algae/ Blooms __ Other*	Circle One or both: Drainage Structure / Pipe __ N/A _X_ Good __ Corroded __ Cracked __ Exposed Steel __ Other*	__ N/A __ None __ Channeling __ Depressions _X_ Bank Erosion __ Displaced Riprap __ Other*	__ N/A __ No Distress _X_ Distressed __ Sparse __ Undesirable Woody __ Invasive Plants	_X_ None __ At Crossing __ Overland Flow __ Drainage Outfall	Approx. Distance: __________ Feet Name of Waterbody:	Available Space: _X_ Yes __ No Slope: __ Slight __ Moderate __ Steep Obstructions: __ Trees __ Boulders __ Other*
10/11/2013	I-14	Water St	road/parking lot runoff	inlet	N/A	N/A		N/A	N/A	parking lot/ roadway	0	inlets in parking lot collects runoff from parking lots	__ Bioretention Area __ Plunge Pool __ Treatment Swale __ Infiltration Trench / Basin __ Wet Pond / Constructed Wetlands __ Filter Strip _X_ Leaching CBs / Sub-Chambers	__ Easy __ Moderate Difficult	__ None __ Slight build up __ Heavy build up Approx. Depth __________ Inches	__ None __ Grease/Oil __ Grass Clippings __ Compost __ Trash/Debris __ Algae/ Blooms __ Other*	Circle One or both: Drainage Structure / Pipe __ N/A __ Good __ Corroded __ Cracked __ Exposed Steel __ Other*	__ N/A __ None __ Channeling __ Depressions __ Bank Erosion __ Displaced Riprap __ Other*	__ N/A __ No Distress __ Distressed __ Sparse __ Undesirable Woody __ Invasive Plants	__ None __ At Crossing __ Overland Flow __ Drainage Outfall	Approx. Distance: __________ Feet Name of Waterbody:	Available Space: __ Yes __ No Slope: __ Slight __ Moderate __ Steep Obstructions: __ Trees __ Boulders __ Other*
10/11/2013	I-15	Water St	road/parking lot runoff	inlet	N/A	N/A		N/A	N/A	parking lot/ roadway	0	inlets in parking lot collects runoff from parking lots	__ Bioretention Area __ Plunge Pool __ Treatment Swale __ Infiltration Trench / Basin __ Wet Pond / Constructed Wetlands __ Filter Strip _X_ Leaching CBs / Sub-Chambers	__ Easy __ Moderate Difficult	_X_ None __ Slight build up __ Heavy build up Approx. Depth __________ Inches	_X_ None __ Grease/Oil __ Grass Clippings __ Compost __ Trash/Debris __ Algae/ Blooms __ Other*	Circle One or both: Drainage Structure / Pipe _X_ N/A __ Good __ Corroded __ Cracked __ Exposed Steel __ Other*	_X_ N/A __ None __ Channeling __ Depressions __ Bank Erosion __ Displaced Riprap __ Other*	_X_ N/A __ No Distress __ Distressed __ Sparse __ Undesirable Woody __ Invasive Plants	__ None __ At Crossing __ Overland Flow _X_ Drainage Outfall	Approx. Distance: __________ Feet Name of Waterbody:	Available Space: __ Yes __ No Slope: __ Slight __ Moderate __ Steep Obstructions: __ Trees __ Boulders __ Other*
10/11/2013	I-16	In front of athletic building	road/parking lot runoff	inlet	N/A	N/A		N/A	N/A	parking lot/ roadway	0	inlets in parking lot collects runoff from parking lots	__ Bioretention Area __ Plunge Pool __ Treatment Swale __ Infiltration Trench / Basin __ Wet Pond / Constructed Wetlands __ Filter Strip _X_ Leaching CBs / Sub-Chambers	__ Easy __ Moderate Difficult	__ None __ Slight build up __ Heavy build up Approx. Depth __________ Inches	__ None __ Grease/Oil __ Grass Clippings __ Compost __ Trash/Debris __ Algae/ Blooms __ Other*	Circle One or both: Drainage Structure / Pipe __ N/A __ Good __ Corroded __ Cracked __ Exposed Steel __ Other*	__ N/A __ None __ Channeling __ Depressions __ Bank Erosion __ Displaced Riprap __ Other*	__ N/A __ No Distress __ Distressed __ Sparse __ Undesirable Woody __ Invasive Plants	__ None __ At Crossing __ Overland Flow __ Drainage Outfall	Approx. Distance: __________ Feet Name of Waterbody:	Available Space: __ Yes __ No Slope: __ Slight __ Moderate __ Steep Obstructions: __ Trees __ Boulders __ Other*

Date	Source ID	Major Road/Street	Type of Potential Source (Erosion / Roadway Drainage/ Septic / Lawn Area)	Drainage System or Culvert (Y/N and What Type)	Size	Material	Waterway (Y/N) (Type e.g. swale, ditch, brook, river, stream)	Sediment (Y/N)	Erosion (major /minor)	Surrounding Land Use	IMG # Photos	Notes
10/11/2013	I-17	In front of athletic building	road/parking lot runoff	inlet	N/A	N/A		N/A	N/A	parking lot/ roadway	0	inlets in parking lot collects runoff from parking lots
10/11/2013	I-18	Mountain View	road/parking lot runoff	inlet	N/A	N/A		N/A	N/A	parking lot/ roadway	0	inlets in parking lot collects runoff from parking lots
10/11/2013	I-19	Mountain View	road/parking lot runoff	inlet	N/A	N/A		N/A	N/A	parking lot/ roadway	0	inlets in parking lot collects runoff from parking lots
10/11/2013	I-20	Cheshire Hall	road/parking lot runoff	inlet	N/A	N/A		N/A	N/A	parking lot/ roadway	0	inlets in parking lot collects runoff from parking lots
10/11/2013	I-21	Cheshire Hall	road/parking lot runoff	inlet	N/A	N/A		N/A	N/A	parking lot/ roadway	0	inlets in parking lot collects runoff from parking lots
10/11/2013	I-22	Parking lot next to Student Center	road/parking lot runoff	inlet	N/A	N/A		N/A	N/A	parking lot/ roadway	0	inlets in parking lot collects runoff from parking lots
10/11/2013	BMP	Mountain Rd	Parking lot runoff	BMP (bioretention area)	N/A	N/A		N/A	N/A	Parking lot and college campus	2552-2555	Bioretention BMP
10/11/2013	S-18	Kimball Rd	road drainage	swale	N/A	N/A	swale	N	N	Road	003-005	swale's in good condition
10/11/2013	S-19	Kimball Rd	road drainage	swale	N/A	N/A	swale	N	Minor	Road	006-009	Property could be town owned/ sharp corner with driect shoulder drainage to Pond

Source ID	Potential Type of BMP	Accessability	Sediment Accumulation	Deposits	Drainage Structural or Culvert Condition	Erodibility	Vegetation	Direct Runoff to Waterbody	Proximity to Waterbody	Constraints
I-17	__ Bioretention Area __ Plunge Pool __ Treatment Swale __ Infiltration Trench / Basin __ Wet Pond / Constructed Wetlands __ Filter Strip _X_ Leaching CBs / Sub-Chambers	__ Easy __ Moderate Difficult	__ None __ Slight build up __ Heavy build up Approx. Depth ________ Inches	__ None __ Grease/Oil __ Grass Clippings __ Compost __ Trash/Debris __ Algae/ Blooms __ Other*	Circle One or both: Drainage Structure / Pipe __ N/A __ Good __ Corroded __ Cracked __ Exposed Steel __ Other*	__ N/A __ None __ Channeling __ Depressions __ Bank Erosion __ Displaced Riprap __ Other*	__ N/A __ No Distress __ Distressed __ Sparse __ Undesirable Woody __ Invasive Plants	__ None __ At Crossing __ Overland Flow __ Drainage Outfall	Approx. Distance: __________ Feet Name of Waterbody:	Available Space: __ Yes __ No Slope: __ Slight __ Moderate __ Steep Obstructions: __ Trees __ Boulders __ Other*
I-18	__ Bioretention Area __ Plunge Pool __ Treatment Swale __ Infiltration Trench / Basin __ Wet Pond / Constructed Wetlands __ Filter Strip __ Leaching CBs / Sub-Chambers	__ Easy __ Moderate Difficult	__ None __ Slight build up __ Heavy build up Approx. Depth ________ Inches	__ None __ Grease/Oil __ Grass Clippings __ Compost __ Trash/Debris __ Algae/ Blooms __ Other*	Circle One or both: Drainage Structure / Pipe __ N/A __ Good __ Corroded __ Cracked __ Exposed Steel __ Other*	__ N/A __ None __ Channeling __ Depressions __ Bank Erosion __ Displaced Riprap __ Other*	__ N/A __ No Distress __ Distressed __ Sparse __ Undesirable Woody __ Invasive Plants	__ None __ At Crossing __ Overland Flow __ Drainage Outfall	Approx. Distance: __________ Feet Name of Waterbody:	Available Space: __ Yes __ No Slope: __ Slight __ Moderate __ Steep Obstructions: __ Trees __ Boulders __ Other*
I-19	__ Bioretention Area __ Plunge Pool __ Treatment Swale __ Infiltration Trench / Basin __ Wet Pond / Constructed Wetlands __ Filter Strip _X_ Leaching CBs / Sub-Chambers	__ Easy __ Moderate Difficult	__ None __ Slight build up __ Heavy build up Approx. Depth ________ Inches	__ None __ Grease/Oil __ Grass Clippings __ Compost __ Trash/Debris __ Algae/ Blooms __ Other*	Circle One or both: Drainage Structure / Pipe __ N/A __ Good __ Corroded __ Cracked __ Exposed Steel __ Other*	__ N/A __ None __ Channeling __ Depressions __ Bank Erosion __ Displaced Riprap __ Other*	__ N/A __ No Distress __ Distressed __ Sparse __ Undesirable Woody __ Invasive Plants	__ None __ At Crossing __ Overland Flow __ Drainage Outfall	Approx. Distance: __________ Feet Name of Waterbody:	Available Space: __ Yes __ No Slope: __ Slight __ Moderate __ Steep Obstructions: __ Trees __ Boulders __ Other*
I-20	__ Bioretention Area __ Plunge Pool __ Treatment Swale __ Infiltration Trench / Basin __ Wet Pond / Constructed Wetlands __ Filter Strip _X_ Leaching CBs / Sub-Chambers	__ Easy __ Moderate Difficult	__ None __ Slight build up __ Heavy build up Approx. Depth ________ Inches	__ None __ Grease/Oil __ Grass Clippings __ Compost __ Trash/Debris __ Algae/ Blooms __ Other*	Circle One or both: Drainage Structure / Pipe __ N/A __ Good __ Corroded __ Cracked __ Exposed Steel __ Other*	__ N/A __ None __ Channeling __ Depressions __ Bank Erosion __ Displaced Riprap __ Other*	__ N/A __ No Distress __ Distressed __ Sparse __ Undesirable Woody __ Invasive Plants	__ None __ At Crossing __ Overland Flow __ Drainage Outfall	Approx. Distance: __________ Feet Name of Waterbody:	Available Space: __ Yes __ No Slope: __ Slight __ Moderate __ Steep Obstructions: __ Trees __ Boulders __ Other*
I-21	__ Bioretention Area __ Plunge Pool __ Treatment Swale __ Infiltration Trench / Basin __ Wet Pond / Constructed Wetlands __ Filter Strip _X_ Leaching CBs / Sub-Chambers	__ Easy __ Moderate Difficult	__ None __ Slight build up __ Heavy build up Approx. Depth ________ Inches	__ None __ Grease/Oil __ Grass Clippings __ Compost __ Trash/Debris __ Algae/ Blooms __ Other*	Circle One or both: Drainage Structure / Pipe __ N/A __ Good __ Corroded __ Cracked __ Exposed Steel __ Other*	__ N/A __ None __ Channeling __ Depressions __ Bank Erosion __ Displaced Riprap __ Other*	__ N/A __ No Distress __ Distressed __ Sparse __ Undesirable Woody __ Invasive Plants	__ None __ At Crossing __ Overland Flow __ Drainage Outfall	Approx. Distance: __________ Feet Name of Waterbody:	Available Space: __ Yes __ No Slope: __ Slight __ Moderate __ Steep Obstructions: __ Trees __ Boulders __ Other*
I-22	__ Bioretention Area __ Plunge Pool __ Treatment Swale __ Infiltration Trench / Basin __ Wet Pond / Constructed Wetlands __ Filter Strip _X_ Leaching CBs / Sub-Chambers	__ Easy __ Moderate Difficult	__ None __ Slight build up __ Heavy build up Approx. Depth ________ Inches	__ None __ Grease/Oil __ Grass Clippings __ Compost __ Trash/Debris __ Algae/ Blooms __ Other*	Circle One or both: Drainage Structure / Pipe __ N/A __ Good __ Corroded __ Cracked __ Exposed Steel __ Other*	__ N/A __ None __ Channeling __ Depressions __ Bank Erosion __ Displaced Riprap __ Other*	__ N/A __ No Distress __ Distressed __ Sparse __ Undesirable Woody __ Invasive Plants	__ None __ At Crossing __ Overland Flow __ Drainage Outfall	Approx. Distance: __________ Feet Name of Waterbody:	Available Space: __ Yes __ No Slope: __ Slight __ Moderate __ Steep Obstructions: __ Trees __ Boulders __ Other*
BMP	__ Bioretention Area __ Plunge Pool __ Treatment Swale __ Infiltration Trench / Basin __ Wet Pond / Constructed Wetlands __ Filter Strip __ Leaching CBs / Sub-Chambers	__ Easy __ Moderate Difficult	__ None __ Slight build up __ Heavy build up Approx. Depth ________ Inches	__ None __ Grease/Oil __ Grass Clippings __ Compost __ Trash/Debris __ Algae/ Blooms __ Other*	Circle One or both: Drainage Structure / Pipe __ N/A __ Good __ Corroded __ Cracked __ Exposed Steel __ Other*	__ N/A __ None __ Channeling __ Depressions __ Bank Erosion __ Displaced Riprap __ Other*	__ N/A __ No Distress __ Distressed __ Sparse __ Undesirable Woody __ Invasive Plants	__ None __ At Crossing __ Overland Flow __ Drainage Outfall	Approx. Distance: __________ Feet Name of Waterbody:	Available Space: __ Yes __ No Slope: __ Slight __ Moderate __ Steep Obstructions: __ Trees __ Boulders __ Other*
S-18	__ Bioretention Area __ Plunge Pool __ Treatment Swale _X_ Infiltration Trench / Basin __ Wet Pond / Constructed Wetlands __ Filter Strip __ Leaching CBs / Sub-Chambers	_X_ Easy __ Moderate Difficult	_X_ None __ Slight build up __ Heavy build up Approx. Depth ________ Inches	__ None __ Grease/Oil __ Grass Clippings __ Compost __ Trash/Debris __ Algae/ Blooms _X_ Other* Beavers	Circle One or both: Drainage Structure / Pipe _X_ N/A __ Good __ Corroded __ Cracked __ Exposed Steel __ Other*	_X_ N/A __ None __ Channeling __ Depressions __ Bank Erosion __ Displaced Riprap __ Other*	__ N/A _X_ No Distress __ Distressed __ Sparse __ Undesirable Woody _X_ Invasive Plants	__ None __ At Crossing _X_ Overland Flow __ Drainage Outfall swale	Approx. Distance: ____50______ Feet Name of Waterbody: Pearly	Available Space: _X_ Yes __ No Slope: _X_ Slight __ Moderate __ Steep Obstructions: __ Trees __ Boulders __ Other*
S-19	__ Bioretention Area __ Plunge Pool __ Treatment Swale __ Infiltration Trench / Basin __ Wet Pond / Constructed Wetlands __ Filter Strip __ Leaching CBs / Sub-Chambers	_X_ Easy __ Moderate Difficult	_X_ None __ Slight build up __ Heavy build up Approx. Depth ________ Inches	__ None _X_ Grease/Oil __ Grass Clippings __ Compost _X_ Trash/Debris __ Algae/ Blooms __ Other*	Circle One or both: Drainage Structure / Pipe _X_ N/A __ Good __ Corroded __ Cracked __ Exposed Steel __ Other*	__ N/A __ None _X_ Channeling _X_ Depressions __ Bank Erosion __ Displaced Riprap __ Other*	__ N/A __ No Distress _X_ Distressed __ Sparse __ Undesirable Woody __ Invasive Plants	__ None __ At Crossing _X_ Overland Flow __ Drainage Outfall	Approx. Distance: ____10______ Feet Name of Waterbody: Pearly	Available Space: _X_ Yes __ No Slope: _X_ Slight __ Moderate __ Steep Obstructions: __ Trees __ Boulders __ Other*

Date	Source ID	Major Road/Street	Type of Potential Source (Erosion / Roadway Drainage/ Septic / Lawn Area)	Drainage System or Culvert (Y/N and What Type)	Size	Material	Waterway (Y/N) (Type e.g. swale, ditch, brook, river, stream)	Sediment (Y/N)	Erosion (major /minor)	Surrounding Land Use	IMG # Photos	Notes	Potential Type of BMP	Accessability	Sediment Accumulation	Deposits	Drainage Structural or Culvert Condition	Erodibility	Vegetation	Direct Runoff to Waterbody	Proximity to Waterbody	Constraints
10/11/2013	C-2	Kimball Rd	road drainage	culvert	12"	CMP	swale	Y	Major	Road/Residential	010-012	Tributary/Sediment buried up on steep section of road eroded swale	__ Bioretention Area _X_ Plunge Pool __ Treatment Swale __ Infiltration Trench / Basin __ Wet Pond / Constructed Wetlands __ Filter Strip _X_ Leaching CBs / Sub-Chambers	__ Easy _X_ Moderate __ Difficult	__ None _X_ Slight build up __ Heavy build up Approx. Depth __<1_______ Inches	__ None _X_ Grease/Oil __ Grass Clippings __ Compost __ Trash/Debris __ Algae/ Blooms _X_ Other* Sediment	Circle One or both: Drainage Structure / Pipe __ N/A __ Good _X_ Corroded __ Cracked _X_ Exposed Steel __ Other*	__ N/A __ None __ Channeling _X_ Depressions _X_ Bank Erosion __ Displaced Riprap __ Other* Steep	__ N/A __ No Distress _X_ Distressed __ Sparse __ Undesirable Woody __ Invasive Plants	__ None _X_ At Crossing __ Overland Flow __ Drainage Outfall	Approx. Distance: ____50______ Feet Name of Waterbody: Pearly	Available Space: __ Yes _X_ No Slope: __ Slight __ Moderate _X_ Steep sides Obstructions: _X_ Trees _X_ Boulders __ Other*
10/11/2013	S-20	Kimball Rd	road drainage		N/A	N/A		Y	Major	Road/Residential	013-015	Driveway eroded	__ Bioretention Area _X_ Plunge Pool __ Treatment Swale __ Infiltration Trench / Basin __ Wet Pond / Constructed Wetlands __ Filter Strip __ Leaching CBs / Sub-Chambers	_X_ Easy __ Moderate Difficult	__ None __ Slight build up _X_ Heavy build up Approx. Depth ____2-3_____ Inches	__ None __ Grease/Oil __ Grass Clippings __ Compost __ Trash/Debris __ Algae/ Blooms _X_ Other* Sediment	Circle One or both: Drainage Structure / Pipe _X_ N/A __ Good __ Corroded __ Cracked __ Exposed Steel __ Other*	__ N/A __ None _X_ Channeling __ Depressions __ Bank Erosion __ Displaced Riprap __ Other*	__ N/A __ No Distress _X_ Distressed __ Sparse __ Undesirable Woody __ Invasive Plants	__ None __ At Crossing _X_ Overland Flow __ Drainage Outfall	Approx. Distance: _____100_____ Feet Name of Waterbody: Pearly	Available Space: _X_ Yes __ No Slope: __ Slight _X_ Moderate __ Steep Obstructions: __ Trees __ Boulders __ Other*
10/11/2013	C-3	Kimball Rd	roadway drainage		N/A	N/A		Y	Major	Road/Residential	016-017	Roadway leading to pond eroded, private no erosion	Diversion __ Bioretention Area _X_ Plunge Pool __ Treatment Swale _X_ Infiltration Trench / Basin __ Wet Pond / Constructed Wetlands __ Filter Strip __ Leaching CBs / Sub-Chambers Stabilize Roadway	_X_ Easy __ Moderate Difficult	__ None __ Slight build up _X_ Heavy build up Approx. Depth _________ Inches	__ None __ Grease/Oil __ Grass Clippings __ Compost __ Trash/Debris __ Algae/ Blooms _X_ Other* Sediment	Circle One or both: Drainage Structure / Pipe _X_ N/A __ Good __ Corroded __ Cracked __ Exposed Steel __ Other*	__ N/A __ None _X_ Channeling __ Depressions _X_ Bank Erosion __ Displaced Riprap __ Other*	__ N/A __ No Distress __ Distressed __ Sparse __ Undesirable Woody __ Invasive Plants no veg	__ None __ At Crossing _X_ Overland Flow __ Drainage Outfall	Approx. Distance: ____100______ Feet Name of Waterbody: Pearly	Available Space: _X_ Yes __ No Slope: __ Slight __ Moderate _X_ Steep Obstructions: __ Trees __ Boulders __ Other*
10/11/2013	C-4	Kimball Rd	roadway drainage	culvert	12"	N/A	wetland	N	Minor	Road, Wood, Res, Wetland	18	No major issues, wetland up slope draining wetland	_X_ Bioretention Area _X_ Plunge Pool __ Treatment Swale __ Infiltration Trench / Basin __ Wet Pond / Constructed Wetlands __ Filter Strip __ Leaching CBs / Sub-Chambers	_X_ Easy __ Moderate Difficult	_X_ None __ Slight build up __ Heavy build up Approx. Depth _________ Inches	__ None __ Grease/Oil _X_ Grass Clippings _X_ Compost __ Trash/Debris __ Algae/ Blooms __ Other*	Circle One or both: Drainage Structure / Pipe __ N/A _X_ Good __ Corroded __ Cracked __ Exposed Steel __ Other*	__ N/A __ None __ Channeling __ Depressions _X_ Bank Erosion __ Displaced Riprap __ Other*	__ N/A _X_ No Distress __ Distressed __ Sparse __ Undesirable Woody __ Invasive Plants	__ None _X_ At Crossing __ Overland Flow __ Drainage Outfall	Approx. Distance: ____200______ Feet Name of Waterbody:	Available Space: __ Yes _X_ No Slope: _X_ Slight __ Moderate __ Steep Obstructions: __ Trees _X_ Boulders __ Other*
10/11/2013	C-4a	Kimball Rd	roadway drainage	culvert?	?	?	swale	N	None	Road/Residential	019-023	No major issues good town road, next to area potential (Bobs)	_X_ Bioretention Area __ Plunge Pool __ Treatment Swale _X_ Infiltration Trench / Basin __ Wet Pond / Constructed Wetlands __ Filter Strip __ Leaching CBs / Sub-Chambers	_X_ Easy __ Moderate Difficult	_X_ None __ Slight build up __ Heavy build up Approx. Depth _________ Inches	__ None __ Grease/Oil _X_ Grass Clippings _X_ Compost __ Trash/Debris __ Algae/ Blooms __ Other*	Circle One or both: Drainage Structure / Pipe __ N/A _X_ Good __ Corroded __ Cracked __ Exposed Steel __ Other*	__ N/A _X_ None __ Channeling __ Depressions __ Bank Erosion __ Displaced Riprap __ Other*	_X_ N/A __ No Distress __ Distressed __ Sparse __ Undesirable Woody __ Invasive Plants	__ None _X_ At Crossing __ Overland Flow __ Drainage Outfall	Approx. Distance: ____150______ Feet Name of Waterbody:	Available Space: __ Yes _X_ No Slope: __ Slight _X_ Moderate __ Steep Obstructions: __ Trees __ Boulders __ Other*
10/11/2013	S-21	Kimball Rd	roadway/driveway drainage		N/A	N/A		Y	Major	Road/Residential/ Wooded	024-031	Lots of fine sediment, eroded driveway (steep), road to Bobs and washed out homes	__ Bioretention Area _X_ Plunge Pool _X_ Treatment Swale __ Infiltration Trench / Basin __ Wet Pond / Constructed Wetlands __ Filter Strip __ Leaching CBs / Sub-Chambers	_X_ Easy __ Moderate Difficult	__ None _X_ Slight build up __ Heavy build up Approx. Depth ____2-3_____ Inches	__ None __ Grease/Oil _X_ Grass Clippings _X_ Compost __ Trash/Debris __ Algae/ Blooms _X_ Other* sediment	Circle One or both: Drainage Structure / Pipe __ N/A __ Good __ Corroded __ Cracked __ Exposed Steel __ Other*	__ N/A __ None __ Channeling __ Depressions __ Bank Erosion _X_ Displaced Riprap __ Other*	__ N/A __ No Distress _X_ Distressed __ Sparse __ Undesirable Woody __ Invasive Plants	__ None __ At Crossing _X_ Overland Flow __ Drainage Outfall	Approx. Distance: ___200_______ Feet Name of Waterbody:	Available Space: _X_ Yes __ No Slope: __ Slight __ Moderate _X_ Steep very steep driveway washout Obstructions: __ Trees __ Boulders __ Other*
10/11/2013	C-5	Kimball Rd	roadway/driveway drainage	culvert, outfall, inlet				Y	None	Residential	032-038	Outfall drains direct to pond. Driange at steep area collapsed culvert up rd	_X_ Bioretention Area __ Plunge Pool _X_ Treatment Swale _X_ Infiltration Trench / Basin __ Wet Pond / Constructed Wetlands __ Filter Strip __ Leaching CBs / Sub-Chambers remove direct discharge out of outfall pipe	__ Easy _X_ Moderate __ Difficult	__ None _X_ Slight build up __ Heavy build up Approx. Depth __2-3_______ Inches	__ None _X_ Grease/Oil _X_ Grass Clippings _X_ Compost __ Trash/Debris __ Algae/ Blooms __ Other*	Circle One or both: Drainage Structure / Pipe __ N/A __ Good __ Corroded __ Cracked __ Exposed Steel __ Other* Unknown	__ N/A _X_ None __ Channeling __ Depressions __ Bank Erosion __ Displaced Riprap __ Other*	__ N/A __ No Distress _X_ Distressed __ Sparse __ Undesirable Woody __ Invasive Plants	__ None __ At Crossing __ Overland Flow _X_ Drainage Outfall CB @ base of hill/swale below septic system	Approx. Distance: _____150_____ Feet Name of Waterbody:	Available Space: _X_ Yes __ No Slope: __ Slight _X_ Moderate __ Steep Obstructions: _X_ Trees _X_ Boulders __ Other*
10/11/2013	S-22	Kimball Rd	roadway drainage		N/A	N/A		N	major	Residential	039-041	Steep eroded slope, septic system on steep slope 3 yrs old	__ Bioretention Area __ Plunge Pool __ Treatment Swale __ Infiltration Trench / Basin __ Wet Pond / Constructed Wetlands __ Filter Strip __ Leaching CBs / Sub-Chambers X slope stabilization	__ Easy _X_ Moderate __ Difficult	_X_ None __ Slight build up __ Heavy build up Approx. Depth _________ Inches	__ None __ Grease/Oil _X_ Grass Clippings __ Compost __ Trash/Debris __ Algae/ Blooms __ Other*	Circle One or both: Drainage Structure / Pipe _X_ N/A __ Good __ Corroded __ Cracked __ Exposed Steel __ Other*	__ N/A __ None _X_ Channeling __ Depressions _X_ Bank Erosion __ Displaced Riprap __ Other*	__ N/A __ No Distress _X_ Distressed __ Sparse __ Undesirable Woody __ Invasive Plants	__ None __ At Crossing _X_ Overland Flow __ Drainage Outfall	Approx. Distance: ____75______ Feet Name of Waterbody:	Available Space: __ Yes _X_ No Slope: __ Slight __ Moderate _X_ Steep Obstructions: __ Trees __ Boulders __ Other*
10/11/2013	S-23	Kimball Rd	roadway drainage		N/A	N/A		Y	Minor	Residential/Road	042-044	John's house rd drainage steep, maj infiltration goes to CB @ K13 Milfoil in cove-large issue years ago treated recently	__ Bioretention Area _X_ Plunge Pool __ Treatment Swale _X_ Infiltration Trench / Basin __ Wet Pond / Constructed Wetlands __ Filter Strip __ Leaching CBs / Sub-Chambers	_X_ Easy __ Moderate Difficult	__ None _X_ Slight build up __ Heavy build up Approx. Depth __2_______ Inches	__ None __ Grease/Oil _X_ Grass Clippings _X_ Compost __ Trash/Debris __ Algae/ Blooms __ Other*	Circle One or both: Drainage Structure / Pipe _X_ N/A __ Good __ Corroded __ Cracked __ Exposed Steel __ Other*	__ N/A __ None _X_ Channeling __ Depressions __ Bank Erosion __ Displaced Riprap __ Other*	__ N/A __ No Distress __ Distressed _X_ Sparse __ Undesirable Woody __ Invasive Plants	__ None _X_ At Crossing _X_ Overland Flow __ Drainage Outfall	Approx. Distance: _____250_____ Feet Name of Waterbody:	Available Space: _X_ Yes __ No Slope: __ Slight __ Moderate _X_ Steep Obstructions: __ Trees __ Boulders __ Other*

