Des Plaines River/ Higgins Creek Watershed TMDL Report

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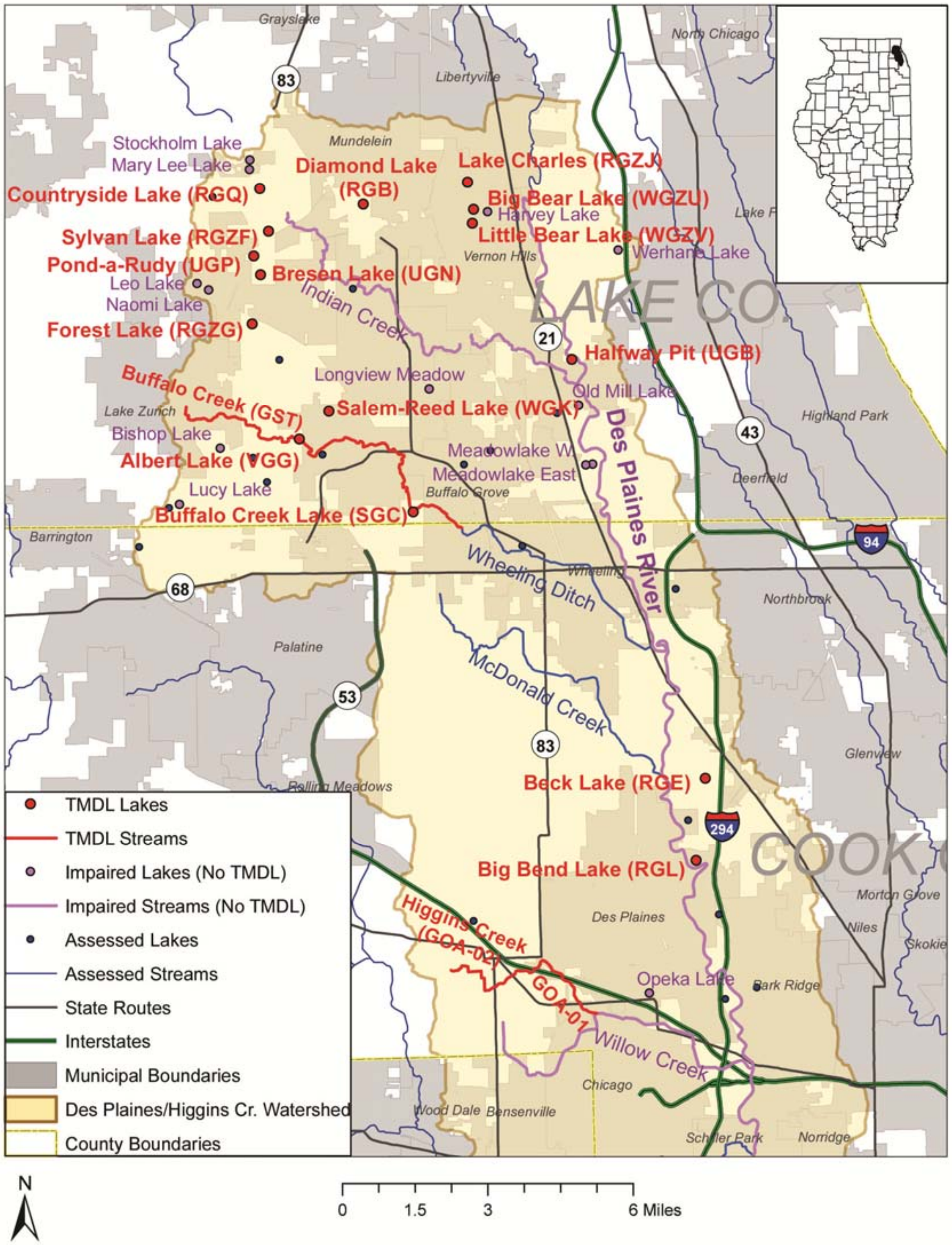

Illinois Environmental Protection Agency

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Contents

List of Appendices

List of Tables

List of Figures

Executive Summary

Section 303(d) of the Clean Water Act (CWA) requires the Illinois Environmental Protection Agency (EPA) to identify and list all state waters that fail to meet water quality standards (WQS). This list is referred to as the 303(d) list and is revisited every two years to either remove those waters that have attained their designated uses, or to include additional waters not previously deemed impaired. Impaired waterbodies included on the 303(d) list require Total Maximum Daily Load (TMDL) development.

A TMDL is an estimation of the maximum amount of a pollutant that a waterbody can receive and still meet WQS. It assesses contributing point and nonpoint sources and identifies pollution reductions necessary for designated use attainment. A TMDL identifies the source of impairment and provides reduction estimates to meet WQS. Pollutant reductions are then allocated to contributing sources, thus triggering the need for pollution control and increased management responsibilities amongst sources in the watershed.

Within the Des Plaines/Higgins Creek Watershed, 18 impaired waterbodies were identified for TMDL development. The Des Plaines/Higgins Creek Watershed is located in Cook, Lake, and DuPage Counties in far northeastern Illinois, and extends north into Wisconsin. The only waterbody classification applicable to waterbodies within the Des Plaines/Higgins Creek Watershed is the General Use classification which includes designated uses such as aquatic life, aesthetic quality, and primary contact recreation uses. The identified impairments include dissolved oxygen (DO), fecal coliform, chloride, and phosphorus (total).

Available data used for assessing these waterbodies originated from numerous water quality stations within the Des Plaines/Higgins Creek Watershed. Data were obtained from legacy and modernized USEPA Storage and Retrieval (STORET) databases, Lake County data, Metropolitan Water Reclamation District of Greater Chicago (MWRDGC) data, and Illinois EPA database data. Data relevant to impairments were compiled for each impaired waterbody and summary statistics were calculated to further characterize each pollutant.

Various models were used for TMDL development, the level of which was primarily based on the complexity of the system and the availability of data. The Lake Loading Response Model (LLRM) was used to model total phosphorus impairments in the lakes. It was also used for dissolved oxygen impairments in lakes where dissolved oxygen deficits resulted from nutrient over-enrichment. Load duration curves were developed for the fecal coliform and chloride analyses in Buffalo and Higgins Creeks. For the fecal coliform impairment in Sylvan Lake, a mass balance, in conjunction with the Simple Method, was used to develop the TMDL. For the DO impairments in Buffalo and Higgins Creeks, QUAL-2K was used to simulate the DO concentration in water column based on instream water quality and physical conditions. The calibrated models were used to calculate load capacity for each impairment parameter, i.e. TMDL. The TMDL is allocated to point sources and non-point sources, with margin of safety accounted. The load reduction for each source is calculated by comparing the existing load and load allocations (see Section 7.0)

An implementation plan was developed to provide general guidance for local communities and watershed groups to follow in order to achieve the stipulated TMDL allocations and reductions (Section 8.0). The plan recommends best management practices (BMPs) for non-point source pollution control. Implementation of BMPs by the citizens who live and work in the watershed is essential to the success in reducing the pollutants loads and improving water quality.

1.0 Introduction

This Total Maximum Daily Load (TMDL) report is presented to fulfill the requirements to develop TMDLs as part of that state's Clean Water Act (CWA) Section 303(d) compliance. The purpose of the project is to develop TMDLs for eighteen designated waterbodies in the Des Plaines River/Higgins Creek Watershed in northeastern Illinois.

Section 303(d) of the CWA and US EPA's Water Quality Planning Regulations (40 CFR Part 130) require states to develop TMDLs for impaired waterbodies that are not meeting designated uses or WQS. A TMDL is a calculation of the maximum amount of pollutants that a waterbody can receive and still meet the WQS necessary to protect the designated beneficial use (or uses) for that waterbody. The TMDL process establishes the allowable loadings of pollutants for a waterbody based on the relationship between pollutant sources and water quality conditions, so that states and local communities can establish water quality based controls to reduce pollutants from both point and nonpoint sources and restore and maintain the quality of their water resources.

Water is an essential resource for the inhabitants of the Earth and protecting this resource is the goal for many across the globe. United States policies and regulations, such as the CWA, were created and are implemented to help maintain the quality of our water resources in the United States. The US EPA, via the CWA, charged each designated state with developing WQS. These WQS are laws or regulations that states authorize to protect and/or enhance water quality, to ensure that a waterbody's designated use (or uses) is (are) not compromised by poor water quality and to protect public health and welfare. In general, WQS consist of three elements:

- The designated beneficial use (e.g., recreation, protection of aquatic life, aesthetic quality, and public and food processing water supply) of a waterbody or segment of a waterbody,
- The water quality criteria necessary to support the designated beneficial use of a waterbody or segment of a waterbody, and
- An anti-degradation policy, so that water quality improvements are conserved, maintained and protected.

The Illinois Pollution Control Board (IPCB) established its WQS. The WQS are included in Title 35: Environmental Protection, Subtitle C: Water Pollution, Chapter 1: Pollution Control Board, Part 302: Water Quality Standards.

Every two years Illinois EPA submits the Illinois Integrated Water Quality Report and Section 303(d) List. This report documents surface and groundwater conditions throughout the state. The 303(d) List portion of this report identifies impaired water bodies, grouped by watershed, and identifies suspected sources of impairment. These waters are prioritized for TMDL development into high, medium, and low categories based on designated use and pollution severity and are then targeted for TMDL development. Non-pollutant causes of impairment, such as habitat degradation and aquatic algae, are not addressed under the TMDL, but are addressed by programs such as the 319 program and other nonpoint source grant programs. Some non-pollutants may be addressed by reducing pollutants for which a TMDL is developed. For example, some implementation activities to reduce phosphorus also reduce total suspended solids, excessive algae and improve habitat.

A watershed's TMDL report consists of data analysis to quantitatively assess water quality, documentation of waterbodies or segments of waterbodies that are impaired, and identification of potential contributing sources to impairment. Based on these factors, the amount and type of load reduction needed to bring water quality into compliance is calculated. The TMDL report provides the scientific basis for states and local communities to establish water quality-based controls to reduce pollutant loads from both point (i.e., waste load allocations) and non-point sources (i.e., load allocations).

Illinois EPA has uses a three-stage approach to develop TMDLs for a watershed:

- Stage 1 – Watershed characterization, historical dataset evaluation, data analysis, methodology selection, data gap identification;
- Stage 2 – Data collection to fill in data gaps, if necessary; and
- Stage 3 – Model calibration, TMDL scenarios, and implementation plans.

The purpose of Stage 1 is to characterize the watershed background; verify impairments in the listed waterbody by comparing observed data with WQS or appropriate targets; evaluate spatial and temporal water quality variation; provide a preliminary assessment of sources contributing to impairments; and describe potential TMDL development approaches. If available data collected for the watershed are deemed sufficient by Illinois EPA, Stage 2 may be omitted and Stage 3 will be completed. If sufficient water quality data or supporting information are lacking for an impaired waterbody, then Stage 2 is required and field sampling will be conducted in order to obtain necessary data to complete Stage 3. Stage 3 includes model development, allocations and reductions needed for waterbody improvement and implementation actions for local stakeholders.

This report documents Stages 1 through 3 in the Illinois EPA approach for TMDL development for the Des Plaines River/Higgins Creek Watershed. The report is organized into eight main sections. Section 1.0 discusses the definition of TMDLs and targeted impaired waterbodies in Des Plaines River/Higgins Creek Watershed, for which TMDLs will be developed. Section 2.0 describes the characteristics of the watershed. Section 3.0 briefly discusses the process of public participation and involvement. Section 4.0 describes the applicable WQS and water quality assessment. Section 5.0 presents the assessment and analysis of available water quality data. Section 6.0 discusses the methodology selection for the TMDL development, identification of the data gaps, and provides recommendations for additional data collection, if necessary. Section 7.0 presents the development of TMDLs for targeted impaired waterbodies. Section 8.0 provides an implementation plan for use in bringing the targeted impaired waterbodies back into compliance with the water quality standards.

1.1 Definition of a Total Maximum Daily Load (TMDL)

According to the 40 CFR Part 130.2, the TMDL (the maximum load a waterbody can be receive without exceeding WQS or result in non attainment of a designated use) for a waterbody is equal to the sum of the individual loads from point sources (i.e., waste load allocations or WLAs), and load allocations (LAs) from nonpoint sources (including natural background conditions). Section 303(d) of the CWA also states that the TMDL must be established at a level necessary to achieve the applicable WQS with seasonal variations and a margin of safety (MOS) which takes into account any lack of knowledge concerning the relationship between effluent limitations and water quality. In equation form, a TMDL may be expressed as follows:

TMDL = WLA + LA + MOS

where:

WLA =	Waste Load Allocation (i.e., loadings from point sources);
LA =	Load Allocation (i.e., loadings from nonpoint sources including natural background); and
MOS =	Margin of Safety.

TMDLs can be expressed in terms of either mass per time, toxicity or other appropriate measures [40 CFR, Part 130.2 (i)]. US EPA recommends that all TMDLS and associated LA and WLAs be expressed in terms of daily increments but may include alternative non-daily expression of pollutant loads to facilitate implementation of the applicable water quality standard. TMDLs also shall take into account the seasonal variability of pollutant loading and hydrology to ensure the WQS are met in all seasons and during all hydrologic conditions. Though not required by CWA, Illinois EPA requires that an implementation plan be developed for each watershed, which may be used as a guideline for local stakeholders to restore water quality. This implementation plan will include recommendations for implementing best management practices (BMPs), cost estimates, institutional needs to implement BMPs and controls throughout the watershed, and time frame for completion of implementation activities.

The MOS accounts for the lack of knowledge or uncertainty concerning the true relationship between loading and attainment of WQS. This uncertainty is often a product of data gaps, either temporally or spatially, in the measurement of water quality. The MOS should be proportional to the anticipated level of uncertainty - the higher the uncertainty, the greater the MOS. The MOS is generally based on a qualitative assessment of the relative amount of uncertainty as a matter of best professional judgment (BPJ). The MOS can be either explicit or implicit. If an explicit MOS is used, a portion of the total allowable loading is allocated to the MOS. If the MOS is implicit, a specific value is not assigned to the MOS, but is already factored in during the TMDL development process. Use of an implicit MOS is appropriate when assumptions used to develop the TMDL are believed to be so conservative that they sufficiently account for the MOS.

1.2 Targeted Waterbodies for TMDL Development

In May 2008, Illinois EPA prepared a draft Illinois Integrated Water Quality Report and Section 303(d) List-2008 (commonly referred to as the 303(d) List) to fulfill the requirement of Section 305(b), 303(d) and 314 of the CWA (IEPA, 2008). Under US EPA's review and partial approval, the report presents a detailed water quality assessment process and results for streams and lakes in the State of Illinois. The water quality assessments are based on biological, physicochemical, physical habitat, and toxicity data. Each waterbody has one or more of designated uses which may include aquatic life, aesthetic quality, indigenous aquatic life (for specific Chicago-area waterbodies), primary contact (swimming), secondary contact (recreation), public and food processing water supply, and fish consumption. The degree of support (attainment) of a designated use in a waterbody (or segment) is assessed as Fully Supporting (good), Not Supporting (fair), or Not Supporting (poor). Waters in which at least one applicable use is not fully supported is designated as "impaired." Potential causes and sources of impairment are also identified for these waters. The 303(d) List is prioritized on a watershed basis based on the requirements of 40 CFR Part 130.7(b)(4). Watershed boundaries are based on United States Geological Survey (USGS) ten-digit hydrologic units, to provide the state with the ability to address watershed issues at a manageable level and document improvements to a watershed's health (ILLINOIS EPA, 2008). TMDL development is also conducted on a watershed basis so that the impaired waters upstream of an individual segment may be addressed at the same time.

The TMDL focuses on the 10 digit hydrologic unit code of 0712000405. Fifteen lake segments and three river segments are identified as impaired and selected for TMDL development in the Des Plaines / Higgins Watershed (IEPA, 2008). **Table 1-1** summarizes these waterbodies, designated uses, and impairments identified by the Illinois EPA. The designated uses for these waterbodies are primarily aesthetic quality and aquatic life. The identified causes for impairment that have numerical WQS include total phosphorus, fecal coliform, dissolved oxygen (DO), and chloride. DO, however, is considered a non-pollutant by Illinois EPA, yet it does have a numeric water quality standard. The Illinois EPA will ascertain potential causes for low dissolved oxygen using the TMDL process and will develop a TMDL only if the cause is attributable to a pollutant that has a numerical WQS. For example, if a 50-acre lake suffers from low DO due to excessive algal densities which is related to elevated phosphorus concentrations, the Illinois EPA will develop a phosphorus TMDL for the waterbody. If a lake is impaired for phosphorus and dissolved oxygen, yet less than 20 acres, the phosphorus standard does not apply. TMDL allocations and reductions will be developed for phosphorus in order to improve dissolved oxygen in the lake. TMDLs will not be developed for waterbodies listed as impaired based on non numerical WQS (e.g., excessive algae) or statistical guidelines (e.g., total suspended solids). For dissolved oxygen impairments, the dissolved oxygen parameter itself will not be calculated as a TMDL, but will be addressed through a different, contributory parameter. Waterbodies targeted for TMDL development are listed in **Table 1-2**. For other causes such as total suspended solids and excessive algae/aquatic plants, the TMDL implementation plan can potentially address the impairment by reducing other TMDL parameters such as phosphorus that are associated with this impairment. For example, a TMDL done for phosphorus in lakes will recommend BMPs in the implementation plan that when put in place will reduce siltation/ sedimentation and total suspended solid impairments in those waters. Reduction of phosphorus in lakes can also reduce the impairment of excessive aquatic algae and aquatic plants.

Table 1-1 Illinois 2008 Integrated Report (303(d) and Waterbody Assessment) Information for Des Plaines/Higgins Creek Watershed

Waterbody	**TMDL Pollutant**	**Aquatic Life Impairments Addressed**	**Aesthetic Quality Use Addressed**	**Recreational Use Addressed**
Albert Lake	TP	**DO, TP** TSS	**TP**, TSS	
Beck Lake	TP		**TP**, aquatic plants	
Big Bear Lake	TP	**TP**, TSS, aquatic plants	**TP**, TSS, aquatic plants	
Big Bend Lake	TP		**TP**, TSS, aquatic plants	
Bresen Lake	TP		**TP**, TSS, aquatic plants	
Buffalo Creek	Fecal, chloride, CBOD, NH3	**Chloride, DO**		**Fecal**
Buffalo Creek Lake	TP	**TP, DO**, TSS	**TP, DO**, TSS	
Countryside Lake	TP		**TP**, TSS, aquatic plants	
Diamond Lake	TP		**TP**, TSS, aquatic plants	
Forest Lake	TP		**TP**, TSS	
Half Day Pit	TP	**TP**, TSS	**DO, TP**, TSS	
Higgins Creek GOA-01	Fecal, chloride	**Chloride**, *nickel, pH, TP, zinc, fluoride*		**Fecal**
Higgins Creek GOA-02	Fecal, chloride	**Chloride**, DO		**Fecal**
Lake Charles	TP		**TP**, TSS, aquatic plants	
Little Bear Lake	TP		**TP**, TSS, aquatic plants	
Pond-A-Rudy	TP	**DO, TP**, TSS, aquatic plants	**TP**, TSS, aquatic plants	
Salem Reed Lake	TP		**TP**, TSS, aquatic plants	
Sylvan Lake	Fecal, TP		**TP**, TSS	**Fecal**
Total	24	12	16	4

- **Bolded parameters have numeric standards and will have TMDL allocations.**
- *Italicized parameters- The source causing impairment is believed to originate solely from point sources. The point source will be required to meet the water quality standard at the point of discharge. The Illinois EPA, based on the information available, believes that the compliance with the WQS will be achieved after all point source dischargers have installed the appropriate controls. A TMDL will not be prepared for this pollutant at this time, but the waterbody will be assessed again after the appropriate point source controls have been operational.*

Table 1-2 Waterbodies Targeted for TMDL Development in the Des Plaines/Higgins Creek Watershed

Waterbody Name	Segment ID	TMDL Impairment	Additional Parameter Addressed	Potential Sources
Albert Lake (outlet)	IL_VGG	Dissolved oxygen	Phosphorus (total), total suspended solids	Source unknown
Beck Lake	IL_RGE	Phosphorus (total)	Aquatic plants	Runoff from forest/grassland/ parkland, urban runoff/storm sewers, waterfowl
Big Bear Lake	IL_WGZU	Phosphorus (total)	Total suspended solids, aquatic plants	Source unknown
Big Bend Lake	IL_RGL	Phosphorus (total)	Total suspended solids, aquatic plants	Littoral/shore area modifications (non-riverine), runoff from forest/grassland/parkland, urban runoff/storm sewers
Bresen Lake	IL_UGN	Phosphorus (total)	Total suspended solids, aquatic plants	Source unknown
Buffalo Creek	IL_GST	Chloride, dissolved oxygen, fecal coliform		Source unknown, urban runoff/storm sewers
Buffalo Creek Lake	IL_SGC	Dissolved oxygen, phosphorus (total)	Total suspended solids	Source unknown
Countryside Lake	IL_RGQ	Phosphorus (total)	Total suspended solids, aquatic plants	Runoff from forest/grassland/ parkland, rural (residential areas), source unknown
Diamond Lake	IL_RGB	Phosphorus (total)	Total suspended solids, aquatic plants	Source unknown
Forest Lake	IL_RGZG	Phosphorus (total)	Total suspended solids	Agriculture, source unknown, urban runoff/storm sewers
Half Day Pit Lake	IL_UGB	Dissolved oxygen	Phosphorus (total), total suspended solids	Source unknown
Higgins Creek	IL_GOA-01	Chloride, fecal coliform		Municipal point source discharges, urban runoff/storm sewers
Higgins Creek	IL_GOA-02	Chloride, dissolved oxygen, fecal coliform		Urban runoff/storm sewers
Lake Charles	IL_RGZJ	Phosphorus (total)	Total suspended solids, aquatic plants	Source unknown
Little Bear Lake	IL_WGZV	Phosphorus (total)	Phosphorus (total), total suspended solids, aquatic plants	Source unknown

Waterbody Name	Segment ID	TMDL Impairment	Additional Parameter Addressed	Potential Sources
Pond-A-Rudy	IL_UGP	Dissolved oxygen	Total suspended solids, aquatic plants	Source unknown
Salem-Reed Lake	IL_WGK	Phosphorus (total)	Total suspended solids, aquatic plants	Source unknown
Sylvan Lake	IL_RGZF	Fecal coliform, phosphorus (total)	Total suspended solids	Source unknown

2.0 Watershed Characterization

This section describes the general characteristics of the Des Plaines River/Higgins Creek Watershed including location (Section 2.1), topography (Section 2.2), land use (Section 2.3), soil information (Section 2.4), population (Section 2.5), climate and precipitation (Section 2.6), and hydrology (Section 2.7).

2.1 Watershed

A watershed is a geographic area that shares a hydrologic connection - all the water within that area drains to a common waterway. Watersheds are important because pollution at the water's source may impact water quality in all downgradient areas including its convergence with a common waterway. Understanding the watershed is an essential step in the TMDL process.

The Des Plaines/Higgins Creek Watershed (**Figure 2-1**) is located in Cook, Lake, and DuPage Counties in far northeastern Illinois, and extends north into Wisconsin. According to the 10-digit Hydrologic Unit Code (HUC) watersheds, this watershed drains approximately 222,998 acres (348 square miles) within Illinois via its main waterway, the Des Plaines River. The Des Plaines River (the receiving waterbody for both Buffalo Creek and Higgins Creek) flows south from Wisconsin, across the state boundary, and continues in a southern direction until it is influenced by the Chicago Sanitary and Ship Canal near Riverside Lockport, Illinois. This area encompasses much of the northern and western Chicago suburbs, including the populous areas of Libertyville, Elmhurst, Des Plaines, and Chicago O'Hare International Airport. **Table 2-1** provides details for each sub-watershed targeted for TMDL development within the Des Plaines/Higgins Creek Watershed, **Figures 2-2** and **2-3** present the waterbodies listed for TMDL development. The Des Plaines River mainstem is not being addressed through this TMDL. This report will focus on the tributaries and lakes located in the same 10 digit hydrologic unit code, 0712000405 (**Figure 2-2**).

Table 2-1 Sub-Watershed County and Area Information

Watershed	Segment ID	Area (acres)	County
Albert Lake (outlet)	IL_VGG	1,300	Lake County
Beck	IL_RGE	372	Cook County
Big Bear/Little Bear	IL_WGZU/ IL_WGZV	3,339	Lake County
Big Bend	IL_RGL	707	Cook County
Bresen Lake	IL_UGN	251	Lake County
Buffalo Creek	IL_GST, IL_SGC	11,768	Lake County
Countryside Lake	IL_RGQ	1,953	Lake County
Diamond	IL_RGB	1,983	Lake County
Forest	IL_RGZG	528	Lake County
Half Day Pit	IL_UGB	27	Lake County
Higgins Creek	IL_GOA-01, IL GOA-02	5,289	Cook County
Lake Charles	IL_RGZJ	2,522	Lake County
Pond-A-Rudy	IL_UGP	62	Lake County
Salem-Reed	IL_WGK	130	Lake County
Sylvan	IL_RGZF	534	Lake County

Figure 2-1 Des Plaines/Higgins Creek Watershed

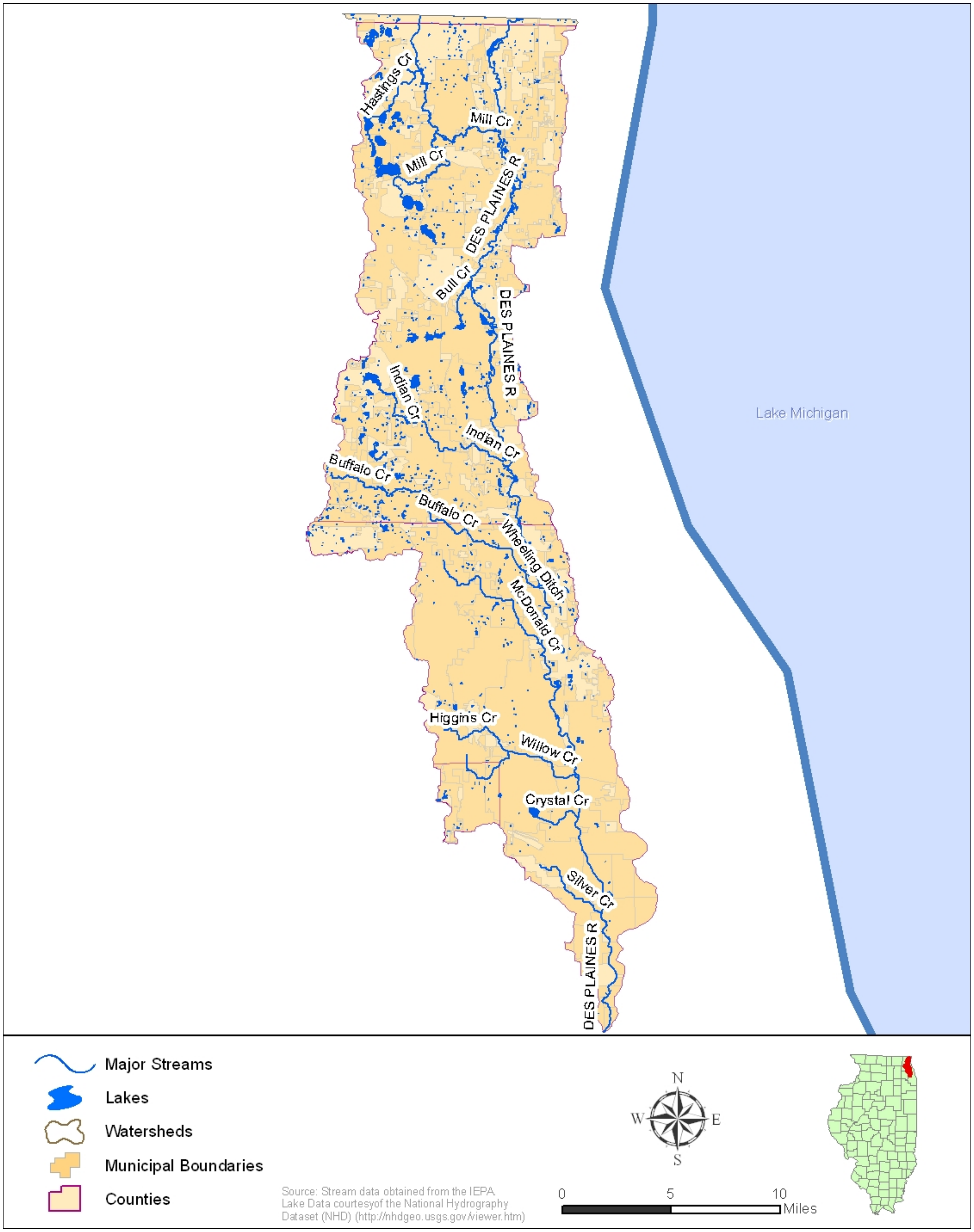


Figure 2-2 TMDL Waterbody Overview

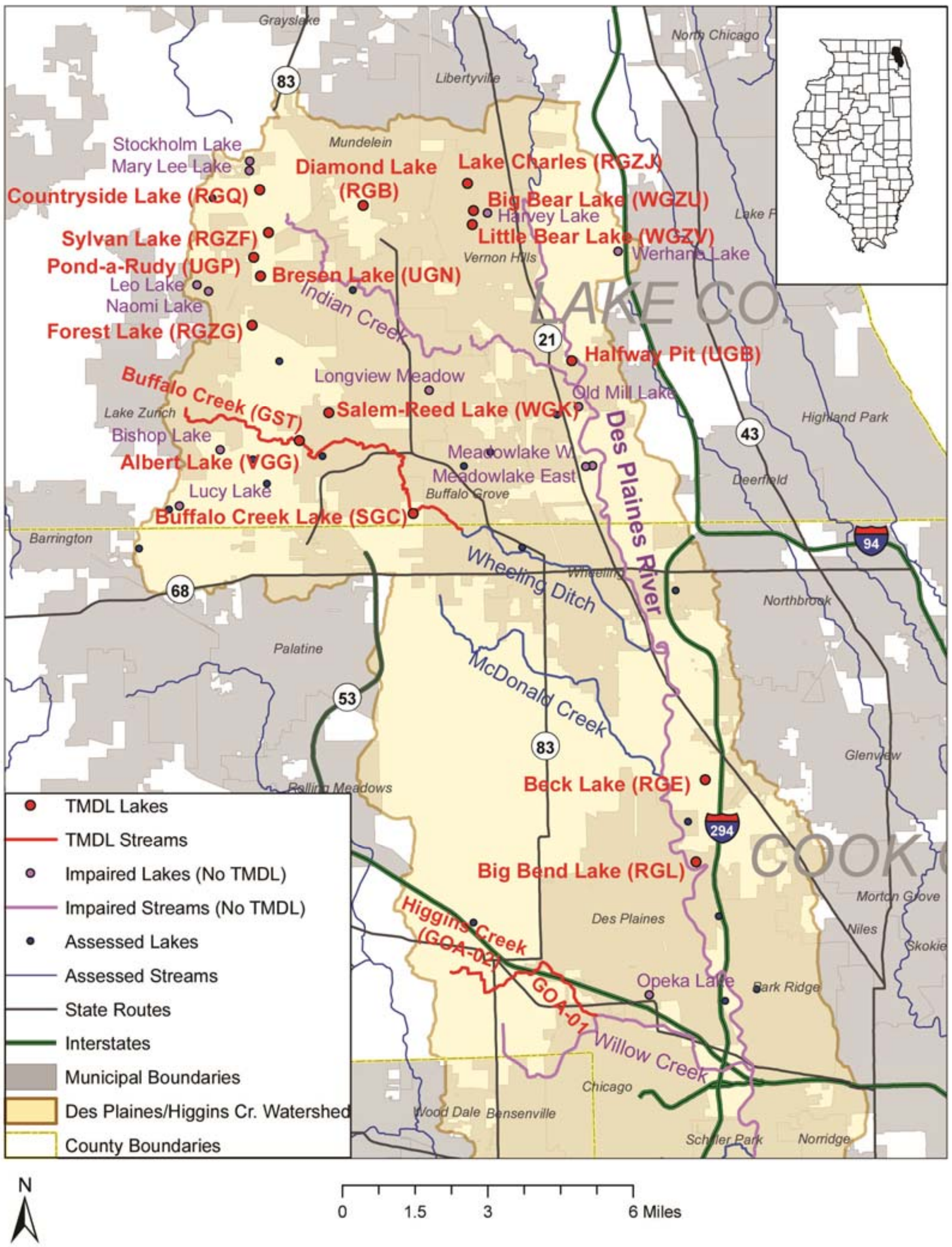
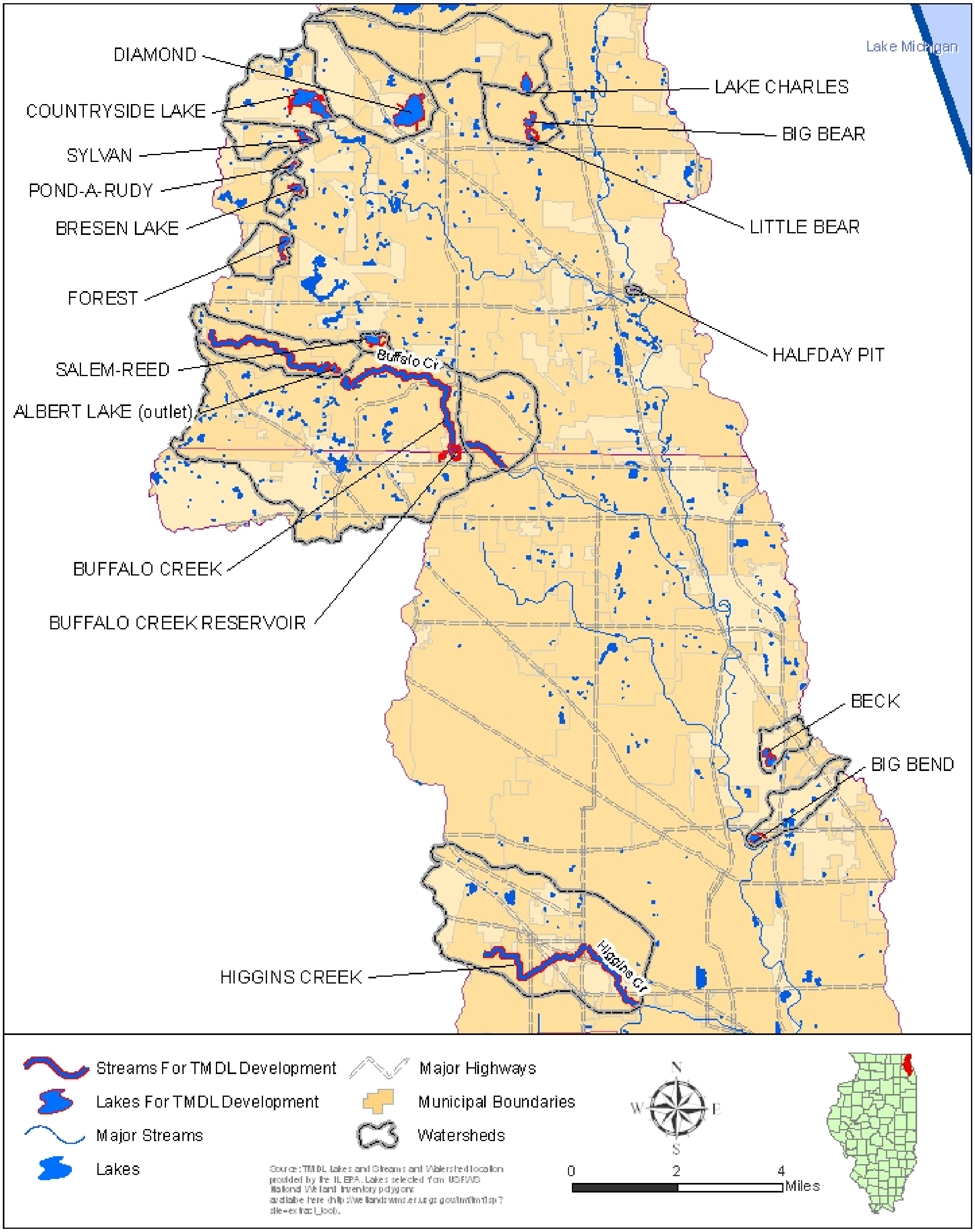


Figure 2-3 Des Plaines/Higgins Creek TMDL Watershed Map

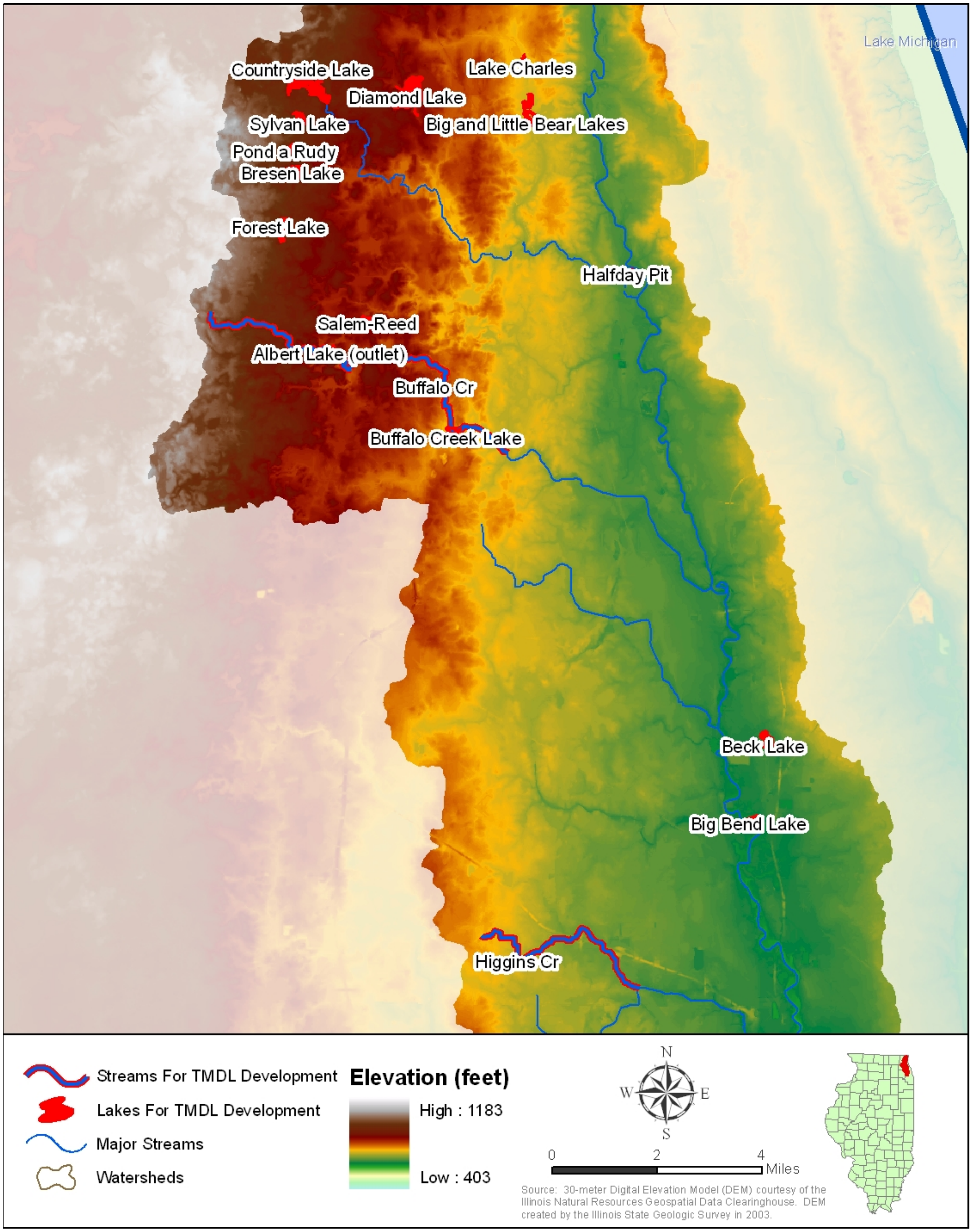


2.2 Topography

Topography influences soil types, precipitation, and subsequently watershed hydrology and pollutant loading. For the Des Plaines/Higgins Creek Watershed, a USGS 30-meter resolution Digital Elevation Model (DEM) was obtained from the Illinois Natural Resources Geospatial Data Clearinghouse to characterize the topography. The DEM was then cropped to the northern extent of the Des Plaines/Higgins Creek Watershed, as provided by the Illinois EPA, and analyzed. **Figure 2-4** displays elevations in color ramp throughout the Des Plaines/Higgins Creek Watershed. In general, the watershed starts at a higher elevation in the west and northwest and grades down to a lower elevation in the east or southeast toward Lake Michigan, resulting overall surface water flow from northwest to southeast. The percent change of elevation across the Des Plaines/Higgins Creek Watershed is approximately 34% and ranges from 919 feet to 606 feet.

The elevation of the Des Plaines River is 670 feet as it leaves Wisconsin and enters Illinois. It flows southward when it has confluences with Mill Creek, Indiana Creek, Buffalo Creek/Wheeling Drainage Ditch, and Willow Creek/Higgins Creek and then exits the watershed to the south at about 608 feet. Streams with 303(d) listed segments flow from the west around the higher elevations in the watershed to the east where they enter the Des Plaines River. Buffalo Creek starts in the west at around 863 feet and enters the Des Plaines at around 637 feet. Higgins Creek Starts in the southwest of the watershed at about 700 feet and confluences with the Des Plaines River at around 611 feet. The stream slope is extremely low, less than 0.001.

Figure 2-4 Des Plaines/Higgins Creek Watershed Digital Elevation Model



2.3 Land Use

Land use is dynamic, especially on the fringes of large urban areas. The constant change and type of land use has an impact on water quality. Land use data for the watershed were extracted from the Illinois Gap Analysis Project (IL-GAP) Land Cover data layer. IL-GAP was started at the Illinois Natural History Survey (INHS) in 1996, and the land cover layer was the first component of the project. The IL-GAP Land Cover data layer is a product of the Illinois Interagency Landscape Classification Project (IILCP), an initiative to produce statewide land cover information on a recurring basis cooperatively managed by the United States Department of Agriculture National Agricultural Statistics Service (NASS), the Illinois Department of Agriculture (IDA), and the Illinois Department of Natural Resources (IDNR). The land cover data were generated using 30-meter grid resolution satellite imagery taken during 1999 and 2000. The IL-GAP Land Cover data layer contains 23 land cover categories, including detailed classification in the vegetated areas of Illinois.

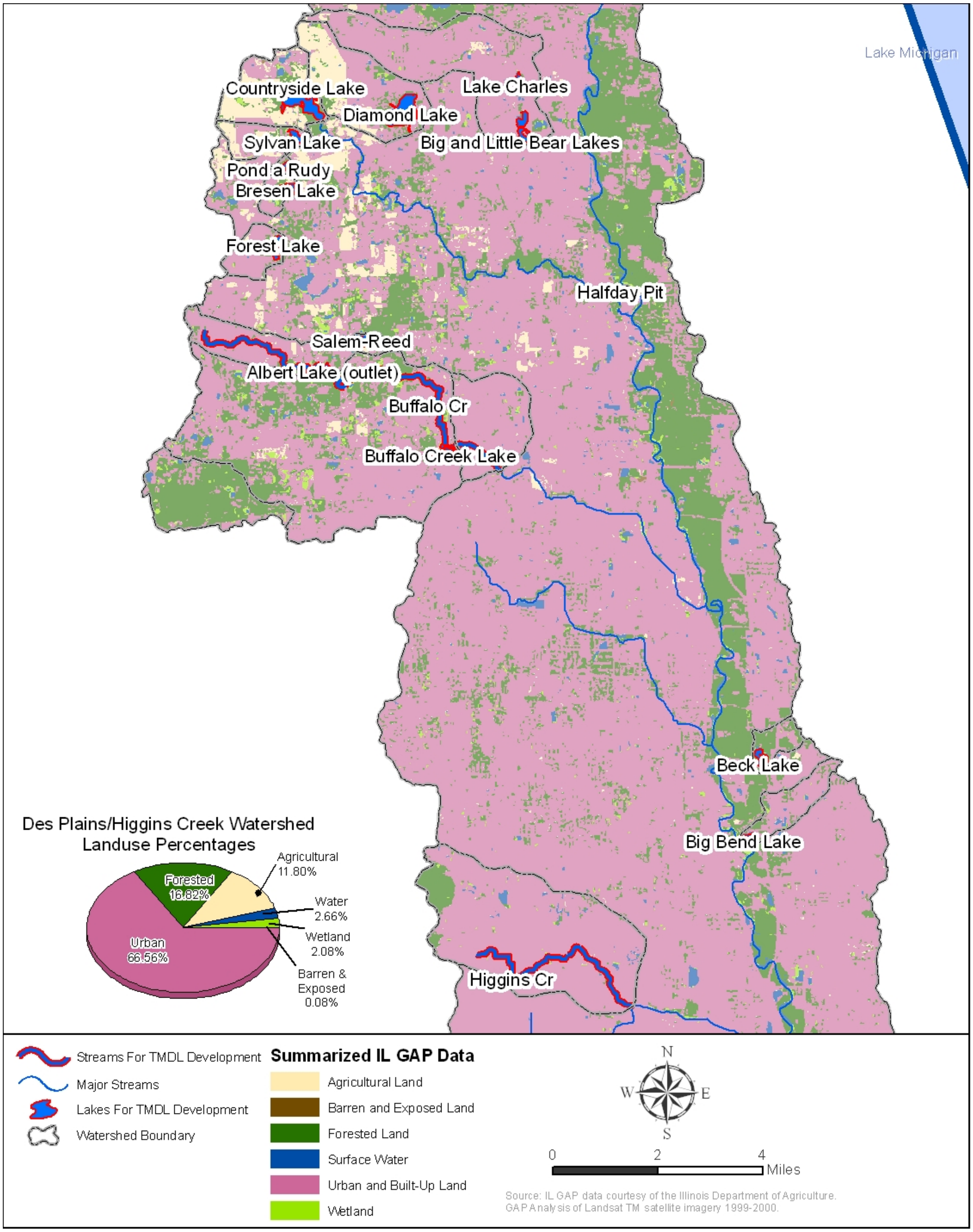
Tables 2-2 summarize the land use for the watershed while **Figure 2-5** presents land use and land cover within the Des Plaines River/Higgins Creek Watershed. It shows urban lands are dominant, accounting for 66.6% of the total area in the Des Plaines/Higgins Creek Watershed. Urban medium density contributes the most to this percentage at 25.76% of the total land cover. Forested land accounts for 16.8%, the second largest percentage, of which the most dominant class is upland mesic at 6.6%. Agricultural land only accounts for 11.8% of the land cover within the watershed, or about 26,323.98 acres. Of agricultural land, rural grasslands and corn are the dominant contributors, at just over 4% of watershed area each. Surface water makes up 2.7%, wetlands 2.1%, and barren and exposed land 0.1%. Overall, urban and built-up land is generally located in the central and southern parts of the watershed, near the city of Chicago and urban sprawl areas. The second most predominant land cover, forested land, encompasses most of the northern part and some western areas of the watershed. Forested land and wetlands can generally be found along the Des Plaines River and near other surface water features.

Specific land use data for each watershed can be found in **Appendix A.**

Table 2-2 Summary of IL-GAP Data for the Des Plaines/Higgins Creek Watershed

Watershed	Agricultural land	Forested land	Surface water	Urban and built-up land:	Wetland
Entire Des Plaines/Higgins Creek Watershed	11.8%	16.8%	2.7%	66.6%	2.1%
Albert Lake	1.8%	15.6%	1.9%	79.5%	1.2%
Beck Lake	---	56.5%	10.8%	30.7%	2.0%
Big Bear and Little Bear Lake	1.7%	5.9%	3.7%	88.1%	0.7%
Big Bend Lake	---	17.5%	6.2%	74.1%	2.2%
Bresen Lake	19.1%	11.7%	10.4%	52.4%	6.4%
Buffalo Creek	1.7%	19.4%	1.9%	74.1%	3.0%
Buffalo Creek Lake	1.9%	21.9%	2.0%	70.8%	3.3%
Countryside Lake	45.1%	16.2%	10.5%	26.4%	1.7%
Diamond Lake	32.6%	12.7%	8.5%	44.5%	1.7%
Forest Lake	5.3%	8.4%	7.6%	77.5%	1.2%
Half-day Pit	---	17.8%	41.9%	31.9%	8.3%
Higgins Creek	0.1%	7.1%	1.3%	91.0%	0.5%
Lake Charles	2.2%	6.6%	2.2%	88.5%	0.6%
Pond-a-Rudy	11.1%	35.0%	5.7%	38.2%	10.0%
Salem-Reed	11.3%	18.9%	27.6%	35.6%	6.6%
Sylvan Lake	38.0%	15.3%	5.9%	39.2%	1.6%

Figure 2-5 Des Plaines/Higgins Creek Watershed Land Use Map



2.4 Soils

Soils data and Geographic Information Systems (GIS) files from the Natural Resources Conservation Service (NRCS) were used to characterize soils in the Des Plaines River/Higgins Creek Watershed. General soils data and map unit delineations for the country are provided as part of the Soil Survey Geographic (SSURGO) database. Field mapping methods using national standards are used to construct the soil maps in the SSURGO database. Mapping scales generally range from 1:12,000 to 1:63,360; SSURGO is the most detailed level of soil mapping prepared by the NRCS. A map unit is composed of several soil series having similar properties. Identification fields in the GIS coverage can be linked to a database that provides information on chemical and physical soil characteristics. The SSURGO database contains many soil characteristics associated with each map unit. Of particular interest are the hydrologic soil group and the K-factor of the Universal Soil Loss Equation (USLE).

The SSURGO data was analyzed based on drainage class, hydrologic group and K-factor. The drainage class, as stated in the SSURGO database is, "The natural drainage condition of the soil [which] refers to the frequency and duration of wet periods" (Soil Survey Staff, "Table Column Descriptions"). Poorly drained soils can be found in areas where there is frequent flooding such as land adjacent to lakes and streams. This is evident in **Figure 2-6** which displays drainage classes of SSURGO data in the Des Plaines/Higgins Creek Watershed. However, some excessively drained areas can be found interspersed around the lakes. Excessively drained areas may in part be caused by anthropogenic sources, such as construction of residential and paved areas near the lakes. It may also be a part of the natural geology, with localized areas prone to excessive drainage. The majority of the watershed is moderately well drained and the southern part has no data due to the intense urban nature of Chicago and its surrounding suburbs.

The hydrologic soil group classification identifies soil groups with similar infiltration and runoff characteristics during periods of prolonged wetting. Typically, clay soils that are poorly drained have lower infiltration rates, while well-drained sandy soils have the greatest infiltration rates. The United States Department of Agriculture (USDA) has defined four hydrologic groups (A, B, C, or D) for soils. Type A soil has high infiltration while D soil has very low infiltration rate. **Figure 2-7** shows the distribution of hydrologic soil group. Generally the watershed has a moderate to slow infiltration rate (hydrologic group C). Areas near the Lake Michigan on the eastern, lower elevation side of the watershed contain both slow (hydrologic group D) to moderately high infiltration rates (hydrologic group B). High infiltration rates may be anthropogenic in nature, in similarity to the reasoning behind the excessively drained areas discussed above. Again, the no data area is likely due to the intense urban area of Chicago.

A commonly used soil attribute of interest is the K-factor, a dimensionless coefficient used as a measure of a soil's natural susceptibility to erosion. Factor values may range from 0 for water surfaces to 1.00 (although in practice, maximum K-factor values do not generally exceed 0.67). Large K-factor values reflect greater potential soil erodibility.

The compilation of K-factor from the SSURGO data was done in several steps. Soils are classified in the SSURGO database by map unit symbol. Each map unit symbol is made up of components consisting of several horizons (or layers). The K-factor was determined by selecting the dominant components in the most surficial horizon per each map unit. The distribution of K-factor values in the Des Plaines River/Higgins Creek Watershed is shown in **Figure 2-8**. K-factors range from 0.10 to 0.43 in this watershed. Areas with the highest K-factor seem to be found along the Des Plaines River, while the rest of the watershed is distributed with fairly moderate erosion potential.

Figure 2-6 Des Plaines/Higgins Creek SSURGO Drainage Class

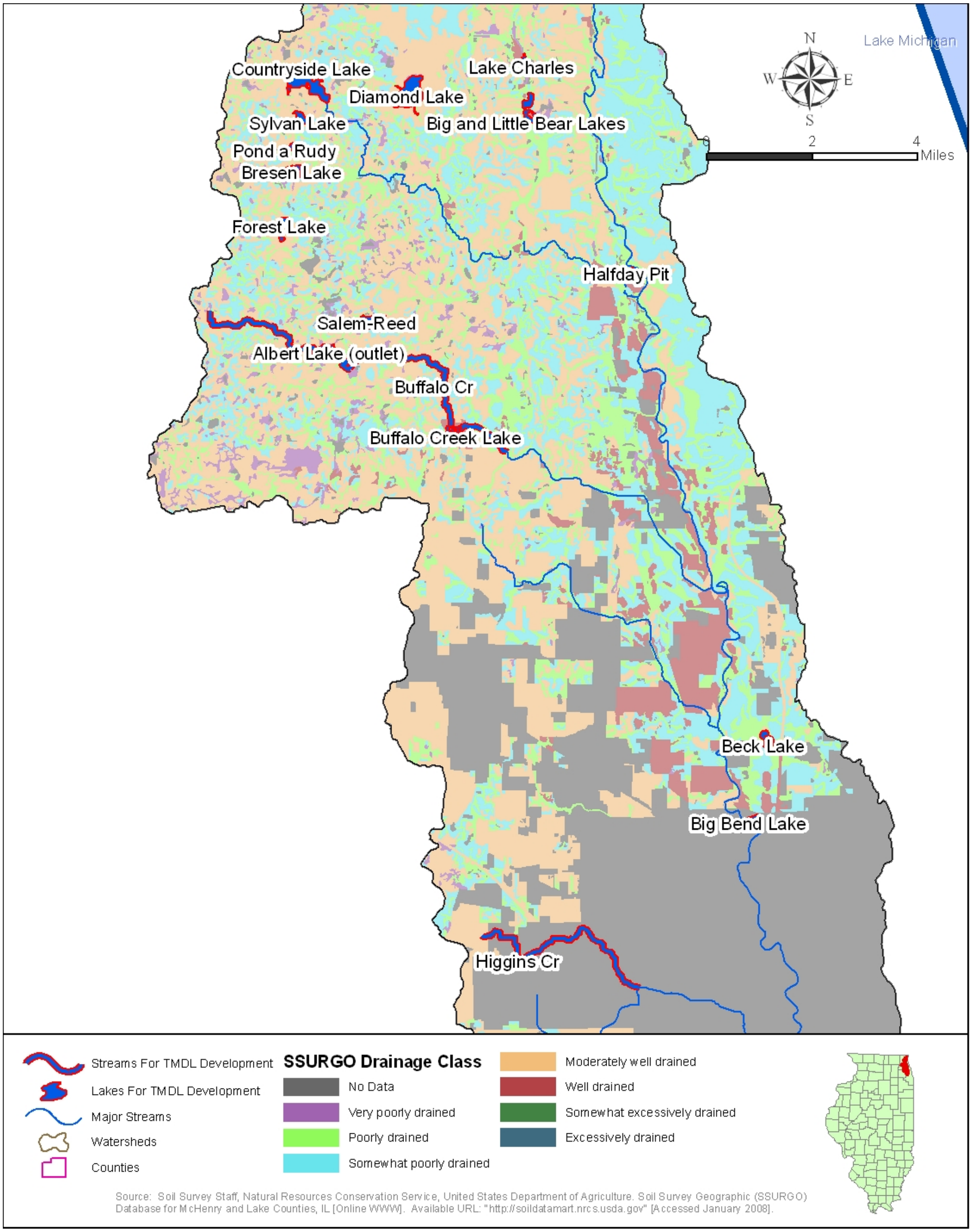


Figure 2-7 Des Plaines/Higgins Creek SSURGO Hydrologic Group

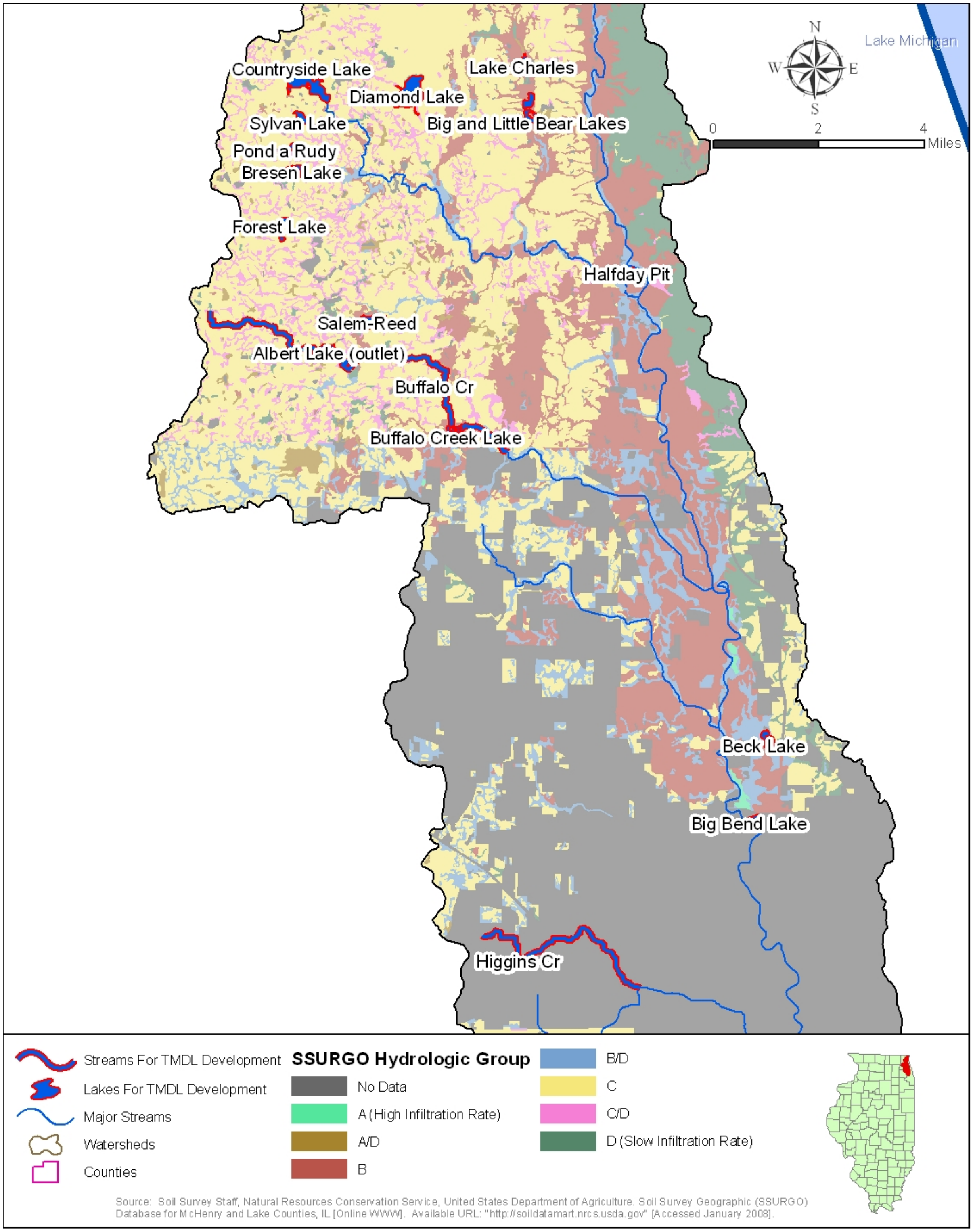
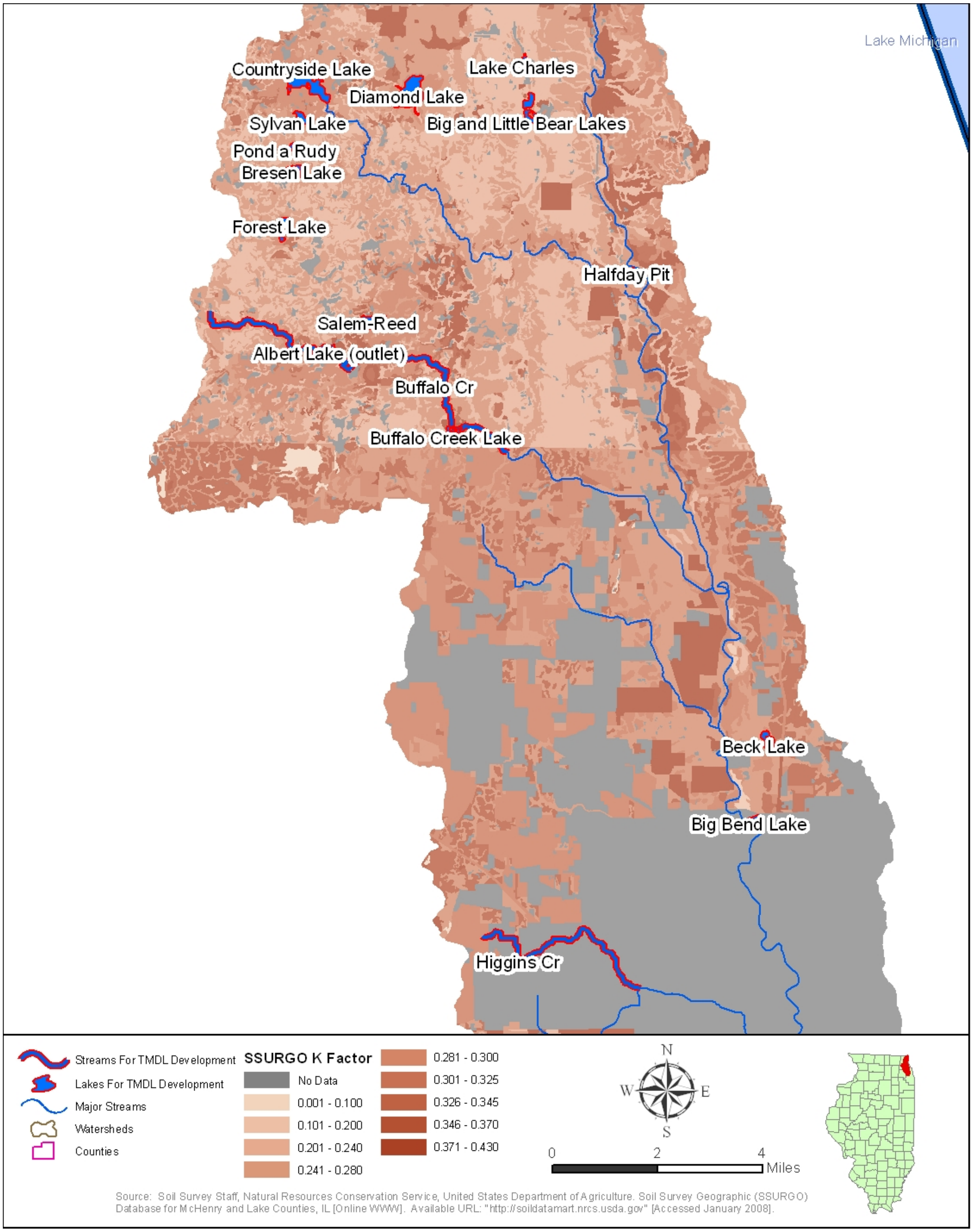


Figure 2-8 Des Plaines/Higgins Creek SSURGO K-Factor

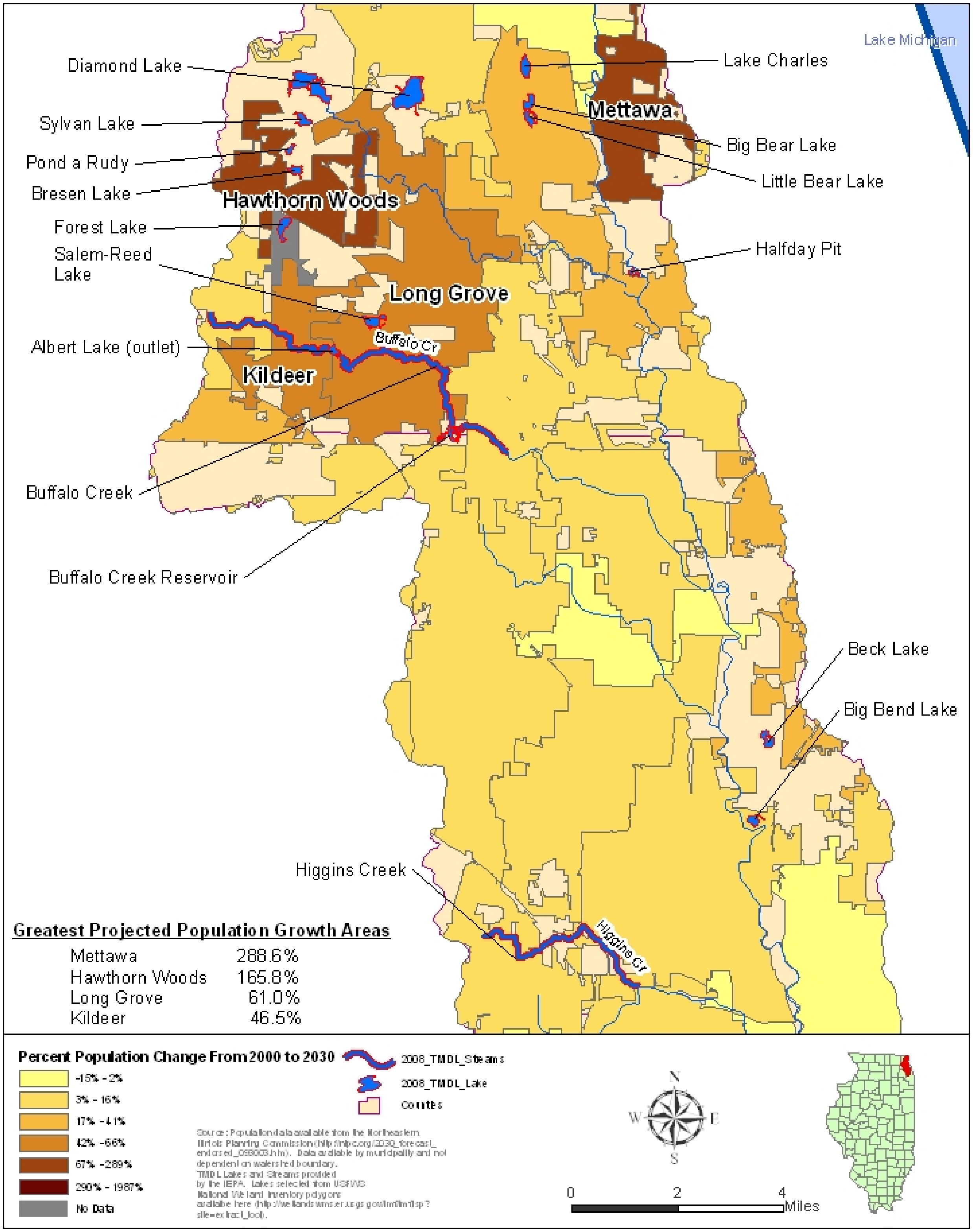


2.5 Population

The area within the Des Plaines River /Higgins Creek Watershed is primarily residential with some forest preserves along the Des Plaines River that create a nearly continuous greenway through all of Lake County and most of Cook County. Census 2000 data in format of TIGER/Line Shape file were downloaded to analyze the population in the targeted TMDL watershed of this report. According to these data, the Des Plaines/Higgins Creek Watershed population is about 914,500 persons with an average density of approximately 2,600 persons per square mile. Census blocks with the highest populations can be found in the southern part of the watershed toward Chicago and sparsely spaced throughout the northern areas.

The Illinois Department of Commerce and Economic Opportunity provide population projections by municipality on their website ("Population Projections", 2005). **Figure 2-9** depicts the percent population change in the Des Plains watershed from 2000 to 2030. In general, the far northern portion of the watershed is expected to have the most growth (1,900%). The town of Old Mill Creek is also expected to have significant growth by the year 2030 (1,986%). The central area of the watershed in the far west and far east portions is anticipated to have approximate growth of 289% in Mettawa and 166% in Hawthorn, respectively. Based on these data, development will grow dramatically in the fringes as urban sprawl continues.

Figure 2-9 Des Plaines/Higgins Creek Population Projection



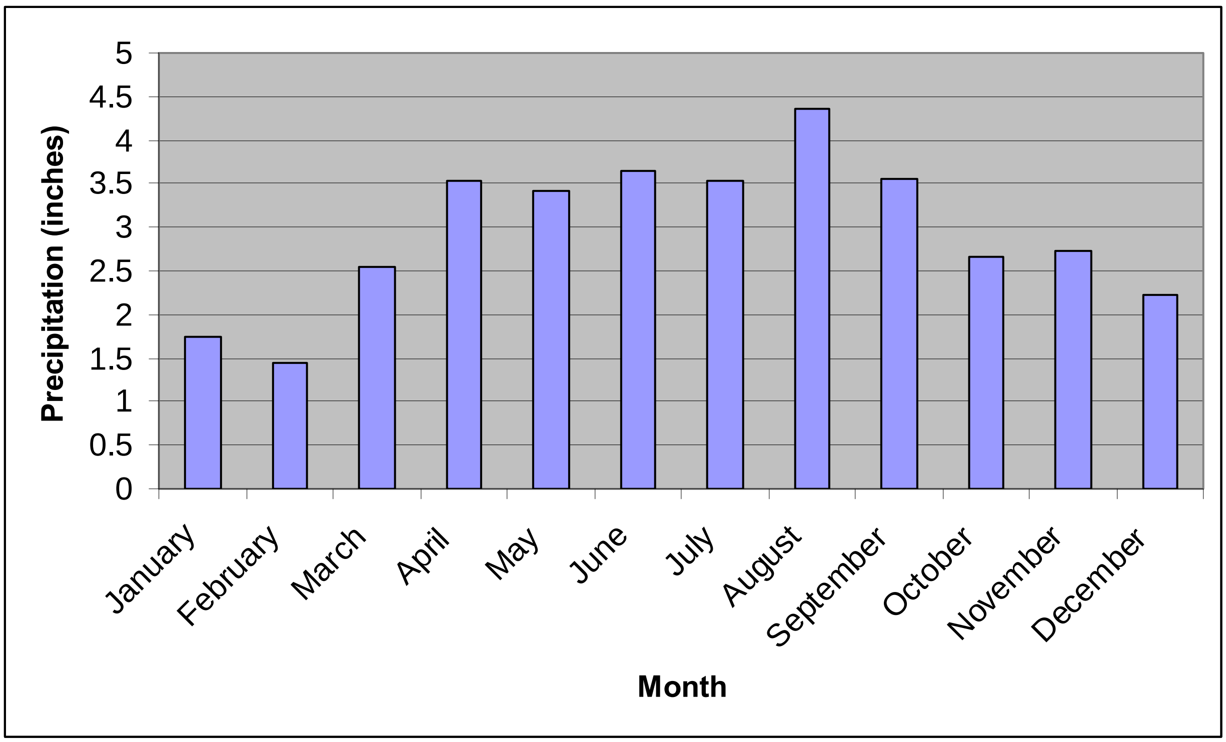
2.6 Climate and Precipitation

Northeast Illinois has a continental climate with highly variable weather. The temperatures of continental climates are not buffered by the influence of a large waterbody (like an ocean, inland sea or Great Lake). Areas with continental climates often experience wide temperature fluctuations throughout the year.

Temperature and precipitation data were obtained from the Illinois State Climatologist Office website. The nearest monitoring station to the Des Plaines/Higgins Creek Watershed is the O'Hare Airport, which is located in the watershed. Climate data were analyzed for O'Hare between the years of 1958 to 2007 although data were not available for all years. Based on the available data, the mean high summer temperature was 81.8° F and the mean low temperature in winter was 17.9° F. Mean annual high temperatures were approximately 58.9° F, while mean annual low temperatures were near 40.2° F.

The mean monthly precipitation in Elgin from 1958-2007 (data not available all years) can be found in **Figure 2-10**. Elgin receives most of its precipitation in the spring and summer months.

Figure 2-10 Mean Monthly Precipitation at O'Hare Airport, IL (1958-2007)



2.7 Hydrology

Understanding how water moves and flows is an important component of understanding a watershed. All of the parameters listed in the previous sections (i.e. topography, soils, and precipitation) impact hydrology. Hydrological data are available from the USGS website (www.usgs.gov, 2008). The USGS maintains stream gages throughout the US and they monitor conditions such as gage height and stream flow, and at some locations, precipitation.

Three relevant stream gages within the Des Plaines/Higgins Creek Watershed maintain stream flow or discharge information are: Des Plaines River at Russell, IL (05527800), Buffalo Creek near Wheeling, IL (05528500), and Des Plaines River near Des Plaines, IL (05529000). The Des Plaines gage at Russell is located just south of the Wisconsin/Illinois border in the northern most area of the watershed. The Buffalo Creek gage is located in the central portion of the watershed within Buffalo Creek. The Des Plaines gage near Des Plaines is located in the south central part and is the most downstream gage with data in the watershed. **Table 2-3** details summary statistics for stream gages throughout the watershed and **Figure 2-11** displays their relative locations.

The Buffalo Creek gage encompasses data from 1953 to 2007 and is located about a third of the way up the main stem in the area with significant elevation change. Located just below the TMDL segments, this receives drainage from 19.6 square miles of the area of concern. **Figure 2-12** displays the relative mean monthly stream flow measured at the Buffalo Creek gage. The averaged flow over the 55 years worth of data was 18.76 cubic feet per second (cfs). Stream flows were greatest in the late spring months, while lowest flows were recorded in the fall.

Most lake data were obtained from Lake County reports while others, such as Beck and Big Bend Lake were acquired from Cook County. Beck Lake was constructed in 1958 and has a surface area of 38 acres with a maximum depth of 23 feet and a one mile shoreline. Beck Lake is a kidney shaped tollway borrow pit and is located on the west side of the Tri-State Tollway approximately 0.5 miles north of Central Road and 2.5 miles northeast of Des Plaines. This lake is currently owned the Cook County Forest Preserve who permits boating activities. Fish species that inhabit the lake include: largemouth bass, bluegill, perch, walleye, channel catfish, crappie, and bullheads.

Similar to Beck Lake, Big Bend Lake was also constructed in 1958, and while the surface area is slightly smaller than Beck Lake (22 acres), it is a slightly deeper lake (maximum depth is 25 feet) and has a longer shoreline (approximately 1.1 miles). Big Bend Lake is a crescent shaped forest preserve lake and is located between Golf Road and Bender Road on the north side of the Des Plaines River to which it is connected by a short, shallow but wide channel. Similar to Beck Lake the Cook County Forest Preserve owns the lake and permits boating activities. Similar fish species are also found in Big Bend Lake.

Albert Lake is located in both Long Grove and Killdeer between Cuba Road and Long Grove Road. The lake is privately owned and was created in 1950 by damming Buffalo Creek. Albert Lake has a surface area of 18.7 acres, a one mile shoreline length, and a maximum depth of 2 feet. Due to the shallow nature of the lake, recreational activities are prohibited. Catfish, carp and largemouth bass can all be found in Albert Lake.

Diamond Lake is an approximate 154-acre glacial lake in the Village of Mundelein with a maximum depth of 25 feet and a shoreline of 5.9 miles. The shoreline is 97% developed as residential and two homeowner's associations have private recreational areas on the lake. The Mundelein Park District also offers a public boat launch. Diamond Lake receives flow from two small tributaries along the west shoreline that drain residential and agricultural areas. Storm water from residential areas on the east side of the lake also contributes to the lake system. Fish species that inhabit the lake include: yellow bass, yellow perch, bluegill, carp and bullhead.

Countryside Lake is a privately owned, 141.78-acre impoundment located in unincorporated Fremont Township. The lake was created by damming Indian Creek in 1926 as a private recreation area. Water enters the lake from Indian Creek on the west of the lake and from two small tributaries on the south and western ends. Countryside Lake has an average depth of 6.5-feet (maximum depth of ten feet) and a shoreline of 3.9 miles. Historically, the lake has been used for fishing and swimming. The lake has an on-going fish stocking program and fish species present include: Largemouth Bass, Black Crappie, Bluegill, Northern Pike, Tiger Musky, Walleye and Yellow Perch.

Sylvan Lake is a U-shaped, 32 acre man-made lake in Fremont Township near the intersection of Midlothian and Gilmer Roads. It was created in 1936 by damming a small tributary of Indian Creek and 99.8% of the shoreline was developed by 2001. The average depth is 7.5 feet, with a maximum depth of 14 feet. Access to Sylvan Lake is entirely private and the Sylvan Lake Improvement Association owns approximately 87% of the shore bottom. Private homeowners own the remaining 13%. Water enters the lake from two creeks at the western end of the bays and by storm water from surrounding neighborhoods. Recreational lake activities include boating (no wake), swimming and fishing. Past studies by the Illinois Department of Natural Resources indicate the fishery of Sylvan Lake in poor health due to a lack of quality habitat as well as poor water clarity; however, there is a large common carp population.

Forest Lake is located adjacent to the town of Hawthorne Woods in unincorporated Ela Township. Old McHenry Road is to the north and Quentin road borders the west side of the lake. One small, natural tributary drains into the lake at the northwest end, and four storm water outlets empty into the lake at various locations. The lake was created in 1934 by dredging a wetland and flooding the surrounding area by damming the creek. Ownership of Forest Lake primarily belongs to the Forest Lake Community Association, but several parcels on the southwest end of the lake are privately owned. Forest Lake is a shallow, man-made impoundment with a surface area of 39.3 acres and a mean depth of 4.5 feet. A five foot concrete overflow dam at the northeast end of the lake allows water to drain to Forest Lake Drain, the only outlet. Four access areas owned by the Forest Lake Community Association provide year round access. The lake's main uses are fishing and swimming. Rowboats and small boats with electric motors are allowed. Fish species include: white crappie, bluegill, large-mouth bass, pumpkinseed, warmouth, black crappie, northern pike, yellow perch, common carp and blunt-nose minnows.

Lake Charles is located in Libertyville Township, in the Village of Vernon Hills, west of highway 21 and north of state highway 60. The lake is a man-made impoundment developed circa 1925 by damming Hawthorn Drainage Ditch. It covers 39.3 acres with a maximum depth of 10.9 feet and an average depth of 5.45 feet. The shoreline length is 1.1 miles and the western and southern shores are next to the White Deer Run Golf Course. The golf course uses the lake for aesthetics and irrigation. The sole inlet is at the northern end and a concrete spillway at the south end provides the lone outlet. Lake access was restricted as of 2000. There have been no recent fish surveys although large numbers of carp have been reported.

Buffalo Creek Reservoir is located near the municipality of Buffalo Grove and has a surface area of 34.8 acres and a shoreline length of approximately 3.0 miles. The average depth is 3.0 feet and the maximum depth is approximately 6.0 feet. The reservoir was created in 1984 and expanded during 1989. Water quality is considered poor compared to many lakes in Lake County. A small sewage treatment plant at the Alden Long Grove Rehabilitation and Health Care facility in Long Grove discharges its effluent into an unnamed tributary of Buffalo Creek, upstream of the reservoir. Carp were frequently seen in the reservoir.

Half Day Pit is located near Lincolnshire and has a surface area of 14.1 acres and a shoreline of approximately 0.9 miles. The maximum depth is 14.1 feet with an average depth of 7.1 feet. Half Day Pit's water quality is poor compared to many lakes in Lake County. The entire shoreline was classified as undeveloped, as it is part of the Lake County Forest Preserve District. No recent fish surveys have been conducted.

Bresen Lake is a 24 acre lake located in unincorporated Lake County, southwest of Gilmer Road near the Village of Hawthorn Woods. Originally a slough, the lake was built in 1964 when an earthen dam was constructed at the northeast end. Water enters the lake from two inlets and exits through a spillway at the dam. Bresen Lake has a maximum depth of 10.5 feet and an average depth of 5.25 feet with a shoreline length of 1.1 miles. The lake is privately owned and is used primarily for motorized and non-motorized boating, fishing, wildlife observation and aesthetics. There is no access except through the owner's property. The owner stocked the lake with 100 grass carp in 1989. No other information was available with regard to fish species present.

Pond-A-Rudy (PAR) is located near the municipality of Mundelein and has a surface area of 13.9 acres. The shoreline is 0.7 miles in length and the average and maximum depths area 1.0 and 2.0 feet, respectively. Originally a slough, PAR was constructed in 1946 and discharges to Bresen Lake. There is no distinguishable inlet; although, a small creek enters a wetland area on the southwest side. Due to its shallow depth, PAR probably freezes through during the winter, killing fish that could not find refuge in the adjoining creek and nearby Bresen Lake. 95% of the shoreline is undeveloped and development is limited to one single-family residence.

Salem Lake is located in Ela Township within the village of Long Grove between Cuba Road and Old McHenry Road. The lake is a shallow man-made impoundment created in 1946, with a surface area of 38.0 acres and a mean depth of 4.5 feet. The shoreline is approximately 2.0 miles long. The lake receives its water through rainfall and storm water inflows. The outflow of the lake is a weir-like dam on the northwest shore that allows water to drain into Kildeer Creek. Access to the lake is public; although, bottom ownership belongs to primarily CF Industries, located on the southwest shore. Homeowners on the eastern shoreline have private access through their properties. The lake's main use is fishing, as swimming is prohibited. Rowboats and small boats with electric motors are the most common, as CF Industries does not allow gas-powered motors. Fish kills have historically occurred on Salem Lake as a result of dense aquatic vegetation and algal blooms. A fish survey conducted during 1993 detected bluegill, largemouth bass and common carp.

Big Bear and Little Bear Lakes are located within the Village of Vernon Hills. Both were created as detention basin in the mid-1970 as residential and commercial areas were developed in the vicinity. Big Bear Lake receives flow at its northwest corner from Lake Charles via a small stream. Big Bear Lake is directly connected at the southwest corner to Little Bear Lake by a short channel. Water flows from Little Bear Lake out into Seavey Drainage Ditch, which eventually reaches the Des Plaines River. Big Bear Lake covers 25 acres, and has a maximum depth of 11 feet. Little Bear Lake is 26 acres and has a maximum depth of 22 feet.   Shore and pier fishing is common. Although, motorized fishing is prohibited, people can rent paddleboats and bike boats from the Park District. To enhance fishing, the Village of Vernon Hills annually stocks Big Bear and Little Bear Lakes with 75 largemouth bass and 215 channel catfish. No other fish stocking is done and a fishery assessment has not been completed by the Illinois Department of Natural Resources.

Table 2-3 Summary Statistics for Stream Gage in the Des Plaines/Higgins Creek Watershed

Station ID	Station Name	Date Range	Minimum Flow (cfs)	Maximum Flow (cfs)	Median Flow (cfs)	Mean Flow (cfs)
05528230	Indian Creek at Prairie View	1989 - 1996	0.17	1030	17	34.92
05528500	Buffalo Creek near Wheeling	1952 – 2009	0	525	8	18.76
05529000	Des Plains River near Des Plaines	1940 – 2009	0	4870	145	306.34
05529500	McDonald Creek near Mount Prospect	1952 – 2009	0	476	2.3	6.49
05530000	Weller Creek at Des Plains	1950 - 2009	0	1120	2.3	10.38

Figure 2-11 Des Plaines/Higgins Creek Watershed USGS Gaging Stations and Water Quality Stations

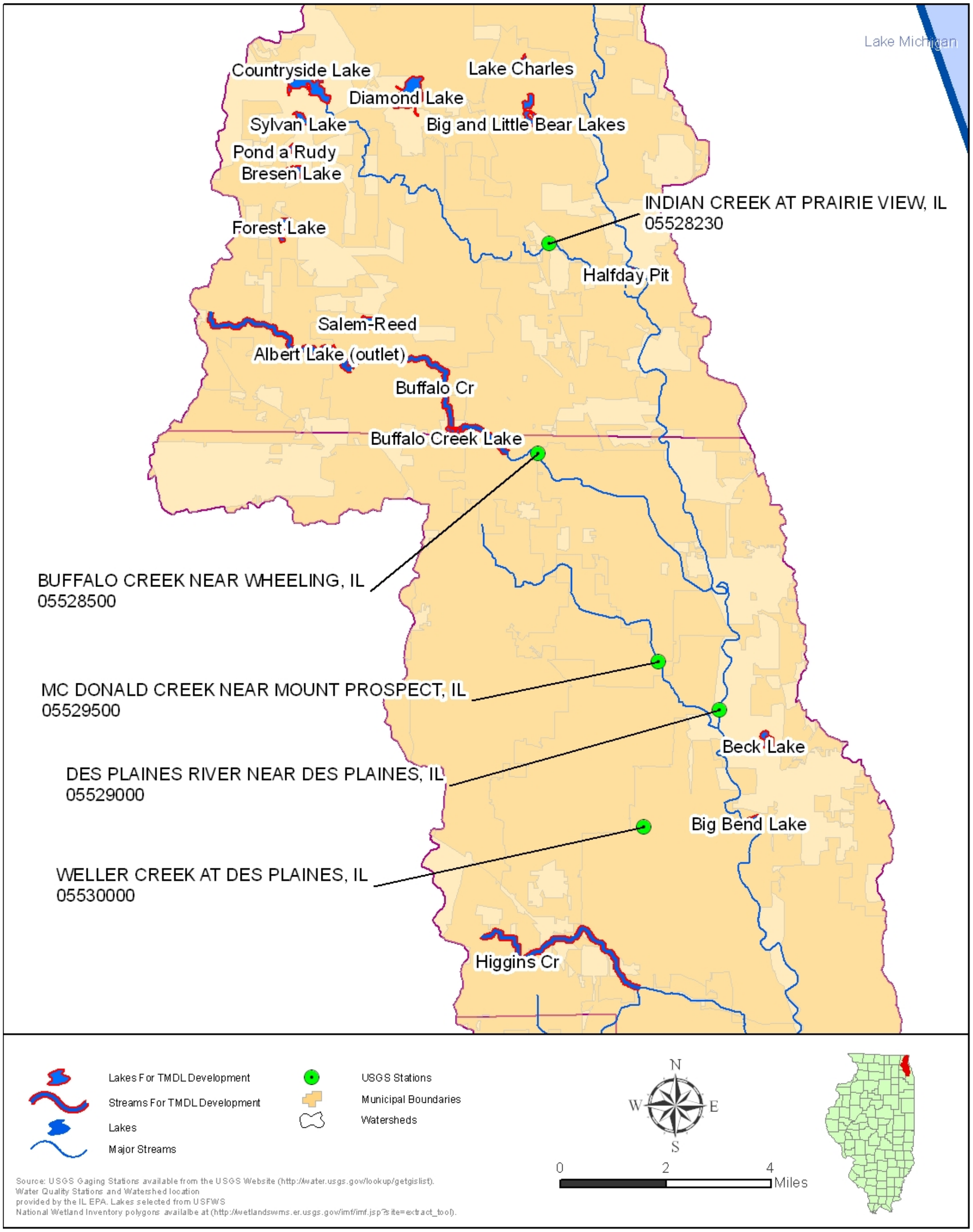
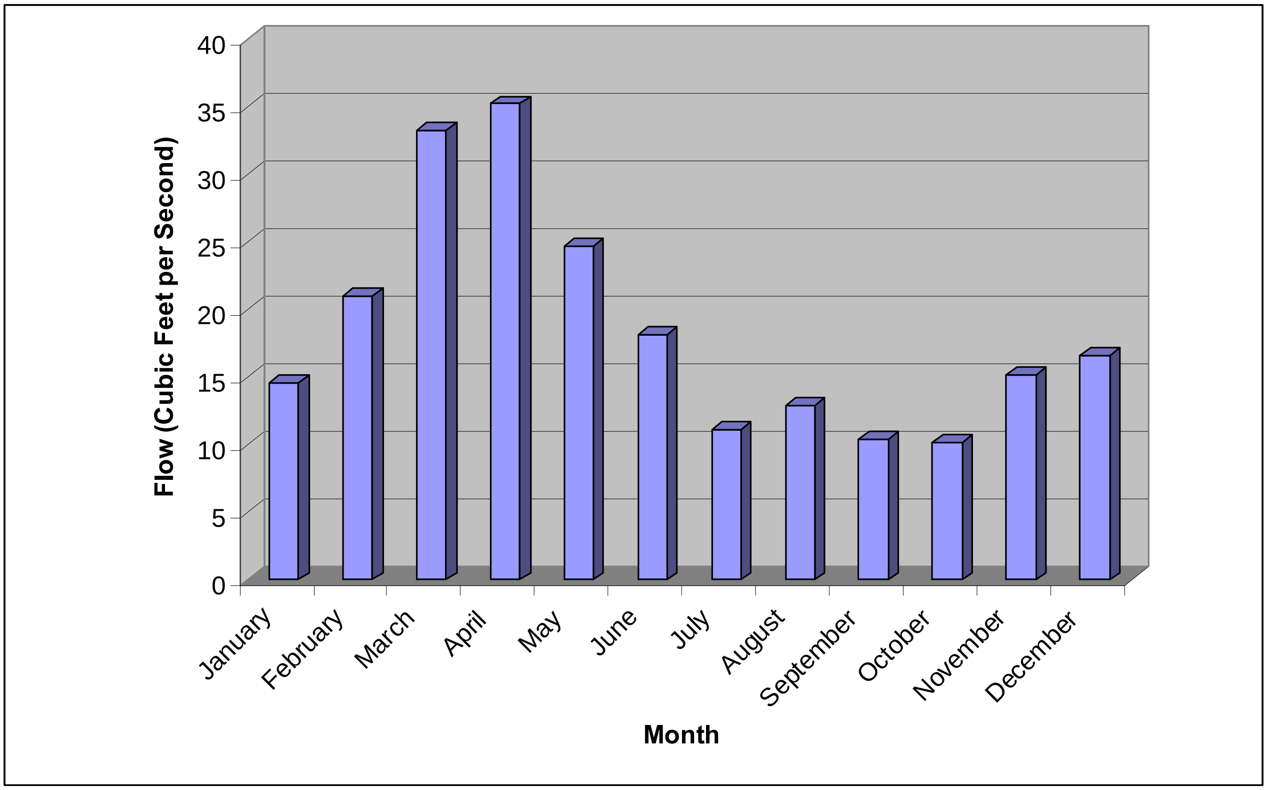


Figure 2-12 Mean Monthly Stream Flow for Buffalo Creek near Wheeling, IL USGS Gage Station 1953-2007



3.0 Public Participation and Involvement

The Illinois EPA is committed to keeping the watershed stakeholders and general public informed and involved throughout the TMDL process. Success for any TMDL implementation plan relies on a knowledgeable public to assist in follow-through required for attainment of water uses within their watershed. It is important to engage the local citizens as early in the process as possible by providing opportunities to learn and process information. This ensures that concerns and issues are identified at an early stage, so that they can be addressed and facilitate maximum cooperation in the implementation of the recommended courses of actions identified in the TMDL process. All stakeholders should have access to enough information to allay concerns, gain confidence in the TMDL process and understand the purpose and the regulatory authority or other responsible party that will implement recommendations.

