



Combined Downriver Inter-Municipality Committee  
PLOAD Description  
Description of inputs/assumptions for modeling and pollutant load  
reductions and basin calculations

# Storm Water Pollutant Load Analysis

## PLOAD Description

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.<sup>1</sup>

At its heart, PLOAD employs the Simple Method<sup>2</sup> 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,<sup>3</sup> and has been used by the MDEQ to develop Total Maximum Daily Load (TMDL) allocations for the neighboring Ecorse River in southeast Michigan.<sup>4</sup> It is assumed that the pending biota TMDL for the Combined Downriver Watershed will also be developed using PLOAD analysis.

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:<sup>5</sup>

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

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 <sub>run</sub> /inches <sub>rain</sub> )
$C_u$	=	Event Mean Concentration for land use type $u$ (mg/L)
$A_u$	=	Are of land use type $u$ (acres)
2.72	=	Conversion factor
12	=	Conversion factor

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<sup>1</sup> 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.

<sup>2</sup> 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.

<sup>3</sup> 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.

<sup>4</sup> 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.

<sup>5</sup> 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.

$R_{vu}$  is derived from the following equation:

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

Where:

$I_u$  = Percent imperviousness land use type  $u$  (%)

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.<sup>6,7,8</sup> 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 Brenner<sup>9</sup> 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),<sup>10</sup> presented below:

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

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

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<sup>6</sup> 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.

<sup>7</sup> 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>

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

<sup>9</sup> 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.

<sup>10</sup> 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.

sandy clay.<sup>11</sup> The resulting estimates of pollutant load reductions from stream bank stabilization projects are presented in Table E1.

#### *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 within the Ecorse River to the north were provided by the Wayne County Department of Environment (DOE).<sup>12</sup> No illicit discharge investigations have yet been conducted within the CDR watershed. However, 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.<sup>13</sup> Pollutant load reductions that could be achieved by correcting these illicit connections were calculated by DOE. The pilot program for commercial facilities conducted by DOE encompassed approximately 20% of the Ecorse River watershed. Reductions that might be achieved by implementing an IDEP program throughout the CDR watershed were estimated by extrapolating the Ecorse Creek results across the CDR basin.

Repair of a sanitary sewer along the Sexton-Kilfoil (serving 37 residences) provided additional reductions in pollutant loadings in Ecorse Creek (Table E2).<sup>14</sup> 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 Rouge River Basin) and using average per-capita wastewater pollutant load rates from previously published sources.<sup>15</sup> 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.<sup>16</sup> 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.<sup>17</sup> Pollutant removal estimates are shown in Table E3.

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<sup>11</sup> 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.

<sup>12</sup> 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.

<sup>13</sup> Ibid

<sup>14</sup> Ibid

<sup>15</sup> 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.

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

<sup>17</sup> 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 Regional Detention*

As described in Section 5.4.3, the PLOAD model for the CDR watershed incorporated existing regional storm water collection systems within the Wyandotte-Southfield Drainage District and storm water detention systems at Detroit Metropolitan Airport (Table 5-5). 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 E4).<sup>18,19,20</sup> Drainage areas for these potential sites were estimated from the 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 E5 and E6.

#### *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.<sup>21</sup> 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

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<sup>18</sup> 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>

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

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

<sup>21</sup> Bobrin, J. and H. Sheehan. 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.

are.<sup>22</sup> 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 E7.

*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 E8.

*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 E9.

*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 the Wyandotte-Southfield Drainage District, was investigated by modifying the PLOAD model. Pollutant reductions that could be achieved by implementing a 5% re-forestation goal are presented in Table E10.

*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 E11.

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<sup>22</sup> 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.