Date	Source ID	Major Road/Street	Type of Potential Source (Erosion / Roadway Drainage/ Septic / Lawn Area)	Drainage System or Culvert (Y/N and What Type)	Size	Material	Waterway (Y/N) (Type e.g. swale, ditch, brook, river, stream)	Sediment (Y/N)	Erosion (major /minor)	Surrounding Land Use	IMG # Photos	Notes
10/11/2013	O-9	Kimball Rd	roadway drainage		N/A	N/A		N	major	Residential/Road	045-046	Water has to pool to prevent beach erosion, pland dumping
10/11/2013	I-23	Kimball Rd	roadway drainage	CB, MH, Outfall	12 or less	CMP		Y	None	Residential/Road	047-049	Direct outfall 1 CB in Rd and open MH along road to outfall
10/11/2013	C-8	Kimball Rd	roadway drainage	culvert, outfall	12"	CMP		Y	Major	Residential	050-055	Steep gravel road leads to sharp turn, needs drainage improvements *follow-up Anne outfall, reroute outfall drainage too deep
10/11/2013	S-24	Kimball Rd	roadway drainage		N/A	N/A		Y	Major	Wooded	062-065	Eroded gravel area, steep issues
10/11/2013	I-24, O-10	Kimball Rd	roadway drainage	outfall, CB	12"	HDPE		Y	Minor	Residential/Wooded	066-068	Gravel rd drains to CB with plunge pool, steep slopes
10/11/2013	S-25	Kimball Rd	roadway drainage		N/A	N/A		Y	Minor	Residential/Wooded	069-071	*Anne house - gravel rd drainage issues Nolton, repeat plunge pools , redirect ditch line gravel puddled area on drainage steep slope discharge
10/11/2013	S-26	Kimball Rd	roadway drainage		N/A	N/A		Y	Major	Residential/Wooded	072-078	End of Kimball Rd, drainage issues and steep slopes from RD, good area to send it but must be deeper, clear cut area above with 8-10 years, plunge pools
10/11/2013	S-27	No Name on FPU	roadway drainage		N/A	N/A		N	Minor	Campus	0	Steep roadway to Rindge Hall, install curbing and pull offs with rain gardens
10/11/2013	I-25	No Name on FPU	roadway/parking lot drainage	CB	6"	CMP		Y	None	Campus/Parking	079-084	Drainage system near Edgewood Hall/ Handle upper area runoff in rain garden/ use CB over flow

Source ID	Potential Type of BMP	Accessability	Sediment Accumulation	Deposits
O-9	__ Bioretention Area __ Plunge Pool __ Treatment Swale _X_ Infiltration Trench / Basin __ Wet Pond / Constructed Wetlands _X_ Filter Strip __ Leaching CBs / Sub-Chambers	_X_ Easy __ Moderate Difficult	_X_ None __ Slight build up __ Heavy build up Approx. Depth _________ Inches	__ None __ Grease/Oil __ Grass Clippings _X_ Compost _X_ Trash/Debris __ Algae/ Blooms _X_ Other* Beach erosion
I-23	_X_ Bioretention Area __ Plunge Pool __ Treatment Swale __ Infiltration Trench / Basin __ Wet Pond / Constructed Wetlands __ Filter Strip _X_ Leaching CBs / Sub-Chambers	_X_ Easy __ Moderate Difficult	__ None _X_ Slight build up __ Heavy build up Approx. Depth _________ Inches	__ None _X_ Grease/Oil _X_ Grass Clippings __ Compost __ Trash/Debris __ Algae/ Blooms __ Other*
C-8	_X_ Bioretention Area _X_ Plunge Pool _X_ Treatment Swale __ Infiltration Trench / Basin __ Wet Pond / Constructed Wetlands __ Filter Strip __ Leaching CBs / Sub-Chambers	_X_ Easy __ Moderate Difficult	__ None __ Slight build up _X_ Heavy build up Approx. Depth _________ Inches	__ None __ Grease/Oil _X_ Grass Clippings __ Compost _X_ Trash/Debris __ Algae/ Blooms _X_ Other* Sediment
S-24	__ Bioretention Area __ Plunge Pool __ Treatment Swale __ Infiltration Trench / Basin __ Wet Pond / Constructed Wetlands __ Filter Strip __ Leaching CBs / Sub-Chambers X Gravel rd BMP	_X_ Easy __ Moderate Difficult	__ None __ Slight build up _X_ Heavy build up Approx. Depth _________ Inches	__ None __ Grease/Oil __ Grass Clippings _X_ Compost __ Trash/Debris __ Algae/ Blooms __ Other*
I-24, O-10	__ Bioretention Area __ Plunge Pool __ Treatment Swale __ Infiltration Trench / Basin __ Wet Pond / Constructed Wetlands __ Filter Strip __ Leaching CBs / Sub-Chambers Good basin, steep slopes, plunge pool	_X_ Easy __ Moderate Difficult	__ None _X_ Slight build up __ Heavy build up Approx. Depth _________ Inches	__ None __ Grease/Oil __ Grass Clippings __ Compost __ Trash/Debris __ Algae/ Blooms __ Other*
S-25	__ Bioretention Area _X_ Plunge Pool _X_ Treatment Swale __ Infiltration Trench / Basin __ Wet Pond / Constructed Wetlands __ Filter Strip __ Leaching CBs / Sub-Chambers	__ Easy _X_ Moderate __ Difficult	__ None _X_ Slight build up __ Heavy build up Approx. Depth _________ Inches	_X_ None __ Grease/Oil __ Grass Clippings __ Compost __ Trash/Debris __ Algae/ Blooms __ Other*
S-26	__ Bioretention Area _X_ Plunge Pool __ Treatment Swale _X_ Infiltration Trench / Basin __ Wet Pond / Constructed Wetlands _X_ Filter Strip __ Leaching CBs / Sub-Chambers stabilize steep slopes, repair gravel drainage puddling	__ Easy _X_ Moderate __ Difficult	__ None _X_ Slight build up __ Heavy build up Approx. Depth _________ Inches	__ None __ Grease/Oil _X_ Grass Clippings _X_ Compost __ Trash/Debris __ Algae/ Blooms __ Other*
S-27	_X_ Bioretention Area __ Plunge Pool __ Treatment Swale _X_ Infiltration Trench / Basin __ Wet Pond / Constructed Wetlands __ Filter Strip __ Leaching CBs / Sub-Chambers curbing or rd stabilization on steep hill	_X_ Easy __ Moderate Difficult	_X_ None __ Slight build up __ Heavy build up Approx. Depth _________ Inches	__ None _X_ Grease/Oil _X_ Grass Clippings __ Compost __ Trash/Debris __ Algae/ Blooms __ Other*
I-25	_X_ Bioretention Area __ Plunge Pool __ Treatment Swale __ Infiltration Trench / Basin __ Wet Pond / Constructed Wetlands __ Filter Strip __ Leaching CBs / Sub-Chambers	_X_ Easy __ Moderate Difficult	__ None _X_ Slight build up __ Heavy build up Approx. Depth _____<1_____ Inches	__ None _X_ Grease/Oil _X_ Grass Clippings __ Compost __ Trash/Debris __ Algae/ Blooms __ Other*

Source ID	Drainage Structural or Culvert Condition	Erodibility	Vegetation	Direct Runoff to Waterbody	Proximity to Waterbody	Constraints
O-9	Circle One or both: Drainage Structure / Pipe _X_ N/A __ Good __ Corroded __ Cracked __ Exposed Steel __ Other*	__ N/A __ None _X_ Channeling __ Depressions __ Bank Erosion __ Displaced Riprap _X_ Other* beach erosion	__ N/A __ No Distress _X_ Distressed __ Sparse __ Undesirable Woody __ Invasive Plants	__ None __ At Crossing _X_ Overland Flow __ Drainage Outfall	Approx. Distance: _____10_____ Feet Name of Waterbody:	Available Space: _X_ Yes __ No Slope: _X_ Slight __ Moderate __ Steep Obstructions: __ Trees __ Boulders __ Other*
I-23	Circle One or both: Drainage Structure / Pipe __ N/A __ Good __ Corroded _X_ Cracked Block built __ Exposed Steel __ Other*	_X_ N/A __ None __ Channeling __ Depressions __ Bank Erosion __ Displaced Riprap __ Other*	__ N/A _X_ No Distress __ Distressed __ Sparse __ Undesirable Woody _X_ Invasive Plants	__ None __ At Crossing __ Overland Flow _X_ Drainage Outfall	Approx. Distance: _____75_____ Feet Name of Waterbody:	Available Space: _X_ Yes __ No Slope: _X_ Slight __ Moderate __ Steep Obstructions: __ Trees __ Boulders __ Other*
C-8	Circle One or both: Drainage Structure / Pipe __ N/A _X_ Good __ Corroded __ Cracked __ Exposed Steel __ Other*	__ N/A __ None _X_ Channeling _X_ Depressions __ Bank Erosion __ Displaced Riprap __ Other* Gravel rd puddle erosion	__ N/A __ No Distress _X_ Distressed __ Sparse __ Undesirable Woody __ Invasive Plants	__ None _X_ At Crossing __ Overland Flow _X_ Drainage Outfall	Approx. Distance: ___100_______ Feet Name of Waterbody:	Available Space: _X_ Yes __ No Slope: __ Slight __ Moderate _X_ Steep Obstructions: __ Trees __ Boulders __ Other*
S-24	Circle One or both: Drainage Structure / Pipe _X_ N/A __ Good __ Corroded __ Cracked __ Exposed Steel __ Other*	__ N/A __ None _X_ Channeling _X_ Depressions __ Bank Erosion __ Displaced Riprap __ Other*	__ N/A __ No Distress _X_ Distressed __ Sparse __ Undesirable Woody __ Invasive Plants	__ None __ At Crossing _X_ Overland Flow __ Drainage Outfall	Approx. Distance: _____100_____ Feet Name of Waterbody:	Available Space: _X_ Yes __ No Slope: __ Slight __ Moderate _X_ Steep Obstructions: _X_ Trees _X_ Boulders __ Other*
I-24, O-10	Circle One or both: Drainage Structure / Pipe __ N/A _X_ Good (except for wood cover) __ Corroded __ Cracked __ Exposed Steel __ Other*	__ N/A __ None __ Channeling __ Depressions _X_ Bank Erosion __ Displaced Riprap __ Other*	__ N/A _X_ No Distress __ Distressed __ Sparse __ Undesirable Woody __ Invasive Plants	__ None __ At Crossing __ Overland Flow _X_ Drainage Outfall Gravel rd drains	Approx. Distance: _____100_____ Feet Name of Waterbody:	Available Space: __ Yes _X_ No Slope: __ Slight __ Moderate _X_ Steep Obstructions: _X_ Trees _X_ Boulders __ Other*
S-25	Circle One or both: Drainage Structure / Pipe _X_ N/A __ Good __ Corroded __ Cracked __ Exposed Steel __ Other*	__ N/A __ None _X_ Channeling __ Depressions _X_ Bank Erosion __ Displaced Riprap __ Other*	__ N/A __ No Distress _X_ Distressed __ Sparse __ Undesirable Woody __ Invasive Plants	__ None __ At Crossing _X_ Overland Flow __ Drainage Outfall	Approx. Distance: _____75_____ Feet Name of Waterbody:	Available Space: _X_ Yes __ No Some Slope: __ Slight __ Moderate _X_ Steep Obstructions: _X_ Trees _X_ Boulders __ Other*
S-26	Circle One or both: Drainage Structure / Pipe _X_ N/A __ Good __ Corroded __ Cracked __ Exposed Steel __ Other*	__ N/A __ None _X_ Channeling _X_ Depressions _X_ Bank Erosion __ Displaced Riprap __ Other*	__ N/A __ No Distress _X_ Distressed __ Sparse __ Undesirable Woody __ Invasive Plants	__ None __ At Crossing _X_ Overland Flow __ Drainage Outfall	Approx. Distance: _____80_____ Feet Name of Waterbody:	Available Space: _X_ Yes __ No Slope: __ Slight _X_ Moderate __ Steep Obstructions: __ Trees __ Boulders __ Other*
S-27	Circle One or both: Drainage Structure / Pipe _X_ N/A __ Good __ Corroded __ Cracked __ Exposed Steel __ Other*	__ N/A __ None _X_ Channeling __ Depressions __ Bank Erosion __ Displaced Riprap __ Other*	__ N/A __ No Distress _X_ Distressed __ Sparse __ Undesirable Woody __ Invasive Plants	_X_ None __ At Crossing __ Overland Flow __ Drainage Outfall	Approx. Distance: ___500_______ Feet Name of Waterbody: Pearly	Available Space: _X_ Yes __ No Slope: __ Slight __ Moderate _X_ Steep Obstructions: __ Trees __ Boulders __ Other*
I-25	Circle One or both: Drainage Structure / Pipe __ N/A _X_ Good __ Corroded __ Cracked __ Exposed Steel __ Other*	__ N/A _X_ None __ Channeling __ Depressions __ Bank Erosion __ Displaced Riprap __ Other*	__ N/A _X_ No Distress __ Distressed __ Sparse __ Undesirable Woody __ Invasive Plants	_X_ None __ At Crossing __ Overland Flow __ Drainage Outfall	Approx. Distance: ______200____ Feet Name of Waterbody: Wetland to Pearly	Available Space: _X_ Yes __ No Slope: __ Slight _X_ Moderate __ Steep Obstructions: __ Trees __ Boulders _X_ Other* Utility Fence

Date	Source ID	Major Road/Street	Type of Potential Source (Erosion / Roadway Drainage/ Septic / Lawn Area)	Drainage System or Culvert (Y/N and What Type)	Size	Material	Waterway (Y/N) (Type e.g. swale, ditch, brook, river, stream)	Sediment (Y/N)	Erosion (major /minor)	Surrounding Land Use	IMG # Photos	Notes	Potential Type of BMP	Accessability	Sediment Accumulation	Deposits	Drainage Structural or Culvert Condition	Erodibility	Vegetation	Direct Runoff to Waterbody	Proximity to Waterbody	Constraints
10/11/2013	S-28	Library Parking	roadway drainage		15"	RCP		Y	None	Parking	085-093	Drainage system in library parking - divert runoff to infiltration divider or swale. Retrofit exist drianage with bioretention	_X_ Bioretention Area __ Plunge Pool __ Treatment Swale _X_ Infiltration Trench / Basin __ Wet Pond / Constructed Wetlands __ Filter Strip __ Leaching CBs / Sub-Chambers	_X_ Easy __ Moderate Difficult __	__ None _X_ Slight build up __ Heavy build up Approx. Depth ___<1______ Inches	__ None _X_ Grease/Oil __ Grass Clippings __ Compost _X_ Trash/Debris __ Algae/ Blooms __ Other*	Circle One or both: Drainage Structure / Pipe __ N/A _X_ Good __ Corroded __ Cracked __ Exposed Steel __ Other*	_X_ N/A __ None __ Channeling __ Depressions __ Bank Erosion __ Displaced Riprap __ Other*	__ N/A __ No Distress __ Distressed _X_ Sparse __ Undesirable Woody __ Invasive Plants	_X_ None __ At Crossing __ Overland Flow __ Drainage Outfall	Approx. Distance: ____500______ Feet Name of Waterbody: Wetland to Pearly	Available Space: __ Yes __ No Slope: __ Slight _X_ Moderate __ Steep Obstructions: __ Trees __ Boulders _X_ Other* Utility

Appendix J
Stormwater BMP Evaluation

Appendix J – Stormwater BMP Alternatives Analysis and Evaluation Description

Summaries and results of the Stormwater BMP identification and ranking analysis are provided in Tables J.1, J.2, J.3 and J.4. Provided below is a summary of the methods used for the first and second phases of stormwater BMP ranking process:

***Phase 1* -** The eleven criteria used for the first phase of the feasibility ranking included; Number of locations handled, BMP type, Proximity to nearest waterbody, Proximity to the pond, Direct or In-direct Discharge, Waterbody type receiving the discharge, Land Owner, BMP Subwatershed Land Uses, Potential site constraints, Ease of implementation, Anticipated maintenance requirements and potential permit requirements. These criteria were assigned points based on a range of values for each BMP site and then once the points were tallied, the BMPs were ranked from the highest number of total points down to the lowest number of points. Ranking criteria breakdowns can be seen under the notes for Table J.2 and are provided below:

Number of Locations Handled: 1 location = 1 ; 2 locations = 2 ; 3 locations = 3 ; 4 locations = 4 ; 5 or more locations (or handles large portion of upper watershed = 5

BMP Type: Large Bioretention / Gravel Wetlands = 8 ; Large Infiltration = 7; Large Storage / Treatment Basin = 6 ; Small Bioretention = 5; Small Infiltration = 4; Sediment Removal = 3; Erosion Repair / Stabilization = 2; Swales / Drainage Improvements = 1 (combo is additive)

Waterbody: Pearly Pond = 4; Large Tributary to Pearly = 3; Small Stream = 2; Wetland / Drainage way = 1

Direct / Indirect Discharge: Direct = 4 ; Indirect = 2

Proximity to Nearest Waterbody: Within 25 feet = 7 ; 26 feet - 50 feet = 6 ; 51 -100 feet = 5 ; 101 - 250 feet = 4 ; 251 - 500 feet = 3; 500 - 1000 feet = 2; 1001+ feet = 1

Proximity to Pearly Lake: Within 50 feet = 8; 51 feet - 250 feet = 7; 251 -500 feet = 6; 501 - 1000 feet = 5; 1001 - 2000 feet = 4; 2001 - 4000 feet = 3; 4001 - 6000 feet = 2; 6001+ feet = 1

Land Owner: FPU Owned (no easements) = 4; Rindge Owned = 3; State or Other Town = 2; Private (easement needed) = 1 (combo takes average of two)

Land Use: Mixed Urban (Med Res) / Commercial = 6.0; Parks / Institutional = 5.0 Low Density Residential = 4.0; Agricultural = 3.0; Meadow = 2.0 Forested / Wetland = 1.0 (combo takes average of two)

Construction / Maintenance: Easy, low number of issues = 5 ; Moderate, possible equipment maneuvering/ access issues = 3 ; Difficult, expensive equipment maneuvering/ road closures = 1

Site Constraints: Minor constraints = 3 ; Moderate constraints (moderate slopes, water within 100 feet, some vegetation) = 2 ; Major constraints (steep slopes, water/wetlands with 50 feet, large trees) = 1

Permitting: No Permit Needed = 3 ; Minor Impact Permit Needed = 2 ; Major Impact Permit Needed = 1

Following the BMP feasibility analysis, the prospective BMPs were properly sized to determine removal rates and associated costs. Sizing of all the prospective BMPs was done by applying the NH DES WQV sizing criteria. The WQV goal is also established to ensure adequate removal of pollutants such as phosphorus and sediment in stormwater runoff. These pollutants can be removed through infiltration, filtering and other water quality BMPs.

The WQV is the amount of stormwater runoff from a rainfall event that should be captured and treated to remove the majority of stormwater pollutants on an average annual basis. NHDES defines the WQV as the volume of runoff associated with the first one-inch of rainfall, which is equivalent to capturing and treating the runoff from the 90^{th} percentile of all rainfall. Per the manual, WQV is calculated as follows:

$$WQV = (P)(Rv)(A)$$

Where:

WQV = Water quality volume
P = 1” of rainfall
Rv = unitless runoff coefficient = Rv = 0.05 + 0.9(I)
I = percent impervious cover draining to the structure converted to decimal form
A = total site area draining to the structure

The WQV treatment goals were calculated for each subwatershed and are shown in Table 6-2 as cubic feet of runoff and inches of runoff. The inches of runoff allows comparison of subwatersheds to determine which produces the greatest volume of runoff per area. Subwatersheds 2 and 4 contribute the greatest inches of runoff. These goals assume all impervious surfaces in the watershed can be treated, which may not be the case. However, any stormwater treatment BMPs proposed in the watershed should be designed to meet the WQV using the above equation.

	Area (acres)	% Impervious Area	WQV GOAL (cf)	Estimated P Load (kg/yr)
Sub-1	162.1	12%	68,589	14.2
Sub-2	763.7	3%	80,768	31.3
Sub-3	743.1	1%	28,350	20.1
Sub-4	459.2	10%	158,631	29.4
Total	2,128.1		336,338	95.0

Phase 2 - A second phase of the ranking process was used to select the final BMPs for each watershed area using cost and pollutant removal estimates. The second ranking process utilized specific watershed data and results from the BMP analysis. Below is a summary of the methods used for the second phase of BMP ranking process:

Based on the estimated WQV for each BMP subwatershed, an estimated cost and phosphorus reduction was predicted for each BMP site.

Pollution reductions for each subwatershed were estimated using a combination of LLRM model loading data and independent excel spreadsheets. LLRM was used to estimate the total potential load that could reach the BMP. Calculations based on target WQV and type of BMP were used to determine the estimated load reduction achieved through implementation of structural stormwater practices in institutional, commercial/transportation and residential land uses throughout the watershed. This assumed that highly impervious surfaces associated with these land uses would be treated with structural practices, and excluded wetlands, water, forest, and brush land uses, which would not likely be treated using a structural BMP. This established an estimated annual load reduction for specific BMP options that considered a more realistic treatment area based on the layout of drainage infrastructure and topography. This was further adjusted to reflect removal efficiencies of each of the BMP alternatives based on the size of the BMP compared to the target WQV. The annual load was then applied over a ten year period for BMP comparison purposes. Pollutant loading estimates for each BMP are summarized in Table J.5.

Using the estimated size (WQV target) of the proposed BMP, an estimated construction cost was developed to construct the BMP based on treatment type. These costs were based on historical cost data for stormwater BMPs and best engineering judgment. The following are approximate construction estimates per BMP type:

	Install	**Material**	**Total**	**Unit**
Extended Detention Pond	$2.00	$1.00	$3.00	per CF
Infiltration Pond	$2.00	$2.50	$4.50	per CF
Stilling Basin	$2.00	$1.50	$3.50	per CF
Gravel Wetland	$3.00	$5.00	$8.00	per CF
Wetpond/Constructed Wetlands	$2.50	$3.00	$5.50	per CF
Large Biorentention	$2.50	$3.50	$6.00	per CF
Small Rain Garden	$5.00	$15.00	$20.00	per CF
Small Infiltration Trench	$2.00	$8.00	$10.00	per CF
Sediment Forebay BMP	$1.50	$1.00	$2.50	per CF
Dredge	$1.50	$0.00	$1.50	per CF
Roadside Swales & BMPs	$1.50	$3.00	$4.50	per SF
Maintenance Level Spreader	$5.00	$15.00	$20.00	per SF

Riprap Spillway	$5.00	$10.00	$15.00	per SF
Riprap Infiltration BMP	$3.00	$8.00	$11.00	per SF
Filter Media BMP	$10.00	$20.00	$30.00	per SF
Streambank Stabilization	$3.00	$4.50	$7.50	per SF
Naturalized Bank Stabilization	$4.00	$6.00	$10.00	per SF
Steep Slope Stabilization	$2.00	$3.00	$5.00	per SF
Erosion Repair	$0.50	$1.00	$1.50	per SF
Vegetated Buffer	$2.00	$4.00	$6.00	per SF
Small Diameter Culvert	$500.00	$250.00	$750.00	per LF
Large Diameter Culvert	$700.00	$300.00	$1,000.00	per LF
Small Box Culvert Replacement	$1,000.00	$500.00	$1,500.00	per LF
Large Box Culvert Replacement	$2,500.00	$1,000.00	$3,500.00	per LF

Based on those assumptions, the construction at each site can be estimated by multiplying the unit price times the size of the BMP to determine a maximum potential construction cost. Other potential cost components are added in based on the potential scope of the project, surrounding terrain and other construction variables noted during field investigations that could affect costs (e.g. potential high groundwater, working near wetlands, working under water, apparent nearby ledge, etc.). Costs for these items including pumping, additional excavation, installation of drainage structures and drainage piping are added to the overall construction cost. This cost likely represents the price to hire a private contractor to do this work. The project might also require topographical/boundary survey, design/engineering, permitting, bidding and construction admin/oversight.

Some of these items may not be necessary for each BMP, but for comparison purposes, these are all based on a percentage of the total estimated construction effort. The projects might also not be done for 5 to 10 years from the time of this report and there could be other unforeseen costs (e.g. traffic controls, specialty construction, blasting, special design/permitting requirements) so a contingency is carried which is a percentage of the total project cost. Finally, once the BMP is built it will have to be maintained. This cost can vary based on size, type of BMP and who is completing the work.

A general annual O&M cost is carried for each BMP. For ranking comparison purposes, the maintenance costs are carried for ten years as the BMP begins to removes phosphorus after implementation. The annual cost is multiplied by ten and added to the total cost to determine the final BMP cost for final selection.

The purpose of the BMP rankings is to relatively compare BMPs using a similar logic to determine the most beneficial project. Rather than using a cost range for each BMP like what will be documented in the report, the costs used for BMP analysis represent the largest scope and most conservative estimate for each option. It is understood that these are still conceptual and only created for comparison purposes. Cost estimates for each BMP used for the BMP ranking are summarized in Table J.6.

