



Lake Simcoe Basin Stormwater Management and Retrofit Opportunities 2007



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1 Introduction

1.1 Study Purpose

Stormwater runoff represents a major source of pollution to Lake Simcoe and its tributaries. The Lake, which is already showing signs of impairment due to anthropogenic activities, is under increasing stress due to urban growth. Currently, 16,508.7 hectares (6.3%) of the watershed is comprised of urban land use (Figure 1.1). Uncontrolled, stormwater can negatively affect water quality, stream form and function, the biologic capacity of a stream, and increase flooding potential. Interception of stormwater runoff through the use of Stormwater Management Facilities (SMF) at the outlet of urban catchments can reduce the severity of these impacts. In order to properly site SMFs it is necessary to delineate urban drainage catchments and identify outlets to watercourses or waterbodies. This exercise also results in a summation of all urban area allowing for the calculation of the total urban phosphorus load, the phosphorus reduction achieved through existing SMFs, and the potential phosphorus reduction that could be achieved through the construction of additional SMFs.

To date the delineation of urban catchments across the Lake Simcoe Watershed has been captured through Watershed Planning documents, municipal infrastructure improvements or new development applications. This has excluded many areas, particularly older urban cores, and the resulting data set, constructed over the last 10 years, may not represent current conditions in some locations. **The purpose of this study is to create a complete, consistent and contemporary data set of all urban catchments, outlets, existing SMFs and locations of potential SMFs, and to calculate the phosphorus load associated with urban stormwater runoff in the Lake Simcoe Watershed.**

1.2 Study Deliverables









- Delineation of stormwater catchments for all urban areas of the Lake Simcoe Watershed.
- Identification of existing Stormwater Management Facilities and level of treatment.
- Calculation of the total phosphorus load coming from urban areas and reduction achieved through existing controls.
- Identification of potential retrofit opportunities and associated phosphorus reduction.



Lake Simcoe Watershed

- Figure 1.1 -

Legend

-  Major Watercourse
-  Watershed Boundary
-  Major Road
-  Upper Tier Boundary
-  Lower Tier Boundary
-  Waterbody
-  Urban Area
-  Subwatershed

The information depicted on this map has been compiled from various sources. While every effort has been made to accurately depict the information, data/mapping errors may exist. This map has been produced for illustrative purposes only.

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Projection: NAD 83, UTM Zone 17N

LSRCA GIS Services
Created December 2007

2 What is Stormwater

2.1 What is Stormwater?

Urban stormwater runoff occurs as rain or melting snow washes streets, parking lots and rooftops of dirt and debris, minor spills and landscaping chemicals and fertilizers. In the past it was common practice to route stormwater directly to streams, rivers or lakes in the most efficient manner possible. This practice typically has negative impacts on the receiving water course. Over the last two decades this has changed and efforts are now made to intercept and treat stormwater prior to its entering watercourses or waterbodies. However, in many older urban areas stormwater typically still reaches watercourses untreated.

Urban stormwater runoff is also greatly affected by land use type. Commercial and industrial areas typically have more impervious area (e.g. paved parking lots, sidewalks, roof tops) than any other type of land use and consequently, generate more urban runoff and pollution. In sharp contrast are open areas that have little if any paved surfaces. In these areas, the natural hydrologic cycle occurs whereby water can infiltrate down into the ground to be filtered by the soil before entering local streams and watercourses or continue deeper to recharge the ground water aquifer.

2.2 Environmental Impact of Stormwater

The impact of stormwater runoff on stream ecosystems has been well documented and in almost every instance is detrimental to the health of local rivers and streams. Impacts to watercourses have been categorized as follows (Scheuler, 1987):

- changes to stream hydrology (flow)
- changes to stream form (channel morphology)
- degraded water quality, and
- changes to aquatic habitat

These changes truly illustrate the concept of the “ecosystem” whereby all things are related or inter-connected. For example, changes to stream hydrology occur due to alterations in the natural hydrologic cycle as a result of urbanization (Figure 2.1 and 2.2). As the amount of impervious area increases, the runoff characteristics change. This change results in increases in the frequency and the magnitude of runoff events, a decrease in baseflow, and an increase in flow velocities and energy. These changes further affect the form or morphology of the stream.

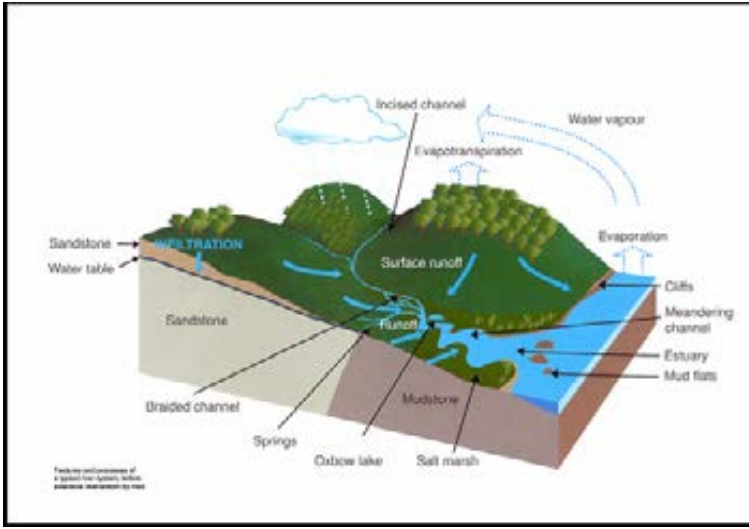


Figure 2.1 – Natural Hydrologic Cycle

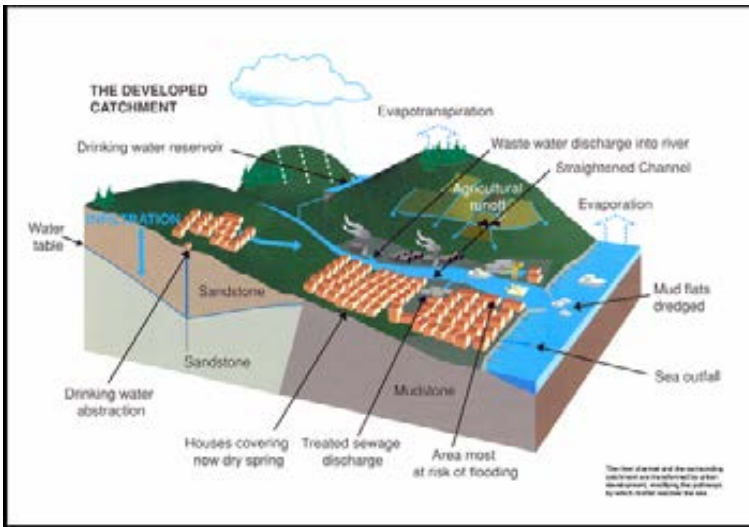
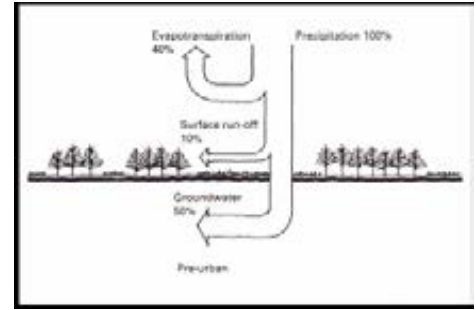
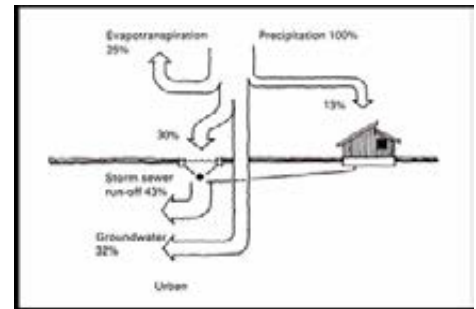


Figure 2.2 – Urban Hydrologic Cycle



Streams naturally adjust to changes in hydrology. Some of the problems associated with urban channels include: channel widening, down cutting, sedimentation and channel braiding. These changes occur due to the increase in the erosive force associated with the increase in stream flow. As the velocity of a stream increases, the erosive force is transferred to the streambanks that may begin to erode. If the banks are well vegetated or armoured, the erosive force can be transferred to the stream bottom and down cutting of the streambed can occur.



Figure 2.3 – Example of a braided channel

As a result of the erosion, additional sediment and bedload are introduced into the stream system causing a further imbalance. This additional sediment when deposited along the inside bend of a river may transfer even more force along the outside bend. Further deposition can occur where the river gradient flattens out and results in the creation of a braided channel (Figure 2.3).

One of the most significant environmental impacts of stormwater runoff is to water quality. Problems with degraded water quality directly affect the aquatic ecosystem, recreational opportunities and aesthetics. This occurs as pollutants are washed off of streets, parking lots, rooftops, and roadways into storm drains or ditches which discharge to rivers, streams and lakes. Generally, concentrations of pollutants such as bacteria (e.g. *Escherichia coli*, fecal coliform, *Pseudomonas aeruginosa* and fecal streptococci), nutrients (e.g. phosphorus, nitrogen), metals and organic compounds are higher in urban stormwater runoff than the acceptable limits established in the PWQO (MOE, 1994). Oil and gas spills and misapplication or over application of fertilizers and pesticides can also enter water bodies via stormwater runoff. Other harmful impacts include increased water temperature and the collection of trash and debris.

It is a combination of all the previously mentioned changes (hydrology, channel morphology, and water quality) that influence stream ecology and health. Impacts on the aquatic community range from the outright destruction of habitat to reductions in stream productivity and species diversity. The destruction of habitat can occur as spawning beds, nursery areas and structure are covered with sediment. Another way in which habitat can be destroyed is through thermal degradation. Cold water streams are defined as having a water temperature that does not exceed 20°C. Stormwater runoff can reach temperatures exceeding 30°C because it is draining off warm pavement. These inputs of warm water can significantly impact the temperature regime within cold water systems.

2.3 Stormwater Runoff Controls

There are various methods of controlling stormwater runoff, from small-scale single lot controls to larger scale end-of-pipe stormwater management facilities

(SMF). Stormwater management ponds (SMP) are classified as end-of-pipe facilities and are the control method focused on in this report. The most common types of ponds include; wet ponds, dry ponds and artificial wetlands.



Wet Ponds

Wet ponds are an effective end-of-pipe SMP and a fairly common one. A properly designed facility with both quantity and quality control acts to hold the first flush of a storm event in a wet pond allowing sediment to settle out. The same settlement process retains nutrients, like phosphorus, that have been absorbed by the sediment. The quantity section of the pond retains

the water from the wet pond and allows it to slowly enter the stream, reducing the damage to stream morphology associated with higher velocity and volume flows. Because wet ponds are so versatile, they reduce the need for multiple end-of-pipe facilities and are also less land intensive than other facilities such as wetlands. However, their uses may be limited in some areas as they do increase downstream water temperature.

Dry Ponds

Dry ponds have no permanent pool and act chiefly as a quantity control facility. As such they are effective at erosion control and reducing the risk of flooding. Dry ponds are commonly designed with a 24-hour retention period allowing little time for contaminants to be settled out and therefore, only make a small contribution to improving water quality. There is the potential that ponds designed with longer retention periods (such as 48 hours) may begin to improve water quality, however little monitoring data exists to confirm this. Dry ponds are mainly used in combination with other facilities or in areas where increased downstream water temperature is a major concern.



Wetlands

Artificial wetlands are an end-of-pipe facility that is very effective at improving water quality. As with wet ponds, artificial wetlands have a permanent pool that minimizes re-suspension, minimizes blockage of the outlet, provides extended settling and is very efficient at cycling pollutants. Due to the shallow depth of wetlands, they are more land intensive than wet ponds. Their shallow depth also makes them more susceptible to problems during winter and they may freeze to the bottom negating their effectiveness at settling out contaminants. This problem can be addressed by creating a hybrid wetland/wet pond facility with a deeper sediment forebay. The shallow depth also reduces the quantity control capabilities of a wetland with the active volume generally being the extent of its storage capacity.

To date, there has been little performance monitoring of wetlands in Ontario to better understand their biological impacts and enhancements. It is assumed that water quality benefits are enhanced because of the uptake associated with the density of aquatic plants. However, it is known that like wet ponds, wetlands may increase the downstream water temperature and provide increased habitat for wildlife. The issue of providing wildlife habitat is presently being debated by many agencies and naturalist groups. SMP are designed for the purpose of intercepting and containing pollutants and concern over the impacts that these pollutants could have on wildlife have merit. Therefore, it is recommended that features to enhance wildlife habitat not be included into the design or retrofit of SMF.

Based on the Stormwater Practices Manual (MOE, 1994, 2003), there are various levels of stormwater control established to ensure the protection of receiving waters (e.g. watercourse, ditch, lake). These guidelines were produced by the Ministry of Environment taking into consideration concerns from the Ministry of Natural Resources (Fish Habitat Protection Guidelines for Developing Areas, 1994). Four levels of protection were established focusing on the ability of SMP to control and remove suspended solids.

Level 1 is the most stringent level of protection designed to protect habitat which is essential to the fisheries productivity (e.g. spawning, rearing and feeding areas) and requires 80% removal of suspended solids.

Level 2 protection calls for a 70% removal of suspended solids. In this instance the receiving water can sustain the increased loading without a decrease in fisheries productivity.

Level 3 controls are relaxed further requiring a 60% sediment removal rate again reflecting the lower quality of the receiving water for fish production.

Level 4 controls exclusively address retrofit situations where, due to site constraints the other levels of control cannot be achieved. Level 4 protection is

not to be considered for any new development, only for instances where uncontrolled urban areas can implement some SMF to improve environmental health.

It is important to realize that, while these guidelines are specific to suspended solids, other pollutants such as bacteria, metals, and nutrients (e.g. phosphorus) are reduced by the same controls. Due to severe water quality problems in Lake Simcoe, and the potential destruction of the cold water fishery (e.g. lake trout, *Salvelinus namaycush*), the entire watershed has been deemed a special policy area. As a result, all new development in the watershed since 1996 has been required to construct SMF that meet the most stringent criteria or Level 1 protection. This special policy designation was a result of a recommendation contained in the Lake Simcoe Environmental Management Strategy (LSEMS) "Our Waters, Our Heritage, 1995" report, which deals exclusively with efforts to reduce phosphorus inputs to Lake Simcoe.

3. Methodology

3.1 Catchment Delineation

In the context of this study an urban catchment is used to describe a specific area, such as city block or subdivision, which drains to a common outlet or Stormwater Management Facility (SMF) by means of a subsurface system or surface topography. Greenspaces such as parks, golf courses, riparian valleys or naturalized areas were excluded from the data set and all subsequent calculations as runoff characteristics of these areas are significantly different from urban.

Catchment boundaries were defined using subdivision / development design plans. For areas where these plans did not exist a combination of field investigation and consultation with town engineers and works departments was employed. This was more typical of older urban areas. These catchments were then classified into the following six categories based on the level of stormwater management control:

- Uncontrolled (catchments that do not flow into a SMF)
- Quantity control (catchments that flow into a quantity SMF)
- Level 1 (catchments that flow into a Level 1 SMF)
- Level 2 (catchments that flow into a Level 2 SMF)
- Level 3 (catchments that flow into a Level 3 SMF)
- Level 4 (catchments that flow into a Level 4 SMF)

3.2 Stormwater Management Facility Identification

For this study, Stormwater Management Ponds were the primary type of facility examined. Pond locations were identified through the use of subdivision / development plans and use of orthophotography from the year 2005, for the regions of Durham and York, and 2002, for Simcoe County. For the control level of a pond, the subdivision / development plans were used or there was consultation with the respective town engineers.

3.3 Phosphorus Reduction by Level of Control Methodology

Phosphorus reductions for the 4 levels of control were defined as follows:

- Level 1 = 80% phosphorus reduction
- Level 2 = 69% phosphorus reduction
- Level 3 = 54% phosphorus reduction
- Level 4 = 40% phosphorus reduction

These reductions were adopted from available monitoring data in the Southern Ontario area and represent monitoring data on a Level 1 pond (Liang, 1999) and Level 2 pond (LSRCA, 2003). Phosphorus reductions achieved by the ponds vary by season and storm intensity. The numbers adopted for this report represent what is estimated to be the average efficiency of the facility and are applied to the calculation of yearly loadings.

Phosphorus reductions for Level 3 and 4 were estimated based on the proportional difference between Levels 1 and 2 and the reductions for suspended solids in the MOEs' "Stormwater Management Practices Planning and Design Manual". Quantity ponds are assumed to have a negligible effect on phosphorus reduction and are therefore not assigned any reduction coefficient.

