7 Pollutant Sources and Pollutant Loads

The following section provides information on potential pollutant sources in the watershed and an approximation of existing pollutant loads and reductions needed based on pollutant thresholds/target values.

7.1 Potential Pollutant Sources

Information about watershed problems and potential causes listed above in Table 88 have been linked to potential sources in the following tables. The Indiana Department of Environmental Management defines a sources as an activity, material, or structure that results in a cause of nonpoint source pollution.

Problem	The degradation and loss of upland, wetland and riparian habitats is negatively affecting our watershed's ability to store and filter storm water runoff while also providing important habitat and recreation opportunities.
Potential Cause(s)	Encroachment on and conversion of upland, riparian and wetland habitat for development and agricultural land uses.
Potential Sources	• Between 1985 and 2010 approximately 759 acres of forest, 2,430 acres of grassland, 1,079 acres of scrub/shrub, and 563 acres of wetland habitat has been converted. • Nearly 220 acres (3%) of core forest habitat was lost between 1996 and 2006. • Percentage of human land uses occurring within 100-foot riparian buffer: 53% Headwaters Main Beaver Dam Ditch, 63% Main Beaver Dam Ditch, 65% Headwaters Turkey Creek, 40% Deer Creek, 60% City of Merrillville, 44% Duck Creek, 35% Lake George, 45% Little Calumet River, and 57% Willow Creek subwatersheds. • Subwatershed wetland loss: Headwaters Main Beaver Dam Ditch 75%, Main Beaver Dam Ditch 86%, Headwaters Turkey Creek 76%, Deer Creek 71%, City of Merrillville 76%, Duck Creek 81%, Lake George 61%, Little Calumet River 69%, and Willow Creek 74%. • Subwatershed drainage area 10% or less wetland: Headwaters Main Beaver Dam Ditch 10% , Main Beaver Dam Ditch 5%, Headwaters Turkey Creek 9%, Deer Creek 7%, City of Merrillville 8%, Duck Creek 5%, Lake George 10%, Little Calumet River 10%, and Willow Creek 9% subwatersheds.

Table 89 Potential causes and sources of habitat degredation

Problem	Some streams and lakes are frequently turbid and have nuisance levels of aquatic plant growth and algal blooms.
Potential Cause(s)	• Nutrient concentrations often exceed the protective water quality target values established by this watershed plan. • Sediment concentrations often exceed the protective water quality target values established by this watershed plan. • Streams are disassociated from their floodplains
Potential Sources	• CSO communities: Crown Point and Gary (4 Headwaters Main Beaver Dam Ditch subwatershed, 1 Main Beaver Dam Ditch subwatershed, 5 Little Calumet River subwatershed). • SSOs: Merrillville and Portage (1 Headwaters Turkey Creek subwatershed, 1 City of Merrillville subwatershed and 1 Willow Creek subwatershed). • Pasture and livestock operations (# animal units/subwatershed: 208 Headwaters Main Beaver Dam Ditch, 299 Main Beaver Dam Ditch, 242 Headwaters Turkey Creek, 420 Deer Creek, 325 City of Merrillville, 311 Duck Creek, 290 Lake George, 328 Little Calumet River, 411 Willow Creek). • 26,000 acres of row crop production in the watershed • Approximately 2,600 acres (10%) of row crop production occur on HEL soils

	• Approximately 18,500 acres (71%) of row crop are tile drained • Approximately 45% of row crop in corn is conventional tillage • There are approximately 23,000 septic systems in the watershed based on number of rural households. The highest densities are located in the Headwaters Main Beaver Dam Ditch (402 households/mi^2), Headwaters Turkey Creek (280 households/mi^2), and Duck Creek (243 households/mi^2). • Domestic pets in population centers (# dogs/subwatershed: 8,500 Headwaters Main Beaver Dam Ditch, 13,000 Main Beaver Dam Ditch, 19,000 Headwaters Turkey Creek, 5,000 Deer Creek, 29,000 City of Merrillville, 6,000 Duck Creek, 13,000 Lake George, 37,000 Little Calumet River, 20,000 Willow Creek). • MS4 entities (#/subwatershed: 6 Headwaters Main Beaver Dam Ditch, 3 Main Beaver Dam Ditch, 6 Headwaters Turkey Creek, 5 Deer Creek, 4 City of Merrillville, 4 Duck Creek, 4 Lake George, 7 Little Calumet River, 4 Willow Creek). • Percentage of human land uses occurring within 100-foot riparian buffer: 53% Headwaters Main Beaver Dam Ditch, 63% Main Beaver Dam Ditch, 65% Headwaters Turkey Creek, 40% Deer Creek, 60 City of Merrillville, 44% Duck Creek, 35% Lake George, 45% Little Calumet River, and 57% Willow Creek subwatersheds. • Moderate to high levels of streambank erosion was documented at 28 of the 35 stream monitoring sites. • 24 of the 35 stream monitoring sites are located on stream reaches that have been channelized. • Streams that are disassociated from there floodplain or ditches that were not designed with benches. • Approximately 112 miles of stream are maintained as regulated drains. • Flow-duration curves point to streams flows being strongly influenced by runoff and as a result are flashy.