Illinois EPA, along with AECOM, held two public meetings within the Des Plaines/Higgins Creek Watershed on the development of this TMDL. This section will be regularly updated following public meetings.

The Stage 1 meeting for the Des Plaines/Higgins Creek Watershed TMDL was held May 19, 2009 at 6 pm at the CMS Suburban North Building in Des Plaines. A public notice was posted in the Buffalo Grove Countryside, Des Plaines Journal and Vernon Hill Review newspapers. The draft Stage 1 report was available online and in paper at the Des Plaines, Buffalo Grove and Vernon Hills City Halls. The meeting record closed June 18, 2009. Approximately 35 people attended the meeting.

The Stage 3 meeting was held on August 11, 2010 at the same location and the meeting record closed on August 25, 2010. Information on this meeting and the Responsiveness Summary are included in the appendix of this TMDL report. The Responsiveness Summary includes the agencies responses to questions and comments from the public meeting.

A third public meeting on an updated Stage 3 Report including the Implementation Plan took place on August 28, 2012 at the Des Plaines Public Library.

General information regarding the process of TMDL development in Illinois can be found at http://www.epa.state.il.us/water/tmdl. This link also contains paths to notice of public meetings and other TMDL-related watershed information for the entire state of Illinois.

Background information on general watershed theory, watershed management, best management practices and the CWA can be found on the EPA's water website at http://www.epa.gov/watertrain/.

For other reports and studies concerning the Des Plaines River watershed please visit the Illinois Rivers Decision Support System: Des Plaines River watershed Investigation website (http://ilrdss.sws.uiuc.edu). The website contains reports, data and additional links to other sources specifically related to this watershed. Additionally, the Lake County Stormwater Management Commission has information about ongoing projects and reports for the Des Plaines River watershed at http://www.co.lake.il.us/smc/projects/wmb/Des Plaines.asp.

4.0 Applicable Water Quality Standards and TMDL Targets

Water pollution control programs are designed to protect the beneficial uses of the water resources within the state. Each state has the responsibility to set WQS that protect these beneficial uses, also called “designated uses.” Illinois waters are designated for various uses including aquatic life, wildlife, agricultural use, primary contact (e.g., swimming, water skiing), secondary contact (e.g., boating, fishing), industrial use, drinking water, food-processing water supply and aesthetic quality. Illinois’ WQS provide the basis for assessing whether the beneficial uses of the state’s waters are being attained.

4.1 Illinois Pollution Control Program

The Illinois Pollution Control Program (IPCB) is responsible for setting WQS to protect designated uses. The IL EPA is responsible for developing scientifically based water quality criteria and proposing them to the IPCB for adoption into state rules and regulations. The Illinois WQS are established in the Illinois Administrative Rules Title 35, Environmental Protection; Subtitle C, Water Pollution; Chapter I, Pollution Control Board; Part 302, Water Quality Standards. The federal CWA requires the states to review and update WQS every three years. Illinois EPA, in conjunction with USEPA, identifies and prioritizes those standards to be developed or revised during this three-year period. The IPCB has established four primary sets (or categories) of narrative and numeric WQS for surface waters.

4.2 Designated Uses

The waters of Illinois are classified by designated uses, which include: General Use, Public and Food Processing Water Supplies, Lake Michigan, and Secondary Contact and Indigenous Aquatic Life Use (Illinois EPA 2005). The only waterbody classification applicable to the Des Plaines/Higgins Creek Watershed is the General Use classification.

4.2.1 General Use

The General Use classification is defined by IPCB as: The General Use standards will protect the state's water for aquatic life, wildlife, agricultural use, secondary contact use and most industrial uses and ensure the aesthetic quality of the state's aquatic environment. Primary contact uses are protected for all General Use waters whose physical configuration permits such use.

4.3 Applicable Illinois Water Quality Standards

The streams in this watershed were assessed at less than full support using biological indicators and water chemistry was analyzed for exceedences of Water Quality Standards. **Table 4-1** summarizes the applicable WQS for the Des Plaines/Higgins Creek Watershed.

Table 4-1 Applicable Water Quality Standards for the Des Plains/Higgins Creek Watershed

Parameter	Units	General Use Water Quality Standard
Chloride, total	mg/L	500
Dissolved Oxygen (above thermocline in thermally stratified waters or entire	mg/L	March – July 5.0 instantaneous minimum 6.0 as daily mean averaged over 7 days August – February

water column in unstratified waters)		3.5 instantaneous minimum 4.0 as daily mean averaged over 7 days 5.5 as daily mean averaged over 30 days
Fecal Coliform (May through October)	cfu/100 ml	200 geometric mean based on a minimum of 5 samples taken over any 30 day period; 400 maximum not to be exceeded in more than 10% of samples taken during any 30 day period.
pH	s.u.	6.5 – 9.0 except for natural causes
Phosphorus, total	mg/L	0.05 in any reservoir or lake with a surface area of at least 20 acres or in any stream at the point where it enters any such lake or reservoir

Due to limited state resources, fecal coliform bacteria is not normally sampled at a frequency necessary to apply the General Use standard, i.e., at least five times per month during May through October, and very little data available from others are collected at the required frequency. Therefore, assessment guidelines are based on application of the standard when sufficient data is available to determine standard exceedances; but, in most cases, attainment of primary contact use is based on a broader methodology intended to assess the likelihood that the General Use standard is being attained. To assess primary contact use, Illinois EPA uses all fecal coliform bacteria from water samples collected in May through October, over the most recent five-year period (i.e., 2002 through 2006). Based on these water samples, geometric means and individual measurements of fecal coliform bacteria are compared to the concentration thresholds in Tables C-16 and C-174-2. To apply the guidelines, the geometric mean of fecal coliform bacteria concentration is calculated from the entire set of May through October water samples, across the five years. No more than 10% of all the samples may exceed 400 cfu/100 ml and the geometric mean may not exceed 200 cfu/100 ml for a water body considered Fully Supporting. Though the standard includes two numbers, either one is equally valid for TMDL development.

From May to September, the LCHD's Lakes Management Unit samples Sylvan Beach two times a month. The water samples are tested for E. coli bacteria, which are found in the intestines of almost all warm-blooded animals as with fecal coliform bacteria. If water samples come back high for E. coli (>235 E. coli/100 ml), the management body for the bathing beach is notified and a sign is posted indicating beach closure. Illinois EPA assessed Primary Contact Designated Use at lakes with LCHD data using the beach closure information. If there has been a closure within the last 5 years, the water is considered impaired for Primary Contact (Swimming) Use.

4.4 TMDL Targets

In order for a water body to be listed as Full Support, it must meet all of its applicable designated uses. Because WQS are designed to protect those designated uses a pollutant's numeric WQS is therefore used as the target or endpoint for establishing a TMDL. **Table 4-3** summarizes the targets that will be used in the TMDL development for the Des Plaines/Higgins Creek Watershed. It should be noted that fecal coliform TMDL development was based on the 200 cfu/100 ml geometric mean value as described in the previous section. The instantaneous standard of 400 cfu/100 ml is the basis for permit for most facility fecal coliform permit limits, but the TMDL will use the geometric mean target of 200 cfu/100ml as it offers additional margin of safety. The TMDL is based on the geometric mean standard, but both parts of the water quality standard apply and offer the same level of protection. Permit limits can either be set at the geometric mean standard or the instantaneous depending on the level of monitoring and staff available to the municipality. The IEPA permit engineer will determine which apply.

Table 4-2 Guidelines for Assessing Primary Contact Use in Illinois Streams and Inland Lakes

Degree of Use Support	Guidelines
Fully Supporting (Good)	No exceedances of the fecal coliform bacteria standard in the last five years <u>and</u> the geometric mean of all fecal coliform bacteria observations ≤200/100 ml, <u>and</u> ≤10% of all observations exceed 400/100 ml.
Not Supporting (Fair)	One exceedance of the fecal coliform bacteria standard in the last five years (when sufficient data is available to assess the standard) <u>or</u> The geometric mean of all fecal coliform bacteria observations in the last five years ≤200/100 ml, <u>and</u> >10% of all observations in the last five years exceed 400/100 ml <u>or</u> The geometric mean of all fecal coliform bacteria observations in the last five years >200/100 ml, <u>and</u> ≤25% of all observations in the last five years exceed 400/100 ml.
Not Supporting (Poor)	More than one exceedance of the fecal coliform bacteria standard in the last five years (when sufficient data is available to assess the standard) <u>or</u> The geometric mean of all fecal coliform bacteria observations in the last five years >200/100 ml, <u>and</u> >25% of all observations in the last five years exceed 400/100 ml

Table 4-3 TMDL Targets for Impaired Waterbodies in the Des Plaines/Higgins Creek Watershed

Waterbody Name	Segment ID	Impairment	TMDL Target	Units
Albert Lake (outlet)	IL_VGG	Dissolved Oxygen	>5.0 Mar-Jul, >3.5 Aug-Feb	mg/L
Beck Lake	IL_RGE	Total Phosphorus	<0.05	mg/L
Big Bear Lake	IL_WGZU	Total Phosphorus	<0.05	mg/L
Bresen Lake	IL_UGN	Total Phosphorus	<0.05	mg/L
Buffalo Creek	IL_GST	Fecal coliform	<200	cfu/100 ml
		Dissolved Oxygen	>5.0 Mar-Jul, >3.5 Aug-Feb	mg/L
		Chloride	<500	mg/L
Buffalo Creek Lake	IL_SGC	Total Phosphorus	<0.05	mg/L
		Dissolved Oxygen	>5.0 Mar-Jul, >3.5 Aug-Feb	mg/L
Big Bend Lake	IL_RGL	Total Phosphorus	<0.05	mg/L
Countryside Lake	IL_RGQ	Total Phosphorus	<0.05	mg/L
Diamond Lake	IL_RGB	Total Phosphorus	<0.05	mg/L
Forest Lake	IL_RGZG	Total Phosphorus	<0.05	mg/L
Half Day Pit Lake	IL_UGB	Dissolved Oxygen	>5.0 Mar-Jul, >3.5 Aug-Feb	mg/L
Higgins Cr.	IL_GOA-01	Chloride	<500	mg/L
		Fecal Coliform	<200	cfu/100 ml
		pH	6.5 – 9.0	s.u.
Higgins Cr.	IL_GOA-02	Chloride	<500	mg/L
		Dissolved Oxygen	>5.0 Mar-Jul, >3.5 Aug-Feb	mg/L
		Fecal Coliform	<200	cfu/100 ml
Lake Charles	IL_RGZJ	Total Phosphorus	<0.05	mg/L
Little Bear Lake	IL_WGZV	Total Phosphorus	<0.05	mg/L
Pond-A-Rudy	IL_UGP	Dissolved Oxygen	>5.0 Mar-Jul, >3.5 Aug-Feb	mg/L
Salem-Reed Lake	IL_WGK	Total Phosphorus	<0.05	mg/L
Sylvan Lake	IL_RGZF	Fecal coliform	<200	cfu/100 ml
		Total Phosphorus	<0.05	mg/L
		Dissolved Oxygen	>5.0 Mar-Jul, >3.5 Aug-Feb	mg/L

5.0 Water Quality Assessment

Data were collected and reviewed from many sources in order to further characterize the Des Plaines/Higgins Creek Watershed. Data have been collected from surface waters and point and nonpoint sources. This information is presented and discussed in further detail throughout the remainder of this section. A complete database is also included in **Appendix B**.

5.1 Water Quality Data

The Des Plaines/Higgins Creek Watershed has 18 impaired segments within its drainage area that are targeted for TMDL development. Available data used for assessing these waterbodies originated from 36 water quality stations within the Des Plaines/Higgins Creek Watershed. **Figure 5-1** shows the water quality data stations within the watershed that contain data relevant to the impaired segments. **Appendix C** contains individual waterbody maps and **Appendix D** contains individual watershed maps.

Data used for analysis are a combination of both legacy and modernized USEPA Storage and Retrieval (STORET) databases, Lake County data, Metropolitan Water Reclamation District of Greater Chicago (MWRDGC) data, and Illinois EPA database data (**Table 5-1**). The compiled database ranges from 1977 through 2007.

Data relevant to impairments were compiled for each impaired waterbody and summarized. The following parameters are grouped by impairment and discussed in relation to the relevant Illinois numeric WQS. For all assessments, compliance is determined at the surface of a stream or at the one-foot depth from the lake surface with the exception of dissolved oxygen which is assessed above the thermocline in stratified lakes.

Table 5-1 Available Monitoring Data

Waterbody Name	Segment ID	Agency	Data Years
Albert Lake	VGG	LCHD	2001
Beck Lake	RGE	Illinois EPA	1997, 2001, 2006
Big Bear Lake	WGZU	Illinois EPA	1993, 1997, 1998, 2002, 2006
		LCHD	2002
Big Bend Lake	RGL	Illinois EPA	1998, 2000, 2001, 2004, 2006
Bresen Lake	UGN	LCHD	2000
Buffalo Creek	GST	MWRGDC (WW-12)	2001- 2007
Buffalo Creek Lake	SGC	Illinois EPA	2001
		LCHD	2001
Countryside Lake	RGQ	LCHD	2000, 2005-2007
Diamond Lake	RGB	Illinois EPA	2001- 2003
		LCHD	1977, 1979, 1989, 1992, 1997, 2002
Forest Lake	RGZG	LCHD	1990, 1991, 2000, 2003-2006
Half-day Pit	UGB	LCHD	2003
Higgins Creek	GOA-01, 02	MWRGDC (WW-77,78)	2001-2007
Lake Charles	RGZJ	LCHD	2000
Little Bear Lake	WGZV	Illinois EPA	1998, 2006
		LCHD	1989, 1997, 2002
Pond-a-Rudy	UGP	LCHD	2001
Salem-Reed Lake	WGK	LCHD	1998, 2000
Sylvan Lake	RGZF	LCHD	1996, 2001, 2003-2007

5.1.1 Total Phosphorus

The WQS for total phosphorus is a maximum concentration of 0.05 mg/L and is applicable only to lakes with a surface area of 20 acres or greater. The distribution of phosphorus concentrations for each impaired segment in the Des Plaines/Higgins Creek Watershed is presented in **Figures 5-1** through **5-5**. Data used for the assessments ranged from 1977 to 2007 (**Table 5-2**).

Table 5-2 Total Phosphorus Data Summary 1977 – 2007

Waterbody Name	Segment	Units	Observations	Violations	Min	Max	Average	Median	Standard Deviation
Beck Lake	**IL_RGE**	mg/L	38	8	0.01	1.20	0.06	0.03	0.19
Big Bear Lake	**IL_WGZU**	mg/L	30	14	0.02	0.10	0.06	0.06	0.02
Big Bend Lake	**IL_RGL**	mg/L	59	19	0.01	2.62	0.15	0.04	0.48
Bresen Lake	**IL_UGN**	mg/L	5	4	0.04	0.19	0.11	0.12	0.06
Buffalo Creek	**IL_SGC**	mg/L	5	5	0.14	0.18	0.16	0.15	0.01
Countryside Lake	**IL_RGQ**	mg/L	19	10	0.01	0.21	0.07	0.06	0.05
Diamond Lake	**IL_RGB**	mg/L	38	5	0.01	0.18	0.04	0.03	0.03
Forest Lake	**IL_RGZG**	mg/L	32	23	0.02	0.35	0.12	0.09	0.09
Lake Charles	**IL_RGZJ**	mg/L	5	4	0.02	0.08	0.06	0.07	0.02
Little Bear Lake	**IL_WGZV**	mg/L	20	5	0.03	0.08	0.05	0.04	0.01
Salem-Reed Lake	**IL_WGK**	mg/L	9	4	0.03	0.27	0.11	0.04	0.09
Sylvan Lake	**IL_RGZF**	mg/L	10	7	0.04	0.14	0.07	0.06	0.03

Figure 5-1 Monitoring Stations Used for Assessing Impairments

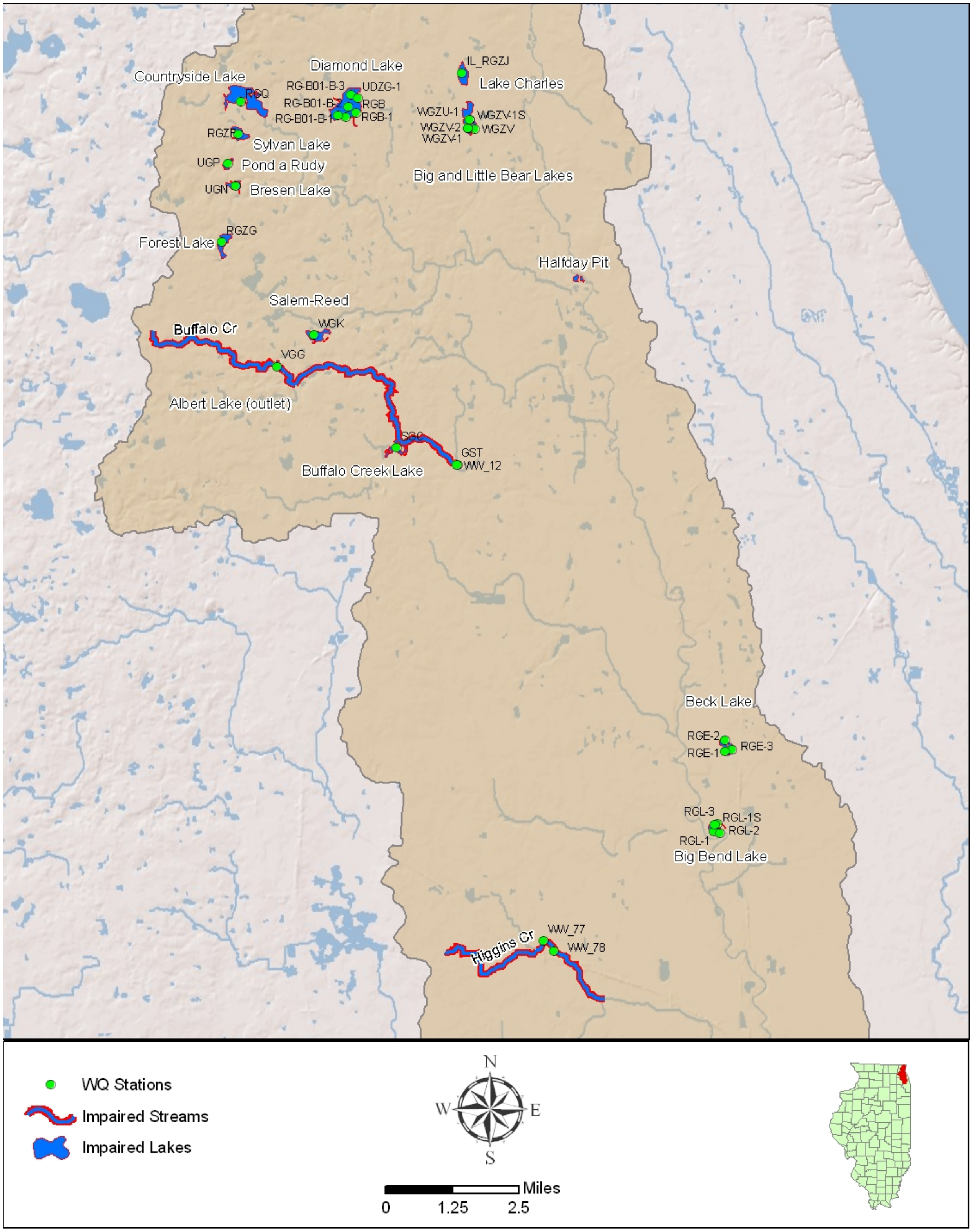


Figure 5-2 Total Phosphorus Distribution 1977 – 2007 for Diamond (RGB), Beck (RGE), Countryside (RGQ), Sylvan (RGZF), Forest (RGZG), Buffalo Creek (SGC), Bresen (UGN), Salem-Reed (WGK), Big Bear (WGZU), Little Bear (WGZV) and Big Bend (RGL)

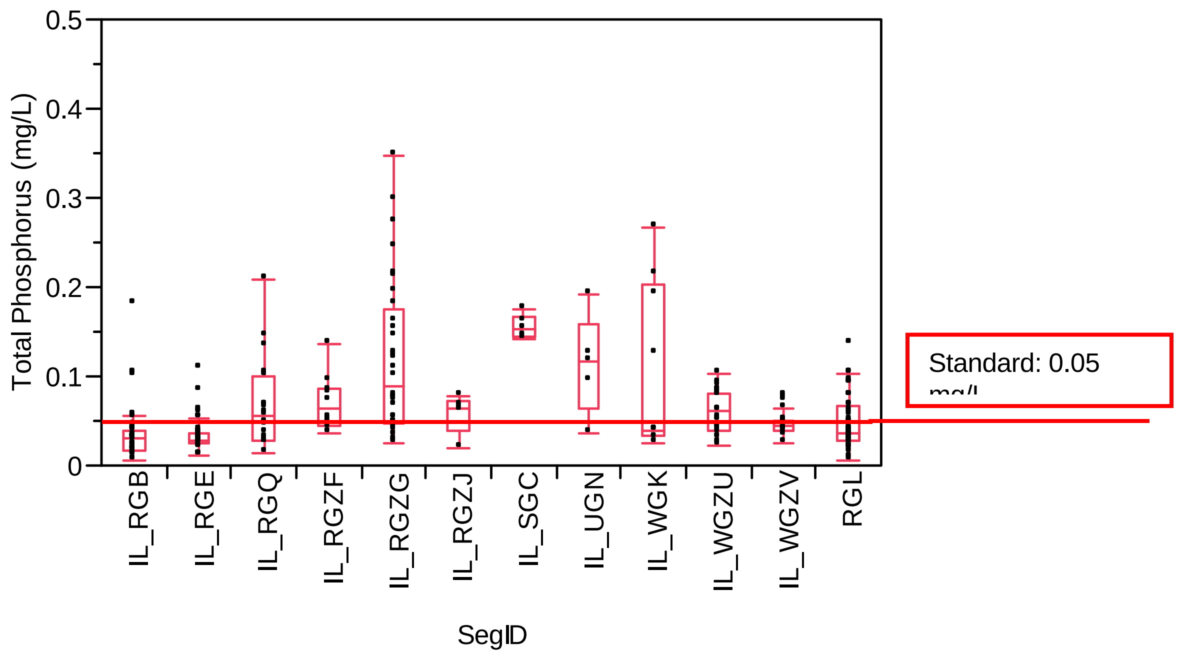


Figure 5-3 Total Phosphorus Time-Series at Diamond Lake (RGB), Beck Lake (RGE), Countryside Lake (RGQ), and Sylvan Lake (RGZF)

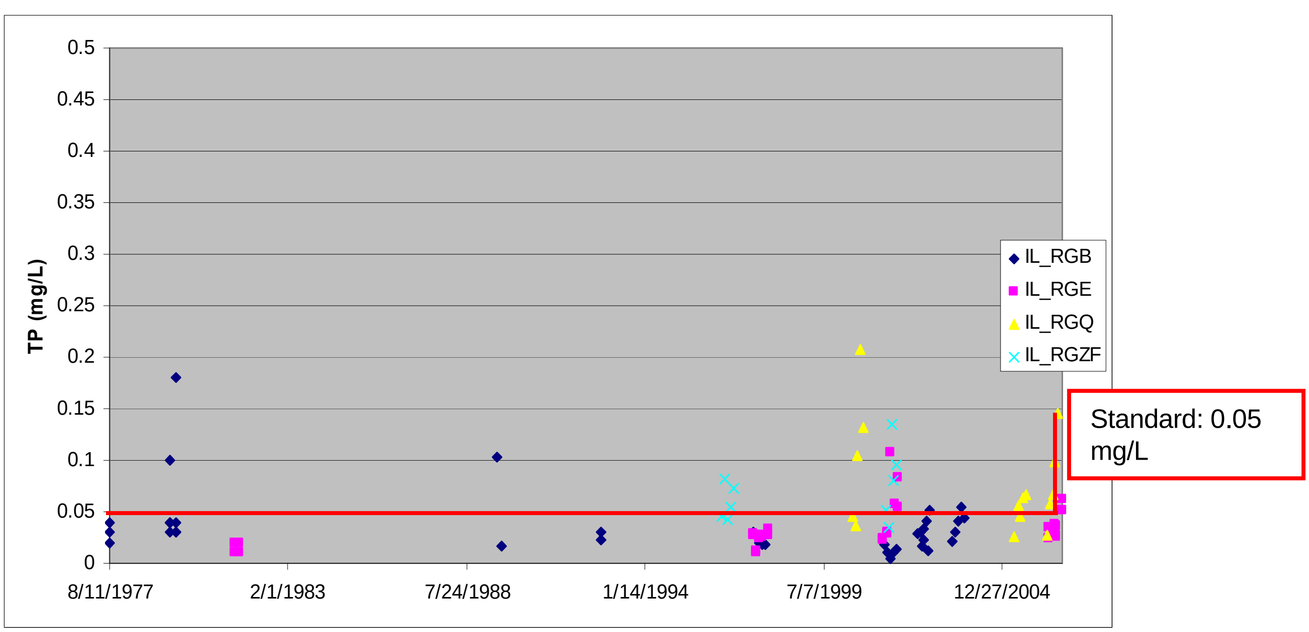


Figure 5-4 Total Phosphorus Time-Series at Forest Lake (RGZG), Lake Charles (RGZJ), Buffalo Creek Lake (SGC), and Bresen Lake (UGN)

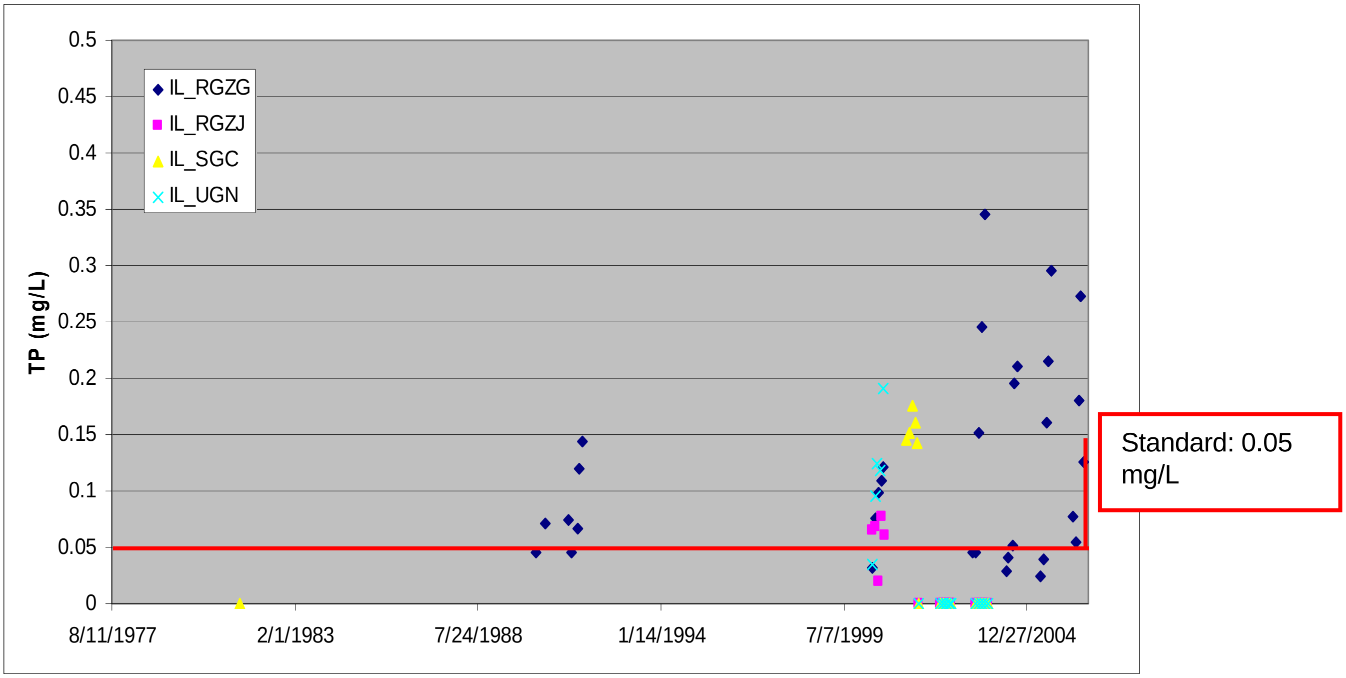
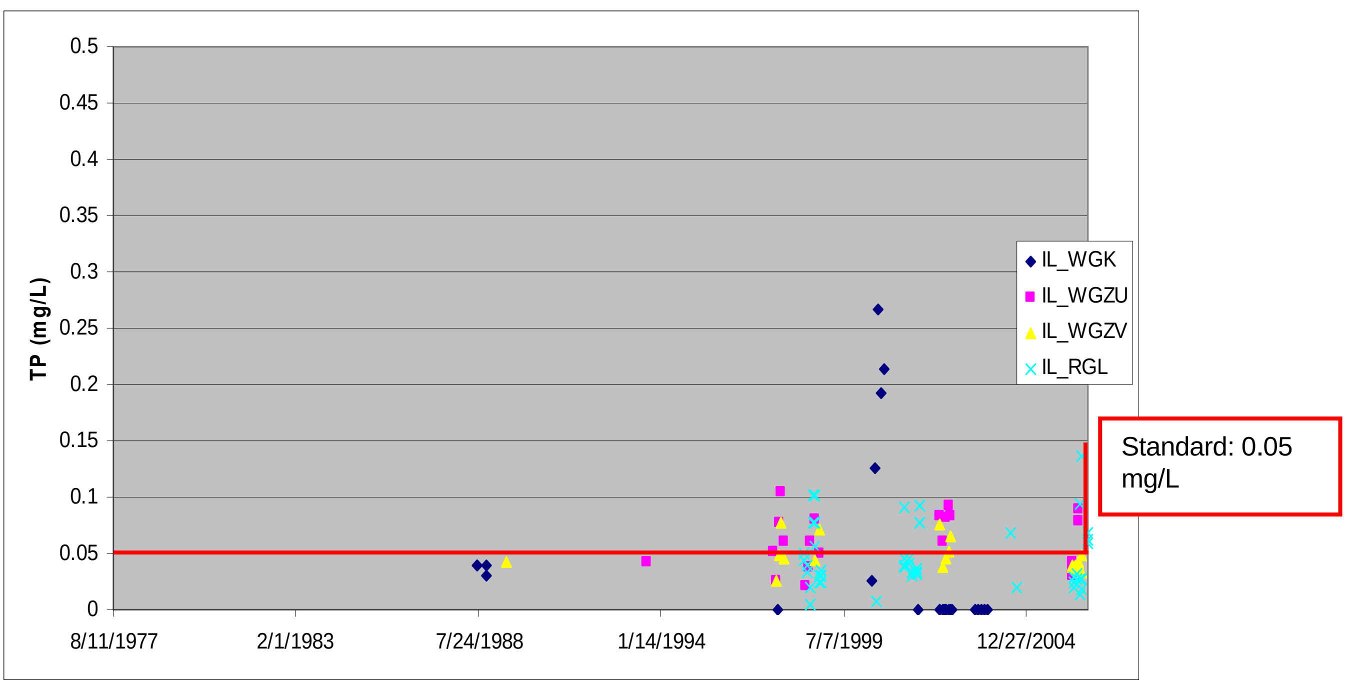


Figure 5-5 Total Phosphorus Time-Series at Salem-Reed Lake (WGK), Big Bear Lake (WGZU), Little Bear Lake (WGZV), and Big Bend Lake (RGL)



5.1.2 Dissolved Oxygen

Six waterbody segments were found to be impaired for low DO based on the latest criterion. The WQS for DO, which includes a seasonal component, is 5.0 mg/L from March through July and the daily mean averaged over seven days must not be less than 6.0 mg/L. From August through February the instantaneous minimum is 3.5 mg/L, the daily mean averaged over seven days must not be less than 4.0 mg/L, and the daily mean averaged over 30 days must not be less than 5.5 mg/L. DO is only assessed in lakes above the thermocline in stratified lakes. DO concentrations for impaired segments in the Des Plaines/Higgins Creek Watershed are presented in **Figures 5-6** through **5-8**. Data used for assessments ranged from 2000 to 2007 (**Table 5-3**).

Table 5-3 Dissolved Oxygen Data Summary 2000 – 2007

Waterbody Name	Segment	Units	Observ ations	Violati ons	Min	Max	Avg	Median	Standard Deviation
Albert Lake	**IL_VGG**	mg/L	20	12	1.0	8.4	4.42	3.7	2.61
Buffalo Creek	**IL_GST**	mg/L	52	2	2.1	13.4	9.32	9.9	2.75
Buffalo Creek Lake	**IL_SGC**	mg/L	27	6	3.9	9.28	6.29	5.9	1.81
Half Day Pit	**IL_UGB**	mg/L	47	5	0.4	18.8	8.04	6.5	4.28
Higgins Creek	**IL_GOA-02**	mg/L	41	2	3.5	14.4	8.46	8.0	2.39
Pond-a-Rudy	**IL_UGP**	mg/L	5	1	4.3	14.8	9.74	10.2	4.35

Figure 5-6 Dissolved Oxygen Distribution 2000 - 2007 for Higgins Creek (GOA-02), Buffalo Creek (GST), Buffalo Creek Lake (SGC), Half-day Pit (UGB), Pond-a-Rudy (UGP) and Albert Lake (VGG)

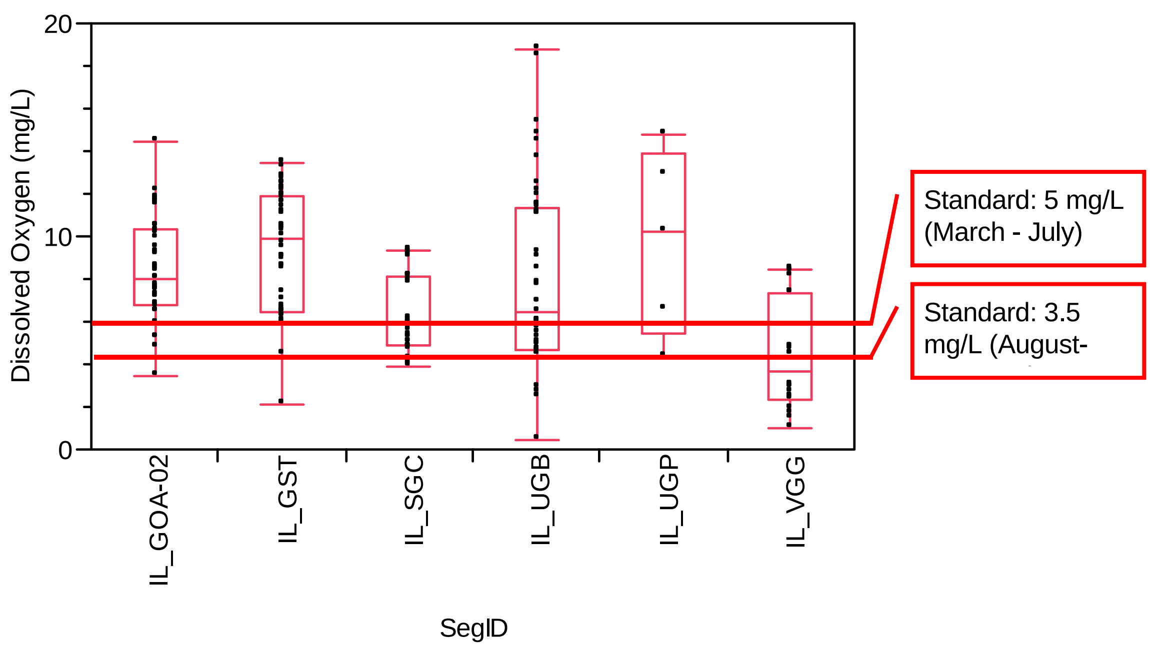


Figure 5-7 Dissolved Oxygen Time-Series at Higgins Creek (GOA-02), Buffalo Creek (GST), and Buffalo Creek Lake (SGC)

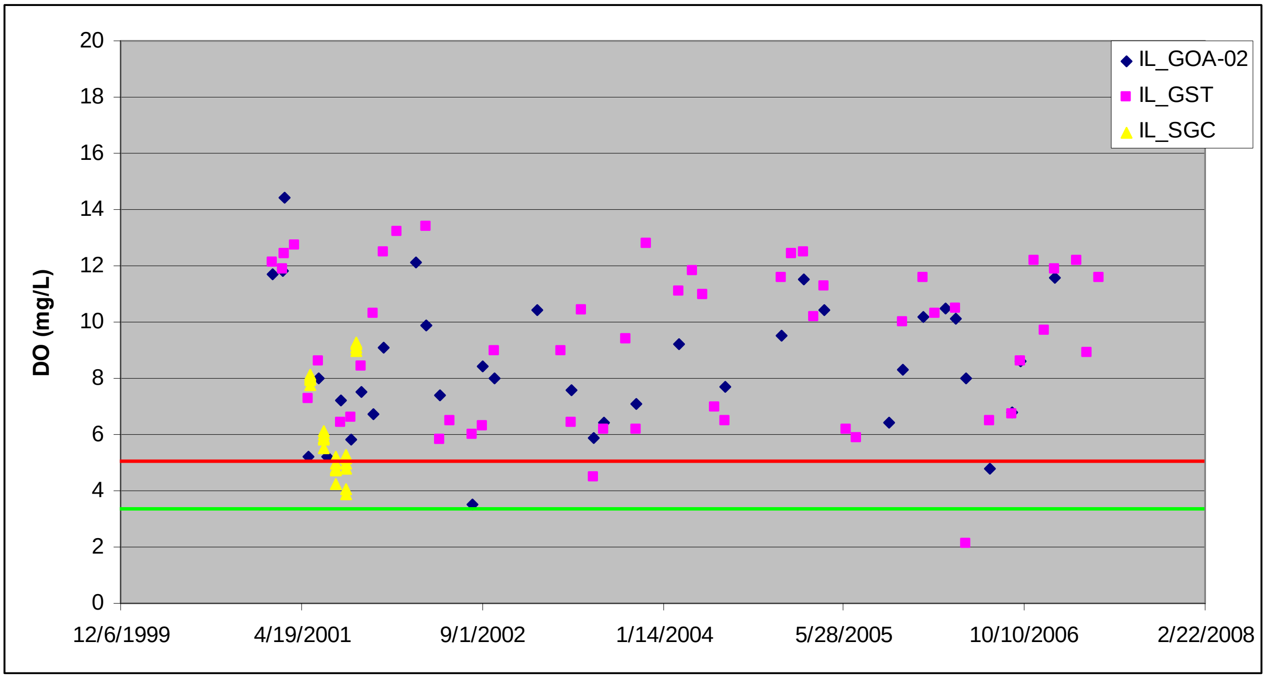
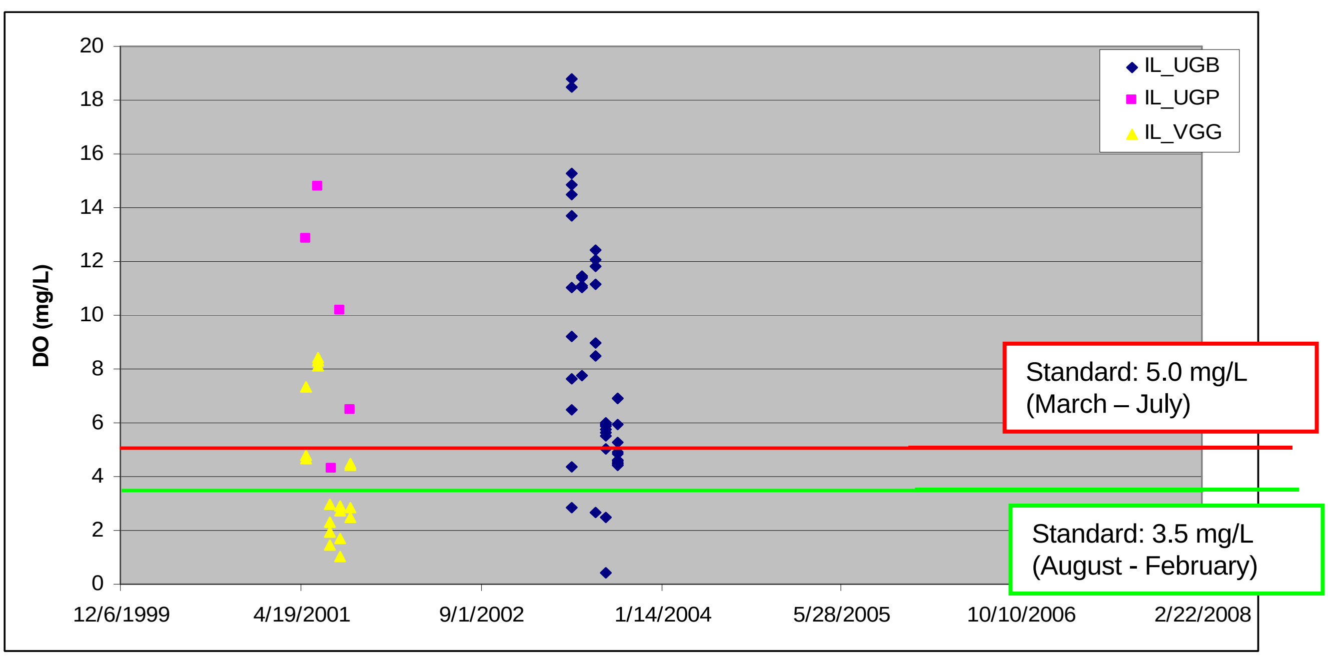


Figure 5-8 Dissolved Oxygen Time-Series at Half Day Pit (UGB), Pond-a-Rudy (UGP), and Albert Lake (VGG)



5.1.3 Fecal Coliform/E. Coli

The distribution of fecal coliform and E. coli for each impaired segment in the Des Plaines/Higgins Creek Watershed is presented in **Figures 5-9** through **5-11**. The WQS for fecal coliform is a 200 cfu/100ml geometric mean based on a minimum of five samples taken over any 30 day period or a 400 cfu/100ml maximum not to be exceeded in more than 10% of samples taken during any 30 day period. Due to the unlikelihood of having five fecal coliform samples per month upon which to judge compliance, the last seven years of data were used for assessment purposes. For E. coli assessments the beach closure threshold count is 235 cfu/100 ml. Data used for assessments ranged from 2001 to 2007 (**Table 5-4**).

Table 5-4 Fecal Coliform Data Summary 2001 - 2007

Waterbody Name	Segment	Units	Observations	# Violations (>200)	Min	Max	Geo-mean	Median	Standard Deviation
Buffalo Creek	**IL_GST**	cfu/100 ml	21	15	60	28,000	856	940	6,205
Higgins Creek	**IL_GOA-01**	cfu/100 ml	42	12	0	190,000	150	40	34,138
Higgins Creek	**IL_GOA-02**	cfu/100 ml	23	20	160	1,100,000	3,389	2,400	265,107
Sylvan Lake (E. coli data)	**IL_RGZF**	cfu/100 ml	16	2	10	1,000	49	60	298

Figure 5-9 Fecal Coliform Distribution 2001 – 2007 for Higgins Creek (GOA-01 and GOA-02), Buffalo Creek (GST) and Sylvan Lake (RGZF)

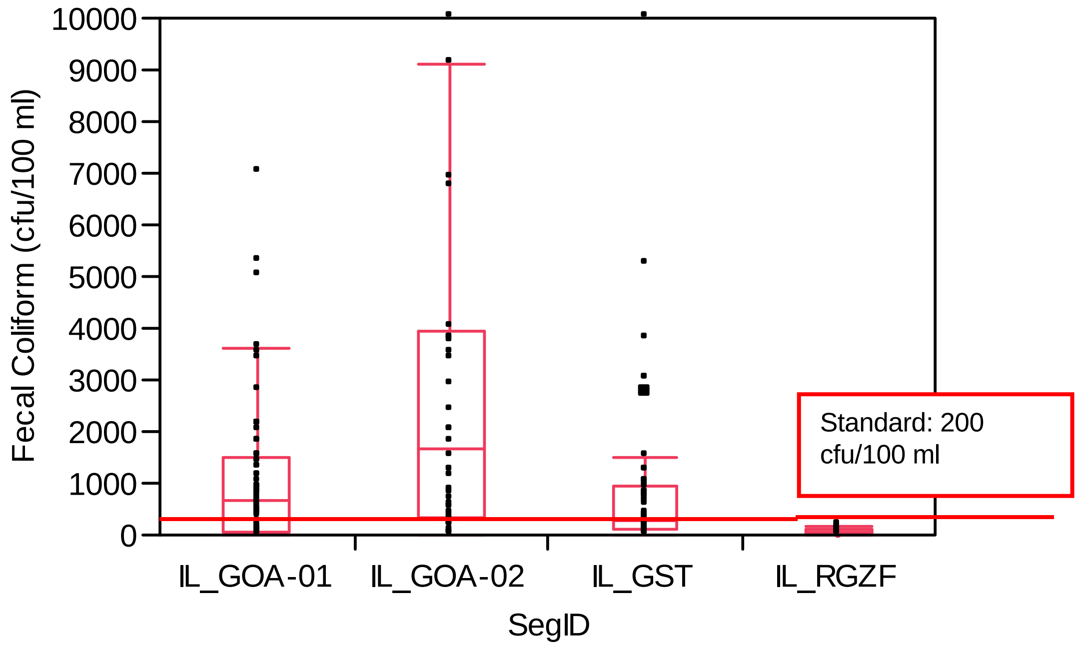


Figure 5-10 Fecal Coliform Time-Series for Higgins Creek (GOA-01 and GOA-02) and Buffalo Creek (GST)

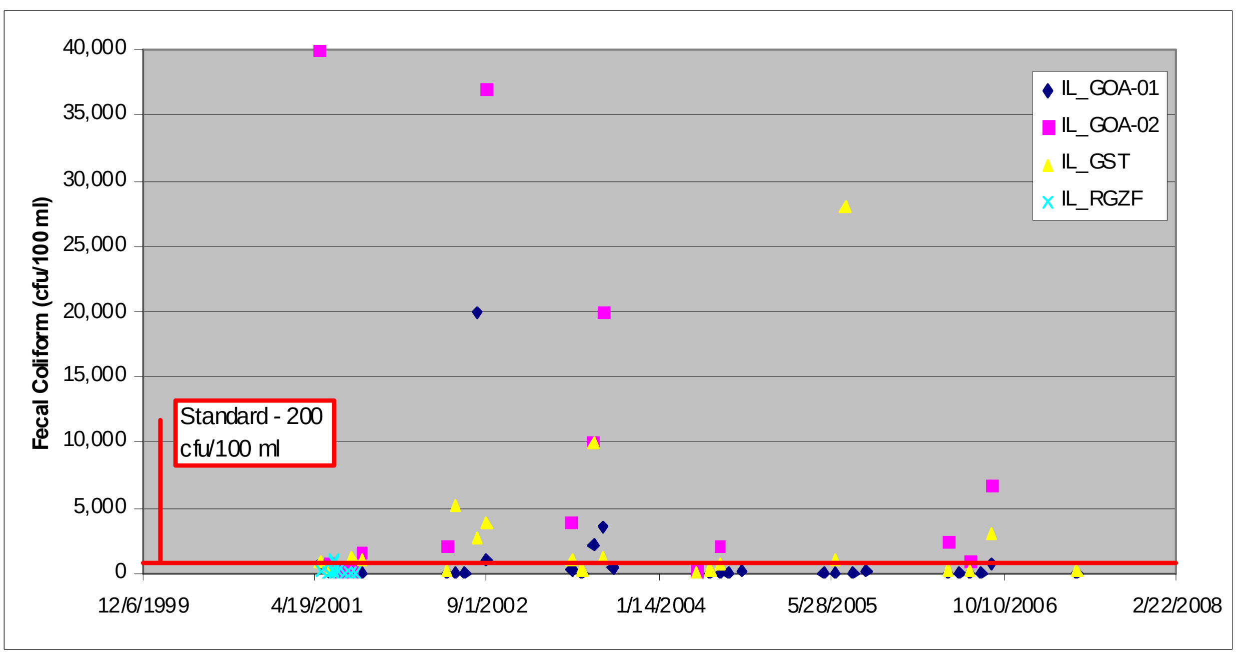
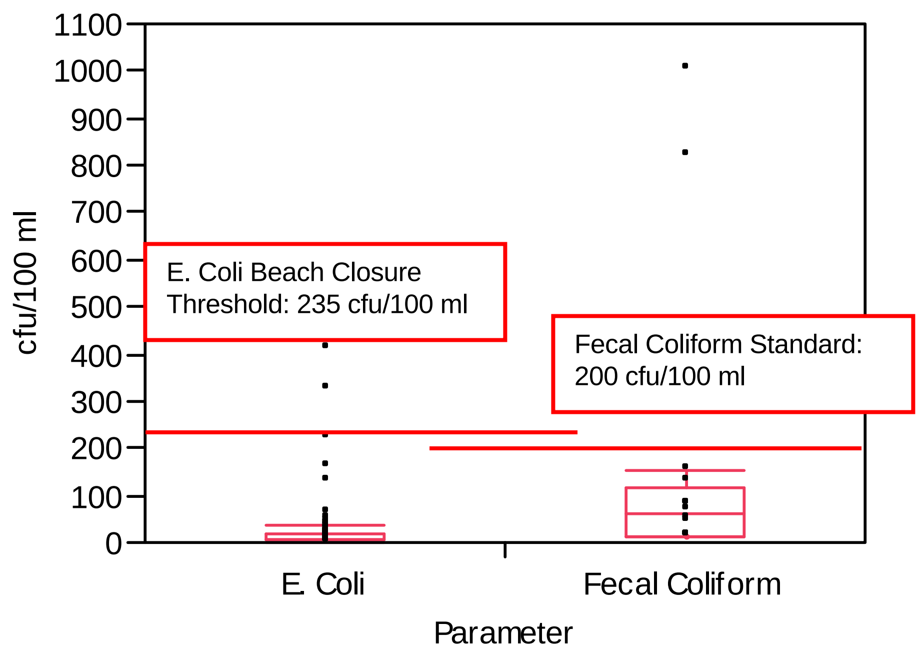


Figure 5-11 Bacteria Distribution for Sylvan Lake (RGZF)



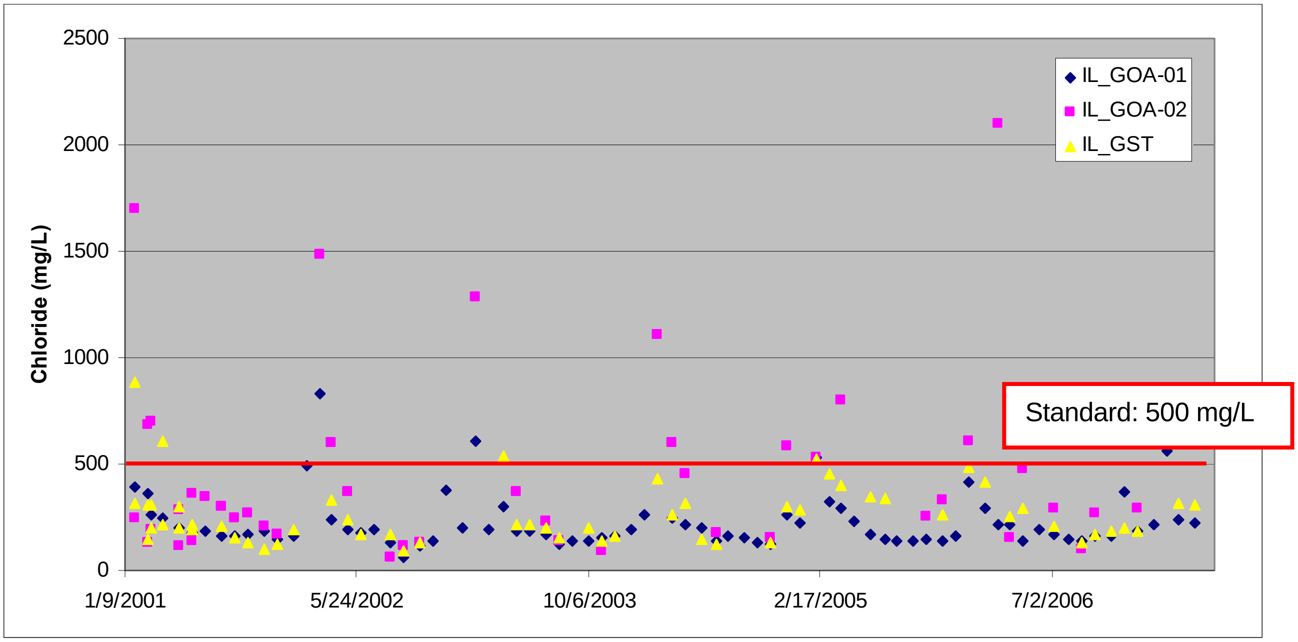
5.1.4 Chloride

Chloride exceedances were recorded in several segments of the Des Plaines/Higgins Creek Watershed. **Table 5-5** and **Figure 5-12** summarize the average chloride values for each impaired segment. The general use WQS for chloride is 500 mg/L and available data used for assessment ranged from 2001 to 2007.

Table 5-5 Chloride Data Summary 2001 - 2007

Water-body Name	Segment	Units	Obser-vations	Violations	Min	Max	Avg.	Median	Standard Deviation
Buffalo Cr	IL_GST	mg/L	87	6	94	882	249	206	138
Higgins Creek	IL_GOA-01	mg/L	83	4	62	830	211	183	134
Higgins Creek	IL_GOA-02	mg/L	44	13	65	2,097	438	290	422

Figure 5-12 Chloride Time-Series for Higgins Creek (GOA-01 and GOA-02) and Buffalo Creek (GST)



5.2 Potential Point Sources

A number of point source dischargers actively maintain National Pollutant Discharge Elimination System (NPDES) permits, including Municipal Separate Storm Sewer Systems (MS4) within the Des Plaines/Higgins Creek Watershed. MS4s serve a potential source of pollutants as they are regulated to discharge stormwater. Pollutants such as nutrients, metals, and pathogens can be transported during precipitation events and discharged through MS4 outfalls. Fertilizers for lawns and other landscaping along with pet waste are a few of the substances that can be transported during rain events. Impervious surface stormwater runoff can contribute to a significant load to waterbodies as the first flush can be heavily laden with organics. Approximately 74 percent of the watershed is covered under MS4 jurisdictions (258.1 square miles).

Discharge Monitoring Reports (DMRs) for each discharger will be required for the Stage 3 analysis of the TMDL, as available data will be quantified and analyzed to determine the point source loading for each receiving water. **Table 5-6** lists the existing NPDES permits as provided by EPA's Enforcement Compliance History Online (ECHO) database and **Table 5-7** lists the MS4 communities. Those facilities without fecal coliform permit limits listed in **Table 5-6** were granted disinfection exemptions. In addition, MWRDGC's Kirie Facility has a disinfection exemption for its Outfall 002. Geographic locations are labeled in **Figures 5-13** and **5-14**. Permitted NPDES limits can be found in **Appendix E**.

Table 5-6 Existing NPDES Dischargers in the Des Plaines/Higgins Creek Watershed

	NPDES Number	Receiving Water	Receiving Water Segment	Daily Avg Flow (MGD)	Daily Max Flow (MGD)	Monitored Parameters
Alden Long Grove Rehab.	IL0051934	Buffalo Cr.	Tributary to GST	0.015	0.037	CBOD, Suspended Solids, pH, Fecal Coliform, DO
BP Products – O'Hare Terminal (4 outfalls)	IL0034347	Higgins Cr.	GOA-01	0.029	N/A	pH, TSS
C.M. Products, Inc.	IL0066311	UT to Flint Creek	GST	0.033	0.066	pH, temperature
Camp Reinberg STP	IL0048542	UT to Salt Cr.	GST	0.004	0.01	DO, BOD, NH4, Fecal Coliform, pH
CITGO Petroleum Corp. (2 outfalls)	IL0025461	Higgins Cr.	GOA-02	0.185	N/A	BOD
Des Plaines MHP	IL0054160	UT to Higgins Cr.	GOA-01	0.069	0.177	BOD, Suspended Solids, pH, Fecal Coliform, NH4, DO
Shell Oil – Des Plaines (5 outfalls)	IL0046736	Higgins Cr.	GOA-02	2.788	13	Total Dissolved Solids, pH, TSS
Exxon Mobil Corp. (4 outfalls)	IL0066362	Higgins Cr.	GOA-02	0.0043	N/A	Total Dissolved Solids, pH
Fox Point MHP	IL0049930	Des Plaines R.	G-36	0.016	0.04	pH, TSS, Fecal Coliform, BOD
Jiffy Lube	IL0072729	UT to Des Plaines R.	GS-01	0.0005	0.0072	pH
Lake County DWP - Des Plaines STP	IL0022055	Aptakistic Cr.	G-36	16	51.8	CBOD, TSS, DO, pH, Fecal Coliform, NH4
Lake Cnty DWP – Diamond –Sylvan STP	IL0022080	Indian Cr.	GU-02	0.34	1.19	DO, pH, TSS, NH4, Fecal Coliform, BOD
Lake County DWP - New Century STP	IL0022071	Des Plaines R.	G-35	6	18	BOD, Suspended Solids, pH, Fecal Coliform, NH4, DO
Leider Greenhouse	IL0067881	Aptakistic Cr.	G-36	0.0058	0.0327	pH, BOD, TSS, NH4
Libertyville STP	IL0029530	Des Plaines R.	G-35	4	8	BOD, Suspended Solids, pH, Fecal Coliform, NH4, DO
Marathon Petroleum – Mt. Prospect (2 outfalls)	IL0062791	Higgins Cr.	GOA-02	0.7	N/A	pH, TSS, BOD
Mundelein STP (2 outfalls)	IL0022501	Des Plaines R.	G-35	4.95	15	BOD, Suspended Solids, pH, Fecal Coliform, NH4, Phosphorus, Nitrogen, DO
MWRDGC Kirie WRP (4 outfalls)	IL0047741	Higgins Cr.	GOA-01	52	110	CBOD, TSS, DO, pH, Fecal Coliform, NH4

	NPDES Number	Receiving Water	Receiving Water Segment	Daily Avg Flow (MGD)	Daily Max Flow (MGD)	Monitored Parameters
Prairie Materials Sales, Inc.	IL0068063	Willow Cr.	GS-01	N/A	N/A	N/A - General Stormwater Permit
Unoven – Des Plaines Terminal	IL0042242	Higgins Cr.	GOA-02	N/A	N/A	N/A - General Stormwater Permit

Table 5-7 Existing MS4 Dischargers to Waterbodies Targeted for TMDL Development in the Des Plaines/Higgins Creek Watershed

Municipality	MS4 Permit ID	Permittee	Drainage Area (Sq. Miles)
Arlington Heights	ILR400282	Village of Arlington Heights	7.4
Barrington	ILR400285	Village of Barrington	4.9
Buffalo Grove	ILR400303	Village of Buffalo Grove	9.0
Chicago	ILR400173	Chicago City	1.0
Deer Park	ILR400323	Village of Deer Park	3.7
Des Plaines	ILR400325	City of Des Plaines	15.8
Elk Grove	ILR400334	Village of Elk Grove Village/Supt. of Utilities	10.9
Glenview	ILR400343	Village of Glenview	14.0
Hawthorn Woods	ILR400209	Hawthorn Wood Village	6.1
Illinois Tollway	ILR400494	Illinois Tollway Authority	0.15
Inverness	ILR400359	Village of Inverness	6.9
Kildeer	ILR400215	Kildeer Village	3.7
Lake Zurich	ILR400370	Village of Lake Zurich	6.9
Long Grove	ILR400219	Long Grove Village	13.2
Mt Prospect	ILR400393	Village of Mt. Prospect	10.0
Palatine	ILR400416	Village of Palatine	13.4
Rolling Meadows	ILR400435	City of Rolling Meadows	5.6

Figure 5-13 Existing NPDES Dischargers in the Des Plaines/Higgins Creek Watershed

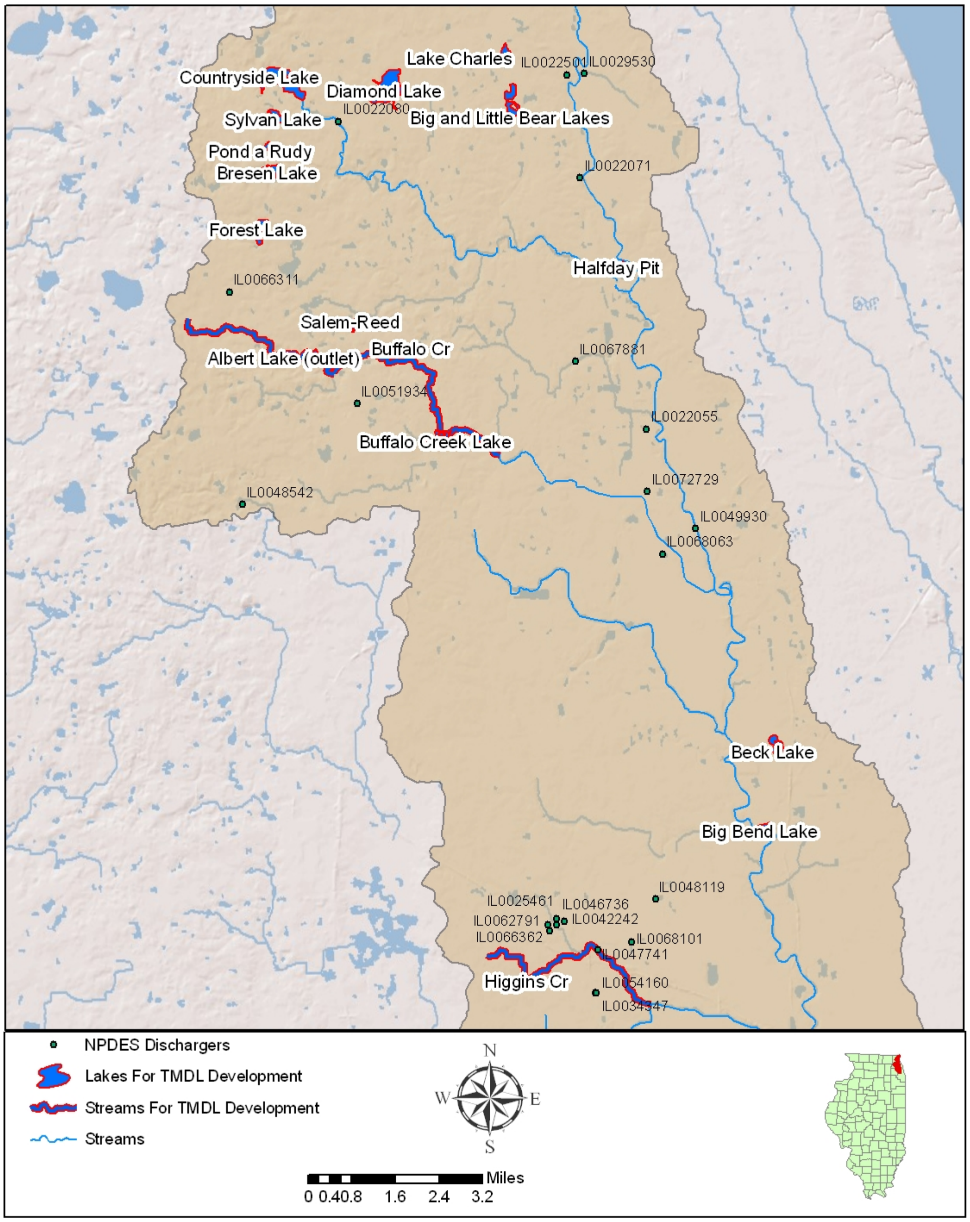
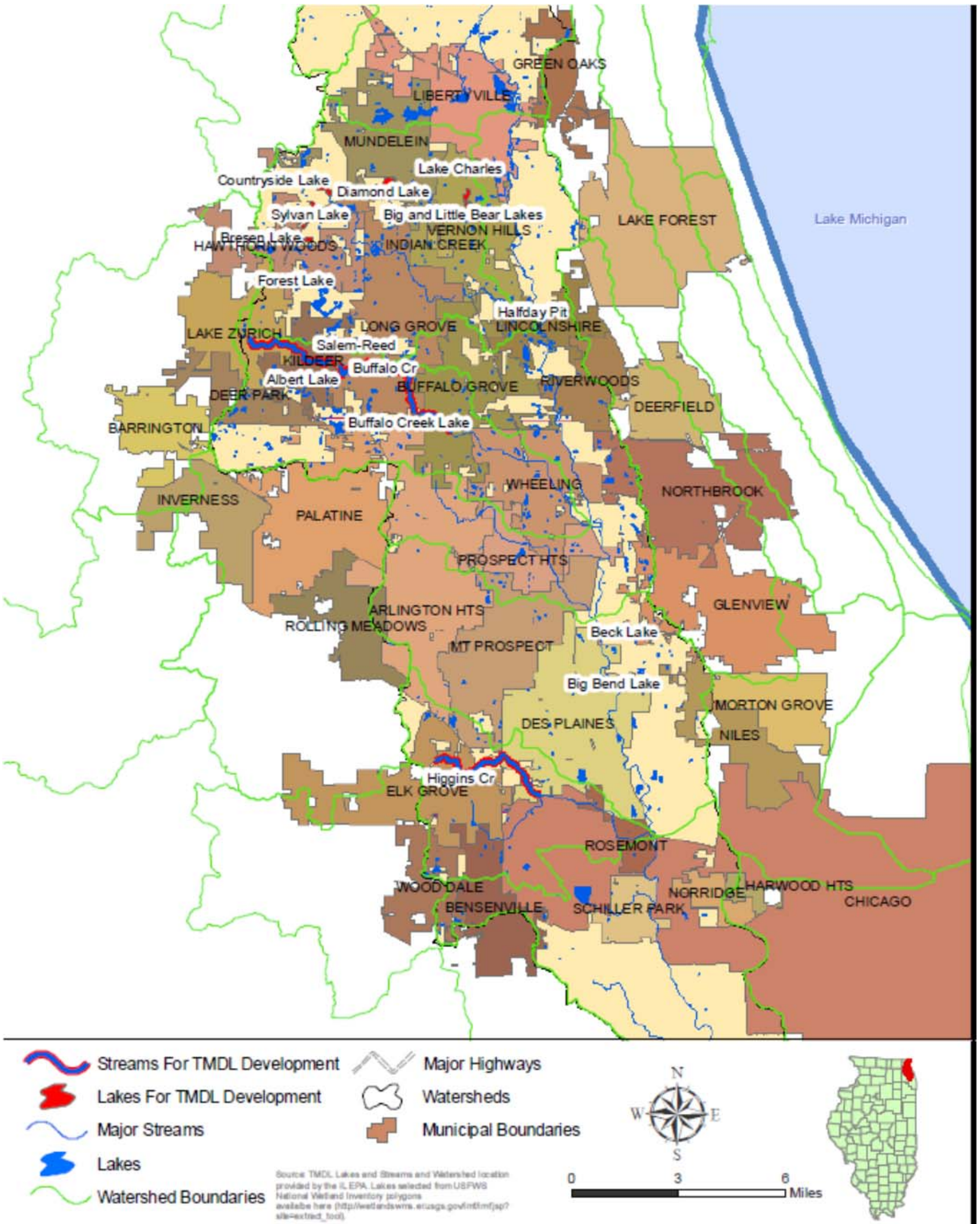


Figure 5-14 Existing MS4 Dischargers in the Des Plaines/Higgins Creek Watershed



5.3 Non-Point Sources

The Des Plaines/Higgins Creek Watershed is dominated by urban growth; current land use is approximately 67% urban. Further, almost 12% of the remaining land use is considered agricultural, a primary source of non-point source pollution in waterbodies. To properly manage and maintain water quality in the Des Plaines/Higgins Creek Watershed, the impacts associated with new development and agriculture must be carefully evaluated.

Urban and suburban development can adversely impact water quality in a number of ways. During the construction phase of development soils destabilized as a result of clearing, grading, and excavation are subject to increased erosion by wind and water. These eroded soils can be carried offsite and deposited in receiving waters such as lakes, rivers and wetlands. Adverse impacts associated with such sediment loading include increased turbidity and habitat modification, including smothering of invertebrates and covering spawning beds. Typically, the construction phase is relatively short-lived; however, the impacts to receiving waters from poorly managed construction activities may be extremely severe and the effects can endure long after the project is over.

Post-construction receiving water quality impacts may become more pronounced due to potentially dramatic changes to the area's hydrology (reduced baseflow and exaggerated peak flow volumes), and the change in land use compared to predevelopment conditions. The increase in impervious areas, such as roadways and parking lots, can often result in increased runoff rates and volumes. This can result in increased streambank erosion which can lead to increased sediment loading and its associated water quality problems. The increased runoff can also accelerate the transport of land-borne pollutants such as pathogens, heavy metals, oil and grease, sediment, pesticides, fertilizers and other nutrients, and toxic organic contaminants. Increased imperviousness can also cause significant elevations in receiving water temperatures during summer months. Winter road deicing activities can contribute high levels of chlorides or sediment.

Agricultural practices in the Des Plaines/Higgins Creek Watershed can also adversely impact water quality. The dominant crops found in the watershed are corn (37%) and soybean (23%), but other harvested crops include winter wheat, grain, and hay. Fertilizers used for such crops typically consist of nitrogen and phosphorus and are considered a potential source of nutrient enrichment in waterbodies. Along with nutrients, agricultural runoff can contain soil particles and manure that has been applied as fertilizer. All of the impaired waterbodies within the Des Plaines/Higgins Creek Watershed are potentially impacted by agricultural practices with the exception of Half Day Pit, Big Bend Lake, Beck Lake, and Albert Lake.

The land uses for each of the watersheds vary. Urban land use represents the dominant land use in the following watersheds: Albert Lake (80%), Big and Little Bear Lakes (88%), Big Bend Lake (74%), Bresen Lake (52%), Buffalo Creek (74%), Buffalo Lake (71%), Diamond Lake (45%), Forest Lake (78%), Half Day Pit (32%), Higgins Creek (91%), Lake Charles (89%), Pond-A-Rudy (38%), Salem-Reed (36%), and Sylvan Lake (39%). Forested land represents the largest land use in the Beck Lake watershed (57%) while agricultural land is the dominant land use in Countryside Lake watershed (45%) and is also a large portion of the Sylvan Lake (38%) and Diamond Lake (33%) watersheds. Land use will impact implementation actions recommended in the Implementation Plan.

Water quality impacts may be evaluated in terms of short-term impacts, and long-term impacts. Individual runoff events can cause short-term impacts to receiving waters, and are typically on a timescale of hours to days. Changes to the dry and wet weather hydrology, streambank morphology, and water chemistry of the receiving water are considered long-term impacts. Such long-term chemical impacts are most critical for those waters with longer residence times such as lakes and wetlands, and slow-moving stream segments. With regards to urban development and agriculture, pollutant concentrations are best used to evaluate short-term effects, while pollutant loadings are appropriate for assessing long-term impacts. Des Plaines/Higgins Creek Watershed planners and developers need to understand these impacts and carefully plan in order to mitigate the negative water quality impacts of development and agriculture.

5.3.1 Total Phosphorus (Nutrient) Load Reduction

The most prevalent water quality issue in the watershed is nutrient over-enrichment of both lakes and streams. Loading of oxygen-demanding materials can come from a variety of non-point sources. There is very little agricultural activity within the watershed; however, urban nature of the land use of fertilizers for lawns and other landscaping can still greatly contribute nutrients and organic material to the receiving waterbody. A TMDL done for phosphorus in lakes will recommend BMPs in the implementation plan (see Section 8.6 of the report) and when put in place will reduce siltation-sedimentation and total suspended solid impairments in those waters as well as the rivers and streams in the watershed. Phosphorus often sorbs on soil particles, so efforts to reduce phosphorus loads will involve reduction of sediment loads as well (USEPA, 1999). As discussed in Section 8.6, several of the BMPs needed for the impaired waters will reduce sediment as well as phosphorus. For example, stream bank stabilization/vegetated buffers on the shorelines for the lakes will reduce sediment loads as well as phosphorus loads into the lakes. Street sweeping will reduce fine sediments and organic debris that transports phosphorus via stormwater systems.

Reduction of phosphorus in lakes can also reduce the impairment of excessive aquatic algae and aquatic plants as phosphorus is the limiting nutrient for algal and plant growth in Illinois waters. Therefore by addressing/developing TMDLs for dissolved oxygen and phosphorus in lakes we are by practice addressing phosphorus in rivers and streams. Likewise, the practice to be implemented to reduce phosphorus is directly linked to reducing TSS. Overland flow drives phosphorus and TSS nonpoint source inputs- reducing one will in turn equally reduce the other cause of impairment.

5.3.2 Fecal Coliform Wasteload Allocation Criteria for MS4s

The critical condition for fecal coliform load duration TMDLs was established by hydrologic category. Each category has a corresponding percent reduction associated with the hydrologic regime. In addition, loading by season was evaluated. Flow duration intervals were plotted by month to determine if there is a strong seasonal component. Although this will not change allocations, this may assist in implementation planning. The WQS for fecal coliform is 200 cfu/100ml geometric mean based on a minimum of five samples taken over any 30 day period. In addition a seasonal maximum of 400 cfu/100ml may not to be exceeded in more than 10% of samples taken during any 30 day period during the months of May through October. For E. coli assessments the beach closure threshold count is 235 cfu/100 ml. Data used for assessments ranged from 2001 to 2007 (See Table 5-4 in the report). Waste load allocations for fecal coliform were based on NPDES permit limits when the permits contained numeric effluent limits for the pollutant of concern. Daily average and daily maximum discharge flows and permit limits were used to calculate a daily load and serve as the WLA. The need for additional fecal coliform controls at each facility will be evaluated through the NPDES permitting program as each facility applies for permit renewal. In addition fecal coliform reduction implementation actions should be taken by MS4 communities and other non-point sources to minimize fecal coliform loading in the receiving waterbodies. The size of the Kirie WWTP discharge in comparison to the stream flow requires that extremely productive MS4 and non-point source pollution management in the watershed.

5.4 Watershed Studies and Other Watershed Information

There are a number of groups in the watershed that have collected and developed information and studies that are pertinent to this TMDL. Listed below is some of the information found for this watershed.

- Lake County Reports – The Lakes Management Unit has been collecting water quality data on Lake County lakes since the 1960s. Thirteen lakes within the Des Plaines/Higgins Creek Watershed were assessed by Lake County. A detailed report summarizing water quality, lake characteristics, data analyses, existing problems, and recommendations was created for each waterbody. Additional information can be found at the Lake County website: http://www.lakecountyil.gov/Health/want/LakeReports.htm.
- Bio assessment of Higgins Creek at Station 78 - This study was conducted by the MWRD in 2005 to assess the conditions of the waterways within their service area. Its objectives were to determine the extent to which biological assemblages were impaired and determine the stressors and sources that were associated with those impairments. The sample results suggest that while there is low richness in the Hester-Dendy (HD) samples and a lack of EPT taxa, pollution type stress is relatively low in Higgins Creek. This report is available at the MWRD website: www.mwrdgc.dst.il.us/RD/IEPA_Reports/Waterways/biological/MWRD %202005%20Chicago %20Waterways%20Benthic%20[Report1].pdf
- Buffalo Creek Forest Preserve Master Plan – In 2008, the Lake County Forest Preserve Board of Commissioners in conjunction with the MWRD and the Lake County Department of Transportation, approved the Buffalo Creek Master Plan. This plan was designed to improve public access and provide natural resources restoration. Other facets of the plan include: guidance for an additional 30-acre stormwater storage reservoir, road improvements designed to reduce traffic, and a plan to transform an existing agricultural field into a high-quality wetland. Additional information can be found at: http://www.lcfpd.org/preserves/index.cfm?fuseaction=home.view&object_id=156&type=P

6.0 TMDL Approach and Data Needs

This chapter discusses the methodology used for the development of TMDLs for the Des Plaines/Higgins Creek Watershed. While a detailed watershed modeling approach can be advantageous, a simpler approach is often able to efficiently meet the requirements of a TMDL and yet still support a TMDL-guided and site-specific implementation plan. The final selection of a methodology was determined with consultation with the Illinois EPA based on following factors:

- Fundamental requirements of a defensible and approvable TMDL
- Data availability
- Fund availability
- Public acceptance
- Complexity of water body

Methodology for estimating daily loads will depend on available data as well as the selected analysis.

6.1 Modeling Approach for Total Phosphorus

An export coefficient model linked to empirical in-lake response models was used to determine existing loading and load reductions required to bring phosphorus impaired waterbodies into compliance with current WQS. This model, LLRM (lake load response model), was developed by AECOM and has been used on more than 35 lake TMDLs.

LLRM uses export coefficients for runoff, groundwater and nutrients to estimate loading as a function of land use. Yields are assigned to each defined parcel (sub-watershed) in the lake watershed. Loading estimates are adjusted based on proximity to the lake, soils and major BMPs in place. Model yields were compared to measured data, where available. Export coefficients and attenuation factors were adjusted such that model loading accurately reflects actual loading based on sample data and measured in-lake concentrations.

Watershed and subwatershed boundaries were delineated based topography. Watershed land use was determined using publically available GIS data layers from the Illinois Natural Resource Geospatial Data Clearinghouse, or similar source. LLRM were set-up on a sub-watershed level using available land use and average annual precipitation. The spreadsheet-based export coefficient model allows the user to select watershed yield coefficients and attenuation factors from a range appropriate in the region. The model also includes direct inputs for atmospheric deposition, septic systems, point sources, waterfowl and internal loading from lake sediments.

The generated load to the lake is processed through five empirical models: Kirchner & Dillon 1975, Vollenweider 1975, Larsen & Mercier 1976, Jones & Bachmann 1976 and Reckhow 1977, and the modeled total phosphorus concentration is based on the average of these equations. These empirical models predict in-lake phosphorus concentrations based on loading and lake characteristics such as mean water depth, volume, inflow, flushing and settling rates. Predicted in-lake phosphorus is compared to measured data. An acceptable agreement between measured and predicted concentrations indicates loading estimates are appropriate for use in the preparation of a TMDL.

Adjustments to the loading portion of the model are made when necessary based on best professional judgment to ensure acceptable agreement between measured and predicted concentrations. These empirical models also predict chlorophyll concentrations and water clarity (Secchi disk transparency). LLRM also includes a statistical evaluation of algal bloom probability.

Once the model has been calibrated to existing conditions, adjustments to the model can be made to determine predevelopment conditions and the load reductions necessary to meet WQS. In some instances, waterbodies are naturally eutrophic and may not achieve numerical WQS even under predevelopment conditions. The percent reduction is based on the water quality standard of 0.05 mg/L of phosphorus.

LLRM is most effective when calibrated with water quality data for the target system, but can be used with limited data. While it is a spreadsheet model with inherent limitations on applied algorithms and resultant reliability of predictions, it provides a rational means to link actual water quality data and empirical models in an approach that addresses the whole watershed and lake. LLRM is an easy and efficient method of estimating current loads to lakes as well as providing predictions on lake response under countless loading scenarios.

LLRM, as well as most simplified lake models, predicts phosphorus concentrations and estimates loading on an average annual basis. As required by the EPA, the TMDL must be expressed on a daily basis. However, there is some flexibility in how the daily loads may be expressed (US EPA, 2006). Several of these options are presented in “Options for Expressing Daily Loads in TMDLs” (US EPA, 2007). For TMDLs based on watershed load and in-lake response models providing predictions on an annual basis, the EPA offers a method for calculating the maximum daily limit based on long-term average and variability. This statistical approach is preferred since long periods of continuous simulation data and extensive flow and loading data are not available. The following expression assumes that loading data are log-normal distributed and is based on a long term average load calculated by the empirical model and an estimation of the variability in loading.

$$MDL = LTA * e^{[z\sigma - 0.5\sigma^2]}$$

Where:
MDL = maximum daily limit
LTA = long-term average
Z = z-statistic of the probability of occurrence
$\sigma^2 = \ln(CV^2 + 1)$
CV= coefficient of variation

Data from similar lakes were used in situations where there are not enough data to determine probability of occurrence or coefficient of variation for the impaired waterbody.

WLAs were determined based on NPDES permit effluent limitations and average/maximum flows. WLAs for NPDES-permitted stormwater discharges, including current and future MS4s, “Urbanized” areas and construction and industrial discharges that do not have numerical effluent limitations were expressed as a percent reduction instead of a numerical target. Stormwater discharges are required to meet the percentage reduction or the existing instream standard for the pollutant of concern, whichever is less restrictive.

Critical conditions for lakes typically occur during the summertime, when the potential (both occurrence and frequency) for nuisance algal blooms are greatest. The loading capacity for total phosphorus is set to achieve desired water quality standards during this critical time period and also provide adequate protection for designated uses throughout the year. The target goal is based on average annual values, which is typically higher than summer time values. Since summer epilimnetic values are typically about 20% less than mean annual concentrations (Nurnberg, 1996 & 1998), an annual load allocation based on mean annual concentrations will be sufficiently low to protect designated uses impacted by TP in the critical summer period. This approach is conservative and provides and implicit MOS.

The LLRM derived TMDL takes into account seasonal variations because the allowable annual load is developed to be protective of the most sensitive (i.e., biologically responsive) time of year (summer), when conditions most favor the growth of algae. Maximum annual loads are calculated based on an overall annual average concentration. Summer epilimnetic concentrations are typically lower than the average annual concentration, so it is assumed that loads calculated in this manner will be protective of designated uses in the summer season, in which the most sensitive of designated uses (swimming) occurs. It is possible that concentrations of phosphorus will be higher than the annual average during other seasons, most notably in the spring, but higher phosphorus levels at that time does not compromise uses. The TMDL is expected to protect all designated uses of the impaired waterbody.

6.2 Modeling Approach for Fecal Coliform

Many states currently use load duration curves for fecal coliform TMDLs for its simplicity and effectiveness. Load duration curves use water quality criteria, ambient concentrations, and observed flows to estimate loading capacities for streams under various flow conditions.

The first step in this process is to obtain an appropriate stream flow record. This is often difficult for streams not monitored by the United States Geological Survey (USGS). There are methods, however, for developing streamflow statistics on ungaged streams. Regional curve numbers and regression equations are typical used in such instances. Alternatively, a gaged reference watershed can used to obtain a streamflow record.

Flow and load duration curves are developed from the streamflow record and WQS. The flow duration curve is based on flow frequency which provides a probability of meeting or exceeding of a given flow. The duration curves are broken into hydrologic categories where high flows represent a duration interval of 0-10%, moist conditions represent 10-40%, mid-range flows 40-60%, dry conditions 60-90% and low flows 90-100%. In urban environments, point sources often represent the stream flow during low flow conditions. Because impervious cover prevents infiltration and inhibits baseflow, the majority of the stream flow is comprised of point source discharges. Conversely, during high flow periods, the impervious cover increases the amount of generated stormwater as storm events tend to run off into receiving waterbodies.

Once the flow duration curve is established, a load duration curve can be generated by multiplying streamflow with the numerical WQS and a conversion factor to obtain the load per day for a given streamflow. Individual measurements can be plotted against the load duration curve to evaluate patterns of impairment. Values that fall above the load duration line indicate an exceedance of the daily load and hence, WQS. These data can aid in determining whether impairment occurs more frequently in one of the hydrologic categories (wet, moist, mid-range, dry or low).

The MOS for duration curves can be implicit or explicit. Implicit MOS are derived from the inherent assumptions in establishing the water quality target. Explicit MOS include setting the water quality target lower than the WQS or not allocating a portion of the allowable load. For the Des Plaines/Higgins Creek TMDL, an explicit MOS of 10% of the allowable load was used.

WLAs were based on National Pollutant Discharge Elimination System (NPDES) permit limits. Average and maximum discharge flow and permit limits were used to calculate a daily load and serve as the WLA. Waste load allocations for NPDES-permitted stormwater discharges, including current and future MS4s, “Urbanized” areas and construction and industrial discharges that do not have numerical effluent limitations are expressed as a percent reduction instead of a numerical target. The NPDES Phase II Stormwater Regulations require all areas defined as “Urbanized” by the US Census to obtain a permit for the discharge of stormwater. Stormwater discharges are required to meet the percentage reduction or the existing instream standard for the pollutant of concern, whichever is less restrictive. The load allocation (LA) for all non-regulated sources will also be expressed as a percent reduction. The percent reduction is based on the maximum reduction required to meet WQS plus a margin of safety under critical conditions.

The critical condition for fecal coliform load duration TMDLs was established by hydrologic category. Each category has a corresponding percent reduction associated with the hydrologic regime. In addition, loading by season was evaluated. Flow duration intervals were plotted by month to determine if there is a strong seasonal component. Although this will not change allocations, this may assist in implementation planning.

Load duration curves, however, are not an effective methodology for a fecal coliform TMDL in a lake. Sylvan Lake (IL-RGZF) is currently the only fecal-impaired waterbody in the Des Plaines/Higgins Creek Watershed. The QUAL-2K model was originally recommended for use in the estimation of bacterial loading in the lake (see below). While QUAL-2K is capable of simulating pathogens as a function of temperature, light, and settling; insufficient data prevented the successful calibration of the model. As such, a combination of Schueler’s Simple Method and a mass balance were used to model fecal coliform loading to Sylvan Lake. The Simple Method was used to estimate the nonpoint source contributions to the lake and the mass balance was used to calculate fecal coliform levels within the lake.

6.3 Modeling Approach for Dissolved Oxygen

QUAL-2K, a spreadsheet model that is based on the fundamental Streeter-Phelps DO sag equation, is recommended for DO TMDL development for impaired waterbodies in the Des Plaines/Higgins Creek Watershed. QUAL-2K is a one-dimensional, steady-state model that can accommodate point and non-point source loading and is capable of modeling DO in streams and well-mixed lakes. QUAL-2K is an updated version of QUAL-2E and has been developed using a Microsoft Excel interface. QUAL-2K allows for model segmentation, the use of two forms of carbonaceous BOD (both slow and rapid oxidizing forms), and is also capable of accommodating anoxia and sediment – water interactions. While the model is simplistic in nature, it is capable of estimating critical BOD concentrations associated with instream DO concentrations of 5 mg/L.

If sufficient data are available, load duration curves could also be used to adequately simulate BOD loading associated with DO sags in streams. These calculated loads are the basis for recommending TMDL reductions if necessary.

6.4 Modeling Approach for Chloride

Similar to fecal coliform, load duration curves are recommended for the chloride TMDLs. The duration curve was used to estimate the percent of time that a WQS is exceeded. The waste load allocations were based on criteria concentrations which will then be converted into a distribution of allowable loads as a function of daily flow.

6.5 Data Needs

Effective TMDL development heavily relies on site-specific data. Sufficient flow and water quality data are required for the evaluation of water conditions and for model calibration. In fact, data availability often dictates the modeling approach used for various watersheds. Five types of data are crucial for the Des Plaines/Higgins Creek Watershed TMDL development:

- Flow data
- Meteorological data
- Water quality data
- Watershed and water body physical parameters
- Source characteristics data

There were numerous waterbodies within the Des Plaines/Higgins Creek Watershed that did not have the sufficient data observations typically needed for TMDL development (i.e. less than 2 years of data). Additional stage two sampling was recommended for eight of the lakes in the TMDL watershed (**Table 6-1**).

Table 6-1 Waterbodies with Insufficient Data within the Des Plaines/Higgins Creek Watershed

Waterbody (Segment)	Parameter	Available Data (# Years)	Stage Two Sampling (Yes/No)
Bresen Lake (IL-UGN)	Total Phosphorus	1	Yes
Buffalo Creek Reservoir (IL-SGC)	Total Phosphorus	1	Yes
Lake Charles (IL-RGZJ)	Total Phosphorus	1	Yes
Salem Reed Lake (IL-WGK)	Total Phosphorus	1	Yes
Sylvan Lake (IL-RGZF)	Total Phosphorus	2	Yes
Pond-a-Rudy (IL-UGP)	Dissolved Oxygen	1	Yes
Half Day Pit (IL-UGB)	Dissolved Oxygen	1	Yes
Buffalo Creek Reservoir (IL-SGC)	Dissolved Oxygen	1	Yes
Albert Lake (IL-VGG)	Dissolved Oxygen	1	Yes
Sylvan Lake (IL-RGZF)	Fecal Coliform	1	Yes

Point source discharge data from all NPDES permittees within the watershed will also be necessary for the Stage 3 analysis. Individual NPDES permits, DMRs, and measured discharge data are all pertinent to TMDL development. Data were obtained either using EPA's ECHO database or by directly contacting permittees.

6.6 Stage 2 Data Collection

Additional data were collected as part of the Stage 2 data collection process. Water quality data were collected at Pond-a-Rudy, Half-day Pit, Albert Lake, Bresen Lake, Buffalo Creek Reservoir, Lake Charles, Salem-Reed Lake and Sylvan Lake. Four water quality sampling events were conducted from August to September 2009. Water quality parameters collected were total phosphorus, dissolved phosphorus, and total suspended solids. Field parameters collected were pH, conductivity, Secchi disk readings, and temperature. Pond-a-Rudy, Half-day Pit, Albert Lake, and Buffalo Creek Reservoir were also sampled for dissolved oxygen. The Stage 2 data were collected for use in the Stage 3 modeling procedures.