3.4 Phosphorus Loading Methodology

Phosphorus loads were calculated by catchment based on catchment size, level of imperviousness (residential area = 0.45, industrial / commercial = 0.85), Level of control (if a Stormwater facility exists) and an average phosphorus load per hectare per year of 1.32 (residential) or 1.82 (industrial / commercial) based on monitoring data from Liang, 1999.

3.5 Retrofit Identification Methodology

Retrofit opportunities were identified using orthophotography and the outlets data set generated by this study. The outlet of each uncontrolled catchment, or those with Stormwater Facilities below Level 1 control, were examined on the orthophotography to see if there was sufficient room for the construction of a Facility. Typically only outlets that drain to open spaces, communal spaces, park land or town land were considered. Any proposed retrofits that would significantly encroach on private property, existing buildings or require alterations to existing infrastructure were excluded. Sizing of the facility was based on the area of the contributing catchment and sizing guidelines outlined in MOE's "Stormwater Management Practices Planning and Design Manual", 1994. All ponds were assumed to be 1m in depth and construction costs were based on \$150 per m³ excavated.

The tools used to identify the retrofit opportunities contained in this report may not capture all the local site constraints at each location. As well, individual Town or Municipal By-Laws or zoning may restrict certain locations. Therefore, not all the opportunities identified in the report will be possible. Improvements in treatment technology or design may make some of those retrofits that are not possible today, achievable in the future.

4. Results

4.1 Stormwater Catchments

In the context of this study the following urban areas were included: the towns of Aurora, Bradford, Innisfil, Newmarket and Uxbridge, the villages of Ballantrae, Beaverton, Cannington, Holland Landing, Keswick, Mount Albert, Pottageville, Schomberg, Sharon and Sutton and the cities of Barrie and Orillia. A total of 1174 stormwater catchments were identified within these urban areas, representing a total area of 18,229.43 hectares (Table 4.1). Of this urban area approximately 62.2% is uncontrolled, 6.6% has quantity control only and 21.2% is controlled by a level 1, 2, 3 or 4 stormwater facility. Furthermore, of those catchments that have some level of stormwater control, 82% are level 1, 6% are level 2, 8% are level 3 and 4% are level 4. In an examination of each of the urban areas, Uxbridge stands out with the highest percentage of urban area treated by SMF at 47%. The majority of urban areas have a low percentage of controlled area, below 20%, with a few being completely uncontrolled. This being more typical of older urban areas that predate current stormwater practices. Table 4.2 details the area and percent of controlled versus uncontrolled in each subwatershed.

Table 4.1 – Urban Catchments in the Lake Simcoe Watershed and Associated Control Level

Location	Total Number of Catchments	Total Urban Area (ha)	Uncontrolled			Quantity			Level 1			Level 2			Level 3			Level 4			Controlled (Total of Levels 1 to 4)		
			#	Area (ha)	% (area)	#	Area (ha)	% (area)	#	Area (ha)	% (area)	#	Area (ha)	% (area)	#	Area (ha)	% (area)	#	Area (ha)	% (area)	#	Area (ha)	% (area)
Aurora	210	2930.15	153	1941.49	66	27	357.28	12	20	407.43	14	4	60.84	2	6	163.11	6	0	0	30	631.38	22	
Ballantrae	51	725.93	33	277.31	38	12	230.98	32	6	217.64	30	0	0	0	0	0	0	0	6	217.64	30		
Barrie	198	3957.42	136	2446.64	62	43	878.50	22	16	546.89	14	3	85.39	2	0	0	0	0	19	632.28	16		
Beaverton	38	254.34	38	254.34	100	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0		
Bradford	38	581.82	32	413.29	71	3	71.88	12	3	96.65	17	0	0	0	0	0	0	3	96.65	17			
Cannington	17	106.96	15	94.69	89	1	3.60	3	0	0	0	0	0	0	0	0	1	8.67	8	1	8.67	8	
Holland Landing	50	450.68	38	351.63	78	11	97.82	22	1	1.23	0.002	0	0	0	0	0	0	1	1.23	0.002			
Innisfil	181	2116.87	150	1417.92	67	12	289.08	14	15	371.47	18	2	38.40	2	0	0	0	17	409.87	19			
Keswick	96	899.54	83	602.38	71	3	52.82	6	5	70.59	8	1	21.65	2	2	53.16	6	2	98.94	11	10	244.34	27
Mount Albert	18	163.17	15	108.12	66	0	0	0	3	55.05	34	0	0	0	0	0	0	3	55.05	34			
Newmarket	108	3104.03	51	1040.88	33.5	19	919.42	29.6	33	1002.45	32.3	1	15.31	0.5	3	77.62	2.5	1	48.35	1.6	38	1143.73	36.9
Orillia – Lake Simcoe	27	1468.13	27	1468.13	100	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0		
Pottageville	13	88.26	12	76.88	87	1	11.38	13	0	0	0	0	0	0	0	0	0	0	0	0	0		
Schomberg/Lloydtown	27	149.40	23	113.43	76	0	0	0	4	35.97	24	0	0	0	0	0	0	4	35.97	24			
Sharon	10	248.41	8	130.49	52.5	1	86.69	35	1	31.23	12.5	0	0	0	0	0	0	1	31.23	12.5			
Sutton	49	306.58	48	269.44	88	0	0	0	1	37.14	12	0	0	0	0	0	0	1	37.14	12			
Uxbridge	43	677.74	30	337.54	50	2	22.42	3	10	308.56	46	0	0	0	1	9.22	1	11	317.78	47			
Totals	1174	18,229.43	892	11,344.60	62.2	135	3021.87	16.6	118	3182.30	17.5	11	221.59	1.2	12	303.11	1.7	4	155.96	0.8	145	3862.96	21.2
Orillia – Lake Couchiching*	49	799.64	49	799.64	100	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0		

- Approximately 1/3 of Orillia drains to Lake Couchiching not Lake Simcoe and was therefore not included in Simcoe totals. Orillia drainage to Couchiching is presented for information purposes.

Table 4.2 – Urban Catchments by Subwatershed and Associated Control Level

Location	Total Number of Catchments	Total Urban Area (ha) Used	Uncontrolled (Including Quantity Control)			Level 1			Level 2			Level 3			Level 4			Controlled (Total of Levels 1 to 4)		
			#	Area (ha)	% (area)	#	Area (ha)	% (area)	#	Area (ha)	% (area)	#	Area (ha)	% (area)	#	Area (ha)	% (area)	#	Area (ha)	% (area)
Barrie Creeks	148	2783.50	145	2659.26	96	1	56.00	2	2	68.24	3	0	0	0	0	0	0	3	124.24	5
Beaver River	27	190.326	26	181.652	95	0	0	0	0	0	0	0	0	0	1	8.674	5	1	8.67	5
Beaverton Creeks	16	97.35	16	97.35	100	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Black River	55	534.01	49	387.41	72.5	6	146.60	27.5	0	0	0	0	0	0	0	0	0	6	146.60	27.5
East Holland River	408	6992.93	341	5191.47	74	52	1436.23	20.5	5	76.15	1.1	9	240.73	3.4	1	48.35	0.7	67	1801.46	26
Georgina Creeks	53	401.44	50	312.94	78	0	0	0	0	0	2	53.16	13	1	35.34	9	3	88.50	22	
Hewitts Creek	12	343.20	6	85.55	25	4	240.50	70	1	17.15	5	0	0	0	0	0	0	5	257.65	75
Innisfil Creeks	158	1714.389	143	1332.784	78	14	364.011	21	1	17.594	1	0	0	0	0	0	0	15	381.605	22
Jacksons Point Creeks	6	61.91	6	61.91	100	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Keswick Creeks	37	276.44	33	233.79	84.6	3	21.00	7.6	1	21.65	7.8	0	0	0	0	0	0	4	42.65	15.4
Lovers Creek	61	1233.20	49	954.56	77	11	257.84	21	1	20.80	2	0	0	0	0	0	0	12	278.64	23
Maksinonge River	17	233.60	15	155.28	66.5	1	14.72	6.3	0	0	0	0	0	0	1	63.60	27.2	2	78.32	33.5
Oro North Creeks	27	1468.13	27	1468.13	100	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Pefferlaw River	4	61.30	2	15.31	25	2	45.98	75	0	0	0	0	0	0	0	0	0	2	45.98	25
Uxbridge Brook	43	677.74	32	359.96	53	10	308.56	46	0	0	0	1	9.22	1	0	0	0	11	317.78	47
West Holland River	91	1086.34	78	795.49	73	13	290.85	27	0	0	0	0	0	0	0	0	0	13	290.85	27
Whites Creek	12	73.63	12	73.63	100	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0

4.2 Phosphorus Loading

In total, the urban areas of the Lake Simcoe Watershed represent a modeled phosphorus load of 26,916.87 kg/yr, of which approximately 4262.08 kg/yr (16%) has been reduced through the existing stormwater controls (Table 4.3). With a resulting phosphorus load of approximately 22,654.79 kg/yr, stormwater runoff contributes approximately 1/3 of the yearly phosphorus load to Lake Simcoe. Obviously the larger urban areas such as Aurora, Barrie and Newmarket contribute larger amounts of phosphorus (56% of the total urban load), but these areas are also achieving some of the largest reductions through SMFs. Newmarket stands out in that it is achieving a phosphorus reduction more than double that of Aurora or Barrie. While runoff from Orillia is divided, the portion draining to Lake Simcoe and Lake Couchiching has a total phosphorus load comparable to Aurora or Newmarket due in part to the fact that there are no significant Stormwater Control Facilities in these areas. Uxbridge, while being a smaller urban area, is achieving the highest percent reduction when compared to its total load out of all urban areas in the Watershed.

Within the Lake Simcoe Watershed the East Holland Subwatershed is the most urbanized, home to both Aurora and Newmarket. Approximately 8054.43 kg of phosphorus runs to the East Holland per year via stormwater runoff, which is 35.6% of the total urban load of the Watershed. As a result stormwater runoff is having a major impact on the health of the East Holland River. Stormwater runoff is one of the main reasons that the East Holland is the most degraded system in the Lake Simcoe Watershed. Table 4.4 breaks down the urban stormwater phosphorus load by relevant subwatershed.

While Barrie has the largest phosphorus load in the Watershed (25.5% of the total urban load), runoff travels to the lake either directly or through a number of small creeks. This avoids the cumulative loading impacts seen in the East Holland River but transfers much of it directly to the Lake. Disparity in the level of control between the various subwatersheds in Barrie is fairly dramatic. Barrie Creeks Subwatershed (comprising the majority of Barrie) is 95% uncontrolled and contributes 77% (4442.88 kg/yr) of the phosphorus load from Barrie. Lovers Creek and Hewitts Creek in south Barrie are 71% and 15% uncontrolled respectively and contribute 21% (1207.73 kg/yr) and 2% (131.29 kg/yr) respectively of the phosphorus load from Barrie. Hewitts Creek Subwatershed has the greatest proportion of stormwater control in the entire Lake Simcoe Watershed. Barrie Creeks is comprised primarily of the older sections of Barrie that predate current stormwater practices, while the urban area in Lovers and Hewitts Creeks is recent development that was subject to Level 1 stormwater control policies.

Table 4.3 – Urban Stormwater Phosphorus Loading by Urban Area

Location	Phosphorus Loading (kg/yr) Without Existing Stormwater Treatment	Phosphorus Loading (kg/yr) With Existing Stormwater Treatment	Difference in Phosphorus Loading (kg/yr)	Percent (%) Difference in Phosphorus loading
Aurora	4287.77	3610.66	677.11	16
Ballantrae	958.23	728.40	229.83	24
Barrie	6478.37	5781.89	696.48	11
Beaverton	344.98	344.98	0	0
Bradford	835.86	733.79	102.07	12
Cannington	151.79	147.21	4.58	3
Holland Landing	627.66	625.17	2.49	0.3
Innisfil	2918.19	2490.95	427.24	15
Keswick	1225.48	1036.66	188.82	15
Mount Albert	215.38	157.25	58.13	27
Newmarket	4712.80	3309.54	1403.26	30
Orillia – Lake Simcoe	2064.09	2064.09	0	0
Pottageville	116.50	116.50	0	0
Schomberg/Lloydtown	243.12	187.62	55.50	23
Sharon	327.91	294.93	32.98	10
Sutton	436.80	397.59	39.21	9
Uxbridge	971.94	627.56	344.38	35
Totals	26,916.87	22,654.79	4262.08	16
Orillia – Lake Couchiching*	1280.96	1280.96	0	0

* Approximately 1/3 of Orillia drains to Lake Couchiching not Lake Simcoe and was therefore not included in Simcoe totals. Orillia drainage to Couchiching is presented for information purposes.

Table 4.4 – Urban Stormwater Phosphorus Loading by Subwatershed

Location	Phosphorus Loading (kg/yr) Without Existing Stormwater Treatment	Phosphorus Loading (kg/yr) With Existing Stormwater Treatment	Difference in Phosphorus Loading (kg/yr)	Percent (%) Difference in Phosphorus loading
Barrie Creeks	4564.17	4442.88	121.29	3
Beaver River	271.07	266.49	4.58	2
Beaverton Creeks	128.51	128.51	0	0
Black River	734.03	579.21	154.82	21
East Holland River	10276.13	8167.95	2108.18	20.5
Georgina Creeks	544.46	487.91	56.55	10.5
Hewitts Creek	453.02	183.43	269.59	60
Innisfil Creeks	2263.45	1863.03	400.42	18
Jacksons Point Creeks	81.72	81.72	0	0
Keswick Creeks	388.66	342.34	46.32	12
Lovers Creek	2115.91	1783.5	332.41	16
Maksinonge River	311.11	261.99	49.12	16
Oro North Creeks	2064.09	2064.09	0	0
Pefferlaw River	80.91	32.35	48.56	60
Uxbridge Brook	971.94	627.56	344.38	35.5
West Holland River	1570.48	1244.64	325.84	21
Whites Creek	97.19	97.19	0	0
Totals	26916.85	22654.79	4262.06	16

5. Remediation

5.1 General Stormwater Remediation Practices

Small lot level controls can be effective at mitigating some of the impacts of stormwater if adopted at a large scale. These include disconnection of downspouts direct to storm drains, installation of rain barrels and soak away pits, naturalization of grassed swales and ditches, minimizing use of landscaping chemicals and fertilizers and insuring proper application and disposal. Larger scale programs should include increased street cleaning in late winter to avoid accumulated sand and salt from being washed into water bodies. The Canadian Environmental Protection Act defined road salt containing chloride as toxic under the Act (Environment Canada, 2001).

Efforts to address stormwater runoff should include:

- Municipalities in the Lake Simcoe Watershed initiating a rain barrel program to educate the public about stormwater, the benefits and uses of captured rain water along with subsidizing the purchase of rain barrels.
- Municipalities in the Lake Simcoe Watershed adopting the “*Code of Practice for the Environmental Management of Road Salts*” (Environment Canada, 2004) as well as examining potential alternatives to road salt where it would not pose a threat to safety.
- Municipalities in the Lake Simcoe Watershed following the Town of Newmarket’s example, along with 135 other Canadian Municipalities (<http://www.flora.org/healthyottawa/BylawList.pdf>, 2007), and ban the cosmetic use of pesticides.

5.2 Stormwater Pond Retrofit Opportunities

As this report focused on SMFs in the form of ponds, the mitigation opportunities examined here are Stormwater Ponds. Stormwater remediation opportunities examined include construction of ponds in uncontrolled catchments or upgrading of existing facilities or quantity only facilities to a higher level of control (e.g. Level 1).

A total of 279 of these opportunities have been identified, affecting a total of 7142.28 hectares (Table 5.1). The total estimated cost associated with the proposed retrofits is \$116,714,229.50, with a potential phosphorus reduction of 7260.20 kg/yr or 32% of the total urban load. Details of each retrofit opportunity can be found in Appendix 2.

The reduction achieved by these retrofit opportunities is calculated using current SMF effectiveness monitoring data and are based on current technology. Further effectiveness monitoring of ponds under varying conditions and seasons, as well as monitoring of the phosphorus loadings associated with various land

uses may further refine these numbers. Advances in stormwater treatment technology may further improve phosphorus reductions and allow for treatment in areas where it is currently not possible. It is therefore important to continually monitor and evaluate emerging treatment technologies for their potential to further reduce phosphorus loading associated with urban stormwater runoff.

