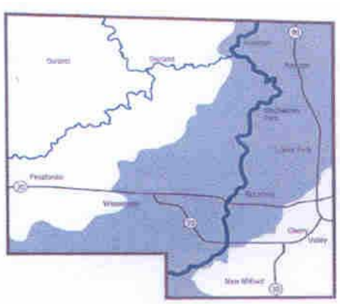
WATERSHED MODELING STUDY
SOUTH KINNIKINNICK CREEK AND NORTH KENT CREEK
IN WINNEBAGO COUNTY, ILLINOIS

APRIL 2008

PREPARED FOR



UPPER ROCK RIVER PARTNERSHIP

PREPARED BY

BAETIS ENVIRONMENTAL SERVICES, INC.
CHICAGO, ILLINOIS

ACKNOWLEDGEMENTS

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1. INTRODUCTION

The Winnebago County Forest Preserve District retained Baetis Environmental Services, Inc. to support its' watershed management efforts with the Upper Rock River Ecosystem Partnership (URREP). Specifically, Baetis was tasked to develop watershed models for South Kinnikinnick Creek and Kent Creek. These two subwatersheds are located in Winnebago and Boone Counties, Illinois (Figure 1).

Baetis utilized an US EPA-supported program package BASINS (Better Assessment Science Integrating Point and Non-point Sources) to perform much of the watershed characterizations and all of the modeling. BASINS is a multi-purpose environmental analysis system that integrates GIS, watershed data, and state-of-the-art environmental assessment and modeling tools into one convenient package (see http://www.epa.gov/waterscience/basins/).

Chapter 2 of this report, Watershed Characterization, provides quantitative descriptions of South Kinnikinnick Creek and North Kent Creek. Tabular and spatial information are provided on topography, land use/land cover, hydrology, soils and other environmental resources. Chapter 3, Watershed Modeling, details the construction of watershed pollutant runoff models and their findings, and an example of model utility. There are appendices on water quality data collected in South Kinnikinnick Creek and Kent Creek under another project sponsored by the City of Rockford and Rock River Water Reclamation District, and details on model input computer files.

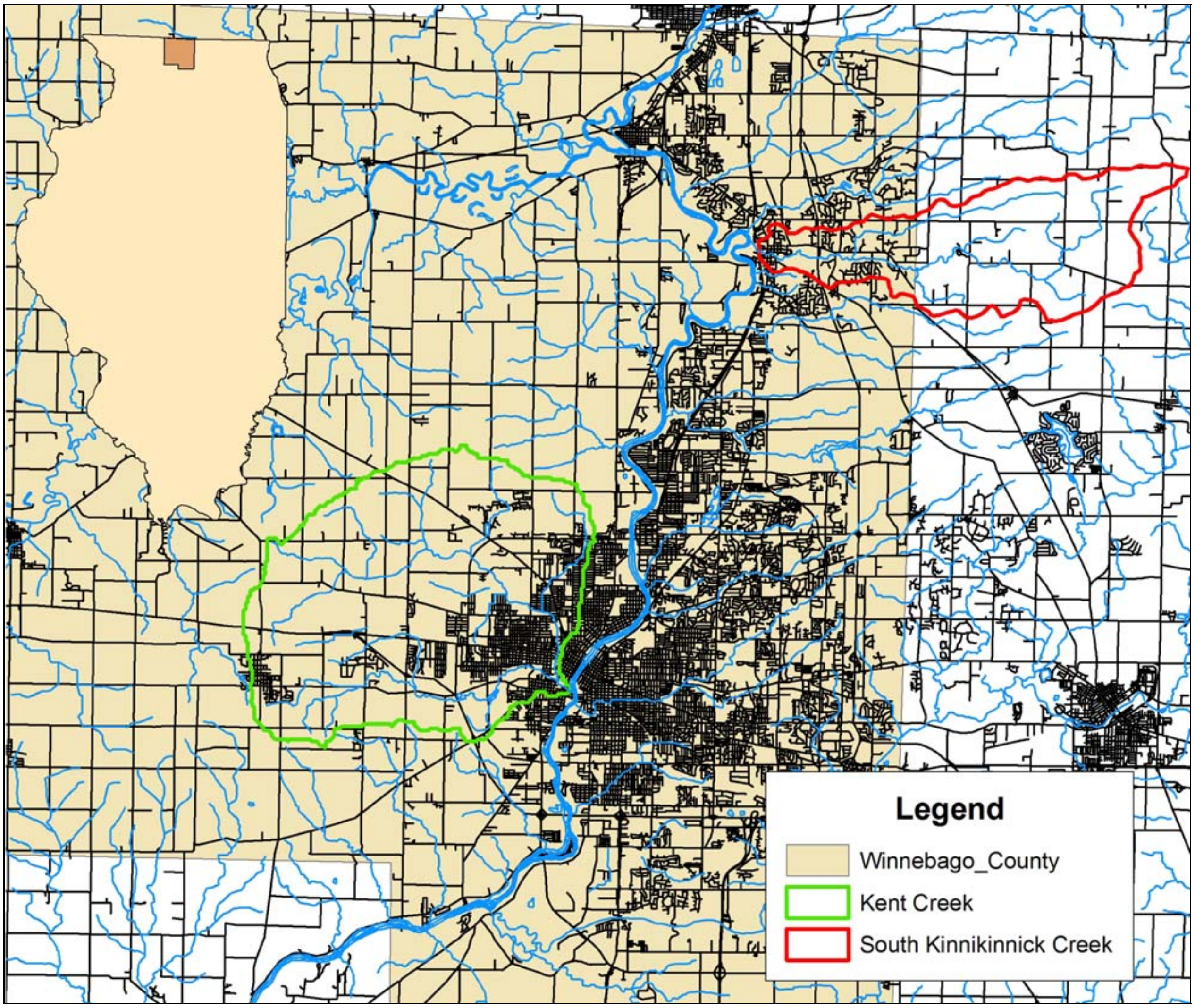

Figure 1. Location Map

2. WATERSHED CHARACTERIZATION

Chapter 2 presents data on land uses, pollutant sources, and other characteristics of the two watersheds used to develop the models. Data were either downloaded using BASIN's automated data download feature, or local sources (WinGIS, City of Rockford, Illinois DNR GIS Clearinghouse) were found containing data with that were either more current or of a higher resolution.

2.1 PHYSIOGRAPHY, TOPOGRAPHY AND STREAM COURSES

The study area is in the Rock River Hill Country physiographic region. It has been glaciated, but the glacial deposition is relatively thin. The resulting topography closely reflects the underlying pre-glacial bedrock surface, and is characterized by rolling hills and well-developed stream valleys. There is considerable variation in the character of the land in the county. Lands west of the Rock River are relatively hilly, with narrow and V-shaped valleys. The glacial drift is often less than 25 feet (IDNR, 1998a). East of the Rock River, where the deposition of glacial till is typically greater than 100 feet (IDNR, 1998b), the Rock River Hill Country has more of a gently rolling topography, and stream valleys are broader and do not typically intersect the bedrock.

Watershed boundaries were developed using BASINS's automatic watershed delineation routine. This routine uses digital elevation models to define drainage boundaries and land and watercourse slopes. We compared the boundaries delineated using this method to those manually digitized from USGS 7.5-minute topographic maps, and found them favorably comparable. BASINS also subdivided each study watershed into subunits for further analysis. South Kinnikinnick Creek was subdivided into three subbasins and Kent Creek into 13 subbasins Figures 2 and 3, Tables 1 and 2). These subbasins are the units of area for BASINS' modeling and estimation of watershed non-point source pollutant loads.

Table 1. South Kinnikinnick Creek Subwatersheds in BASINS

Subbasin	Stream Length (m)	Area (ac)	Area (mi^2)	Average Slope (%)	Name
3	12,766	7,785	12.2	14.5	East
2	5,289	1,906	3.0	19.7	North
1	3,885	1,139	1.8	11.3	Mouth
Total	21,940	10,830	17.0		