TABLE J.1 - STORMWATER BMP OPTIONS

BMP Map ID	BMP Description / Type	Problem Areas Handled (Field Study I.D.)	Location	BMP Type	Subwatershed ID	Waterbody	Discharge Type (Direct or Indirect)	Proximity to Waterbody (ft.)	Proximity to Pearly Lake (ft.)	Property Owner	Town	Land use Type	Maintenance Access	Site Constraints for BMP	Permitting Required
1	Plunge pools and swales along Rt. 119 at existing outfalls	S-1, S-2	NH Route 119 / Highway Drainage	Sediment Removal	Pearly Lake Drainage	Pearly Lake	Direct	50	50	State	Rindge	Forested	Easy	Minor	Minor
2	Plunge pools and infiltration swales	S-3	NH Route 119 / Highway Drainage	Sediment Removal	Pearly Lake Drainage	Pearly Lake	Direct	200	200	State	Rindge	Forested	Easy	Minor	Minor
3	Bioretention / Treatment BMPs along Rt. 119	S-4	NH Route 119 / Highway Drainage	Large Bioretention	Pearly Lake Drainage	Pearly Lake	Indirect	50	50	State	Rindge	Forested	Easy	Moderate	Minor
4	Roadside swales and Treatment Filter Strip / Bioretention	C-10	University Drive / Roadway Drainage	Small Bioretention / Vegetated Filters	Pearly Lake Drainage	Pearly Lake	Indirect	50	50	Town	Rindge	Forested	Easy	Difficult	Minor
5	Steep swale check dams and infiltrate @ end near FPU Facilities	S-5	Warren & University Road / Roadway Drainage	Drainage Improvements / Small Infiltration	Pearly Lake Drainage	Pearly Lake	Indirect	600	600	Private	Rindge	Forested	Moderate	Difficult	None
6	Install curbing, headwall rehab, stabilize shoulder, install deep sump catch basins	S-6, C-12	University Drive / Sawmill Road	Stabilization / Drainage Improvements	College Road Inlet Subwatershed	Stream	Direct	100	350	Town/FPU	Rindge	Low Density Residential	Moderate	Moderate	Minor
7	Stabilize shoulder and access, repair erosion with mulch, infiltration trenches	S-7, S-8	University Drive / Boat Shoreline Access	Stabilization / Small Infiltration	Pearly Lake Drainage	Pearly Lake	Direct	25	25	Town	Rindge	Roadway	Difficult	Difficult	Minor
8	Rain Gardens upstream and downstream of culvert	C-13	University Drive / Sawmill Road	Small Bioretention	Pearly Lake Drainage	Pearly Lake	Direct	50	50	FPU	Rindge	Low Density Residential	Easy	Major	Major
9	Parking lot Infiltration BMPs	S-9	Sawmill Road / Parking Area	Large Infiltration	College Road Inlet Subwatershed	Stream	Indirect	300	500	FPU	Rindge	Medium Density Residential	Easy	Minor	None
10	Rain Gardens along FPU parking lots	S-10	University Drive / Parking Area	Small Bioretention	Pearly Lake Drainage	Pearly Lake	Indirect	200	200	FPU	Rindge	Low Density Residential	Moderate	Minor	None
11	Drainage Improvements, CB to bioretention areas and gravel wetlands, install infiltration strip & stabilization to beach area	C-14, S-11	University Drive / Beach Area & Fields	Gravel Wetland / Vegetated Buffers	Pearly Lake Drainage	Pearly Lake	Direct	0	280	FPU	Rindge	Low Density Residential	Moderate	Moderate	Minor
12	Raingarden at FPU Community Center	S-12	Franklin Pierce Drive / Community Center	Small Bioretention	Pearly Lake Drainage	Pearly Lake	Indirect	450	450	FPU	Rindge	Medium Density Residential	Moderate	Moderate	None
13	Improve parking lot drainage, replace pipe, install new stormwater structures, fix pipe infrastructure	S-13	Ingalls & Mountain Road / FPU Parking Area	Small Infiltration / Drainage Improvements	College Road Inlet Subwatershed	Pearly Lake	Indirect	450	450	FPU	Rindge	Medium Density Residential	Difficult	Difficult	None
14	Bioretention swales along whole road, use existing CB as overflow	S-14	Ingalls & Mountain Road / Roadway Drainage	Small Bioretention	Pearly Lake Drainage	Pearly Lake	Indirect	300	300	FPU	Rindge	Medium Density Residential	Difficult	Moderate	None
15	Stabilization at outfall & plunge pools	O-2	Ingalls & Mountain Road / Roadway Drainage	Stabilization / Sediment Removal	Pearly Lake Drainage	Pearly Lake	Indirect	300	300	Town	Rindge	Forested	Moderate	Moderate	None
16	Redirect drainage to new bioretention area along steep FPU roads	C-15	Franklin Pierce Drive / Community Center	Large Bioretention	Pearly Lake Drainage	Pearly Lake	Indirect	400	400	FPU	Rindge	Medium Density Residential	Moderate	Difficult	None
17	Multiple plunge pools, stabilization and general erosion repairs	C-16	Ingalls & Mountain Road / Gravel Roadway Drainage	Stabilization / Sediment Removal	Pearly Lake Drainage	Pearly Lake	Indirect	300	300	Town	Rindge	Forested	Difficult	Difficult	None
18	Plunge pools and gravel road stabilization	C-17, C-18	Ingalls & Mountain Road / Gravel Roadway Drainage	Stabilization / Sediment Removal	Pearly Lake Drainage	Pearly Lake	Indirect	500	500	Town	Rindge	Forested	Difficult	Difficult	None
19	Infiltration BMPs & Swale Improvements	S-18	Kimball Road / Roadway Drainage	Small Infiltration / Drainage Improvements	Pearly Lake Drainage	Pearly Lake	Indirect	150	150	Town	Rindge	Low Density Residential	Moderate	Easy	Minor
20	BMP wetpond, bioretention system, roadway structures drainage and piping	S-19	Kimball Road / Sharp Curve	Wet Pond / Small Bioretention	Pearly Lake Drainage	Pearly Lake	Indirect	100	100	Town	Rindge	Low Density Residential	Easy	Minor	Minor
21	Shoulder stabilization, plunge pool at culvert and swale	C-2	Kimball Road / Roadway Culvert	Stabilization / Sediment Removal	Pearly Lake Drainage	Pearly Lake	Direct	150	150	Private	Rindge	Low Density Residential	Moderate	Moderate	Minor
22	Drainage improvements on both sides of roadway & long steep driveway needs to be stabilized	S-20	Kimball Road / Roadway Drainage	Stabilization	Pearly Lake Drainage	Pearly Lake	Indirect	250	250	Private	Rindge	Low Density Residential	Moderate	Moderate	Minor
23	Stabilization of shoulders, infiltration swales and erosion repairs	C-3, C-4	Kimball Road / Roadway Drainage	Stabilization	Pearly Lake Drainage	Pearly Lake	Indirect	200	200	Private	Rindge	Forested / Wetland	Easy	Difficult	Major
24	Install infiltration swale and large plunge pool, possibly stabilize bottom of driveways	S-21	Kimball Road / Roadway Drainage	Stabilization / Sediment Removal	Pearly Lake Drainage	Pearly Lake	Indirect	250	250	Private	Rindge	Low Density Residential	Moderate	Moderate	Minor
25	Culvert repair and swale stabilization	C-5	Kimball Road / Roadway Culvert	Drainage Improvements / Stabilization	Pearly Lake Drainage	Pearly Lake	Direct	150	150	Town	Rindge	Low Density Residential	Moderate	Minor	Minor
26	Roadside swale and raingarden	S-23, I-23	Kimball Road / Roadway Drainage	Small Bioretention / Drainage Improvements	Pearly Lake Drainage	Pearly Lake	Indirect	200	200	Private	Rindge	Low Density Residential	Easy	Moderate	Minor
27	Stabilize beach access, install rain gardens at end of outfall	O-9	Kimball Road / Beach Access	Small Bioretention / Stabilization	Pearly Lake Drainage	Pearly Lake	Direct	25	25	Private	Rindge	Low Density Residential	Easy	Major	Minor
28	Install roadside settling basins with overflow structures, bioretention and new culvert pipe, roadside stabilization	C-8, S-24	Kimball Road / Roadway Drainage	Large Storage BMP / Small Bioretention	Pearly Lake Drainage	Pearly Lake	Indirect	150	150	Private	Rindge	Low Density Residential	Easy	Moderate	Minor
29	Install new swale, CB, outfall pipe, and plunge pool	S-25, I-24	Private Road / Roadway Drainage	Drainage Improvements / Sediment Removal	Pearly Lake Drainage	Pearly Lake	Indirect	100	100	Private	Rindge	Low Density Residential	Moderate	Moderate	None
30	New swale with check dam, stabilize erosion	S-26	Private Road / Dead End	Stabilization / Drainage Improvements	Pearly Lake Drainage	Pearly Lake	Indirect	150	150	Private	Rindge	Low Density Residential	Moderate	Moderate	Minor
31	Swale with check dams, infiltration BMPs with rain gardens	S-27	Mountain Road/ FPU Campus	Small Bioretention / Small Infiltration	Pearly Lake Drainage	Pearly Lake	Indirect	550	550	FPU	Rindge	Medium Density Residential	Easy	Moderate	None
32	Raingardens along FPU roads and parking areas	I-25	Franklin Pierce Drive / FPU Campus	Small Bioretention	College Road Inlet Subwatershed	Wetland	Indirect	1100	1100	FPU	Rindge	Medium Density Residential	Easy	Moderate	None
33	New CBs, new drainage diversions & infiltration BMPs throughout FPU parking lots and buildings	S-28	Franklin Pierce Drive / FPU Library & Courts	Large Infiltration	Mountain Road Inlet Subwatershed	Wetland	Indirect	450	1250	FPU	Rindge	Medium Density Residential	Easy	Moderate	None
34	Parking lot BMPs retrofit to existing drainage systems infiltration dividers, new pipe	I-13,I-14, I-15, I-16, I-17	Franklin Pierce Drive / Parking Areas & Athletic Bubble	Large Infiltration	Mountain Road Inlet Subwatershed	Wetland	Indirect	175	1800	FPU	Rindge	Medium Density Residential	Moderate	Moderate	None

TABLE J.1 - STORMWATER BMP OPTIONS

BMP Map ID	BMP Description / Type	Problem Areas Handled (Field Study I.D.)	Location	BMP Type	Subwatershed ID	Waterbody	Discharge Type (Direct or Indirect)	Proximity to Waterbody (ft.)	Proximity to Pearly Lake (ft.)	Property Owner	Town	Land use Type	Maintenance Access	Site Constraints for BMP	Permitting Required
35	Big infiltration BMP for FPU parking lots & buildings	I-18, I-19	Franklin Pierce Drive / Volley Ball Courts	Large Infiltration	Mountain Road Inlet Subwatershed	Wetland	Indirect	550	1800	FPU	Rindge	Medium Density Residential	Moderate	Moderate	None
36	Infiltration along parking lot, along fence and curb, require new drainage system	I-20, I-21	Franklin Pierce Drive / Dormitory Parking	Large Infiltration / Drainage Improvements	Pearly Lake Drainage	Pearly Lake	Indirect	1000	1000	FPU	Rindge	Medium Density Residential	Moderate	Moderate	None
37	Infiltration BMPs / Raingardens throughout FPU parking lots	I-22	Franklin Pierce Drive / Community Center Parking	Small Bioretention / Small Infiltration	Pearly Lake Drainage	Pearly Lake	Indirect	450	475	FPU	Rindge	Medium Density Residential	Moderate	Moderate	None
38	Infiltration BMPs and filter strips along roadway and ball field parking lot	C-37, C-38	Mountain Road / Ball field Parking	Large Infiltration	College Road Inlet Subwatershed	Wetland along tributary of Pearly Lake	Indirect	550	900	FPU	Rindge	Wetland	Moderate	Moderate	None
39	Steep roadway drainage stabilization, swales, checkdams & plunge pools	C-35, C-36	Mountain Road / Roadway Drainage	Stabilization / Drainage Improvements	College Road Inlet Subwatershed	Tributary to Pearly	Indirect	350	1500	Town	Rindge	Forested	Moderate	Moderate	None
40	Swale, curbing and CBs	C-32, C-34	Mountain Road / Roadway Drainage	Swale / Drainage Improvements	College Road Inlet Subwatershed	Tributary to Pearly	Direct	100	2550	Town	Rindge	Forested	Easy	Moderate	None
41	Headwall replacement, structure stabilization, drainage improvements	C-33	Mountain Road / Drainage Culvert	Stabilization / Drainage Improvements	College Road Inlet Subwatershed	Tributary to Pearly	Indirect	175	2300	Town	Rindge	Forested	Easy	Easy	None
42	Drainage improvement on both sides of road, plunge pool, check dams	C-40	Ingalls & Mountain Road/Tributary Culvert Crossing	Sediment Removal / Drainage Improvements	Mountain Road Inlet Subwatershed	Tributary to Pearly	Direct	0	500	Town	Rindge	Forested	Easy	Major	Minor
43	Road rebuilding, drainage improvements and culvert repair / replacement	C-42	Doll House Road/ Stream Culvert Crossing	Drainage Improvements	Bower Inlet Subwatershed	Tributary to Pearly	Direct	0	4050	Private	Rindge	Forested / Wetland	Difficult	Difficult	Major
44	Culvert to a tributary improve drainage with swales on both sides of culvert	C-25	Bowers Hill Road/ Tributary Culvert Crossing	Drainage Improvements	Bower Inlet Subwatershed	Tributary to Pearly	Direct	0	2400	Town	Rindge	Forested	Easy	Difficult	Major
45	Improve drainage on both sides of gravel road, replace box culvert	C-21	Red Gate Road/ Stream Culvert Crossing	Drainage Improvements	Bower Inlet Subwatershed	Tributary to Pearly	Direct	0	5250	Town	Jaffrey	Forested	Easy	Difficult	Major
46	Improve drainage with swales on both sides of road, replace box culvert	C-23	Red Gate Road/ Stream Culvert Crossing	Drainage Improvements	Bower Inlet Subwatershed	Tributary to Pearly	Direct	0	9000	Town	Jaffrey	Forested	Easy	Major	Minor
47	Swale and shoulder stabilization, gravel Rd BMPs, plunge pools	C-20	Ingalls Road / Gravel Rd Drainage	Sediment Removal / Drainage Improvements	Bower Inlet Subwatershed	Tributary to Pearly	Indirect	150	4200	Town	Jaffrey	Forested	Easy	Easy	None
48	Riprap swales, plunge pool and shoulder stabilization	C-22, S-16	Ingalls Road / Gravel Rd Drainage	Stabilization / Drainage Improvements	Mountain Road Inlet Subwatershed	Tributary to Pearly	Indirect	200	4700	Town	Jaffrey	Forested	Easy	Easy	None
49	Improve drainage on both sides with swales	C-24	Red Gate Road/ Roadway Drainage	Drainage Improvements	Bower Inlet Subwatershed	Wetland to Pearly	Direct	0	7800	Town	Jaffrey	Wetland	Easy	Moderate	Major
50	Formal drainage that collects runoff from field and infiltration	C-39	Ball Field Trails / Tributary Crossing	Small Infiltration / Drainage Improvements	College Road Inlet Subwatershed	Tributary to Pearly	Direct	0	1050	Town	Ringge	Low Density Residential	Difficult	Major	Major

TABLE J.2 - STORMWATER BMP OPTIONS - PHASE 1 RANKING SUMMARY

BMP Map ID	BMP Description / Type	Problem Areas Handled (Field Study I.D.)	Location	BMP Type	Subwatershed ID	Waterbody	Discharge Type (Direct or Indirect)	Proximity to Waterbody (ft.)	Proximity to Pearly Lake (ft.)	Property Owner	Town	Land use Type	Maintenance Access	Site Constraints for BMP	Permitting Required	Number of Locations	BMP Type	Waterbody	Direct / Indirect Discharge	Proximity to Waterbody	Proximity to Pearly	Land Owner	Land Use	Construction / Maintenance Access	Site Constraints	Permit Requirements	Priority Points	BMP Rank
11	Drainage Improvements, CB to bioretention areas and gravel wetlands, install infiltration strip & stabilization to beach area	C-14, S-11	University Drive / Beach Area & Fields	Gravel Wetland / Vegetated Buffers	Pearly Lake Drainage	Pearly Lake	Direct	0	280	FPU	Rindge	Low Density Residential	Moderate	Moderate	Minor	2	13	4	4	7	6	4	5.5	3	2	2	**52.5**	**1**
8	Rain Gardens upstream and downstream of culvert	C-13	University Drive / Sawmill Road	Small Bioretention	Pearly Lake Drainage	Pearly Lake	Direct	50	50	FPU	Rindge	Low Density Residential	Easy	Major	Major	1	5	4	4	7	8	4	5.5	5	1	1	**45.5**	**2**
3	Bioretention / Treatment BMPs along Rt. 119	S-4	NH Route 119 / Highway Drainage	Large Bioretention	Pearly Lake Drainage	Pearly Lake	Indirect	50	50	State	Rindge	Forested	Easy	Moderate	Minor	1	8	4	2	7	8	2	2.5	5	2	2	**43.5**	**3**
20	BMP wetpond, bioretention system, roadway structures drainage and piping	S-19	Kimball Road / Sharp Curve	Wet Pond / Small Bioretention	Pearly Lake Drainage	Pearly Lake	Indirect	100	100	Town	Rindge	Low Density Residential	Easy	Minor	Minor	1	11	1	2	6	7	3	2.5	5	3	2	**43.5**	**4**
27	Stabilize beach access, install rain gardens at end of outfall	O-9	Kimball Road / Beach Access	Small Bioretention / Stabilization	Pearly Lake Drainage	Pearly Lake	Direct	25	25	Private	Rindge	Low Density Residential	Easy	Major	Minor	1	7	4	4	7	8	1	2.5	5	1	2	**42.5**	**5**
34	Parking lot BMPs retrofit to existing drainage systems infiltration dividers, new pipe	I-13, I-14, I-15, I-16, I-17	Franklin Pierce Drive / Parking Areas & Athletic Bubble	Large Infiltration	Mountain Road Inlet Subwatershed	Wetland	Indirect	175	1800	FPU	Rindge	Medium Density Residential	Moderate	Moderate	None	5	7	1	2	5	4	4	6	3	2	3	**42**	**6**
37	Infiltration BMPs / Raingardens throughout FPU parking lots	I-22	Franklin Pierce Drive / Community Center Parking	Small Bioretention / Small Infiltration	Pearly Lake Drainage	Pearly Lake	Indirect	450	475	FPU	Rindge	Medium Density Residential	Moderate	Moderate	None	2	9	1	2	4	6	4	6	3	2	3	**42**	**7**
1	Plunge pools and swales along Rt. 119 at existing outfalls	S-1, S-2	NH Route 119 / Highway Drainage	Sediment Removal	Pearly Lake Drainage	Pearly Lake	Direct	50	50	State	Rindge	Forested	Easy	Minor	Minor	2	3	4	4	7	8	2	2.5	5	2	2	**41.5**	**8**
31	Swale with check dams, infiltration BMPs with rain gardens	S-27	Mountain Road/ FPU Campus	Small Bioretention / Small Infiltration	Pearly Lake Drainage	Pearly Lake	Indirect	550	550	FPU	Rindge	Medium Density Residential	Easy	Moderate	None	1	9	1	2	4	5	4	5.5	5	2	3	**41.5**	**9**
28	Install roadside settling basins with overflow structures, bioretention and new culvert pipe, roadside stabilization	C-8, S-24	Kimball Road / Roadway Drainage	Large Storage BMP / Small Bioretention	Pearly Lake Drainage	Pearly Lake	Indirect	150	150	Private	Rindge	Low Density Residential	Easy	Moderate	Minor	2	11	1	2	5	7	1	2.5	5	2	2	**40.5**	**10**
9	Parking lot Infiltration BMPs	S-9	Sawmill Road / Parking Area	Large Infiltration	College Road Inlet Subwatershed	Stream	Indirect	300	500	FPU	Rindge	Medium Density Residential	Easy	Minor	None	1	7	1	2	5	6	4	2.5	5	3	3	**39.5**	**11**
2	Plunge pools and infiltration swales	S-3	NH Route 119 / Highway Drainage	Sediment Removal	Pearly Lake Drainage	Pearly Lake	Direct	200	200	State	Rindge	Forested	Easy	Minor	Minor	1	3	4	4	6	7	2	2.5	5	3	2	**39.5**	**12**
33	New CBs, new drainage diversions & infiltration BMPs throughout FPU parking lots and buildings	S-28	Franklin Pierce Drive / FPU Library & Courts	Large Infiltration	Mountain Road Inlet Subwatershed	Wetland	Indirect	450	1250	FPU	Rindge	Medium Density Residential	Easy	Moderate	None	1	7	1	2	4	4	4	6	5	2	3	**39**	**13**
16	Redirect drainage to new bioretention area along steep FPU roads	C-15	Franklin Pierce Drive / Community Center	Large Bioretention	Pearly Lake Drainage	Pearly Lake	Indirect	400	400	FPU	Rindge	Medium Density Residential	Moderate	Difficult	None	1	8	1	2	4	6	4	6	3	1	3	**39**	**14**
25	Culvert repair and swale stabilization	C-5	Kimball Road / Roadway Culvert	Drainage Improvements / Stabilization	Pearly Lake Drainage	Pearly Lake	Direct	150	150	Town	Rindge	Low Density Residential	Moderate	Minor	Minor	1	3	4	4	6	7	3	4	3	2	2	**39**	**15**
21	Shoulder stabilization, plunge pool at culvert and swale	C-2	Kimball Road / Roadway Culvert	Stabilization / Sediment Removal	Pearly Lake Drainage	Pearly Lake	Direct	150	150	Private	Rindge	Low Density Residential	Moderate	Moderate	Minor	1	5	4	4	5	7	3	3	3	2	2	**39**	**16**
7	Stabilize shoulder and access, repair erosion with mulch, infiltration trenches	S-7, S-8	University Drive / Boat Shoreline Access	Stabilization / Small Infiltration	Pearly Lake Drainage	Pearly Lake	Direct	25	25	Town	Rindge	Roadway	Difficult	Difficult	Minor	2	6	4	4	7	8	3	1	1	1	2	**39**	**17**
10	Rain Gardens along FPU parking lots	S-10	University Drive / Parking Area	Small Bioretention	Pearly Lake Drainage	Pearly Lake	Indirect	200	200	FPU	Rindge	Low Density Residential	Moderate	Minor	None	1	5	2	2	6	7	4	2.5	3	3	3	**38.5**	**18**
35	Big infiltration BMP for FPU parking lots & buildings	I-18, I-19	Franklin Pierce Drive / Volley Ball Courts	Large Infiltration	Mountain Road Inlet Subwatershed	Wetland	Indirect	550	1800	FPU	Rindge	Medium Density Residential	Moderate	Moderate	None	2	7	1	2	4	4	4	6	3	2	3	**38**	**19**
36	Infiltration along parking lot, along fence and curb, require new drainage system	I-20, I-21	Franklin Pierce Drive / Dormitory Parking	Large Infiltration / Drainage Improvements	Pearly Lake Drainage	Pearly Lake	Indirect	1000	1000	FPU	Rindge	Medium Density Residential	Moderate	Moderate	None	2	8	1	2	3	4	4	6	3	2	3	**38**	**20**
38	Infiltration BMPs and filter strips along roadway and ball field parking lot	C-37, C-38	Mountain Road / Ball field Parking	Large Infiltration	College Road Inlet Subwatershed	Wetland along tributary of Pearly Lake	Indirect	550	900	FPU	Rindge	Wetland	Moderate	Moderate	None	2	7	3	2	4	5	4	2.5	3	2	3	**37.5**	**21**

TABLE J.2 - STORMWATER BMP OPTIONS - PHASE 1 RANKING SUMMARY

BMP Map ID	BMP Description / Type	Problem Areas Handled (Field Study I.D.)	Location	BMP Type	Subwatershed ID	Waterbody	Discharge Type (Direct or Indirect)	Proximity to Waterbody (ft.)	Proximity to Pearly Lake (ft.)	Property Owner	Town	Land use Type	Maintenance Access	Site Constraints for BMP	Permitting Required	Number of Locations	BMP Type	Waterbody	Direct / Indirect Discharge	Proximity to Waterbody	Proximity to Pearly	Land Owner	Land Use	Construction / Maintenance Access	Site Constraints	Permit Requirements	Priority Points	BMP Rank
12	Raingarden at FPU Community Center	S-12	Franklin Pierce Drive / Community Center	Small Bioretention	Pearly Lake Drainage	Pearly Lake	Indirect	450	450	FPU	Rindge	Medium Density Residential	Moderate	Moderate	None	1	5	1	2	4	6	4	6	3	2	3	37	22
42	Drainage improvement on both sides of road, plunge pool, check dams	C-40	Ingalls & Mountain Road/Tributary Culvert Crossing	Sediment Removal / Drainage Improvements	Mountain Road Inlet Subwatershed	Tributary to Pearly	Direct	0	500	Town	Rindge	Forested	Easy	Major	Minor	1	4	3	4	7	6	3	1	5	1	2	37	23
4	Roadside swales and Treatment Filter Strip / Bioretention	C-10	University Drive / Roadway Drainage	Small Bioretention / Vegetated Filters	Pearly Lake Drainage	Pearly Lake	Indirect	50	50	Town	Rindge	Forested	Easy	Difficult	Minor	1	7	1	2	7	7	3	1	5	1	2	37	24
32	Raingardens along FPU roads and parking areas	I-25	Franklin Pierce Drive / FPU Campus	Small Bioretention	College Road Inlet Subwatershed	Wetland	Indirect	1100	1100	FPU	Rindge	Medium Density Residential	Easy	Moderate	None	1	5	1	2	3	4	4	6	5	2	3	36	25
14	Bioretention swales along whole road, use existing CB as overflow	S-14	Ingalls & Mountain Road / Roadway Drainage	Small Bioretention	Pearly Lake Drainage	Pearly Lake	Indirect	300	300	FPU	Rindge	Medium Density Residential	Difficult	Moderate	None	1	5	1	2	5	6	4	6	1	2	3	36	26
19	Infiltration BMPs & Swale Improvements	S-18	Kimball Road / Roadway Drainage	Small Infiltration / Drainage Improvements	Pearly Lake Drainage	Pearly Lake	Indirect	150	150	Town	Rindge	Low Density Residential	Moderate	Easy	Minor	1	5	1	2	6	7	3	2.5	3	3	2	35.5	27
26	Roadside swale and raingarden	S-23, I-23	Kimball Road / Roadway Drainage	Small Bioretention / Drainage Improvements	Pearly Lake Drainage	Pearly Lake	Indirect	200	200	Private	Rindge	Low Density Residential	Easy	Moderate	Minor	2	6	1	2	5	7	1	2.5	5	2	2	35.5	28
6	Install curbing, headwall rehab, stabilize shoulder, install deep sump catch basins	S-6, C-12	University Drive / Sawmill Road	Stabilization / Drainage Improvements	College Road Inlet Subwatershed	Stream	Direct	100	350	Town/FPU	Rindge	Low Density Residential	Moderate	Moderate	Minor	2	3	1	4	6	6	3.5	2.5	3	2	2	35	29
29	Install new swale, CB, outfall pipe, and plunge pool	S-25, I-24	Private Road / Roadway Drainage	Drainage Improvements / Sediment Removal	Pearly Lake Drainage	Pearly Lake	Indirect	100	100	Private	Rindge	Low Density Residential	Moderate	Moderate	None	2	4	1	2	6	7	1	4	3	2	3	35	30
40	Swale, curbing and CBs	C-32, C-34	Mountain Road / Roadway Drainage	Swale / Drainage Improvements	College Road Inlet Subwatershed	Tributary to Pearly	Direct	100	2550	Town	Rindge	Forested	Easy	Moderate	None	2	2	3	4	6	3	3	1	5	2	3	34	31
13	Improve parking lot drainage, replace pipe, install new stormwater structures, fix pipe infrastructure	S-13	Ingalls & Mountain Road / FPU Parking Area	Small Infiltration / Drainage Improvements	College Road Inlet Subwatershed	Pearly Lake	Indirect	450	450	FPU	Rindge	Medium Density Residential	Difficult	Difficult	None	1	5	1	2	4	6	4	6	1	1	3	34	32
50	Formal drainage that collects runoff from field and infiltration	C-39	Ball Field Trails / Tributary Crossing	Small Infiltration / Drainage Improvements	College Road Inlet Subwatershed	Tributary to Pearly	Direct	0	1050	Town	Rindge	Low Density Residential	Difficult	Major	Major	1	5	3	4	7	4	4	3	1	1	1	34	33
41	Headwall replacement, structure stabilization, drainage improvements	C-33	Mountain Road / Drainage Culvert	Stabilization / Drainage Improvements	College Road Inlet Subwatershed	Tributary to Pearly	Indirect	175	2300	Town	Rindge	Forested	Easy	Easy	None	1	3	3	2	5	3	3	2.5	5	3	3	33.5	34
15	Stabilization at outfall & plunge pools	O-2	Ingalls & Mountain Road / Roadway Drainage	Stabilization / Sediment Removal	Pearly Lake Drainage	Pearly Lake	Indirect	300	300	Town	Rindge	Forested	Moderate	Moderate	None	1	5	1	2	5	6	3	2.5	3	2	3	33.5	35
23	Stabilization of shoulders, infiltration swales and erosion repairs	C-3, C-4	Kimball Road / Roadway Drainage	Stabilization	Pearly Lake Drainage	Pearly Lake	Indirect	200	200	Private	Rindge	Forested / Wetland	Easy	Difficult	Major	2	2	2	2	7	7	1	2.5	5	1	1	32.5	36
47	Swale and shoulder stabilization, gravel Rd BMPs, plunge pools	C-20	Ingalls Road / Gravel Rd Drainage	Sediment Removal / Drainage Improvements	Bower Inlet Subwatershed	Tributary to Pearly	Indirect	150	4200	Town	Jaffrey	Forested	Easy	Easy	None	1	4	1	2	6	3	3	1	5	3	3	32	37
39	Steep roadway drainage stabilization, swales, checkdams & plunge pools	C-35, C-36	Mountain Road / Roadway Drainage	Stabilization / Drainage Improvements	College Road Inlet Subwatershed	Tributary to Pearly	Indirect	350	1500	Town	Rindge	Forested	Moderate	Moderate	None	2	3	3	2	4	4	3	2.5	3	2	3	31.5	38
48	Riprap swales, plunge pool and shoulder stabilization	C-22, S-16	Ingalls Road / Gravel Rd Drainage	Stabilization / Drainage Improvements	Mountain Road Inlet Subwatershed	Tributary to Pearly	Indirect	200	4700	Town	Jaffrey	Forested	Easy	Easy	None	2	3	2	2	5	2	3	1	5	3	3	31	39
30	New swale with check dam, stabilize erosion	S-26	Private Road / Dead End	Stabilization / Drainage Improvements	Pearly Lake Drainage	Pearly Lake	Indirect	150	150	Private	Rindge	Low Density Residential	Moderate	Moderate	Minor	1	3	1	2	6	7	1	2.5	3	2	2	30.5	40
24	Install infiltration swale and large plunge pool, possibly stabilize bottom of driveways	S-21	Kimball Road / Roadway Drainage	Stabilization / Sediment Removal	Pearly Lake Drainage	Pearly Lake	Indirect	250	250	Private	Rindge	Low Density Residential	Moderate	Moderate	Minor	1	5	1	2	5	6	1	2.5	3	2	2	30.5	41
45	Improve drainage on both sides of gravel road, replace box culvert	C-21	Red Gate Road/ Stream Culvert Crossing	Drainage Improvements	Bower Inlet Subwatershed	Tributary to Pearly	Direct	0	5250	Town	Jaffrey	Forested	Easy	Difficult	Major	1	1	3	4	7	2	3	2.5	5	1	1	30.5	42

