



PLOAD Description
Description of Inputs/Assumptions For
Modeling and Pollutant Load Reductions
Basin Calculations

Storm Water Pollutant Load Analysis

In order to predict how various best management practices (BMPs) and open space preservation or restoration may, in turn, assist in limiting pollutant loads to streams within the Ecorse Creek Watershed, pollutant load export from the watershed was modeled under both existing and future land use conditions. Average annual pollutant loads to Ecorse Creek were modeled using the U.S. Environmental Protection Agency's (EPA) PLOAD model.¹

At its heart, PLOAD employs the Simple Method² for calculating stormwater pollutant loads. The Simple Method is an empirical model developed for estimating and comparing relative stormflow-generated pollutant export from urban development sites under differing land use and storm water management scenarios. The Simple Method is best suited for small drainage areas, generally those less than or equal to one square mile. It has been endorsed by the U.S. EPA as a screening tool for NPDES storm water projects and permit applications,³ and has been used by the MDEQ to develop Total Maximum Daily Load (TMDL) allocations for the Ecorse River in southeast Michigan.⁴

The Simple Method requires information concerning the watershed drainage area, impervious surface coverage, storm water runoff pollutant concentrations and annual precipitation and employs the following equation:⁵

$$L_p = \sum u (*P_j * R_{vu} * C_u * A_u * 2.72/12)$$

Where:

L_p	=	Annual pollutant load (lbs)
U	=	Land use type u
P	=	Annual Precipitation (inches)
P_j	=	Proportion of rain events that generate surface runoff (default = 0.9)
R_{vu}	=	Runoff Coefficient for land use type u (inches _{run} /inches _{rain})
C_u	=	Event Mean Concentration for land use type u (mg/L)
A_u	=	Area of land use type u (acres)
2.72	=	Conversion factor
12	=	Conversion factor

R_{vu} is derived from the following equation:

$$R_{vu} = 0.05 + (0.009 * I_u)$$

Where:

I_u	=	Percent imperviousness land use type u (%)
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¹ U.S.EPA (United States Environmental Protection Agency). 2001. PLOAD version 3.0: An ArcView GIS Tool to Calculate Nonpoint Sources of Pollution in Watershed and Stormwater Projects – User's Manual. United States Environmental Protection Agency, January 2001.

² Schueler, T.T. 1987. Controlling Urban Runoff: A Practical Manual for Planning and Designing Urban BMPs. Publ. No. 87703. Metropolitan Washington Council of Governments, Washington, DC.

³ U.S. EPA (U.S. Environmental Protection Agency). 2001. PLOAD version 3.0: An ArcView GIS Tool to Calculate Nonpoint Sources of Pollution in Watershed and Stormwater Projects, User's Manual. United States Environmental Protection Agency. January 2001.

⁴ Goodwin, K. 2003. Total Maximum Daily Load for Biota for the Ecorse River Watershed, Wayne County, Michigan. Michigan Department of Environmental Quality, Water Division. July 7, 2003.

⁵ U.S. EPA (U.S. Environmental Protection Agency). 2001. PLOAD version 3.0: An ArcView GIS Tool to Calculate Nonpoint Sources of Pollution in Watershed and Stormwater Projects, User's Manual. United States Environmental Protection Agency. January 2001.

Values for event mean concentrations (EMCs) for twelve common storm water pollutants, annual rainfall, and land use specific imperviousness values for ten land use categories were taken from published data developed for the Rouge and Clinton River basins in southeast Michigan.^{6,7,8} Impervious surface coverage and EMCs for mixed residential and commercial land use were calculated by averaging the published values for medium density residential and commercial land uses. Values for both directly connected imperviousness and total impervious surface coverage, were used as inputs to the model. This was done because studies have shown that models that include all areas within a watershed tend to overestimate surface runoff and resultant pollutant loads, so actual loads are likely between the values derived from these two different models. (A study conducted by Richards and Brenner⁹ within the Huron River Watershed found as much as 63% of the Huron River Watershed drains to depressional areas that capture and hold runoff internally).

Pollutant Reductions from Bank Stabilization/Restoration

A list of on-going, planned, or potential stream bank erosion projects was identified through discussions with individual community representatives. Where unknown, the length(s) of the stream bank section to be stabilized were estimated based on areas designated on maps in these same discussions. Pollutant reductions attributed to planned or potential stream bank stabilization actions/projects were calculated using the Channel Erosion Equation (CEE),¹⁰ presented below:

$$\text{CEE} = \text{Length (ft.)} \times \text{Height (ft.)} \times \text{LRR (ft./yr.)} \times \text{Soil weight (ton/ft.}^3\text{)}$$

Where:

LRR = Lateral Recession Rate

Estimated values for lateral recession rate values and for soil weight were applied based upon typical recession rates for moderate stream bank erosion and for loams, sandy clay loams, and sandy clay.¹¹ The resulting estimates of pollutant load reductions from stream bank stabilization projects are presented in Table F1.