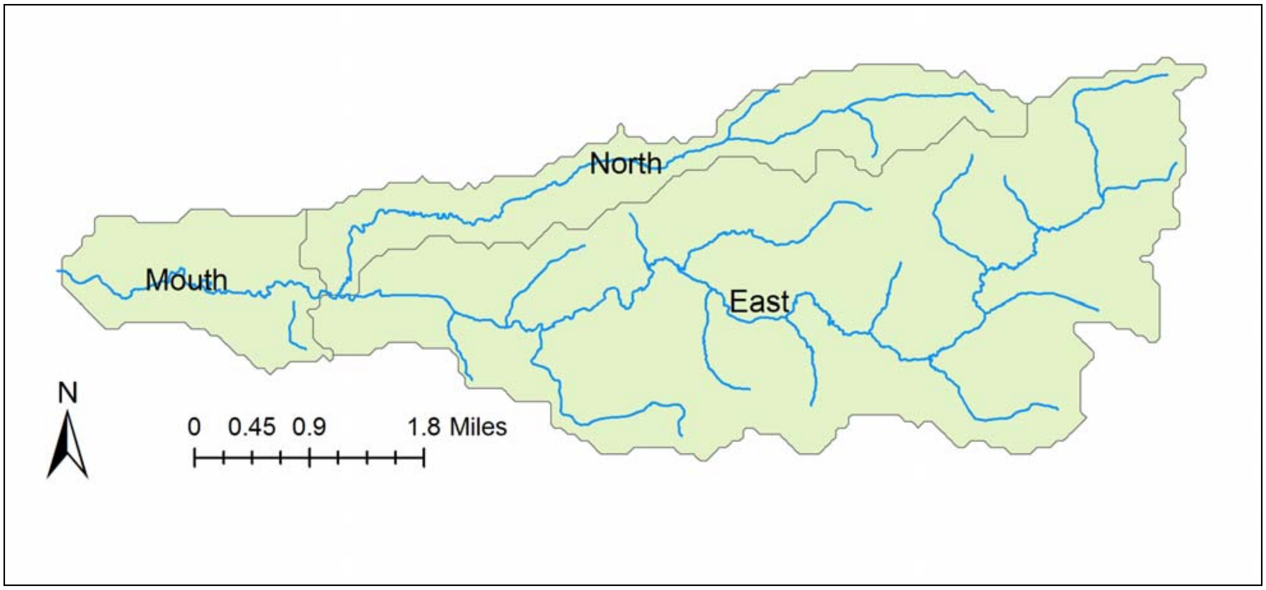

Figure 2. South Kinnikinnick Creek Subbasins

Table 2. Kent Creek Subwatersheds in BASINS

Subbasin	Stream Length (m)	Area (ac)	Area (mi^2)	Average Slope
8	1,492	1,840	2.9	10.9
6	1,922	2,591	4.0	9.7
10	2,733	2,580	4.0	9.2
7	6,431	6,250	9.8	12.3
5	1,977	1,018	1.6	11.1
4	1,844	618	1.0	11.1
3	2,226	1,617	2.5	6.6
2	3,213	1,031	1.6	8.8
9	1,638	1,548	2.4	2.7
12	2,491	2,234	3.5	6.9
11	7,118	3,700	5.8	11.5
13	3,829	3,646	5.7	15.4
1	637	109	0.2	22.2
Total	37,551	28,782	45.0	

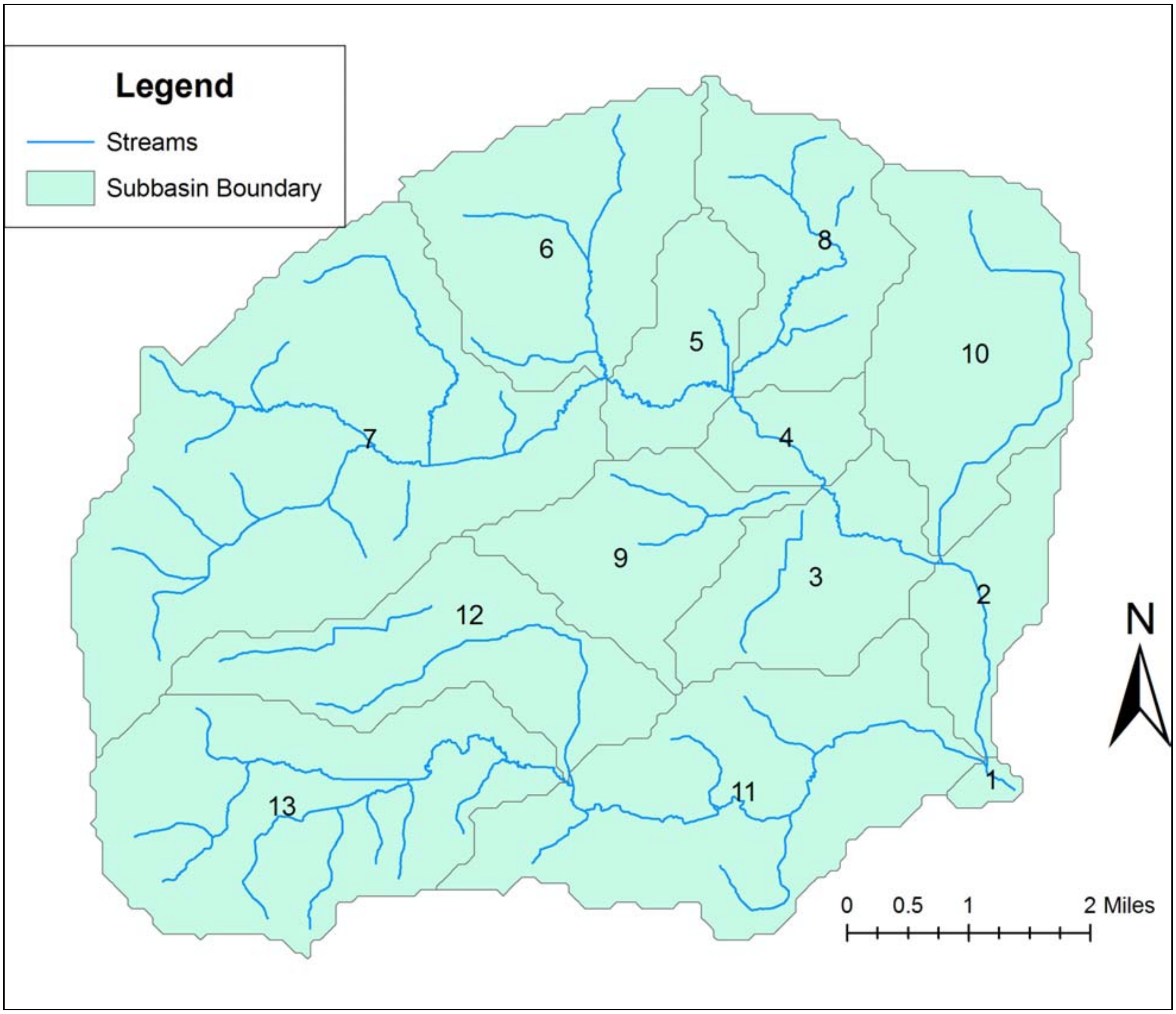

Figure 3. Kent Creek Subbasins

2.2 SOILS

Soils data were taken from the STATSGO data set, a digital general soil association map developed by the National Cooperative Soil Survey and distributed by the Natural Resources Conservation Service. STATSGO is a broad based inventory of soils and nonsoil areas that occur in a repeatable pattern on the landscape, which can be cartographically shown at the scale mapped. The soil maps for STATSGO are compiled by generalizing more detailed soil survey maps. Soil associations for South Kinnikinnick Creek and Kent Creek are mapped in Figures 4 and 5. The principal soil association present in South Kinnikinnick Creek watershed is Flagg-Pecatonica-Kendall (IL039), but the western part of the drainage also includes Plano-Griswold-Ringwood (IL015), Warsaw-Lorenzo-Dakota (IL022) and Kidder-McHenry-Pella (IL047). The principal soil association present in the Kent Creek watershed is Plano-Griswold-Ringwood (IL015), but there are also large areas of Tama-Muscatine-Sable (IL002), Warsaw-Lorenzo-Dakota (IL022) and Ogle-Durand-Tama (IL007).