TABLE J.2 - STORMWATER BMP OPTIONS - PHASE 1 RANKING SUMMARY

BMP Map ID	BMP Description / Type	Problem Areas Handled (Field Study I.D.)	Location	BMP Type	Subwatershed ID	Waterbody	Discharge Type (Direct or Indirect)	Proximity to Waterbody (ft.)	Proximity to Pearly Lake (ft.)	Property Owner	Town	Land use Type	Maintenance Access	Site Constraints for BMP	Permitting Required	Number of Locations	BMP Type	Waterbody	Direct / Indirect Discharge	Proximity to Waterbody	Proximity to Pearly	Land Owner	Land Use	Construction / Maintenance Access	Site Constraints	Permit Requirements	Priority Points	BMP Rank
5	Steep swale check dams and infiltrate @ end near FPU Facilities	S-5	Warren & University Road / Roadway Drainage	Drainage Improvements / Small Infiltration	Pearly Lake Drainage	Pearly Lake	Indirect	600	600	Private	Rindge	Forested	Moderate	Difficult	None	1	5	1	2	4	5	3	2.5	3	1	3	**30.5**	43
44	Culvert to a tributary improve drainage with swales on both sides of culvert	C-25	Bowers Hill Road/ Tributary Culvert Crossing	Drainage Improvements	Bower Inlet Subwatershed	Tributary to Pearly	Direct	0	2400	Town	Rindge	Forested	Easy	Difficult	Major	1	1	3	4	7	3	3	1	5	1	1	**30**	44
46	Improve drainage with swales on both sides of road, replace box culvert	C-23	Red Gate Road/ Stream Culvert Crossing	Drainage Improvements	Bower Inlet Subwatershed	Tributary to Pearly	Direct	0	9000	Town	Jaffrey	Forested	Easy	Major	Minor	1	1	3	4	7	1	3	1	5	1	2	**29**	45
49	Improve drainage on both sides with swales	C-24	Red Gate Road/ Roadway Drainage	Drainage Improvements	Bower Inlet Subwatershed	Wetland to Pearly	Direct	0	7800	Town	Jaffrey	Wetland	Easy	Moderate	Major	1	1	3	4	7	1	3	1	5	2	1	**29**	46
17	Multiple plunge pools, stabilization and general erosion repairs	C-16	Ingalls & Mountain Road / Gravel Roadway Drainage	Stabilization / Sediment Removal	Pearly Lake Drainage	Pearly Lake	Indirect	300	300	Town	Rindge	Forested	Difficult	Difficult	None	1	5	1	2	5	6	3	1	1	1	3	**29**	47
18	Plunge pools and gravel road stabilization	C-17, C-18	Ingalls & Mountain Road / Gravel Roadway Drainage	Stabilization / Sediment Removal	Pearly Lake Drainage	Pearly Lake	Indirect	500	500	Town	Rindge	Forested	Difficult	Difficult	None	2	5	1	2	4	6	3	1	1	1	3	**29**	48
22	Drainage improvements on both sides of roadway & long steep driveway needs to be stabilized	S-20	Kimball Road / Roadway Drainage	Stabilization	Pearly Lake Drainage	Pearly Lake	Indirect	250	250	Private	Rindge	Low Density Residential	Moderate	Moderate	Minor	1	2	1	2	5	7	1	2.5	3	2	2	**28.5**	49
43	Road rebuilding, drainage improvements and culvert repair / replacement	C-42	Doll House Road/ Stream Culvert Crossing	Drainage Improvements	Bower Inlet Subwatershed	Tributary to Pearly	Direct	0	4050	Private	Rindge	Forested / Wetland	Difficult	Difficult	Major	1	1	3	4	7	2	1	1	1	1	1	**23**	50
															Totals - Top 50													

Ranking Criteria

Number of Locations Handled: Five or more locations (or handles large portion of watershed) = 5; Four locations = 4; Three locations = 3; Two locations = 2; One location = 1

BMP Type: Large Bioretention / Gravel Wetlands = 8 ; Large Infiltration = 7; Large Storage / Treatment Basin = 6 ; Small Bioretention = 5; Small Infiltration = 4; Sediment Removal = 3; Erosion Repair / Stabilization = 2; Swales / Drainage Improvements = 1 (combo of two is additive)

Waterbody: Pearly Pond = 4; Large Tributary to Pearly = 3; Small Stream = 2; Wetland / Drainage way = 1

Direct / Indirect Discharge: Direct = 4 ; Indirect = 2

Proximity to Nearest Waterbody: Within 25 feet = 7 ; 26 feet - 50 feet = 6 ; 51 -100 feet = 5 ; 101 - 250 feet = 4 ; 251 - 500 feet = 3; 500 - 1000 feet = 2; 1001+ feet = 1

Proximity to Pearly Lake: Within 50 feet = 8; 51 feet - 250 feet = 7; 251 -500 feet = 6; 501 - 1000 feet = 5; 1001 - 2000 feet = 4; 2001 - 4000 feet = 3; 4001 - 6000 feet = 2; 6001+ feet = 1

Land Owner: FPU Owned (no easements) = 4; Rindge Owned = 3; State or Other Town = 2; Private (easement needed) = 1 (combo takes average of two)

Land Use: Mixed Urban (Med Res) / Commercial = 6; Parks / Institutional = 5; Low Density Residential = 4; Agricultural = 3; Meadow = 2; Forested / Wetland = 1 (combo takes average of two)

Construction / Maintenance: Easy, low number of issues = 5 ; Moderate, possible equipment maneuvering/ access issues = 3 ; Difficult, expensive equipment maneuvering/ road closures = 1

Site Constraints: Minor constraints = 3 ; Moderate constraints (moderate slopes, water within 100 feet, some vegetation) = 2 ; Major constraints (steep slopes, water/wetlands with 50 feet, large trees) = 1

Permitting: No Permit Needed = 3 ; Minor Impact Permit Needed = 2 ; Major Impact Permit Needed = 1

TABLE J.3 - STORMWATER BMP OPTIONS - PHASE 2 RANKING SUMMARY

Rank	BMP Map ID	BMP Description / Type	Problem Areas Handled (Field Study I.D.)	Location	BMP Type	Area (acres)	Impervious Area (acres)	Impervious Percent (%)	Construction Cost ($)	Engineer Costs ($)	Total Costs w/ Contingency ($)	Total Cost Grant Request (60%) ($)	Total Cost Grant Match (40%) ($)	Total 10 yr. Costs ($)	BMP Efficiency (%)	Total TP Loading (kg/yr.)	TP Annual Removal (kg/yr.)	TP 10 Yr. Removal (kg)	10 Year Cost / kg TP ($/kg)
1	11	Drainage Improvements, CB to bioretention areas and gravel wetlands, install infiltration strip & stabilization to beach area	C-14, S-11	University Drive / Beach Area & Fields	Gravel Wetland / Vegetated Buffers	9.4	3.33	35%	$164,500	$56,500	$265,200	$159,120	$106,080	$271,200	65%	7.12	4.63	46.27	$5,862
2	37	Infiltration BMPs / Raingardens throughout FPU parking lots	I-22	Franklin Pierce Drive / Community Center Parking	Small Bioretention / Small Infiltration	3.9	3.11	80%	$95,200	$37,100	$158,800	$95,280	$63,520	$164,800	65%	2.99	1.94	19.42	$8,488
3	27	Stabilize beach access, install rain gardens at end of outfall	O-9	Kimball Road / Beach Access	Small Bioretention / Stabilization	4.4	0.75	17%	$26,500	$14,600	$49,300	$29,580	$19,720	$54,300	65%	0.93	0.61	6.06	$8,956
4	20	BMP wetpond, bioretention system, roadway structures drainage and piping	S-19	Kimball Road / Sharp Curve	Wet Pond / Small Bioretention	6.4	0.98	15%	$37,400	$17,900	$66,400	$39,840	$26,560	$71,400	65%	1.09	0.71	7.10	$10,051
5	33	New CBs, new drainage diversions & infiltration BMPs throughout FPU parking lots and buildings	S-28	Franklin Pierce Drive / FPU Library & Courts	Large Infiltration	2.7	1.89	72%	$73,700	$30,700	$125,300	$75,180	$50,120	$131,300	65%	2.01	1.31	13.05	$10,059
6	12	Raingarden at FPU Community Center	S-12	Franklin Pierce Drive / Community Center	Small Bioretention	0.7	0.50	75%	$11,100	$14,600	$30,800	$18,480	$12,320	$35,800	65%	0.54	0.35	3.52	$10,170
7	3	Bioretention / Treatment BMPs along Rt. 119	S-4	NH Route 119 / Highway Drainage	Large Bioretention	12.4	1.71	14%	$64,800	$26,500	$109,600	$65,760	$43,840	$115,600	65%	1.65	1.07	10.72	$10,785
8	31	Swale with check dams, infiltration BMPs with rain gardens	S-27	Mountain Road/ FPU Campus	Small Bioretention / Small Infiltration	1.8	0.47	26%	$58,900	$26,000	$101,900	$61,140	$40,760	$107,900	65%	1.45	0.94	9.43	$11,447
9	42	Drainage improvement on both sides of road, plunge pool, check dams	C-40	Ingalls & Mountain Road/Tributary Culvert Crossing	Sediment Removal / Drainage Improvements	16.4	2.52	15%	$35,800	$17,800	$64,300	$38,580	$25,720	$70,300	25%	2.34	0.58	5.84	$12,038
10	28	Install roadside settling basins with overflow structures, bioretention and new culvert pipe, roadside stabilization	C-8, S-24	Kimball Road / Roadway Drainage	Large Storage BMP / Small Bioretention	4.0	0.99	25%	$40,000	$18,700	$70,400	$42,240	$28,160	$75,400	65%	0.90	0.58	5.84	$12,905
11	32	Raingardens along FPU roads and parking areas	I-25	Franklin Pierce Drive / FPU Campus	Small Bioretention	2.0	1.45	74%	$76,500	$31,400	$129,500	$77,700	$51,800	$135,500	65%	1.56	1.01	10.14	$13,358
12	36	Infiltration along parking lot, along fence and curb, require new drainage system	I-20, I-21	Franklin Pierce Drive / Dormitory Parking	Large Infiltration / Drainage Improvements	3.1	2.61	84%	$118,200	$43,800	$194,400	$116,640	$77,760	$200,400	65%	2.30	1.50	14.96	$13,397
13	38	Infiltration BMPs and filter strips along roadway and ball field parking lot	C-37, C-38	Mountain Road / Ball field Parking	Large Infiltration	10.3	1.55	15%	$121,200	$44,900	$199,300	$119,580	$79,720	$205,300	65%	2.27	1.47	14.75	$13,919
14	9	Parking lot Infiltration BMPs	S-9	Sawmill Road / Parking Area	Large Infiltration	1.4	1.36	100%	$42,500	$21,000	$76,200	$45,720	$30,480	$81,200	65%	0.82	0.54	5.36	$15,152
15	35	Big infiltration BMP for FPU parking lots & buildings	I-18, I-19	Franklin Pierce Drive / Volley Ball Courts	Large Infiltration	3.3	2.49	76%	$145,300	$52,000	$236,800	$142,080	$94,720	$242,800	65%	2.44	1.59	15.89	$15,278
16	26	Roadside swale and raingarden	S-23, I-23	Kimball Road / Roadway Drainage	Small Bioretention / Drainage Improvements	3.6	0.46	13%	$30,400	$15,800	$55,400	$33,240	$22,160	$60,400	65%	0.60	0.39	3.88	$15,579
17	16	Redirect drainage to new bioretention area along steep FPU roads	C-15	Franklin Pierce Drive / Community Center	Large Bioretention	1.7	1.06	63%	$57,200	$25,200	$98,900	$59,340	$39,560	$103,900	65%	0.96	0.62	6.21	$16,737
18	34	Parking lot BMPs retrofit to existing drainage systems infiltration dividers, new pipe	I-13,I-14, I-15, I-16, I-17	Franklin Pierce Drive / Parking Areas & Athletic Bubble	Large Infiltration	2.9	2.31	81%	$141,700	$51,000	$231,200	$138,720	$92,480	$237,200	65%	2.02	1.31	13.10	$18,104
19	14	Bioretention swales along whole road, use existing CB as overflow	S-14	Ingalls & Mountain Road / Roadway Drainage	Small Bioretention	0.9	0.34	39%	$11,700	$14,600	$31,600	$18,960	$12,640	$36,600	65%	0.30	0.20	1.97	$18,601
20	21	Shoulder stabilization, plunge pool at culvert and swale	C-2	Kimball Road / Roadway Culvert	Stabilization / Sediment Removal	6.5	0.52	8%	$9,600	$13,200	$27,400	$16,440	$10,960	$32,400	25%	0.67	0.17	1.67	$19,414
21	7	Stabilize shoulder and access, repair erosion with mulch, infiltration trenches	S-7, S-8	University Drive / Boat Shoreline Access	Stabilization / Small Infiltration	3.5	0.64	19%	$54,300	$23,600	$93,500	$56,100	$37,400	$100,500	65%	0.78	0.51	5.08	$19,799
22	8	Rain Gardens upstream and downstream of culvert	C-13	University Drive / Sawmill Road	Small Bioretention	1.8	0.98	55%	$74,900	$25,600	$120,600	$72,360	$48,240	$125,600	65%	0.94	0.61	6.11	$20,568
23	10	Rain Gardens along FPU parking lots	S-10	University Drive / Parking Area	Small Bioretention	2.6	0.74	29%	$45,300	$21,700	$80,400	$48,240	$32,160	$85,400	65%	0.59	0.38	3.85	$22,184
24	19	Infiltration BMPs & Swale Improvements	S-18	Kimball Road / Roadway Drainage	Small Infiltration / Drainage Improvements	1.7	0.44	25%	$22,800	$13,600	$43,700	$26,220	$17,480	$48,700	65%	0.31	0.20	2.03	$23,955

TABLE J.3 - STORMWATER BMP OPTIONS - PHASE 2 RANKING SUMMARY

Rank	BMP Map ID	BMP Description / Type	Problem Areas Handled (Field Study I.D.)	Location	BMP Type	Area (acres)	Impervious Area (acres)	Impervious Percent (%)	Construction Cost ($)	Engineer Costs ($)	Total Costs w/ Contingency ($)	Total Cost Grant Request (60%) ($)	Total Cost Grant Match (40%) ($)	Total 10 yr. Costs ($)	BMP Efficiency (%)	Total TP Loading (kg/yr.)	TP Annual Removal (kg/yr.)	TP 10 Yr. Removal (kg)	10 Year Cost / kg TP ($/kg)
25	4	Roadside swales and Treatment Filter Strip / Bioretention	C-10	University Drive / Roadway Drainage	Small Bioretention / Vegetated Filters	2.3	0.69	30%	$26,400	$14,800	$49,400	$29,640	$19,760	$55,400	45%	0.48	0.21	2.15	$25,824
26	1	Plunge pools and swales along Rt. 119 at existing outfalls	S-1, S-2	NH Route 119 / Highway Drainage	Sediment Removal	1.0	1.00	100%	$14,700	$13,400	$33,700	$20,220	$13,480	$39,700	25%	0.61	0.15	1.52	$26,194
27	29	Install new swale, CB, outfall pipe, and plunge pool	S-25, I-24	Private Road / Roadway Drainage	Drainage Improvements / Sediment Removal	3.4	0.43	13%	$12,500	$14,700	$32,600	$19,560	$13,040	$37,600	25%	0.52	0.13	1.30	$28,939
28	2	Plunge pools and infiltration swales	S-3	NH Route 119 / Highway Drainage	Sediment Removal	2.3	0.70	30%	$13,900	$13,400	$32,800	$19,680	$13,120	$38,800	25%	0.48	0.12	1.21	$32,134
29	25	Culvert repair and swale stabilization	C-5	Kimball Road / Roadway Culvert	Drainage Improvements / Stabilization	2.5	0.49	20%	$20,800	$12,900	$40,400	$24,240	$16,160	$45,400	10%	0.64	0.06	0.64	$70,517
30	6	Install curbing, headwall rehab, stabilize shoulder, install deep sump catch basins	S-6, C-12	University Drive / Sawmill Road	Stabilization / Drainage Improvements	3.0	0.53	18%	$34,900	$17,100	$62,400	$37,440	$24,960	$67,400	10%	0.47	0.05	0.47	$142,579
	Totals - Top 30					121.75	37.04		$1,682,700	$744,100	$2,912,200	$1,747,320	$1,164,880	$3,078,200		40.78	23.95	239.53	

TABLE J.4 - STORMWATER BMP OPTIONS -TOP 10 BMP SITES

Rank	BMP Map ID	BMP Description / Type	Problem Areas Handled (Field Study I.D.)	Location	BMP Type	Area (acres)	Impervious Area (acres)	Impervious Percent (%)	Total Costs w/ Contingency ($)	Total Cost Grant Request (60%) ($)	Total Cost Grant Match (40%) ($)	Total 10 yr. Costs ($)	BMP Efficiency (%)	Total TP Loading (kg/yr.)	TP Annual Removal (kg/yr.)	TP 10 Yr. Removal (kg/yr.)	10 Year Cost / kg TP ($/kg)	Total TP Loading (lb./yr.)	TP Annual Removal (lb./yr.)	TP 10 Yr. Removal (lb./yr.)	10 Year Cost / lb. TP ($/lb.)
1	11	Drainage Improvements, CB to bioretention areas and gravel wetlands, install infiltration strip & stabilization to beach area	C-14, S-11	University Drive / Beach Area & Fields	Gravel Wetland / Vegetated Buffers	9.4	3.33	35%	$265,200	$159,120	$106,080	$271,200	65%	7.12	4.63	46.27	$5,862	15.71	10.21	102.14	$2,655
2	37	Infiltration BMPs / Raingardens throughout FPU parking lots	I-22	Franklin Pierce Drive / Community Center Parking	Small Bioretention / Small Infiltration	3.9	3.11	80%	$158,800	$95,280	$63,520	$164,800	65%	2.99	1.94	19.42	$8,488	6.59	4.29	42.86	$3,845
3	27	Stabilize beach access, install rain gardens at end of outfall	O-9	Kimball Road / Beach Access	Small Bioretention / Stabilization	4.4	0.75	17%	$49,300	$29,580	$19,720	$54,300	65%	0.93	0.61	6.06	$8,956	2.06	1.34	13.38	$4,057
4	20	BMP wetpond, bioretention system, roadway structures drainage and piping	S-19	Kimball Road / Sharp Curve	Wet Pond / Small Bioretention	6.4	0.98	15%	$66,400	$39,840	$26,560	$71,400	65%	1.09	0.71	7.10	$10,051	2.41	1.57	15.68	$4,553
5	33	New CBs, new drainage diversions & infiltration BMPs throughout FPU parking lots and buildings	S-28	Franklin Pierce Drive / FPU Library & Courts	Large Infiltration	2.7	1.89	72%	$125,300	$75,180	$50,120	$131,300	65%	2.01	1.31	13.05	$10,059	4.43	2.88	28.81	$4,557
6	12	Raingarden at FPU Community Center	S-12	Franklin Pierce Drive / Community Center	Small Bioretention	0.7	0.50	75%	$30,800	$18,480	$12,320	$35,800	65%	0.54	0.35	3.52	$10,170	1.20	0.78	7.77	$4,607
7	3	Bioretention / Treatment BMPs along Rt. 119	S-4	NH Route 119 / Highway Drainage	Large Bioretention	12.4	1.71	14%	$109,600	$65,760	$43,840	$115,600	65%	1.65	1.07	10.72	$10,785	3.64	2.37	23.66	$4,885
8	31	Swale with check dams, infiltration BMPs with rain gardens	S-27	Mountain Road/ FPU Campus	Small Bioretention / Small Infiltration	1.8	0.47	26%	$101,900	$61,140	$40,760	$107,900	65%	1.45	0.94	9.43	$11,447	3.20	2.08	20.81	$5,186
9	42	Drainage improvement on both sides of road, plunge pool, check dams	C-40	Ingalls & Mountain Road/Tributary Culvert Crossing	Sediment Removal / Drainage Improvements	16.4	2.52	15%	$64,300	$38,580	$25,720	$70,300	25%	2.34	0.58	5.84	$12,038	5.16	1.29	12.89	$5,453
10	28	Install roadside settling basins with overflow structures, bioretention and new culvert pipe, roadside stabilization	C-8, S-24	Kimball Road / Roadway Drainage	Large Storage BMP / Small Bioretention	4.0	0.99	25%	$70,400	$42,240	$28,160	$75,400	65%	0.90	0.58	5.84	$12,905	1.98	1.29	12.90	$5,846
	Totals - Top 10					62.03	16.25		$1,042,000	$625,200	$416,800	$1,098,000		21.01	12.73	127.25		46.39	28.09	280.91	

TABLE J.5 - STORMWATER BMP OPTIONS - PHOSPHORUS LOADING SUMMARY

BMP Map ID	BMP Description / Type	Location	BMP Type	BMP Drainage Area (acres)	Drainage Area Land Use Inst/Parks (acres)	Drainage Area Land Use Urban / Commercial (acres)	Drainage Area Land Use Roads (acres)	Drainage Area Land Use Residential (acres)	Drainage Area Land Use Forest (acres)	Drainage Area Land Use Agricultural-Hay (acres)	Drainage Area Land Use Wetland / Pond (acres)	Drainage Area Land Use Bare Soil (acres)	Land Use TP Loading Inst/Parks (kg/year)	Land Use TP Loading Urban / Commercial (kg/year)	Land Use TP Loading Roads (kg/year)	Land Use TP Loading Residential (kg/year)	Land Use TP Loading Forest (kg/year)	Land Use TP Loading Agricultural - Hay (kg/year)	Land Use TP Loading Wetland / Pond (kg/year)	Land Use TP Loading Bare Soil (kg/year)	BMP TP Loading (kg/year)	BMP TP Loading (lbs/year)
11	Drainage Improvements, CB to bioretention areas and gravel wetlands, install infiltration strip & stabilization to beach area	University Drive / Beach Area & Fields	Gravel Wetland / Vegetated Buffers	**9.42**	5.46	2.83	0.66	0.00	0.47	0.00	0.00	0.00	4.42	2.29	0.40	0.00	0.02	0.00	0.00	0.00	**7.13**	**15.71**
8	Rain Gardens upstream and downstream of culvert	University Drive / Sawmill Road	Small Bioretention	**1.79**	0.00	0.72	0.36	0.36	0.36	0.00	0.00	0.00	0.00	0.58	0.22	0.13	0.01	0.00	0.00	0.00	**0.94**	**2.07**
3	Bioretention / Treatment BMPs along Rt. 119	NH Route 119 / Highway Drainage	Large Bioretention	**12.40**	0.00	0.62	1.24	0.00	10.54	0.00	0.00	0.00	0.00	0.50	0.75	0.00	0.40	0.00	0.00	0.00	**1.65**	**3.64**
20	BMP wetpond, bioretention system, roadway structures drainage and piping	Kimball Road / Sharp Curve	Wet Pond / Small Bioretention	**6.40**	0.00	0.00	0.45	1.66	4.10	0.00	0.00	0.19	0.00	0.00	0.27	0.61	0.15	0.00	0.00	0.06	**1.09**	**2.41**
27	Stabilize beach access, install rain garden at end of outfall	Kimball Road / Beach Access	Small Bioretention / Stabilization	**4.40**	0.00	0.00	0.22	1.89	2.20	0.00	0.00	0.09	0.00	0.00	0.13	0.69	0.08	0.00	0.00	0.03	**0.93**	**2.06**
34	Parking lot BMPs retrofit to existing drainage systems infiltration dividers, new pipe	Franklin Pierce Drive / Parking Areas & Athletic Bubble	Large Infiltration	**2.85**	0.29	1.14	1.43	0.00	0.00	0.00	0.00	0.00	0.23	0.92	0.87	0.00	0.00	0.00	0.00	0.00	**2.02**	**4.45**
37	Infiltration BMPs / Raingardens throughout FPU parking lots	Franklin Pierce Drive / Community Center Parking	Small Bioretention / Small Infiltration	**3.89**	0.00	3.11	0.78	0.00	0.00	0.00	0.00	0.00	0.00	2.52	0.47	0.00	0.00	0.00	0.00	0.00	**2.99**	**6.59**
1	Plunge pools and swales along Rt. 119 at existing outfalls	NH Route 119 / Highway Drainage	Sediment Removal	**1.00**	0.00	0.00	1.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.61	0.00	0.00	0.00	0.00	0.00	**0.61**	**1.34**
31	Swale with check dams, infiltration BMPs with rain gardens	Mountain Road/ FPU Campus	Small Bioretention / Small Infiltration	**1.84**	1.47	0.18	0.18	0.00	0.00	0.00	0.00	0.00	1.19	0.15	0.11	0.00	0.00	0.00	0.00	0.00	**1.45**	**3.20**
28	Install roadside settling basins with overflow structures, bioretention and new culvert pipe, roadside stabilization	Kimball Road / Roadway Drainage	Large Storage BMP / Small Bioretention	**3.97**	0.00	0.04	0.60	0.99	2.14	0.00	0.00	0.20	0.00	0.03	0.36	0.36	0.08	0.00	0.00	0.06	**0.90**	**1.98**
9	Parking lot Infiltration BMPs	Sawmill Road / Parking Area	Large Infiltration	**1.36**	0.00	0.00	1.36	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.83	0.00	0.00	0.00	0.00	0.00	**0.83**	**1.82**
2	Plunge pools and infiltration swales	NH Route 119 / Highway Drainage	Sediment Removal	**2.32**	0.00	0.00	0.70	0.00	1.62	0.00	0.00	0.00	0.00	0.00	0.42	0.00	0.06	0.00	0.00	0.00	**0.48**	**1.07**
33	New CBs, new drainage diversions & infiltration BMPs throughout FPU parking lots and buildings	Franklin Pierce Drive / FPU Library & Courts	Large Infiltration	**2.65**	0.40	1.59	0.66	0.00	0.00	0.00	0.00	0.00	0.32	1.29	0.40	0.00	0.00	0.00	0.00	0.00	**2.01**	**4.43**
16	Redirect drainage to new bioretention area along steep FPU roads	Franklin Pierce Drive / Community Center	Large Bioretention	**1.69**	0.00	0.85	0.42	0.00	0.42	0.00	0.00	0.00	0.00	0.68	0.26	0.00	0.02	0.00	0.00	0.00	**0.96**	**2.11**
25	Culvert repair and swale stabilization	Kimball Road / Roadway Culvert	Drainage Improvements / Stabilization	**2.46**	0.00	0.00	0.12	1.48	0.86	0.00	0.00	0.00	0.00	0.00	0.07	0.54	0.03	0.00	0.00	0.00	**0.64**	**1.42**
21	Shoulder stabilization, plunge pool at culvert and swale	Kimball Road / Roadway Culvert	Stabilization / Sediment Removal	**6.52**	0.00	0.00	0.13	0.78	5.28	0.00	0.00	0.33	0.00	0.00	0.08	0.28	0.20	0.00	0.00	0.11	**0.67**	**1.47**
7	Stabilize shoulder and access, repair erosion with mulch, infiltration trenches	University Drive / Boat Shoreline Access	Stabilization / Small Infiltration	**3.46**	0.00	0.52	0.10	0.59	2.25	0.00	0.00	0.00	0.00	0.42	0.06	0.21	0.08	0.00	0.00	0.00	**0.78**	**1.72**
10	Rain Gardens along FPU parking lots	University Drive / Parking Area	Small Bioretention	**2.59**	0.00	0.00	0.65	0.39	1.55	0.00	0.00	0.00	0.00	0.00	0.39	0.14	0.06	0.00	0.00	0.00	**0.59**	**1.31**
35	Big infiltration BMP for FPU parking lots & buildings	Franklin Pierce Drive / Volley Ball Courts	Large Infiltration	**3.27**	0.33	1.96	0.98	0.00	0.00	0.00	0.00	0.00	0.26	1.59	0.60	0.00	0.00	0.00	0.00	0.00	**2.45**	**5.40**
36	Infiltration along parking lot, along fence and curb, require new drainage system	Franklin Pierce Drive / Dormitory Parking	Large Infiltration / Drainage Improvements	**3.12**	0.00	2.03	1.09	0.00	0.00	0.00	0.00	0.00	0.00	1.64	0.66	0.00	0.00	0.00	0.00	0.00	**2.30**	**5.08**
38	Infiltration BMPs and filter strips along roadway and ball field parking lot	Mountain Road / Ball field Parking	Large Infiltration	**10.32**	1.03	0.83	0.83	0.00	5.88	0.00	1.75	0.00	0.84	0.67	0.50	0.00	0.22	0.00	0.05	0.00	**2.27**	**5.01**
12	Raingarden at FPU Community Center	Franklin Pierce Drive / Community Center	Small Bioretention	**0.67**	0.00	0.67	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.54	0.00	0.00	0.00	0.00	0.00	0.00	**0.54**	**1.20**

