TSH
engineers
architects
planners

Totten Sims Hubicki Associates
72 Victoria Street South, Suite 202
Kitchener, Ontario, Canada N2G 4Y9
(519) 886-2160 Fax: (519) 886-1697
E-mail: waterloo@tsh.ca www.tsh.ca

July 6, 2000

Mr. Alex Grant
51 Toronto Street South
P.O. Box 190
UXBRIDGE, Ontario
L9P 1T1

Dear Alex:

Re: Uxbridge SWM
TSH File No. 54-21578-01

Attached please find three copies of the Final Draft of the Uxbridge Urban Area Stormwater Management Study Report. Should you have any questions or comments, please do not hesitate to contact our office.

Yours truly,

TSH associates

For Ray H. Tufgar, M.Eng., M.B.A., P.Eng.
Manager, Waterloo Branch

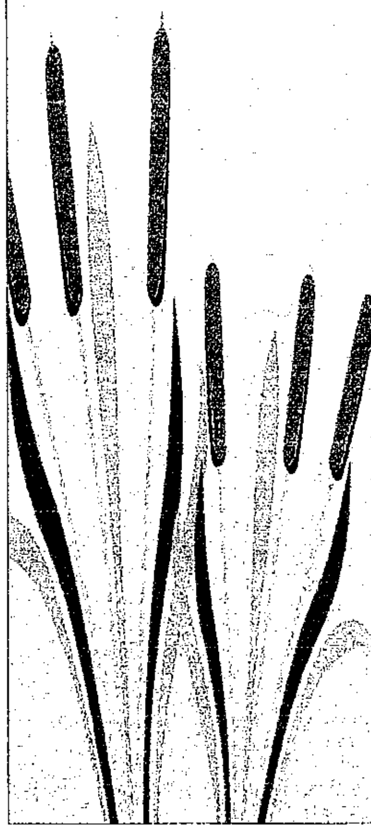
CTB/cb

c.c.:
Tom Hogenbirk, LSRCA
Thom Sloley, The Regional Municipality of Durham
Stephen Maude, Ministry of Environment
Don Weatherbe, Donald G. Weatherbe Associates
Jim McEwen, TSH

d\data\21678\21678L04.doc

Township of Uxbridge

Uxbridge Urban Area Stormwater Management Study



Final Report

July 2000

TSHi Associates
Donald G Weatherbe Associates Inc.
James Li

MEMORANDUM

TO: Township of Uxbridge

FROM: J. D. McEwen, P.Eng.

DATE: 22 January 2002

RE: Uxbridge Revised Construction Cost Estimates and Updated Report Tables
TSH Project No. 54-21678

A revised estimate of construction costs has been prepared for the Township of Uxbridge to reflect the significant increase in construction costs. Attached please find the relevant report tables reflecting the cost changes and also the cost of implementation to meet phosphorous reduction targets. As a result of the cost increases, the cash-in-lieu contribution is updated to \$225/ha/%. This affects Recommendation 2 (pg. 26) under Section 5.0 (Implementation) of the Uxbridge Urban Area Stormwater Management Study Report. It should be noted that costs have been provided by the City of Kitchener, the City of Mississauga, suppliers and TSH staff for various components. These updated costs are based on a small sample (11 pond sites), and costs currently used by other cities.

It should also be noted that Table 3.5.2 (implementation schedule and costs) and the table entitled Construction Costs include the contingency and engineering costs of 10% and 20% respectively. All other tables only include construction costs. The value of \$225/ha/% for developers includes the engineering and contingency costs in addition to the construction costs.

Amended Tables 3.4.1, 3.4.2, 3.4.3, 3.4.4, 3.4.5, 3.4.6, 3.4.7, 3.4.8, and 3.5.2 are attached.

J. D. McEwen, P.Eng.
Vice President – Municipal

:ll
L:\PROJECTS\54-\54-21678\01515 memo Twp Uxb.doc

TABLE 3.4.1

CONSTRUCTION OR REPLACEMENT COST
POTENTIAL SWM RETROFITS
TOWNSHIP OF UXBRIDGE

Category	Location #	Corresponding Area (LSRCA)	Treatment Area Overlap	Drainage Area (ha)	SWM Upgrade Potential	Capital Cost Estimates (no amoritization) Sediment Forebay	Sediment (3) Forebay	Baffles	Baffles	Filtration Pond	Filtration Pond (7)	Infiltration Pond	Infiltration Pond	Wet Pond	Wet Pond	Wetland	Wetland	OGS	OGS	Filter	Filter	Roof Dis.	Roof Dis. (8)	Open Ditch	Open Ditch	Exfiltration System	Exfiltration System
						(5% eff)	(5% eff)	(25% eff)	(25% eff)	(30% eff)	(30% eff)	(90% eff)	(90% eff)	(varies)	(varies)	(varies)	(varies)	(40% eff)	(40% eff)	(50% eff)	(50% eff)	(20% eff)	(20% eff)	(10% eff)	(10% eff)	(90% eff)	(90% eff)
						LE = 40		LE = 40/15 (9)		LE =40		LE = 40		LE =40		LE =40		LE =40		LE =40		LE =40		LE =40		LE = 40	
						($/ha)	($/ha)	($/m)	($/kg)	($/ha)	($/kg)	($/ha)	($/kg)	($/ha)	($/kg)	($/ha)	($/kg)	($/ha)	($/kg)	($/ha)	($/kg)	($/ha)	($/kg)	($/ha) (4)	($/kg)	($/kg)	($/kg)
A) Existing Identified Pond Retrofits Locations																											
	1	Area M	yes	31.4	- add sand filter or wetland (2)	$600	$3,750	$1,433 (5)	$5,705	$2,900	$3,021	N/A	N/A	N/A	N/A	$2,068	$1,618	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A
	2	Area L	no	85.8	- add sand filter or wetland (2)	N/A	N/A	$1,204 (6)	$2,807	$2,900	$3,021	N/A	N/A	N/A	N/A	$2,068	$2,154	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A
	3	Area N	no	85	- add sand filter or wetland (2)	$600	$3,750	N/A	N/A	$2,900	$3,021	N/A	N/A	N/A	N/A	$2,068	$2,154	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A
	4	Area R	no	16.2	- no upgrade potential	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A
	5	Area S	no	10.57	- expansion	$600	$3,750	N/A	N/A	$2,900	$3,021	N/A	N/A	$4,775	$4,974	$2,068	$2,154	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A
	6	Area O	no	31.1	- no upgrade potential	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A
	7	Area A	no	11.9	- new pond (redeveloped area)	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	$4,775	$2,984	$2,068	$1,293	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A
B) LSRCA Identified Retrofit/New Locations																										N/A	N/A
	8	Area B	no	10.4	- possible pond	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	$4,775	$2,984	$2,068	$1,293	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A
	9	Area B or O (1)	no	10.4	- possible pond	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	$4,775	$2,981	$2,068	$1,291	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A
	10	Area B	no	1.5	- enhance/formalize wetland	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	$2,068	$2,154	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A
	11	Area F	no	1.4	- OG separator	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	$6,348	$3,607	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A
	12	Area G	no	1.5	- OG on east side	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	$6,348	$4,959	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A
	13	Area G	no	5.7	- filter on west side	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	$7,990	$5,549	N/A	N/A	N/A	N/A	N/A	N/A
C) New Areas Identified for SWM																										N/A	N/A
	14	Area U	no	4.5	- enhance/formalize wetland	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	$2,068	$1,567	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A
	15	Area E	no	18.7	-pond already approved	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	$2,068	$2,154	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A
	16	Area C/D	no	0.5	- enhance/formalize wetland	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	$2,068	$2,872	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A
	17	Area T	no	1.0	- wetland/infiltration	N/A	N/A	N/A	N/A	N/A	N/A	$2,530	$878	$4,775	$2,984	$2,068	$1,293	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A
	18	Area Q	yes	3.3	- pond/wetland/infiltration	N/A	N/A	N/A	N/A	N/A	N/A	$2,530	$1,129	$4,775	$4,974	$2,068	$2,154	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A
	19	Area Q	yes	3.2	- pond/wetland/infiltration	N/A	N/A	N/A	N/A	N/A	N/A	$2,530	$1,129	$4,775	$4,974	$2,068	$2,154	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A
	20	Area Q	yes	3.0	- pond/wetland/infiltration	N/A	N/A	N/A	N/A	N/A	N/A	$2,530	$1,129	$4,775	$4,974	$2,068	$2,154	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A
	21	Area Q	yes	1.5	- pond/wetland/infiltration	N/A	N/A	N/A	N/A	N/A	N/A	$2,530	$1,129	$4,775	$4,974	$2,068	$2,154	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A
D) Roof Leader Disconnection	Testa area	Area M	yes	24.2	- enhanced infiltration	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	$2,066	$5,380	N/A	N/A	N/A	N/A
E) i) Open Ditch Enhancement	various	various	yes	77	- enhanced infiltration	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	$1,898	$5,931	N/A	N/A
ii) Exfiltration System	various	various	yes	77	- exfiltration addition	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	$2,368	$1,057
F) OGS/Filters	B,F,G,I	B,F,G,I	no	56.9	-OGS/filter installation	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	$6,348	$4,959	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A
						Min. ($/kg)	$3,750	Min. ($/kg)	$2,807	Min. ($/kg)	$3,021	Min. ($/kg)	$878	Min. ($/kg)	$2,981	Min. ($/kg)	$1,291	Min. ($/kg)	$3,607	Min. ($/kg)	$5,549	Min. ($/kg)	$5,380	Min. ($/kg)	$5,931	Min. ($/kg)	$1,057
						Max. ($/kg)	$3,750	Max. ($/kg)	$5,705	Max. ($/kg)	$3,021	Max. ($/kg)	$1,129	Max. ($/kg)	$4,974	Max. ($/kg)	$2,872	Max. ($/kg)	$4,959	Max. ($/kg)	$5,549	Max. ($/kg)	$5,380	Max. ($/kg)	$5,931	Max. ($/kg)	$1,057

Notes:
LE - Life Expectancy in years (not to exceed 40 years for this evaluation as the analysis is based over a 40 year period)
Costs do not include contingency or engineering costs. Add 30% to each item to include these.
(1) Area 8 and 9 are the same drainage areas with 2 possible pond locations
(2) Add sediment forebay and/or baffles
(3) Sediment Forebay assumed to be 20% of the permanent pool volume required (preferred by MOE) with a 5% increase in removal efficiency.
(4) Assumes an average home frontage of 20 m and average lot size of 0.08 ha.
(5) Assumes the pond is shallow enough for armourstone baffles (approximately 100 m required)
(6) Assumes curthain baffles are required (180 m) due to the depth of the pond.
(7) Assumes 30% removal efficiency from filtration ponds.
(8) Testa area contains 256 lots requiring roof leader disconnection at $200 per lot.
(9) Armour stone baffles life expectancy = 40 years; baffle curtain life expectancy = 15 years

TABLE 3.4.2

MAINTENANCE COSTS
POTENTIAL SWM RETROFITS
TOWNSHIP OF UXBRIDGE

Category	Location #	Corresponding Area (LSRCA)	Treatment Area Overlap	Drainage Area (ha)	SWM Upgrade Potential	Maintenance Activities and Related Costs																					
						Sediment Forebay (5% eff)	Sediment (3) Forebay (5% eff)	Baffles (25% eff)	Baffles (25% eff)	Filtration Pond (30% eff)	Filtration Pond (7) (90% eff)	Infiltration Pond (90% eff)	Infiltration Pond (90% eff)	Wet Pond (various)	Wet Pond (various)	Wetland (various)	Wetland (various)	OGS (40% eff)	OGS (40% eff)	Filter (50% eff)	Filter (50% eff)	Roof Dis. (8) (20% eff)	Roof Dis. (20% eff)	Open Ditch (10% eff)	Open Ditch (10% eff)	Exfiltration System (90% eff)	Exfiltration System (90% eff)
						LE = 40		LE = 40/15 (9)		LE =40		LE = 40		LE =40		LE =40		LE =40		LE =40		LE =40		LE =40		LE = 40	
						($/ha)	($/kg)	($/m)	($/kg)	($/ha)	($/kg)	($/ha)	($/kg)	($/ha)	($/kg)	($/ha)	($/kg)	($/ha)	($/kg)	($/ha)	($/kg)	($/ha)	($/kg)	($/ha) (4)	($/kg)	($/ha) (4)	($/kg)
A) Existing Identified Pond Retrofits Locations																											
	1	Area M	yes	31.4	- add sand filter or wetland (2)	$79	$495	$0 (5)	$0	$401	$417	N/A	N/A	N/A	N/A	$396	$310	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A
	2	Area L	no	85.8	- add sand filter or wetland (2)	N/A	N/A	$1 (6)	$2	$401	$417	N/A	N/A	N/A	N/A	$396	$310	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A
	3	Area N	no	85	- add sand filter or wetland (2)	$79	$495	N/A	N/A	$401	$417	N/A	N/A	N/A	N/A	$396	$310	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A
	4	Area R	no	16.2	- no upgrade potential	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A
	5	Area S	no	10.57	- expansion	$79	$495	N/A	N/A	$401	$417	N/A	N/A	$396	$413	$396	$413	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A
	6	Area O	no	31.1	- no upgrade potential	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A
	7	Area A	no	11.9	- new pond (redeveloped area)	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	$396	$413	$396	$248	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A
B) LSRCA Identified Retrofit/New Locations																										N/A	N/A
	8	Area B	no	10.4	- possible pond	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	$396	$248	$396	$248	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A
	9	Area B or O (1)	no	10.4	- possible pond	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	$396	$247	$396	$247	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A
	10	Area B	no	1.5	- enhance/formalize wetland	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	$396	$826	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A
	11	Area F	no	1.4	- OG separator	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	$500	$284	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A
	12	Area G	no	1.5	- OG on east side	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	$500	$391	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A
	13	Area G	no	5.7	- filter on west side	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	$35	$24	N/A	N/A	N/A	N/A	N/A	N/A
C) New Areas Identified for SWM																										N/A	N/A
	14	Area U	no	4.5	- enhance/formalize wetland	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	$396	$300	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A
	15	Area E	no	18.7	-pond already approved	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	$396	$413	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A
	16	Area C/D	no	0.5	- enhance/formalize wetland	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	$396	$550	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A
	17	Area T	no	1.0	- wetland/infiltration	N/A	N/A	N/A	N/A	N/A	N/A	$401	$139	$396	$248	$396	$248	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A
	18	Area Q	yes	3.3	- pond/wetland/infiltration	N/A	N/A	N/A	N/A	N/A	N/A	$401	$179	$396	$413	$396	$413	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A
	19	Area Q	yes	3.2	- pond/wetland/infiltration	N/A	N/A	N/A	N/A	N/A	N/A	$401	$179	$396	$413	$396	$413	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A
	20	Area Q	yes	3.0	- pond/wetland/infiltration	N/A	N/A	N/A	N/A	N/A	N/A	$401	$179	$396	$413	$396	$413	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A
	21	Area Q	yes	1.5	- pond/wetland/infiltration	N/A	N/A	N/A	N/A	N/A	N/A	$401	$179	$396	$413	$396	$413	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A
D) Roof Leader Disconnection	Testa area	Area M	yes	24.2	- enhanced infiltration	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	$0	$0	N/A	N/A	N/A	N/A
E) i) Open Ditch Enhancemen	various	various	yes	77	- enhanced infiltration	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	$43	$133	N/A	N/A
ii) Exfiltration System	various	various	yes	77	-exfiltration system	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	$16	$7
F) OGS/Filters	B,F,G,I	B,F,G,I	no	56.9	-OGS/filter installation	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	$500	$391	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A
						Min. ($/kg)	$495	Min. ($/kg)	$0	Min. ($/kg)	$417	Min. ($/kg)	$139	Min. ($/kg)	$247	Min. ($/kg)	$247	Min. ($/kg)	$284	Min. ($/kg)	$24	Min. ($/kg)	$0	Min. ($/kg)	$133	Min. ($/kg)	$7
						Max. ($/kg)	$495	Max. ($/kg	$2	Max. ($/kg)	$417	Max. ($/kg)	$179	Max. ($/kg)	$413	Max. ($/kg	$826	Max. ($/kg	$391	Max. ($/kg	$24	Max. ($/kg)	$0	Max. ($/kg)	$133	Max. ($/kg)	$7

Notes:
LE - Life Expectancy in years (not to exceed 40 years for this evaluation as the analysis is based over a 40 year period)
(1) Area 8 and 9 are the same drainage areas with 2 possible pond locations
(2) Add sediment forebay and/or baffles
(3) Sediment Forebay assumed to be 20% of the permanent pool volume required (preferred by MOE) with a 5% increase in removal efficiency.
(4) Assumes an average home frontage of 20 m and average lot size of 0.08 ha.
(5) Assumes the pond is shallow enough for armourstone baffles (approximately 100 m required)
(6) Assumes curthain baffles are required (160 m) due to the depth of the pond.
(7) Assumes 30% removal efficiency from filtration ponds.
(8) Testa area contains 256 lots requiring roof leader disconnection at $200 per lot.
(9) Armour stone baffles life expectancy = 40 years; baffle curtain life expectancy = 15 years

TABLE 3.4.3

PRESENT VALUE CAPITAL AND REPAIR COSTS
POTENTIAL SWM RETROFITS
TOWNSHIP OF UXBRIDGE

Capital Cost Estimates (no amortization)

Category	Location #	Corresponding Area (LSRCA)	Treatment Area Overlap	Drainage Area (ha)	SWM Upgrade Potential	Sediment Forebay (5% eff) LE = 40 ($/ha)	Sediment (3) Forebay (5% eff) LE = 40 ($/kg)	Baffles (10% eff) LE = 40/15 (9) ($/m)	Baffles (10% eff) LE = 40/15 (9) ($/kg)	Filtration Pond (30% eff) LE =40 ($/ha)	Filtration Pond (7) (30% eff) LE =40 ($/kg)	Infiltration Pond (0% eff) LE = 40 ($/ha)	Infiltration Pond (90% eff) LE = 40 ($/kg)	Wet Pond (various) LE =40 ($/ha)	Wet Pond (various) LE =40 ($/kg)	Wetland (various) LE =40 ($/ha)	Wetland (various) LE =40 ($/kg)	OGS (40% eff) LE =40 ($/ha)	OGS (40% eff) LE =40 ($/kg)	Filter (50% eff) LE =40 ($/ha)	Filter (50% eff) LE =40 ($/kg)	Roof Dis. (8) (20% eff) LE =40 ($/ha)	Roof Dis. (20% eff) LE =40 ($/kg)	Open Ditch (10% eff) LE =40 ($/ha) (4)	Open Ditch (10% eff) LE =40 ($/kg)	Exfiltration System (90% eff) LE = 40 ($/ha)	Exfiltration System (90% eff) LE = 40 ($/kg)
A) Existing Identified Pond Retrofits Locations																											
	1	Area M	yes	31.4	- add sand filter or wetland (2)	$600	$3,750	$1,433 (5)	$5,705	$2,900	$3,021	N/A	N/A	N/A	N/A	$2,068	$1,616	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A
	2	Area L	no	85.8	- add sand filter or wetland (2)	N/A	N/A	$1,204 (6)	$2.807	$2,900	$3,021	N/A	N/A	N/A	N/A	$2,068	$1,616	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A
	3	Area N	no	85	- add sand filter or wetland (2)	$600	$3,750	N/A	N/A	$2,900	$3,021	N/A	N/A	N/A	N/A	$2,068	$1,616	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A
	4	Area R	no	16.2	- no upgrade potential	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A
	5	Area S	no	10.57	- expansion	$600	$3,750	N/A	N/A	$2,900	$3,021	N/A	N/A	$4,775	$4,974	$2,068	$2,154	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A
	6	Area O	no	31.1	- no upgrade potential	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A
	7	Area A	no	11.9	- new pond (redeveloped area)	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	$4,775	$4,974	$2,068	$1,293	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A
B) LSRCA Identified Retrofit/New Locations																											
	8	Area B	no	10.4	- possible pond	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	$4,775	$2,984	$2,068	$1,293	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A
	9	Area B or O (1)	no	10.4	- possible pond	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	$4,775	$2,981	$2,068	$1,291	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A
	10	Area B	no	1.5	- enhance/formalize wetland	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	$2,068	$2,154	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A
	11	Area F	no	1.4	- OG separator	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	$6,412	$3,643	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A
	12	Area G	no	1.5	- OG on east side	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	$6,412	$5,009	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A
	13	Area G	no	5.7	- filter on west side	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	$8,926	$6,199	N/A	N/A	N/A	N/A	N/A	N/A
C) New Areas Identified for SWM																											
	14	Area U	no	4.5	- enhance/formalize wetland	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	$2,068	$1,567	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A
	15	Area E	no	18.7	-pond already approved	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	$2,068	$2,154	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A
	16	Area C/D	no	0.5	- enhance/formalize wetland	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	$2,068	$2,872	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A
	17	Area T	no	1.0	- wetland/infiltration	N/A	N/A	N/A	N/A	N/A	N/A	$2,530	$878	$4,775	$2,984	$2,068	$1,293	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A
	18	Area Q	yes	3.3	- pond/wetland/infiltration	N/A	N/A	N/A	N/A	N/A	N/A	$2,530	$1,129	$4,775	$4,974	$2,068	$2,154	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A
	19	Area Q	yes	3.2	- pond/wetland/infiltration	N/A	N/A	N/A	N/A	N/A	N/A	$2,530	$1,129	$4,775	$4,974	$2,068	$2,154	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A
	20	Area Q	yes	3.0	- pond/wetland/infiltration	N/A	N/A	N/A	N/A	N/A	N/A	$2,530	$1,129	$4,775	$4,974	$2,068	$2,154	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A
	21	Area Q	yes	1.5	- pond/wetland/infiltration	N/A	N/A	N/A	N/A	N/A	N/A	$2,530	$1,129	$4,775	$4,974	$2,068	$2,154	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A
D) Roof Leader Disconnection	Testa area	Area M	yes	24.2	- enhanced infiltration	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	$2,066	$5,380	N/A	N/A	N/A	N/A
E) i) Open Ditch Enhancemen	various	various	yes	77	- enhanced infiltration	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	$75	$234	N/A	N/A
ii) Exfiltration System	various	various	yes	77	-exfiltration system	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	$1,443	$644
F) OGS/Filters	B,F,G,I	B,F,G,I	no	56.9	-OGS/filter installation	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	$6,412	$5,009	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A
						Min ($/kg)	$3,750	Min ($/kg)	$2,807	Min ($/kg)	$3,021	Min ($/kg)	$878	Min ($/kg)	$2,981	Min ($/kg)	$1,291	Min ($/kg)	$3,643	Min ($/kg)	$6,199	Min ($/kg)	$5,380	Min ($/kg)	$234	Min ($/kg)	$644
						Max ($/kg)	$3,750	Max ($/kg)	$5,705	Max ($/kg)	$3,021	Max ($/kg)	$1,129	Max ($/kg)	$4,974	Max ($/kg)	$2,872	Max ($/kg)	$5,009	Max ($/kg)	$6,199	Max ($/kg)	$5,380	Max ($/kg)	$234	Max ($/kg)	$644

Notes:
LE - Life Expectancy in years (not to exceed 40 years for this evaluation as the analysis is based over a 40 year period)
(1) Area 8 and 9 are the same drainage areas with 2 possible pond locations
(2) Add sediment forebay and/or baffles
(3) Sediment Forebay assumed to be 20% of the permanent pool volume required (preferred by MOE) with a 5% increase in removal efficiency.
(4) Assumes an average home frontage of 20 m and average lot size of 0.08 ha.
(5) Assumes the pond is shallow enough for armourstone baffles (approximately 100 m required)
(6) Assumes curthain baffles are required (160 m) due to the depth of the pond.
(7) Assumes 30% removal efficiency from filtration ponds.
(8) Testa area contains 256 lots requiring roof leader disconnection at $200 per lot.
(9) Armour stone baffles life expectancy = 40 years; baffle curtain life expectancy = 15 years

TABLE 3.4.4

TOTAL PRESENT VALUE COSTS
POTENTIAL SWM RETROFITS
TOWNSHIP OF UXBRIDGE

Category	Location #	Corresponding Area (LSRCA)	Treatment Area Overlap	Drainage Area (ha)	SWM Upgrade Potential	Sediment Forebay (5% eff) ($/ha)	Sediment (3) Forebay (5% eff) Forebay ($/kg)	Baffles (25% eff) ($/m)	Baffles (25% eff) ($/kg)	Filtration Pond (30% eff) ($/ha)	Filtration Pond (7) (30% eff) ($/kg)	Infiltration Pond (90% eff) ($/ha)	Infiltration Pond (90% eff) ($/kg)	Wet Pond (various) ($/ha)	Wet Pond (various) ($/kg)	Wetland (various) ($/ha)	Wetland (various) ($/kg)	OGS (40% eff) ($/ha)	OGS (40% eff) ($/kg)	Filter (50% eff) ($/ha)	Filter (50% eff) ($/kg)	Roof Dis. (8) (20% eff) ($/ha)	Roof Dis. (20% eff) ($/kg)	Open Ditch (10% eff) ($/ha) (4)	Open Ditch (10% eff) ($/kg)	Exfiltration System (90% eff) ($/ha)	Exfiltration System (90% eff) ($/kg)
						LE = 40		LE = 40/15 (9)		LE =40		LE = 40		LE =40		LE =40		LE =40		LE =40		LE =40		LE =40		LE = 40	
A) Existing Identified Pond Retrofits Locations																											
	1	Area M	yes	31.4	- add sand filter or wetland (2)	$1,657	$10,354	$1,433 (5)	$5,705	$8,243	$8,586	N/A	N/A	N/A	N/A	$7,351	$5,743	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A
	2	Area L	no	85.8	- add sand filter or wetland (2)	N/A	N/A	$13,691 (6)	$31,914	$8,243	$8,586	N/A	N/A	N/A	N/A	$7,351	$5,743	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A
	3	Area N	no	85	- add sand filter or wetland (2)	$1,657	$10,354	N/A	N/A	$8,243	$8,586	N/A	N/A	N/A	N/A	$7,351	$5,743	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A
	4	Area R	no	16.2	- no upgrade potential	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A
	5	Area S	no	10.57	- expansion	$1,657	$10,354	N/A	N/A	$8,243	$8,586	N/A	N/A	$10,058	$10,477	$7,351	$7,657	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A
	6	Area O	no	31.1	- no upgrade potential	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A
	7	Area A	no	11.9	- new pond (redeveloped area)	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	$10,058	$6,286	$7,351	$4,594	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A
B) LSRCA Identified Retrofit/New Locations																											
	8	Area B	no	10.4	- possible pond	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	$10,058	$6,286	$7,351	$4,594	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A
	9	Area B or O (1)	no	10.4	- possible pond	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	$10,058	$6,280	$7,351	$4,590	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A
	10	Area B	no	1.5	- enhance/formalize wetland	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	$7,351	$7,657	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A
	11	Area F	no	1.4	- OG separator	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	$13,078	$7,431	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A
	12	Area G	no	1.5	- OG on east side	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	$13,078	$10,217	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A
	13	Area G	no	5.7	- filter on west side	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	$9,394	$6,524	N/A	N/A	N/A	N/A	N/A	N/A
C) New Areas Identified for SWM																											
	14	Area U	no	4.5	- enhance/formalize wetland	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	$7,351	$5,569	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A
	15	Area E	no	18.7	-pond already approved	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	$7,351	$7,657	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A
	16	Area C/D	no	0.5	- enhance/formalize wetland	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	$7,351	$10,210	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A
	17	Area T	no	1.0	- wetland/infiltration	N/A	N/A	N/A	N/A	N/A	N/A	$7,873	$2,734	$10,058	$6,286	$7,351	$4,594	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A
	18	Area Q	yes	3.3	- pond/wetland/infiltration	N/A	N/A	N/A	N/A	N/A	N/A	$7,873	$3,515	$10,058	$10,477	$7,351	$7,657	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A
	19	Area Q	yes	3.2	- pond/wetland/infiltration	N/A	N/A	N/A	N/A	N/A	N/A	$7,873	$3,515	$10,058	$10,477	$7,351	$7,657	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A
	20	Area Q	yes	3.0	- pond/wetland/infiltration	N/A	N/A	N/A	N/A	N/A	N/A	$7,873	$3,515	$10,058	$10,477	$7,351	$7,657	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A
	21	Area Q	yes	1.5	- pond/wetland/infiltration	N/A	N/A	N/A	N/A	N/A	N/A	$7,873	$3,515	$10,058	$10,477	$7,351	$7,657	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A
D) Roof Leader Disconnection	Testa area	Area M	yes	24.2	- enhanced infiltration	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	$2,068	$5,380	N/A	N/A	N/A	N/A
E) i) Open Ditch Enhancemen	various	various	yes	77	- enhanced infiltration	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	$642	$2,006	N/A	N/A
ii) Exfiltration System	various	various	yes	77	- exfiltration system	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	$2,650	$1,183
F) Stormceptors	B,F,G,I	B,F,G,I	no	56.9	-stormceptor installation	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	$13,078	$10,217	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A
						Min. $/kg	$10,354	Min. $/kg	$5,705	Min. $/kg	$8,586			Min. $/kg	$6,280	Min. $/kg	$4,590	Min. $/kg	$7,431	Min. $/kg	$6,524	Min. $/kg	$5,380	Min. $/kg	$2,006	Min. $/kg	$1,183
						Max. $/kg	$10,354	Max. $/kg	$31,914	Max. $/kg	$8,586			Max. $/kg	$10,477	Max. $/kg	$10,210	Max. $/kg	$10,217	Max. $/kg	$6,524	Max. $/kg	$5,380	Max. $/kg	$2,006	Max. $/kg	$1,183

Notes:
LE - Life Expectancy in years (not to exceed 40 years for this evaluation as the analysis is based over a 40 year period)
(1) Area 8 and 9 are the same drainage areas with 2 possible pond locations
(2) Add sediment forebay and/or baffles
(3) Sediment Forebay assumed to be 20% of the permanent pool volume required (preferred by MOE) with a 5% increase in removal efficiency.
(4) Assumes an average home frontage of 20 m and average lot size of 0.08 ha.
(5) Assumes the pond is shallow enough for armourstone baffles (approximately 100 m required)
(6) Assumes curthain baffles are required (160 m) due to the depth of the pond.
(7) Assumes 30% removal efficiency from filtration ponds.
(8) Testa area contains 256 lots requiring roof leader disconnection at $200 per lot.
(9) Armour stone baffles life expectancy = 40 years; baffle curtain life expectancy = 15 years

TABLE 3.4.5
CAPTIAL COST RANKING WITH ALL OPTIONS
TOWNSHIP OF UXBRIDGE

Location #	Corresponding Area (LSRCA)	P Loading (kg/year)	Potential P Removed (kg/yr)	$/kg	SWM Type
17	Area T	3.3	3.0	$878	Infiltration Pond
various	various	246.4	221.8	$1,057	Exfiltration System
18	Area Q	10.5	9.5	$1,129	Infiltration Pond
19	Area Q	10.4	9.4	$1,129	Infiltration Pond
20	Area Q	9.5	8.6	$1,129	Infiltration Pond
21	Area Q	4.7	4.2	$1,129	Infiltration Pond
9	Area B or O (1)	NA	NA	$1,291	Wetland
7	Area A	38.1	19.1	$1,293	Wetland
8	Area B	33.4	16.7	$1,293	Wetland
17	Area T	3.3	1.7	$1,293	Wetland
14	Area U	19.8	5.9	$1,567	Wetland
1	Area M	100.5	40.2	$1,616	Wetland
5	Area S	33.8	10.1	$2,154	Wetland
10	Area B	4.9	1.5	$2,154	Wetland
18	Area Q	10.5	3.2	$2,154	Wetland
19	Area Q	10.4	3.1	$2,154	Wetland
2	Area L	274.6	82.4	$2,154	Wetland
3	Area N	272.0	81.6	$2,154	Wetland
15	Area E	59.9	18.0	$2,154	Wetland
20	Area Q	9.5	2.9	$2,154	Wetland
21	Area Q	4.7	1.4	$2,154	Wetland
2	Area L	274.6	68.7	$2,807	Baffles
16	Area C/D	1.2	0.4	$2,872	Wetland
9	Area B or O (1)	NA	NA	$2,981	Wet Pond
7	Area A	38.1	19.1	$2,984	Wet Pond
8	Area B	33.4	16.7	$2,984	Wet Pond
17	Area T	3.3	1.7	$2,984	Wet Pond
1	Area M	100.5	30.2	$3,021	Filtration Pond
2	Area L	274.6	82.4	$3,021	Filtration Pond
3	Area N	272.0	81.6	$3,021	Filtration Pond
5	Area S	33.8	10.1	$3,021	Filtration Pond
11	Area F	6.3	2.5	$3,607	OGS
1	Area M	100.5	5.0	$3,750	Sediment Forebay
3	Area N	272.0	13.6	$3,750	Sediment Forebay
5	Area S	33.8	1.7	$3,750	Sediment Forebay
12	Area G	4.9	2.0	$4,959	OGS
B,F,G,I	B,F,G,I	182.1	72.8	$4,959	OGS
5	Area S	33.8	10.1	$4,974	Wet Pond
18	Area Q	10.5	3.2	$4,974	Wet Pond
19	Area Q	10.4	3.1	$4,974	Wet Pond
20	Area Q	9.5	2.9	$4,974	Wet Pond
21	Area Q	4.7	1.4	$4,974	Wet Pond
Testa area	Area M	77.3	15.5	$5,380	Roof Leader Diss,.
13	Area G	5.7	2.9	$5,549	Filter System
1	Area M	100.5	25.1	$5,705	Baffles
various	various	246.4	24.6	$5,931	Open Ditch Enhancement