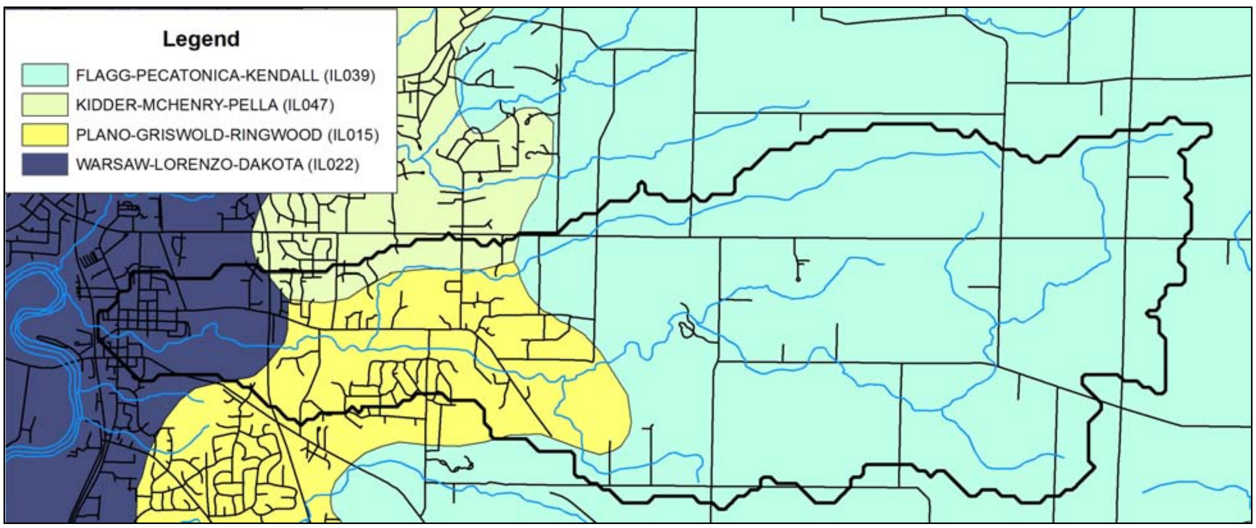

Figure 4. Soil Associations in South Kinnikinnick Creek Watershed

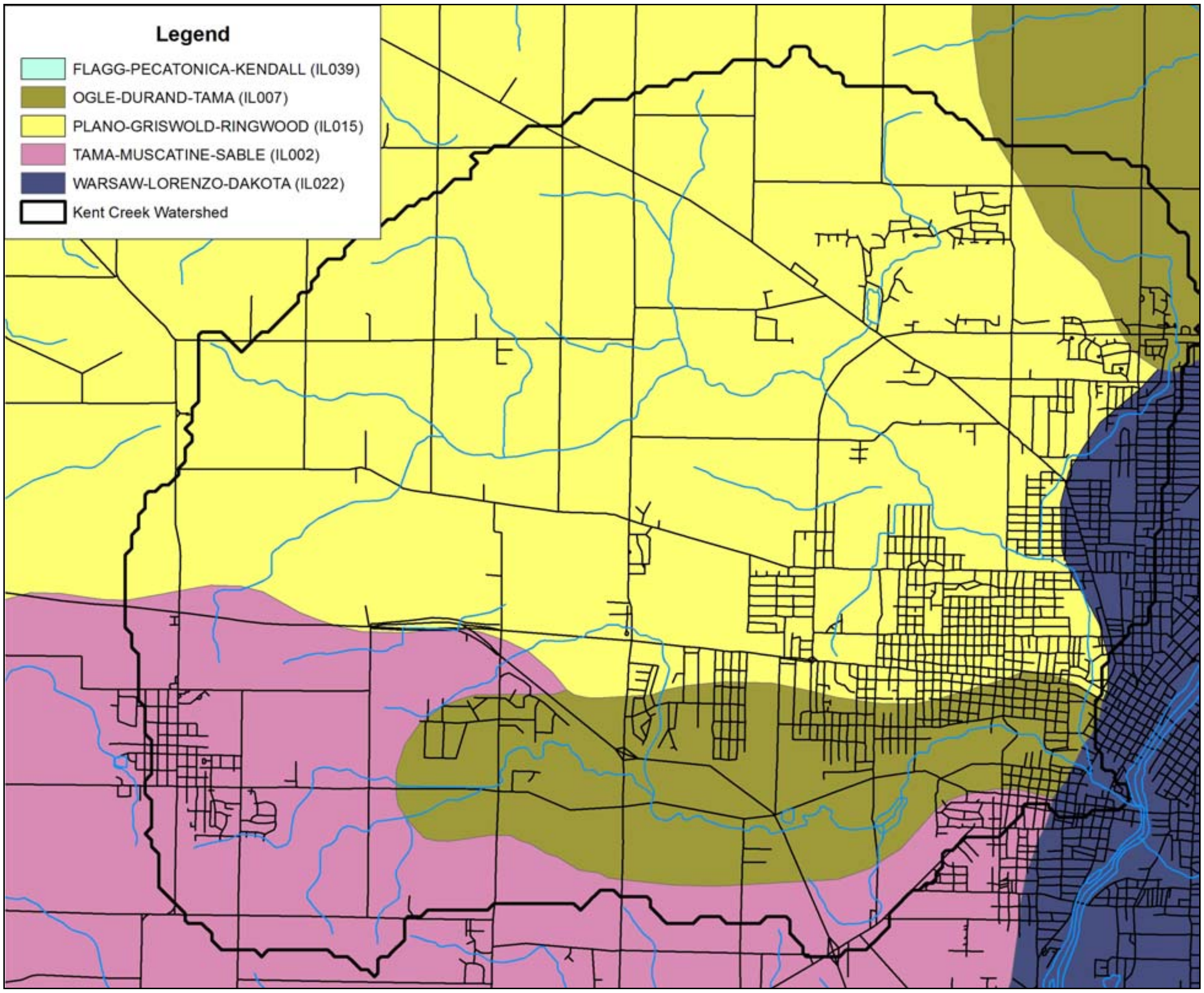

Figure 5. Soil Associations in Kent Creek Watershed

2.3 LAND USE / LAND COVER AND WATER POLLUTION SOURCES

Land use data were developed from the Illinois Gap Analysis Program (http://www.agr.state.il.us/gis/pass/gapdata/). The satellite imagery was captured in 1999 and classified by the Illinois Natural History Survey. Land use in the watersheds is summarized in Tables 3 and 4. Figures 6 and 7 map land uses.

Table 3. South Kinnikinnick Watershed Land Use/Land Cover (acres)

Land Use/Land Cover	Subbasin			Total
	East	North	Mouth	
Agriculture	4,736	1,063	137	5,935
Grass	1,257	370	346	1,973
Forest	1,516	396	362	2,274
Urban Land	98	20	183	301
Water or Wetland	172	53	114	339
Barren Land	2	3	-	5
Total	7,781	1,905	1,143	10,829

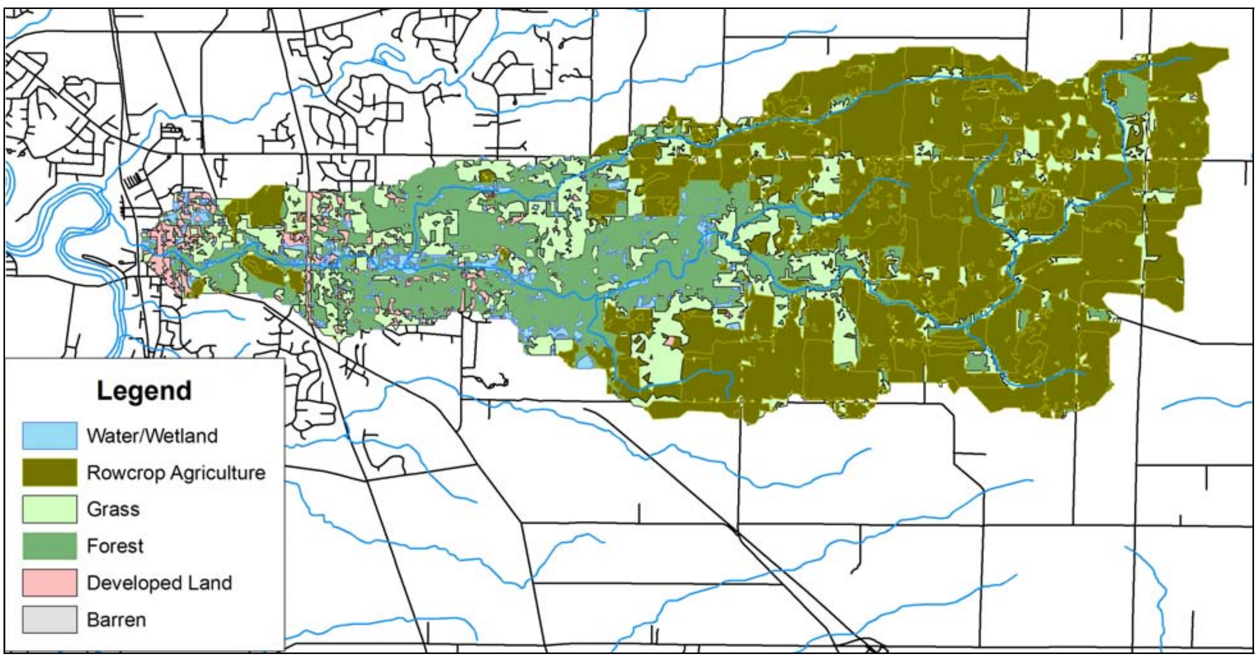

Figure 6. Land Use and Cover in South Kinnikinnick Creek Watershed

Table 4. Land Use/Land Cover in the Kent Creek Watershed (acres)

Subbasin	Agriculture	Grass	Forest	Urban	Water/Wetland	Barren	Total
1	-	12	4	88	2	-	106
2	8	63	69	835	59	-	1,034
3	138	319	197	719	244	-	1,617
4	224	159	138	31	58	-	611
5	290	234	321	20	145	-	1,010
6	1,926	426	152	18	65	-	2,586
7	4,678	892	333	167	162	-	6,232
8	1,042	236	322	64	172	-	1,837
9	918	262	123	134	110	-	1,547
10	988	473	163	803	148	-	2,574
11	910	625	862	939	336	2	3,674
12	1,149	500	222	183	181	-	2,234
13	2,159	801	334	219	120	-	3,634
Total	14,430	5,002	3,241	4,220	1,803	2	28,695

Land use and cover is a major determinant of stream water quality. The modeling discussions in Chapter 3 detail this linkage more specifically. Other factors affecting stream water quality include riparian condition, hydromodifications, human and animal population densities, point source discharges, soil type, climate, geology, and slope. South Kinnikinnick Creek has not permitted point source discharges, but there are low-density recreational (horses) and agricultural livestock operations in the watershed. Kent Creek has a number of recorded point source discharges. These were downloaded from EPA on-line databases and mapped (Figure 8), but some are no longer in operation. Because we were not able to update the EPA's point source discharge database, the Kent Creek point source pollutants are not specifically included in the estimates presented in Chapter 3.