TABLE J.5 - STORMWATER BMP OPTIONS - PHOSPHORUS LOADING SUMMARY

BMP Map ID	BMP Description / Type	Location	BMP Type	BMP Drainage Area (acres)	Drainage Area Land Use Inst/Parks (acres)	Drainage Area Land Use Urban / Commercial (acres)	Drainage Area Land Use Roads (acres)	Drainage Area Land Use Residential (acres)	Drainage Area Land Use Forest (acres)	Drainage Area Land Use Agricultural-Hay (acres)	Drainage Area Land Use Wetland / Pond (acres)	Drainage Area Land Use Bare Soil (acres)	Land Use TP Loading Inst/Parks (kg/year)	Land Use TP Loading Urban / Commercial (kg/year)	Land Use TP Loading Roads (kg/year)	Land Use TP Loading Residential (kg/year)	Land Use TP Loading Forest (kg/year)	Land Use TP Loading Agricultural - Hay (kg/year)	Land Use TP Loading Wetland / Pond (kg/year)	Land Use TP Loading Bare Soil (kg/year)	BMP TP Loading (kg/year)	BMP TP Loading (lbs/year)
42	Drainage improvement on both sides of road, plunge pool, check dams	Ingalls & Mountain Road/Tributary Culvert Crossing	Sediment Removal / Drainage Improvements	**16.39**	0.00	0.00	2.46	0.00	9.01	3.28	1.64	0.00	0.00	0.00	1.49	0.00	0.34	0.46	0.04	0.00	**2.34**	**5.16**
4	Roadside swales and Treatment Filter Strip / Bioretention	University Drive / Roadway Drainage	Small Bioretention / Vegetated Filters	**2.29**	0.00	0.00	0.69	0.00	1.60	0.00	0.00	0.00	0.00	0.00	0.42	0.00	0.06	0.00	0.00	0.00	**0.48**	**1.05**
32	Raingardens along FPU roads and parking areas	Franklin Pierce Drive / FPU Campus	Small Bioretention	**1.97**	0.10	1.71	0.16	0.00	0.00	0.00	0.00	0.00	0.08	1.39	0.10	0.00	0.00	0.00	0.00	0.00	**1.56**	**3.44**
14	Bioretention swales along whole road, use existing CB as overflow	Ingalls & Mountain Road / Roadway Drainage	Small Bioretention	**0.88**	0.00	0.22	0.18	0.00	0.48	0.00	0.00	0.00	0.00	0.18	0.11	0.00	0.02	0.00	0.00	0.00	**0.30**	**0.67**
19	Infiltration BMPs & Swale Improvements	Kimball Road / Roadway Drainage	Small Infiltration / Drainage Improvements	**1.74**	0.00	0.00	0.44	0.00	1.31	0.00	0.00	0.00	0.00	0.00	0.26	0.00	0.05	0.00	0.00	0.00	**0.31**	**0.69**
26	Roadside swale and raingarden	Kimball Road / Roadway Drainage	Small Bioretention / Drainage Improvements	**3.64**	0.00	0.00	0.18	1.09	2.37	0.00	0.00	0.00	0.00	0.00	0.11	0.40	0.09	0.00	0.00	0.00	**0.60**	**1.32**
6	Install curbing, headwall rehab, stabilize shoulder, install deep sump catch basins	University Drive / Sawmill Road	Stabilization / Drainage Improvements	**3.04**	0.00	0.00	0.46	0.30	2.28	0.00	0.00	0.00	0.00	0.00	0.28	0.11	0.09	0.00	0.00	0.00	**0.47**	**1.04**
29	Install new swale, CB, outfall pipe, and plunge pool	Private Road / Roadway Drainage	Drainage Improvements / Sediment Removal	**3.41**	0.00	0.00	0.24	0.78	2.39	0.00	0.00	0.00	0.00	0.00	0.14	0.29	0.09	0.00	0.00	0.00	**0.52**	**1.15**
40	Swale, curbing and CBs	Mountain Road / Roadway Drainage	Swale / Drainage Improvements	**2.40**	0.00	0.00	0.17	0.00	2.23	0.00	0.00	0.00	0.00	0.00	0.10	0.00	0.08	0.00	0.00	0.00	**0.19**	**0.41**
13	Improve parking lot drainage, replace pipe, install new stormwater structures, fix pipe infrastructure	Ingalls & Mountain Road / FPU Parking Area	Small Infiltration / Drainage Improvements	**0.54**	0.19	0.14	0.22	0.00	0.00	0.00	0.00	0.00	0.15	0.11	0.13	0.00	0.00	0.00	0.00	0.00	**0.39**	**0.87**
50	Formal drainage that collects runoff from field and infiltration	Ball Field Trails / Tributary Crossing	Small Infiltration / Drainage Improvements	**7.18**	5.03	0.00	0.00	0.00	1.80	0.00	0.36	0.00	4.07	0.00	0.00	0.00	0.07	0.00	0.01	0.00	**4.14**	**9.14**
41	Headwall replacement, structure stabilization, drainage improvements	Mountain Road / Drainage Culvert	Stabilization / Drainage Improvements	**6.79**	0.00	0.00	0.75	0.00	5.98	0.00	0.00	0.00	0.00	0.00	0.45	0.00	0.22	0.00	0.00	0.00	**0.68**	**1.50**
15	Stabilization at outfall & plunge pools	Ingalls & Mountain Road / Roadway Drainage	Stabilization / Sediment Removal	**2.13**	1.73	0.00	0.19	0.00	0.21	0.00	0.00	0.00	1.40	0.00	0.12	0.00	0.01	0.00	0.00	0.00	**1.52**	**3.35**
23	Stabilization of shoulders, infiltration swales and erosion repairs	Kimball Road / Roadway Drainage	Stabilization	**4.31**	0.00	0.00	0.17	0.86	3.28	0.00	0.00	0.00	0.00	0.00	0.10	0.31	0.12	0.00	0.00	0.00	**0.54**	**1.19**
47	Swale and shoulder stabilization, gravel Rd BMPs, plunge pools	Ingalls Road / Gravel Rd Drainage	Sediment Removal / Drainage Improvements	**5.38**	0.00	0.00	1.08	0.00	3.93	0.27	0.11	0.00	0.00	0.00	0.65	0.00	0.15	0.04	0.00	0.00	**0.84**	**1.86**
39	Steep roadway drainage stabilization, swales, checkdams & plunge pools	Mountain Road / Roadway Drainage	Stabilization / Drainage Improvements	**3.41**	0.07	0.00	0.34	0.00	3.00	0.00	0.00	0.00	0.06	0.00	0.21	0.00	0.11	0.00	0.00	0.00	**0.38**	**0.83**
48	Riprap swales, plunge pool and shoulder stabilization	Ingalls Road / Gravel Rd Drainage	Stabilization / Drainage Improvements	**6.59**	0.00	0.00	0.66	0.33	5.60	0.00	0.00	0.00	0.00	0.00	0.40	0.12	0.21	0.00	0.00	0.00	**0.73**	**1.61**
30	New swale with check dam, stabilize erosion	Private Road / Dead End	Stabilization / Drainage Improvements	**2.72**	0.00	0.00	0.05	0.41	2.26	0.00	0.00	0.00	0.00	0.00	0.03	0.15	0.08	0.00	0.00	0.00	**0.27**	**0.59**
24	Install infiltration swale and large plunge pool, possibly stabilize bottom of driveways	Kimball Road / Roadway Drainage	Stabilization / Sediment Removal	**4.41**	0.00	0.00	0.18	3.00	1.23	0.00	0.00	0.00	0.00	0.00	0.11	1.09	0.05	0.00	0.00	0.00	**1.25**	**2.75**
45	Improve drainage on both sides of gravel road, replace box culvert	Red Gate Road/ Stream Culvert Crossing	Drainage Improvements	**6.41**	0.00	0.00	1.09	0.00	5.00	0.00	0.32	0.00	0.00	0.00	0.66	0.00	0.19	0.00	0.01	0.00	**0.86**	**1.89**
5	Steep swale check dams and infiltrate @ end near FPU Facilities	Warren & University Road / Roadway Drainage	Drainage Improvements / Small Infiltration	**3.73**	0.00	0.11	0.82	0.00	2.61	0.19	0.00	0.00	0.00	0.09	0.50	0.00	0.10	0.03	0.00	0.00	**0.71**	**1.57**
44	Culvert to a tributary improve drainage with swales on both sides of culvert	Bowers Hill Road/ Tributary Culvert Crossing	Drainage Improvements	**5.38**	0.00	0.00	0.22	0.00	4.79	0.11	0.27	0.00	0.00	0.00	0.13	0.00	0.18	0.02	0.01	0.00	**0.33**	**0.73**

TABLE J.5 - STORMWATER BMP OPTIONS - PHOSPHORUS LOADING SUMMARY

BMP Map ID	BMP Description / Type	Location	BMP Type	BMP Drainage Area (acres)	Drainage Area Land Use Inst/Parks (acres)	Drainage Area Land Use Urban / Commercial (acres)	Drainage Area Land Use Roads (acres)	Drainage Area Land Use Residential (acres)	Drainage Area Land Use Forest (acres)	Drainage Area Land Use Agricultural-Hay (acres)	Drainage Area Land Use Wetland / Pond (acres)	Drainage Area Land Use Bare Soil (acres)	Land Use TP Loading Inst/Parks (kg/year)	Land Use TP Loading Urban / Commercial (kg/year)	Land Use TP Loading Roads (kg/year)	Land Use TP Loading Residential (kg/year)	Land Use TP Loading Forest (kg/year)	Land Use TP Loading Agricultural - Hay (kg/year)	Land Use TP Loading Wetland / Pond (kg/year)	Land Use TP Loading Bare Soil (kg/year)	BMP TP Loading (kg/year)	BMP TP Loading (lbs/year)
46	Improve drainage with swales on both sides of road, replace box culvert	Red Gate Road/ Stream Culvert Crossing	Drainage Improvements	**9.95**	0.00	0.00	1.59	0.00	8.16	0.00	0.20	0.00	0.00	0.00	0.97	0.00	0.31	0.00	0.01	0.00	**1.28**	**2.82**
49	Improve drainage on both sides with swales	Red Gate Road/ Roadway Drainage	Drainage Improvements	**7.75**	0.00	0.00	1.09	0.00	4.34	0.00	2.33	0.00	0.00	0.00	0.66	0.00	0.16	0.00	0.06	0.00	**0.88**	**1.95**
17	Multiple plunge pools, stabilization and general erosion repairs	Ingalls & Mountain Road / Gravel Roadway Drainage	Stabilization / Sediment Removal	**0.89**	0.00	0.00	0.31	0.00	0.58	0.00	0.00	0.00	0.00	0.00	0.19	0.00	0.02	0.00	0.00	0.00	**0.21**	**0.46**
18	Plunge pools and gravel road stabilization	Ingalls & Mountain Road / Gravel Roadway Drainage	Stabilization / Sediment Removal	**2.63**	0.00	0.66	0.47	0.00	1.50	0.00	0.00	0.00	0.00	0.53	0.29	0.00	0.06	0.00	0.00	0.00	**0.88**	**1.93**
22	Drainage improvements on both sides of roadway & long steep driveway needs to be stabilized	Kimball Road / Roadway Drainage	Stabilization	**2.10**	0.00	0.00	0.06	0.00	0.99	0.00	0.00	1.05	0.00	0.00	0.04	0.00	0.04	0.00	0.00	0.34	**0.42**	**0.92**
43	Road rebuilding, drainage improvements and culvert repair / replacement	Doll House Road/ Stream Culvert Crossing	Drainage Improvements	**5.21**	0.00	0.00	0.78	0.00	4.17	0.00	0.26	0.00	0.00	0.00	0.47	0.00	0.16	0.00	0.01	0.00	**0.64**	**1.41**
Totals - Top 50				**211.66**	**16.08**	**19.92**	**28.98**	**14.92**	**118.77**	**3.84**	**7.23**	**1.85**	**13.02**	**16.12**	**17.59**	**5.43**	**4.47**	**0.54**	**0.19**	**0.60**	**57.97**	**127.79**

TABLE J.6 - STORMWATER BMP OPTIONS -COST DATA SUMMARY

BMP Map ID	BMP Description / Type	Location	BMP Type	Area (acres)	Impervious Area (acres)	Impervious Percent (%)	BMP Volume Provided (cf)	Additional BMP Area (sf)	Large Culvert Install Cost ($)	Large Culvert Material Cost ($)	Small Culvert Install Cost ($)	Small Culvert Mat'l Cost ($)	Drainage Pipe Cost ($)	Drainage Structure Cost ($)	WQV BMP Install Costs ($)	WQV BMP Material Costs ($)	Add'l BMP Install Costs ($)	Add'l BMP Material Costs ($)	Add'l Excavation Costs ($)	Add'l Item Costs ($)	Total Construction Cost ($)	Survey Costs ($)	Permitting Costs ($)	Design Costs ($)	Bid / Construction Oversight Costs ($)	Total Engineering Costs ($)	Total Project Costs w/ Contingencies ($)	Annual Maintenance ($)	Total 10 yr. Costs ($)
11	Drainage Improvements, CB to bioretention areas and gravel wetlands, install infiltration strip & stabilization to beach area	University Drive / Beach Area & Fields	Gravel Wetland / Vegetated Buffers	9.4	3.33	35%	12000.0	1,500	$0	$0	$0	$0	$22,500	$21,000	$36,000	$60,000	$3,000	$6,000	$1,019	$14,950	**$164,500**	$3,600	$3,500	$32,900	$16,500	**$56,500**	**$265,200**	$600	**$271,200**
37	Infiltration BMPs / Raingardens throughout FPU parking lots	Franklin Pierce Drive / Community Center Parking	Small Bioretention / Small Infiltration	3.9	3.11	80%	11000.0	0	$0	$0	$0	$0	$15,000	$21,000	$22,000	$27,500	$0	$0	$1,019	$8,650	**$95,200**	$3,600	$5,000	$19,000	$9,500	**$37,100**	**$158,800**	$600	**$164,800**
27	Stabilize beach access, install rain gardens at end of outfall	Kimball Road / Beach Access	Small Bioretention / Stabilization	4.4	0.75	17%	900.0	400	$0	$0	$0	$0	$1,500	$3,500	$4,500	$13,500	$200	$400	$500	$2,410	**$26,500**	$3,100	$3,500	$5,300	$2,700	**$14,600**	**$49,300**	$500	**$54,300**
20	BMP wetpond, bioretention system, roadway structures drainage and piping	Kimball Road / Sharp Curve	Wet Pond / Small Bioretention	6.4	0.98	15%	3000.0	0	$0	$0	$0	$0	$7,500	$7,000	$7,500	$9,000	$0	$0	$2,963	$3,400	**$37,400**	$3,200	$3,500	$7,500	$3,700	**$17,900**	**$66,400**	$500	**$71,400**
33	New CBs, new drainage diversions & infiltration BMPs throughout FPU parking lots and buildings	Franklin Pierce Drive / FPU Library & Courts	Large Infiltration	2.7	1.89	72%	7200.0	0	$0	$0	$0	$0	$12,750	$21,000	$14,400	$18,000	$0	$0	$889	$6,700	**$73,700**	$3,600	$5,000	$14,700	$7,400	**$30,700**	**$125,300**	$600	**$131,300**
12	Raingarden at FPU Community Center	Franklin Pierce Drive / Community Center	Small Bioretention	0.7	0.50	75%	1800.0	0	$0	$0	$0	$0	$1,500	$0	$3,600	$4,500	$0	$0	$500	$1,010	**$11,100**	$3,100	$5,000	$4,000	$2,500	**$14,600**	**$30,800**	$500	**$35,800**
3	Bioretention / Treatment BMPs along Rt. 119	NH Route 119 / Highway Drainage	Large Bioretention	12.4	1.71	14%	6650.0	900	$0	$0	$0	$0	$7,500	$7,000	$16,625	$23,275	$2,250	$1,350	$870	$5,890	**$64,800**	$3,500	$3,500	$13,000	$6,500	**$26,500**	**$109,600**	$600	**$115,600**
31	Swale with check dams, infiltration BMPs with rain gardens	Mountain Road/ FPU Campus	Small Bioretention / Small Infiltration	1.8	0.47	26%	1700.0	1,000	$0	$0	$0	$0	$7,500	$7,000	$8,500	$25,500	$1,500	$3,000	$500	$5,350	**$58,900**	$3,300	$5,000	$11,800	$5,900	**$26,000**	**$101,900**	$600	**$107,900**
42	Drainage improvement on both sides of road, plunge pool, check dams	Ingalls & Mountain Road/Tributary Culvert Crossing	Sediment Removal / Drainage Improvements	16.4	2.52	15%	6000.0	500	$0	$0	$0	$0	$7,500	$7,000	$9,000	$6,000	$750	$1,500	$833	$3,260	**$35,800**	$3,500	$3,500	$7,200	$3,600	**$17,800**	**$64,300**	$600	**$70,300**
28	Install roadside settling basins with overflow structures, bioretention and new culvert pipe, roadside stabilization	Kimball Road / Roadway Drainage	Large Storage BMP / Small Bioretention	4.0	0.99	25%	2812.5	800	$0	$0	$0	$0	$15,000	$7,000	$5,625	$4,219	$1,600	$2,400	$500	$3,630	**$40,000**	$3,200	$3,500	$8,000	$4,000	**$18,700**	**$70,400**	$500	**$75,400**
32	Raingardens along FPU roads and parking areas	Franklin Pierce Drive / FPU Campus	Small Bioretention	2.0	1.45	74%	5625.0	0	$0	$0	$0	$0	$22,500	$21,000	$11,250	$14,063	$0	$0	$694	$6,950	**$76,500**	$3,400	$5,000	$15,300	$7,700	**$31,400**	**$129,500**	$600	**$135,500**
36	Infiltration along parking lot, along fence and curb, require new drainage system	Franklin Pierce Drive / Dormitory Parking	Large Infiltration / Drainage Improvements	3.1	2.61	84%	9375.0	0	$0	$0	$0	$0	$22,500	$28,000	$23,438	$32,813	$0	$0	$694	$10,740	**$118,200**	$3,400	$5,000	$23,600	$11,800	**$43,800**	**$194,400**	$600	**$200,400**
38	Infiltration BMPs and filter strips along roadway and ball field parking lot	Mountain Road / Ball field Parking	Large Infiltration	10.3	1.55	15%	5775.0	1,500	$0	$0	$0	$0	$37,500	$28,000	$14,438	$20,213	$3,000	$6,000	$991	$11,010	**$121,200**	$3,600	$5,000	$24,200	$12,100	**$44,900**	**$199,300**	$600	**$205,300**
9	Parking lot Infiltration BMPs	Sawmill Road / Parking Area	Large Infiltration	1.4	1.36	100%	4875.0	0	$0	$0	$0	$0	$7,500	$7,000	$9,750	$12,188	$0	$0	$2,167	$3,860	**$42,500**	$3,200	$5,000	$8,500	$4,300	**$21,000**	**$76,200**	$500	**$81,200**
35	Big infiltration BMP for FPU parking lots & buildings	Franklin Pierce Drive / Volley Ball Courts	Large Infiltration	3.3	2.49	76%	9750.0	0	$0	$0	$0	$0	$52,500	$35,000	$19,500	$24,375	$0	$0	$722	$13,210	**$145,300**	$3,400	$5,000	$29,100	$14,500	**$52,000**	**$236,800**	$600	**$242,800**
26	Roadside swale and raingarden	Kimball Road / Roadway Drainage	Small Bioretention / Drainage Improvements	3.6	0.46	13%	2062.5	750	$0	$0	$0	$0	$7,500	$7,000	$4,125	$5,156	$1,125	$2,250	$500	$2,770	**$30,400**	$3,200	$3,500	$6,100	$3,000	**$15,800**	**$55,400**	$500	**$60,400**
16	Redirect drainage to new bioretention area along steep FPU roads	Franklin Pierce Drive / Community Center	Large Bioretention	1.7	1.06	63%	3750.0	0	$0	$0	$0	$0	$15,000	$14,000	$9,375	$13,125	$0	$0	$500	$5,200	**$57,200**	$3,100	$5,000	$11,400	$5,700	**$25,200**	**$98,900**	$500	**$103,900**
34	Parking lot BMPs retrofit to existing drainage systems infiltration dividers, new pipe	Franklin Pierce Drive / Parking Areas & Athletic Bubble	Large Infiltration	2.9	2.31	81%	9000.0	0	$0	$0	$0	$0	$52,500	$35,000	$18,000	$22,500	$0	$0	$833	$12,880	**$141,700**	$3,500	$5,000	$28,300	$14,200	**$51,000**	**$231,200**	$600	**$237,200**
14	Bioretention swales along whole road, use existing CB as overflow	Ingalls & Mountain Road / Roadway Drainage	Small Bioretention	0.9	0.34	39%	1250.0	0	$0	$0	$0	$0	$4,500	$0	$2,500	$3,125	$0	$0	$500	$1,060	**$11,700**	$3,100	$5,000	$4,000	$2,500	**$14,600**	**$31,600**	$500	**$36,600**
21	Shoulder stabilization, plunge pool at culvert and swale	Kimball Road / Roadway Culvert	Stabilization / Sediment Removal	6.5	0.52	8%	1050.0	1,250	$0	$0	$0	$0	$0	$0	$1,575	$1,050	$1,875	$3,750	$500	$880	**$9,600**	$3,200	$3,500	$4,000	$2,500	**$13,200**	**$27,400**	$500	**$32,400**
7	Stabilize shoulder and access, repair erosion with mulch, infiltration trenches	University Drive / Boat Shoreline Access	Stabilization / Small Infiltration	3.5	0.64	19%	2300.0	5,000	$0	$0	$0	$0	$0	$0	$4,600	$18,400	$10,000	$15,000	$1,352	$4,940	**$54,300**	$3,800	$3,500	$10,900	$5,400	**$23,600**	**$93,500**	$700	**$100,500**
8	Rain Gardens upstream and downstream of culvert	University Drive / Sawmill Road	Small Bioretention	1.8	0.98	55%	3000.0	0	$0	$0	$0	$0	$3,750	$3,500	$15,000	$45,000	$0	$0	$889	$6,810	**$74,900**	$3,100	$0	$15,000	$7,500	**$25,600**	**$120,600**	$500	**$125,600**

BMP Construction Cost Estimate: Based on a combination of drainage piping, drainage structures, BMP installation, additional excavation costs, potential rock excavation and supplemental costs
- **Pipe Costs:** Linear feet of pipe times $150/lf pipe between 0-500 ft.; and $75/lf for lengths over 500 feet
- **Structure Costs:** Number of drainage structures needed times $3,500 per structure
- **BMP Installation Costs:** Cost to represent excavation, stabilization and installation of all standard stormwater treatment BMP components:
- **BMP Material Costs:** Cost to represent the required materials for stabilization and installation of all standard stormwater treatment BMP components:
- **Excavation/ Prep/ Clearing Costs:** Cost per cubic yard to excavate existing terrain beyond the volume required for the BMP construction. Estimated based on area of BMP and approximate cut depths to clear, grub, level the area and provide access prior to BMP installation
- **Supplemental Costs:** Costs carried for supplemental work that would be required for a specific BMP or location. Additional costs include liners for ponds, road re-grading, infrastructure retrofits, utility relocations, traffic control and grading required to control water and runoff during construction

BMP Engineering Cost Estimate: Based on a combination of survey, permitting and engineering/design cost estimates
- **Survey Costs:** Based on estimates to obtain topographic survey for design and permitting. Cost includes a rough base price plus a cost per acre based on the footprint of the BMP
- **Permitting Costs:** Based on estimates to perform BMP permitting for local, state and supplemental permitting. Costs based on historical data and past experience and depend on potential impacts to the brook, wetland area, surface water resources and applicable buffers.
- **Engineering Costs:** Based on estimates to complete design, plans and specifications ready for bidding. Based on a combination of historical data, an approximate 20% of construction budget and previous design project experience. Costs do not include bidding and construction based services.
- **Bid & Construction Oversight:** Based on estimates to complete bid and construction services including administrative services, construction oversight and inspection. Based on a combination of historical data and previous design project experience.

BMP Total Cost Estimate: Based on the combination of total construction costs plus engineering costs

BMP Total 10yr Cost Estimate: Based on the combination of total BMP costs plus anticipated BMP annual maintenance costs applied over a ten year period.
- **Annual Maintenance Costs:** Based on estimates to maintain the function of the BMP on an annual basis. Cost includes a rough base price plus a cost per square foot based on the footprint of the BMP

TABLE J.6 - STORMWATER BMP OPTIONS -COST DATA SUMMARY

BMP Map ID	BMP Description / Type	Location	BMP Type	Area (acres)	Impervious Area (acres)	Impervious Percent (%)	BMP Volume Provided (cf)	Additional BMP Area (sf)	Large Culvert Install Cost ($)	Large Culvert Material Cost ($)	Small Culvert Install Cost ($)	Small Culvert Mat'l Cost ($)	Drainage Pipe Cost ($)	Drainage Structure Cost ($)	WQV BMP Install Costs ($)	WQV BMP Material Costs ($)	Add'l BMP Install Costs ($)	Add'l BMP Material Costs ($)	Add'l Excavation Costs ($)	Add'l Item Costs ($)	Total Construction Cost ($)	Survey Costs ($)	Permitting Costs ($)	Design Costs ($)	Bid / Construction Oversight Costs ($)	Total Engineering Costs ($)	Total Project Costs w/ Contingencies ($)	Annual Maintenance ($)	Total 10 yr. Costs ($)
10	Rain Gardens along FPU parking lots	University Drive / Parking Area	Small Bioretention	2.6	0.74	29%	2600.0	0	$0	$0	$0	$0	$15,000	$14,000	$5,200	$6,500	$0	$0	$500	$4,120	**$45,300**	$3,100	$5,000	$9,100	$4,500	**$21,700**	**$80,400**	$500	**$85,400**
19	Infiltration BMPs & Swale Improvements	Kimball Road / Roadway Drainage	Small Infiltration / Drainage Improvements	1.7	0.44	25%	1575.0	1,000	$0	$0	$0	$0	$0	$0	$3,150	$12,600	$1,500	$3,000	$500	$2,080	**$22,800**	$3,200	$3,500	$4,600	$2,300	**$13,600**	**$43,700**	$500	**$48,700**
4	Roadside swales and Treatment Filter Strip / Bioretention	University Drive / Roadway Drainage	Small Bioretention / Vegetated Filters	2.3	0.69	30%	2512.5	2,000	$0	$0	$0	$0	$0	$0	$5,025	$6,281	$4,000	$8,000	$681	$2,400	**$26,400**	$3,400	$3,500	$5,300	$2,600	**$14,800**	**$49,400**	$600	**$55,400**
1	Plunge pools and swales along Rt. 119 at existing outfalls	NH Route 119 / Highway Drainage	Sediment Removal	1.0	1.00	100%	900.0	2,500	$0	$0	$0	$0	$0	$0	$1,350	$900	$6,250	$3,750	$1,130	$1,340	**$14,700**	$3,400	$3,500	$4,000	$2,500	**$13,400**	**$33,700**	$600	**$39,700**
29	Install new swale, CB, outfall pipe, and plunge pool	Private Road / Roadway Drainage	Drainage Improvements / Sediment Removal	3.4	0.43	13%	1550.0	100	$0	$0	$0	$0	$3,000	$3,500	$2,325	$1,550	$150	$300	$500	$1,130	**$12,500**	$3,200	$5,000	$4,000	$2,500	**$14,700**	**$32,600**	$500	**$37,600**
2	Plunge pools and infiltration swales	NH Route 119 / Highway Drainage	Sediment Removal	2.3	0.70	30%	675.0	2,500	$0	$0	$0	$0	$0	$0	$1,013	$675	$6,250	$3,750	$963	$1,270	**$13,900**	$3,400	$3,500	$4,000	$2,500	**$13,400**	**$32,800**	$600	**$38,800**
25	Culvert repair and swale stabilization	Kimball Road / Roadway Culvert	Drainage Improvements / Stabilization	2.5	0.49	20%	0.0	750	$0	$0	$10,000	$5,000	$0	$0	$0	$0	$1,125	$2,250	$500	$1,890	**$20,800**	$3,100	$3,500	$4,200	$2,100	**$12,900**	**$40,400**	$500	**$45,400**
6	Install curbing, headwall rehab, stabilize shoulder, install deep sump catch basins	University Drive / Sawmill Road	Stabilization / Drainage Improvements	3.0	0.53	18%	0.0	500	$0	$0	$0	$0	$15,000	$14,000	$0	$0	$750	$1,500	$500	$3,180	**$34,900**	$3,100	$3,500	$7,000	$3,500	**$17,100**	**$62,400**	$500	**$67,400**
Totals - Top 30				**121.75**	**37.04**																**$1,682,700**					**$744,100**	**$2,912,200**	**$16,600**	**$3,078,200**