TABLE 3.4.6
PRESENT VALUE COST RANKING WITH ALL OPTIONS
TOWNSHIP OF UXBRIDGE

Location #	Corresponding Area (LSRCA)	P Loading (kg/year)	Potential P Removed (kg/yr)	$/kg	SWM Type
various	various	246.4	221.8	$1,183	Exfiltration System
various	various	246.4	24.6	$2,006	Open Ditch Enhancement
17	Area T	3.3	3.0	$2,734	Infiltration Pond
18	Area Q	10.5	9.5	$3,515	Infiltration Pond
19	Area Q	10.4	9.4	$3,515	Infiltration Pond
20	Area Q	9.5	8.6	$3,515	Infiltration Pond
21	Area Q	4.7	4.2	$3,515	Infiltration Pond
9	Area B or O (1)	NA	NA	$4,590	Wetland
7	Area A	38.1	19.1	$4,594	Wetland
8	Area B	33.4	16.7	$4,594	Wetland
17	Area T	3.3	1.7	$4,594	Wetland
Testa area	Area M	77.3	15.5	$5,380	Roof Leader Disconnection
14	Area U	19.8	5.9	$5,569	Wetland
1	Area M	100.5	25.1	$5,705	Baffles
1	Area M	100.5	40.2	$5,743	Wetland
2	Area L	274.6	82.4	$5,743	Wetland
3	Area N	272.0	81.6	$5,743	Wetland
9	Area B or O (1)	NA	NA	$6,280	Wet Pond
7	Area A	38.1	19.1	$6,286	Wet Pond
8	Area B	33.4	16.7	$6,286	Wet Pond
17	Area T	3.3	1.7	$6,286	Wet Pond
13	Area G	5.7	2.9	$6,524	Filter System
11	Area F	6.3	2.5	$7,431	OGS
5	Area S	33.8	10.1	$7,657	Wetland
10	Area B	4.9	1.5	$7,657	Wetland
15	Area E	59.9	18.0	$7,657	Wetland
18	Area Q	10.5	3.2	$7,657	Wetland
19	Area Q	10.4	3.1	$7,657	Wetland
20	Area Q	9.5	2.9	$7,657	Wetland
21	Area Q	4.7	1.4	$7,657	Wetland
5	Area S	33.8	10.1	$8,586	Filtration Pond
1	Area M	100.5	30.2	$8,586	Filtration Pond
2	Area L	274.6	82.4	$8,586	Filtration Pond
3	Area N	272.0	81.6	$8,586	Filtration Pond
16	Area C/D	1.2	0.4	$10,210	Wetland
12	Area G	4.9	2.0	$10,217	OGS
B,F,G,I	B,F,G,I	182.1	72.8	$10,217	OGS
1	Area M	100.5	5.0	$10,354	Sediment Forebay
5	Area S	33.8	1.7	$10,354	Sediment Forebay
3	Area N	272.0	13.6	$10,354	Sediment Forebay
5	Area S	33.8	10.1	$10,477	Wet Pond
18	Area Q	10.5	3.2	$10,477	Wet Pond
19	Area Q	10.4	3.1	$10,477	Wet Pond
20	Area Q	9.5	2.9	$10,477	Wet Pond
21	Area Q	4.7	1.4	$10,477	Wet Pond
2	Area L	274.6	68.7	$31,914	Baffles

TABLE 3.4.7

LOCATION RANKING BY ESTIMATED CAPITAL COSTS WITHOUT DUPLICATIONS
UXBRIDGE TOWNSHIP SWM STUDY
UXBRIDGE, ONTARIO

Location #	Corresponding LSRCA Area	Est. $/kg P. Removed	P Removed (kg)	Cumulative P Removed (kg)	Estimated Capital Cost	Cumulative Capital Cost	SWM Type	
17	Area T	$878	3	3	$2,634	$2,634	Infiltration Pond	
18	Area Q	$1,129	9.45	12.45	$10,669	$13,303	Infiltration Pond	
19	Area Q	$1,129	9.36	21.81	$10,567	$23,870	Infiltration Pond	
20	Area Q	$1,129	8.55	30.36	$9,653	$33,523	Infiltration Pond	
21	Area Q	$1,129	4.23	34.59	$4,776	$38,299	Infiltration Pond	
9	Area B or O (1)	$1,291	16.7	51.29	$21,560	$59,859	Wetland	
7	Area A	$1,293	19.1	70.39	$24,696	$84,555	Wetland	
8	Area B	$1,293	16.7	87.09	$21,593	$106,148	Wetland	
14	Area U	$1,567	5.9	92.99	$9,245	$115,394	Wetland	
1	Area M	$1,616	40.2	133.19	$64,963	$180,357	Wetland	← Target = 122 kg(1)
2	Area L	$2,154	82.4	215.59	$177,490	$357,846	Wetland	
3	Area N	$2,154	81.6	297.19	$175,766	$533,613	Wetland	
5	Area S	$2,154	10.1	307.29	$21,755	$555,368	Wetland	
10	Area B	$2,154	1.5	308.79	$3,231	$558,599	Wetland	
15	Area E	$2,154	18	326.79	$38,772	$597,371	Wetland	
16	Area C/D	$2,872	0.4	327.19	$1,149	$598,520	Wetland	
11	Area F	$3,607	2.5	329.69	$9,018	$607,537	OGS	
12	Area G	$4,959	2	331.69	$9,918	$617,455	OGS	
B,F,G,I	B,F,G,I	$4,959	72.8	404.49	$361,015	$978,471	OGS	
Testa area	Area M	$5,380	15.5	419.99	$83,390	$1,061,861	Roof Leader Diss,.	
13	Area G	$5,549	2.9	422.89	$16,092	$1,077,953	Filter System	
various	various	$5,931	24.6	447.49	$145,903	$1,223,855	Open Ditch Enhancement	
various	various	$1,057	221.8	224.8	$234,443	$237,077	Exfiltration System	

TABLE 3.4.8

LOCATION RANKING BY ESTIMATED TOTAL PRESENT VALUE COSTS WITHOUT DUPLICATIONS
UXBRIDGE TOWNSHIP SWM STUDY
UXBRIDGE, ONTARIO

Location #	Corresponding LSRCA Area	Est. $/kg Removed	P Removed (kg)	Cumulative P Removed (kg)	Estimated PV Cost	Cumulative PV Cost	SWM Type
various	various	$2,006	24.6	24.6	$49,348	$49,348	Open Ditch Enhancement
17	Area T	$2,734	3	27.6	$8,202	$57,550	Infiltration Pond
18	Area Q	$3,515	9.5	37.1	$33,393	$90,942	Infiltration Pond
19	Area Q	$3,515	9.4	46.5	$33,041	$123,983	Infiltration Pond
20	Area Q	$3,515	8.6	55.1	$30,229	$154,212	Infiltration Pond
21	Area Q	$3,515	4.2	59.3	$14,763	$168,975	Infiltration Pond
9	Area B or O (1)	$4,590	16.7	76	$76,653	$245,628	Wetland
7	Area A	$4,594	19.1	95.1	$87,745	$333,374	Wetland
8	Area B	$4,594	16.7	111.8	$76,720	$410,093	Wetland
Testa area	Area M	$5,380	15.5	127.3	$83,393	$493,487	Roof Leader Disconnection
14	Area U	$5,569	5.9	133.2	$32,857	$526,344	Wetland
1	Area M	$5,705	25.1	158.3	$143,196	$669,539	Baffles
2	Area L	$5,743	82.4	240.7	$473,223	$1,142,762	Wetland
3	Area N	$5,743	81.6	322.3	$468,629	$1,611,391	Wetland

TABLE OF RECOMMENDATIONS

TABLE 3.5.2

IMPLEMENTATION SITES
UXBRIDGE TOWNSHIP SWM STUDY
UXBRIDGE, ONTARIO

Location #	Corresponding LSRCA Area	P Removed (kg)	Cumulative P Removed (kg)	Est. Capital Cost	Cumulative Capital Cost	SWM Type
Implementation Sites						
various	various	24.6	24.6	$189,959	$189,959	Open Ditch Enhancement
17	Area T	3	27.6	$3,289	$193,248	Infiltration Pond
18	Area Q	9.5 7.33	37.1	$10,854	$204,102	Infiltration Pond
19	Area Q	9.4 7.25	46.5	$10,525	$214,627	Infiltration Pond
20	Area Q	8.6	55.1	$9,867	$224,494	Infiltration Pond
21	Area Q	4.2	59.3	$4,934	$229,428	Infiltration Pond
9	Area B or O (1)	16.7	76	$27,955	$257,383	Wetland
7	Area A	19.1	95.1	$31,987	$289,370	Wetland
8	Area B	16.7	111.8	$27,955	$317,325	Wetland
Testa area	Area M	15.5	127.3	$169,255	$486,580	Roof Leader Disconnection
Contingent Implementation Sites			**TARGET = 122**			
14	Area U	5.9	133.2	$12,096	$498,676	Wetland
1	Area M	25.1	158.3	$58,498	$557,174	Baffles
2	Area L	82.4	240.7	$230,630	$729,306	Wetland
3	Area N	81.6	322.3	$228,480	$785,654	Wetland
various	various	140.14	- -	$237,006	- -	Exfiltration (1)

Note:
- Ranking based on Present Value cost however, costs presented in this Table are Capital Costs.
- Costs on this table now include engineering and contingency costs of 30% and 10% respectively
(1) - Exfiltration phosphorous removal totals have not been considered in achieving the target as this method should be implemented on a opportunity basis. As roads are being reconstructed, exfiltration should be considered. However, it is not cost effective to intall exfiltration systems when road reconstruction is not occuring.

Construction Costs
Township of Uxbridge
June 2001

SWM Measure	Construction ($/ha) - 99/2000	Construction ($/ha) - 2001	Engineering (20% of const.)	Contingency (10% of const.)	Total ($/ha)
Stone Baffles	$200	$1,433	$287	$143	$1,863
Baffle Curtains	$416	$1,204	$241	$120	$1,565
Open Ditch	$1,650	$1,898	$380	$190	$2,467
Infiltration Ponds	$3,000	$2,530	$506	$253	$3,289
Wet Ponds	$3,000	$4,775	$955	$478	$6,208
Roof Disconnection	$5,380	$5,380	$1,076	$538	$6,994
Filters	$7,982	$7,990	$1,598	$799	$10,387
Wetlands	$3,500	$2,068	$414	$207	$2,688
Exfiltration	$2,059	$2,368	$474	$237	$3,078
OGS	$5,520	$6,348	$1,270	$635	$8,252

TOWNSHIP OF UXBRIDGE
URBAN AREA - STORMWATER MANAGEMENT STUDY

TABLE OF CONTENTS

TABLE OF CONTENTS – cont'd

on/or after
page

TOWNSHIP OF UXBRIDGE

URBAN AREA
STORMWATER MANAGEMENT STUDY

1.0 INTRODUCTION

1.1 General

The Township of Uxbridge is under development pressure and the Regional Municipality of Durham has planned expansion to the Water Pollution Control Plant (WPCP) to permit urban expansion. The Town and the WPCP (**Figure 1.1.1**) are located adjacent to Uxbridge Brook which outlets to Lake Simcoe. Uxbridge Brook and Lake Simcoe have been identified in the Uxbridge Brook Watershed Plan (UBWP) as sensitive areas that require stringent water quality protection. The Uxbridge Brook Watershed Plan has indicated water quality targets for a range of parameters including phosphorous.

As part of the approval process for the WPCP expansion, a condition has been set to reduce phosphorous loadings from existing urban development as well as ensuring that phosphorous is targeted specifically for future development.

This report provides an outline of a stormwater management plan for urban development areas (existing and future) to provide for the control of phosphorous. The drainage system for existing development areas is reviewed for stormwater management opportunities. This includes providing control facilities (ie. SWM ponds, oil/grit separators, filters, infiltration) in areas where no SWM facilities exist. Where SWM facilities have been constructed, potential retrofit opportunities are investigated. At source pollution prevention measures are also considered. Recommendations are provided for new development areas to ensure that the most effective phosphorous control approach is provided.

1.2 Background

As part of the Class Environmental Assessment for the Uxbridge Brook Water Pollution Control Plant (UBWPCP), the Regional Municipality of Durham requested a deviation from Policy 2 with respect to phosphorous loadings to the Uxbridge Brook. The Ministry of Environment (MOE) responded to this request in correspondence dated March 16, 1993. In order to release the reserve capacity for future development, prior to expansion of the Uxbridge Brook Water Pollution Control Plant, the MOE requested that the Township of Uxbridge complete a stormwater management implementation plan and receive MOE concurrence with the plan. In 1997, the Regional Municipality of Durham filed their Class Environmental Assessment report for the Uxbridge Brook Water Pollution Control Plant.

In accordance with conditions specified by MOE, the Lake Simcoe Region Conservation Authority (LSRCA) prepared the Uxbridge Brook Watershed Plan (UBWP) dated February 1997 in consultation with staff of the Ministry of Environment and the Township of Uxbridge. As well, Township Council recently adopted Amendment #19 to the local official plan, which establishes the limits for the current urban boundary.

The Township of Uxbridge, in consultation with the Regional Municipality of Durham initiated the process of preparing terms of reference and calling tenders for preparation of the implementation plan as required by MOE. The terms of reference were issued on September 15, 1999 and the Township of Uxbridge awarded the assignment to Totten Sims Hubicki Associates on October 18, 1999.

It is intended that the implementation plan provide a summary of techniques, conditions, proposed time table, a monitoring program and recommended methods to ensure that the measures proposed in the Uxbridge Brook Watershed Plan for both existing and new developments are implemented utilizing the principles of total phosphorous management.

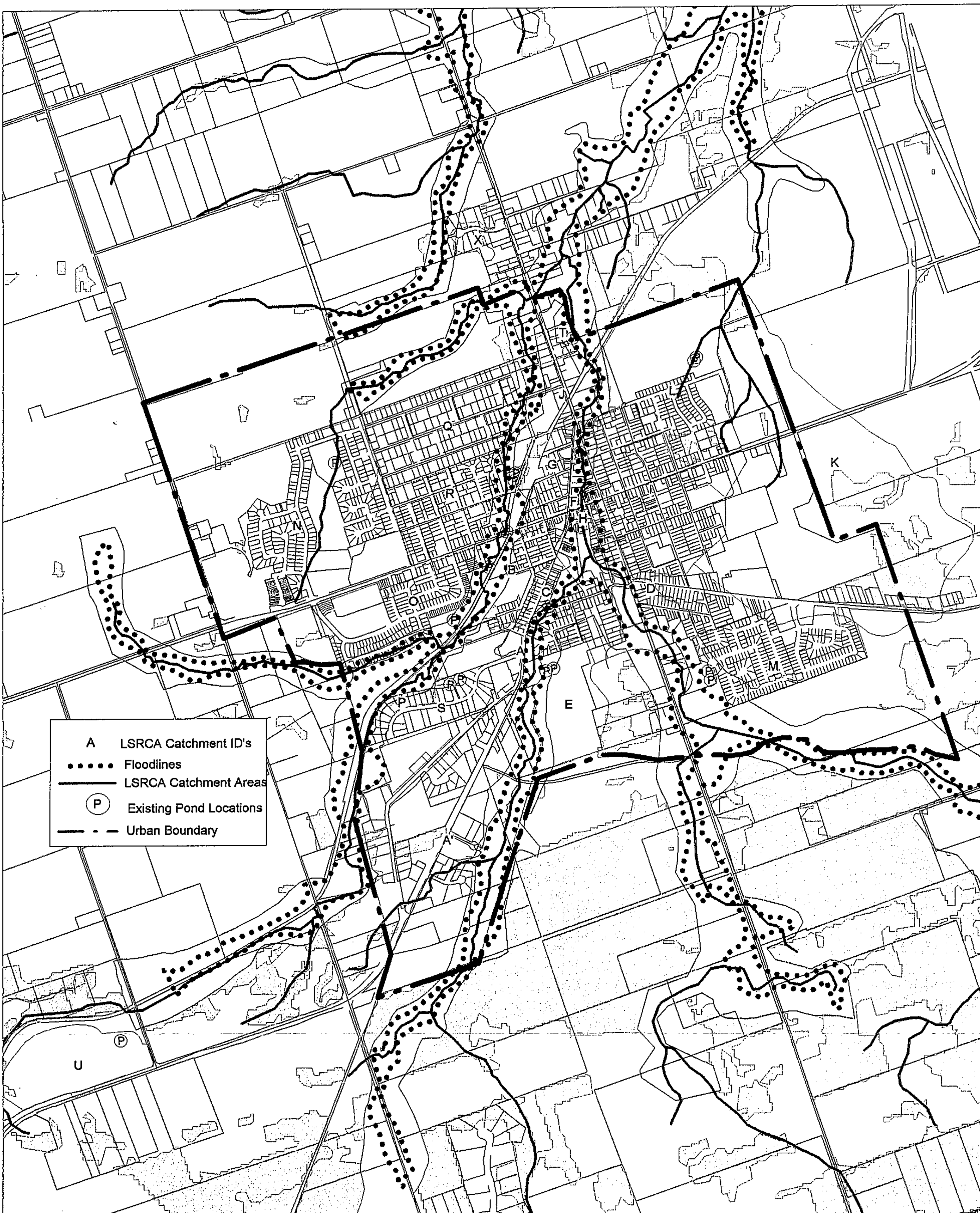


Figure 1.1.1: Study Area

Scale 1:12,500

In correspondence dated January 25, 2000, the Township was advised that the Regional Municipality of Durham will continue to monitor utilization of the Uxbridge Brook Water Pollution Control Plant capacity in order to determine the timing for expansion of the subject facility. If the optimization study currently underway by the Region at the plant indicates that the existing plant can be re-rated to provide some additional capacity, then the actual construction of additional treatment works to raise the final plant capacity to 1.15 MIGD, may be further delayed.

1.3 Approach

The purpose of this study is to provide a Stormwater Management Plan for urban areas (existing and future) within the Township of Uxbridge. It includes an investigation of opportunities for either new facilities or retrofit (of existing) in the existing development areas and new facilities for future development areas. A phosphorous target is set based upon the objectives for Uxbridge Brook and the planned expansion of Uxbridge. An implementation plan is provided to provide guidance on how to put the plan in place (see **Figure 1.3.1**).

The study components carried out include:

- Review of background material related to phosphorous control needs and loadings.
- Review of current land use conditions and planned expansion.
- Investigation of current drainage conditions and the identification of opportunities for new SWM facilities for phosphorous control.
- Review of current SWM facilities and identification of retrofit opportunities for phosphorous control.
- Assessment of SWM opportunities (new and retrofit) to evaluate feasibility, cost, and long term effectiveness.
- Investigation of future development areas and opportunities for SWM including facilities that would jointly control existing and future development areas.
- Public meeting to discuss opportunities and an approach prior to finalization.
- Selection of a SWM plan/approach for existing and future development areas.

1.4 Report Structure

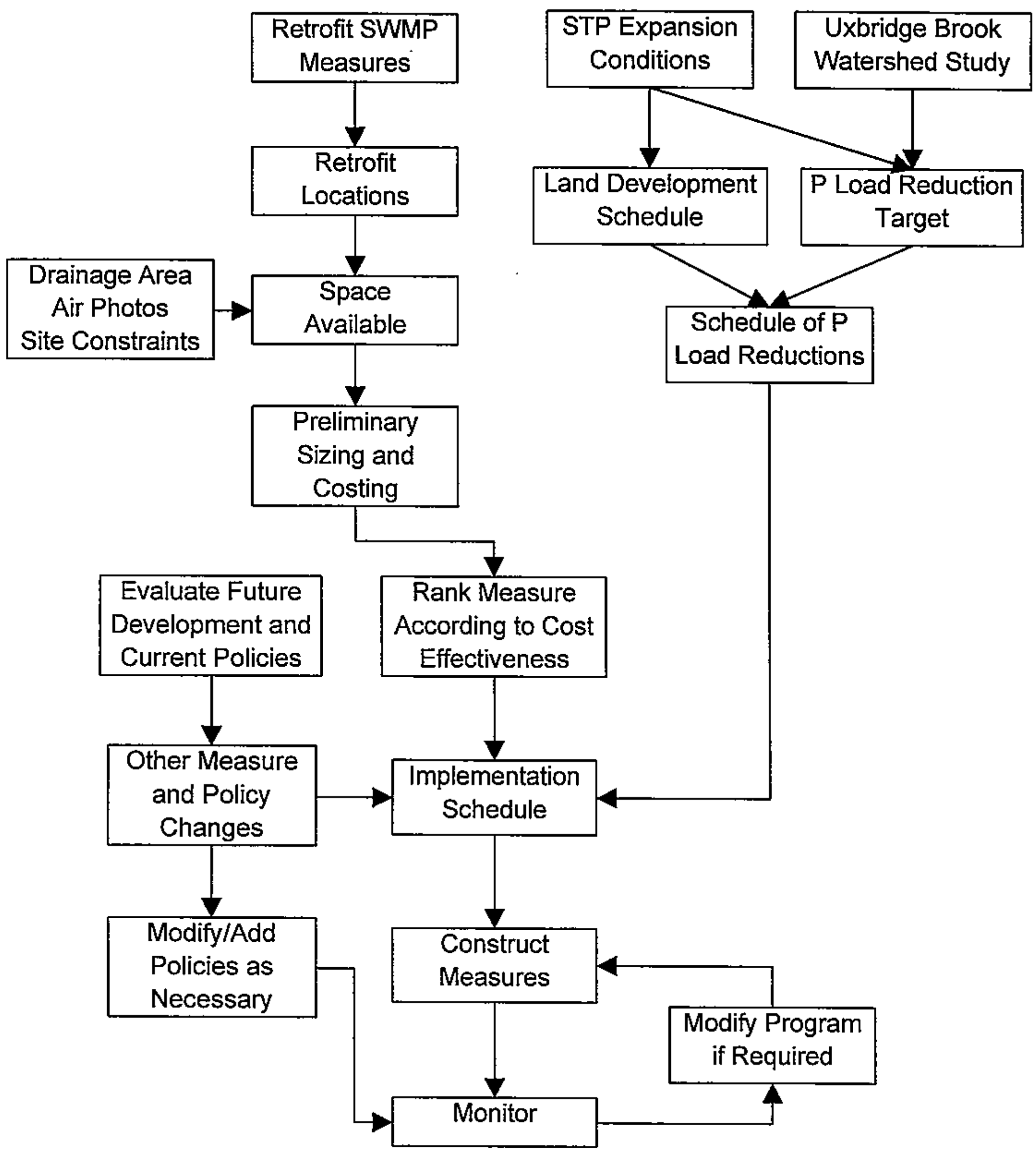
This report provides a summary of the approach taken and the findings. The following sections outline the report:

1.0 INTRODUCTION
- 1.1 General – overview of study purpose
- 1.2 Background – information leading to this study
- 1.3 Approach – key items covered in the study
- 1.4 Report Structure – overview of report sections

2.0 ASSESSMENT OF EXISTING CONDITIONS
- 2.1 Introduction – outline of section
- 2.2 Total Phosphorous Loading Targets – setting of a phosphorous target for this study
- 2.3 Drainage system Conditions – outline of drainage conditions

FIGURE 1.3.1

UXBRIDGE SWM STUDY RETROFIT APPROACH
TOWNSHIP OF UXBRIDGE



3.0 DEVELOPMENT OF A SWM APPROACH
- 3.1 Introduction – outline of section
- 3.2 Current Technologies – review of SWM technologies available
- 3.3 SWM Opportunities – description of SWM opportunities for existing development and some non development areas)
- 3.4 Comparison and Selection of Opportunities/Options – selection process for SWM
- 3.5 Recommended Approach – outline of recommended SWM for existing areas

4.0 FUTURE DEVELOPMENT
- 4.1 Introduction – overview of section
- 4.2 Development Opportunities – future planned development areas
- 4.3 Control Targets – targets for future development areas
- 4.4 Design Technology/Approach – approach for future development areas

5.0 IMPLEMENTATION
- 5.1 Introduction – overview of section
- 5.2 Design Considerations – outline of design requirements
- 5.3 Scheduling – phasing of works
- 5.4 Funding Considerations – potential funding sources
- 5.5 Maintenance Requirements – needs for future maintenance

2.0 ASSESSMENT OF EXISTING CONDITIONS

2.1 Introduction

An assessment of existing conditions is carried out to evaluate opportunities for stormwater management (SWM) for phosphorous reduction. This includes a review of phosphorous loadings to allow for setting a realistic target and the investigation of the existing drainage and stormwater management system to identify SWM enhancement opportunities.

Initially, the phosphorous loading from existing urban areas is investigated including urban runoff and the pollution control plant. These loadings are compared to the rest of the watershed and, in particular rural areas as well as the objectives of the watershed plan in setting a target.

The existing drainage system and stormwater management facilities are investigated for potential upgrades. Specific opportunities for phosphorous removal are reviewed including at source controls as well as enhancing the current SWM facilities.

2.2 Total Phosphorous Loading Target

The Uxbridge Brook Watershed Plan (LSRCA, 1997) developed an overall plan for controlling phosphorous discharges in the watershed from urban and rural sources. The primary goal is to control phosphorous loadings to Lake Simcoe because of the eutrophic conditions of excess algae growth in lake. This results in depleted oxygen levels in the bottom waters of the lake, placing severe stresses on the important fishery. In addition, loading targets are aimed at reducing phosphorous levels in the Uxbridge Brook itself and in Wagner Lake downstream from the Uxbridge Urban area.

Uxbridge Brook is a policy 2 area for consideration of total phosphorous discharges from an expanded sewage treatment plant. The Ministry of the Environment (MOE) sets Provincial Water Quality Objectives (PWQOs), which represent a desirable level of water quality for surface waters in Ontario. If the PWQO is exceeded for more than 25% of the samples, the river reach is typically considered to be 'Policy 2'. Policy 2, as stated in MOE's Water Management document (1994), entails the following conditions:

"Water quality, which presently does not meet the Provincial Water Quality Objectives, shall not be degraded further and all practical measures shall be taken to upgrade the water quality to the Objectives."

Therefore, MOE does not support increased loading of a Policy 2 parameter to the receiving waters from the discharge of treated wastewater. However, MOE does recognize special situations where a Policy Deviation may be requested. In such a case, more detailed studies involving the impact of the Policy 2 parameter would be necessary. Policy 2 goes on to state:

> *"However, it is recognized that in some circumstances, it may not be technically feasible, physically possible or socially desirable to improve water quality toward the PWQO.*
>
> *Accordingly, where it is clearly demonstrated that all reasonable and practical measure to attain the PWQOs have been undertaken but where:*

1) *the PWQOs are not attainable because of natural background water quality; or*
2) *the PWQOs are not attainable because of irreversible human-induced condition; or*
3) *to attain or maintain the PWQOs would results in substantial and widespread adverse economic and social impact; or*
4) *suitable pollution prevention techniques are not available;*

then deviations from this policy may be allowed, subject to the approval of the Ministry of the Environment."

As part of the Environmental Study Report for expansion of the water pollution control plant (WPCP), the Region of Durham requested a deviation from Policy 2 for phosphorous discharges from the plant. The Ministry of the Environment responded with a series of conditions for the deviation (Stephen Maude to R.B.Baker, 1993/03/16). Regarding WPCP the MOE letter stated: "The Certificate of Approval for the WPCP shall specify a monthly average total phosphorous concentration of 0.15 mg/L as an effluent requirement and 0.10 mg/L as an effluent objective. For a WPCP with the proposed design capacity of 5221 m^3/day the corresponding requirement for total phosphorous loading would be 285 kg/year or less." (Note that using the effluent objective of 0.10 mg/L would give a loading rate of 190 kg/year)

Two conditions respecting stormwater are paraphrased below:

- stormwater quality management shall be implemented on all new developments; and,
- existing development and approved but unconstructed developments shall implement stormwater management practices.

The Uxbridge Brook Watershed Plan (LSRCA, 1997) developed an overall plan for controlling phosphorous discharges in the watershed from urban and rural sources. The primary goal is to control phosphorous loadings to Lake Simcoe because of the eutrophic conditions of excess algae growth in lake. This results in depleted oxygen levels in the bottom waters of the lake, placing severe stresses on the important fishery. In addition, loading targets are aimed at reducing phosphorous levels in the Uxbridge Brook itself and in Wagner Lake downstream from the Uxbridge Urban area.

In the Watershed Plan, loadings of phosphorous were calculated from urban point and non point sources. Figure 6.1 from the Watershed Plan is reproduced here (Figure 2.2.1) showing the distribution of total phosphorous loads from all sources. Urban sources account for 23 % of the loads with the load from urban runoff at 17% of the total being the largest urban source.

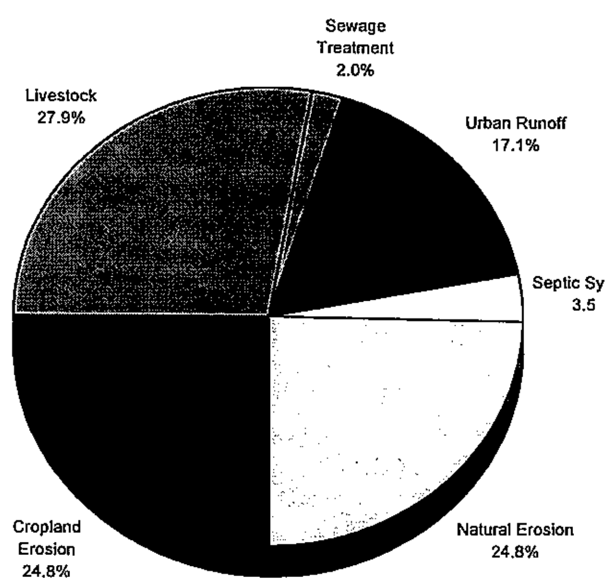


Figure 2.2.1: Phosphorous Loadings to Uxbridge Brook From All Sources

Control programs were considered for both urban and rural sources. The urban sources are discussed in more detail below.

Various control measures were assumed in control scenarios, including development with normal level controls for stormwater. Total phosphorous loading rates used in the UBWP report were based on an earlier study "Development and Implementation of a Phosphorous Loading Watershed Management Model for Lake Simcoe, (Beak Consultants, 1994, prepared for Lake Simcoe Region Conservation Authority). Loading rates are given below:

Table 2.2.1 Total Phosphorous Unit Loading Rates for Lake Simcoe

Loading Component	**Unit Area Loading Rates (kg/ha)**
Urban Dry Weather	0.658
Urban Stormwater	2.53
Agriculture with livestock	0.187
Agriculture – tilled land	0.4
Pasture/barren	0.086
Scrubland	0.068
Forest	0.1

The original calculations were repeated and presented in Appendix D – Phosphorous Load Calculations. Table D1 presents a reconstruction of Table 6.9 of the Uxbridge Brook Watershed Plan (UBWP). In completing the calculation, some minor errors were corrected in the calculation of future and recommended loads. Table D2 was then constructed by several additions,

- included additional areas to be developed
- added a partially developed commercial area not accounted for in the original study
- used a higher background load for undeveloped areas (discussed below)

The resulting loads for the Uxbridge urban area are summarized below.