7.0 Total Maximum Daily Load

7.1 Fecal Coliform and Chloride

Load duration curves were selected to analyze fecal coliform and chloride impairments for streams within the Des Plaines/Higgins Creek Watershed. Load duration curves use water quality criteria, ambient concentrations, and observed flows to estimate loading capacities for streams under various flow conditions.

The following process was followed to determine load reductions using load duration curves within the selected stream segments:

- Historic stream flow data was collected from the USGS website. Flows for those stream segments without monitoring gages (IL_GOA-01 and IL_GOA-02) were calculated by means of watershed scaling (see Section 7.1.2).
- Flow duration curves were developed using the streamflow record for IL_GST, IL_GOA-01 and IL_GOA-02.
- The duration curves for these segments were separated into hydrologic categories where high flows represent a duration interval of 0-10%, moist conditions represent 10-40%, mid-range flows 40-60%, dry conditions 60-90% and low flows 90-100%.
- Load duration curves were generated by multiplying streamflow with the numerical WQS and a conversion factor to obtain the load per day for a given streamflow.
- Individual fecal coliform and chloride in-stream observations were plotted against the load duration curve to evaluate patterns of impairment. Values that fell above the load duration line indicated an exceedance of the daily maximum load.

Since load duration curves are dependent on streamflow, they are not an effective methodology for use in a lake. Sylvan Lake (IL-RGZF) is currently the only lake in the Des Plaines/Higgins Creek Watershed that is impaired for fecal coliform. A combination of Schueler's Simple Method (Schueler 1987) and a mass balance approach were used to model fecal coliform loading to Sylvan Lake.

The WQS for fecal coliform is 200 cfu/100ml geometric mean based on a minimum of five samples taken over any 30 day period. In addition a seasonal maximum of 400 cfu/100ml may not to be exceeded in more than 10% of samples taken during any 30 day period during the months of May through October. The general use WQS for chloride is 500 mg/L.

Waste load allocations were based on NPDES permit limits when the permits contained numeric effluent limits for the pollutant of concern. Daily average and daily maximum discharge flows and permit limits were used to calculate a daily load and serve as the WLA. Waste load allocations for NPDES-permitted stormwater discharges, including MS4s, urbanized areas and construction and industrial discharges that do not have numerical effluent limitations are often expressed as a percent reduction; however, for this analysis a numerical target was calculated. For example, when calculating WLAs for MS4s, the WLA for NPDES point source dischargers and the MOS and reserve capacity were summed and subtracted from the loading capacity of the waterbody. The remainder was then multiplied by the percent of area covered by MS4s. This value was then subtracted from the loading capacity and the remainder was left to LA. The WLA for individual MS4s were further calculated by calculating the areal extent of each MS4 relative to one another within the watershed.

The remaining allocations were allotted to nonpoint sources. The LA for all non-regulated sources was also expressed as a percent reduction. Percent reductions for WLAs and LAs were based on the maximum reduction required to meet WQS plus a MOS of 10 percent and a reserve capacity of 5 percent.

7.1.1 Buffalo Creek (IL_GST)

The Buffalo Creek gage data has been operating since 1953 and is located immediately downstream of the impaired segments. The drainage area upstream of the gage is 19.6 square miles.

7.1.1.1 Fecal Coliform Load Capacity

Data for fecal coliform from the years 2000 to 2009 were used to assess the loading capacity of Buffalo creek. A fecal coliform target of 200 cfu/100 ml was established. During these years, 25 samples of fecal coliform were collected in this stream segment with 21 samples above the WQS. **Tables 7-1** shows recommended load reductions for fecal coliform while the load duration curve is displayed in **Figure 7-1** as well as **Appendix F**. **Table 7-2** displays the current wasteload based on observed fecal coliform and flow data.

Table 7-1 Target Loading Reductions for Fecal Coliform in Buffalo Creek (IL_GST-01)[1]

units = cfu/day	High Flows (0-10)	% Total Load	Moist Con-ditions (10-40)	% Total Load	Mid-Range Flows (40-60)	% Total Load	Dry Con-ditions (60-90)	% Total Load	Low Flows (90-100)	% Total Load
TMDL	4.50E+11	N/A	1.22E+11	N/A	4.89E+10	N/A	1.81E+10	N/A	4.11E+09	N/A
Current Load	1.98E+12	N/A	7.93E+11	N/A	5.53E+10	N/A	1.23E+11	N/A	2.06E+10	N/A
MS4*	2.85E+11	63%	7.74E+10	63%	3.09E+10	63%	---	N/A	---	N/A
LA	9.74E+10	22%	2.65E+10	22%	1.06E+10	22%	1.52E+10	84%	3.35E+09	82%
WLA**	3.56E+08	0.1%	1.44E+08	0.1%	1.44E+08	0.3%	1.44E+08	1%	1.44E+08	3%
Reserve Capacity	2.25E+10	5%	6.12E+09	5%	2.45E+09	5%	9.05E+08	5%	2.06E+08	5%
MOS	4.50E+10	10%	1.22E+10	10%	4.89E+09	10%	1.81E+09	10%	4.11E+08	10%
% Reduction	**77%**	**N/A**	**85%**	**N/A**	**12%**	**N/A**	**85%**	**N/A**	**80%**	**N/A**

1 Median values were used to determine the loading capacity for each flow regime. The geometric mean of observed data was used to calculate the current load to the stream.

* MS4 – WLA for Separate Sanitary Sewer System - Stormwater NPDES Permits

** WLA – WLA for Waste Water Treatment Plant - NPDES Permits

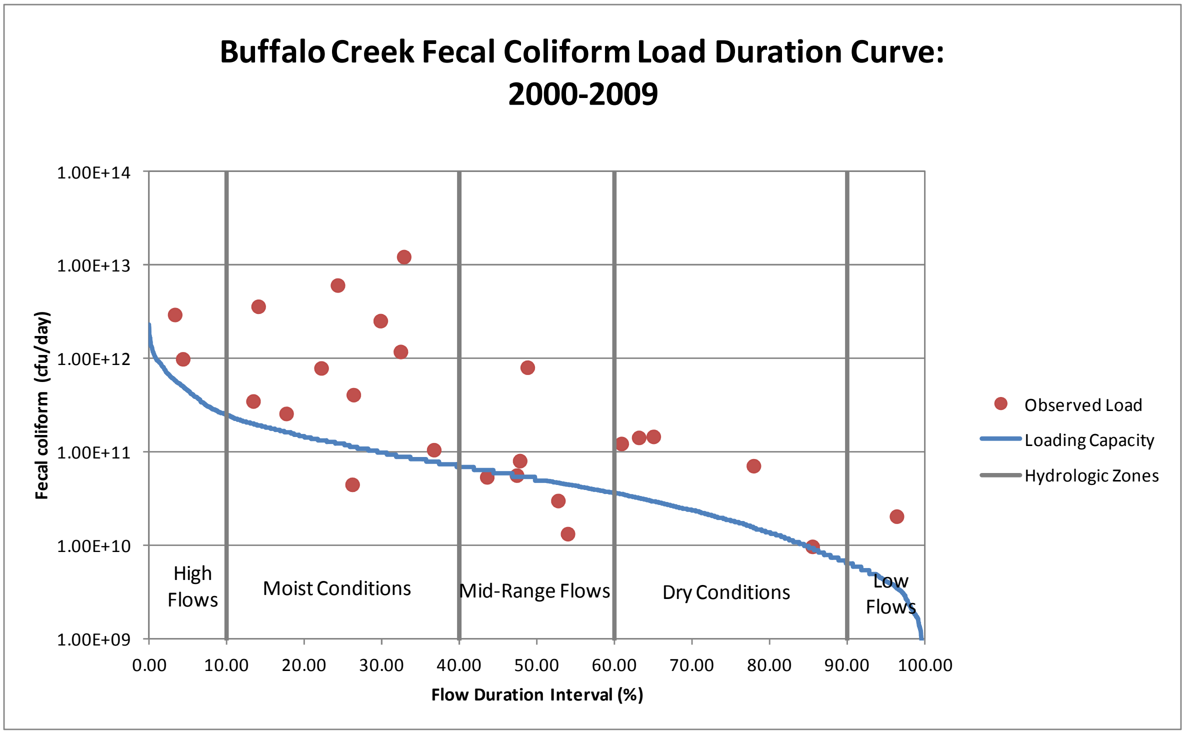
Table 7-2 Target Loading Reductions for Fecal Coliform in Buffalo Creek (IL_GST-01) Based on DMR data[1]

units = cfu/day	High Flows (0-10)	% Total Load	Moist Con-ditions (10-40)	% Total Load	Mid-Range Flows (40-60)	% Total Load	Dry Con-ditions (60-90)	% Total Load	Low Flows (90-100)	% Total Load
TMDL	4.50E+11	N/A	1.22E+11	N/A	4.89E+10	N/A	1.81E+10	N/A	4.11E+09	N/A
Current Load	1.98E+12	N/A	7.93E+11	N/A	5.53E+10	N/A	1.23E+11	N/A	2.06E+10	N/A
MS4	2.85E+11	63%	7.75E+10	63%	3.10E+10	63%	---	N/A	---	N/A
LA	9.75E+10	22%	2.65E+10	22%	1.06E+10	22%	1.54E+10	85%	3.48E+09	85%
Current Wasteload	1.61E+08	0.04%	1.51E+07	0.01%	1.51E+07	0.03%	1.51E+07	0.1%	1.51E+07	0.4%
Reserve Capacity	2.25E+10	5%	6.12E+09	5%	2.45E+09	5%	9.05E+08	5%	2.06E+08	5%
MOS	4.50E+10	10%	1.22E+10	10%	4.89E+09	10%	1.81E+09	10%	4.11E+08	10%
% Reduction	**77%**	**N/A**	**85%**	**N/A**	**12%**	**N/A**	**85%**	**N/A**	**80%**	**N/A**

[1] Median fecal values and average and maximum observed flows were used to calculate the WLA.

Reductions in fecal coliform loads are required for all flow regimes as the observed load in the stream was higher than the loading capacity. The greatest recommended fecal coliform reduction was 85% for Buffalo Creek and corresponds to dry flow conditions. The majority of loading (63%) is from MS4s in the watershed and the next major source is nonpoint source pollution (22%). The WLA is based on the design average flow (DAF) for moist to dry conditions and the design maximum flow (DMF) for high flow conditions. A handful of NPDES violations for fecal coliform were observed for Alden Long Grove Rehabilitation Center, but the median fecal coliform value from 2000 through 2008 was 10 cfu/100 ml. Average flow for the facility was 0.04 MGD while the maximum observed flow was 0.425 MGD. During high and low flow regimes, permitted dischargers, not including MS4s, account for approximately 0.1% and 3% of the TMDL, respectively. To account for future growth, a 5 % reserve capacity was included. This reserve capacity is for any treatment plant that adds unsewered areas to their sewer coverage and can be used to increase the bacteria waste load allocation for the facility.

Figure 7-1 Buffalo Creek Fecal Coliform vs. Flow



7.1.1.2 Fecal Coliform Waste Load Allocation

Point source dischargers within the Buffalo Creek watershed include the Alden Long Grove Rehab (IL0051934) and Camp

STP (IL0048542). Waste load allocations are based on the standard of 200 cfu/100 ml and DAF for moist the dry loads and DMF for high flow conditions. MS4s within the watershed include Long Grove, Lake Zurich, Buffalo Grove, Kildeer, Deer Park, Barrington, Palatine, Inverness, and Arlington Heights. Because MS4s are primarily stormwater driven discharges, the allocation to each MS4 was based on the respective size of each MS4 and the percent of area taken up by each within the watershed. **Table 7-3** shows the WLAs for fecal coliform for the Buffalo Creek watershed.

Table 7-3 Fecal Coliform Waste Load Allocation for Buffalo Creek (IL_GST-01)

Point Source Dischargers	WLA @ High Flows (MM/day)	WLA @ Moist Conditions (MM/day)	WLA @ Mid-Range Flows (MM/day)	WLA @ Dry Conditions (MM/day)	WLA @ Low Flows (MM/day)
Alden Long Grove Rehab	281	114	114	114	114
Camp Reinberg STP	75	30	30	30	30
Long Grove MS4	46,658	12,656	5,059	---	---
Lake Zurich MS4	25,834	7,007	2,801	---	---
Buffalo Grove MS4	34,551	9,372	3,746	---	---
Kildeer MS4	13,813	3,747	1,498	---	---
Deer Park MS4	13,551	3,675	1,469	---	---
Barrington MS4	17,910	4,858	1,941	---	---
Palatine MS4	48,280	13,096	5,235	---	---
Inverness MS4	25,321	6,868	2,745	---	---
Arlington Heights MS4	60,637	16,447	6,574	---	---

7.1.1.3 Chloride Load Capacity

Data for chloride from the years 2000 to 2009 were used to assess the loading capacity of Buffalo creek. A chloride target of 500 mg/L was established. During these years, chloride samples collected during this time period totaled 54 samples with 5 samples exceeding the WQS. **Table 7-4** shows recommended load reductions for chloride while the load duration curve is displayed in **Figure 7-2** as well as **Appendix F**.

Table 7-4 Target Loading Reductions for Chloride in Buffalo Creek (IL_GST-01)

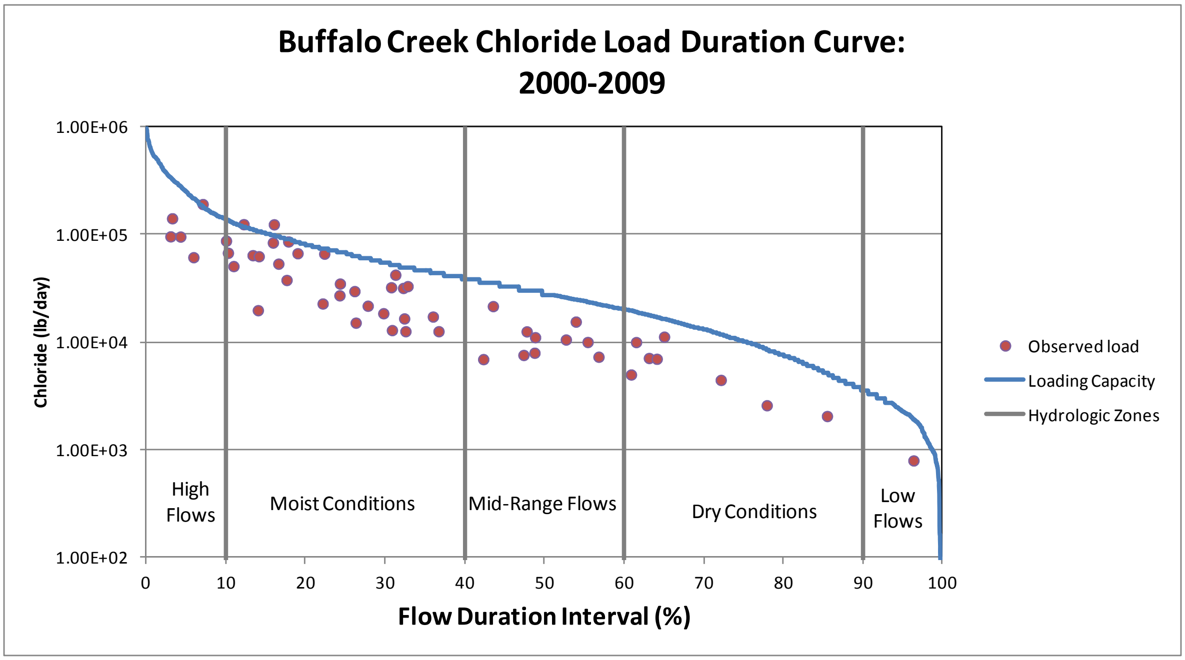
units = lbs/day	High Flows (0-10)	% Total Load	Moist Con-ditions (10-40)	% Total Load	Mid-Range Flows (40-60)	% Total Load	Dry Con-ditions (60-90)	% Total Load	Low Flows (90-100)	% Total Load
TMDL	247,936	N/A	67,374	N/A	26,950	N/A	9,971	N/A	2,264	N/A
Current Load	190,807	N/A	124,227	N/A	21,546	N/A	11,215	N/A	796	N/A
MS4	166,286	67%	45,186	67%	18,075	67%	---	N/A	---	N/A
LA	56,857	23%	15,450	23%	6,180	23%	8,974	90%	2,037	90%
WLA	---	N/A	---	N/A	---	N/A	---	N/A	---	N/A
MOS	24,794	10%	6,737	10%	2,695	10%	997	10%	226	10%
% Reduction	**---**	**N/A**	**46%**	**N/A**	**---**	**N/A**	**11%**	**N/A**	**---**	**N/A**

[1] Median values were used to determine the loading capacity for each flow regime. The maximum observation was used to calculate the current load to the stream.

Since observed load is lower than capacity during high, mid-range, and low flows reductions in chloride loading are required for only moist and dry conditions. The greatest recommended chloride reduction was 46% for Buffalo Creek and corresponds to moist flow conditions.

To further determine the nature of the chloride impairment, a seasonal analysis was conducted using data from October through March. The majority of chloride exceedances occurred during this time period which suggests that the impairment may attributable to de-icing activities that occur during this period.

Figure 7-2 Buffalo Creek Chloride vs. Flow



7.1.1.4 Chloride Waste Load Allocation

Point source dischargers within the Buffalo Creek watershed include the Alden Long Grove Rehab (IL0051934) and Camp Reinberg STP (IL0048542). These dischargers do not monitor chloride in their effluent, and as such, were not provided with a chloride allocation. Further, the seasonal analysis indicates that chloride exceedance likely originates from de-icing activities. Therefore, all of the WLA was given to MS4s. MS4s within the watershed include Long Grove, Lake Zurich, Buffalo Grove, Kildeer, Deer Park, Barrington, Palatine, Inverness, and Arlington Heights. Because MS4s are primarily stormwater driven discharges, the allocation to each MS4 was based on the respective size of each MS4 and the percent of area taken up by each within the watershed. **Table 7-5** shows the WLAs for chloride for the Buffalo Creek watershed.

Table 7-5 Chloride Waste Load Allocation for Buffalo Creek (IL_GST-01)

Point Source Dischargers	WLA @ High Flows (MM/day)	WLA @ Moist Conditions (MM/day)	WLA @ Mid-Range Flows (MM/day)	WLA @ Dry Conditions (MM/day)	WLA @ Low Flows (MM/day)
Long Grove MS4	27,075	7,357	2,943	---	---
Lake Zurich MS4	14,991	4,074	1,629	---	---
Buffalo Grove MS4	20,050	5,448	2,179	---	---
Kildeer MS4	8,015	2,178	871	---	---
Deer Park MS4	7,864	2,137	855	---	---
Barrington MS4	10,393	2,824	1,130	---	---
Palatine MS4	28,017	7,613	3,045	---	---
Inverness MS4	14,693	3,993	1,597	---	---
Arlington Heights MS4	35,187	9,562	3,825	---	---

7.1.2 Higgins Creek (IL_GOA-01)

Due to an absence of flow data, the daily flow record from stream gage 05529500 located on McDonald Creek was used as a reference stream to Higgins Creek. Watershed scaling was conducted using the following equation:

$$Q2_{unknown} = (Q1 \times Area\ 2)/Area\ 1,$$

where

$Q2_{unknown}$ = Higgins Creek flow
Q1 = McDonald Creek flow
Area 1 = McDonald Creek watershed area
Area 2= Higgins Creek Watershed area

Further, the WWTPs within the watershed contribute significant flow to Higgins Creek but were not accounted for in the watershed scaling analysis. Therefore, monthly average flows from the WWTPs based on DMR data were summed and added to the derived daily flow record. This record indicates that during all but high flows, the discharge from WWTPs makes up more than 90% of the flow in Higgins Creek. In dry and low flow conditions, the flow from WWTPs makes up more than 99% of the estimated flow.

7.1.2.1 Fecal Coliform Load Capacity

Data from 2000 to 2009 for fecal coliform were used to assess the loading capacity of Higgins Creek (IL_GOA-01). A fecal coliform target of 200 cfu/100 ml was established. During this time period, 35 samples from this stream segment were analyzed for fecal coliform with 10 samples above the WQS.

No explicit margin of safety was included for the fecal coliform TMDL; instead an implicit margin of safety was used. The implicit margin of safety is based on the conservative approach to developing the TMDL. The approach used does not account for losses of bacteria due to die off and settling. These processes are known to lead to significant losses of indicator bacteria. IEPA believes that an explicit MOS is not necessary for this segment because the WLA is based on observed average DMR record or design maximum flow of the point source discharges which account for more than 90% of river flow. These facilities are required to monitor the concentration of fecal coliform to ensure that the concentration does not exceed their permitted limits. This substantially reduces the uncertainty associated with fecal coliform loading to this segment.

Table 7-6 summarizes the recommended load reductions for fecal coliform. **Table 7-7** summarizes load reductions based on fecal coliform DMR data for comparison with **Table 7-6**. **Table 7-8** contains the WLAs for fecal coliform for the Higgins Creek Watershed. Load duration curves are displayed in **Figure 7-3** as well as **Appendix F.**

Table 7-6 Target Loading Reductions for Fecal Coliform in Higgins Creek (IL_GOA-01) [1]

units = cfu/day	High Flows (0-10)	% Total Load	Moist Con-ditions (10-40)	% Total Load	Mid-Range Flows (40-60)	% Total Load	Dry Con-ditions (60-90)	% Total Load	Low Flows (90-100)	% Total Load
TMDL	9.60E+11	N/A	6.35E+11	N/A	6.19E+11	N/A	6.12E+11	N/A	6.08E+11	N/A
Current Load	9.49E+11	N/A	3.89E+11	N/A	1.24E+12	N/A	1.09E+11	N/A	3.05E+11	N/A
MS4	9.09E+10	9%	2.10E+10	3%	8.93E+09	1%	---	N/A	---	N/A
LA	3.50E+10	4%	8.10E+09	1%	3.44E+09	1%	5.67E+09	1%	2.06E+09	1%
WLA	8.34E+11	87%	6.06E+11	96%	6.06E+11	98%	6.06E+11	99%	6.06E+11	99%
% Reduction	**0%**	**NA**	**0%**	**NA**	**50%**	**NA**	**0%**	**NA**	**0%**	**NA**

[1] Median flow values were used to determine the loading capacity for each flow regime. The geometric mean of observed data was used to calculate the current load to the stream.

Table 7-7 Target Loading Reductions for Fecal Coliform in Higgins Creek (IL_GOA-01) Based on DMR data[1]

units = cfu/day	High Flows (0-10)	% Total Load	Moist Con-ditions (10-40)	% Total Load	Mid-Range Flows (40-60)	% Total Load	Dry Con-ditions (60-90)	% Total Load	Low Flows (90-100)	% Total Load
TMDL	9.60E+11	N/A	6.35E+11	N/A	6.19E+11	N/A	6.12E+11	N/A	6.08E+11	N/A
Current Load	9.49E+11	N/A	3.89E+11	N/A	1.24E+12	N/A	1.09E+11	N/A	3.05E+11	N/A
MS4	5.04E+11	52%	3.21E+11	51%	3.09E+11	50%	---	N/A	---	N/A
LA	1.94E+11	20%	1.24E+11	19%	1.19E+11	19%	4.21E+11	69%	4.17E+11	69%
Current Wasteload	2.63E+11	28%	1.91E+11	30%	1.91E+11	31%	1.91E+11	31%	1.91E+11	31%
% Reduction	**0%**	**NA**	**0%**	**NA**	**50%**	**NA**	**0%**	**NA**	**0%**	**NA**

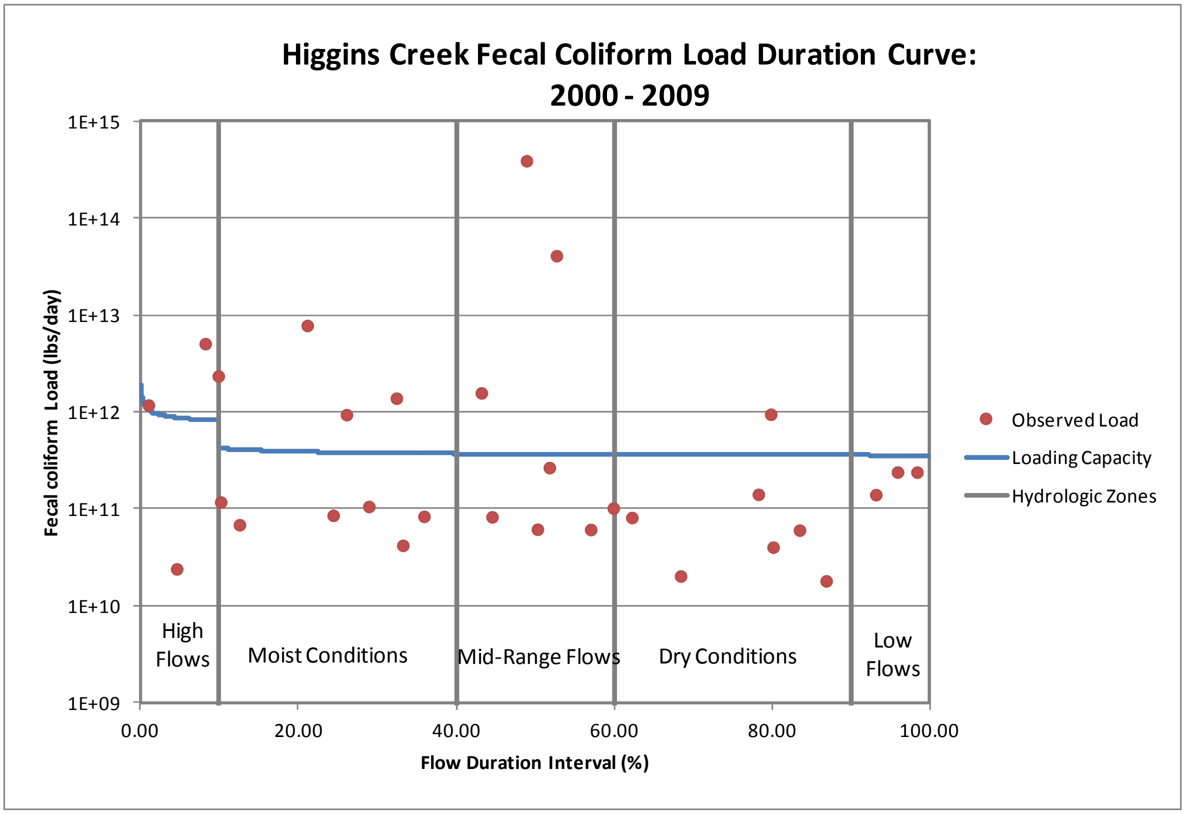
[1] Median fecal values and average and maximum observed flows were used to calculate the WLA.

A reduction in fecal loading is only required for the mid-range flow regime based on the observed data. The loading capacity of the stream segment was higher than the observed in-stream load for the other flow regimes. It should be noted that the current load may be changed if additional observed data points are available.

No reserve capacity was calculated for Higgins Creek because the watershed is primarily developed urban land. However, the capacity of the WWTPs that discharge to this segment could be increased if their discharge standards are protective of water quality standards without creating a risk to water quality standards. This increase in flow would effectively increase the stream flow and the resulting applicable TMDL.

The upstream segment of Higgins Creek (GOA-02) is impaired for fecal coliform and allocation information is available in Section 7.1.3. The load duration curve for fecal coliform in Higgins Creek (IL_GOA-1) is shown below in **Figure 7-3** and can be found in **Appendix F**.

Figure 7-3 Higgins Creek Fecal Coliform vs. Flow



7.1.2.2 Fecal Coliform Waste load Allocation

Point source dischargers within the Higgins Creek Watershed include the BP – O'Hare Terminal (IL0034347), the Des Plaines Mobile Home Park (IL0054160), and the MWRDGC Kirie WWTP (IL0047741). BP O'Hare Terminal does not contain any sanitary discharge and therefore will not have allocations. MS4s within the watershed include Arlington Heights, Rolling Meadows, Mount Prospect, Des Plaines, Elk Grove, and Chicago. Because MS4s are primarily stormwater driven discharges, the allocation to each MS4 was based on the respective size of each MS4 and the percent of area taken up by each within the watershed. However, no allocation remains for MS4s under dry to low flow conditions.

As previously stated, the in-stream flow of Higgins Creek is predominantly comprised of WWTP effluent from Kirie Water Reclamation Plant (IL0047741) and Des Plaines Mobile Home Park (IL0054160). As a result, the vast majority of the loading comes from these point sources and in particular from Kirie WRP due to its high flows. Based on DMR data from 2004 to 2009, the monthly maximum concentrations have exceeded 200 cfu/100ml four times at Kirie WRP and 18 times at Des Plaines MHP. The median fecal coliform value from Kirie WRP from 2004 to 2009 was 63 cfu/100 ml while the average observed flow was 80 MGD with a maximum observed flow of 147 MGD. The point sources are required to meet the discharge limit specified in their NPDES permit. Kirie WRP and Des Plaines MHP will be monitored for any further violations through the IEPA NPDES compliance and enforcement process. On the other hand, stormwater from MS4s and non-permitted stormwater flows are other sources contributing to the impairment in the Higgins Creek. Therefore, the WLAs for the WWTPs were calculated by using the existing permitted concentrations and the average historical flows for moist to dry flow regimes and design maximum flow for the high flow regime. The remaining WLA was allocated to the MS4s and LA based on the proportion of area within the watershed they represent. Even during high flow conditions, little load remains for diffuse source allocations. However, under drier flow regimes, Higgins Creek is less likely to receive strong influence from stormwater sources. **Table 7-8** shows the WLA for fecal coliform.

Table 7-8 Fecal Coliform Waste load Allocation for Higgins Creek (IL_GOA-01)

Point Source Dischargers	WLA @ High Flows (MM/day)	WLA @ Moist Conditions (MM/day)	WLA @ Mid-Range Flows (MM/day)	WLA @ Dry Conditions (MM/day)	WLA @ Low Flows (MM/day)
Des Plaines MHP	1,340	522	522	522	522
MWRDGC Kirie WRP	832,841	605,702	605,702	605,702	605,702
Arlington Hts MS4	8,172	1,890	803	---	---
Rolling Meadows MS4	174	40	17	---	---
Mt Prospect MS4	9,143	2,115	898	---	---
Des Plaines MS4	15,160	3,507	1,489	---	---
Elk Grove MS4	32,567	7,534	3,199	---	---
Chicago MS4	442	102	43	---	---

7.1.2.3 Chloride Load Capacity

Data from 2000 to 2009 for chloride were used to assess the loading capacity of Higgins Creek (IL_GOA-01). A chloride target of 500 mg/L was established. There were 40 chloride samples collected during this period with 13 samples exceeding the WQS. **Table 7-9** summarizes the recommended load reductions for chloride.

Table 7-9 Target Loading Reductions for Chloride in Higgins Creek (IL_GOA-01)[1]

units = lbs/day	High Flows (0-10)	% Total Load	Moist Conditions (10-40)	% Total Load	Mid-Range Flows (40-60)	% Total Load	Dry Conditions (60-90)	% Total Load	Low Flows (90-100)	% Total Load
TMDL	926,631	N/A	256,050	N/A	226,323	N/A	221,945	N/A	218,350	N/A
Current Load	441,567	N/A	591,224	N/A	338,885	N/A	254,302	N/A	409,771	N/A
MS4	575,438	62%	159,007	62%	140,547	62%	---	N/A	---	N/A
LA	258,530	28%	71,438	28%	63,144	28%	199,750	90%	196,515	90%
WLA	---	N/A	---	N/A	---	N/A	---	N/A	---	N/A
MOS	92,663	10%	25,605	10%	22,632	10%	22,194	10%	21,835	10%
% Reduction	**---**	**NA**	**57%**	**NA**	**33%**	**NA**	**13%**	**NA**	**47%**	**NA**

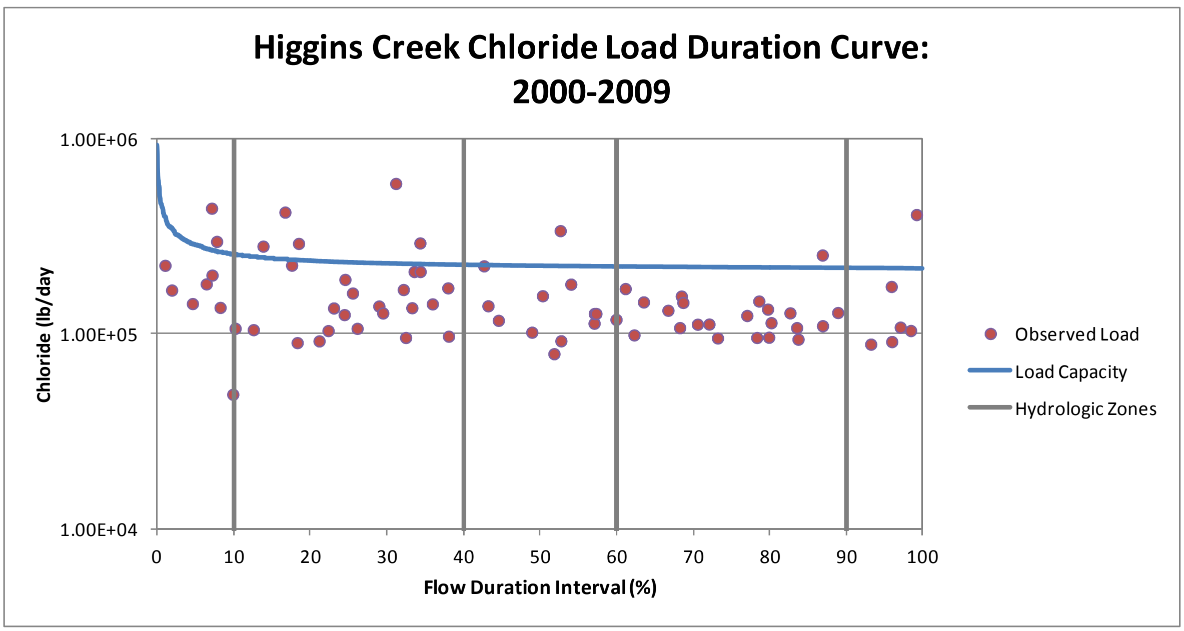
[1] Median values were used to determine the loading capacity for each flow regime. The maximum observation was used to calculate the current load to the stream.

Reductions in chloride loading are required for all flow regimes except high flows. The greatest recommended fecal chloride reduction was 57% for Higgins Creek (IL_GOA-01) and corresponds to moist flow conditions.

Exceedances under dry conditions or low flows typically suggest that point source dischargers are responsible for the exceedance. However, because chloride is commonly found in de-icing material, a seasonal analysis was conducted from October through March. This period also coincides with lower precipitation.

A review of existing data indicates that all chloride exceedances occurred during the period October through March which coincides with the timing of increased de-icing activities. A load duration curve for chloride in Higgins Creek (IL_GOA-1) is below in **Figure 7-4** and can be found in **Appendix F**.

Figure 7-4 Higgins Creek Chloride vs. Flow



7.1.2.4 Chloride Waste load Allocation

Point source dischargers within the Higgins Creek Watershed include the BP – O'Hare Terminal (IL0034347), the Des Plaines Mobile Home Park (IL0054160), and the MWRDGC Kirie WWTP (IL0047741). BP O'Hare Terminal intermittently discharges hydrostatic test water. Chloride is not a typical pollutant present in this type of discharge, so no allocations will be given. The mobile home park is a minor facility discharging less than 0.1 MGD and will not be given a WLA based on the insignificant amount of chloride expected in the discharge. Since Kirie WWTP is a major facility (52 MGD) and is not required to monitor chloride, at the time of their next permit renewal, chloride monitoring will be required.

MS4s within the watershed include Arlington Heights, Rolling Meadows, Mount Prospect, Des Plaines, Elk Grove, and Chicago. Because MS4s are primarily stormwater driven discharges, the allocation to each MS4 was based on the respective size of each MS4 and the percent of area taken up by each within the watershed.

The NPDES dischargers do not monitor chloride in their effluent, and as such, were not provided with an allocation. Further, the seasonal analysis indicates that chloride exceedance likely originates from de-icing activities. **Table 7-10** shows the WLA for chloride.

Table 7-10 Chloride Waste load Allocation for Higgins Creek (IL_GOA-01)

Point Source Dischargers	WLA @ High Flows (lbs/day)	WLA @ Moist Conditions (lbs/day)	WLA @ Mid-Range Flows (lbs/day)	WLA @ Dry Conditions (lbs/day)	WLA @ Low Flows (lbs/day)
Arlington Hts MS4	71,402	19,731	17,440	---	---
Rolling Meadows MS4	1,502	420	372	---	---
Mt Prospect MS4	79,894	22,077	19,513	---	---
Des Plaines MS4	132,461	36,602	32,353	---	---
Elk Grove MS4	284,461	78,633	69,504	---	---
Chicago MS4	3,866	1,069	944	---	---
Illinois Tollway MS4	1,727	477	421	---	

7.1.3 Higgins Creek (IL_GOA-02)

Similar to segment IL_GOA-01, daily flow data from stream gage 05529500 located on McDonald Creek were used to estimate flow in Higgins Creek. Also, some WWTPs within the watershed contribute significant flow to Higgins Creek but were not accounted for in the watershed scaling analysis. Therefore, daily average flows from the WWTPs were summed and added to the daily flow record.

7.1.3.1 Fecal Coliform Load Capacity

Data from 2000 to 2009 for fecal coliform were used to assess the loading capacity of Higgins Creek. During this time, 17 samples of fecal coliform were collected in this stream segment with 15 samples above the WQS. **Table 7-11** contains recommended load reductions for fecal coliform. A load duration curve is displayed in **Figure 7-5** as well as **Appendix F**.

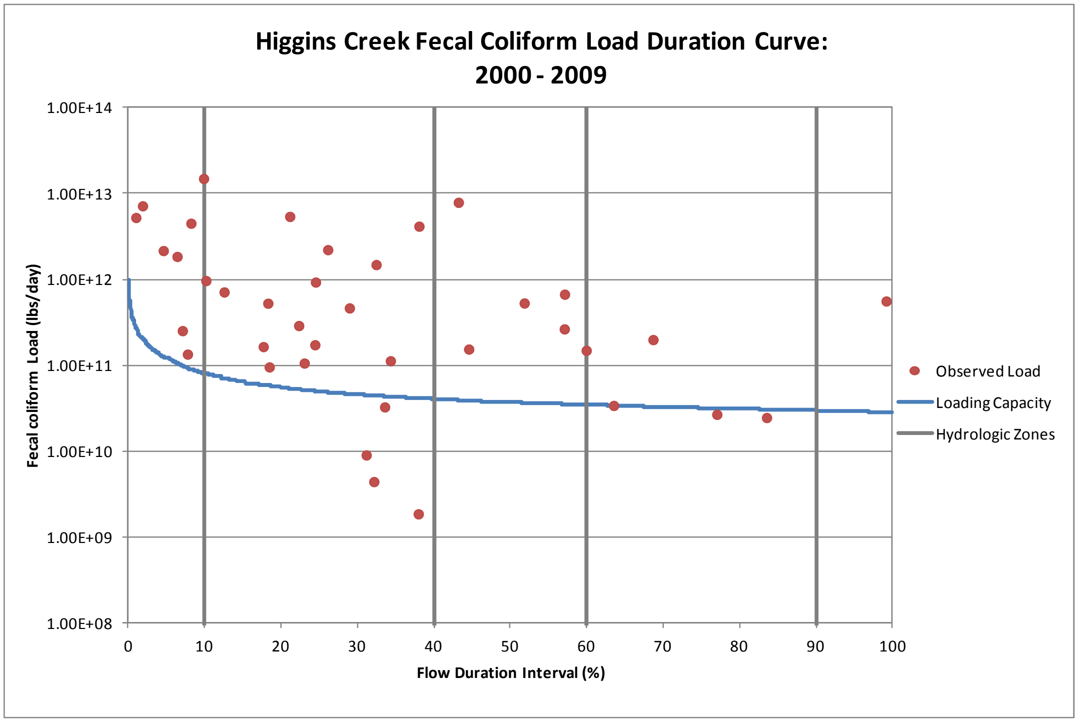
Table 7-11 Target Loading Reductions for Fecal Coliform in Higgins Creek (IL_GOA-02)[1]

units = cfu/day	High Flows (0-10)	% Total Load	Moist Con-ditions (10-40)	% Total Load	Mid-Range Flows (40-60)	% Total Load	Dry Con-ditions (60-90)	% Total Load	Low Flows (90-100)	% Total Load
TMDL	1.21E+11	N/A	4.92E+10	N/A	3.68E+10	N/A	3.19E+10	N/A	2.92E+10	N/A
Current Load	1.90E+12	N/A	2.00E+11	N/A	1.19E+12	N/A	4.60E+10	N/A	5.59E+10	N/A
MS4	7.41E+10	61%	3.02E+10	61%	2.26E+10	61%	---	N/A	---	N/A
LA	2.85E+10	24%	1.16E+10	24%	8.70E+09	24%	2.71E+10	85%	2.48E+10	85%
WLA	---	N/A	---	N/A	---	N/A	---	N/A	---	N/A
Reserve Capacity	6.03E+09	5%	2.46E+09	5%	1.84E+09	5%	1.59E+09	5%	1.46E+09	5%
MOS	1.21E+10	10%	4.92E+09	10%	3.68E+09	10%	3.19E+09	10%	2.92E+09	10%
% Reduction	**94%**	**NA**	**75%**	**NA**	**97%**	**NA**	**31%**	**NA**	**95%**	**NA**

[1] Median values were used to determine the loading capacity for each flow regime. The geometric mean of observed data was used to calculate the current load to the stream.

Reductions in fecal loading are required for all flow regimes. Because existing NPDES dischargers within this segment are oil terminals, discharges do not contain domestic waste, and as such, no fecal coliform WLA was provided to them. The greatest recommended fecal coliform reduction was 97% for Higgins Creek (IL_GOA-02) and corresponds to mid-range flow conditions. The majority of reductions need to be made for MS4s (61%) and load allocations (nonpoint sources) (24%) at higher flows and load allocation (nonpoint sources) (85%) at lower flows. To account for future growth, a 5 percent reserve capacity was included. This reserve capacity is for any treatment plant that adds unsewered areas to their sewer coverage and can be used to increase the bacteria waste load allocation for the facility.

Figure 7-5 Higgins Creek Fecal Coliform vs. Flow



7.1.3.2 Fecal Coliform Waste load Allocation

Point source dischargers within the Higgins Creek Watershed include CITGO Petroleum Corporation (IL0025461), Shell Oil (IL0046736), Exxon Mobil Corp (IL0066362), Marathon Petroleum Mt. Prospect (IL0062791) and Unoven (IL0042242). None of these point sources have sanitary wastes in their discharge and therefore will not have allocations. MS4s within the watershed include Arlington Heights, Rolling Meadows, Mount Prospect, Des Plaines, and Elk Grove. Because MS4s are primarily stormwater driven discharges, the allocation to each MS4 was based on the respective size of each MS4 and the percent of area taken up by each within the watershed.

Waste load allocations were only provided under high flow, moist, and mid-flow conditions. **Table 7-12** shows the WLA for fecal coliform.

Table 7-12 Fecal Coliform Waste load Allocation for Higgins Creek (IL_GOA-02)

Point Source Dischargers	WLA @ High Flows (MM/day)	WLA @ Moist Conditions (MM/day)	WLA @ Mid-Range Flows (MM/day)	WLA @Dry Conditions (MM/day)	WLA @ Low Flows (MM/day)
Arlington Hts MS4	12,530	5,107	3,822	---	---
Rolling Meadows MS4	272	111	83	---	---
Mt Prospect MS4	13,989	5,702	4,267	---	---
Des Plaines MS4	1,835	748	560	---	---
Elk Grove MS4	45,540	18,564	13,892	---	---

7.1.3.3 Chloride Load Capacity

Data from 2000 to 2009 for chloride were used to assess the loading capacity of Higgins Creek. Chloride samples collected during this time totaled 68 samples with 19 samples exceeding the WQS. **Table 7-13** contains recommended load reductions for chloride. A load duration curve is displayed in **Figure 7-6** as well as **Appendix F**.

Table 7-13 Target Loading Reductions for Chloride in Higgins Creek (IL_GOA-02)[1]

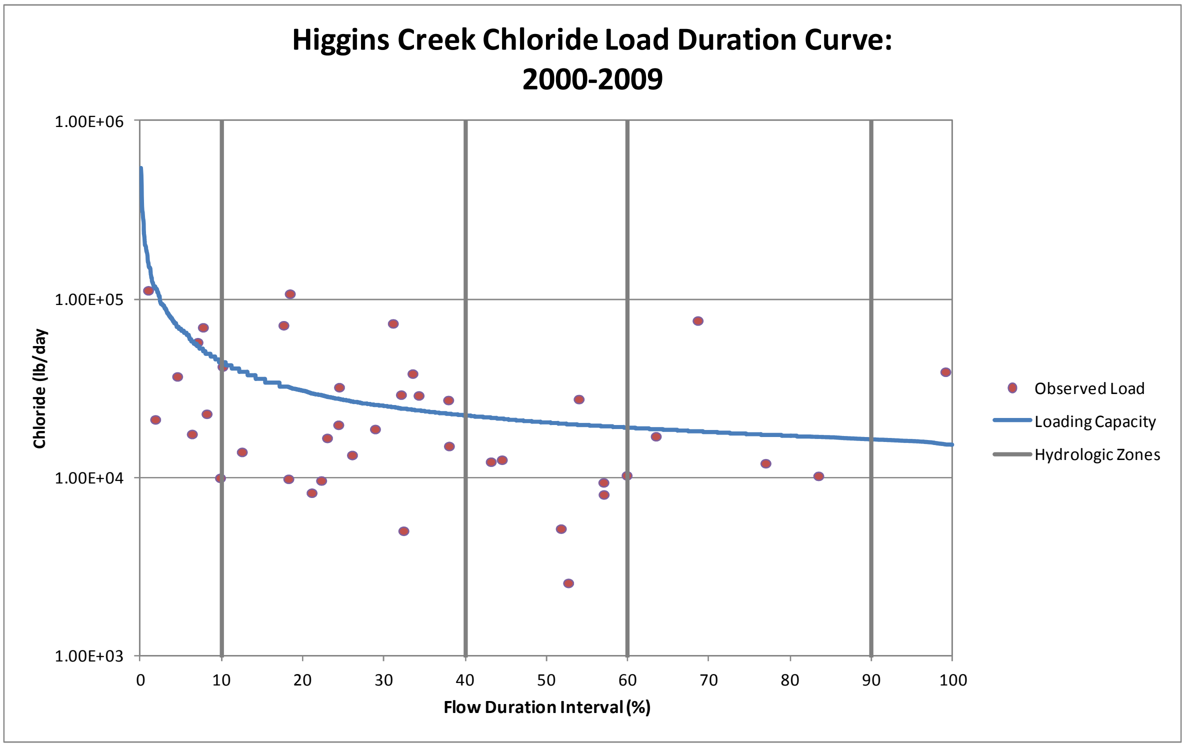
units = lbs/day	High Flows (0-10)	% Total Load	Moist Conditions (10-40)	% Total Load	Mid-Range Flows (40-60)	% Total Load	Dry Conditions (60-90)	% Total Load	Low Flows (90-100)	% Total Load
TMDL	66,358	N/A	27,220	N/A	20,413	N/A	17,520	N/A	16,048	N/A
Current Load	112,793	N/A	107,977	N/A	27,665	N/A	76,327	N/A	39,380	N/A
MS4	41,208	62%	16,903	62%	12,676	62%	---	N/A	---	N/A
LA	18,514	28%	7,594	28%	5,695	28%	15,768	90%	14,443	90%
WLA	---	N/A	---	N/A	---	N/A	---	N/A	---	N/A
MOS	6,636	10%	2,722	10%	2,041	10%	1,752	10%	1,605	10%
% Reduction	**41%**	**NA**	**75%**	**NA**	**26%**	**NA**	**77%**	**NA**	**59%**	**NA**

[1] Median values were used to determine the loading capacity for each flow regime. The maximum observation was used to calculate the current load to the stream.

Reductions in chloride loading are required for all flow regimes. The greatest recommended chloride reduction was 77% for Higgins Creek (IL_GOA-02) and corresponds to dry flow conditions.

Because chloride is commonly found in de-icing material, a seasonal analysis was conducted from October through March. This period also coincides with lower precipitation. A review of existing data indicates that chloride exceedances occurred during the period from October through March and should be attributed to de-icing activities.

Figure 7-6 Higgins Creek Chloride vs. Flow



7.1.3.4 Chloride Waste load Allocation

Point source dischargers within the Higgins Creek Watershed include CITGO Petroleum Corporation (IL0025461), Shell Oil (IL0046736), Exxon Mobil Corp (IL0066362), Marathon Petroleum Mt. Prospect (IL0062791) and Unoven (IL0042242). Since NPDES dischargers are not required to monitor for chloride in their effluent, they were not provided with an allocation. Further, the seasonal analysis indicates that chloride exceedances likely originate from de-icing activities. MS4s within the watershed include Arlington Heights, Rolling Meadows, Mount Prospect, Des Plaines, and Elk Grove. Because MS4s are primarily stormwater driven discharges, the allocation to each MS4 was based on the respective size of each MS4 and the percent of area taken up by each within the watershed. **Table 7-14** shows the WLAs for chloride.

Table 7-14 Chloride Waste load Allocation for Higgins Creek (IL_GOA-02)

Point Source Dischargers	WLA @ High Flows (lbs/day)	WLA @ Moist Conditions (lbs/day)	WLA @ Mid-Range Flows (lbs/day)	WLA @ Dry Conditions (lbs/day)	WLA @ Low Flows (lbs/day)
Arlington Hts MS4	6,950	2,850	2,138	---	---
Rolling Meadows MS4	150	61.8	45.8	---	---
Mt Prospect MS4	7,760	3,182	2,387	---	---
Des Plaines MS4	1,018	418	313	---	---
Elk Grove MS4	25,207	10,340	7,755	---	---

Point Source Dischargers	WLA @ High Flows (lbs/day)	WLA @ Moist Conditions (lbs/day)	WLA @ Mid-Range Flows (lbs/day)	WLA @ Dry Conditions (lbs/day)	WLA @ Low Flows (lbs/day)
Illinois Tollway MS4	124	51	38	---	---

7.1.4 Sylvan Lake (IL_RGZF)

7.1.4.1 Load Capacity

The fecal coliform target for Sylvan Lake is 200 cfu/100 ml. Sylvan Lake is also listed as impaired due to excessive total phosphorus concentrations (see Section 7.3.15). The WQS for fecal coliform is a 200 cfu/100ml geometric mean based on a minimum of five samples taken over any 30 day period or a 400 cfu/100ml maximum not to be exceeded in more than 10 percent of samples taken during any 30 day period. Since this standard only applies during the months of May through October, only data from this time period were used for analysis.

A combination of mass balance and the simple method (Schueler, 1987) was used to develop the fecal coliform TMDL for Sylvan Lake. The mass balance was used to determine the loading capacity of the lake, and then the maximum observed fecal coliform value (1,000 cfu/100 ml) was used to calculate observed loads within the lake. The simple method was then used to determine the loading from each land use within the watershed relative to one another based on a back-calculation from the mass balance as well as the following equation:

$$L = CF \times P \times Pj \times Rv \times C \times A$$

where

L = Pollutant load (fecal coliform counts per time interval)
CF = Conversion factor (1,028,270 ml/in-acre)
P = Precipitation depth (inches)
Pj = Fraction of rainfall that produces runoff (assumed to be 0.9 [Schueler, 1987])
Rv = Runoff coefficient, which is calculated using: Rv = 0.05 + 0.9(% Imperviousness)
C = Pollutant concentration in (FC/100 ml) which was expressed using the geometric mean of all observed data
A = Area of the watershed (acres)

To meet the fecal coliform target in Sylvan Lake, an 80 percent reduction in fecal coliform load is required. **Table 7-15** shows the observed and target fecal coliform load as well as the required percent reduction for Sylvan Lake. Detailed summaries regarding the fecal coliform impairment in Sylvan Lake can be found in **Appendix F**.

Table 7-15 Annual Average Loading Capacity for Sylvan Lake

Existing Conditions (10^6 org/day)	Target Load (10^6 org/day)	Percent Reduction
2,960,887	592,177	80%

7.1.4.2 Waste load Allocation

The only point source dischargers within the Sylvan Lake watershed are the Hawthorn Woods and Long Grove MS4s. MS4s are primarily stormwater driven discharges; therefore, allocations to each

MS4 was based on the respective size of each MS4 and the percent of area taken up by each within the watershed. **Table 7-16** shows the WLAs for each MS4.

Table 7-16 Waste load Allocation for Sylvan Lake

Point Source Dischargers	Fecal Coliform Load (MM org/day)
Hawthorn Woods MS4	187,415
Long Grove MS4	378
Load Allocation	433,993
Reserve Capacity	29,609
MOS	59,218

7.1.5 Load Allocation

The remaining unallocated pollutant load was incorporated into the load allocation. The load from septic failure is implicitly incorporated in LA because of the lack of data. Ten percent of the loading capacity was reserved for a margin of safety and a five percent reserve capacity was also reserved for future growth for fecal coliform, as chloride is not typically regulated through the NPDES program. The load allocation is calculated as the loading capacity minus the waste load allocation minus the margin of safety and reserve capacity.

Required reductions for fecal coliform and chloride that originate from nonpoint sources during periods of mid to high flows are discussed in greater detail in the Implementation Plan.

7.1.6 Margin of Safety/Reserve Capacity

Section 303(d) of the Clean Water Act and USEPA's regulations (40 CFR 130.7) require that TMDLs are established such that applicable WQS can be met with a MOS. The MOS is intended to account for uncertainty or lack of knowledge of the relationship between loading and attainment of the WQS. The MOS can either be implicit or added as a separate component of the TMDL (explicit). The MOS for fecal coliform using the load duration curves, the simple method, and mass balance is explicit, except for Higgins Creek IL_GOA-01 which is implicit. The reasoning behind this can be found in Section 7.1.2.

Further, to account for future growth, a 5 percent reserve capacity was included with each analysis when possible. This reserve capacity is for any treatment plant that adds unsewered areas to their sewer coverage. This can be used to increase the bacteria waste load allocation for the facility.

7.1.7 Critical Conditions and Seasonality

The CWA and USEPA's regulations require that TMDLs include a component to address seasonal variations and critical conditions for stream flow, loading, and water quality parameters. Critical conditions are the period when the greatest reductions in loading are required. The loading capacity for fecal coliform is set to achieve desired water quality standards which only apply during the months of May through October. Therefore, the seasonal analysis for fecal coliform is addressed through adherence to the water quality standard.

The chloride standard is applicable to the entire year. Use of load duration curves, however, analyzes in-stream chloride concentrations on a daily basis over the entire range of observable flows. Therefore, the critical condition for chloride load duration TMDLs is established by hydrologic category. It is defined as the greatest reduction needed to meet WQS among all hydrologic categories.

7.2 Dissolved Oxygen

7.2.1 Albert Lake (IL_VGG)

While a TMDL is not required for Sylvan Lake due to its size (<20 acres), it is currently listed as being impaired due to excessive total phosphorus concentrations. High concentrations of total phosphorus were observed each time low dissolved oxygen data were recorded. Excessive phosphorus loading can stimulate algal and aquatic plant life production, and when production is too high anoxic conditions can be observed throughout the water column of a lake. IL EPA believes that reducing the total phosphorus in the lake will result in attainment of the dissolved oxygen standard. Please refer to Section 7.3.1 for details regarding the total phosphorus TMDL that addresses the DO impairment for this segment.

7.2.2 Buffalo Creek (IL_GST)

Low dissolved oxygen has been observed in the IL-GST segment of Buffalo Creek. QUAL-2K was selected to model dissolved oxygen concentrations, as well as ammonia and carbonaceous biochemical oxygen demand (CBOD), throughout the creek. Data from 2000 to 2009 were used for the analysis. Details regarding the QUAL-2K analysis can be found in **Appendix G**.

7.2.2.1 Load Capacity

The dissolved oxygen target for Buffalo Creek is 5 mg/L. However, because dissolved oxygen is not considered a pollutant, reductions in CBOD and ammonia will need to be made in order to maintain compliance with the dissolved oxygen standard. Ammonia and CBOD were chosen for model development because these are pollutants regulated through the NPDES program and were common constituents throughout each permit. CBOD represents the oxygen demand from both organic and inorganic compounds. Total ammonia can contribute to dissolved oxygen deficits when bacteria convert ammonium (a component of total ammonia) to nitrate. This process can deplete in-stream oxygen concentrations. The resulting allocations for CBOD and ammonia are implemented in the NPDES and MS4 permits.

Table 7-17 lists the CBOD and ammonia reductions necessary to achieve the dissolved oxygen target.

Table 7-17 Carbonaceous Biochemical Oxygen Demand and Ammonia Allocations

	CBOD			NH3		
	lb/day	kg/day	kg/yr	lb/day	kg/day	kg/yr
TMDL (target)	97.03	44.01	16064.1	6.24	2.83	1033.73
Observed Load	158.96	72.10	26318	8.92	4.05	1477.11
MS4	65.04	29.50	10768	4.18	1.90	674.99
LA	8.59	3.90	1422.19	0.24	0.11	38.76
WLA	13.7	6.21	2268.21	1.2	0.54	193.78
MOS	9.70	4.40	1606.41	0.62	0.28	103.37
% Reduction	39%	39%	39%	30%	30%	30%

7.2.2.2 Waste load Allocation

Allocations were developed for CBOD and ammonia. The WLA for NPDES point sources was based on maximum daily permit limits and flow and it was assumed that compliance with their respective discharge permits will result in attainment of receiving water standards for dissolved oxygen. The DMF was selected because a review of DMR data showed that discharges originating from the Alden Long Grove Rehabilitation Center were closer to the permitted DMF of 0.037 MGD. Camp Reinberg discharges infrequently; however, to remain consistent, the DMF was used to calculate the WLA for CBOD. Alden Long Grove Rehabilitation Center was not given a total ammonia allocation since the permit doesn't include a limit for ammonia. Records show that both dischargers are meeting their permit limits. The CBOD WLA accounts for 5% of the observed load (9% of the target load) while the ammonia WLA accounts for 1% of the observed load (2% of the target load). MS4s and nonpoint sources received the stipulated reductions for CBOD and ammonia loading. **Table 7-18** shows the WLAs for the MS4s within the Higgins Creek Watershed.

Table 7-18 Allocations for Buffalo Creek

Point Source Discharger	CBOD Allocation (lb/d)	Total Ammonia allocation (lb/d)
Alden Long Grove Rehab	12.0	---
Camp Reinberg	1.7	1.2
Long Grove MS4	14.72	1.14
Lake Zurich MS4	5.40	0.42
Buffalo Grove MS4	9.05	0.70
Kildeer MS4	9.74	0.75
Deer Park MS4	6.67	0.51
Barrington MS4	0.05	0.004
Palatine MS4	7.70	0.59
Inverness MS4	0.004	0.0003
Arlington Heights MS4	3.18	0.25

7.2.3 Buffalo Creek Lake (IL_SGC)

Buffalo Creek Lake is an online lake or impoundment of the Buffalo Creek segment IL_GST described in Section 7.2.2. This riverine segment is also impaired for DO and a TMDL was developed using QUAL2K modeling which included Buffalo Creek Lake in the model. If DO is reduced within the Buffalo Creek IL_GST segment, it follows that DO would also be reduced in Buffalo Creek Lake. Additionally, sampling data from 2001 and 2008 suggest that occurrences of low dissolved oxygen coincide with higher concentrations of total phosphorus in Buffalo Creek Lake. Because excessive phosphorus loading can lead to anoxic conditions, a reduction in total phosphorus concentrations in the lake should result in attainment of the dissolved oxygen standard. The dissolved oxygen target for Buffalo Creek Lake is 5 mg/L. Please refer to Section 7.3.6 for details regarding the total phosphorus TMDL that addresses the DO impairment for this segment.

7.2.4 Half Day Pit (IL_UGB)

Half Day Pit is not currently impaired for total phosphorus due to its size (<20 acres); however, recent sampling data suggest that occurrences of low dissolved oxygen coincide with high concentrations of total phosphorus. Because excessive phosphorus loading can lead to anoxic conditions, a reduction in total phosphorus concentrations in the lake should result in attainment of the dissolved oxygen standard. The dissolved oxygen target for Half Day Pit is 5 mg/L. Refer to Section 7.3.10 for details regarding the total phosphorus TMDL that addresses the DO impairment for this segment.

7.2.5 Higgins Creek (IL_GOA-02)

IL-GOA-02 is listed for low DO impairment based on water quality data. The low DO can be attributed to pollutants such CBOD, nutrients and the stream conditions such as sediment oxygen demand (SOD), low aeration, and hydraulic alteration. QUAL-2K was used to simulate DO concentrations throughout the creek. The downstream segment of Higgins Creek (IL_GOA-01) was also modeled to provide a downstream boundary for model development. Details regarding the QUAL-2K analysis can be found in **Appendix G**.

Representative data from MWRGDC stations WW-77 and WW_78 were used to calibrate the model for critical low oxygen conditions. Flow was estimated using watershed scaling as there is no flow gaging stations in Higgins Creek as indicated in Section 7.1.2. The date with DO lower than the water quality standards was considered as the critical condition (occurred during July 5, 2006). As there are no specific data for SOD, initial estimates were used based on literature values for typical streams. A value of 1 gO2/m2/d for SOD was obtained through calibration. There are several dischargers in the segment that were modeled, including several oil terminal facilities. Five oil terminals discharge to an unnamed tributary to Higgins Creek. The tributary flows into segment IL-GOA-02. The Kirie WWTP main outfall (up to 110 MGD) discharges to segment IL_GOA-01 which is not impaired for low DO. DMR data show that the permit limits are being met for all dischargers except the Des Plaines Mobile Home Park, which had occasional CBOD and ammonia exceedances. The Des Plaines Mobile Home Park also discharges to segment IL_GOA-01.

7.2.5.1 Load Capacity

The dissolved oxygen target for Higgins Creek is 5 mg/L. the calibrated QUAL2K model was used to evaluate the parameter or parameters causing the low DO concentration in the Creek. CBOD and ammonia were initially targeted for reduction using QUAL-2K. CBOD represents the oxygen demand from both organic and inorganic compounds. Nutrients such as nitrogen compounds and phosphorus can contribute to dissolved oxygen deficits when biochemical reactions take place within the water column. This process can deplete in-stream oxygen concentrations. Reductions in CBOD nutrient loads were modeled to determine if DO levels improved upon the reductions. The model results, however, did not show improved dissolved oxygen levels. Similarly, the reduction of nutrients, i.e., ammonia and total phosphorus, does not increase the DO to the target level in the stream.

The model results suggest that SOD and not nutrients or CBOD is a contributor to the low dissolved oxygen in Higgins Creek. SOD is the overall rate of oxygen removal demand from the water column that is caused by biological, biochemical, and chemical processes at the sediment-water interface. These processes are driven by anaerobic chemical compounds in the riverbed sediments and particulate BOD materials such as algae and other organic matter that settle out of the water column. The oxygen depleting materials come from storm water runoff in the watershed and point source discharge. SOD is caused by the consumption of oxygen by bacteria as they respire and decompose algae and other organic materials that have settled to the bottom of Higgins Creek.

The hydraulic alteration also contributes to the buildup of SOD materials and DO decease. Based on an aerial photo, a small dam structure immediately upstream of the Elmhurst Road Bridge creates an impoundment in Higgins Creek. When the creek reaches this area, the flow velocities dramatically decrease because of the impoundment. This velocity reduction causes the organic material in the stream to settle out and contribute to the quick buildup of SOD, which consume the DO from the creek flow. In addition, the velocity decrease results in the lower aeration, which indirectly reduce the DO concentration in the creek.

Neither load capacity nor a TMDL for a specific pollutant was developed for Higgins Creek IL-GOA-02 as the low DO concentration is caused by SOD and hydraulic alteration, which are considered conditions not pollutants. However, non-point source pollution control BMPs are recommended in the implementation plan (Section 8.0) to reduce organic matter in the stormwater runoff in order to lower SOD rate in the stream bed. In addition, a natural stream condition can be restored by removing the hydraulic alteration and increasing the re-aeration. It is also recommended that additional monitoring be conducted to further assess the flow and DO-impacted processes.

7.2.5.2 Waste load Allocation

Because there was no TMDL developed for this segment, no WLAs were developed for CBOD or ammonia. It is recommended that the point sources monitor organic matters and nutrients in their discharge.

7.2.6 Pond-A-Rudy (IL_UGP)

Pond-A-Rudy is not currently listed as impaired for elevated total phosphorus concentrations due to its size (<20 acres), but sampling data suggest that low dissolved oxygen data can be attributed to high concentrations of total phosphorus. High levels of in-lake phosphorus concentrations can lead to anoxic conditions; therefore, reduction of total phosphorus concentrations in the lake should result in attainment of the dissolved oxygen standard. Refer to Section 7.3.13 for details regarding the total phosphorus TMDL which addresses the DO impairment.

7.2.7 Load Allocation

The remaining unallocated CBOD and ammonia for Buffalo and Higgins Creeks was incorporated into the load allocation, including possible load from septic failure due to the lack of data. Similarly, for Albert Lake, Half Day Pit, and Pond-A-Rudy the remaining total phosphorus was considered part of the load allocation. Ten percent of the loading capacity was reserved for a margin of safety. The load allocation is calculated as the loading capacity minus the waste load allocation minus the margin of safety.

7.2.8 Margin of Safety/Reserve Capacity

Section 303(d) of the Clean Water Act and USEPA's regulations (40 CFR 130.7) require that TMDLs are established such that applicable WQS can be met with a MOS. The MOS is intended to account for uncertainty or lack of knowledge of the relationship between loading and attainment of the WQS. The MOS can either be implicit or added as a separate component of the TMDL (explicit). The MOS for dissolved oxygen using QUAL-2K is set at 10%. No reserve capacity was included for dissolved oxygen.

7.2.9 Critical Conditions and Seasonality

The CWA and USEPA's regulations require that TMDLs include a component to address seasonal variations and critical conditions for stream flow, loading, and water quality parameters. For dissolved oxygen, critical conditions typically occur during the summer months when warm temperatures (and low oxygen solubility) and low flow can be present. By maintaining compliance with water quality standards during critical periods, then dissolved oxygen concentrations should be above the water quality standard during other seasons.

7.3 Total Phosphorus

LLRM was selected for use in the Des Plaines watershed to develop lake load estimates for phosphorous in support of the development of TMDLs for Beck Lake, Big Bear Lake, Bresen Lake, Buffalo Creek Lake, Big Bend Lake, Countryside Lake, Diamond Lake, Forest Lake, Lake Charles, Little Bear Lake, Salem-Reed Lake, and Sylvan Lake. In addition, LLRM was used to develop dissolved oxygen TMDLs for Albert Lake, Half Day Pit, and Pond-A-Rudy based on a causal relationship between phosphorus and dissolved oxygen. LLRM is a spreadsheet based export coefficient model linked to empirical in-lake response models. **Appendix H** contains details for the LLRM models developed for each impaired waterbody assessed. **Appendix C** contains maps for lakes and rivers while **Table 7-51** summarizes the daily total phosphorus loads for each of the impaired lakes.

LLRM estimates lake loading as a function of land use by using export coefficients for runoff, groundwater, and nutrients in addition to direct inputs for atmospheric deposition, septic systems, point sources, waterfowl and internal loading from lake sediments. Runoff and baseflow coefficients were selected for each land use type from literature values. The median literature values were initially used with some adjustments based on watershed characteristics during the calibration process **(Table 7-19).**

Table 7-19 Phosphorus Export Coefficients Used in LLRM Development

Land Use Type	Phosphorus Export (KG/HA/YR)[1]			
	Maximum	Mean	Median	Minimum
Low density residential (>1 ac lots)	6.23	1.91	1.10	0.19
Medium density residential (0.3-0.9 ac lots) + highway corridors	6.23	1.91	1.10	0.19
High density residential (<0.3 ac lots) + commercial	6.23	1.91	1.10	0.19
Industrial	6.23	1.91	1.10	0.19
Park, Institutional, Recreational or Cemetery	6.23	1.91	1.10	0.19
Agricultural with cover crops (minimal bare soil)	2.90	1.08	0.80	0.10
Agricultural with row crops (some bare soil)	18.60	4.46	2.20	0.26
Agricultural pasture with livestock	4.90	1.50	0.80	0.14
Concentrated livestock holding area	795.20	300.70	224.00	21.28
Land with tree canopy over upland soils and vegetation	0.83	0.24	0.20	0.02
Land with tree canopy over wetland soils and vegetation	0.83	0.24	0.20	0.02
Open wetland or lake area (no substantial canopy)	0.83	0.24	0.20	0.02
Open meadow area (no clearly wetland, but no canopy)	0.83	0.24	0.20	0.02
Mining or construction areas, largely bare soils	4.90	1.50	0.80	0.14

(1) Phosphorus export coefficients were based on Reckhow (1980).

The model uses hydrology inputs to govern how much water is input into the watershed and what portion is converted to runoff or baseflow. Precipitation data were obtained from the National Climactic Data Center (NCDC) for the Chicago O'Hare station. Annual average precipitation values are depicted in **Table 7-20**. Watershed flow data were not available so a mean flow was calculated using watershed scaling.

Areal water yield based on flow and drainage area data for Buffalo Creek (USGS Gage 05528500) is 1.5 cubic feet per second per square mile of drainage area. The areal water yield was multiplied by the drainage area to get an expected mean flow for that area.

Table 7-20 Annual Average Precipitation in the Des Plaines/Higgins Creek Watershed

Year	2000	2001	2002	2003	2004	2005	2006	2007	2008	2009
Inches	40.8	39.13	36.81	32.08	36.4	22.87	42.2	46.26	48.88	45.1
Meters	1.03	0.99	0.93	0.81	0.92	0.58	1.07	1.18	1.24	1.15

Water attenuation values were selected based on watershed characteristics. Water is attenuated mostly by evapotranspiration losses. Some depression storage is expected, seepage into the ground is possible, and wetlands can remove considerable water on the way to the lake. In general, a 5% loss is to be expected in nearly all cases, and greater losses are plausible with lower gradient or wetland dominated landscapes.

Watershed and sub-watershed boundaries were delineated based on topography. Watershed land use was determined using the Chicago Metropolitan Agency for Planning 2005 Land Use Inventory. The model estimates lake loading for each sub-watershed. Loading estimates are adjusted based on proximity to the lake, soils, and major BMPs in place. Model yields are compared to measured data, where available, and export coefficients and attenuation factors are adjusted such that model loading accurately reflects actual loading.

Five other sources of N and TP are recognized in the model: atmospheric deposition, internal loading, waterfowl and other wildlife, point sources, and on-site wastewater disposal (septic) systems. Both wet and dry deposition occurs and has been well documented in the literature. Internal loads can be generated from direct release from the sediment (dissolved TP, ammonium N), re-suspension of sediment (particulate TP or N) with possible dissociation from particles, or from macrophytes ("leakage" or senescence).

Atmospheric deposition values were taken from the literature and are chosen based on the dominant land use in the contributing area. Internal loading was estimated based on whether the lake has reported periods of anoxia and an estimated anoxic area of the lake. Inputs from various bird species and other water dependent wildlife (e.g., beavers, muskrats, mink or otter) have also been evaluated in the literature. Site specific wildlife counts were not available so model inputs were selected based on estimates derived from Lake County Stormwater Management Commission Lake Reports.

LLRM allows for up to three point sources, specific input points for discharges with known quantity and quality. The annual volume, average concentration, and basin where the input occurs must be specified. Septic system inputs in non-direct drainage basins are accounted for in baseflow export coefficients. A separate process is provided for direct drainage areas where dense housing may contribute disproportionately, such as within a zone of 125 feet from the lake. The number of people per household, water use per person per day, N and TP concentrations and attenuation factors are input to the model. A summary of loading for septic tanks, atmospheric, point sources, wildlife, and internal loading for each watershed can be found in **Appendix H.**

The same approach applied to attenuation of water is applied to the phosphorus attenuation. Here attenuation can range from 0 to 1.0, with the value representing the portion of the load that reaches the terminus of the basin. With natural or human enhanced removal processes, it is unusual for the entire load to pass through a basin, but it is also unusual for more than 60 to 70% of it to be removed. Best professional judgment regarding the nature of removal processes in each basin was used to adjust attenuation factors in the model. Infiltration, filtration, detention and uptake will lower the attenuation value entered, and knowledge of the literature on Best Management Practices is needed to make reliable judgments on attenuation values.

Once the model was calibrated to existing conditions, the model assumptions were changed to facilitate prediction of in-lake conditions under potential past or future conditions. The natural background scenario set a lower bound on expected nutrient levels in the lake, based on the predicted inputs to the lake in the absence of human influence. This involves setting all developed uses (including residential, commercial, industrial and agricultural uses) as forest or wetland because these land use represents historical condition and has low impact on water quality, and increasing attenuation by an additional 10 percent for each sub-watershed (decreasing attenuation factors in the corresponding model cells, as less nutrients are exported with more undeveloped land to absorb them). In some instances, waterbodies, such as Bresen Lake and Half Day Pit, are naturally eutrophic and may not achieve numerical WQS even under predevelopment conditions. The percent reduction is based on the lake standard of 0.05 mg/L.

At the other extreme, a maximum build-out scenario will provide an upper bound on conditions that might be expected if development is not better managed. Remaining forest and agricultural land was converted to low density urban area for this scenario. Additionally, attenuation was decreased by 10 percent to represent the higher nutrient levels exported with developed land.

WLAs were determined based on NPDES permit effluent limitations and average flow. IL EPA will require a phosphorus monitoring program to be implemented at municipal wastewater treatment plants when a permit is renewed. WLAs for NPDES-permitted stormwater discharges, including current and future MS4s, “Urbanized” areas and construction and industrial discharges that do not have numerical effluent limitations were expressed as a percent reduction instead of a numerical target. Stormwater discharges are required to meet the percentage reduction or the existing instream standard for the pollutant of concern, whichever is less restrictive. LA includes non-point source load and diffuse loads from septic tank failure (non-direct drainage basins) which cannot be accounted for due to lack of data.

7.3.1 Albert Lake (IL_VGG)

Total phosphorus concentrations in Albert Lake were measured in 2001 and 2008 and exceeded the WQS 6 out of 9 samples collected. LLRM was used to estimate phosphorus loads and was calibrated to the mean of the measured in-lake concentrations for 2008. Albert Lake likely has high internal loading due to the historic discharge from Lake Zurich STP upstream of the lake in Buffalo Creek. The plant exceeded its NPDES discharge limits for BOD, TSS, and fecal coliform and was closed in the mid-1980s. While records of phosphorus discharges from the plant were not kept, it is likely that a large amount of phosphorus was discharged and may have settled in the sediments of Albert Lake (Brant et al, 2001).

7.3.1.1 Load Capacity

While the surface area of Albert Lake (18 acres) precludes it from compliance with the total phosphorus standard, IL EPA believes that controlling nutrient over-enrichment will lead to the attainment of the dissolved oxygen standard. As such, the total phosphorus target for Albert Lake is 0.05 mg/L. Existing data suggest nutrient over-enrichment as high phosphorus concentrations have been observed since 2000. To meet the phosphorus target in Albert Lake, an 89 percent reduction in phosphorus loads is required. **Table 7-21** shows the annual average total phosphorus concentrations for existing, natural background, and future growth conditions.

Table 7-21 Annual Average Concentrations for Albert Lake

Existing Conditions (mg/L)	Percent Reduction	Natural Background Conditions (mg/L)	Future Growth (mg/L)
0.442	89%	0.044	0.500

7.3.1.2 Waste load Allocation

The point source dischargers within the Albert Lake watershed are the Lake Zurich, Long Grove, and Kildeer MS4s. Because MS4s are primarily stormwater driven discharges, the allocation to each MS4 was based on the respective size of each MS4 and the percent of area taken up by each within the watershed. **Table 7-22** shows the WLAs for each MS4.

Table 7-22 Waste load Allocation for Albert Lake

Point Source Dischargers	Total Phosphorus Load (lbs/day)
Lake Zurich	0.620
Long Grove	0.226
Kildeer	0.475

7.3.2 Beck Lake (IL_RGE)

Total phosphorus concentrations in Beck Lake were measured in 2001 and 2006 and exceeded the WQS 5 out of 9 samples in 2001 and 3 out of 15 samples in 2006. LLRM was used to estimate phosphorus loads and was calibrated to the median of the measured in-lake concentrations for 2001.

7.3.2.1 Load Capacity

The total phosphorus target for Beck Lake is 0.05 mg/L. Excessive phosphorus loading can stimulate algal and aquatic plant life production, and when production is too high anoxic conditions can be observed throughout the water column of a lake. IL EPA believes that attainment of the total phosphorus target of 0.05 mg/L will result in a reduction in plant productivity, which should result in attainment of the total phosphorus standard. To meet the phosphorus target in Beck Lake, a 10 percent reduction in phosphorus loads is required. **Table 7-23** shows the annual average total phosphorus concentrations for existing, natural background, and future growth conditions.

Table 7-23 Annual Average Concentrations for Beck Lake

Existing Conditions (mg/L)	Percent Reduction	Natural Background Conditions (mg/L)	Future Growth (mg/L)
0.055	10%	0.019	0.091

7.3.2.2 Waste load Allocation

The only point source discharger within the Beck Lake watershed is the Glenview MS4; therefore, it received 100 percent of the WLA. **Table 7-24** shows the WLA for the Glenview MS4.

Table 7-24 Waste load Allocation for Beck Lake

Point Source Dischargers	Total Phosphorus Load (lbs/day)
Glenview	0.117

7.3.3 Big Bear Lake (IL_WGZU)

Total phosphorus concentrations in Big Bear Lake have exceeded the WQS in samples collected 1997, 1998, 2002 and 2006. LLRM was used to estimate phosphorus loads and was calibrated to the mean of the measured in-lake concentrations for 2002.

7.3.3.1 Load Capacity

The total phosphorus target for Big Bear Lake is 0.05 mg/L. Existing data suggest nutrient over-enrichment as high phosphorus concentrations have been observed in the lake. To meet the phosphorus target in Big Bear Lake, a 33 percent reduction in phosphorus loads is required. **Table 7-25** shows the annual average total phosphorus concentrations for existing, natural background, and future growth conditions.

Table 7-25 Annual Average Concentrations for Big Bear Lake

Existing Conditions (mg/L)	Percent Reduction	Natural Background Conditions (mg/L)	Future Growth (mg/L)
0.075	33%	0.008	0.120

7.3.3.2 Waste load Allocation

The only point source dischargers within the Big Bear Lake watershed are the Libertyville, Mundelein, and Vernon Hills MS4s. Because MS4s are primarily stormwater driven discharges, the allocation to each MS4 was based on the respective size of the MS4 and the percent of area taken up within the watershed. **Table 7-26** shows the WLAs for each MS4.

Table 7-26 Waste load Allocation for Big Bear Lake

Point Source Dischargers	Total Phosphorus Load (lbs/day)
Libertyville	0.260
Mundelein	1.030
Vernon Hills	0.559

7.3.4 Big Bend Lake (IL_RGL)

Total phosphorus concentrations in Big Bend Lake were higher than the WQS for 20 of 59 samples collected in 1998, 2001, 2004 and 2006. LLRM was used to estimate phosphorus loads and the model was calibrated to the observed total phosphorus concentrations for 2001.

During periods of high flow, the Des Plaines River periodically backflows into Big Bend Lake and inundates the lake. To account for this while modeling, the backflow was treated as a point source in the LLRM interface. Using conservative assumptions, it was assumed that the average lake level represents 50 percent of the total volume of the lake. As such, during periods of high flow, it was assumed that Big Bend Lake would be completely flooded and that approximately half of the lake volume would consist of Des Plaines River water. It was assumed that the lake would flood at a frequency of 5 percent. When calculating the total phosphorus load from the Des Plaines River, ambient water quality data from station WW_13 were paired with flow data from the river. Because it was assumed that backflow would occur 5 percent of the time, the average total phosphorus concentration was calculated only using those ambient data when the river flow exceeded the 95th percentile (1,520 cfs).

7.3.4.1 Load Capacity

The total phosphorus target for Big Bend Lake is 0.05 mg/L. Elevated phosphorus concentrations have been observed in the lake since 1998, and based on modeling results, a 74 percent reduction in phosphorus loads is required. **Table 7-27** shows the annual average total phosphorus concentrations for existing and natural background conditions. It was assumed when modeling natural background conditions that the river would have higher baseflow and lower peak flows. As such, it was assumed that the river would not backflow into the lake. Future growth conditions were not simulated because the phosphorus load from the Des Plaines River could not be estimated using LLRM.

Table 7-27 Annual Average Concentrations for Big Bend Lake

Existing Conditions (mg/L)	Percent Reduction	Natural Background Conditions (mg/L)
0.196	74%	0.060

7.3.4.2 Waste load Allocation

The only point source dischargers within the Big Bend Lake watershed are the Glenview and Des Plaines MS4s. In addition, the Des Plains River was treated as a nonpoint source since the lake is only inundated periodically. A load allocation was given to the river based on the flow calculations described above and a phosphorous concentration of 0.05 mg/L, which allows for a 66 percent reduction in phosphorous load from the river. LAs were given to the Des Plaines River as a whole as this TMDL only focused on Big Bend Lake, not on the main stem of the Des Plaines River. After allocations were given to the River, allocations were given to each MS4 based on the respective size of the MS4 and the percent area taken up by each within the watershed. **Table 7-28** shows the WLAs for each MS4 and the LA for the Des Plaines River.

Table 7-28 Load Allocations for Big Bend Lake

Point Source Dischargers	Total Phosphorus Load (lbs/day)
Glenview MS4 – WLA	0.009
Des Plaines River - LA	1.376

7.3.5 Bresen Lake (IL_UGN)

Total phosphorus concentrations in Bresen Lake were measured in 2000 and 2008 and exceeded the WQS 4 out of 5 samples in 2000 and 4 out of 4 samples in 2008. LLRM was used to estimate phosphorus loads and was calibrated to the mean of the measured in-lake concentrations for 2000.

7.3.5.1 Load Capacity

The total phosphorus target for Bresen Lake is 0.05 mg/L. High phosphorus concentrations have been observed in the lake, and in order to meet the phosphorus target, a 59 percent reduction in phosphorus loads is required. **Table 7-29** shows the annual average total phosphorus concentrations for existing, natural background, and future growth conditions. Natural background conditions for Bresen Lake are higher than the target for total phosphorous suggesting that the WQS may not be attainable for this lake.

Table 7-29 Annual Average Concentrations for Bresen Lake

Existing Conditions (mg/L)	Percent Reduction	Natural Background Conditions (mg/L)	Future Growth (mg/L)
0.121	59%	0.089	0.154

7.3.5.2 Waste load Allocation

The only point source discharger within the Bresen Lake watershed is the Hawthorn Woods MS4, and was therefore allocated 100% of the available WLA. **Table 7-30** shows the WLAs for each MS4.

Table 7-30 Waste load Allocation for Bresen Lake

Point Source Dischargers	Total Phosphorus Load (lbs/day)
Hawthorn Woods	0.199

7.3.6 Buffalo Creek Lake (IL_SGC)

Total phosphorus concentrations in Buffalo Creek Lake were measured in 2001 and 2008, exceeding the WQS 5 out of 5 samples in 2001 and 4 out of 4 samples in 2008. LLRM was used to estimate phosphorus loads and was calibrated to the mean of the measured in-lake concentrations for 2001.

7.3.6.1 Load Capacity

The total phosphorus target for Buffalo Creek Lake is 0.05 mg/L. Elevated total phosphorus data suggest potential problems with nutrient over-enrichment since 2001. To meet the phosphorus target in Buffalo Creek Lake, a 65 percent reduction in phosphorus loads is required. **Table 7-31** shows the annual average total phosphorus concentrations for existing, natural background, and future growth conditions.

Table 7-31 Annual Average Concentrations for Buffalo Creek Lake

Existing Conditions (mg/L)	Percent Reduction	Natural Background Conditions (mg/L)	Future Growth (mg/L)
0.143	65%	0.016	0.198

7.3.6.2 Waste load Allocation

The point source dischargers within the Buffalo Creek Lake watershed are the Arlington Heights, Barrington, Buffalo Grove, Deer Park, Inverness, Kildeer, Lake Zurich, Long Grove, and Palatine MS4s, as well as the two NPDES dischargers (IL0051934 and IL0048542). The allocations to each MS4 were based on the respective size of the MS4 and the percent of area taken up within the watershed. The allocations for the NPDES dischargers were typically based on permitted limits; however, no total phosphorus discharge data were available. Therefore, a total phosphorus concentration of 3.5 mg/L was used to estimate loading to the lake (Short, 1999). **Table 7-32** shows the WLAs for each MS4.

Table 7-32 Waste load Allocation for Buffalo Creek Lake

Point Source Dischargers	Total Phosphorus Load (lbs/day)
Arlington Heights MS4	0.357
Barrington MS4	0.003
Buffalo Grove MS4	0.075
Deer Park MS4	0.745
Inverness MS4	0.0005
Kildeer MS4	1.090
Lake Zurich MS4	0.602
Long Grove MS4	1.600
Palatine MS4	0.864
Alden Grove Rehab- IL0051934	0.448
Camp Reinberg Forest Preserve- IL0048542	0.117

7.3.7 Countryside Lake (IL_RGQ)

Total phosphorus concentrations in Countryside Lake were measured in 2000 and 2005 through 2007 and exceeded the WQS 11 out of 19. LLRM was used to estimate phosphorus loads and was calibrated to the mean of the measured in-lake concentrations for 2000.

7.3.7.1 Load Capacity

The total phosphorus target for Countryside Lake is 0.05 mg/L. A total phosphorus reduction of 51 percent is required as in-lake sampling data have persistently been above standard. **Table 7-33** shows the annual average total phosphorus concentrations for existing, natural background, and future growth conditions.

Table 7-33 Annual Average Concentrations for Countryside Lake

Existing Conditions (mg/L)	Percent Reduction	Natural Background Conditions (mg/L)	Future Growth (mg/L)
0.103	51%	0.016	0.141

7.3.7.2 Waste load Allocation

The only point source dischargers within the Countryside Lake watershed are the Hawthorn Woods, Long Grove, and Mundelein MS4s. Allocations to the MS4s were based on the respective size of the MS4 and the percent of area taken up within the watershed. **Table 7-34** shows the WLAs for each MS4.

Table 7-34 Waste load Allocation for Countryside Lake

Point Source Dischargers	Total Phosphorus Load (lbs/day)
Hawthorn Woods MS4	0.261
Long Grove MS4	0.0005
Mundelein MS4	0.183

7.3.8 Diamond Lake (IL_RGB)

Total phosphorus concentrations in Diamond Lake were measured and exceeded the WQS for 2 out of 18 samples from 2001 to 2003. LLRM was used to estimate phosphorus loads and was calibrated to the mean concentration while the existing load and percent reduction were calculated using the highest recorded value (0.055 mg/L measured in September 2003). In this case the highest recorded value was used because both the mean and the median values for each year sampled were below the target value.

7.3.8.1 Load Capacity

The total phosphorus target for Diamond Lake is 0.05 mg/L. Existing phosphorus data suggest nutrient over-enrichment as a 9 percent reduction in phosphorus loads is required to meet standards. **Table 7-35** shows the annual average total phosphorus concentrations for existing, natural background, and future growth conditions.

Table 7-35 Annual Average Concentrations for Diamond Lake

Existing Conditions (mg/L)	Percent Reduction	Natural Background Conditions (mg/L)	Future Growth (mg/L)
0.055	9%	0.008	0.058

7.3.8.2 Waste load Allocation

The only point source dischargers within the Diamond Lake watershed are the Mundelein and Long Grove MS4s. Each MS4s was provided with an allocation based on the respective size of the MS4 and the percent of area taken up within the watershed. **Table 7-36** shows the WLAs for each MS4.

Table 7-36 Waste load Allocation for Diamond Lake

Point Source Dischargers	Total Phosphorus Load (lbs/day)
Mundelein MS4	0.556
Long Grove MS4	0.108

7.3.9 Forest Lake (IL_RGZG)

Total phosphorus concentrations in Forest Lake were measured in 1990, 1991, 2000, and 2003 through 2006, and 2008 and exceeded the WQS 23 out of 32 times. LLRM was used to estimate phosphorus loads and was calibrated to the mean of the measured in-lake concentrations for 2006.

7.3.9.1 Load Capacity

The total phosphorus target for Forest Lake is 0.05 mg/L. Observed total phosphorus concentrations above standard have been observed since 2000. A 63 percent reduction in phosphorus loads is required to meet the phosphorus target in Forest Lake. **Table 7-37** shows the annual average total phosphorus concentrations for existing, natural background, and future growth conditions.

Table 7-37 Annual Average Concentrations for Forest Lake

Existing Conditions (mg/L)	Percent Reduction	Natural Background Conditions (mg/L)	Future Growth (mg/L)
0.133	63%	0.02	0.166

7.3.9.2 Waste load Allocation

The only point source dischargers within the Forest Lake watershed are the Hawthorn Woods and Lake Zurich MS4s and each was allocated total phosphorus loads by means of their percent area within the watershed and the respective size of each. **Table 7-38** shows the WLAs for each MS4.

Table 7-38 Waste load Allocation for Forest Lake

Point Source Dischargers	Total Phosphorus Load (lbs/day)
Hawthorn Woods MS4	0.189
Lake Zurich MS4	0.150

7.3.10 Half Day Pit (IL_UGB)

Total phosphorus concentrations in Half Day Pit were measured in 2008 and all collected samples suggest nutrient over-enrichment. LLRM was used to estimate phosphorus loads and was calibrated to the mean of the measured in-lake concentrations for 2008. Half Day Pit is also influenced by the Des Plaines River during periods of high flows as the river backflows into the lake during periods of high flow. This phenomenon was accounted for in the model by treating the river as a point source.