Pollutant Reductions from Detection and Elimination of Illicit Discharges

Estimated values for pollutant loads attributed to known illicit cross-connections between sanitary and storm sewer systems were provided by the Wayne County Department of Environment (DOE).¹² The DOE conducted dye testing of commercial buildings within a portion of the Ecorse Creek watershed from 2003 through 2005. During this period, 519 facilities were inspected, resulting in the identification of 276 illicit connections at 76 facilities.¹³ Pollutant load reductions that could be achieved by correcting these illicit connections were calculated

⁶ Cave, K., T. Quasebarth, and E. Harold. 1994. Technical Memorandum. Selection of Stormwater Pollutant Loading Factors. Rouge River National Wet weather Demonstration Program. RPO-MOD-TM34.00. 39pp.

⁷ Perry, S. and A. Hamann. 1998. Utilizing GIS as a Tool in Mapping Impervious Surfaces and Protecting Southeast Michigan's Headwaters. <http://gis.esri.com/library/userconf/proc98/PROCEED/TO450/PAP448/P448.HTM>

⁸ Kluiteneberg, E. 1994. *Determination of Impervious Area and Directly Connected Impervious Area*. Memo for the Wayne County Rouge Program Office. Detroit, MI.

⁹ Richards, P.L. and A.J. Brenner. 2004. Delineating Source Areas for Runoff in Depressional Landscapes: Implications for Hydrologic Modeling. *J. Great Lakes Res.* 30(1):9-21. International Association of Great Lakes Research, Ann Arbor, MI.

¹⁰ MDEQ (Michigan Department of Environmental Quality). 1999. Pollutants Controlled Calculation and Documentation for Section 319 Watersheds Training Manual. Michigan Department of Environmental Quality, Water Division, Nonpoint Source Unit, Lansing, MI. Revised June 1999.

¹¹ MDEQ (Michigan Department of Environmental Quality). 1999. Pollutants Controlled Calculation and Documentation for Section 319 Watersheds Training Manual. Michigan Department of Environmental Quality, Water Division, Nonpoint Source Unit, Lansing, MI. Revised June 1999.

¹² Wayne County Department of Environment. 2005. Final Report for Clean Water Initiative Clean Water Grant: Illicit Connection Elimination in Ecorse Creek, CMI-CWF #2001-0078. Submitted to the Michigan Department of Environmental Quality, Water Division. June 2005.

¹³ Ibid

by DOE. The pilot program for commercial facilities conducted by DOE encompassed approximately 20% of the watershed. Additional reductions that might be achieved by expanding the IDEP program throughout the watershed were estimated by extrapolating their results across the other 80% of the basin.

Repair of a sanitary sewer along the Sexton-Kilfoil (serving 37 residences) provided additional reductions in pollutant loadings (Table F2).¹⁴ Further load reductions that could potentially be achieved by implementing a time-of-sale inspection program for residential buildings were calculated assuming a 7.8% rate of illicit connections (the average value found in extensive dye-testing within the neighboring Rouge River Basin, which is lower than the detection rate found so far in the Ecorse Creek drainage) and using average per-capita wastewater pollutant load rates from previously published sources.¹⁵ The resulting estimated reductions are also presented in (Table F2).

Pollutant Reductions from High Efficiency Street Sweeping

Interviews with, and survey questionnaires collected from, municipal representatives identified the curb miles and frequency of street sweeping currently being done by municipal departments, as well as the agency responsible and the type of sweeping machinery used. Sweepers were characterized as Mechanical (M), Vacuum-assisted (V), or high efficiency (H.E.), or a combination of Mechanical and Vacuum.

The amount of TSS removed annually through these existing programs was calculated using efficiency data for the various types of sweepers from Minton et. al.¹⁶ No increases in sweeping frequency were modeled, but estimates were calculated to determine the differential benefit in additional pollutant removal assuming all communities currently operating mechanical and/or vacuum machines upgrade to high efficiency sweepers over time. Values for estimated phosphorus and nitrogen removals associated with higher efficiency sweeping were calculated using values from the MDEQ's guidance for calculating nonpoint pollutant reduction.¹⁷ Pollutant removal estimates are shown in Table F3.