Table 2.2.2 Urban Total Phosphorous Loads to Uxbridge Brook

	A) Existing P load Kg/yr	B) Future P Load Kg/yr	C) BMP Recommended Kg/yr
Urban Point Sources	110	285	285
Urban Runoff	1253.6	1324.2	1168.9
Total Urban Loads	1363.6	1609.2	1453.9

Note: these loads based on Table 6.9 (UBWP, 1997) have been corrected and revised

The total urban load increase from Scenario A to B above of 245.6 kg could be considered the ultimate goal, since to achieve it would represent a zero increase in phosphorous with the urban development. If the effluent objective of 190 kg/year is used in the calculation, then the ultimate target could decrease to 150.6 kg/yr. The use of the effluent objective in the calculation may be reasonable since the WPCP would be operated to achieve this level, but whether it could achieve it on a consistent basis is uncertain. Consequently, the use of this value is accepts more risk.

The UBWP adopted a target that was considered achievable given the opportunities for retrofits. The difference between Scenario B and C above for urban runoff is 155.3 kg. The Uxbridge Brook Watershed

Plan (LSRCA, 1997) considered that the 155.3 (165 kg in the original) was to be achieved from a combination of retrofit measures from existing developments and additional controls for as yet unapproved developments as follows:

Table 2.2.3 Breakdown of Recommended Urban Runoff Loadings (Uxbridge Brook Watershed Plan)

Urban area	Load reduction kg/yr	Subwatershed area
Existing urban area (retrofits)	122.4	A,B,F,G,I,S
Approved developments	-	E
Vacant lands to be developed	32.8	K
Total	155.3	

Note: corrected values used

Existing development target

Based on the calculations revised from the Watershed Plan, the target reduction in total phosphorous loading for retrofit consideration is 122.4 kg/year. This target is based on:

a) the application of reasonable retrofit methodologies
b) meeting the ultimate target of 150.6 kg/year phosphorous load reduction (using the effluent loading objective as the basis)
c) adoption of the target (along with the target for new development discussed below) results in a zero net increase in total phosphorous load with the level of urban expansion considered in this report.

Since new developments have been proposed in addition to those identified in the Watershed Plan i.e. in Area K, they will be considered separately.

New development targets

The approved developments were assumed to be controlled to level 1 (in reference to the Manual of Stormwater Management Practices, MOE 1994), i.e. TSS reduction 80% and TP reduction 50 % through use of extended detention wet ponds. The vacant lands to be developed were assumed to be controlled to better than level 1, i.e. TSS reduction better than 80% and TP reduction to 80% with use of wet ponds followed by filters. It should be realized that even with the higher level of control, the new developments still represent an additional load of phosphorous to the watershed. This is illustrated by the load calculation for Area K.

2.2.4 Calculation of Loading Reductions for Area K (high background)

	Unit Load kg/ha	Total load for 34.2 ha
Existing undeveloped Area K (portion to be developed 34.2 ha)	0.3	10.3
New development uncontrolled	3.2	109
New development with level 1 controls (50% reduction)	1.6	54.7
New development with Level 1 plus (80% reduction)	0.64	21.9

Based on revised calculations in Table 6.9 UBWP

Consequently, the development results in an approximate doubling in loadings, even though the stormwater management controls proposed can be considered "state of the art". If additional controls to provide 90% reduction are introduced, there is virtually no increase in phosphorous loads with development. This level of control is difficult to achieve unless a series of measures are included to provide a "treatment train". This can include infiltration measures at the lot level (downspouts to soak away pits), local drainage consisting of swales and infiltration or exfiltration systems, and end-of-pipe treatment for remaining flows. If the target cannot be achieved, then additional retrofit measures can be undertaken to meet the overall objective of no increase in total phosphorous load with urbanization. This issue is discussed further in Section 3.2.4.

2.2.5 Calculation of Loading Reductions for Area K (90% removal)

	Unit Load kg/ha	Total load for 34.2 ha
Existing undeveloped Area K (portion to be developed 34.2 ha)	0.3	10.3
New development uncontrolled	3.2	109
New development with level 1 controls (50% reduction)	1.6	54.7
New development with Level 1 plus (90% reduction)	0.32	10.9

2.3 Drainage System Conditions

The older areas within the urban boundary of the Township includes a system of roadway open ditches, culverts and shallow storm sewer systems including catchbasins, manholes and outfall structures to the Uxbridge Brook. The open ditches and swales are well defined within the urban boundary and all systems are designed to accommodate the five year storm event. There is very little evidence of extensive erosion in the open ditch systems and receiving watercourses.

In the newer developments, the roadway systems include deep storm sewer systems to accommodate weeping tile drainage outlets and the systems are most commonly designed for the five year storm event. For the most part, in newer developments, storm drainage outlets to quantity control facilities in accordance with LSRCA policy. In most recent developments, quality / quantity stormwater management facilities have been constructed to meet current LSRCA criteria.

Several stormwater management ponds within the urban boundary have been retrofitted recently to enhance stormwater quality treatment.

The age of the underground infrastructure varies significantly from the older section of the Town site to the newer sections. The entire system is maintained by the Public Works Department of the Township of Uxbridge on a regular basis. The Township of Uxbridge proactively cleans out all catchbasins on a regular basis.

Generally, all roof leaders drain directly onto each lot within the Township of Uxbridge with the exception of the Testa Subdivision (see **Figure 1.1.1**). Approximately 256 lots within the Testa Subdivision have rooftop drainage leaders connected directly to the storm sewer network.

3.0 DEVELOPMENT OF STORMWATER MANAGEMENT APPROACH

3.1 Overview of Approach

A systematic process to develop a preferred plan of action was followed as outlined in **Figure 1.3.1**. The approach includes the following steps which are detailed in the sections following.

- Identify technologies for retrofit, including costs and performance
- Identify suitability criteria for options
- Review locations for retrofit and establish suitability
- Review other opportunities to add existing areas to new developments
- Establish costs and performance
- Carry out screening and ranking of options based on unit cost for phosphorous reduction
- Identify additional factors for each measure such as land ownership and availability
- Consider source control and pollution prevention measures
- Recommend an approach

3.2 Current Technology for Retrofit Stormwater Management Practices

Retrofit practices refers to adding storm water quality elements to an existing drainage system. This could include adding stand-alone elements, such as ponds and oil grit separators, or upgrading existing ponds by adding sediment forebay or filtering modules.

In addition, pollution prevention at source is considered, since this type of management practice can be highly effective in reducing pollution.

3.2.1 Discussion of Phosphorous Removal

Phosphorous is a naturally occurring element, which is necessary for life functions of plants and animals, since it performs a unique function of transferring energy in the life processes. In order to promote growth of plants, it is added as a fertilizer to agricultural crops and residential lawns and gardens. It is present in soluble and sediment bound fractions, with a common ratio of 2/3 sediment bound and 1/3 soluble. Phosphorous in the sediment forms can consist of plant and animal material, or bound to inorganic sediments. The targets for phosphorous control are in units of load or mass over time (kg/day or kg/year) of total phosphorous, which measures both the soluble and sediment forms.

A variety of processes are used to control phosphorous in treatment plants including sedimentation, uptake by biological organisms, adsorption of soluble phosphorous to particles (such as clay), and chemical precipitation with iron salts or lime. In stormwater runoff treatment, sedimentation and uptake by plants is the most common method, along with infiltration. Any method that reduces runoff also reduces the load of phosphorous. Many methods involve more than one process. Stormwater management ponds that retain a wet pool (called wet ponds) provide for both sedimentation and uptake by biological organisms such as plants and bacteria. The biological uptake can be enhanced by the addition of aquatic plants in artificial wetlands. Wetlands may require harvesting of plant tissue to continue to absorb phosphorous, since some have shown that they can be saturated with the nutrient.

This points out the significance of the phosphorous cycle. As a nutrient involved in biological growth it will cycle in the environment. Available in water or sediment, it is taken up by plants only to be released as the plant material decays and becomes available for other plants to use. It is preferable to infiltrate the phosphorous into the ground, where it remains attached to sediment that filters out in the soil or adsorbed to soil particles. **Table 3.2.1** summarizes the capability of different types of control practices to remove phosphorous.

Table 3.2.1 Phosphorous Removal Capability of Stormwater Management Measures

Process	Measures	Phosphorous with Sediment	Soluble Phosphorous
Sedimentation	Sediment forebays; ponds; oil grit separators	Yes	No
Infiltration	Infiltration ponds and trenches; grassed swales; downspout disconnection	Yes	Yes
Filtration with sand	Sand filters	Yes	No
Filtration with special media	Sand peat mixed media filters; iron salts media; zeolite media.	Yes	Yes
Municipal operational source control	Street sweeping; catch basin cleaning	Yes	No
Residential source control	Reduced fertilizer use; alternate lawn practices	Yes	Yes

3.2.2 Technologies for Upgrades

Upgrades to existing pond:

- **Forebay**. Addition of an inlet forebay can increase sediment (and total phosphorous) capture by 5% and allow for easier maintenance. Area requirement: approx. 10% to 20% of existing pond area. **Figure 3.2.1** presents the elements of a forebay.
  Suitability Criteria – if a pond lacks this component and land is available, this upgrade should be considered.

- **Baffles.** Round shaped ponds with inlets close to the outlet lead to short circuiting and reduced performance. Baffles or berms can offset this effect and provide improved performance. A recent paper "Extending Retention Times in Stormwater Pond with Retrofitted Baffles" (R.R. Mathews et al, Water Qual. Res. J. Canada, 1997, Vol 32, No.1) indicated an increase in effective volume with predicted improvement in sedimentation by 29%. Baffle concepts are shown on **Figure 3.2.2**. Performance: assume 25% improved efficiency. Area requirement: Baffles: 0%; berms constructed of stacked stone blocks are effective for shallow ponds 1 m deep or so.
  Suitability Criteria – a pond is a good candidate for baffles if it is round shaped with a length to width ratio of 1 to 2 or less, or the inlet is close to the outlet.

- **Outlet filter.** Addition of an underdrained filter will increase performance by 30%. High flows will be bypassed. Since the pond attenuates flow, smaller outlet filters are economical. There must be additional head to allow for the water to pool 1 m above the filter and for the underdrain to function under gravity flow. Area requirement: approximately 50% increase in the existing pond size. If space is limited, underground filters as described below may be used. **Figure 3.2.3** gives the configuration of an outlet filter.

  Suitability Criteria – a pond is a candidate if space is available and a suitable head differential of 2 m between the outlet and receiving stream.

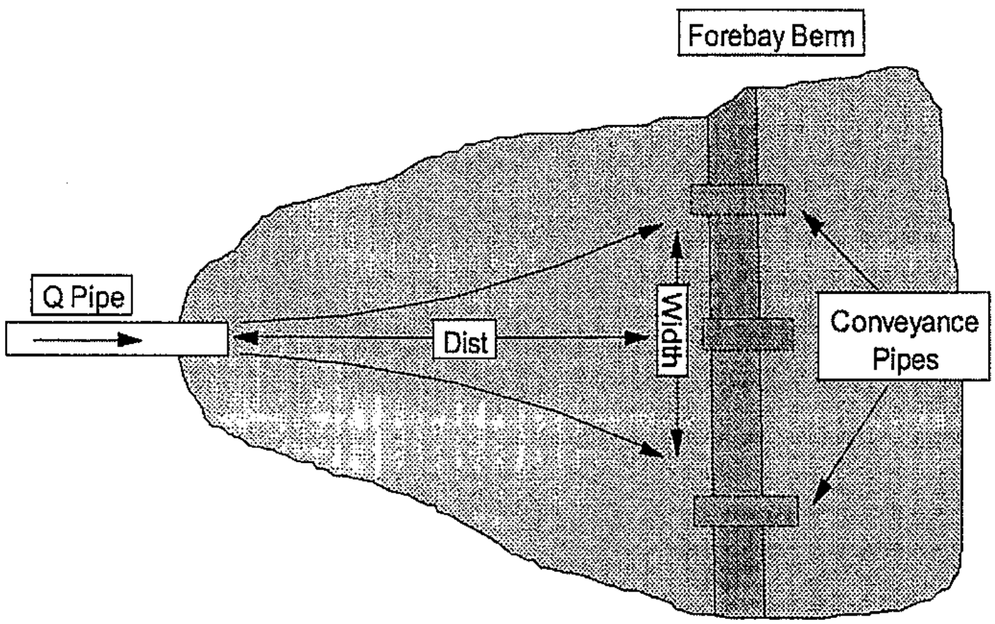
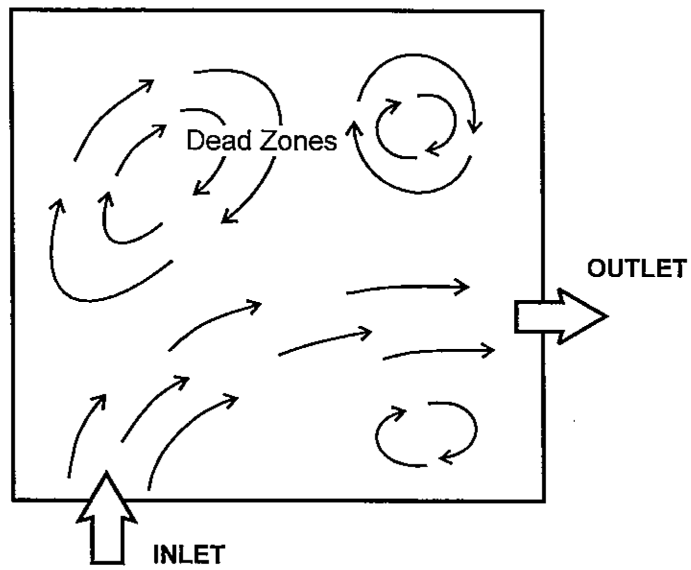


Figure 3.2.1: Sediment Forebay (ref: SWM Planning & Design Manual, MOE)

Figure 3.2.2
POND BAFFLES CONCEPT

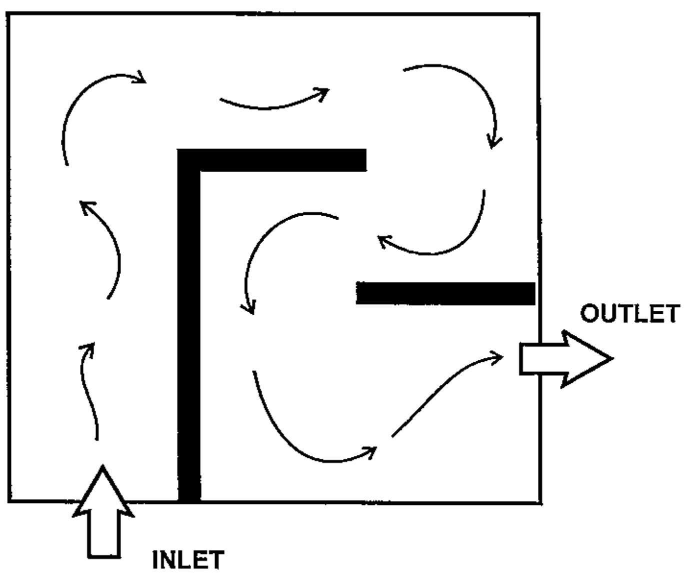
EXISTING POND CONFIGURATION



Dead zones are ineffective at removing sediment during runoff events

Most of the flow short circuits the main volume of the pond

POND CONFIGURATION WITH BAFFLES



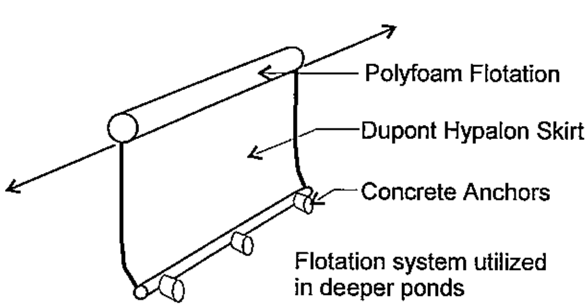
Addition of baffles eliminates short circuits increasing the effective treatment volume of the pond, significantly improving pond efficiency

Baffles can be:

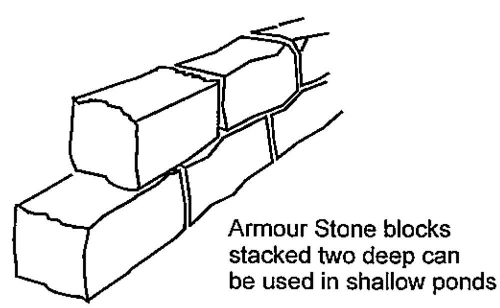
A Floating Curtains

B Armour Stone Blocks

A Floating Curtains



B Armour Stone Blocks



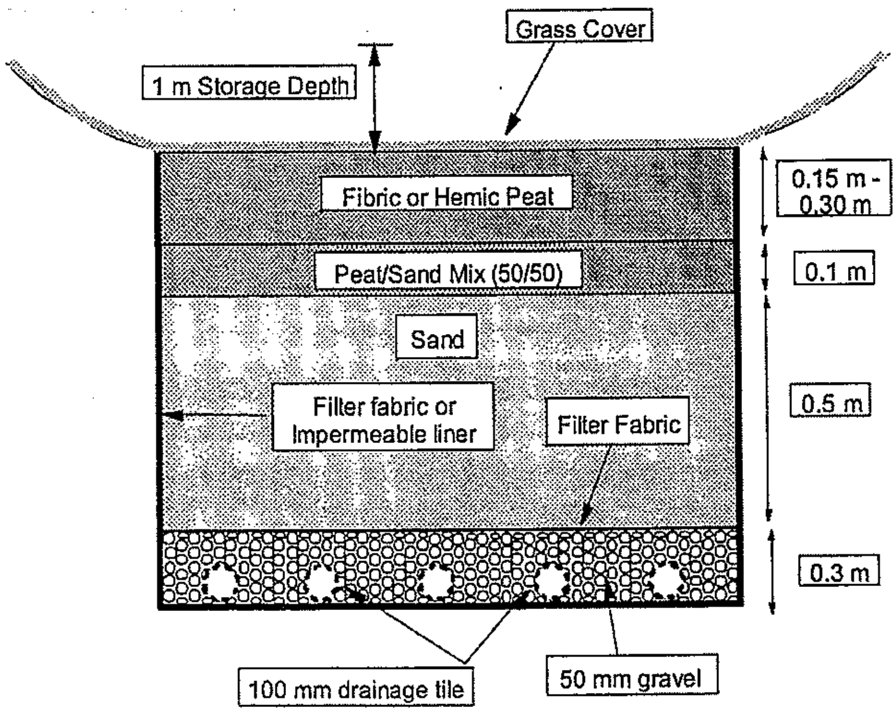


Figure 3.2.3: Outlet Filter Pond (Ref: SWM Planning & Design Manual, MOE)

- **Outlet wetland.** An outlet wetland will filter sediments, take up nutrients and improve performance by 30%. Wetlands are generally shallow to allow floating and emergent plants to root on the bottom, although deeper pools can be included as shown in **Figure 3.2.4**. Area requirement: approximately double the existing pond size.
  Suitability Criteria - if land is available, this is an idea upgrade to a pond.

- **Expanded pond with wetland addition**. The existing pond area can be expanded to allow for shallow wetland features. Similar to the above it will improve performance by 30%. Area requirement: 30 to 40% of existing pond area.
  Suitability Criteria, with less land available, this upgrade makes sense.

Stand alone retrofits.

- **New ponds.** New ponds meeting guidelines in the MOE Manual (Stormwater Management Practices Planning and Design Manual, MO 1994) to level 1 requirements can achieve up to 80% SS removal and 60% TP removal. Often designed with wetland features as shown in **Figure 3.2.5**. With additional wetland features larger than shown on the figure or outlet filters, 80% TP removal can be achieved. Area requirement: dependent on drainage area.
  Suitability Criteria – ideal for new developments. For retrofits, space requirements can be a problem.

- **Oil grit separator (OGS).** Types with an internal or external bypass can achieve 60% TSS and 40% TP removal. There is extensive experience with this type of system in Ontario and elsewhere and good monitoring data is becoming available. A recent MOE study (Comparison of year round performance of two types of oil grit separators, Dale Henry et al, MOE 1999) reported that the Stormceptor OGS removed 61% of TSS, while the conventional three chambered type removed 48%. The two types are shown in **Figure 3.2.6**. Area requirement: these systems have a small footprint and can be placed in the road right-of-way (ROW).

  Appendix A provides an analysis of costs for OGSS of various sizes. There is a clear economy of scale for building the larger units that emerges from the analysis. Also, when the efficiency is taken into account, the units sized for higher performance are only slightly more expensive on a unit cost basis ($/kg of phosphorous removed annually) than units sized for lower performance.

  Suitability Criteria: one of the few types of systems that can fit into an urban retrofit where no open space is available. The system can be used as a pretreatment for filters and infiltration systems. Ideal if spills are a concern.

- **Filters.** This type of system has been applied extensively in the US and very little in Ontario. Some systems can be supplied with media specific to phosphorous removal. The Stormwater Management company provides filters with a proprietary mixed media, including iron salts that removes sediment bound phosphorous by physical filtration and soluble phosphorous by adsorption and precipitation. On a unit cost basis, however, conventional type sand or sand/peat media filters may be more effective. Analysis of costs and performance of two systems shown in **Figure 3.2.7** is presented in Appendix A. Filters are relatively low rate devices and benefit from having storage preceding them. There needs to be a drop in elevation from the sewer to the filter outlet to allow for the filter head losses of a metre or more. Area requirement: Depends on type and application. Space must be provided for storage, if none is present. Also, pretreatment with an OGS is advised. Suitability Criteria – where space, upstream storage and elevation change is available, and high performance is required.

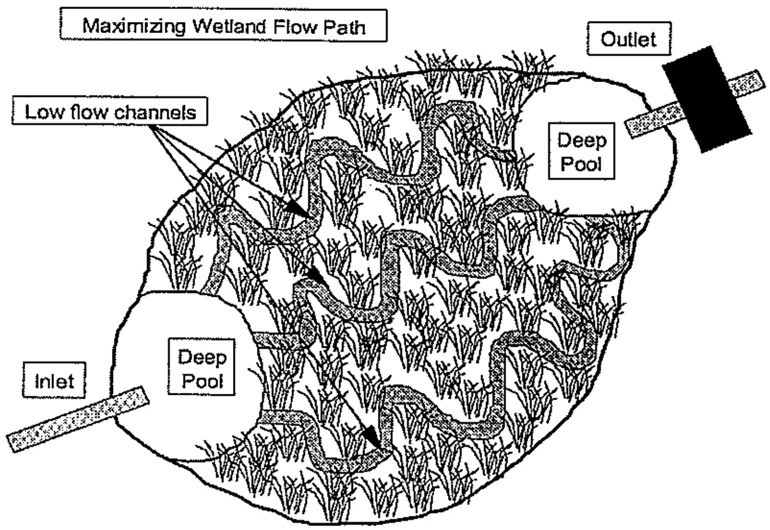


Figure 3.2.4: Outlet Wetland (Ref: SWM Planning & Design Manual, MOE)

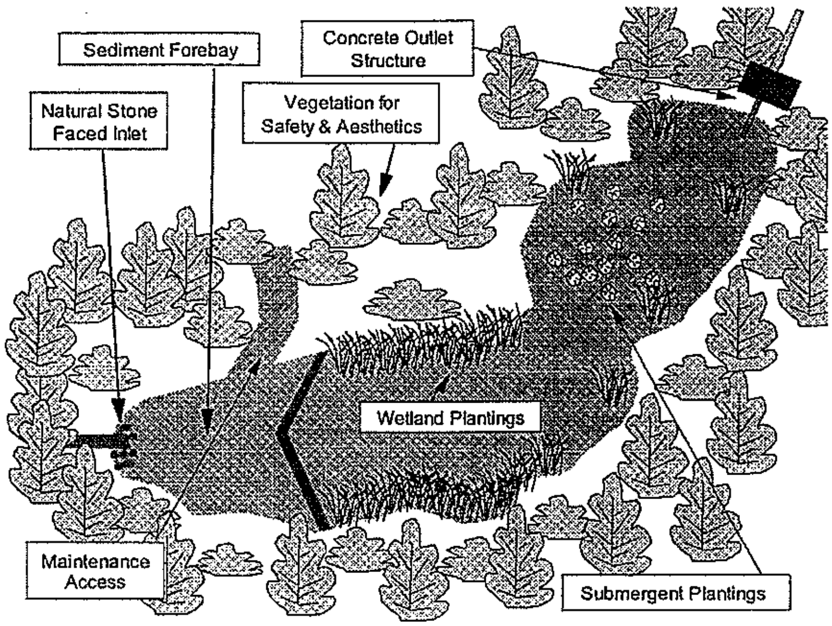


Figure 3.2.5: Extended Detention Wet Pond (Ref: SWM Planning & Design Manual, MOE)

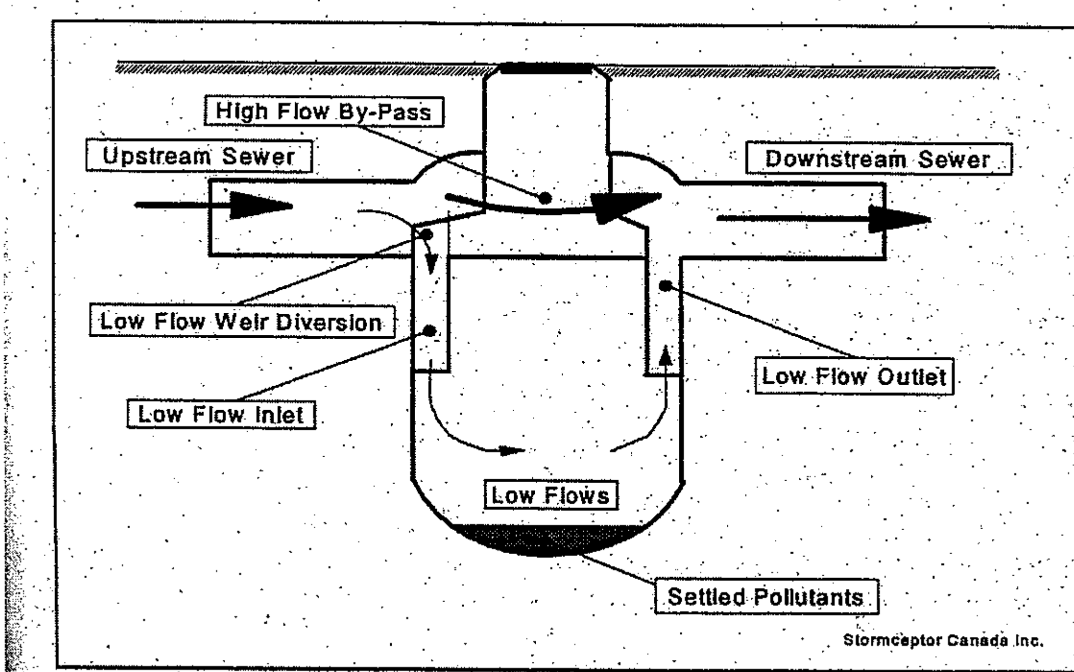


Figure 3.2.6a: Manhole Type with Internal Bypass
(Ref. SWMP Planning and Design Manual, MOE, 1994)

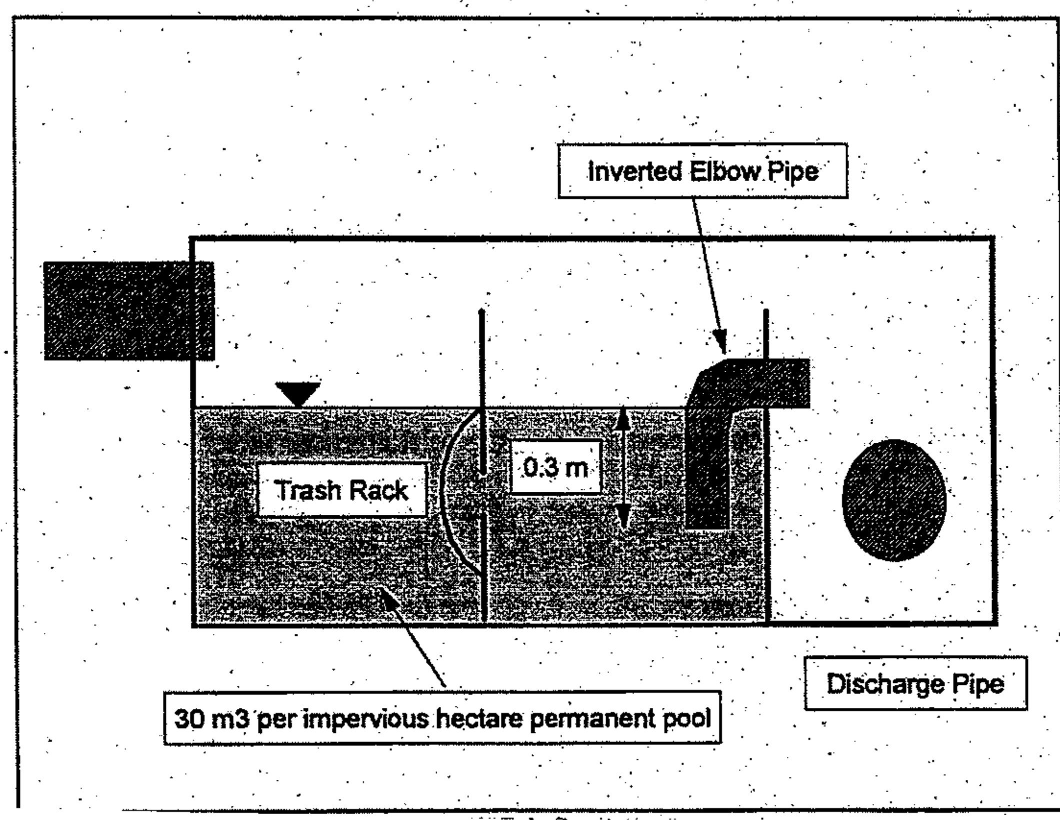


Figure 3.2.6b: Standard 3 Chamber Oil/Grit Separator
(Ref. SWMP Planning and Design Manual, MOE, 1994)

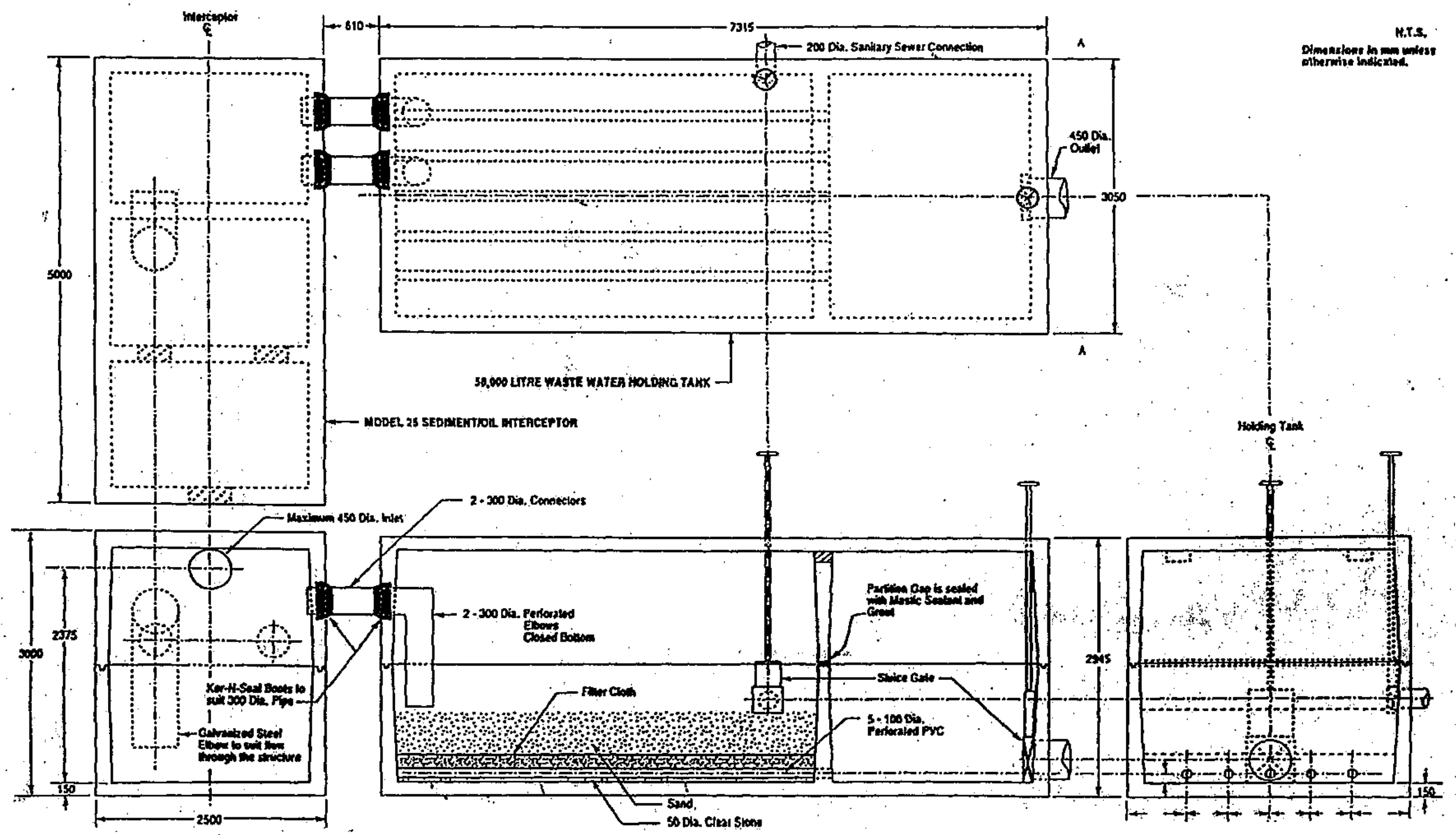


Figure 3.2.7a: Typical Wilkinson Sand Filter Bed System (Wilkinson, 1996)

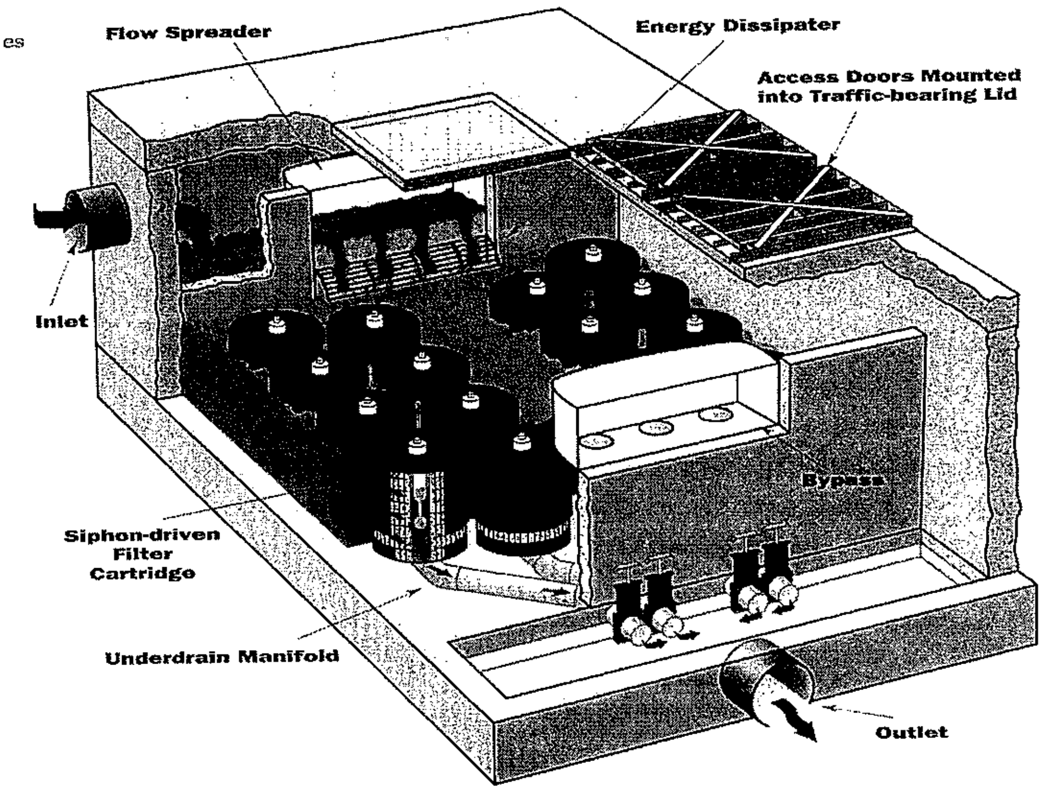


Figure 3.2.7b: Typical StormFilter (Ref: Stormwater Management Inc.)