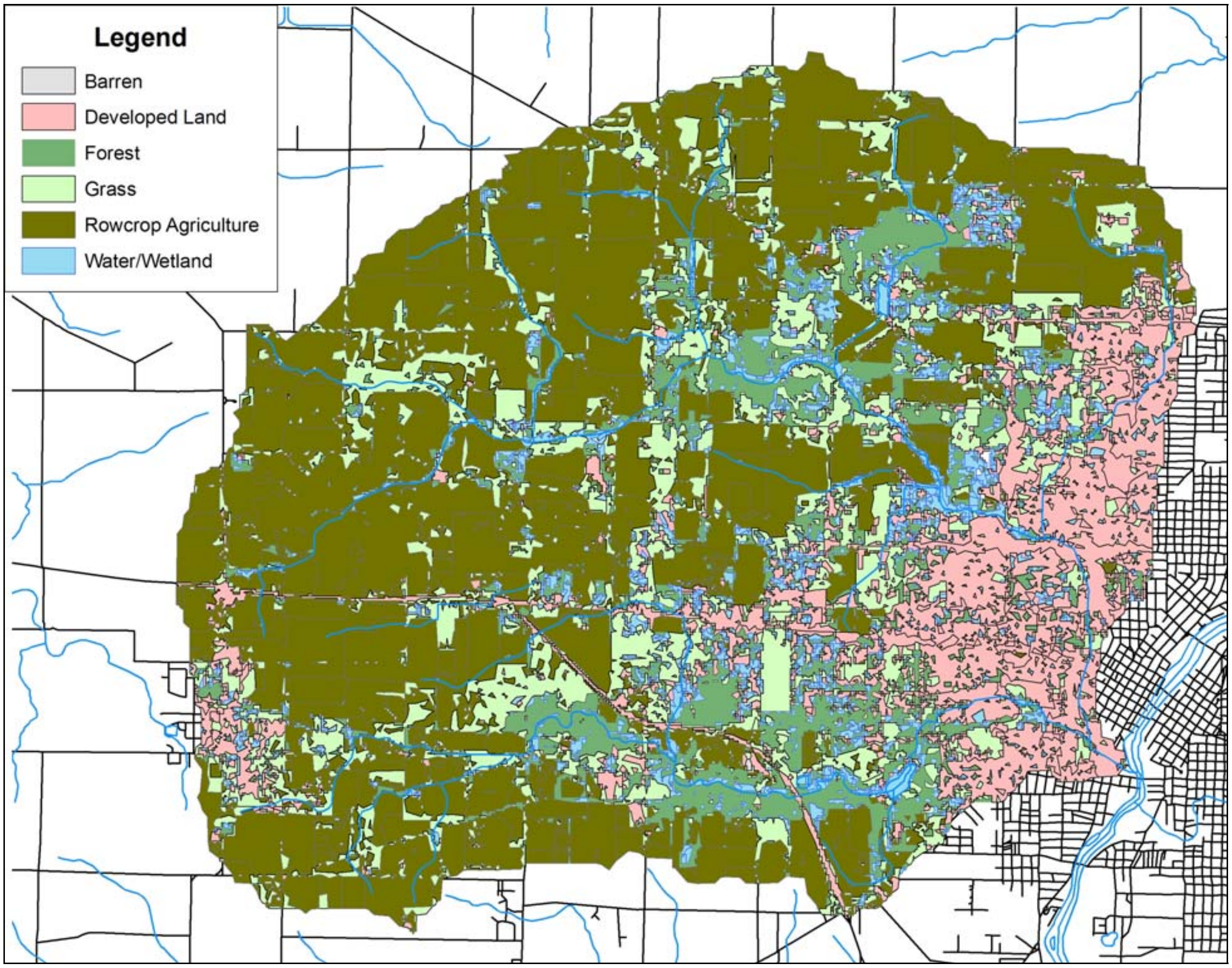

Figure 7. Land Use and Cover in Kent Creek Watershed

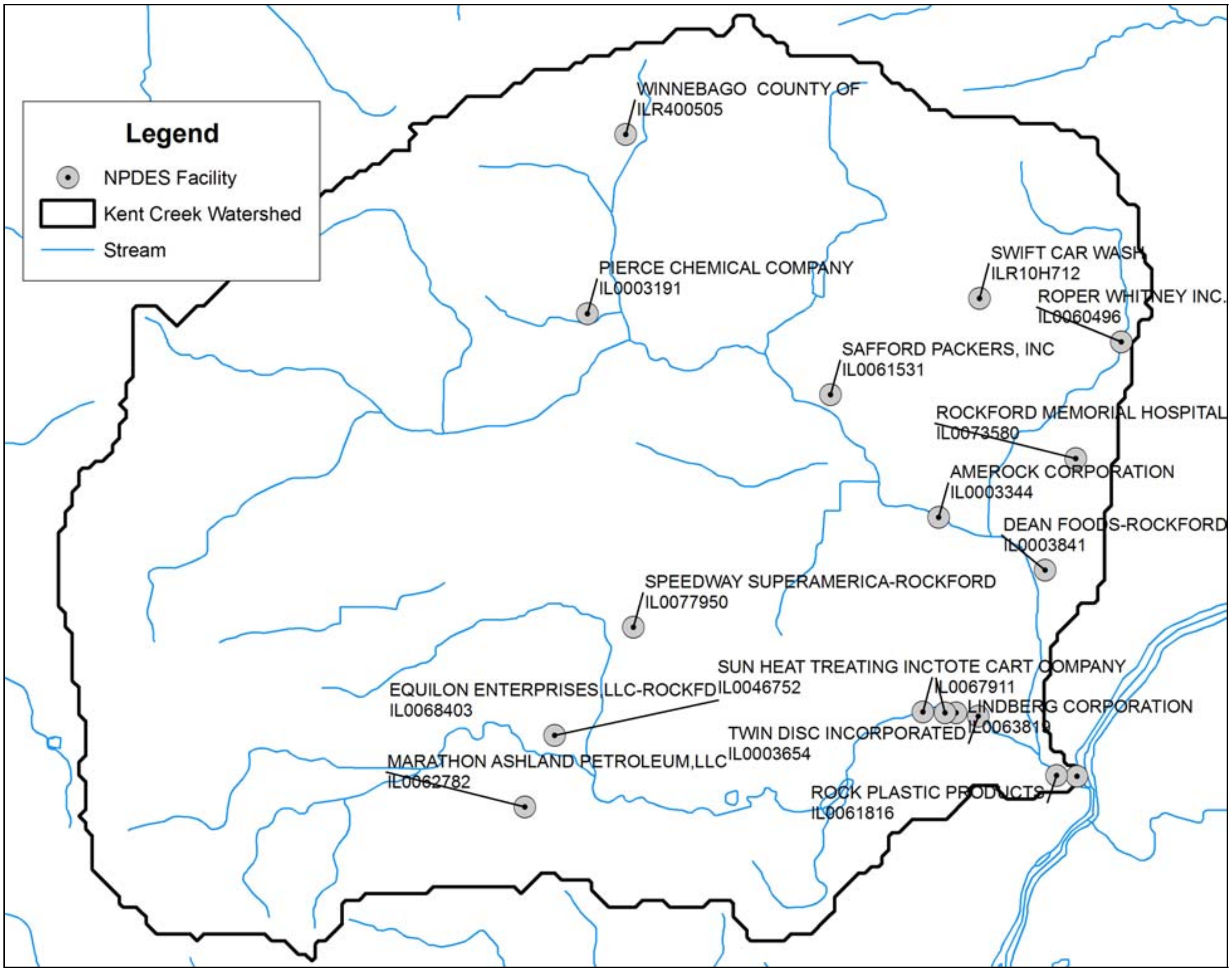

Figure 8. Permitted Point Sources in Kent Creek Watershed

3. WATERSHED MODELING

This chapter describes watershed model development, findings and future recommendations. Modeling has been performed using BASINS (Better Assessment Science Integrating Point & Nonpoint Sources), a modeling package developed by US EPA. BASINS is a multi-purpose environmental analysis system that integrates a geographical information system (GIS), national watershed data, and state-of-the-art environmental assessment and modeling tools into one convenient package.

3.1 MODEL DEVELOPMENT

BASINS has built-in routines for downloading environmental and water resources data. BASINS downloadable data supplemented data already developed by Baetis under prior studies for other Winnebago County institutions.

Watershed and subwatershed boundaries were delineated using BASINS' automatic watershed delineator and national digital elevation models. The watershed boundaries compared favorably with those delineated manually from USGS 7½-minute quadrangle maps. During the automatic watershed delineation BASINS also generates stream reach and watershed outlets shapefiles for use in HSPF.

Pollutant load estimates were generated using the PLOAD module in BASINS. PLOAD estimates nonpoint sources of pollution on an annual average basis, for any user-specified pollutant. The calculations are made using either the export coefficient or the event mean concentration approach. Best management practices (BMPs), which serve to reduce NPS loads, and point source loads, may also be included in computing total watershed loads. The PLOAD application requires pre-processed GIS and tabular input data:

- GIS land use data
- GIS watershed data
- GIS BMP site and area data (optional)
- Pollutant loading rate data tables
- Impervious terrain factor data tables
- Pollutant reduction BMP data tables (optional)

• Point source facility locations and loads (optional).