Table 5.1 – Retrofit Opportunities by Urban Area

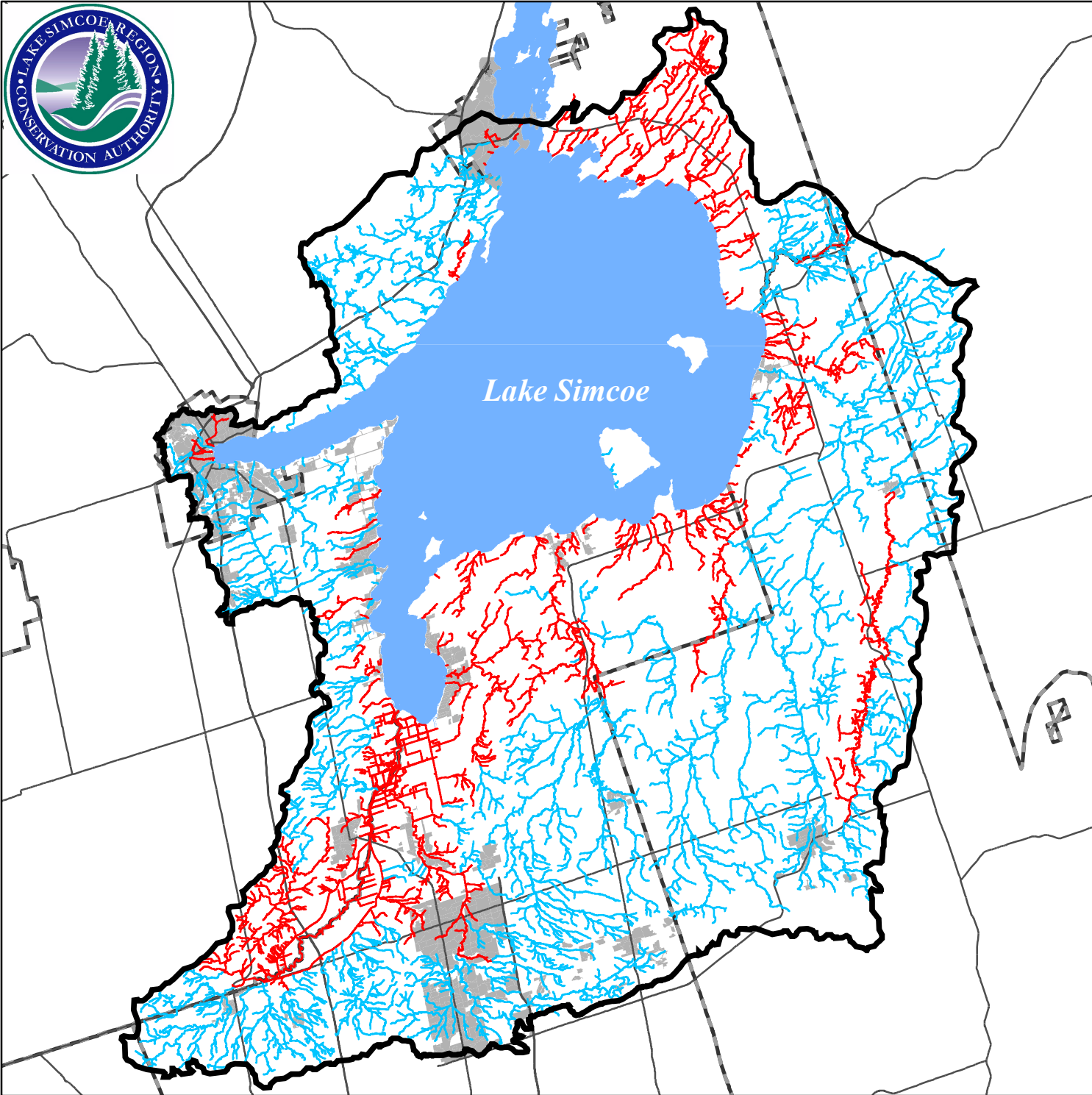
Location	Number of Retrofits	Area (ha) Affected By Retrofits	Estimated Cost (\$150/m ³ excavated)	Phosphorus Loading (kg/yr) With Existing Stormwater Treatment	Phosphorus Loading (kg/yr) With Proposed Retrofits	Difference in Phosphorus Loading (kg/yr)	Percent (%) Difference in Phosphorus Loading (kg/yr)
Aurora	37	782.35	\$13,640,613.00	3610.66	2868.50	742.16	21
Ballantrae	20	295.84	\$5,187,724.50	728.40	415.99	312.41	43
Barrie	39	1363.37	\$30,953,220.00	5781.89	3919.43	1862.46	32
Beaverton	13	109.74	\$1,958,307.00	344.98	229.10	115.88	34
Bradford	6	348.79	\$6,879,850.50	733.79	339.87	393.92	54
Cannington	6	82.41	\$1,643,466.00	147.21	56.29	90.92	62
Holland Landing	20	332.58	\$6,243,045.00	625.17	255.16	370.01	59
Innisfil	46	599.13	\$11,845,516.50	2490.95	1796.03	694.92	28
Keswick	23	434.09	\$7,140,145.50	1036.66	669.33	367.33	35
Mount Albert	6	93.98	\$1,719,139.50	157.25	58.00	99.25	63
Newmarket	16	959.95	\$11,836,184.00	3309.54	2533.04	776.50	23
Orillia –Lake Simcoe	5	1126.82	\$6,204,700.50	2064.09	1330.89	733.20	36
Pottageville	5	62.06	\$1,163,599.50	116.50	50.96	65.54	56
Schomberg/Lloydtown	7	80.77	\$1,769,485.50	187.62	80.68	106.94	57
Sharon	3	135.81	\$1,701,172.50	294.93	164.10	130.83	44
Sutton	13	164.89	\$3,316,116.00	397.59	206.56	191.03	48
Uxbridge	14	169.70	\$3,511,944.00	627.56	420.66	206.90	33
Totals	279	7142.28	\$116,714,229.50	22,654.79	15,394.59	7260.20	32
Orillia – Lake Couchiching	6	190.95	\$3,569,269.50	1280.96	1023.61	257.35	20

* Approximately 1/3 of Orillia drains to Lake Couchiching not Lake Simcoe and was therefore not included in Simcoe totals. Orillia drainage to Couchiching is presented for information purposes.

5.3 Coldwater Habitat Protection

As discussed previously in this report, stormwater runoff can be warmed significantly as it drains off warm pavement and experience further warming as it sits in a pond. This temperature difference can be very disruptive to coldwater habitat that requires a stable water temperature. Alterations of stormwater pond design can help to minimize temperature increases in receiving watercourses. Construction of a bottom-draw outlet works by drawing from the cooler water at the bottom of the pond and releasing this into the receiving watercourse. For this to be effective it is necessary for the pond to have a deep pool (2-3m) in order to allow the water to adequately cool. Another strategy to help cool down water in a stormwater pond is to plant a vegetative buffer along the edge of the pond providing shade and thereby cooling the water. This type of natural design could also be used when constructing the outlet channels. Alternately, implementing a night time or early morning release of water can help minimize the temperature increase as water temperature in ponds typically decreases overnight (MOE, 2003).







Figure 5.1 displays the watercourses that are managed for coldwater in the Lake Simcoe Watershed and Appendix 3 lists existing ponds as well as retrofit opportunities that outlet to these reaches. Alteration of existing ponds could be implemented along with routine maintenance, repair, expansion or targeted stewardship initiatives. Some form of thermal mitigation also needs to be considered for each of the retrofit opportunities that outlet to a coldwater system. Incorporation of these thermal mitigation features would serve to protect and enhance coldwater habitat. A further benefit of bottom draw outlets is their ability to contain oil and gas spills in a stormwater pond and facilitate easy clean up. Bottom draw outlets should therefore also be considered in areas prone to oil and gas spills such as industrial areas, catchments with multiple gas stations or large impervious areas.



Water Management

- Figure 5.1 -

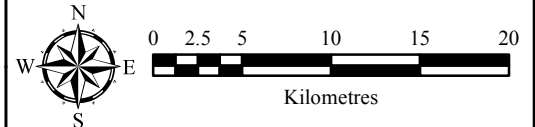
Legend

-  Cold Water Stream
-  Warm Water Stream
-  Major Road
-  Upper Tier Boundary
-  Waterbody
-  Urban Area

The information depicted on this map has been compiled from various sources. While every effort has been made to accurately depict the information, data/mapping errors may exist. This map has been produced for illustrative purposes only.

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Projection: NAD 83, UTM Zone 17N

LSRCA GIS Services
Created December 2007

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Appendix 2 – Stormwater Retrofit Opportunities by Municipality

Aurora Retrofit Opportunities

Location	Type of SWMP Retrofit	Size of SWMP (m3) (assuming 1m deep)	P Reduction(kg/yr) Level 1 80%, Level 2 69%, Level 3 54%, Level 4 40%	Estimated Cost (\$150/m3 excavated)	Estimated Cost (per kg P removed)	Constraints
A-C15 (Wenderly Dr. east of Iber Cr.)	No existing pond, room for level 1 wet pond	444.06	3.75	66609.00	17762.40	Fisheries concerns
A-C18 (southwest corner of Edward St. and Vata Cr.)	No existing pond, room for level 1 wet pond	745.86	7.16	111879.00	15625.56	None
A-C19 (east side of Allaura Blvd. south of Edward St.)	No existing pond, room for level 1 wet pond	1234.34	11.85	185151.00	15624.56	None
A-C25 (north of Stone Rd. Between October Lane and Bayview Ave.)	Retrofit of existing quantity pond to level 1 wet pond	1648.93	13.93	247339.50	17755.89	None
A-C8 (south of Wellington St. E. and east of Mary St.)	Retrofit of existing quantity pond to level 1 wet pond	3274.45	31.43	491167.50	15627.35	Property ownership (?)
A-EC15 (southeast of Wilmac Cr. and west of Woodbine Ave.)	No existing pond, room for level 1 wet pond	949.13	8.02	142369.50	17751.81	Property ownership (?), and some tree removal

Location	Type of SWMP Retrofit	Size of SWMP (m3) (assuming 1m deep)	P Reduction (kg/yr) Level 1 80%, Level 2 69%, Level 3 54%, Level 4 40%	Estimated Cost (\$150/m3 excavated)	Estimated Cost (per kg P removed)	Constraints
A-EC16 (southwest corner of West Park Blvd. and Lady Diana Cr.)	No existing pond, room for level 1 wet pond	4002.10	33.81	600315.00	17755.55	Fisheries concerns
A-EC18 (northeast corner of Ram Forest Rd. N. and Fortecon Dr.)	Retrofit of existing quantity pond to level 1 wet pond	1874.85	18.00	281227.50	15623.75	Property ownership (?) and fisheries concerns
A-EC19 (East of Ram Forest Rd.N. and south of Fortecon Dr.)	No existing pond, room for level 1 wet pond	1975.40	18.96	296310.00	15628.16	Property ownership (?)
A-EC19, A-EC21 (northeast of Norbett Dr. and Ram Forest Rd. N.)	Alternative to A-EC19, construct level 1 pond to treat both catchments	3291.01	30.33	493651.50	16276.01	Slight drainage diversion of A-EC19
A-EC22 (south of Forest Trail)	No existing pond, room for level 1 wet pond	873.40	9.22	131010.00	14209.33	Tree removal
A-EC24, A-EC25 (north of Ruth Cr. and Elsa Dr.)	No existing pond, room for level 1 wet pond to treat both catchments	564.98	4.77	84747.00	17766.67	Tree removal

Location	Type of SWMP Retrofit	Size of SWMP (m3) (assuming 1m deep)	P Reduction (kg/yr) Level 1 80%, Level 2 69%, Level 3 54%, Level 4 40%	Estimated Cost (\$150/m3 excavated)	Estimated Cost (per kg P removed)	Constraints
A-EC27 (southeast corner of Ram Forest Rd. N. and Aurora Rd.)	Retrofit of existing quantity pond to level 1 wet pond	734.79	6.35	110218.50	17357.24	None
A-NC15 (south of St. John's Sideroad E. and east of Industrial Parkway N.)	Retrofit of existing quantity pond to level 1 wet pond	375.58	3.18	56337.00	17716.04	None
A-NC15, A-NC16 (east of Industrial Parkway N. south of St. John's Sideroad E.)	Alternative to A-NC15 retrofit. Room for level 1 wet pond to treat both catchments	1062.45	8.98	159367.50	17746.94	None
A-NC18 (east of Birkshire Dr. at Perivale Gardens)	Retrofit of existing level 3 wet pond to level 1 wet pond	2541.42	8.95	381213.00	42593.63	None
A-NC19 (northeast corner of Limeridge St. and Kirkvalley Crescent)	Retrofit of existing level 3 wet pond to level 1 wet pond	4834.28	17.02	725142.00	42605.29	None

Location	Type of SWMP Retrofit	Size of SWMP (m3) (assuming 1m deep)	P Reduction (kg/yr) Level 1 80%, Level 2 69%, Level 3 54%, Level 4 40%	Estimated Cost (\$150/me excavated)	Estimated Cost (per kg P removed)	Constraints
A-NC26, A-NC28 (southwest of Hollandview Trail and Woodroof Crescent)	Retrofit of existing ponds to one level 1 wet pond to treat both catchments	2012.69	5.15	301903.50	58622.04	None
A-NC27 (northwest corner of Woodroof Crescent and Hollandview Trail)	Retrofit of existing level 3 wet pond to level 1 wet pond	2167.71	11.45	325156.50	28397.95	None
A-NC30 (northwest of John West Way and north of Wellington St. E.)	Retrofit of existing quantity pond to level 1 wet pond	394.83	3.34	59224.50	17731.89	None
A-NC7, A-NC8 (northwest of Ashley Place, east of Yonge St.)	Retrofit of existing quantity ponds to one level 1 wet pond to treat both catchments	1455.48	13.48	218322.00	16195.99	None
A-NW10, A-NW11 (southeast corner of Willow Farm Lane and Heatherfield Lane)	No existing pond, room for level 1 wet pond to treat both catchments	2506.95	21.18	376042.50	17754.60	None

Location	Type of SWMP Retrofit	Size of SWMP (m3) (assuming 1m deep)	P Reduction (kg/yr) Level 1 80%, Level 2 69%, Level 3 54%, Level 4 40%	Estimated Cost (\$150/m3 excavated)	Estimated Cost (per kg P removed)	Constraints
A-NW18, A-NW19 (southeast corner of Heathwood Heights Dr.)	No existing pond, room for level 1 wet pond to treat both catchments	3682.73	31.11	552409.50	17756.65	Tree removal
A-NW24, A-NW27, A-NW37, A-NW38, A-NW39 (south of Kemano Dr. between Autumn Way and Delayne Dr.)	No existing pond, room for level 1 wet pond to treat all five catchments	4482.33	37.87	672349.50	17754.15	Fisheries concerns and tree removal
A-NW28 (south of Orchard Heights Blvd. between Parkland Crt. and Yonge St.)	No existing pond, room for level 1 wet pond	6469.60	54.66	970440.00	17754.12	May have to redirect walking path.
A-NW31, A-NW36 (south of Aurora Heights Dr. at Laurwood Crt.)	Retrofit of existing quantity pond to level 2 wet pond to treat both catchments	1957.43	29.72	293614.50	9879.36	Located in park area
A-NW33 (north of Wellington St. W. between Marksbury Crt. and Harmon Ave.)	Retrofit of existing quantity pond to level 1 wet pond	626.70	5.30	94005.00	17736.79	None

Location	Type of SWMP Retrofit	Size of SWMP (m3) (assuming 1m deep)	P Reduction (kg/yr) Level 1 80%, Level 2 69%, Level 3 54%, Level 4 40%	Estimated Cost (\$150/m3 excavated)	Estimated Cost (per kg P removed)	Constraints
A-NW34 (northeast corner of Wellington St. W. and McLeod Dr.)	Retrofit of existing quantity pond to level 1 wet pond	495.27	4.18	74290.50	17772.85	None
A-NW41 (northeast corner of Aurora Heights Dr. and Community Centre Lane)	No existing pond, room for level 1 wet pond	4949.59	41.82	742438.50	17753.19	May have to redirect walking path.
A-NW43 (northeast of Jasper Dr. and Dunham Crescent)	No existing pond, room for level 1 wet pond	1405.61	11.87	210841.50	17762.55	None
A-NW7, A-NW8, A-NW9 (west of Willow Farm Lane and northeast of Wilkinson Place)	Retrofit of existing quantity pond to level 1 wet pond to treat all three catchments	3618.13	33.52	542719.50	16190.92	Fisheries concerns
A-SC12 (northwest corner of Crossing Bridge Place)	Retrofit of existing quantity pond to level 1 wet pond	430.71	3.64	64606.50	17749.04	None