- **Roof leader disconnection.** Disconnection can reduce runoff flow volume by up to 20%. Flow is diverted to the ground and either infiltrates or evapotranspires. Any runoff receives filtering from the soil. Addition of rain barrels can enhance performance, make this more attractive to some and provide water conservation. Program acceptance can be improved with education and incentives. Some municipalities have enforced the disconnection with bylaws. **Figure 3.2.8** shows a roof leader connected to a soak-away pit. They can also be discharged to a rain barrel or a splash-pad on the ground. Overall performance: relates to impervious area of roof tops disconnected and soil type and the percentage of residents that implement the change. If a totally voluntary program is used, expect only 10% to take up the change. With a subsidized program involving site visits and free installation expect 50 to 70% uptake. Expect 90% or better with bylaw required disconnection backed up by an enforcement effort. Expect 20% TP reduction.
  Suitability Criteria - medium to low density single family residential areas are ideal with suitable soils. Not all downspouts can be disconnected in retrofit situations because the discharge location may not be suitable. Enforcement programs should provide for exceptions.

- **Open ditch enhancement.** Existing ditch systems with driveway culverts provide reasonable environmental benefits. Often residents ask for "upgrades" to curb and gutter systems because of maintenance issues with the ditch and culvert. Alternate systems that avoid curb and gutter, and also avoid deep ditches and culverts can be installed as shown in **Figure 3.2.9**. These also improve infiltration and filtering action and enhance TP removal by 10% or more. In areas with existing ditches, a conversion to standard curb and gutter draining to conventional storm sewers would increase phosphorous loads by 20 % if no other control measures were added.

  The study "An Evaluation of Roadside Ditches and Other Related Stormwater Management Practices" (J.F.Sabourin and Associates Inc., 1997) provides a procedure for evaluating over 20 SWM measures, allows for an objective setting step, provides full life cycle cost analysis and quantification of performance. The measures and expected performance are presented in **Table 3.2.3** below. This procedure was tested and upgraded recently (Demonstration of a Conveyance System Selection Tool in Urban Road Projects, for TRCA, TSH and Donald G. Weatherbe Associates, 2000).
  Suitability Criteria: where existing roadside ditches are to be upgraded.

- **Infiltration ponds.** Infiltration systems remove pollutants from the runoff system, increase base flow and help control temperature. Soil permeability must be suitable to allow rapid draining of water into the soil. Concern about contamination of drinking water aquifers will limit the application to residential areas and roof drains from other types of land uses. **Figure 3.2.10** shows a design. Performance: Assume designs to capture runoff from 15 mm storms will infiltrate 90% of runoff on an annual basis. Space requirement: Similar to stormwater ponds with higher benefits.
  Suitability Criteria: Where space is available, soils are permeable and groundwater is not vulnerable to stormwater contaminants.

- **Exfiltration system.** The system shown in **Figure 3.2.11** was installed in the former City of Etobicoke as part of a road reconstruction project. The road and sewer replacement costs would be borne in any event, so the exfiltration system need only consider additional costs of the exfiltration trench and permeable pipe. The system is suitable where soils are permeable (gravel, sand and sandy loam). Benefits and limitations are similar to infiltration ponds. An analysis of the cost differential is provided in Appendix A. Performance: Assume designs to capture runoff from 15 mm storms will infiltrate 90% of runoff on an annual basis. Space requirement: No additional space since it is done in the road right-of-way.
  Suitability Criteria: Where roads or sewers are planned for rehabilitation or replacement, soils are permeable and groundwater is not vulnerable to stormwater contaminants.

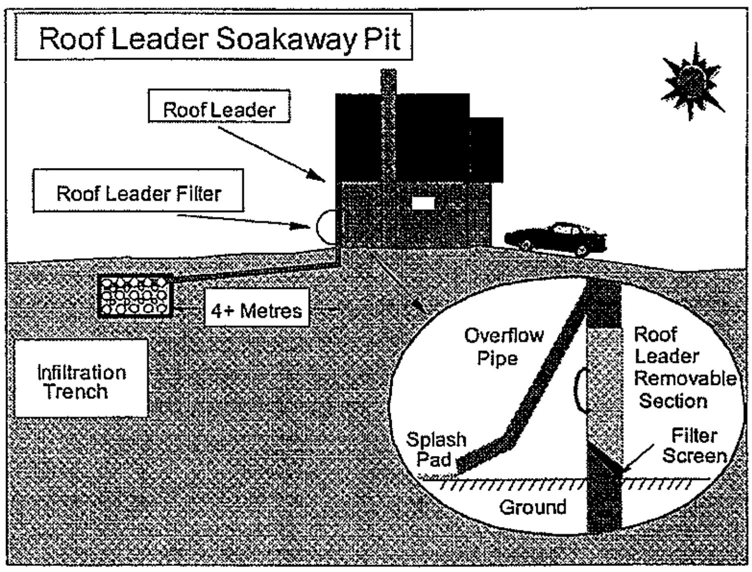
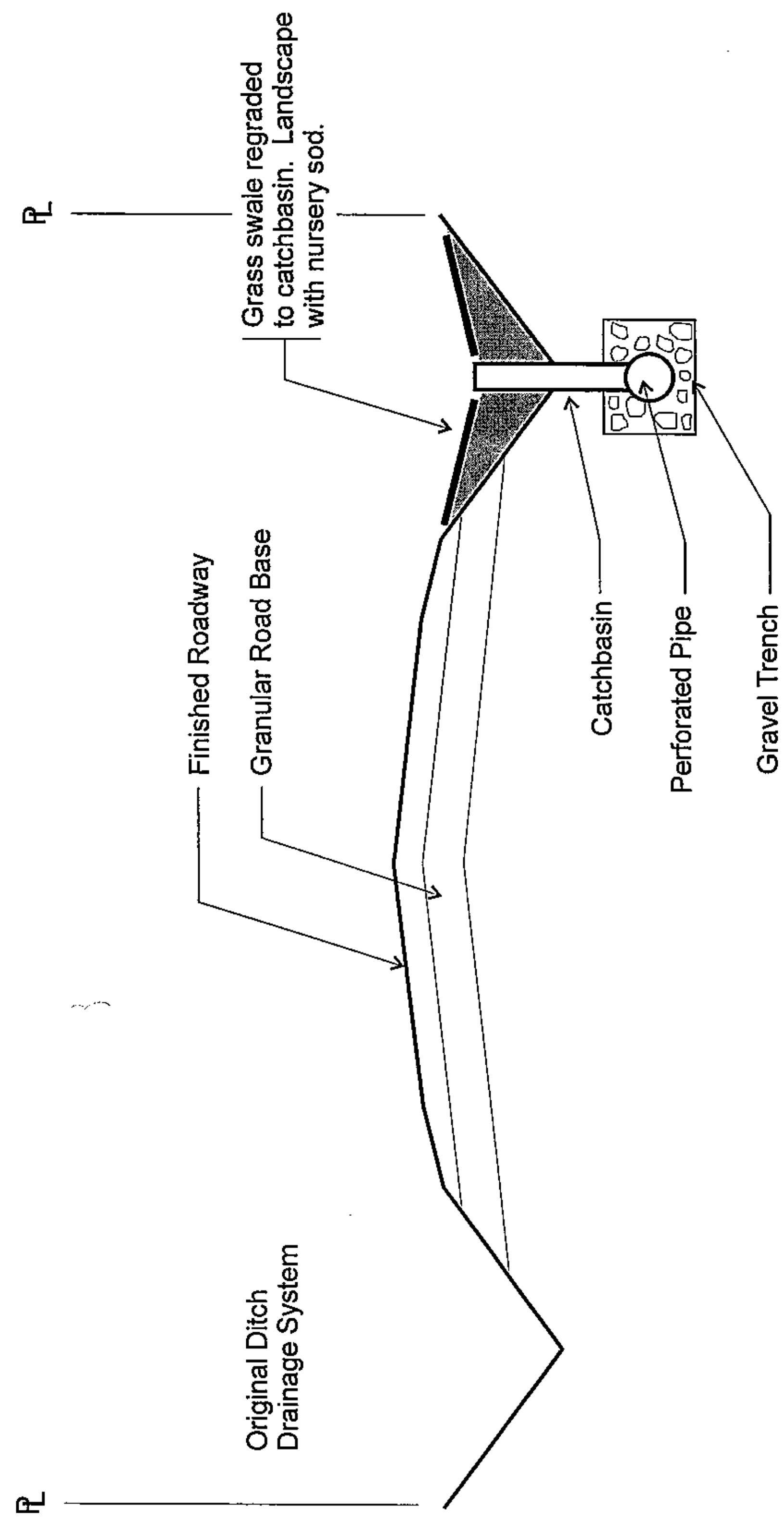


Figure 3.2.8: Downspout Disconnection (Ref: SWM Planning & Design Manual, MOE)

Figure 3.2.9
OPEN DITCH ENHANCEMENT



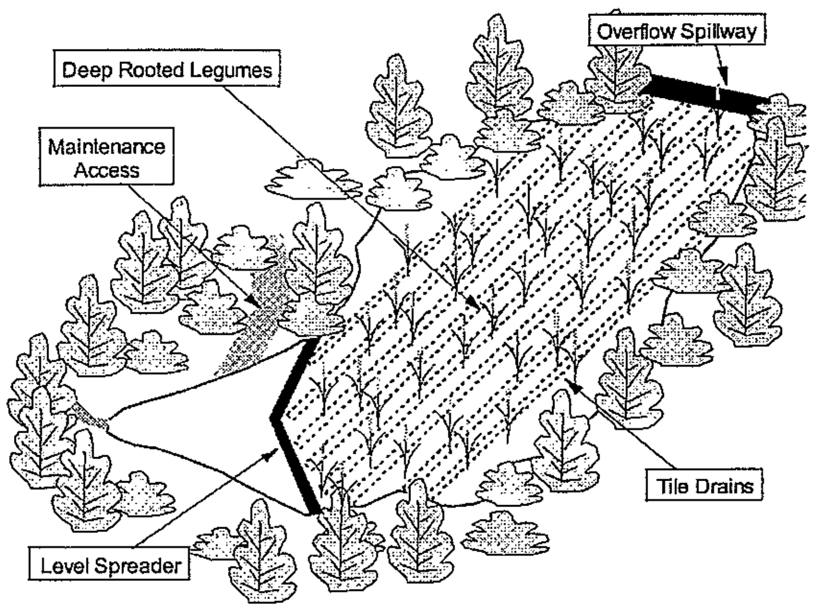


Figure 3.2.10: Infiltration Basin (Ref: SWM Planning & Design Manual, MOE)

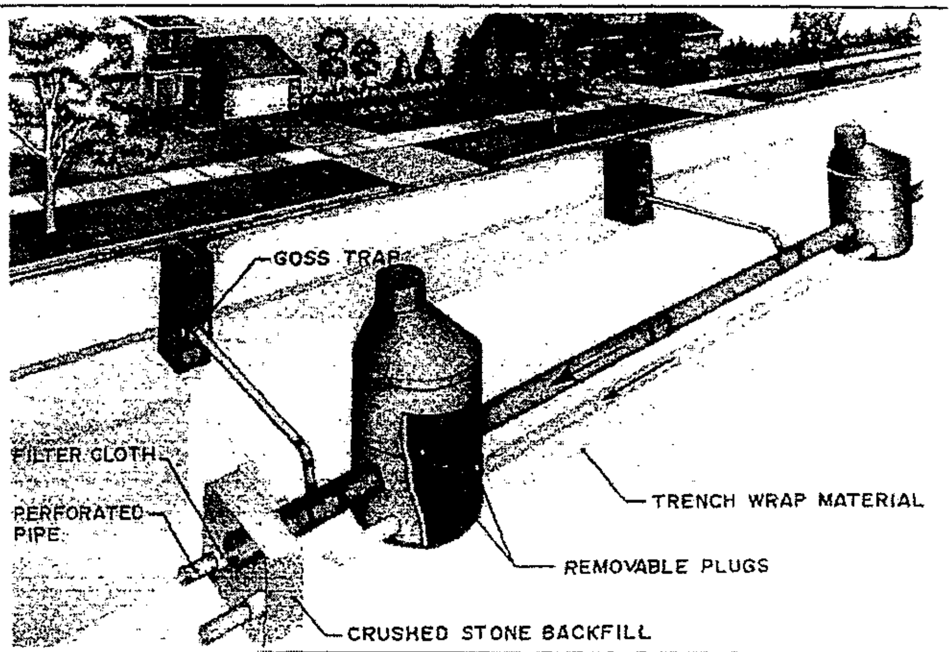


Figure 3.2.11: Typical Curb & Gutter Drainage System with Catchbasins and Exfiltration Trenches

Table 3.2.2 below provides a review of the phosphorous performance of different measures as reported in the literature.

Table 3.2.2 Phosphorous Removal Efficiencies for Stormwater BMPs

Method	Efficiency of Phosphorous Removal	Notes	Reference
Wet Ponds	40 to 60%	Typical removal rates –Ontario	1, 7
Ponds	25 - 86% 10 to 90%	Range of Ontario case studies	1, 3
Buffer strips	60%	50 ft of grass	2
Swales	30%		3
Grass filter strip	20 to 40%	Lack of data – not too effective in denser urban areas – high velocity flows	3
Oil/grit separators	30 to 40%	Conventional design – susceptible to wash-out - efficiency depends on maintenance frequency. Bypass type more effective	3, 6
Sand filters; peat sand filters	45% to 50%	Sediment bound P	4
Special media filters	65%	Sediment and dissolved contaminants	5,8
Extended detention ponds (dry)	10 to 30%	Mostly sedimentation	3
Wetlands	-ve to 90%	Mixed results – mostly +ve	3
Infiltration trenches	60%	Efficiency quoted may be infiltration and removal	3

References:
1. The Study of Stormwater Quality Best Management Practices, Marshall Macklin Monaghan for MOE, March 1991.
2. The Role of Natural Buffer Strips in Controlling Phosphorous and Sediment Runoff
3. A Current Assessment of Urban Best Management Practices, Thomas Scheuler *et al* March 1992, Metropolitan Washington Council of Governments.
4. Municipal Wastewater Management Fact Sheets – Stormwater BMPs, EPA 832-F-96-001 1996 USEPA
5. Peat-Sand Filters, John Galli, MWCOG, Dec. 1994.
6. Comparison of year round performance of two types of oil grit separators, Dale Henry et al, MOE 1999.
7. Stormwater Management Planning and Design Manual, MOE 2000 (Draft)
8. Personal Communication with Stormwater Management company, 2000

3.2.3 Source Control and Pollution Prevention

Additional ways to remove phosphorous include source control or pollution prevention. This involves reducing the amount of chemicals used and thus reducing the amount available for discharge to the environment. Since this type of measure can involve changing behaviour of individual residents or commercial workers, education and community action programs can play a large part of any pollution prevention program. A recent report outlines many measures for controlling pollutants at source (Stormwater Pollution Prevention Handbook, MOE 1999 Draft). Some measures relevant to phosphorous control are outlined below.

- **Reduced fertilizer use.** Education is required for residents to apply only needed amounts to lawns. Many municipalities are reducing the area of cultivated grassed areas and allowing more natural areas to prevail in parks and other public spaces.

- **Alternate lawn practices.** Naturescaping promotes natural lawn care techniques and encourages lawn replacement with alternatives, including drought-tolerant plants. Xeriscape landscaping is an alternative landscape method that emphasizes water conservation. Replacement of lawns with meadowgrasses or rockgardens with low maintenance requirements will reduce water usage and reduce the need for fertilizers and pesticides and herbicides.

- **Pet litter control.** Pet feces (often called pet litter) are deposited primarily by dogs and left uncollected by owners. This material ends up in storm drainage and causes problems of oxygen depletion, aesthetic nuisance, bacterial contamination and nutrient enrichment from phosphorous and nitrogen. Control programs involve changing individual behavior by preventing the littering action. Public education to prevent the littering activities by individuals and their pets has the most promise. Several municipalities have dog litter control "Stoop and Scoop" bylaws.

- **Municipal operations.** Some reduction in the discharge of pollutants to stormwater from street surfaces can be accomplished by conducting street cleaning on a regular basis. The primary and historical role of street cleaning is for sediment and litter control. Catch basin and stormwater inlet maintenance should be done on a regular basis to remove pollutants, reduce high pollutant concentrations during the first flush of storms, prevent clogging of the downstream conveyance system and restore the catch basin's sediment-trapping capacity.

The existing practices in Uxbridge were reviewed to ascertain if specific areas should be upgraded. Table 3.2.3 presents a summary of the applicable bylaws relating to source control. In general, the township has applicable bylaws for source control and pollution prevention that are applied to public properties. Additional education of residents and commercial establishments to apply measures to reduce pesticide use that are being applied to public property would be beneficial. In addition, the drainage policies established by Bylaw 89-53 should be amended to update it to reflect the findings of this report.

Table 3.2.3 Township of Uxbridge Bylaws Relating to Stormwater and Source Control

Bylaw/Policy	Description
Design Criteria and Standard Detail Drawings for Subdivision Developments and Site Plans, 1989 (bylaw 89-53). Amended by bylaw 99-064	Contains procedures for submission of plans of subdivision and site plans. Describes Storm Drainage and Stormwater Management policies and requirements, including quantity and quality control. Details of grading, sewer connections and erosion control and provided. Roof drain downspouts are required to be discharged to the surface onto a splashpad.
Litter Control – A bylaw to prohibit the throwing, placing or depositing of refuse or debris on property of the municipality. Bylaw No. 91-27 Also Bylaw No. 89-48 - A bylaw to control littering of and injury to Township roads and bridges	Prohibits the improper disposal of litter, including pet litter. "A person having a domestic animal under their control shall forthwith upon deposit by the animal of waste on property of the municipality remove the said waste from the property of the municipality. Provides for fines up to $5000 for and offence. This includes prohibitions against debris or mud falling off motor vehicles. Also prohibits sweeping dirt or lawn rakings onto the road.
Park Control – A bylaw to provide for the use, regulation protection and government of parks. Bylaw no. 92-94	Prohibits dumping of litter in parks, including pet litter. Feeding geese, ducks or other waterfowl is also prohibited. Signs informing residents of the bylaw are placed in public parks.
Turf management – A bylaw to adopt a turf management policy. Bylaw no. 97-150	Focuses of reduction of pesticide use to the lowest possible level with the eventual goal being the elimination of pesticide use. Provides for ranking public properties by usage and adopting Non Pesticide Management and Integrated Pest Management practices to minimize pesticide usage. Naturalization and partial naturalization areas are also defined.
Plumbing Inspection – A bylaw to regulate and require inspection of plumbing and drainage installations. Bylaw75-38	New connections to sewers require inspections. Prohibits cross connection of storm to sanitary and sanitary to storm sewers

Operational Measures

The current practices in the Township of Uxbridge were reviewed with the Ben Kester, Director of Public Works as follows:

- **Street sweeping** – each street is swept once per year with the downtown swept twice. A brush type sweeper is used.

- **Catch basin cleaning** – these are cleaned once per year in spring or early summer. The collected material is deposited in the works yard with the liquid soaking into the ground and sediment retained on site.
- **Snow disposal** - any snow collected from the downtown area is disposed of at a MOE approved snow disposal site.
- **Hazardous household waste** – The Region of Durham has provision for receiving these at the landfill site.

Discussion of bylaws and operational measures

The drainage policies in bylaw 89-53 should be updated to reflect the findings of this report. It is noted that the bylaw now provides for roadside ditch cross-sections in new subdivisions. Other bylaws provide good coverage of source control measures and likely do not need modification.

Operational measures are generally satisfactory. Street sweeping frequency could be increased somewhat, but the benefits for total phosphorous removal would be slight unless the frequency was very high, i.e. weekly. This level of effort would be very costly. When the sweeper is replaced, a vacuum or combination brush/vacuum type should be purchased, as this type is more effective at removing fine particles, which are the most contaminated.

3.2.4 Treatment Train Evaluation of Performance

A procedure for calculating the efficiency of several measures applied in series or treatment train is provided in "A Stormwater Retrofit Plan for the Centennial Creek Subwatershed" by James Li, Don Weatherbe, Derek Mack-Mumford, and Michael D'Andrea, (1998 W. James ed.).

> "A multi-efficiency model is used to estimate the cumulative volume (N_v) and solids loading (N_s) reduction efficiencies of a series of RSWMPs

$$N_v = \left[1 - \prod_i^n (1-\eta_v)\right] * 100\% \qquad (3)$$

$$N_s = \left[1 - \prod_i^n (1-\eta_v)(1-\eta_s)\right] * 100\% \qquad (4)$$

where i is the i^{th} RSWMP, n is the total number of RSWMPs, η_v is the runoff volume reduction efficiency of a RSWMP, and η_s is the solids concentration reduction efficiency of a RSWMP. For a RSWMP which reduces solids concentration only (e.g., oil/grit separators, ponds), η_v is zero. For a RSWMP which reduces runoff volume only (e.g., downspout disconnection, stormwater exfiltration systems), η_s is zero." An example of the procedure is provided in **Appendix B.** This procedure should be used when calculating performance of multiple methods in meeting the 90% target for new development.

3.3 SWM Opportunities

In order to determine the potential opportunities for phosphorous removal through the implementation of SWM measures, potential sites and retrofit/management techniques were divided into eight categories. These potential SWM retrofits and the corresponding phosphorous removal efficiencies are summarized in **Table 3.3.1**. Categories for SWM opportunities identified in **Table 3.3.1** include the following:

TABLE 3.3.1

POTENTIAL SWM RETROFITS AND ASSOCIATED LOADING REDUCTIONS
TOWNSHIP OF UXBRIDGE

Category	Location #	Corresponding Area (LSRCA)	Drainage Area (ha)	SWM Upgrade Potential	P Loading (kg/ha/year)	P Loading (kg/year)	Existing Removal Efficiency (%)	Existing P Removed/Year	Final Removal Efficiency (%)	Increased P Removal (kg)	Total P Removed/Year (kg)
A) Existing Identified Pond Retrofits Locations											
	1	Area M	31.4	- add sand filter or wetland (2)	3.2	100.5	40	40.2	80	40.2	80.4
	2	Area L	85.8	- add sand filter or wetland (2)	3.2	274.6	40	109.8	80	109.8	219.6
	3	Area N	85	- add sand filter or wetland (2)	3.2	272.0	40	108.8	80	108.8	217.6
	4	Area R	16.2	- no upgrade potential	3.2	51.8	40	20.7	40	0.0	20.7
	5	Area S	10.57	- expansion	3.2	33.8	50	16.9	80	10.1	27.1
	6	Area O	31.1	- no upgrade potential	3.2	99.5	40	39.8	40	0.0	39.8
	7	Area A	11.9	- new pond (redeveloped area)	3.2	38.1	0	0.0	50	19.0	19.0
B) LSRCA Identified Retrofit/New Locations											
	8	Area B	10.4	- possible pond	3.2	33.4	0	0.0	50	16.7	16.7
	9	Area B or O (1)	10.4	- possible pond	3.2	NA	0	NA	50	NA	NA
	10	Area B	1.5	- enhance/formalize wetland	3.2	4.9	10	0.5	40	1.5	2.0
	11	Area F	1.4	- OG separator	4.4	6.3	0	0.0	40	2.5	2.5
	12	Area G	1.5	- OG on east side	3.2	4.9	0	0.0	40	2.0	2.0
	13	Area G	5.7	- filter on west side	3.2	18.2	0	0.0	45	8.2	8.2
C) New Areas Identified for SWM											
	14	Area U	4.5	- enhance/formalize wetland	4.4	19.8	10	2.0	40	5.9	7.9
	15	Area E	18.7	-pond already approved	3.2	59.9	50	29.9	80	18.0	47.9
	16	Area C/D	0.5	- enhance/formalize wetland	2.4	1.2	10	0.1	40	0.4	0.5
	17	Area T	1.0	- wetland/infiltration	3.2	3.3	0	0.0	50	1.7	1.7
	18	Area Q	3.3	- pond/wetland/infiltration	3.2	10.5	20	2.1	50	3.1	5.2
	19	Area Q	3.2	- pond/wetland/infiltration	3.2	10.4	20	2.1	50	3.1	5.2
	20	Area Q	3.0	- pond/wetland/infiltration	3.2	9.5	20	1.9	50	2.9	4.8
	21	Area Q	1.5	- pond/wetland/infiltration	3.2	4.7	20	0.9	50	1.4	2.3
D) Roof Leader Disconnection	Testa area	Area M	24.2	- enhanced infiltration	3.2	77.3	40	30.9	52	9.3	40.2
E) i) Open Ditch Enhancement	various	various	77	- enhanced infiltration	3.2	246.4	20	49.3	30	24.6	73.9
(ii) Exfiltration System	various	various	77	- exfiltration addition	3.2	246.4	20	49.3	90	172.5	221.8
F) OGS/Filter	B,F,G,I	B,F,G,I	56.9	-OGS/filter installation	3.2	182.1	0	0.0	40	72.8	72.8
G) Undevloped Areas (3)	various	various	120.7	- pond/wetland	3.2	386.2	50	193.1	90	154.5	347.6

Notes:
(1) Area 8 and 9 are the same drainage areas with 2 possible pond locations
(2) Add sediment forebay and/or baffles
(3) Undeveloped areas have not been included in the totals section as they are not representative of the existing conditions.

A) Existing Identified Pond Retrofit Locations
B) LSRCA Identified Retrofits/New Locations
C) New Areas Identified for SWM
D) Roof Leader Disconnection
E) Open Ditch Enhancement
F) Exfiltration System
G) OGS/Filters
H) Undeveloped Areas

Division of the SWM retrofit techniques provided a means to initially screen each opportunity based on feasibility, public acceptability, efficiency, and effectiveness. The following sections discuss the opportunities present within each category. A visual representation of the selected locations is provided in **Figure 3.3.1.** Numbered areas on **Figure 3.3.1** correspond to the location numbers provided in **Table 3.3.1.**

3.3.1 Existing Identified Pond Retrofit Locations

The existing identified pond retrofit locations encompass areas currently serviced by SWM ponds and one currently developed area, which is slated for redevelopment (Pond No. 7). Existing ponds currently remove approximately 40% of the phosphorous entering each system, however incorporating additional features at some selected ponds may increase the phosphorous removal to up to approximately 80%. These features include addition of the following:

i) sediment forebays where none are present;
ii) baffle systems for ponds which are short circuiting or do not have a 3:1 length to width ratio;
iii) filtration ponds following the current pond system; and
iv) wetlands following the current pond system.

Sediment forebays are an effective means of settling out sediment including attached phosphorous. Sediment forebays are easily maintained as the majority of sediment settles in a relatively small and confined area. Sedimentation is also encouraged by the implementation of baffle systems. Whether the baffle system consists of armour stone or baffle curtains, the intent is to lengthen the flow path to increase the detention time and encourage sedimentation.

Filtration ponds encourage the removal of phosphorous from stormwater runoff by allowing the water to be filtered through media which is capable of both physically capturing sediment bound phosphorous and absorbing the soluble phosphorous prior to entering the surface water course. In addition, filtration ponds also encourage sedimentation, which will contribute to the removal of phosphorous.

Wetlands that exist either alone or in a treatment train atmosphere serve several purposes in the removal of phosphorous. Wetlands encourage sedimentation and also remove phosphorous by means of biological uptake.

As identified in **Table 3.3.1**, four existing ponds and one new pond in a redevelopment area (Pond 7) have SWM retrofit potential. The total drainage area of these locations is approximately 225 hectares (ha) which could potentially remove an additional 288 kg/year of phosphorous. The feasibility of these options is discussed in Section 3.4 of this report.