Table 90 Potential causes and sources of turbid streams and algal blooms

Problem	Elevated pathogens levels pose a health risk to full body contact recreational use of streams.
Potential Cause(s)	*E. coli* concentrations often exceed state water quality standards.
Potential Sources	• NPDES permitted WWTPs (1 Headwaters Main Beaver Dam Ditch subwatershed, 4 Deer Creek subwatershed, 1 Little Calumet River subwatershed, 1 Willow Creek subwatershed). • CSO communities: Crown Point and Gary (4 Headwaters Main Beaver Dam Ditch subwatershed, 1 Main Beaver Dam Ditch subwatershed, 5 Little Calumet River subwatershed). • SSOs: Merrillville and Portage (1 Headwaters Turkey Creek subwatershed, 1 City of Merrillville subwatershed and 1 Willow Creek subwatershed). • Pasture and livestock operations (# animal units/subwatershed: 208 Headwaters Main Beaver Dam Ditch, 299 Main Beaver Dam Ditch, 242 Headwaters Turkey Creek, 420 Deer Creek, 325 City of Merrillville, 311 Duck Creek, 290 Lake George, 328 Little Calumet River, 411 Willow Creek). • There are approximately 23,000 septic systems in the watershed based on number of rural households. The estimated failure rate is somewhere between 1-2% which equates to 230 to 460 failing systems. The highest densities of systems are located in the Headwaters Main Beaver Dam Ditch (402 households/mi2), Headwaters Turkey Creek (280 households/mi2), and Duck Creek (243 households/mi2). • Domestic pets in population centers (# dogs/subwatershed: 8,500 Headwaters Main Beaver Dam Ditch, 13,000 Main Beaver Dam Ditch, 19,000 Headwaters Turkey Creek,

	5,000 Deer Creek, 29,000 City of Merrillville, 6,000 Duck Creek, 13,000 Lake George, 37,000 Little Calumet River, 20,000 Willow Creek). • An estimated 20% of dog owners do not pick up their pet's waste. • Nuisance level urban goose populations because of suitable habitat and feeding (ex. below Lake George dam) • MS4 entities (#/subwatershed: 6 Headwaters Main Beaver Dam Ditch, 3 Main Beaver Dam Ditch, 6 Headwaters Turkey Creek, 5 Deer Creek, 4 City of Merrillville, 4 Duck Creek, 4 Lake George, 7 Little Calumet River, 4 Willow Creek).

Table 91 Potential causes and sources of pathogens

Problem	Poor quality fish community structure and numbers limit recreational use of streams and lakes.
Potential Cause(s)	• Streams lack the habitat quality that is conducive to supporting a healthy warm water fishery as indicated by QHEI scores. • Dissolved oxygen concentrations fall below state water quality standards. • Nutrient concentrations often exceed the protective water quality target values established by this watershed restoration plan. • Ammonia concentrations often exceed the protective water quality target values established by this watershed plan. • Sediment concentrations often exceed the protective water quality target values established by this watershed plan.
Potential Sources	• Sites 1, 3, 5, 8, 10, 11, 17, 19-22, and 24-36 have habitat quality that is generally not conducive of supporting a healthy warm water fishery (QHEI <51). • There are seven dams located in the watershed. • There are 112 miles of channel that are managed as regulated drains, representing approximately 39% of the total stream miles, in the watershed. • 24 of the 35 stream monitoring sites are located on stream reaches that have been channelized. • Flow-duration curves point to streams flows being strongly influenced by runoff and as a result are flashy. • Percentage of human land uses occurring within 100-foot riparian buffer: 53% Headwaters Main Beaver Dam Ditch, 63% Main Beaver Dam Ditch, 65% Headwaters Turkey Creek, 40% Deer Creek, 60% City of Merrillville, 44% Duck Creek, 35% Lake George, 45% Little Calumet River, and 57% Willow Creek subwatersheds.

Table 92 Potential causes and sources resulting in poor quality fish communities

Problem	Hydromodification activities are negatively affecting aquatic life and recreational use of streams and lakes.
Potential Cause(s)	Hydromodification activities disrupts hydraulic, geomorphic, physiochemical, and biotic stream functions
Potential Sources	• Seven dams located in the watershed. • There are 112 miles of channel that are managed as county regulated drains, representing approximately 39% of the total stream miles, in the watershed. • 24 of the 35 stream monitoring sites are located on stream reaches that have been channelized. • Flow-duration curves point to streams flows being strongly influenced by runoff and as a result are flashy.

Table 93 Potential causes and sources of hydromodication negatively affecting aquatic life and recreational use

Problem	Excessive sediment and nutrient loading threaten aquatic life and recreational use of streams and lakes.
Potential Cause(s)	• Nutrient concentrations often exceed the protective water quality target values established by this watershed restoration plan. • Sediment concentrations often exceed the protective water quality target values established by this watershed restoration plan.
Potential Sources	• CSO communities: Crown Point and Gary (4 Headwaters Main Beaver Dam Ditch subwatershed, 1 Main Beaver Dam Ditch subwatershed, 5 Little Calumet River subwatershed). • SSOs: Merrillville and Portage (1 Headwaters Turkey Creek subwatershed, 1 City of Merrillville subwatershed and 1 Willow Creek subwatershed). • Pasture and livestock operations (# animal units/subwatershed: 208 Headwaters Main Beaver Dam Ditch, 299 Main Beaver Dam Ditch, 242 Headwaters Turkey Creek, 420 Deer Creek, 325 City of Merrillville, 311 Duck Creek, 290 Lake George, 328 Little Calumet River, 411 Willow Creek). • 26,000 acres of row crop production in the watershed • Approximately 2,600 acres (10%) of row crop production occur on HEL soils • Approximately 18,500 acres (71%) of row crop are tile drained • Approximately 45% of row crop in corn is conventional tillage • There are approximately 23,000 septic systems in the watershed based on number of rural households. The highest densities are located in the Headwaters Main Beaver Dam Ditch (402 households/mi^2), Headwaters Turkey Creek (280 households/mi^2), and Duck Creek (243 households/mi^2). • Domestic pets in population centers (# dogs/subwatershed: 8,500 Headwaters Main Beaver Dam Ditch, 13,000 Main Beaver Dam Ditch, 19,000 Headwaters Turkey Creek, 5,000 Deer Creek, 29,000 City of Merrillville, 6,000 Duck Creek, 13,000 Lake George, 37,000 Little Calumet River, 20,000 Willow Creek). • MS4 entities (#/subwatershed: 6 Headwaters Main Beaver Dam Ditch, 3 Main Beaver Dam Ditch, 6 Headwaters Turkey Creek, 5 Deer Creek, 4 City of Merrillville, 4 Duck Creek, 4 Lake George, 7 Little Calumet River, 4 Willow Creek). • Percentage of human land uses occurring within 100-foot riparian buffer: 53% Headwaters Main Beaver Dam Ditch, 63% Main Beaver Dam Ditch, 65% Headwaters Turkey Creek, 40% Deer Creek, 60 City of Merrillville, 44% Duck Creek, 35% Lake George, 45% Little Calumet River, and 57% Willow Creek subwatersheds. • Moderate to high levels of streambank erosion was documented at 28 of the 35 stream monitoring sites. • 24 of the 35 stream monitoring sites are located on stream reaches that have been channelized. • Flow-duration curves point to streams flows being strongly influenced by runoff and as a result are flashy.