Using conservative assumptions, it was assumed that the average lake level represents 50 percent of the total volume of the lake. As such, during periods of high flow, it was assumed that Half Day Pit would be completely flooded and that approximately half of the lake volume would consist of Des Plaines River water. It was assumed that the lake would flood at a frequency of 5 percent. When calculating the total phosphorus load from the Des Plaines River, ambient water quality data from station WW_13 were paired with flow data from the river. Because it was assumed that backflow would occur 5 percent of the time, the average total phosphorus concentration was calculated only using those ambient data when the river flow exceeded the 95^{th} percentile (1,520 cfs).

7.3.10.1 Load Capacity

The surface area of Half Day Pit (13 acres) makes the total phosphorus standard not applicable. However, IL EPA believes that a reduction in total phosphorus will lead to the attainment of the dissolved oxygen standard. Phosphorus exceeded the phosphorus standard for all sampling events. The total phosphorus target for Half Day Pit is 0.05 mg/L. To meet the phosphorus target in Half Day Pit, an 80 percent reduction in phosphorus loading is required. **Table 7-39** shows the annual average total phosphorus concentrations for existing and natural background conditions. It was assumed when modeling natural background conditions that the river would have higher baseflow and lower peak flows. As such, it was assumed that the river would not backflow into the lake. Future growth conditions were not simulated because the phosphorus load from the Des Plaines River could not be estimated using LLRM.

Table 7-39 Annual Average Concentrations for Half Day Pit

Existing Conditions (mg/L)	Percent Reduction	Natural Background Conditions (mg/L)
0.251	80%	0.151

7.3.10.2 Waste load Allocation

Allocations were given to each MS4 based on the respective size of the MS4 and the percent area taken up by each within the watershed. **Table 7-40** shows the WLA for Lincolnshire MS4.

Table 7-40 Waste load Allocation for Half Day Pit

Point Source Dischargers	Total Phosphorus Load (lbs/day)
Lincolnshire MS4	0.205

7.3.11 Lake Charles (IL_RZGJ)

Total phosphorus concentrations in Lake Charles were measured in 2000 and 2008 and exceeded the WQS 8 out of 9 samples collected. LLRM was used to estimate phosphorus loads and was calibrated to the mean of the measured in-lake concentrations for 2000.

7.3.11.1 Load Capacity

The total phosphorus target for Lake Charles is 0.05 mg/L. Nutrient over-enrichment was observed as high phosphorus concentrations have been observed since 2000. To meet the phosphorus target in Lake Charles, a 13 percent reduction in phosphorus loads is required. **Table 7-41** shows the annual average total phosphorus concentrations for existing, natural background, and future growth conditions.

Table 7-41 Annual Average Concentrations for Lake Charles

Existing Conditions (mg/L)	Percent Reduction	Natural Background Conditions (mg/L)	Future Growth (mg/L)
0.058	13%	0.009	0.073

7.3.11.2 Waste load Allocation

The only point source dischargers within the Lake Charles watershed are the Libertyville, Mundelein, and Vernon Hills MS4s. The allocation to each MS4 was based on the respective size of each MS4 and the percent of area taken up by each within the watershed. **Table 7-42** shows the WLAs for each MS4.

Table 7-42 Waste load Allocation for Lake Charles

Point Source Dischargers	Total Phosphorus Load (lbs/day)
Libertyville MS4	0.300
Mundelein MS4	1.171
Vernon Hills MS4	0.282

7.3.12 Little Bear Lake (IL_WGZV)

Total phosphorus concentrations in Little Bear Lake were measured in 1989, 1997, 1998, 2002 and 2006 and exceeded the WQS 5 out of 20 samples collected. LLRM was used to estimate phosphorus loads and was calibrated to the mean of the measured in-lake concentrations for 2006.

7.3.12.1 Load Capacity

The total phosphorus target for Little Bear Lake is 0.05 mg/L. Elevated total phosphorus data have been observed since 1989 which suggests a history of nutrient over-enrichment. A 7 percent reduction in phosphorus loads is required to meet the phosphorus target in Little Bear Lake. **Table 7-43** shows the annual average total phosphorus concentrations for existing, natural background, and future growth conditions.

Table 7-43 Annual Average Concentrations for Little Bear Lake

Existing Conditions (mg/L)	Percent Reduction	Natural Background Conditions (mg/L)	Future Growth (mg/L)
0.054	7%	0.005	0.096

7.3.12.2 Waste load Allocation

The only point source dischargers within the Little Bear Lake watershed are the Libertyville, Mundelein, and Vernon Hills MS4s. Because MS4s are primarily stormwater driven discharges, the allocation to each MS4 was based on the respective size of each MS4 and the percent of area taken up by each within the watershed. **Table 7-44** shows the WLAs for each MS4.

Table 7-44 Waste load Allocation for Little Bear Lake

Point Source Dischargers	Total Phosphorus Load (lbs/day)
Libertyville MS4	0.231
Mundelein MS4	0.915
Vernon Hills MS4	0.661

7.3.13 Pond-A-Rudy (IL_UGP)

Total phosphorus concentrations in Pond-A-Rudy were measured in 2001 and 2008 and collected samples suggest nutrient over-enrichment. LLRM was used to estimate phosphorus loads and was calibrated to the mean of the measured in-lake concentrations for 2001.

7.3.13.1 Load Capacity

The surface area of Pond-A-Rudy (14 acres) precludes it from compliance with the total phosphorus standard; however, IL EPA believes that a reduction in nutrient enrichment will lead to the attainment of the dissolved oxygen standard. As such, the total phosphorus target for Pond-A-Rudy is 0.05 mg/L. Elevated phosphorus concentrations have been observed since 2001 and in order to meet the phosphorus target in Pond-A-Rudy, a 67 percent reduction in phosphorus loads is required. **Table 7-45** shows the annual average total phosphorus concentrations for existing, natural background, and future growth conditions.

Table 7-45 Annual Average Concentrations for Pond-A-Rudy

Existing Conditions (mg/L)	Percent Reduction	Natural Background Conditions (mg/L)	Future Growth (mg/L)
0.151	67%	0.024	0.182

7.3.13.2 Waste load Allocation

The only point source discharger within the Pond-A-Rudy watershed is the Hawthorn Woods MS4. Because Hawthorn Woods is the only MS4 within the watershed, it received the entire WLA. **Table 7-46** shows the WLAs for the MS4.

Table 7-46 Waste load Allocation for Pond-A-Rudy

Point Source Dischargers	Total Phosphorus Load (lbs/day)
Hawthorn Woods MS4	0.072

7.3.14 Salem Reed Lake (IL_WGK)

Total phosphorus concentrations in Salem Reed Lake were measured in 1988, 2000 and 2008 and exceeded the WQS 7 out of 13 samples collected. LLRM was used to estimate phosphorus loads and was calibrated to the mean of the measured in-lake concentrations for 2000.

7.3.14.1 Load Capacity

The total phosphorus target for Salem Reed Lake is 0.05 mg/L. Elevated total phosphorus concentrations have been observed since 2000 suggesting potential problems with nutrient enrichment. To meet the phosphorus target in Salem Reed Lake, a 69 percent reduction in phosphorus loads is required. **Table 7-47** shows the annual average total phosphorus concentrations for existing, natural background, and future growth conditions.

Table 7-47 Annual Average Concentrations for Salem Reed Lake

Existing Conditions (mg/L)	Percent Reduction	Natural Background Conditions (mg/L)	Future Growth (mg/L)
0.16	69%	0.049	0.183

7.3.14.2 Waste load Allocation

The only point source discharger within the Salem Reed Lake watershed is the Long Grove MS4 and was therefore allotted the entire WLA. **Table 7-48** shows the WLA for the MS4.

Table 7-48 Waste load Allocation for Salem Reed Lake

Point Source Dischargers	Total Phosphorus Load (lbs/day)
Long Grove MS4	0.193

7.3.15 Sylvan Lake (IL_RGZF)

Total phosphorus concentrations in Sylvan Lake were measured in 1996, 2001 and 2008 and exceeded the WQS 11 out of 14 samples collected. LLRM was used to estimate phosphorus loads and was calibrated to the mean of the measured in-lake concentrations for 2001.

7.3.15.1 Load Capacity

The total phosphorus target for Sylvan Lake is 0.05 mg/L. Sylvan Lake is also listed as impaired due to excessive fecal coliform (see Section 7.1.4). IL EPA believes that reducing total phosphorus concentrations in the lake should result in a reduction in plant productivity, which should then result in attainment of water quality standard. To meet the phosphorus target in Sylvan Lake, a 35 percent reduction in phosphorus loads is required. **Table 7-49** shows the annual average total phosphorus concentrations for existing, natural background, and future growth conditions.

Table 7-49 Annual Average Concentrations for Sylvan Lake

Existing Conditions (mg/L)	Percent Reduction	Natural Background Conditions (mg/L)	Future Growth (mg/L)
0.077	35%	0.011	0.118

7.3.15.2 Waste load Allocation

The only point source dischargers within the Sylvan Lake watershed are the Hawthorn Woods and Long Grove MS4s. Because MS4s are primarily stormwater driven discharges, the allocation to each

MS4 was based on the respective size of each MS4 and the percent of area taken up by each within the watershed. **Table 7-50** shows the WLAs for each MS4.

Table 7-50 Waste load Allocation for Sylvan Lake

Point Source Dischargers	Total Phosphorus Load (lbs/day)
Hawthorn Woods MS4	0.172
Long Grove MS4	0.0004

7.3.16 Load Allocation

The remaining unallocated total phosphorus for all lakes was incorporated into the load allocation. Ten percent of the loading capacity was reserved for a margin of safety. The load allocation is calculated as the loading capacity minus the waste load allocation minus the margin of safety. The allocation summaries are listed in **Table 7-51**. With the exception of Buffalo Creek Lake, there are no NPDES facilities that discharge to these lakes. Therefore, WLA reductions will be achieved through MS4s as total phosphorus violations were not observed in NDPES permits.

Table 7-51 Total Phosphorus Allocation Summary

Lake	Existing Load (lbs/day)	Target Load (lbs/day)	Reduction (%)	MS4/Waste load Allocation (lbs/day)	MOS (lbs/day)	Load Allocation (lbs/day)
Albert Lake	13.07	1.48	89%	1.32	0.15	0.01
Beck Lake	0.45	0.40	10%	0.12	0.04	0.25
Big Bear Lake	3.19	2.13	33%	1.85	0.21	0.07
Big Bend Lake	6.51	1.66	74%	1.40	0.17	0.10
Bresen Lake	0.84	0.35	59%	0.20	0.03	0.11
Buffalo Creek Lake	25.96	9.06	65%	5.89	0.91	2.26
Countryside Lake	4.17	2.03	51%	0.44	0.20	1.38
Diamond Lake	1.93	1.75	9%	0.66	0.18	0.92
Forest Lake	1.52	0.57	63%	0.34	0.06	0.17
Half Day Pit	11.73	2.34	80%	0.55	0.23	1.56
Lake Charles	2.36	2.05	13%	1.75	0.21	0.09
Little Bear Lake	2.23	2.08	7%	1.81	0.21	0.06
Pond-A-Rudy	0.42	0.14	67%	0.07	0.01	0.05
Salem Reed Lake	0.70	0.22	69%	0.19	0.02	0.001
Sylvan Lake	0.80	0.51	35%	0.17	0.05	0.29

7.3.17 Margin of Safety/Reserve Capacity

Section 303(d) of the Clean Water Act and USEPA's regulations (40 CFR 130.7) require that TMDLs are established such that applicable WQS can be met with a MOS. The MOS is intended to account for uncertainty or lack of knowledge of the relationship between loading and attainment of the WQS. The MOS can either be implicit or added as a separate component of the TMDL (explicit). The MOS for phosphorus using the LLRM is explicit. There is substantial uncertainty in concentration inputs to the models related to the timing of sampling and analytical methods, and the empirical equations used to predict in-lake phosphorus concentrations, mean and maximum chlorophyll, Secchi disk transparency, and bloom probability also introduce variability into the predictions. There is no reserve capacity for phosphorus.

7.3.18 Critical Conditions and Seasonality

The CWA and USEPA's regulations require that TMDLs include a component to address seasonal variations and critical conditions for stream flow, loading, and water quality parameters. Critical conditions are the period when the greatest reductions in loading are required, and for lakes this typically occurs during the summertime, when the potential (both occurrence and frequency) for nuisance algal blooms are greatest. The loading capacity for total phosphorus is set to achieve desired water quality standards during this critical time period and also to provide adequate protection for designated uses throughout the year. Therefore a load allocation based on average concentrations is sufficiently low to protect designated uses in the critical summer period.

The LLRM derived TMDL takes into account seasonal variations because the allowable annual load is developed to be protective of the most sensitive (i.e., biologically responsive) time of year (summer), when conditions most favor the growth of algae. Maximum annual loads are calculated based on an overall annual average concentration. Summer epilimnetic concentrations are typically lower than the average annual concentration, so it is assumed that loads calculated in this manner will be protective of designated uses in the summer season, in which the most sensitive of designated uses (swimming) occurs. It is possible that concentrations of phosphorus will be higher than the annual average during other seasons, most notably in the spring, but higher phosphorus levels at that time does not compromise uses. The TMDL is expected to protect all designated uses of the impaired waterbody.

8.0 Implementation Plan

8.1 Introduction

TMDLs and pollutant load reductions have been presented for the Des Plaines River/Higgins Creek Watershed impaired waterbodies in the previous section. This section presents an implementation plan which describes how the TMDLs can be achieved through an integrated watershed management approach. Focus is placed on the impaired segments and causes for the impairment. BMPs and any additional pollution control measures are identified which could be taken to bring impaired waterbodies back into attainment with water quality standards by meeting the percent reductions assigned to each waterbody. The plan provides guidance to local stakeholders or watershed work groups for planning and undertaking future water quality improvement activities. The following sections of this plan discuss the pollutant sources, implementation actions, BMPs and their effectiveness and cost, available funding sources, monitoring, and a suggested timeline for the implementation process.

8.2 Pollutant Sources and Management

The Des Plaines River/Higgins Creek Watershed contains 15 lakes and three river segments each with different impairments including chloride, dissolved oxygen, fecal coliform, and phosphorus. The 348 square mile watershed is located in the northern and western Chicago suburbs including portions of Cook, DuPage, and Lake Counties. The land use is mostly medium to low intensity urban, although some agricultural activities still exist in the northwest portion of the watershed. The northwestern portion of the watershed has some significant elevation change, but the remainder is relatively flat. The most prevalent water quality issue in the watershed is nutrient over-enrichment of both lakes and streams. The other issues are the overloading of fecal coliform to the three stream segments and one lake and chloride inputs during the winter months.

There are two distinct categories for sources of pollution to a surface waterbody, point and non-point sources. Point source pollution originates from any discrete conveyance which would include discharges from industrial, concentrated animal feeding, or municipal. Conversely, non-point source pollution originates from diffuse sources and is generally carried to the waterbody by overland runoff.

BMPs can be implemented to reduce or prevent pollution from entering waterbodies. These practices can be non-structural such as a watershed program and policy change; or can be individual or combinations of structures used to physically detain, treat and/or prevent pollution from reaching the waterbody. Generally, a combination of practices is the most effective stormwater management program.

Point sources are regulated under the CWA National Pollution Discharge Elimination System (NPDES). The CWA prohibits discharge of pollutants into waters of the United States unless a permit is obtained. In addition to the typical waste water treatment plant, both large and small municipalities with separate stormwater collection systems must also obtain coverage by NPDES permits. Operators of regulated small MS4s are required to design their programs to reduce the discharge of pollutants to the maximum extent practicable (MEP), protect water quality, and satisfy the appropriate water quality requirements of the CWA. The Phase II Rule outlines a stormwater management program comprising the following six minimum control measures through implementation of the MEP standard.

- **Public education and outreach**: Distribution of educational materials and performing community outreach in an effort to inform citizens about the impacts of stormwater discharges on waterbodies and the steps that can be taken to reduce pollutants in stormwater runoff.
- **Public participation/involvement**: Effective publication of public hearings and provision of opportunities for citizens to participate in program development and implementation.
- **Illicit discharge detection and elimination**: Development and implementation of a plan to detect and eliminate illicit discharges to the stormwater system which will involve development of a storm sewer system map and informing the community about the hazards associated with illegal discharge and improper disposal of waste.
- **Construction site runoff control**: Development, implementation, and enforcement of a stormwater pollution prevention program for construction activities that disturb one or more acres of land.
- **Post-construction runoff control**: Development, implementation, and enforcement of a program to address post-construction stormwater runoff from new development and redevelopment projects disturbing one acre or more, including a long term BMP maintenance program.
- **Pollution prevention/good housekeeping**: Development and implementation of an operation and maintenance program to reduce or prevent municipal pollutant discharge to the MEP standard. This program must have a municipal staff training component on pollution prevention measures ad techniques.

Non-point source pollution not captured under the NPDES Stormwater Phases I and II Rules are typically managed by the adoption and implementation of non-point source management programs. These programs are largely voluntary and promote practices on a watershed scale. Section 319 of the CWA allows grants to be awarded for assessment reports and programs to manage non-point source pollution. These grants are covered in more details in Section 8.7 and **Appendix I** of this Plan.

8.3 Implementation Actions and Management Measures for Chloride

Chloride is a conservative ion, so once introduced into waterbodies it will not be broken down or lost and has the potential to accumulate over time. Chloride is toxic to aquatic organisms at high concentrations and lower concentrations of chloride may impact biological community structure, diversity and productivity. Chloride salts can also affect soil stability, permeability and increase potential for erosion. Both Buffalo Creek (Segment IL_GST) and Higgins Creek (Segments IL_GOA-01 and IL_GOA-02) are impaired for chloride. Buffalo Creek has a 46% targeted loading reduction, the Higgins Creek headwater segment IL_GOA-02 has a 77% targeted loading reduction, and downstream Higgins Creek IL_GOA-01 has a 57% targeted loading reduction.

8.3.1 Point Sources of Chloride

Seasonal analysis of all three segments indicates that chloride exceedances mainly occurred during the winter months when road de-icing is necessary for public safety. As a result, waste load allocations were not given to NPDES facilities like sewage treatment plants. It is recommended that the facilities in this watershed conduct sampling and characterize the chloride concentration in their discharge in order to verify the allocation.

8.3.2 MS4 and Non-Point Sources of Chloride

Land use for both the Buffalo Creek and Higgins Creek Watersheds is predominantly urban and built up (71% for Buffalo Creek and 91% for Higgins Creek) with some forested land (22% for Buffalo Creek and 7% for Higgins Creek). Since it is believed that chloride sources originate mainly from road de-icing activities using chloride salts, load allocations were given to MS4s within the watershed as indicated on **Tables 8-1** to **8-3.**

Table 8-1 MS4 Allocations for Buffalo Creek IL_GST

MS4 Discharger	NPDES ID	WLA @ High Flows (lbs/day)	WLA @ Moist Condition (lbs/day)	WLA @ Mid-Range Flows (lbs/day)
Long Grove	ILR400219	27,075	7,357	2,943
Lake Zurich	ILR400370	14,991	4,074	1,629
Buffalo Grove	ILR400303	20,050	5,448	2,179
Kildeer	ILR400215	8,015	2,178	871
Deer Park	ILR400323	7,864	2,137	855
Barrington	ILR400285	10,393	2,824	1,130
Palatine	ILR400416	28,017	7,613	3,045
Inverness	ILR400359	14,693	3,993	1,597
Arlington Heights	ILR400282	35,187	9,562	3,825

Table 8-2 MS4 Allocations for Higgins Creek IL_GOA-01

MS4 Discharger	NPDES ID	WLA @ High Flows (lbs/day)	WLA @ Moist Condition (lbs/day)	WLA @ Mid-Range Flows (lbs/day)
Arlington Heights	ILR400282	71,402	19,731	17,440
Rolling Meadows	ILR400435	1,502	420	372
MT Prospect	ILR400393	79,894	22,077	19,513
Des Plaines	ILR400325	132,461	36,602	32,353
Elk Grove	ILR400334	284,461	78,633	69,504
Chicago	ILR400173	3,866	1,069	944
Illinois Tollway	ILR400494	1,727	477	421

Table 8-3 MS4 Allocations for Higgins Creek IL_GOA-02

MS4 Discharger	NPDES ID	WLA @ High Flows (lbs/day)	WLA @ Moist Condition (lbs/day)	WLA @ Mid-Range Flows (lbs/day)
Arlington Heights	ILR400282	6,950	2,850	2,138
Rolling Meadows	ILR400435	150	61.8	45.8
MT Prospect	ILR400393	7,760	3,182	2,387
Des Plaines	ILR400325	1,018	418	313
Elk Grove	ILR400334	25,207	10,340	7,755
Illinois Tollway	ILR400494	124	51	38

A literature study was done for the Salt Creek and DuPage River watersheds located west of the Des Plaines River/Higgins Creek Watershed. These watersheds are also experiencing excessive chloride loading to waterbodies and detailed information can be obtained from the study (DRSCW, 2007). Municipalities and private party contractors, Illinois Department of Transportation, and the Illinois Tollway Authority are the primary parties responsible for snow removal and road de-icing within the watershed. These parties typically dispatch snow removal crews during and immediately after snow events. The following BMPs will provide a basis for management of chloride salt application to roadways. Environment Canada has useful information and case studies providing cost/benefit information to assist in implementation (see http://www.ec.gc.ca/nopp/roadsalt/en/index.cfm). The following subsections provide the brief discussions on the practices to minimize the chloride loads.

8.3.2.1 Public Education and Staff Training

Educating the public is generally the first step in any water quality improvement campaign. Increased awareness about the application of road salt and the effects of excessive loading to waterbodies can increase community support for chloride use reduction. Information about what homeowners and businesses can do to limit chloride salt application in addition to municipal leadership should be included. The following elements could be included in the public education program:

- Informative fact sheets for public distribution. Environmental group outreach lists can be useful and the information could be in a general, adaptive form.
- Presentation or fact sheets targeted to municipal government officials.
- Public access television.
- Newspaper articles or advertisements.
- Declaration of “Limited Salt Use Areas” to highlight water quality protection and increase awareness.

Staff training is critical to reduce the quantity of road salt used as operators responsible for salt handling and application can have the largest impact on overuse and product loss. The City of Toronto achieved significant salt reduction and cost savings by implementing a salt management plan with corresponding training program (Environment Canada, 2004). Elements of a staff training program could include:

- Initial training for new employees, including on-the-job training from experienced personnel. Programs are also offered by the American Public Works Association and Northeastern Illinois Public Safety Training Academy.
- Routine annual refresher training for salt handling and application operators highlighting the impacts of road salt on water quality, infrastructure and associated costs to the public. Proper storage and handling and application equipment and techniques should be covered including record keeping and review of salt quantities required for each situation.
- Required training for private snow removal contractors generally involved in parking lot and private road snow removal. This could be done through a licensing or permitting process.

8.3.2.2 Storage and Handling

Proper storage and handling of road salt limits loss of salt to the environment and provides cost savings. The Salt Institute has published a Salt Storage Handbook (Salt Institute, 2006) with recommended practices and design criteria for storage facilities. Additionally, the Transportation Association of Canada (TAC) has published detailed BMPs for salt storage (TAC, 2003). Illinois Department of Transportation already has standard designs which can be adopted by municipalities. Existing facilities should be evaluated for improvement and bulk handling practices reviewed. Areas to focus evaluation should be protection from environmental conditions like wind and rain, storage on an impervious pad, and controlled off-site drainage. Training on proper handling and equipment inspection practices should include:

- Salt should be handled as little as possible to avoid particle breakdown and loss of material.
- Spillage should be minimized and cleaned up as soon as practicable.

8.3.2.3 Application

Proper application of salt for snow and ice control is fundamental to obtaining the desired effect of public road safety while minimizing product loss to the environment. Several guidelines and recommendations have been published including the Salt Spreading, Maintenance, Application, Rates & Timing (SMART) Learning Guide BMPs by TAC (TAC, 2005) and the Minnesota Department of Transportation handbook for snowplow operators (MN/DOT, 2005). Records should be kept of salt use for each route, during each storm, by each vehicle and by each operator. The records should be examined regularly to confirm that the target salt application rates are being met. Plowing snow just prior to salt application is good practice and if side-cast snow accumulation interferes with continued plowing, it should be removed to an offsite disposal facility. There are two alternative application methods which could increase the effectiveness of traditional rock salt application during and after snow events described below.

- Use of a pre-wetting agent has been shown to reduce wasted salt during application by traffic scatter or wind by about 25% (WTIC, 2005). Pre-wetted salt also acts more than dry salt because there is no delay waiting for a brine to form. Pre-wetting can be done onboard spreader trucks or by pre-treating salt stockpiles before loading trucks.
- Anti-icing programs should strongly be considered in conjunction with deicing programs. This involves the application of deicing agents on roads prior to ice or snow events. Correct timing for application involves use of accurate weather forecasts or weather information systems. These systems may require purchase or equipment modification and employee training. Programs can take advantage of the Illinois state-wide Road Weather Information Systems (RWIS) or provide their own means of weather condition monitoring. The Minnesota

Department of Transportation Field handbook reports that anti-icing uses about 25% of the material at a tenth of the cost of conventional deicing (MN/DOT, 2005).

8.3.2.4 Alternative Products

Non-chloride deicing products are available for purchase and agencies have well documented their use. It is recommended that a long-term pilot study be done within the watershed to determine effectiveness for this application. Section 8.7 lists alternative deicers and associated costs. Acetate deicers do not contain chloride but can be relatively expensive. Organic deicers are also somewhat expensive, but can be used in select areas or in combination with other deicing liquids. Carol Stream and McHenry County Division of Transportation have used beet-based deicers and are getting positive results.

More detailed information can be found in the Chloride Usage Education and Reduction Program Study (DRSCW, 2007) by the DuPage River Salt Creek Workgroup, posted at http://www.drscw.org/.

8.4 Implementation Actions and Management Measures for Dissolved Oxygen

Sufficient dissolved oxygen levels are critical for healthy aquatic ecosystems. Maintaining sufficient levels is a balance between diffusion and aeration inputs and chemical and biological oxygen demand. Decreased levels of DO occur when oxygen-demanding inputs are greater than the waterbody's ability for diffusion. Buffalo Creek (IL_GST) and the headwater segment of Higgins Creek (IL_GOA-02) are impaired for low DO as well as Albert Lake (IL_VGG), Half Day Pit Lake (IL_UGB), and Pond-A-Rudy (IL_UGP). Dissolved oxygen is not considered a pollutant and, therefore, the TMDL and implementation plan focus on the oxygen demand exerted by ammonia and the CBOD loading in order to achieve the DO TMDL target. In addition, elevated phosphorus levels in the three lakes impaired for DO correlated well with decreased DO levels. It is believed that addressing phosphorus loading to lakes will result in attainment of the DO water quality standard (see Section 8.6). Therefore, only the two stream segment DO reductions are addressed in the Implementation Plan. Buffalo Creek requires a 39% reduction in CBOD and 30% reduction in ammonia, while Higgins Creek requires addressing increased sediment oxygen demand (SOD) levels. Higgins Creek headwaters water quality data is limited and no SOD data exists to estimate a required percent reduction. It is recommended that additional monitoring be performed in this segment in order to more accurately characterize the oxygen demanding constituents.

8.4.1 Point Sources of Oxygen Demanding Materials

There are only a few point source dischargers to the Buffalo Creek and Higgins Creek's impaired segments. All have relatively small discharge volumes. Analysis of data indicated that all facilities have been discharging within permit limits except for Des Plaines Mobile Home Park which had occasional CBOD and ammonia exceedances. The model results indicated that the source of low DO levels in Higgins Creek was due to potentially high levels of SOD and no TMDL was developed. Therefore, no pollutant load allocation was given to Des Plaines Mobile Home Park which discharges to Higgins Creek. It is recommended that this facility continue to monitor nitrogen compounds and CBOD in the future while the source of SOD is continued to be investigated.

A TMDL was developed for Buffalo Creek which specified CBOD and ammonia waste load allocations for Alden Long Grove Rehabilitation Center and Camp Reinberg STP. These pollutant load allocations were based on permit limits and are shown in **Table 8-4**. However, Alden Long Grove

Rehabilitation Center does not have a permit limit for ammonia so no ammonia allocation was given to this facility.

Table 8-4 Point Source Allocations for Buffalo Creek IL_GST

Point Source Dischargers	NPDES ID	CBOD Allocation (lb/d)	Total Ammonia Allocation (lb/d)	DAF (MGD)	DMF (MGD)
Alden Long Grove Rehab	IL0051934	12.0	---	0.015	0.037
Camp Reinberg STP	IL0048542	1.7	1.2	0.004	0.01

The need for additional CBOD and ammonia loading controls at each facility will be evaluated through the NPDES permitting program as each facility applies for permit renewal. At this point, each facility is operating within their permit limits and reductions are not recommended. Additional monitoring could be performed at the Alden Long Grove Rehabilitation Center to get a better understanding of the contributing load from that facility.

8.4.2 MS4 and Non-Point Sources of Oxygen Demanding Materials

Land use for both the Buffalo Creek and Higgins Creek Watersheds is predominantly urban and built up (71% for Buffalo Creek and 91% for Higgins Creek) with some forested land (22% for Buffalo Creek and 7% for Higgins Creek). Waste load allocations were given to MS4s within the watershed as indicated on **Table 8-5**. As discussed in Section 8.4.1, no load allocation was given to MS4s or non-point sources within the Higgins Creek Watershed.

Table 8-5 MS4 Allocations for Buffalo Creek IL_GST

MS4 Discharger	NPDES ID	CBOD Allocation (lb/d)	Total Ammonia Allocation (lb/d)
Long Grove	ILR400219	56.35	2.34
Lake Zurich	ILR400370	20.66	0.86
Buffalo Grove	ILR400303	34.66	1.44
Kildeer	ILR400215	37.31	1.55
Deer Park	ILR400323	25.55	1.06
Barrington	ILR400285	0.20	0.01
Palatine	ILR400416	29.50	1.23
Inverness	ILR400359	0.01	0.00
Arlington Heights	ILR400282	12.19	0.51

Loading of oxygen-demanding materials can come from a variety of non-point sources. There is very little agricultural activity within the watershed; however, due to the low density urban nature of the land use, fertilizers for lawns and other landscaping can still greatly contribute nutrients and organic material to the receiving waterbody. Not only do organics require oxygen during decomposition, but oxygen is consumed in the nitrification process. Heavy loads of nutrients will support algae proliferation which will alter the diurnal DO cycle through photosynthesis and respiration. Additionally, large quantities of algae biomass die-off will decompose and deplete DO, producing hypoxia. Accumulation of these oxygen demanding materials in the bottom sediments of streams allows for a disproportionately large population of bacteria to accumulate in the upper layer of the sediments. In conjunction with sediment bacteria, biochemical and chemical processes at the sediment-water interface are driven by anaerobic compounds and exert an oxygen demand on the water column. This sediment oxygen demand is determined to be the cause of low DO levels in Higgins Creek. There is some forested land use, especially in Buffalo Creek, in which wildlife are readily abundant and contributing a background exertion of oxygen demand. Impervious surface stormwater runoff can contribute a significant load to waterbodies as the first flush can be heavily laden with organics. Pets can also have a significant contribution to excess loading of waterbodies.

Many management options are available to address CBOD and ammonia loading to streams and indirectly reduce SOD, as well. Most often they include detaining pollutant loads from stormwater runoff for some pre-treatment and a more consistent loading which the stream can handle. The following BMPs are describe in further detail in Section 8.8 and are prescribed for implementation:

- Bio-retention cells
- Filter strips and riparian buffers
- Nutrient management
- Septic system maintenance
- Street sweeping
- Vegetated swales
- Wildlife exclusion
- Wetlands

Physical processes can also affect in-stream DO concentrations by altering water temperature (oxygen saturation) and diffusion rates. Due to altered landscapes, many streams have been cut-off from their floodplain and have adjusted channel geometry. This can produce streams with low, stagnant baseflow and with little vertical channel variation. It slows oxygen diffusion rates by reducing the ability of the water column to mix and aerate. In addition, riparian vegetation can be lost and stream channels can get very wide which reduces shade and increases water temperature. Oxygen saturation is reduced at increased temperatures. Concrete lined channels, such as portions of Higgins Creek, may also increase water temperature under direct sunlight. Bank erosion is very common in degraded streams which can be a source of pollutant loading and exacerbate the degraded condition. Urban streams are characterized by high storm flows with a high pollutant carrying capacity and very low baseflows with low carrying capacity. This creates high sediment and non-point source loading during the high flows which then falls out of the water column during baseflows and contributes to SOD. The loss of stream channel variation and in-stream habitat will also reduce the biological productivity of the stream which reduces its ability to process pollutant loads.

The ambient water quality data sampling station for Buffalo Creek IL_GST is located at the downstream end of the segment. Immediately upstream of the station, Buffalo Creek runs through a golf course and just upstream of that is the Buffalo Creek Reservoir impoundment. This reservoir was created by an inline dam and most of the time is relatively shallow with nutrient enrichment issues. It is suggested that a monitoring location be setup above the reservoir in order to assess the impact of the reservoir on downstream DO concentrations. The value of this reservoir should then be evaluated and a study performed on the impoundment structure for possible modification or removal. A good example of this process is in the DuPage River Watershed where the inline impoundment creating Churchill Lagoons was removed to increase DO in the DuPage River (see www.drscw.org). On Higgins Creek, a small impoundment structure immediately upstream of the Elmhurst road bridge reduces the velocities of the creek. Removal of this structure would reduce pollutant settling (and SOD) and increase aeration, providing for benefits for water quality improvement.

Physical measures can be used to increase baseflow and aeration processes within the stream. These measures include channel modifications, the addition of riprap or pool and riffle sequences, bank stabilization. Implementation of these items can be a significant undertaking; however, the benefits are substantial and an initial detailed monitoring program of Buffalo Creek and Higgins Creek would be the first step in targeting reaches for restoration. More information about stream geomorphological restoration can be found at the USDA Natural Resource Conservation Service water quality/stream restoration website, http://go.usa.gov/Ko0.

8.5 Implementation Actions and Management Measures for Fecal Coliform

Fecal coliforms are a class of bacteria which are used as indicator microorganisms of the possible presence of pathogens with fecal origins. They indicate likely presence of incomplete treatment or untreated human or animal waste within a waterbody and can be considered a concern for human health. Buffalo Creek (IL_GST), both segments of Higgins Creek (IL_GOA-01 and IL_GOA-02), and Sylvan Lake (IL_RGZF) are impaired for fecal coliform. Targeted fecal coliform loading reductions required for each segment are: 85% for Buffalo Creek, 97% for Higgins Creek headwaters (IL_GOA-02), 50% for Higgins Creek downstream (IL_GOA-01), and 80% for Sylvan Lake.

8.5.1 Point Sources of Fecal Coliform

There are only four point source dischargers who have sanitary waste streams that would contribute to fecal coliform loading to impaired waterbodies as indicated in **Tables 8-6** and **8-7**. Neither the headwater segment of Higgins Creek (IL_GOA-02) nor Sylvan Lake contains point source dischargers in its contributing watershed. It should be noted that loading was calculated based on a 200 cfu/100mL target and permit limits for two of the point sources, Alden Long Grove Rehabilitation Center and Des Plaines Mobile Home Park, are 400 cfu/100mL. The permit limit based WLA for Higgins Creek, namely the MWRDGC Kirie WRP allocation, was large enough to comprise the entire available TMDL target loading to Higgins Creek IL_GOA-01 under moist to low flow conditions. As a result, no load allocation was available for MS4s or non-point sources in this segment for any flow condition except high flows.

Table 8-6 Fecal Coliform WLAs for Buffalo Creek IL_GST

Discharger	NPDES ID	Allocation at High Flow (Million cfu/day)	Allocation at Moist to Low Flow Conditions (Million cfu/day)	DMR Median Loading (Million cfu/day)	Design Avg Flow (MGD)	Design Max. Flow (MGD)
Alden Long Grove Rehab	IL0051934	281	114	10	0.015	0.037
Camp Reinberg STP	IL0048542	75	30	No Data	0.004	0.01

Table 8-7 Fecal Coliform WLAs for Higgins Creek IL_GOA-01

Discharger	NPDES ID	Allocation at High Flow (Million cfu/day)	Allocation at Moist to Low Flow Conditions (Million cfu/day)	DMR Median Loading (Million cfu/day)	Design Avg. Flow (MGD)	Design Max. Flow (MGD)
MWRDGC Kirie WRP	IL0047741	832,841	605,702	63	52	110
Des Plaines MHP	IL0054160	1,340	522	0	0.069	0.177

Alden Long Grove Rehabilitation Center STP has a low median fecal coliform discharge value. However, discharge data from 2002-2008 indicates that the facility occasionally discharged high concentrations of fecal coliform to Buffalo Creek. MWRDGC Kirie WRP is a large municipal waste water treatment plant discharging to a relatively small stream. As a result, a large amount of the stream flow is comprised of this effluent and though a couple of high concentrations have occurred, the effluent normally has low fecal coliforms. Des Plaines Mobile Home Park has had high concentrations in the past, but recent data indicates that the discharge now has low concentrations and is a very small discharge. It should also be noted that the segment upstream of the point sources on Higgins Creek is also impaired for fecal coliform bacteria. Point sources are not considered to be significant contributors of fecal coliform to either creek.

The need for additional fecal coliform controls at each facility will be evaluated through the NPDES permitting program as each facility applies for permit renewal. All facilities already have disinfection processes in place and have had relatively few exceedances. However, improving disinfection processes can improve water quality of receiving waterbodies. Disinfection can be improved by optimizing the current disinfection process or installing alternative treatment options. Commonly used alternatives to chlorine include sodium hypochlorite, calcium hypochlorite, chlorine dioxide, ozone and UV radiation technologies. Each treatment facility has its own wastewater characteristics and treatment process so disinfectant effectiveness has to be evaluated through detailed analysis specific to each facility.

8.5.2 MS4 and Non-Point Sources of Fecal Coliform

Land use for both the Buffalo Creek and Higgins Creek Watersheds is predominantly urban and built up (71% for Buffalo Creek and 91% for Higgins Creek) with some forested land (22% for Buffalo Creek and 7% for Higgins Creek). Land use for Sylvan Lake has agricultural influence (38%) in addition to the urban and built up (39%) and forested land (15%). Load allocations were given to MS4s within the watershed as indicated on **Tables 8-8** to **8-11**. As discussed in Section 5.1, no load allocation was available for MS4s or non-point sources in the Higgins Creek IL_GOA-01 Watershed under moist to low flow conditions. It is expected that non-point sources will contribute fecal coliform loads to Higgins Creek during these flow regimes and MS4s will contribute some during moist and mid-range flows. As such, implementation actions should be taken to address MS4 and non-point sources to minimize as much MS4 and diffuse source loading as possible. The size of the Kirie WWTP discharge in comparison to the streamflow requires that extremely productive MS4 and non-point source pollution management.

Table 8-8 Fecal Coliform MS4 Allocations for Buffalo Creek IL_GST

MS4 Discharger	NPDES ID	Allocation at High Flows (Million cfu/day)	Allocation at Moist Conditions (Million cfu/day)	Allocation at Mid-Range Flows (Million cfu/day)
Long Grove	ILR400219	46,658	12,656	5,059
Lake Zurich	ILR400370	25,834	7,007	2,801
Buffalo Grove	ILR400303	34,551	9,372	3,746
Kildeer	ILR400215	13,813	3,747	1,498
Deer Park	ILR400323	13,551	3,675	1,469
Barrington	ILR400285	17,910	4,858	1,941
Palatine	ILR400416	48,280	13,096	5,235

Inverness	ILR400359	25,321	6,868	2,745
Arlington Heights	ILR400282	60,637	16,447	6,574

Table 8-9 Fecal Coliform MS4 Allocations for Higgins Creek IL_GOA-01

MS4 Discharger	NPDES ID	Allocation at High Flows (Million cfu/day)	Allocation at Moist Conditions (Million cfu/day)	Allocation at Mid-Range Flows (Million cfu/day)
Arlington Heights	ILR400282	8,172	1,890	803
Rolling Meadows	ILR400435	174	40	17
MT Prospect	ILR400393	9,143	2,115	898
Des Plaines	ILR400325	15,160	3,507	1,489
Elk Grove	ILR400334	32,567	7,534	3,199
Chicago	ILR400173	442	102	43

Table 8-10 Fecal Coliform MS4 Allocations for Higgins Creek IL_GOA-02

MS4 Discharger	NPDES ID	Allocation at High Flows (Million cfu/day)	Allocation at Moist Conditions (Million cfu/day)	Allocation at Mid-Range Flows (Million cfu/day)
Arlington Heights	ILR400282	12,530	5,107	3,822
Rolling Meadows	ILR400435	272	111	83
MT Prospect	ILR400393	13,989	5,702	4,267
Des Plaines	ILR400325	1,835	748	560
Elk Grove	ILR400334	45,540	18,564	13,892

Table 8-11 Fecal Coliform MS4 Allocations for Sylvan Lake IL_RGZF

MS4 Discharger	NPDES ID	Allocation (Million cfu/day)
Hawthorn Woods	ILR400209	187,415
Long Grove	ILR400219	378

Fecal coliform loading can be attributed to non-point sources where animal or human waste is generated or being transported. There are very few agricultural activities in the Buffalo Creek and Higgins Creek Watersheds. However, Sylvan Lake has active agricultural practices including grazing livestock. Proper management techniques must be implemented to prevent agricultural runoff from reaching tributaries to Sylvan Lake.

Additional contributors of fecal coliform loading to waterbodies are resident and migratory waterfowl. The estimated average spring population of giant Canada geese in Illinois during 2001 to 2003 was 91,000 individuals and is expected to experience an annual growth of 6% (USFWS, 2011). There are wildlife exclusion and harassment techniques which can reduce nuisance populations of wildlife. Vegetative native plant buffer strips are major deterrents to Canada geese. These can be planted along stream corridors and lake shorelines. Buffer strips and riparian areas not only deter geese from congregating along waters and prevent erosion but can decrease phosphorus, suspended solids and fecal coliform from runoff.

Irresponsible ownership of domestic animals or pets can contribute large amounts of fecal coliform. High traffic areas can install waste disposal receptacles along with sanitary collection supplies or enact responsible owner ordinances.

Existing sanitary sewer collection systems serve a large part of the Higgins Creek and Buffalo Creek watersheds and some of the Sylvan Lake watershed. Aging sanitary sewer infrastructure can be a source of fecal coliform to waterbodies and must be mitigated with a comprehensive management, operation, and maintenance program (MOM). USEPA Region 4 provides a guideline for preparing MOM programs in USEPA, 2005, and Region 1 provides a template document which can be found by searching the USEPA website. Many municipalities and counties only maintain the main sewer lines and the homeowner is responsible for all lateral lines on the property. These can be difficult and expensive to maintain or repair and so many property sewer connections are degraded. The City of Milwaukee had an alternative analysis performed to identify potential sewer lateral maintenance programs, including potential funding options (UW-Madison, 2010). Finally, the areas that are unsewered are dependent on small package wastewater treatment plants or septic systems. Septic systems must be properly maintained in order to process waste water to an acceptable level. Dysfunctional or poorly maintained systems are very large sources of fecal coliform. Lake County Health Department has very useful information on how to properly maintain a septic system. Information can be found on their website at http://www.lakecountyil.gov/Health/want/Pages/SepticWell.aspx.

The following structural BMPs are recommended for implementation in Buffalo and Higgins Creek Watershed, which are described in further detail in Section 8.7:

- Filter strips and riparian buffers
- Septic system maintenance
- Wetlands or runoff detention
- Wildlife exclusion

The following structural BMPs are recommended for the Sylvan Lake Watershed to reduce fecal coliform loading to watershed, as discussed in detail in Section 8.7:

- Filter strips
- Livestock and wildlife exclusion
- Septic system maintenance
- Wetlands or runoff detention

8.6 Implementation Actions and Management Measures for Phosphorus

Phosphorus is a nutrient critical to healthy ecosystems at low concentrations. Over enrichment of phosphorus can result in aquatic ecosystem degradation when nitrogen is also available in sufficient quantities. Nutrient enrichment can result in rapid algal growth as available nutrients and carbon dioxide are consumed. This response can alter pH, decrease DO which is critical to other aquatic biota, alter the diurnal DO pattern, and even create anoxic conditions. In addition, this reduces water clarity and light penetration and is aesthetically displeasing.

Phosphorus is critical for plant growth and is often the limiting nutrient. The form that can be readily used by plants and therefore can stimulate nuisance algae blooms is orthophosphate (PO_4^{3-}). The amount of phosphorus tied up in the nucleic acids of food and waste is actually quite low. This organic material is eventually converted to orthophosphate by bacteria.

Phosphorus levels in water are related to oxygen levels in that nutrient enrichment promotes the growth of nuisance algae that subsequently dies and serves as food for bacteria. Oxygen is used by bacteria that consume dead organic matter. Plant photosynthesis produces oxygen, but at night, respiration reverses the process and consumes oxygen. Under these conditions, oxygen can be depleted unless it is replenished from the air. Conversely, oxygen concentrations can become supersaturated during the day, due to abnormally high amounts of photosynthesis. The significant swing in diurnal DO levels causes stress to both fish and invertebrate communities.

Inputs of phosphorus originate from both point and nonpoint sources. Most of the phosphorus discharged by point sources is soluble. Another characteristic of point sources is they have a continuous impact and are human in origin, for instance, effluents from municipal sewage treatment plants and permitted industrial discharges. The contribution from failed on-site wastewater treatment systems can also be significant, especially if they are concentrated in a small area. The phosphorus concentration in raw waste water is generally 8-10 mg/l and after secondary treatment is generally 4-6 mg/l.

The non-point sources of phosphates include: natural decomposition of rocks and minerals, stormwater runoff, agricultural runoff, erosion and sedimentation, atmospheric deposition, and direct input by animals/wildlife (Oram, 2012). Phosphorus load from rural storm water varies depending on land use and management practices and includes contributions from livestock feedlots and pastures and row crop agriculture. Crop fertilizer includes granular inorganic types and organic types such as manure or sewage sludge. Pasture land is especially a concern if the livestock have access to the stream. Large feedlots with manure storage lagoons create the potential for overflows and accidental spills.

A characteristic of phosphorus discharged by nonpoint sources is that the impact is intermittent and is most often associated with storm water runoff. Sedimentation can impact the physical attributes of the stream and act as a transport mechanism for phosphorus. Phosphorus from nonpoint sources is generally insoluble or particulate, and most of this phosphorus is bound tightly to soil particles and enters streams from erosion, although some comes from tile drainage.

Erosion is worse on streams without any riparian buffer zone and streams that are channelized because they no longer have a functioning flood plain and cannot expel sediment during flooding. Additionally, phosphorus transport to the stream decreases with decreased sedimentation. Oxygen levels must also be considered, because phosphorus is released from sediment at higher rates under anoxic conditions; therefore as mentioned earlier, lack of tree and shade not only increase water temperature and photosynthesis but also decrease oxygen levels and create anoxic conditions.

Various BMPs such as riparian buffers, and agricultural tile management not only reduce soil erosion, but can also reduce the sediment and associated phosphorus load within runoff with entrapment. BMPs to reduce total phosphorus can also affect sediment. BMPs that serve to restrain overland flow and allow infiltration will reduce total phosphorus (TP) loads and allow sediment time to settle out many of the BMPs proposed will reduce both TP and sediment.

Considering the linkages between phosphorus and oxygen outlined above, it is expected that the measures taken to reduce the loads of phosphorus from identified point sources and nonpoint source to meet the Waste Load Allocations and Load Allocations in this TMDL, will improve the fluctuations and oxygen levels and increase the biotic integrity scores for fish and macroinvertebrate communities in the impaired water bodies.

Twelve lakes are impaired for phosphorus including Beck Lake (IL_RGE), Big Bear Lake (IL_WGZU), Bresen Lake (IL_UGN, Buffalo Creek Lake (IL_SGC), Big Bend Lake (IL_RGL), Countryside Lake (IL_RGQ), Diamond Lake (IL_RGB), Forest Lake (IL_RGZG), Lake Charles (IL_RGZJ), Little Bear Lake (IL_WGZV), Salem-Reed Lake (IL_WGK), and Sylvan Lake (IL_RGZF). As discussed in Section 4.0 and Section 7.3, Albert Lake (IL_VGG), Half Day Pit (IL_UGB) and Pond-A-Rudy (IL_UGP) are too small to qualify for phosphorus impairments according the phosphorus water quality standards. However, phosphorus TMDLs were developed as surrogates to address DO impairments and so the waterbodies will also be included in this section. Targeted phosphorus loading reductions required for each lake are presented in **Table 8-12**.

Table 8-12 Target Phosphorus Loading Reductions for Lakes in the Des Plaines/Higgins Creek Watershed

Waterbody	Percent Reduction	Waterbody	Percent Reduction
Albert Lake	89	Forest Lake	63
Beck Lake	10	Half Day Pit	80
Big Bear Lake	33	Lake Charles	13
Big Bend Lake	74	Little Bear Lake	7
Bresen Lake	59	Pond-A-Rudy	67
Buffalo Creek Lake	65	Salem-Reed Lake	69
Countryside Lake	51	Sylvan Lake	35
Diamond Lake	9		

8.6.1 Point Sources of Phosphorus

There are only two point source dischargers located within the watershed of a lake impaired for phosphorus as indicated in **Table 8-13**. However, the Des Plaines River occasionally floods into both Big Bend Lake and Half Day Pit. The River was modeled as a nonpoint source so it was included in this section as indicated in **Tables 8-14** and **8-15**. LAs were given to the Des Plaines River as a whole as this TMDL only focused on Big Bend Lake, not on the main stem of the Des Plaines River.

Table 8-13 Phosphorus WLA for Buffalo Creek Lake IL_SGC

Discharger	NPDES ID	Allocation (lbs/day)	DMR Average Loading (lbs/day)	Design Average Flow (MGD)	Design Maximum Flow (MGD)
Alden Long Grove Rehab	IL0051934	0.448	No Data	0.015	0.037
Camp Reinberg STP	IL0048542	0.117	No Data	0.004	0.01

Table 8-14 Phosphorus LA for Big Bend Lake IL_RGL From Des Plaines River Inundation

Discharger	NPDES ID	Allocation (lbs/day)	DMR Average Loading (lbs/day)	Design Average Flow (MGD)	Design Maximum Flow (MGD)
Des Plaines River	NA	1.376	NA	NA	NA

Table 8-15 Phosphorus LA for Half Day Pit IL_UGB From Des Plaines River Flooding

Discharger	NPDES ID	Allocation (lbs/day)	DMR Average Loading (lbs/day)	Design Average Flow (MGD)	Design Maximum Flow (MGD)
Des Plaines River	NA	0.340	NA	NA	NA

The need for phosphorus controls at each facility will be evaluated through the NPDES permitting program as each facility applies for permit renewal. Both Alden Grove Rehabilitation and Health Care Center and Camp Reinberg STP will be required to monitor for phosphorus in their next permitting cycle. This will provide observed data which can be used to evaluate the actual influence each of these facilities' discharges have on Buffalo Creek Lake phosphorus concentrations.

The Des Plaines River occasionally floods into both Big Bend Lake and Half Day Pit. This occurs during high flow conditions in the River when phosphorus concentrations are generally greatest. Conservative waste load allocations were developed and to efficiently address phosphorus in both lakes, it is suggested that a site specific study be conducted to characterize the phosphorus concentration of the Des Plaines River at the flooding location and the volume of floodwater received by each lake. This would characterize the influence of the Des Plaines River on phosphorus concentrations within both Big Bend Lake and Half Day Pit. Phosphorus in the Des Plaines River could then be more accurately addressed.

8.6.2 MS4 and Non-Point Sources of Phosphorus

Land use for phosphorus impaired lakes is summarized in **Table 8-16** and is predominantly urban and built up land. Bresen Lake, Countryside Lake, Diamond Lake and Sylvan Lake have significant agricultural components. Forested land use ranges from approximately 6% in Big Bear and Little Bear Lake Watershed to 57% in Beck Lake Watershed.

Table 8-16 Land Use for Lakes Assigning Phosphorus Allocations in the Des Plaines/Higgins Creek Watershed

Watershed	Agricultural land	Forested land	Surface water	Urban and built-up land:	Wetland
Entire Des Plaines River Watershed	11.8%	16.8%	2.7%	66.6%	2.1%
Albert Lake	1.8%	15.6%	1.9%	79.5%	1.2%
Beck Lake	---	56.5%	10.8%	30.7%	2.0%
Big Bear and Little Bear Lake	1.7%	5.9%	3.7%	88.1%	0.7%
Big Bend Lake	---	17.5%	6.2%	74.1%	2.2%
Bresen Lake	19.1%	11.7%	10.4%	52.4%	6.4%
Buffalo Creek Lake	1.9%	21.9%	2.0%	70.8%	3.3%
Countryside Lake	45.1%	16.2%	10.5%	26.4%	1.7%
Diamond Lake	32.6%	12.7%	8.5%	44.5%	1.7%
Forest Lake	5.3%	8.4%	7.6%	77.5%	1.2%
Half-day Pit	---	17.8%	41.9%	31.9%	8.3%
Lake Charles	2.2%	6.6%	2.2%	88.5%	0.6%
Pond-A-Rudy	11.1%	35.0%	5.7%	38.2%	10.0%
Salem-Reed Lake	11.3%	18.9%	27.6%	35.6%	6.6%
Sylvan Lake	38.0%	15.3%	5.9%	39.2%	1.6%

Load allocations were given to MS4s within the watershed as indicated on **Tables 8-17** to **8-31** including the percent area that each MS4 covers in each waterbody's contributing watershed.

Table 8-17 Phosphorus MS4 Allocations for Albert Lake IL_VGG

MS4 Discharger	NPDES ID	Area of Watershed (%)	Allocation (lbs/day)
Lake Zurich	ILR400370	47	0.620
Long Grove	ILR400219	17	0.226
Kildeer	ILR400215	36	0.475

Table 8-18 Phosphorus MS4 Allocations for Beck Lake IL_RGE

MS4 Discharger	NPDES ID	Area of Watershed (%)	Allocation (lbs/day)
Glenview	ILR400343	32	0.117

Table 8-19 Phosphorus MS4 Allocations for Big Bear Lake IL_WGZU

MS4 Discharger	NPDES ID	Area of Watershed (%)	Allocation (lbs/day)
Libertyville	ILR400374	14	0.260
Mundelein	ILR400395	54	1.030
Vernon Hills	ILR400252	29	0.559

Table 8-20 Phosphorus MS4 Allocations for Big Bend Lake IL_RGL

MS4 Discharger	NPDES ID	Area of Watershed (%)	Allocation (lbs/day)
Glenview	ILR400343	8	0.009
Des Plaines	ILR400325	13	0.015

Table 8-21 Phosphorus MS4 Allocations for Bresen Lake IL_UGN

MS4 Discharger	NPDES ID	Area of Watershed (%)	Allocation (lbs/day)
Hawthorn Woods	ILR400209	64	0.199

Table 8-22 Phosphorus MS4 Allocations for Buffalo Creek Lake IL_SGC

MS4 Discharger	NPDES ID	Area of Watershed (%)	Allocation (lbs/day)
Arlington Heights	ILR400282	5	0.357
Barrington	ILR400285	0.1	0.003
Buffalo Grove	ILR400303	1	0.075
Deer Park	ILR400359	10	0.745
Inverness	ILR400359	<0.1	0.0005
Kildeer	ILR400215	14	1.090
Lake Zurich	ILR400370	8	0.602
Long Grove	ILR400219	21	1.600
Palatine	ILR400416	11	0.864

Table 8-23 Phosphorus MS4 Allocations for Countryside Lake IL_RGQ

MS4 Discharger	NPDES ID	Area of Watershed (%)	Allocation (lbs/day)
Hawthorn Woods	ILR400209	14	0.261
Long Grove	ILR400219	<0.1	0.0005
Mundelein	ILR400395	18	0.183

Table 8-24 Phosphorus MS4 Allocations for Diamond Lake IL_RGB

MS4 Discharger	NPDES ID	Area of Watershed (%)	Allocation (lbs/day)
Mundelein	ILR400395	35	0.556
Long Grove	ILR400219	7	0.108

Table 8-25 Phosphorus MS4 Allocations for Forest Lake IL_RGZG

MS4 Discharger	NPDES ID	Area of Watershed (%)	Allocation (lbs/day)
Hawthorn Woods	ILR400209	37	0.189
Lake Zurich	ILR400370	29	0.150

Table 8-26 Phosphorus MS4 Allocations for Half Day Pit IL_UGB

MS4 Discharger	NPDES ID	Area of Watershed (%)	Allocation (lbs/day)
Lincolnshire	ILR400375	12	0.205

Table 8-27 Phosphorus MS4 Allocations for Lake Charles IL_RZGJ

MS4 Discharger	NPDES ID	Area of Watershed (%)	Allocation (lbs/day)
Libertyville	ILR400374	16	0.300
Mundelein	ILR400395	63	1.171
Vernon Hills	ILR400252	15	0.282

Table 8-28 Phosphorus MS4 Allocations for Little Bear Lake IL_WGZV

MS4 Discharger	NPDES ID	Area of Watershed (%)	Allocation (lbs/day)
Libertyville	ILR400374	12	0.231
Mundelein	ILR400395	49	0.915
Vernon Hills	ILR400252	35	0.661

Table 8-29 Phosphorus MS4 Allocations for Pond-A-Rudy IL_UGP

MS4 Discharger	NPDES ID	Area of Watershed (%)	Allocation (lbs/day)
Hawthorn Woods	ILR400209	58	0.072

Table 8-30 Phosphorus MS4 Allocations for Salem Reed Lake IL_WGK

MS4 Discharger	NPDES ID	Area of Watershed (%)	Allocation (lbs/day)
Long Grove	ILR400219	99	0.193

Table 8-31 Phosphorus MS4 Allocations for Sylvan Lake IL_RGZF

MS4 Discharger	NPDES ID	Area of Watershed (%)	Allocation (lbs/day)
Hawthorn Woods	ILR400209	17	0.172
Long Grove	ILR400219	0.1	0.0004

Non-point source phosphorus loading can originate from many anthropological and natural sources. There is a fair amount of land use variation between phosphorus impaired lakes in the Des Plaines/Higgins Creek Watershed. In general, these are urban land use dominated watersheds with some remaining forest and open space. Urban dominated systems are very susceptible to sporadic, intense stormwater runoff conditions due to increased impervious surfaces like roads and parking lots. This creates periods of time where waterbodies have very little water volume input followed by periods where large volumes of water are moving at increased velocities to waterbodies. Nutrients and other pollutants accumulate on urban surfaces during dry periods until they are transported by stormwater runoff to the waterbody in high concentrations. This adds to the pulsing effect which is very difficult for receiving waterbodies to handle.

Phosphorus adsorbs to soil particles. Under increased velocities, water has an increased soil carrying capacity and erosion becomes an issue. This is exacerbated during construction activities when soil has been exposed and can be easily transported offsite. BMPs targeting phosphorus loading aim to reduce runoff velocities and detain phosphorus laden stormwater where some bio-uptake can occur along with a slow, consistent discharge of the runoff water to the receiving waterbody (e.g. detention/retention ponds and swales). Other methods employ soil interception techniques to remove sediment from runoff (e.g. silt fence). Construction sites over one acre must obtain a stormwater permit which includes soil and stormwater management plans during and post-construction. Guidance for plan development and suggested BMPs can be found at http://www.epa.state.il.us/water/permits/storm-water/construction.html.

Low impact development (LID) techniques such as permeable or porous pavements, rain gardens, and vegetated rooftops can be used to reduce the intensity of stormwater runoff events. LID information can be found at USEPA LID site, http://www.epa.gov/owow/NPS/lid/. These processes combine to produce increased loading of phosphorus from urban runoff.

In addition to treating the transport of phosphorus to waterbodies, the loading of phosphorus can be addressed. Landscaping fertilizers for private residences and businesses contain nutrients for plant growth, but over-fertilization produces an excess of phosphorus that will wash away. Lawn service firms are already prohibited from using certain high phosphorus fertilizers. Maine, Minnesota, and Wisconsin have enacted statewide bans on the sale or use of lawn fertilizers that contain phosphorus. Lake County provides a list of vendors who carry phosphorus free fertilizers, http://www.lakecountyil.gov/Stormwater/LakeCountyWatersheds/BMPs/Pages/LandscapeDesignMaint.aspx.

A few of the waterbodies still have agricultural components that have yet to be converted to urban use as these watersheds are at the edge of the City of Chicago urban sprawl. Runoff from agriculture contains livestock waste and/or nutrients from exposed soil or over fertilized crops. In order to maximize productivity, the maximum extent of land is sometimes used. This can leave waterbodies with little protection from upgradient crops or allow livestock in the waterbody itself. The following

BMPs are recommended for implementation in phosphorus impaired lake watersheds. The details of these BMPs are described in **Section 8.7**.

- Conservation Tillage
- Filter strips and riparian buffers
- Livestock exclusion
- Nutrient management
- Sediment control basins
- Septic system maintenance
- Street sweeping
- Wetlands

8.7 Lake County Health Department Implementation Actions and Management Measures for Lakes

Along with phosphorus, many of the lakes are impaired for total suspended solids and aquatic algae. Albert, Big Bear, Big Bend, Bresen, Buffalo Creek, Countryside, Diamond, Forest, Half-day Pit, Charles, Little Bear, Pond-a-Rudy, Salem-Reed and Sylvan lakes are impaired for total suspended solids. Beck, Big Bear, Big Bend, Bresen, Countryside, Diamond, Charles, Little Bear, Pond-a-Rudy and Salem-Reed are impaired for excessive aquatic plants. Along with controls and BMPs for phosphorus, other actions are available in the Lake County Health Department (LCHD) detailed lake reports, http://www.lakecountyil.gov/Helth/want/Pages/LakeReports.aspx.

Albert Lake is impaired due to dissolved oxygen, phosphorus and total suspended solids. Carp are a source of resuspended sediment/phosphorus from the bottom of the lake. The high level of sediment in the water decreases light penetration and growth of vegetation. Corrective measure to control the carp in the lake could have a beneficial effect on lowering suspended solids and phosphorus levels in the water. The lake is also shallow as a result of the Lake Zurich sewage treatment plant effluent discharged several decades ago. Although this plant is not longer in service, the lake still has a high sediment load as a result. With any increase in depth, the lake would not be as susceptible to wind mixing. This would result in less resuspension of solids/phosphorus. Water clarity would increase and plant growth would allow oxygen levels to increase.

Big Bear/ Little Bear Lakes are impaired due to phosphorus, total suspended solids and aquatic plants. The majority of the shoreline is being mowed to the edge of the lake. This not only increases erosion along the bank, but welcomes geese inhabitants. Buffer strips along edges, at least 30 feet in width, are recommended throughout the shoreline. Exotic plants species seem to be a problem in the shoreline area and native plants are recommended in buffer strips. High phosphorus levels lead to increased nuisance algal growth that uses the resuspended nutrients for growth. Decreasing the phosphorus/sediment should decrease the algal growth leading to increased clarity and plant growth.

Bresen Lake is impaired due to phosphorus, total suspended solids and aquatic plants. The lake is managed privately where herbicides are applied for excessive plant growth. The LC recommends a change in the herbicide management. It is thought that excessive amounts of herbicide may lead to the loss of too much plant growth. Plants help stabilize the bottom sediments and without any, resuspension can be a problem. Also, part of the shoreline is mowed up to the shoreline which leads to erosion. Buffer strips are recommended. This lake receives water from Pond-a-Rudy. Any decrease in phosphorus from this source, will benefit this lake also.

Buffalo Creek is impaired due to dissolved oxygen, phosphorus and total suspended solids. The reservoir receives high loads of nutrients and sediment from upstream waters. Carp are also causing resuspension problems. Decreasing upstream levels of phosphorus and suspended solids is recommended. There are shoreline erosion problems in this lake and stabilization techniques are mentioned in the LC report. Buffer strips can be one of the least inexpensive methods to stabilize shorelines. They are also recommended upstream of the lake to reduce nutrients. Other watershed recommendations include reducing stormwater, improving fertilizer techniques and conservation practices for agricultural land.

Countryside Lake is impaired due to phosphorus, total suspended solids and aquatic plants. The lake is part of the IEPA Volunteer Lake Monitoring Program (VLMP) and has a lake association (CLU). Implementation activities include native vegetated shorelines, aquatic plant control plans, improving septic systems, removing pet wastes, and actions to reduce nutrients and sediment from the upper watershed. The CLU has already banned phosphorus from lawn fertilizers. In recent years, the lake has seen improvement trends in water quality.

Diamond Lake is impaired due to phosphorus, total suspended solids and aquatic plants. Most of the water clarity problems on this glacial lake are due to suspended sediment resuspended from the bottom from wind, powerboats and carp activities. This is a very suburban watershed and over half of lakeside owners have a seawall on the shoreline. Recommendations include native plant buffer strips, aquatic plant controls for specific areas and other improvements to naturalize areas.

Forest Lake is impaired due to phosphorus and total suspended solids. This lake was a former wetland area that was impounded. Most of the lake belongs to the Forest Lake Community Association. There is a lack of aquatic plants which provide sediment stability. Turbidity and aquatic algae have decreased water clarity. Recommendations include providing native aquatic vegetation, eliminating common carp and improving habitat.

Half Day Pit is impaired due to dissolved oxygen, phosphorus and total suspended solids. This water is an old borrow pit. Low water clarity has been attributed to resuspension of sediment from carp activity and backflow from the Des Plaines River. There are also high measures of TDS and chlorides most likely the result of deicing salt used on roadways. Moderate and severe shoreline erosion exists on the lake. It is a very small watershed and any improvements to decreasing sedimentation and erosion will increase clarity.

Lake Charles is impaired due to phosphorus, total suspended solids and aquatic algae. There is no public access to the lake with the exception of the golf course. It is only used for aesthetic and irrigation purposes for the course. The watershed is very suburban/residential. Watershed control options such as proper construction practices and low phosphorus fertilizers are recommended along with buffer strips along the golf course streams and lake will reduce nutrients. There is also a strong carp population that causes sediment to be resuspended.

Pond-A-Rudy is impaired due to dissolved oxygen, phosphorus, total suspended solids and aquatic plants. The lake was previously a slough that was dammed and feeds water into Bresen Lake. At some point in time the dam was removed and the area reverted back to its original state so it is shallow and filled in with vegetation. It is a very productive wetland and has naturally occurring swings of dissolved oxygen. Aquatic life found in the lake includes species tolerable to lower dissolved oxygen or adaptive in that they can move outside of the lake during hard freezes. This is a high quality wetland that is not suited for anything else. It is a very small watershed and the only recommendation is removal of exotic vegetative species.

Salem-Reed Lake is impaired due to phosphorus, total suspended solids and aquatic plants. This lake was previously a wetland area and most of it is owned privately by CF Industries. A small parcel is owned by the Long Grove Park District. This water has high phosphorus and excessive aquatic algae. Recommendations include an algal management plan, buffer strips, removal of exotic species and erosion control practices for the shoreline.

Sylvan Lake is impaired due to fecal coliform, phosphorus and total suspended solids. The river was dammed to create this lake and soon after the Sylvan Lake Management Associate was formed for management issues. Over management from herbicides and grass carp have led to too little aquatic plants existing in the lake. Common carp are adding to the problem because they resuspend solids in the sediment which decreases water clarity. Recommendations include naturalizing shoreline areas and removal of exotic species.

8.8 BMPs

Controlling pollutant loading to the impaired waterbodies in the Des Plaines/Higgins Creek Watershed will involve implementing the suggested BMPs from Section 8.6. This section provides a more detailed description of the common BMPs previously mentioned, including their effectiveness and estimate cost.

8.8.1 Bioretention Cells

Bioretention uses soil, plants, and microbes to treat stormwater prior to infiltration or discharge. Stormwater is routed through either rain gardens or bioretention cells and allowed to infiltrate. Percolation through soil allows for filtration and treatment of the stormwater. Impermeable liners are sometimes used to capture water prior to reaching the water table so that it can be discharged to surface waters or other BMPs; some bioretention cells and rain gardens will allow the water to percolate to the water table (MassDEP 2008). A variety of vegetation can be planted for pollutant uptake with the ultimate goal to provide vegetation particularly effective at reducing particular pollutants of concern.

<u>Effectiveness</u>

Bioretention is extremely effective at reducing TSS, metals, and nutrients but insufficient data exist to determine the removal efficiencies for fecal coliform. Total phosphorous reductions have been observed to range from 30% to 90%.

<u>Cost</u>

Costs for bioretention BMPs vary greatly based on the size, the drainage area, site constraints, type of vegetation, the pollutants of concern, and inclusion of additional BMPs. Bioretention is a relatively low-cost technology with subsequent maintenance dependent on the type of vegetation planted at the site. They are typically installed in areas that would have been landscaped, thus the true cost is less than the construction cost reported. Estimated costs from Brown and Schueler (1997) are approximately $6.80 per cubic foot of water treated.

8.8.2 Constructed Wetlands

Constructed wetlands are manmade wetlands designed for treatment of stormwater. A combination of biogeochemical processes, plant uptake, stormwater retention and settling can allow for efficient pollutant removal. Wetlands are designed to accommodate a known volume of stormwater, and vegetation is selected based on the pollutant of concern. Stormwater is routed through the wetland which acts as a filter.

<u>Effectiveness</u>

Constructed wetlands have demonstrated the ability to remove up to 80% TSS, 40% to 60% for total phosphorus, 20% to 85% for metals, and up to 75% for pathogens. The effectiveness of the pollutant removal is highly dependent on the pollutants of concern, site specific constraints, and the volume of required treatment. In addition to the benefit of pollutant removal, constructed wetlands also serve as wildlife habitat and add aesthetic value to communities (MassDEP 2008).

<u>Cost</u>

The relative cost of constructing a wetland can be high depending on the level of design and the amount of treatment required. Also, land constraints can be problematic as the size of such wetlands can be significant depending on the application. While subsequent maintenance is not significant in terms of cost, constructed wetlands are susceptible to drought periods and may require additional monitoring during such periods (MassDEP 2008). A cost equation developed by Brown and Schueler (1997) generally results in around $57,000 for a one acre-foot treatment wetland. Wet ponds with well designed aesthetics have been shown to increase property value, which can help offset some of the construction cost. Additionally, wetlands are long lived treatment options which can spread initial investment over a long time period.

8.8.3 Conservative Tillage

Conservative tillage is a practice used to reduce exposed soil during crop cultivation. This effectively reduces tilled crop erosivity when exposed to wind and/or stormwater runoff. Conservation tillage maintains at least 30% of the soil surface covered by residue after planting the next year's crop. No-till, strip-till, ridge-till and mulch-till are each separate methods requiring different types of specialized or modified equipment and adaptations in management. This practice reduces wind and water soil erosion, however, it requires additional herbicide to control weed growth.

<u>Effectiveness</u>

Conservative tillage practices can remove up to 45% of the dissolved and total phosphorus from runoff and 60%-90% of sediment erosion depending on the method according to the Minnesota Department of Agriculture. Generally, the more area left untilled, the less soil erosion.

<u>Cost</u>

Conservative tillage requires specialized equipment, but decreases fuel and labor costs. The Food and Agriculture Organization of the United Nations Natural Resources and Environment Department reports that conventional tillage is approximately 1.13 times more expensive than conservation tillage methods. According to the University of Missouri Extension, costs for corn and soybean production under conservation tillage are approximately the same as no tillage.

8.8.4 Filter Strips and Riparian Buffers

Filter strips are a created or preserved area of vegetation designed to intercept runoff and entrap sediment and other pollutants by reducing runoff velocity. These can be placed along impervious areas where sheet flow occurs. Riparian buffers are similar, but should consist of native species and are positioned along streams or lakes. An added benefit is that slowing the runoff aids in infiltration and can assist in stabilizing bank erosion. Sediment and pollutants are removed by filtration, deposition, infiltration, absorption, and vegetative uptake (AISWCD, 2009).

Effectiveness

Provided that the correct filter strip design criteria have been followed, nearly 80% of the maximum potential settleable solids removal can be achieved with an even greater efficiency if the strip length is increased (AISWCD, 2009). Riparian buffers of 30 ft wide have shown 25-30% removal of phosphorus and 70-90% removal of sediment, while 90 ft wide buffers have shown 70-80% phosphorus removal (NCSU, 2002).

Cost

Constructed filter strip costs can be $13,000 to $30,000 per acre according to www.lakesuperiorstreams.org. However, if proper planning is performed during land development, filter strips can simply be untouched land and costs are only associated with loss of the use of the filter strip area or riparian buffer.

8.8.5 Livestock and wildlife exclusion

Livestock access to lakes and streams can increase bank erosion, trample riparian buffers causing short circuiting of pollutant treatment, and provide direct input of manure to the waterbody. Exclusion or restricting access to streams and lakes with fencing help reduce pollutant loads from livestock and wildlife. Fencing should be placed outside of the riparian area to prevent manure from being entrained during flooding. Fencing can also be used to keep pets and some wildlife away from waterbodies. Another method is to limit access of people to all areas of the waterbody which indirectly keeps a large percentage of pet waste at a distance from the waterbody. Waterfowl are an issue for phosphorus and fecal coliform loading at lakes and slow moving streams. Acoustic devices and other repellants can be used to stress nuisance waterfowl so they avoid congregating in areas.

Effectiveness

Exclusion reduces direct deposition of animal waste as well as lake and streambank trampling. USEPA (2003) indicates a 15 to 49% reduction in phosphorus loading as a result of cattle exclusion practices.

Cost

Depending on type of fencing used for exclusion, NRCS indicates that capital costs can range from $23 to $44 per head of cattle.

8.8.6 Nutrient Management

Commercial and manure fertilizers applied to farmland account for a significant source of nutrient loading. Development of a nutrient management plan is one of the most effective BMPs for agricultural phosphorus loading management. The plan should address fertilizer application rates, methods and timing. Soil testing is done to identify fertilizer needs for crop growth support. The method of application can be adjusted from soil surface to deep bands next to the seed zone. This method reduces the amount of phosphorus available for transport to waterbodies. Fertilizer should not be applied when the chance of a large rain event is high or frozen or snow covered ground conditions exist.

Effectiveness

USEPA (2003) has indicated that a 35% average reduction of total phosphorus load has been reported in Pennsylvania. Deep placement of fertilizer has shown 20-50% reduction in phosphorus.

Cost

Deep placement of fertilizer can cost approximately $3.50 per acre. Soil testing can cost $6-18 per acre. Proper fertilizer application will reduce unnecessary use of fertilizer which will result in a cost savings.

8.8.7 Sediment Control Basin

Sediment control basins can be installed temporarily or permanently in areas where expected erosion is to occur. They are relatively small ponding basins formed by excavation or an embankment where water is collected. The reduced velocity allows sediment to fall out of stormwater runoff as it is detained for a period of time. An outlet structure allows for the controlled discharge of captured runoff. The storage capacity needs to be designed for detention storage and sediment storage. Basins have to be inspected periodically and cleaned if they become over laden with sediment.

Effectiveness

Sediment control basins can trap up to 70-80% of the sediment inflow loading. USEPA estimates an average effectiveness of 75% total suspended solids removal (USEPA, 1993)

Cost

USEPA (1993) indicates that the average cost of sediment basins with less that 50,000 ft^3 of storage is approximately $0.60 per ft^3 of storage. Basins greater than 50,000 ft of storage have an average cost of $0.30 per ft^3 of storage.

8.8.8 Vegetated Swales

Vegetated swales include grassed channels, dry swale, wet swale, biofilter, or bioswales. They are vegetated open-channels designed to attenuate stormwater runoff to reduce velocities and provide some treatment by sedimentation, filtration and infiltration. Swales are good substitutes for conventional drainage ditches and can be used along roads or to convey stormwater to other BMPs like sediment control basins.

Effectiveness

The USEPA Menu of BMPs estimates that vegetated swales remove about 29% of total phosphorus inflow and 81% of total suspended solids. The type of design will have impacts where a grassed channel will act more like a drainage ditch and have lower pollutant removals, but a bioswale will act more like a wetland and have higher removal rates.

Cost

According to the USEPA Menu of BMPs, vegetated swales can cost approximately \$0.50 per ft^2. However, if included in part of the original construction design, they can be less costly than traditional concrete conveyance structures.

8.8.9 Street Sweeping

Street sweeping has been a common practice for many years for aesthetic purposes and have been effective at removing large items like litter, leaves and twigs, and road debris. The Nationwide Urban Runoff Program conducted by US EPA in the 1980's concluded that street sweeping has been considered to be ineffective at improving water quality. Since that time, sweeper technology has advanced from mechanical broom cleaners to regenerative air vacuum sweepers to high efficiency vacuum-assisted dry sweepers. This most recent technology has the capability of picking up a very high percentage of the finest sediment particles (where most water quality pollutants are attached) in dry, wet, or even frozen conditions. A well designed street sweeping program using high efficiency street sweepers is a cost effective method to reduce water quality pollutants from urban runoff. Focus should be on acquiring or upgrading current equipment to high efficiency sweeper technology and the timing/frequency appropriate to specific areas. Sweep frequency can be adjusted by municipal area (central business district, arterials, commercial/industrial, etc.) and if possible, timing should be prior to storm events. On-street parking policies will also increase the accessible by sweepers and in turn provide increased pollutant removal. Three reports from the Ramsey-Washington Metro Watershed District (Minneapolis, MN, area) outline the state of the practice, results from a comprehensive survey, and policy development provide useful additional information (RWMWD, 2005).

Effectiveness

Effectiveness is largely determined by sweeper technology. Broom sweepers are not effective at removing the sediment size fraction containing the majority of water quality pollutants. Regenerative air and vacuum sweepers have been show to remove up to 70% total suspended solids, but may still be not very effective at removing the smallest particle sizes (less than 125 µm). High efficiency sweepers have been extremely effective in removing fine sediments and preventing escape to the air with efficiencies ranging from 70% for particles less than 63 µm to 96% for particles larger than 6370 µm (Sutherland and Jelen, 1997; RWMWD, 2005).

Cost

Street sweeping is a cost-effective practice because the long-term removal costs per pound of materials when compared to other methods is low. It can also reduce pollutant loadings to other structural BMPs which will reduce maintenance costs and improve effectiveness to those structures. Initial capital costs of a new sweeper are quite high. The following two **Tables** (**8-32** and **8-33**) summarize costs outlined in RWMWD (2005).

Table 8-32 Street Sweeper Cost Data (2005 Dollars)

Sweeper Type	Life (years)	Purchase Price (\$)	Operation and Maintenance Costs (\$/curb-mile)
Mechanical	5	100,000	40
Vacuum	8	200,000	20

Table 8-33 Sweeping Costs Based Upon Frequency ($/Curb-Mile/Year) (2005 Dollars)

Sweeper Type	Sweeping Frequency					
	Weekly	Bi-Weekly	Monthly	Four Times per Year	Twice per Year	Annual
Mechanical	$2,235	$1,120	$520	$170	$90	$45
Vacuum	$1,260	$630	$290	$100	$50	$25

8.8.10 Septic System Failure Identification and Prevention

Septic systems treat household waste in areas without access to public sewers. According to the US Census Bureau, 4.8 million housing units with septic systems were located in the Midwest in 2007. Septic systems are generally thought of in very rural areas, but much of the Chicago area suburbs are not sewered. Improper use and maintenance of an on-site sewage disposal system can result in odors, mosquito breeding, expensive repair and replacement, sewage backup to the home, contamination of groundwater or surface water, and the spread of disease. Failure can result from unsuitable soil conditions, improper design and installation, or inadequate maintenance. Programs addressing failing septic systems can focus on field screening, however, this can be very labor intensive and there is a lack of easy, dependable identification techniques. To supplement this effort some options are to require septic system inspection at time of property sale, enforce a recurring pump out requirement with non-compliance fines, and/or implement a fee for recurring services. Initial site evaluation and system design during construction can also increase the likelihood that a system does not require as much maintenance. Example programs can be found on USEPA's Septic (Onsite) Systems website, http://cfpub.epa.gov/owm/septic, and additional information can be found on Illinois EPA's septic system maintenance website, http://www.epa.state.il.us/well-water/septic-system-maintenance.html. Additional guidance for community management program development can be found in USEPA (2003a).

Effectiveness

According to USEPA, Conventional septic systems remove around 72% of TSS, 45% of BOD, 28% of TN, 57% of TP and 3.5 logs of pathogens. These numbers are actually less effective than a well designed constructed wetland. A poorly maintained or failing system will perform at some point lower than this.

Cost

Replacing a septic system can cost around $3,000 to $7,000 per unit and depends on local conditions and geographic location. Revolving load funds and service fees can be used to help minimize costs of repair. Failing system detection program costs include trained personnel, cost of materials for inspection, and follow-up. The Mason County Washington Department of Health Services has used dye tests ($295) and visual inspection ($95) for on-site inspections for a number of years. Cost to oversee repairs was estimated around $285. Other methods which may be more cost effective are the use of the brightener test or color infrared aerial photography. More information can be found at USEPA's Menu of BMPs website, http://cfpub.epa.gov/npdes/stormwater/menuofbmps.

8.8.11 Additional Options

The following **Table 8-34** excerpted from the Illinois Urban Manual (AISWCD, 2009) provides a tool for applicable structural BMP selection. On the table below, “1” indicates that the control measure has a slight impact, “2” indicates a moderate impact, and “3’ indicates a significant impact on addressing the listed problems. Detailed efficiency studies on each BMP can be found at the International Stormwater BMP Database, www.bmpdatabase.org.

Table 8-34 BMP Selection Guide

TABLE 2.1 PRACTICE SELECTION GUIDE

			PROBLEMS													
NAME	CODE	BRIEF DEFINITION	Sheet & Rill Erosion	Rill & Gully Erosion	Streambank Erosion	Stream Channel Erosion	Toxics & Salt Reducion	Flooding	Increased Peak Flow	Nutrient Pollution	Pesticide Pollution	Sediment Damage	Dust Control	Construction Road Maintenance	Water Table Control	Organic Pollution
Bioretention	800	Constructed wetland to improve stormwater quality				3	3	3	3	3	3	3			3	3
Construction Road Stabilization	806	Stabilize temporary roads to reduce erosion		3								2	2	3		
Culvert Inlet Protection	808	Temporary sediment filter at culvert inlets										2				
Dewatering	813	Removal of water from construction sites								1		1			1	
Diversion	815	Channel and ridge constructed to collect and divert runoff	2	2	1		1	1		1	1	1				
Diversion Dike	820	Perimeter dike to manage and divert runoff	2	2	1		1	1		1	1	1				
Dust Control	825	Controlling dust on construction sites and roads	1				1						3	1		
Erosion Control Blanket	830	Preformed degradable erosion blanket	2		1	1				1	1	2	1			
Erosion Control Blanket - TRM	831	Preformed nondegradable erosion mat	2		2	3				1	1	2	1			
Filter Strip	835	Vegetated filter zone to remove pollutants			2		1			1	1	2				
Grass-Lined Channels	840	Natural or constructed channel vegetated to convey water		2		2		1		1	1	1			1	
Infiltration Trench	847	Pits or trenches designed to hold water to increase infiltration	1	1				1	1	1	1					
Inlet Protection-Excavated Drain	855	Excavated area to trap sediment at storm drain inlet								1	1	1				
Inlet Protection-Fabric Drop	860	Temporary practice to control sediment at storm drain inlet								1	1	2				
Inlet Protection - Paved Areas	861	Temporary sediment control barrier at storm drain inlet								1	1	1				
Inlet Protection-Sod Filter	862	Sediment filter using sod around a storm drain drop inlet								1	1	1				
Inlet Protection - Unpaved Areas	863	Temporary practice to control sediment at storm drain inlet								1	1	1				
Land Grading	865	Smoothing surface to planned grade to improve site	2	2				1		1	1	1		2		
Level Spreader	870	Structure to spread water flow uniformly	1	1	1					1	1	1				
Mulching	875	Placing materials to protect soil surface	2	2	1				1	2	2	2	2			
Permanent Vegetation	880	Establishing permanent vegetative cover	3	3	2		2	2	2	3	3	3	3	1		
Permeable Pavement	890	Pavement having interspersed sod, gravel, or sand areas	1	1				1	1	1	1					
Polyacrylamide (PAM) for Temporary	893	Agent to bind soil and prevent erosion.	3	1								3	3			
Polyacrylamide (PAM) for Turbidity Re	894	Agent to flocculate fine silts and clay in stormwater.						1		2		3				
Portable Sediment Tank	895	Container for trapping sediment from runoff water								1	1	2				
Right-of-way Diversion	900	Structure to control roadway erosion		1				1				1		2		
Rock Check Dam	905	Structure to control erosion in ditch or grass swale		3								2				
Rock Outlet Protection	910	Rocked area at outlets to reduce flow erosion		2		2						1				
Silt Fence	920	Temporary sediment barrier of filter fabric	2	2						1	1	2				
Sodding	925	Laying blanket of established turf to protect area	3	3	2		1	2	2	3	3	3	3	1		
Stabilized Construction Entrance	930	Rock pad at entrance or exit to control tracking of mud to streets										1		3		
Structural Streambank Stabilization	940	Structure to control streambank erosion			3							2				
Subsurface Drain	945	An underground water collection and transport tube	1	1	2		2	1	2	1	1	1		2	3	
Sump Pit	950	Temporary pit to trap and filter water								2	2	2				
Surface Roughening	953	Grooving, stair stepping, or tracking across a slope	1	1					1			1				
Temporary Concrete Washout Fac.	954	Management of solid and liquid wastes from concrete					3					2				
Temporary Diversion	955	Temporary diversion for runoff control	2	2	1		1	1		1	1	1				
Temporary Sediment Trap	960	Temporary ponding basin to trap sediment		1					1	1	1	2				
Temporary Seeding	965	Planting vegetation to protect areas from erosion	3	2	2		2	2	2	2	2	2	2			
Temporary Slope Drain	970	Short term water conveyance down a sloping area		2						1	1	1		1		
Temporary Stream Crossing	975	Short term stream crossing for equipment			1	1								2		
Temporary Stream Diversion	976	Short term stream diversion to allow construction in the dry.				1						6				
Temporary Swale	980	Temporary excavated drainageway to control runoff		1		1		1		1	1	1				
Topsoiling	981	Adding or replacing quality soil to the surface	2	1			2	1	1	1	1	1				
Tree/Forest Ecosystem Preservation	984	Protecting contiguous stands of trees from construction damage	2	2	2			2	1	3	3	1	2		1	
Tree and Shrub Planting	985	Planting trees and shrubs	3	3	3		2	1	2	3	3	3	3		2	
Tree Protection	990	Protecting individual trees from construction damage	1	1	1			1	1	1	1	1	1		1	
Tree Protection-Augering	991	Protecting individual trees from underground construction damage	1	1	1			1	1	1	1	1	1		1	
Vegetative Streambank Stabilization	995	Vegetation to control streambank erosion			3					1	1	1				
Well Decommissioning	996	Permanent sealing of a water well, boring, or monitoring well								3	3					3

June 2010 selguide.xls

8.8.12 Reasonable Assurance and Available Cost-Share

USEPA guidance on TMDL requires reasonable assurances that a TMDL will actually achieve necessary pollution reductions from both point sources and nonpoint sources. A TMDL must specify how the pollution reductions will be achieved and maintained and identify necessary funds or other mechanisms to achieve nonpoint source reductions. The previous sections provided information on available BMPs which will be implemented at the discretion of the watershed workgroup. Implementation of these BMPs will improve the water quality of the impaired segments of the Des Plaines River/Higgins Creek Watershed. The following section focuses on the several cost-share programs which are available to assist in implementation of resource conservation practices.

Section 319 Nonpoint Source Pollution Control Grants Section 319(h) of the Clean Water Act allocates funds on an annual basis to each state and is a common source of funding for watershed groups. Illinois EPA receives these funds from the federal government to help implement the Illinois' Nonpoint Source Management Program. Illinois EPA's 319(h) Nonpoint Source Pollution Control Financial Assistance Program offers financial assistance to five project categories through the control of NPS pollution. These categories include development of a watershed based plan or TMDL, implementation of a watershed based plan or TMDL, BMP implementation to control or prevent NPS pollution, NPS pollution information and outreach activities, and monitoring or research. In 2011, Illinois EPA estimated that approximately $3.9 million is available in Illinois for Section 319(h) Grant Program funded projects per year which will typically support around 15-25 projects. There is no limit to the maximum amount for which one can apply; however, the program will typically fund 60 percent of the total project cost, leaving the remaining 40 percent the responsibility of local match. Projects under a TMDL Implementation Plan fall into the high priority project type and will receive higher consideration than others. More information can be found on the Illinois EPA Nonpoint Source Unit website, http://www.epa.state.il.us/water/watershed/nonpoint-source.html. There is a document that will assist with this urban watershed, Urban BMPs-Supplemental Guidance for Funding Eligibility, which is provided by t he unit and should be reference during project planning.

Although some of the following programs are tailored to agricultural lands, opportunities may exist for utilizing these programs as land is converted from agricultural to urban land uses. The following USDA program description has been excerpted from the NRCS website, http://www.nrcs.usda.gov/wps/portal/nrcs/main/national/programs/financial. Additional sources of funding can be found in **Appendix I**.

Conservation Reserve Program (CRP) The CRP is a voluntary program for eligible producers that offer incentive and maintenance payments for specified conservation activities on eligible crop or pasture lands. The program's purpose is to encourage the planting of ground covers that improve soil, water and wildlife resources. CRP makes available federal cost-share assistance of up to 50% of the participant's cost in installing approved conservation practices. Contract duration may last from ten to fifteen years. CRP could potentially be used in steep-sloped areas that would otherwise prohibit development. CRP could also be utilized for tree or native grass plantings in conjunction with required buffers between development and sensitive water bodies.