The option we selected in PLOAD for calculation of pollutant loads uses event mean concentrations in the US EPA's Simple Method. Two basic equations are required to calculate the loads for each specified pollutant. A runoff coefficient (R_{VU}) for each type of land use is based on the percent impervious value (I_U):

$$R_{VU} = 0.05 + (0.009 * I_U)$$

Percent impervious was determined by Baetis in prior studies using satellite imagery and GIS tools. Mean annual pollutant loads (L_P) are then calculated by PLOAD as:

$$L_P = \Sigma\,(P \cdot P_J \cdot R_{VU} \cdot C_U \cdot A_U)$$

Where: P = Precipitation (36.28 inches/year in Rockford)

P_J = Ratio of storms producing runoff (we used the default value of 0.9)

C_U = Event Mean Concentration (EMC) for land use type u

A_U = Area of land use type u

The loading rates are derived from the EMC tables. Land use areas are interpreted from the land use and watershed boundary shapefiles.

Calibration of the PLOAD models for each watershed involves the varying of EMC values to produce results reasonably consistent with observed water quality data (Appendix A). PLOAD input and output files are listed in Appendix B. Input EMC and imperviousness values are given for each land use type in each watershed.

3.2 MODEL CONFIRMATION

Watershed model results are confirmed if the results are consistent not only with observed data, but also with comparable research studies at other watersheds. PLOAD output includes not only mean annual pollutant loadings, but also pollutant export coefficients (also known as unit area loading rates). Table 5 and Figure 9 compare the unit areal loading rates predicted by the calibrated PLOAD models with those measured by researchers in several other watersheds in the Midwest and elsewhere. The comparison is suitable, given the relative uncertainty associated with this modeling exercise.

Table 5. Comparison of Unit Area Loading Rates from the Study Areas to Published Literature

Watershed	Location	Area (sq mi)	Land Use			TSS Unit Area Load (lbs/ac)	Total N Unit Area Load (lbs/ac)	Phosphorus Unit Area Load (lbs/ac)	Reference
			% Urban	% Forest	% Agri				
Turtle Creek	Wisconsin	199	5%	4%	89%	347		1.13	Corsi, et al. undated
S. Pheasant Branch	Wisconsin	5.7	15%	0%	84%	197		0.53	Corsi, et al. undated
Pheasant Branch	Wisconsin	18.3	8%	0.1%	90%	253		1.02	Corsi, et al. undated
Jackson Creek	Wisconsin	16.8	13%	0%	86%	53		0.30	Corsi, et al. undated
Delevan Lake Tributary	Wisconsin	10	1%	2%	95%	25		0.08	Corsi, et al. undated
Cedar Run, Occoquan River	Virginia	153	unpubl.	unpubl.	unpubl.	205	5.0	0.52	Dougherty et al. 2006
Cub Run, Occoquan River Basin	Virginia	49	50%	unpubl.	unpubl.	449	5.3	0.56	Dougherty et al. 2006
Upper Bull Run, Occoquan	Virginia	25.8	unpubl.	unpubl.	unpubl.	367	4.6	0.56	Dougherty et al. 2006
Upper Broad Run, Occoquan	Virginia	50.6	unpubl.	unpubl.	unpubl.	210	4.2	0.49	Dougherty et al. 2006
Lake Minnetonka	Minnesota	4.E-05	0	predom.	0			0.08	Singer and Rust 1975
Marcell Experimental Forest	Minnesota	3.E-02	unpubl.	predom.	unpubl.		2.2	0.25	Timmons et al. 1977
Hubbard Brook Experimental Forest	Minnesota	0.06	unpubl.	predom.	unpubl.		3.6	0.02	Likens, et al. 1977
Black Creek	Indiana	19.1	5%	6%	89%		25.6	2.81	Lake and Morrison 1977
Smith-Fry Drain	Indiana	3.6	3%	8%	89%		28.3	2.90	Lake and Morrison 1977
Dreisbach Drain	Indiana	2.8	12%	5%	83%		23.1	2.68	Lake and Morrison 1977
Macedonia	Iowa	0.6	0%	0%	100%		8.6	0.58	Burwell et al. 1974
Treynor	Iowa	0.2	0%	0%	100%		12.6	0.24	Burwell et al. 1974
Thames River	Ontario	19.6	unpubl.	unpubl.	88%		14.4	1.14	Coote et al. 1978
Big Creek	Ontario	30.6	unpubl.	unpubl.	96%		5.7	0.23	Coote et al. 1978
AuSable River	Ontario	23.9	unpubl.	8%	88%		37.0	0.81	Coote et al. 1978
Grand River	Ontario	7.2	unpubl.	7%	91%		18.1	0.89	Coote et al. 1978
Middle Thames River	Ontario	11.6	unpubl.	15%	77%		27.8	1.37	Coote et al. 1978
Maitland River	Ontario	unpubl.	unpubl.	29%	68%		12.8	0.14	Coote et al. 1978
Shelter Valley Creek	Ontario	21.8	unpubl.	37%	43%		2.9	0.07	Coote et al. 1978
Twenty Mile Creek	Ontario	11.7	unpubl.	18%	79%		13.8	1.37	Coote et al. 1978
Humber River	Ontario	9.2	unpubl.	8%	82%		9.9	0.44	Coote et al. 1978

Table 5. Comparison of Unit Area Loading Rates from the Study Areas to Published Literature

Watershed	Location	Area (sq mi)	Land Use			TSS Unit Area Load (lbs/ac)	Total N Unit Area Load (lbs/ac)	Phosphorus Unit Area Load (lbs/ac)	Reference
			% Urban	% Forest	% Agri				
Hillman Creek	Ontario	7.7	unpubl.	10%	67%		22.5	0.81	Coote et al. 1978
Saugeen River	Ontario	17.4	unpubl.	9%	88%		8.4	0.72	Coote et al. 1978
Four Mile Creek	Ohio	49.7	1%	8%	91%		36	1.25	Vanni et al. 2001
Little Four Mile Creek	Ohio	30.8	1%	5%	94%		46	0.96	Vanni et al. 2001
Marshall's Branch	Ohio	4.7	1%	7%	92%		27	1.43	Vanni et al. 2001
South Kinnikinnick Creek	Illinois	16.9	3%	21%	55%	66	10	0.35	
Kent Creek	Illinois	44.8	15%	11%	50%	80	17	0.50	

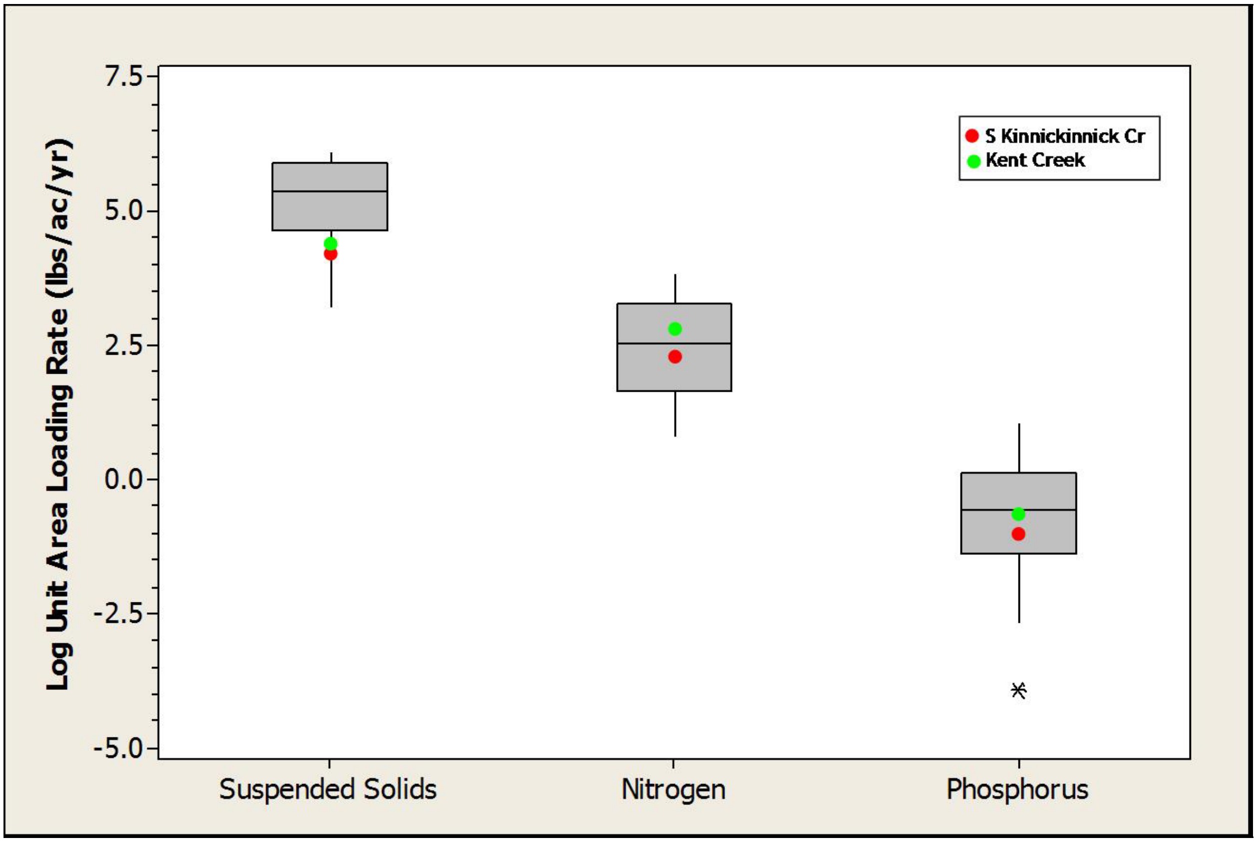

Figure 9. Comparison of Predicted and Literature Unit Area Loading Rates

3.3 MODEL RESULTS

Existing land use conditions and long term average precipitation rates were used in BASINS/PLOAD to estimate current pollutant loads from the two study watersheds (Tables 6 and 7). We modeled total suspended solids (TSS), total nitrogen (TN) and total phosphorus (TP). The loads tabulated below represent mean annual export of the modeled pollutant from the drainage.