Table 94 Potential causes and sources of sediment and nutrient loading

Problem	Losses of upland, riparian and wetland habitats, and increases in impervious surface cover exacerbate streambank erosion and downstream flooding.
Potential Cause(s)	• Conversion of forest, grassland and wetland habitats for human land uses such as development and agriculture. • Development siting and implementation of post-development practices not sufficiently protective of environmental features and ecosystem functions.
Potential Sources	• Percentage of human land uses occurring within 100-foot riparian buffer: 53% Headwaters Main Beaver Dam Ditch, 63% Main Beaver Dam Ditch, 65% Headwaters

	Turkey Creek, 40% Deer Creek, 60% City of Merrillville, 44% Duck Creek, 35% Lake George, 45% Little Calumet River, and 57% Willow Creek subwatersheds. • Impervious surface cover exceeds 10% in the Headwaters Main Beaver Dam Ditch (16%), Main Beaver Dam Ditch (15%), Headwaters Turkey Creek (21%), City of Merrillville (26%), Lake George (18%), Little Calumet River (28%) and Willow Creek subwatersheds (25%). • Subwatershed wetland loss: Headwaters Main Beaver Dam Ditch 75%, Main Beaver Dam Ditch 86%, Headwaters Turkey Creek 76%, Deer Creek 71%, City of Merrillville 76%, Duck Creek 81%, Lake George 61%, Little Calumet River 69%, and Willow Creek 74%. • Subwatershed drainage area 10% or less wetland: Headwaters Main Beaver Dam Ditch 10% , Main Beaver Dam Ditch 5%, Headwaters Turkey Creek 9%, Deer Creek 7%, City of Merrillville 8%, Duck Creek 5%, Lake George 10%, Little Calumet River 10%, and Willow Creek 9% subwatersheds.

Table 95 Potential sources streambank erosion and downstream flooding related to habitat loss

7.2 Current Runoff Volume & Pollutant Loads

Storm water runoff is the volume of water generated by a storm that does not infiltrate into the ground or is not retained in storage as surface water. A pollutant load is the mass of a pollutant (ex. pounds of sediment or nutrients) that passes a particular point (ex. monitoring station) of a river in specific amount of time (ex. annually). *E. coli* has no mass and its “load” is expressed as a concentration of colony forming units (CFU) or most probable number (MPN).

7.2.1 Pollutant Load Modeling

A number of models were considered and used during the development of this watershed plan to estimate pollutant loads and storm water runoff volume. The models included the Spreadsheet Tool for Estimating Pollutant Loads (STEPL), Region 5, Hydrologic Simulation Program- FORTRAN (HSPF), Nonpoint Source Pollution & Erosion Comparison Tool (NSPECT), and the Kentucky Nutrient models. STEPL and Region 5 are both fairly simple spreadsheet based models that were run by NIRCP. Because of the complexity and time intensity, NIRPC contracted with Purdue University Calumet- Department of Mechanical Engineering to setup and run the HSPF, NSPECT and Kentucky Nutrient models.

The STEPL model was used to estimate annual runoff volume and nutrient and sediment pollutant loads for each site catchment area. The Kentucky Nutrient Model was used to estimate nitrate and total phosphorus loads. The nitrate data was incorporated in the HSPF model as well. Later, NIRPC decided to also use HSPF to estimate nutrient loading with data processed using the Kentucky Nutrient Model. The Region 5 model was used to estimate load reductions anticipated through best management practice implementation (See Section 11.6). The NSPECT model was setup to evaluate landscape scale restoration activities such as reforestation and future land use/land cover changes.

Ultimately the STEPL model was selected to estimate the load reductions needed (Section 7.3) because data was calculated and available at the smaller catchment scale as opposed to the subwatershed scale with HSPF.

Additional information about the models used is available from the following websites.

STEPL & Region 5: http://it.tetratech-ffx.com/steplweb/default.htm
HSPF: http://water.usgs.gov/software/HSPF/

Kentucky Nutrient Model:
https://www.uky.edu/WaterResources/assets/docs/pdf/The%20Kentucky%20Nutrient%20Model%20Report%2010-06-14.pdf
NSPECT: https://coast.noaa.gov/digitalcoast/tools/opennspect.html

7.2.2 HSPF Modeling Results

Failing septic systems, livestock and CSO were identified as specific sources in the HSPF model. General nonpoint sources were allocated between permeable and impermeable land cover types (Table 96). Permeable land use-land cover includes some urban development, agriculture, forest, wetlands, and barren land. Impermeable land is solely urban development.