Conservation 2000 –Stream Bank Stabilization and Restoration Program This program is a long-term, state-supported initiative to protect natural resources and enhance outdoor recreational opportunities in Illinois. There are many components to this program, one being the Stream Bank Stabilization and Restoration Program. The stream bank stabilization and restoration program is designed to demonstrate effective, inexpensive vegetative and bio-engineering techniques for limiting stream bank erosion. Program monies fund demonstration projects at suitable locations statewide and provide cost-share assistance to landowners with severely eroding streambanks. The Illinois Department of Agriculture, Illinois' soil and water conservation districts (SWCDs) and the Natural Resources Conservation Service of the U.S. Department of Agriculture (NRCS) serve as partners in implementing the program. Both cost-share assistance and demonstration project funding require sites meet assessment and selection criteria established for successful stream bank stabilization using vegetative or other bio-engineering techniques. Program funds may be used for labor, equipment, and materials. Proposals must be sponsored by the local SWCD. Grant recipients are selected by an independent committee in the fall of the year. Recipients of cost-share and demonstration project funding must agree to maintain stream bank stabilization practices for at least 10 years. For more information about this program, contact your local SWCD or the Illinois Department of Agriculture.

Environmental Quality Incentives Program (EQIP) EQIP is a voluntary program for eligible producers, on eligible land, that offers incentive payments of up to 90% of the costs on eligible conservation practices. Soon to be available under the EQIP program are Conservation Innovation Grants. These grants, after their draft provisions have been finalized, are anticipated to be available for use by the broader public to leverage federal investment, stimulate innovative approaches, and accelerate technology transfer. Any development proposal that could incorporate conservation best management practices could potentially be eligible under this program. Developers who need to meet local development requirements mandating groundwater protection, buffers and storm water detention, could utilize this program to help offset implementation costs. Some types of practices that could qualify under EQIP include riparian forest buffers, rock chutes, wetland enhancement, filter strips, diversions, water and sediment control basins, and grassed waterways. One example in Illinois of the use of EQIP funds in an urbanizing area includes a site near East Peoria, where EQIP funds were used prior to site development for the construction of two ponds to include spillway construction, seeding, and mulching.

Farmland Protection Program/Farm and Ranch Lands Protection Program (FPP/FRPP) The purpose of the FPP/FRPP is to encourage topsoil protection by limiting non-agricultural uses of the land. Under the program, the federal government may contribute up to 50% of the cost for the purchase of development rights regarding a qualifying parcel. At the time of this writing, the FRPP rules were in draft form and open for public comment. The FRPP is anticipated to be similar in many ways to the FPP program, which has been repealed. The FRPP program could potentially be used in conjunction with community development or agricultural land subdivision. The FRPP could be useful for development requirements that encourage open space set-asides which maximizes land remaining on the tax rolls. FRPP would also be useful for planned unit developments or conservation subdivision designs that permit the agreed-upon density, yet allow larger areas of contiguous open space. Land under FRPP could also be used for other than row-crop production. Tree farms, specialty crops, gardens, and nurseries are all potential land uses under the program that could continue to generate revenues for both the land owner and the community while providing open space, aesthetic features, and passive storm water management.

Wildlife Habitat Incentives Program (WHIP) Through this program, NRCS provides technical expertise and funding needed for practices that enhance wildlife habitat on private land. Landowners may enter into five to ten year agreements to implement an approved habitat enhancement plan. Longer agreements may be available for landowners that are willing to create long-lasting habitat for especially vulnerable species. This program is unique in that a farm tract number is not a requirement for enrollment. Any privately owned land can be eligible under WHIP as long as it enhances wildlife habitat. Examples of where this program could be utilized in site planning and development include odd lots or land contiguous to streams, lakes, or storm water detention/retention areas where native plantings that enhance wildlife habitat are desirable.

Wetlands Reserve Program (WRP) WRP is a voluntary program that provides technical and financial assistance to eligible landowners to address wetlands, wildlife habitat, and other soil and water natural resource concerns. Through this program, eligible landowners must file an application for a permanent conservation easement, a 30-year easement, or a minimum 10-year restoration agreement. The federal government may pay up to 100% for wetland restoration and permanent easement costs; 75% of restoration and 75% of the permanent easement costs on a 30-year easement; and 75% of restoration costs for a restoration cost-share agreement. One example of a development that has taken advantage of the wetland reserve program has been the Hidden Creek development in Ohio, where 232 acres were set aside in perpetuity to protect wildlife habitat along a nearby creek. The developer, working in cooperation with the NRCS and the local soil and water conservation district, desired to maintain the environmentally-sensitive areas of the property in a natural state and made the decision to qualify and participate. Prior to development, the environmentally-sensitive lands were set aside and the USDA-NRCS, in accordance with WRP program criteria, designed the wetlands and were awarded a permanent conservation easement. The developer was eligible for cost-share money and technical assistance and the wetlands thereafter will provide wetland functions that can be used in conjunction with development: passive storm water detention, ground water filtering, and natural open space.

8.9 Monitoring Plan

This section presents the monitoring programs that can be used to assess and track the performance of the management actions proposed in this implementation plan. **Table 8-35** presents available data from the monitoring stations within the Des Plaines/Higgins Creek impaired segments.

Table 8-35 Available Monitoring Data

Waterbody Name	Segment ID	Agency
Albert Lake	VGG	Lake County Health Department Lakes Management Unit
Beck Lake	RGE	Illinois Environmental Protection Agency
Big Bear Lake	WGZU	Illinois Environmental Protection Agency
		Lake County Health Department Lakes Management Unit
Big Bend Lake	RGL	Illinois Environmental Protection Agency
Bresen Lake	UGN	Lake County Health Department Lakes Management Unit
Buffalo Creek	GST	Metropolitan Water Reclamation District of Greater Chicago (Site WW-12)
Buffalo Creek Lake	SGC	Illinois Environmental Protection Agency
		Lake County Health Department Lakes Management Unit
Countryside Lake	RGQ	Lake County Health Department Lakes Management Unit
Diamond Lake	RGB	Illinois Environmental Protection Agency
		Lake County Health Department Lakes Management Unit
Forest Lake	RGZG	Lake County Health Department Lakes Management Unit
Half-day Pit	UGB	Lake County Health Department Lakes Management Unit
Higgins Creek	GOA-01, 02	Metropolitan Water Reclamation District of Greater Chicago (Sites WW-77,78)
Lake Charles	RGZJ	Lake County Health Department Lakes Management Unit
Little Bear Lake	WGZV	Illinois Environmental Protection Agency
		Lake County Health Department Lakes Management Unit
Pond-a-Rudy	UGP	Lake County Health Department Lakes Management Unit
Salem-Reed Lake	WGK	Lake County Health Department Lakes Management Unit
Sylvan Lake	RGZF	Lake County Health Department Lakes Management Unit

8.9.1 Illinois Environmental Protection Agency

Illinois EPA maintains an Ambient Water Quality Monitoring Network. The program obtains samples once every six weeks at 213 stations which are analyzed for a minimum of 55 parameters including pH, temperature, dissolved oxygen, suspended solids, nutrients, fecal coliform bacteria and metals. Additional parameters specific to individual stations or waterbodies are also collected and analyzed.

8.9.2 Intensive River Basin Surveys

Total assessments of watersheds are performed on a 5 year cycle to provide a characterization of existing watershed conditions. As part of this effort, intensive surveys are conducted by the Illinois EPA and the Illinois Department of Natural Resources to supplement existing data. Special sampling programs are developed for specific stream assessments when requisite data are absent from state databases.

8.9.3 Lake County Health Department Lakes Management Unit

The Lake County Health Department established the Lakes Management Unit (LMU) to address degrading water quality concerns of many of the lakes which communities have been built around. The LMU collects baseline water quality data from 32 different lakes in the county monthly during the summer. These data include analysis for nutrients, solids, temperature, dissolved oxygen and various other parameters. Beach monitoring for E. coli bacteria is also performed during the summer on a bimonthly basis for beach closure support. Once per year, lake condition summary reports called Detailed Lake Reports are developed to provide recent data analysis, threats to the lake and corresponding recommendations.

8.9.4 Lake County Stormwater Management Commission

The Lake County Stormwater Management Commission manages the stormwater program for Lake County and local jurisdictions. The Lake Management Unit has been collecting water quality data on Lake County lakes since the 1960s. Thirteen lakes within the Des Plaines/Higgins Creek Watershed were assessed by Lake County. A detailed report summarizing water quality, lake characteristics, data analyses, existing problems, and recommendations was created for each waterbody.

The implementation of the Lake County Comprehensive Stormwater Management plan is one of the responsibilities of the Commission. The Des Plaines Watershed Advisory committee, a sub-division of the Lake County Stormwater Management Commission, addresses stormwater issues in the Des Plaines Watershed. One of the responsibilities of this committee is to develop a Watershed Plan for the Des Plaines River.

8.9.5 Lake County Forest Preserve Board

The Lake County Forest Preserve Board manages the Buffalo Creek Forest Preserve. In 2008, the Lake County Forest Preserve Board of Commissioners in conjunction with the MWRDG and the Lake County Department of Transportation, approved the Buffalo Creek Master Plan. This plan was designed to improve public access and provide natural resources restoration. Other facets of the plan include: guidance for an additional 30-acre stormwater storage reservoir, road improvements designed to reduce traffic, and a plan to transform an existing agricultural field into a high-quality wetland.

8.9.6 Metropolitan Water Reclamation District of Greater Chicago (MWRDGC)

The MWRDG manages the stormwater program for Cook County and local jurisdictions. Individual Watershed Planning Councils (WPC) represent communities within the watershed, and Technical Advisory Committees provide technical advice on stormwater plans and ordinances. The Lower Des Plaines WPC developed a Detailed Watershed Plan for the Lower Des Plaines River.

8.9.7 Additional Monitoring

Comprehensive water quality monitoring is critical for assessing the health of waterbodies within the Des Plaines/Higgins Creek Watershed. While numerous monitoring stations exist throughout the watershed, special studies or additional monitoring stations may be required to better monitor water quality improvements. Additional monitoring is especially suggested above Buffalo Creek Lake and at the sections of the Des Plaines River which flood into Big Bend Lake and Half Day Pit. Additional information on SOD in Higgins Creek would also be useful.

8.10 Implementation Time Line

The implementation time line will be determined by the watershed stakeholders and watershed group. It is recommended that the implementation of controls for the Des Plaines/Higgins Creek Watershed be completed in phases so that measureable targets and goals can be established and revisited if necessary. Interim, measurable milestones should also be developed within each phase to better manage goal achievement or re-evaluation. This type of iterative evaluation, or adaptive management, will allow for optimal results of the BMP controls and technological upgrades.

Phase I of this implementation plan consists of establishing a framework for stakeholder involvement and a planning group structure. This is the first step in building key partnerships with the important government, business, citizen, educational, environmental, and landowner groups involved in the watershed. The Upper Des Plaines River Ecosystem Partnership has already identified and successfully incorporated many of the potential stakeholder groups in the watershed. This partnership was formed in 1996 and has been involved in many successful projects throughout the watershed. The TMDL implementation responsibility can be taken on by this partnership or another watershed group. However, the local resources of this group should be utilized going forward. Additional information on how to develop watershed plans (and watershed groups) can be found in CMAP (2007) and/or USEPA (2008). The expectation is that this process will not take longer than one year as an organization already exists in the watershed.

Phase II of this implementation plan should focus on public education so that the general public is aware of the benefits of high quality waterbodies. By instilling the value of water quality, the willingness to fund BMPs will likely increase. Because installation of non-point BMPs will likely be voluntary, it is best to educate the public first so that recommendations for BMPs will be more seriously considered. Public education could occur through stakeholder meetings, public meetings, flyers, postings, and TV and radio announcements. Also during this time, WWTPs should evaluate their current disinfection systems to determine the efficacy of their system and evaluate the costs to potentially upgrade their facilities. Phase II should last approximately one year and throughout this process, water quality monitoring should continue. Public education components should continue through all phases of implementation to foster awareness and support for the program.

Phase III of the implementation schedule will involve adoption of BMP measures, including evaluations of particular BMPs for specific sensitive areas. Using some of the options listed in this plan, stakeholders need to decide how they prefer to address the impairments and determine a timeline for constructing them. A critical factor in this phase is to identify and secure funding. 319 Grants are one of the most common approaches, but other sources from the Reasonable Assurance section should be investigated. Concurrent with selecting and constructing BMPs, an inspection program for the BMPs must also be developed to ensure optimal performance and efficiency. At this point, WWTPs should recommend whether they will upgrade or replace their disinfection systems. Phase III should last another two years and continued water quality monitoring should continue.

Phase IV will primarily involve continued inspection of BMPs and construction of new disinfection systems if recommended. Estimated loadings to waterbodies should be re-calculated using the latest ambient data collected through monitoring efforts. The effectiveness of the implemented BMPs and/or facility upgrades should be evaluated at this point and modifications to or additional BMPs and/or facility upgrades may be warranted. Due to the financial commitments of facility upgrades and the non-point nature of many of these impairments, Phase IV can be challenging and last between five to ten years. Monitoring of any implemented BMP may need to continue for 2 to 3 years after installation in order to see significant water quality changes.

A summary of the time line for the four phases is presented in **Table 8-36** for convenience. Throughout all phases the principles of adaptive management should be applied so that unnecessary or obsolete action items be removed rather than implemented.

Table 8-36 Implementation Time Line Summary

Waterbody Name	Time Duration
Phase I	Year one
Phase II	Year two with public education and water quality monitoring
Phase III	Years three through four with continued education and water quality monitoring
Phase IV	Years five through ten (or even fifteen) with continued education and water quality monitoring

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Appendix A

Land Use Tables and Graphs

Land Use in the Des Plaines/Higgins Creek Watershed

Watershed	Agricultural land	Forested land	Surface water	Urban and built-up land:	Wetland
Entire Des Plaines	11.80%	16.80%	2.70%	66.60%	2.10%
Albert Lake	1.80%	15.60%	1.90%	79.50%	1.20%
Beck Lake		56.50%	10.80%	30.70%	2.00%
Big Bear and Little Bear Lake	1.70%	5.90%	3.70%	88.10%	0.70%
Big Bend Lake		17.50%	6.20%	74.10%	2.20%
Bresen Lake	19.10%	11.70%	10.40%	52.40%	6.40%
Buffalo Creek	1.70%	19.40%	1.90%	74.10%	3.00%
Buffalo Creek Lake	1.90%	21.90%	2.00%	70.80%	3.30%
Countryside Lake	45.10%	16.20%	10.50%	26.40%	1.70%
Diamond Lake	32.60%	12.70%	8.50%	44.50%	1.70%
Forest Lake	5.30%	8.40%	7.60%	77.50%	1.20%
Half-day Pit		17.80%	41.90%	31.90%	8.30%
Higgins Creek	0.10%	7.10%	1.30%	91.00%	0.50%
Lake Charles	2.20%	6.60%	2.20%	88.50%	0.60%
Pond-a-Rudy	11.10%	35.00%	5.70%	38.20%	10.00%
Salem-Reed	11.30%	18.90%	27.60%	35.60%	6.60%
Sylvan Lake	38.00%	15.30%	5.90%	39.20%	1.60%

Summary Land Use Data for Des Plaines/Higgins

IL GAP Classification	Summarized Area (acres)	Summarized Area (mi^2)	Watershed
URBAN AND BUILT UP LAND	148,422.6	231.9	66.6%
FORESTED LAND	3,7511.1	58.6	16.8%
AGRICULTURAL LAND	2,6324.0	41.1	11.8%
OTHER SURFACE WATER	5,937.9	9.3	2.7%
WETLAND	4,632.9	7.2	2.1%
OTHER BARREN AND EXPOSED LAND	169.9	0.3	0.08%

Summary of IL-GAP Data for the Albert Lake Watershed

IL GAP Classification	Summarized Area (acres)	Summarized Area (mi^2)	Summarized Percentage
URBAN AND BUILT-UP LAND	1053.8	1.65	79.5%
FORESTED LAND	190.5	0.30	14.4%
OTHER: SURFACE WATER	25.8	0.04	1.9%
AGRICULTURAL LAND	23.9	0.04	1.8%
FORESTED LAND	16.1	0.03	1.2%
WETLAND	15.5	0.02	1.2%

Summary of IL-GAP Data for the Beck Lake Watershed

IL GAP Classification	Summarized Area (acres)	Summarized Area (mi^2)	Summarized Percentage
FORESTED LAND	0.6	0.00	56.5%
URBAN AND BUILT-UP LAND	113.9	0.18	30.7%
OTHER: SURFACE WATER	40.2	0.06	10.8%
WETLAND	7.5	0.01	2.0%

Summary of IL-GAP Data for the Big Bear and Little Bear Lakes Watersheds

IL GAP Classification	Summarized Area (acres)	Summarized Area (mi^2)	Summarized Percentage
URBAN AND BUILT-UP LAND	2947.1	4.60	88.1%
FORESTED LAND	196.7	0.31	5.9%
OTHER: SURFACE WATER	124.4	0.19	3.7%
AGRICULTURAL LAND	56.0	0.09	1.7%
WETLAND	22.2	0.03	0.7%

Summary of IL-GAP Data for the Big Bend Lake Watershed

IL GAP Classification	Summarized Area (acres)	Summarized Area (mi^2)	Summarized Percentage
URBAN AND BUILT-UP LAND	523.4	0.82	74.1%
FORESTED LAND	123.9	0.19	17.5%
OTHER: SURFACE WATER	43.6	0.07	6.2%
WETLAND	15.7	0.02	2.2%

Summary of IL-GAP Data for the Bresen Lake Watershed

IL GAP Classification	Summarized Area (acres)	Summarized Area (mi^2)	Summarized Percentage
URBAN AND BUILT-UP LAND	131.8	0.21	52.4%
AGRICULTURAL LAND	47.9	0.07	19.1%
FORESTED LAND	29.5	0.05	11.7%
OTHER: SURFACE WATER	26.1	0.04	10.4%
WETLAND	16.1	0.03	6.4%

Summary of IL-GAP Data for the Buffalo Creek Watershed

IL GAP Classification	Summarized Area (acres)	Summarized Area (mi^2)	Summarized Percentage
URBAN AND BUILT-UP LAND	8713.0	13.61	74.1%
FORESTED LAND	2279.9	3.56	19.4%
WETLAND	348.3	0.54	3.0%
OTHER	221.0	0.35	1.9%
AGRICULTURAL LAND	198.3	0.31	1.7%

Summary of IL-GAP Data for the Buffalo Creek Lake Watershed

IL GAP Classification	Summarized Area (acres)	Summarized Area (mi^2)	Summarized Percentage
URBAN AND BUILT-UP LAND	7201.3	11.25	70.8%
FORESTED LAND	2232.0	3.49	21.9%
WETLAND	335.6	0.52	3.3%
OTHER: SURFACE WATER	207.7	0.32	2.0%
AGRICULTURAL LAND	196.6	0.31	1.9%
OTHER: BARREN AND EXPOSED LAND	1.6	0.00	0.0%

Summary of IL-GAP Data for the Countryside Lake Watershed

IL GAP Classification	Summarized Area (acres)	Summarized Area (mi^2)	Summarized Percentage
AGRICULTURAL LAND	878.4	1.37	45.1%
URBAN AND BUILT-UP LAND	514.7	0.80	26.4%
FORESTED LAND	314.9	0.49	16.2%
OTHER: SURFACE WATER	203.5	0.32	10.5%
WETLAND	32.2	0.05	1.7%
OTHER: BARREN AND EXPOSED LAND	2.8	0.00	0.1%

Summary of IL-GAP Data for the Diamond Lake Watershed

IL GAP Classification	Summarized Area (acres)	Summarized Area (mi^2)	Summarized Percentage
URBAN AND BUILT-UP LAND	886.1	1.38	44.5%
AGRICULTURAL LAND	648.3	1.01	32.6%
FORESTED LAND	253.4	0.40	12.7%
OTHER: SURFACE WATER	168.9	0.26	8.5%
WETLAND	33.7	0.05	1.7%

Summary of IL-GAP Data for the Forest Lake Watershed

IL GAP Classification	Summarized Area (acres)	Summarized Area (mi^2)	Summarized Percentage
URBAN AND BUILT-UP LAND	408.4	0.64	77.5%
FORESTED LAND	44.2	0.07	8.4%
OTHER: SURFACE WATER	40.0	0.06	7.6%
AGRICULTURAL LAND	28.2	0.04	5.3%
WETLAND	6.3	0.01	1.2%

Summary of IL-GAP Data for the Half Day Pit Watershed

IL GAP Classification	Summarized Area (acres)	Summarized Area (mi^2)	Summarized Percentage
OTHER: SURFACE WATER	11.5	0.02	41.9%
URBAN AND BUILT-UP LAND	8.8	0.01	31.9%
FORESTED LAND	4.9	0.01	17.8%
WETLAND	2.3	0.00	8.3%

Summary of IL-GAP Data for the Higgins Creek Watershed

IL GAP Classification	Summarized Area (acres)	Summarized Area (mi^2)	Summarized Percentage
URBAN AND BUILT-UP LAND	4808.9	7.51	91.0%
FORESTED LAND	372.8	0.58	7.1%
OTHER: SURFACE WATER	70.2	0.11	1.3%
WETLAND	27.0	0.04	0.5%
AGRICULTURAL LAND	5.4	0.01	0.1%

Summary of IL-GAP Data for the Lake Charles Watershed

IL GAP Classification	Summarized Area (acres)	Summarized Area (mi^2)	Summarized Percentage
URBAN AND BUILT-UP LAND	2242.0	3.50	88.6%
FORESTED LAND	165.9	0.26	6.6%
AGRICULTURAL LAND	55.3	0.09	2.2%
OTHER: SURFACE WATER	54.5	0.09	2.2%
WETLAND	14.1	0.02	0.6%

Summary of IL-GAP Data for the Pond-a-Rudy Watershed

IL GAP Classification	Summarized Area (acres)	Summarized Area (mi^2)	Summarized Percentage
URBAN AND BUILT-UP LAND	23.8	0.04	38.2%
FORESTED LAND	21.8	0.03	35.0%
AGRICULTURAL LAND	6.9	0.01	11.1%
WETLAND	6.2	0.01	9.9%
OTHER: SURFACE WATER	3.6	0.01	5.7%

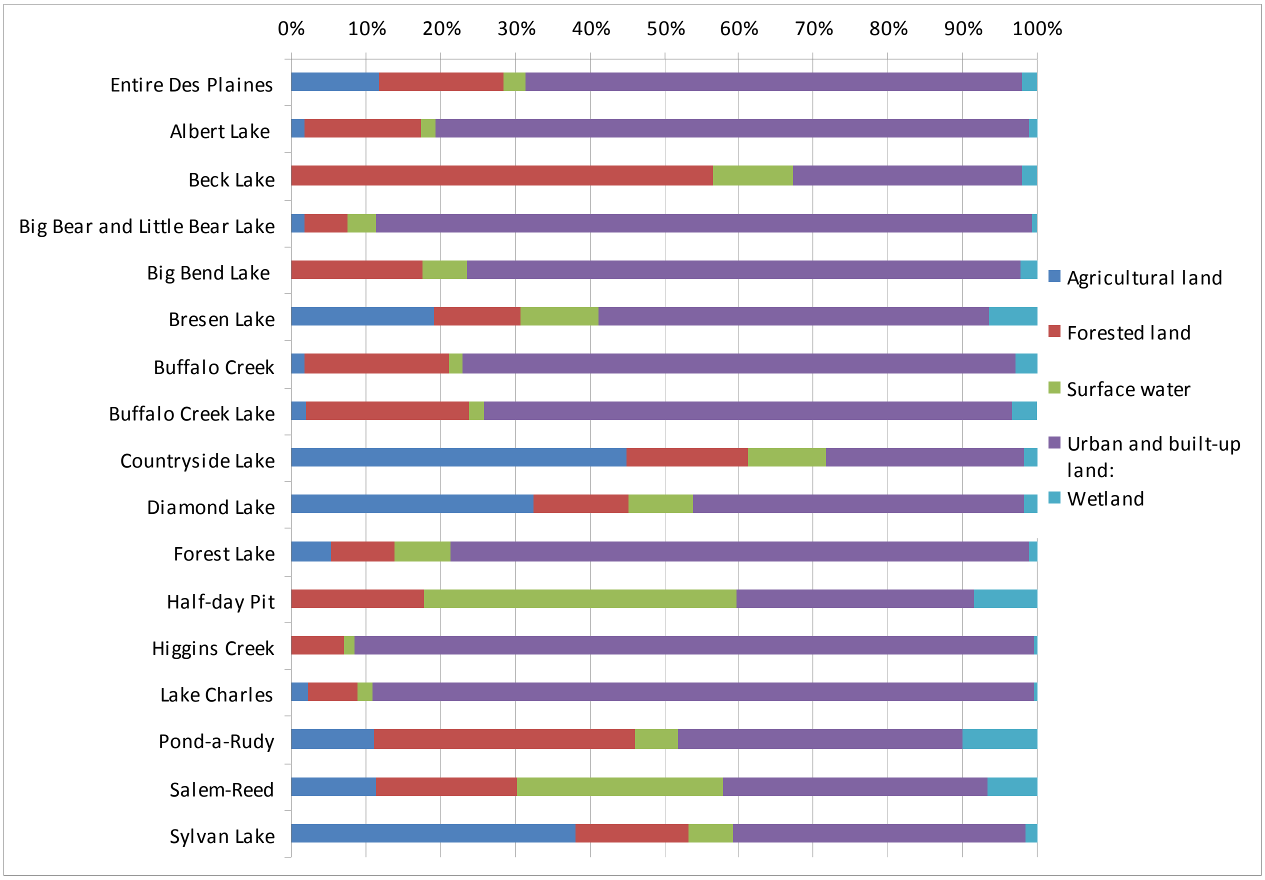
Summary of IL-GAP Data for the Salem-Reed Watershed

IL GAP Classification	Summarized Area (acres)	Summarized Area (mi^2)	Summarized Percentage
URBAN AND BUILT-UP LAND	47.4	0.07	35.6%
OTHER: SURFACE WATER	36.8	0.06	27.6%
FORESTED LAND	25.2	0.04	18.9%
AGRICULTURAL LAND	15.0	0.02	11.3%
WETLAND	8.8	0.01	6.6%

Summary of IL-GAP Data for the Sylvan Lake Watershed

IL GAP Classification	Summarized Area (acres)	Summarized Area (mi^2)	Summarized Percentage
URBAN AND BUILT-UP LAND	211.0	0.33	39.2%
AGRICULTURAL LAND	205.0	0.32	38.0%
FORESTED LAND	82.4	0.13	15.3%
OTHER: SURFACE WATER	31.7	0.05	5.9%
WETLAND	8.9	0.01	1.6%

Land Use in the Des Plaines/Higgins Creek Watershed



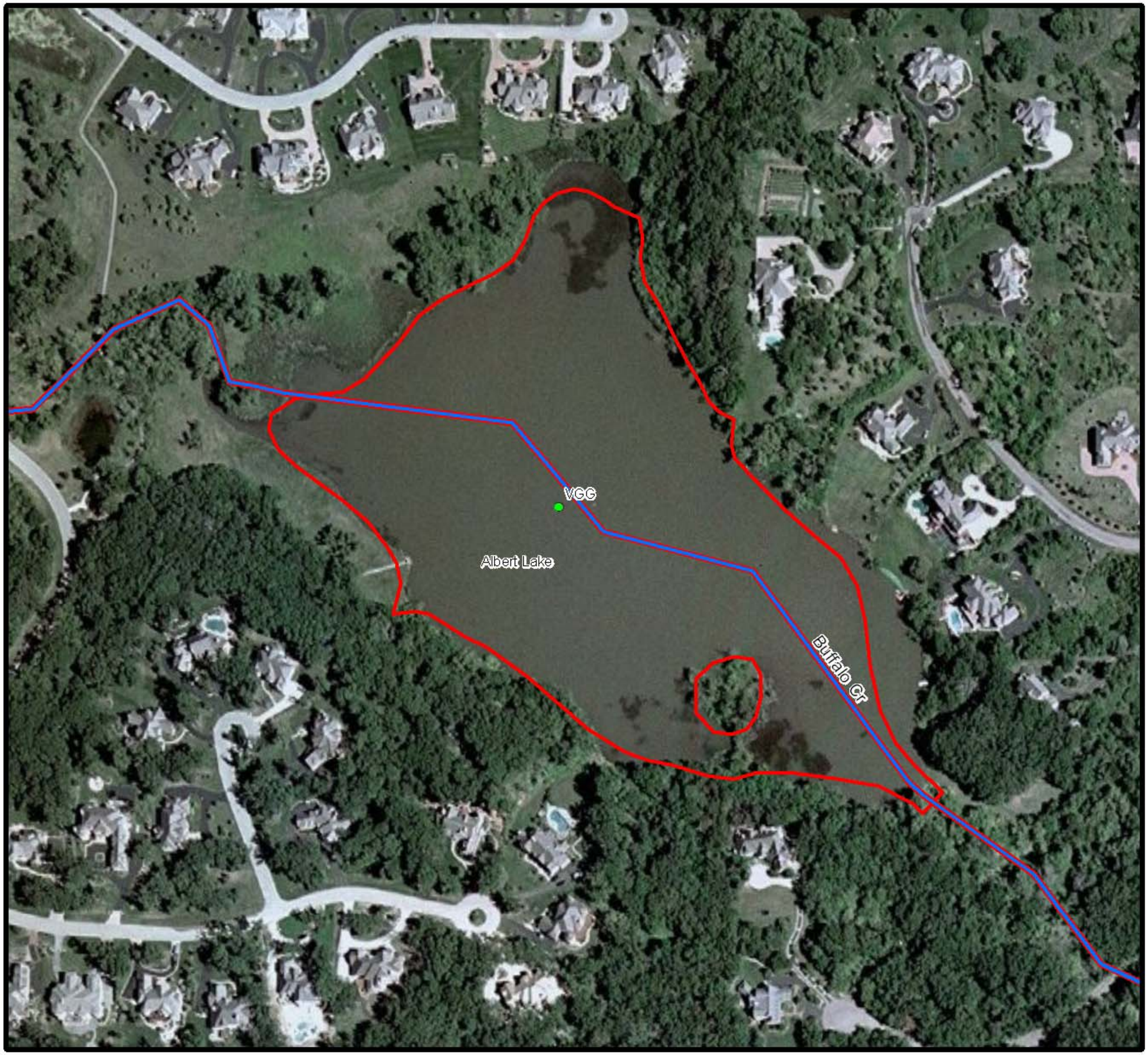
Appendix B

Water Quality Data

Separate Excel File

Appendix C

Waterbody Maps



Albert

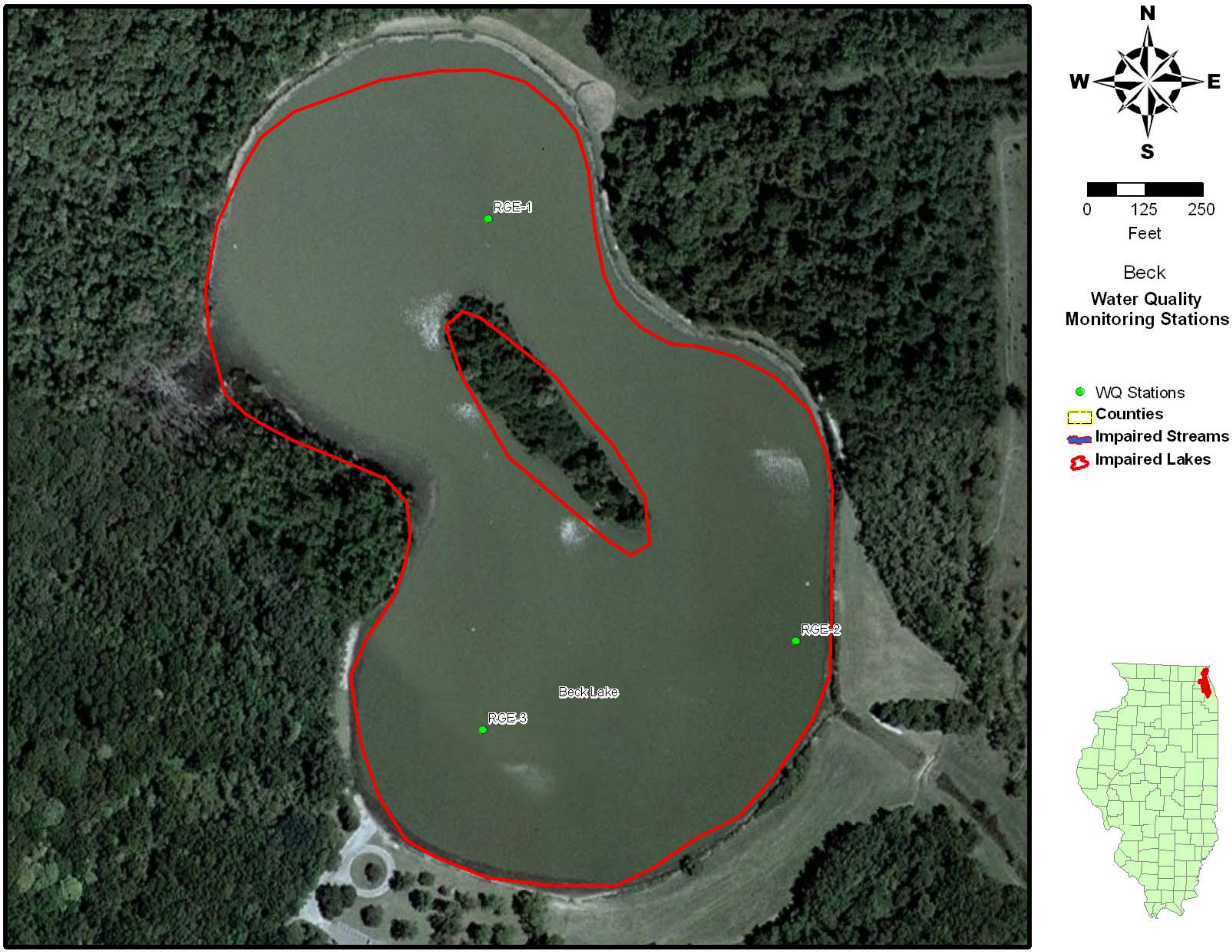
Water Quality Monitoring Stations

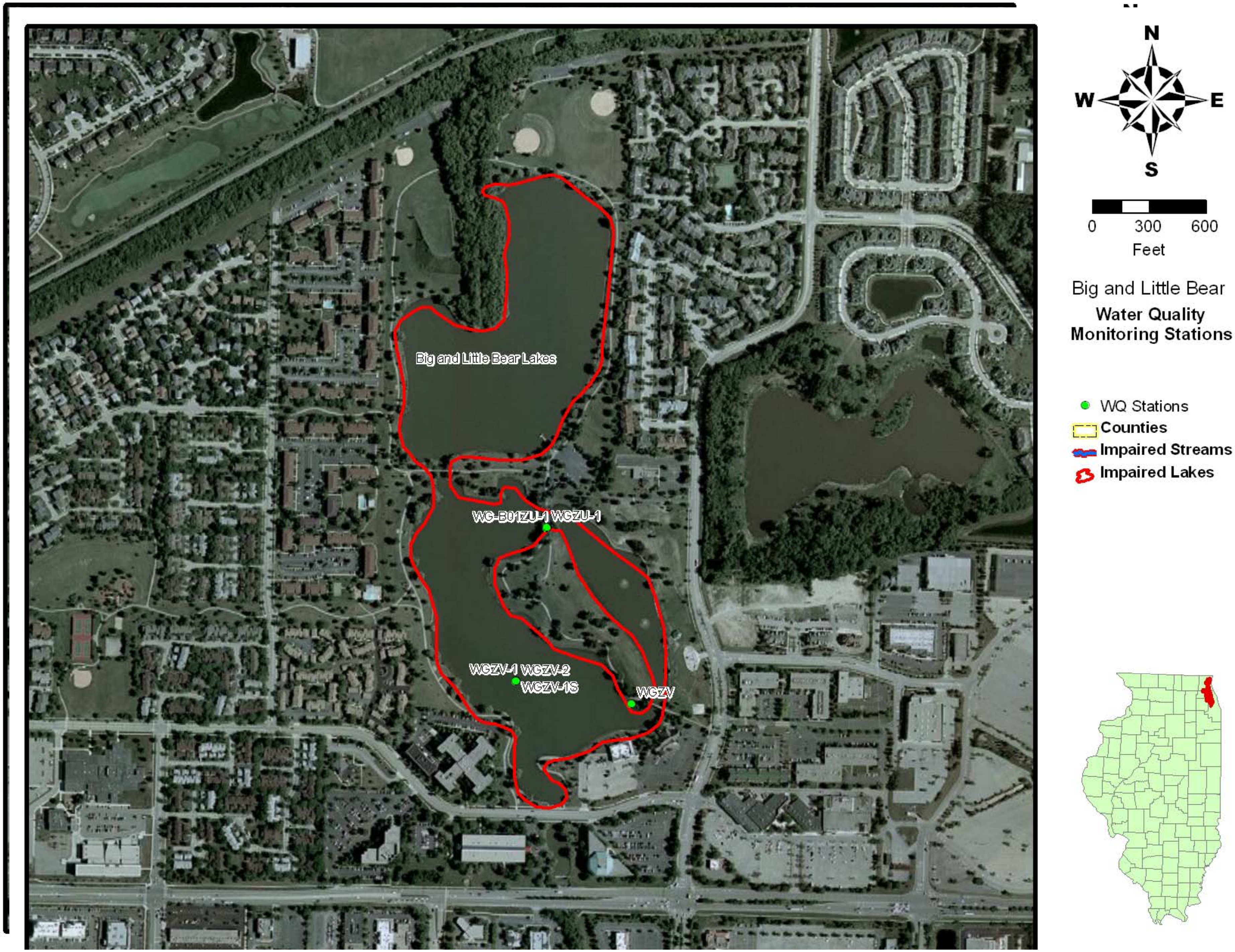
WQ Stations

Counties

Impaired Streams

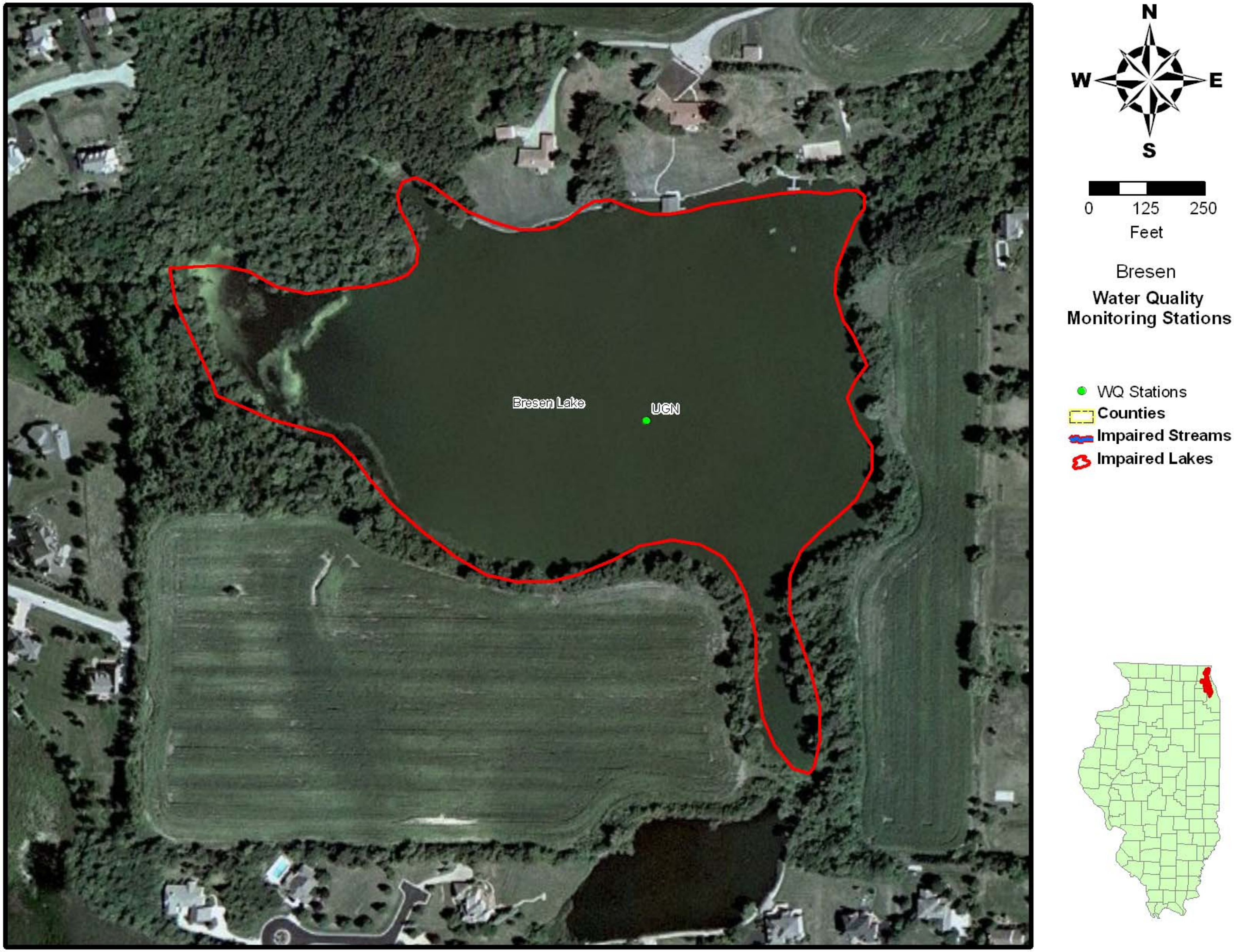
Impaired Lakes


RGE-1
RGE-2
RGE-3
Beck Lake
N
W
E
S
0
125
250
Feet
Beck
Water Quality Monitoring Stations
WQ Stations
Counties
Impaired Streams
Impaired Lakes

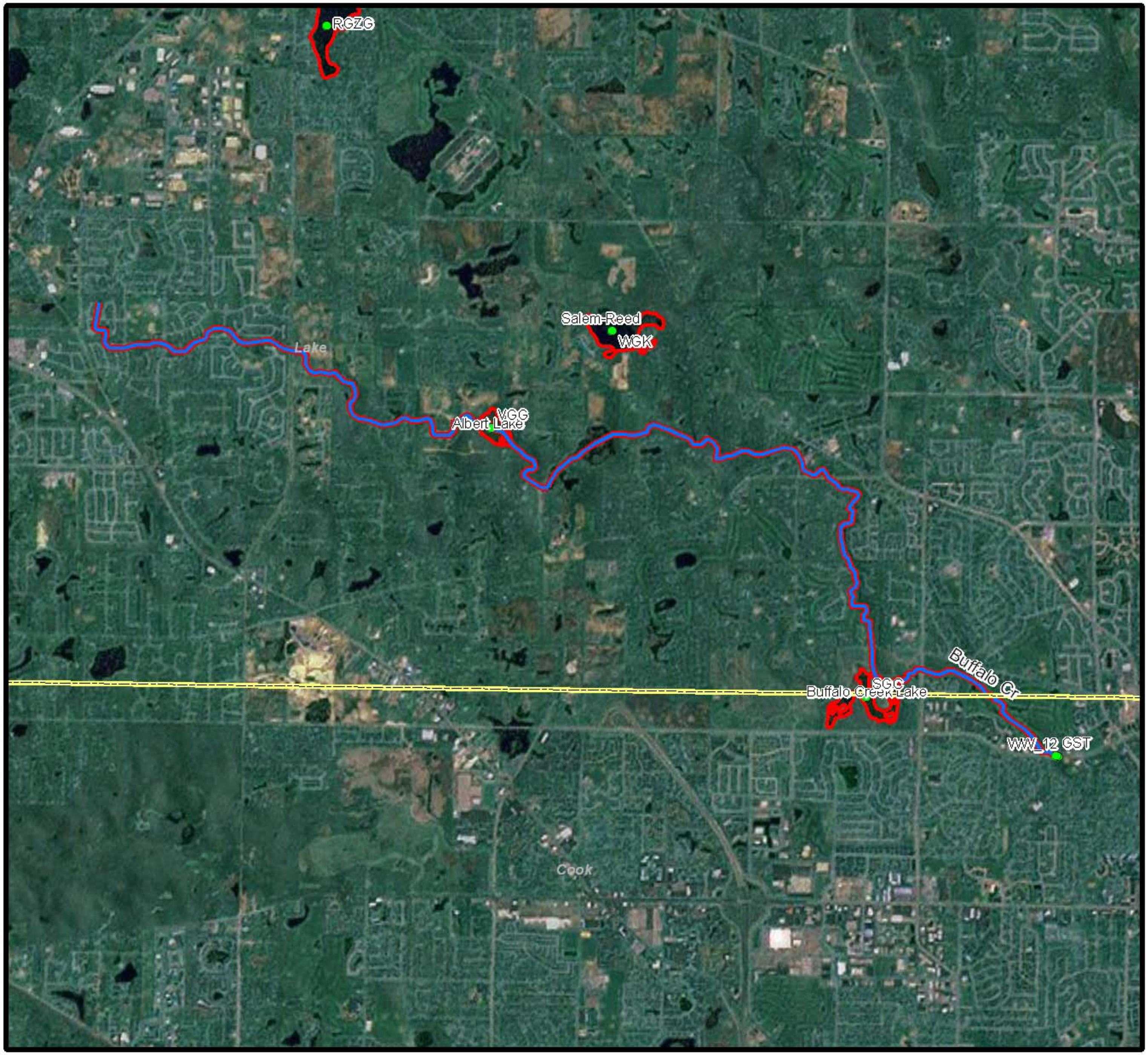


N
W
E
S
0
300
600
Feet
Big and Little Bear
Water Quality
Monitoring Stations
WQ Stations
Counties
Impaired Streams
Impaired Lakes
Big and Little Bear Lakes
WG-B01ZU-1 WGZU-1
WGZV-1 WGZV-2
WGZV-1S
WGZV

N
W
E
S
0
125
250
Feet
Big Bend
Water Quality Monitoring Stations
WQ Stations
Counties
Impaired Streams
Impaired Lakes
RGL-1S
RGL-3
Big Bend Lake
RGL-1
RGL-2



Bresen Lake
UGN
N
W
E
S
0
125
250
Feet
Bresen
Water Quality
Monitoring Stations
WQ Stations
Counties
Impaired Streams
Impaired Lakes



RGZG
Salem-Reed
WGK
Lake
VGG
Albert Lake
Buffalo Cr
SGC
Buffalo Creek Lake
WW_12 GST
Cook

N
W
E
S
0
2,000
4,000
Feet
Buffalo Creek
Water Quality
Monitoring Stations
WQ Stations
Counties
Impaired Streams
Impaired Lakes

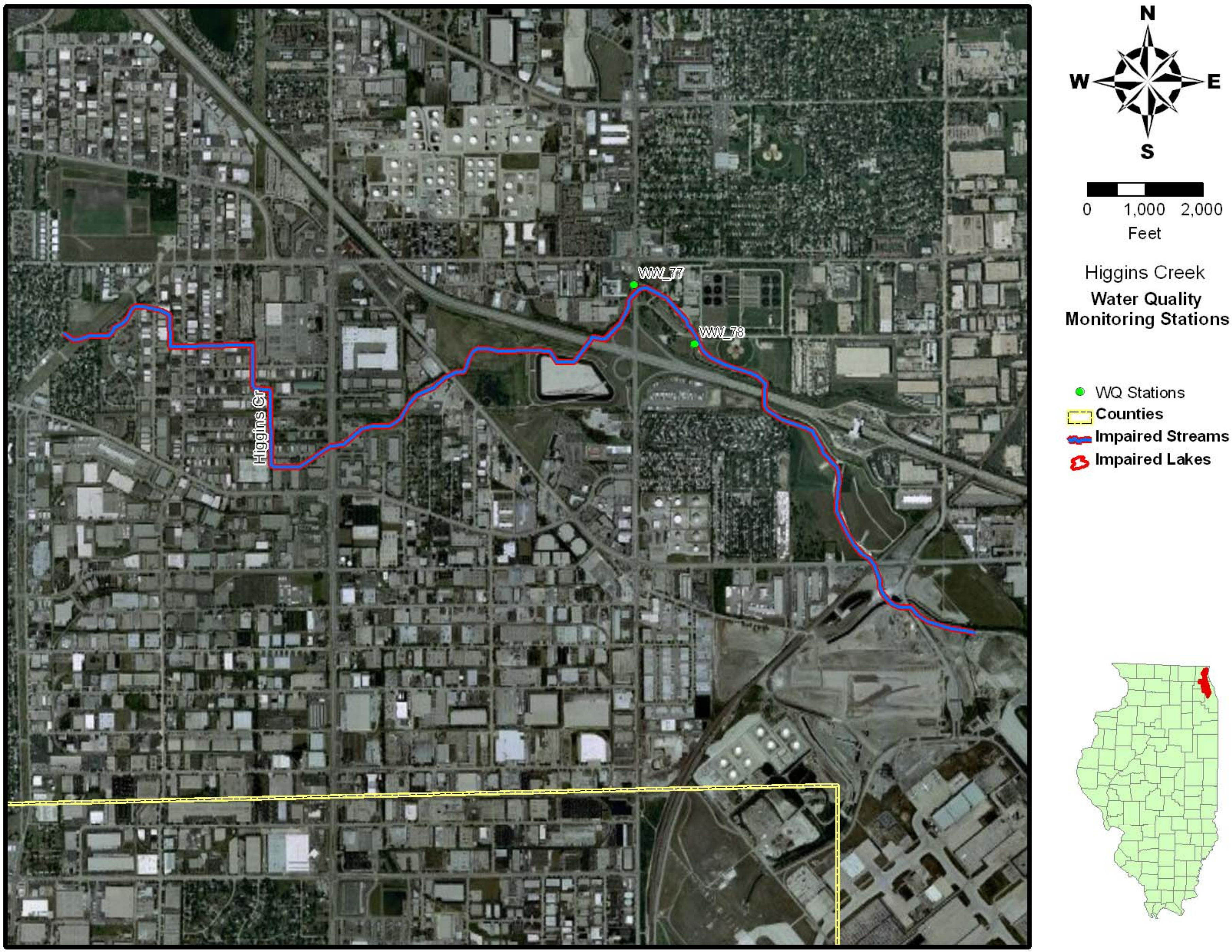
N
W
E
S
0
300
600
Feet
Charles
Water Quality Monitoring Stations
WQ Stations
Counties
Impaired Streams
Impaired Lakes
IL_RGZJ
Lake Charles

N
W
E
S
0
300
600
Feet
Countryside
Water Quality
Monitoring Stations
WQ Stations
Counties
Impaired Streams
Impaired Lakes
RGQ
Countryside Lake

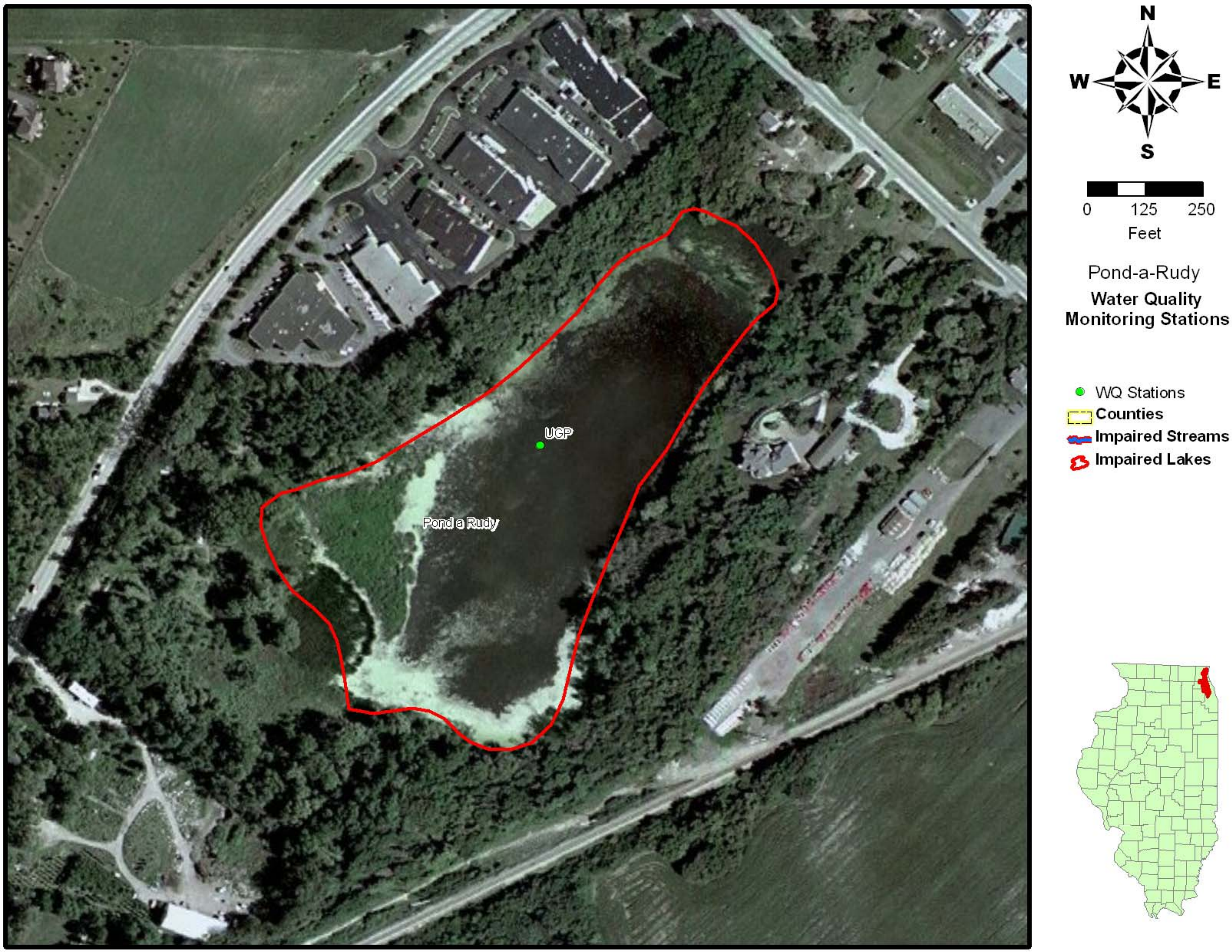
N
W
E
S
0
300
600
Feet
Diamond
Water Quality
Monitoring Stations
WQ Stations
Counties
Impaired Streams
Impaired Lakes
RG-B01-B-3
UDZG-1
Diamond Lake
RG-B01-B-1
RGB-1
RG-B01-B-2
RGB


Forest Lake
RGZG
N
W
E
S
0
300
600
Feet
Forest
Water Quality Monitoring Stations
WQ Stations
Counties
Impaired Streams
Impaired Lakes

Halfday Pit
N
W
E
S
0
125
250
Feet
Halfday Pit
Water Quality Monitoring Stations
WQ Stations
Counties
Impaired Streams
Impaired Lakes



WW_77
WW_78
Higgins Cr
N
W
E
S
0 1,000 2,000
Feet
Higgins Creek
Water Quality
Monitoring Stations
WQ Stations
Counties
Impaired Streams
Impaired Lakes


UGP
Pond a Rudy
N
W
E
S
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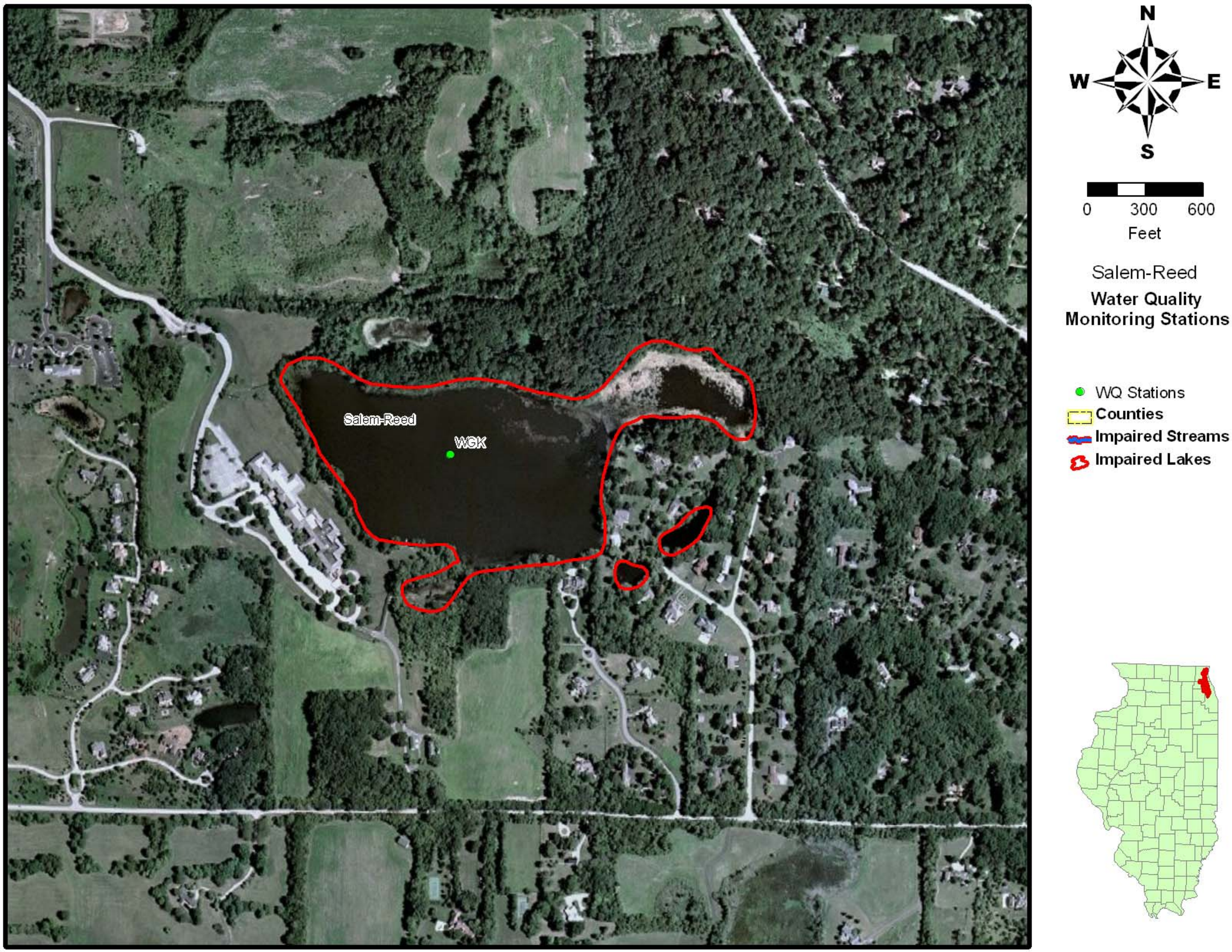
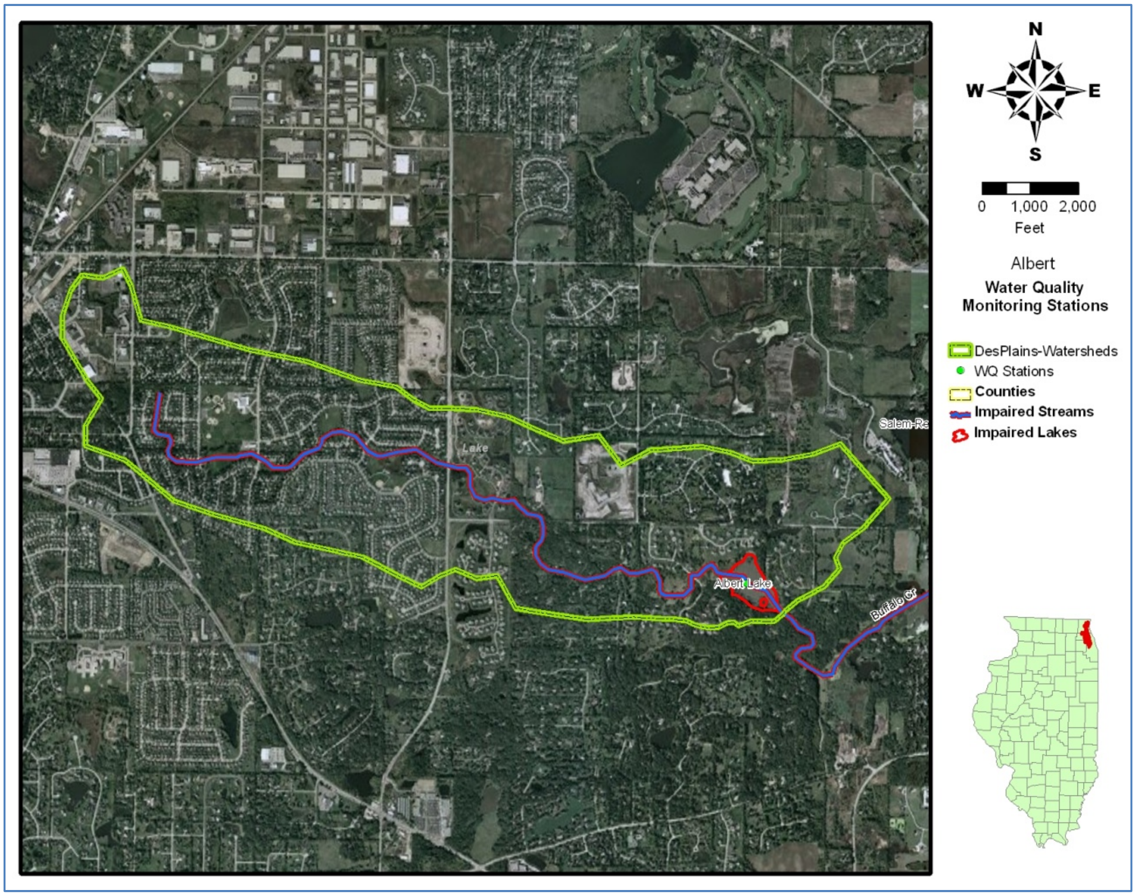
125
250
Feet
Pond-a-Rudy
Water Quality
Monitoring Stations
WQ Stations
Counties
Impaired Streams
Impaired Lakes

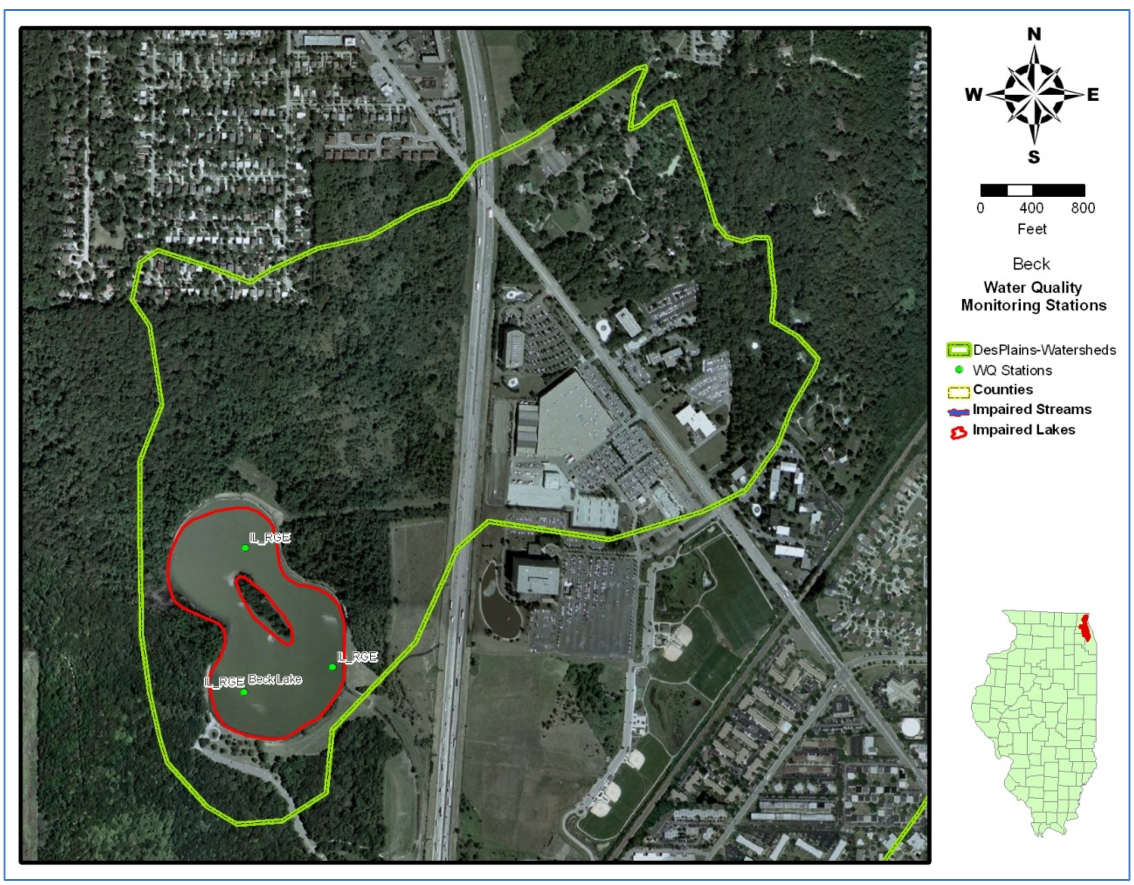

N
W
E
S
0
300
600
Feet
Salem-Reed
Water Quality
Monitoring Stations
WQ Stations
Counties
Impaired Streams
Impaired Lakes
Salem-Reed
WGK

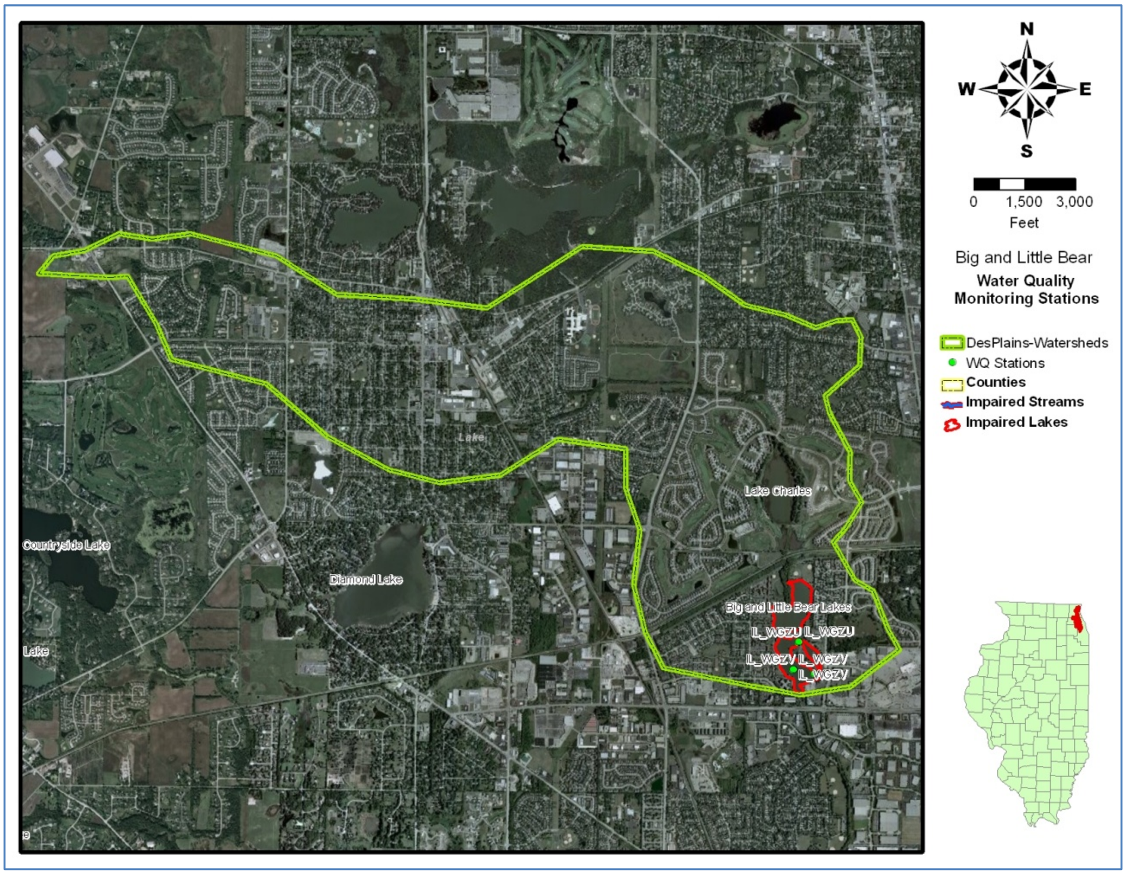
Sylvan Lake
RGZF
N
W
E
S
0
125
250
Feet
Sylvan
Water Quality
Monitoring Stations
WQ Stations
Counties
Impaired Streams
Impaired Lakes

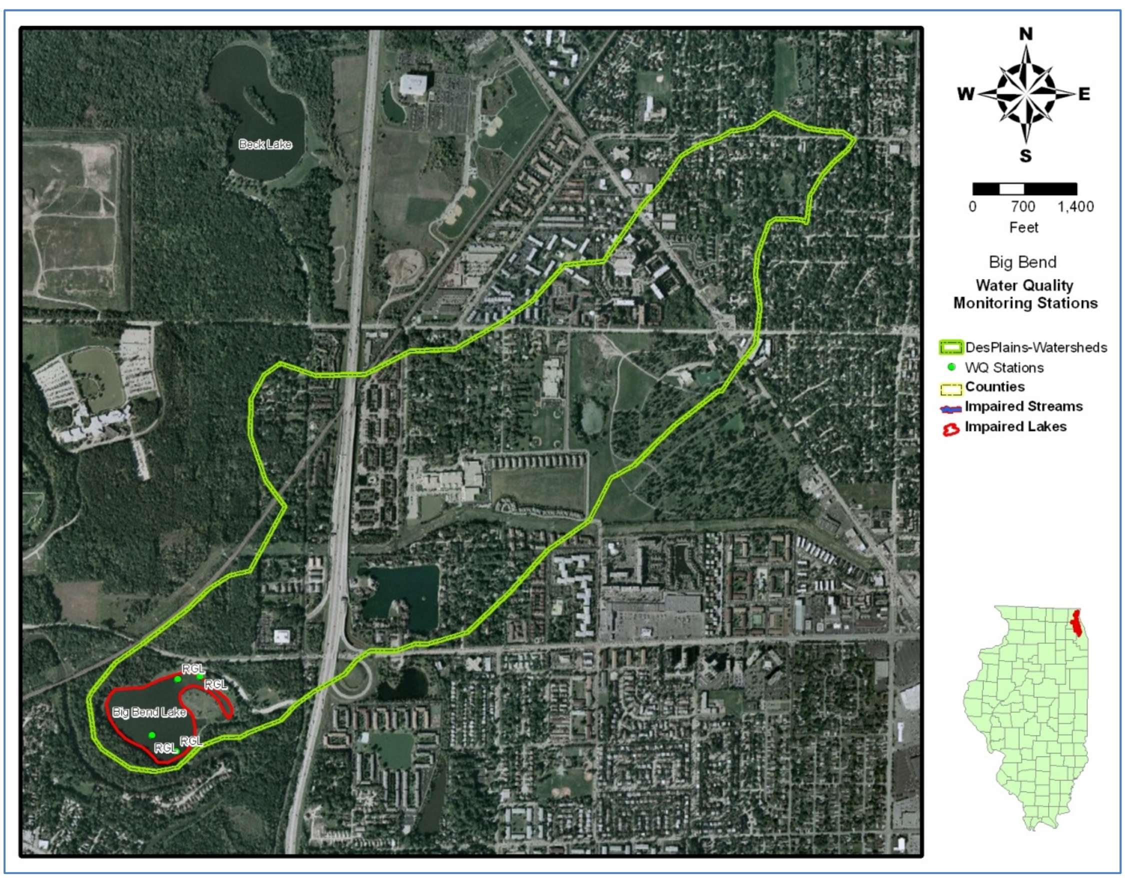
Appendix D

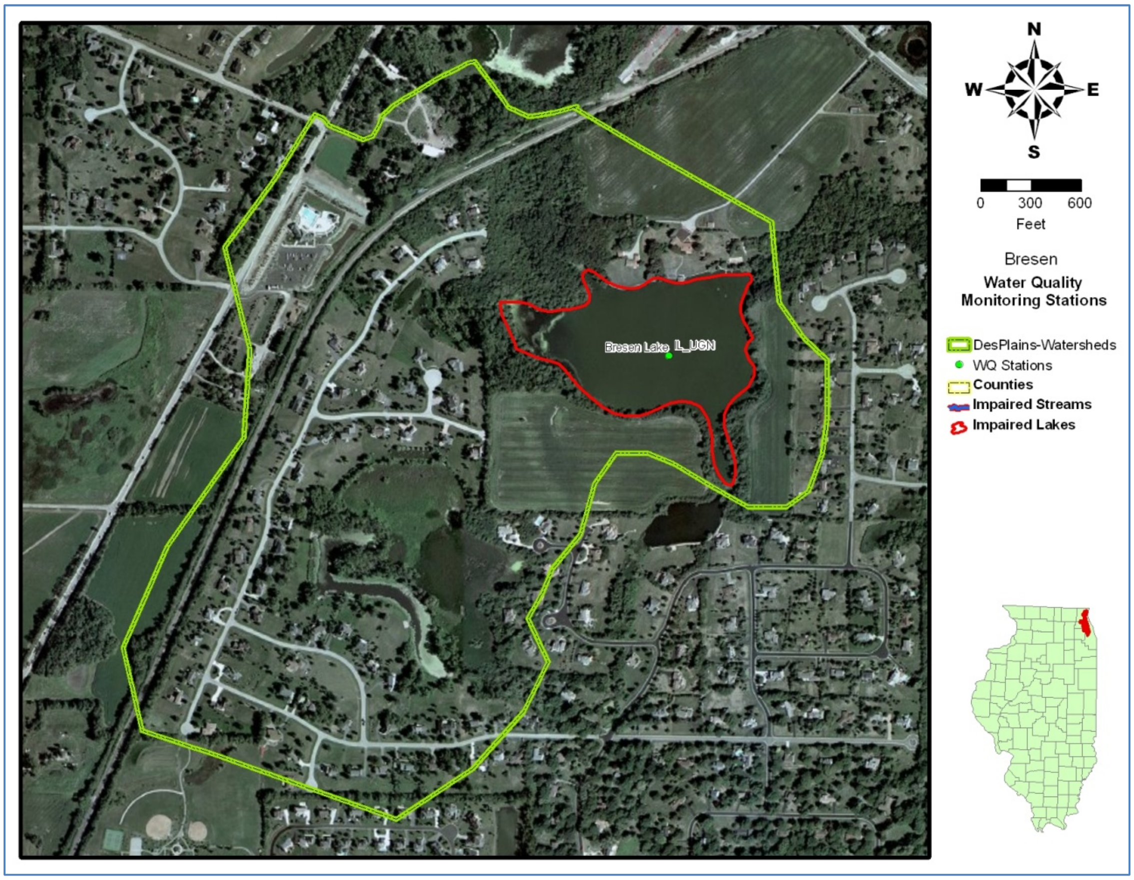
Watershed Maps

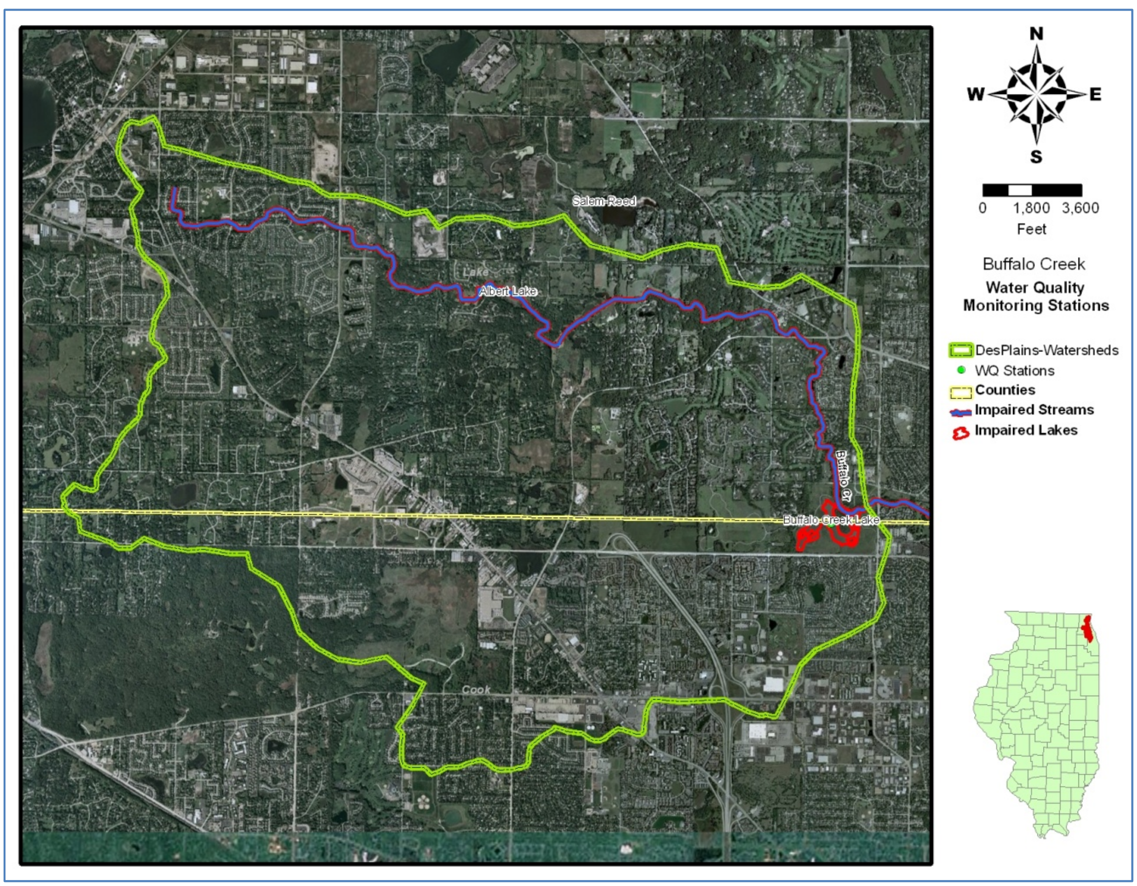

N
W
E
S
0 1,000 2,000
Feet
Albert
Water Quality
Monitoring Stations
DesPlains-Watersheds
WQ Stations
Counties
Impaired Streams
Impaired Lakes
Albert Lake
Buffalo Cr
Salem-Rd

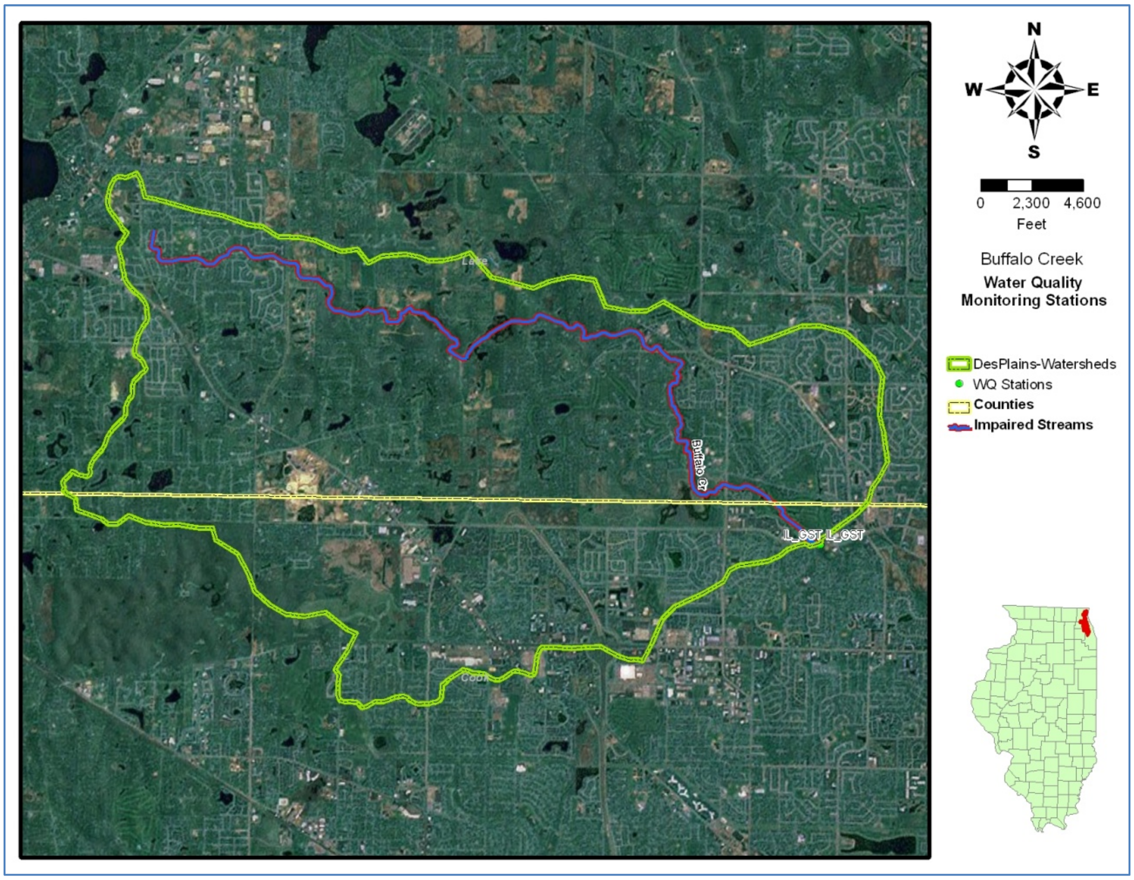

N
W
E
S
0 400 800
Feet
Beck
Water Quality
Monitoring Stations
DesPlains-Watersheds
WQ Stations
Counties
Impaired Streams
Impaired Lakes
IL_RGE
IL_RGE
IL_RGE
Beck Lake

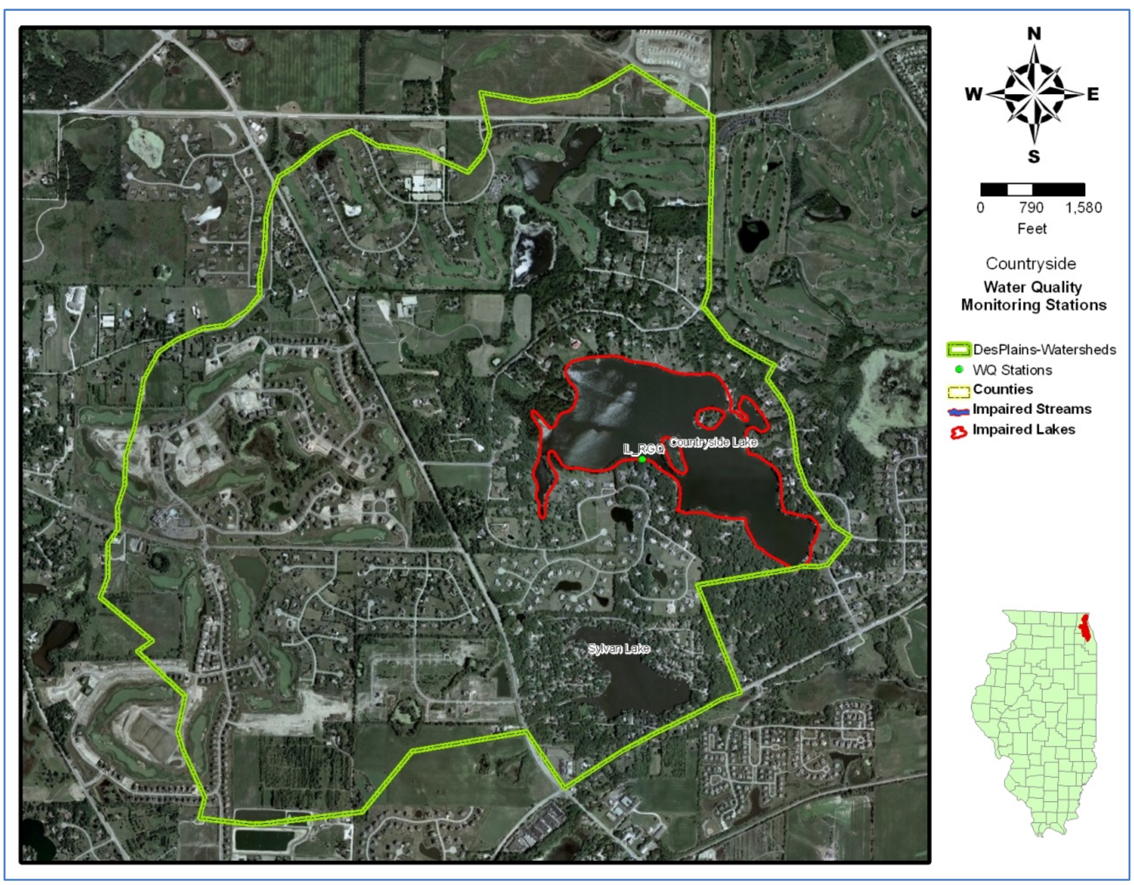

N
W
E
S
0 1,500 3,000
Feet
Big and Little Bear
Water Quality
Monitoring Stations
DesPlains-Watersheds
WQ Stations
Counties
Impaired Streams
Impaired Lakes
Lake
Lake Charles
Countryside Lake
Diamond Lake
Big and Little Bear Lakes
IL_WGZU IL_WGZU
IL_WGZV IL_WGZV
IL_WGZV

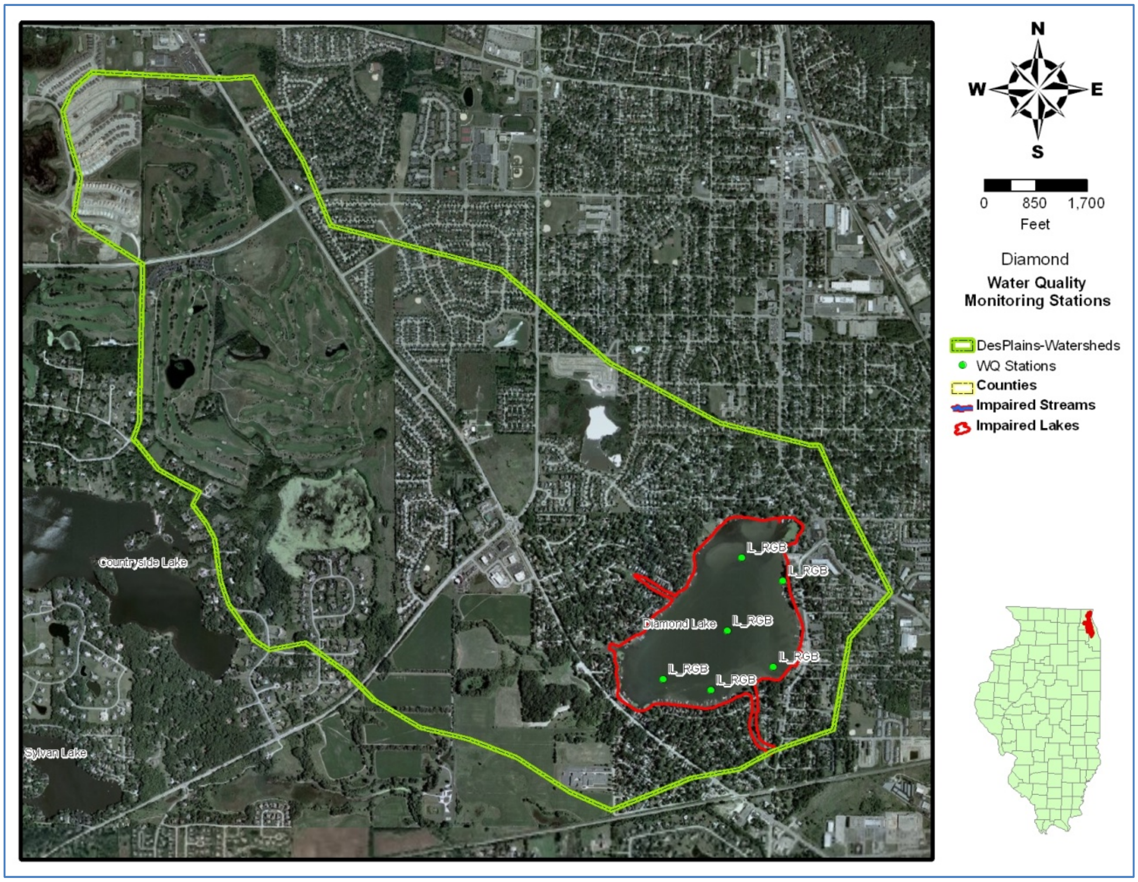

N
W
E
S
0 700 1,400
Feet
Big Bend
Water Quality
Monitoring Stations
DesPlains-Watersheds
WQ Stations
Counties
Impaired Streams
Impaired Lakes
Beck Lake
Big Bend Lake
RGL
RGL
RGL
RGL