Pollutant Reductions from Regional Detention

As described in Section 5.5.3, the PLOAD model developed by the Michigan Department of Environmental Quality for the Ecorse Creek TMDL was revised to incorporate a revised watershed boundary and to account for existing regional wet-basin detention systems in the City of Taylor and at Detroit Metropolitan Airport (Table 5-6). Interviews with municipal representatives identified a number of additional planned or potential locations for some form of regional storm water detention (e.g., off-line storage, enlarging of flood plain areas for additional storm water storage, wetland creation, etc.). Pollutant load reductions achievable through construction of wet-basin detention systems, constructed wetlands, or floodplain detention were calculated using the PLOAD model and published values for specific BMP pollutant removal efficiencies (Table F4).^{18,19,20} Drainage areas for these potential sites were estimated from the

¹⁴ Ibid

¹⁵ U.S. EPA. 1980. Design Manual, Onsite Wastewater Treatment and Disposal Systems (EPA/625/1-80-012). U.S. Environmental Protection Agency, Office of Research and Development, Washington DC.

¹⁶ Minton, Gary R. & Sutherland, Roger, "Stormwater Treatment Northwest" (newsletter), Vol. 9, No. 4, December 2003.

¹⁷ MDEQ (Michigan Department of Environmental Quality). 1999. Pollutants Controlled Calculation and Documentation for Section 319 Watersheds Training Manual. Michigan Department of Environmental Quality, Water Division, Nonpoint Source Unit, Lansing, MI. Revised June 1999.

¹⁸ U.S. EPA (U.S. Environmental Protection Agency). 2003. National Menu of Best management practices for Storm Water Phase II. <http://cfpub.epa.gov/npdes/stormwater/menuofbmps/post.cfm>

¹⁹ Tetra Tech MPS. 2002. Stormwater BMP Prioritization Analysis for the Kent and Brighton Lake Sub-Basins, Oakland and Livingston Counties, Michigan.

²⁰ Brown W., and T.R. Schueler. 1997. National Pollutant Removal Performance Database for Stormwater BMPs. Center for Watershed Protection, Ellicott City, MD.

size of areas available for detention. Land uses within those areas were determined from existing geographic information system (GIS) data.

Pollutant Reductions from Woodland and Wetland Preservation

Similarly, a variation of PLOAD calculations for pollutant loading was used to estimate potential pollutant load reductions that might be achieved through implementation of municipal woodland or wetland ordinances. For woodlands, all large blocks of existing forest land, equal to or greater than 5 acres in size, were identified using the GIS system data. Wetlands less than 5 acres in size were identified as well, to determine the value of communities protecting those wetlands that are not protected by statute; isolated wetlands less than five (5) acres in size. These areas were contrasted with future land use GIS coverage for the same areas.

Pollutant load estimates were calculated for these areas/acreages as they currently exist as wetland or woodland and as they are projected to be in the year 2030. The difference between these pollutant loading values equals the potential pollutant loads reduction from enactment of protective ordinances. It must be noted that this is not a reduction from current pollutant loads, but represents a potential reduction from future pollutant loads. The calculated values are presented in Tables F5 and F6.

Pollutant Reductions from Woodland and Wetland Preservation

In build-out analysis of three Townships bordering the City of Ann Arbor, the Washtenaw County Drain Commissioner's Office found that a 14% reduction in impervious surfaces could be achieved through the combination of several policy and design requirements for new development.²¹ The largest benefit was found in policy and design changes relative to street widths, open space design, and parking lot sizing. In particular, reducing residential road widths to 22 feet, (2) encouraging open space or clustered development for new homes, and (3) reducing parking stall dimensions to 9' x 18', requiring areas set aside for compact car parking,, reducing parking lot aisle widths, and reducing existing parking ratios per square foot of building floor are. ²² This 14% reduction was applied to high density residential, commercial, and mixed residential/commercial land uses, again using the PLOAD model, to estimate potential pollutant load reductions. The results of this analysis are presented in Table F7.

²¹ Sheehan, H. and J. Bobrin. 1999. Imperviousness Reduction and Mitigation in Tributaries of the Huron River: A stormwater management study of Ann Arbor, Scio, and Superior Townships. Report of the Washtenaw County Drain Commissioner to the Michigan Department of Environmental Quality, Great Lakes Protection Fund, November 1999. MDEQ (Michigan Department of Environmental Quality). 1999. Pollutants Controlled Calculation and Documentation for Section 319 Watersheds Training Manual. Michigan Department of Environmental Quality, Water Division, Nonpoint Source Unit, Lansing, MI. Revised June 1999.