The HSPF model indicated that the highest E. coli loads occur in the Little Calumet-Deep River and Headwaters Main Beaver Dam Ditch subwatersheds followed by the Headwaters Turkey Creek subwatershed.

The HSPF model indicated that CSOs are a major contributor of *E. coli* loading where they exist and when CSO events occur in the watershed. CSOs contribute at least an order of magnitude more to *E. coli* loading than failing septic systems or livestock. The largest loads originate from CSOs located in the Little Calumet-Deep River subwatershed.

The HSPF model also indicates that livestock is a slightly greater contributor to *E. coli* loads than failing septic systems in 7 of the 9 subwatersheds. However, it is important to note that the numbers and locations of either is an approximation based on agricultural census data from 2007 and populated unsewered areas respectively. A failure rate of 1.5% was assumed in estimating the contribution from failing septic systems.

Subwatershed	Failing Septic Systems (counts/day)	Livestock (counts/day)	Combined Sewer Overflow (counts/day)	Average NPS Load Permeable (counts/ac./day)	Average NPS Load Impermeable (counts/ac./day)
Headwaters Main Beaver Dam Ditch	2.86E+10	4.19E+10	2.55E+11	3.84E+11	4.8E+08
Main Beaver Dam Ditch-Deep River	1.85E+10	5.34E+10	0	3.84E+11	4.8E+08
Headwaters Turkey Creek	2.86E+10	4.19E+10	0	3.84E+11	4.8E+08
Deer Creek-Deep River	1.63E+10	5.03E+10	0	3.84E+11	4.8E+08
City of Merrillville-Turkey Creek	4.94E+10	3.86E+10	0	3.84E+11	4.8E+08
Duck Creek	3.27E+10	3.33E+10	0	3.84E+11	4.8E+08
Lake George-Deep River	4.18E+10	3.55E+10	0	3.84E+11	4.8E+08
Little Calumet River-Deep River	2.37E+09	3.62E+10	1.59E+12	3.84E+11	4.8E+08
Willow Creek-Burns Ditch	4.79E+10	5.22E+10	0	3.84E+11	4.8E+08

Table 96 Estimated E. coli loads by subwatershed (HSPF)

Agricultural land was shown to have an average *E. coli* load two orders of magnitude greater than the next highest land use type which was urban land uses (Table 97).

Land Use Type	Average E. coli Load (counts/ac./day)
Urban or Built-up Land	1.61E+11
Agricultural Land	2.37E+13
Forest Land	1.31E+11
Wetlands/Water	4.82E+07
Barren Land	4.82E+07

Table 97 Estimated E. coli load by land use (HSPF)

The HSPF model indicated that the highest nitrate loads occur in the Headwaters Main Beaver Dam Ditch and Little Calumet-Deep River subwatersheds followed by the Main Beaver Dam Ditch-Deep River subwatershed (Table 98).

As with *E. coli*, the HSPF model indicated that CSOs are a major contributor of nitrate loading where they exist in the watershed. The largest nitrate loads originate from CSOs located in the Headwaters Main Beaver Dam Ditch subwatershed. The HSPF model also indicates that failing septic systems are another important contributor of nitrate loading.

Subwatershed	Failing Septic Systems (lbs./day)	Livestock (lbs./day)	Combined Sewer Overflow (lbs./day)	Average NPS Load Permeable (lbs./ac./day)	Average NPS Load Impermeable (lbs./ac./day)
Headwaters Main Beaver Dam Ditch	0.0048	0.0066	49.3326	0.0011	0.0012
Main Beaver Dam Ditch-Deep River	0.2429	0.0084	0	0.0011	0.0012
Headwaters Turkey Creek	0.0040	0.0074	0	0.0011	0.0012
Deer Creek-Deep River	0.0277	0.0079	0	0.0011	0.0012
City of Merrillville-Turkey Creek	0.0840	0.0061	0	0.0011	0.0012
Duck Creek	0.0556	0.0053	0	0.0011	0.0012
Lake George-Deep River	0.0711	0.0056	0	0.0011	0.0012
Little Calumet River-Deep River	0.0045	0.0057	6.7875	0.0011	0.0012
Willow Creek-Burns Ditch	0.0815	0.0082	0	0.0011	0.0012

Table 98 Estimated nitrate loads by subwatershed (HSPF)

7.2.3 STEPL Modeling Results

Urban land cover contributes approximately 66% of the annual runoff volume in the watershed (Figure 218). Table 99 presents runoff volume, expressed in acre-feet, by land cover type for each site's catchment area. No BMPs were applied to the model for these estimates.