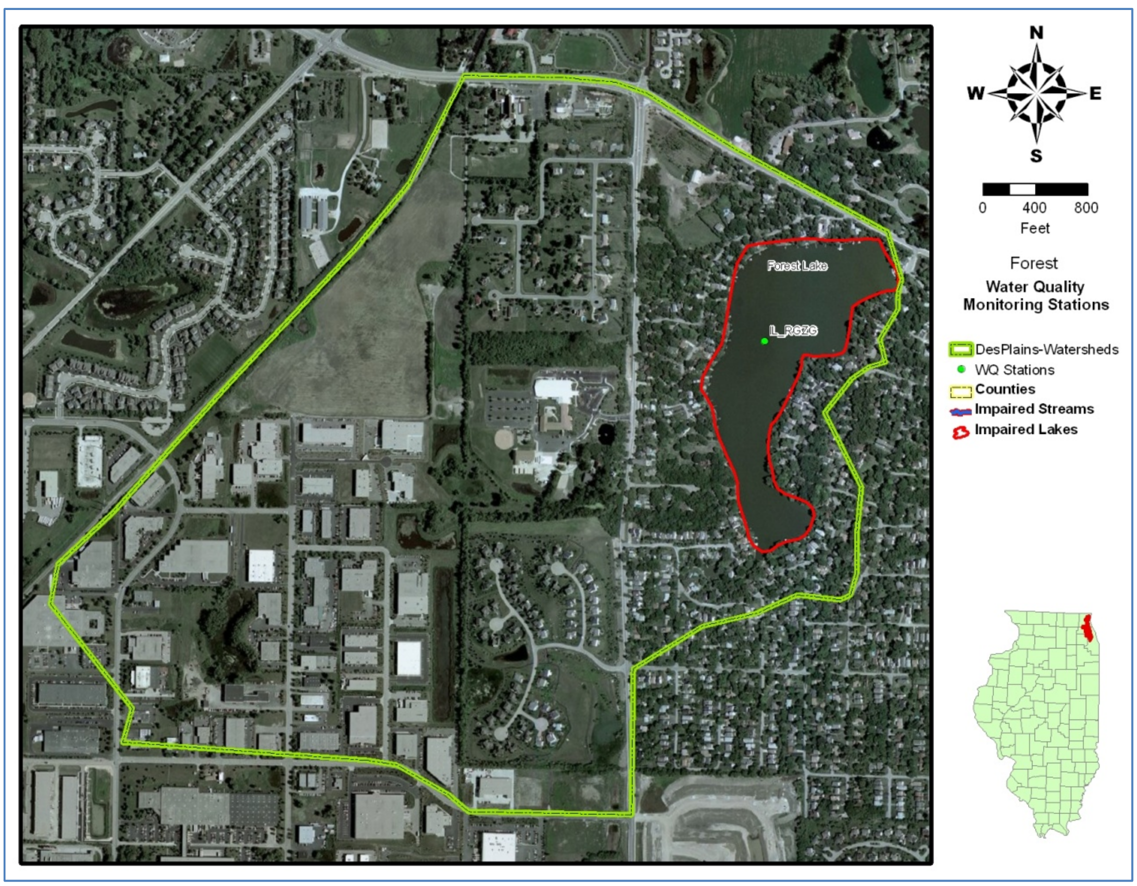

N
W
E
S
0
300
600
Feet
Bresen
Water Quality
Monitoring Stations
DesPlains-Watersheds
WQ Stations
Counties
Impaired Streams
Impaired Lakes
Bresen Lake
IL_UGN

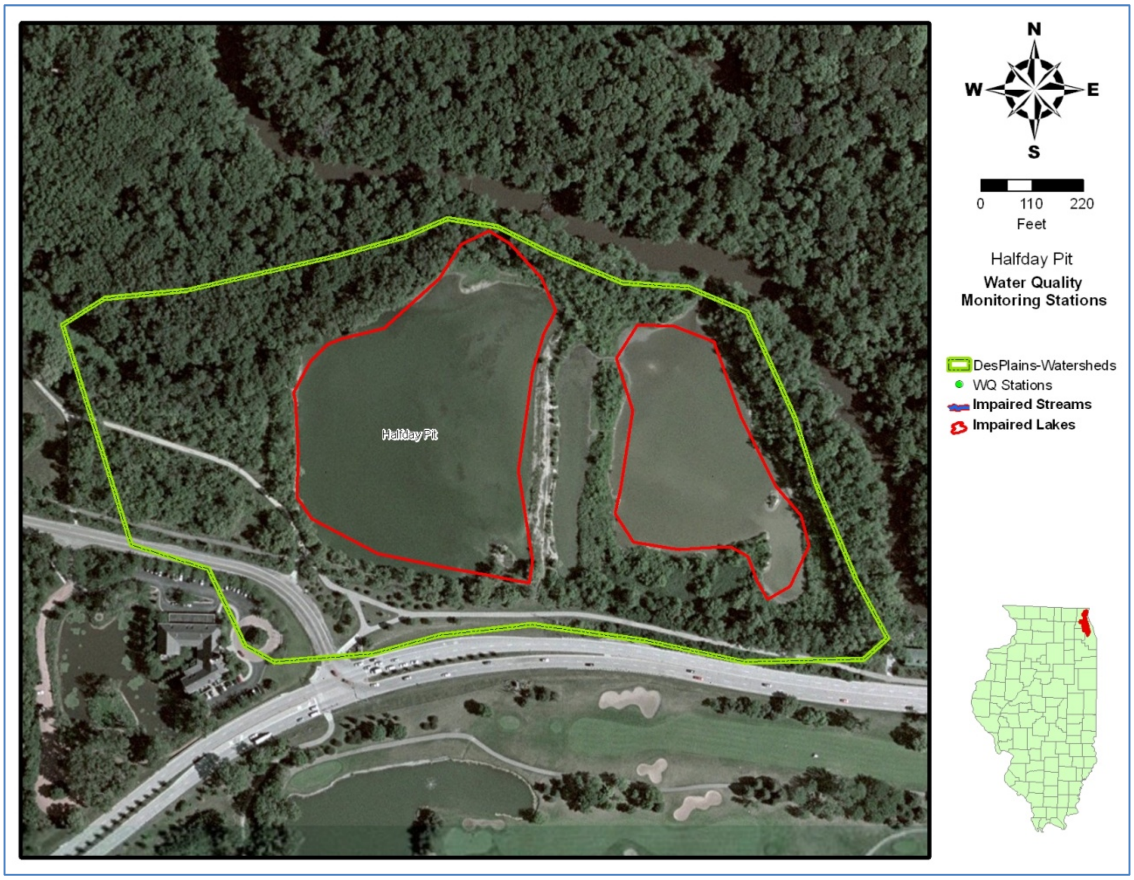

N
W
E
S
0
1,800
3,600
Feet
Buffalo Creek
Water Quality
Monitoring Stations
DesPlains-Watersheds
WQ Stations
Counties
Impaired Streams
Impaired Lakes
Salem-Reed
Lake
Albert Lake
Buffalo Cr
Buffalo Creek Lake
Cook


N
W
E
S
0 2,300 4,600
Feet
Buffalo Creek
Water Quality
Monitoring Stations
DesPlains-Watersheds
WQ Stations
Counties
Impaired Streams
Buffalo Cr
L_GST L_GST

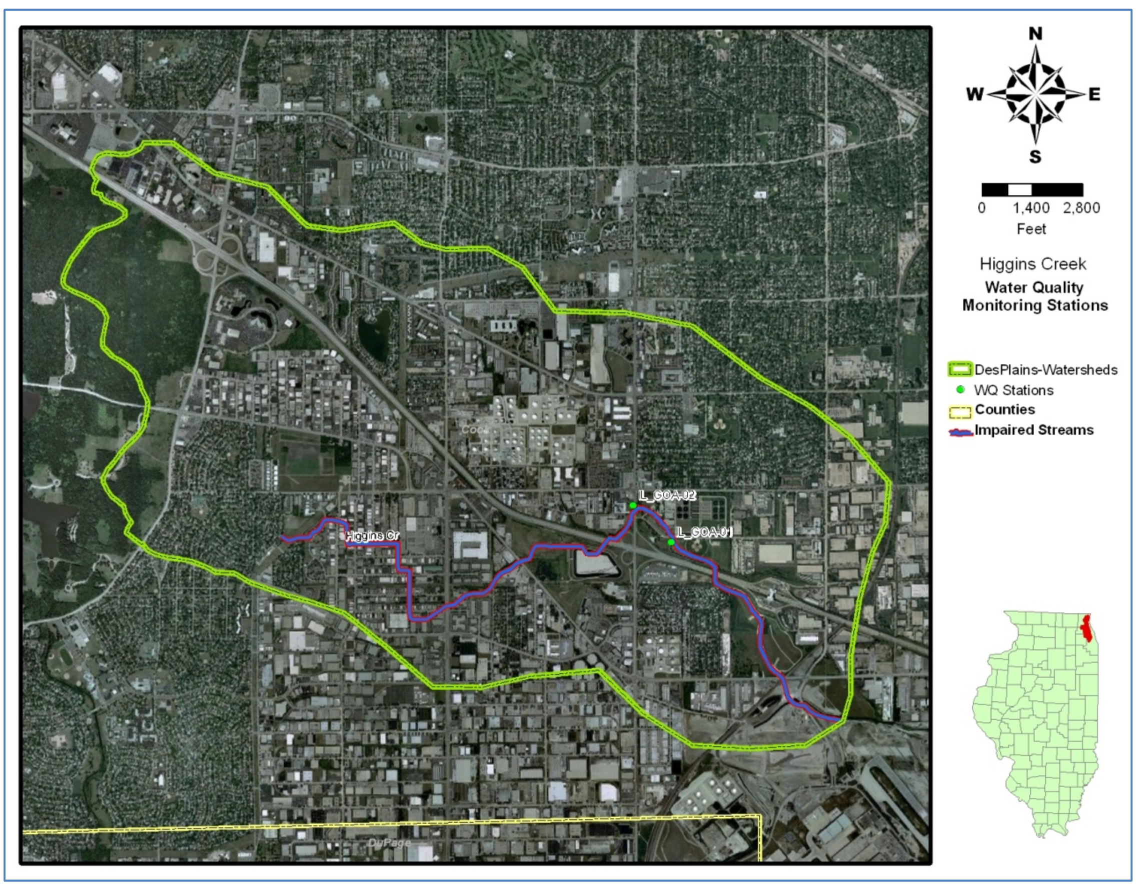

N
W
E
S
0 790 1,580
Feet
Countryside
Water Quality
Monitoring Stations
DesPlains-Watersheds
WQ Stations
Counties
Impaired Streams
Impaired Lakes
L_RGG
Countryside Lake
Sylvan Lake


N
W
E
S
0 850 1,700
Feet
Diamond
Water Quality
Monitoring Stations
DesPlains-Watersheds
WQ Stations
Counties
Impaired Streams
Impaired Lakes
Countryside Lake
Sylvan Lake
Diamond Lake
IL_RGB

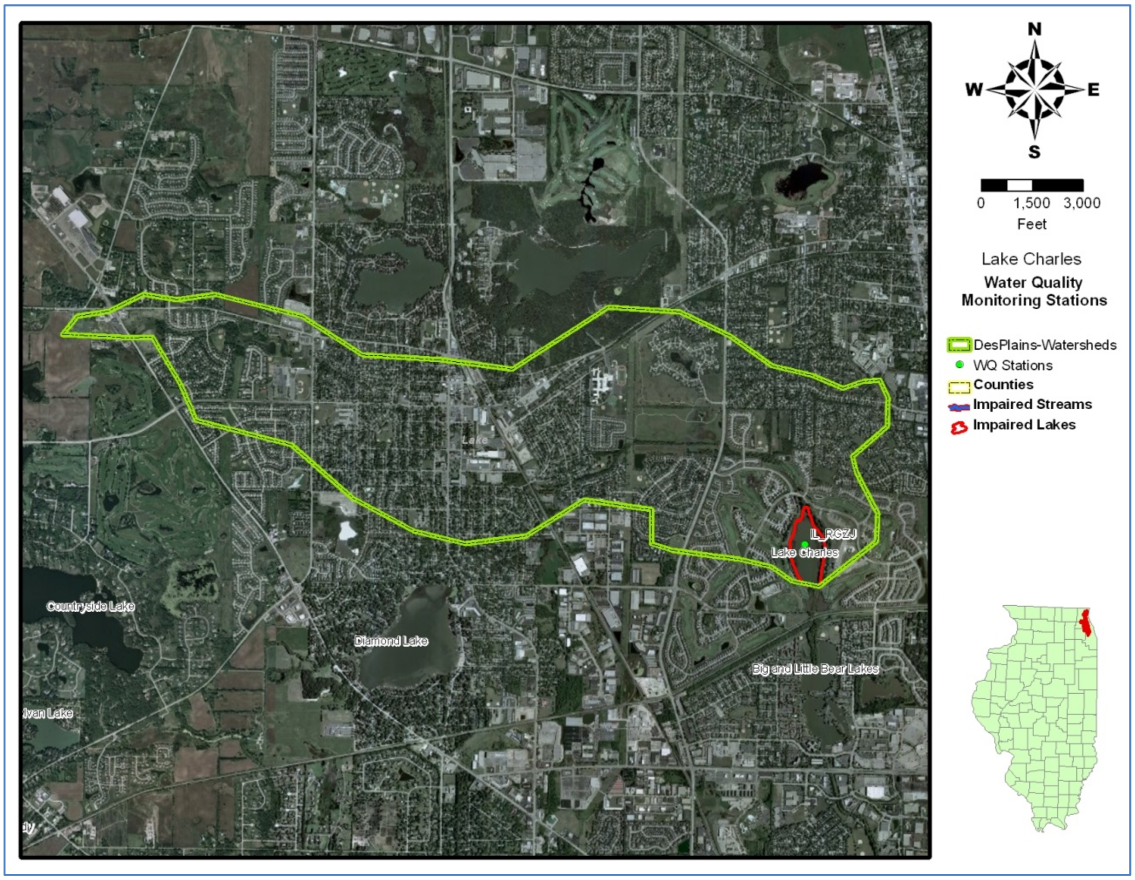

N
W
E
S
0 400 800
Feet
Forest
Water Quality
Monitoring Stations
DesPlains-Watersheds
WQ Stations
Counties
Impaired Streams
Impaired Lakes
Forest Lake
IL_RGZG



N
W
E
S
0
110
220
Feet
Halfday Pit
Water Quality
Monitoring Stations
DesPlains-Watersheds
WQ Stations
Impaired Streams
Impaired Lakes
Halfday Pit



N
W
E
S
0
1,400
2,800
Feet
Higgins Creek
Water Quality
Monitoring Stations
DesPlains-Watersheds
WQ Stations
Counties
Impaired Streams
L_GOA-02
L_GOA-01
Higgins Cr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W
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S
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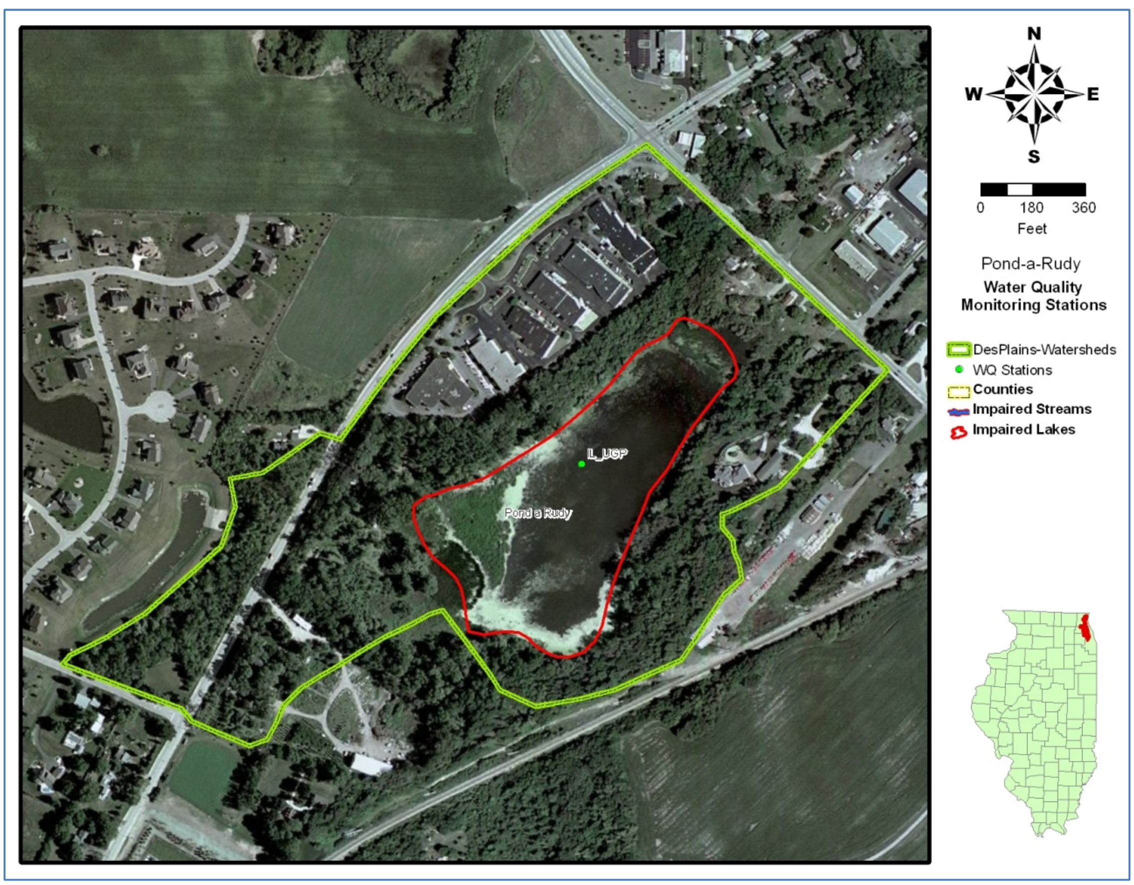
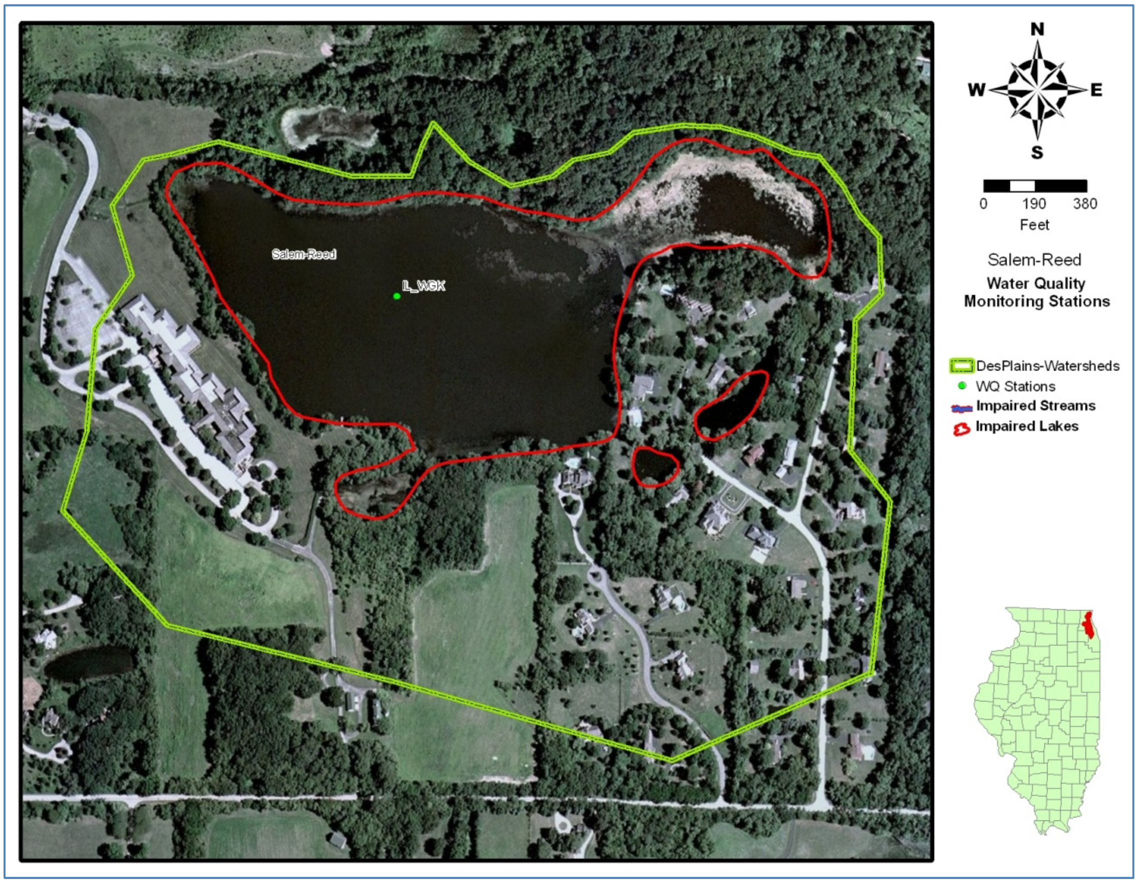
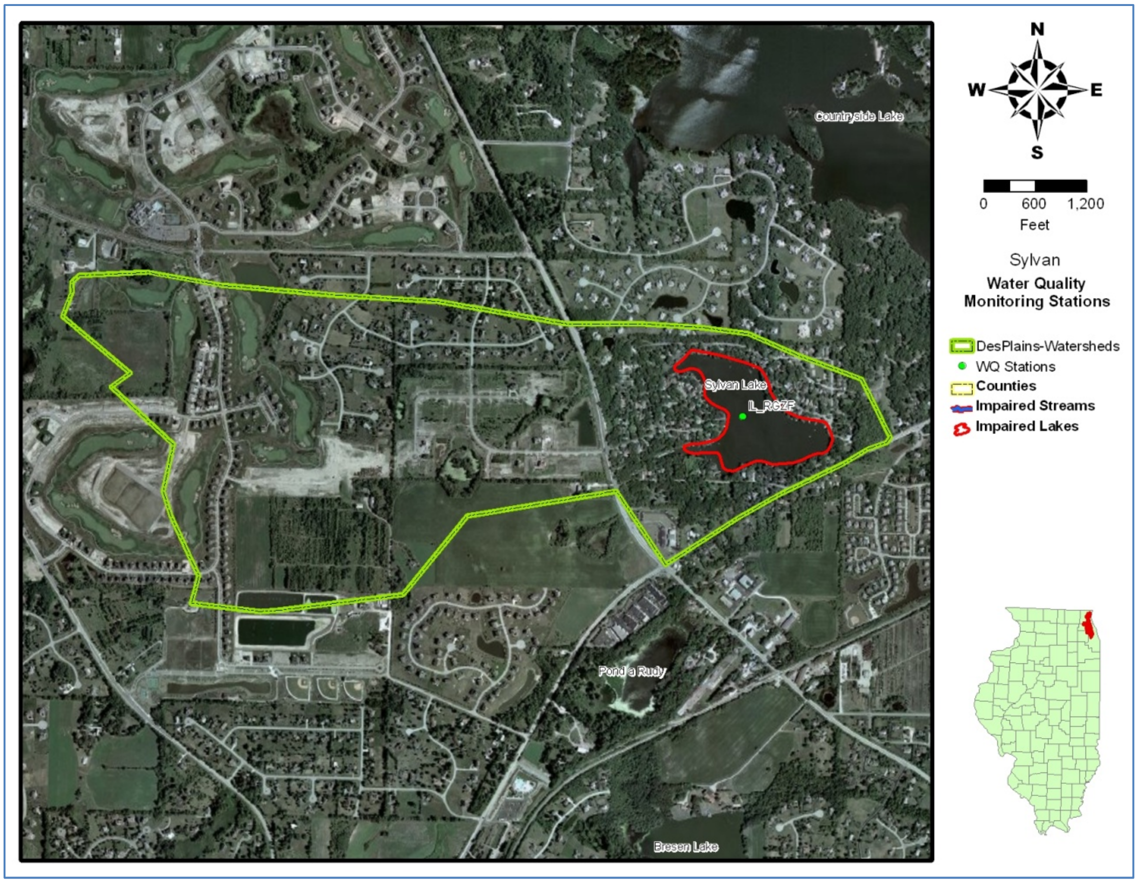
Feet
Lake Charles
Water Quality
Monitoring Stations
DesPlains-Watersheds
WQ Stations
Counties
Impaired Streams
Impaired Lakes
IL_RGZJ
Lake Charles
Countryside Lake
Diamond Lake
Big and Little Bear Lakes


N
W
E
S
0 180 360
Feet
Pond-a-Rudy
Water Quality
Monitoring Stations
DesPlains-Watersheds
WQ Stations
Counties
Impaired Streams
Impaired Lakes
IL_UGP
Pond a Rudy



Salem-Reed
IL_WGK
N
W
E
S
0
190
380
Feet
Salem-Reed
Water Quality
Monitoring Stations
DesPlains-Watersheds
WQ Stations
Impaired Streams
Impaired Lakes



N
W
E
S
0 600 1,200
Feet
Sylvan
Water Quality Monitoring Stations
DesPlains-Watersheds
WQ Stations
Counties
Impaired Streams
Impaired Lakes
Countryside Lake
Sylvan Lake
L_RGZF
Pond a Rudy
Bresen Lake

Appendix E

NPDES Permit Limits

Existing NPDES Dischargers in the Des Plaines/Higgins Creek Watershed

	NPDES Number	Receiving Water	Receiving Water Segment	Daily Avg Flow (MGD)	Daily Max Flow (MGD)	Monitored Parameters
Alden Long Grove Rehab.	IL0051934	Buffalo Cr.	Tributary to GST	0.015	0.037	CBOD, Suspended Solids, pH, Fecal Coliform, DO
BP Products – O'Hare Terminal (4 outfalls)	IL0034347	Higgins Cr.	GOA-01	0.029	N/A	pH, TSS
C.M. Products, Inc.	IL0066311	UT to Flint Creek	GST	0.033	0.066	pH, temperature
Camp Reinberg STP	IL0048542	UT to Salt Cr.	GST	0.004	0.01	DO, BOD, NH4, Fecal Coliform, pH
CITGO Petroleum Corp. (2 outfalls)	IL0025461	Higgins Cr.	GOA-02	0.185	N/A	BOD
Des Plaines MHP	IL0054160	UT to Higgins Cr.	GOA-01	0.069	0.177	BOD, Suspended Solids, pH, Fecal Coliform, NH4, DO
Shell Oil – Des Plaines (5 outfalls)	IL0046736	Higgins Cr.	GOA-02	2.788	13	Total Dissolved Solids, pH, TSS
Exxon Mobil Corp. (4 outfalls)	IL0066362	Higgins Cr.	GOA-02	0.0043	N/A	Total Dissolved Solids, pH
Fox Point MHP	IL0049930	Des Plaines R.	G-36	0.016	0.04	pH, TSS, Fecal Coliform, BOD
Jiffy Lube	IL0072729	UT to Des Plaines R.	GS-01	0.0005	0.0072	pH
Lake County DWP - Des Plaines STP	IL0022055	Aptakistic Cr.	G-36	16	51.8	CBOD, TSS, DO, pH, Fecal Coliform, NH4
Lake Cnty DWP – Diamond –Sylvan STP	IL0022080	Indian Cr.	GU-02	0.34	1.19	DO, pH, TSS, NH4, Fecal Coliform, BOD
Lake County DWP - New Century STP	IL0022071	Des Plaines R.	G-35	6	18	BOD, Suspended Solids, pH, Fecal Coliform, NH4, DO
Leider Greenhouse	IL0067881	Aptakistic Cr.	G-36	0.0058	0.0327	pH, BOD, TSS, NH4
Libertyville STP	IL0029530	Des Plaines R.	G-35	4	8	BOD, Suspended Solids, pH, Fecal Coliform, NH4, DO
Marathon Petroleum – Mt. Prospect (2 outfalls)	IL0062791	Higgins Cr.	GOA-02	0.7	N/A	pH, TSS, BOD
Mundelein STP (2 outfalls)	IL0022501	Des Plaines R.	G-35	4.95	15	BOD, Suspended Solids, pH, Fecal Coliform, NH4, Phosphorus, Nitrogen, DO
MWRDGC Kirie WRP (4 outfalls)	IL0047741	Higgins Cr.	GOA-01	52	110	CBOD, TSS, DO, pH, Fecal Coliform, NH4

	NPDES Number	Receiving Water	Receiving Water Segment	Daily Avg Flow (MGD)	Daily Max Flow (MGD)	Monitored Parameters
Prairie Materials Sales, Inc.	IL0068063	Willow Cr.	GS-01	N/A	N/A	N/A - General Stormwater Permit
Unoven – Des Plaines Terminal	IL0042242	Higgins Cr.	GOA-02	N/A	N/A	N/A - General Stormwater Permit

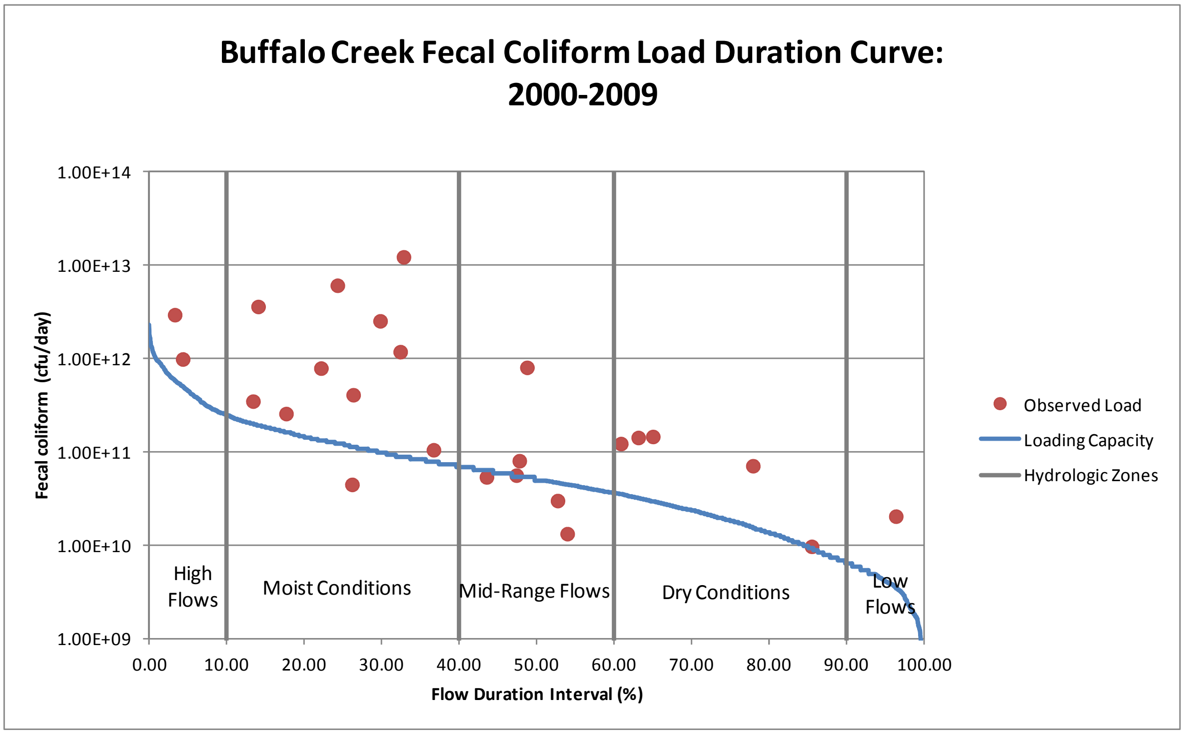
Existing MS4 Dischargers to Waterbodies Targeted for TMDL Development in the Des Plaines/Higgins Creek Watershed

Municipality	MS4 Permit ID	Permittee	Drainage Area (Sq. Miles)
Arlington Heights	ILR400282	Village of Arlington Heights	7.4
Barrington	ILR400285	Village of Barrington	4.9
Buffalo Grove	ILR400303	Village of Buffalo Grove	9.0
Chicago	ILR400173	Chicago City	1.0
Deer Park	ILR400323	Village of Deer Park	3.7
Des Plaines	ILR400325	City of Des Plaines	15.8
Elk Grove	ILR400334	Village of Elk Grove Village/Supt. of Utilities	10.9
Glenview	ILR400343	Village of Glenview	14.0
Hawthorn Woods	ILR400209	Hawthorn Wood Village	6.1
Illinois Tollway	ILR400494	Illinois Tollway Authority	0.15
Inverness	ILR400359	Village of Inverness	6.9
Kildeer	ILR400215	Kildeer Village	3.7
Lake Zurich	ILR400370	Village of Lake Zurich	6.9
Long Grove	ILR400219	Long Grove Village	13.2
Mt Prospect	ILR400393	Village of Mt. Prospect	10.0
Palatine	ILR400416	Village of Palatine	13.4
Rolling Meadows	ILR400435	City of Rolling Meadows	5.6

Appendix F

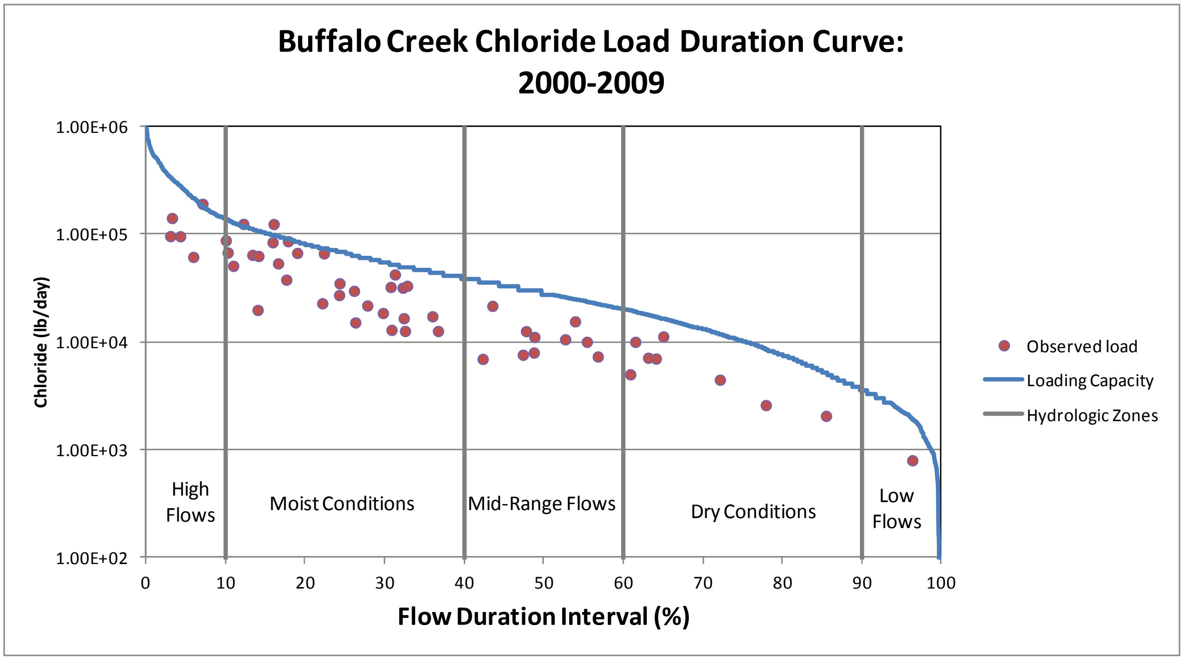
Load Duration Curve and Mass Balance Analysis

Buffalo Creek (IL_GST-01): Fecal Coliform vs. Flow



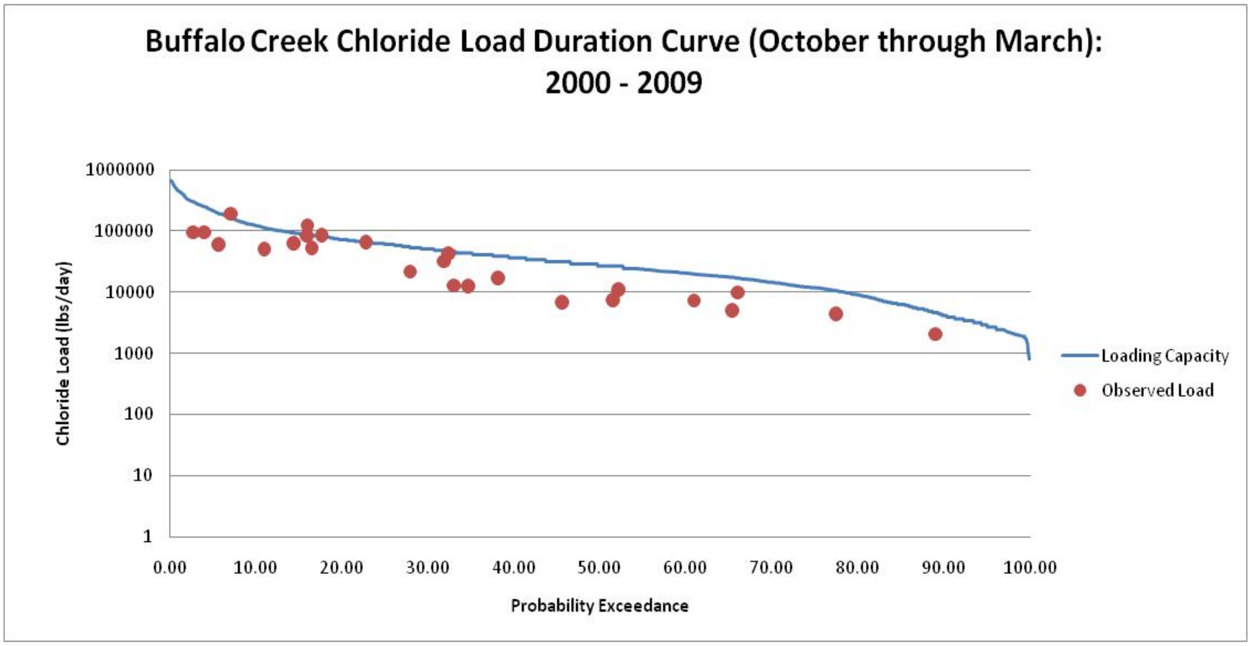
units = cfu/day	High Flows (0-10)	% Total Load	Moist Conditions (10-40)	% Total Load	Mid-Range Flows (40-60)	% Total Load	Dry Conditions (60-90)	% Total Load	Low Flows (90-100)	% Total Load
TMDL	4.50E+11	N/A	1.22E+11	N/A	4.89E+10	N/A	1.81E+10	N/A	4.11E+09	N/A
Current Load	1.98E+12	N/A	7.93E+11	N/A	5.53E+10	N/A	1.23E+11	N/A	2.06E+10	N/A
MS4	2.85E+11	63%	7.74E+10	63%	3.09E+10	63%	---	N/A	---	N/A
LA	9.74E+10	22%	2.65E+10	22%	1.06E+10	22%	1.52E+10	84%	3.35E+09	82%
WLA	3.56E+08	0.1%	1.44E+08	0.1%	1.44E+08	0.3%	1.44E+08	1%	1.44E+08	3%
Reserve Capacity	2.25E+10	5%	6.12E+09	5%	2.45E+09	5%	9.05E+08	5%	2.06E+08	5%
MOS	4.50E+10	10%	1.22E+10	10%	4.89E+09	10%	1.81E+09	10%	4.11E+08	10%
% Reduction	**77%**	**N/A**	**85%**	**N/A**	**12%**	**N/A**	**85%**	**N/A**	**80%**	**N/A**

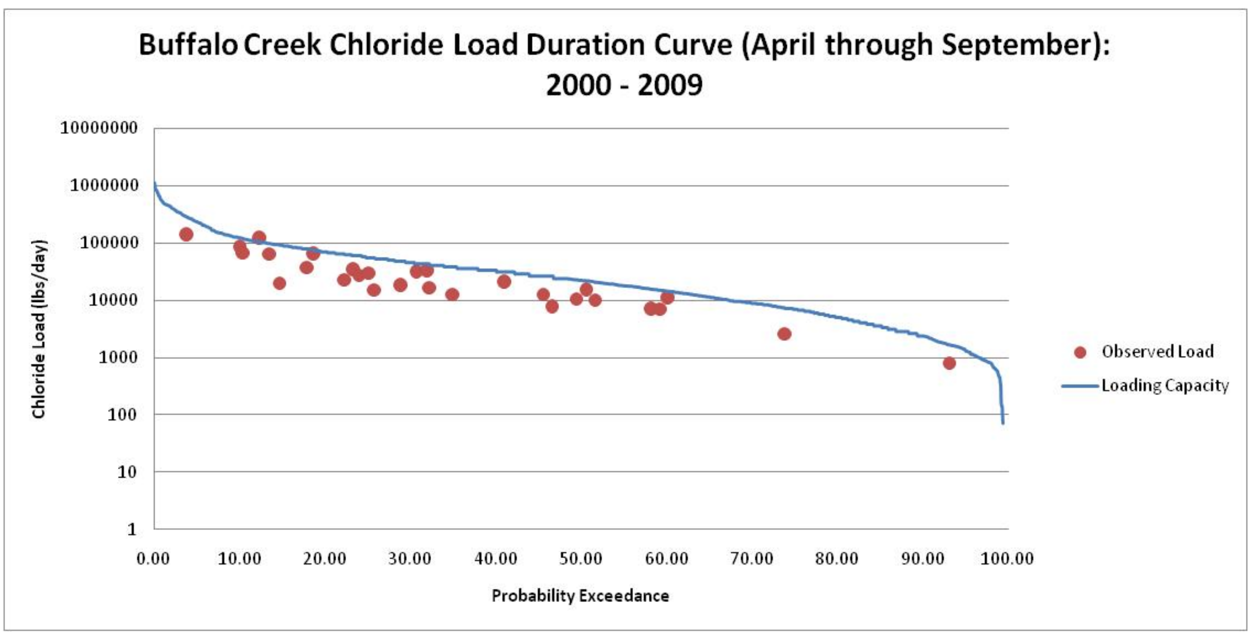
Buffalo Creek (IL_GST-01): Chloride vs. Flow



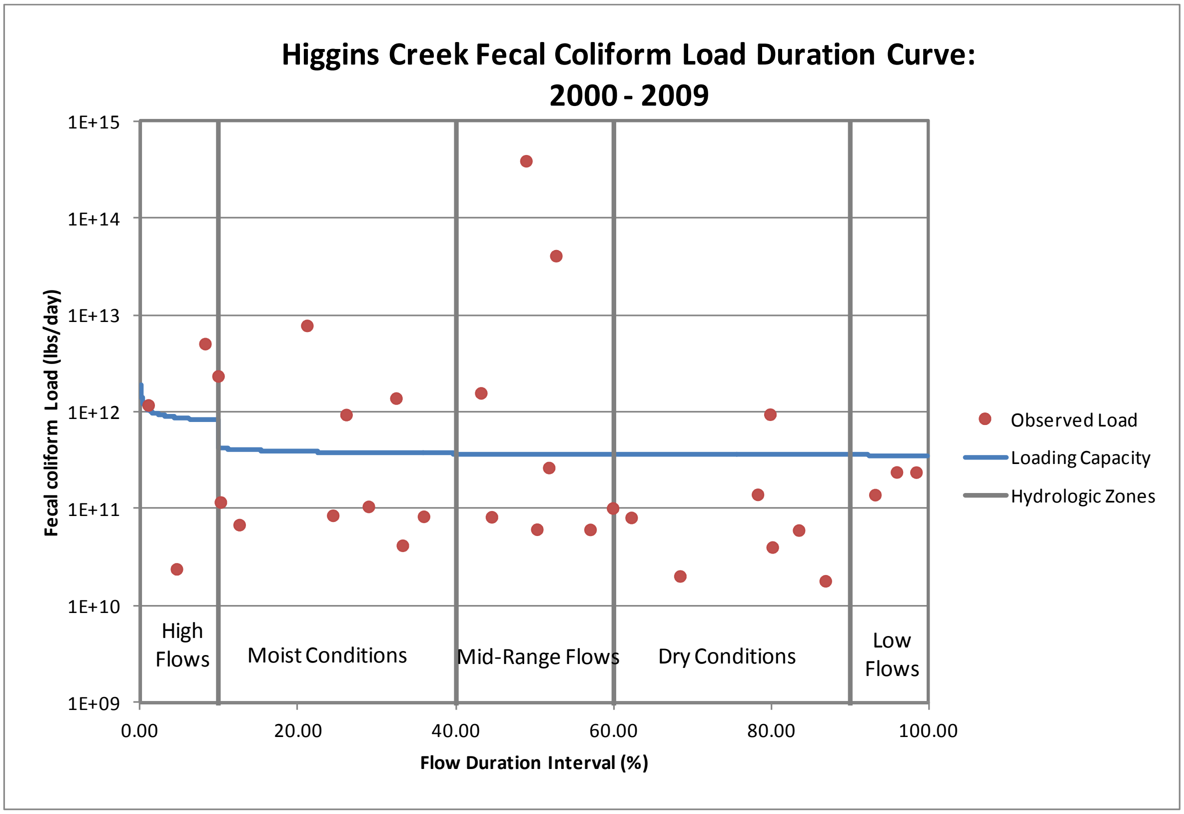
units = lbs/day	High Flows (0-10)	% Total Load	Moist Conditions (10-40)	% Total Load	Mid-Range Flows (40-60)	% Total Load	Dry Conditions (60-90)	% Total Load	Low Flows (90-100)	% Total Load
TMDL	247,936	N/A	67,374	N/A	26,950	N/A	9,971	N/A	2,264	N/A
Current Load	190,807	N/A	124,227	N/A	21,546	N/A	11,215	N/A	796	N/A
MS4	166,286	67%	45,186	67%	18,075	67%	---	N/A	---	N/A
LA	56,857	23%	15,450	23%	6,180	23%	8,974	90%	2,037	90%
WLA	---	N/A	---	N/A	---	N/A	---	N/A	---	N/A
MOS	24,794	10%	6,737	10%	2,695	10%	997	10%	226	10%
% Reduction	**---**	**N/A**	**46%**	**N/A**	**---**	**N/A**	**11%**	**N/A**	**---**	**N/A**

Buffalo Creek (IL_GST-01): Chloride vs. Flow (October through March/April through September)



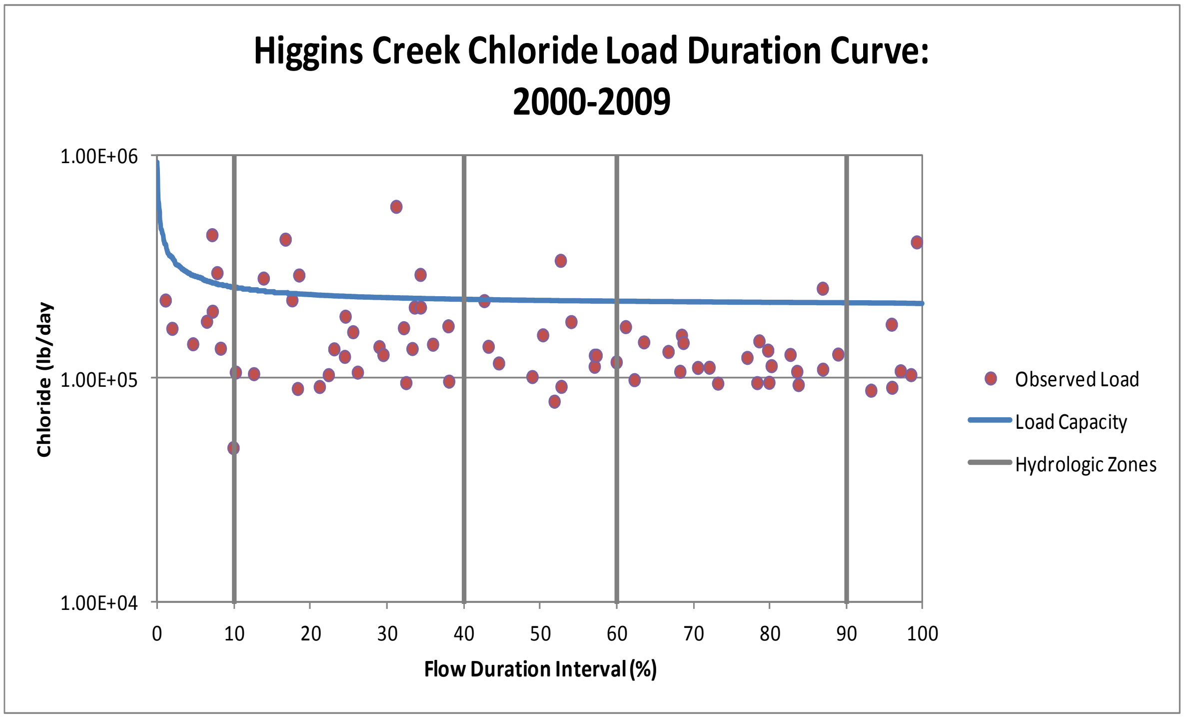


Higgins Creek (IL_GOA-01): Fecal Coliform vs. Flow



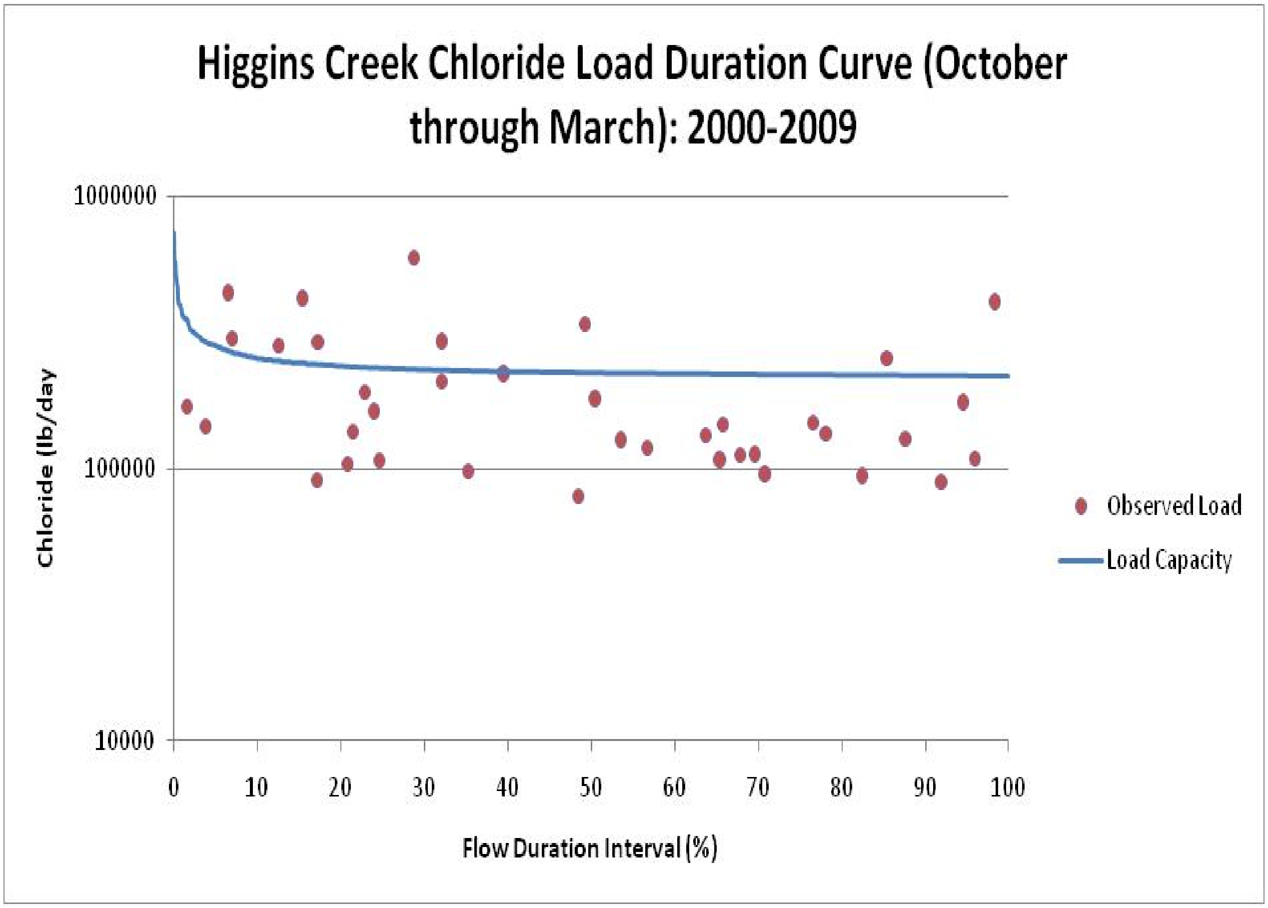
units = cfu/day	High Flows (0-10)	% Total Load	Moist Conditions (10-40)	% Total Load	Mid-Range Flows (40-60)	% Total Load	Dry Conditions (60-90)	% Total Load	Low Flows (90-100)	% Total Load
TMDL	9.60E+11	N/A	4.24E+11	N/A	4.07E+11	N/A	4.00E+11	N/A	3.96E+11	N/A
Current Load	1.37E+12	N/A	2.37E+11	N/A	8.17E+11	N/A	7.10E+10	N/A	1.98E+11	N/A
MS4	2.16E+10	2%	---	N/A	---	N/A	---	N/A	---	N/A
LA	8.32E+09	1%	---	N/A	---	N/A	---	N/A	---	N/A
WLA	8.34E+11	87%	3.94E+11	93%	3.94E+11	97%	3.94E+11	99%	3.94E+11	99%
Reserve Capacity	---	N/A	---	N/A	---	N/A	---	N/A	---	N/A
MOS	9.60E+10	10%	4.24E+10	10%	4.07E+10	10%	4.00E+10	10%	3.96E+10	10%
% Reduction	**30%**	**NA**	**0%**	**NA**	**50%**	**NA**	**0%**	**NA**	**0%**	**NA**

Higgins Creek (IL_GOA-01): Chloride vs. Flow

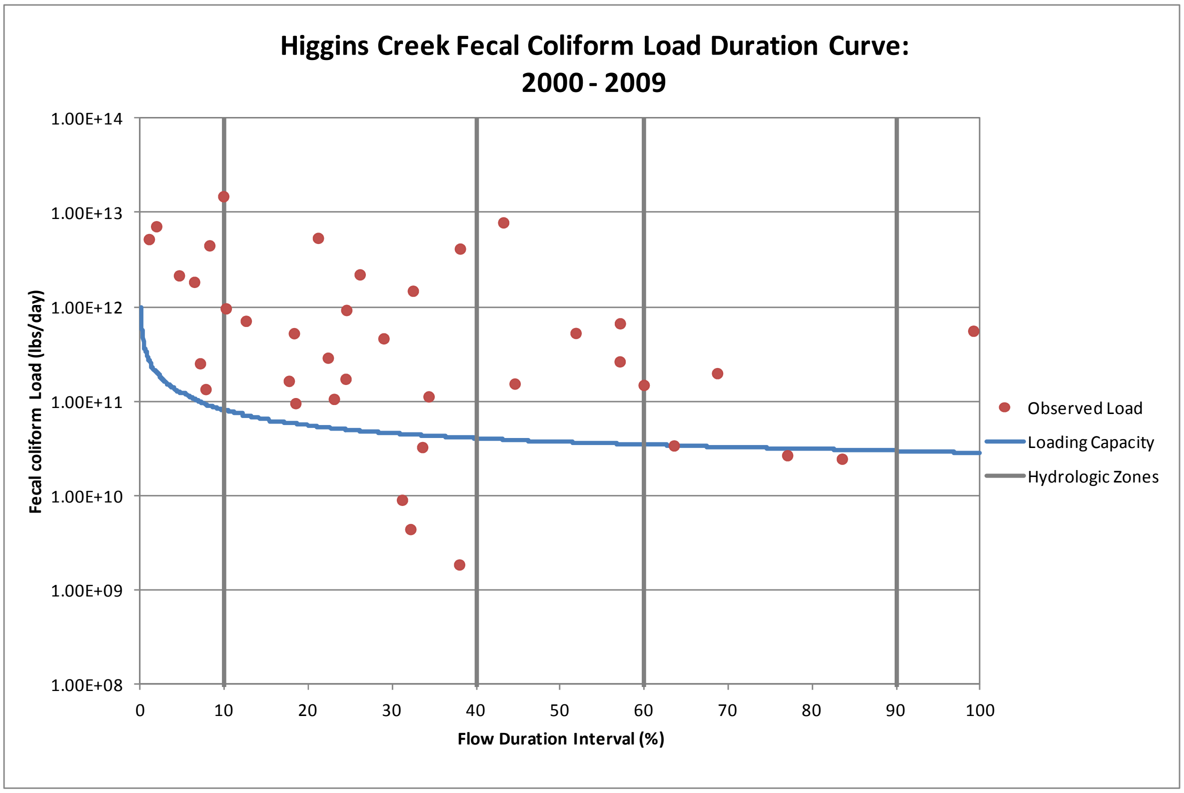


units = lbs/day	High Flows (0-10)	% Total Load	Moist Conditions (10-40)	% Total Load	Mid-Range Flows (40-60)	% Total Load	Dry Conditions (60-90)	% Total Load	Low Flows (90-100)	% Total Load
TMDL	926,631	N/A	256,050	N/A	226,323	N/A	221,945	N/A	218,350	N/A
Current Load	441,567	N/A	591,224	N/A	338,885	N/A	254,302	N/A	409,771	N/A
MS4	575,438	62%	159,007	62%	140,547	62%	---	N/A	---	N/A
LA	258,530	28%	71,438	28%	63,144	28%	199,750	90%	196,515	90%
WLA	---	N/A	---	N/A	---	N/A	---	N/A	---	N/A
MOS	92,663	10%	25,605	10%	22,632	10%	22,194	10%	21,835	10%
% Reduction	**---**	**NA**	**57%**	**NA**	**33%**	**NA**	**13%**	**NA**	**47%**	**NA**

Higgins Creek (IL_GOA-01): Chloride vs. Flow (October through March)

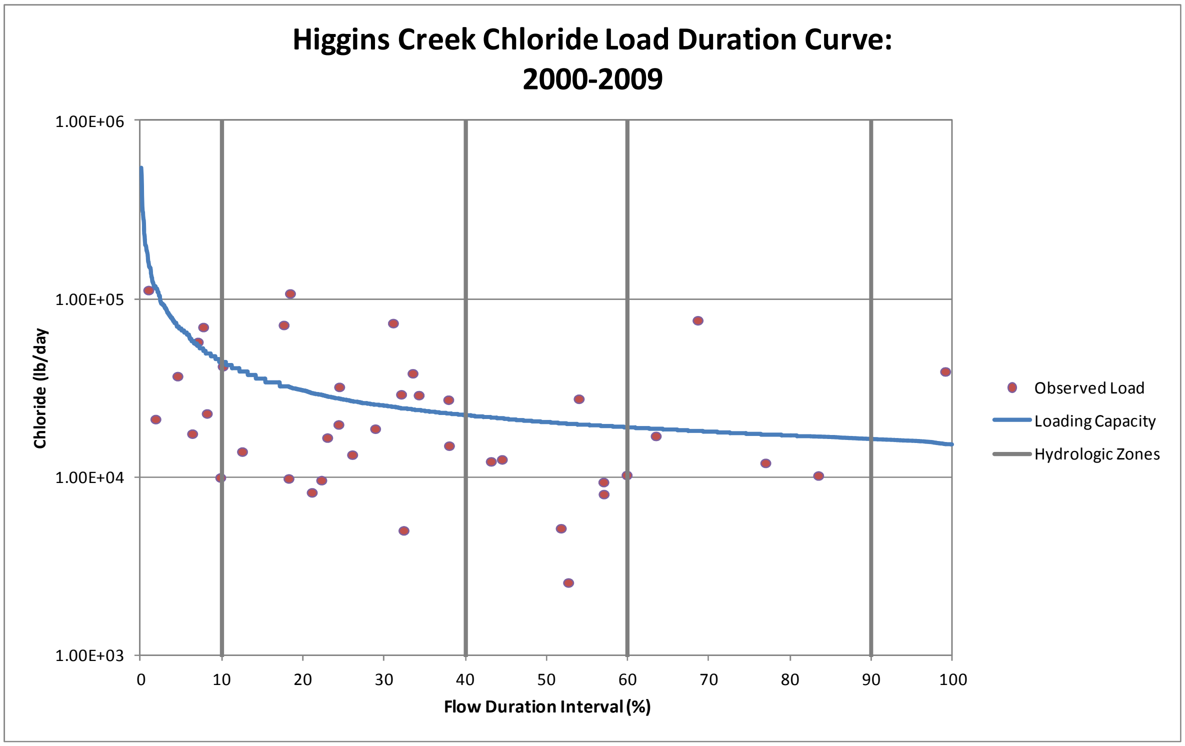


Higgins Creek (IL_GOA-02): Fecal Coliform vs. Flow



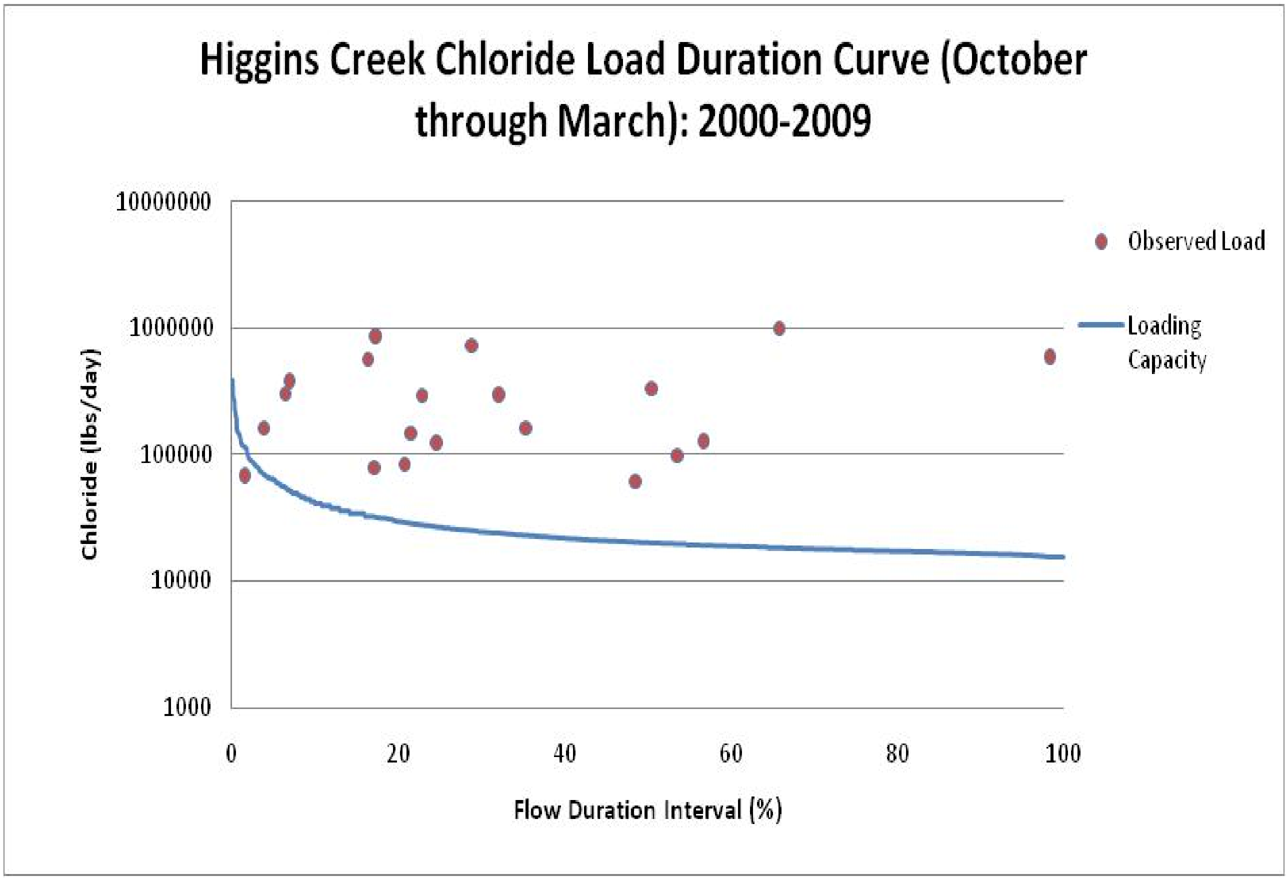
units = cfu/day	High Flows (0-10)	% Total Load	Moist Conditions (10-40)	% Total Load	Mid-Range Flows (40-60)	% Total Load	Dry Conditions (60-90)	% Total Load	Low Flows (90-100)	% Total Load
TMDL	1.21E+11	N/A	4.95E+10	N/A	3.71E+10	N/A	3.19E+10	N/A	2.92E+10	N/A
Current Load	2.07E+12	N/A	2.18E+11	N/A	1.19E+12	N/A	4.60E+10	N/A	4.60E+10	N/A
MS4	7.41E+10	61%	3.04E+10	61%	2.28E+10	61%	---	N/A	---	N/A
LA	2.85E+10	24%	1.17E+10	24%	8.77E+09	24%	2.71E+10	85%	2.48E+10	85%
WLA	---	N/A	---	N/A	---	N/A	---	N/A	---	N/A
Reserve Capacity	6.03E+09	5%	2.48E+09	5%	1.86E+09	5%	1.59E+09	5%	1.46E+09	5%
MOS	1.21E+10	10%	4.95E+09	10%	3.71E+09	10%	3.19E+09	10%	2.92E+09	10%
% Reduction	**94%**	**NA**	**77%**	**NA**	**97%**	**NA**	**31%**	**NA**	**37%**	**NA**

Higgins Creek (IL_GOA-02): Chloride vs. Flow



units = lbs/day	High Flows (0-10)	% Total Load	Moist Conditions (10-40)	% Total Load	Mid-Range Flows (40-60)	% Total Load	Dry Conditions (60-90)	% Total Load	Low Flows (90-100)	% Total Load
TMDL	66,358	N/A	27,220	N/A	20,413	N/A	17,520	N/A	16,048	N/A
Current Load	112,793	N/A	107,977	N/A	27,665	N/A	76,327	N/A	39,380	N/A
MS4	41,208	62%	16,903	62%	12,676	62%	---	N/A	---	N/A
LA	18,514	28%	7,594	28%	5,695	28%	15,768	90%	14,443	90%
WLA	---	N/A	---	N/A	---	N/A	---	N/A	---	N/A
MOS	6,636	10%	2,722	10%	2,041	10%	1,752	10%	1,605	10%
% Reduction	**41%**	**NA**	**75%**	**NA**	**26%**	**NA**	**77%**	**NA**	**59%**	**NA**

Higgins Creek (IL_GOA-02): Chloride vs. Flow (October through March)



Sylvan Lake: Mass Balance and Simple Method Approach to the Fecal Coliform Impairment

Lake Dimensions:

Surface Area (ft^2)	1,393,920
Depth (ft)	8
Volume (ft^3)	10,454,400
Volume (ml)	296,088,680,448
Max Observed Fecal Coliform (cfu/100 ml)	1,000
Target (cfu/100 ml)	200
Fecal Max (cfu/lake)	**2,960,886,804,480**
Target (cfu/lake)	**592,177,360,896**

Waste Load Allocations for Sylvan Lake (cfu/lake):

TMDL (target)	**592,177,360,896**
Total fecal loading	**2,960,886,804,480**
Load Allocation	
Load Allocation	433,992,818,454
Cropland	193,138,343,785
High Intensity Residential	178,910,562,843
Mixed Forest	61,943,911,826
Wasteload Allocation	
Wasteload Allocation	187,793,410,487
Hawthorn Woods	187,415,009,236
Long Grove	378,401,251
Reserve Capacity	
Reserve Capacity	29,608,868,045
% reduction	**80%**

Fecal Loading per Land Use:

Land Use	Land Use %	Fecal (cfu/lake)
Cropland	0.00071%	7.76E+04
Cropland	0.00489%	5.34E+05
High Intensity Residential	0.00004%	3.14E+06
Cropland	0.07029%	7.66E+06
Mixed Forest	0.05828%	3.79E+06
Cropland	0.29706%	3.24E+07
Mixed Forest	0.61885%	4.02E+07
High Intensity Residential	1.37622%	9.76E+10
Wetland	0.00432%	0.00E+00
Cropland	0.03935%	4.29E+06
Mixed Forest	0.21583%	1.40E+07
High Intensity Residential	0.67568%	4.79E+10
High Intensity Residential	0.20981%	1.49E+10
Cropland	0.37706%	4.11E+07
Mixed Forest	0.14937%	9.71E+06
Cropland	0.11309%	1.23E+07
Mixed Forest	0.14494%	9.42E+06
Cropland	1.37898%	1.50E+08
Mixed Forest	0.11611%	7.55E+06
High Intensity Residential	1.72690%	1.22E+11
Cropland	0.19334%	2.11E+07
Mixed Forest	0.09531%	6.19E+06
High Intensity Residential	0.01837%	1.30E+09
Cropland	0.09970%	1.09E+07
Cropland	0.09779%	1.07E+07
Mixed Forest	0.13345%	8.67E+06
High Intensity Residential	0.03271%	2.32E+09
Cropland	0.09630%	1.05E+07
Mixed Forest	0.12316%	8.00E+06
High Intensity Residential	3.33355%	2.36E+11
Cropland	0.02650%	2.89E+06
Mixed Forest	0.04130%	2.68E+06
High Intensity Residential	0.68317%	4.84E+10
Cropland	0.34617%	3.78E+07
Mixed Forest	0.00840%	5.46E+05
High Intensity Residential	0.00740%	5.25E+08
Mixed Forest	0.01055%	6.86E+05
High Intensity Residential	2.48534%	1.76E+11

Land Use	Land Use %	Fecal (cfu/lake)
High Intensity Residential	0.33820%	2.40E+10
High Intensity Residential	0.62753%	4.45E+10
Cropland	1.00288%	1.09E+08
Mixed Forest	0.08526%	5.54E+06
Cropland	0.14728%	1.61E+07
Mixed Forest	0.38883%	2.53E+07
High Intensity Residential	0.15263%	1.08E+10
Wetland	0.03926%	0.00E+00
Cropland	0.83278%	9.08E+07
Mixed Forest	0.47809%	3.11E+07
High Intensity Residential	3.21478%	2.28E+11
High Intensity Residential	0.17441%	1.24E+10
High Intensity Residential	0.20427%	1.45E+10
Cropland	0.73601%	8.03E+07
High Intensity Residential	0.01263%	8.95E+08
Cropland	0.08082%	8.81E+06
Mixed Forest	0.09532%	6.20E+06
High Intensity Residential	0.84325%	5.98E+10
Mixed Forest	0.14141%	9.19E+06
High Intensity Residential	0.01698%	1.20E+09
Wetland	0.00135%	0.00E+00
Cropland	0.54886%	5.99E+07
Cropland	1.05166%	1.15E+08
Mixed Forest	0.00241%	1.57E+05
Mixed Forest	0.19115%	1.24E+07
Wetland	0.00053%	0.00E+00
Cropland	0.25421%	2.77E+07
High Intensity Residential	0.17121%	1.21E+10
Cropland	1.90676%	2.08E+08
Mixed Forest	0.48807%	3.17E+07
Water	0.05342%	0.00E+00
High Intensity Residential	0.87721%	6.22E+10
Cropland	0.01587%	1.73E+06
Mixed Forest	0.00015%	9.97E+03
High Intensity Residential	0.44423%	3.15E+10
High Intensity Residential	0.17258%	1.22E+10
Cropland	0.02905%	3.17E+06
Mixed Forest	0.22233%	1.44E+07
Water	0.57678%	0.00E+00

Fecal Loading per Land Use (continued):

Land Use	Land Use %	Fecal (cfu/lake)
High Intensity Residential	0.68855%	4.88E+10
Wetland	0.30263%	0.00E+00
Cropland	3.89084%	4.24E+08
Mixed Forest	1.69417%	1.10E+08
Water	0.01221%	0.00E+00
High Intensity Residential	0.88206%	6.25E+10
Wetland	0.07948%	0.00E+00
Cropland	0.00009%	9.39E+03
Mixed Forest	2.17145%	1.41E+08
Water	0.28703%	0.00E+00
High Intensity Residential	1.00340%	7.11E+10
Wetland	0.20325%	0.00E+00
Cropland	0.19596%	2.14E+07
High Intensity Residential	0.52426%	3.72E+10
Mixed Forest	0.02650%	1.72E+06
High Intensity Residential	0.18729%	1.33E+10
Cropland	0.00442%	4.82E+05
Mixed Forest	0.10295%	6.69E+06
High Intensity Residential	0.33884%	2.40E+10
Mixed Forest	0.34542%	2.24E+07
Water	3.69167%	0.00E+00
High Intensity Residential	0.18157%	1.29E+10
Wetland	0.32772%	0.00E+00
Cropland	0.06563%	7.16E+06
Mixed Forest	0.70604%	4.59E+07
Water	0.05193%	0.00E+00
High Intensity Residential	1.35310%	9.59E+10
Cropland	0.33393%	3.64E+07
Mixed Forest	0.03944%	2.56E+06
Cropland	0.58539%	6.38E+07
High Intensity Residential	0.90021%	6.38E+10
Cropland	0.40430%	4.41E+07
Mixed Forest	0.03292%	2.14E+06
High Intensity Residential	0.00721%	5.11E+08
Cropland	0.94556%	1.03E+08
High Intensity Residential	0.11445%	8.11E+09
Cropland	3.03916%	3.31E+08
High Intensity Residential	0.50943%	3.61E+10
Cropland	0.07368%	8.03E+06
High Intensity Residential	0.18669%	1.32E+10
Cropland	0.13248%	1.44E+07

Land Use	Land Use %	Fecal (cfu/lake)
Mixed Forest	0.11139%	7.24E+06
High Intensity Residential	0.84539%	5.99E+10
Cropland	0.97029%	1.06E+08
Mixed Forest	1.09172%	7.10E+07
High Intensity Residential	1.44942%	1.03E+11
Wetland	0.02416%	0.00E+00
Cropland	0.34380%	3.75E+07
Mixed Forest	0.17523%	1.14E+07
Water	0.00165%	0.00E+00
High Intensity Residential	0.18786%	1.33E+10
Cropland	0.21629%	2.36E+07
Mixed Forest	0.07231%	4.70E+06
High Intensity Residential	0.02401%	1.70E+09
Cropland	2.25368%	2.46E+08
High Intensity Residential	2.48420%	1.76E+11
Cropland	0.16642%	1.81E+07
Mixed Forest	0.04060%	2.64E+06
High Intensity Residential	0.05326%	3.78E+09
Cropland	0.00038%	4.16E+04
High Intensity Residential	0.23577%	1.67E+10
Cropland	0.01547%	1.69E+06
Mixed Forest	0.00092%	6.01E+04
High Intensity Residential	0.19245%	1.36E+10
Cropland	0.00014%	1.48E+04
Mixed Forest	0.01046%	6.80E+05
Wetland	0.06411%	0.00E+00
Cropland	0.18820%	2.05E+07
Mixed Forest	0.04090%	2.66E+06
Wetland	0.05863%	0.00E+00
Mixed Forest	0.10086%	6.56E+06
Cropland	0.12114%	1.32E+07
High Intensity Residential	0.28404%	2.01E+10
Cropland	0.16624%	1.81E+07
Mixed Forest	0.08157%	5.30E+06
High Intensity Residential	0.09434%	6.69E+09
Wetland	0.10427%	0.00E+00
Cropland	1.47370%	1.61E+08
Mixed Forest	0.00098%	6.39E+04
High Intensity Residential	0.09661%	6.85E+09
Cropland	0.30417%	3.32E+07

Fecal Loading per Land Use (continued):

Land Use	Land Use %	Fecal (cfu/lake)	Land Use	Land Use %	Fecal (cfu/lake)
High Intensity Residential	0.10919%	7.74E+09	Mixed Forest	0.08046%	5.23E+06
Cropland	0.10324%	1.13E+07	High Intensity Residential	0.43973%	3.12E+10
Mixed Forest	0.06066%	3.94E+06	Cropland	0.07480%	8.16E+06
High Intensity Residential	0.11342%	8.04E+09	Water	0.04102%	0.00E+00
Cropland	0.05528%	6.03E+06	High Intensity Residential	0.09833%	6.97E+09
Mixed Forest	0.30202%	1.96E+07	Wetland	0.01724%	0.00E+00
High Intensity Residential	0.95460%	6.77E+10	Cropland	0.21830%	2.38E+07
Cropland	0.01777%	1.94E+06	High Intensity Residential	0.35666%	2.53E+10
Mixed Forest	0.19073%	1.24E+07	Cropland	1.42812%	1.56E+08
High Intensity Residential	0.35316%	2.50E+10	Mixed Forest	0.22447%	1.46E+07
Cropland	3.26958%	3.57E+08	High Intensity Residential	0.09863%	6.99E+09
Mixed Forest	0.18998%	1.23E+07	Cropland	1.08652%	1.18E+08
Water	0.02835%	0.00E+00	Mixed Forest	0.06960%	4.52E+06
High Intensity Residential	2.22410%	1.58E+11	High Intensity Residential	0.22410%	1.59E+10
Wetland	0.07034%	0.00E+00	Wetland	0.00009%	0.00E+00
Cropland	0.03995%	4.36E+06	Cropland	0.19718%	2.15E+07
Mixed Forest	0.04946%	3.21E+06	High Intensity Residential	0.01738%	1.23E+09
High Intensity Residential	0.47420%	3.36E+10	Cropland	0.07263%	7.92E+06
Cropland	2.92076%	3.19E+08	High Intensity Residential	0.34140%	2.42E+10
Mixed Forest	0.12838%	8.34E+06	Wetland	0.00037%	0.00E+00
High Intensity Residential	2.25552%	1.60E+11	High Intensity Residential	0.33045%	2.34E+10
Cropland	0.07503%	8.18E+06	Cropland	0.23744%	2.59E+07
Mixed Forest	0.26756%	1.74E+07	Mixed Forest	0.06186%	4.02E+06
High Intensity Residential	0.08554%	6.06E+09	High Intensity Residential	0.09669%	6.85E+09
Cropland	0.14790%	1.61E+07	Cropland	0.13557%	1.48E+07
High Intensity Residential	0.03430%	2.43E+09	High Intensity Residential	0.07292%	5.17E+09
Cropland	0.24313%	2.65E+07	High Intensity Residential	0.27576%	1.95E+10
High Intensity Residential	0.06542%	4.64E+09	Wetland	0.06443%	0.00E+00
Cropland	0.24089%	2.63E+07	Cropland	0.14022%	1.53E+07
Mixed Forest	0.17941%	1.17E+07	Mixed Forest	0.03517%	2.29E+06
High Intensity Residential	0.12055%	8.55E+09	High Intensity Residential	0.04439%	3.15E+09
Cropland	0.37417%	4.08E+07	Wetland	0.09362%	0.00E+00
Cropland	0.07045%	7.68E+06	Cropland	0.03895%	4.25E+06
Cropland	0.47523%	5.18E+07	High Intensity Residential	0.17977%	1.27E+10
Mixed Forest	0.04160%	2.70E+06	Cropland	0.57921%	6.32E+07
High Intensity Residential	0.84660%	6.00E+10	Mixed Forest	0.08310%	5.40E+06
Wetland	0.03529%	0.00E+00	High Intensity Residential	0.06007%	4.26E+09
Cropland	0.03560%	3.88E+06	Cropland	0.14175%	1.55E+07
High Intensity Residential	0.34435%	2.44E+10	Cropland	0.25919%	2.83E+07
Cropland	0.11482%	1.25E+07	High Intensity Residential	0.02642%	1.87E+09
High Intensity Residential	0.09633%	6.83E+09	High Intensity Residential	0.01741%	1.23E+09
Cropland	0.16533%	1.80E+07	Cropland	0.19467%	2.12E+07
Water	0.06189%	0.00E+00	High Intensity Residential	0.02490%	1.77E+09
High Intensity Residential	0.28929%	2.05E+10	Cropland	0.01866%	2.03E+06
Wetland	0.04368%	0.00E+00	Cropland	0.00476%	5.19E+05
Cropland	0.34664%	3.78E+07	Cropland	0.16682%	1.82E+07
			Cropland	0.01592%	1.74E+06
			High Intensity Residential	0.00002%	1.11E+06

Appendix G

QUAL-2K Modeling

QUAL2K Model Setup: Buffalo Creek

This section describes the process that was used to set up the QUAL2K model for Buffalo Creek.

Stream Segmentation

The impaired section in the Buffalo Creek watershed includes three unnamed tributaries and section of Buffalo Creek, Buffalo Creek from the headwaters to the USGS gaging station on Aptakisit Road. The stream and the tributaries were segmented in into a series of sub-segments designated in the model as reaches. Buffalo Creek was segmented into 11 reaches. Two unnamed tributaries were segmented into 3 reaches and the third one was segmented into 2 reaches. The total length of the modeled segment on Buffalo Creek is 14.51 kilometers. The length of the first unnamed tributary (UT1) is 3.76 kilometers, the second tributary (UT2) is 11.26 kilometers, and the third (UT3) is 2.57 kilometers. The length of each segment was determined based on stream geometry and characteristics, tributary location, and point source locations.

Geometry, Flow Data, Weather Data

Stream geometry, elevations, and slopes were estimated from aerial satellite imagery and Geographic Information System (GIS) data. The bottom slope was estimated from aerial photos assuming a trapezoidal cross section. The Manning formula was selected to simulate flow, water depth, and water velocity. The Manning's n value for earthen channels of 0.03 was used.

The hourly weather data for air temperature, dew point, wind speed and cloud cover was obtained from the Chicago O'Hare weather station. **Table G-1** shows the summary of climate data acquired for modeling purposes.

Table G-1: Weather Data

5/7/01 Time	Air Temperature		Dew Point:		Wind Speed	
	°F	°C	°F	°C	MPH	m/s
12:56 AM	60.1	15.6	59	15.0	6.9	3.1
1:56 AM	62.1	16.7	59	15.0	9.2	4.1
2:56 AM	62.1	16.7	59	15.0	9.2	4.1
3:04 AM	60.8	16.0	59	15.0	9.2	4.1
3:56 AM	61	16.1	59	15.0	10.4	4.6
4:56 AM	61	16.1	57.9	14.4	10.4	4.6
5:56 AM	62.1	16.7	57.9	14.4	9.2	4.1
6:36 AM	62.6	17.0	57.2	14.0	10.4	4.6
6:56 AM	63	17.2	59	15.0	10.4	4.6
7:56 AM	64	17.8	59	15.0	9.2	4.1
8:15 AM	64.4	18.0	59	15.0	9.2	4.1
8:56 AM	64.9	18.3	59	15.0	9.2	4.1
9:10 AM	66.2	19.0	60.8	16.0	11.5	5.1
9:56 AM	66	18.9	60.1	15.6	12.7	5.7
10:56 AM	64.9	18.3	61	16.1	11.5	5.1

5/7/01 Time	Air Temperature		Dew Point:		Wind Speed	
	°F	°C	°F	°C	MPH	m/s
11:40 AM	64.4	18.0	62.6	17.0	12.7	5.7
11:56 AM	66	18.9	62.1	16.7	12.7	5.7
12:22 PM	66.2	19.0	62.6	17.0	12.7	5.7
12:35 PM	66.2	19.0	62.6	17.0	11.5	5.1
12:56 PM	64.9	18.3	61	16.1	15	6.7
1:40 PM	62.6	17.0	60.8	16.0	11.5	5.1
1:56 PM	63	17.2	60.1	15.6	12.7	5.7
2:10 PM	62.6	17.0	60.8	16.0	10.4	4.6
2:56 PM	63	17.2	57.9	14.4	16.1	7.2
3:31 PM	64.4	18.0	57.2	14.0	12.7	5.7
3:56 PM	64	17.8	55	12.8	11.5	5.1
4:36 PM	66.2	19.0	51.8	11.0	17.3	7.7
4:56 PM	64.9	18.3	51.1	10.6	12.7	5.7
5:56 PM	66	18.9	46	7.8	12.7	5.7
6:56 PM	64.9	18.3	45	7.2	10.4	4.6
7:56 PM	64	17.8	43	6.1	11.5	5.1
8:56 PM	60.1	15.6	44.1	6.7	3.5	1.6
9:56 PM	55	12.8	46	7.8	5.8	2.6
10:56 PM	55	12.8	45	7.2	4.6	2.1
11:56 PM	55	12.8	44.1	6.7	4.6	2.1

Boundary Conditions

Boundary conditions are defined in the QUAL2K model by headwaters data. There are no water quality monitoring stations upstream in Buffalo Creek or its tributaries. Headwater conditions were estimated based on observed data at downstream stations. USGS gaging station 5528500 is located at the end of the modeled segment in Buffalo Creek. Watershed scaling was used to determine tributary flows based on sub-watershed areas (see Section 7.1.2).

Critical conditions

Critical conditions were determined to be during the summer low flow conditions. Data from May 2001 were selected because they represented low dissolved oxygen conditions and low stream flows and there were supplementary data for the segment. Dissolved oxygen data are summarized in **Table G-2**.

Table G-2: Water Quality Data

Date	Sampling Point	DO (mg/L)
7-May-01	WW_12	7.3
02-May-01	Albert Lake Inflow	4.8
02-May-01	Albert Lake Outflow	7.3
14-May-01	Buffalo Creek Lake	8.1

Point Source Loads

There are two point source discharges within the modeled area. One discharger is located in UT 1, the other in UT 2. Effluent data was obtained from the Illinois EPA Discharge Monitoring Reporting Data Retrieval database. A summary of point source effluent quality is provided in **Table G-3**.

Table G-3: Point Source Discharger Effluent Quality

Stream name	Facility Name & NPDES	Discharge Point (km)	Flow (m3/s)	BOD (mg/L)	NH3 (mg/L)	DO (mg/L)
Unnamed Tributary 1	Alden Long Grove Rehab. IL0051934	0.26	0.15	10	0.1	5
Unnamed Tributary 2	Camp Reinberg IL0048542	7.84	0.0018	9.8	0.1	5

QUAL2K Model Calibration

Flow, dissolved oxygen, and temperature were simulated for Buffalo Creek. Observed data at the water quality monitoring stations and at Albert and Buffalo Creek Lakes were also used to calibrate the model. The month of May 2001 was considered the critical condition for model calibration. Non-point source loading was added as incremental diffuse flow for all the model reaches.

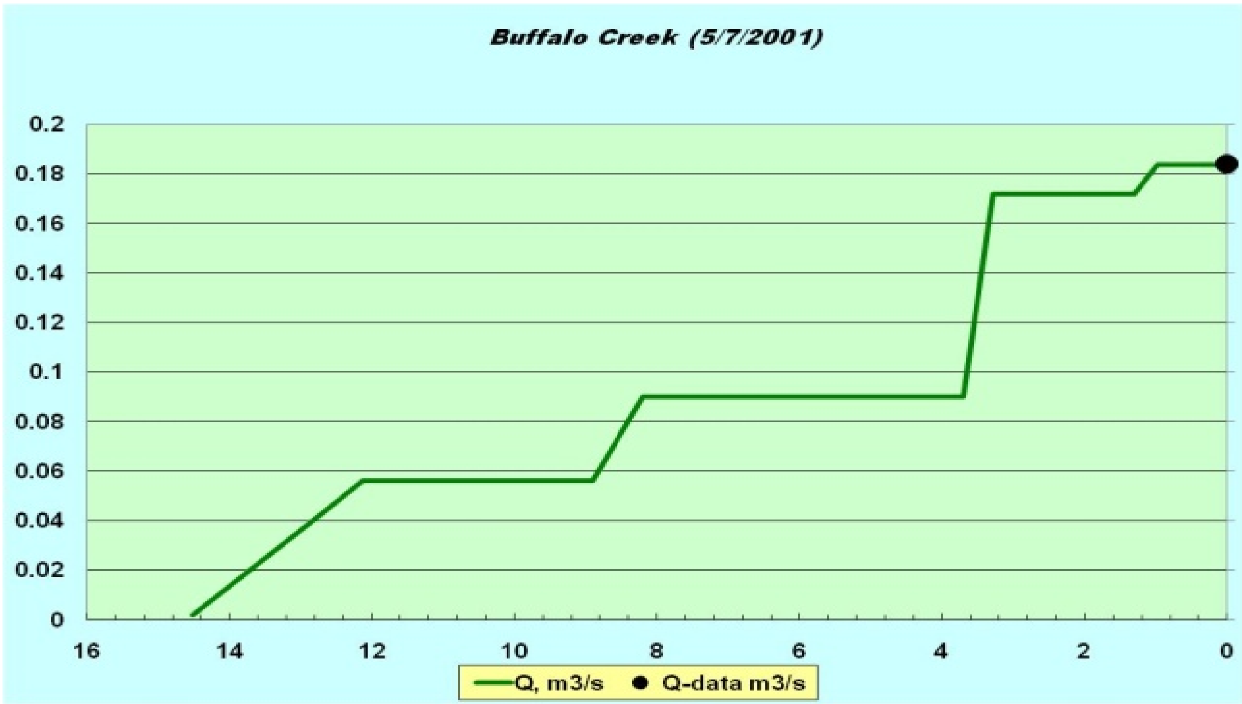
Load Reductions

The Illinois water quality standard for dissolved oxygen is 5 mg/L. The TMDL target loads were calculated based on this water quality standard.