Location	Type of SWMP Retrofit	Size of SWMP (m3) (assuming 1m deep)	P Reduction (kg/yr) Level 1, 80%, Level 2 69%, Level 3 54%, Level 4 40%	Estimated Cost (\$150/m3 excavated)	Estimated Cost (per kg P removed)	Constraints
A-SC7 (northwest corner of Monkman Crt.)	No existing pond, room for level 1 wet pond	593.64	5.02	89046.00	17738.25	None
A-SE3 (east of Offord Crescent cul-de-sac)	Retrofit of existing quantity pond to level 1 wet pond	6380.55	53.90	957082.50	17756.63	Fisheries concerns
A-SW2 (northeast corner of Bathurst St. and McClellan Way)	Retrofit of existing level 3 wet pond to level 1 wet pond	2407.70	12.71	361155.00	28415.03	Some tree removal
A-SW6 (south of Henderson Dr. between McClellan Way and Ardill Crescent)	Retrofit of existing quantity pond to level 1 wet pond	8617.75	72.80	1292662.50	17756.35	None
A-WC1, A-WC5 (north of Timpson Dr. and east of Tannery Creek Crescent)	Retrofit of existing quantity pond to level 1 wet pond	3618.53	30.57	542779.50	17755.30	None
A-WC25 (southeast corner of Highland Gate and Bathurst St.)	Retrofit of existing quantity pond to level 1 wet pond	3111.80	32.86	466770.00	14204.81	Fisheries concerns

Location	Type of SWMP Retrofit	Size of SWMP (m3) (assuming 1m deep)	P Reduction (kg/yr) Level 1 80%, Level 2 69%, Level 3 54%, Level 4 40%	Estimated Cost (\$150/m3 excavated)	Estimated Cost (per kg P removed)	Constraints
A-WC3 (south of Wellington St. W. and Windham Trail)	Retrofit of existing quantity pond to level 1 wet pond	1475.64	12.46	221346.00	17764.53	None
		Sum of Best Alternatives	742.18	\$13,640,613.00		

Ballantrae Retrofit Opportunities

Location	Type of SWMP Retrofit	Size of SWMP (m3) (assuming 1m deep)	P Reduction(kg/yr) Level 1 80%, Level 2 69%, Level 3 54%, Level 4 40%	Estimated Cost (\$150/m3 excavated)	Estimated Cost (per kg P removed)	Constraints
BAL-NE5 (east of Lakewoods Dr. north of Aurora Rd.)	No existing pond, room for level 1 wet pond	691.21	7.30	103681.50	14202.95	Tree removal and property ownership
BAL-NW1 (northwest of Woodheath Lane and Hawking Crt.)	Retrofit existing quantity pond to a level 1 wet pond	2629.46	27.77	394419.00	14203.06	Some tree removal
BAL-NW10 (northwest corner of McCowan Rd. and Cranborne Dr.)	Retrofit existing quantity pond to a level 1 wet pond	640.08	6.76	96012.00	14202.96	None
BAL-NW11 (northeast corner of Grayfield Dr. and Aurora Rd.)	Retrofit existing quantity pond to a level 1 wet pond	3864.55	32.65	579682.50	17754.44	None
BAL-NW12 (between 84 and 92 Ballantrae Rd.)	Retrofit existing quantity pond to a level 1 wet pond	3183.74	26.90	477561.00	17753.20	None

Location	Type of SWMP Retrofit	Size of SWMP (m3) (assuming 1m deep)	P Reduction (kg/yr) Level 1 80%, Level 2 69%, Level 3 54%, Level 4 40%	Estimated Cost (\$150/m3 excavated)	Estimated Cost (per kg P removed)	Constraints
BAL-NW13 (south of Ballantrae Rd. between George Pipher Lane and Highway 48)	Retrofit existing quantity pond to a level 1 wet pond	4754.40	40.17	713160.00	17753.55	Property ownership (?)
BAL-NW14 (south of Aurora Rd. and west of Tamarac Dr.)	Retrofit existing quantity pond to a level 1 wet pond	5889.78	49.76	883467.00	17754.56	Property ownership (?)
BAL-NW7 (northwest side of Greenvalley Circle west of David Wright Crt.)	No existing pond, room for level 1 wet pond	1014.88	10.72	152232.00	14200.75	Tree removal and some fisheries concerns (creek location)
BAL-NW8 (west side of Greenvalley Circle south of Blue Ridge Trail)	No existing pond, room for level 1 wet pond	2016.41	17.03	302461.50	17760.51	Tree removal and some fisheries concerns (proposed area is adjacent to stream)
BAL-SE10, BAL SE14 (northeast of Lakeshore Rd, west of Ninth Line)	No existing pond, room for level 1 wet pond to treat both catchments	874.90	7.39	131235.00	17758.46	Property ownership (?)

Location	Type of SWMP Retrofit	Size of SWMP (m3) (assuming 1m deep)	P Reduction (kg/yr) Level 1 80%, Level 2 69%, Level 3 54%, Level 4 40%	Estimated Cost (\$150/m3 excavated)	Estimated Cost (per kg P removed)	Constraints
BAL-SE11 (southwest corner of Wylie Lane and Valley Rd.)	No existing pond, room for level 1 wet pond	200.32	1.70	30048.00	17675.29	None
BAL-SE13 (southeast corner of Valleyfield Rd.)	No existing pond, room for level 1 wet pond	1098.76	9.28	164814.00	17760.13	Property ownership (?)
BAL-SE19 (rear of 17 and 21 Island Lake Dr.)	Retrofit existing quantity pond to a level 1 wet pond	1050.19	8.87	157528.50	17759.70	Some tree removal
BAL-SE2 (southeast of Lakeshore Rd. and Treeview Ave.)	No existing pond, room for level 1 wet pond	1165.47	12.30	174820.50	14213.05	Tree removal
BAL-SE3 (southeast of Brookdale Crt.)	Retrofit existing quantity pond to a level 1 wet pond	920.95	7.78	138142.50	17756.11	Some tree removal
BAL-SW1 (northwest corner of Elia Dr.)	Retrofit existing quantity pond to a level 1 wet pond	1148.12	12.13	172218.00	14197.69	Tree removal and property ownership

Location	Type of SWMP Retrofit	Size of SWMP (m3) (assuming 1m deep)	P Reduction (kg/yr) Level 1 80%, Level 2 69%, Level 3 54%, Level 4 40%	Estimated Cost (\$150/m3 excavated)	Estimated Cost (per kg P removed)	Constraints
BAL-SW10 (southeast corner of Felcher Blvd. and High Point Dr.)	No existing pond, room for level 1 wet pond	1150.21	9.72	172531.50	17750.15	Property ownership (?)
BAL-SW2 (southwest corner of Hill Country Dr.)	Retrofit existing quantity pond to a level 1 wet pond	491.16	5.18	73674.00	14222.78	Tree removal
BAL-SW3 (north of 1,5 and 9 Hill Country Dr.)	No existing pond, room for level 1 wet pond	1266.86	13.38	190029.00	14202.47	Tree removal
BAL-SW5 (northeast corner of William Andrew Ave.)	Retrofit existing quantity pond to a level 1 wet pond	533.38	5.90	80007.00	13560.51	None
		Total:	312.69	\$5,187,724.50		

Barrie Retrofit Opportunities

Location	Type of SWMP Retrofit	Size of SWMP (m3) (assuming 1m deep)	P Reduction(kg/yr) Level 1 80%, Level 2 69%, Level 3 54%, Level 4 40%	Estimated Cost (\$150/m3 excavated)	Estimated Cost (per kg P removed)	Constraints
BAR-C14 (northeast corner of Vespra St. and Ellen St.)	No existing pond, room for level 1.	197.57	1.90	29635.50	15597.63	None
BAR-C29 (end of Sanford St, north of Tiffin St.)	No existing pond, room for level 1 wet pond.	225.28	1.90	33792.00	17785.26	None
BAR-C6 (south of Edgehill Dr. and northwest of Cedar Point Dr.)	No existing pond, room for level 1 wet pond.	2929.69	28.13	439453.50	15622.24	Property ownership (?)
BAR-NE15 (southwest of St.Vincent St. and north of Grove St. E.)	No existing pond, room for level 2 wet pond to treat drainage from north half of BAR-NE15	4174.23	65.99	626134.50	9488.32	Flow splitter will need to be installed under St. Vincent St. Site can not handle upstream contributions.
BAR-NE16 (southeast of Rose St. and west of Blue Mound Dr.)	No existing pond, room for level 1 wet pond.	1955.36	16.52	293304.00	17754.48	Soccer field?
BAR-NE2 (southeast corner of Corrinhall St. and Buchanan St.)	Retrofit of existing dry pond to level 1 wet pond	541.09	4.57	81163.50	17767.84	None

Location	Type of SWMP Retrofit	Size of SWMP (m3) (assuming 1m deep)	P Reduction (kg/yr) Level 1 80%, Level 2 69%, Level 3 54%, Level 4 40%	Estimated Cost (\$150/m3 excavated)	Estimated Cost (per kg P removed)	Constraints
BAR-NE33 (west corner of Highway 400 and St. Vincent St.)	No existing pond, room for level 1 wet pond.	877.87	7.42	131680.50	17746.70	None
BAR-NE34, BAR-NE35, BAR-NE36, BAR-NE37, BAR-NE38 (southeast of Highway 400 and north of Ottawa Ave.)	No existing pond, may be possible to fit level 2 pond to intercept all drainage	5361.12	82.25	804168.00	9777.12	Possible fisheries concerns as it was once headwaters. Property belongs to?
BAR-NW1, BAR-NW5, BAR-NW6 (west of Browning Trail)	Retrofit dry pond. Alternative to BAR-NW3 and BAR-NW4 retrofit. Would also treat BAR-NW1, BAR-NW5 and BAR-NW6. Room for Level 1 pond	10651.71	99.86	1597756.50	15999.96	Some tree removal
BAR-NW11, BAR-NW13 (west of Anne St. N. and North of Shelley Lane)	Retrofit and expand dry pond to level 1 wet pond.	4273.29	36.11	640993.50	17751.14	Removal of trees

Location	Type of SWMP Retrofit	Size of SWMP (m3) (assuming 1m deep)	P Reduction (kg/yr) Level 1 80%, Level 2 69%, Level 3 54%, Level 4 40%	Estimated Cost (\$150/m3 excavated)	Estimated Cost (per kg P removed)	Constraints
BAR-NW17 (north corner of Livingstone St. W. and Ford St.)	Retrofit of existing dry pond to level 1 wet pond	7480.26	63.19	1122039.00	17756.59	Encroach slightly on recreational facilities.
BAR-NW18, BAR-NW19 (north fo Cundles Rd. W. and southwest of Lillian Crescent)	Retrofit southern portion of pond for level 1 pond to treat both catchments	1734.05	14.65	260107.50	17754.78	None
BAR-NW2 (south of Sunnidale Rd. and northeast of Iriwin Dr.)	Retrofit of existing dry pond to level 1 wet pond	3499.70	29.57	524955.00	17752.96	Some tree removal
BAR-NW24 (north corner of Highway 400 and Sunnidale Rd.)	No existing pond, room for level 1 wet pond.	1979.44	16.72	296916.00	17758.13	Some tree removal
BAR-NW3, BAR-NW4 (northwest of McVeigh Dr. and south of Cundles Rd. W.)	Retrofit of existing dry pond to level 1 wet pond	2250.57	19.00	337585.50	17767.66	Next to ball diamond

Location	Type of SWMP Retrofit	Size of SWMP (m3) (assuming 1m deep)	P Reduction (kg/yr) Level 1 80%, Level 2 69%, Level 3 54%, Level 4 40%	Estimated Cost (\$150/m3 excavated)	Estimated Cost (per kg P removed)	Constraints
BAR-NW32 (west of Coulter St. and northeast of Highway 400)	No existing pond, room for level 1 wet pond.	1708.39	14.76	256258.50	17361.69	Removal of trees
BAR-NW33, BAR-NW34 (southwest of Bayfield St. between Coulter St. and Highway 400)	Room exists for a level 1 pond to treat both areas.	10869.47	104.35	1630420.50	15624.54	None
BAR-NW8 (south of Livingstone St. W. and east of Etherington Crescent)	Retrofit of existing dry pond to level 2 wet pond	1036.89	15.74	155533.50	9881.42	None
BAR-NW9 (Lillian Crescent southeast of Sinclair Crt.)	No pond exists. Alternative to treating BAR-NW2, BAR-NW8 and BAR-NW17 separately. Room for level 1 pond to treat all 4 catchments	19638.77	165.91	2945815.50	17755.50	May be soccer field in footprint. Some tree removal.

Location	Type of SWMP Retrofit	Size of SWMP (m3) (assuming 1m deep)	P Reduction (kg/yr) Level 1 80%, Level 2 69%, Level 3 54%, Level 4 40%	Estimated Cost (\$150/m3 excavated)	Estimated Cost (per kg P removed)	Constraints
BAR-SE18 (south of Tollendal Mill Rd. and west of Wallwin's Way)	Retrofit of existing dry pond to level 1 wet pond	1516.95	12.82	227542.50	17749.02	None
BAR-SE19 (northeast corner of Macmillan Crescent and Tomlin Crt.)	Retrofit of existing dry pond to level 1 wet pond	947.95	8.01	142192.50	17751.87	None
BAR-SE20 (west of Maclaren Ave. and South of Little Ave.)	No existing pond, room for level 1 wet pond.	475.04	4.02	71256.00	17725.37	None
BAR-SE22 (southwest corner of D'Ambrosio Dr. and Yonge St.)	Retrofit of existing dry pond to level 1 wet pond	2218.07	18.74	332710.50	17754.03	None
BAR-SE23 (southeast corner of Chalmers Dr. and Loon Ave.)	Retrofit of existing dry pond to level 1 wet pond	2939.93	24.84	440989.50	17753.20	None
BAR-SE32, BAR-SE33 (northwest corner of Herrell Ave. and Firman Dr.)	Retrofit of existing dry pond to level 1 wet pond	1914.77	16.18	287215.50	17751.27	None. This alternative does not interfere with drainage channel therefore avoiding fisheries concerns.

Location	Type of SWMP Retrofit	Size of SWMP (m3) (assuming 1m deep)	P Reduction (kg/yr) Level 1 80%, Level 2 69%, Level 3 54%, Level 4 40%	Estimated Cost (\$150/m3 excavated)	Estimated Cost (per kg P removed)	Constraints
BAR-SE36 (north of Big Bay Point Rd. and between Huronia Rd. and Pickett Crescent)	No existing pond, room for level 1 wet pond.	1669.25	14.10	250387.50	17757.98	Property ownership (?)
BAR-SE4, BAR-SE5 (southeast corner of Walnut Crescent)	No existing pond, room for level 1 wet pond.	4725.20	39.92	708780.00	17755.01	Tree removal
BAR-SE46 (west of Minet's Point Rd, between Burton Ave. and Lakeshore Dr.)	Alternative to treating BAR-SE57 separately. Also treats BAR-SE46. Retrofit existing pond to provide Level 1 treatment.	10514.81	88.83	1577221.50	17755.50	None
BAR-SE50 (southeast corner of Little Ave. and McConkey Place)	Retrofit portion of pond to provide Level 1 treatment.	230.01	1.94	34501.50	17784.28	None
BAR-SE54 (south of Ellis Dr. and east of Welham Rd.)	Retrofit of existing quantity pond to level 1 wet pond	13359.13	128.25	2003869.50	15624.71	Online pond. Flow from SW49 and natural drainage pass through.