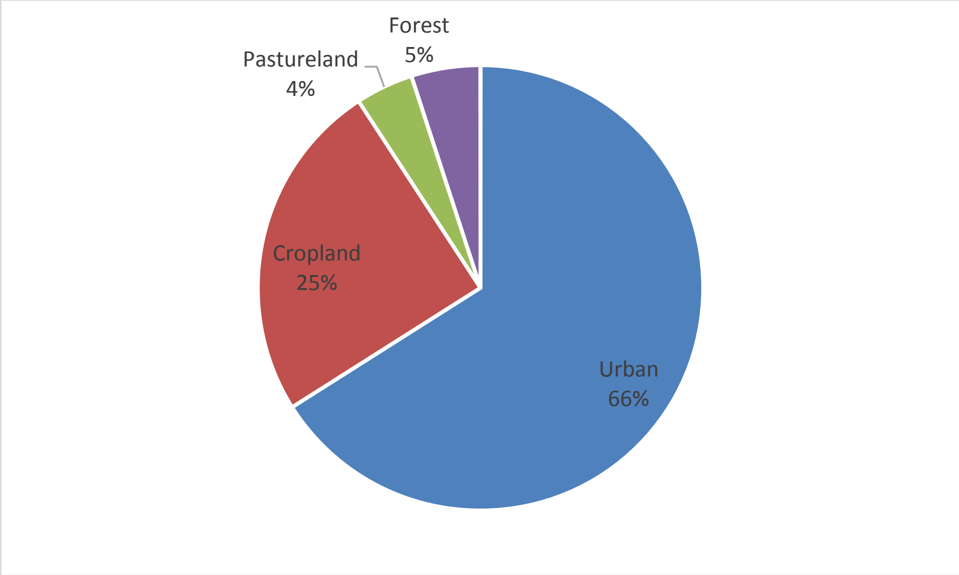

Figure 218 Percent land cover contribution to runoff volume (STEPL)

Site #	Urban (ac-ft)	Cropland (ac-ft)	Pastureland (ac-ft)	Forest (ac-ft)	Tot Runoff Vol (ac-ft)
1	3,930	243	5	29	4,208
2	926	1	-	28	955
3	1,643	1,003	48	24	2,717
5	32	-	-	3	35
6	1,675	19	6	47	1,748
7	1,649	258	14	80	2,001
8	2,225	491	41	269	3,026
9	1,090	982	322	227	2,620
10	1,131	388	58	55	1,632
11	472	1,491	195	200	2,358
12	54	151	194	228	627
13	239	149	141	113	642
14	941	363	109	80	1,492
15	3,881	1,908	198	71	6,058
16	1,204	946	150	111	2,411
17	141	631	129	61	961
18	372	1,749	251	154	2,525
19	1,341	33	19	100	1,492
20	2,741	177	36	162	3,116
21	1,515	4	14	43	1,577
22	302	647	36	19	1,005
23	535	506	144	277	1,463
24	774	437	5	2	1,218
25	3,254	228	36	165	3,682

26	2,824	738	79	166	3,806
27	1,130	53	70	74	1,326
28	1,173	1	31	107	1,312
29	384	2	1	30	417
30	1,174	118	24	53	1,369
31	935	226	11	31	1,203
32	2,734	88	11	100	2,933
33	1,953	197	25	31	2,205
34	1,658	602	109	196	2,566
35	435	827	98	79	1,438
36	449	1,962	371	153	2,935

Table 99 Estimated annual runoff (STEPL)

Estimated annual pollutant loads for nitrogen, phosphorus, biological oxygen demand, and sediment for each site's catchment area is provided in Table 100. No BMPs were applied to the model for these estimates. Annual loading was also calculated on a per acre basis to help identify which catchments were contributing a higher proportion of pollutant loads.

Site #	Nitrogen Load		Phosphorus Load		BOD Load		Sediment Load	
	(lb/yr)	(lb/ac/yr)	(lb/yr)	(lb/ac/yr)	(lb/yr)	(lb/ac/yr)	(t/yr)	(lb/ac/yr)
1	27,827	3.0	5,532	0.6	95,185	10.2	630	135.7
2	5,334	0.6	847	0.1	20,085	2.2	122	26.2
3	27,034	2.9	6,914	0.7	64,140	6.9	404	87.1
5	191	0.0	32	0.0	721	0.1	4	0.9
6	10,529	1.1	1,860	0.2	39,195	4.2	229	49.3
7	13,559	1.5	2,915	0.3	42,597	4.6	245	52.8
8	20,988	2.3	4,707	0.5	61,733	6.6	363	78.3
9	27,392	2.9	6,833	0.7	64,137	6.9	342	73.6
10	13,801	1.5	3,267	0.4	37,740	4.1	214	46.1
11	31,976	3.4	8,990	1.0	61,711	6.6	379	81.6
12	5,308	0.6	1,146	0.1	12,893	1.4	43	9.3
13	5,627	0.6	1,221	0.1	14,772	1.6	62	13.3
14	13,035	1.4	3,062	0.3	35,338	3.8	188	40.4
15	56,826	6.1	14,011	1.5	142,545	15.3	857	184.6
16	25,589	2.8	6,618	0.7	60,014	6.5	344	74.1
17	13,681	1.5	3,773	0.4	26,386	2.8	154	33.1
18	36,623	3.9	10,332	1.1	68,789	7.4	423	91.1
19	7,865	0.8	1,387	0.1	29,527	3.2	162	34.8
20	18,030	1.9	3,433	0.4	63,488	6.8	354	76.2
21	8,167	0.9	1,337	0.1	31,811	3.4	175	37.6
22	13,800	1.5	3,914	0.4	26,922	2.9	174	37.6
23	13,970	1.5	3,586	0.4	32,510	3.5	175	37.6
24	12,099	1.3	3,122	0.3	29,380	3.2	183	39.3
25	21,095	2.3	3,947	0.4	73,405	7.9	423	91.2

26	28,915	3.1	6,577	0.7	82,470	8.9	484	104.3
27	7,598	0.8	1,325	0.1	27,234	2.9	142	30.6
28	6,413	0.7	1,023	0.1	24,924	2.7	136	29.3
29	2,523	0.3	470	0.1	9,448	1.0	52	11.2
30	8,343	0.9	1,618	0.2	27,803	3.0	160	34.5
31	8,943	1.0	2,009	0.2	25,707	2.8	156	33.6
32	15,773	1.7	2,774	0.3	58,547	6.3	333	71.7
33	13,638	1.5	2,640	0.3	45,418	4.9	266	57.3
34	20,954	2.3	4,951	0.5	56,450	6.1	322	69.4
35	18,180	2.0	4,788	0.5	36,802	4.0	194	41.7
36	41,786	4.5	11,196	1.2	80,366	8.7	416	89.6
Total	603,411		142,153		1,610,195		9,310	

Table 100 Estimated annual pollutant loading by catchment (STEPL)

Estimated total annual pollutant loads by source are present in Table 101 and Figure 219. Table 101 also includes area loads which show that cropland contributes higher nutrient and sediment loads on a per acre basis.