Table G-4: Allocations for Buffalo Creek

	CBOD			NH3		
	lb/day	kg/day	kg/yr	lb/day	kg/day	kg/yr
TMDL (target)	97.03	44.01	16064.1	6.24	2.83	1033.73
Observed Load	158.96	72.10	26318	8.92	4.05	1477.11
MS4	65.04	29.50	10768	4.18	1.90	674.99
LA	8.59	3.90	1422.19	0.24	0.11	38.76
WLA	13.7	6.21	2268.21	1.2	0.54	193.78
MOS	9.70	4.40	1606.41	0.62	0.28	103.37
% Reduction	39%	39%	39%	30%	30%	30%

Figure G-1: Observed and Simulated Flow (top) and Temperature (bottom)



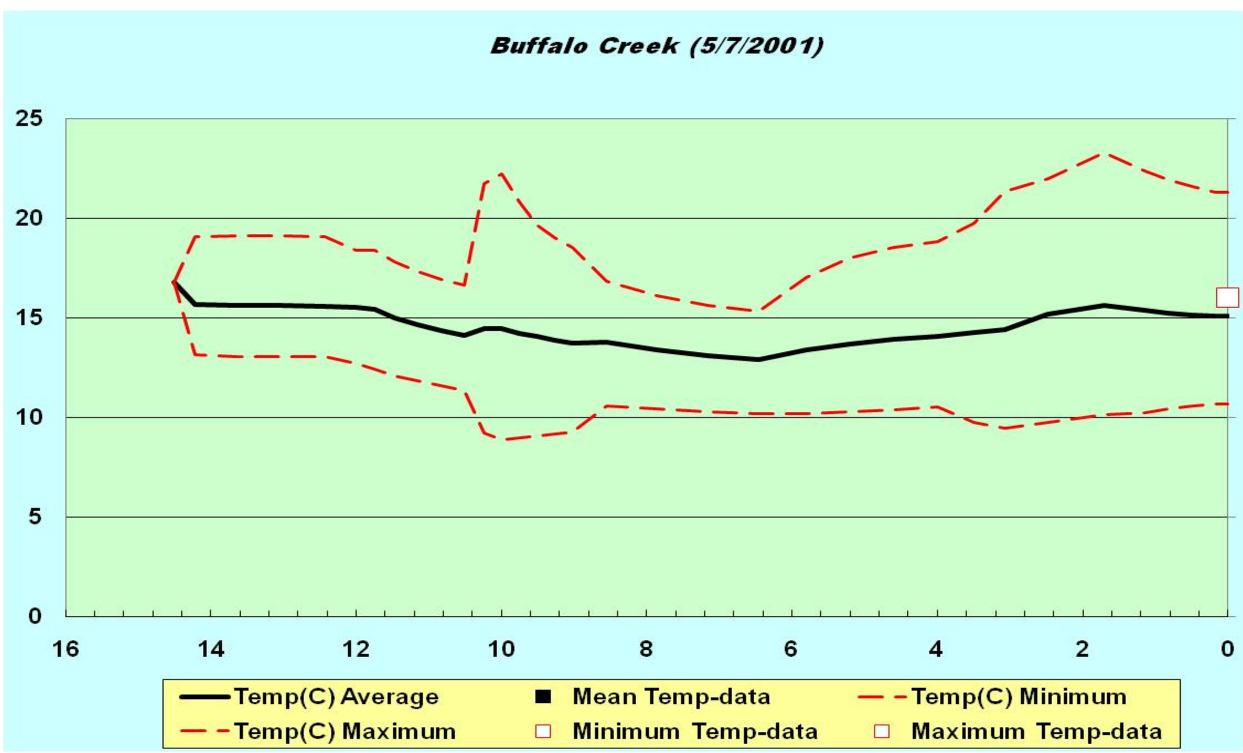
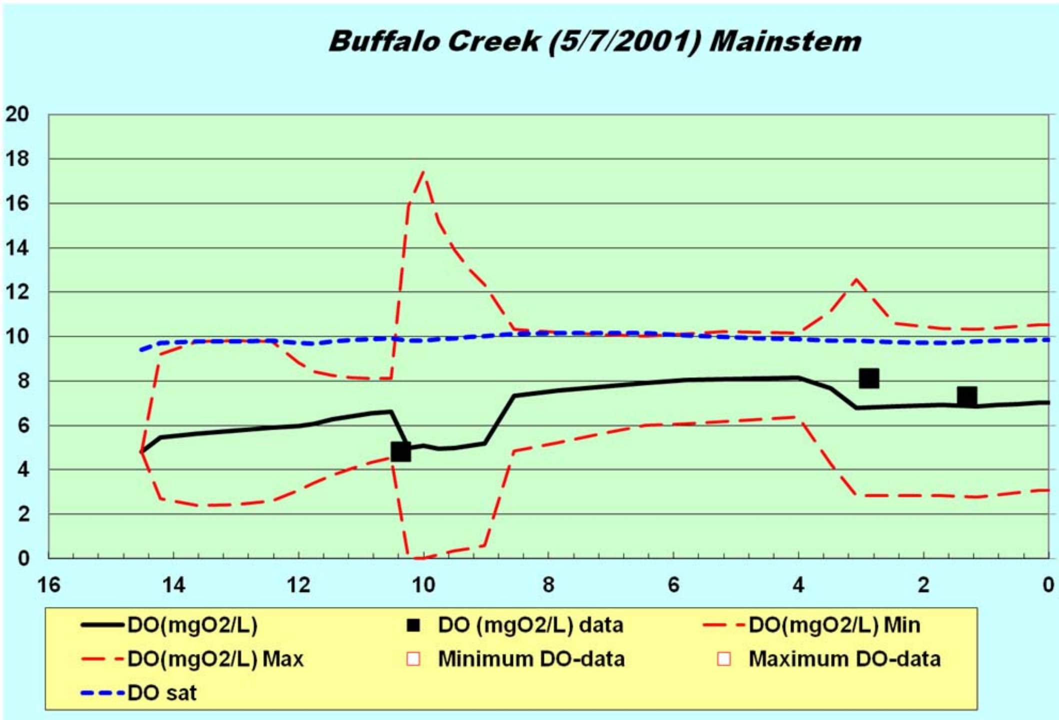


Figure G-2: Dissolved Oxygen Calibrated Run (top) and Dissolved Oxygen Reductions (bottom)



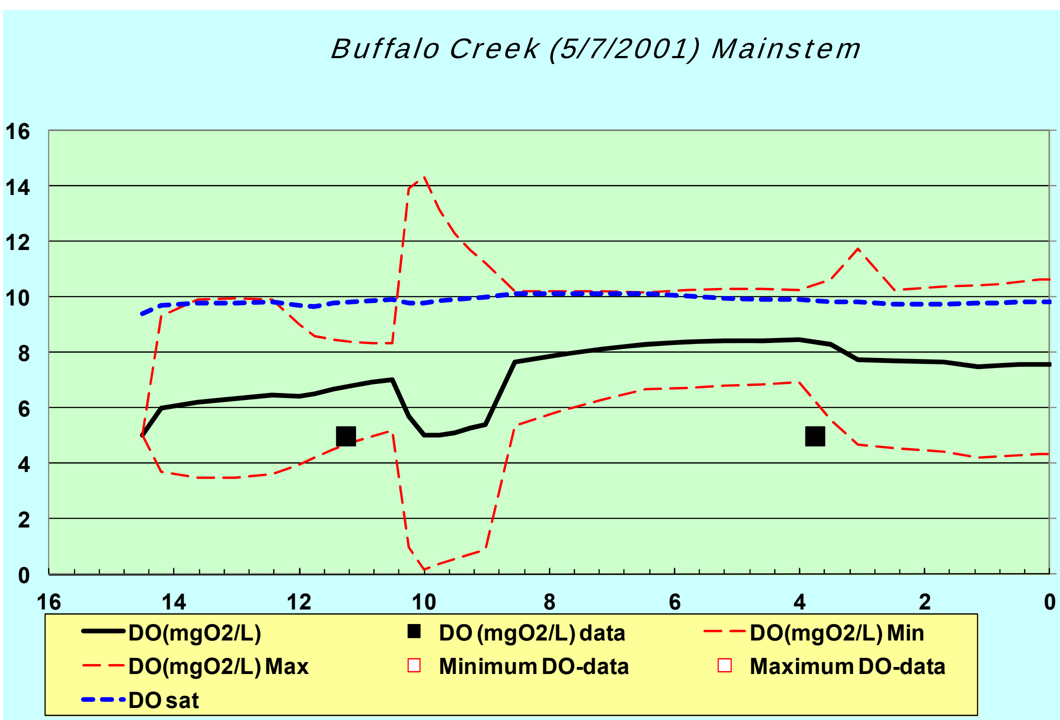


Figure G-3: QUAL-2K Inputs for Buffalo Creek

QUAL2K FORTRAN

Stream Water Quality Model

Steve Chapra, Hua Tao and Greg Pelletier

Version 2.11b8

System ID:		
River name	**Buffalo Creek**	
Saved file name	**Buffalo Creek All**	
Directory where file saved	**laines Final\Buffalo Creek\Qual2K\data file**	
Month	**5**	
Day	**7**	
Year	**2001**	
Local time hours to UTC	**-5**	
Daylight savings time	**Yes**	
Calculation:		
Calculation step	**0.1**	**hours**
Final time	**30**	**day**
Solution method (integration)	**Euler**	
Solution method (pH)	**Brent**	
Time zone	**Eastern Standard Time**	
Program determined calc step	**0.093750**	**hours**
Time of last calculation	**0.33**	**minutes**
Time of sunrise	**6:39 AM**	
Time of solar noon	**1:48 PM**	
Time of sunset	**8:57 PM**	
Photoperiod	**14.30**	**hours**

Headwater 0 (Mainstem)													
Headwater label	*Reach No*	*Flow*	*Elevation*	*Weir*				**Rating Curves**					
		Rate		*Height*	*Width*	*adam*	*bdam*	*Velocity*		*Depth*		*Channel*	*Manning*
		(m^3/s)	*(m)*	*(m)*	*(m)*			*Coefficient*	*Exponent*	*Coefficient*	*Exponent*	*Slope*	*n*
Mainstem headwater	1	0.005	253.000	0.0000	0.0000	1.2500	0.9000	0.0000	0.000	0.0000	0.000	0.004	0.0500
Water Quality Constituents	*Units*	*12:00 AM*	*1:00 AM*	*2:00 AM*	*3:00 AM*	*4:00 AM*	*5:00 AM*	*6:00 AM*	*7:00 AM*	*8:00 AM*	*9:00 AM*	*10:00 AM*	*11:00 AM*
Temperature	C	16.80	16.80	16.80	16.80	16.80	16.80	16.80	16.80	16.80	16.80	16.80	16.80
Conductivity	umhos	1.56	1.56	1.56	1.56	1.56	1.56	1.56	1.56	1.56	1.56	1.56	1.56
Inorganic Solids	mgD/L												
Dissolved Oxygen	mg/L	4.81	4.81	4.81	4.81	4.81	4.81	4.81	4.81	4.81	4.81	4.81	4.81
CBODslow	mgO2/L												
CBODfast	mgO2/L	5.00	5.00	5.00	5.00	5.00	5.00	5.00	5.00	5.00	5.00	5.00	5.00
Organic Nitrogen	ugN/L	500.00	500.00	500.00	500.00	500.00	500.00	500.00	500.00	500.00	500.00	500.00	500.00
NH4-Nitrogen	ugN/L	100.00	100.00	100.00	100.00	100.00	100.00	100.00	100.00	100.00	100.00	100.00	100.00
NO3-Nitrogen	ugN/L	158.00	158.00	158.00	158.00	158.00	158.00	158.00	158.00	158.00	158.00	158.00	158.00
Organic Phosphorus	ugP/L	50.00	50.00	50.00	50.00	50.00	50.00	50.00	50.00	50.00	50.00	50.00	50.00
Inorganic Phosphorus (SRP)	ugP/L	145.00	145.00	145.00	145.00	145.00	145.00	145.00	145.00	145.00	145.00	145.00	145.00
Phytoplankton	ugA/L												
Internal Nitrogen (INP)	ugN/L												
Internal Phosphorus (IPP)	ugP/L												
Detritus (POM)	mgD/L												
Pathogen	cfu/100 mL												
Alkalinity	mgCaCO3/L	288.00	288.00	288.00	288.00	288.00	288.00	288.00	288.00	288.00	288.00	288.00	288.00
TSS	mg/l									31.30			
Constituent ii													
Constituent iii													
pH	s.u.	7.18	7.18	7.18	7.18	7.18	7.18	7.18	7.18	7.18	7.18	7.18	7.18

Bot Width	*Side*	*Side*	*Dispersion*								
m	*Slope*	*Slope*	*m2/s*								
1.22	0.00	0.00	0.00								
12:00 PM	*1:00 PM*	*2:00 PM*	*3:00 PM*	*4:00 PM*	*5:00 PM*	*6:00 PM*	*7:00 PM*	*8:00 PM*	*9:00 PM*	*10:00 PM*	*11:00 PM*
16.80	16.80	16.80	16.80	16.80	16.80	16.80	16.80	16.80	16.80	16.80	16.80
1.56	1.56	1.56	1.56	1.56	1.56	1.56	1.56	1.56	1.56	1.56	1.56
4.81	4.81	4.81	4.81	4.81	4.81	4.81	4.81	4.81	4.81	4.81	4.81
5.00	5.00	5.00	5.00	5.00	5.00	5.00	5.00	5.00	5.00	5.00	5.00
500.00	500.00	500.00	500.00	500.00	500.00	500.00	500.00	500.00	500.00	500.00	500.00
100.00	100.00	100.00	100.00	100.00	100.00	100.00	100.00	100.00	100.00	100.00	100.00
158.00	158.00	158.00	158.00	158.00	158.00	158.00	158.00	158.00	158.00	158.00	158.00
50.00	50.00	50.00	50.00	50.00	50.00	50.00	50.00	50.00	50.00	50.00	50.00
145.00	145.00	145.00	145.00	145.00	145.00	145.00	145.00	145.00	145.00	145.00	145.00
288.00	288.00	288.00	288.00	288.00	288.00	288.00	288.00	288.00	288.00	288.00	288.00
7.18	7.18	7.18	7.18	7.18	7.18	7.18	7.18	7.18	7.18	7.18	7.18

Headwater 1 (Tributary 1)													
Headwater label	*Reach No*	*Flow*	*Elevation*	*Weir*				*Rating Curves*					
		Rate		*Height*	*Width*	*adam*	*bdam*	*Velocity*		*Depth*		*Channel*	*Manning*
		(m^3/s)	*(m)*	*(m)*	*(m)*			*Coefficient*	*Exponent*	*Coefficient*	*Exponent*	*Slope*	*n*
UT1	6	0.001	240.000			1.2500	0.9000					0.009	0.0500
Water Quality Constituents	*Units*	*12:00 AM*	*1:00 AM*	*2:00 AM*	*3:00 AM*	*4:00 AM*	*5:00 AM*	*6:00 AM*	*7:00 AM*	*8:00 AM*	*9:00 AM*	*10:00 AM*	*11:00 AM*
Temperature	C	16.00	16.00	16.00	16.00	16.00	16.00	16.00	16.00	16.00	16.00	16.00	16.00
Conductivity	umhos	1.15	1.15	1.15	1.15	1.15	1.15	1.15	1.15	1.15	1.15	1.15	1.15
Inorganic Solids	mgD/L												
Dissolved Oxygen	mg/L	7.50	7.50	7.50	7.50	7.50	7.50	7.50	7.50	7.50	7.50	7.50	7.50
CBODslow	mgO2/L												
CBODfast	mgO2/L	5.00	5.00	5.00	5.00	5.00	5.00	5.00	5.00	5.00	5.00	5.00	5.00
Organic Nitrogen	ugN/L	800.00	800.00	800.00	800.00	800.00	800.00	800.00	800.00	800.00	800.00	800.00	800.00
NH4-Nitrogen	ugN/L	200.00	200.00	200.00	200.00	200.00	200.00	200.00	200.00	200.00	200.00	200.00	200.00
NO3-Nitrogen	ugN/L	300.00	300.00	300.00	300.00	300.00	300.00	300.00	300.00	300.00	300.00	300.00	300.00
Organic Phosphorus	ugP/L	50.00	50.00	50.00	50.00	50.00	50.00	50.00	50.00	50.00	50.00	50.00	50.00
Inorganic Phosphorus (SRP)	ugP/L	100.00	100.00	100.00	100.00	100.00	100.00	100.00	100.00	100.00	100.00	100.00	100.00
Phytoplankton	ugA/L												
Internal Nitrogen	ugN/L												
Internal Phosphorus	ugP/L												
Detritus (POM)	mgD/L												
Pathogen	cfu/100 mL												
Alkalinity	mgCaCO3/L	100.00	100.00	100.00	100.00	100.00	100.00	100.00	100.00	190.00	100.00	100.00	100.00
TSS	mg/l									36.60			
Constituent ii													
Constituent iii													
pH	s.u.	7.00	7.00	7.00	7.00	7.00	7.00	7.00	7.00	7.69	7.00	7.00	7.00

Bot Width	*Side*	*Side*	*Dispersion*								
m	*Slope*	*Slope*	*m2/s*								
1.80	0.00	0.00									
12:00 PM	*1:00 PM*	*2:00 PM*	*3:00 PM*	*4:00 PM*	*5:00 PM*	*6:00 PM*	*7:00 PM*	*8:00 PM*	*9:00 PM*	*10:00 PM*	*11:00 PM*
16.00	16.00	16.00	16.00	16.00	16.00	16.00	16.00	16.00	16.00	16.00	16.00
1.15	1.15	1.15	1.15	1.15	1.15	1.15	1.15	1.15	1.15	1.15	1.15
7.50	7.50	7.50	7.50	7.50	7.50	7.50	7.50	7.50	7.50	7.50	7.50
5.00	5.00	5.00	5.00	5.00	5.00	5.00	5.00	5.00	5.00	5.00	5.00
800.00	800.00	800.00	800.00	800.00	800.00	800.00	800.00	800.00	800.00	800.00	800.00
200.00	200.00	200.00	200.00	200.00	200.00	200.00	200.00	200.00	200.00	200.00	200.00
300.00	300.00	300.00	300.00	300.00	300.00	300.00	300.00	300.00	300.00	300.00	300.00
50.00	50.00	50.00	50.00	50.00	50.00	50.00	50.00	50.00	50.00	50.00	50.00
100.00	100.00	100.00	100.00	100.00	100.00	100.00	100.00	100.00	100.00	100.00	100.00
100.00	100.00	100.00	100.00	100.00	100.00	100.00	100.00	100.00	100.00	100.00	100.00
7.00	7.00	7.00	7.00	7.00	7.00	7.00	7.00	7.00	7.00	7.00	7.00

Headwater 2 (Tributary 2)													
Headwater label	Reach No	Flow	Elevation	Weir				Rating Curves					
		Rate		Height	Width	adam	bdam	Velocity		Depth		Channel	Manning
		(m^3/s)	(m)	(m)	(m)			Coefficient	Exponent	Coefficient	Exponent	Slope	n
UT2	11	0.001	262.000			1.2500	0.9000					0.008	0.0500
Water Quality Constituents	Units	12:00 AM	1:00 AM	2:00 AM	3:00 AM	4:00 AM	5:00 AM	6:00 AM	7:00 AM	8:00 AM	9:00 AM	10:00 AM	11:00 AM
Temperature	C	16.00	16.00	16.00	16.00	16.00	16.00	16.00	16.00	16.00	16.00	16.00	16.00
Conductivity	umhos	1.40	1.40	1.40	1.40	1.40	1.40	1.40	1.40	1.40	1.40	1.40	1.40
Inorganic Solids	mgD/L												
Dissolved Oxygen	mg/L	7.50	7.50	7.50	7.50	7.50	7.50	7.50	7.50	7.50	7.50	7.50	7.50
CBODslow	mgO2/L												
CBODfast	mgO2/L	5.00	5.00	5.00	5.00	5.00	5.00	5.00	5.00	5.00	5.00	5.00	5.00
Organic Nitrogen	ugN/L	800.00	800.00	800.00	800.00	800.00	800.00	800.00	800.00	800.00	800.00	800.00	800.00
NH4-Nitrogen	ugN/L	200.00	200.00	200.00	200.00	200.00	200.00	200.00	200.00	200.00	200.00	200.00	200.00
NO3-Nitrogen	ugN/L	300.00	300.00	300.00	300.00	300.00	300.00	300.00	300.00	300.00	300.00	300.00	300.00
Organic Phosphorus	ugP/L	50.00	50.00	50.00	50.00	50.00	50.00	50.00	50.00	50.00	50.00	50.00	50.00
Inorganic Phosphorus (SRP)	ugP/L	100.00	100.00	100.00	100.00	100.00	100.00	100.00	100.00	100.00	100.00	100.00	100.00
Phytoplankton	ugA/L												
Internal Nitrogen	ugN/L												
Internal Phosphorus	ugP/L												
Detritus (POM)	mgD/L												
Pathogen	cfu/100 mL												
Alkalinity	mgCaCO3/L	100.00	100.00	100.00	100.00	100.00	100.00	100.00	100.00	100.00	100.00	100.00	100.00
Constituent i													
Constituent ii													
Constituent iii													
pH	s.u.	7.50	7.50	7.50	7.50	7.50	7.50	7.50	7.50	7.50	7.50	7.50	7.50

Bot Width	Side	Side	Dispersion								
m	Slope	Slope	m2/s								
2.40	0.00	0.00									
12:00 PM	1:00 PM	2:00 PM	3:00 PM	4:00 PM	5:00 PM	6:00 PM	7:00 PM	8:00 PM	9:00 PM	10:00 PM	11:00 PM
16.00	16.00	16.00	16.00	16.00	16.00	16.00	16.00	16.00	16.00	16.00	16.00
1.40	1.40	1.40	1.40	1.40	1.40	1.40	1.40	1.40	1.40	1.40	1.40
7.50	7.50	7.50	7.50	7.50	7.50	7.50	7.50	7.50	7.50	7.50	7.50
5.00	5.00	5.00	5.00	5.00	5.00	5.00	5.00	5.00	5.00	5.00	5.00
800.00	800.00	800.00	800.00	800.00	800.00	800.00	800.00	800.00	800.00	800.00	800.00
200.00	200.00	200.00	200.00	200.00	200.00	200.00	200.00	200.00	200.00	200.00	200.00
300.00	300.00	300.00	300.00	300.00	300.00	300.00	300.00	300.00	300.00	300.00	300.00
50.00	50.00	50.00	50.00	50.00	50.00	50.00	50.00	50.00	50.00	50.00	50.00
100.00	100.00	100.00	100.00	100.00	100.00	100.00	100.00	100.00	100.00	100.00	100.00
100.00	100.00	100.00	100.00	100.00	100.00	100.00	100.00	100.00	100.00	100.00	100.00
7.50	7.50	7.50	7.50	7.50	7.50	7.50	7.50	7.50	7.50	7.50	7.50

Headwater 3 (Tributary 3)

Headwater label	Reach No	Flow	Elevation	Weir				Rating Curves					
		Rate		Height	Width	adam	bdam	Velocity		Depth		Channel	Manning
		(m^3/s)	(m)	(m)	(m)			Coefficient	Exponent	Coefficient	Exponent	Slope	n
UT3	16	0.005	207.000			1.2500	0.9000					0.001	0.0500
Water Quality Constituents	**Units**	**12:00 AM**	**1:00 AM**	**2:00 AM**	**3:00 AM**	**4:00 AM**	**5:00 AM**	**6:00 AM**	**7:00 AM**	**8:00 AM**	**9:00 AM**	**10:00 AM**	**11:00 AM**
Temperature	C	16.00	16.00	16.00	16.00	16.00	16.00	16.00	16.00	16.00	16.00	16.00	16.00
Conductivity	umhos	1.15	1.15	1.15	1.15	1.15	1.15	1.15	1.15	1.15	1.15	1.15	1.15
Inorganic Solids	mgD/L												
Dissolved Oxygen	mg/L	7.50	7.50	7.50	7.50	7.50	7.50	7.50	7.50	7.50	7.50	7.50	7.50
CBODslow	mgO2/L												
CBODfast	mgO2/L	5.00	5.00	5.00	5.00	5.00	5.00	5.00	5.00	5.00	5.00	5.00	5.00
Organic Nitrogen	ugN/L	800.00	800.00	800.00	800.00	800.00	800.00	800.00	800.00	800.00	800.00	800.00	800.00
NH4-Nitrogen	ugN/L	200.00	200.00	200.00	200.00	200.00	200.00	200.00	200.00	200.00	200.00	200.00	200.00
NO3-Nitrogen	ugN/L	300.00	300.00	300.00	300.00	300.00	300.00	300.00	300.00	300.00	300.00	300.00	300.00
Organic Phosphorus	ugP/L	50.00	50.00	50.00	50.00	50.00	50.00	50.00	50.00	50.00	50.00	50.00	50.00
Inorganic Phosphorus (SRP)	ugP/L	100.00	100.00	100.00	100.00	100.00	100.00	100.00	100.00	100.00	100.00	100.00	100.00
Phytoplankton	ugA/L												
Internal Nitrogen	ugN/L												
Internal Phosphorus	ugP/L												
Detritus (POM)	mgD/L												
Pathogen	cfu/100 mL												
Alkalinity	mgCaCO3/L	190.00	190.00	190.00	190.00	190.00	190.00	190.00	190.00	190.00	190.00	190.00	190.00
Constituent i													
Constituent ii													
Constituent iii													
pH	s.u.	7.69	7.69	7.69	7.69	7.69	7.69	7.69	7.69	7.69	7.69	7.69	7.69

Bot Width	Side	Side	Dispersion								
m	Slope	Slope	m2/s								
1.20	0.00	0.00									
12:00 PM	**1:00 PM**	**2:00 PM**	**3:00 PM**	**4:00 PM**	**5:00 PM**	**6:00 PM**	**7:00 PM**	**8:00 PM**	**9:00 PM**	**10:00 PM**	**11:00 PM**
16.00	16.00	16.00	16.00	16.00	16.00	16.00	16.00	16.00	16.00	16.00	16.00
1.15	1.15	1.15	1.15	1.15	1.15	1.15	1.15	1.15	1.15	1.15	1.15
7.50	7.50	7.50	7.50	7.50	7.50	7.50	7.50	7.50	7.50	7.50	7.50
5.00	5.00	5.00	5.00	5.00	5.00	5.00	5.00	5.00	5.00	5.00	5.00
800.00	800.00	800.00	800.00	800.00	800.00	800.00	800.00	800.00	800.00	800.00	800.00
200.00	200.00	200.00	200.00	200.00	200.00	200.00	200.00	200.00	200.00	200.00	200.00
300.00	300.00	300.00	300.00	300.00	300.00	300.00	300.00	300.00	300.00	300.00	300.00
50.00	50.00	50.00	50.00	50.00	50.00	50.00	50.00	50.00	50.00	50.00	50.00
100.00	100.00	100.00	100.00	100.00	100.00	100.00	100.00	100.00	100.00	100.00	100.00
190.00	190.00	190.00	190.00	190.00	190.00	190.00	190.00	190.00	190.00	190.00	190.00
7.69	7.69	7.69	7.69	7.69	7.69	7.69	7.69	7.69	7.69	7.69	7.69

Reach for diel plot	18																Hy
Element for diel plot	4	Reach	Headwater	Reach			Location		Element	Elevation		Downstream					
Reach	Downstream	Number	Reach	length	Downstream		Upstream	Downstream	Number	Upstream	Downstream	Latitude			Longitude		
Label	end of reach label			(km)	Latitude	Longitude	(km)	(km)	>=1	(m)	(m)	Degrees	Minutes	Seconds	Degrees	Minutes	Seconds
1.000	Headwater reach	1	Yes	2.38	42.19	88.04	14.510	12.130	4	261.000	240.000	42.00	11	9	-88.00	-3	27.59
2.000		2		0.51	0.00	0.00	12.130	11.620	2	240.000	235.000						
3.000		3		1.26	0.00	0.00	11.620	10.360	4	235.000	225.000						
4.000	Albert lake	4		0.48	0.00	0.00	10.360	9.880	2	225.000	224.000						
5.000		5		0.98	42.17	88.03	9.880	8.900	4	224.000	222.000	42.00	10	27	-88.00	-1	-43.45
6.000	trib1	6	Yes	0.66	0.00	0.00	3.760	3.100	2	240.000	234.000						
7.000		7		2.64	0.00	0.00	3.100	0.460	4	234.000	222.000						
8.000		8		0.46	42.17	88.03	0.460	0.000	2	222.000	221.000	42.00	10	27	-88.00	-1	-43.45
9.000		9		2.79	0.00	0.00	8.900	6.110	4	221.000	216.000						
10.000		10		2.41	42.16	87.99	6.110	3.700	4	216.000	213.000	42.00	9	32	-87.00	-59	-25.597
11.000	trib2	11	Yes	3.42	0.00	0.00	11.260	7.840	4	262.000	234.000						
12.000		12		1.07	0.00	0.00	7.840	6.770	2	234.000	230.000						
13.000		13		6.77	42.16	87.99	6.770	0.000	5	230.000	213.000	42.00	9	32	-87.00	-59	-25.597
14.000	Buffalo Creek Lake	14		0.83	0.00	0.00	3.700	2.870	2	213.000	209.000						
15.000		15		1.56	42.15	87.97	2.870	1.310	2	209.000	204.000	42.00	9	7	-87.00	-58	-9.43
16.000	tirb3	16	Yes	0.94	0.00	0.00	2.570	1.630	4	207.000	205.000						
17.000		17		1.63	0.00	0.00	1.630	0.000	4	205.000	204.000						
18.000		18		1.31	42.15	87.96	1.310	0.000	4	204.000	200.000	42.00	9	7	-87.00	-57	-28

Weir				Rating Curves				Manning Formula					Prescribed	Bottom	Bottom
Height	Width	adam	bdam	Velocity		Depth		Channel	Manning	Bot Width	Side	Side	Dispersion	Algae	SOD
(m)	(m)			Coefficient	Exponent	Coefficient	Exponent	Slope	n	m	Slope	Slope	m2/s	Coverage	Coverage
0.0000	0.0000	1.2500	0.9000	0.0000	0.000	0.0000	0.000	0.0040	0.0300	4.00	0.0000	0.0000		10.00%	50.00%
0.0000	0.0000	1.2500	0.9000	0.0000	0.000	0.0000	0.000	0.0030	0.0300	4.00	0.0000	0.0000		10.00%	50.00%
0.0000	0.0000	1.2500	0.9000	0.0000	0.000	0.0000	0.000	0.0020	0.0300	4.00	0.0000	0.0000		10.00%	50.00%
0.0000	0.0000	1.2500	0.9000	0.0000	0.000	0.0000	0.000	0.0010	0.0300	865.00	0.0000	0.0000		10.00%	50.00%
0.0000	0.0000	1.2500	0.9000	0.0000	0.000	0.0000	0.000	0.0020	0.0300	4.00	0.0000	0.0000		10.00%	50.00%
0.0000	0.0000	1.2500	0.9000	0.0000	0.000	0.0000	0.000	0.0090	0.0300	4.00	0.0000	0.0000		10.00%	50.00%
		1.2500	0.9000					0.0050	0.0300	5.00	0.0000	0.0000		10.00%	50.00%
		1.2500	0.9000					0.0030	0.0300	5.00	0.0000	0.0000		10.00%	50.00%
		1.2500	0.9000					0.0010	0.0300	8.00	0.0000	0.0000		10.00%	50.00%
		1.2500	0.9000					0.0010	0.0300	8.00	0.0000	0.0000		10.00%	50.00%
		1.2500	0.9000					0.0080	0.0300	6.00	0.0000	0.0000		10.00%	50.00%
		1.2500	0.9000					0.0040	0.0300	8.00	0.0000	0.0000		10.00%	50.00%
		1.2500	0.9000					0.0030	0.0300	8.00	0.0000	0.0000		10.00%	50.00%
		1.2500	0.9000					0.0010	0.0300	156.00	0.0000	0.0000		10.00%	50.00%
		1.2500	0.9000					0.0040	0.0300	16.00	0.0000	0.0000		10.00%	50.00%
		1.2500	0.9000					0.0010	0.0300	16.00	0.0000	0.0000		10.00%	50.00%
		1.2500	0.9000					0.0010	0.0300	16.00	0.0000	0.0000		10.00%	50.00%
		1.2500	0.9000					0.0030	0.0300	16.00	0.0000	0.0000		10.00%	50.00%

				Upstream	Downstream	12:00 AM	1:00 AM	2:00 AM	3:00 AM	4:00 AM	5:00 AM	6:00 AM	7:00 AM	8:00 AM	9:00 AM	10:00 AM	11:00 AM	12:00 PM	1:00 PM	2:00 PM	3:00 PM	4:00 PM	5:00 PM	6:00 PM	7:00 PM	8:00 PM	9:00 PM	10:00 PM	11:00 PM
Upstream	Reach	Downstream	Reach	Distance	Distance	Hourly air temperature for each reach (degrees C)																							
Label	Label	Label	Number	km	km	(The input values are applied as point estimates at each time. Linear interpolation is used to estimate values between the hourly inputs.)																							
Mainstem headwater	1.00	Headwater reach	1	14.510	12.130	12.80	15.60	16.70	16.70	16.10	16.10	16.70	17.20	17.80	18.30	18.90	18.30	18.90	18.30	17.20	17.20	17.80	18.30	18.90	18.30	17.80	15.60	12.80	12.80
Headwater reach	2.00		2	12.130	11.620	12.80	15.60	16.70	16.70	16.10	16.10	16.70	17.20	17.80	18.30	18.90	18.30	18.90	18.30	17.20	17.20	17.80	18.30	18.90	18.30	17.80	15.60	12.80	12.80
	3.00		3	11.620	10.360	12.80	15.60	16.70	16.70	16.10	16.10	16.70	17.20	17.80	18.30	18.90	18.30	18.90	18.30	17.20	17.20	17.80	18.30	18.90	18.30	17.80	15.60	12.80	12.80
	4.00	Albert lake	4	10.360	9.880	12.80	15.60	16.70	16.70	16.10	16.10	16.70	17.20	17.80	18.30	18.90	18.30	18.90	18.30	17.20	17.20	17.80	18.30	18.90	18.30	17.80	15.60	12.80	12.80
Albert lake	5.00		5	9.880	8.900	12.80	15.60	16.70	16.70	16.10	16.10	16.70	17.20	17.80	18.30	18.90	18.30	18.90	18.30	17.20	17.20	17.80	18.30	18.90	18.30	17.80	15.60	12.80	12.80
UT1	6.00	trib1	6	3.760	3.100	12.80	15.60	16.70	16.70	16.10	16.10	16.70	17.20	17.80	18.30	18.90	18.30	18.90	18.30	17.20	17.20	17.80	18.30	18.90	18.30	17.80	15.60	12.80	12.80
trib1	7.00		7	3.100	0.460	12.80	15.60	16.70	16.70	16.10	16.10	16.70	17.20	17.80	18.30	18.90	18.30	18.90	18.30	17.20	17.20	17.80	18.30	18.90	18.30	17.80	15.60	12.80	12.80
	8.00		8	0.460	0.000	12.80	15.60	16.70	16.70	16.10	16.10	16.70	17.20	17.80	18.30	18.90	18.30	18.90	18.30	17.20	17.20	17.80	18.30	18.90	18.30	17.80	15.60	12.80	12.80
	9.00		9	8.900	6.110	12.80	15.60	16.70	16.70	16.10	16.10	16.70	17.20	17.80	18.30	18.90	18.30	18.90	18.30	17.20	17.20	17.80	18.30	18.90	18.30	17.80	15.60	12.80	12.80
	10.00		10	6.110	3.700	12.80	15.60	16.70	16.70	16.10	16.10	16.70	17.20	17.80	18.30	18.90	18.30	18.90	18.30	17.20	17.20	17.80	18.30	18.90	18.30	17.80	15.60	12.80	12.80
UT2	11.00	trib2	11	11.260	7.840	12.80	15.60	16.70	16.70	16.10	16.10	16.70	17.20	17.80	18.30	18.90	18.30	18.90	18.30	17.20	17.20	17.80	18.30	18.90	18.30	17.80	15.60	12.80	12.80
trib2	12.00		12	7.840	6.770	12.80	15.60	16.70	16.70	16.10	16.10	16.70	17.20	17.80	18.30	18.90	18.30	18.90	18.30	17.20	17.20	17.80	18.30	18.90	18.30	17.80	15.60	12.80	12.80
	13.00		13	6.770	0.000	12.80	15.60	16.70	16.70	16.10	16.10	16.70	17.20	17.80	18.30	18.90	18.30	18.90	18.30	17.20	17.20	17.80	18.30	18.90	18.30	17.80	15.60	12.80	12.80
	14.00	Buffalo Creek Lake	14	3.700	2.870	12.80	15.60	16.70	16.70	16.10	16.10	16.70	17.20	17.80	18.30	18.90	18.30	18.90	18.30	17.20	17.20	17.80	18.30	18.90	18.30	17.80	15.60	12.80	12.80
Buffalo Creek Lake	15.00		15	2.870	1.310	12.80	15.60	16.70	16.70	16.10	16.10	16.70	17.20	17.80	18.30	18.90	18.30	18.90	18.30	17.20	17.20	17.80	18.30	18.90	18.30	17.80	15.60	12.80	12.80
UT3	16.00	tirb3	16	2.570	1.630	12.80	15.60	16.70	16.70	16.10	16.10	16.70	17.20	17.80	18.30	18.90	18.30	18.90	18.30	17.20	17.20	17.80	18.30	18.90	18.30	17.80	15.60	12.80	12.80
tirb3	17.00		17	1.630	0.000	12.80	15.60	16.70	16.70	16.10	16.10	16.70	17.20	17.80	18.30	18.90	18.30	18.90	18.30	17.20	17.20	17.80	18.30	18.90	18.30	17.80	15.60	12.80	12.80
	18.00		18	1.310	0.000	12.80	15.60	16.70	16.70	16.10	16.10	16.70	17.20	17.80	18.30	18.90	18.30	18.90	18.30	17.20	17.20	17.80	18.30	18.90	18.30	17.80	15.60	12.80	12.80

				Upstream	Downstream	12:00 AM	1:00 AM	2:00 AM	3:00 AM	4:00 AM	5:00 AM	6:00 AM	7:00 AM
Upstream	*Reach*	*Downstream*	*Reach*	*Distance*	*Distance*	*Wind speed for each reach 7m above water surface (m/s)*							
Label	*Label*	*Label*	*Number*	*km*	*km*	*(The input values are applied as point estimates at each time. Linear interpolation is used to estin*							
Mainstem headwater	1.00	Headwater reach	1	14.510	12.130	2.00	3.00	4.10	4.10	4.10	4.60	4.60	4.60
Headwater reach	2.00		2	12.130	11.620	2.00	3.00	4.10	4.10	4.10	4.60	4.60	4.60
	3.00		3	11.620	10.360	2.00	3.00	4.10	4.10	4.10	4.60	4.60	4.60
	4.00	Albert lake	4	10.360	9.880	2.00	3.00	4.10	4.10	4.10	4.60	4.60	4.60
Albert lake	5.00		5	9.880	8.900	2.00	3.00	4.10	4.10	4.10	4.60	4.60	4.60
UT1	6.00	trib1	6	3.760	3.100	2.00	3.00	4.10	4.10	4.10	4.60	4.60	4.60
trib1	7.00		7	3.100	0.460	2.00	3.00	4.10	4.10	4.10	4.60	4.60	4.60
	8.00		8	0.460	0.000	2.00	3.00	4.10	4.10	4.10	4.60	4.60	4.60
	9.00		9	8.900	6.110	2.00	3.00	4.10	4.10	4.10	4.60	4.60	4.60
	10.00		10	6.110	3.700	2.00	3.00	4.10	4.10	4.10	4.60	4.60	4.60
UT2	11.00	trib2	11	11.260	7.840	2.00	3.00	4.10	4.10	4.10	4.60	4.60	4.60
trib2	12.00		12	7.840	6.770	2.00	3.00	4.10	4.10	4.10	4.60	4.60	4.60
	13.00		13	6.770	0.000	2.00	3.00	4.10	4.10	4.10	4.60	4.60	4.60
	14.00	Buffalo Creek Lake	14	3.700	2.870	2.00	3.00	4.10	4.10	4.10	4.60	4.60	4.60
Buffalo Creek Lake	15.00		15	2.870	1.310	2.00	3.00	4.10	4.10	4.10	4.60	4.60	4.60
UT3	16.00	tirb3	16	2.570	1.630	2.00	3.00	4.10	4.10	4.10	4.60	4.60	4.60
tirb3	17.00		17	1.630	0.000	2.00	3.00	4.10	4.10	4.10	4.60	4.60	4.60
	18.00		18	1.310	0.000	2.00	3.00	4.10	4.10	4.10	4.60	4.60	4.60

8:00 AM	9:00 AM	10:00 AM	11:00 AM	12:00 PM	1:00 PM	2:00 PM	3:00 PM	4:00 PM	5:00 PM	6:00 PM	7:00 PM	8:00 PM	9:00 PM	10:00 PM	11:00 PM
ıate values between the hourly inputs.)															
4.11	4.11	5.60	5.10	5.60	6.70	5.10	7.10	5.10	5.60	5.60	4.60	5.10	1.50	2.50	2.50
4.11	4.11	5.60	5.10	5.60	6.70	5.10	7.10	5.10	5.60	5.60	4.60	5.10	1.50	2.50	2.50
4.11	4.11	5.60	5.10	5.60	6.70	5.10	7.10	5.10	5.60	5.60	4.60	5.10	1.50	2.50	2.50
4.11	4.11	5.60	5.10	5.60	6.70	5.10	7.10	5.10	5.60	5.60	4.60	5.10	1.50	2.50	2.50
4.11	4.11	5.60	5.10	5.60	6.70	5.10	7.10	5.10	5.60	5.60	4.60	5.10	1.50	2.50	2.50
4.11	4.11	5.60	5.10	5.60	6.70	5.10	7.10	5.10	5.60	5.60	4.60	5.10	1.50	2.50	2.50
4.11	4.11	5.60	5.10	5.60	6.70	5.10	7.10	5.10	5.60	5.60	4.60	5.10	1.50	2.50	2.50
4.11	4.11	5.60	5.10	5.60	6.70	5.10	7.10	5.10	5.60	5.60	4.60	5.10	1.50	2.50	2.50
4.11	4.11	5.60	5.10	5.60	6.70	5.10	7.10	5.10	5.60	5.60	4.60	5.10	1.50	2.50	2.50
4.11	4.11	5.60	5.10	5.60	6.70	5.10	7.10	5.10	5.60	5.60	4.60	5.10	1.50	2.50	2.50
4.11	4.11	5.60	5.10	5.60	6.70	5.10	7.10	5.10	5.60	5.60	4.60	5.10	1.50	2.50	2.50
4.11	4.11	5.60	5.10	5.60	6.70	5.10	7.10	5.10	5.60	5.60	4.60	5.10	1.50	2.50	2.50
4.11	4.11	5.60	5.10	5.60	6.70	5.10	7.10	5.10	5.60	5.60	4.60	5.10	1.50	2.50	2.50
4.11	4.11	5.60	5.10	5.60	6.70	5.10	7.10	5.10	5.60	5.60	4.60	5.10	1.50	2.50	2.50
4.11	4.11	5.60	5.10	5.60	6.70	5.10	7.10	5.10	5.60	5.60	4.60	5.10	1.50	2.50	2.50
4.11	4.11	5.60	5.10	5.60	6.70	5.10	7.10	5.10	5.60	5.60	4.60	5.10	1.50	2.50	2.50
4.11	4.11	5.60	5.10	5.60	6.70	5.10	7.10	5.10	5.60	5.60	4.60	5.10	1.50	2.50	2.50
4.11	4.11	5.60	5.10	5.60	6.70	5.10	7.10	5.10	5.60	5.60	4.60	5.10	1.50	2.50	2.50

				Upstream	Downstream	12:00 AM	1:00 AM	2:00 AM	3:00 AM	4:00 AM	5:00 AM	6:00 AM	7:00 AM
Upstream	Reach	Downstream	Reach	Distance	Distance	Hourly cloud cover shade for each reach (Percent)							
Label	Label	Label	Number	km	km	(Percent of sky that is covered by clouds. The input values are applied as point estimates at each							
Mainstem headwater	1.00	Headwater reach	1	14.510	12.130	90.0%	90.0%	90.0%	90.0%	90.0%	90.0%	90.0%	90.0%
Headwater reach	2.00		2	12.130	11.620	90.0%	90.0%	90.0%	90.0%	90.0%	90.0%	90.0%	90.0%
	3.00		3	11.620	10.360	90.0%	90.0%	90.0%	90.0%	90.0%	90.0%	90.0%	90.0%
	4.00	Albert lake	4	10.360	9.880	90.0%	90.0%	90.0%	90.0%	90.0%	90.0%	90.0%	90.0%
Albert lake	5.00		5	9.880	8.900	90.0%	90.0%	90.0%	90.0%	90.0%	90.0%	90.0%	90.0%
UT1	6.00	trib1	6	3.760	3.100	90.0%	90.0%	90.0%	90.0%	90.0%	90.0%	90.0%	90.0%
trib1	7.00		7	3.100	0.460	90.0%	90.0%	90.0%	90.0%	90.0%	90.0%	90.0%	90.0%
	8.00		8	0.460	0.000	90.0%	90.0%	90.0%	90.0%	90.0%	90.0%	90.0%	90.0%
	9.00		9	8.900	6.110	90.0%	90.0%	90.0%	90.0%	90.0%	90.0%	90.0%	90.0%
	10.00		10	6.110	3.700	90.0%	90.0%	90.0%	90.0%	90.0%	90.0%	90.0%	90.0%
UT2	11.00	trib2	11	11.260	7.840	90.0%	90.0%	90.0%	90.0%	90.0%	90.0%	90.0%	90.0%
trib2	12.00		12	7.840	6.770	90.0%	90.0%	90.0%	90.0%	90.0%	90.0%	90.0%	90.0%
	13.00		13	6.770	0.000	90.0%	90.0%	90.0%	90.0%	90.0%	90.0%	90.0%	90.0%
	14.00	Buffalo Creek Lake	14	3.700	2.870	90.0%	90.0%	90.0%	90.0%	90.0%	90.0%	90.0%	90.0%
Buffalo Creek Lake	15.00		15	2.870	1.310	90.0%	90.0%	90.0%	90.0%	90.0%	90.0%	90.0%	90.0%
UT3	16.00	tirb3	16	2.570	1.630	90.0%	90.0%	90.0%	90.0%	90.0%	90.0%	90.0%	90.0%
tirb3	17.00		17	1.630	0.000	90.0%	90.0%	90.0%	90.0%	90.0%	90.0%	90.0%	90.0%
	18.00		18	1.310	0.000	90.0%	90.0%	90.0%	90.0%	90.0%	90.0%	90.0%	90.0%

8:00 AM	9:00 AM	10:00 AM	11:00 AM	12:00 PM	1:00 PM	2:00 PM	3:00 PM	4:00 PM	5:00 PM	6:00 PM	7:00 PM	8:00 PM	9:00 PM	10:00 PM	11:00 PM
time. Linear interpolation is used to estimate values between the hourly inputs.)															
90.0%	90.0%	90.0%	90.0%	70.0%	70.0%	70.0%	70.0%	90.0%	90.0%	90.0%	90.0%	90.0%	90.0%	90.0%	90.0%
90.0%	90.0%	90.0%	90.0%	70.0%	70.0%	70.0%	70.0%	90.0%	90.0%	90.0%	90.0%	90.0%	90.0%	90.0%	90.0%
90.0%	90.0%	90.0%	90.0%	70.0%	70.0%	70.0%	70.0%	90.0%	90.0%	90.0%	90.0%	90.0%	90.0%	90.0%	90.0%
90.0%	90.0%	90.0%	90.0%	70.0%	70.0%	70.0%	70.0%	90.0%	90.0%	90.0%	90.0%	90.0%	90.0%	90.0%	90.0%
90.0%	90.0%	90.0%	90.0%	70.0%	70.0%	70.0%	70.0%	90.0%	90.0%	90.0%	90.0%	90.0%	90.0%	90.0%	90.0%
90.0%	90.0%	90.0%	90.0%	70.0%	70.0%	70.0%	70.0%	90.0%	90.0%	90.0%	90.0%	90.0%	90.0%	90.0%	90.0%
90.0%	90.0%	90.0%	90.0%	70.0%	70.0%	70.0%	70.0%	90.0%	90.0%	90.0%	90.0%	90.0%	90.0%	90.0%	90.0%
90.0%	90.0%	90.0%	90.0%	70.0%	70.0%	70.0%	70.0%	90.0%	90.0%	90.0%	90.0%	90.0%	90.0%	90.0%	90.0%
90.0%	90.0%	90.0%	90.0%	70.0%	70.0%	70.0%	70.0%	90.0%	90.0%	90.0%	90.0%	90.0%	90.0%	90.0%	90.0%
90.0%	90.0%	90.0%	90.0%	70.0%	70.0%	70.0%	70.0%	90.0%	90.0%	90.0%	90.0%	90.0%	90.0%	90.0%	90.0%
90.0%	90.0%	90.0%	90.0%	70.0%	70.0%	70.0%	70.0%	90.0%	90.0%	90.0%	90.0%	90.0%	90.0%	90.0%	90.0%
90.0%	90.0%	90.0%	90.0%	70.0%	70.0%	70.0%	70.0%	90.0%	90.0%	90.0%	90.0%	90.0%	90.0%	90.0%	90.0%
90.0%	90.0%	90.0%	90.0%	70.0%	70.0%	70.0%	70.0%	90.0%	90.0%	90.0%	90.0%	90.0%	90.0%	90.0%	90.0%
90.0%	90.0%	90.0%	90.0%	70.0%	70.0%	70.0%	70.0%	90.0%	90.0%	90.0%	90.0%	90.0%	90.0%	90.0%	90.0%
90.0%	90.0%	90.0%	90.0%	70.0%	70.0%	70.0%	70.0%	90.0%	90.0%	90.0%	90.0%	90.0%	90.0%	90.0%	90.0%
90.0%	90.0%	90.0%	90.0%	70.0%	70.0%	70.0%	70.0%	90.0%	90.0%	90.0%	90.0%	90.0%	90.0%	90.0%	90.0%
90.0%	90.0%	90.0%	90.0%	70.0%	70.0%	70.0%	70.0%	90.0%	90.0%	90.0%	90.0%	90.0%	90.0%	90.0%	90.0%
90.0%	90.0%	90.0%	90.0%	70.0%	70.0%	70.0%	70.0%	90.0%	90.0%	90.0%	90.0%	90.0%	90.0%	90.0%	90.0%

				Upstream	Downstream	12:00 AM	1:00 AM	2:00 AM	3:00 AM	4:00 AM	5:00 AM	6:00 AM	7:00 AM
Upstream	Reach	Downstream	Reach	Distance	Distance	Integrated hourly effective shade for each reach (Percent)							
Label	Label	Label	Number	km	km	(Percent of solar radiation that is blocked because of shade from topography and vegetation. Hou							
Mainstem headwater	1.00	Headwater reach	1	14.510	12.130	100.0%	100.0%	100.0%	100.0%	100.0%	100.0%	100.0%	50.0%
Headwater reach	2.00		2	12.130	11.620	100.0%	100.0%	100.0%	100.0%	100.0%	100.0%	100.0%	0.0%
	3.00		3	11.620	10.360	100.0%	100.0%	100.0%	100.0%	100.0%	100.0%	100.0%	85.0%
	4.00	Albert lake	4	10.360	9.880	100.0%	100.0%	100.0%	100.0%	100.0%	100.0%	100.0%	0.0%
Albert lake	5.00		5	9.880	8.900	100.0%	100.0%	100.0%	100.0%	100.0%	100.0%	100.0%	85.0%
UT1	6.00	trib1	6	3.760	3.100	100.0%	100.0%	100.0%	100.0%	100.0%	100.0%	100.0%	90.0%
trib1	7.00		7	3.100	0.460	100.0%	100.0%	100.0%	100.0%	100.0%	100.0%	100.0%	90.0%
	8.00		8	0.460	0.000	100.0%	100.0%	100.0%	100.0%	100.0%	100.0%	100.0%	90.0%
	9.00		9	8.900	6.110	100.0%	100.0%	100.0%	100.0%	100.0%	100.0%	100.0%	85.0%
	10.00		10	6.110	3.700	100.0%	100.0%	100.0%	100.0%	100.0%	100.0%	100.0%	50.0%
UT2	11.00	trib2	11	11.260	7.840	100.0%	100.0%	100.0%	100.0%	100.0%	100.0%	100.0%	95.0%
trib2	12.00		12	7.840	6.770	100.0%	100.0%	100.0%	100.0%	100.0%	100.0%	100.0%	95.0%
	13.00		13	6.770	0.000	100.0%	100.0%	100.0%	100.0%	100.0%	100.0%	100.0%	75.0%
	14.00	Buffalo Creek Lake	14	3.700	2.870	100.0%	100.0%	100.0%	100.0%	100.0%	100.0%	100.0%	0.0%
Buffalo Creek Lake	15.00		15	2.870	1.310	100.0%	100.0%	100.0%	100.0%	100.0%	100.0%	100.0%	0.0%
UT3	16.00	tirb3	16	2.570	1.630	100.0%	100.0%	100.0%	100.0%	100.0%	100.0%	100.0%	0.0%
tirb3	17.00		17	1.630	0.000	100.0%	100.0%	100.0%	100.0%	100.0%	100.0%	100.0%	0.0%
	18.00		18	1.310	0.000	100.0%	100.0%	100.0%	100.0%	100.0%	100.0%	100.0%	40.0%

8:00 AM	9:00 AM	10:00 AM	11:00 AM	12:00 PM	1:00 PM	2:00 PM	3:00 PM	4:00 PM	5:00 PM	6:00 PM	7:00 PM	8:00 PM	9:00 PM	10:00 PM	11:00 PM
rly values are applied as integrated values for each hour, e.g. the value at 12:00 AM is applied from 12:00 to 1:00 AM)															
50.0%	50.0%	50.0%	50.0%	50.0%	50.0%	50.0%	50.0%	50.0%	50.0%	50.0%	100.0%	100.0%	100.0%	100.0%	100.0%
0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	100.0%	100.0%	100.0%	100.0%	100.0%
85.0%	85.0%	85.0%	85.0%	85.0%	85.0%	85.0%	85.0%	85.0%	85.0%	85.0%	100.0%	100.0%	100.0%	100.0%	100.0%
0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	100.0%	100.0%	100.0%	100.0%	100.0%
85.0%	85.0%	85.0%	85.0%	85.0%	85.0%	85.0%	85.0%	85.0%	85.0%	85.0%	100.0%	100.0%	100.0%	100.0%	100.0%
90.0%	90.0%	90.0%	90.0%	90.0%	90.0%	90.0%	90.0%	90.0%	90.0%	90.0%	100.0%	100.0%	100.0%	100.0%	100.0%
90.0%	90.0%	90.0%	90.0%	90.0%	90.0%	90.0%	90.0%	90.0%	90.0%	90.0%	100.0%	100.0%	100.0%	100.0%	100.0%
90.0%	90.0%	90.0%	90.0%	90.0%	90.0%	90.0%	90.0%	90.0%	90.0%	90.0%	100.0%	100.0%	100.0%	100.0%	100.0%
85.0%	85.0%	85.0%	85.0%	85.0%	85.0%	85.0%	85.0%	85.0%	85.0%	85.0%	100.0%	100.0%	100.0%	100.0%	100.0%
50.0%	50.0%	50.0%	50.0%	50.0%	50.0%	50.0%	50.0%	50.0%	50.0%	50.0%	100.0%	100.0%	100.0%	100.0%	100.0%
95.0%	95.0%	95.0%	95.0%	95.0%	95.0%	95.0%	95.0%	95.0%	95.0%	95.0%	100.0%	100.0%	100.0%	100.0%	100.0%
95.0%	95.0%	95.0%	95.0%	95.0%	95.0%	95.0%	95.0%	95.0%	95.0%	95.0%	100.0%	100.0%	100.0%	100.0%	100.0%
75.0%	75.0%	75.0%	75.0%	75.0%	75.0%	75.0%	75.0%	75.0%	75.0%	75.0%	100.0%	100.0%	100.0%	100.0%	100.0%
0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	100.0%	100.0%	100.0%	100.0%	100.0%
0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	100.0%	100.0%	100.0%	100.0%	100.0%
0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	100.0%	100.0%	100.0%	100.0%	100.0%
0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	100.0%	100.0%	100.0%	100.0%	100.0%
40.0%	40.0%	40.0%	40.0%	40.0%	40.0%	40.0%	40.0%	40.0%	40.0%	40.0%	100.0%	100.0%	100.0%	100.0%	100.0%

QUAL2K
Stream Water Quality Model
Buffalo Creek (5/7/2001)
Water Column Rates

Parameter	*Value*	*Units*	*Symbol*
Stoichiometry:			
Carbon	**40**	**gC**	gC
Nitrogen	**7.2**	**gN**	gN
Phosphorus	**1**	**gP**	gP
Dry weight	**100**	**gD**	gD
Chlorophyll	**2**	**gA**	gA
Inorganic suspended solids:			
Settling velocity	**1.304**	**m/d**	v_i
Oxygen:			
Reaeration model	**Owens-Gibbs**		
User reaeration coefficient α	**0**		α
User reaeration coefficient β	**0**		β
User reaeration coefficient γ	**0**		γ
Temp correction	**1.3**		θ_a
Reaeration wind effect	**None**		
O2 for carbon oxidation	**2.69**	**gO_2/gC**	r_{oc}
O2 for NH4 nitrification	**4.57**	**gO_2/gN**	r_{on}
Oxygen inhib model CBOD oxidation	**Exponential**		
Oxygen inhib parameter CBOD oxidation	**0.60**	**L/mgO2**	K_{socf}
Oxygen inhib model nitrification	**Exponential**		
Oxygen inhib parameter nitrification	**0.60**	**L/mgO2**	K_{sona}
Oxygen enhance model denitrification	**Exponential**		
Oxygen enhance parameter denitrification	**0.60**	**L/mgO2**	K_{sodn}
Oxygen inhib model phyto resp	**Exponential**		
Oxygen inhib parameter phyto resp	**0.60**	**L/mgO2**	K_{sop}
Oxygen enhance model bot alg resp	**Exponential**		
Oxygen enhance parameter bot alg resp	**0.60**	**L/mgO2**	K_{sob}
Slow CBOD:			
Hydrolysis rate	**1**	**/d**	k_{hc}
Temp correction	**1.047**		θ_{hc}
Oxidation rate	**5**	**/d**	k_{dcs}
Temp correction	**1.047**		θ_{dcs}
Fast CBOD:			
Oxidation rate	**4**	**/d**	k_{dc}
Temp correction	**1.047**		θ_{dc}
Organic N:			
Hydrolysis	**0.001**	**/d**	k_{hn}
Temp correction	**1.07**		θ_{hn}
Settling velocity	**0**	**m/d**	v_{on}
Ammonium:			
Nitrification	**1**	**/d**	k_{na}
Temp correction	**1.07**		θ_{na}
Nitrate:			
Denitrification	**0.5**	**/d**	k_{dn}
Temp correction	**1.07**		θ_{dn}
Sed denitrification transfer coeff	**0**	**m/d**	v_{di}
Temp correction	**1.07**		θ_{di}
Organic P:			
Hydrolysis	**0**	**/d**	k_{hp}
Temp correction	**1.07**		θ_{hp}
Settling velocity	**1.999**	**m/d**	v_{op}
Inorganic P:			
Settling velocity	**0**	**m/d**	v_{ip}
Inorganic P sorption coefficient	**0.073**	**L/mgD**	K_{dpi}
Sed P oxygen attenuation half sat constant	**1.831**	**mgO_2/L**	k_{spi}
Phytoplankton:			
Max Growth rate	**2.5**	**/d**	k_{gp}
Temp correction	**1.07**		θ_{gp}
Respiration rate	**0.1**	**/d**	k_{rp}
Temp correction	**1.07**		θ_{rp}
Excretion rate	**0**	**/d**	k_{ep}
Temp correction	**1.07**		θ_{dp}
Death rate	**0**	**/d**	k_{dp}
Temp correction	**1**		θ_{dp}
External Nitrogen half sat constant	**15**	**ugN/L**	k_{sPp}
External Phosphorus half sat constant	**2**	**ugP/L**	k_{sNp}
Inorganic carbon half sat constant	**2.00E-05**	**moles/L**	k_{sCp}
Light model	**Half saturation**		
Light constant	**57.6**	**langleys/d**	K_{Lp}
Ammonia preference	**25**	**ugN/L**	k_{hnxp}
Subsistence quota for nitrogen	**0**	**mgN/mgA**	q_{0Np}
Subsistence quota for phosphorus	**0**	**mgP/mgA**	q_{0Pp}
Maximum uptake rate for nitrogen	**0**	**mgN/mgA/d**	ρ_{mNp}
Maximum uptake rate for phosphorus	**0**	**mgP/mgA/d**	ρ_{mPp}
Internal nitrogen half sat constant	**0**	**mgN/mgA**	K_{qNp}
Internal phosphorus half sat constant	**0**	**mgP/mgA**	K_{qPp}
Settling velocity	**0.15**	**m/d**	v_a
Bottom Algae:			
Growth model	**Zero-order**		
Max Growth rate	**999.991**	**$mgA/m^2/d$ or /d**	C_{gb}
Temp correction	**1.07**		θ_{gb}
First-order model carrying capacity	**1000**	**mgA/m^2**	$a_{b,max}$
Respiration rate	**1**	**/d**	k_{rb}
Temp correction	**1.07**		θ_{rb}
Excretion rate	**0.5**	**/d**	k_{eb}
Temp correction	**1.05**		θ_{db}
Death rate	**0.09**	**/d**	k_{db}
Temp correction	**1.07**		θ_{db}
External nitrogen half sat constant	**0.052**	**ugN/L**	k_{sPb}
External phosphorus half sat constant	**96.379**	**ugP/L**	k_{sNb}
Inorganic carbon half sat constant	**1.00E-05**	**moles/L**	k_{sCb}
Light model	**Half saturation**		
Light constant	**76.319**	**langleys/d**	K_{Lb}
Ammonia preference	**99.982**	**ugN/L**	k_{hnxb}
Subsistence quota for nitrogen	**2.524**	**mgN/mgA**	q_{0N}
Subsistence quota for phosphorus	**0.002**	**mgP/mgA**	q_{0P}
Maximum uptake rate for nitrogen	**149.913**	**mgN/mgA/d**	ρ_{mN}
Maximum uptake rate for phosphorus	**5.009**	**mgP/mgA/d**	ρ_{mP}
Internal nitrogen half sat constant	**0.384**	**mgN/mgA**	K_{qN}
Internal phosphorus half sat constant	**0.102**	**mgP/mgA**	K_{qP}
Detritus (POM):			
Dissolution rate	**7.179**	**/d**	k_{dt}
Temp correction	**1.07**		θ_{dt}
Fraction of dissolution to fast CBOD	**1.00**		F_f
Settling velocity	**0.236**	**m/d**	v_{dt}
Pathogens:			
Decay rate	**0.8**	**/d**	k_{dx}
Temp correction	**1.07**		θ_{dx}
Settling velocity	**1**	**m/d**	v_x
Light efficiency factor	**1.00**		α_{path}
pH:			
Partial pressure of carbon dioxide	**347**	**ppm**	p_{CO2}
Constituent i			
First-order reaction rate	**0**	**/d**	
Temp correction	**1**		θ_{dx}
Settling velocity	**0**	**m/d**	v_{dt}
Constituent ii			
First-order reaction rate	**0**	**/d**	
Temp correction	**1**		θ_{dx}
Settling velocity	**0**	**m/d**	v_{dt}
Constituent iii			
First-order reaction rate	**0**	**/d**	
Temp correction	**1**		θ_{dx}
Settling velocity	**0**	**m/d**	v_{dt}

QUAL2K

Stream Water Quality Model

Buffalo Creek (5/7/2001)

Light Parameters and Surface Heat Transfer Models:

Parameter	*Value*	*Unit*	
Photosynthetically Available Radiation	**0.47**		
Background light extinction	**0.2**	*/m*	k_{eb}
Linear chlorophyll light extinction	**0.0088**	*1/m-(ugA/L)*	α_p
Nonlinear chlorophyll light extinction	**0.054**	*1/m-(ugA/L)2/3*	α_{pn}
ISS light extinction	**0.052**	*1/m-(mgD/L)*	α_i
Detritus light extinction	**0.174**	*1/m-(mgD/L)*	α_o
Solar shortwave radiation model			
Atmospheric attenuation model for solar	**Ryan-Stolzenbach**		
Bras solar parameter (used if Bras solar model is selected)			
atmospheric turbidity coefficient (2=clear, 5=smoggy, default=2)	**2**		n_{fac}
Ryan-Stolzenbach solar parameter (used if Ryan-Stolzenbach solar model is selected)			
atmospheric transmission coefficient (0.70-0.91, default 0.8)	**0.75**		a_{tc}
Downwelling atmospheric longwave IR radiation			
atmospheric longwave emissivity model	**Brunt**		
Evaporation and air convection/conduction			
wind speed function for evaporation and air convection/conduction	**Brady-Graves-Geyer**		
Sediment heat parameters			
Sediment thermal thickness	**10**	*cm*	H_s
Sediment thermal diffusivity	**0.005**	*cm^2/s*	α_s
Sediment density	**1.6**	*g/cm^3*	ρ_s
Water density	**1**	*g/cm^3*	ρ_w
Sediment heat capacity	**0.4**	*cal/(g ^oC)*	C_{ps}
Water heat capacity	**1**	*cal/(g ^oC)*	C_{pw}
Sediment diagenesis model			
Compute SOD and nutrient fluxes	**Yes**		

	Tributary	Headwater	Location		Diffuse	Diffuse		Spec	Inorg	Diss	CBOD	CBOD	Organic
			Up	Down	Abstraction	Inflow	Temp	Cond	SS	Oxygen	slow	fast	N
Name	No.*	Label	km	km	m3/s	m3/s	C	umhos	mgD/L	mg/L	mgO2/L	mgO2/L	ugN/L
Incremental Flows	0	Mainstem headwater	14.510	12.130	0.0000	0.0200	16.80	1.56		4.81		5.00	550.00
2.000	0	Mainstem headwater	12.130	11.620	0.0000	0.0130	16.80	1.56		4.81		5.00	550.00
3	0	Mainstem headwater	11.620	10.360	0.0000	0.0130	16.80	1.56		4.81		5.00	550.00
4	0	Mainstem headwater	10.360	9.880	0.0000		16.80	1.56		4.81		5.00	550.00
5	0	Mainstem headwater	9.880	8.900	0.0000		16.80	1.56		4.81		5.00	550.00
6	1	UT1	3.760	3.100	0.0000	0.0180	16.80	1.07		7.50		5.00	800.00
7	1	UT1	3.100	0.460	0.0000		16.80	1.07		7.50		5.00	800.00
8	1	UT1	0.460	0.000	0.0000		16.80	1.07		7.50		5.00	800.00
9	0	Mainstem headwater	8.900	6.110	0.0000	0.0200	20.00	1.35		7.30		5.00	550.00
10	0	Mainstem headwater	6.110	3.700	0.0000	0.0200	20.00	1.35		7.30		5.00	550.00
11	2	UT2	11.260	7.840	0.0000	0.0100	20.00	1.35		7.50		5.00	800.00
12	2	UT2	7.840	6.770	0.0000	0.0200	20.00	1.35		7.50		5.00	800.00
13	2	UT2	6.770	0.000	0.0000	0.0200	20.00	1.35		7.50		5.00	800.00
14	0	Mainstem headwater	3.700	2.870	0.0000		23.00	1.08		8.13		5.00	800.00
15	0	Mainstem headwater	2.870	1.310	0.0000	0.0010	23.00	1.08		8.13		5.00	800.00
16	3	UT3	2.570	1.630	0.0000	0.0050	23.00	1.08		7.50		5.00	800.00
17	3	UT3	1.630	0.000	0.0000	0.0020	23.00	1.08		7.50		5.00	800.00
18	0	Mainstem headwater	1.310	0.000	0.0000		23.00	1.08		8.13		5.00	800.00

	Tributary	Headwater	Location	Point		Temperature		
				Abstraction	Inflow	mean	range/2	time of
Name	No.	Label	km	m3/s	m3/s	°C	°C	max
Camp Reinburg IL0048524	1	UT1	0.26	0.0000	0.0006	22.00		
Alden Long Grove Rehab IL0051934	2	UT2	7.84	0.0000	0.0018	22.00		

Inorganic Suspended Solids			Dissolved Oxygen			Slow CBOD			Fast CBOD			Organic N		
mean	range/2	time of	mean	range/2	time of	mean	range/2	time of	mean	range/2	time of	mean	range/2	time of
mg/L	mg/L	max	mg/L	mg/L	max	mgO2/L	mgO2/L	max	mgO2/L	mgO2/L	max	ugN/L	ugN/L	max
12.00			5.00			10.00								
1.00			5.00			8.90								

Ammonia N			Nitrate + Nitrite N			Organic P			Inorganic P			Phytoplankton		
mean	range/2	time of	mean	range/2	time of	mean	range/2	time of	mean	range/2	time of	mean	range/2	time of
ugN/L	ugN/L	max	ugN/L	ugN/L	max	ugP/L	ugP/L	max	ugP/L	ugP/L	max	ugA/L	ugA/L	max
100.00						400.00								
100.00						400.00								

Internal Nitrogen			Internal Phosphorus			Detritus			Pathogen Indicator Bacteria			Alkalinity		
mean	range/2	time of	mean	range/2	time of	mean	range/2	time of	mean	range/2	time of	mean	range/2	time of
ugN/L	ugN/L	max	ugP/L	ugP/L	max	mgD/L	mgD/L	max	cfu/100ml	cfu/100ml	max	mgCaCO3/L	mgCaCO3/L	max
												100.00		
												100.00		

Constituent i			Constituent ii			Constituent iii			pH		
mean	range/2	time of	mean	range/2	time of	mean	range/2	time of	mean	range/2	time of
		max			max			max	s.u.	s.u.	max
									7.00		
									7.20		

QUAL-2K Model Setup: Higgins Creek

This section describes the process that was used to set up the QUAL2K model for Higgins Creek.

Stream Segmentation

The impaired section of Higgins Creek includes one unnamed tributary (UT1) and a segment of Higgins creek beginning near Udall Park and ending at the Chicago O'Hare Airport near Mount Prospect Road. The stream and the tributary were segmented into a series of sub-segments designated as reaches. Higgins Creek was segmented in 5 reaches; the unnamed tributary was segmented in three reaches. The total length of the modeled Higgins Creek segment is 7.22 kilometers; the length of UT1 is 2.63 kilometers. The length of each segment was determined based on stream geometry and characteristics, tributary location, and point source locations.

Geometry, Elevations and Weather Data

Stream geometry, elevations, and slopes were estimated from aerial satellite imagery and Geographic Information System (GIS) data. The bottom slope was estimated from aerial photos assuming a trapezoidal cross section. The Manning formula was selected to simulate flow, water depth, and water velocity. A Manning's n value of 0.03 was used for earthen channels and 0.012 was used for concrete channels.

The hourly weather data for air temperature, dew point, wind speed and cloud cover were obtained from the Chicago O'Hare weather station and are displayed in **Table G-5**.

Table G-5: Climate Data from Chicago O'Hare Airport

7/6/06 Time	Temp. (°F)	Temp (°C)	Dew Point (°F)	Dew point (°C)	Wind Speed (mph)	Wind Speed (m/s)
0:05	68.3	20.2	54.3	12.4	2	0.8154
1:05	67.9	19.9	54.8	12.7	3	1.2231
2:05	67.6	19.8	53.2	11.8	1	0.4077
3:05	67.2	19.6	56.3	13.5	5	2.0385
4:05	65.5	18.6	59.2	15.1	6	2.4462
4:55	65.2	18.4	59.9	15.5	4	1.6308
6:05	65.9	18.8	58.1	14.5	1	0.4077
7:05	68.3	20.2	56.5	13.6	2	0.8154
8:05	69.1	20.6	51.8	11.0	3	1.2231
9:05	70.5	21.4	52.5	11.4	4	1.6308
10:05	70.4	21.3	51.9	11.1	3	1.2231
11:05	70.9	21.6	50.2	10.1	3	1.2231
12:05	71.5	21.9	49.6	9.8	3	1.2231
13:05	72.2	22.3	49.1	9.5	4	1.6308
14:05	72.6	22.6	51.2	10.7	3	1.2231
15:05	73.5	23.1	50.9	10.5	4	1.6308
16:05	73.3	22.9	50.7	10.4	3	1.2231
17:05	72.8	22.7	50.8	10.4	3	1.2231
18:05	72.7	22.6	47.6	8.7	3	1.2231
19:00	71.6	22.0	48.5	9.2	2	0.8154

7/6/06 Time	Temp. (°F)	Temp (°C)	Dew Point (°F)	Dew point (°C)	Wind Speed (mph)	Wind Speed (m/s)
20:00	69.8	21.0	50.9	10.5	1	0.4077
21:00	69.4	20.8	48.3	9.1	1	0.4077
22:05	68.6	20.3	50.3	10.2	1	0.4077
23:05	68.1	20.1	49.8	9.9		0
23:55	67.1	19.5	49.4	9.7		0

Boundary Conditions

Boundary conditions are defined in the QUAL2K model by the headwater data. There are no water quality monitoring stations or flow gaging stations upstream of Higgins Creek or its tributary. Headwaters conditions were estimated based on observed data at downstream stations. Flow was estimated using McDonald Creek, a gaged stream with similar watershed characteristics. The Higgins Creek flow was determined through watershed scaling (see Section 7.1.2).

Critical conditions

Critical conditions were determined to be during the summer low flow conditions. Data from July 2006 were selected because they represented low dissolved oxygen conditions in the stream (**Table G-6**).

Table G-6: Ambient Stations Data

Date	Sampling Point	DO (mg/L)	NH3N (mg/L)	TKN (mg/L)	TP (mg/L)
July 5, 2006	WW_77	4.8	0.29	1.39	0.16
July 5, 2006	WW_78	8.1	0.42	1.9	0.36

Point Source Loads

There are three point source discharges on the mainstem on Higgins Creek and five on UT1. The five point source discharges on the tributary are all located in a contiguous section and were represented as one discharge in the model. Effluent data were obtained from the IL EPA Discharge Monitoring Reporting Data Retrieval database. A data summary is shown in **Table G-7**.

Table G-7: Point Source Discharger Effluent Quality

Stream name	Facility Name & NPDES	Discharge Point (km)	Flow (m3/s)	BOD (mg/L)	NH3 (mg/L)	DO (mg/L)
Higgins Creek	Kirie WRP IL0047471	2.79	1.14	2	0.37	8.2
	Des Plaines MHP IL0054160	0.5	0.027	2	0.21	6
	BP Products IL0034347	0.5	0.018	---	---	5
Unnamed Tributary	Exxon Mobil IL0066362	1.25	0.0015	---	---	5
	Marathon Petroleum IL 62791	1.25	0	---	---	---
	Unoven – Des Plaines Terminal IL0042242	1.25	0	---	---	---
	CITGO Petroleum IL0025461	1.25	0.072	---	---	5
	Shell Oil IL0046736	1.25	0	---	---	---

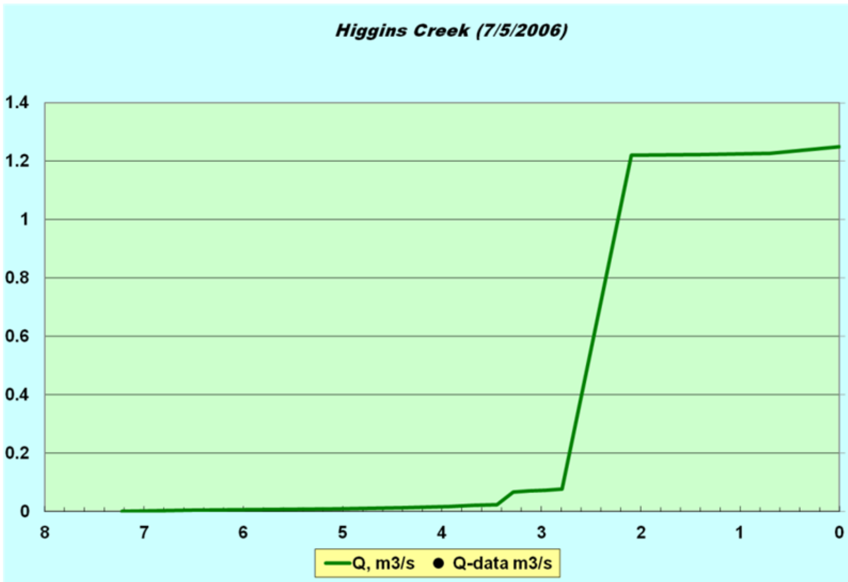
QUAL2K Model Calibration

Flow, dissolved oxygen and temperature were simulated for Higgins Creek. Observed data at the two water quality stations were used to calibrate the model. Data for ammonia, TKN and total phosphorus was available for both sampling stations and were used for model calibration. CBOD data were not available for the stream. CBOD stream values ranging from 1 -5 mg/L were used to calibrate the model. The month of July 2006 presented low dissolved oxygen concentrations which were considered critical conditions for model calibration. Base flow was added as incremental diffuse flow for all the model reaches. Ammonia, nitrate and total phosphorus loads were adjusted during calibration to match the recorded data at the monitoring stations. The model predicted lower oxygen concentrations than the concentrations recorded at WW_77 in the reaches before the water quality sampling station.

Load Reductions

The Illinois water quality standard for dissolved oxygen is 5 mg/L. Loads for NH3N, CBOD, organic nitrogen and phosphorus were reduced to determine the effect in the dissolve oxygen curve. Reductions in nutrients and CBOD did not result in dissolved oxygen levels above the standard. Adjusting SOD values resulted in higher dissolved oxygen concentrations but below the 5 mg/L target.

Figure G-4 Observed Flow (top) and Temperature (bottom)



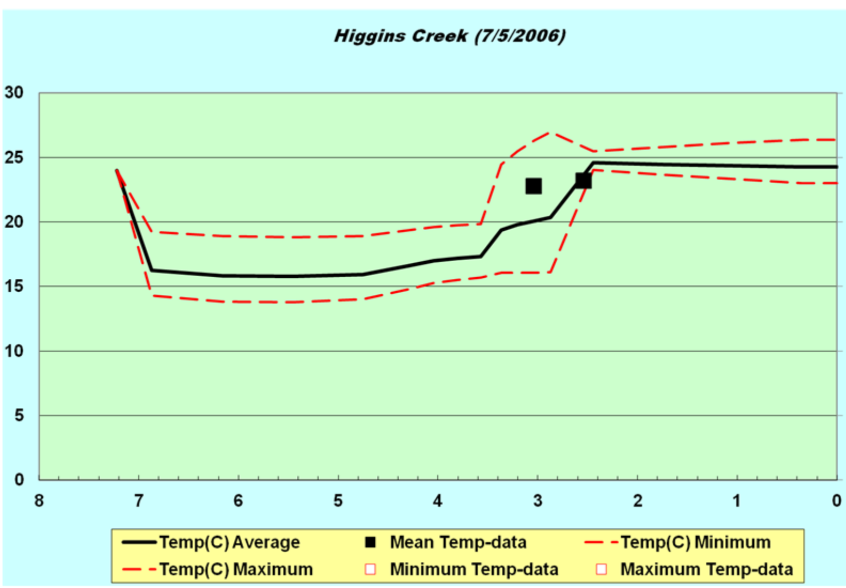


Figure G-5 Dissolved Oxygen Calibration

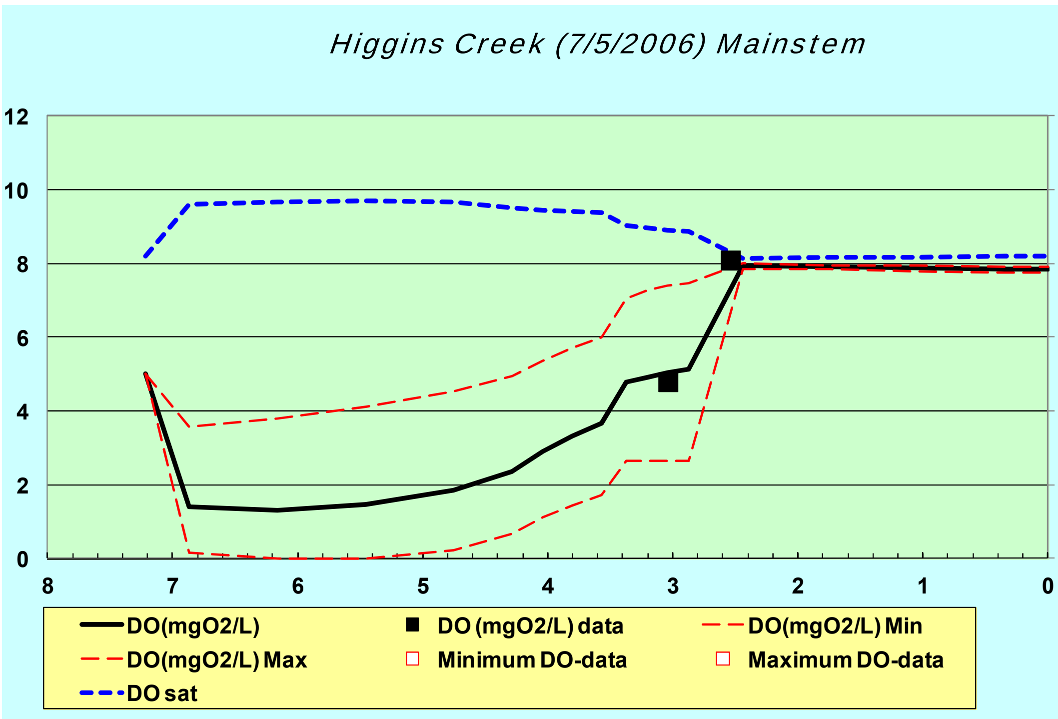


Figure G-6 QUAL2K Model Input Files

QUAL2K FORTRAN

Stream Water Quality Model

Steve Chapra, Hua Tao and Greg Pelletier

Version 2.11b8

System ID:		
River name	**Higgins Creek**	
Saved file name	**Higgins Cal 7 26**	
Directory where file saved	**al\Higgins Creek\Qual2K Higgins\data files**	
Month	**7**	
Day	**5**	
Year	**2006**	
Local time hours to UTC	**-6**	
Daylight savings time	**Yes**	
Calculation:		
Calculation step	**0.1**	**hours**
Final time	**30**	**day**
Solution method (integration)	**Euler**	
Solution method (pH)	**Brent**	
Time zone	**Central Standard Time**	
Program determined calc step	**0.093750**	**hours**
Time of last calculation	**0.13**	**minutes**
Time of sunrise	**5:22 AM**	
Time of solar noon	**12:56 PM**	
Time of sunset	**8:30 PM**	
Photoperiod	**15.14**	**hours**

Number of Headwaters	2

Headwater 0 (Mainstem)

Headwater label	Reach No	Flow	Elevation	Weir				Rating Curves				Manning Formula					Prescribed								
		Rate		Height	Width	adam	bdam	Velocity		Depth		Channel	Manning	Bot Width	Side	Side	Dispersion								
		(m^3/s)	(m)	(m)	(m)			Coefficient	Exponent	Coefficient	Exponent	Slope	n	m	Slope	Slope	m2/s								
Mainstem headwater	1	0.001	211.000	0.0000	0.0000	1.2500	0.9000	0.0000	0.000	0.0000	0.000	0.003	0.0300	4.00	0.00	0.00	0.00								
Water Quality Constituents	Units	12:00 AM	1:00 AM	2:00 AM	3:00 AM	4:00 AM	5:00 AM	6:00 AM	7:00 AM	8:00 AM	9:00 AM	10:00 AM	11:00 AM	12:00 PM	1:00 PM	2:00 PM	3:00 PM	4:00 PM	5:00 PM	6:00 PM	7:00 PM	8:00 PM	9:00 PM	10:00 PM	11:00 PM
Temperature	C	24.00	24.00	24.00	24.00	24.00	24.00	24.00	24.00	24.00	24.00	24.00	24.00	24.00	24.00	24.00	24.00	24.00	24.00	24.00	24.00	24.00	24.00	24.00	24.00
Conductivity	umhos																								
Inorganic Solids	mgD/L																								
Dissolved Oxygen	mg/L	5.00	5.00	5.00	5.00	5.00	5.00	5.00	5.00	5.00	5.00	5.00	5.00	5.00	5.00	5.00	5.00	5.00	5.00	5.00	5.00	5.00	5.00	5.00	5.00
CBODslow	mgO2/L																								
CBODfast	mgO2/L	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00
Organic Nitrogen	ugN/L	350.00	350.00	350.00	350.00	350.00	350.00	350.00	350.00	350.00	350.00	350.00	350.00	350.00	350.00	350.00	350.00	350.00	350.00	350.00	350.00	350.00	350.00	350.00	350.00
NH4-Nitrogen	ugN/L	100.00	100.00	100.00	100.00	100.00	100.00	100.00	100.00	100.00	100.00	100.00	100.00	100.00	100.00	100.00	100.00	100.00	100.00	100.00	100.00	100.00	100.00	100.00	100.00
NO3-Nitrogen	ugN/L	100.00	100.00	100.00	100.00	100.00	100.00	100.00	100.00	100.00	100.00	100.00	100.00	100.00	100.00	100.00	100.00	100.00	100.00	100.00	100.00	100.00	100.00	100.00	100.00
Organic Phosphorus	ugP/L	50.00	50.00	50.00	50.00	50.00	50.00	50.00	50.00	50.00	50.00	50.00	50.00	50.00	50.00	50.00	50.00	50.00	50.00	50.00	50.00	50.00	50.00	50.00	50.00
Inorganic Phosphorus (SRP)	ugP/L	10.00	10.00	10.00	10.00	10.00	10.00	10.00	10.00	10.00	10.00	10.00	10.00	10.00	10.00	10.00	10.00	10.00	10.00	10.00	10.00	10.00	10.00	10.00	10.00
Phytoplankton	ugA/L																								
Internal Nitrogen (INP)	ugN/L																								
Internal Phosphorus (IPP)	ugP/L																								
Detritus (POM)	mgD/L																								
Pathogen	cfu/100 mL																								
Alkalinity	mgCaCO3/L	120.00	120.00	120.00	120.00	120.00	120.00	120.00	120.00	120.00	120.00	120.00	120.00	120.00	120.00	120.00	120.00	120.00	120.00	120.00	120.00	120.00	120.00	120.00	120.00
Constituent i																									
Constituent ii																									
Constituent iii																									
pH	s.u.	7.00	7.00	7.00	7.00	7.00	7.00	7.00	7.00	7.00	7.00	7.00	7.00	7.00	7.00	7.00	7.00	7.00	7.00	7.00	7.00	7.00	7.00	7.00	7.00

Headwater 1 (Tributary 1)

Headwater label	Reach No	Flow	Elevation	Weir				Rating Curves				Manning Formula					Prescribed								
		Rate		Height	Width	adam	bdam	Velocity		Depth		Channel	Manning	Bot Width	Side	Side	Dispersion								
		(m^3/s)	(m)	(m)	(m)			Coefficient	Exponent	Coefficient	Exponent	Slope	n	m	Slope	Slope	m2/s								
UT1	3	0.001	205.000			1.2500	0.9000					0.003	0.0300	3.00	0.00	0.00									
Water Quality Constituents	Units	12:00 AM	1:00 AM	2:00 AM	3:00 AM	4:00 AM	5:00 AM	6:00 AM	7:00 AM	8:00 AM	9:00 AM	10:00 AM	11:00 AM	12:00 PM	1:00 PM	2:00 PM	3:00 PM	4:00 PM	5:00 PM	6:00 PM	7:00 PM	8:00 PM	9:00 PM	10:00 PM	11:00 PM
Temperature	C	24.00	24.00	24.00	24.00	24.00	24.00	24.00	24.00	24.00	24.00	24.00	24.00	24.00	24.00	24.00	24.00	24.00	24.00	24.00	24.00	24.00	24.00	24.00	24.00
Conductivity	umhos																								
Inorganic Solids	mgD/L																								
Dissolved Oxygen	mg/L	5.00	5.00	5.00	5.00	5.00	5.00	5.00	5.00	5.00	5.00	5.00	5.00	5.00	5.00	5.00	5.00	5.00	5.00	5.00	5.00	5.00	5.00	5.00	5.00
CBODslow	mgO2/L																								
CBODfast	mgO2/L	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00
Organic Nitrogen	ugN/L	350.00	350.00	350.00	350.00	350.00	350.00	350.00	350.00	350.00	350.00	350.00	350.00	350.00	350.00	350.00	350.00	350.00	350.00	350.00	350.00	350.00	350.00	350.00	350.00
NH4-Nitrogen	ugN/L	100.00	100.00	100.00	100.00	100.00	100.00	100.00	100.00	100.00	100.00	100.00	100.00	100.00	100.00	100.00	100.00	100.00	100.00	100.00	100.00	100.00	100.00	100.00	100.00
NO3-Nitrogen	ugN/L	50.00	50.00	50.00	50.00	50.00	50.00	50.00	50.00	50.00	50.00	50.00	50.00	50.00	50.00	50.00	50.00	50.00	50.00	50.00	50.00	50.00	50.00	50.00	50.00
Organic Phosphorus	ugP/L	50.00	50.00	50.00	50.00	50.00	50.00	50.00	50.00	50.00	50.00	50.00	50.00	50.00	50.00	50.00	50.00	50.00	50.00	50.00	50.00	50.00	50.00	50.00	50.00
Inorganic Phosphorus (SRP)	ugP/L	10.00	10.00	10.00	10.00	10.00	10.00	10.00	10.00	10.00	10.00	10.00	10.00	10.00	10.00	10.00	10.00	10.00	10.00	10.00	10.00	10.00	10.00	10.00	10.00
Phytoplankton	ugA/L																								
Internal Nitrogen	ugN/L																								
Internal Phosphorus	ugP/L																								
Detritus (POM)	mgD/L																								
Pathogen	cfu/100 mL																								
Alkalinity	mgCaCO3/L	120.00	120.00	120.00	120.00	120.00	120.00	120.00	120.00	120.00	120.00	120.00	120.00	120.00	120.00	120.00	120.00	120.00	120.00	120.00	120.00	120.00	120.00	120.00	120.00
Constituent i																									
Constituent ii																									
Constituent iii																									
pH	s.u.	7.00	7.00	7.00	7.00	7.00	7.00	7.00	7.00	7.00	7.00	7.00	7.00	7.00	7.00	7.00	7.00	7.00	7.00	7.00	7.00	7.00	7.00	7.00	7.00

Reach for diel plot	6										
Element for diel plot	2	Reach	Headwater	Reach			Location		Element	Elevation	
Reach	Downstream	Number	Reach	length	Downstream		Upstream	Downstream	Number	Upstream	Downstream
Label	end of reach label			(km)	Latitude	Longitude	(km)	(km)	>=1	(m)	(m)
1.000	Headwaters	1	Yes	2.82	42.02	87.95	7.220	4.400	4	202.000	211.000
2.000		2		0.95	42.02	87.94	4.400	3.450	4	202.000	199.000
3.000	UT1	3	Yes	0.87	42.03	87.95	2.630	1.760	4	205.000	202.000
4.000	UT1	4		0.87	42.02	88.00	1.760	0.890	4	202.000	200.000
5.000	UT1	5		0.89	42.02	87.94	0.890	0.000	4	200.000	199.000
6.000		6		0.66	42.02	87.94	3.450	2.790	4	199.000	198.000
7.000		7		2.79	42.01	87.92	2.790	0.000	4	198.000	195.000