Location	Type of SWMP Retrofit	Size of SWMP (m3) (assuming 1m deep)	P Reduction (kg/yr) Level 1 80%, Level 2 69%, Level 3 54%, Level 4 40%	Estimated Cost (\$150/m3 excavated)	Estimated cost (per kg P removed)	Constraints
BAR-SE55 (east of Welham Dr. and north of Mapleview Dr.)	Retrofit of existing dry pond to level 1 wet pond	2187.05	20.99	328057.50	15629.23	None
BAR-SE56 (east of Welham Rd. and north of Saunders Rd.)	Retrofit of existing dry pond to level 1 wet pond	3506.16	33.66	525924.00	15624.60	None
BAR-SE57 (west of Woodcrest Rd. and Greenfield Ave.)	Retrofit existing dry pond to level 1 wet pond	3831.39	32.37	574708.50	17754.36	None
BAR-SE58 (southeast of Wilson Crt)	No existing pond, room for level 1 wet pond.	199.24	1.72	29886.00	17375.58	Tree removal
BAR-SE68 (east of Bayview Dr. and north of Lockhart Rd.)	Alternative to BAR-SW50 retrofit. Room for level 1 wet pond to treat both catchments	14560.30	139.78	2184045.00	15624.87	None, this facility would also handle the flow from catchment BAR-SW42 which is already treated as level 1, therefore it was not used in the calculations.
BAR-SE83 (Between Peck St. and Cox Mill Rd.)	No existing pond, room for level 1 wet pond.	374.30	3.16	56145.00	17767.41	None

Location	Type of SWMP Retrofit	Size of SWMP (m3) (assuming 1m deep)	P Reduction (kg/yr) Level 1 80%, Level 2 69%, Level 3 54%, Level 4 40%	Estimated Cost (\$150/m3 excavated)	Estimated Cost (per kg P removed)	Constraints
BAR-SE9 (northeast corner of Cox Mill Rd. and Mary Anne Dr.)	Retrofit of existing dry pond to level 1 wet pond	2642.97	22.33	396445.50	17753.94	Space constraints, pond would need to exceed 1m depth.
BAR-SW1 (east of Patterson Rd. between Tiffin St. and Phillips St.)	No existing pond, room for level 1 wet pond.	1005.00	8.50	150750.00	17735.29	Property ownership (?)
BAR-SW2 (between Patterson Rd. and Highway 400 east of Phillips St.)	No existing pond, room for level 1 wet pond.	2236.44	21.47	335466.00	15624.87	Property ownership (?)
BAR-SW20 (northeast corner of Chieftan Crescent)	No existing pond, room for level 1 wet pond.	1398.16	11.81	209724.00	17758.17	None
BAR-SW24 (south of Chieftan Crescent and northeast of Fairview Rd.)	No existing pond, room for level 1 wet pond.	3765.35	36.14	564802.50	15628.18	Potential fisheries concerns

Location	Type of SWMP Retrofit	Size of SWMP (m3) (assuming 1m deep)	P Reduction (kg/yr) Level 1 80%, Level 2 69%, Level 3 54%, Level 4 40%	Estimated Cost (\$150/m3 excavated)	Estimated Cost (per kg P removed)	Constraints
BAR-SW28 (southeast corner of Montserrand St. and Beacon Rd.)	No existing pond, room for level 1 wet pond.	1335.22	11.28	200283.00	17755.59	None
BAR-SW38 (between Barrie View Dr. and Highway 400 north of Mapleview Dr.)	Retrofit of existing dry pond to level 1 wet pond	1320.25	12.67	198037.50	15630.43	None
BAR-SW4, BAR-SW19 (between Morrow Rd. and Highway 400 north of Essa Rd.)	No existing pond, room for level 1 wet pond.	7097.46	65.03	1064619.00	16371.20	Property ownership (?)
BAR-SW41 (west of Bayview Dr. and north of Saunders Rd.)	Alternative to retrofitting BAR-SW52, also providing treatment to BAR-SW41. Retrofit existing pond to Level 1 pond.	12116.88	115.83	1817532.00	15691.38	Potential fisheries concerns. Some tree removal.

Location	Type of SWMP Retrofit	Size of SWMP (m3) (assuming 1m deep)	P Reduction (kg/yr) Level 1 80%, Level 2 69%, Level 3 54%, Level 4 40%	Estimated Cost (\$150/m3 excavated)	Estimated Cost (per kg P removed)	Contraints
BAR-SW46 (between Mayfair Rd. and Quail Crescent, west of Essa Rd.)	Retrofit of existing dry pond to level 1 wet pond	756.01	6.53	113401.50	17366.23	None
BAR-SW47 (northwest corner of Logger's Run and Evergreen Crt.)	Retrofit of existing dry pond to level 1 wet pond	1073.38	9.27	161007.00	17368.61	None
BAR-SW5 (Between Highway 400 and Campbell Ave.)	No existing pond, room for level 1 wet pond.	10728.82	103.00	1609323.00	15624.50	None
BAR-SW50 (northeast corner of Commerce Park Dr.)	Retrofit of existing dry pond to level 2 wet pond	1859.97	29.40	278995.50	9489.64	None
BAR-SW52 (northeast corner of Mapleview Dr. and Bryne Dr.)	Retrofit of existing dry pond to level 1 wet pond	4159.62	39.94	623943.00	15622.01	None

Location	Type of SWMP Retrofit	Size of SWMP (m3) (assuming 1m deep)	P Reduction (kg/yr) Level 1 80%, Level 2 69%, Level 3 54%, Level 4 40%	Estimated Cost (\$150/m3 excavated)	Estimated Cost (per kg P removed)	Constraints
Between Vine Cres and Shirley Ave.	No pond exists. Alternative to BAR-NW11 and BAR-NW13 retrofit. Also treats BAR-NW15, BAR-NW25 and BAR-NW27. Room for Level 1 pond.	7554.13	63.84	1133119.50	17749.37	Removal of trees
East of Bayview Dr.	Alternative to treating BAR-SW20 and BAR-SW24 separately. Also treats BAR-SW21 and BAR-SW26. Room exists for Level 1 pond.	11748.02	111.17	1762203.00	15851.43	Tree removal. Potential fisheries concerns.
Firman Dr and Little Ave.	Second alternative. Treats SE32, SE33, SE35, SE36, SE44, SE52, SE60 and also treats SE34 and SE41. Retrofit existing pond to Level 1 facility.	18847.88	170.97	2827182.00	16536.13	Fisheries concerns
Herrell Ave and Leggott Ave.	Alternative to BAR-SE36. Also treats BAR-SE35, BAR-SE44, BAR-SE52, BAR-SE60. Room for Level 1 pond.	14754.82	136.39	2213223.00	16227.16	Property ownership(?), fisheries concerns, tree removal.

Location	Type of SWMP Retrofit	Size of SWMP (m3) (assuming 1m deep)	P Reduction (kg/yr) Level 1 80%, Level 2 69%, Level 3 54%, Level 4 40%	Estimated Cost (\$150/m3 excavated)	Estimated Cost (per kg P removed)	Constraints
North of Ardagh Rd.	No pond exists. Alternative to treating BAR-SW46 and BAR-SW47 separately. Also treats BAR-SW16 and BAR-SW17. Room for Level 1 pond.	3411.24	29.17	511686.00	17541.52	Some tree removal
South of Cundles Rd. W.	No pond exists. Alternative to treating BAR-NW2, BAR-NW8, BAR-NW9, BAR-NW17, BAR-NW18, BAR-NW19, BAR-NW21 and BAR-NW31 with separate facilities. Room for level 1 pond.	27085.13	228.81	4062769.50	17756.08	Some tree removal
		Sum of Best Alternatives	1935.12	\$30,953,220.00		

Beaverton Retrofit Opportunities

Location	Type of SWMP Retrofit	Size of SWMP (m3) (assuming 1m deep)	P Reduction(kg/yr) Level 1 80%, Level 2 69%, Level 3 54%, Level 4 40%	Estimated Cost (\$150/m3 excavated)	Estimated Cost (per kg P removed)	Constraints
BVR-NE4 (end of James St. northwest of Centre St.)	No existing pond, room for level 1 wet pond	1180.23	9.97	177034.50	17756.72	Tree removal
BVR-NE5 (south side of Main St./Concession 6 east of Patricia Crescent)	No existing pond, room for level 1 wet pond	941.27	7.95	141190.50	17759.81	Tree removal and fisheries concerns
BVR-NW6 (northwest side of Morrison Ave. between 6th St. and 7th St.)	No existing pond, room for level 1 wet pond	1261.78	10.66	189267.00	17754.88	Some tree removal and property ownership (?)
BVR-NW7, BVR-NW8 (northeast of 3rd St. between Morrison Ave. and Ethel Park Dr.)	No existing pond, room for level 1 wet pond to treat both catchments	940.78	7.95	141117.00	17750.57	Some tree removal and fisheries concerns.

Location	Type of SWMP Retrofit	Size of SWMP (m3) (assuming 1m deep)	P Reduction (kg/yr) Level 1 80%, Level 2 69%, Level 3 54%, Level 4 40%	Estimated Cost (\$150/m3 excavated)	Estimated Cost (per kg P removed)	Constraints
BVR-NW9 (northwest of Lake Land Crescent and Polluck Ave.)	No existing pond, room for level 1 wet pond	2289.63	19.34	343444.50	17758.25	None
BVR-SE4, BVR-SE5 (northeast of North St. and Simcoe St.)	No existing pond, room for level 1 wet pond to treat both catchments	1280.31	10.81	192046.50	17765.63	Fisheries concerns
BVR-SW1 (southwest side of Moorelands Dr.)	No existing pond, room for level 1 wet pond	530.62	5.60	79593.00	14213.04	Fisheries concerns
BVR-SW12 (north of Simcoe St. and west of Mara Rd.)	No existing pond, room for level 1 wet pond	778.72	6.58	116808.00	17751.98	Pond footprint would be on northwest corner of park, some tree removal
BVR-SW13 (northwest end of Church St.)	No existing pond, room for level 1 wet pond	506.51	4.28	75976.50	17751.52	Some tree removal
BVR-SW14 (west side of Murray St. northeast of Concession 5)	No existing pond, room for level 1 wet pond	774.05	6.54	116107.50	17753.44	Tree removal

Location	Type of SWMP Retrofit	Size of SWMP (m3) (assuming 1m deep)	P Reduction (kg/yr) Level 1 80%, Level 2 69%, Level 3 54%, Level 4 40%	Estimated Cost (\$150/m3 excavated)	Estimated Cost (per kg P removed)	Constraints
BVR-SW15 (northwest corner of Short St. and George St.)	No existing pond, room for level 1 wet pond	455.48	3.85	68322.00	17745.97	Tree removal
BVR-SW2 (east side of McLennan's Beach Rd. south of Concession 5)	No existing pond, room for level 1 wet pond	1286.02	13.58	192903.00	14204.93	Fisheries concerns
BVR-SW4 (southwest corner of Moorelands Dr. and Concession 5)	No existing pond, room for level 1 wet pond	829.98	8.77	124497.00	14195.78	None
		Total:	115.88	\$1,958,307.00		

Bradford Retrofit Opportunities

Location	Type of SWMP Retrofit	Size of SWMP (m3) (assuming 1m deep)	P Reduction(kg/yr) Level 1 80%, Level 2 69%, Level 3 54%, Level 4 40%	Estimated Cost (\$150/m3 excavated)	Estimated Cost (per kg P removed)	Constraints
BWG-NE4, BWG-NE5 (northeast corner of Britannia Ave.)	No existing pond, room for level 1 wet pond to treat both catchments	3265.00	27.248	489750.00	17973.80	None
BWG-NE4, BWG-NE5, BWG-NE6 (northeast corner of Industrial Crt. and Industrial Rd.)	Alternative to retrofit for BWG-NE4 & BWG-NE5, also treats BWG-NE6. Room for level 1 wet pond.	5522.67	48.920	828400.50	16933.78	None
BWG-NE8, BWG-NE10 (northeast corner of Dissette St. and Holland St.)	No existing pond, room for level 1 wet pond to treat both catchments	6494.00	55.528	974100.00	17542.50	Drainage and chanel diversion. Pond footprint would be on agricultural lands.
BWG-NW1 (southwest corner of 8th Line and Noble Dr.)	No existing pond, room for level 1 wet pond	2826.00	23.880	423900.00	17751.26	None
BWG-NW2 (west of Barrie St. between Compton Crescent and Parkside Crt.)	Retrofit existing quantity pond to a level 1 wet pond.	8143.00	68.800	1221450.00	17753.63	None
BWG-NW2, BWG-NE3 (east of Yonge St. and north of the 8th Line)	Alternative to BWG-NW2 retrofit. Room for level 1 wet pond.	8960.00	75.688	1344000.00	17757.11	Pond would be online (possible wetland) and require tree removal

Location	Type of SWMP Retrofit	Size of SWMP (m3) (assuming 1m deep)	P Reduction (kg/yr) Level 1 80%, Level 2 69%, Level 3 54%, Level 4 40%	Estimated Cost (\$150/m3 excavated)	Estimated Cost (per kg P removed)	Constraints
BWG-NW5, BWG-SE1, BWG-SE2, BWG-SE3, BWG-SE4, BWG-SE5, BWG-SW1 (south of Edward St. between Simcoe Rd. and Morris Rd.)	No existing pond, room for one large level 1 wet pond to treat all catchments.	17123.63	147.848	2568544.50	17372.87	Pond footprint may be on existing recreational facilities.
BWG-NW5, BWG-SE1, BWG-SE2, BWG-SE3, BWG-SE4, BWG-SE5, BWG-SW1, BWG-SE6, BWG-SE7, BWG-SE8, BWG-SE10, BWG-SE11 (north of 6th Line between Zima Parkway and Canal Rd.)	Alternative to above retrofit, would also treat an additional 5 untreated catchments plus two already treated catchments with one level 1 wet pond.	22063.00	189.576	3309450.00	17457.11	Pond footprint would be on agricultural land. Catchments BWG-SW3 and BWG-SE9 which are already treated would run through this facility (they are not included in these calculations)
		Sum of Best Alternatives	393.592	\$6,879,850.50		

Cannington Retrofit Opportunities

Location	Type of SWMP Retrofit	Size of SWMP (m3) (assuming 1m deep)	P Reduction(kg/yr) Level 1 80%, Level 2 69%, Level 3 54%, Level 4 40%	Estimated Cost (\$150/m3 excavated)	Estimated Cost (per kg P removed)	Constraints
C-NE1 (northwest end of Adelaide St.)	No existing pond, room for level 1 wet pond	3134.72	27.09	470208.00	17357.25	None
C-NW1 (northwest corner of Riverlea Rd.)	Retrofit existing level 4 pond to level 1 wet pond	910.81	4.58	136621.50	29830.02	None
C-NW2 (northeast corner of Meadowlands Dr.)	No existing pond, room for level 1 wet pond	875.83	7.40	131374.50	17753.31	Property ownership (?)
C-NW3, C-SW1 (northwest corner of Regional Road 12 and Sideroad 18a)	No existing pond, room for level 1 wet pond to treat both catchments	2923.37	24.70	438505.50	17753.26	None
C-SE5 (south of Shedden St. between St. John St. and Peace St.)	No existing pond, room for level 1 wet pond	1894.59	16.01	284188.50	17750.69	Some tree removal

Location	Type of SWMP Retrofit	Size of SWMP (m3) (assuming 1m deep)	P Reduction (kg/yr) Level 1 80%, Level 2 69%, Level 3 54%, Level 4 40%	Estimated Cost (\$150/m3 excavated)	Estimated Cost (per kg P removed)	Constraints
C-SW2, C-SW3, C-SW4 (south of Park St. at Prince St.)	Retrofit existing quantity pond to level 1 wet pond to treat all three catchments	1217.12	11.16	182568.00	16359.14	None
		Total:	90.94	\$1,643,466.00		

Holland Landing Retrofit Opportunities

Location	Type of SWMP Retrofit	Size of SWMP (m3) (assuming 1m deep)	P Reduction(kg/yr) Level 1 80%, Level 2 69%, Level 3 54%, Level 4 40%	Estimated Cost (\$150/m3 excavated)	Estimated Cost (per kg P removed)	Constraints
HL-NE1 (southeast corner of Yonge St. and Beckett Ave.)	Retrofit of existing quantity pond to level 1 wet pond	2015.88	17.03	302382.00	17755.84	On East Gwillimbury Library property(aesthetics)
HL-NE2, HL-NE3 (northwest corner of Doane Rd. and Yonge St.)	No existing pond, room for level 1 wet pond	3565.35	30.12	534802.50	17755.73	Tree removal
HL-NE4 (west side of Yonge St. at Cedar St.)	No existing pond, room for level 2 wet pond	1493.03	22.67	223954.50	9878.89	Property ownership (?), online pond, west of site
HL-NW1, HL-NW2 (southeast corner of Karissa Lane)	Retrofit of existing quantity pond to level 1 wet pond	1942.42	16.40	291363.00	17766.04	None
HL-NW13 (north end of River Dr.)	No existing pond, room for level 1 wet pond	352.62	2.98	52893.00	17749.33	Tree removal
HL-NW14 (southwest corner of Morgan's Rd.)	No existing pond, room for level 1 wet pond	440.90	3.73	66135.00	17730.56	Property ownership (?) and tree removal
HL-NW15, HL-SW14 (north end of Sluse Rd.)	No existing pond, room for level 1 wet pond	2413.58	23.17	362037.00	15625.25	Possible natural pond/wetland at this location, tree removal