Sources	N Load (lb/yr)	N Load (lb/ac/yr)	P Load (lb/yr)	P Load (lb/ac/yr)	BOD Load (lb/yr)	BOD Load (lb/ac/yr)	Sed Load (t/yr)	Sed Load (t/ac/yr)
Urban	239,763	4.86	37,188	0.75	942,489	19.12	5,478	0.11
Cropland	318,784	12.36	97,011	3.76	516,213	20.02	3,735	0.14
Pastureland	32,845	5.59	2,846	0.48	106,199	18.07	55	0.01
Forest	2,280	0.22	1,294	0.13	5,530	0.54	43	0.00
Septic	9,738	-	3,814	-	39,765	-	-	-
Total	603,411	-	142,153	-	1,610,195	-	9,310	-

Table 101 Estimated total annual pollutant load by source

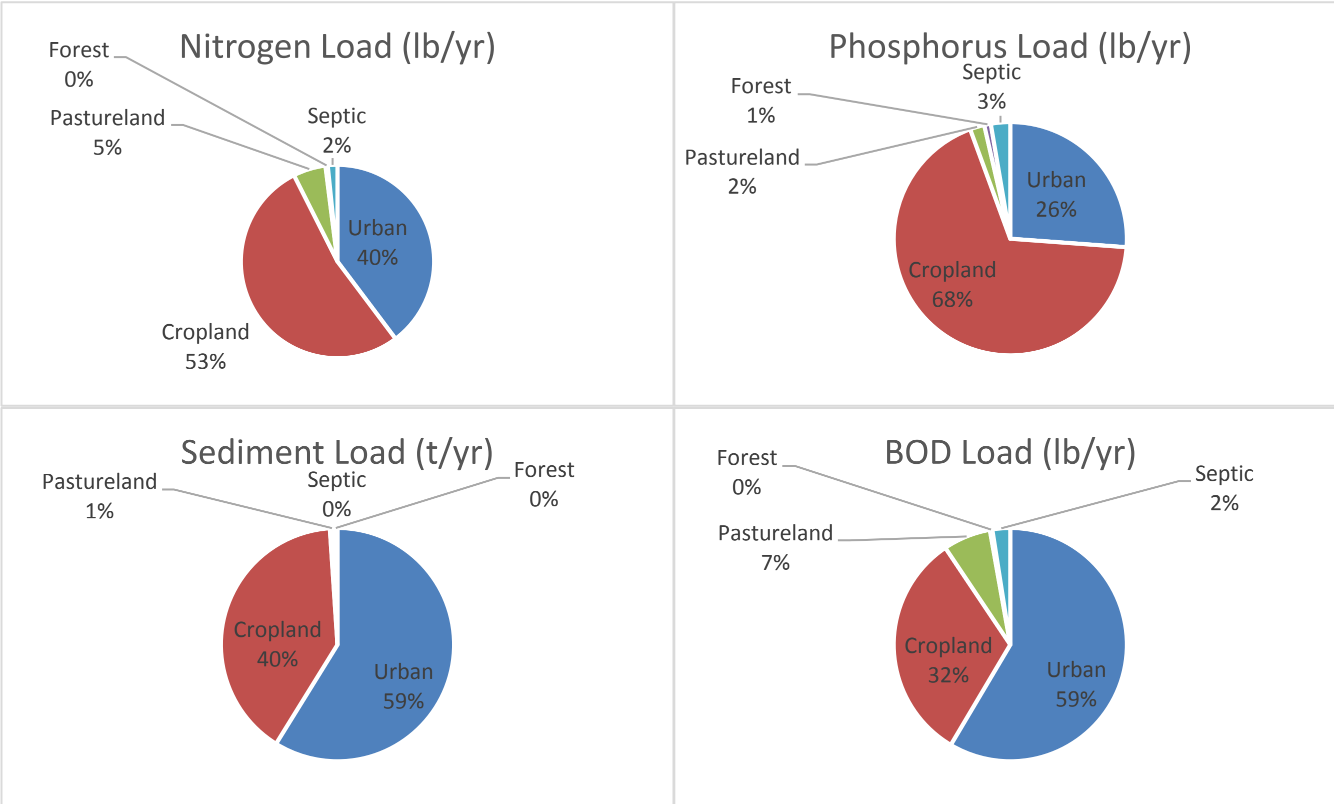

Figure 219 Estimated total annual pollutant load by source (STEPL)

The following table provides a summary of *E. coli* data from the Deep River-Portage Burns Waterway TMDL.