BMP Construction Cost Estimate: Based on a combination of drainage piping, drainage structures, BMP installation, additional excavation costs, potential rock excavation and supplemental costs
- **Pipe Costs:** Linear feet of pipe times $150/lf pipe between 0-500 ft.; and $75/lf for lengths over 500 feet
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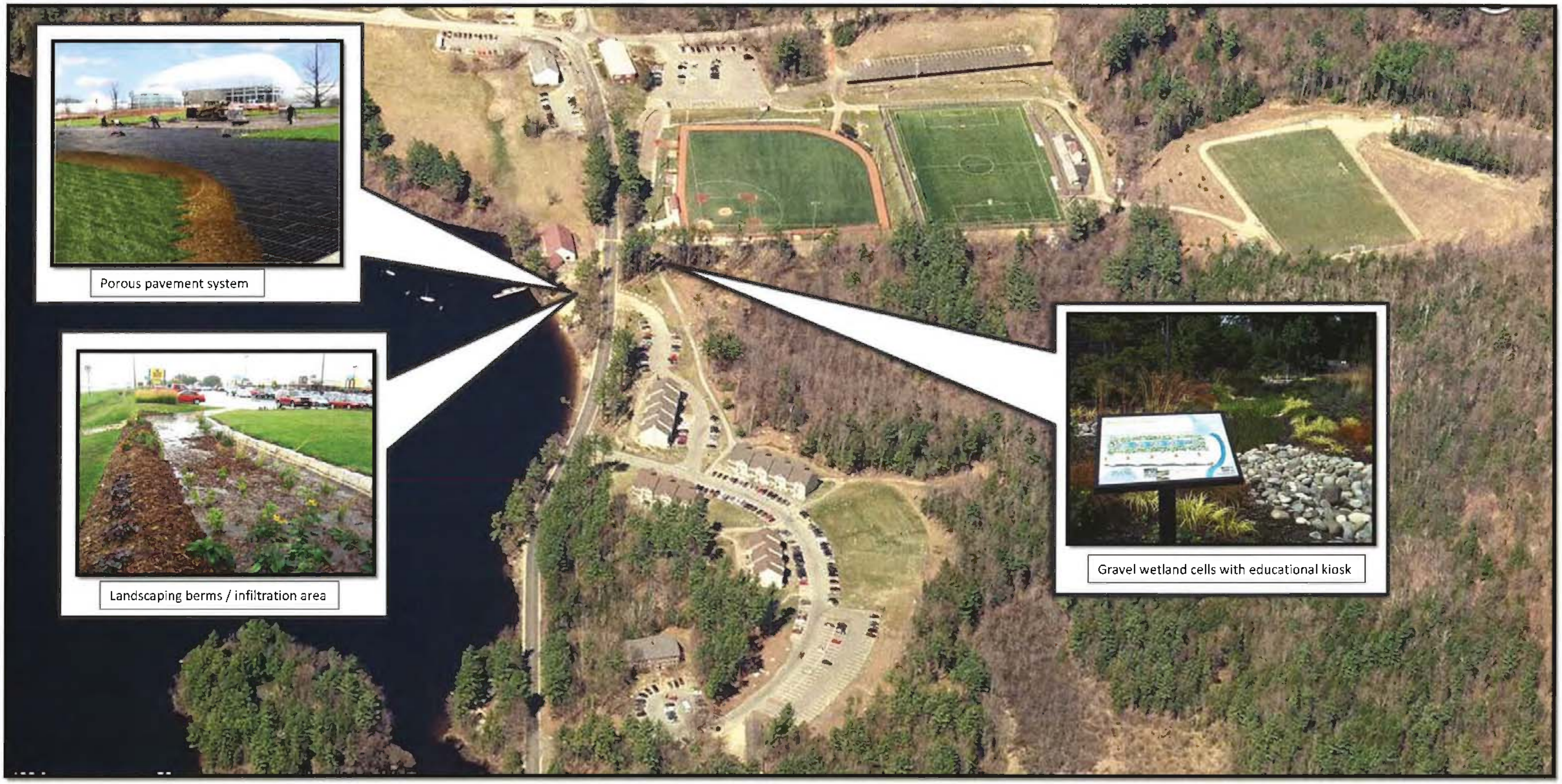
- **Excavation/ Prep/ Clearing Costs:** Cost per cubic yard to excavate existing terrain beyond the volume required for the BMP construction. Estimated based on area of BMP and approximate cut depths to clear, grub, level the area and provide access prior to BMP installation
- **Supplemental Costs:** Costs carried for supplemental work that would be required for a specific BMP or location. Additional costs include liners for ponds, road re-grading, infrastructure retrofits, utility relocations, traffic control and grading required to control water and runoff during construction

BMP Engineering Cost Estimate: Based on a combination of survey, permitting and engineering/design cost estimates
- **Survey Costs:** Based on estimates to obtain topographic survey for design and permitting. Cost includes a rough base price plus a cost per acre based on the footprint of the BMP
- **Permitting Costs:** Based on estimates to perform BMP permitting for local, state and supplemental permitting. Costs based on historical data and past experience and depend on potential impacts to the brook, wetland area, surface water resources and applicable buffers.
- **Engineering Costs:** Based on estimates to complete design, plans and specifications ready for bidding. Based on a combination of historical data, an approximate 20% of construction budget and previous design project experience. Costs do not include bidding and construction based services.
- **Bid & Construction Oversight:** Based on estimates to complete bid and construction services including administrative services, construction oversight and inspection. Based on a combination of historical data and previous design project experience.

BMP Total Cost Estimate: Based on the combination of total construction costs plus engineering costs

BMP Total 10yr Cost Estimate: Based on the combination of total BMP costs plus anticipated BMP annual maintenance costs applied over a ten year period.
- **Annual Maintenance Costs:** Based on estimates to maintain the function of the BMP on an annual basis. Cost includes a rough base price plus a cost per square foot based on the footprint of the BMP

Appendix K
Stormwater Conceptual BMPs



Option 1 – FPU Campus - Boat House & Fields

Install gravel wetland cells on either side of access pathway connected by cross culvert. Install underground drainage piping as needed to divert drainage to gravel wetlands from roadways / parking areas and ball fields. Design treatment areas to overflow to existing outfall by connecting gravel wetland piping to existing drainage piping. Stabilize a portion of gravel parking area at the boat house with porous pavers and/or porous pavement systems (Geoblock®). Prevent beach erosion by installing curbing / landscaping berms to capture and infiltrate sheet runoff prior to reaching beach area. Provide educational kiosk.

Option 2 – FPU Campus – East Parking Areas

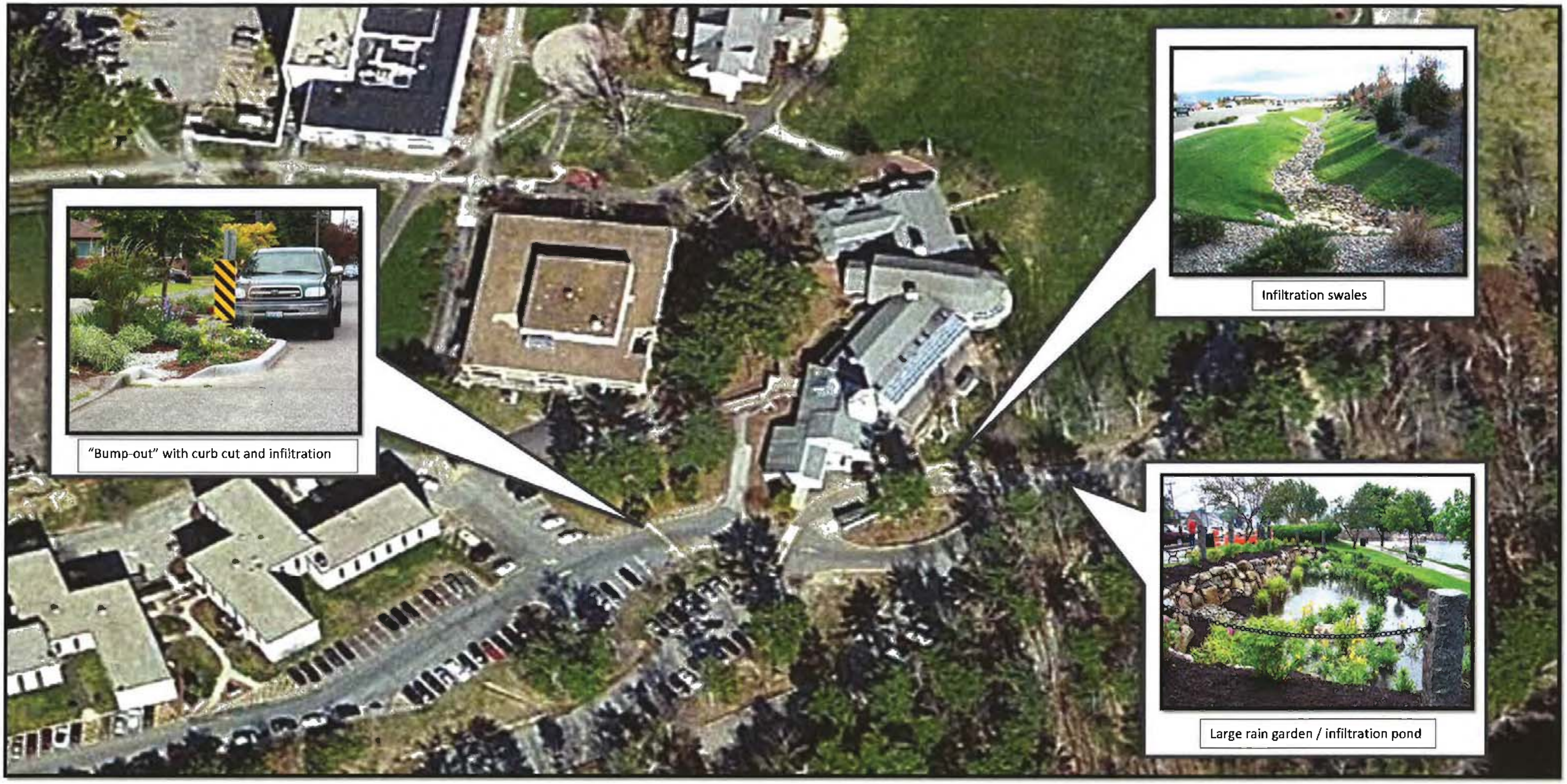
Install tree box filters or infiltration dividers throughout large parking areas on the east side of FPU campus. Install infiltration beds or large rain gardens adjacent to tennis courts to handle runoff from nearby paved parking areas and ball fields. Install underground drainage piping as needed to divert drainage to treatment areas. Design treatment areas to overflow to existing outfalls by connecting to existing drainage piping.

Option 3 - Kimball Rd – Beach Access

Install several rain gardens at Beach access. Use existing drainage system to connect rain garden overflows to outlet piping. Install rain gardens on both sides of Kimball Road and adjacent to the beach area / existing drainage outfall. Stabilize a small section of beach access with porous pavers and/or porous pavement systems (Geoblock®). Provide overflow system for porous pavement to prevent runoff from flowing over beach area. Connect overflow to existing drainage system.

Option 4 - Kimball Rd – Sharp Corner

Install new curbing and divert flows to small treatment areas on either side of sharp curve via curb cuts. Install up-gradient catch basins and drainage piping as needed to divert drainage to a wetpond located on Town owned property. Up-gradient catch basins will reduce the amount of runoff reaching the "low spot" on the sharp curve. Re-grade sections of roadway as needed to divert runoff to treatment areas. Install roadside vegetated buffers along the lakeside shoulder and create one stabilized pathway for snow mobiles to access the lake from the roadway.



Option 5 – FPU Campus – West Parking Areas & Roadway

Install a series of curb-cuts and "bump-outs" to direct runoff to rain gardens / infiltration areas on main section of roadway. Place "bump-outs" in specific areas to promote traffic calming for busy sections of roadway and areas of heavy pedestrian traffic. Along steep sections of roadway, install infiltration swales reinforced with rounded riprap or river stone. Install checkdams to reduce runoff velocities and promote infiltration. Connect overflows for drainage system to existing drainage. Install larger rain garden / infiltration pond at the base of the steep roadway section and re-direct existing drainage outfall into treatment area.

Option 6 – FPU Campus – Community Center

Install rain gardens at FPU community center to handle runoff from adjacent walkways and paths. Convert a section of existing drainage swale adjacent to Mountain Road to an infiltration swale by installing sub-surface crushed stone beds and riprap checkdams. Install infiltration beds/gardens around Community Center and connect existing roof leaders to infiltration beds for irrigation of vegetation.

Option 7 – Route 119 – Existing drainage swales and paved outfalls

Install plunge pools / sediment traps on lakeside shoulder (westbound) of Route 119. Plunge pools will be installed where surface runoff from roadway drains onto existing paved swales. Plunge pools to be installed at locations that can be easily maintained from the roadway shoulder and without interference with existing guardrail infrastructure. Retrofit existing drainage swale along eastbound shoulder of Route 119 by installing bio-retention or gravel treatment swale. Install rock check dams to reduce velocities and promote subsurface flows.

Option 8 – Mountain Rd – Gravel Road Drainage & Erosion

Re-grade and stabilize steep gravel roadway sections. Re-grade and reinforce drainage swales with stabilization materials and check dams to reduce runoff velocities and prevent erosion. In some very steep areas install riprap swales with reinforced shoulders. On flatter sections of roadway install vegetated swales reinforced with turf blankets. Install plunge pools and gabion level spreaders at existing outfalls to prevent erosion on steep slopes. Stabilize sections of upper roadway embankments and eroded drainage channels with bio-engineered slope treatment.

Option 9 – Mountain / Ingalls Rd – Culvert Crossing & Drainage

Improve grading on roadway. Stabilize existing drainage swales with turf reinforcement / vegetation and install checkdams. Install series of small drainage crossings with plunge pools and infiltration areas along steep portions of roadway. Improve drainage around culvert crossing and stabilize side slopes with wing-walls and riprap drainage swales. Install level spreader and treatment BMPs near culvert if permissible by NHDES.

Option 10 - Kimball Rd – Gravel Turn-around

Re-grade and stabilize steep gravel roadway section of private road. Install drainage swales with check dams to reduce runoff velocities. Install underground piping and drainage structures as needed to reduce puddles and erosion at turn-around. Direct new drainage system to small wetpond and/or gravel treatment system prior to discharge into existing drainage outfall piping.

Appendix L
Wastewater BMP Evaluation

Appendix L – Wastewater BMP Alternatives Analysis and Evaluation Description

Provided below is a description of the methods used for the wastewater BMP ranking process. A summary of the assumptions and results for the wastewater BMP ranking analysis is provided below in Table L.1.

Potential wastewater BMPs were identified and evaluated for feasibility. Conservative cost and pollutant load reduction approximations were made to compare the cost per kilogram of phosphors removed for each alternative over a ten year period. The most cost effective alternatives were selected for further evaluation and study as recommendations. This summary includes a description of each of the analyzed alternatives with the assumptions used to generate cost and pollutant removal estimates (These are provided in no particular order):

1. **Current Discharge – Increase TP Removal at the Plant with Chemicals –** The FPU WWTP uses grit chambers and rotating biological contactors to treat the wastewater. Phosphorus and other pollutants are removed through the use of flocculation, settling, biological removal and filtering. The flocculation process is enhanced through addition of chemicals to promote binding of particles in the waste stream, making them larger and more likely to settle or be filtered. This is done at the FPU WWTP by the addition of aluminum sulfate. Sodium hydroxide is also added to the wastewater to control the pH at a level that is adequate for flocculation.

   The treatment plant currently uses approximately 6,000 -7,000 gallons per year of aluminum sulfate with an average resultant phosphorus concentration of 0.22 mg/L in the wastewater stream. This effluent would produce approx. 11-14 kg of phosphorus per year based on the estimated annual flow. This load could be reduced at the FPU facility by adding more aluminum sulfate and sodium hydroxide per gallon of treated effluent. Currently the dosage rate of 1 gallon of aluminum sulfate and 10 lbs of sodium hydroxide is added per 2,000 gallons of treated effluent. This BMP assumes that this dosage rate could be increased slightly to between 1.03 – 1.10 gals of aluminum sulfate and approx. 11 -12 lbs of sodium hydroxide per 2,000 gallons to decrease the concentration by approx. 50% - 70%. This could translate to between approx. 200 - 700 additional gallons of aluminum sulfate per year and potentially decrease the annual loading to the RIBs to 6-7 kg/ year. Dosage rates and actual concentration decreases would have to be confirmed through small scale pilot studies prior to full scale implementation of this BMP. It should be noted that the current phosphorus removal efficiency of the WWTP is estimated around 95% and to cut that by 50%-70%, the plant overall efficiency would increase to 98% or 99%. This potential phosphorus reduction could be hard to achieve. The benefits of improving this overall small increase in efficiency should be weighed heavily against the potential costs associated with increasing admixtures by 5% to 10%.

   The current cost of aluminum sulfate is $1.19 per gallon and sodium hydroxide is $0.0224 per pound. Additional costs for this BMP would include installation of new feed system for sodium hydroxide and an aluminum sulfate diaphragm pump feeder. To be conservative, removal efficiencies for this BMP could be 50%.

2. **Current Discharge – Iron Enhanced Sand Filtration in RIBs –** Similar to a residential leach field, the rapid infiltration beds use washed sand to physically remove phosphorus from the FPU treatment plant effluent. The treated effluent is pumped to the beds and the wastewater is hydraulically loaded on top of the sand layers to promote the rapid infiltration into the substrate and groundwater below. The sand material is used to filter and absorb the flocculated phosphorus, but rapid infiltration is not always effective at removing the dissolved phosphorus portion in the waste stream. The dissolved portion can still pass through to the surrounding groundwater and surface water. Eventually the top portion of the sand beds can become "blinded" or clogged with phosphorus, minimizing the sand's assimilative capacity to remove more phosphorus. This can be avoided through rotation of the beds and routine maintenance that includes mixing of the top layers of sand. Even with these efforts, eventually the sand will need to be replaced.

   At the time of replacement, the new sand can be mixed with iron filings, which can increase the capacity of the sand to remove dissolved phosphorus by binding the phosphorus through oxidization of the iron. FPU anticipates having to do this replacement within ten years of construction which would be 2019. This BMP assumes that as a pilot study, the iron filings could be added to one of the beds to determine if the phosphorus removal could be increased. It is assumed that the beds are 1.58 acres in size and the top 4 inches of material might be replaced. Iron filings would be added at a rate of 5% to 8% by weight of sand. It is estimated that approx. 800 cubic yards of sand and 100 tons of iron filings would be needed. It is assumed that filings can cost approx. $900/ton to purchase and sand can cost up to $40 per cubic yard. Removal efficiencies could 50% to 60%. Actual TP load reductions for this BMP could vary based on the implementation of other WWTP improvements. Potential loading to the RIBs could be reduced based on reduced loadings elsewhere. For comparison purposes, this BMP assumes no other BMPs are implemented in the "upstream" portion of the waste stream.

3. **Current Discharge – Increase Retention Time of Plant –** As noted above, The FPU WWTP could become more efficient at removing phosphorus and other pollutants. In addition to adding chemicals, this could be done by increasing the retention or contact time of the plant. The longer time period the water is treated, the better removal of pollutants. This could be done in many ways, but most would require higher principal costs to physically modify or add on to the plant treatment works. These modifications could include, but are not limited to:

   - Addition of an RBC to provide, two contactors in series;
   - Installation of recycle piping to run RBCs in series or include multiple runs through the contactors;
   - Installation of additional treatment components like secondary settling tanks or sequencing batch reactors.

   It is assumed that the principal costs for all of these modifications or upgrades could be in the range of one million dollars or more for a plant of this size. These upgrades could be funded through different means, but would likely one be planned for the future if the FPU campus were to expand greatly. Removal efficiencies could increase by 30% - 40%.

4. **Current Discharge – Collection System Improvements –** The sewer collection system for FPU includes both gravity pipes and pressure mains. Some of the gravity pipes could potentially add increased flows that can affect the operation of the treatment. Due to the nature of the waste stream associated with a populations living on a college campus, the wastewater system is susceptible to shock loading or large fluctuations of the waste water flows, causing the plant to be overwhelmed, thereby decreasing the treatment of pollutants for that time period. This can happen when the majority of the population prepares for school in the morning, east at lunchtime or when preparing for bed in the evening. If the collection system is in poor condition, large amounts of inflow and infiltration (I&I) can have the same effect on the treatment plant by overwhelming it with increased flows during wet seasons or rain storms.

   FPU has been in the process of inspecting and monitoring the collection system for I&I and conducted one round of pipe improvements to minimize these effects. There still remain several portions of the system that could use these improvements and it is estimated by FPU staff that a storm that produces 1-inch of rain, results in approx. 10,000 additional gallons of flow to the WWTP. As a long-term BMP, this I&I program could be continued and the system maintained to reduce this shock-loading and increase the resilience of the plant. A 12-inch diameter sewer pipe could cost approx. $50 - $80 per linear foot to line and an additional $30 - $50 per linear foot to inspect. Removal efficiencies could be 20% to 30%.

5. **Current Discharge – WWTP Headworks Improvements –** Similar to the proposed improvements to the collection system, this BMP would provide resiliency for the plant by reducing the effects of flow fluctuations associated with the campus wastewater stream. As noted above, The FPU WWTP uses grit chambers and rotating biological contactors to treat wastewater. The plant layout and individual components rely on a steady flow of wastewater to operate at the highest capability and shock-loading can cause issues with treatment. This BMP would include a means to minimize the effects of shock-loading by adding storage capacity at the headworks of the plant.

   A large storage tank could buffer impacts by storing wastewater during increased periods of flow and releasing the water slowly to the treatment plant at a rate similar to normal operation. This would allow the plant and treatment components to function under a consistent condition and potentially increase the removal of pollutants. It is assumed that a 10,000 gallon underground tank (approx. 1/3 of the daily flow) could provide enough buffering capacity during peak times. However, collection and study of flow data the daily trends would be recommended to confirm this sizing. Large cast-in-place concrete tanks can cost $4 and $8 per gallon to construct. Removal efficiencies could increase by 30% - 40%.

6. **Current Discharge – Reduced Water Consumption –** This BMP count include many different options to help reduce the amount of water the WWTP needs to handle in a day and to buffer some of the shock-loading that can occur during times of high water consumption. Options for reduced water consumption on campus include, but are not limited to:

- Installation of low flush toilets;
- Installation of low flow fixtures;
- Installation of gray water recycle systems.

It is assumed that the principal costs for all of these modifications or upgrades could be in the range of $50,000 to $250,000 or more per building on campus depending on the size and type of facility. There are approx. 20 buildings on campus and some of the large dormitories or cafeteria's produce a lot more wastewater than others and also have a lot more plumbing fixtures. This can result in a large variation in cost, but also provide a lot higher benefit towards water use reduction, improving the cost-effectiveness.

These upgrades could be funded through several different means and should be planned carefully to coincide with any future planned improvements or upgrades to existing facilities. Additionally, due to the relatively high costs and potential LEED tax savings associated with these options, this "green technology" approach should be considered during long-term planning and the benefits should be weighted over time to determine if these could be a cost-effective approach for the particular building or facility. Small pilot studies could be completed first on smaller buildings prior to complete conversion of larger buildings to determine the feasibility, potential issues and benefits associated with these technologies. These projects should be budgeted well in advance if the FPU campus expands or new develop is proposed. Removal efficiencies could increase by 20% - 30%.

7. **Historic Discharge – Restoration of Wetland – Dredge or Harvest –** It is assumed that **t**he northern wetland in the Mountain Road Inlet Subwatershed is highly eutrophic and has lost both its assimilative capacity to naturally reduce phosphorus levels through bioretention and biological means and lost its hydraulic capacity due to excessive plant growth/die-off and sedimentation. The residual phosphorus for years of wastewater discharge has overwhelmed the waterbody and combined with additional nutrient loading from stormwater the system is now releasing phosphorus to the nearby streams and Pearly Pond.

   Attempts to restore the wetland could be made by reducing the excess growth and sedimentation to reestablish its nutrient buffering capacity. This could be done by dredging sediments or harvesting excess plant growth and along with that removing a large source of phosphorus and other nutrients. The wetland would then have to be re-established with native plant species to promote healthy nutrient uptake and release and balance the system so it does not release high levels of phosphorus. Any of these alternatives could have large environmental impacts to the eco-system and wildlife that rely on the wetland for food a shelter. This approach would have to be carefully planned and permitted and is likely to be considered too high an impact to that ecosystem to make it beneficial. It is assumed that the wetland is approximately 20 acres in size. The cost to dredge or harvest is assumed to be $30 to $50 per cubic year of wetland plant/sediment. This does not include the cost to dispose of the material. A cost of $3- $5 per square yard is assumed for installation / restoration of wetland plants. Removal efficiencies could be very high for the large phosphorus particles. Dissolved phosphorus levels could also decline very rapidly, but could level out or potently increase while the system tries to reach a balance. For comparison purposes, an immediate removal of 90% is assumed for the first year, followed by 50% removal subsequent years. This option was ruled out due to environmental concerns.

8. **Historic Discharge – Restoration of Wetland – Phosphorus Binding –** In addition to the removal of the excess phosphorus in the wetland, the buffering capacity could be increased by binding the stored phosphorus through chemical treatment. This could include the application of alum or other chemicals that would be used to bind the phosphorus that is stored in the sediment and decayed plant material. This type of treatment has been implemented successfully on lakes and ponds that have become eutrophic. However, the costs are very high and the implementation should be carefully planned to minimize potential environmental side effects associated with chemical treatment. Additionally, the cost to apply chemicals to a confined wetland with very little open water could be much higher than a typical open water application. The application efficiency may also be in question due to the excessive plant growth. It can cost approximately $700 - $1,500 per acre to treat an open surface water body. Removal efficiencies would be similar to those for dredging with a large removal followed by a reduced efficiency until levels dissipate. For comparison purposes, an immediate removal of 90% is assumed for the first year, followed by 50% removal subsequent years. This option was ruled also out due to environmental concerns. Removal efficiencies could

9. **Historic Discharge – Treatment of Wetland Effluent –** Potential BMPs with much less environmental impact would include the treatment of phosphorus at the discharge of the wetland into Pearly Pond. This option could utilize existing access points where the wetland discharges through culverts prior to entering the pond. These culverts and the area around them could be retrofitted with treatment methods that would promote nutrient uptake until the wetland naturally reaches a more healthy nutrient balance and effluent phosphorus concentrations diminish. Treatment methods could include:

    - Installation of off-line treatment pond with new culvert;
    - Retrofit of culverts and crossings to include iron enhanced sand filters;
    - Installation of temporary floating treatment islands or cells at various locations prior to discharge into the pond.

    These BMPs would utilize a much smaller footprint and therefore have less environmental impacts, although would still require challenging permitting due to construction in or/nearby water resources. Costs for iron enhanced sand can be assumed to be between $6.00 and $10.00 per cubic foot of filter. Costs for a treatment pond could be $5.50 per cubic foot of pond volume installed and the cost for a floating treatment island could be $5 to $25 per square foot depending on what materials are used and who completes installation. Annual O&M costs for these alternatives could range from $500 per year the treatment pond up to $2,000 per year for the floating treatment islands. Removal efficiencies might not be as high or as immediate as dredging / chemical binding alternatives, but could still be in the 50% to 70% range per year for dissolved phosphorus for each of the alternatives over the lifespan of the project. Routine annual maintenance costs should also be carried for these alternatives.