Table E1. Bank Stabilization / Restoration

Project & Location	Length (ft)	Height (ft)	LRR (ft/yr)	Soil Weight (ton/ft <sup>2</sup> )	Indiv Proj Reductions (ton/ft <sup>2</sup> )	Indiv Proj TP Reductions (lbs/yr)	Indiv Proj N Reductions (lbs/yr)
VanClef Drain between Telegraph & I-75	5,200	5	0.1	0.045	117.0	117	234
Blakely Drain between I-75 and Allen Road	4,200	5	0.1	0.045	94.5	95	189
Brownstown Creek between Telegraph & Twp Boundary	2,400	5	0.1	0.045	54.0	54	108
Brownstown Creek Chatham Park Area	2,400	5	0.1	0.045	54.0	54	108
Drain No. 1 at Brownstown Twp Hall			0.1				
Thorofare Canal at Township-owned properties	1,200	5	0.1	0.045	27.0	27	54
Goetske Drain between Middlebelt and Telegraph	600	5	0.1	0.045	13.5	14	27
Northern sections of islands (2) that comprise City	500	5	0.1	0.045	11.3	11	22.5
Huntington Drain at Reflection Pond N of Sibley Rd	250	5	0.1	0.045	5.6	6	11.25
Frank & Poet Drain at former State Regional Center	2,600	5	0.1	0.045	58.5	59	117
Frank & Poet Drain at confluence with Sutliff & Kenope	1,000	5	0.1	0.045	22.5	23	45
Frank & Poet Drain west of Dix-Toledo	1,400	5	0.1	0.045	31.5	32	63
Blakely Drain in City park, S of Van Horn Road	800	5	0.1	0.045	18.0	18	36
Brownstown Creek between Hall Rd and I-75	2,000	5	0.1	0.045	45.0	45	90
Brownstown Creek north of West Road	500	5	0.1	0.045	11.3	11	22.5
Detroit River at Bishop Park	450	5	0.1	0.045	10.1	10	20.25
Detroit River at Wyandotte Shores Golf Course	1,300	5	0.1	0.045	29.3	29	58.5
Blakely Drain at McLouth Park	500	5	0.1	0.045	11.3	11	22.5
Frank & Poet Drain at Gibraltar Trade Center	200	5	0.1	0.045	4.5	5	9
Blakely Drain at Grix and Hall	400	5	0.1	0.045	9.0	9	18
Frank & Poet Drain at Riverview Golf Course	150	5	0.1	0.045	3.4	3	6.75
Drain on west side of WCAA property	1,500	5	0.1	0.045	33.8	34	67.5
Frank & Poet Drain at Southland Mall							
<b>Totals</b>	<b>29,550</b>	<b>5</b>	<b>0.1</b>	<b>0.045</b>	<b>664.9</b>	<b>665</b>	<b>1,330</b>
					<b>1,329,750</b>		<b>lbs./yr</b>

Table E2. Illicit Discharge Detection and Elimination - Note: No IDEP data available for CDR, Ecorse Creek Watershed values used as estimates (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 <sub>5</sub>	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 <sub>5</sub>	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)					
					TP	TSS	BOD <sub>5</sub>	COD	Ammonia	Fec. Col.	TP	TSS	BOD <sub>5</sub>	COD	Ammonia	Fec. Col.
Brownstown Township	8,322	2.76	0.53	27,375	23	245	245	376	12	1.E+09	4,989	53,140	53,140	81,554	2,603	2.E+11
Gibraltar	1,728	2.46	0.99	27,375	23	245	245	376	63	1.E+09	1,725	18,371	18,371	28,193	4,724	7.E+10
Grosse Isle Township	4,122	2.64	1.00	27,375	23	245	245	376	63	1.E+09	4,459	47,503	47,503	72,903	12,215	2.E+11
Huron Township	4,745	2.88	0.07	27,375	23	245	245	376	63	1.E+09	392	4,176	4,176	6,409	1,074	2.E+10
Riverview	5,352	2.38	1.00	27,375	23	245	245	376	63	1.E+09	5,220	55,604	55,604	85,335	14,298	2.E+11
Romulus	8,439	2.70	0.52	27,375	23	245	245	376	63	1.E+09	4,855	51,721	51,721	79,376	13,300	2.E+11
Southgate	12,836	2.33	0.85	27,375	23	245	245	376	63	1.E+09	10,418	110,972	110,972	170,309	28,536	5.E+11
Taylor	24,776	2.63	0.31	27,375	23	245	245	376	63	1.E+09	8,278	88,178	88,178	135,326	22,674	4.E+11
Trenton	8,137	2.38	1.00	27,375	23	245	245	376	63	1.E+09	7,936	84,538	84,538	129,740	21,738	3.E+11
Woodhaven	4,708	2.63	0.96	27,375	23	245	245	376	63	1.E+09	4,871	51,889	51,889	79,633	13,343	2.E+11
Wyandotte	11,816	2.36	0.93	27,375	23	245	245	376	63	1.E+09	10,628	113,208	113,208	173,739	29,111	5.E+11
<b>Totals</b>											<b>63,771</b>	<b>679,299</b>	<b>679,299</b>	<b>1,042,517</b>	<b>163,615</b>	<b>3.E+12</b>