Location	Type of SWMP Retrofit	Size of SWMP (m3) (assuming 1m deep)	P Reduction (kg/yr) Level 1 80%, Level 2 69%, Level 3 54%, Level 4 40%	Estimated Cost (\$150/m3 excavated)	Estimated Cost (per kg P removed)	Constraints
HL-NW7, HL-NW8 (end of Oriole Dr. east of Cotton Crt.)	No existing pond, room for level 1 wet pond	5884.76	49.72	882714.00	17753.70	Fisheries concerns and tree removal
HL-NW9 (east of Cotton Crt. at Sand Rd.)	Retrofit of existing quantity pond to level 1 wet pond	669.49	5.66	100423.50	17742.67	None
HL-SE1 (northeast corner of Chapman St.)	No existing pond, room for level 1 wet pond	269.07	2.27	40360.50	17779.96	None
HL-SE10 (southeast end of Holland River Blvd.)	No existing pond, room for level 1 wet pond	1421.72	12.01	213258.00	17756.70	None
HL-SE2,HL-SE6 (northeast corner of Oakridge Crt.)	Retrofit of existing quantity pond to level 1 wet pond	3046.85	25.73	457027.50	17762.44	None
HL-SE3 (pond south of Thompson Dr. and east of Oakridge Crt.)	Retrofit of existing quantity pond to level 1 wet pond	386.58	3.26	57987.00	17787.42	None
HL-SE4 (southwest of Thompson Dr. and Stonehill Blvd.)	Retrofit of existing quantity pond to level 1 wet pond	1060.90	8.96	159135.00	17760.60	None

Location	Type of SWMP Retrofit	Size of SWMP (m3) (assuming 1m deep)	P Reduction (kg/yr) Level 1 80%, Level 2 69%, Level 3 54%, Level 4 40%	Estimated Cost (\$150/m3 excavated)	Estimated Cost (per kg P removed)	Constraints
HL-SE5, HL-SE7 (northwest corner of Colony Trail Blvd. and Stonehill Blvd.)	Retrofit of existing quantity pond to level 1 wet pond	2508.03	21.19	376204.50	17753.87	Fisheries concerns
HL-SE2,HL-SE3,HL-SE4,HL-SE5,HL-SE6,HL-SE7 (between Colony Trail Blvd. and Thompson Dr. west of Stonehill Blvd.)	Alternative to above retrofits, would be able to treat all 6 catchments with one big level 1 wet pond	7002.36	59.14	1050354.00	17760.47	Fisheries concerns
HL-SE9, HL-SE11, HL-SE12 (northeast corner of Stegman Rd.)	No existing pond, room for level 1 wet pond to treat all three catchments	3813.78	32.54	572067.00	17580.42	Pond could possibly being online (wetland), fisheries concerns
HL-SW1 (northeast corner of McKenzie Dr. and Aranton Crt.)	No existing pond, room for level 1 wet pond	1840.31	15.54	276046.50	17763.61	Tree removal
HL-SW12 (pond on southeast corner of McKenzie Dr. and Centennial Ave.)	Retrofit of existing quantity pond to level 1 wet pond	1423.14	13.66	213471.00	15627.45	None

Location	Type of SWMP Retrofit	Size of SWMP (m3) (assuming 1m deep)	P Reduction (kg/yr) Level 1 80%, Level 2 69%, Level 3 54%, Level 4 40%	Estimated Cost (\$150/m3 excavated)	Estimated Cost (per kg P removed)	Constraints
HL-SW2, HL-SW7 (south side of Bradford St. between Holland Landing Rd. and Olive St.)	No existing pond, room for level 1 wet pond to treat both catchments	1951.69	16.49	292753.50	17753.40	Tree removal
HL-SW3 (southwest corner of Samuel Lount Rd.)	Retrofit of existing quantity pond to level 1 wet pond	1983.26	16.75	297489.00	17760.54	None
HL-SW4,HL-SW6 (northwest corner of West St.)	No existing pond, room for level 1 wet pond	536.43	4.53	80464.50	17762.58	Tree removal
HL-SW5 (southeast corner of Yonge St. and Mount Albert Sideroad)	No existing pond, room for level 1 wet pond	794.14	6.71	119121.00	17752.76	None
HL-SW8,HL-SW9,HL-SW10,HL-SW11 (north of Olive St. and west of Yonge St.)	No existing pond, room for level 1 wet pond to treat all four catchments	1806.37	15.26	270955.50	17755.93	Fisheries concerns and tree removal
		Sum of Best Alternatives	366.38	\$6,243,045.00		

Innisfil Retrofit Opportunities

Location	Type of SWMP Retrofit	Size of SWMP (m3) (assuming 1m deep)	P Reduction(kg/yr) Level 1 80%, Level 2 69%, Level 3 54%, Level 4 40%	Estimated Cost (\$150/m3 excavated)	Estimated Cost (per kg P removed)	Constraints
I-N1 (2163 Jans Blvd.)	Retrofit of existing quantity pond to level 1 wet pond.	2373.61	20.06	356041.50	17748.83	None
I-N10 (northwest corner of Leslie Dr. and Willard Ave.)	No existing pond, room for level 1 wet pond.	511.24	4.32	76686.00	17751.39	Tree removal
I-N12, I-N13, I-N14 (east of Alderslea Crescent between Florence Rd. and Park Rd.)	No existing pond, room for level 1 wet pond to treat all three catchments.	2379.78	20.11	356967.00	17750.72	Property ownership (?)
I-N16 (2259 Taylorwoods Blvd.)	Retrofit of existing level 2 wet pond to level 1 wet pond.	1143.58	2.56	171537.00	67006.64	None
I-N28 (end of James St. north of 9th Line)	No existing pond, room for level 1 wet pond.	816.62	6.90	122493.00	17752.61	Tree removal
I-N29 (698 Trinity St.)	Retrofit of existing quantity pond to level 1 wet pond.	934.53	7.90	140179.50	17744.24	None
I-N31 (southeast corner of Cedar Path and Kathryn Rd.)	No existing pond, room for level 1 wet pond.	757.20	6.40	113580.00	17746.88	Tree removal

Location	Type of SWMP Retrofit	Size of SWMP (m3) (assuming 1m deep)	P Reduction (kg/yr) Level 1 80%, Level 2 69%, Level 3 54%, Level 4 40%	Estimated Cost (\$150/m3 excavated)	Estimated Cost (per kg P removed)	Constraints
I-N41 (southeast corner of Carniola Dr. and Clarkesville St.)	No existing pond, room for level 1 wet pond.	464.90	3.93	69735.00	17744.27	Tree removal
I-N42, I-N43 (north of Cornerbrook Trail)	No existing pond, room for level 1 wet pond to treat both catchments.	1375.91	11.63	206386.50	17746.04	None
I-N45, I-N47 (east of Primrose Lane)	No existing pond, room for level 1 wet pond to treat both catchments.	1730.91	14.63	259636.50	17746.86	Property ownership (?)
I-N5 (southwest of Leslie Dr. and Adullam Ave.)	Retrofit of existing quantity pond to level 1 wet pond.	305.51	2.58	45826.50	17762.21	None
I-N50 (northwest corner of Riverview Circle and Sunset Dr.)	No existing pond, room for level 1 wet pond.	1250.15	10.56	187522.50	17757.81	Some tree removal
I-N54 (southeast corner of Pinegrove Ave. and Cove Ave.)	No existing pond, room for level 1 wet pond.	2569.81	21.71	385471.50	17755.48	Tree removal and property ownership
I-N57 (south end of Glenhaven Beach Rd.)	No existing pond, room for level 1 wet pond	358.32	3.02	53748.00	17797.35	Tree removal and property ownership
I-N59 (northeast corner of Linda St.)	No existing pond, room for level 1 wet pond.	1710.49	14.45	256573.50	17755.95	Property ownership (?)

Location	Type of SWMP Retrofit	Size of SWMP (m3) (assuming 1m deep)	P Reduction (kg/yr) Level 1 80%, Level 2 69%, Level 3 54%, Level 4 40%	Estimated Cost (\$150/m3 excavated)	Estimated Cost (per kg P removed)	Constraints
I-N61 (southwest corner of Minnetonka Rd. and West St.)	No existing pond, room for level 1 wet pond.	1017.25	8.59	152587.50	17763.39	Tree removal and property ownership
I-N7 (southeast of the cul-de-sac on Goshen Rd.)	No existing pond, room for level 1 wet pond.	403.82	3.41	60573.00	17763.34	None
I-N70 (northwest corner of Rosemary Lane and Murray Blvd.)	No existing pond, room for level 1 wet pond.	480.56	4.06	72084.00	17754.68	Tree removal and property ownership
I-N73 (northwest corner of Guest Rd.)	No existing pond, room for level 1 wet pond.	287.17	2.42	43075.50	17799.79	Tree removal
I-N78 (north of Shoreview Dr. at Fairway Rd.)	No existing pond, room for level 1 wet pond.	1055.34	11.14	158301.00	14210.14	Tree removal and property ownership
I-N84 (northwest corner of Quantz Crescent and Wilkinson St.)	Retrofit of existing quantity pond to level 1 wet pond.	2054.08	21.69	308112.00	14205.26	None
I-N9 (northwest corner of Spring St.)	No existing pond, room for level 1 wet pond.	461.72	3.90	69258.00	17758.46	Some tree removal, online pond downstream of site
I-NW1, I-NW3 (West side of Yonge St., south of Southview Ave.)	No existing pond, room for level 1 wet pond to treat both catchments.	5531.38	46.73	829707.00	17755.34	Property ownership (?)

Location	Type of SWMP Retrofit	Size of SWMP (m3) (assuming 1m deep)	P Reduction (kg/yr) Level 1 80%, Level 2 69%, Level 3 54%, Level 4 40%	Estimated Cost (\$150/m3 excavated)	Estimated Cost (per kg P removed)	Constraints
I-NW11 (north of 9th Line, between Highway 400 and Doral Dr.)	Retrofit of existing quantity pond to level 1 wet pond.	810.97	7.78	121645.50	15635.67	None
I-NW13 (south of cul-de-sac on Bowman St.)	No existing pond, room for level 1 wet pond.	10904.15	104.68	1635622.50	15624.98	Property ownership and creek location (fisheries concerns)
I-NW14 (3277 Clifford Crt.)	Retrofit of existing quantity pond to level 1 wet pond.	8537.33	81.96	1280599.50	15624.69	None
I-NW15 (northeast corner of Industrial Park Rd.)	No existing pond, room for level 1 wet pond.	1354.44	13.00	203166.00	15628.15	Property ownership (?)
I-NW2 (7883 Yonge St.)	Retrofit of existing quantity pond to level 1 wet pond.	3280.18	37.71	492027.00	13047.65	None
I-NW4 (north of Nelson Crescent and east of Newholme Circle)	No existing pond, room for level 1 wet pond.	1464.22	12.37	219633.00	17755.30	Property ownership (?)
I-NW5 (east side of Yonge St. north of Lynn St.)	No existing pond, room for level 1 wet pond.	3473.92	29.34	521088.00	17760.33	Property ownership (?)
I-NW6 (2600 Lawrence Ave.)	Retrofit of existing quantity pond to level 1 wet pond.	2364.70	19.98	354705.00	17753.00	None

Location	Type of SWMP Retrofit	Size of SWMP (m3) (assuming 1m deep)	P Reduction (kg/yr) Level 1 80%, Level 2 69%, Level 3 54%, Level 4 40%	Estimated Cost (\$150/m3 excavated)	Estimated Cost (per kg P removed)	Constraints
I-NW7 (2706 Dempster Ave.)	Retrofit of existing quantity pond to level 1 wet pond.	1976.68	16.70	296502.00	17754.61	None
I-NW8 (2856 Dempster Ave.)	Retrofit of existing quantity pond to level 1 wet pond.	2374.42	20.06	356163.00	17754.89	None
I-NW9 (northeast corner of Doral Dr. and Bowman St.)	Retrofit of existing level 2 wet pond to level 1 wet pond.	1352.27	3.02	202840.50	67165.73	None
I-S1 (2098 Fennel Dr.)	Retrofit of existing quantity pond to level 1 wet pond.	1921.80	16.23	288270.00	17761.55	None
I-S11 (east of Lakeshore Blvd. at North Shore Dr.)	No existing pond, room for level 1 wet pond.	353.25	2.98	52987.50	17781.04	Tree removal and property ownership
I-S14 (end of Wood st, east of Dempsey St.)	No existing pond, room for level 2 wet pond.	242.33	3.68	36349.50	9877.58	End of road
I-S21 (cul-de-sac at the end of Church Dr. south of Killarney Beach Rd.)	No existing pond, room for level 1 wet pond.	557.23	4.70	83584.50	17783.94	Some tree removal
I-S23 (northwest of Killarney Beach Dr. and Church Dr.)	No existing pond, room for level 1 wet pond.	521.06	4.40	78159.00	17763.41	Located on edge of park, perhaps some tree removal, little disturbance to park

Location	Type of SWMP Retrofit	Size of SWMP (m3) (assuming 1m deep)	P Reduction (kg/yr) Level 1 80%, Level 2 69%, Level 3 54%, Level 4 40%	Estimated Cost (\$150/m3 excavated)	Estimated Cost (per kg P removed)	Constraints
I-S4 (Gilford St. east of Beach Rd.)	No existing pond, room for level 2 wet pond.	241.36	3.66	36204.00	9891.80	End of road
I-S45 (6th line east of Houston Ave.)	No existing pond, room for level 1 wet pond.	223.40	1.89	33510.00	17730.16	None
I-S5 (Poplar Rd. east of Beach Rd.)	No existing pond, room for level 2 wet pond.	163.62	2.48	24543.00	9896.37	Property ownership (?)
I-S61 (Eastern Ave. southeast of Lakelands Ave.)	No existing pond, room for level 1 wet pond.	304.35	2.57	45652.50	17763.62	Some tree removal
I-SW1 (southeast corner of Commerce Park Dr. and Forest Valley Dr.)	No existing pond, room for level 1 wet pond.	3034.57	25.64	455185.50	17752.94	Property ownership (?)
I-SW4 (southeast corner of Forest Valley Dr.)	Retrofit of existing quantity pond to level 1 wet pond.	1005.30	10.62	150795.00	14199.15	None
I-SW8 (southeast corner of Innisbrook St.)	Retrofit of existing quantity pond to level 1 wet pond.	2534.68	26.77	380202.00	14202.54	Some tree removal
		Total:	704.92	\$11,845,516.50		

Keswick Retrofit Opportunities

Location	Type of SWMP Retrofit	Size of SWMP (m3) (assuming 1m deep)	P Reduction(kg/yr) Level 1 80%, Level 2 69%, Level 3 54%, Level 4 40%	Estimated Cost (\$150/m3 excavated)	Estimated Cost (per kg P removed)	Constraints
K-N10 (southwest corner of Highcastle Ave, and Kerfoot Crescent)	Retrofit of existing quantity pond to level 1 wet pond	2773.27	23.43	415990.50	17754.61	Park (?)
K-N29 (southwest side of Metropolitan Crescent at Simcoe Ave.)	No existing pond, room for level 2 wet pond	1060.45	16.76	159067.50	9490.90	None
K-N32 (west of Cook's Bay rd. between Beach Rd. and Garden Ave.)	No existing pond, room for level 1 wet pond	479.67	4.05	71950.50	17765.56	Some tree removal
K-N33 (northwest corner of Burnaby Dr.)	Retrofit of existing level 4 pond to level 1 wet pond	3711.16	18.66	556674.00	29832.48	None
K-N34 (west of Cook's Bay Rd. at Craigmawr Blvd.)	No existing pond, room for level 3 wet pond	968.35	25.10	145252.50	5786.95	Tree removal
K-N36 (northwest corner of Way's Bay Dr. and Windy Shore Dr.)	No existing pond, room for level 1 wet pond	2307.08	19.49	346062.00	17755.87	Tree removal