TABLE L.1 - WASTEWATER BMP OPTIONS - COSTS AND RANKING

BMP I.D.	BMP Description / Type	BMP Material Costs ($)	Add'l Material Costs ($)	BMP Installation Costs ($)	Add'l Item Cost ($)	Pipe Item Cost ($)	Structure Item Cost ($)	Total Implement Cost ($)	Total Engineer Costs ($)	Annual Planning Cost ($)	Total Planning Costs ($)	Total Costs ($)	Total Project Costs w/ Contingency ($)	Total Cost Grant Request (60%) ($)	Total Cost Grant Match (40%) ($)	Annual O & M Cost ($)	Total 10 yr. Costs ($)	Total Annual TP Loading (kg/yr.)	TP 10 Yr. Removal (kg)	10 Year Cost / kg TP ($/kg)	Notes
WW-1	Historic Discharge - Wetland Effluent Treatment - Floating Wetland Islands	$5,000	$0	$2,500	$500	$0	$0	$8,000	$3,200	$2,000	$10,000	$21,200	$31,800	$19,080	$12,720	$1,000	$41,800	40.00	280.00	$149	Costs assume five 10x10 floating islands are installed at $15 per square foot plus additional $500 for anchors and tie systems. It is assumed that it costs $1,000 per year to remove and replace dead vegetation. TP loading assumes 30 kg/year from wastewater. An average reduction of 60% - 70% is assumed
WW-2	Historic Discharge - Wetland Effluent Treatment - Iron Enhanced Sand Filter	$7,500	$0	$5,000	$10,000	$0	$0	$22,500	$11,000	$2,000	$4,000	$37,500	$56,250	$33,750	$22,500	$3,000	$86,250	40.00	240.00	$359	Costs assume a 50 foot long sand filter is installed in line with the culvert. This includes 50 cubic yards of sand and 5 tons of filings and additional costs to provide a gabion access pad. TP loading assumes 30 kg/year from wastewater. It is assumed that this filter would be replaced twice in 10 years. An average reduction of 60% - 70% is assumed
WW-3	Current Discharge - Increase TP Removal at Plant through Chemical Additives	$5,950	$1,120	$5,000	$1,000	$0	$0	$13,070	$5,921	$500	$5,000	$23,991	$35,987	$21,592	$14,395	$500	$40,987	12.00	60.00	$683	Costs assume an annual increase of 500 additional gallons of aluminum sulfate plus and 5,000 pounds of sodium hydroxide over a ten year period plus and installation cost for pumps and feeder systems. Additional O&M costs were included at $500 per year. TP loading assumes 11 kg/year from wastewater. An average reduction of 50% is assumed
WW-4	Historic Discharge - Wetland Effluent Treatment - Off-line Pond	$25,000	$0	$30,000	$5,000	$10,000	$14,000	$84,000	$35,200	$2,000	$4,000	$123,200	$184,800	$110,880	$73,920	$500	$189,800	40.00	260.00	$730	Costs assume an offline wetpond would be sized for approx. 1% of the wetland volume. The cost also includes $24,000 for diversion piping with structures and $5,000 for additional items. O&M costs were included at $500 per year. TP loading assumes 30 kg/year from wastewater. An average reduction of 60% - 70% is assumed
WW-5	Historic Discharge - Wetland Restoration through Chemical Treatment	$30,000	$0	$32,000	$0	$0	$0	$62,000	$38,600	$5,000	$10,000	$110,600	$165,900	$99,540	$66,360	$0	$165,900	40.00	216.00	$768	Costs assume 20 acres of wetland is chemically treated twice in the 10 year period by pontoon boat or by hand. TP loading assumes 30 kg/year from wastewater. An average reduction of 90% the first year and 50% subsequent years is assumed
WW-6	Current Discharge - Iron Enhanced Sand in RIBs	$32,000	$85,500	$8,000	$0	$0	$0	$125,500	$12,500	$500	$5,000	$143,000	$214,500	$128,700	$85,800	$500	$219,500	12.00	70.80	$3,100	Costs assume 800 cubic yards of sand and 95 tons of filings plus and installation cost for those materials. Additional O&M costs were included at $500 per year. TP loading assumes 11 kg/year from wastewater. An average reduction of 50% - 60% is assumed
WW-7	Current Discharge - WWTP Headworks Improvements	$20,000	$5,000	$40,000	$15,000	$15,000	$5,000	$100,000	$45,000	$2,000	$4,000	$149,000	$223,500	$134,100	$89,400	$2,000	$243,500	12.00	46.80	$5,203	Costs assume a 10,000 gallon equalization tank is installed plus $15,000 in misc. equipment and $20,000 for piping and cast-in-place structures. O&M costs were included at $2,000 per year. TP loading assumes 11 kg/year from wastewater. An average reduction of 30% - 40% is assumed
WW-8	Historic Discharge - Wetland Restoration through Dredging / Harvesting	$230,000	$194,000	$291,000	$0	$0	$0	$715,000	$120,000	$2,000	$2,000	$837,000	$1,255,500	$753,300	$502,200	$0	$1,255,500	40.00	216.00	$5,813	Costs assume 4,600 cubic yards of material is dredged/harvested and the wetland is restored using plant plugs and seed mixes at $2 per square yard. TP loading assumes 30 kg/year from wastewater. An average reduction of 90% the first year and 50% subsequent years is assumed
WW-9	Current Discharge - Collection System Improvements	$30,000	$80,000	$0	$0	$0	$0	$110,000	$44,000	$1,500	$15,000	$169,000	$253,500	$152,100	$101,400	$0	$253,500	12.00	34.80	$7,284	Costs assume 1,000 linear feet of pipe are inspected and lined over 10 years. This would include about 25% of the gravity collection system on campus. TP loading assumes 11 kg/year from wastewater. An average reduction of 20% - 30% is assumed
WW-10	Current Discharge - Reduced Water Consumption / Source Loading	$200,000	$0	$0	$0	$0	$0	$200,000	$80,000	$2,000	$20,000	$300,000	$450,000	$270,000	$180,000	$2,000	$470,000	12.00	34.80	$13,506	Costs assume two dorm buildings are retrofitted with small pilot gray water systems at $100,000 per system. O&M costs were included at $2,000 per year. TP loading assumes 11 kg/year from wastewater. An average reduction of 20% - 30% is assumed
WW-11	Current Discharge - Increase Retention Time of Plant	$0	$0	$150,000	$250,000	$11,250	$10,000	$421,250	$151,375	$2,000	$4,000	$576,625	$864,938	$518,963	$345,975	$5,000	$914,938	12.00	46.80	$19,550	Costs assume $400,000 for purchase and installation of an additional RBS or batch reactor plus another $20,000 for piping and cast-in-place structures. O&M costs were included at $5,000 per year. TP loading assumes 11 kg/year from wastewater. An average reduction of 30% - 40% is assumed

Appendix M
Septic System BMP Evaluation

Appendix M – Septic System BMP Alternatives Analysis and Evaluation Description

Provided below is a description of the methods used for the septic system BMP ranking process. A summary of the assumptions and results for the septic system BMP ranking analysis is provided below in Table M.1.

Potential BMPs were identified and evaluated for feasibility. Conservative cost and pollutant load reduction approximations were made to compare the cost per kilogram of phosphors removed for each alternative over a ten year period. The most cost effective alternatives were selected for further evaluation and study as recommendations. This summary includes a description of each of the analyzed alternatives with the assumptions used to generate cost and pollutant removal estimates (These are provided in no particular order):

1. **Public Education & Routine Maintenance –** Currently, septic systems in the densely populated residential areas do not seem to be a big concern. Based on results of the Resident Survey, most residents understand the importance of routine maintenance and a properly functioning septic system. Even though the majority residents are well educated on this area and other phosphorus source reduction techniques, there are still more people that need to be reached, potential candidates can be trained on how to reach out to others and additional pieces of education to provide. Several public outreach campaigns could be planned to ensure the knowledge that exists around the lake continues to be passed to new residents and homeowners in the long-term. This can be an on-going effort and the outreach can be tailored for different potential issues and technologies that become available in the future. According to results of the Resident Survey, approximately 50% routinely clean their septic tank every two years, while the remaining 40% - 50% go much longer between cleanings or don't know.

   One example of this outreach could be distribution of septic system maintenance logs with information /advertisement for local septic tank cleaning companies. This could lead to potential cost sharing / saving on maintenance activities. Representatives from neighborhood groups can reach out to companies to explore cost saving benefits through bulk cleanings and potential free advertisement through distribution of the maintenance log. Additionally, there are other bits of knowledge that may not be relevant now, but could become relevant in the future. For example, results of the Resident Survey showed that approximately 40% of the respondents had septic systems that were over 15 years in age. Educational campaigns could be developed to teach homeowners how to detect a failing septic system, before the problem becomes too costly. Even though leach field replacement can be expensive, pipe back-ups can result in expensive cleanups and even worse, damage to the home. A public education program should include monitoring of system maintenance and tracking of replaced and/or repaired septic systems within 125 feet of the pond. Costs for public education can vary, but for BMP comparison purposes, an annual budget of $2,500 was carried for education efforts through-out the watershed. This could affect all 46 septic systems within the shoreland buffer and could eventually improve removal efficiencies by 50% - 60%.

2. **Sewering of Residential Areas –** Sewering was one of the two structural BMP alterative that was explored for Pearly Pond. It could be a long-term cost-effective solution for

some locations around the pond based on the size of the population and the proximity to the FPU WWTP, which currently is the only wastewater treatment plant in the area. For BMP ranking purposes, the three aforementioned densely populated septic areas were identified for sewering.

This alternative would transfer the phosphorus load completely from the septic inputs to the wastewater inputs. Even though these alternatives would increase phosphorus loading to the WWTP, the overall benefit would be better plant operation due to more consistent seasonal flows at the plant and less fluctuation in daily flows and shock-loading by using a controlled pump schedule to fit in between the times of high demand associated with the campus wastewater stream. For comparison purposes, phosphorus removal efficiencies due to sewering was assumed to be 70% - 90% of the total load from the selected area for Kimball Road and Moose Lane. This assumes a 90% connection rate to the system after ten years, as some of the homeowners may choose to remain on septic. Sewering options for the Lakeview apartments assumes a 90% reduction of the total anticipated load for that complex assuming that a portion of that phosphorus load would stay in the leach field for some years while some would go to the WWTP and potentially to Pearly Pond via the RIB discharge.

Costs for conceptual sewering include gravity piping, sewer infrastructure and residential connections. For costing purposes, only one pump station with holding tank was assumed for all the alternatives. The storage tank and pump would be tied to the existing pressure line on University Drive to make the final connection to the WWTP. It is most likely that a long-term sewering project would be completed in several phases. For this project, the storage tank and additional pump would be completed first on FPU campus, followed by phased piping projects to tie in nearby neighborhoods as the sewer line is extended to the maximum extent. The sewer projects would be terminated at the point where the collection system could no longer be fed by gravity. Any potential extension would require an additional pump station to make the connection. Thus, as the residential areas become farther away, the cost effectiveness may go down, requiring the exploration of other structural alternatives. Costs for sewering included a cost of $100 to $125 per linear foot for gravity pipe, between $4 and $8 per gallon to construct a storage tank and $20,000 - $30,000 for an automated pump system. Sewering options with pumps should include a $5,000 annual O&M cost for monitoring, maintenance and repairs.

3. **Small Community Wastewater Systems –** In lieu of sewering, options to construct small individual wastewater collection and treatment systems in rural or isolated areas was reviewed for several locations around the pond. These systems are more cost-effective then sewering because the use of large and lengthy gravity piping and the need for large pump stations could be avoided. The treatment systems would consist of storage tanks and leaching structures / leaching fields similar to the RIBs. These could be strategically located to be on town-owned or private property. The treatment areas could be constructed outside the 125 foot shoreland buffer and up gradient of the area it serves to ensure clearance to groundwater and/or ledge.. The collection system can utilize small individual low pressure pumps at each household or use a shared storage tank / pump system for cost savings. Existing septic tanks can also be retrofitted with pumps to tie into the low pressure collection system.

Pollutant removal efficiencies for the community systems would be more effective than individual septic systems located along the shoreline, because of the increased distance from the pond and Even though these options would reduce the total septic system in the model and TMDL based on re-location outside the shoreland buffer, these would not eliminate the phosphorus load to the lake completely as there would still be loading to the groundwater and eventual the lake. Removal efficiencies for these options are assumed to be 85% - 95% for the affected septic systems based on placement outside the shoreland buffer. This BMP assumes it would potentially affect approx. 6 systems on the University / Moose Lane side of the pond and 40 systems along Kimball Road side.

There are two major component costs associated with this alternative, the principal cost to install the treatment system, tanks, pumps and small diameter pressure line and long-term operation and maintenance cost for electricity, repairs and maintenance of the system. With In most cases, these systems can be paid for through low interest loans with assistance by the town or pond association. With community systems like this, the associated households can share the costs to not only pay down the principal loan, but also the long-term O&M costs. These community systems become more cost-effective with increased "buy-in" by local residents to the system, thereby reducing overall costs to each payer as well as removing the long-term liability of costs associated with an individual paying for an expensive septic system repair and / or replacement. Even though the larger system may be more cost-effective, a principal cost of between $10,000 to $20,000 per home depending on how many homes are handled plus a $500 annual O&M cost per household was assumed for all of the potential alternatives analyzed. An additional cost for low pressure piping was included at $50 per linear foot)

TABLE M.1 - SEPTIC SYSTEM BMP OPTIONS - COST AND RANKING

BMP I.D.	BMP Description / Type	BMP Material Costs ($)	Add'l Material Costs ($)	BMP Installation Costs ($)	Add'l Item Cost ($)	Pipe Item Cost ($)	Structure Item Cost ($)	Total Implement Cost ($)	Total Engineer Costs ($)	Annual Planning Cost ($)	Total Planning Costs ($)	Total Costs ($)	Total Project Costs w/ Contingency ($)	Total Cost Grant Request (60%) ($)	Total Cost Grant Match (40%) ($)	Annual O & M Cost ($)	Total 10 yr. Costs ($)	Total Annual TP Loading (kg/yr.)	TP 10 Yr. Removal (kg)	10 Year Cost / kg TP ($/kg)	Notes
SS-1	Public Education Program & Routine Maintenance - Kimball Rd	$40,000	$0	$0	$2,500	$0	$0	$42,500	$0	$2,000	$20,000	$62,500	$93,750	$56,250	$37,500	$0	$93,750	8.00	46.40	$2,020	It could cost $200 to maintain a tank and 20 tanks are cleaned 5 times (every 2 years). Public education includes 5 publishing's at $500 each and $1000 per year to plan and coordinate public education. TP loading assumes 20 systems are improved at 0.20 kg/year. An average reduction of 40% - 60% is assumed
SS-2	Sewering - Lakeview Apartments	$10,000	$6,000	$15,000	$7,500	$12,500	$3,500	$54,500	$26,800	$5,000	$10,000	$91,300	$136,950	$82,170	$54,780	$5,000	$186,950	10.00	90.00	$2,077	It could cost $5.00 per gallon to install a tank with approx. $20,000 additional pumps and fixtures. Approx. 200 feet of piping at $80 per LF plus manhole structures at $3,500 each. TP loading assumes 1 large system is removed at 10 kg/year. A reduction of 90% is assumed
SS-3	Public Education Program & Routine Maintenance - Moose Ln / University	$6,000	$0	$0	$2,500	$0	$0	$8,500	$0	$2,000	$20,000	$28,500	$42,750	$25,650	$17,100	$0	$42,750	1.20	6.96	$6,142	It could cost $200 to maintain a tank and 10 tanks are cleaned 5 times (every 2 years). Public education includes 5 publishing's at $500 each and $1000 per year to plan and coordinate public education. TP loading assumes 20 systems are improved at 0.20 kg/year. An average reduction of 40% - 60% is assumed
SS-4	Community WW System - Kimball Road 1	$150,000	$150,000	$90,000	$0	$225,000	$0	$615,000	$266,000	$5,000	$10,000	$891,000	$1,336,500	$801,900	$534,600	$15,000	$1,486,500	6.00	57.00	$26,079	It could cost $10,000 per household to install a pump and leach field with approx. $60,000 additional tanks / fixtures. Approx. 3000 feet of piping at $50 per LF. TP loading assumes 20 homes are removed at 0.20 kg/year. A reduction of 95% is assumed
SS-5	Community WW System - Kimball Road 2	$100,000	$50,000	$30,000	$0	$75,000	$0	$255,000	$112,000	$5,000	$10,000	$377,000	$565,500	$339,300	$226,200	$5,000	$615,500	2.00	19.00	$32,395	It could cost $15,000 per household to install a pump and leach field with approx. $30,000 additional tanks / fixtures. Approx. 1500 feet of piping at $50 per LF. TP loading assumes 10 homes are removed at 0.20 kg/year. A reduction of 95% is assumed
SS-6	Sewering - Kimball Rd	$40,000	$10,000	$100,000	$20,000	$300,000	$52,500	$522,500	$229,000	$5,000	$10,000	$761,500	$1,142,250	$685,350	$456,900	$5,000	$1,192,250	4.00	32.00	$37,258	It could cost $7.00 per gallon to install a tank with approx. $30,000 additional pumps and fixtures. Approx. 200 feet of piping at $80 per LF plus manhole structures at $3,500 each. TP loading assumes 20 homes are removed at 0.20 kg/year. A reduction of 70%-90% is assumed
SS-7	Community WW System - Moose Lane	$90,000	$30,000	$18,000	$0	$45,000	$0	$183,000	$78,200	$5,000	$10,000	$271,200	$406,800	$244,080	$162,720	$3,000	$436,800	1.20	11.40	$38,316	It could cost $20,000 per household to install a pump and leach field with approx. $18,000 additional tanks / fixtures. Approx. 900 feet of piping at $50 per LF. TP loading assumes 6 homes are removed at 0.20 kg/year. A reduction of 95% is assumed
SS-8	Sewering - Moose Lane	$30,000	$8,000	$60,000	$15,000	$100,000	$17,500	$230,500	$102,200	$5,000	$10,000	$342,700	$514,050	$308,430	$205,620	$5,000	$564,050	1.20	9.60	$58,755	It could cost $6.00 per gallon to install a tank with approx. $23,000 additional pumps and fixtures. Approx. 200 feet of piping at $80 per LF plus manhole structures at $3,500 each. TP loading assumes 6 homes are removed at 0.20 kg/year. A reduction of 90% is assumed

Appendix N
Waterfowl BMP Evaluation

Appendix N – Waterfowl BMP Alternatives Analysis and Evaluation Description

Provided below is a description of the methods used for the waterfowl BMP ranking process. A summary of the assumptions and results for the waterfowl BMP ranking analysis is provided below in Table N.1.

Potential waterfowl BMPs were identified and evaluated for feasibility. Conservative cost and pollutant load reduction approximations were made to compare the cost per kilogram of phosphors removed for each alternative over a ten year period. It is assumed that of the total average population of 55 geese per year, 40 birds are located on FPU campus and 15 birds are associated with migratory flocks. The most cost effective alternatives were selected for further evaluation and study as recommendations. This summary includes a description of each of the analyzed alternatives with the assumptions used to generate cost and pollutant removal estimates (These are provided in no particular order):

1. **Physical and Behavioral Deterrents –** As noted, **t**hese BMPs can include a wide variety of proprietary and behavioral modifications. These BMPs can also be tied in with scare tactics and other similar controls; however the focus of these BMPs is to modify the human/geese interaction and to adjust behaviors so specific locations of the watershed are no longer attractive to geese for feeding, resting and nesting. Scare tactics do modify geese behavior, however do it in a different manner. Deterrents can be used through-out the watershed; however most of these focus on direct shoreline areas where large geese populations have been observed. For the purposes of this report, these options are mainly focused on controlling the migratory geese populations on the pond and associated shoreline areas rather than the FPU campus area. The options can also be tested on the campus population, however may have varying effects since some of these options could be hard to implement on a large scale. The following deterrent options were evaluated:
   - Public Education program developed to discourage geese feeding and/other human/geese interactions;
   - Installation of goose fencing or electric barriers on shoreline properties;
   - The use of noise makers, distress calls & ultrasonic repellants;
   - Spray repellents and applicants for vegetation;
   - Other actions to remove food source (stop feeding the geese).

   Pollutant removal efficiencies for these BMPs are somewhat unpredictable due to uncertainties with actual populations and BMP effectiveness. For comparison purposes, it is assumed that these BMPs will focus on the transient population of 15 geese and that could be reduced by 40% to 60%. Costs for these BMPs assume a $1,000 per year budget for public education campaign, $500 for educational signs and materials, $150-$250 for noise makers/distress calls, $300 - $500 for ultrasonic repellants and $150 - $200 per property for goose fence. Additionally, a cost of $100 per year is carried for the upkeep, repairs and operation of these deterrents.

2. **Hazing / Scare Tactics –** These options cover any potential control measure which is used to physically scare or haze the geese enough, that they will choose to nest and feed elsewhere. These techniques should be focused on hazing/scaring adults in the area with goslings to permanently change their preference of nesting territory. Goslings will be

scared enough to prevent their return in future years. It should be cautioned that the use of these methods may not work for long periods of time and routine adjustments maybe required to maintain the effectiveness as the geese get used to them. Additionally, these tactics would have to be carefully planned to occur at specific times of year and for a specific duration to adequately control the population. These BMPs are mainly focused on managing the resident population of 40 geese on FPU campus and the pond, however can be employed anywhere within the watershed or shoreline along with other control strategies to improve overall effectiveness of the measure for any of the geese populations at Pearly. These options provide measures that can be used on a wider range and in larger areas similar to the campus. The following scare tactics were evaluated:

1. Visual Scares (ballons), Predator Effigies and Decoys;
2. Purchase a swan, pair of swans or other predatory bird to haze the birds;
3. Hire / Rent border collies to harass and haze the birds;
4. Hire companies who employ flying drones or remote control boats to scare the birds.

Like deterrents, pollutant removal efficiencies for these BMPs are also unpredictable and could vary from year to year. For comparison purposes, it is assumed that these BMPs will focus on the transient population of 40 geese and that number could be reduced by 30% - 50% each year. It is also assumed that some of these rates would decrease as populations decreased or as birds became used to the scare tactics. Costs for these options include $75 - $100 per visual predator decoy, $3,000 or more to purchase a swan or predatory bird, $500 per visit to rent or hire border collies and $1,000 – $1,500 per visit to hire/rent remote control devices. It was assume that hiring or renting would need to be done at least 4 times per year. It was assumed that O&M costs for all of these BMPs would include a cost of $1,500 per year to coordinate, monitor, maintain, plan and/or move/replace these BMPs if these are implemented as a pilot study. It is also assumed that it would cost an additional $2,500 per year to feed, care for and provide seasonal shelter for a swan or other bird.

3. **Landscape modifications –** Similar to deterrent methods, landscape modifications aim to control waterfowl behaviors and limit potential human/geese interaction. These options were separated from the general deterrents BMPs because costs associated with most of these options are much higher and could require design, permitting and construction to implement. These BMPs can be implemented on shoreline properties and on a large scale for the FPU campus. The are typically used to prevent an area from being attractive to the geese for resting, nesting and eating. These BMPs focus on three major behaviors of geese:

- Geese prefer to nest within 150 feet of a shoreline;
- Geese prefer a clear, flat walking path from the water to their resting., nesting and eating grounds; and
- Geese prefer short manicured lawn or grass areas because it is easier to get the preferred young chutes of vegetation.

A wide variety of structural BMPs can be employed to prevent geese from leaving the water to eat and nest at the preferred location. In a lot of cases along the Pearly shoreline, there are already very steep, rocky and vegetated shorefronts, which naturally prevent the geese from landing a those locations. For that reason, these specific management techniques can be focused on very specific locations around Pearly which have been confirmed by the results and observations from the Resident Survey. Properties with beaches, flat open areas or manicured lawns directly adjacent to the waterfront will be best areas to focus land modification BMPs. The following land modification BMPs were evaluated:

- Implementation of Shoreline Vegetated / Rocky Buffers along shoreline;
- Construction of Perched Beaches;
- Establishing meadows versus mowed / well-maintained lawn areas.

The focus of landscape modification would be for the longer-term as these are more permanent structural BMPs and could have the largest impact on both of the goose populations observed in the watershed. For this reason removal efficiencies for these BMPs assumed focus on both the transient population of 15 geese and the campus population of 40 geese. A rate of removal was assumed to be approx. 50% - 70% for the long-term depending on the type of modification. Costs associated with these BMPs vary greatly based on size and scope. Property owners can construct these modifications themselves or hire private contractors to complete the work. For comparison purposes, the following costs were assumed: Cost to construct a shoreline buffer could be $1,500 - $2,500 per property. The cost to design, permit and construct a perched beach could be $5,000 - $7,000 per property. An additional cost for O&M for these BMPs included approx. $100 per year to maintain and replace vegetation as needed. It is very hard to assume a cost for establishing meadows in lieu of well-maintained lawns. It is likely to cost nothing for this BMP and could even save individual property owners money in long-term maintenance. For ranking purposes, it is assumed that this BMP could cost $100 per year to coordinate or make alterations as needed.

TABLE N.1 - WATERFOWL BMP OPTIONS - COSTS AND RANKING

BMP I.D.	BMP Description / Type	BMP Material Costs ($)	BMP Installation Costs ($)	BMP Annual Rental Costs ($)	Total Implement Cost ($)	Total Engineering Costs ($)	Annual Planning Cost ($)	Total Planning Costs ($)	Total Costs ($)	Total Project Costs w/ Contingency ($)	Total Cost Grant Request (60%) ($)	Total Cost Grant Match (40%) ($)	Annual O & M Costs ($)	Total 10 yr. Costs ($)	Total Annual TP Loading (kg/yr)	TP 10 Yr. Removal (kg)	10 Year Cost / kg TP ($/kg)	Notes
WF-1	Conversion to Meadows (Less mowing and manicured lawns)	$0	$0	$0	$0	$0	$100	$1,000	$1,000	$1,500	$900	$600	$0	$1,500	23.00	138.00	$11	It is assumed that converting lawn areas to meadow would only cost approx. $100 per year to plan and coordinate. TP loading assumes 40 geese at 0.40 kg/year. An average reduction of 60% is assumed
WF-2	Hire / Rental of Border Collies	$0	$0	$4,000	$4,000	$0	$1,500	$15,000	$19,000	$28,500	$17,100	$11,400	$0	$28,500	16.00	80.00	$356	It is assumed to be effective, border collies are rented 8 different times per year plus an annual planning / O&M budget of $1,500. TP loading assumes 40 geese at 0.40 kg/year. An average reduction of 50% is assumed
WF-3	Installation of visual scare or decoys	$4,500	$1,000	$0	$5,500	$0	$500	$5,000	$10,500	$15,750	$9,450	$6,300	$1,000	$25,750	16.00	65.60	$393	It is assumed that 2 different decoys are used on 30 properties plus an annual planning / O&M budget of $1,500. TP loading assumes 40 geese at 0.40 kg/year. An average reduction of 40% - 50% is assumed
WF-4	Public Educational Campaign	$2,000	$0	$0	$2,000	$600	$1,000	$10,000	$12,600	$18,900	$11,340	$7,560	$100	$19,900	7.00	42.00	$474	Educational campaign includes installation of 4 signs/kiosks and an annual planning budget of $2,000. TP loading assumes 15 geese at 0.40 kg/year. An average reduction of 60% is assumed
WF-5	Goose Fencing on Private Properties	$2,250	$2,250	$0	$4,500	$0	$500	$5,000	$9,500	$14,250	$8,550	$5,700	$100	$15,250	7.00	28.00	$545	Installation of fencing is assumed to require 50 linear feet on 30 different properties plus an annual planning budget of $500. TP loading assumes 15 geese at 0.40 kg/year. An average reduction of 40% is assumed
WF-6	Shoreline Vegetated Buffers	$22,500	$22,500	$0	$45,000	$9,000	$500	$5,000	$59,000	$88,500	$53,100	$35,400	$100	$89,500	23.00	161.00	$556	It is assumed that vegetated buffers are installed on 30 properties plus an annual planning budget of $500 per year and maintenance budget of $100 per year. TP loading assumes 55 geese at 0.40 kg/year. An average reduction of 70% is assumed
WF-7	Hire / Rental of Drones or Remote Control Boats	$0	$0	$12,000	$12,000	$0	$1,500	$15,000	$27,000	$40,500	$24,300	$16,200	$0	$40,500	16.00	65.60	$617	It is assumed to be effective, drones are rented 8 different times per year plus an annual planning / O&M budget of $1,500. TP loading assumes 40 geese at 0.40 kg/year. An average reduction of 40% - 50% is assumed
WF-8	Purchase of swan or predatory bird	$3,000	$0	$0	$3,000	$0	$1,500	$15,000	$18,000	$27,000	$16,200	$10,800	$2,500	$52,000	16.00	80.00	$650	It is assumed that one swan would be purchased with an annual planning of $1,500 and an annual feeding/caring budget of $2,500. TP loading assumes 40 geese at 0.40 kg/year. An average reduction of 50% is assumed
WF-9	Noise makers on Private Properties	$7,500	$0	$0	$7,500	$0	$500	$5,000	$12,500	$18,750	$11,250	$7,500	$100	$19,750	7.00	21.70	$910	It is assumed that noise makers are placed on 30 different properties plus an annual planning budget of $500. TP loading assumes 15 geese at 0.40 kg/year. An average reduction of 30% - 40% is assumed
WF-10	Ultrasonic Repellants on Private Properties	$15,000	$0	$0	$15,000	$0	$500	$5,000	$20,000	$30,000	$18,000	$12,000	$100	$31,000	7.00	28.70	$1,080	It is assumed that ultra-sonic repellants are placed on 30 different properties plus an annual planning budget of $500. TP loading assumes 15 geese at 0.40 kg/year. An average reduction of 40% - 50% is assumed
WF-11	Perched Beaches	$75,000	$75,000	$0	$150,000	$60,000	$500	$5,000	$215,000	$322,500	$193,500	$129,000	$100	$323,500	23.00	115.00	$2,813	It is assumed that perched beaches are installed on 30 properties, require permitting and design plus an annual planning budget of $500 per year and maintenance budget of $100 per year. TP loading assumes 55 geese at 0.40 kg/year. An average reduction of 50% is assumed