3.3.2 LSRCA Identified Retrofit Locations/New Locations

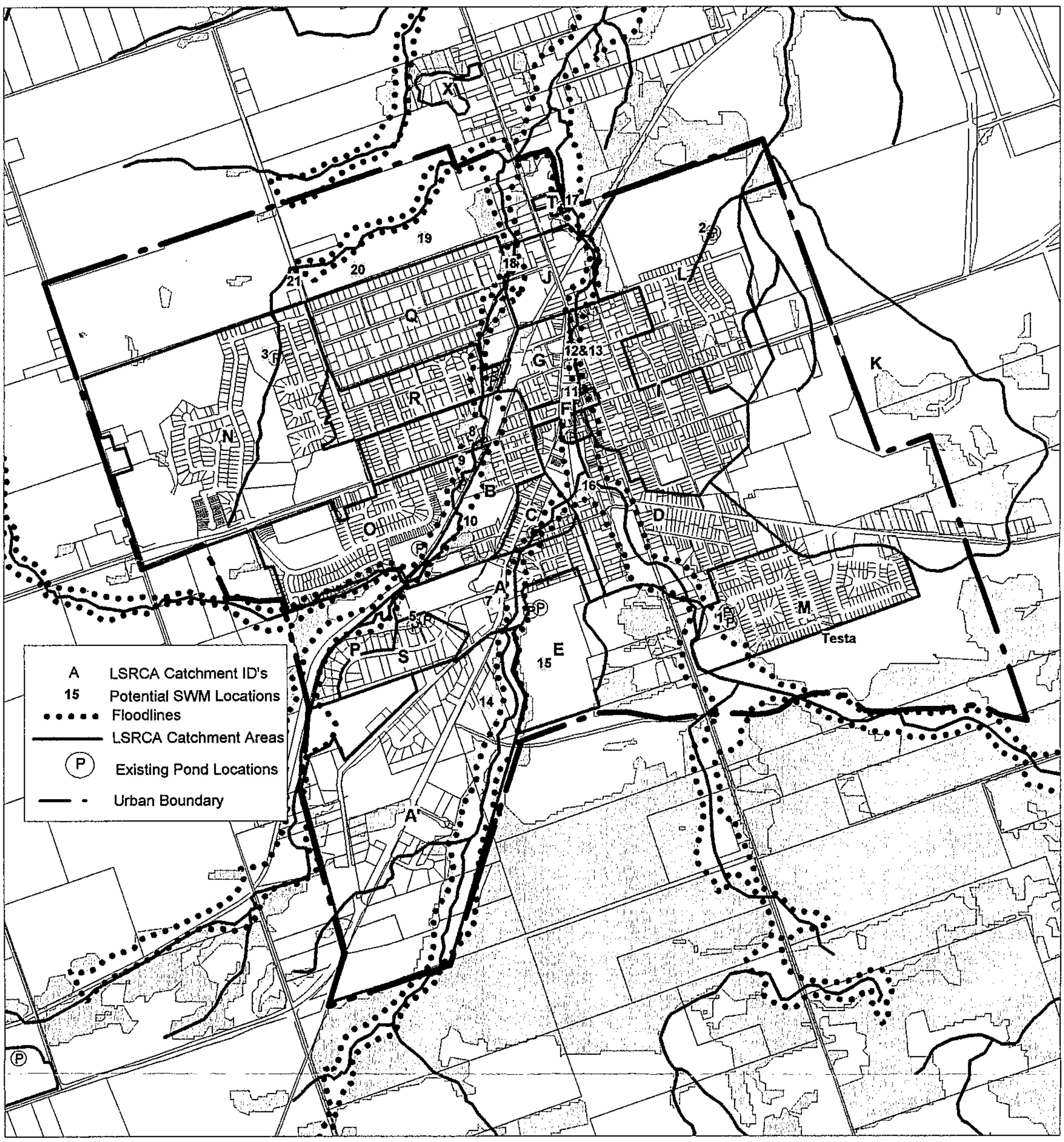


Figure 3.3.1: Potential SWM Retrofit Opportunities Scale 1:12,500

The second category includes locations identified by the LSRCA in the Uxbridge Brook Watershed Report. Six possible locations for SWM/phosphorous removal enhancement have been identified in this category totaling approximately 20.5 ha. Potential SWM measures in these locations include ponds, wetland enhancement, oil/grit separators (OGS), and filters. The additional phosphorous removal potential from this category is approximately 31.8 kg/year. Locations 12 and 13 are illustrated in **Figures 3.3.2** and **3.3.3** respectively.

3.3.3 New Areas Identified for SWM

Eight new areas have been identified for SWM enhancement that have no current control and that were not recognized in the Uxbridge Brook Watershed Report. These areas are generally eligible for new ponds or wetlands, wetland enhancement in locations where informal wetlands currently exist, and incorporation of infiltration ponds in areas where groundwater vulnerability is not of grave concern. These newly identified areas account for 35.7 ha of Uxbridge Township and could potentially remove up to an additional 36.4 kg of phosphorous each year. Locations 18 through 21 (all contained in LSRCA Area Q) are currently achieving approximately 20% phosphorous removal due to the presence of roadside ditches. Location 9 is illustrated in **Figure 3.3.4.**

3.3.4 Roof Leader Disconnection

The Testa subdivision, which encompasses approximately 24.2 acres and 256 lots, is currently the only Uxbridge subdivision which has downspouts connected to the storm sewer network. Disconnection of these downspouts could reduce the current phosphorous loading by up to 12% which translates to a total phosphorous reduction of approximately 9.3 kg/year. The costs associated with downspout disconnection are discussed in Section 3.4 of this report.

3.3.5 Open Ditch Enhancement

The Town of Uxbridge contains numerous areas with roadside ditches as an alternative to curb and gutter methods. The presence of these roadside ditches already provides enhancement to stormwater runoff by providing limited infiltration and sedimentation benefits. Approximately 77 ha of the Town of Uxbridge are currently serviced by open ditches, particularly in LSRCA Area Q where open ditches are the predominant method of stormwater conveyance. Enhancement of the 77 ha of area serviced by open ditches could result in the removal of up to an additional 24.6 kg/year. This is a removal increase of 10% above the 20% already provided by the presence of roadside ditches. It is understood that the residents of LSRCA Area Q are currently on private septic systems and are requesting connection to the Town sanitary sewer system. Open ditch enhancement could be facilitated during the construction of this connection, which could significantly reduce the cost associated with open ditch enhancement. An example of the existing roadside open ditches in Area Q is provided in **Figure 3.3.5.**

3.3.6 Exfiltration Systems

Exfiltration systems (i.e. Etobicoke system) is an extremely efficient means of removing phosphorous from stormwater runoff by infiltrating the majority of runoff into the ground through a perforated pipe system. Exfiltration systems are applicable in areas where roadside ditches currently exist and where groundwater vulnerability is not a dominant factor. **Figure 3.3.6** presents the groundwater vulnerability boundaries created from the Uxbridge Brook Watershed Plan Hydrogeology Study prepared by C.C. Tatham & Associates Ltd. The intent of the groundwater vulnerability line is to protect and maintain groundwater recharge areas, baseflows, cold water fish habitat and safe drinking water.

Figure 3.3.2: Area G SWM Opportunity

Figure 3.3.3: Area G SWM Opportunity

Figure 3.3.4: Potential Pond Location 9

Figure 3.3.5: Existing Roadside Ditches (Area Q)

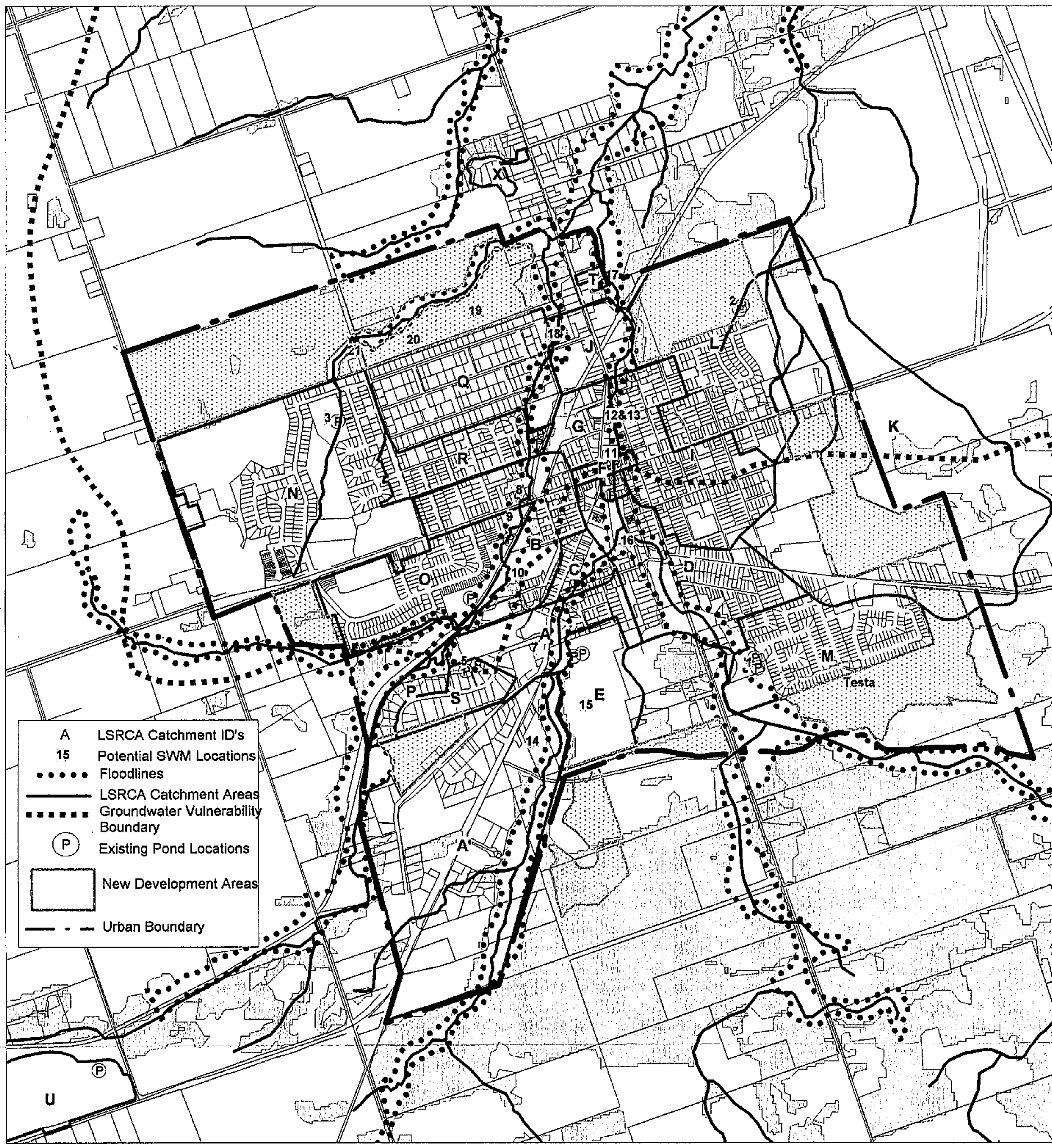


Figure 3.3.6: Groundwater Vulnerability Boundaries

Scale 1:12,500

Sites located to the north of the boundary are considered acceptable areas for infiltration. As such, LSRCA Area Q would be a prime candidate for exfiltration system installation, particularly during the construction of any sanitary sewer connections or road reconstruction. Exfiltration systems can provide up to 90% phosphorous removal, which translates to approximately 43 kg/year in LSRCA Area Q alone.

In addition to exfiltration by means of piping systems, exfiltration may also be accomplished by the addition of infiltration ponds. These ponds serve the same purpose of infiltrating the stormwater runoff into the ground instead of discharging to surface water. The applicability of selected locations is based on the same principles as the sewer exfiltration systems. It should be noted that both means of exfiltration require appropriate underlying soils.

3.3.7 Oil Grit Separators/Filters

Oil grit separators (OGS) or filters can provide an effective means of phosphorous removal in areas where space is limited or in areas where small drainage areas require servicing. These can be placed in the road right-of-way in areas that are currently unserviced by any SWM measures. A total of 56.9 ha of Uxbridge Township would be eligible for OGS installation, which could reduce the phosphorous load by up to 40% or 72.8 kg/year. Costs associated with OGSs/filters are discussed in Section 3.4 of this report.

3.3.8 Undeveloped Areas

Approximately 121 ha of the urban area of Uxbridge is anticipated to be developed in the near future under the Township Secondary Plan. The potential loading from these areas and any associated removals have been included in **Table 3.3.1** but have not been included in the total loadings and total removals as they do not have any bearing on the current conditions experienced in the urban area. The total increase in loadings due to development are expected to be approximately 386.2 kg of phosphorous per year. Incorporation of appropriate SWM measures by developers in these areas could potentially reduce the expected phosphorous loadings by up to 90%, or 347.6 kg/year (as compared to current practices).

3.4 Comparison and Selection

Several factors comprise the selection process of choosing the most appropriate means of stormwater management and phosphorous removal. These factors include the following:

- Feasibility;
- Public acceptance;
- Land ownership;
- Stream sensitivity;
- Order of opportunity;
- Efficiency;
- Effectiveness on a phosphorous removal basis; and
- Effectiveness on a cost basis in both the long and short term.

The initial screening as discussed in Section 3.3 considered feasibility, acceptability, and effectiveness. To complete the assessment a cost estimate was required.

In order to determine the most cost effective means of removing phosphorous from stormwater runoff in Uxbridge, a cost estimate based on dollars per kilogram of phosphorous removed was completed for each SWM opportunity discussed in Section 3.3. Four cost estimates were completed for each location based on the following:

a) Construction or replacement costs;

b) Annual maintenance costs;
c) Present value of capital and repair costs; and
d) Total present value costs.

The aforementioned cost estimates are provided in **Tables 3.4.1** through **3.4.4**. Total present value costs are based on a 40-year duration at a 7% discount rate. Costs per hectare were determined from the report entitled "An Evaluation of Roadside Ditches and Other Related Stormwater Management Practices" prepared by J.F. Sabourin and Associates Inc. for the Metropolitan Toronto and Region Conservation Authority.

It should be noted that the costs utilized for implementation of the exfiltration system were calculated by taking the difference between a standard road construction with storm sewers and a road constructed with the exfiltration system in place. This method was also used to calculate costs for roadside ditch enhancement. Sample calculations for these estimates are provided in **Appendix A.** The costs utilized in the costing tables do not include road construction and associated costs. Implementation of this alternative may be applicable during any construction that may be required in LSRCA Area Q.

Tables 3.4.1 through **3.4.4** provided a means to rank each alternative based on cost per kilogram of phosphorous removed. Locations with multiple opportunities were duplicated during the initial rankings, which are summarized in **Tables 3.4.5** and **3.4.6** for construction or replacement costs and total present value costs respectively. **Tables 3.47** and **3.4.8** summarize the rankings for each alternative based on cost without duplication. The cumulative amount of phosphorus removed is also indicated on these tables to identify any cutoff points for implementation of any alternatives.

Both armour stone baffles and baffle curtains rank highly in both capital cost and present worth comparisons. Baffling can increase pond efficiency by up to 25% by increasing the residence time and hence settling capabilities of the existing ponds. This technique may also be considered in new ponds to be constructed depending on the pond configuration.

The cost effectiveness of the Etobicoke Exfiltration System was apparent in the cost per kilogram analysis. Implementation of this measure is appropriate and cost effective during road reconstruction and may be completed as opportunities arise. Additional conditions affecting implementation of this measure include the suitability of underlying soils and the location of the site in relation to the groundwater vulnerability line.

The results of the ranking indicate that infiltration ponds are among the most cost effective means of removing phosphorous from stormwater runoff on a capital cost basis. They are also ranked highly on a total present worth value based on a 40 year timeframe. These ponds are only applicable in areas where groundwater vulnerability is not an issue. LCRCA Areas T and Q may be suitable for implementation of infiltration ponds because they lie north of the groundwater vulnerability line. The suitability of underlying soils would need to be confirmed prior to implementation of this option.

Several areas where new wetponds could be constructed also ranked above the cutoff point of 132 kg of phosphorous removed. Additional costs for these ponds could arise depending on land ownership and the cost of buying non-Township owned land if required. Location 9 in LSRCA Area B appears to be a particularly good location for construction of a new pond or wetland.

Although open ditch enhancement ranked low in the capital cost evaluation, it is the second most cost efficient option in the total present value evaluation. This is likely due to the low maintenance and repair costs and the longevity of the system. Again, this cost is based on the cost difference between implementing standard roads with sewers and upgrading roads with ditch enhancement. The dominating factor of implementation of this option may be opportunity created during scheduled road reconstruction.

TABLE 3.4.1

CONSTRUCTION OR REPLACEMENT COST
POTENTIAL SWM RETROFITS
TOWNSHIP OF UXBRIDGE

						Capital Cost Estimates (no amoritization)																					
						Sediment Forebay	Sediment (3) Forebay	Baffles	Baffles	Filtration Pond	Filtration Pond (7)	Infiltration Pond	Infiltration Pond	Wet Pond	Wet Pond	Wetland	Wetland	OGS	OGS	Filter	Filter	Roof Dis.	Roof Dis. (8)	Open Ditch	Open Ditch	Exfiltration System	Exfiltration System
			Treatment Area			(5% eff)	(5% eff)	(25% eff)	(25% eff)	(30% eff)	(30% eff)	(90% eff)	(90% eff)	(varies)	(varies)	(varies)	(varies)	(40% eff)	(40% eff)	(50% eff)	(50% eff)	(20% eff)	(20% eff)	(10% eff)	(10% eff)	(90% eff)	(90% eff)
		Corresponding	Area	Drainage	SWM Upgrade	LE = 40		LE = 40/15 (9)		LE =40		LE = 40		LE =40		LE =40		LE =40		LE =40		LE =40		LE =40		LE = 40	
Category	Location #	Area (LSRCA)	Overlap	Area (ha)	Potential	($/ha)	($/ha)	($/m)	($/kg)	($/ha)	($/kg)	($/ha)	($/kg)	($/ha)	($/kg)	($/ha)	($/kg)	($/ha)	($/kg)	($/ha)	($/kg)	($/ha)	($/kg)	($/ha) (4)	($/kg)	($/kg)	($/kg)
A) Existing Identified Pond Retrofits Locations																											
	1	Area M	yes	31.4	- add sand filter or wetland (2)	$600	$3,750	$200 (5)	$796	$2,900	$3,021	N/A	N/A	N/A	N/A	$3,500	$2,734	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A
	2	Area L	no	85.8	- add sand filter or wetland (2)	N/A	N/A	$416 (6)	$970	$2,900	$3,021	N/A	N/A	N/A	N/A	$3,500	$3,646	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A
	3	Area N	no	85	- add sand filter or wetland (2)	$600	$3,750	N/A	N/A	$2,900	$3,021	N/A	N/A	N/A	N/A	$3,500	$3,646	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A
	4	Area R	no	16.2	- no upgrade potential	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A
	5	Area S	no	10.57	- expansion	$600	$3,750	N/A	N/A	$2,900	$3,021	N/A	N/A	$3,000	$3,125	$3,500	$3,646	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A
	6	Area O	no	31.1	- no upgrade potential	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A
	7	Area A	no	11.9	- new pond (redeveloped area)	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	$3,000	$1,875	$3,500	$2,188	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A
B) LSRCA Identified Retrofit/New Locations																										N/A	N/A
	8	Area B	no	10.4	- possible pond	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	$3,000	$1,875	$3,500	$2,188	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A
	9	Area B or O (1)	no	10.4	- possible pond	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	$3,000	$1,873	$3,500	$2,185	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A
	10	Area B	no	1.5	- enhance/formalize wetland	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	$3,500	$3,646	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A
	11	Area F	no	1.4	- OG separator	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	$5,520	$3,136	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A
	12	Area G	no	1.5	- OG on east side	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	$5,520	$4,313	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A
	13	Area G	no	5.7	- filter on west side	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	$7,982	$5,543	N/A	N/A	N/A	N/A	N/A	N/A
C) New Areas Identified for SWM																										N/A	N/A
	14	Area U	no	4.5	- enhance/formalize wetland	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	$3,500	$2,652	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A
	15	Area E	no	18.7	-pond already approved	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	$3,500	$3,646	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A
	16	Area C/D	no	0.5	- enhance/formalize wetland	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	$3,500	$4,861	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A
	17	Area T	no	1.0	- wetland/infiltration	N/A	N/A	N/A	N/A	N/A	N/A	$3,000	$1,042	$3,000	$1,875	$3,500	$2,188	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A
	18	Area Q	yes	3.3	- pond/wetland/infiltration	N/A	N/A	N/A	N/A	N/A	N/A	$3,000	$1,339	$3,000	$3,125	$3,500	$3,646	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A
	19	Area Q	yes	3.2	- pond/wetland/infiltration	N/A	N/A	N/A	N/A	N/A	N/A	$3,000	$1,339	$3,000	$3,125	$3,500	$3,646	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A
	20	Area Q	yes	3.0	- pond/wetland/infiltration	N/A	N/A	N/A	N/A	N/A	N/A	$3,000	$1,339	$3,000	$3,125	$3,500	$3,646	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A
	21	Area Q	yes	1.5	- pond/wetland/infiltration	N/A	N/A	N/A	N/A	N/A	N/A	$3,000	$1,339	$3,000	$3,125	$3,500	$3,646	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A
D) Roof Leader Disconnection	Testa area	Area M	yes	24.2	- enhanced infiltration	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	$2,066	$5,380	N/A	N/A	N/A	N/A
E) i) Open Ditch Enhancement	various	various	yes	77	- enhanced Infiltration	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	$1,650	$5,156	N/A	N/A
ii) Exfiltration System	various	various	yes	77	- exfiltration addition	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	$2,059	$919
F) OGS/Filters	B,F,G,I	B,F,G,I	no	56.9	-OGS/filter installation	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	$5,520	$4,313	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A
						Min. ($/kg)	$3,750	Min. ($/kg)	$796	Min. ($/kg)	$3,021	Min. ($/kg)	$1,042	Min. ($/kg)	$1,873	Min. ($/kg)	$2,185	Min. ($/kg)	$3,136	Min. ($/kg)	$5,543	Min. ($/kg)	$5,380	Min. ($/kg)	$5,156	Min. ($/kg)	$919
						Max. ($/kg)	$3,750	Max. ($/kg)	$970	Max. ($/kg)	$3,021	Max. ($/kg)	$1,339	Max. ($/kg)	$3,125	Max. ($/kg)	$4,861	Max. ($/kg)	$4,313	Max. ($/kg)	$5,543	Max. ($/kg)	$5,380	Max. ($/kg)	$5,156	Max. ($/kg)	$919

Notes:
LE - Life Expectancy in years (not to exceed 40 years for this evaluation as the analysis is based over a 40 year period)
(1) Area 8 and 9 are the same drainage areas with 2 possible pond locations
(2) Add sediment forebay and/or baffles
(3) Sediment Forebay assumed to be 20% of the permanent pool volume required (preferred by MOE) with a 5% increase in removal efficiency.
(4) Assumes an average home frontage of 20 m and average lot size of 0.08 ha.
(5) Assumes the pond is shallow enough for armourstone baffles (approximately 100 m required)
(6) Assumes curthain baffles are required (160 m) due to the depth of the pond.
(7) Assumes 30% removal efficiency from filtration ponds.
(8) Testa area contains 256 lots requiring roof leader disconnection at $200 per lot.
(9) Armour stone baffles life expectancy = 40 years; baffle curtain life expectancy = 15 years

TABLE 3.4.2

MAINTENANCE COSTS
POTENTIAL SWM RETROFITS
TOWNSHIP OF UXBRIDGE

Category	Location #	Corresponding Area (LSRCA)	Treatment Area Overlap	Drainage Area (ha)	SWM Upgrade Potential	Sediment Forebay (5% eff) ($/ha)	Sediment (3) Forebay (5% eff) ($/kg)	Baffles (25% eff) ($/m)	Baffles (25% eff) ($/kg)	Filtration Pond (30% eff) ($/ha)	Filtration Pond (7) (90% eff) ($/kg)	Infiltration Pond (90% eff) ($/ha)	Infiltration Pond (90% eff) ($/kg)	Wet Pond (various) ($/ha)	Wet Pond (various) ($/kg)	Wetland (various) ($/ha)	Wetland (various) ($/kg)	OGS (40% eff) ($/ha)	OGS (40% eff) ($/kg)	Filter (50% eff) ($/ha)	Filter (50% eff) ($/kg)	Roof Dis. (8) (20% eff) ($/ha)	Roof Dis. (20% eff) ($/kg)	Open Ditch (10% eff) ($/ha) (4)	Open Ditch (10% eff) ($/kg)	Exfiltration System (90% eff) ($/ha) (4)	Exfiltration System (90% eff) ($/kg)
						LE = 40		LE = 40/15 (9)		LE =40		LE = 40		LE =40		LE =40		LE =40		LE =40		LE =40		LE =40		LE = 40	
A) Existing Identified Pond Retrofits Locations																											
	1	Area M	yes	31.4	- add sand filter or wetland (2)	$79	$495	$0 (5)	$0	$401	$417	N/A	N/A	N/A	N/A	$396	$310	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A
	2	Area L	no	85.8	- add sand filter or wetland (2)	N/A	N/A	$1 (6)	$2	$401	$417	N/A	N/A	N/A	N/A	$396	$310	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A
	3	Area N	no	85	- add sand filter or wetland (2)	$79	$495	N/A	N/A	$401	$417	N/A	N/A	N/A	N/A	$396	$310	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A
	4	Area R	no	16.2	- no upgrade potential	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A
	5	Area S	no	10.57	- expansion	$79	$495	N/A	N/A	$401	$417	N/A	N/A	$396	$413	$396	$413	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A
	6	Area O	no	31.1	- no upgrade potential	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A
	7	Area A	no	11.9	- new pond (redeveloped area)	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	$396	$413	$396	$248	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A
B) LSRCA Identified Retrofit/New Locations																										N/A	N/A
	8	Area B	no	10.4	- possible pond	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	$396	$248	$396	$248	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A
	9	Area B or O (1)	no	10.4	- possible pond	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	$396	$247	$396	$247	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A
	10	Area B	no	1.5	- enhance/formalize wetland	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	$396	$826	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A
	11	Area F	no	1.4	- OG separator	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	$500	$284	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A
	12	Area G	no	1.5	- OG on east side	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	$500	$391	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A
	13	Area G	no	5.7	- filter on west side	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	$35	$24	N/A	N/A	N/A	N/A	N/A	N/A
C) New Areas Identified for SWM																										N/A	N/A
	14	Area U	no	4.5	- enhance/formalize wetland	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	$396	$300	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A
	15	Area E	no	18.7	-pond already approved	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	$396	$413	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A
	16	Area C/D	no	0.5	- enhance/formalize wetland	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	$396	$550	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A
	17	Area T	no	1.0	- wetland/infiltration	N/A	N/A	N/A	N/A	N/A	N/A	$401	$139	$396	$248	$396	$248	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A
	18	Area Q	yes	3.3	- pond/wetland/infiltration	N/A	N/A	N/A	N/A	N/A	N/A	$401	$179	$396	$413	$396	$413	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A
	19	Area Q	yes	3.2	- pond/wetland/infiltration	N/A	N/A	N/A	N/A	N/A	N/A	$401	$179	$396	$413	$396	$413	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A
	20	Area Q	yes	3.0	- pond/wetland/infiltration	N/A	N/A	N/A	N/A	N/A	N/A	$401	$179	$396	$413	$396	$413	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A
	21	Area Q	yes	1.5	- pond/wetland/infiltration	N/A	N/A	N/A	N/A	N/A	N/A	$401	$179	$396	$413	$396	$413	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A
D) Roof Leader Disconnection	Testa area	Area M	yes	24.2	- enhanced infiltration	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	$0	$0	N/A	N/A	N/A	N/A
E) i) Open Ditch Enhancement	various	various	yes	77	- enhanced infiltration	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	$43	$133	N/A	N/A
ii) Exfiltration System	various	various	yes	77	-exfiltration system	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	$16	$7
F) OGS/Filters	B,F,G,I	B,F,G,I	no	56.9	-OGS/filter installation	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	$500	$391	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A
						Min. ($/kg)	$495	Min. ($/kg)	$0	Min. ($/kg)	$417	Min. ($/kg)	$139	Min. ($/kg)	$247	Min. ($/kg)	$247	Min. ($/kg)	$284	Min. ($/kg)	$24	Min. ($/kg)	$0	Min. ($/kg)	$133	Min. ($/kg)	$7
						Max. ($/kg)	$495	Max. ($/kg)	$2	Max. ($/kg)	$417	Max. ($/kg)	$179	Max. ($/kg)	$413	Max. ($/kg)	$826	Max. ($/kg)	$391	Max. ($/kg)	$24	Max. ($/kg)	$0	Max. ($/kg)	$133	Max. ($/kg)	$7

Notes:
LE - Life Expectancy in years (not to exceed 40 years for this evaluation as the analysis is based over a 40 year period)
(1) Area 8 and 9 are the same drainage areas with 2 possible pond locations
(2) Add sediment forebay and/or baffles
(3) Sediment Forebay assumed to be 20% of the permanent pool volume required (preferred by MOE) with a 5% increase in removal efficiency.
(4) Assumes an average home frontage of 20 m and average lot size of 0.08 ha.
(5) Assumes the pond is shallow enough for armourstone baffles (approximately 100 m required)
(6) Assumes curthain baffles are required (160 m) due to the depth of the pond.
(7) Assumes 30% removal efficiency from filtration ponds.
(8) Testa area contains 256 lots requiring roof leader disconnection at $200 per lot.
(9) Armour stone baffles life expectancy = 40 years; baffle curtain life expectancy = 15 years

TABLE 3.4.3

PRESENT VALUE CAPITAL AND REPAIR COSTS
POTENTIAL SWM RETROFITS
TOWNSHIP OF UXBRIDGE

Capital Cost Estimates (no amoritization)