Site	# of Samples	% Samples Violating Target	Maximum MPN/100mL	Average MPN/100mL
1	10	60%	1986.3	551.9
2	10	90%	2419.6	1340.4
3	10	80%	2419.6	1240.2
5	10	20%	344.8	132.6
6	10	10%	260.3	107.3
7	10	90%	1732.9	656.1
8	10	80%	2419.6	612.9
9	10	40%	2419.6	622.2
10	10	60%	2419.6	661.2
11	10	80%	2419.6	1216
12	10	70%	2419.6	669.7
13	10	80%	2419.6	957.8
14	10	40%	2419.6	438.5
15	10	90%	2419.6	699.3
16	10	80%	2419.6	720
17	10	80%	1732.9	501.6

Site	# of Samples	% Samples Violating Target	Maximum MPN/100mL	Average MPN/100mL
18	10	80%	2419.6	785.8
19	10	50%	2419.6	511.5
20	10	60%	2419.6	629.9
21	10	40%	613.1	233.2
22	10	80%	>2419.6	687.6
23	10	30%	1986.3	372
24	10	80%	>2419.6	1,297.50
25	10	40%	2419.6	414.3
26	10	29%	770.1	207.6
27	10	50%	1413.6	360
28	7	29%	770.1	207.6
29	10	80%	1986.3	668.9
30	10	20%	344.8	168.8
31	10	60%	1553.1	564.9
32	10	20%	866.4	238
33	10	80%	2419.6	810.9
34	10	40%	1119.9	351.8
35	10	100%	2419.6	1001.3
36	10	100%	2419.6	1301.9

Table 102 Summary of E. coli site data from TMDL

7.3 Pollutant Load Reductions Needed

The US EPA's Spreadsheet Tool for Estimating Pollutant Load (STEPL) model was also used to estimate pollutant loads reductions needed for each catchment area and the watershed as a whole. The watershed restoration plan targets listed below were used as STEPL model inputs. The steering committee ultimately decided to use more stringent nutrient targets than chosen by IDEM for the TMDL study. Total suspended solids and *E. coli* targets from the TMDL were retained. The watershed plan water quality targets are the same or more stringent than those used for the TMDL. Therefore meeting the reductions listed in the tables below would also meet the load reductions called for in the TMDL.

Parameter	TMDL Target Value	Watershed Plan Target Value
Total Phosphorus	No value should exceed 0.30 mg/L	No value should exceed 0.07 mg/L
Total Nitrogen	NA	No value should exceed 3.3 mg/L
Biological Oxygen Demand	NA	No value should exceed 2 mg/L
Total Suspended Solids	No value should exceed 30.0 mg/L	No value should exceed 30.0 mg/L
E. coli	No value should exceed 125 counts/100 mL (geometric mean)	No value should exceed 125 counts/100 mL (geometric mean)

Table 103 TMDL water quality targets compared to the watershed restoration plan targets

The following four tables show the overall reductions needed to meet the water quality targets for total nitrogen, total phosphorus, biological oxygen demand, and sediment as measured by total suspended solids.

Site #	N Current Load (lb/year)	N Target Load (lb/year)	N Load Reduction (lb/year)	% N Load Reduction
1	27,827	34,676	NA	NA
2	5,334	7,627	NA	NA
3	27,034	23,594	3,439	13
5	191	282	NA	NA
6	10,529	14,071	NA	NA
7	13,559	15,903	NA	NA
8	20,988	24,625	NA	NA
9	27,392	23,596	3,796	14
10	13,801	13,608	193	1
11	31,976	23,043	8,932	28
12	5,308	5,834	NA	NA
13	5,627	5,675	NA	NA
14	13,035	12,615	421	3
15	56,826	51,738	5,088	9
16	25,589	21,469	4,120	16
17	13,681	9,509	4,172	30
18	36,623	25,132	11,491	31
19	7,865	11,419	NA	NA
20	18,030	24,114	NA	NA
21	8,167	11,852	NA	NA
22	13,800	9,676	4,124	30
23	13,970	13,226	744	5
24	12,099	10,505	1,594	13
25	21,095	28,471	NA	NA
26	28,915	31,137	NA	NA
27	7,598	10,280	NA	NA
28	6,413	9,991	NA	NA
29	2,523	3,373	NA	NA
30	8,343	10,696	NA	NA
31	8,943	9,753	NA	NA
32	15,773	22,306	NA	NA
33	13,638	17,134	NA	NA
34	20,954	21,561	NA	NA
35	18,180	13,592	4,588	25
36	41,786	28,775	13,011	31
Total	603,411	600,857	2,554	<1

Table 104 Nitrogen load reductions needed by catchment (STEPL)

Site #	P Current Load (lb/year)	P Target Load (lb/year)	P Load Reduction (lb/year)	% P Load Reduction
1	5,532	1,942	3,590	65
2	847	245	602	71
3	6,914	2,310	4,604	67
5	32	9	22	70
6	1,860	513	1,347	72
7	2,915	900	2,015	69
8	4,707	1,550	3,156	67
9	6,833	2,313	4,520	66
10	3,267	1,036	2,231	68
11	8,990	3,091	5,899	66
12	1,146	448	698	61
13	1,221	427	794	65
14	3,062	973	2,089	68
15	14,011	4,613	9,398	67
16	6,618	2,169	4,448	67
17	3,773	1,301	2,472	66
18	10,332	3,562	6,770	66
19	1,387	409	978	71
20	3,433	1,029	2,403	70
21	1,337	371	966	72
22	3,914	1,323	2,591	66
23	3,586	1,235	2,351	66
24	3,122	1,011	2,111	68
25	3,947	1,243	2,704	69
26	6,577	2,133	4,443	68
27	1,325	407	918	69
28	1,023	317	706	69
29	470	118	352	75
30	1,618	517	1,101	68
31	2,009	658	1,351	67
32	2,774	827	1,947	70
33	2,640	837	1,804	68
34	4,951	1,632	3,319	67
35	4,788	1,451	3,337	70
36	11,196	3,534	7,662	68
Total	142,153	46,453	95,699	67