Table E3. High Efficiency Street Sweeping

	Estimated Miles in Watershed	Exist. Effic. per Type and Frequency	High Efficiency % Reduction	Current Reductions	Added Reduct. w/ High Eff. Sweeper	Added TP Reduct. w/ High Eff. Sweeper	Added N Reduct. w/ High Eff. Sweeper
1 Brownstown Twp (6 wks in Fall) M	24	0.17	0.51	1,803	3,605	2	4
2 Grosse Ile Twp							
3 Huron Twp							
4 Gibraltar (3x/Year) M	7	0.17	0.51	556	1,112	1	1
5 Riverview (Monthly, April - Aug) M	30	0.17	0.51	2,253	4,507	2	5
6 Romulus (8-10x/Year) M	42	0.17	0.51	3,155	6,309	3	6
7 Southgate (Weekly, April- Nov) M	64	0.29	0.79	8,200	14,138	7	14
8 Taylor (Monthly) M	71	0.17	0.51	5,333	10,665	5	11
9 Woodhaven (Weekly, spring - fall) M+V	35	0.33	0.79	5,103	7,113	4	7
10 W-B Schools						0	0
11 Wyandotte (Every 10-14 days, spring - fall) M+V	97	0.33	0.63	14,143	12,857	6	13
12 Wayne County	1,476	0.03	0.49	19,557	299,875	150	300
13 WCAA							
<b>Street Sweeping Subtotal</b>					<b>360,182</b>	<b>178</b>	<b>357</b>

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

Table E4. Regional Detention

Estimated TSS Loads and Reductions from Existing Sumps, Lift Stations and Detention, Detroit Metro Airport

Land Use Category	Acres (Au)	TSS Conc. (Cu)	Percent Imperviousness (Iu)	Annual Precipitation (P)	P <sub>i</sub>	Runoff Coefficient (Rcu)*	TSS Annual Load**	% of Total Load	% of Land Use	TSS (lbs/yr) Removed	TP (lbs/yr) Removed	TKN (lbs/yr) Removed
Low Density Residential	37.5	70	18.8	31	0.9	0.219	3,639	0.3%	1.2%	2,383	13	54
Medium Density Residential	0.0	70	37.8	31	0.9	0.390	0	0.0%	0.0%	0	0	0
High Density Residential	0.0	97	51.4	31	0.9	0.513	0	0.0%	0.0%	0	0	0
Transportation	2,612.9	141	52.9	31	0.9	0.526	1,225,750	98.5%	84.4%	802,867	1,794	4,905
Commercial	20.8	77	56.2	31	0.9	0.556	5,629	0.5%	0.7%	3,687	12	39
Mixed Residential and Commercial Use	0.0	74	47.0	31	0.9	0.473	0	0.0%	0.0%	0	0	0
Forest & Rural Open	282.4	51	1.9	31	0.9	0.067	6,112	0.5%	9.1%	4,003	6	35
Wetland	67.6	6	2.4	31	0.9	0.072	184	0.0%	2.2%	120	1	7
Water	53.0	6	100.0	31	0.9	0.950	1,910	0.2%	1.7%	1,251	12	78
Active Agriculture	20.4	145	2.0	31	0.9	0.068	1,272	0.1%	0.7%	833	2	5
Urban Open	0.0	51	10.9	31	0.9	0.148	0	0.0%	0.0%	0	0	0
Industrial	0.0	149	75.9	31	0.9	0.733	0	0.0%	0.0%	0	0	0
<b>Total</b>	<b>3,094.6</b>						<b>1,244,496</b>	<b>100.0%</b>	<b>100.0%</b>	<b>815,145</b>	<b>1,840</b>	<b>5,123</b>

Estimated TSS Loads and Reductions from Regional Detention Opportunities Identified by Communities