Category	Location #	Corresponding Area (LSRCA)	Treatment Area Overlap	Drainage Area (ha)	SWM Upgrade Potential	Sediment Forebay (5% eff) LE = 40 ($/ha)	Sediment (3) Forebay (5% eff) LE = 40 ($/kg)	Baffles (10% eff) LE = 40/15 (9) ($/m)	Baffles (10% eff) LE = 40/15 (9) ($/kg)	Filtration Pond (30% eff) LE =40 ($/ha)	Filtration Pond (7) (30% eff) LE =40 ($/kg)	Infiltration Pond (0% eff) LE = 40 ($/ha)	Infiltration Pond (90% eff) LE = 40 ($/kg)	Wet Pond (various) LE =40 ($/ha)	Wet Pond (various) LE =40 ($/kg)	Wetland (various) LE =40. ($/ha)	Wetland (various) LE =40. ($/kg)	OGS (40% eff) LE =40 ($/ha)	OGS (40% eff) LE =40 ($/kg)	Filter (50% eff) LE =40 ($/ha)	Filter (50% eff) LE =40 ($/kg)	Roof Dis. (8) (20% eff) LE =40 ($/ha)	Roof Dis. (20% eff) LE =40 ($/kg)	Open Ditch (10% eff) LE =40 ($/ha) (4)	Open Ditch (10% eff) LE =40 ($/kg)	Exfiltration System (90% eff) LE = 40 ($/ha)	Exfiltration System (90% eff) LE = 40 ($/kg)
A) Existing Identified Pond Retrofits Locations																											
	1	Area M	yes	31.4	- add sand filter or wetland (2)	$600	$3,750	$200 (5)	$796	$2,900	$3,021	N/A	N/A	N/A	N/A	$3,500	$2,734	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A
	2	Area L	no	85.8	- add sand filter or wetland (2)	N/A	N/A	$609 (6)	$1,419	$2,900	$3,021	N/A	N/A	N/A	N/A	$3,500	$2,734	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A
	3	Area N	no	85	- add sand filter or wetland (2)	$600	$3,750	N/A	N/A	$2,900	$3,021	N/A	N/A	N/A	N/A	$3,500	$2,734	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A
	4	Area R	no	16.2	- no upgrade potential	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A
	5	Area S	no	10.57	- expansion	$600	$3,750	N/A	N/A	$2,900	$3,021	N/A	N/A	$3,000	$3,125	$3,500	$3,646	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A
	6	Area O	no	31.1	- no upgrade potential	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A
	7	Area A	no	11.9	- new pond (redeveloped area)	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	$3,000	$3,125	$3,500	$2,188	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A
B) LSRCA Identified Retrofit/New Locations																											
	8	Area B	no	10.4	- possible pond	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	$3,000	$1,875	$3,500	$2,188	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A
	9	Area B or O (1)	no	10.4	- possible pond	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	$3,000	$1,873	$3,500	$2,185	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A
	10	Area B	no	1.5	- enhance/formalize wetland	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	$3,500	$3,646	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A
	11	Area F	no	1.4	- OG separator	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	$5,584	$3,173	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A
	12	Area G	no	1.5	- OG on east side	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	$5,584	$4,362	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A
	13	Area G	no	5.7	- filter on west side	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	$8,918	$6,193	N/A	N/A	N/A	N/A	N/A	N/A
C) New Areas Identified for SWM																											
	14	Area U	no	4.5	- enhance/formalize wetland	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	$3,500	$2,652	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A
	15	Area E	no	18.7	-pond already approved	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	$3,500	$3,646	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A
	16	Area C/D	no	0.5	- enhance/formalize wetland	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	$3,500	$4,861	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A
	17	Area T	no	1.0	- wetland/infiltration	N/A	N/A	N/A	N/A	N/A	N/A	$3,000	$1,042	$3,000	$1,875	$3,500	$2,188	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A
	18	Area Q	yes	3.3	- pond/wetland/infiltration	N/A	N/A	N/A	N/A	N/A	N/A	$3,000	$1,339	$3,000	$3,125	$3,500	$3,646	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A
	19	Area Q	yes	3.2	- pond/wetland/infiltration	N/A	N/A	N/A	N/A	N/A	N/A	$3,000	$1,339	$3,000	$3,125	$3,500	$3,646	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A
	20	Area Q	yes	3.0	- pond/wetland/infiltration	N/A	N/A	N/A	N/A	N/A	N/A	$3,000	$1,339	$3,000	$3,125	$3,500	$3,646	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A
	21	Area Q	yes	1.5	- pond/wetland/infiltration	N/A	N/A	N/A	N/A	N/A	N/A	$3,000	$1,339	$3,000	$3,125	$3,500	$3,646	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A
D) Roof Leader Disconnection	Testa area	Area M	yes	24.2	- enhanced infiltration	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	$2,066	$5,380	N/A	N/A	N/A	N/A
E) i) Open Ditch Enhancement	various	various	yes	77	- enhanced infiltration	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	-$173	-$542	N/A	N/A
ii) Exfiltration System	various	various	yes	77	-exfiltration system	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	$2,134	$953
F) OGS/Filters	B,F,G,I	B,F,G,I	no	56.9	-OGS/filter installation	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	$5,584	$4,362	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A
						Min ($/kg)	$3,750	Min ($/kg)	$796	Min ($/kg)	$3,021	Min ($/kg)	$1,042	Min ($/kg)	$1,873	Min ($/kg)	$2,185	Min ($/kg)	$3,173	Min ($/kg)	$6,193	Min ($/kg)	$5,380	Min ($/kg)	-$542	Min ($/kg)	$953
						Max ($/kg)	$3,750	Max ($/kg)	$1,419	Max ($/kg)	$3,021	Max ($/kg)	$1,339	Max ($/kg)	$3,125	Max ($/kg)	$4,861	Max ($/kg)	$4,362	Max ($/kg)	$6,193	Max ($/kg)	$5,380	Max ($/kg)	-$542	Max ($/kg)	$953

Notes:
LE - Life Expectancy in years (not to exceed 40 years for this evaluation as the analysis is based over a 40 year period)
(1) Area 8 and 9 are the same drainage areas with 2 possible pond locations
(2) Add sediment forebay and/or baffles
(3) Sediment Forebay assumed to be 20% of the permanent pool volume required (preferred by MOE) with a 5% increase in removal efficiency.
(4) Assumes an average home frontage of 20 m and average lot size of 0.08 ha.
(5) Assumes the pond is shallow enough for armourstone baffles (approximately 100 m required)
(6) Assumes curthain baffles are required (160 m) due to the depth of the pond.
(7) Assumes 30% removal efficiency from filtration ponds.
(8) Testa area contains 256 lots requiring roof leader disconnection at $200 per lot.
(9) Armour stone baffles life expectancy = 40 years; baffle curtain life expectancy = 15 years

TABLE 3.4.4

TOTAL PRESENT VALUE COSTS
POTENTIAL SWM RETROFITS
TOWNSHIP OF UXBRIDGE

Total Present Value Costs

Category	Location #	Corresponding Area (LSRCA)	Treatment Area Overlap	Drainage Area (ha)	SWM Upgrade Potential	Sediment Forebay (5% eff) LE = 40 ($/ha)	Sediment (3) Forebay (5% eff) LE = 40 Forebay ($/kg)	Baffles (25% eff) LE = 40/15 (9) ($/m)	Baffles (25% eff) LE = 40/15 (9) ($/kg)	Filtration Pond (30% eff) LE =40 ($/ha)	Filtration Pond (7) (30% eff) LE =40 ($/kg)	Infiltration Pond (90% eff) LE = 40 ($/ha)	Infiltration Pond (90% eff) LE = 40 ($/kg)	Wet Pond (various) LE =40 ($/ha)	Wet Pond (various) LE =40 ($/kg)	Wetland (various) LE =40 ($/ha)	Wetland (various) LE =40 ($/kg)	OGS (40% eff) LE =40 ($/ha)	OGS (40% eff) LE =40 ($/kg)	Filter (50% eff) LE =40 ($/ha)	Filter (50% eff) LE =40 ($/kg)	Roof Dis. (8) (20% eff) LE =40 ($/ha)	Roof Dis. (20% eff) LE =40 ($/kg)	Open Ditch (10% eff) LE =40 ($/ha) (4)	Open Ditch (10% eff) LE =40 ($/kg)	Exfiltration System (90% eff) LE = 40 ($/ha)	Exfiltration System (90% eff) LE = 40 ($/kg)
A) Existing Identified Pond Retrofits Locations																											
	1	Area M	yes	31.4	- add sand filter or wetland (2)	$1,657	$10,354	$202 (5)	$804	$8,243	$8,586	N/A	N/A	N/A	N/A	$8,783	$6,862	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A
	2	Area L	no	85.8	- add sand filter or wetland (2)	N/A	N/A	$611 (6)	$1,424	$8,243	$8,586	N/A	N/A	N/A	N/A	$8,783	$6,862	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A
	3	Area N	no	85	- add sand filter or wetland (2)	$1,657	$10,354	N/A	N/A	$8,243	$8,586	N/A	N/A	N/A	N/A	$8,783	$6,862	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A
	4	Area R	no	16.2	- no upgrade potential	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A
	5	Area S	no	10.57	- expansion	$1,657	$10,354	N/A	N/A	$8,243	$8,586	N/A	N/A	$8,283	$8,628	$8,783	$9,149	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A
	6	Area O	no	31.1	- no upgrade potential	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A
	7	Area A	no	11.9	- new pond (redeveloped area)	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	$8,283	$5,177	$8,783	$5,489	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A
B) LSRCA Identified Retrofit/New Locations																											
	8	Area B	no	10.4	- possible pond	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	$8,283	$5,177	$8,783	$5,489	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A
	9	Area B or O (1)	no	10.4	- possible pond	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	$8,283	$5,172	$8,783	$5,484	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A
	10	Area B	no	1.5	- enhance/formalize wetland	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	$8,783	$9,149	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A
	11	Area F	no	1.4	- OG separator	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	$12,250	$6,960	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A
	12	Area G	no	1.5	- OG on east side	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	$12,250	$9,570	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A
	13	Area G	no	5.7	- filter on west side	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	$9,386	$6,518	N/A	N/A	N/A	N/A	N/A	N/A
C) New Areas Identified for SWM																											
	14	Area U	no	4.5	- enhance/formalize wetland	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	$8,783	$6,654	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A
	15	Area E	no	18.7	-pond already approved	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	$8,783	$9,149	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A
	16	Area C/D	no	0.5	- enhance/formalize wetland	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	$8,783	$12,199	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A
	17	Area T	no	1.0	- wetland/infiltration	N/A	N/A	N/A	N/A	N/A	N/A	$8,343	$2,897	$8,283	$5,177	$8,783	$5,489	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A
	18	Area Q	yes	3.3	- pond/wetland/infiltration	N/A	N/A	N/A	N/A	N/A	N/A	$8,343	$3,724	$8,283	$8,628	$8,783	$9,149	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A
	19	Area Q	yes	3.2	- pond/wetland/infiltration	N/A	N/A	N/A	N/A	N/A	N/A	$8,343	$3,724	$8,283	$8,628	$8,783	$9,149	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A
	20	Area Q	yes	3.0	- pond/wetland/infiltration	N/A	N/A	N/A	N/A	N/A	N/A	$8,343	$3,724	$8,283	$8,628	$8,783	$9,149	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A
	21	Area Q	yes	1.5	- pond/wetland/infiltration	N/A	N/A	N/A	N/A	N/A	N/A	$8,343	$3,724	$8,283	$8,628	$8,783	$9,149	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A
D) Roof Leader Disconnection	Testa area	Area M	yes	24.2	- enhanced infiltration	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	$2,066	$5,380	N/A	N/A	N/A	N/A
E) i) Open Ditch Enhancement	various	various	yes	77	- enhanced infiltration	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	$394	$1,231	N/A	N/A
ii) Exfiltration System	various	various	yes	77	- exfiltration system	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	$2,341	$1,045
F) Stormceptors	B,F,G,I	B,F,G,I	no	56.9	-stormceptor installation	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	$12,250	$9,570	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A
Notes:						Min. $/kg	$10,354	Min. $/kg	$804	Min. $/kg	$8,586			Min. $/kg	$5,172	Min. $/kg	$5,484	Min. $/kg	$6,960	Min. $/kg	$6,518	Min. $/kg	$5,380	Min. $/kg	$1,231	Min. $/kg	$1,045
LE - Life Expectancy in years (not to exceed 40 years for this evaluation as the analysis is based over a 40 year period)						Max. $/kg	$10,354	Max. $/kg	$1,424	Max. $/kg	$8,586			Max. $/kg	$8,628	Max. $/kg	$12,199	Max. $/kg	$9,570	Max. $/kg	$6,518	Max. $/kg	$5,380	Max. $/kg	$1,231	Max. $/kg	$1,045

(1) Area 8 and 9 are the same drainage areas with 2 possible pond locations
(2) Add sediment forebay and/or baffles
(3) Sediment Forebay assumed to be 20% of the permanent pool volume required (preferred by MOE) with a 5% increase in removal efficiency.
(4) Assumes an average home frontage of 20 m and average lot size of 0.08 ha.
(5) Assumes the pond is shallow enough for armourstone baffles (approximately 100 m required)
(6) Assumes curthain baffles are required (160 m) due to the depth of the pond.
(7) Assumes 30% removal efficiency from filtration ponds.
(8) Testa area contains 256 lots requiring roof leader disconnection at $200 per lot.
(9) Armour stone baffles life expectancy = 40 years; baffle curtain life expectancy = 15 years

TABLE 3.4.5
CAPTIAL COST RANKING WITH ALL OPTIONS
TOWNSHIP OF UXBRIDGE

Location #	Corresponding Area (LSRCA)	P Loading (kg/year)	Potential P Removed (kg/yr)	$/kg	SWM Type
1	Area M	100.5	25.1	$796	Baffles
various	various	246.4	221.8	$919	Exfiltration System
2	Area L	274.6	68.7	$970	Baffles
17	Area T	3.3	3.0	$1,042	Infiltration Pond
18	Area Q	10.5	9.5	$1,339	Infiltration Pond
19	Area Q	10.4	9.4	$1,339	Infiltration Pond
20	Area Q	9.5	8.6	$1,339	Infiltration Pond
21	Area Q	4.7	4.2	$1,339	Infiltration Pond
9	Area B or O (1)	NA	NA	$1,873	Wet Pond
7	Area A	38.1	19.1	$1,875	Wet Pond
8	Area B	33.4	16.7	$1,875	Wet Pond
17	Area T	3.3	1.7	$1,875	Wet Pond
9	Area B or O (1)	NA	NA	$2,185	Wetland
7	Area A	38.1	19.1	$2,188	Wetland
8	Area B	33.4	16.7	$2,188	Wetland
17	Area T	3.3	1.7	$2,188	Wetland
14	Area U	19.8	5.9	$2,652	Wetland
1	Area M	100.5	40.2	$2,734	Wetland
5	Area S	33.8	10.1	$3,021	Filration Pond
1	Area M	100.5	30.2	$3,021	Filration Pond
2	Area L	274.6	82.4	$3,021	Filration Pond
3	Area N	272.0	81.6	$3,021	Filration Pond
5	Area S	33.8	10.1	$3,125	Wet Pond
18	Area Q	10.5	3.2	$3,125	Wet Pond
19	Area Q	10.4	3.1	$3,125	Wet Pond
20	Area Q	9.5	2.9	$3,125	Wet Pond
21	Area Q	4.7	1.4	$3,125	Wet Pond
11	Area F	6.3	2.5	$3,136	OGS
5	Area S	33.8	10.1	$3,646	Wetland
10	Area B	4.9	1.5	$3,646	Wetland
18	Area Q	10.5	3.2	$3,646	Wetland
19	Area Q	10.4	3.1	$3,646	Wetland
2	Area L	274.6	82.4	$3,646	Wetland
3	Area N	272.0	81.6	$3,646	Wetland
15	Area E	59.9	18.0	$3,646	Wetland
20	Area Q	9.5	2.9	$3,646	Wetland
21	Area Q	4.7	1.4	$3,646	Wetland
1	Area M	100.5	5.0	$3,750	Sediment Forebay
3	Area N	272.0	13.6	$3,750	Sediment Forebay
5	Area S	33.8	1.7	$3,750	Sediment Forebay
12	Area G	4.9	2.0	$4,313	OGS
B,F,G,I	B,F,G,I	182.1	72.8	$4,313	OGS
16	Area C/D	1.2	0.4	$4,861	Wetland
various	various	246.4	24.6	$5,156	Open Ditch Enhancement
Testa area	Area M	77.3	15.5	$5,380	Roof Leader Diss,.
13	Area G	5.7	2.9	$5,543	Filter System

TABLE 3.4.6
PRESENT VALUE COST RANKING WITH ALL OPTIONS
TOWNSHIP OF UXBRIDGE

Location #	Corresponding Area (LSRCA)	P Loading (kg/year)	Potential P Removed (kg/yr)	$/kg	SWM Type
1	Area M	100.5	25.1	$804	Baffles
various	various	246.4	221.8	$1,045	Exfiltration System
various	various	246.4	24.6	$1,231	Open Ditch Enhancement
2	Area L	274.6	68.7	$1,424	Baffles
17	Area T	3.3	3.0	$2,897	Infiltration Pond
18	Area Q	10.5	9.5	$3,724	Infiltration Pond
19	Area Q	10.4	9.4	$3,724	Infiltration Pond
20	Area Q	9.5	8.6	$3,724	Infiltration Pond
21	Area Q	4.7	4.2	$3,724	Infiltration Pond
9	Area B or O (1)	NA	NA	$5,172	Wet Pond
7	Area A	38.1	19.1	$5,177	Wet Pond
8	Area B	33.4	16.7	$5,177	Wet Pond
17	Area T	3.3	1.7	$5,177	Wet Pond
Testa area	Area M	77.3	15.5	$5,380	Roof Leader Disconnection
9	Area B or O (1)	NA	NA	$5,484	Wetland
7	Area A	38.1	19.1	$5,489	Wetland
8	Area B	33.4	16.7	$5,489	Wetland
17	Area T	3.3	1.7	$5,489	Wetland
13	Area G	5.7	2.9	$6,518	Filter System
14	Area U	19.8	5.9	$6,654	Wetland
1	Area M	100.5	40.2	$6,862	Wetland
2	Area L	274.6	82.4	$6,862	Wetland
3	Area N	272.0	81.6	$6,862	Wetland
11	Area F	6.3	2.5	$6,960	OGS
5	Area S	33.8	10.1	$8,586	Filtration Pond
1	Area M	100.5	30.2	$8,586	Filtration Pond
2	Area L	274.6	82.4	$8,586	Filtration Pond
3	Area N	272.0	81.6	$8,586	Filtration Pond
5	Area S	33.8	10.1	$8,628	Wet Pond
18	Area Q	10.5	3.2	$8,628	Wet Pond
19	Area Q	10.4	3.1	$8,628	Wet Pond
20	Area Q	9.5	2.9	$8,628	Wet Pond
21	Area Q	4.7	1.4	$8,628	Wet Pond
5	Area S	33.8	10.1	$9,149	Wetland
10	Area B	4.9	1.5	$9,149	Wetland
15	Area E	59.9	18.0	$9,149	Wetland
18	Area Q	10.5	3.2	$9,149	Wetland
19	Area Q	10.4	3.1	$9,149	Wetland
20	Area Q	9.5	2.9	$9,149	Wetland
21	Area Q	4.7	1.4	$9,149	Wetland
12	Area G	4.9	2.0	$9,570	OGS
B,F,G,I	B,F,G,I	182.1	72.8	$9,570	OGS
1	Area M	100.5	5.0	$10,354	Sediment Forebay
5	Area S	33.8	1.7	$10,354	Sediment Forebay
3	Area N	272.0	13.6	$10,354	Sediment Forebay
16	Area C/D	1.2	0.4	$12,199	Wetland

TABLE 3.4.7

LOCATION RANKING BY ESTIMATED CAPITAL COSTS WITHOUT DUPLICATIONS
UXBRIDGE TOWNSHIP SWM STUDY
UXBRIDGE, ONTARIO

Location #	Corresponding LSRCA Area	Est. $/kg P. Removed	P Removed (kg)	Cumulative P Removed (kg)	Estimated Capital Cost	Cumulative Capital Cost	SWM Type	
1	Area M	$796	12.55	12.55	$9,990	$9,990	Stone Baffles	
2	Area L	$970	34.33	46.88	$33,300	$43,290	Baffle Curtains	
17	Area T	$1,042	2.97	49.85	$3,094	$46,384	Infiltration Pond	
19	Area Q	$1,339	7.56	57.41	$10,123	$56,506	Infiltration Pond	
20	Area Q	$1,339	7.02	64.43	$9,400	$65,906	Infiltration Pond	
18	Area Q	$1,339	7.65	72.08	$10,243	$76,150	Infiltration Pond	
21	Area Q	$1,339	3.42	75.5	$4,579	$80,729	Infiltration Pond	
9	Area B	$1,873	16.7	92.2	$31,279	$112,008	Wet Pond	
7	Area A	$1,875	19.05	111.25	$35,719	$147,727	New Pond	
14	Area U	$2,652	5.94	117.19	$15,753	$163,480	Wetland	
5	Area S	$3,021	6.99	124.18	$21,117	$184,597	Wet Pond Ex.	← Target = 122 kg(1)
11	Area F	$3,136	2.52	126.7	$7,903	$192,499	OGS	
10	Area B	$3,646	54.4	181.1	$198,342	$390,842	Wetland	
3	Area N	$3,646	0.75	181.85	$2,735	$393,576	Wetland	
15	Area E	$3,646	8.97	190.82	$32,705	$426,281	Wetland	
12	Area G	$4,313	1.96	192.78	$8,453	$434,734	OGS	
B,F,G,I	B,F,G,I	$4,313	72.84	265.62	$314,159	$748,893	OGS	
16	Area C/D	$4,861	0.4	266.02	$1,944	$750,838	Wetland	
various	various	$5,156	20.2	286.22	$104,151	$854,989	Open Ditch	
Testa Area	Area M	$5,380	9.3	295.52	$50,034	$905,023	Roof Dis.	
13	Area G	$5,543	8.2	303.72	$45,453	$950,475	Filter	
various	various	$919	140.14	- -	$128,789	- -	Exfiltration	

Notes:
(1) - Exfiltration phosphorous removal totals have not been considered in achieving the target as this method should be implemented on a opportunity basis. As roads are being reconstructed, exfiltration should be considered. However, it is not cost effective to intall exfiltration systems when road reconstruction is not occuring.

TABLE 3.4.8

LOCATION RANKING BY ESTIMATED TOTAL PRESENT VALUE COSTS WITHOUT DUPLICATIONS
UXBRIDGE TOWNSHIP SWM STUDY
UXBRIDGE, ONTARIO

Location #	Corresponding LSRCA Area	Est. $/kg Removed	P Removed (kg)	Cumulative P Removed (kg)	Estimated PV Cost	Cumulative PV Cost	SWM Type	
1	Area M	$804	12.55	12.55	$10,090	$10,090	Stone Baffles	
various	various	$1,231	20.2	32.75	$24,866	$34,956	Open Ditch	
2	Area L	$1,424	34.33	67.08	$48,886	$83,842	Baffle Curtains	
17	Area T	$2,897	2.97	70.05	$8,603	$92,446	Infiltration Pond	
19	Area Q	$3,724	7.56	77.61	$28,153	$120,599	Infiltration Pond	
20	Area Q	$3,724	7.02	84.63	$26,142	$146,742	Infiltration Pond	
18	Area Q	$3,724	7.65	92.28	$28,489	$175,230	Infiltration Pond	
21	Area Q	$3,724	3.42	95.7	$12,736	$187,966	Infiltration Pond	
9	Area B	$5,172	16.7	112.4	$86,372	$274,339	Wet Pond	
7	Area A	$5,177	19.05	131.45	$98,622	$372,961	Wet Pond	← Target= 122 kg (1)
Testa Area	Area M	$5,830	9.3	140.75	$54,219	$427,180	Roof Dis.	
13	Area G	$6,518	8.2	148.95	$53,448	$480,627	Filter	
14	Area U	$6,654	5.94	154.89	$39,525	$520,152	Wetland	
3	Area N	$6,862	54.4	209.29	$373,293	$893,445	Wetland	
11	Area F	$6,960	2.52	211.81	$17,539	$910,984	OGS	
5	Area S	$8,586	6.99	218.8	$60,016	$971,000	Ex. Wetpond	
10	Area B	$9,149	0.75	219.55	$6,862	$977,862	Wetland	
15	Area E	$9,149	8.97	228.52	$82,067	$1,059,928	Wetland	
12	Area G	$9,570	1.96	230.48	$18,757	$1,078,686	OGS	
B,F,G,I	B,F,G,I	$9,570	72.84	303.32	$697,079	$1,775,764	OGS	
16	Area C/D	$12,199	0.4	303.72	$4,880	$1,780,644	Wetland	
various	various	$1,045	140.14	--	$146,446	--	Exfiltration	

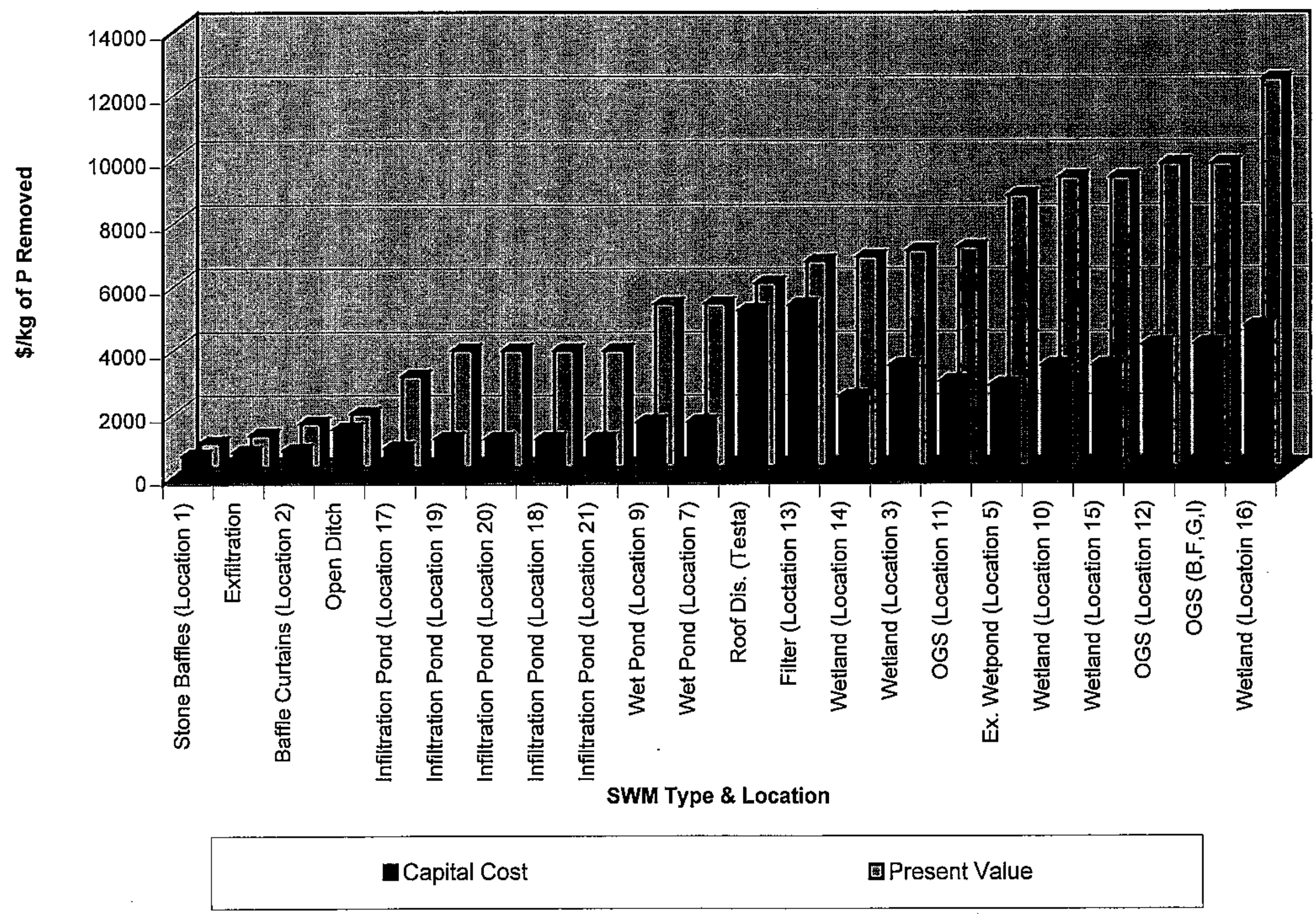
Notes:
(1) - Exfiltration phosphorous removal totals have not been considered in achieving the target as this method should be implemented on a opportunity basis. As roads are being reconstructed, exfiltration should be considered. However, it is not cost effective to intall exfiltration systems when road reconstruction is not occuring.

Implementation of roof leader disconnection is the last option making the 132 kg cutoff for the total present value evaluation. This option was not ranked highly in the capital cost evaluation. Implementation of this option could only occur in the Testa Subdivision (LSRCA Area M) and could potentially remove an additional 9.3 kg of phosphorous each year. It should be noted that adding stone baffles to the existing Testa SWM pond could already increase the removal of phosphorous in LSRCA Area M by 12.55 kg. Therefore, implementation of this option may not be feasible.

In both capital cost and present worth scenarios, oil/grit separators rank below the 132 kg cutoff with the exception of location 11 in the capital cost evaluation. It should be noted that should this option be required at anytime, small drainage areas, which comprise areas B, F, G and I can be separately serviced by oil/grit separators in the road right-of-ways.

The capital and total present value costs in units of dollars/kg of phosphorous removed for each measure are illustrated in Figure 3.4.1.

Figure 3.4.1: Capital and Present Value Cost Comparison



3.5 Recommended Approach

For existing areas, the target of 122 kg/yr of total phosphorous can be achieved by completing control measures at the first 10 locations shown on **Table 3.4.8.** Since total life cycle costs are the most relevant in making public expenditures, the present value of all capital and operating costs is the preferred basis for making decisions. However, in the implementation phase, additional factors will have to be taken into account. **Table 3.5.1** identifies the factors that apply to each area.

Factors to consider include:

- **Stream Sensitivity**

The immediate area that the measure will affect to must be considered. Since all stream reaches are considered equally sensitive, this must be reviewed for each site. Methods of stormwater management that could potentially block fish passage with in-line ponds, and that have the potential to increase stream temperatures have been avoided in the selection process and should be avoided in future SWM measure considerations.

- **Groundwater Vulnerability**

Areas in the most vulnerable southern portion of the town should not consider infiltration of road drainage unless pretreatment is provided and only residential drainage is considered. Vulnerable areas have been determined through the Uxbridge Brook Watershed Plan Hydrogeology Study prepared by C.C. Tatham & Associates Ltd. The upper aquifers within the watershed should be protected as they serve as the mian urban/rural water supply source. As a result of the groundwater vulnerability line, some sites may not be appropriate for infiltration practices, particularly if there is spill potential associated with the land use practices.

- **Appropriate Soils**

Infiltration proposal such the infiltration ponds and exfiltration systems can only be applied where soils are permeable i.e. gravel, sand or sandy loam.

- **Land Ownership**

No land costs have been incorporated in the analysis. If land for ponds or other SWM measures is not in public ownership, then it may be appropriate to consider these costs. In this case, measures requiring land purchase will have increased capital and total costs and this will change their location on the ranking and may not make the cut off.

- **Opportunity**

Road or drainage systems reconstruction presents an opportunity to introduce enhanced roadside ditches, exfiltration systems, oil grit separators or filters. These opportunities must be taken when presented, since they significantly reduce costs for those measures that are constructed in the road right-of-way. If there are no plans to upgrade some of the roadways in the 10 year time frame identified in the study, then the tables should be revised and new measures considered.

Figures 3.5.1 and **3.5.2** present cumulative P removed versus capital cost and total present value costs. Everything below the target cut off should be implemented. **Table 3.5.2** presents the Implementation List. Four additional measures have been included as a contingency, since it is likely that not all of the measures on the implementation list will be implemented after consideration of the factors discussed above. It should be noted that phosphorous removal for exfiltration systems has not been considered in achieving a target as implementation of this measure should be completed on an opportunity basis. The target line will move upwards as this measure is implemented.