²² Sheehan, H. and J. Bobrin. 1999. Imperviousness Reduction and Mitigation in Tributaries of the Huron River: A stormwater management study of Ann Arbor, Scio, and Superior Townships. Report of the Washtenaw County Drain Commissioner to the Michigan Department of Environmental Quality, Great Lakes Protection Fund, November 1999. MDEQ (Michigan Department of Environmental Quality). 1999. Pollutants Controlled Calculation and Documentation for Section 319 Watersheds Training Manual. Michigan Department of Environmental Quality, Water Division, Nonpoint Source Unit, Lansing, MI. Revised June 1999.

Pollutant Reductions from Wayne County Storm Water Ordinance

Similar to calculations for regional detention PLOAD calculations were applied to the acreage expected to change to high density residential, commercial, mixed commercial and industrial land uses, between 2000 and 2030 (current and future land use GIS data layers). The potential TSS pollutant reductions that could be achieved by applying the Wayne County Storm Water ordinance detention standards to these lands, and again assuming average pollutant removal efficiencies as reported in storm water literature, are presented in Table F8.

Pollutant Reductions from Converting Agricultural Land to Forest

Wayne County is rapidly losing agricultural land. By 2030, SEMCOG projects that the majority of parcels now in active agriculture will be converted to other uses. PLOAD calculations were again employed to determine how conversion of existing agricultural land to forest would influence pollutant loads. The results of this analysis are summarized in Table F9.

Pollutant Reductions from Reforesting 5% of the Watershed

Similarly, the impact of a watershed-wide goal of reforesting 5% of all lands within the watershed, excluding those within the boundaries of Detroit Metro Airport or otherwise serviced by Taylor's regional detention system, was investigated by modifying the PLOAD model. Pollutant reductions that could be achieved by implementing a 5% re-forestation goal are presented in Table F10.

Pollutant Reductions Attributed to Bioretention Retrofits

Retrofitting existing commercial and high density residential land uses with bioretention systems to treat storm water runoff was also explored using the PLOAD model and published pollutant removal efficiency data for bioretention. Pollutant reductions for retrofitting 10, 20, 30, 50, and 60% of the acreage in these land uses are presented in Table F11.

Table F1. Bank Stabilization / Restoration

Project & Location	Length	Height	LRR	Soil Weight	Indiv Proj TSS Reductions Indiv Proj	Indiv Proj TP Reductions Indiv Proj	Indiv Proj N Reductions Indiv Proj
N Branch between Telegraph & Southfield	3,000	5	0.1	0.045	67.5	68	135
Douglas & Kelly Dr confluence with Ecorse Creek	100	5	0.1	0.045	2.3	2	4.5
N Branch at Telegraph Road	100	5	0.1	0.045	2.3	2	4.5
Ecorse Creek adjacent to city-owned brownfield site	3,800	5	0.1	0.045	85.5	86	171
S Branch east of Fort Street	1,000	5	0.1	0.045	22.5	23	45
S Branch near Goddard and 12th Street	300	5	0.1	0.045	6.8	7	13.5
Black Creek at Romulus Elementary School	60	5	0.1	0.045	1.4	1	2.7
N Branch East of Allen Road	150	5	0.1	0.045	3.4	3	6.75
Streambank Stabilization Subtotal	8,510	5	0.1	0.045	191.5 382,950	191	383

tons/yr
lbs./yr

Table F2. Illicit Discharge Detection and Elimination (from Wayne Co. DOE reports)

Summary of Estimated Pollutant Load Reductions to the Ecorse Creek Watershed (not otherwise included in Lincoln Park residential reductions below): January 2003 through March 2005

Flow gallons/year	Ammonia	Surfactants	TOC	K	TSS	BOD ₅	TP	TS
	7	1,695	380	1,326	8,462			

Summary October 2004 through December 2004 pollutant load reductions attributed to repair of sanitary sewer along Sexton-Kilfoil in the City of Lincoln Park

Flow gallons/year	Ammonia	Surfactants	TOC	K	TSS	BOD ₅	TP	TS
	245	31		123	2	5,011	450	17,181

Estimated Pollutant Load Reductions from Ecorse Creek Watershed in Residential Areas Not Yet Dye-Tested