Land Use Category	Acres (Au)	TSS Conc. (Cu)	Percent Imperviousness (Iu)	Annual Precipitation (P)	P <sub>i</sub>	Runoff Coefficient (Rcu)*	TSS Annual Load**	% of Total Load	% of Land Use	TSS (lbs/yr) Removed	TP (lbs/yr) Removed	TKN (lbs/yr) Removed
Allen Park (Railroad)	28.6	74	30.3	31	0.9	0.322	4,286	0.8%	0.8%	2,808	12	46
Allen Park (City Park)	28.6	74	30.3	31	0.9	0.322	4,286	0.8%	0.8%	2,808	12	46
Lincoln Park (Dix North)	47.7	74	30.3	31	0.9	0.322	7,138	1.4%	1.4%	4,675	20	76
Lincoln Park (Dix South)	864.2	74	30.3	31	0.9	0.322	129,444	25.3%	25.3%	84,786	363	1,381
Southgate (North)	128.1	74	30.3	31	0.9	0.322	19,195	3.7%	3.7%	12,573	54	205
Southgate (South)	62.3	74	30.3	31	0.9	0.322	9,327	1.8%	1.8%	6,109	26	100
Taylor (South of I-94)	887.2	74	30.3	31	0.9	0.322	132,891	25.9%	25.9%	87,044	373	1,418
Taylor (Jolly Rogers)	667.7	74	30.3	31	0.9	0.322	100,012	19.5%	19.5%	65,508	281	1,067
Taylor (I-94 & Beverly)	1,864.8	74	30.3	31	0.9	0.322	279,328	54.5%	54.5%	182,960	784	2,981
<b>Total</b>	<b>3,419.7</b>						<b>512,232</b>	<b>100.0%</b>	<b>100.0%</b>	<b>335,512</b>	<b>1,926</b>	<b>7,319</b>







## Basin Calculation Notes

Volumes of basins were determined as follows:

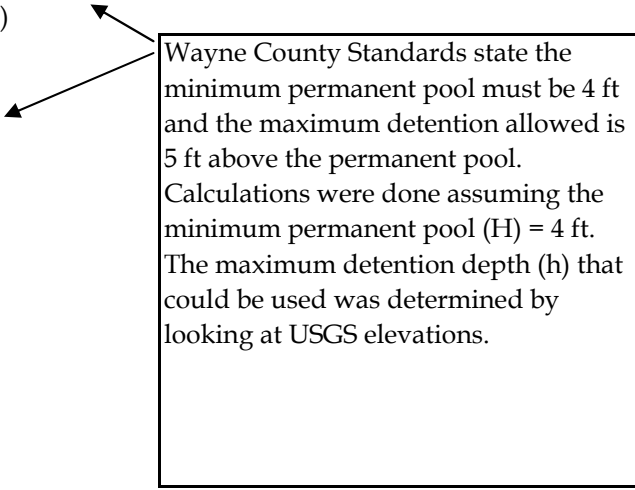
1. The surface area was estimated based on aerial photography interpretation only
2. The dimensions of the basin (L1 and l1) were estimated by using the surface area and assuming a shape for each basin based on the map
3. B1 is the surface area (L1 \* l1)
4. L2 and l2 are based on the depth of detention (h)
5. Using geometry and the maximum 1:6 slopes (per Wayne County Standards), L2 = L1-(12\*h) and l2 = l1-(12\*h)
6. B2 is the area = L2 \* l2 (see drawing)
7. L3 and l3 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 l3 = l2-48
9. B3 is the area = L3 \* l3 (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:

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

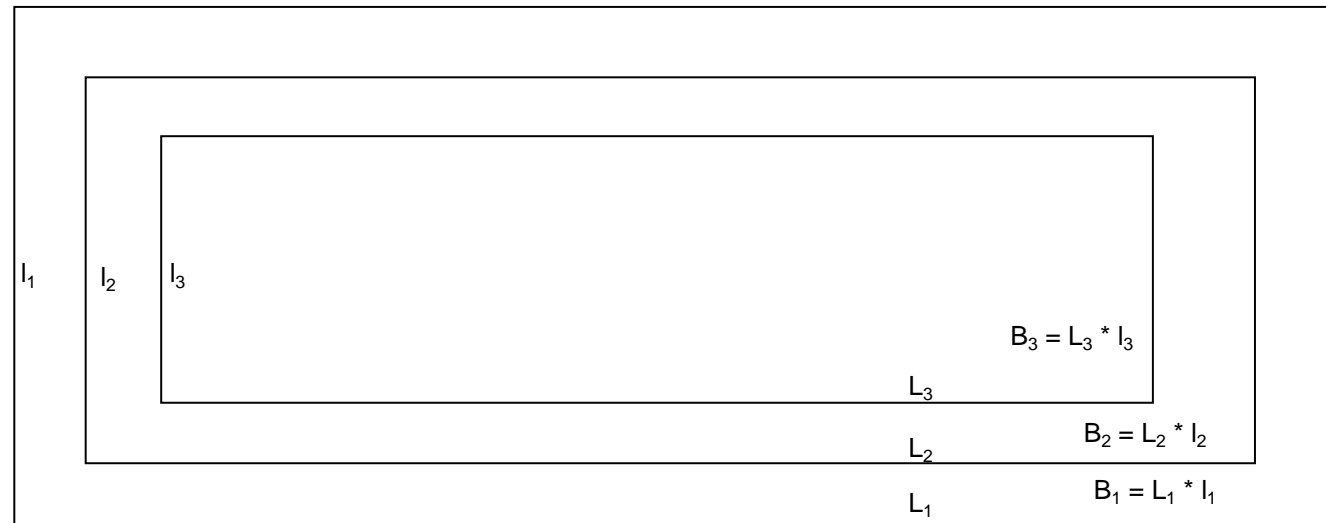
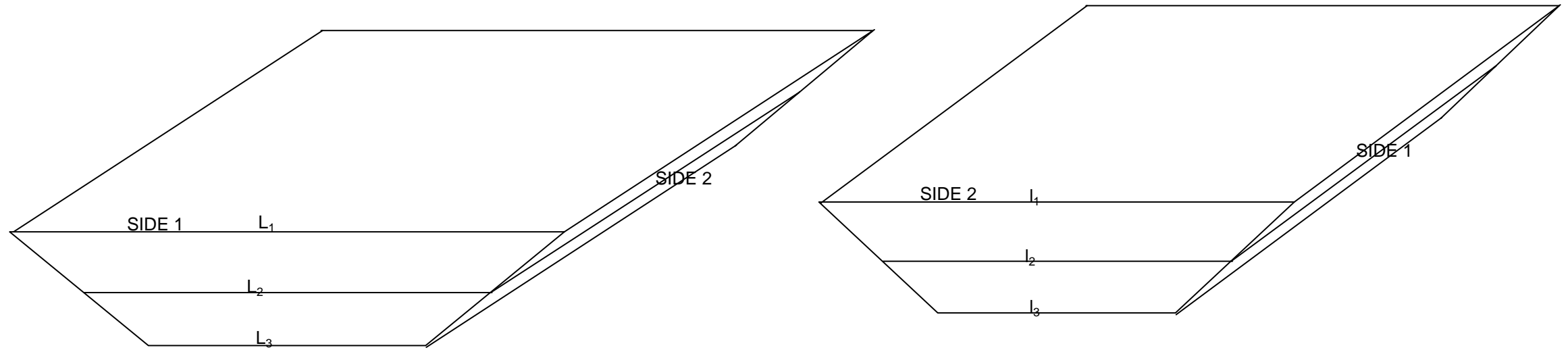
12. The total volume is the detention volume + the permanent volume



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.

### Combined Downriver - Basin Volume 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	Brownstown (Ford Property)	603	1207	727,821	728,333	543	1147	622,821	495	1099	544,005	5	4	2,331,875	3,374,447	5,706,322	3,300,000
2	Woodhaven (Brownstown Creek)	344	1035	356,040	356,298	284	975	276,900	236	927	218,772	5	4	989,064	1,578,830	2,567,894	1,600,000
3	Southgate (Regional Center North)	330	330	108,900	109,117	270	270	72,900	222	222	49,284	5	4	242,832	452,010	694,842	450,000
4	Southgate (Regional Center South)	389	389	151,321	151,516	329	329	108,241	281	281	78,961	5	4	372,868	646,367	1,019,235	650,000



## Combined Downriver - Basin Drainage Area Calculations

Basin #	Location	surface area (sqft)	detention volume (cf)	C-factor	Qo (cfs/acre)	T10 (minutes)	Vs (cf/acre)	Drainage Area (acres)
1	Brownstown (Ford Property)	727,821	3,374,447	0.40	0.38	90.01	6108.78	1381
2	Woodhaven (Brownstown Creek)	356,040	1,578,830	0.40	0.38	90.01	6108.78	646
3	Southgate (Regional Center North)	108,900	452,010	0.40	0.38	90.01	6108.78	185
4	Southgate (Regional Center South)	151,321	646,367	0.40	0.38	90.01	6108.78	265

Wayne County Standards:

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

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

Assume a C factor depending on drainage area  $Q_o$

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

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

$$V_t = V_s * A * C$$

$V_t$  = detention volume; back calculate to find A