Table 105 Phosphorus load reductions needed by catchment (STEPL)

Site #	BOD Current Load (lb/year)	BOD Target Load (lb/year)	BOD Load Reduction (lb/year)	% BOD Load Reduction
1	95,185	22,433	72,752	76
2	20,085	4,660	15,425	77
3	64,140	16,749	47,392	74
5	721	173	549	76
6	39,195	8,687	30,507	78
7	42,597	10,304	32,294	76
8	61,733	16,187	45,547	74
9	64,137	16,744	47,393	74
10	37,740	9,215	28,526	76
11	61,711	17,601	44,110	71
12	12,893	3,948	8,946	69
13	14,772	3,831	10,941	74
14	35,338	8,559	26,780	76
15	142,545	36,048	106,496	75
16	60,014	15,337	44,677	74
17	26,386	7,301	19,085	72
18	68,789	19,484	49,305	72
19	29,527	7,042	22,485	76
20	63,488	15,122	48,366	76
21	31,811	7,232	24,580	77
22	26,922	7,431	19,492	72
23	32,510	9,291	23,219	71
24	29,380	7,432	21,948	75
25	73,405	17,895	55,510	76
26	82,470	20,730	61,740	75
27	27,234	6,397	20,837	77
28	24,924	6,100	18,825	76
29	9,448	2,074	7,374	78
30	27,803	6,799	21,005	76
31	25,707	6,478	19,229	75
32	58,547	13,801	44,746	76
33	45,418	10,904	34,514	76
34	56,450	14,583	41,867	74
35	36,802	9,822	26,980	73
36	80,366	21,483	58,882	73
Total	1,610,195	407,876	1,202,319	75

Table 106 BOD load reductions needed by catchment (STEPL)

Site #	Sed Current Load (t/year)	Sed Target Load (t/year)	Sed Load Reduction (t/year)	% Sed Load Reduction
1	630	263	367	58
2	122	35	86	71
3	404	272	132	33
5	4	1	3	70
6	229	72	157	68
7	245	113	133	54
8	363	185	179	49
9	342	254	88	26
10	214	123	91	42
11	379	341	38	10
12	43	39	4	10
13	62	43	19	31
14	188	112	76	40
15	857	545	312	36
16	344	247	97	28
17	154	142	11	7
18	423	393	30	7
19	162	54	108	67
20	354	133	220	62
21	175	53	122	70
22	174	150	24	14
23	175	132	43	25
24	183	120	62	34
25	423	162	262	62
26	484	257	227	47
27	142	51	91	64
28	136	42	94	69
29	52	16	36	69
30	160	66	94	59
31	156	81	75	48
32	333	113	220	66
33	266	109	157	59
34	322	189	133	41
35	194	157	37	19
36	416	378	38	9
Total	9,310	5,444	3,866	42

Table 107 Sediment load reductions needed by catchment (STEPL)

Site	# of Samples	% Samples Violating Target	Maximum MPN/100mL	Average MPN/100mL	% Reduction
1	10	60%	1986.3	551.9	57.40%
2	10	90%	2419.6	1340.4	82.50%
3	10	80%	2419.6	1240.2	81.10%
5	10	20%	344.8	132.6	0%
6	10	10%	260.3	107.3	0%
7	10	90%	1732.9	656.1	64.20%
8	10	80%	2419.6	612.9	61.70%
9	10	40%	2419.6	622.2	62.20%
10	10	60%	2419.6	661.2	64.50%
11	10	80%	2419.6	1216	80.70%
12	10	70%	2419.6	669.7	64.90%
13	10	80%	2419.6	957.8	75.50%
14	10	40%	2419.6	438.5	46.40%
15	10	90%	2419.6	699.3	66.40%
16	10	80%	2419.6	720	67.40%
17	10	80%	1732.9	501.6	53.20%
18	10	80%	2419.6	785.8	70.10%
19	10	50%	2419.6	511.5	54.10%
20	10	60%	2419.6	629.9	62.70%
21	10	40%	613.1	233.2	0%
22	10	80%	>2419.6	687.6	65.80%
23	10	30%	1986.3	372	36.80%
24	10	80%	>2419.6	1,297.50	81.90%
25	10	40%	2419.6	414.3	43.30%
26	10	29%	770.1	207.6	69.50%
27	10	50%	1413.6	360	34.70%
28	7	29%	770.1	207.6	69.50%
29	10	80%	1986.3	668.9	64.90%
30	10	20%	344.8	168.8	0%
31	10	60%	1553.1	564.9	58.40%
32	10	20%	866.4	238	1.20%
33	10	80%	2419.6	810.9	71.00%
34	10	40%	1119.9	351.8	33.20%
35	10	100%	2419.6	1001.3	76.50%
36	10	100%	2419.6	1301.9	81.90%

Table 108 E. coli load reductions needed by catchment (TMDL)

The following table summarizes the current loads, target loads, load reductions, and percent reductions for the watershed. In order to calculate the overall watershed geomean (average) for *E. coli*, the site geomeans were averaged together and then an overall percent reduction was calculated from this value.

Pollutant	Current Load	Target Load	Load Reduction	% Reduction
Nitrogen (lb/year)	603,411	600,857	2,554	<1
Phosphorus (lb/year)	142,153	46,453	95,699	67
BOD (lb/year)	1,610,195	407,876	1,202,319	75
Sediment (t/year)	9,310	5,444	3,866	42
	Average	**Target Value**	**-**	**% Reduction**
***E. coli* (CFU/100mL)**	627	125	-	80

Table 109 Overall current and target loads and load reductions needed for the watershed