Municipality	Number of Households	Indivs per Household	% Pop in Watershed	Per Capita Water Use (gallons/year)	Average Pollutant Concentrations in Residential Wastewater (mg/L)						Estimated Reductions (lbs./year except fecal coliform = organisms or CFUs)					
					TP	TSS	BOD ₅	COD	Ammonia	Fec. Col.	TP	TSS	BOD ₅	COD	Ammonia	Fec. Col.
Allen Park	11,974	2.43	1.00	27,375	23	245	245	376	12	1.E+09	11,924	127,015	127,015	194,930	6,221	5.E+11
Dearborn Heights	23,276	2.47	0.35	27,375	23	245	245	376	63	1.E+09	8,246	87,838	87,838	134,805	22,587	4.E+11
Ecorse	4,339	2.58	0.63	27,375	23	245	245	376	63	1.E+09	2,890	30,787	30,787	47,248	7,917	1.E+11
Inkster	11,169	2.67	0.08	27,375	23	245	245	376	63	1.E+09	978	10,414	10,414	15,983	2,678	4.E+10
Lincoln Park	16,167	2.46	1.00	27,375	23	245	245	376	63	1.E+09	16,298	173,610	173,610	266,438	44,643	7.E+11
Melvindale	4,499	2.38	0.05	27,375	23	245	245	376	63	1.E+09	219	2,337	2,337	3,587	601	1.E+10
Romulus	8,439	2.70	0.25	27,375	23	245	245	376	63	1.E+09	2,334	24,866	24,866	38,162	6,394	1.E+11
Southgate	12,636	2.33	0.13	27,375	23	245	245	376	63	1.E+09	1,593	16,972	16,972	25,047	4,364	7.E+10
Taylor	24,776	2.63	0.69	27,375	23	245	245	376	63	1.E+09	18,425	196,267	196,267	301,209	50,469	8.E+11
Westland	36,533	2.34	0.40	27,375	23	245	245	376	63	1.E+09	14,013	149,270	149,270	229,083	38,384	6.E+11
Wyandotte	11,816	2.36	0.90	27,375	23	245	245	376	63	1.E+09	10,285	109,556	109,556	168,135	28,171	4.E+11
											87,206	928,932	928,932	1,425,626	212,428	4.E+12

Table F3. High Efficiency Street Sweeping

	Estimated Miles in Watershed	Exist. Effic. per Type and Frequency	High Efficiency % Reduction	Current Reductions	Added TSS Reduct.		Added N Reduct.	
					w/ High Eff. Sweeper	Added TP Reduct. w/ High Eff. Sweeper	w/ High Eff. Sweeper	Added N Reduct. w/ High Eff. Sweeper
Allen Park (Bi-weekly, April to Oct)								
Dearborn Heights (Weekly, April to Oct) M	75	0.29	0.79	9,610	16,568		8	17
Ecorse								
Inkster								
Lincoln Park (2x/Month, April to Oct) (Weekly, October) I	121	0.33	0.63	17,642	16,038		8	16
Melvindale (Weekly) M	3	0.29	0.79	384	663		0	1
Romulus (8-10x/Year) M	21	0.17	0.51	1,577	3,155		2	3
Southgate (Weekly, April - Nov) M	11	0.29	0.79	1,409	2,430		1	2
Taylor (Monthly) M	85	0.17	0.51	6,384	12,769		6	13
Westland (3x/Year) H.E.	6	0.51	0.51	1,352	0		0	0
Wyandotte (Every 10-14 Days) M+V	3	0.41	0.63	543	292		0	0
Wayne County	746	0.03	0.49	9,881	151,513		76	152
WCAA								
Street Sweeping Subtotal					203,426		93	187

lbs/year

Minton, Gary R. & Sutherland, Roger, "Stormwater Treatment Northwest" (newsletter), Vol. 9, No. 4, December 2003

Table F8. Wayne County Storm Water Detention Standards

Estimated TSS Removal from Implementing Wayne County Storm Water Ordinance for Future Increases in High Density Residential, Commercial, and Industrial Uses

Land Use Category	Net Acres (Au)	TSS Conc. (Cu)	Percent Imperviousness (Iu)	Annual Precipitation (P)	P _f	Runoff Coefficient (Rvu)*	TSS Annual Load	% of Total Load	% of Land Use	TSS (lbs/yr) Removed	TP (lbs/yr) Removed	TKN (lbs/yr) Removed
High Density Residential	3,347.0	97	51.4	31	0.9	0.513	1,052,441	40.2%	43.3%	689,349	2,239	8,510
Mixed Residential and Commercial Use	3,109.8	74	47.0	31	0.9	0.473	688,362	26.3%	40.3%	450,877	1,920	7,296
Industrial	1,267.1	149	75.9	31	0.9	0.733	875,291	33.5%	16.4%	573,315	1,212	4,607
Total	7,723.9						2,616,094	100.0%	100.0%	1,713,542	5,372	20,413