Location	Type of SWMP Retrofit	Size of SWMP (m3) (assuming 1m deep)	P Reduction (kg/yr) Level 1 80%, Level 2 69%, Level 3 54%, Level 4 40%	Estimated Cost (\$150/m3 excavated)	Estimated Cost (per kg P removed)	Constraints
K-N37 (south side of Morton Ave. between Annamaria Dr. and Carrick Ave.)	No existing pond, room for level 1 wet pond	753.63	6.37	113044.50	17746.39	None
K-N38 (west of Woodbine Ave. and south of Fennimore Place)	Retrofit of existing level 4 pond to level 1 wet pond	6677.45	33.58	1001617.50	29827.80	None
K-N41 (west of Windy Shore Dr. at Woodland Dr.)	No existing pond, room for level 1 wet pond	555.27	4.69	83290.50	17759.17	None
K-N48 (southwest of Margaret Place and north of Riveredge Dr.)	Retrofit of existing quantity pond to level 1 wet pond	3092.74	26.13	463911.00	17753.96	None
K-S11 (west of Lake Dr. S. at Parkwood Ave.)	No existing pond, room for level 1 wet pond	1484.13	12.54	222619.50	17752.75	Some tree removal
K-S14, K-S15 (northwest side of Lake Dr. S. between Parkway Ave. and Woodycrest Ave.)	No existing pond, room for level 1 wet pond to treat both catchments	1885.55	15.93	282832.50	17754.71	None

Location	Type of SWMP Retrofit	Size of SWMP (m3) (assuming 1m deep)	P Reduction (kg/yr) Level 1 80%, Level 2 69%, Level 3 54%, Level 4 40%	Estimated Cost (\$150/m3 excavated)	Estimated Cost (per kg P removed)	Constraints
K-S16, K-S43 (northwest side of Lake Dr. S. between Pine Beach Dr. and Elm Ave.)	No existing pond, room for level 1 wet pond to treat both catchments	1315.73	11.11	197359.50	17764.13	None
K-S2 (north of Ravenshoe Rd. and west of West Park Heights)	No existing pond, room for level 1 wet pond	895.49	7.57	134323.50	17744.19	Tree removal
K-S22 (northwest corner of Lake Dr. S. and Bayview Ave.)	No existing pond, room for level 1 wet pond	922.38	7.79	138357.00	17760.85	Some tree removal
K-S28 (between Bayview Ave. and Bessborough Dr. west of Fairwood Dr.)	No existing pond, room for level 1 wet pond	713.67	6.03	107050.50	17752.99	Fisheries concerns and tree removal
K-S29 (southwest side of Fairwood Dr. and Rinaldo Rd.)	Retrofit of existing level 2 wet pond to level 1 wet pond	1407.33	3.14	211099.50	67229.14	None

Location	Type of SWMP Retrofit	Size of SWMP (m3) (assuming 1m deep)	P Reduction (kg/yr) Level 1 80%, Level 2 69%, Level 3 54%, Level 4 40%	Estimated Cost (\$150/m3 excavated)	Estimated Cost (per kg P removed)	Constraints
K-S3 (northwest side of Lake Dr. S. between Winnifred Dr. and Adeline Dr.)	No existing pond, room for level 1 wet pond	1292.07	10.92	193810.50	17748.21	None
K-S36, K-S37 (north of Riverglen Dr. and east of The Queensway S.)	No existing pond, room for level 1 wet pond to treat both catchments	3160.02	27.26	474003.00	17388.22	Fisheries concerns and tree removal
K-S39 (southeast corner of Riverglen Dr. and Windover Dr.)	Retrofit of existing quantity pond to level 1 wet pond	3147.74	26.59	472161.00	17757.09	None
K-S4, K-S6 (southwest corner of Shirlea Blvd.)	No existing pond, room for level 1 wet pond to treat both catchments	2474.46	20.90	371169.00	17759.28	None
K-S8 (north of Walter St. between Lake Dr. S. and Georgette St.)	No existing pond, room for level 1 wet pond	3448.09	29.13	517213.50	17755.36	None

Location	Type of SWMP Retrofit	Size of SWMP (m3) (assuming 1m deep)	P Reduction (kg/yr) Level 1 80%, Level 2 69%, Level 3 54%, Level 4 40%	Estimated Cost (\$150/m3 excavated)	Estimated Cost (per kg P removed)	Constraints
K-S9, K-S10 (west side of Lake Dr. S. between Pasedena Dr. and Miami Dr.)	No existing pond, room for level 1 wet pond to treat both catchments	3075.24	25.98	461286.00	17755.43	None
		Total:	383.15	\$7,140,145.50		

Mount Albert Retrofit Opportunities

Location	Type of SWMP Retrofit	Size of SWMP (m3) (assuming 1m deep)	P Reduction(kg/yr) Level 1 80%, Level 2 69%, Level 3 54%, Level 4 40%	Estimated Cost (\$150/m3 excavated)	Estimated Cost (per kg P removed)	Constraints
MT-S11, MTS12 (north of Mill St. between Water St. and Centre St.)	No existing pond, room for level 1 wet pond to treat both catchments	1347.92	11.38	202188.00	17766.96	Fisheries concerns and tree removal
MT-S13, MT-S14 (northeast corner of Royal Oak Dr. and Valley Mills Dr.)	No existing pond, room for level 1 wet pond to treat both catchments	1342.18	11.34	201327.00	17753.70	Fisheries concerns and tree removal
MT-S16 (northwest of Mount Albert Rd. and Samuel Harper Crt.)	No existing pond, room for level 1 wet pond	1830.06	15.46	274509.00	17756.08	None
MT-S5 (northwest corner of King St. and Shannon Rd.)	No existing pond, room for level 1 wet pond	4552.31	38.46	682846.50	17754.72	Fisheries concerns
MT-S7, MT-S8 (east of Highway 48, between Mount Albert Rd. and Albert St.)	No existing pond, room for level 1 wet pond to treat both catchments	1239.44	10.47	185916.00	17757.02	None

Location	Type of SWMP Retrofit	Size of SWMP (m3) (assuming 1m deep)	P Reduction (kg/yr) Level 1 80%, Level 2 69%, Level 3 54%, Level 4 40%	Estimated Cost (\$150/m3 excavated)	Estimated Cost (per kg P removed)	Constraints
MT-S9 (northwest corner of Hi-View Dr.)	No existing pond, room for level 1 wet pond	1149.02	12.14	172353.00	14197.12	Some tree removal
		Total:	99.25	\$1,719,139.50		

Newmarket Retrofit Opportunities

Location	Type of SWMP Retrofit	Size of SWMP (m3) (assuming 1m deep)	P Reduction(kg/yr) Level 1 80%, Level 2 69%, Level 3 54%, Level 4 40%	Estimated Cost (\$150/m3 excavated)	Estimated Cost (per kg P removed)	Constraints
N-CE14 (northwest corner of College Manor Dr. and Devanjan Circle)	Retrofit of existing quantity pond to level 2 wet pond	2821.49	42.83	423223.50	9881.47	None
N-CE18 (southeast corner of Renzius Crt.)	Retrofit of existing quantity pond to level 2 wet pond	3067.27	46.56	460090.50	9881.67	None
N-CE4, N-CE5 (northeast of Three Seasons Dr. and west of Carlson Dr.)	Retrofit of existing quantity pond to level 2 wet pond	3467.39	53.91	520108.50	9647.72	Pond footprint would be located in park
N-CE8 (southwest corner of Gorham St. and Crowder Blvd.)	Retrofit of existing quantity pond to level 1 wet pond	1930.85	16.31	289627.50	17757.66	Fisheries concerns
N-CW11, N-CW2, N-CW3, N-CW5, N-CW7 (northeast of Eagle St. W. at McCaffrey Rd.)	Retrofit of existing quantity pond to level 2 wetland pond	4842.27	n/a	726340.50	n/a	None, phosphorus reduction could not be calculated for wetland, therefore estimated cost per kg P removed cannot be calculated

Location	Type of SWMP Retrofit	Size of SWMP (m3) (assuming 1m deep)	P Reduction (kg/yr) Level 1 80%, Level 2 69%, Level 3 54%, Level 4 40%	Estimated Cost (\$150/m3 excavated)	Estimated Cost (per kg P removed)	Constraints
N-NE1 (northeast of Leslie St. and Ringwell Dr.)	Retrofit of existing quantity pond to level 1 wet pond	13139.25	126.14	1970887.50	15624.60	Pond would be located in East Gwillimbury
N-NE10 (west of Mountainview Place and north of Lundy's Lane)	Retrofit existing quantity pond to level 1 wet pond	3307.60	27.94	496140.00	17757.34	None
N-NE2 (south of Stellar Dr. between Pony Dr. and Harry Walker Parkway)	Retrofit of existing quantity pond to level 2 wet pond	6154.81	97.29	923221.50	9489.38	None
N-NE6, N-NE7 (northeast corner of Bayview Parkway and Elgin St.)	No existing pond, room for level 3 wet pond	3650.13	94.60	547519.50	5787.73	Fisheries concerns
N-NE9 (northwest corner of Traviss Dr.)	No existing pond, room for level 1 wet pond	3790.79	32.02	568618.50	17758.23	Some tree removal
N-NW4 (Upper Canada Mall, northwest corner of Yonge St. and Davis Dr.)	Retrofit of existing level 3 wet pond to level 1 wet pond	4709.56	19.91	706434.00	35481.37	None

Location	Type of SWMP Retrofit	Size of SWMP (m3) (assuming 1m deep)	P Reduction (kg/yr) Level 1 80%, Level 2 69%, Level 3 54%, Level 4 40%	Estimated Cost (\$150/m3 excavated)	Estimated Cost (per kg P removed)	Constraints
N-NW5 (northeast corner of Dorchester Crt.)	Retrofit of existing quantity pond to level 1 wet pond	9659.71	81.61	1448956.50	17754.64	Pond located on Town of East Gwillimbury property.
N-NW7 (southwest corner of Bexhill Rd. and Main St. N.)	No existing pond, room for level 1 wet pond	1263.22	10.67	189483.00	17758.48	Property ownership and tree removal.
N-SE11 (northeast corner of Schaeffer Outlook)	Major maintenance and repair of existing pond including new outfall and restoration	n/a	n/a	20000.00	n/a	None
N-SE4, N-SE8 (northeast corner of Walpole Crescent)	Combine level 2 wet pond and quantity pond to form level 1 wet pond to treat both catchments	16552.61	123.16	2482891.50	20159.89	Potential fisheries concerns
N-SW6 (southwest end of Bosworth Crt.)	No existing pond, room for level 1 wet pond	417.61	3.53	62641.50	17745.47	Some tree removal
		Total:	776.48	\$11,836,184.00		

Orillia Retrofit Opportunities

Location	Type of SWMP Retrofit	Size of SWMP (m3) (assuming 1m deep)	P Reduction(kg/yr) Level 1 80%, Level 2 69%, Level 3 54%, Level 4 40%	Estimated Cost (\$150/m3 excavated)	Estimated Cost (per kg P removed)	Constraints
O-NE10 (south of Atherly Rd. between Highway 12 and Collins Dr.)	No existing pond, room for level 1 wet pond	2448.38	20.68	367257.00	17759.04	Slight drainage diversion and some tree removal
O-NE11 (south of Atherly Rd. and east of Collins Dr.)	No existing pond, room for level 1 wet pond	466.32	4.03	69948.00	17356.82	None
O-NE12 (north of Atherly Rd/Highway 12 and west of Couchiching Point Rd.)	No existing pond, room for level 1 wet pond	2107.53	17.81	316129.50	17750.11	Pond footprint would be in park, some tree removal
O-NE34, O-NE35 (north of Atherly Rd. and northeast of Bayview Parkway)	No existing pond, room for level 1 wet pond to treat both catchments	2102.78	18.14	315417.00	17387.93	Pond footprint would be in park, some tree removal

Location	Type of SWMP Retrofit	Size of SWMP (m3) (assuming 1m deep)	P Reduction (kg/yr) Level 1 80%, Level 2 69%, Level 3 54%, Level 4 40%	Estimated Cost (\$150/m3 excavated)	Estimated Cost (per kg P removed)	Constraints
O-NE36, O-NE37 (northeast of Museum Dr. and Brewery Lane)	No existing pond, room for level 1 wet pond to treat both catchments	2870.06	24.79	430509.00	17366.24	Tree removal
O-NE4 (southeast corner of Woodside Dr. and Laurentian Lane)	Retrofit of existing quantity pond to level 4 wet pond	3923.21	103.57	588481.50	5681.97	Some tree removal
O-NE46, O-NE47 (east side of Centennial Dr. southeast of Tecumseh St.)	No existing pond, room for level 3 wet pond to treat both catchments	2836.31	70.87	425446.50	6003.20	Pond footprint would be in park and slight drainage diversion
O-NE58 (west side of Drinkwater Dr. between Cunningham Crescent and Bridget Dr.)	No existing pond, room for level 1 wet pond	6084.61	58.42	912691.50	15622.93	None
O-NE7 (southwest corner of Cedar Island Rd.)	No existing pond room for level 1 wet pond	7793.84	67.34	1169076.00	17360.80	Tree removal

Location	Type of SWMP Retrofit	Size of SWMP (m3) (assuming 1m deep)	P Reduction (kg/yr) Level 1 80%, Level 2 69%, Level 3 54%, Level 4 40%	Estimated Cost (\$150/m3 excavated)	Estimated Cost (per kg P removed)	Constraints
O-NE9, O-SE12 (west side of Forest Ave. S. northeast of Victoria Crescent)	No existing pond, room for level 1 wet pond	16500.83	139.40	2475124.50	17755.56	Tree removal
O-SE1, O-SE3, O-SE4, O-NE2, O-NE4, O-NE8 (south of Highway 12 and southwest of Kitchener St.)	Alternative to O-NE4 retrofit. No existing pond, room for level 4 wet pond.	18964.76	543.90	2844714.00	5230.22	Property ownership (?), drainage diversion
O-SE5, O-SE6 (southwest side of West St. S. at Olive Crescent)	No existing pond room for level 1 wet pond to treat both catchments	2984.38	25.22	447657.00	17750.08	Some tree removal
		Lake Simcoe Total:	733.23	\$6,204,700.50		
		Lake Couchiching Total:	257.37	\$3,569,269.50		

Pottageville Retrofit Opportunities

Location	Type of SWMP Retrofit	Size of SWMP (m3) (assuming 1m deep)	P Reduction(kg/yr) Level 1 80%, Level 2 69%, Level 3 54%, Level 4 40%	Estimated Cost (\$150/m3 excavated)	Estimated Cost (per kg P removed)	Constraints
P-S1 (northeast of Edward Pottage Crescent)	Retrofit of existing quantity pond to level 1 wet pond	1422.04	12.02	213306.00	17745.92	Some tree removal
P-S11 (west of Archibald Rd. between Lloydtown-Aurora Rd. and Cook Dr.)	No existing pond, room for level 1 wet pond	1748.20	14.77	262230.00	17754.23	Slight drainage diversion away from channel and some tree removal
P-S13 (north of Lloydtown-Aurora Rd. and west of Weedon Crt.)	No existing pond, room for level 1 wet pond	1485.97	12.55	222895.50	17760.60	Fisheries concerns and tree removal
P-S4 (southwest corner of Lloydtown-Aurora Rd. and 7th Concession)	No existing pond, room for level 1 wet pond	634.41	5.36	95161.50	17754.01	Property ownership (?) and tree removal

Location	Type of SWMP Retrofit	Size of SWMP (m3) (assuming 1m deep)	P Reduction (kg/yr) Level 1 80%, Level 2 69%, Level 3 54%, Level 4 40%	Estimated Cost (\$150/m3 excavated)	Estimated Cost (per kg P removed)	Constraints
P-S7, P-S8, P-S12 (northeast side of Cook Dr. between Bachly Crescent and Archibald Rd.)	No existing pond, room for level 1 wet pond to treat all three catchments	2466.71	20.83	370006.50	17763.15	Tree removal
		Total:	65.53	\$1,163,599.50		

Schomberg/Lloydtown Retrofit Opportunities

Location	Type of SWMP Retrofit	Size of SWMP (m3) (assuming 1m deep)	P Reduction(kg/yr) Level 1 80%, Level 2 69%, Level 3 54%, Level 4 40%	Estimated Cost (\$150/m3 excavated)	Estimated Cost (per kg P removed)	Constraints
SCH-L1, SCH-L3, SCH-L4, SCH-L5 (southeast corner of Centre St. and Rebellion Way)	No existing pond, room for level 1 wet pond to treat all four catchments	1320.61	11.16	198091.50	17750.13	Fisheries concerns, some tree removal and property ownership (?)
SCH-S1, SCH-S2 (west side of Western Ave. and northwest of Elmwood Ave.)	No existing pond, room for level 1 wet pond to treat both catchments	1224.54	10.35	183681.00	17746.96	None
SCH-S14, SCH-S15, SCH-9 (northwest corner of Main St. and Cooper Dr.)	No existing pond, room for level 1 wet pond to treat all three catchments	2090.65	17.67	313597.50	17747.45	Some tree removal
SCH-S16, SCH-S17, SCH-S18 (northwest of Marlynn Dr.)	No existing pond, room for level 1 wet pond to treat all three catchments	802.40	6.77	120360.00	17778.43	Property ownership (?)