Table 6. S. Kinnikinnick Creek Watershed Nonpoint Source Mean Annual Pollutant Loads

Subwatershed	TSS Load		Phosphorus Load		Nitrogen Load	
	Pounds	lbs/acre	Pounds	lbs/acre	Pounds	lbs/acre
East	550,267	70.7	2,825	0.363	75,068	9.65
North	123,424	64.8	634	0.333	17,136	9.00
Mouth	46,578	40.9	355	0.311	15,540	13.64
Total	720,269		3,814		107,744	

Table 7. Kent Creek Watershed Nonpoint Source Mean Annual Pollutant Loads

Subwatershed	TSS Load		Phosphorus Load		Nitrogen Load	
	Pounds	lbs/acre	Pounds	lbs/acre	Pounds	lbs/acre
1	14,526	137	131	1.236	5,842	55.26
2	136,543	133	1,225	1.189	54,621	53.04
3	132,177	82	1,126	0.697	49,552	30.69
4	31,337	51	178	0.288	5,785	9.38
5	37,325	37	201	0.198	6,590	6.50
6	218,810	85	1,112	0.430	27,995	10.83
7	549,626	88	2,869	0.461	75,202	12.09
8	128,238	70	686	0.377	19,333	10.62
9	125,423	81	723	0.468	22,216	14.39
10	242,721	94	1,745	0.678	67,315	26.15
11	259,159	71	1,914	0.525	77,152	21.17
12	159,326	71	924	0.414	29,134	13.05
13	278,191	77	1,543	0.426	45,566	12.57
	2,313,403		14,376		486,303	

3.4 AN EXAMPLE APPLICATION

PLOAD allows the user to evaluate land use changes, implementation of Best Management Practices (BMPs) and other factors affecting pollutant loads. Land use changes, BMPs, and streambank erosion control structures serve to reduce pollutant loads and PLOAD has options to calculate loads based on the remedial effects of the various BMP types. BMP types may be represented in the model as either area or site features, but the computation for both is similar. After existing conditions are evaluated, these options can be invoked to recalculate the pollutant loads.

To illustrate the utility of these watershed models, Baetis evaluated one future scenario. Baetis evaluated the pollutant load changes associated with a potential land use change in Subbasin 1, the mouth (or westernmost) subbasin delineated in the South Kinnikinnick Creek watershed. Here, 87+ acres are being acquired by the Natural Land Institute, Roscoe Township, and Winnebago County Forest Preserve District. Much of this property is currently productive corn and soybean fields, is in the floodplain, and given its proximity to the stream, would potentially significantly affect stream water quality during wet weather. Under a future scenario, this floodplain area would become grassland (Figure 10) or forest.

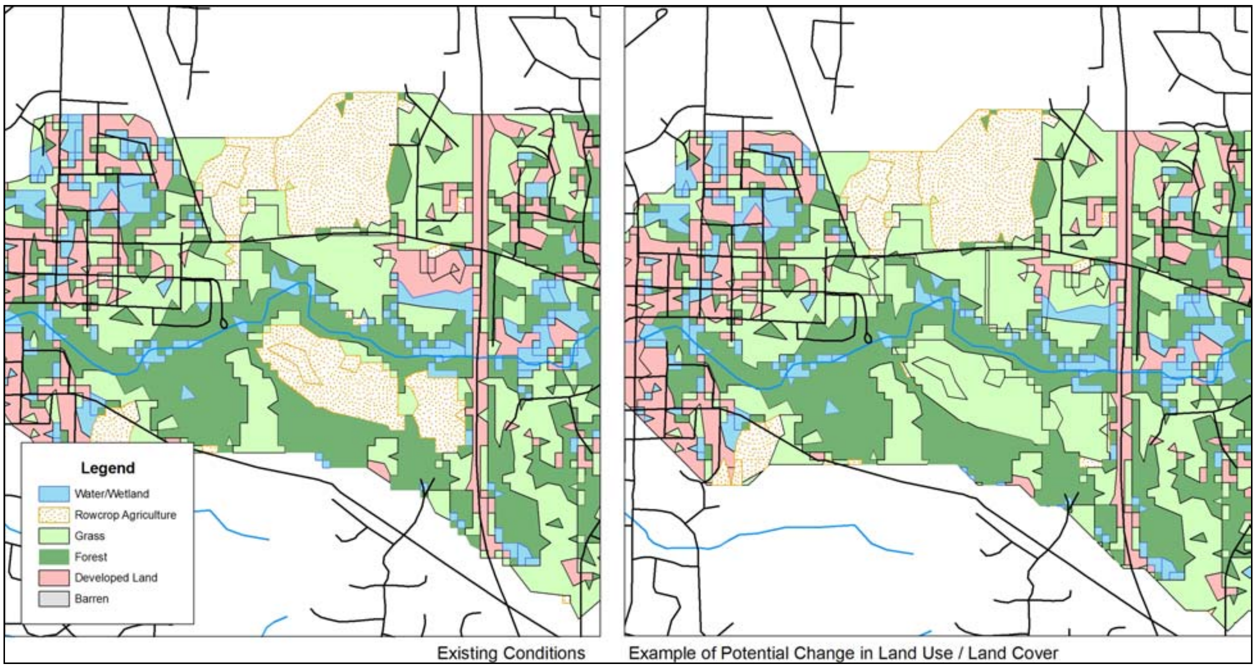

Figure 10. Existing and Potential Land Use in Lower South Kinnikinnick Creek Watershed

Table 8 summarizes the pollutant loads from South Kinnikinnick Creek watershed under the potential land use change in Subbasin 1. The estimated reduction in loads is tabulated below as well.

Table 8. Potential Kinnikinnick Watershed Mean Annual Pollutant Loads

Subwatershed	TSS Load		Phosphorus Load		Nitrogen Load	
	Pounds	lbs/acre	Pounds	lbs/acre	Pounds	lbs/acre
East	550,267	70.7	2,825	0.363	75,068	9.65
North	123,424	64.8	634	0.333	17,136	9.00
Mouth	40,121	35.2	318	0.279	14,570	12.79
	713,812		3,777		106,774	

Table 9. Decrease in Pollutant Load Associated with a Potential Land Use Change

Subwatershed	Suspended Solids	Phosphorus	Nitrogen
East	0%	0%	0%
North	0%	0%	0%
Mouth	14%	10%	6%
Total	0.9%	1.0%	0.9%

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APPENDICES

A. WATER QUALITY DATA

This appendix reviews water quality data collected by Baetis Environmental Services, Inc. from 2003 through 2007 in Winnebago County, Illinois under the partnership SCORE, the Sinnissippi Coalition for Restoration of the Environment. SCORE is an informal partnership between the City of Rockford, the Rock River Water Reclamation District (District), and the Illinois Environmental Protection Agency (IEPA).

A.1 METHODS

All data were collected in compliance with a Quality Assurance Project Plan (SCORE 2004). The QAPP specifies the methods for sampling, sample handling and preservation, sample analysis, and field surveys.

A.2 SUBWATERSHEDS AND SAMPLING LOCATIONS

Water quality continues to be analyzed from samples collected at numerous locations in tributaries of the Rock River, including North Kent Creek and South Kinnikinnick Creek. Figure A-1 is a map showing the locations of sampling stations. Each sampling location was selected to characterize pollutant loads from subwatersheds draining to the Rock River. Tributaries to the Rock River have been sampled under two protocols: T1 and T2 are near the mouths of North and South Kent Creeks respectively. A full suite of water quality analyses is performed from monthly samples collected at these two sites. T6 is also on North Kent Creek, upstream of T1, at Anna Page Park. T11 is near the mouth of South Kinnikinnick Creek. T6 and T11 are “coliform source assessment samples”. Only fecal coliform bacteria, suspended solids and a few field parameters are measured there.