Appendix O
Preliminary Stormwater BMP Designs

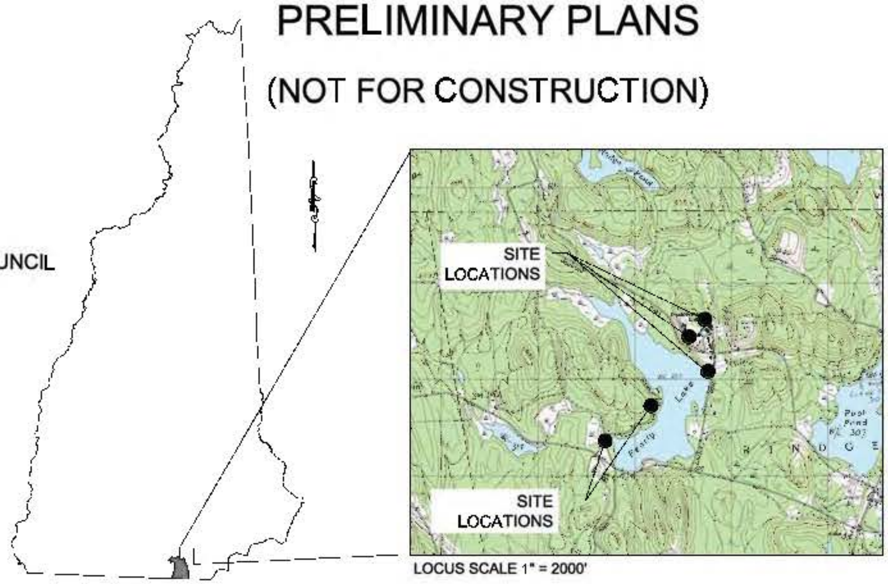
PEARLY POND WATERSHED RESTORATION

STORMWATER IMPROVEMENTS
RINDGE, NH

NOVEMBER 2014
PRELIMINARY PLANS

(NOT FOR CONSTRUCTION)

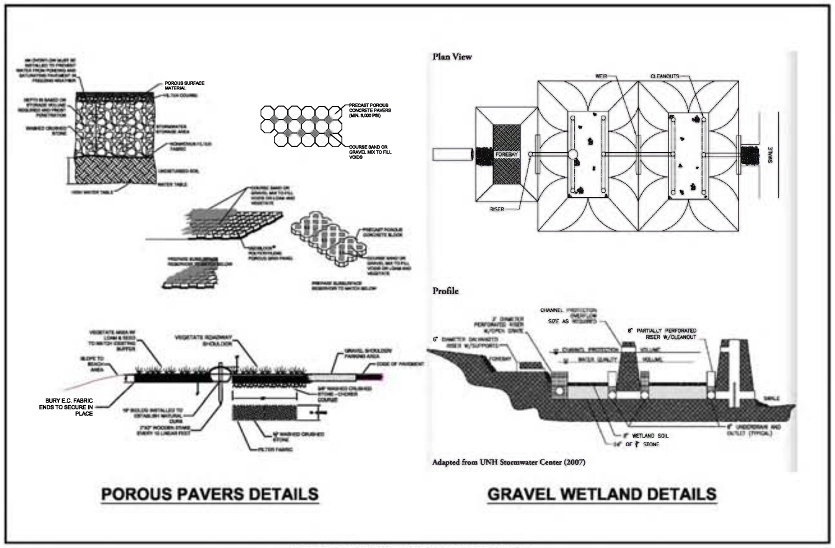
FRANKLIN PIERCE UNIVERSITY
PEARLY POND ASSOCIATION
PEARLY POND MANAGEMENT ADVISORY COUNCIL
TOWN OF RINDGE



LOCUS SCALE 1" = 2000'

SHEET	TITLE
C-1	SITE 1 PROPOSED IMPROVEMENTS
C-2	SITE 2 PROPOSED IMPROVEMENTS
C-3	SITE 3 PROPOSED IMPROVEMENTS
C-4	SITE 4 PROPOSED IMPROVEMENTS
C-5	SITE 5 PROPOSED IMPROVEMENTS

COMPREHENSIVE ENVIRONMENTAL INCORPORATED • MERRIMACK, NEW HAMPSHIRE

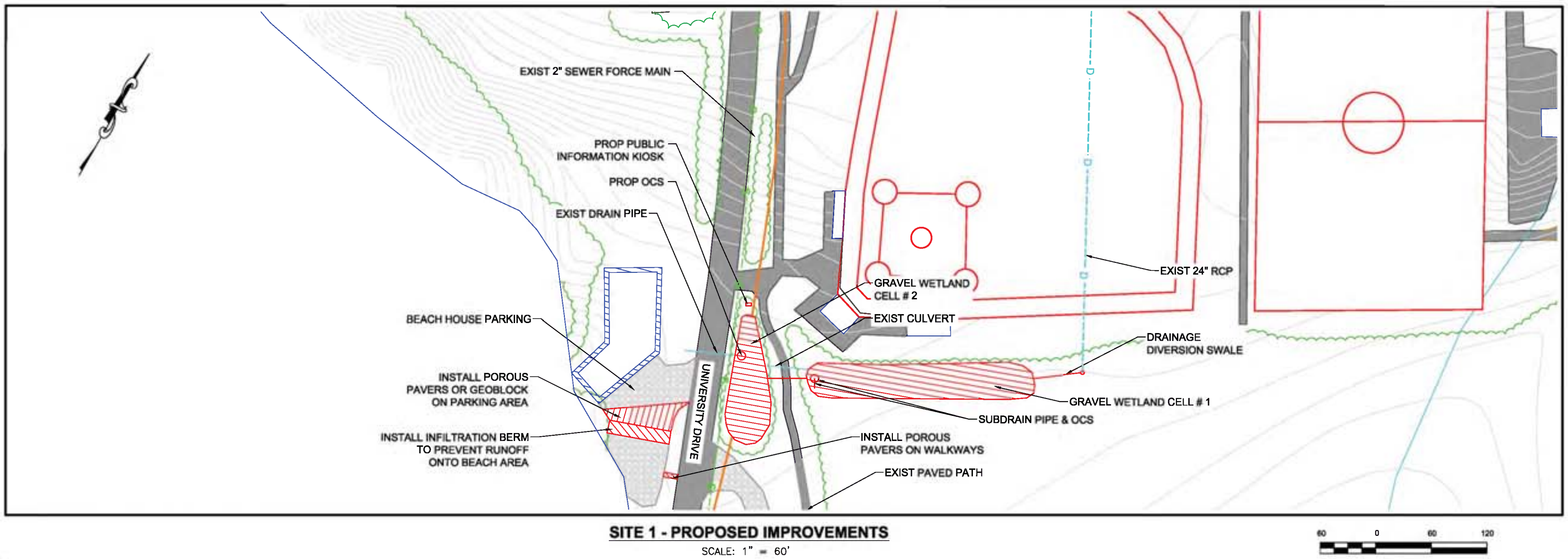


SITE 1 - PROPOSED DETAILS

NOT TO SCALE

SITE 1 - ORTHO OVERVIEW

SCALE: 1" = 100'



SITE 1 - PROPOSED IMPROVEMENTS

SCALE: 1" = 60'

General Notes

1. DRAWINGS BASED ON NH GIS GRANIT LAYER INFORMATION FOR THE TOWN OF RINDGE, NH AND SUPPLEMENTAL INFORMATION PROVIDED BY THE TOWN OF RINDGE, NH AND FRANKLIN PIERCE UNIVERSITY.

2. CONCEPTUAL PLANS AND LOCALIZED PROPERTY BASE MAPS ARE BASED ON CEI FIELD INVESTIGATIONS CONDUCTED BETWEEN SEPTEMBER 2013 AND OCTOBER 2013.

2. WETLAND DELINEATION FOR BORDERING VEGETATED WETLANDS HAVE NOT BEEN COMPLETED. ALL RESOURCE AREA DELINEATIONS ARE BASED ON GIS DATA FROM NH GRANIT.

3. THE LOCATION OF UNDERGROUND UTILITIES HAVE NOT BEEN VERIFIED OR INSPECTED.

4. RIGHT OF WAY LOCATIONS AND PROPERTY BOUNDS HAVE NOT BEEN SURVEYED.

5. THE PROPOSED STORMWATER IMPROVEMENTS DEPICTED ON THESE PLANS ARE NOT FOR CONSTRUCTION AND INTENDED FOR CONCEPTUAL PURPOSES ONLY.

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TOWN OF RINDGE

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Checked by: MLL
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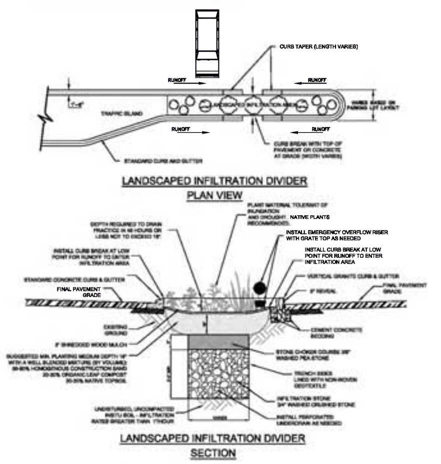
Sheet: C-1



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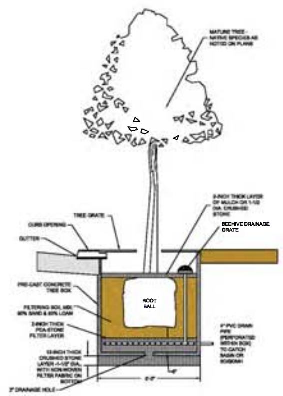

TREE BOX FILTER DETAIL

SITE 2 - PROPOSED DETAILS

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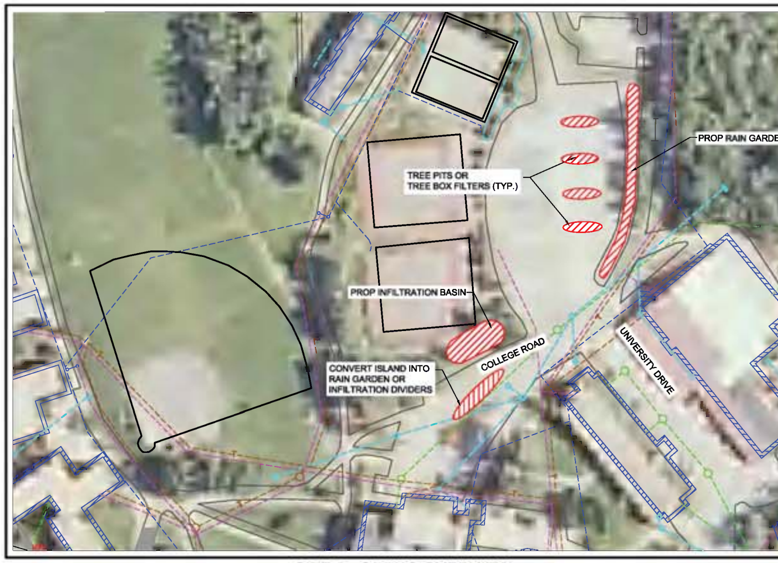

SITE 2 - ORTHO OVERVIEW

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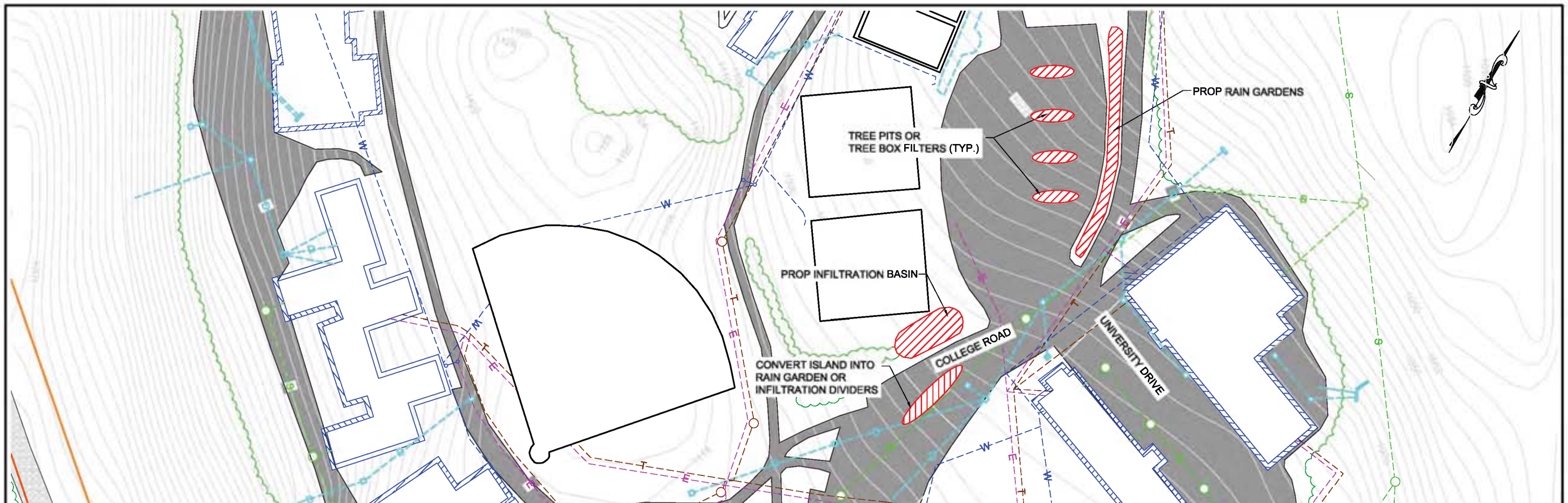

SITE 2 - PROPOSED IMPROVEMENTS

SCALE: 1" = 60'

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Plan View Scale: 1" = 60'

General Notes

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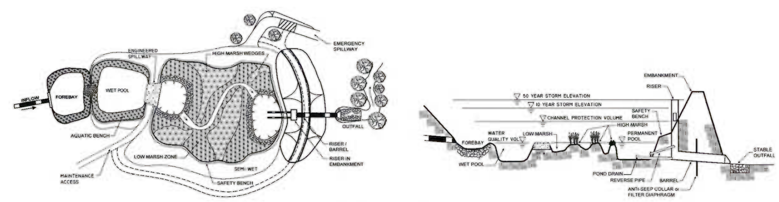
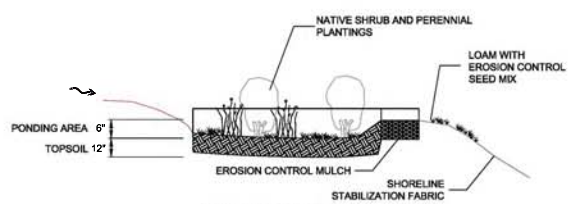


WET POND DETAILS



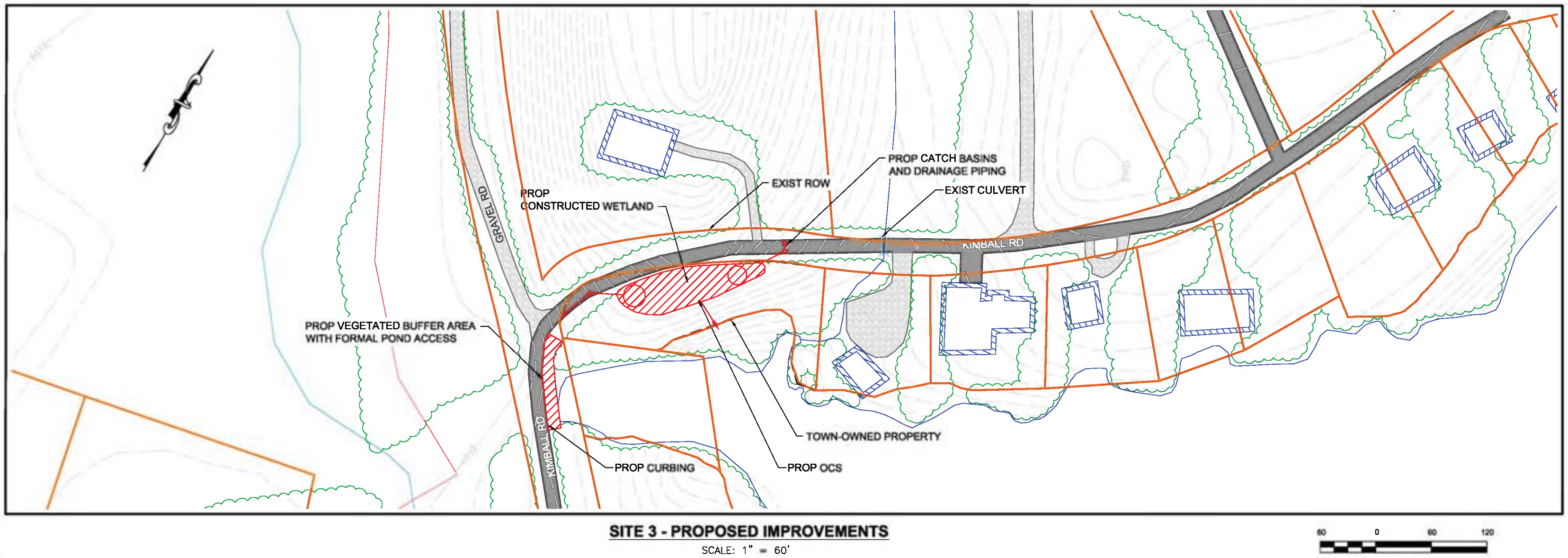
VEGETATED BUFFER DETAIL

SITE 3 - PROPOSED DETAILS

NOT TO SCALE

SITE 3 - ORTHO OVERVIEW

SCALE: 1" = 100'



SITE 3 - PROPOSED IMPROVEMENTS

SCALE: 1" = 60'

General Notes

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SITE 3 - PROPOSED IMPROVEMENTS

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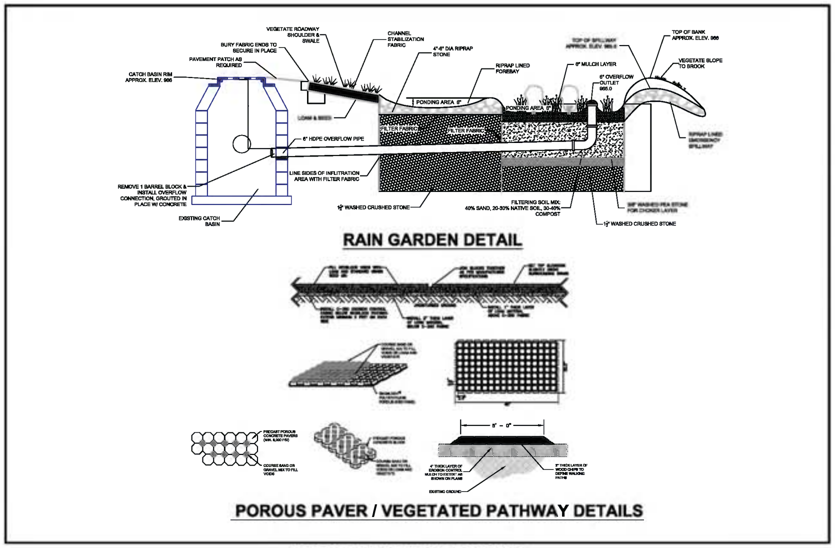

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SITE 4 - ORTHO OVERVIEW
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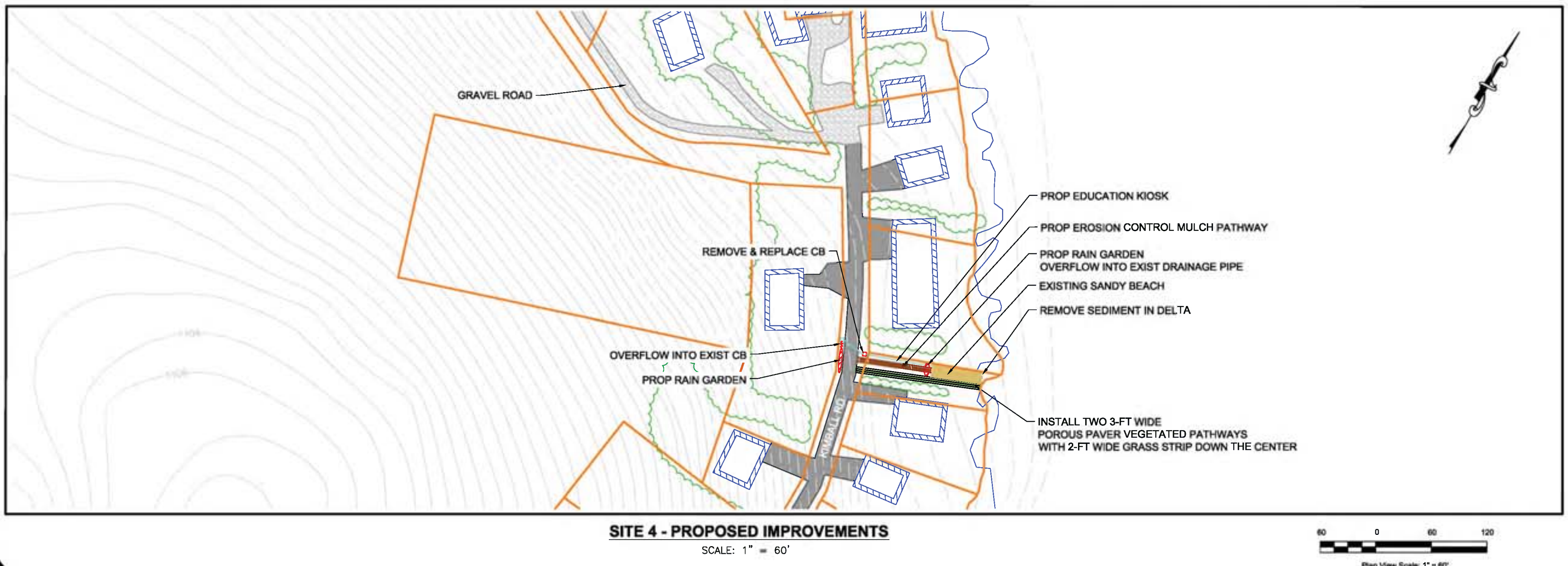

SITE 4 - PROPOSED IMPROVEMENTS
SCALE: 1" = 60'

General Notes

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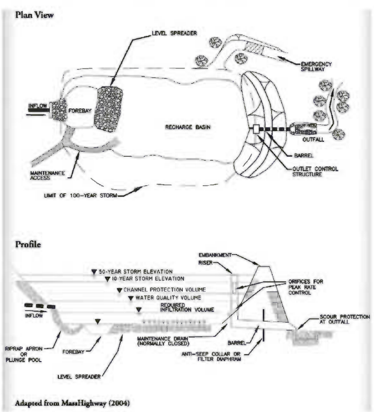
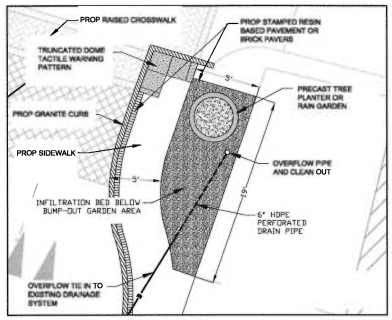
Designed by: BCL Checked by: MLL	C-4
Scale: As Shown	



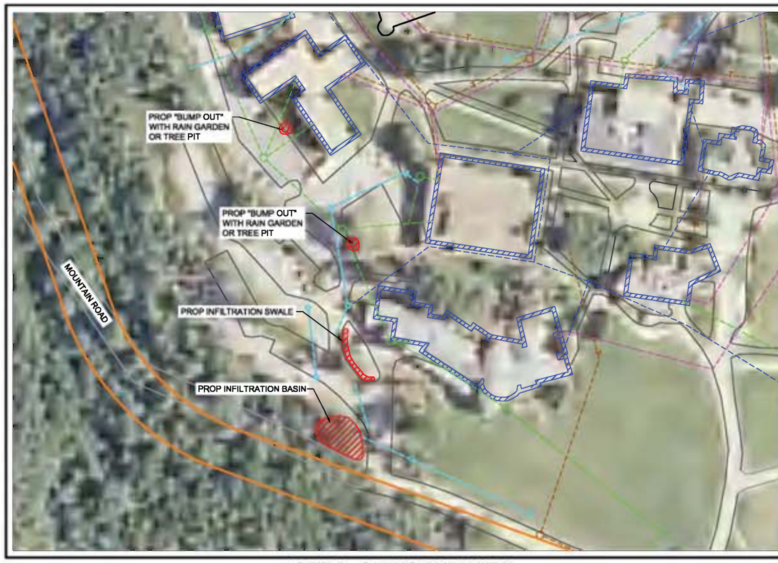
INFILTRATION BASIN DETAIL



"BUMP OUT" WITH RAIN GARDEN OR TREE PIT DETAIL

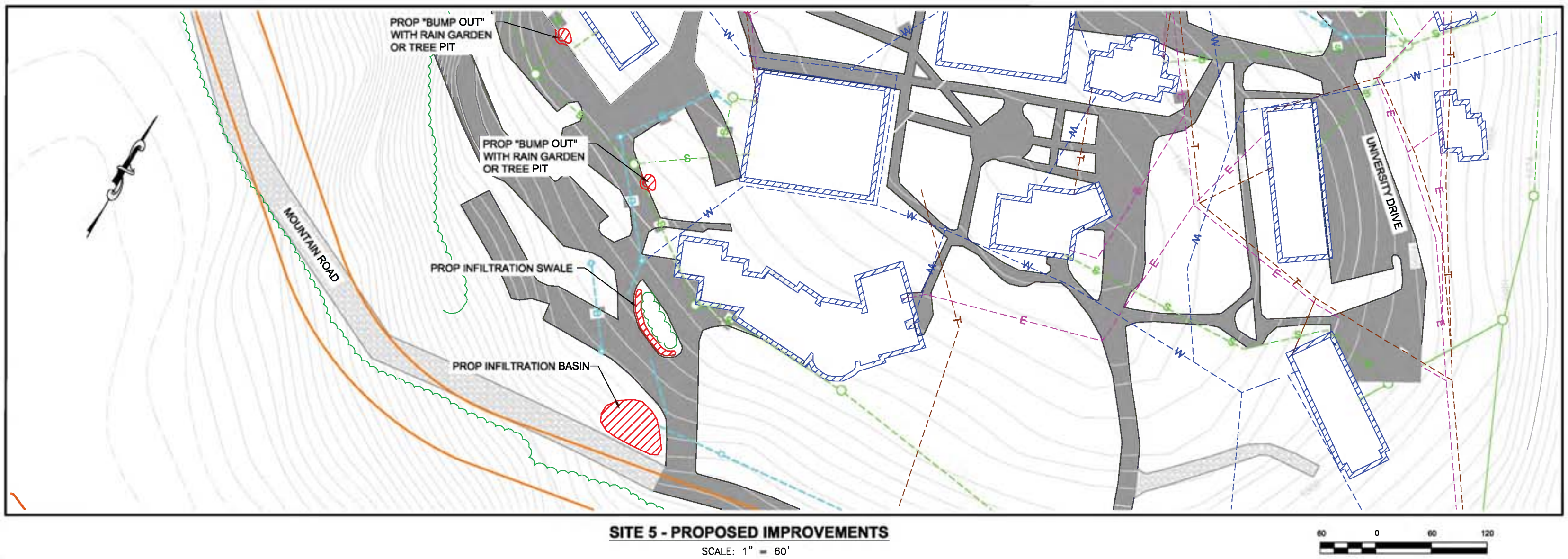
SITE 5 - PROPOSED DETAILS

NOT TO SCALE



SITE 5 - ORTHO OVERVIEW

SCALE: 1" = 80'



SITE 5 - PROPOSED IMPROVEMENTS

SCALE: 1" = 60'

General Notes

1. DRAWINGS BASED ON NH GIS GRANIT LAYER INFORMATION FOR THE TOWN OF RINDGE, NH AND SUPPLEMENTAL INFORMATION PROVIDED BY THE TOWN OF RINDGE, NH AND FRANKLIN PIERCE UNIVERSITY.

2. CONCEPTUAL PLANS AND LOCALIZED PROPERTY BASE MAPS ARE BASED ON CEI FIELD INVESTIGATIONS CONDUCTED BETWEEN SEPTEMBER 2013 AND OCTOBER 2013.

2. WETLAND DELINEATION FOR BORDERING VEGETATED WETLANDS HAVE NOT BEEN COMPLETED. ALL RESOURCE AREA DELINEATIONS ARE BASED ON GIS DATA FROM NH GRANIT.

3. THE LOCATION OF UNDERGROUND UTILITIES HAVE NOT BEEN VERIFIED OR INSPECTED.

4. RIGHT OF WAY LOCATIONS AND PROPERTY BOUNDS HAVE NOT BEEN SURVEYED.

5. THE PROPOSED STORMWATER IMPROVEMENTS DEPICTED ON THESE PLANS ARE NOT FOR CONSTRUCTION AND INTENDED FOR CONCEPTUAL PURPOSES ONLY.

PRELIMINARY PLANS
NOT FOR CONSTRUCTION

No.	Revision/Issue	Date

COMPREHENSIVE ENVIRONMENTAL INCORPORATED
21 DEPOT STREET
MERRIMACK, NH 03054

SITE 5 - PROPOSED IMPROVEMENTS

FRANKLIN PIERCE UNIVERSITY
PEARLY POND ASSOCIATION
PEARLY POND MANAGEMENT ADVISORY COUNCIL
TOWN OF RINDGE

Project: NO. 308-1 Date: 11/2014	Sheet: C-5
Designed by: BCL Checked by: MLL	
Scale: As Shown	