Table F9. Converting Agricultural Land to Forest

Land Use Category	Acres (Au)	SS Conc. (mg/l) (Cu)	Percent Total Imperviousness (Iu)	Annual Precipitation (in.) (P)	P _f	Runoff Coefficient (Rvu)	TSS Annual Load (lbs/yr)	% of Total Load	% of Land Use	TP (lbs/yr) Annual Load	TKN (lbs/yr) Annual Load	BOD (lbs/yr) Annual Load	COD (lbs/yr) Annual Load
Low Density Residential	12,546.4	70	18.8	31	0.9	0.219	1,217,446	27.7%	49.0%	9,044	57,742	660,899	2,156,618
Medium Density Residential	0.0	70	37.8	31	0.9	0.390	0	0.0%	0.0%	0	0	0	0
High Density Residential	539.2	97	51.4	31	0.9	0.513	169,548	3.9%	2.1%	419	2,045	24,471	138,085
Transportation	1,511.6	141	52.9	31	0.9	0.526	709,095	16.1%	5.9%	2,162	9,153	120,697	517,992
Commercial	3,183.7	77	56.2	31	0.9	0.556	861,655	19.6%	12.4%	3,693	19,471	234,997	895,226
Mixed Residential/Commercial Use	0.0	74	47.0	31	0.9	0.473	0	0.0%	0.0%	0	0	0	0
Forest & Rural Open	1,896.7	51	1.9	31	0.9	0.067	41,047	0.9%	7.4%	89	757	2,415	21,731
Wetland	2,103.1	6	2.4	31	0.9	0.072	5,714	0.1%	8.2%	76	752	3,809	5,714
Water	93.2	6	100.0	31	0.9	0.950	3,360	0.1%	0.4%	45	442	2,240	3,360
Active Agriculture	1,190.2	51	2.0	31	0.9	0.068	26,103	0.6%	4.6%	56	481	1,535	13,819
Urban Open	614.5	51	10.9	31	0.9	0.148	29,352	0.7%	2.4%	63	541	1,727	15,538
Industrial	1,925.7	149	75.9	31	0.9	0.733	1,330,240	30.3%	7.5%	2,857	18,570	214,267	758,862
Total	25,604.3						4,393,559	100.0%	100.0%	18,505	109,954	1,267,056	4,526,945
						orig diff	4,663,035 269,476			18,638 133	110,455 502	1,267,056 0	4,540,252 13,307

Table F10. 5% Reforestation Goal

Estimated Pollutant Load Reductions from 5% of Existing Land Use Converted to Forest (Excludes areas in Taylor or Metro Airport Detention)

Land Use Category	Acres (Au)	SS Conc. (mg/l) (Cu)	Percent Total Imperviousness (Iu)	Annual Precipitation (in.) (P)	P _f	Runoff Coefficient (Rvu)	TSS Annual Load (lbs/yr)	% of Total Load	% of Land Use	TP (lbs/yr) Annual Load	TKN (lbs/yr) Annual Load	BOD (lbs/yr) Annual Load	COD (lbs/yr) Annual Load
Low Density Residential	12,546.4	70	18.8	31	0.9	0.219	60,872	1.4%	49.0%	9,044	57,742	660,899	2,156,618
Medium Density Residential	0.0	70	37.8	31	0.9	0.390	0	0.0%	0.0%	0	0	0	0
High Density Residential	539.2	97	51.4	31	0.9	0.513	8,477	0.2%	2.1%	419	2,045	24,471	138,085
Transportation	1,511.6	141	52.9	31	0.9	0.526	35,455	0.8%	5.9%	2,162	9,153	120,697	517,992
Commercial	3,183.7	77	56.2	31	0.9	0.556	43,083	1.0%	12.4%	3,693	19,471	234,997	895,226
Mixed Residential/Commercial Use	0.0	74	47.0	31	0.9	0.473	0	0.0%	0.0%	0	0	0	0
Forest & Rural Open	1,896.7	51	1.9	31	0.9	0.067	2,052	0.0%	7.4%	89	757	2,415	21,731
Wetland	2,103.1	6	2.4	31	0.9	0.072	286	0.0%	8.2%	76	752	3,809	5,714
Water	93.2	6	100.0	31	0.9	0.950	168	0.0%	0.4%	45	442	2,240	3,360
Active Agriculture	1,190.2	145	2.0	31	0.9	0.068	3,711	0.1%	4.6%	189	963	1,535	27,127
Urban Open	614.5	51	10.9	31	0.9	0.148	1,468	0.0%	2.4%	63	541	1,727	15,539
Industrial	1,925.7	149	75.9	31	0.9	0.733	66,512	1.5%	7.5%	2,857	18,570	214,267	758,862
Total	25,604.3						222,084	5.1%	100.0%	18,638	110,455	1,267,056	4,540,252

Estimated Pollutant Loads from 5% of Existing Land Use Converted to Forest (Excludes areas in Taylor or Metro Airport Detention)