Table A-1

WATER QUALITY SAMPLING AND BIOASSESSMENT SITES

Designation	Station Type	Name
T1	Stream Bioassessment	North Kent Creek at Fairgrounds Park
T2	Stream Bioassessment	South Kent Creek at Corbin/Tay Sts
T6	Coliform	North Kent Cr at Anna Page Pk (IEPA site IL_PSB-01)
T11	Coliform	South Kinnikinnick Creek

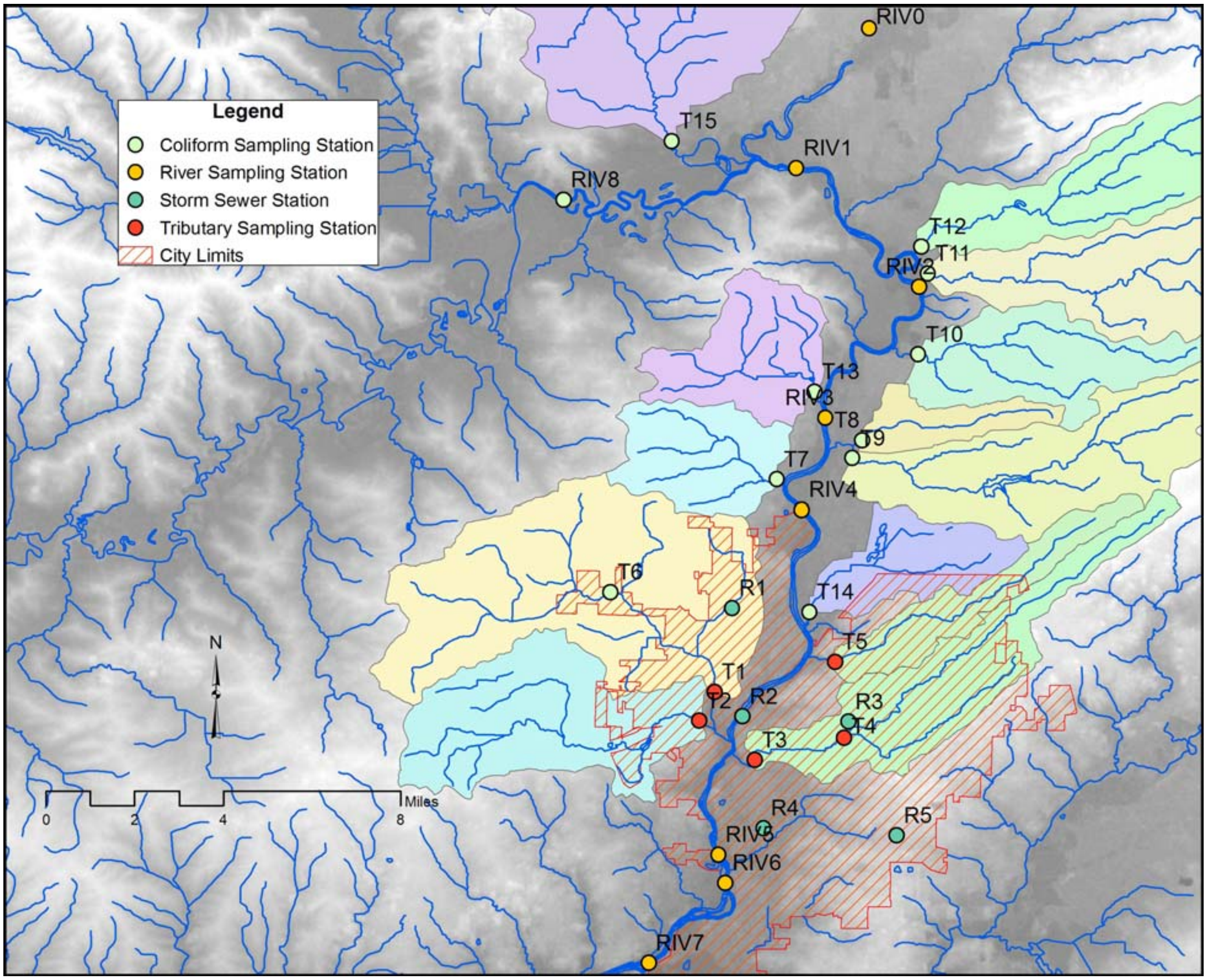

Figure A-11. Sampling Sites

A.3 FIELD MEASUREMENTS

Dissolved oxygen (DO), pH, conductivity and temperature are typically measured each time samples are collected. DO summary statistics are given in Table A-2. The General Use Water Quality Standard applicable to all these streams is given in 35 Ill. Admin. Code 302.206:

> *Dissolved oxygen shall not be less than 6.0 mg/l during at least 16 hours of any 24 hour period, nor less than 5.0 mg/l at any time.*

There are no continuous DO measurement stations, so the 5.0 mg/L standard is our benchmark for evaluating use support in these streams. No DO measurements have been less that 5.0 mg/L.

While Illinois' water quality standards do not address high DO levels, we routinely observe DO saturation well over 100% in many of the Rock River tributaries, including North Kent and South Kinnikinnick Creeks. High DO is the result of photosynthesis and nutrient enrichment, and occurs in rural and urban streams.

Table A-2

DISSOLVED OXYGEN (mg/L) IN TRIBUTARIES

Site	Name	N	Mean	Minimum	Median	Maximum
T1	North Kent Creek	41	10.86	5.45	10.79	21.6
T2	South Kent Creek	41	10.91	7.04	10.19	18.6
T6	N Kent Cr at Anna Page	34	11.40	6.95	11.18	18.92
T11	S Kinnikinnick Creek	30	11.53	6.79	10.91	18.28

Summary statistics on pH values measured in tributaries are given in Table A-3. The General Use Water Quality Standard for pH that is applicable to all these streams is given in 35 Ill. Admin. Code 302.204:

pH shall be within the range of 6.5 to 9.0 except for natural causes.

While none of the tributaries exceeded the upper pH standard, both streams have had measurements less than pH 6.5. This could be a natural phenomenon in the region or there may be unknown anthropogenic reasons.

Table A-3

pH IN TRIBUTARIES

Site	Name	N	Mean	Minimum	Median	Maximum
T1	North Kent Creek	40	7.68	6.5	7.73	8.15
T2	South Kent Creek	40	7.62	6.4	7.665	8.24
T6	N Kent Cr at Anna Page	35	7.50	6.09	7.59	8.1
T11	S Kinnikinnick Creek	30	7.58	6.21	7.71	8.23

Summary statistics for conductivity are given below (Table A-4). The State of Illinois does not have a water quality standard for conductivity. The conductivity of streams draining more urbanized areas tend to be higher than streams draining more rural parts of the county.

Table A-4

WATER CONDUCTIVITY IN TRIBUTARIES (µS/cm)

Site	Name	N	Mean	Minimum	Median	Maximum
T1	North Kent Creek	39	710	166	764	1008
T2	South Kent Creek	40	872	356	882	1931
T6	N Kent Cr at Anna Page	35	662	451	682	734
T11	S Kinnikinnick Creek	30	637	250	683	800

A.4 SOLIDS

Total suspended solids (TSS) and, at T1, total dissolved solids (TDS), have also been measured (Table 10). Summary statistics are given below. The General Use Water Quality Standards applicable to these streams includes a dissolved solids limit of 1,000 mg/L (35 Ill. Admin. Code 302.208). From 2003 through 2007, there have been three recorded instances at T1 that this standard was exceeded. The high TDS levels occurred during winter, and may be due to street salt applications and runoff.

Table A-5

TSS AND TDS IN TRIBUTARIES (mg/L)

Total Suspended Solids						Total Dissolved Solids				
Site	N	Mean	Minimum	Median	Maximum	N	Mean	Minimum	Median	Maximum
T1	41	22	1	12	245	41	416	132	438	540
T2	41	30	3	24	161	41	480	186	478	920
T6	35	10	1	7	30	0	-	-	-	-
T11	30	26	0.5	4.5	310	0	-	-	-	-

A.5 OXYGEN DEMAND

Chemical oxygen demand (COD) is only measured at T1 and T2. 5-day biochemical oxygen demand (BOD) was also measured at T1 prior to May 2005. There are no water quality standards for these parameters, and, the streams do not have depressed DO concentrations. Summary statistics are given in Table A-6.

Table A-6

BOD AND COD (mg/L) IN KENT CREEK (mg/L)

Biochemical Oxygen Demand						Chemical Oxygen Demand				
Site	**N**	**Mean**	**Minimum**	**Median**	**Maximum**	**N**	**Mean**	**Minimum**	**Median**	**Maximum**
T1	14	5.92	1	2.5	24	41	16.98	3	11	113
T2	14	5.52	1	3	16	41	14.95	2	11	64

A.6 NITROGEN AND PHOSPHORUS

Nutrients have only been analyzed at T1 and T2, and include ammonia-nitrogen, nitrate-N, and total phosphorus. Each parameter had several observations that were less than the detection limits. Baetis' statistical analyses involved replacement of results that were less than the detection limit (MDL) with values that were 50% of the MDL.