Location	Type of SWMP Retrofit	Size of SWMP (m3) (assuming 1m deep)	P Reduction (kg/yr) Level 1 80%, Level 2 69%, Level 3 54%, Level 4 40%	Estimated Cost (\$150/m3 excavated)	Estimated Cost (per kg P removed)	Constraints
SCH-S20 (southeast of Magnum Dr. and north of Proctor Rd.)	No existing pond, room for level 1 wet pond	3915.14	37.58	587271.00	15627.22	None
SCH-S3 (southwest of Main St. and northeast of Mill Dam Crt.)	No existing pond, room for level 1 wet pond	975.24	8.24	146286.00	17753.16	Tree removal and property ownership (?)
SCH-S7, SCH-S8 (southwest of Main St. and southeast of Brownsville Crt.)	No existing pond, room for level 1 wet pond to treat both catchments	1467.99	12.73	220198.50	17297.60	Some tree removal
		Total:	104.50	\$1,769,485.50		

Sharon Retrofit Opportunities

Location	Type of SWMP Retrofit	Size of SWMP (m3) (assuming 1m deep)	P Reduction(kg/yr) Level 1 80%, Level 2 69%, Level 3 54%, Level 4 40%	Estimated Cost (\$150/m3 excavated)	Estimated Cost (per kg P removed)	Constraints
SH-S1 (west side of Leslie St. at Jennifer Crescent)	No existing pond, room for level 1 wet pond	3270.06	27.62	490509.00	17759.20	Some tree removal
SH-S7 (north of David Wilson Trail between Civic Centre Dr. and Willow Wood Place)	No existing pond, room for level 1 wet pond	2869.62	24.25	430443.00	17750.23	Fisheries concerns
SH-S9 (northeast corner of Mary Ave. and Donlands Ave.)	Retrofit of existing quantity pond to level 2 wet pond	5201.47	78.96	780220.50	9881.21	None
		Total:	130.83	\$1,701,172.50		

Sutton Retrofit Opportunities

Location	Type of SWMP Retrofit	Size of SWMP (m3) (assuming 1m deep)	P Reduction(kg/yr) Level 1 80%, Level 2 69%, Level 3 54%, Level 4 40%	Estimated Cost (\$150/m3 excavated)	Estimated Cost (per kg P removed)	Constraints
S-C12, S-C16 (northeast of Market St. and Georgina St.)	No existing pond, room for level 1 wet pond to treat both catchments	468.19	3.96	70228.50	17734.47	Tree removal
S-NE1 (southwest end of Dunkirk Ave.)	No existing pond, room for level 1 wet pond	957.93	8.10	143689.50	17739.44	Some tree removal
S-NE2 (west of Joan St. between Evans Ave. and Rose St.)	No existing pond, room for level 1 wet pond	2260.21	19.10	339031.50	17750.34	Slight drainage diversion and tree removal
S-NE3 (east of Joan St. between Lynn St. and Mum's Ave.)	No existing pond, room for level 1 wet pond	671.96	5.68	100794.00	17745.42	Some tree removal
S-NE7 (northeast corner of Joan St. and Bedford Rd.)	No existing pond, room for level 1 wet pond	1058.03	8.94	158704.50	17752.18	Tree removal
S-NE8, S-NE9 (southwest corner of Elizabeth St. and George Rd.)	No existing pond, room for level 1 wet pond to treat both catchments	1924.99	16.25	288748.50	17769.14	Tree removal

Location	Type of SWMP Retrofit	Size of SWMP (m3) (assuming 1m deep)	P Reduction (kg/yr) Level 1 80%, Level 2 69%, Level 3 54%, Level 4 40%	Estimated Cost (\$150/m3 excavated)	Estimated Cost (per kg P removed)	Constraints
S-NW10, S-NW12 (east of Sunnidale Blvd. at Meadowlea Ave.)	No existing pond, room for level 1 wet pond to treat both catchments	1595.00	13.47	239250.00	17761.69	Tree removal
S-NW13 (south of Metro Rd. N. and west of Marie St.)	No existing pond, room for level 1 wet pond	655.08	5.54	98262.00	17736.82	Property ownership (?) and some tree removal
S-NW2, S-NW4, S-NW5, S-NW6 (southeast corner of Wood River Bend)	No existing pond, room for level 1 wet pond to treat all four catchments	3747.27	31.66	562090.50	17753.96	Drainage diversion, tree removal and fisheries concerns
S-NW8, S-NW14, S-NW17, S-NW18 (north of Metro Rd. N. between Melody Lane and Hardwood Dr.)	No existing pond, room for level 1 wet pond to treat all four catchments	2757.99	23.30	413698.50	17755.30	Some tree removal, property ownership (?)
S-NW9, S-NW11, S-NW16 (west of Dalton Rd. between Pride Crt. And Roanoke Rd.)	No existing pond, room for level 1 wet pond to treat all three catchments	605.12	5.24	90768.00	17322.14	Drainage diversion, tree removal and fisheries concerns

Location	Type of SWMP Retrofit	Size of SWMP (m3) (assuming 1m deep)	P Reduction (kg/yr) Level 1 80%, Level 2 69%, Level 3 54%, Level 4 40%	Estimated Cost (\$150/m3 excavated)	Estimated Cost (per kg P removed)	Constraints
S-SE2 (south side of Black River Rd. between Maple Ave. and Joan St.)	No existing pond, room for level 1 wet pond	1823.31	15.40	273496.50	17759.51	Tree removal
S-SW5 (southeast corner of Dalton Rd. and Black River Rd.)	No existing pond, room for level 1 wet pond	3582.36	34.39	537354.00	15625.30	Tree removal and slight drainage diversion
		Total:	191.03	\$3,316,116.00		

Uxbridge Retrofit Opportunities

Location	Type of SWMP Retrofit	Size of SWMP (m3) (assuming 1m deep)	P Reduction(kg/yr) Level 1 80%, Level 2 69%, Level 3 54%, Level 4 40%	Estimated Cost (\$150/m3 excavated)	Estimated Cost (per kg P removed)	Constraints
U-NE12 (east side of Main St. south of Sany Hook Rd.)	No existing pond, room for level 1 wet pond	390.47	3.30	58570.50	17748.64	Fisheries concerns
U-NE13, U-NE14 (east of Main St. between Colby Rd. and Sandy Hook Rd.)	No existing pond, room for level 1 wet pond to treat both catchments	448.09	3.79	67213.50	17734.43	Fisheries concerns
U-NE15, U-NE16 (north side of Sandy Hook Rd. northeast of Gooseberry Lane)	No existing pond, room for level 1 wet pond to treat both catchments	1448.08	14.31	217212.00	15179.04	Property ownership (?)
U-NE6 (east side of Main St. between North St. and Young St.)	No existing pond, room for level 1 wet pond	2722.28	26.14	408342.00	15621.35	Property ownership (?)
U-NW11, U-NW2 (northwest of Campbell Dr.)	Retrofit of existing level 3 pond to a level 1 wet pond to treat both catchments	3549.53	23.42	532429.50	22733.97	None

Location	Type of SWMP Retrofit	Size of SWMP (m3) (assuming 1m deep)	P Reduction (kg/yr) Level 1 80%, Level 2 69%, Level 3 54%, Level 4 40%	Estimated Cost (\$150/m3 excavated)	Estimated Cost (per kg P removed)	Constraints
U-NW13 (southeast of Cemetary Rd. and Toronto St.)	No existing pond, room for level 1 wet pond	645.70	5.46	96855.00	17739.01	Tree removal
U-NW14, U-NW19 (northeast corner of Toronto St. and Elgin Park Dr.)	No existing pond, room for level 1 wet pond to treat both catchments	1345.90	11.70	201885.00	17255.13	Property ownership (?), fisheries concerns and tree removal
U-NW15 (southwest corner of Cemetery Rd. and Toronto St.)	Retrofit of existing quantity pond to level 1 wet pond	223.34	2.14	33501.00	15654.67	None
U-NW17, U-NW18 (northeast end of Douglas Rd.)	No existing pond, room for level 1 wet pond to treat both catchments	3143.94	30.18	471591.00	15625.94	Tree removal
U-NW3 (northeast of Victoria Dr. and Perry St.)	No existing pond, room for level 1 wet pond	3622.81	30.61	543421.50	17753.07	Property onwership (?)
U-SW1 (northwest of Highway 47 and Parratt Rd.)	Retrofit of existing quantity pond to level 1 wet pond	3202.72	27.67	480408.00	17362.05	None

Location	Type of SWMP Retrofit	Size of SWMP (m3) (assuming 1m deep)	P Reduction (kg/yr) Level 1 80%, Level 2 69%, Level 3 54%, Level 4 40%	Estimated Cost (\$150/m3 excavated)	Estimated Cost (per kg P removed)	Constraints
U-SW2, U-SW3 (southeast corner of Silver Springs Crescent and Rolling Meadows Rd.)	No existing pond, room for level 1 wet pond to treat both catchments	1710.13	18.06	256519.50	14203.74	Slight drainage diversion
U-SW4 (southeast corner of Concession 6 and Silver Springs Crescent)	No existing pond, room for level 1 wet pond	685.34	7.24	102801.00	14199.03	None
U-SW5 (east of Hillborne Crt.)	No existing pond, room for level 1 wet pond	274.63	2.90	41194.50	14205.00	None
		Total:	206.92	\$3,511,944.00		

Appendix 3

Stormwater Ponds or Retrofit Opportunities on Cold Water Reaches

Town	Catchment / Pond	Catchment / Retrofit
Aurora	A-NW5	R-A-SW6
	A-NC3	R-A-SE3
	A-WC4	R-A-NW41
	A-NC5	R-A-NW28
	A-NW1	R-A-C15
	A-NW3	R-A-C18
	A-NW1	R-A-C19
	A-SW13	R-A-C25
	A-NE15	R-A-C8
	A-NE14	R-A-EC15
	A-NE13	R-A-EC16
	A-NE10	R-A-EC18
	A-NE8	R-A-EC19
	A-NE9	R-A-EC19
	A-NE11	R-A-EC22
	A-EC3	R-A-EC24
	A-EC13	R-A-EC27
	A-EC12	R-A-NC15
	A-SC11	R-A-NC15
	A-C27	R-A-NC18
	A-EC17	R-A-NC26
	A-NC10	R-A-NC19
	A-NC28	R-A-NC27
	A-C23	R-A-NC30
	A-C22	R-A-NC7
	A-SW2	R-A-NW10
	A-NC27	R-A-NW18
	A-NC18	R-A-NW24
	A-NC19	R-A-NW31
	A-NC26	R-A-NW33
		R-A-NW34
		R-A-NW43
		R-A-NW7
	R-A-SC12	
	R-A-SC7	
	R-A-SW2	
	R-A-WC1	
	R-A-WC25	
	R-A-WC3	

Town	Catchment / Pond	Catchment / Retrofit
Ballantrae	BAL-NW9	R-BAL-NE5
	BAL-NE3	R-BAL-NW1
	BAL-NE1	R-BAL-NW10
	BAL-NE1	R-BAL-NW11
	BAL-NE2	R-BAL-NW12
	BAL-NE4	R-BAL-NW13
	BAL-NE6	R-BAL-NW14
		R-BAL-NW7
		R-BAL-NW8
		R-BAL-SE10
		R-BAL-SE11
		R-BAL-SE13
		R-BAL-SE19
		R-BAL-SE2
	R-BAL-SE3	
	R-BAL-SW1	
	R-BAL-SW10	
	R-BAL-SW2	
	R-BAL-SW5	
	R-BAL-SW3	
Beaverton		R-BVR-SW1
		R-BVR-SW13
		R-BVR-SW12
Cannington	C-NW1	R-C-NE1
		R-C-NW1
		R-C-NW2
		R-C-SE5
Pottageville		R-P-S1
		R-P-S11
		R-P-S13
		R-P-S4
		R-P-S7
Sharon	SH-S10	R-SH-S9
		R-SH-S1
		R-SH-S7

Town	Catchment / Pond	Catchment / Retrofit
Barrie	BAR-SW42	R-BAR-NW33
	BAR-SE72	R-BAR-NW32
	BAR-SE73	R-BAR-NW17
	BAR-SE70	R-BAR-NW2
	BAR-SE77	R-BAR-NW2
	BAR-SE79	R-BAR-NW18
	BAR-C33	R-BAR-NW2
	BAR-SE75	R-BAR-NW3
	BAR-SE78	R-BAR-NW1
	BAR-SE84	R-BAR-NW24
	BAR-SE90	R-BAR-C6
	BAR-SE86	R-BAR-C29
	BAR-SE87	R-BAR-SW1
	BAR-SE88	R-BAR-SW5
	BAR-SE89	R-BAR-SW4
	BAR-SE2	R-BAR-SW46
	BAR-SW53	R-BAR-SW16
		R-BAR-SW47
		R-BAR-SW28
		R-BAR-SW20
		R-BAR-SW20
		R-BAR-SW24
		R-BAR-SW38
		R-BAR-SW52
		R-BAR-SW41
		R-BAR-SW50
		R-BAR-SE68
		R-BAR-SE4
		R-BAR-SE23
		R-BAR-SE22
		R-BAR-SE9
		R-BAR-SE19
		R-BAR-SE83
		R-BAR-SE20
		R-BAR-SE18
		R-BAR-SE50
		R-BAR-SE36
		R-BAR-SE35
		R-BAR-SE32
		R-BAR-SE32
	R-BAR-SE58	
	R-BAR-NW8	
	R-BAR-SW2	
	R-BAR-SE54	
	R-BAR-SE55	
	R-BAR-SE56	

Town	Catchment / Pond	Catchment / Retrofit
Innisfil	I-S67	R-I-N1
	I-S68	R-I-N10
	I-S69	R-I-N5
	I-S70	R-I-N50
	I-S72	R-I-N84
	I-S71	R-I-N9
	I-N2	R-I-NW1
	I-N15	R-I-NW11
	I-N83	R-I-NW13
	I-NW10	R-I-NW14
		R-I-NW15
		R-I-NW2
		R-I-NW4
		R-I-NW5
		R-I-NW6
		R-I-NW7
		R-I-NW8
		R-I-NW9
		R-I-S1
		R-I-S21
	R-I-S23	
	R-I-SW1	
	R-I-SW4	
	R-I-SW8	
Uxbridge	U-NW16	R-U-NE12
	U-NW12	R-U-NE13
	U-NE11	R-U-NE15
	U-NW21	R-U-NE6
	U-NW11	R-U-NW11
		R-U-NW13
		R-U-NW14
		R-U-NW15
	R-U-NW17	
	R-U-NW3	
	R-U-SW1	
	R-U-SW2	
	R-U-SW4	
	R-U-SW5	
Mt Albert	MT-S1	R-MT-S11
	MT-S2	R-MT-S16
	MT-S18	R-MT-S13
		R-MT-S5
		R-MT-S7
	R-MT-S9	

Town	Catchment / Pond	Catchment / Retrofit
Newmarket	N-SE9	R-N-CE14
	N-SW5	R-N-CE18
	N-SW4	R-N-CE8
	N-SW2	R-N-NE1
	N-SW11	R-N-NE2
	N-CW8	R-N-SE4
	N-SW13	R-N-SW6
	N-SW16	
	N-SW18	
	N-CE23	
	N-SE8	

Town	Catchment / Pond	Catchment / Retrofit
Schomberg	SCH-S13	R-SCH-L1
	SCH-S21	R-SCH-S1
	SCH-S6	R-SCH-S14
		R-SCH-S16
		R-SCH-S20
		R-SCH-S3
		R-SCH-S7

Appendix 4

Supplementary Data

The following is a list of documents or data that were created for this study:

- Stormwatersheds GIS Layer – Polygon layer that includes catchment id's, catchment areas, township and level of stormwater control
- Stormwater Ponds GIS Layer – Point layer that includes stormwater ponds, outlets and retrofit opportunities
- Stormwater phosphorus loading spreadsheets for all urban areas studied
- Maps for each urban area depicting stormwater catchments, level of stormwater control, stormwater ponds, outlets and retrofit opportunities