Land Use Category	Acres (Au)	TSS Conc. (Cu)	Percent Imperviousness (Iu)	Annual Precipitation (P)	P _f	Runoff Coefficient (Rvu)*	TSS Annual Load	% of Total Load	% of Land Use	TP (lbs/yr) Annual Load	TKN (lbs/yr) Annual Load	BOD (lbs/yr) Annual Load	COD (lbs/yr) Annual Load
Forest & Rural Open	1,280.2	51	10.9	31	0.9	0.148	61,150	220.7%	220.7%	13,189	1,127	3,597	32,374
Total	1,280.2						61,150	220.7%	220.7%	13,189	1,127	3,597	32,374

Reduction equals the difference

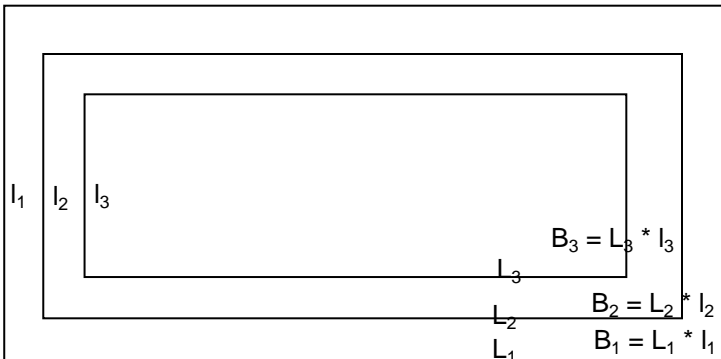
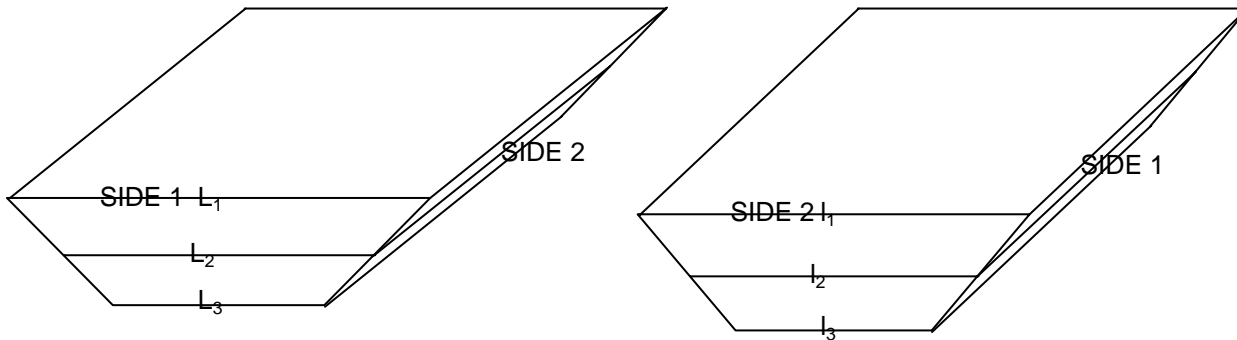
160,933 **5,448** **109,328** **1,263,459** **4,507,879**

Table F11. Commercial Bioretention Retrofits

Land Use Category	Acres (Au)	SS Conc. (mg/l) (Cu)	Percent Total Imperviousness (Iu)	Annual Precipitation (in.) (P)	P _f	Runoff Coefficient (Rvu)	TSS Annual Load (lbs/yr)	% of Total Load	% of Land Use	TP (lbs/yr) Annual Load	TKN (lbs/yr) Annual Load	BOD (lbs/yr) Annual Load	COD (lbs/yr) Annual Load	
Commercial	3,289.1	77	56.2	31	0.9	0.5558	826,987	2984.3%	566.9%	3,815	20,116	242,777	924,863	
High Density Residential	539.9	97	51.4	31	0.9	0.5126	161,135	0.034925808	0.019413908	420	2,048	24,503	138,265	
Comm High Dens Res						diff	711,209							
						diff	136,965							
							10%=>	71,121	20%=>	142,242	30%=>	213,363	50%=>	355,604
							10%=>	13,697	20%=>	27,393	30%=>	41,090	50%=>	68,483
													60%=>	426,725
													60%=>	82,179