Table A-7

NUTRIENT CONCENTRATIONS IN KENT CREEK (mg/L)

Parameter	North Kent Creek			South Kent Creek		
	N	**Mean**	**Median**	**N**	**Mean**	**Median**
Ammonia Nitrogen	41	0.11	0.05	41	0.12	0.10
Nitrate Nitrogen	41	5.65	5.10	41	3.35	3.20
Total Phosphorus	39	0.17	0.10	40	0.16	0.12

A.7 METALS

Concentrations of total metals lead, cadmium, copper, chromium, nickel and zinc are also measured at T1. These data are available upon request from the City or Baetis. With the exception of zinc, concentrations are nearly always less than the quantitation limit (QL).

A.8 FECAL COLIFORM BACTERIA CONCENTRATIONS

Summary statistics on fecal coliform bacteria concentrations measured in tributaries are given in Table A-8. The General Use Water Quality Standard applicable to all these streams is given in 35 Ill. Admin. Code 302.209:

> *During the months May through October, based on a minimum of five samples taken over not more than a 30 day period, fecal coliform shall not exceed a geometric mean of 200 per 100 ml, nor shall more than 10% of the samples during any 30 day period exceed 400 per 100 ml in protected waters.*

Summary data for concentrations of fecal coliform bacteria are tabulated below. Analysis of the tributary bacteria data is complicated due to the right-censoring of many observations, that is, values recorded as “greater than” and flagged as B. The censoring value was not consistent across the dataset, and techniques for analysis of arbitrarily censored data are limited.

Table A-8

FECAL COLIFORM BACTERIA IN TRIBUTARIES
(CFU/100mL)

Station	Description	N	No. B Flags	Median
T1	N. Kent Cr – Fairgrounds	41	4	310
T2	South Kent Creek	42	6	390
T6	N. Kent Cr - Anna Page Pk	35	0	60
T11	S. Kinnikinnick Creek	31	1	220

A.9 REFERENCES

Illinois Environmental Protection Agency (IEPA), 2006. Illinois Integrated Water Quality Report and Section 303(d) list-2006. Illinois EPA Bureau of Water. April 2006. IEPA/BOW/04-005 http://www.epa.state.il.us/water/watershed/reports/303d-report/2006/303d-report.pdf

Sinnissippi Coalition for Restoration of the Environment (SCORE). 2004. Quality Assurance Project Plan, Vers. 2. Rockford, Illinois. Prepared by Baetis Environmental Services, Inc. Chicago, IL.

B. PLOAD MODEL INPUT FILES

BASINS file	Description
SKinn_outlet.shp	BASINS subwatershed outlets file for HSPF
Skinnick.mwprj	BASINS project file
SKinnickwatershedboundary.shp	USGS topo-based manual delineation
SKinndemgw.shp	BASINS automated delineation of subbasins
ssurgosoils.shp	Winnebago County soils
SKinndemgnet.shp	BASINS stream reach file
S_Kinn_NHD.shp	S Kinn National Hydrographic dataset
NHDH0709-NHDFlowline.shp	Cataloging unit NHD
07090005demg.tif	Cataloging unit DEM file
contours_merged.shp	Elevation contours derived from DEM file
KinnickinnickCreekPreserve.shp	Boundaries of land purchased by WCFPD, digitized by Baetis
skinnick_landuse.shp	S Kinn land use for Skinnickwatershedboundary.shp
Imperviousness.dbf, *.xls	Imperviousness estimates used by PLOAD
emc_Kent.dbf	EMC file for PLOAD
emc_SKinn.dbf	EMC file for PLOAD
skinn\SKinndemgw1.shp	S Kinn TSS areal load (pounds/acre) from PLOAD
skinn\SKinndemgw2.shp	S Kinn TSS load (pounds) from PLOAD
skinn\SKinndemgw3.shp	S Kinn TSS EMC file from PLOAD
gage.*	USGS gaging stations downloaded by BASINS
skinn\SKinndemgw7.shp	S Kinn Total Nitrogen areal load (pounds/acre) from PLOAD
skinn\SKinndemgw8.shp	S Kinn Total Nitrogen load (pounds) from PLOAD
skinn\SKinndemgw12.shp	S Kinn Total Nitrogen EMC file from PLOAD
skinn\SKinndemgw13.shp	S Kinn Total Phosphorus areal load (pounds/acre) from PLOAD
skinn\SKinndemgw14.shp	S Kinn Total Phosphorus load (pounds) from PLOAD
skinn\SKinndemgw15.shp	S Kinn Total Phosphorus EMC file from PLOAD
wqobs_SCORE.*	SCORE water quality stations
Winnebago.wdm	Winnebago County meteorological data for HSPF
Alt1.shp	S Kinn land use for PLOAD estimates; identical to skinnick_landuse.* except KinnickinnickCreekPreserve developed land and ag land changed to grass
demg\07090005demgw.shp	Kent subwatershed boundaries
07090005demgnet.shp	Kent subwatershed stream reaches
outlets_kent1.shp	Kent outlets shapefile
demg\07090005demgw1.shp	Kent TSS areal load (count/acre) from PLOAD
demg\07090005demgw2.shp	Kent TSS load (count) from PLOAD
demg\07090005demgw3.shp	Kent TSS EMC file from PLOAD
demg\07090005demgw4.shp	Kent Total Nitrogen areal load (count/acre) from PLOAD
demg\07090005demgw5.shp	Kent Total Nitrogen load (count) from PLOAD
demg\07090005demgw6.shp	Kent Total Nitrogen EMC file from PLOAD
demg\07090005demgw7.shp	Kent total phosphorus areal load (count/acre) from PLOAD
demg\07090005demgw8.shp	Kent total phosphorus load (count) from PLOAD
demg\07090005demgw9.shp	Kent total phosphorus EMC file from PLOAD
skinn\SKinndemgw16.shp	S Kinn Alt 1 TSS areal load (pounds/acre) from PLOAD
skinn\SKinndemgw17.shp	S Kinn Alt 1 TSS load (pounds) from PLOAD

BASINS file	Description
skinn\SKinndemgw18.shp	S Kinn Alt 1 TSS EMC file from PLOAD
skinn\SKinndemgw19.shp	S Kinn Alt 1 Total Nitrogen areal load (pounds/acre) from PLOAD
skinn\SKinndemgw20.shp	S Kinn Alt 1 Total Nitrogen load (pounds) from PLOAD
skinn\SKinndemgw21.shp	S Kinn Alt 1 Total Nitrogen EMC file from PLOAD
skinn\SKinndemgw22.shp	S Kinn Alt 1 Total Phosphorus areal load (pounds/acre) from PLOAD
skinn\SKinndemgw23.shp	S Kinn Alt 1 Total Phosphorus load (pounds) from PLOAD
skinn\SKinndemgw24.shp	S Kinn Alt 1 Total Phosphorus EMC file from PLOAD

Event Mean Concentration files

Kent Creek:

GRIDCODE	GROUP	IMPERVIOUS	TSS	TDS	TN	TP
11	Rowcrop Agriculture	0	300.0		35	1.500
12	Rowcrop Agriculture	0	300.0		35	1.500
13	Rowcrop Agriculture	0	300.0		35	1.500
14	Rowcrop Agriculture	0	300.0		35	1.500
16	Rowcrop Agriculture	0	300.0		35	1.500
17	Grass	0	10.0		10	0.100
22	Forest	0	5.0		5	0.010
23	Forest	0	5.0		5	0.010
24	Forest	0	5.0		5	0.010
25	Forest	0	5.0		5	0.010
26	Forest	0	5.0		5	0.010
31	Developed Land	43	50.0		20	0.450
32	Developed Land	43	50.0		20	0.450
33	Developed Land	43	50.0		20	0.450
34	Developed Land	43	50.0		20	0.450
35	Grass	0	10.0		10	0.100
41	Water/Wetland	0	0.0		1	-0.010
46	Water/Wetland	0	0.0		1	-0.010
47	Water/Wetland	0	0.0		1	-0.010
51	Water/Wetland	0	0.0		1	-0.010

South Kinnikinnick Creek:

GRIDCODE	GROUP	IMPERVIOUS	TSS	TDS	TN	TP
11	Rowcrop Agriculture	0	300		35	1.500
12	Rowcrop Agriculture	0	300		35	1.500
13	Rowcrop Agriculture	0	300		35	1.500
14	Rowcrop Agriculture	0	300		35	1.500
16	Rowcrop Agriculture	0	300		35	1.500
17	Grass	0	10		10	0.100
22	Forest	0	5		5	0.010
23	Forest	0	5		5	0.010
24	Forest	0	5		5	0.010
25	Forest	0	5		5	0.010
26	Forest	0	5		5	0.010
31	Developed	43	50		20	0.450
32	Developed	43	50		20	0.450
33	Developed	43	50		20	0.450
34	Developed	43	50		20	0.450
35	Grass	0	10		10	0.100
41	Water/Wetland	0	0		1	-0.010
46	Water/Wetland	0	0		1	-0.010
47	Water/Wetland	0	0		1	-0.010
51	Water/Wetland	0	0		1	-0.010
52	Barren	0	1000		1	0.000