TABLE 3.5.1

POTENTIAL SWM RETROFITS AND ASSOCIATED LIMITING FACTORS
TOWNSHIP OF UXBRIDGE

Category	Location #	Corresponding Area (LSRCA)	Drainage Area (ha)	SWM Upgrade Potential	FACTOR: Stream Sensitivity	Groundwater Vulnerability	Appropriate Soils	Land Ownership	Opportunity
A) Existing Identified Pond Retrofits Locations									
	1	Area M	31.4	- add sand filter or wetland (2)	X				
	2	Area L	85.8	- add sand filter or wetland (2)	X				
	3	Area N	85	- add sand filter or wetland (2)	X				
	4	Area R	16.2	- no upgrade potential	X				
	5	Area S	10.57	- expansion	X				
	6	Area O	31.1	- no upgrade potential	X				
	7	Area A	11.9	- new pond (redeveloped area)	X				
B) LSRCA Identified Retrofit/New Locations									
	8	Area B	10.4	- possible pond	X			X	
	9	Area B or O (1)	10.4	- possible pond	X			X	
	10	Area B	1.5	- enhance/formalize wetland	X			X	
	11	Area F	1.4	- OG separator	X				
	12	Area G	1.5	- OG on east side	X				
	13	Area G	5.7	- filter on west side	X				
C) New Areas Identified for SWM									
	14	Area U	4.5	- enhance/formalize wetland	X			X	
	15	Area E	18.7	-pond already approved	X				
	16	Area C/D	0.5	- enhance/formalize wetland	X			X	
	17	Area T	1.0	- wetland/infiltration	X	X	X	X	
	18	Area Q	3.3	- pond/wetland/infiltration	X	X	X	X	
	19	Area Q	3.2	- pond/wetland/infiltration	X	X	X	X	
	20	Area Q	3.0	- pond/wetland/infiltration	X	X	X	X	
	21	Area Q	1.5	- pond/wetland/infiltration	X	X	X	X	
D) Roof Leader Disconnection	Testa area	Area M	24.2	- enhanced infiltration	X			X	X
E) i) Open Ditch Enhancement	various	various	77	- enhanced infiltration	X				X
(ii) Exfiltration System	various	various	77	- exfiltration addition	X	X	X		X
F) OGS/Filter	B,F,G,I	B,F,G,I	56.9	-OGS/filter installation	X				X
G) Undevloped Areas	various	various	120.7	- pond/wetland	X				X

Notes:
X - denotes locations where designated factor may be relevant
(1) Area 8 and 9 are the same drainage areas with 2 possible pond locations
(2) Add sediment forebay and/or baffles

TABLE 3.5.2

IMPLEMENTATION SITES
UXBRIDGE TOWNSHIP SWM STUDY
UXBRIDGE, ONTARIO

Location #	Corresponding LSRCA Area	P Removed (kg)	Cumulative P Removed (kg)	Est. Capital Cost	Cumulative Capital Cost	SWM Type
Implementation Sites						
1	Area M	12.55	12.55	$9,990	$9,990	Stone Baffles
various	various	20.2	32.75	$104,151	$114,141	Open Ditch
2	Area L	34.33	67.08	$33,300	$147,441	Baffle Curtains
17	Area T	2.97	70.05	$3,094	$150,535	Infiltration Pond
19	Area Q	7.56	77.61	$10,123	$160,658	Infiltration Pond
20	Area Q	7.02	84.63	$9,400	$170,057	Infiltration Pond
18	Area Q	7.65	92.28	$10,243	$180,301	Infiltration Pond
21	Area Q	3.42	95.7	$4,579	$184,880	Infiltration Pond
9	Area B	16.7	112.4	$31,279	$216,159	Wet Pond
7	Area A	19.05	131.45	$35,719	$251,878	Wet Pond
Contingent Implementation Sites			**TARGET = 122**			
Testa Area	Area M	9.3	140.75	$50,034	$301,912	Roof Dis.
13	Area G	8.2	148.95	$45,453	$347,365	Filter
14	Area U	5.94	154.89	$2,652	$304,564	Wetland
3	Area N	54.4	209.29	$3,646	$351,011	Wetland
various	various	140.14	- -	$128,789	- -	Exfiltration (1)

Note:
- Ranking based on Present Value cost however, costs presented in this Table are Capital Costs.
(1) - Exfiltration phosphorous removal totals have not been considered in achieving the target as this method should be implemented on a opportunity basis. As roads are being reconstructed, exfiltration should be considered. However, it is not cost effective to intall exfiltration systems when road reconstruction is not occuring.

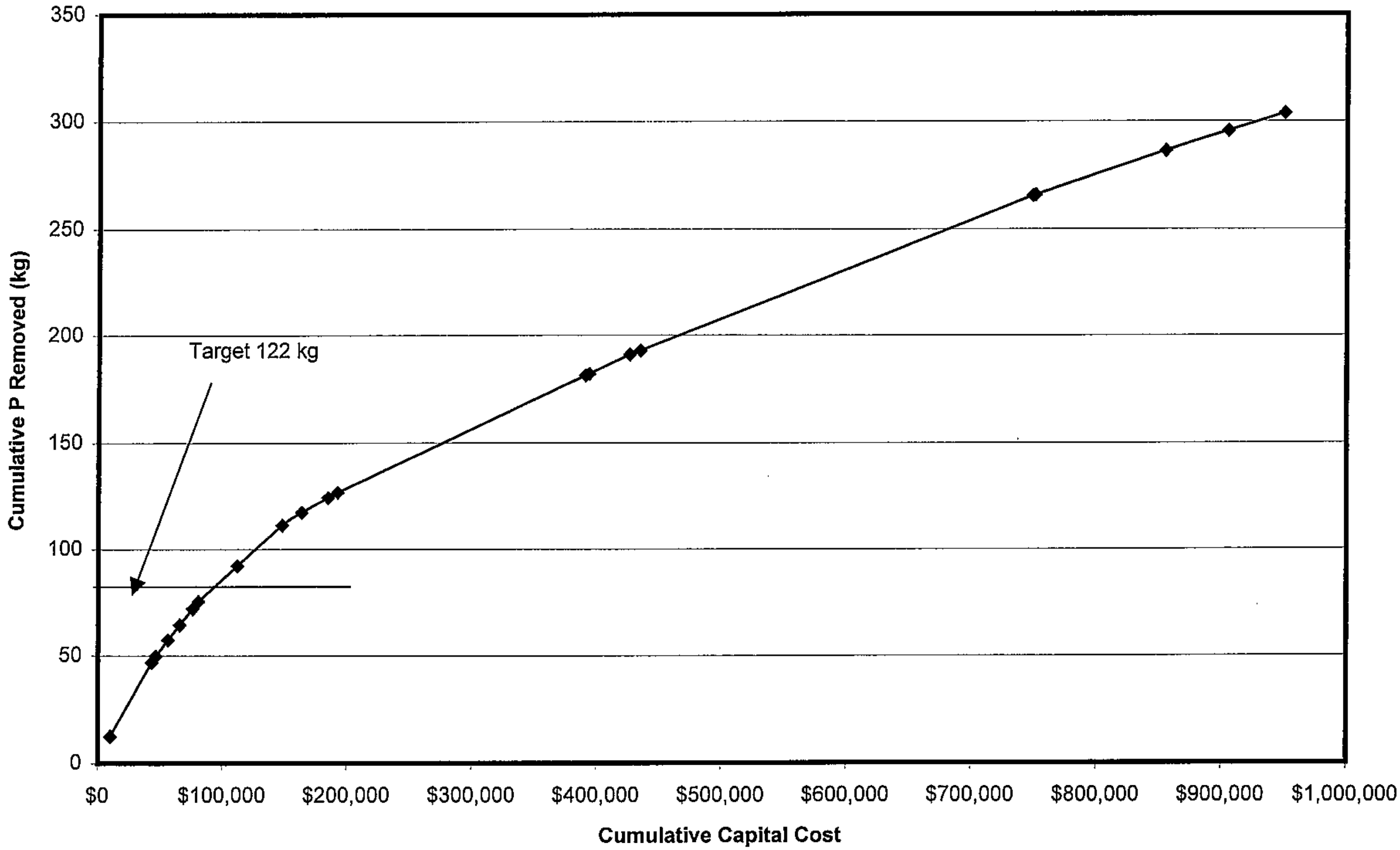


Figure 3.5.1 - Cumulative Capital Cost vs. Cumulative Phoshorous Removed

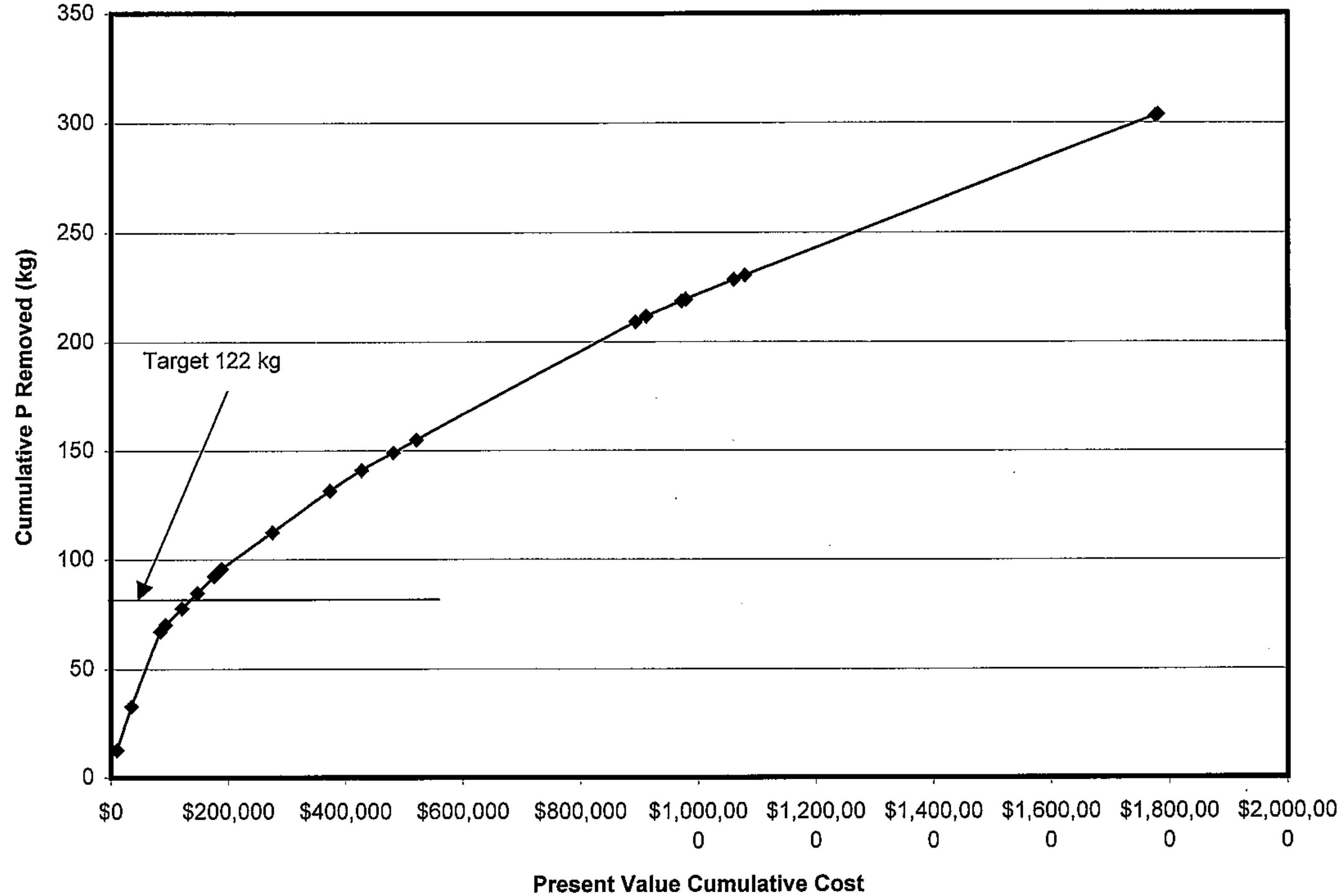


Figure 3.5.2: Cumulative Present Value Cost vs. Cumulative Phosphorous Removed

4.0 FUTURE DEVELOPMENT

4.1 Introduction

The assessment of the existing SWM facilities in Uxbridge determined that the effectiveness in removing phosphorous from urban area runoff is somewhat limited. Measures are available to improve their efficiency and are outlined in the preceding sections (see Section 3.3). This included works such as: adding sediment forebays, adding baffle systems to increase the flow path length, adding filtration or infiltration systems to remove phosphorous, and providing wetlands for the biological removal of phosphorous.

Water quality control requirements, in Ontario are typically established through subwatershed studies or, when not available, through the current MOE Guidelines. Targets vary based upon the sensitivity of the receiving stream. In the case of Uxbridge Brook, the majority of the stream is a cold water habitat. Nutrient loadings have been recognized as a problem and in particular, phosphorous is one of the water quality parameters that have been targeted for control.

Cold water fishery streams generally require Level 1 water quality control based upon the current MOE guidelines (1994). More recent guidelines are available but have not yet been adopted for use. The level of control for fishery protection in the proposed MOE document follows a similar approach.

Development opportunities are reviewed to examine the extent of new development and potential SWM facilities. Control targets are then investigated to identify what is required to provide protection to Uxbridge Brook and an approach recommended.

4.2 Development Opportunities

Future development areas within the urban area of Uxbridge have been identified and are outlined in the current Official Plan. Only one of these development areas was considered in the Uxbridge Brook Watershed Plan (UBWP) when analyzing the potential impact of future development. The future development areas are mostly located on the outside fringes of the urban area as illustrated in **Figure 4.2.1.** Future development is comprised of residential with some potential for commercial uses (south-east portion). As illustrated in **Figure 4.2.1,** the sole area slated for development that overlaps with an LSRCA area is located in LSRCA Area K. This new development is 34.2 ha in size. In total, approximately 121 ha are slated for future development.

Although the future development areas drain to Uxbridge Brook they are serviced by a number of distinct subcatchments. There are opportunities to provide centralized SWM facilities, however separate facilities would be required in each subcatchment

4.3 Control Targets

The need for water quality protection within the Uxbridge Brook Watershed has been identified in the Uxbridge Brook Watershed Plan. The water quality objectives are based upon the need to protect water quality within Uxbridge Brook and Lake Simcoe for aesthetics, health and fisheries protection. Specific targets for runoff have not been set however the overall target is to meet Provincial Water Quality targets for in-stream water. The targets are summarized as follows:

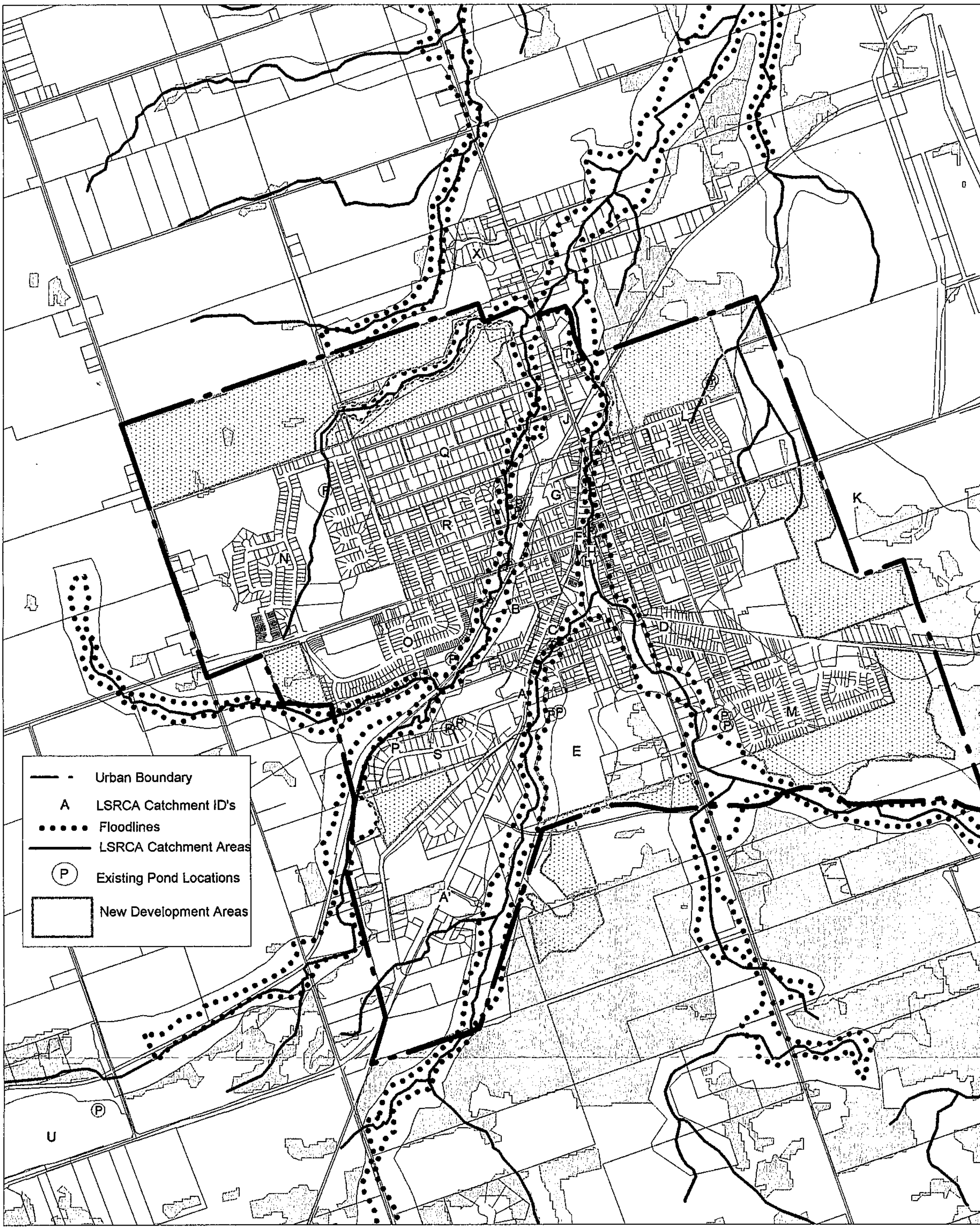


Figure 4.2.1: Future Development Areas Illustrating Subcatchment Boundaries

Scale 1:12,500

Management Issues	Resource Target
Water Quality	To protect ground and surface water which currently meet the Ministry of Environment and Energy Provincial Water Quality Objectives (PWQOs) and Ontario Drinking Water Objectives (ODWOs). To enhance ground and surface waters which do not meet objectives to at least meet these objectives recognizing that in certain areas exceptional water may require more stringent criteria. Furthermore, in some situations natural conditions may make attaining this goal undesirable.
Water Quantity	To protect and maintain the existing flow regime both in terms of peak flows and flow volume and enhance these functions where they have been degraded wherever possible.
Aquatic Habitat	To maintain and where possible improve aquatic habitat of Uxbridge Brook to ensure the continued and improved health of the aquatic ecosystem.
Terrestrial Habitat	Project and enhance existing terrestrial habitat within the watershed including forests, wetlands, meadows, wildlife corridors and feeding grounds. Rehabilitate degraded habitat wherever possible.
Recreational and Aesthetic Amenities	Provide environmentally sound recreational opportunities.

Generally, phosphorous loadings in stormwater runoff increase significantly with urbanization. The modelling for Uxbridge Brook in the UBWP show that the average phosphorous for the watershed is approximately 0.3kg/ha/yr. The loadings for the Uxbridge urban area, however range from 1.6 to 4.4 kg/ha/yr. with the lower loading rates accounted for by the use of SWM measures including ponds. This level of efficiency would require the use of multiple methods (ie. treatment train) or high level measures such as infiltration or sand filter systems. The efficiency of various methods is discussed in Section 3.2.

With the background of 0.3 kg/ha/yr and an assumed uncontrolled load of 3.2 kg/ha/yr, a control target of 90% reduction would be in line with the overall goal of no net increase in loading with urbanization. Although a specific target is not provided in the UBWP it appears that a high level of treatment is necessary to meet the objectives for Uxbridge Brook (ie. approximately 90%). The level of phosphorous removal is expected to be about 50% for wet ponds, and somewhat higher for infiltration systems and wetland/wetpond combination.

It should be emphasized that a treatment train of measures is required to achieve the 90% target. It is likely achievable only if infiltration (or exfiltration) measures are included in the train.

4.4 Design Technology and Approach

In order to provide the high level of treatment being recommended for future development (ie. 90%) facilities are required which provide combinations of high settlement rates, infiltration, filtration or biological systems. The available facilities and their function are discussed in Section 3.2 and summarized as follows:

- Wetpond/Wetlands with sediment forebays (60%)
  - provides sediment removal initially to prevent "filling in" of the wetland and some phosphorous removal
  - wetland system provides biological treatment for phosphorous uptake
  - design according to MOE guidelines is required for effectiveness (ie. extended detention)

  - a combined wetpond and wetland are needed to achieve higher treatment levels (i.e. 80%)

- Sand filter system (combined with sediment removal) (80%)
  - filter system can be designed to provide high levels of phosphorous removal
  - can be designed as an underdrain in a pond or a "tank" system
  - sediment removal is required as pretreatment to prevent "blockage" of the filter
  - storage should be included possibly as part of the pretreatment, to reduce the flow rate to the filter component

- Exfiltration system (90%)
  - consists of a dual pipe underground that exfiltrates water to the groundwater system
  - this is primarily a retrofit device as a result of the high cost

- Infiltration (80 – 90%)
  - infiltration of runoff to the groundwater system directly reduces phosphorous based upon the level of infiltration. If all runoff is trapped for infiltration, 100% removal will be obtained
  - this approach is limited based upon the susceptibility of groundwater to contamination

- Combined measures (0 – 90%)
  - a series of measures can be applied to increase the overall efficiency. Wet ponds (in the extended detention) can be applied with grassed swales, and sediment forebays to provide a high level of treatment. To reach 90% phosphorous removal, infiltration measures must be applied.

Any of the measures outlined can be applied to new development areas in Uxbridge, however some limitations exist.

Infiltration facilities can be provided in some areas of Uxbridge, however infiltration of 80 to 90% of the total rainfall is required in order to meet phosphorous removal requirements. Approximately 10 mm of runoff infiltration would be necessary to achieve over 80% removal. Infiltration is also limited by contamination susceptibility (ie. of groundwater supplies). The susceptibility has been investigated in a past report (Uxbridge Brook Watershed Plan Hydrogeology Study, C.C. Tatham & Associates Ltd., 1996) resulting in susceptible areas identified on **Figure 4.4.1.** Only areas in the northern portion of the Town above the groundwater vulnerability line are acceptable for infiltration.

5.0 IMPLEMENTATION

The recommended stormwater management approach for existing areas includes the modification of existing facilities as well as the installation of new facilities. For new development an enhanced level of control compared to current practices will be expected. In combination this approach will provide a significant reduction in phosphorous loadings to Uxbridge Brook and to meet the phosphorous control targets.

Recommendation 1

The Township of Uxbridge should adopt the following targets for phosphorous control:

a) For existing developments, the phosphorous control target is 122 kg/per year reduction from existing levels

b) For new developments, the phosphorous control target is 90% reduction from predevelopment conditions. Should infiltration/exfiltration methods be impractical for a new development, 80% will be the minimum phosphorous reduction accepted with financial contributions provided in accordance with Recommendation 2.

Recommendation 2

For new developments, the difference in percentage between the achievable removal percentage and 90% will be contributed on a cash-in-lieu basis. The funds should be provided to the Lake Simcoe Region Conservation Authority to manage in a special fund for Uxbridge retrofit projects. The amount to be provided is $100/ha/% for each percentage point less than 90% phosphorous removal.

> Example:
> For a 10 ha development which achieves 80% control,
> The calculation is:
>
> $$\frac{\$100}{\text{ha}\bullet\%} \;\Big|\; 10\text{ ha} \;\Big|\; 10\% = \$10{,}000$$

Recommendation 3

The Township of Uxbridge should commit to an implementation schedule based on achieving the retrofit target in five years and adjust the schedule if required annually based on the pace of new development. Adjustments should be based on the annual target 26.4 kg and an assumed pace of development is 125 housing units per year or 0.21 kg phosphorous per unit.

Recommendation 4

Construction of the following retrofit measures should follow the schedule below:

Retrofit Measures	Schedule
Baffles to be added to existing ponds in Area M and Area L	Spring/summer 2000
Roadside ditch enhancements as part of road/sewer/ditch rehabilitation projects.	With road and sewer rehabilitation programs for each area.
Infiltration ponds at locations 17, 19, 20, 18, 21, and pond at location 7	Integrated with the land around the location as it is developed
Pond at location 9	Begin land purchase in 2000, construct in 2001 or 2002
Roof leader disconnection program – Testa area	Develop education and subsidy program in 2000. Implement

	2001.
Filter for location 13 (Area G)	Request funding from MOE/Env. Canada in 2000. Build in 2001. (see Rec. 9)
Exfiltration	Depends on road/sewer reconstruction program

The retrofit measures will cost $373,000 to implement (total present value which includes operation and maintenance), or $252,000 capital cost. Assuming a five-year time frame, this approximates to $50,000 per year that will have to be expended on construction. Costs for implementing other recommendations are shown below. The program and costs should be modified if exfiltration measures are included.

Recommendation 5
Opportunities for implementing additional measures should be taken during road and sewer rehabilitation or reconstruction. In addition to roadside ditches as discussed above, Etobicoke- type exfiltration systems in the road right-of-way should be considered as well as oil-grit separators and/or filters. Costs for taking advantages of opportunities should be considered on an annual basis along with adjustments to targets.

Recommendation 6
The Township should develop and apply an implementation program for source control and pollution prevention. This should include:

- Review and modification of municipal operations for street cleaning, catchbasin cleaning, and litter control
- Advice to residents on proper application of fertilizers, pesticides and herbicides
- Education on the nature of the storm drainage system and the damages caused to Uxbridge Brook by disposal of wastes into catchbasins.
- Education on alternate landscaping that require lower use of chemicals and conserve water.
- Education on pet litter control.

A budget of $20,000 per year should be allocated to support the program, which includes support for downspout disconnection. Summer student support programs should be accessed to enhance this effort.

Recommendation 7
The Township of Uxbridge should amend the drainage polices and supporting design criteria and drawings in Bylaw 89-53 to reflect the drainage practices in this report. In particular, for new developments, the need to meet total phosphorous targets and the performance calculation procedure should be included. The requirement to provide funds if the targets are not met should also be included.

Recommendation 8
The Township should adopt new standards for drainage controls for new development to meet the total phosphorous target. This includes consideration of all source, drainage system and outlet controls, including infiltration of lot drainage, enhanced roadside ditch drainage, exfiltration system and pond/wetland systems at the outlets. The multi-efficiency model documented in this report should be used to calculate the performance of the treatment train (Appendix B).

Recommendation 9
The Township should request funding support for new technologies. The use of stormwater filters and baffles are relatively new applications for Ontario and are good candidates for funding under environmental technology and environmental monitoring programs of the Province of Ontario and Environment Canada.

Recommendation 10
The Township should carry out an annual review of progress and adjust program to meet targets. The annual review to consist of:

- Review specific progress on the plan in constructing measures.
- Consider the amount of new development in the current year and expected in the next year to adjust targets and timing (as outlined in Recommendation 2).
- Consider any opportunities for retrofits in existing areas that result from road or sewer reconstruction and adjust targets accordingly.
- Review monitoring program and identify if additional measures needed to meet the target
- Recalculate the performance of measures on the basis of multi-efficiency model for areas that have overlapping controls (e.g. roadside ditch enhancements in areas draining to ponds).

Recommendation 11
The Township should implement a maintenance program. This report has identified operation, maintenance and repair costs for each measure to be constructed. The Township should develop maintenance schedules for resources owned by the Township and report on progress to the Implementation Committee on an annual basis. For new measures built as part of new developments, the Township should require developers to maintain the ponds during the construction period, and clean any sediment build-up before turning ponds over to the Township. Estimated operation, maintenance and repair costs, as identified in the J.F. Sabourin report entitled "Evaluation of Roadside Ditches", are summarized in Appendix A.

Recommendation 12
The Township should implement a monitoring program of the control measures and Uxbridge Brook and support organized volunteer members of the public in carrying out this task. Encouragement and support of citizen oriented stewardship programs have shown good success in managing and improving watersheds and increasing public understanding and commitment to remedial and protection programs. A budget of $10,000 per year should be allocated to support laboratory costs.

The monitoring program has several components:

Component	Purpose	Actions carried out by
Program review of schedule and targets	To ensure program is followed	Township of Uxbridge
BMP inspection of Township owned facilities	To ensure ponds and other facilities are maintained	Township of Uxbridge
New pond and BMP	To ensure facilities are working and cleaned out before ownership transferred to the Township	Owners of the facility. Monitoring protocol attached as Appendix C
New technology performance	To ensure new technologies are properly assessed	Recommendation 8 suggests requesting funds from the SWAMP program funded by MOE and Environment Canada
Uxbridge Brook	To assess status of Uxbridge Brook	Township of Uxbridge with support of the LSRCA or citizens group.

A recommended monitoring program is provided in Appendix E

Recommendation 13

The Township should report to the Ontario Ministry of the Environment annually on progress. The Township should consider the formation of a steering committee of Township staff and council members, Lake Simcoe Region Conservation Authority, the Region of Durham, Ministry of the Environment, and representatives of the public to facilitate the annual review and reporting tasks.

RHT/DW/CB/sk
June 2000
data:\21678-01\21678FINALREPTMAR00.DOC

APPENDIX A

Cost and Sizing Calculations

Appendix A:
Cost and Sizing Calculations

1. Sediment Forebay

As stated in the MOE Stormwater Management Practices Planning and Design Manual, a sediment forebay should be approximately 20% of the size of a wet pond. Therefore, 20% of the cost/ha for a wet pond was assumed to be the cost for a sediment forebay.

2. Armour Stone Baffles

Stone baffles were considered for relatively shallow ponds that were predicted to be short-circuiting. The armour stone could be placed one to two stones high and were configured to approximately double to triple the flow path and thus extend the detention time. The cost was determined to be approximately $200/ha based on a unit cost of $200/square face meter supplied and placed. The number of stone baffles that are required are dependent on the configuration and depth of the pond. For square ponds, approximately 1 square face metre is required per hectare if the pond is less than approximately one metre in depth

3. Baffle Curtains

Costs for a floating baffle system were provided by Environetics, Inc. These costs included both materials and installation.

4. Filtration Pond

Filtration pond costs were obtained from the report entitled "An Evaluation of Roadside Ditches and Other Related Stormwater Management Practices", by J.F. Sabourin and Associates Inc. Costs provided in the report were on a cost/hectare basis.

5. Infiltration Pond

Filtration pond costs were obtained from the report entitled "An Evaluation of Roadside Ditches and Other Related Stormwater Management Practices", by J.F. Sabourin and Associates Inc. Costs provided in the report were on a cost/hectare basis.

6. Wet Pond

Wet pond costs were obtained from the report entitled "An Evaluation of Roadside Ditches and Other Related Stormwater Management Practices", by J.F. Sabourin and Associates Inc. Costs provided in the report were on a cost/hectare basis.

7. Wetland

Wetland costs were obtained from the report entitled "An Evaluation of Roadside Ditches and Other Related Stormwater Management Practices", by J.F. Sabourin and Associates Inc. Costs provided in the report were on a cost/hectare basis.

8. Oil/Grit Separator

Table A 1Cost of Oil-Grit Separators

Stormceptor Model	Impervious Drainage area 1)	Supplied cost 2)	Supplied unit cost	Installed unit cost 3)	Unit Cost for TP loading of 4.4 kg/ha/yr 3)	Unit Cost for TP loading of 3.2 kg/ha/yr 3)
#	ha	$	$/ha imp.	$/ha imp.	$/kg	$/kg
300	0.09	6000	66667	100000	56818	78125
750	0.22	10200	46364	69545	39514	54332
1000	0.29	10900	37586	56379	32034	44046
1500	0.44	12500	28409	42614	24212	33292
2000	0.58	13800	23793	35690	20278	27883
3000	0.87	15500	17816	26724	15184	20878
4000	1.16	17500	15086	22629	12858	17679
5000	1.45	19650	13552	20328	11550	15881
6000	1.76	26470	15040	22560	12818	17625

1) Sized according to MOE Level 1 requirement to reduce TSS loads by 80%
Assumed equivalent to 40% TP reduction
Efficiency based on MOE/SWAMP study
2) Costs provided by Stormceptor Canada
3) At 1.5 x supplied cost to provide for construction

Table A2 Oil Grit Separator Cost and Performance Analysis

	Drainage area ha >> 1)	1.45	1.74	2.13	2.74
	Efficiency 1) % >>	40	35	30	25
Model 2)	Load rate kg/ha/yr	Unit Cost in $/kg TP removed annually 3)			
5000	4.4	$11,550	$11,000	$10,483	$9,779
5000	3.2	$15,881	$15,125	$14,415	$13,447

1) Sized according to MOE Level 1, 2, 3 or 4 requirement to reduce TSS loads by 80, 70, 60, 50%
Assumed equivalent to 40, 35, 30, 25% TP reduction
Efficiency based on MOE/SWAMP study
2) Costs provided by Stormceptor Canada
3) At 1.5 x supplied cost to provide for construction

9. Filter

Site for filter application – Area G west side. The drainage area is 5.7 ha at 40% impervious or 2.3 impervious ha, and has no controls. The site at the outlet has 1800 sq.

m available space and provides a good grade drop from the drainage system. We anticipate that 100 cu m of storage (two 50,000 L WWHT) would control 90% of the runoff and release it at 11 L/s followed by 50,000 L Wilkinson WWHT filter or Stormwater Management supplied filter. The storage units would include or be preceded by an overflow or bypass and function as an oil-grit separator with appropriate baffles or elbows.

A. Wilkinson Filter

Storage unit cost.	2 X 50,000 L units @ $8000	16,000
Filter cost	1 X 50,000 L unit @ $15,000	15,000
Sub total – material cost delivered to site		31,000
Construction cost at 50% material cost		15,500
Total cost		$45,500

Annual maintenance and repair — Annual cleaning labour - $200; Replace media @ 5 years $2000

Performance Estimate:		50% TP removal
Load to unit: 90% of 18.2 kg/yr =	1	6.4 kg/yr
TP reduction (performance assumed at 50%)		8.2 kg/year
Unit cost (construction cost only)		$5550.