Ecorse Creek Potential Basin Calculations

Basin #	Location	L1	l1	B1 (sqft) calculated	B1 (sqft) measured	L2	l2	B2 (sqft)	L3	l3	B3 (sqft)	h (detention)	H (permanent)	Volume permanent (cft)	Volume detention (cft)	Total Volume (cft)	Volume detention (cft), rounded
1	Allen Park (Railroad)	147	147	21,609	21,600	87	87	7,569	39	39	1,521	5	4	16,644	69,926	86,570	70,000
2	Allen Park (City Park)	147	147	21,609	21,600	87	87	7,569	39	39	1,521	5	4	16,644	69,926	86,570	70,000
3	Lincoln Park (Dix North)	181	182	32,942	33,023	121	122	14,762	73	74	5,402	5	4	38,792	116,440	155,232	120,000
4	Lincoln Park (Dix South)	679	680	461,720	462,096	619	620	383,780	571	572	326,612	5	4	1,419,248	2,111,662	3,530,910	2,100,000
5	Southgate (North)	407	408	166,056	166,253	383	384	147,072	335	336	112,560	2	4	517,728	313,129	830,857	300,000
6	Southgate (South)	287	288	82,656	82,922	263	264	69,432	215	216	46,440	2	4	230,208	152,155	382,363	150,000
7	Taylor (South of I-94)	688	688	473,344	473,995	628	628	394,384	580	580	336,400	5	4	1,460,032	2,167,900	3,627,932	2,200,000
8	Taylor (Jolly Rogers)	491	737	361,867	362,090	431	677	291,787	383	629	240,907	5	4	1,063,764	1,631,534	2,695,298	1,600,000
9	Taylor (I-94 & Beverly)	984	985	969,240	969,205	924	925	854,700	876	877	768,252	5	4	3,244,368	4,556,764	7,801,132	4,600,000



Ecorse Creek Watershed Estimated Drainage Areas

Basin #	Location	surface area	detention volume	C-factor	Qo	T10	Vs	Drainage Area
		(sqft)	(cf)		(cfs/acre)	(minutes)	(cf/acre)	(acres)
1	Allen Park (Railroad)	21,609	69,926	0.40	0.38	90.01	6108.78	29
2	Allen Park (City Park)	21,609	69,926	0.40	0.38	90.01	6108.78	29
3	Lincoln Park (Dix North)	32,942	116,440	0.40	0.38	90.01	6108.78	48
4	Lincoln Park (Dix South)	461,720	2,111,662	0.40	0.38	90.01	6108.78	864
5	Southgate (North)	166,056	313,129	0.40	0.38	90.01	6108.78	128
6	Southgate (South)	82,656	152,155	0.40	0.38	90.01	6108.78	62
7	Taylor (South of I-94)	473,344	2,167,900	0.40	0.38	90.01	6108.78	887
8	Taylor (Jolly Rogers)	361,867	1,631,534	0.40	0.38	90.01	6108.78	668
9	Taylor (I-94 & Beverly)	969,240	4,556,764	0.40	0.38	90.01	6108.78	1865

$$Q_a = (0.15 \text{ cfs / ac}) * A$$

$$Q_o = \frac{Q_a}{A * C} = \frac{(0.15 \text{ cfs / ac}) * A}{A * C}$$

Assume a C factor depending on drainage area o .

$$T_{10} = -19.9 + \sqrt{\frac{4530}{Q_o}}$$

$$V_s = \frac{9108 * T_{10}}{T_{10} + 19.9} - 40 * Q_o * T_{10}$$

$$V_t = V_s * A * C$$

V_t = detention volume; back calculate to find A

Calculation Notes

Volumes of basins were determined as follows:

1. The surface area was estimated by aerial interpretation only
2. The dimensions of the basin (L1 and I1) were estimated by using the surface area and assuming a shape for each basin based on the map
3. B1 is the surface area (L1 * I1)
4. L2 and I2 are based on the depth of detention (h)
5. Using geometry and the maximum 1:6 slopes (per Wayne County Standards), L2 = L1-(12*h) and I2 = I1-(12*h)
6. B2 is the area = L2 * I2 (see drawing)
7. L3 and I3 are based on the depth of permanent volume (H)
8. Using geometry and the maximum 1:6 slopes (per Wayne County Standards), L3 = L2-48 and I3 = I2-48
9. B3 is the area = L3 * I3 (see drawing)
10. The permanent volume was calculated with the following equation:

$$V = H \frac{(B2 + B3 + \sqrt{(B2 * B3)})}{3}$$

11. The detention volume was calculated with the following equation:

$$V = h \frac{(B1 + B2 + \sqrt{(B1 * B2)})}{3}$$

12. The total volume is the detention volume + the permanent volume

Wayne County Standards state the minimum permanent pool must be 4 ft and the maximum detention allowed is 5 ft above the permanent pool. Calculations were done assuming the minimum permanent pool (H) = 4 ft. The maximum detention depth (h) that could be used was determined by looking at USGS elevations.