B. Stormwater Management supplied filters

Storage unit cost.	2 X 50,000 L units @ $8000	$16,000
Filter Cost	6ft by 12ft unit with 11 cartridges	$30,000
Sub total – material cost delivered to site		$46,000
Construction cost at same as above		$15,500
Total cost		$61,000

Annual maintenance Labour	$500
Replace media @ 1 year	$2500
Performance Estimate:	63% TP removal
Load to unit: 90% of 18.2 kg/yr =	16.4 kg/yr
TP reduction (performance assumed at 63%)	10.2 kg/year
Unit cost (construction cost only)	$5980.

10. Roof Leader Disconnection

Roof leader disconnection costs were obtained from the Scarborough Centennial Creek Report prepared by Dr. James Li. In addition, a cost of $100 per home was published in article entitled "Peel Acts to Plug Basement Floods" printed in the June 20, 2000 edition of the Toronto Star.

11. Open Ditch Enhancement

Open ditch enhancement costs were derived from the Evaluation of Roadside Ditches report as presented in Table A3 below.

12. Etobicoke Exfiltration Costs

This is based on notes made by Donald G. Weatherbe during a meeting to review the sizing of the Etobicoke Exfiltration system, attended by Dr. James Li of Ryerson University (who analyzed costs) and Alan Smith, P.Eng who was modelling the system using a modified version of the MIDUSS drainage model.

It was noted that the original application was oversized. Revised sizing recommendation: for the 2.5 ha area studied, the exfiltration trench length required was estimated at 65 m. The likely road and sewer length was 500 m. Therefore only 65/500 or 13% of the road length needed to be included. To be conservative, it is recommended that a factor of 05 be used.

A cost analysis was carried out of all construction costs associated with the exfiltration system as part of an undergraduate thesis supervised by Dr. Li. The exfiltration cost was estimated at 4% of the total construction cost including the road construction and conventional sewer.

Table A4 provides a summary of calculations used to derive the costs presented in Section 3.4.

A summary of all capital, present value, and operation, maintenance and monitoring costs is provided in Table A5.

Table A3 Construction Costs of Standard Road Drainage with Open Ditch Enhancement

	Unit Costs					Total Costs			
Component	Quantity	Cap Cost	Main.	PV. Cap	PV. Total	Cap Cost	Main.	PV. Cap	PV. Total
Standard Road									
1 Std. road w/curb	250	$311	$1	$311	$318	$77,750	$138	$77,750	$79,583
2 Shallw storm sewer	250	$480	$0	$484	$484	$120,000	$0	$120,900	$120,900
3 Sump pumps	18	$200	$0	$380	$380	$3,600	$0	$6,833	$6,833
4 Manholes	4	$3,300	$5	$3,460	$3,527	$13,200	$20	$13,840	$14,107
5 Catch basins	17	$1,400	$5	$1,560	$1,627	$23,800	$85	$26,520	$27,653
6 Topsoil &grass	250	$36	$0	$44	$44	$9,000	$0	$10,875	$10,875
7 Subdrains	500	$20	$0	$20	$20	$10,000	$0	$10,000	$10,000
					Totals	$257,350	$243	$266,718	$269,950
With Open Ditch Enhancement									
1 Std road w/subdrains &shallow swales	250	$346	$1	$346	$354	$86,500	$150	$86,500	$88,500
2 Shallow storm sewers	250	$480	$0	$483	$484	$120,000	$0	$120,750	$120,900
3 Manholes in street	3	$3,300	$5	$3,460	$3,527	$9,900	$15	$10,380	$10,580
4 Catch basins off street	24	$1,400	$5	$1,560	$1,627	$33,600	$120	$37,440	$39,039
5 Roadside topsoil &grass	250	$36	$0	$45	$45	$9,000	$0	$11,325	$11,325
					Totals	259,000	285	266,394	270,344
Difference Between Standard Road and Road with Open Ditch Enhancement					:	$1,650	$43	-$323	$394
Notes:						(1) Present value			$1,722

Costs are in Per Hectare
PV. Cap is present value of capital, including replacement
Unit costs and quantities from Drainage System Selection Tool v 1.0.2 J.F.Sabourin
(1) - PV costs cannot be lower than Capital costs, therefore adjustment factor of original costs was utilized for the purpose of evaluation

Table A4
Exfiltration vs Standard Road with Storm Sewers

	Unit Costs					Total Costs			
Component	Quantity	Cap Cost	Main.	PV. Cap	PV. Total	Cap Cost	Main.	PV. Cap	PV. Total
Standard Road									
1 Std. road w/curb	$250	$311	$0.55	$311	$318.33	$77,750	$137.50	$77,750	$79,582.5
2 Shallw storm sewer	$250	$480	$0	$483.6	$483.6	$120,000	$0	$120,900	$120,900
3 Sump pumps	$18	$200	$0	$379.63	$379.63	$3,600	$0	$6,833.34	$6,833.34
4 Manholes	$4	$3,300	$5	$3,459.98	$3,526.64	$13,200	$20	$13,839.92	$14,106.56
5 Catch basins	$17	$1,400	$5	$1,559.98	$1,626.64	$23,800	$85	$26,519.66	$27,652.88
6 Topsoil &grass	$250	$36	$0	$43.5	$43.5	$9,000	$0	$10,875	$10,875
7 Subdrains	$500	$20	$0	$20	$20	$10,000	$0	$10,000	$10,000
					Totals	$257,350	$242.50	$266,717.92	$269,950.28
	Quantity	Cap Cost	Main.	PV. Cap	PV. Total	Cap Cost	Main.	PV. Cap	PV. Total
Exfiltration *						$10,294	$78	$10,668.72	$11,706.22
Assuming 20% of the road length is required:						$2,058.80	$15.60	$2,133.74	$2,341.24

*Additonal cost for Exfiltration system is 4% of total cost including road.
Based on "Evaluation of the Etobicoke Exfiltratrion System" by N. Karakis, Ryerson, 1999.

Table A5

Summary of Costs in Dollars Per Hectare
Township of Uxbridge

SWM Measure	Capital Costs ($/ha)	Maintenance Costs ($/ha)	Present Value Capital and Repair Costs ($/ha)	Total Present Value Costs ($/ha)
1. Sediment Forebay	$600	$79	$600	$1,657
2. Armour Stone Baffles (1)	$200	$0	$200	$202
3. Baffle Curtains (1)	$416	$1	$609	$611
4. Filtration Pond	$2,900	$401	$2,900	$8,243
5. Infiltration Pond	$3,000	$401	$3,000	$8,343
6. Wet Pond	$3,000	$396	$3,000	$8,283
7. Wetland	$3,500	$396	$3,500	$8,783
8. Oil Grit Separator	$5,520	$500	$5,584	$12,250
9. Filter	$7,982	$35	$8,918	$9,386
10. Roof Leader Disconnection	$5,380	$0	$2,066	$2,066
11. Open Ditch Enhancement	$1,650	$43	NA	$394
12. Etobicoke Exfiltration	$2,059	$16	$2,134	$2,341

Notes:
- The present value cost estimates are based on a 40 year period.
(1) Costs are in $/m.

APPENDIX B

Laurel Creek Targets – Phosphorous

Appendix B

LAUREL CREEK TARGETS - PHOSPHOROUS

Multi Efficiency Model Calculation of Treatment Train Performance

Workshop Notes Prepared by Donald G. Weatherbe, P.Eng.

TARGET TO BE MET:

A) Instream P levels should .03 mg/l or less (MOEE Provincial Water Quality Guideline) above Laurel Creek Reservoir, and .05 mg/l to .08 mg/l below Laurel Creek Reservoir.

B) For all reaches and tributaries of Laurel Creek. Best Management Practices should be chosen to achieve 90% removal of phosphorous for urban development.

OBJECTIVE OF TARGET

The need for control is based on several factors. Phosphorous is a plant nutrient, which stimulates growth of algae and aquatic plants in the stream channel and in the reservoirs. Excessive algal growth causes reduced dissolved oxygen and represents an aesthetic nuisance. While the current levels are below guideline limits above Laurel Lake in dry weather, significant loads are contributed to the reservoir during runoff events from rural and urban sources. Guideline levels are exceeded downstream of Laurel Lake, with diurnal oxygen variations indicative of mild eutrophication. Laurel Lake and downstream reservoirs - Columbia lake, Silver lake and the small impoundments on the University of Waterloo campus all exhibit signs of eutrophication. It is thought that recycling of phosphorous in the reservoirs contributes to higher levels downstream. In order to maintain levels where they are currently instream, and to reduce loads to the reservoirs, the target of 90% removal was adopted.

"Control of discharges in new developments should be based on achieving 90% reduction in loadings, compared to uncontrolled urban runoff. Reductions can be achieved both by infiltration techniques and by other specific measures. No specific discharge limit was established in this study." (page 7-19, Laurel Creek Watershed Study).

ANALYSIS AND INFORMATION REQUIREMENTS

Since no discharge limit was set in concentration terms, there is no need to calculate runoff concentrations or loadings. The loading reduction target of 90% can be estimated using infiltration and removal efficiencies of best management practices compared to the base case of uncontrolled runoff.

The general relationship to calculate the reduction is given below:

$$TR = [1 - \Pi(1 - I) \Pi (1 - R)] * 100 \qquad (1)$$

Where: TR = Total reduction as a percent compared to base case
I = Reduction in runoff volume due to infiltration as a fraction
R = Reduction in concentration of P, or efficiency as a fraction
Π = Product of terms for I and R to be included for each BMP

Individual BMPs can both reduce volumetric runoff and remove phosphorous. This method accounts for both. It also assumes that each method can remove different fractions of P. While not strictly correct, the assumption is reasonably valid as long as BMPs are chosen that target different sediment or soluble fractions. In other words, it would not be reasonable to include two methods that capture P bound to coarse sediments, since the efficiency of the second in a series would be greatly reduced.

Example: Consider a base condition with all rooftops connected to the storm sewer, and a annual runoff coefficient of 0.5. In the basic design, the planner chooses three BMPs.

Controls consist of:

1. Roof downspouts draining to grass. The new runoff coefficient is 0 .3. Consider that P is not removed in the lot drainage, because of the net effect of fertilizer additions.
   $R_1 = 0.0$, $I_1 = (0.5 - 0.3)/0.5 = .4$

2. Grassed ditches and buffer strips. Swales designed to reduce runoff rates, filter solids and dissolved pollutants and induce infiltration can be effective.
   $R_2 = 0.3$, $I_2 = 0.1$

3. A final stormwater management pond, for sediment control and additional phosphorous and bacterial control. No infiltration is planned and to be conservative, ignore evaporation. Choose an average performance value for Ontario Ponds of 50% P removal.
   $R_3 = 0.5$, $I_3 = 0.0$

The resulting total P removal performance is:

$$TR = [1 - (1 - 0.4)(1 - 0.1)(1 - 0.0)(1 - 0.0)(1 - 0.3)(1 - 0.5)]*100$$

$$= [1 - (0.6)(0.9)(0.7)(0.5)]*100$$

$$= 81\%$$

Since this does not quite meet the target of 90% removal, the designer must add additional infiltration measures, or enhance phosphorous removal, perhaps by adding a wetland component to the pond, or using water quality inlets.

APPENDIX C

Stormwater Management Pond Monitoring Protocol – City of Mississauga

APPENDIX C
STORMWATER MANAGEMENT POND MONITORING PROTOCOL
CITY OF MISSISSAUGA

1.0 Purpose

The City of Mississauga often requires the construction of a stormwater management facility or pond as part of land development activities to control flow rate or improve water quality of stormwater runoff from the development. A servicing agreement between the City and the land developer outlines the conditions and timing for the City to assume responsibility for the facility. One of the conditions is that the developer carry out a monitoring program. This protocol outlines the details of an acceptable monitoring program to be carried out by the land developer. The three main purposes of the program are as follows:

1. To certify that the pond construction conforms to the approved plans and functions as per the design report. (It is built as designed) See Design Conformance Monitoring.

2. To ensure pond performance in removing pollutants and routing flows conforms to the guidelines used in design. (It operates as designed) See Performance Monitoring.

3. To ensure that the pond is maintained during the maintenance and post construction monitoring period. (It is turned over to the City in good condition) See Maintenance Monitoring.

Each of the purposes is realized through different, though related, aspects of the monitoring program.

2. Timing

Two time periods are important for consideration in monitoring:

Construction Period: This is defined as the period following pond construction, during which the land draining to the facility is under development, with active construction activities underway, and land exposed. During this period, erosion and sediment control programs are important in protecting downstream facilities (ie. sewers, ponds and receiving waters) from excessive sediment loads. This period is often specified in the servicing agreement as two or three years. If the active construction period is extended beyond the time specified in the servicing agreement, the City may extend the start of the post construction monitoring period.

Post Construction Period: This period shall be considered to start after the construction period specified in the agreement is complete. This is expected to be the period after the catchment area has been developed and construction activities completed and land stabilized with vegetation. The post construction period shall be as specified in the servicing agreement (usually two years) and follow the construction period. Following the post construction monitoring period, the municipality will assume the operation of the facility from the property developer, subject to conditions being met in the servicing agreement and in this Protocol.

3. Design Conformance Monitoring

This type of monitoring results in a certificate that the pond construction details are as designed, with exceptions only as agreed upon by the City and the consultant for the developer and duly noted on as-built plans. This step is usually completed as soon as construction is complete.

The certificate shall include statements to the effect that the following conforms to design:

- all materials used in construction
- the pond volume, bottom elevation, berm elevations, outlet(s) elevations
- sediment forebay features
- inlet and outlet structures elevations and orifice sizes,
- moveable control elements operation
- flow splitting structures to divert high flows
- emergency spillways
- landscaping including paths
- security aspects such as fencing, grates on sewers, and warning signs
- wetland plantings

The above is intended to be examples of the items to be checked by the consultant prior to issuing a Design Conformance Certificate. An inspection and physical survey following construction, along with the inspections during construction are usually sufficient to determine that the pond is built as designed and will function as designed.

4. Performance Monitoring

Performance monitoring is needed to ensure that hydraulic and pollutant removal performance is acceptable. Information collected can be used to require alteration of the operations to improve performance such as:

- indicate the need for maintenance
- indicate changes to the hydraulic operation to modify extended detention times, or raise or lower the wet pool elevations
- alter inlet flow splitting structures
- indicate need for remedial measures to reduce loadings upstream.

Also the information will be used to assist in characterizing urban runoff in Mississauga, add to the knowledge of pond performance and operating characteristics, and identify the need to modify design guidelines for future pond construction.

The following monitoring is required:

A. Flow splitter/diversion structure (if present) - flow at which diversion to the quantity control pond or bypass of the quality control pond initiates.

- this must be determined for at least one event, to confirm diversion structure setting. Repeat if diversion structure modified.

Timing. Any time after pond is constructed

B. Quantity Control Ponds, ie. flood control ponds, which are separate from quality control ponds.

- flow measurements at inlet and outlet, and pond elevation, for at least one event with flow, to confirm pond operation. Repeat if outlet settings or structures modified.

Timing. Any time after pond is constructed

C. Wet Ponds, ie. water quality control ponds, extended detention ponds and multi-objective water quality/quantity control ponds.

- flow measurements at inlet and outlet for three (3) rainfall induced runoff events per year for two years (six samples total)
- pond elevation during the events
- a flow proportioned composite sample for the same events at the inlet and outlet (if more than one inlet the major inlet may be used, if it can be reasonably expected that it is representative of the other outfall catchment areas), analysed for [see Parameters]. If more than one outlet, samples are to be taken for the outlet which takes the lower flows (as opposed to the flood overflow outlet or emergency overflow spillway).
- operational record for events, including draw down period for the pond
- results calculated as percent reduction in pollutants for all parameters.

Parameters. Composite samples shall be analysed for the following parameters: Total suspended solids, total phosphorus, total kjeldahl nitrogen, ammonia nitrogen, nitrate and nitrite nitrogen (combined), biochemical oxygen demand, chloride, metals (cadmium, chromium, copper, iron, lead, nickel and zinc)

Timing. After post construction (catchment fully developed, with undeveloped land stabilized with vegetation), and prior to assumption.

D. Rainfall Data

- continuous rainfall data must be provided with the flow data, from a gauge within five (5) km of the catchment.

5. Maintenance Monitoring

Maintenance shall be carried out by the Developer for the construction and post construction periods, until the facility is assumed by the City.. The following is a suggested list of maintenance inspection items:

- flow splitting, and inlet and outlet structures free from clogging
- litter build up in ponds
- oil sheen or evidence of industrial spill
- safety and security features in good order, ie. fencing, warning signs, gratings secure
- erosion of berms, vegetation healthy
- wetland vegetation need replanting
- sediment build-up in forebay.
- free operation of moveable control elements

Sediment Build-up. The amount of sediment in the water quality pond and sediment fore-bay shall be monitored annually. Sediment buildup in the construction period could be a problem if construction site erosion and sediment control programs are inadequate. If the sediment accumulation in the forebay at the end of the post construction monitoring period is 50% or more of the expected amount requiring removal identified in the design report, then the developer shall remove the sediment. Prior to removal, the Developer shall ensure samples are taken to identify if special handling or disposal requirements apply (refer to Ontario Regulation 347 Waste Management, Environmental Protection Act, and Guideline for Use at Contaminated Sites in Ontario, MOEE, June 1996).

Timing. Maintenance inspections should be initially frequent after major storms in the first year and seasonally thereafter, as determined by experience. Maintenance monitoring should be carried out during the entire construction and post construction period.

6. Reporting

Prior to assumption, the Developer shall submit a report to the City including the following:

- A statement certifying that the pond is built as designed, listing any differences from the design brief
- Performance monitoring results comparing actual performance to design basis
- Operational changes made to the hydraulic structures to modify flow rates.
- Record of maintenance inspections and activities
- Recommendations for operational improvements, maintenance frequency and design improvements if any.

APPENDIX D

Phosphorous Loading Analysis

Table D 1 Uxbridge Phosphorous Loading Analysis

Based on Table 6.9 Existing Stormwater Outfalls - Urban Uxbridge UBWP 1997

Areas in ha

Area	Size	Residential	Commercial	Undeveloped	Roadside Ditch Area 1)	Exist Control Efficiency %	Existing P Loads	Future developed area	Future Control Efficiency	Future P Loads	Recommended Control Efficiency	Portion of area BMP applied	BMP Recommended P Load
	ha	ha	ha	ha	ha	%	kg/yr	ha	%	kg/yr	%	%	kg/yr
A	19.6	19.6		0		0	62.7		0	62.7	50	70	40.8
B	29.5	29.5		0		0	94.4		0	94.4	50	100	47.2
C	6.2	4.7		1.5		0	15.1		0	15.1	0	100	15.1
D	37.3	32.9	0	4.4	32.9	0	84.5		0	84.5	0	100	84.5
E	19	0		19		0	1.3	19	50	30.4	50	100	30.4
F	2.2	0	2.2	0		0	9.7		0	9.7	10	100	8.7
G	9.5	9.5		0		0	30.4		0	30.4	50	100	15.2
H	1.3	0	1.3	0		0	5.7		0	5.7	0	100	5.7
I	35.2	35.2		0		0	112.6		0	112.6	50	50	84.5
J	13	0	13	0		0	57.2		0	57.2	0	100	57.2
K	130.3	0		130.3		0	8.9	34.2	50	61.3	80	100	28.4
L	53.5	53.5		0		50	85.6		50	85.6	50	100	85.6
M	31.4	31.4		0		50	50.2		50	50.2	50	100	50.2
N	82.4	82.4		0		50	131.8		50	131.8	50	100	131.8
O	31.1	31.1		0		50	49.8		50	49.8	50	100	49.8
P	5.9	0		5.9		50	0.2		50	0.2	50	100	0.2
Q	35.4	35.4		0	35.4	0	90.6		0	90.6	0	100	90.6
R	16.2	16.2		0		50	25.9		50	25.9	50	100	25.9
S	9	9		0		30	20.2		30	20.2	60	100	14.1
T	1	1		0		0	3.2		0	3.2	0	100	3.2
	569						940.1			1021.6			869.3

81.5 dif N-K			
Increase		152.4	dif N-Q
New develop		32.8	
Target		119.5	

1) Roadside ditch areas assumed control efficiency is 20%

Unit Load Rate kg/yr

Resid.	Commer.	Undevel.
3.2	4.4	0.068

Compare collumn totals

	Size	Existing P Loads	Future P Loads	BMP Recommended P Load	
	ha	kg/yr	kg/yr	kg/yr	
This sheet	569	940.1	1021.6	869.3	Modified as noted below
Table 6.9	569	940.1	1041.1	876.3	Original
Table 6.9	569	940.1	1014.7	862.5	Additon errors corrected

Notes on discrepancies between this spreadsheet and original Table 6.9

1. Existing P loads reproduced exactly
2. Future P loads lower due to 1) Area K - calculated loads are higher by 6.6 kg/yr with addition of load from undeveloped portion
   2) round off differences and 3) addition error in original table which overestimated loads by 26.4 kg/yr
3. BMP recommended loads are higher due to 1) Area K - calculated loads are higher by 6.5 kg/yr with addition of load from undeveloped portion
   2) round off differences and 3) addition error in original table which overestimated loads by 13.8 kg/yr

Table D 2 Uxbridge Phosphorous Loading Analysis   Revised Version 2

Based on Table 6.9 Existing Stormwater Outfalls - Urban Uxbridge UBWP 1997
Areas in ha

Area	Size	Residential	Commercial	Undeveloped	Roadside Ditch Area 1)	Exist Control Efficiency %	Existing P Loads	Future developed area	Future Control Efficiency	Future P Loads	Recommended Control Efficiency	Portion of area BMP applied	BMP Recommended P Load
	ha	ha	ha	ha	ha	%	kg/yr	ha	%	kg/yr	%	%	kg/yr
A	19.6	19.6		0		0	62.7		0	62.7	50	70	40.8
A'	85.42	0	59.79	25.62		0	270.8		0	270.8	0	100	270.8
B	29.5	29.5		0		0	94.4		0	94.4	50	100	47.2
C	6.2	4.7		1.5		0	15.5		0	15.5	0	100	15.5
D	37.3	32.9	0	4.4	32.9	0	85.5		0	85.5	0	100	85.5
E	19	0		19		0	5.7	19	50	30.4	50	100	30.4
F	2.2	0	2.2	0		0	9.7		0	9.7	40	100	5.8
G	9.5	9.5		0		0	30.4		0	30.4	50	100	15.2
H	1.3	0	1.3	0		0	5.7		0	5.7	0	100	5.7
I	35.2	35.2		0		0	112.6		0	112.6	50	50	84.5
J	13	0	13	0		0	57.2		0	57.2	0	100	57.2
K	76.64	0		76.64		0	23.0	34.2	50	67.5	80	100	34.6
L	53.5	53.5		0		50	85.6		50	85.6	50	100	85.6
M	31.4	31.4		0		50	50.2		50	50.2	50	100	50.2
N	82.4	82.4		0		50	131.8		50	131.8	50	100	131.8
O	31.1	31.1		0		50	49.8		50	49.8	50	100	49.8
P	5.9	0		5.9		50	0.9		50	0.9	50	100	0.9
Q	35.4	35.4		0	35.4	0	90.6		0	90.6	0	100	90.6
R	16.2	16.2		0		50	25.9		50	25.9	50	100	25.9
S	9	9		0		30	20.2		30	20.2	60	100	14.1
T	1	1		0		0	3.2		0	3.2	0	100	3.2
Undevl 2)	73.65			73.65			22.1	73.65	80	47.1	80	100	47.1
Total	674.4						1253.57			1347.77			1192.51

A' area not included in original Table 6.9
1) Roadside ditch areas assumed control efficiency is 20%
2) Undeveloped area within urban boundary

	Resid.	Commer.	Undevel.
Unit Load Rate kg/yr	3.2	4.4	0.3

	Existing P load Kg/yr	Future P Load Kg/yr	Recommended Load Kg/yr
Point sour	110.0	285	285
Urban Run	1253.6	1347.8	1192.5
Total Urba	1363.6	1632.8	1477.5

A Target	269.2	Total urban increase - ultimate target since it gives zero increase in P load
B Target	155.3	Reduced load with corrected assumptions in original Table 6.9
C Target	122.4	Retrofit target with corrected assumptions in original Table 6.9

Changes from 6.9
1. Corrections as outlined on reconstructed Table 6.9
2. Increase undeveloped unit load rate to 0.3 kg/yr
3. Added new development area.
4. Added area A' that was missed in original Table 6.9

APPENDIX E

Uxbridge Monitoring Program

Appendix E
Uxbridge Monitoring Program

Objectives of the monitoring plan are to:

- Provide information to interested agencies and partners that the program is being implemented
- Provide a record of performance of installed BMPs
- Provide a record of the quality in Uxbridge Brook
- Identify if remedial action is needed for improved performance

Levels of performance that are inadequate should trigger actions to improve the situation. These actions could include:

- Maintenance activity such as cleaning sediment from sediment forebays of ponds, or of the sump in OGS or cleaning media in sand filters
- Additional measures in areas with controls
- New measures for areas with no controls
- Additional efforts for pollution prevention measures

The program has several components:

Component	Purpose	Actions carried out by
Program schedule and targets	To ensure program is followed	Township of Uxbridge
BMP maintenance of Township owned facilities	To ensure ponds and other facilities are maintained	Township of Uxbridge
New pond and BMP	To ensure facilities are working and cleaned out before ownership transferred to the Township	Owners of the facility. Monitoring protocol attached as Appendix C
New technology performance	To ensure new technologies are properly assessed	Recommendation 8 suggests requesting funds from the SWAMP program funded by MOE and Environment Canada
Uxbridge Brook	To assess status of Uxbridge Brook	Township of Uxbridge with support of the LSRCA or citizens group.

It is possible that other government agencies, such as the LSRCA or the SWAMP program may be interested in results and could subsidize the monitoring program.

The Township of Uxbridge may require developers to retain ownership of the BMPs initially, especially during the construction period, to prove that the system operates as designed and that it is cleaned out if necessary following the high sediment loads during the construction period. A Monitoring Protocol developed for the City of Mississauga for this circumstance by Donald G. Weatherbe Associates is provided in the report as Appendix C.

Uxbridge Brook Monitoring

A selected number of sites will be identified for water quality monitoring.
A recommended program is based on a general reconnaissance of water quality as follows:

Parameters	Locations	Timing	Cost Estimate
Total and dissolved phosphorus, TKN and nitrite/nitrate, total suspended solids, E.coli, BOD	7 stations - 3 upstream locations, 2 in Uxbridge and 2 downstream	6 times per year, in spring, summer and fall. One dry weather sample and one wet weather sample in each season	Allow $120 per sample. Cost 7X6X120 =$5,040 per year for lab cost.
Dissolved oxygen and temperature	7 locations plus in-stream ponds	Monthly for 6 months – May to September. Samples to be taken as close to sunrise as possible as well as in mid afternoon.	One time cost for DO and Temp. meter Allow $1,000.
Invertebrates	3 locations	Once per year	Allow $2,100

The lab analysis and invertebrate sampling will cost in the order of $7000 per year. Labour costs for sampling have not been included, since they could vary from nothing for volunteer samplers to a part time summer student. It is recommended that some combination of the above be negotiated with the LCRCA and the citizens group interested in maintaining the quality of Uxbridge Brook. In addition, the LSRCA staff could provide support for database management and interpretation, and report writing. An overall budget of $10,000 per year is estimated for budget purposes, but this could vary depending on the agreement reached with the LSRCA and/or the citizens group.

The following discusses the possible parameters and their significance.

Parameter	Significance	Objectives
Total suspended solids	Suspended solids consist of sediment (soil or organic) particles that may be physically removed by settling or filtration processes. Many of the other pollutants listed below, including nutrients, metals and bacteria are associated with TSS. Stormwater management guidelines for ponds use TSS removal performance as the key parameter for control. Suspended solids are a pollutant since the sediments can settle out in fish spawning areas and damage habitat	There is no Provincial Water Quality Objective (PWQO) for TSS. Many studies use Percent TSS load reduction as a surrogate parameter for pollution control.
Total phosphorous	Phosphorous is a plant nutrient and causes eutrophication in watercourses and lakes.	There is a PWQO for total phosphorus.
Total Kjeldahl nitrogen TKN	TKN refers to a specific laboratory procedure that measures the sum of organic nitrogen plus ammonia nitrogen. Organic nitrogen in protein substances present in living tissues breaks down to form ammonia. Nitrification is the process by which ammonia is oxidized by bacteria, first to nitrite (which is short lived in the environment) and then to the fully oxidized nitrate state. A measure of this process is the nitrogeneous oxygen demand or NOD. Ammonia disassociates in water to form ionized and un-ionized ammonia, with the two forms in equilibrium, depending on the temperature and pH. Nitrogen compounds are plant nutrients and contribute to eutrophication of watercourses and lakes, with excess growths of algae and aquatic macrophytes (weeds).	There is a PWQO for un-ionized ammonia, dependent on temperature and pH. There is no objective for TKN.
Nitrite/nitrates	Nitrite and nitrate nitrogen are often measured together. These are plant nutrients.	There is no PWQO for nitrite or nitrate, although there is a drinking water objective.
Bacteria- fecal coliform (FC), E. coli (EC)	Bacterial parameters are used to indicate the presence of pathogens or disease causing organisms in water. High levels in surface waters can close bathing beaches. The province of Ontario recently modified its bathing beach standard from FC to EC. Since much data exists with the FC parameter, it is worthwhile collecting this for comparability	There is a PWQO for E.coli, based on the geometric mean of at least five samples.
Dissolved oxygen	Dissolved oxygen (DO) depletion in water causes stress to fish populations. DO is often modelled as a function of BOD and	There is a DO PWQO, which is temperature dependent and varies for coldwater versus warmwater fish.
Temperature	Temperature affects many life processes, including fish life. It also affects oxygen saturation and reaeration rates	There is a PWQO relating to thermal discharges. There are targets that are typically established for cold and warm water fisheries for different seasons.

Heavy metals	Pb, Cu. Ni, Zn, Cr, Cd, Fe. These metals are most prevalent in urban drainage associated with TSS to varying degrees. High levels of metals are often toxic to aquatic organisms and can affect the disposal options for dredged sediments from ponds. Many metals are associated with suspended solids.	PWQOs exist for most metals that are toxic to fish.
Trace organic compounds PCBs / chlorobenzene / organochlorine pesticides/ chlorophenol/ phenoxy acid herbicides, PAHs	Contain many industrial chemicals and pesticides including priority pollutants - many of which are persistent, highly toxic, and are suspected or known carcinogens. PAHs are present in urban runoff as fallout from combustion in industrial areas and incinerators. Many of these are associated with suspended solids.	Many of these have PWQOs.
Chloride	Chloride ion is present in urban drainage as a result of road deicing in winter with salt (sodium chloride). Chloride can damage vegetation and drinking water supplies	There is a drinking water objective for salt base on taste and a guideline for sodium based on potential problems for hypertensive people. A standard based on chronic toxicity is being considered.
BOD (biochemical oxygen demand)	A measure of the decomposable organic material in water, in terms of the amount of oxygen consumed biologically over a five-day period. An estimate of this as well as NOD is needed for dissolved oxygen modelling.	There is no PWQO. Rather the effect on DO is a concern and DO has a PWQO
Toxicity, acute	Acute toxicity is a measure of the lethality of the water for specific organisms (rainbow trout and *daphnia magna* (water fleas) carried out over 96 hours. If fifty percent of the organisms die, then it is considered acutely lethal. Urban drainage is often acutely toxic, often attributable to the metals content.	The Canadian Fishery Act requires that new outfalls not be acutely lethal, as do Ontario regulations for industrial dischargers.
Toxicity, chronic	Chronic toxicity tests are carried out using various organisms for a longer term than cute tests. Many tests measure subtle changes in life cycle or reproduction.	Many of the PWQO are based on targets for chronic toxicity
Aquatic macroinvertebrates	Useful for establishing the health of a stream. Species and numbers can be used in indices of water quality and aquatic habitat health	No standards, but they form the basis of establishing the health of a system and can be useful in comparing sites in a watershed.