			Hydraulic Model (Weir Overrides Manning Formula; Manning Formula Override Rating Curves)										
Downstream						Weir				Rating Curves			
Latitude			Longitude			Height	Width	adam	bdam	Velocity		Depth	
Degrees	Minutes	Seconds	Degrees	Minutes	Seconds	(m)	(m)			Coefficient	Exponent	Coefficient	Exponent
42.00	1	3	-87.00	-57	-8.279	0.0000	0.0000	1.2500	0.9000	0.0000	0.000	0.0000	0.000
42.00	1	9	-87.00	-56	-36.6	0.0000	0.0000	1.2500	0.9000	0.0000	0.000	0.0000	0.000
42.00	1	47	-87.00	-57	-15.336	0.0000	0.0000	1.2500	0.9000	0.0000	0.000	0.0000	0.000
42.00	1	29	-87.00	-59	-58.2	0.0000	0.0000	1.2500	0.9000	0.0000	0.000	0.0000	0.000
42.00	1	9	-87.00	-56	-36.6	0.0000	0.0000	1.2500	0.9000	0.0000	0.000	0.0000	0.000
42.00	1	13	-87.00	-56	-18.43			1.2500	0.9000				
42.00	0	21	-87.00	-54	-54.719			1.2500	0.9000				

				Upstream	Downstream	12:00 AM	1:00 AM	2:00 AM	3:00 AM	4:00 AM	5:00 AM	6:00 AM	7:00 AM
Upstream	Reach	Downstream	Reach	Distance	Distance	Hourly air temperature for each reach (degrees C)							
Label	Label	Label	Number	km	km	(The input values are applied as point estimates at each time. Linear interpolation is used to estin							
Mainstem headwater	1.00	Headwaters	1	7.220	4.400	19.90	19.60	18.60	18.40	18.80	18.40	18.80	20.20
Headwaters	2.00		2	4.400	3.450	19.90	19.60	18.60	18.40	18.80	18.40	18.80	20.20
UT1	3.00	UT1	3	2.630	1.760	19.90	19.60	18.60	18.40	18.80	18.40	18.80	20.20
UT1	4.00		4	1.760	0.890	19.90	19.60	18.60	18.40	18.80	18.40	18.80	20.20
	5.00		5	0.890	0.000	19.90	19.60	18.60	18.40	18.80	18.40	18.80	20.20
	6.00		6	3.450	2.790	19.90	19.60	18.60	18.40	18.80	18.40	18.80	20.20
	7.00		7	2.790	0.000	19.90	19.60	18.60	18.40	18.80	18.40	18.80	20.20

8:00 AM	9:00 AM	10:00 AM	11:00 AM	12:00 PM	1:00 PM	2:00 PM	3:00 PM	4:00 PM	5:00 PM	6:00 PM	7:00 PM	8:00 PM	9:00 PM	10:00 PM	11:00 PM
nate values between the hourly inputs.)															
20.60	21.40	21.30	21.60	21.90	22.30	22.60	23.10	22.90	22.70	22.60	22.00	21.00	20.80	20.30	20.00
20.60	21.40	21.30	21.60	21.90	22.30	22.60	23.10	22.90	22.70	22.60	22.00	21.00	20.80	20.30	20.00
20.60	21.40	21.30	21.60	21.90	22.30	22.60	23.10	22.90	22.70	22.60	22.00	21.00	20.80	20.30	20.00
20.60	21.40	21.30	21.60	21.90	22.30	22.60	23.10	22.90	22.70	22.60	22.00	21.00	20.80	20.30	20.00
20.60	21.40	21.30	21.60	21.90	22.30	22.60	23.10	22.90	22.70	22.60	22.00	21.00	20.80	20.30	20.00
20.60	21.40	21.30	21.60	21.90	22.30	22.60	23.10	22.90	22.70	22.60	22.00	21.00	20.80	20.30	20.00
20.60	21.40	21.30	21.60	21.90	22.30	22.60	23.10	22.90	22.70	22.60	22.00	21.00	20.80	20.30	20.00

Manning Formula					Prescribed	Bottom	Bottom	Prescribed	Prescribed	Prescribed	Prescribed
Channel	Manning	Bot Width	Side	Side	Dispersion	Algae	SOD	SOD	CH4 flux	NH4 flux	Inorg P flux
Slope	n	m	Slope	Slope	m2/s	Coverage	Coverage	gO2/m2/d	gO2/m2/d	mgN/m2/d	mgP/m2/d
0.0030	0.0300	4.00	0.0000	0.0000	0.00	0.00%	75.00%	1.00	0.0000	0.0000	0.0000
0.0010	0.0300	5.00	0.0000	0.0000	0.00	0.00%	75.00%	1.00	0.0000	0.0000	0.0000
0.0030	0.0300	3.00	0.0000	0.0000	0.00	0.00%	75.00%	1.00	0.0000	0.0000	0.0000
0.0020	0.0120	5.00	0.5000	0.5000	0.00	0.00%	75.00%	1.00	0.0000	0.0000	0.0000
0.0010	0.0120	9.00	0.5000	0.5000	0.00	0.00%	75.00%	1.00	0.0000	0.0000	0.0000
0.0010	0.0120	10.00	0.5000	0.5000		0.00%	75.00%	1.00			
0.0010	0.0120	10.00	0.5000	0.5000		0.00%	75.00%	1.00			

									3:00 AM	4:00 AM	5:00 AM	6:00 AM	7:00 AM
									reach (degrees C)				
									estimates at each time. Linear interpolation is used to estin				
									13.50	15.10	15.50	14.50	13.60
									13.50	15.10	15.50	14.50	13.60
									13.50	15.10	15.50	14.50	13.60
									13.50	15.10	15.50	14.50	13.60
	5.00		5	0.890	0.000	12.70	11.80	11.80	13.50	15.10	15.50	14.50	13.60
	6.00		6	3.450	2.790	12.70	11.80	11.80	13.50	15.10	15.50	14.50	13.60
	7.00		7	2.790	0.000	12.70	11.80	11.80	13.50	15.10	15.50	14.50	13.60

8:00 AM	9:00 AM	10:00 AM	11:00 AM	12:00 PM	1:00 PM	2:00 PM	3:00 PM	4:00 PM	5:00 PM	6:00 PM	7:00 PM	8:00 PM	9:00 PM	10:00 PM	11:00 PM
nate values between the hourly inputs.)															
11.00	11.40	11.10	10.10	9.80	9.50	10.70	10.50	10.40	10.40	8.70	9.20	10.50	9.10	10.20	9.90
11.00	11.40	11.10	10.10	9.80	9.50	10.70	10.50	10.40	10.40	8.70	9.20	10.50	9.10	10.20	9.90
11.00	11.40	11.10	10.10	9.80	9.50	10.70	10.50	10.40	10.40	8.70	9.20	10.50	9.10	10.20	9.90
11.00	11.40	11.10	10.10	9.80	9.50	10.70	10.50	10.40	10.40	8.70	9.20	10.50	9.10	10.20	9.90
11.00	11.40	11.10	10.10	9.80	9.50	10.70	10.50	10.40	10.40	8.70	9.20	10.50	9.10	10.20	9.90
11.00	11.40	11.10	10.10	9.80	9.50	10.70	10.50	10.40	10.40	8.70	9.20	10.50	9.10	10.20	9.90
11.00	11.40	11.10	10.10	9.80	9.50	10.70	10.50	10.40	10.40	8.70	9.20	10.50	9.10	10.20	9.90

				Upstream	Downstream	12:00 AM	1:00 AM	2:00 AM	3:00 AM	4:00 AM	5:00 AM	6:00 AM	7:00 AM
Upstream	Reach	Downstream	Reach	Distance	Distance	Wind speed for each reach 7m above water surface (m/s)							
Label	Label	Label	Number	km	km	(The input values are applied as point estimates at each time. Linear interpolation is used to estim							
Mainstem headwater	1.00	Headwaters	1	7.220	4.400	0.80	1.20	0.40	2.00	2.40	1.60	0.40	0.80
Headwaters	2.00		2	4.400	3.450	0.80	1.20	0.40	2.00	2.40	1.60	0.40	0.80
UT1	3.00	UT1	3	2.630	1.760	0.80	1.20	0.40	2.00	2.40	1.60	0.40	0.80
UT1	4.00		4	1.760	0.890	0.80	1.20	0.40	2.00	2.40	1.60	0.40	0.80
	5.00		5	0.890	0.000	0.80	1.20	0.40	2.00	2.40	1.60	0.40	0.80
	6.00		6	3.450	2.790	0.80	1.20	0.40	2.00	2.40	1.60	0.40	0.80
	7.00		7	2.790	0.000	0.80	1.20	0.40	2.00	2.40	1.60	0.40	0.80

8:00 AM	9:00 AM	10:00 AM	11:00 AM	12:00 PM	1:00 PM	2:00 PM	3:00 PM	4:00 PM	5:00 PM	6:00 PM	7:00 PM	8:00 PM	9:00 PM	10:00 PM	11:00 PM
nate values between the hourly inputs.)															
1.20	1.60	1.20	1.20	1.20	1.60	1.20	1.60	1.20	1.20	1.20	0.80	0.40	0.40	0.40	0.00
1.20	1.60	1.20	1.20	1.20	1.60	1.20	1.60	1.20	1.20	1.20	0.80	0.40	0.40	0.40	0.00
1.20	1.60	1.20	1.20	1.20	1.60	1.20	1.60	1.20	1.20	1.20	0.80	0.40	0.40	0.40	0.00
1.20	1.60	1.20	1.20	1.20	1.60	1.20	1.60	1.20	1.20	1.20	0.80	0.40	0.40	0.40	0.00
1.20	1.60	1.20	1.20	1.20	1.60	1.20	1.60	1.20	1.20	1.20	0.80	0.40	0.40	0.40	0.00
1.20	1.60	1.20	1.20	1.20	1.60	1.20	1.60	1.20	1.20	1.20	0.80	0.40	0.40	0.40	0.00
1.20	1.60	1.20	1.20	1.20	1.60	1.20	1.60	1.20	1.20	1.20	0.80	0.40	0.40	0.40	0.00

			Upstream	Downstream	12:00 AM	1:00 AM	2:00 AM	3:00 AM	4:00 AM	5:00 AM	6:00 AM	7:00 AM
Reach	Downstream	Reach	Distance	Distance	Hourly cloud cover shade for each reach (Percent)							
Label	Label	Number	km	km	(Percent of sky that is covered by clouds. The input values are applied as point estimates at each							
1.00	Headwaters	1	7.220	4.400	0.0%	70.0%	50.0%	50.0%	30.0%	50.0%	50.0%	50.0%
2.00		2	4.400	3.450	0.0%	70.0%	50.0%	50.0%	30.0%	50.0%	50.0%	50.0%
3.00	UT1	3	2.630	1.760	0.0%	70.0%	50.0%	50.0%	30.0%	50.0%	50.0%	50.0%
4.00		4	1.760	0.890	0.0%	70.0%	50.0%	50.0%	30.0%	50.0%	50.0%	50.0%
5.00		5	0.890	0.000	0.0%	70.0%	50.0%	50.0%	30.0%	50.0%	50.0%	50.0%
6.00		6	3.450	2.790	0.0%	70.0%	50.0%	50.0%	30.0%	50.0%	50.0%	50.0%
7.00		7	2.790	0.000	0.0%	70.0%	50.0%	50.0%	30.0%	50.0%	50.0%	50.0%

8:00 AM	9:00 AM	10:00 AM	11:00 AM	12:00 PM	1:00 PM	2:00 PM	3:00 PM	4:00 PM	5:00 PM	6:00 PM	7:00 PM	8:00 PM	9:00 PM	10:00 PM	11:00 PM
time. Linear interpolation is used to estimate values between the hourly inputs.)															
30.0%	0.0%	50.0%	50.0%	50.0%	30.0%	50.0%	30.0%	30.0%	30.0%	30.0%	30.0%	30.0%	30.0%	30.0%	30.0%
30.0%	0.0%	50.0%	50.0%	50.0%	30.0%	50.0%	30.0%	30.0%	30.0%	30.0%	30.0%	30.0%	30.0%	30.0%	30.0%
30.0%	0.0%	50.0%	50.0%	50.0%	30.0%	50.0%	30.0%	30.0%	30.0%	30.0%	30.0%	30.0%	30.0%	30.0%	30.0%
30.0%	0.0%	50.0%	50.0%	50.0%	30.0%	50.0%	30.0%	30.0%	30.0%	30.0%	30.0%	30.0%	30.0%	30.0%	30.0%
30.0%	0.0%	50.0%	50.0%	50.0%	30.0%	50.0%	30.0%	30.0%	30.0%	30.0%	30.0%	30.0%	30.0%	30.0%	30.0%
30.0%	0.0%	50.0%	50.0%	50.0%	30.0%	50.0%	30.0%	30.0%	30.0%	30.0%	30.0%	30.0%	30.0%	30.0%	30.0%
30.0%	0.0%	50.0%	50.0%	50.0%	30.0%	50.0%	30.0%	30.0%	30.0%	30.0%	30.0%	30.0%	30.0%	30.0%	30.0%

				Upstream	Downstream	12:00 AM	1:00 AM	2:00 AM	3:00 AM	4:00 AM	5:00 AM	6:00 AM	7:00 AM	8:00 AM	9:00 AM	10:00 AM	11:00 AM	12:00 PM	1:00 PM	2:00 PM	3:00 PM	4:00 PM	5:00 PM	6:00 PM	7:00 PM	8:00 PM	9:00 PM	10:00 PM	11:00 PM
Upstream	Reach	Downstream	Reach	Distance	Distance	Integrated hourly effective shade for each reach (Percent)																							
Label	Label	Label	Number	km	km	(Percent of solar radiation that is blocked because of shade from topography and vegetation. Hourly values are applied as integrated values for each hour, e.g. the value at 12:00 AM is applied from 12:00 to 1:00 AM)																							
Mainstem headwater	1.00	Headwaters	1	7.220	4.400	100.0%	100.0%	100.0%	100.0%	100.0%	100.0%	90.0%	90.0%	90.0%	90.0%	90.0%	90.0%	90.0%	90.0%	90.0%	90.0%	90.0%	90.0%	90.0%	100.0%	100.0%	100.0%	100.0%	100.0%
Headwaters	2.00		2	4.400	3.450	100.0%	100.0%	100.0%	100.0%	100.0%	100.0%	80.0%	80.0%	80.0%	80.0%	80.0%	80.0%	80.0%	80.0%	80.0%	80.0%	80.0%	80.0%	80.0%	100.0%	100.0%	100.0%	100.0%	100.0%
UT1	3.00	UT1	3	2.630	1.760	100.0%	100.0%	100.0%	100.0%	100.0%	100.0%	60.0%	60.0%	60.0%	60.0%	60.0%	60.0%	60.0%	60.0%	60.0%	60.0%	60.0%	60.0%	60.0%	100.0%	100.0%	100.0%	100.0%	100.0%
UT1	4.00	UT1	4	1.760	0.890	100.0%	100.0%	100.0%	100.0%	100.0%	100.0%	30.0%	30.0%	30.0%	30.0%	30.0%	30.0%	30.0%	30.0%	30.0%	30.0%	30.0%	30.0%	30.0%	100.0%	100.0%	100.0%	100.0%	100.0%
UT1	5.00	UT1	5	0.890	0.000	100.0%	100.0%	100.0%	100.0%	100.0%	100.0%	60.0%	60.0%	60.0%	60.0%	60.0%	60.0%	60.0%	60.0%	60.0%	60.0%	60.0%	60.0%	60.0%	100.0%	100.0%	100.0%	100.0%	100.0%
UT1	6.00		6	3.450	2.790	100.0%	100.0%	100.0%	100.0%	100.0%	100.0%	30.0%	30.0%	30.0%	30.0%	30.0%	30.0%	30.0%	30.0%	30.0%	30.0%	30.0%	30.0%	30.0%	100.0%	100.0%	100.0%	100.0%	100.0%
	7.00		7	2.790	0.000	100.0%	100.0%	100.0%	100.0%	100.0%	100.0%	30.0%	30.0%	30.0%	30.0%	30.0%	30.0%	30.0%	30.0%	30.0%	30.0%	30.0%	30.0%	30.0%	100.0%	100.0%	100.0%	100.0%	100.0%

QUAL2K

Stream Water Quality Model

Higgins Creek (7/5/2006)

Water Column Rates

Parameter	*Value*	*Units*	*Symbol*
Stoichiometry:			
Carbon	40	gC	gC
Nitrogen	7.2	gN	gN
Phosphorus	1	gP	gP
Dry weight	100	gD	gD
Chlorophyll	1	gA	gA
Inorganic suspended solids:			
Settling velocity	1.304	m/d	v_i
Oxygen:			
Reaeration model	O'Connor-Dobbins		
User reaeration coefficient α	0		α
User reaeration coefficient β	0		β
User reaeration coefficient γ	0		γ
Temp correction	1.45		θ_a
Reaeration wind effect	None		
O2 for carbon oxidation	2.69	gO_2/gC	r_{oc}
O2 for NH4 nitrification	4.57	gO_2/gN	r_{on}
Oxygen inhib model CBOD oxidation	Exponential		
Oxygen inhib parameter CBOD oxidation	0.60	L/mgO2	K_{socf}
Oxygen inhib model nitrification	Exponential		
Oxygen inhib parameter nitrification	0.60	L/mgO2	K_{sona}
Oxygen enhance model denitrification	Exponential		
Oxygen enhance parameter denitrification	0.60	L/mgO2	K_{sodn}
Oxygen inhib model phyto resp	Exponential		
Oxygen inhib parameter phyto resp	0.60	L/mgO2	K_{sop}
Oxygen enhance model bot alg resp	Exponential		
Oxygen enhance parameter bot alg resp	0.60	L/mgO2	K_{sob}
Slow CBOD:			
Hydrolysis rate	0.6	/d	k_{hc}
Temp correction	1.047		θ_{hc}
Oxidation rate	4.5	/d	k_{dcs}
Temp correction	1.047		θ_{dcs}
Fast CBOD:			
Oxidation rate	3	/d	k_{dc}
Temp correction	1.047		θ_{dc}

Death rate	0	/d	k_{dp}
Temp correction	1		θ_{dp}
External Nitrogen half sat constant	15	ugN/L	k_{sPp}
External Phosphorus half sat constant	2	ugP/L	k_{sNp}
Inorganic carbon half sat constant	2.00E-05	moles/L	k_{sCp}
Light model	Half saturation		
Light constant	57.6	langleys/d	K_{Lp}
Ammonia preference	25	ugN/L	k_{hnxp}
Subsistence quota for nitrogen	0	mgN/mgA	q_{0Np}
Subsistence quota for phosphorus	0	mgP/mgA	q_{0Pp}
Maximum uptake rate for nitrogen	0	mgN/mgA/d	ρ_{mNp}
Maximum uptake rate for phosphorus	0	mgP/mgA/d	ρ_{mPp}
Internal nitrogen half sat constant	0	mgN/mgA	K_{qNp}
Internal phosphorus half sat constant	0	mgP/mgA	K_{qPp}
Settling velocity	0.15	m/d	v_a
Bottom Algae:			
Growth model	Zero-order		
Max Growth rate	999.991	$mgA/m^2/d$ or /d	C_{gb}
Temp correction	1.07		θ_{gb}
First-order model carrying capacity	1000	mgA/m^2	$a_{b,max}$
Respiration rate	1	/d	k_{rb}
Temp correction	1.07		θ_{rb}
Excretion rate	0.5	/d	k_{eb}
Temp correction	1.05		θ_{db}
Death rate	0.09	/d	k_{db}
Temp correction	1.07		θ_{db}
External nitrogen half sat constant	0.052	ugN/L	k_{sPb}
External phosphorus half sat constant	96.379	ugP/L	k_{sNb}
Inorganic carbon half sat constant	1.00E-05	moles/L	k_{sCb}
Light model	Half saturation		
Light constant	76.319	langleys/d	K_{Lb}
Ammonia preference	99.982	ugN/L	k_{hnxb}
Subsistence quota for nitrogen	2.524	mgN/mgA	q_{0N}
Subsistence quota for phosphorus	0.002	mgP/mgA	q_{0P}
Maximum uptake rate for nitrogen	149.913	mgN/mgA/d	ρ_{mN}
Maximum uptake rate for phosphorus	5.009	mgP/mgA/d	ρ_{mP}
Internal nitrogen half sat constant	0.384	mgN/mgA	K_{qN}
Internal phosphorus half sat constant	0.102	mgP/mgA	K_{qP}
Detritus (POM):			
Dissolution rate	7.179	/d	k_{dt}
Temp correction	1.07		θ_{dt}
Fraction of dissolution to fast CBOD	1.00		F_f
Settling velocity	0.236	m/d	v_{dt}
Pathogens:			
Decay rate	0.8	/d	k_{dx}
Temp correction	1.07		θ_{dx}
Settling velocity	1	m/d	v_x
Light efficiency factor	1.00		α_{path}
pH:			
Partial pressure of carbon dioxide	347	ppm	p_{CO2}
Constituent i			
First-order reaction rate	0	/d	
Temp correction	1		θ_{dx}
Settling velocity	0	m/d	v_{dt}
Constituent ii			
First-order reaction rate	0	/d	
Temp correction	1		θ_{dx}
Settling velocity	0	m/d	v_{dt}
Constituent iii			
First-order reaction rate	0	/d	
Temp correction	1		θ_{dx}
Settling velocity	0	m/d	v_{dt}

QUAL2K

Stream Water Quality Model

Higgins Creek (7/5/2006)

Light Parameters and Surface Heat Transfer Models:

Parameter	*Value*	*Unit*	
Photosynthetically Available Radiation	**0.47**		
Background light extinction	**0.2**	*/m*	k_{eb}
Linear chlorophyll light extinction	**0.0088**	*1/m-(ugA/L)*	α_p
Nonlinear chlorophyll light extinction	**0.054**	*1/m-(ugA/L)2/3*	α_{pn}
ISS light extinction	**0.052**	*1/m-(mgD/L)*	α_i
Detritus light extinction	**0.174**	*1/m-(mgD/L)*	α_o
Solar shortwave radiation model			
Atmospheric attenuation model for solar	**Ryan-Stolzenbach**		
Bras solar parameter (used if Bras solar model is selected)			
atmospheric turbidity coefficient (2=clear, 5=smoggy, default=2)	**2**		n_{fac}
Ryan-Stolzenbach solar parameter (used if Ryan-Stolzenbach solar model is selected)			
atmospheric transmission coefficient (0.70-0.91, default 0.8)	**0.75**		a_{tc}
Downwelling atmospheric longwave IR radiation			
atmospheric longwave emissivity model	**Brunt**		
Evaporation and air convection/conduction			
wind speed function for evaporation and air convection/conduction	**Brady-Graves-Geyer**		
Sediment heat parameters			
Sediment thermal thickness	**10**	*cm*	H_s
Sediment thermal diffusivity	**0.005**	*cm^2/s*	α_s
Sediment density	**1.6**	*g/cm^3*	ρ_s
Water density	**1**	*g/cm^3*	ρ_w
Sediment heat capacity	**0.4**	*cal/(g ^oC)*	C_{ps}
Water heat capacity	**1**	*cal/(g ^oC)*	C_{pw}
Sediment diagenesis model			
Compute SOD and nutrient fluxes	**Yes**		

	Tributary	Headwater	Location		Diffuse	Diffuse		Spec	Inorg	Diss	CBOD	CBOD
			Up	Down	Abstraction	Inflow	Temp	Cond	SS	Oxygen	slow	fast
Name	No.*	Label	km	km	m3/s	m3/s	C	umhos	mgD/L	mg/L	mgO2/L	mgO2/L
Incremental flow	0	Mainstem headwater	7.220	4.400		0.0111	26.00			5.00		10.00
	0	Mainstem headwater	4.440	3.450		0.0111	26.00			5.00		10.00
	1	UT1	2.630	1.760		0.0132	26.00			5.00		10.00
	1	UT1	1.760	0.890		0.0132	26.00			5.00		10.00
	1	UT1	0.890	0.000		0.0132	26.00			5.00		10.00
	0	Mainstem headwater	3.450	2.790		0.0125	26.00			5.00		10.00
	0	Mainstem headwater	2.790	0.000		0.0125	26.00			5.00		10.00

Organic	Ammon	Nitrate	Organic	Inorganic	Phyto	Internal	Internal				Constituent	Constituent	Constituent	
N	N	N	P	P	plankton	Nitrogen	Phosphorus	Detritus	Pathogen	Alk	i	ii	iii	pH
ugN/L	ugN/L	ugN/L	ugP/L	ugP/L	ug/L	ugN/L	ugP/L	mgD/L	cfu/100 m	mgCaCO3/L				
1200.00	300.00	100.00	100.00	100.00						120.00				7.00
1200.00	300.00	100.00	100.00	100.00						120.00				7.00
1200.00	250.00	200.00	150.00	100.00						120.00				7.00
1200.00	250.00	200.00	150.00	100.00						120.00				7.00
1200.00	250.00	200.00	150.00	100.00						120.00				7.00
1500.00	600.00	300.00	400.00	100.00						120.00				7.00
1500.00	600.00	300.00	400.00	100.00						120.00				7.00

	Tributary	Headwater	Location	Point		Temperature		
				Abstraction	Inflow	mean	range/2	time of
Name	No.	Label	km	m3/s	m3/s	°C	°C	max
Oil terminals (62791,42242,66362,25461, 4673	1	UT1	1.25		0.0005	25.00		
IL0047741	0	Mainstem headwater	2.79		1.1400	25.00		
oil terminals airport (34347)	0	Mainstem headwater	0.50		0.0189	25.00		
IL0054160	0	Mainstem headwater	0.50		0.0012	25.00		

Specific Conductance			Inorganic Suspended Solids			Dissolved Oxygen			Slow CBOD			Fast CBOD		
mean	range/2	time of	mean	range/2	time of	mean	range/2	time of	mean	range/2	time of	mean	range/2	time of
umhos	umhos	max	mg/L	mg/L	max	mg/L	mg/L	max	mgO2/L	mgO2/L	max	mgO2/L	mgO2/L	max
						5.00						5.00		
						8.20						2.00		
						5.00						2.00		
						6.00						3.00		

Organic N			Ammonia N			Nitrate + Nitrite N			Organic P		
mean	range/2	time of	mean	range/2	time of	mean	range/2	time of	mean	range/2	time of
ugN/L	ugN/L	max	ugN/L	ugN/L	max	ugN/L	ugN/L	max	ugP/L	ugP/L	max
50.00			100.00			50.00			100.00		
1300.00			370.00			4000.00			300.00		
100.00			500.00			100.00			100.00		
500.00			210.00			300.00			100.00		

Appendix H

Lake Loading Response Model

Albert Lake LLRM

EXPORT MODEL INPUT AND CALCULATIONS

STD. WATER YIELD (CFS/SQ.MI)	1.6
PRECIPITATION (in M)	1.24

COEFFICIENTS

			RUNOFF EXPORT COEFF.			BASEFLOW EXPORT COEFF.		
LAND USE	Runoff Coefficient (Fraction)	Baseflow Coefficient (Fraction)	P Export Coefficient (kg/ha/yr)	N Export Coefficient (kg/ha/yr)	TSS Export Coefficient (kg/ha/yr)	P Export Coefficient (kg/ha/yr)	N Export Coefficient (kg/ha/yr)	TSS Export Coefficient (kg/ha/yr)
Urban 1 (LDR)	0.40	0.25	1.91	5.50	93	0.050	7.50	0.3
Urban 2 (MDR/Hwy)	0.50	0.15	1.91	9.97	93	0.050	15.00	0.3
Urban 3 (HDR/Com)	0.60	0.05	4.60	9.97	93	0.050	30.00	0.3
Urban 4 (Ind)	0.60	0.05	1.91	5.50	93	0.050	7.50	0.3
Urban 5 (P/I/R/C)	0.40	0.25	1.91	5.50	93	0.050	7.50	0.3
Agric 1 (Cvr Crop)	0.15	0.30	2.00	6.08	100	0.050	2.50	0.3
Agric 2 (Row Crop)	0.30	0.30	5.00	9.00	250	0.050	2.50	0.3
Agric 3 (Grazing)	0.30	0.30	1.50	5.19	100	0.050	5.00	0.3
Agric 4 (Feedlot)	0.45	0.30	300.70	2923.20	15000	0.050	25.00	0.3
Forest 1 (Upland)	0.30	0.40	0.24	2.46	16	0.050	0.50	0.3
Forest 2 (Wetland)	0.05	0.40	0.24	2.46	16	0.050	0.50	0.3
Open 1 (Wetland/Lake)	0.05	0.40	0.24	2.46	16	0.050	0.50	0.3
Open 2 (Meadow)	0.15	0.30	0.24	2.46	16	0.050	0.50	0.3
Open 3 (Excavation)	0.40	0.20	1.50	5.19	1000	0.050	0.50	0.3
Other 1	0.10	0.40	0.24	2.46	16	0.050	0.50	0.3
Other 2	0.35	0.25	1.91	5.50	93	0.050	5.00	0.3
Other 3	0.60	0.05	4.46	9.00	250	0.050	20.00	0.3

Albert Lake LLRM

OTHER AREAL SOURCES	Affected Lake Area (ha)	P Export Coefficient (kg/ha/yr)	N Export Coefficient (kg/ha/yr)	TSS Export Coefficient (kg/ha/yr)
Atmospheric Deposition				
from Forested Area	0	0.20	6.52	32.0
from Agricultural/Rural Area	0	0.30	13.13	66.0
from Urban/Industrial Area	7.57	2.50	21.36	107.0
Internal Loading	7.57	10.00	5.00	1.0

NON-AREAL SOURCES	Number of Source Units	Volume (cu.m/yr)	P Load (kg/unit/yr)	N Load (kg/unit/yr)	TSS Load (kg/unit/yr)	P Load (ppm)	N Load (ppm)	TSS Load (ppm)		
Waterfowl	100		0.20	0.95	5					
Point Sources										
PS-1		0				0.00	0.00	0.0		
PS-2		0				0.00	0.00	0.0		
PS-3		0				0.00	0.00	0.0		
Basin in which Point Source occurs (0=NO 1=YES)										
	BASIN 1	BASIN 2	BASIN 3	BASIN 4	BASIN 5	BASIN 6	BASIN 7	BASIN 8	BASIN 9	BASIN 10
PS-1	0	0	0	0	0	0	0	0	0	0
PS-2	0	0	0	0	0	0	0	0	0	0
PS-3	0	0	0	0	0	0	0	0	0	0

SEPTIC SYSTEM LOAD	Number of Dwellings	Number of People/ Dwelling	Atten Factor Phos	Mean TP Conc (mg/L)	P Load (kg/person/ yr)	P Load kg/yr		Water Gallons/Person/Day	Number of Days	Water Load cu.m/yr
Septic System										
Year Round Septic Systems (125' zone	0	2.5	0.1	8	0.72	0.00		65	365	0.00
Seasonal Septic Systems (125' zone)	0	2.5	0.1	8	0.18	0.00		65	90	0.00
Total Septic System Loading						**0.00**				**0.00**

Albert Lake LLRM

BASIN AREAS										
LAND USE	BASIN 1 AREA (HA)	BASIN 2 AREA (HA)	BASIN 3 AREA (HA)	BASIN 4 AREA (HA)	BASIN 5 AREA (HA)	BASIN 6 AREA (HA)	BASIN 7 AREA (HA)	BASIN 8 AREA (HA)	BASIN 9 AREA (HA)	BASIN 10 AREA (HA)
Urban 1 (LDR)										
Urban 2 (MDR/Hwy)										
Urban 3 (HDR/Com)	19.57	387.43								
Urban 4 (Ind)	5.72									
Urban 5 (P/I/R/C)										
Agric 1 (Cvr Crop)	0.41	0.41								
Agric 2 (Row Crop)	0.11									
Agric 3 (Grazing)		16.2								
Agric 4 (Feedlot)										
Forest 1 (Upland)										
Forest 2 (Wetland)	3.17	9.88								
Open 1 (Wetland/Lake)	2.58	6.84								
Open 2 (Meadow)	25.75	48.07								
Open 3 (Excavation)										
Other 1										
Other 2										
Other 3										

Albert Lake LLRM

ROUTING PATTERN (Which basin flows to which)										
					PASSES THROUGH...					
1=YES 0=NO XXX=BLANK	BASIN 1	BASIN 2	BASIN 3	BASIN 4	BASIN 5	BASIN 6	BASIN 7	BASIN 8	BASIN 9	BASIN 10
	(CU.M/YR)	(CU.M/YR)	(CU.M/YR)	(CU.M/YR)	(CU.M/YR)	(CU.M/YR)	(CU.M/YR)	(CU.M/YR)	(CU.M/YR)	(CU.M/YR)
INDIVIDUAL BASIN	1	1	1	1	1	1	1	1	1	1
BASIN 1 OUTPUT	XXX	0	0	0	0	0	0	0	0	0
BASIN 2 OUTPUT	0	XXX	0	0	0	0	0	0	0	0
BASIN 3 OUTPUT	0	0	XXX	0	0	0	0	0	0	0
BASIN 4 OUTPUT	0	0	0	XXX	0	0	0	0	0	0
BASIN 5 OUTPUT	0	0	0	0	XXX	0	0	0	0	0
BASIN 6 OUTPUT	0	0	0	0	0	XXX	0	0	0	0
BASIN 7 OUTPUT	0	0	0	0	0	0	XXX	0	0	0
BASIN 8 OUTPUT	0	0	0	0	0	0	0	XXX	0	0
BASIN 9 OUTPUT	0	0	0	0	0	0	0	0	XXX	0
BASIN 10 OUTPUT	0	0	0	0	0	0	0	0	0	XXX

WATER ROUTING AND ATTENUATION										
	BASIN 1	BASIN 2	BASIN 3	BASIN 4	BASIN 5	BASIN 6	BASIN 7	BASIN 8	BASIN 9	BASIN 10
SOURCE	(CU.M/YR)	(CU.M/YR)	(CU.M/YR)	(CU.M/YR)	(CU.M/YR)	(CU.M/YR)	(CU.M/YR)	(CU.M/YR)	(CU.M/YR)	(CU.M/YR)
INDIVIDUAL BASIN	382713.6	3607029.8	0	0	0	0	0	0	0	0
BASIN 1 OUTPUT	XXX	0	0	0	0	0	0	0	0	0
BASIN 2 OUTPUT	0	XXX	0	0	0	0	0	0	0	0
BASIN 3 OUTPUT	0	0	XXX	0	0	0	0	0	0	0
BASIN 4 OUTPUT	0	0	0	XXX	0	0	0	0	0	0
BASIN 5 OUTPUT	0	0	0	0	XXX	0	0	0	0	0
BASIN 6 OUTPUT	0	0	0	0	0	XXX	0	0	0	0
BASIN 7 OUTPUT	0	0	0	0	0	0	XXX	0	0	0
BASIN 8 OUTPUT	0	0	0	0	0	0	0	XXX	0	0
BASIN 9 OUTPUT	0	0	0	0	0	0	0	0	XXX	0
BASIN 10 OUTPUT	0	0	0	0	0	0	0	0	0	XXX
CUMULATIVE TOTAL	382713.6	3607029.8	0.0	0.0	0.0	0.0	0	0	0	0
BASIN ATTENUATION	0.90	0.90	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00
OUTPUT VOLUME	344442.2	3246326.8	0.0	0.0	0.0	0.0	0	0	0	0

Albert Lake LLRM

LOAD ROUTING AND ATTENUATION: PHOSPHORUS		
	BASIN 1	BASIN 2
	(KG/YR)	(KG/YR)
BASIN 1 INDIVIDUAL	112.7	1846.3
BASIN 1 OUTPUT	XXX	0.0
BASIN 2 OUTPUT	0.0	XXX
BASIN 3 OUTPUT	0.0	0.0
BASIN 4 OUTPUT	0.0	0.0
BASIN 5 OUTPUT	0.0	0.0
BASIN 6 OUTPUT	0.0	0.0
BASIN 7 OUTPUT	0.0	0.0
BASIN 8 OUTPUT	0.0	0.0
BASIN 9 OUTPUT	0.0	0.0
BASIN 10 OUTPUT	0.0	0.0
CUMULATIVE TOTAL	112.7	1846.3
BASIN ATTENUATION	0.90	0.90
OUTPUT LOAD	101.5	1661.7

LOAD AND CONCENTRATION SUMMARY: PHOSPHORUS		
	BASIN 1	BASIN 2
OUTPUT (CU.M/YR)	344442	3246327
OUTPUT (KG/YR)	101.5	1661.7
OUTPUT (MG/L)	0.295	0.512
REALITY CHECK CONC.		
(Based on real data)		
TERMINAL DISCHARGE?	1	1
(1=YES 2=NO)		
LOAD TO RESOURCE		
WATER (CU.M/YR)	344442	3246327
PHOSPHORUS (KG/YR)	101.5	1661.7
PHOSPHORUS (MG/L)	0.295	0.512
BASIN EXPORT COEFFICIENT	1.77	3.54

DIRECT LOADS TO LAKE	P	N
ATMOSPHERIC (KG/YR)	18.9	161.7
INTERNAL (KG/YR)	75.7	37.9
WATERFOWL (KG/YR)	20.0	95.0
SEPTIC SYSTEM (KG/YR)	0.0	
WATERSHED LOAD (KG/YR)	1763.1	15120.5
TOTAL LOAD TO LAKE (KG/YR)	1877.8	15415.0
(Watershed + direct loads)		
TOTAL INPUT CONC. (MG/L)	0.510	4.184

Albert Lake LLRM

THE MODELS				
	PHOSPHORUS	**PRED.**	**PERMIS.**	**CRITICAL**
		CONC.	**CONC.**	**CONC.**
NAME	**FORMULA**	**(ppb)**	**(ppb)**	**(ppb)**
Mass Balance	TP=L/(Z(F))*1000	510		
(Maximum Conc.)				
Kirchner-Dillon 1975	TP=L(1-Rp)/(Z(F))*1000	449	13	25
(K-D)				
Vollenweider 1975	TP=L/(Z(S+F))*1000	510	14	29
(V)				
Larsen-Mercier 1976	TP=L(1-Rlm)/(Z(F))*1000	472	13	27
(L-M)				
Jones-Bachmann 1976	TP=0.84(L)/(Z(0.65+F))*1000	426	12	24
(J-B)				
Reckhow General (1977)	TP=L/(11.6+1.2(Z(F)))*1000	354	10	20
(Rg)				
Average of Model Values		442	12	25
(without mass balance)				

Beck Lake LLRM

EXPORT MODEL INPUT AND CALCULATIONS

STD. WATER YIELD (CFS/SQ.MI)	1.5
PRECIPITATION (in M)	1.03

COEFFICIENTS			RUNOFF EXPORT COEFF.			BASEFLOW EXPORT COEFF.		
LAND USE	Runoff Coefficient (Fraction)	Baseflow Coefficient (Fraction)	P Export Coefficient (kg/ha/yr)	N Export Coefficient (kg/ha/yr)	TSS Export Coefficient (kg/ha/yr)	P Export Coefficient (kg/ha/yr)	N Export Coefficient (kg/ha/yr)	TSS Export Coefficient (kg/ha/yr)
Urban 1 (LDR)	0.40	0.25	1.10	5.50	93	0.050	7.50	0.3
Urban 2 (MDR/Hwy)	0.50	0.15	0.70	9.97	93	0.050	15.00	0.3
Urban 3 (HDR/Com)	0.60	0.05	0.70	9.97	93	0.050	30.00	0.3
Urban 4 (Ind)	0.60	0.05	0.70	5.50	93	0.050	7.50	0.3
Urban 5 (P/I/R/C)	0.40	0.25	1.10	5.50	93	0.050	7.50	0.3
Agric 1 (Cvr Crop)	0.15	0.30	1.00	6.08	100	0.050	2.50	0.3
Agric 2 (Row Crop)	0.30	0.30	1.00	9.00	250	0.050	2.50	0.3
Agric 3 (Grazing)	0.30	0.30	0.40	5.19	100	0.050	5.00	0.3
Agric 4 (Feedlot)	0.45	0.30	224.00	2923.20	15000	0.050	25.00	0.3
Forest 1 (Upland)	0.30	0.40	0.05	2.46	16	0.050	0.50	0.3
Forest 2 (Wetland)	0.05	0.40	0.05	2.46	16	0.050	0.50	0.3
Open 1 (Wetland/Lake)	0.05	0.40	0.20	2.46	16	0.050	0.50	0.3
Open 2 (Meadow)	0.15	0.30	0.20	2.46	16	0.050	0.50	0.3
Open 3 (Excavation)	0.40	0.20	0.80	5.19	1000	0.050	0.50	0.3
Other 1	0.10	0.40	0.20	2.46	16	0.050	0.50	0.3
Other 2	0.35	0.25	1.10	5.50	93	0.050	5.00	0.3
Other 3	0.60	0.05	2.20	9.00	250	0.050	20.00	0.3

Beck Lake LLRM

OTHER AREAL SOURCES				
	Affected Lake Area (ha)	P Export Coefficient (kg/ha/yr)	N Export Coefficient (kg/ha/yr)	TSS Export Coefficient (kg/ha/yr)
Atmospheric Deposition				
from Forested Area	6	0.20	6.52	32.0
from Agricultural/Rural Area	0	0.30	13.13	66.0
from Urban/Industrial Area	0	1.00	21.36	107.0
Internal Loading	3.4	2.00	5.00	1.0

NON-AREAL SOURCES										
	Number of Source Units	Volume (cu.m/yr)	P Load (kg/unit/yr)	N Load (kg/unit/yr)	TSS Load (kg/unit/yr)	P Load (ppm)	N Load (ppm)	TSS Load (ppm)		
Waterfowl	20		0.20	0.95	5					
Point Sources										
PS-1		0				0.00	0.00	0.0		
PS-2		0				0.00	0.00	0.0		
PS-3		0				0.00	0.00	0.0		
Basin in which Point Source occurs (0=NO 1=YES)										
	BASIN 1	BASIN 2	BASIN 3	BASIN 4	BASIN 5	BASIN 6	BASIN 7	BASIN 8	BASIN 9	BASIN 10
PS-1	0	0	0	0	0	0	0	0	0	0
PS-2	0	0	0	0	0	0	0	0	0	0
PS-3	0	0	0	0	0	0	0	0	0	0

SEPTIC SYSTEM LOAD										
	Number of Dwellings	Number of People/ Dwelling	Atten Factor Phos	Mean TP Conc (mg/L)	P Load (kg/person/ yr)	P Load kg/yr		Water Gallons/Per son/Day	Number of Days	Water Load cu.m/yr
Septic System										
Year Round Septic Systems (125' zone	0	2.5	0.1	8	0.72	0.00		65	365	0.00
Seasonal Septic Systems (125' zone)	0	2.5	0.1	8	0.18	0.00		65	90	0.00
Total Septic System Loading						**0.00**				**0.00**

Beck Lake LLRM

BASIN AREAS										
	BASIN 1	BASIN 2	BASIN 3	BASIN 4	BASIN 5	BASIN 6	BASIN 7	BASIN 8	BASIN 9	BASIN 10
LAND USE	AREA (HA)	AREA (HA)	AREA (HA)	AREA (HA)	AREA (HA)	AREA (HA)	AREA (HA)	AREA (HA)	AREA (HA)	AREA (HA)
Urban 1 (LDR)										
Urban 2 (MDR/Hwy)	2.80952001	3.0008255		0.66599419						
Urban 3 (HDR/Com)	13.8218548	21.5568021	4.17688258	0.02959221						
Urban 4 (Ind)	11.7138165	0.37224854								
Urban 5 (P/I/R/C)										
Agric 1 (Cvr Crop)										
Agric 2 (Row Crop)										
Agric 3 (Grazing)										
Agric 4 (Feedlot)										
Forest 1 (Upland)										
Forest 2 (Wetland)										
Open 1 (Wetland/Lake)				15.3765526						
Open 2 (Meadow)	10.5312227	18.0304211	18.3803379	30.241554						
Open 3 (Excavation)										
Other 1										
Other 2										
Other 3										

Beck Lake LLRM

ROUTING PATTERN (Which basin flows to which)										
					PASSES THROUGH...					
1=YES 0=NO XXX=BLANK	BASIN 1 (CU.M/YR)	BASIN 2 (CU.M/YR)	BASIN 3 (CU.M/YR)	BASIN 4 (CU.M/YR)	BASIN 5 (CU.M/YR)	BASIN 6 (CU.M/YR)	BASIN 7 (CU.M/YR)	BASIN 8 (CU.M/YR)	BASIN 9 (CU.M/YR)	BASIN 10 (CU.M/YR)
INDIVIDUAL BASIN	1	1	1	1	1	1	1	1	1	1
BASIN 1 OUTPUT	XXX	0	1	0	0	0	0	0	0	0
BASIN 2 OUTPUT	0	XXX	1	0	0	0	0	0	0	0
BASIN 3 OUTPUT	0	0	XXX	1	0	0	0	0	0	0
BASIN 4 OUTPUT	0	0	0	XXX	0	0	0	0	0	0
BASIN 5 OUTPUT	0	0	0	0	XXX	0	0	0	0	0
BASIN 6 OUTPUT	0	0	0	0	0	XXX	0	0	0	0
BASIN 7 OUTPUT	0	0	0	0	0	0	XXX	0	0	0
BASIN 8 OUTPUT	0	0	0	0	0	0	0	XXX	0	0
BASIN 9 OUTPUT	0	0	0	0	0	0	0	0	XXX	0
BASIN 10 OUTPUT	0	0	0	0	0	0	0	0	0	XXX

WATER ROUTING AND ATTENUATION										
	BASIN 1	BASIN 2	BASIN 3	BASIN 4	BASIN 5	BASIN 6	BASIN 7	BASIN 8	BASIN 9	BASIN 10
SOURCE	(CU.M/YR)	(CU.M/YR)	(CU.M/YR)	(CU.M/YR)	(CU.M/YR)	(CU.M/YR)	(CU.M/YR)	(CU.M/YR)	(CU.M/YR)	(CU.M/YR)
INDIVIDUAL BASIN	238583.273	250476.522	113157.095	216096.875	0	0	0	0	0	0
BASIN 1 OUTPUT	XXX	0	226654.109	0	0	0	0	0	0	0
BASIN 2 OUTPUT	0	XXX	225428.87	0	0	0	0	0	0	0
BASIN 3 OUTPUT	0	0	XXX	480454.063	0	0	0	0	0	0
BASIN 4 OUTPUT	0	0	0	XXX	0	0	0	0	0	0
BASIN 5 OUTPUT	0	0	0	0	XXX	0	0	0	0	0
BASIN 6 OUTPUT	0	0	0	0	0	XXX	0	0	0	0
BASIN 7 OUTPUT	0	0	0	0	0	0	XXX	0	0	0
BASIN 8 OUTPUT	0	0	0	0	0	0	0	XXX	0	0
BASIN 9 OUTPUT	0	0	0	0	0	0	0	0	XXX	0
BASIN 10 OUTPUT	0	0	0	0	0	0	0	0	0	XXX
CUMULATIVE TOTAL	238583.3	250476.5	565240.1	696550.9	0.0	0.0	0	0	0	0
BASIN ATTENUATION	0.95	0.90	0.85	0.80	1.00	1.00	1.00	1.00	1.00	1.00
OUTPUT VOLUME	226654.1	225428.9	480454.1	557240.8	0.0	0.0	0	0	0	0

Beck Lake LLRM

LOAD ROUTING AND ATTENUATION: PHOSPHORUS				
	BASIN 1	BASIN 2	BASIN 3	BASIN 4
	(KG/YR)	(KG/YR)	(KG/YR)	(KG/YR)
BASIN 1 INDIVIDUAL	23.9	23.2	7.7	11.9
BASIN 1 OUTPUT	XXX	0.0	22.7	0.0
BASIN 2 OUTPUT	0.0	XXX	19.7	0.0
BASIN 3 OUTPUT	0.0	0.0	XXX	40.1
BASIN 4 OUTPUT	0.0	0.0	0.0	XXX
BASIN 5 OUTPUT	0.0	0.0	0.0	0.0
BASIN 6 OUTPUT	0.0	0.0	0.0	0.0
BASIN 7 OUTPUT	0.0	0.0	0.0	0.0
BASIN 8 OUTPUT	0.0	0.0	0.0	0.0
BASIN 9 OUTPUT	0.0	0.0	0.0	0.0
BASIN 10 OUTPUT	0.0	0.0	0.0	0.0
CUMULATIVE TOTAL	23.9	23.2	50.1	52.0
BASIN ATTENUATION	0.95	0.85	0.80	0.80
OUTPUT LOAD	22.7	19.7	40.1	41.6

LOAD AND CONCENTRATION SUMMARY: PHOSPHORUS				
	BASIN 1	BASIN 2	BASIN 3	BASIN 4
OUTPUT (CU.M/YR)	226654	225429	480454	557241
OUTPUT (KG/YR)	22.7	19.7	40.1	41.6
OUTPUT (MG/L)	0.100	0.087	0.084	0.075
REALITY CHECK CONC.				
(Based on real data)				
TERMINAL DISCHARGE?	0	0	1	1
(1=YES 2=NO)				
LOAD TO RESOURCE				
WATER (CU.M/YR)	0	0	480454	557241
PHOSPHORUS (KG/YR)	0.0	0.0	40.1	41.6
PHOSPHORUS (MG/L)	0.000	0.000	0.084	0.075
BASIN EXPORT COEFFICIENT	0.00	0.00	1.78	0.90

DIRECT LOADS TO LAKE	P	N
ATMOSPHERIC (KG/YR)	1.2	39.1
INTERNAL (KG/YR)	6.8	17.0
WATERFOWL (KG/YR)	4.0	19.0
SEPTIC SYSTEM (KG/YR)	0.0	
WATERSHED LOAD (KG/YR)	81.8	3293.0
TOTAL LOAD TO LAKE (KG/YR)	93.8	3368.1
(Watershed + direct loads)		
TOTAL INPUT CONC. (MG/L)	0.085	3.063

Beck Lake LLRM

THE MODELS				
	PHOSPHORUS	**PRED.**	**PERMIS.**	**CRITICAL**
		CONC.	**CONC.**	**CONC.**
NAME	**FORMULA**	**(ppb)**	**(ppb)**	**(ppb)**
Mass Balance	TP=L/(Z(F))*1000	85		
(Maximum Conc.)				
Kirchner-Dillon 1975	TP=L(1-Rp)/(Z(F))*1000	47	19	39
(K-D)				
Vollenweider 1975	TP=L/(Z(S+F))*1000	85	35	70
(V)				
Larsen-Mercier 1976	TP=L(1-Rlm)/(Z(F))*1000	54	22	44
(L-M)				
Jones-Bachmann 1976	TP=0.84(L)/(Z(0.65+F))*1000	59	24	48
(J-B)				
Reckhow General (1977)	TP=L/(11.6+1.2(Z(F)))*1000	32	13	27
(Rg)				
Average of Model Values		55	23	46
(without mass balance)				

Big Bear Lake LLRM

EXPORT MODEL INPUT AND CALCULATIONS

STD. WATER YIELD (CFS/SQ.MI)	1.5
PRECIPITATION (in M)	0.99

COEFFICIENTS			RUNOFF EXPORT COEFF.			BASEFLOW EXPORT COEFF.		
LAND USE	Runoff Coefficient (Fraction)	Baseflow Coefficient (Fraction)	P Export Coefficient (kg/ha/yr)	N Export Coefficient (kg/ha/yr)	TSS Export Coefficient (kg/ha/yr)	P Export Coefficient (kg/ha/yr)	N Export Coefficient (kg/ha/yr)	TSS Export Coefficient (kg/ha/yr)
Urban 1 (LDR)	0.40	0.25	1.10	5.50	93	0.050	7.50	0.3
Urban 2 (MDR/Hwy)	0.50	0.15	1.10	9.97	93	0.050	15.00	0.3
Urban 3 (HDR/Com)	0.60	0.05	1.35	9.97	93	0.050	30.00	0.3
Urban 4 (Ind)	0.60	0.05	1.10	5.50	93	0.050	7.50	0.3
Urban 5 (P/I/R/C)	0.40	0.25	1.10	5.50	93	0.050	7.50	0.3
Agric 1 (Cvr Crop)	0.15	0.30	1.00	6.08	100	0.050	2.50	0.3
Agric 2 (Row Crop)	0.30	0.30	2.20	9.00	250	0.050	2.50	0.3
Agric 3 (Grazing)	0.30	0.30	0.40	5.19	100	0.050	5.00	0.3
Agric 4 (Feedlot)	0.45	0.30	224.00	2923.20	15000	0.050	25.00	0.3
Forest 1 (Upland)	0.30	0.40	0.05	2.46	16	0.050	0.50	0.3
Forest 2 (Wetland)	0.05	0.40	0.05	2.46	16	0.050	0.50	0.3
Open 1 (Wetland/Lake)	0.05	0.40	0.20	2.46	16	0.050	0.50	0.3
Open 2 (Meadow)	0.15	0.30	0.10	2.46	16	0.050	0.50	0.3
Open 3 (Excavation)	0.40	0.20	0.80	5.19	1000	0.050	0.50	0.3
Other 1	0.10	0.40	0.20	2.46	16	0.050	0.50	0.3
Other 2	0.35	0.25	1.10	5.50	93	0.050	5.00	0.3
Other 3	0.60	0.05	2.20	9.00	250	0.050	20.00	0.3

Big Bear Lake LLRM

OTHER AREAL SOURCES	Affected Lake Area (ha)	P Export Coefficient (kg/ha/yr)	N Export Coefficient (kg/ha/yr)	TSS Export Coefficient (kg/ha/yr)
Atmospheric Deposition				
from Forested Area	10.12	0.20	6.52	32.0
from Agricultural/Rural Area	0	0.30	13.13	66.0
from Urban/Industrial Area	0	1.00	21.36	107.0
Internal Loading	0	2.00	5.00	1.0

NON-AREAL SOURCES	Number of Source Units	Volume (cu.m/yr)	P Load (kg/unit/yr)	N Load (kg/unit/yr)	TSS Load (kg/unit/yr)	P Load (ppm)	N Load (ppm)	TSS Load (ppm)
Waterfowl	100		0.20	0.95	5			
Point Sources								
PS-1		0				0.00	0.00	0.0
PS-2		0				0.00	0.00	0.0
PS-3		0				0.00	0.00	0.0

Basin in which Point Source occurs (0=NO 1=YES)	BASIN 1	BASIN 2	BASIN 3	BASIN 4	BASIN 5	BASIN 6	BASIN 7	BASIN 8	BASIN 9	BASIN 10
PS-1	0	0	0	0	0	0	0	0	0	0
PS-2	0	0	0	0	0	0	0	0	0	0
PS-3	0	0	0	0	0	0	0	0	0	0

SEPTIC SYSTEM LOAD	Number of Dwellings	Number of People/ Dwelling	Atten Factor Phos	Mean TP Conc (mg/L)	P Load (kg/person/ yr)	P Load kg/yr		Water Gallons/Person/Day	Number of Days	Water Load cu.m/yr
Septic System										
Year Round Septic Systems (125' zone	0	2.5	0.1	8	0.72	0.00		65	365	0.00
Seasonal Septic Systems (125' zone)	0	2.5	0.1	8	0.18	0.00		65	90	0.00
Total Septic System Loading						**0.00**				**0.00**

Big Bear Lake LLRM

BASIN AREAS										
	BASIN 1	BASIN 2	BASIN 3	BASIN 4	BASIN 5	BASIN 6	BASIN 7	BASIN 8	BASIN 9	BASIN 10
LAND USE	AREA (HA)	AREA (HA)	AREA (HA)	AREA (HA)	AREA (HA)	AREA (HA)	AREA (HA)	AREA (HA)	AREA (HA)	AREA (HA)
Urban 1 (LDR)										
Urban 2 (MDR/Hwy)			9.69							
Urban 3 (HDR/Com)	138.66	143.65	436.4	114.568485						
Urban 4 (Ind)	20.55	8.48	51.1	13.2734014						
Urban 5 (P/I/R/C)										
Agric 1 (Cvr Crop)				0.44256842						
Agric 2 (Row Crop)	6.5									
Agric 3 (Grazing)										
Agric 4 (Feedlot)										
Forest 1 (Upland)										
Forest 2 (Wetland)			6.6							
Open 1 (Wetland/Lake)	1.5		18.9	10.0343057						
Open 2 (Meadow)	29.9	7.1	141.5	73.9537009						
Open 3 (Excavation)										
Other 1										
Other 2										
Other 3										

Big Bear Lake LLRM

ROUTING PATTERN (Which basin flows to which)										
					PASSES THROUGH...					
1=YES 0=NO XXX=BLANK	BASIN 1 (CU.M/YR)	BASIN 2 (CU.M/YR)	BASIN 3 (CU.M/YR)	BASIN 4 (CU.M/YR)	BASIN 5 (CU.M/YR)	BASIN 6 (CU.M/YR)	BASIN 7 (CU.M/YR)	BASIN 8 (CU.M/YR)	BASIN 9 (CU.M/YR)	BASIN 10 (CU.M/YR)
INDIVIDUAL BASIN	1	1	1	1	1	1	1	1	1	1
BASIN 1 OUTPUT	XXX	1	0	0	0	0	0	0	0	0
BASIN 2 OUTPUT	0	XXX	1	0	0	0	0	0	0	0
BASIN 3 OUTPUT	0	0	XXX	1	0	0	0	0	0	0
BASIN 4 OUTPUT	0	0	0	XXX	0	0	0	0	0	0
BASIN 5 OUTPUT	0	0	0	0	XXX	0	0	0	0	0
BASIN 6 OUTPUT	0	0	0	0	0	XXX	0	0	0	0
BASIN 7 OUTPUT	0	0	0	0	0	0	XXX	0	0	0
BASIN 8 OUTPUT	0	0	0	0	0	0	0	XXX	0	0
BASIN 9 OUTPUT	0	0	0	0	0	0	0	0	XXX	0
BASIN 10 OUTPUT	0	0	0	0	0	0	0	0	0	XXX

WATER ROUTING AND ATTENUATION

SOURCE	BASIN 1 (CU.M/YR)	BASIN 2 (CU.M/YR)	BASIN 3 (CU.M/YR)	BASIN 4 (CU.M/YR)	BASIN 5 (CU.M/YR)	BASIN 6 (CU.M/YR)	BASIN 7 (CU.M/YR)	BASIN 8 (CU.M/YR)	BASIN 9 (CU.M/YR)	BASIN 10 (CU.M/YR)
INDIVIDUAL BASIN	1203013.35	1010587.05	3943402.65	1198800.75	0	0	0	0	0	0
BASIN 1 OUTPUT	XXX	1142862.68	0	0	0	0	0	0	0	0
BASIN 2 OUTPUT	0	XXX	2045777.25	0	0	0	0	0	0	0
BASIN 3 OUTPUT	0	0	XXX	5390261.91	0	0	0	0	0	0
BASIN 4 OUTPUT	0	0	0	XXX	0	0	0	0	0	0
BASIN 5 OUTPUT	0	0	0	0	XXX	0	0	0	0	0
BASIN 6 OUTPUT	0	0	0	0	0	XXX	0	0	0	0
BASIN 7 OUTPUT	0	0	0	0	0	0	XXX	0	0	0
BASIN 8 OUTPUT	0	0	0	0	0	0	0	XXX	0	0
BASIN 9 OUTPUT	0	0	0	0	0	0	0	0	XXX	0
BASIN 10 OUTPUT	0	0	0	0	0	0	0	0	0	XXX
CUMULATIVE TOTAL	1203013.4	2153449.7	5989179.9	6589062.7	0.0	0.0	0	0	0	0
BASIN ATTENUATION	0.95	0.95	0.90	0.90	1.00	1.00	1.00	1.00	1.00	1.00
OUTPUT VOLUME	1142862.7	2045777.2	5390261.9	5930156.4	0.0	0.0	0	0	0	0
Reality Check for Indiv. Basin	1020635.6	824492.9	3439175.8	1099146.8	0.0	0.0	0	0	0	0

Big Bear Lake LLRM

LOAD ROUTING AND ATTENUATION: PHOSPHORUS				
	BASIN 1	BASIN 2	BASIN 3	BASIN 4
	(KG/YR)	(KG/YR)	(KG/YR)	(KG/YR)
BASIN 1 INDIVIDUAL	237.2	211.9	707.5	189.7
BASIN 1 OUTPUT	XXX	201.7	0.0	0.0
BASIN 2 OUTPUT	0.0	XXX	351.5	0.0
BASIN 3 OUTPUT	0.0	0.0	XXX	582.5
BASIN 4 OUTPUT	0.0	0.0	0.0	XXX
BASIN 5 OUTPUT	0.0	0.0	0.0	0.0
BASIN 6 OUTPUT	0.0	0.0	0.0	0.0
BASIN 7 OUTPUT	0.0	0.0	0.0	0.0
BASIN 8 OUTPUT	0.0	0.0	0.0	0.0
BASIN 9 OUTPUT	0.0	0.0	0.0	0.0
BASIN 10 OUTPUT	0.0	0.0	0.0	0.0
CUMULATIVE TOTAL	237.2	413.6	1059.0	772.2
BASIN ATTENUATION	0.85	0.85	0.55	0.65
OUTPUT LOAD	201.7	351.5	582.5	501.9

LOAD AND CONCENTRATION SUMMARY: PHOSPHORUS				
	BASIN 1	BASIN 2	BASIN 3	BASIN 4
OUTPUT (CU.M/YR)	1142863	2045777	5390262	5930156
OUTPUT (KG/YR)	201.7	351.5	582.5	501.9
OUTPUT (MG/L)	0.176	0.172	0.108	0.085
REALITY CHECK CONC.				
(Based on real data)				
TERMINAL DISCHARGE?	0	0	0	1
(1=YES 2=NO)				
LOAD TO RESOURCE				
WATER (CU.M/YR)	0	0	0	5930156
PHOSPHORUS (KG/YR)	0.0	0.0	0.0	501.9
PHOSPHORUS (MG/L)	0.000	0.000	0.000	0.085
BASIN EXPORT COEFFICIENT	0.00	0.00	0.00	2.36

DIRECT LOADS TO LAKE	P	N
ATMOSPHERIC (KG/YR)	2.0	66.0
INTERNAL (KG/YR)	0.0	0.0
WATERFOWL (KG/YR)	20.0	95.0
SEPTIC SYSTEM (KG/YR)	0.0	
WATERSHED LOAD (KG/YR)	501.9	13713.4
TOTAL LOAD TO LAKE (KG/YR)	523.9	13874.4
(Watershed + direct loads)		
TOTAL INPUT CONC. (MG/L)	0.087	2.301

Big Bear Lake LLRM

THE MODELS				
	PHOSPHORUS	**PRED.**	**PERMIS.**	**CRITICAL**
		CONC.	**CONC.**	**CONC.**
NAME	**FORMULA**	**(ppb)**	**(ppb)**	**(ppb)**
Mass Balance	TP=L/(Z(F))*1000	87		
(Maximum Conc.)				
Kirchner-Dillon 1975	TP=L(1-Rp)/(Z(F))*1000	78	12	23
(K-D)				
Vollenweider 1975	TP=L/(Z(S+F))*1000	87	13	26
(V)				
Larsen-Mercier 1976	TP=L(1-Rlm)/(Z(F))*1000	74	11	22
(L-M)				
Jones-Bachmann 1976	TP=0.84(L)/(Z(0.65+F))*1000	72	11	21
(J-B)				
Reckhow General (1977)	TP=L/(11.6+1.2(Z(F)))*1000	62	9	19
(Rg)				
Average of Model Values		75	11	22
(without mass balance)				

Big Bend Lake LLRM

EXPORT MODEL INPUT AND CALCULATIONS

STD. WATER YIELD (CFS/SQ.MI)	1.5
PRECIPITATION (in M)	0.99

COEFFICIENTS			RUNOFF EXPORT COEFF.			BASEFLOW EXPORT COEFF.		
LAND USE	Runoff Coefficient (Fraction)	Baseflow Coefficient (Fraction)	P Export Coefficient (kg/ha/yr)	N Export Coefficient (kg/ha/yr)	TSS Export Coefficient (kg/ha/yr)	P Export Coefficient (kg/ha/yr)	N Export Coefficient (kg/ha/yr)	TSS Export Coefficient (kg/ha/yr)
Urban 1 (LDR)	0.30	0.25	2.50	5.50	93	0.050	7.50	0.3
Urban 2 (MDR/Hwy)	0.40	0.15	2.50	9.97	93	0.050	15.00	0.3
Urban 3 (HDR/Com)	0.50	0.05	2.50	9.97	93	0.050	30.00	0.3
Urban 4 (Ind)	0.60	0.05	2.50	5.50	93	0.050	7.50	0.3
Urban 5 (P/I/R/C)	0.40	0.25	2.50	5.50	93	0.050	7.50	0.3
Agric 1 (Cvr Crop)	0.15	0.30	1.08	6.08	100	0.050	2.50	0.3
Agric 2 (Row Crop)	0.30	0.30	4.46	9.00	250	0.050	2.50	0.3
Agric 3 (Grazing)	0.30	0.30	1.50	5.19	100	0.050	5.00	0.3
Agric 4 (Feedlot)	0.45	0.30	300.70	2923.20	15000	0.050	25.00	0.3
Forest 1 (Upland)	0.30	0.40	0.24	2.46	16	0.050	0.50	0.3
Forest 2 (Wetland)	0.05	0.40	0.24	2.46	16	0.050	0.50	0.3
Open 1 (Wetland/Lake)	0.05	0.40	0.30	2.46	16	0.050	0.50	0.3
Open 2 (Meadow)	0.05	0.30	0.30	2.46	16	0.050	0.50	0.3
Open 3 (Excavation)	0.40	0.20	1.50	5.19	1000	0.050	0.50	0.3
Other 1	0.10	0.40	0.24	2.46	16	0.050	0.50	0.3
Other 2	0.35	0.25	1.91	5.50	93	0.050	5.00	0.3
Other 3	0.60	0.05	4.46	9.00	250	0.050	20.00	0.3

Big Bend Lake LLRM

OTHER AREAL SOURCES	Affected Lake Area (ha)	P Export Coefficient (kg/ha/yr)	N Export Coefficient (kg/ha/yr)	TSS Export Coefficient (kg/ha/yr)
Atmospheric Deposition				
from Forested Area	5	0.20	6.52	32.0
from Agricultural/Rural Area	0	0.30	13.13	66.0
from Urban/Industrial Area	5	1.00	21.36	107.0
Internal Loading	5	2.00	5.00	1.0

NON-AREAL SOURCES	Number of Source Units	Volume (cu.m/yr)	P Load (kg/unit/yr)	N Load (kg/unit/yr)	TSS Load (kg/unit/yr)	P Load (ppm)	N Load (ppm)	TSS Load (ppm)
Waterfowl	20		0.20	0.95	5			
Point Sources								
PS-1 (direct to lake)		4558490.35				0.15	0.00	0.0
PS-2		0				0.00	0.00	0.0
PS-3		0				0.00	0.00	0.0

Basin in which Point Source occurs (0=NO 1=YES)

	BASIN 1	BASIN 2	BASIN 3	BASIN 4	BASIN 5	BASIN 6	BASIN 7	BASIN 8	BASIN 9	BASIN 10
PS-1	0	0	0	0	0	0	0	0	0	0
PS-2	0	0	0	0	0	0	0	0	0	0
PS-3	0	0	0	0	0	0	0	0	0	0

SEPTIC SYSTEM LOAD	Number of Dwellings	Number of People/ Dwelling	Atten Factor Phos	Mean TP Conc (mg/L)	P Load (kg/person/ yr)	P Load kg/yr		Water Gallons/Per son/Day	Number of Days	Water Load cu.m/yr
Septic System										
Year Round Septic Systems (125' zone	0	2.5	0.1	8	0.72	0.00		65	365	0.00
Seasonal Septic Systems (125' zone)	0	2.5	0.1	8	0.18	0.00		65	90	0.00
Total Septic System Loading						**0.00**				**0.00**

Big Bend Lake LLRM

BASIN AREAS										
	BASIN 1	BASIN 2	BASIN 3	BASIN 4	BASIN 5	BASIN 6	BASIN 7	BASIN 8	BASIN 9	BASIN 10
LAND USE	AREA (HA)	AREA (HA)	AREA (HA)	AREA (HA)	AREA (HA)	AREA (HA)	AREA (HA)	AREA (HA)	AREA (HA)	AREA (HA)
Urban 1 (LDR)	30.1892349									
Urban 2 (MDR/Hwy)	13.8311423									
Urban 3 (HDR/Com)	162.104707									
Urban 4 (Ind)	14.4320544									
Urban 5 (P/I/R/C)										
Agric 1 (Cvr Crop)	0.43514402									
Agric 2 (Row Crop)										
Agric 3 (Grazing)										
Agric 4 (Feedlot)										
Forest 1 (Upland)										
Forest 2 (Wetland)										
Open 1 (Wetland/Lake)	18.6953327									
Open 2 (Meadow)	46.4924565									
Open 3 (Excavation)										
Other 1										
Other 2										
Other 3										

Big Bend Lake LLRM

ROUTING PATTERN (Which basin flows to which)										
					PASSES THROUGH...					
1=YES 0=NO XXX=BLANK	BASIN 1	BASIN 2	BASIN 3	BASIN 4	BASIN 5	BASIN 6	BASIN 7	BASIN 8	BASIN 9	BASIN 10
	(CU.M/YR)	(CU.M/YR)	(CU.M/YR)	(CU.M/YR)	(CU.M/YR)	(CU.M/YR)	(CU.M/YR)	(CU.M/YR)	(CU.M/YR)	(CU.M/YR)
INDIVIDUAL BASIN	1	1	1	1	1	1	1	1	1	1
BASIN 1 OUTPUT	XXX	0	0	0	0	0	0	0	0	0
BASIN 2 OUTPUT	0	XXX	0	0	0	0	0	0	0	0
BASIN 3 OUTPUT	0	0	XXX	0	0	0	0	0	0	0
BASIN 4 OUTPUT	0	0	0	XXX	0	0	0	0	0	0
BASIN 5 OUTPUT	0	0	0	0	XXX	0	0	0	0	0
BASIN 6 OUTPUT	0	0	0	0	0	XXX	0	0	0	0
BASIN 7 OUTPUT	0	0	0	0	0	0	XXX	0	0	0
BASIN 8 OUTPUT	0	0	0	0	0	0	0	XXX	0	0
BASIN 9 OUTPUT	0	0	0	0	0	0	0	0	XXX	0
BASIN 10 OUTPUT	0	0	0	0	0	0	0	0	0	XXX

WATER ROUTING AND ATTENUATION										
	BASIN 1	BASIN 2	BASIN 3	BASIN 4	BASIN 5	BASIN 6	BASIN 7	BASIN 8	BASIN 9	BASIN 10
SOURCE	(CU.M/YR)	(CU.M/YR)	(CU.M/YR)	(CU.M/YR)	(CU.M/YR)	(CU.M/YR)	(CU.M/YR)	(CU.M/YR)	(CU.M/YR)	(CU.M/YR)
INDIVIDUAL BASIN	1461543.99	0	0	0	0	0	0	0	0	0
BASIN 1 OUTPUT	XXX	0	0	0	0	0	0	0	0	0
BASIN 2 OUTPUT	0	XXX	0	0	0	0	0	0	0	0
BASIN 3 OUTPUT	0	0	XXX	0	0	0	0	0	0	0
BASIN 4 OUTPUT	0	0	0	XXX	0	0	0	0	0	0
BASIN 5 OUTPUT	0	0	0	0	XXX	0	0	0	0	0
BASIN 6 OUTPUT	0	0	0	0	0	XXX	0	0	0	0
BASIN 7 OUTPUT	0	0	0	0	0	0	XXX	0	0	0
BASIN 8 OUTPUT	0	0	0	0	0	0	0	XXX	0	0
BASIN 9 OUTPUT	0	0	0	0	0	0	0	0	XXX	0
BASIN 10 OUTPUT	0	0	0	0	0	0	0	0	0	XXX
CUMULATIVE TOTAL	1461544.0	0.0	0.0	0.0	0.0	0.0	0	0	0	0
BASIN ATTENUATION	0.40	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00
Direct POINT SOURCE	4558490.35									
OUTPUT VOLUME	5143107.9	0.0	0.0	0.0	0.0	0.0	0	0	0	0

Big Bend Lake LLRM

LOAD ROUTING AND ATTENUATION: PHOSPHORUS	
	BASIN 1
	(KG/YR)
BASIN 1 INDIVIDUAL	585.7
BASIN 1 OUTPUT	XXX
BASIN 2 OUTPUT	0.0
BASIN 3 OUTPUT	0.0
BASIN 4 OUTPUT	0.0
BASIN 5 OUTPUT	0.0
BASIN 6 OUTPUT	0.0
BASIN 7 OUTPUT	0.0
BASIN 8 OUTPUT	0.0
BASIN 9 OUTPUT	0.0
BASIN 10 OUTPUT	0.0
CUMULATIVE TOTAL	585.7
BASIN ATTENUATION	0.95
Direct Point Source	665.54
OUTPUT LOAD	1222.0

LOAD AND CONCENTRATION SUMMARY: PHOSPH	
	BASIN 1
OUTPUT (CU.M/YR)	5143108
OUTPUT (KG/YR)	1222.0
OUTPUT (MG/L)	0.238
REALITY CHECK CONC.	
(Based on real data)	
TERMINAL DISCHARGE?	1
(1=YES 2=NO)	
LOAD TO RESOURCE	
WATER (CU.M/YR)	5143108
PHOSPHORUS (KG/YR)	1222.0
PHOSPHORUS (MG/L)	0.238
BASIN EXPORT COEFFICIENT	4.27

DIRECT LOADS TO LAKE	P	N	TSS		WATER
ATMOSPHERIC (KG/YR)	6.0	139.4	695.0	(CU.M/YR)	99000.0
INTERNAL (KG/YR)	10.0	25.0	5.0	(CU.M/YR)	0.0
WATERFOWL (KG/YR)	4.0	19.0	100.0	(CU.M/YR)	0.0
SEPTIC SYSTEM (KG/YR)	0.0			(CU.M/YR)	0.0
WATERSHED LOAD (KG/YR)	1222.0	6081.2	21684.2	(CU.M/YR)	5143107.9
TOTAL LOAD TO LAKE (KG/YR)	1242.0	6264.6	22484.2	(CU.M/YR)	5242107.9
(Watershed + direct loads)					
TOTAL INPUT CONC. (MG/L)	0.237	1.195	4.289		

Big Bend Lake LLRM

THE MODELS				
	PHOSPHORUS	**PRED.**	**PERMIS.**	**CRITICAL**
		CONC.	**CONC.**	**CONC.**
NAME	**FORMULA**	**(ppb)**	**(ppb)**	**(ppb)**
Mass Balance	TP=L/(Z(F))*1000	237		
(Maximum Conc.)				
Kirchner-Dillon 1975	TP=L(1-Rp)/(Z(F))*1000	208	13	25
(K-D)				
Vollenweider 1975	TP=L/(Z(S+F))*1000	237	14	29
(V)				
Larsen-Mercier 1976	TP=L(1-Rlm)/(Z(F))*1000	181	11	22
(L-M)				
Jones-Bachmann 1976	TP=0.84(L)/(Z(0.65+F))*1000	187	11	23
(J-B)				
Reckhow General (1977)	TP=L/(11.6+1.2(Z(F)))*1000	164	10	20
(Rg)				
Average of Model Values		196	12	24
(without mass balance)				

Bresnen Lake LLRM

EXPORT MODEL INPUT AND CALCULATIONS

STD. WATER YIELD (CFS/SQ.MI)	1.5
PRECIPITATION (in M)	1.04

COEFFICIENTS			RUNOFF EXPORT COEFF.			BASEFLOW EXPORT COEFF.		
LAND USE	Runoff Coefficient (Fraction)	Baseflow Coefficient (Fraction)	P Export Coefficient (kg/ha/yr)	N Export Coefficient (kg/ha/yr)	TSS Export Coefficient (kg/ha/yr)	P Export Coefficient (kg/ha/yr)	N Export Coefficient (kg/ha/yr)	TSS Export Coefficient (kg/ha/yr)
Urban 1 (LDR)	0.40	0.25	1.10	5.50	93	0.050	7.50	0.3
Urban 2 (MDR/Hwy)	0.50	0.15	1.10	9.97	93	0.050	15.00	0.3
Urban 3 (HDR/Com)	0.60	0.05	1.50	9.97	93	0.050	30.00	0.3
Urban 4 (Ind)	0.60	0.05	1.10	5.50	93	0.050	7.50	0.3
Urban 5 (P/I/R/C)	0.40	0.25	1.10	5.50	93	0.050	7.50	0.3
Agric 1 (Cvr Crop)	0.15	0.30	1.00	6.08	100	0.050	2.50	0.3
Agric 2 (Row Crop)	0.30	0.30	2.00	9.00	250	0.050	2.50	0.3
Agric 3 (Grazing)	0.30	0.30	0.40	5.19	100	0.050	5.00	0.3
Agric 4 (Feedlot)	0.45	0.30	224.00	2923.20	15000	0.050	25.00	0.3
Forest 1 (Upland)	0.30	0.40	0.05	2.46	16	0.050	0.50	0.3
Forest 2 (Wetland)	0.05	0.40	0.05	2.46	16	0.050	0.50	0.3
Open 1 (Wetland/Lake)	0.05	0.40	0.20	2.46	16	0.050	0.50	0.3
Open 2 (Meadow)	0.15	0.30	0.20	2.46	16	0.050	0.50	0.3
Open 3 (Excavation)	0.40	0.20	0.80	5.19	1000	0.050	0.50	0.3
Other 1	0.10	0.40	0.20	2.46	16	0.050	0.50	0.3
Other 2	0.35	0.25	1.10	5.50	93	0.050	5.00	0.3
Other 3	0.60	0.05	2.20	9.00	250	0.050	20.00	0.3

Bresnen Lake LLRM

OTHER AREAL SOURCES	Affected Lake Area (ha)	P Export Coefficient (kg/ha/yr)	N Export Coefficient (kg/ha/yr)	TSS Export Coefficient (kg/ha/yr)
Atmospheric Deposition				
from Forested Area	5	0.20	6.52	32.0
from Agricultural/Rural Area	4.71	0.30	13.13	66.0
from Urban/Industrial Area	0	1.00	21.36	107.0
Internal Loading	5	2.00	5.00	1.0

NON-AREAL SOURCES	Number of Source Units	Volume (cu.m/yr)	P Load (kg/unit/yr)	N Load (kg/unit/yr)	TSS Load (kg/unit/yr)	P Load (ppm)	N Load (ppm)	TSS Load (ppm)		
Waterfowl	25		0.20	0.95	5					
Point Sources										
PS-1		0				0.00	0.00	0.0		
PS-2		0				0.00	0.00	0.0		
PS-3		0				0.00	0.00	0.0		
Basin in which Point Source occurs (0=NO 1=YES)										
	BASIN 1	BASIN 2	BASIN 3	BASIN 4	BASIN 5	BASIN 6	BASIN 7	BASIN 8	BASIN 9	BASIN 10
PS-1	0	0	0	0	0	0	0	0	0	0
PS-2	0	0	0	0	0	0	0	0	0	0
PS-3	0	0	0	0	0	0	0	0	0	0

SEPTIC SYSTEM LOAD	Number of Dwellings	Number of People/ Dwelling	Atten Factor Phos	Mean TP Conc (mg/L)	P Load (kg/person/ yr)	P Load kg/yr		Water Gallons/Person/Day	Number of Days	Water Load cu.m/yr
Septic System										
Year Round Septic Systems (125' zone	0	2.5	0.1	8	0.72	0.00		65	365	0.00
Seasonal Septic Systems (125' zone)	0	2.5	0.1	8	0.18	0.00		65	90	0.00
Total Septic System Loading						**0.00**				**0.00**

Bresnen Lake LLRM

BASIN AREAS										
LAND USE	BASIN 1 AREA (HA)	BASIN 2 AREA (HA)	BASIN 3 AREA (HA)	BASIN 4 AREA (HA)	BASIN 5 AREA (HA)	BASIN 6 AREA (HA)	BASIN 7 AREA (HA)	BASIN 8 AREA (HA)	BASIN 9 AREA (HA)	BASIN 10 AREA (HA)
Urban 1 (LDR)										
Urban 2 (MDR/Hwy)										
Urban 3 (HDR/Com)	27.79	14.24	3.88	6.88	12.1	7.49				
Urban 4 (Ind)										
Urban 5 (P/I/R/C)										
Agric 1 (Cvr Crop)		0.08553083								
Agric 2 (Row Crop)	2.99658297	13.1814985	3.4616337	8.22	2.36	1.57				
Agric 3 (Grazing)										
Agric 4 (Feedlot)										
Forest 1 (Upland)										
Forest 2 (Wetland)	7.8195347		0.54666066		0.55	0.71				
Open 1 (Wetland/Lake)	1.93597884	9.09755279				5.32				
Open 2 (Meadow)	1.24756805	9.72270406	5.72933133	0.18	4.26	5.8				
Open 3 (Excavation)										
Other 1										
Other 2										
Other 3										

Bresnen Lake LLRM

ROUTING PATTERN (Which basin flows to which)

1=YES 0=NO XXX=BLANK	BASIN 1 (CU.M/YR)	BASIN 2 (CU.M/YR)	BASIN 3 (CU.M/YR)	BASIN 4 (CU.M/YR)	PASSES THROUGH... BASIN 5 (CU.M/YR)	BASIN 6 (CU.M/YR)	BASIN 7 (CU.M/YR)	BASIN 8 (CU.M/YR)	BASIN 9 (CU.M/YR)	BASIN 10 (CU.M/YR)
INDIVIDUAL BASIN	1	1	1	1	1	1	1	1	1	1
BASIN 1 OUTPUT	XXX	1	0	0	0	0	0	0	0	0
BASIN 2 OUTPUT	0	XXX	0	0	0	0	0	0	0	0
BASIN 3 OUTPUT	0	1	XXX	0	0	0	0	0	0	0
BASIN 4 OUTPUT	0	0	0	XXX	1	0	0	0	0	0
BASIN 5 OUTPUT	0	0	0	0	XXX	1	0	0	0	0
BASIN 6 OUTPUT	0	0	1	0	0	XXX	0	0	0	0
BASIN 7 OUTPUT	0	0	0	0	0	0	XXX	0	0	0
BASIN 8 OUTPUT	0	0	0	0	0	0	0	XXX	0	0
BASIN 9 OUTPUT	0	0	0	0	0	0	0	0	XXX	0
BASIN 10 OUTPUT	0	0	0	0	0	0	0	0	0	XXX

WATER ROUTING AND ATTENUATION

SOURCE	BASIN 1 (CU.M/YR)	BASIN 2 (CU.M/YR)	BASIN 3 (CU.M/YR)	BASIN 4 (CU.M/YR)	BASIN 5 (CU.M/YR)	BASIN 6 (CU.M/YR)	BASIN 7 (CU.M/YR)	BASIN 8 (CU.M/YR)	BASIN 9 (CU.M/YR)	BASIN 10 (CU.M/YR)
INDIVIDUAL BASIN	258053.5	266994.037	77201.0367	98644	119033.2	115793.6	0	0	0	0
BASIN 1 OUTPUT	XXX	193540.125	0	0	0	0	0	0	0	0
BASIN 2 OUTPUT	0	XXX	0	0	0	0	0	0	0	0
BASIN 3 OUTPUT	0	307578.133	XXX	0	0	0	0	0	0	0
BASIN 4 OUTPUT	0	0	0	XXX	78915.2	0	0	0	0	0
BASIN 5 OUTPUT	0	0	0	0	XXX	178153.56	0	0	0	0
BASIN 6 OUTPUT	0	0	264552.444	0	0	XXX	0	0	0	0
BASIN 7 OUTPUT	0	0	0	0	0	0	XXX	0	0	0
BASIN 8 OUTPUT	0	0	0	0	0	0	0	XXX	0	0
BASIN 9 OUTPUT	0	0	0	0	0	0	0	0	XXX	0
BASIN 10 OUTPUT	0	0	0	0	0	0	0	0	0	XXX
CUMULATIVE TOTAL	258053.5	768112.3	341753.5	98644.0	197948.4	293947.2	0	0	0	0
BASIN ATTENUATION	0.75	0.90	0.90	0.80	0.90	0.90	1.00	1.00	1.00	1.00
OUTPUT VOLUME	193540.1	691301.1	307578.1	78915.2	178153.6	264552.4	0	0	0	0

Bresnen Lake LLRM

LOAD ROUTING AND ATTENUATION: PHOSPHORUS		
	BASIN 1	BASIN 2
	(KG/YR)	(KG/YR)
BASIN 1 INDIVIDUAL	50.8	53.9
BASIN 1 OUTPUT	XXX	27.9
BASIN 2 OUTPUT	0.0	XXX
BASIN 3 OUTPUT	0.0	56.2
BASIN 4 OUTPUT	0.0	0.0
BASIN 5 OUTPUT	0.0	0.0
BASIN 6 OUTPUT	0.0	0.0
BASIN 7 OUTPUT	0.0	0.0
BASIN 8 OUTPUT	0.0	0.0
BASIN 9 OUTPUT	0.0	0.0
BASIN 10 OUTPUT	0.0	0.0
CUMULATIVE TOTAL	50.8	138.1
BASIN ATTENUATION	0.55	0.90
OUTPUT LOAD	27.9	124.3

LOAD AND CONCENTRATION SUMMARY: PHOSPHORUS		
	BASIN 1	BASIN 2
OUTPUT (CU.M/YR)	193540	691301
OUTPUT (KG/YR)	27.9	124.3
OUTPUT (MG/L)	0.144	0.180
REALITY CHECK CONC.		
(Based on real data)		
TERMINAL DISCHARGE?	0	1
(1=YES 2=NO)		
LOAD TO RESOURCE		
WATER (CU.M/YR)	0	691301
PHOSPHORUS (KG/YR)	0.0	124.3
PHOSPHORUS (MG/L)	0.000	0.180
BASIN EXPORT COEFFICIENT	0.00	2.68

DIRECT LOADS TO LAKE	P	N
ATMOSPHERIC (KG/YR)	2.4	94.4
INTERNAL (KG/YR)	10.0	25.0
WATERFOWL (KG/YR)	5.0	23.8
SEPTIC SYSTEM (KG/YR)	0.0	
WATERSHED LOAD (KG/YR)	124.3	1755.4
TOTAL LOAD TO LAKE (KG/YR)	141.7	1898.6
(Watershed + direct loads)		
TOTAL INPUT CONC. (MG/L)	0.179	2.396

Bresnen Lake LLRM

THE MODELS				
	PHOSPHORUS	**PRED.**	**PERMIS.**	**CRITICAL**
		CONC.	**CONC.**	**CONC.**
NAME	**FORMULA**	**(ppb)**	**(ppb)**	**(ppb)**
Mass Balance	TP=L/(Z(F))*1000	179		
(Maximum Conc.)				
Kirchner-Dillon 1975	TP=L(1-Rp)/(Z(F))*1000	99	19	39
(K-D)				
Vollenweider 1975	TP=L/(Z(S+F))*1000	179	35	70
(V)				
Larsen-Mercier 1976	TP=L(1-Rlm)/(Z(F))*1000	124	24	48
(L-M)				
Jones-Bachmann 1976	TP=0.84(L)/(Z(0.65+F))*1000	133	26	52
(J-B)				
Reckhow General (1977)	TP=L/(11.6+1.2(Z(F)))*1000	68	13	27
(Rg)				
Average of Model Values		121	24	47
(without mass balance)				

Buffalo Creek Lake LLRM

EXPORT MODEL INPUT AND CALCULATIONS

STD. WATER YIELD (CFS/SQ.MI)	1.5
PRECIPITATION (in M)	1.03

COEFFICIENTS			RUNOFF EXPORT COEFF.			BASEFLOW EXPORT COEFF.		
LAND USE	Runoff Coefficient (Fraction)	Baseflow Coefficient (Fraction)	P Export Coefficient (kg/ha/yr)	N Export Coefficient (kg/ha/yr)	TSS Export Coefficient (kg/ha/yr)	P Export Coefficient (kg/ha/yr)	N Export Coefficient (kg/ha/yr)	TSS Export Coefficient (kg/ha/yr)
Urban 1 (LDR)	0.40	0.25	1.10	5.50	93	0.050	7.50	0.3
Urban 2 (MDR/Hwy)	0.50	0.15	1.10	9.97	93	0.050	15.00	0.3
Urban 3 (HDR/Com)	0.60	0.05	1.50	9.97	93	0.050	30.00	0.3
Urban 4 (Ind)	0.60	0.05	1.10	5.50	93	0.050	7.50	0.3
Urban 5 (P/I/R/C)	0.40	0.25	1.10	5.50	93	0.050	7.50	0.3
Agric 1 (Cvr Crop)	0.15	0.30	1.00	6.08	100	0.050	2.50	0.3
Agric 2 (Row Crop)	0.30	0.30	1.00	9.00	250	0.050	2.50	0.3
Agric 3 (Grazing)	0.30	0.30	0.40	5.19	100	0.050	5.00	0.3
Agric 4 (Feedlot)	0.45	0.30	224.00	2923.20	15000	0.050	25.00	0.3
Forest 1 (Upland)	0.30	0.40	0.05	2.46	16	0.050	0.50	0.3
Forest 2 (Wetland)	0.05	0.40	0.05	2.46	16	0.050	0.50	0.3
Open 1 (Wetland/Lake)	0.05	0.40	0.20	2.46	16	0.050	0.50	0.3
Open 2 (Meadow)	0.15	0.30	0.20	2.46	16	0.050	0.50	0.3
Open 3 (Excavation)	0.40	0.20	0.80	5.19	1000	0.050	0.50	0.3
Other 1	0.10	0.40	0.20	2.46	16	0.050	0.50	0.3
Other 2	0.35	0.25	1.10	5.50	93	0.050	5.00	0.3
Other 3	0.60	0.05	2.20	9.00	250	0.050	20.00	0.3

Buffalo Creek Lake LLRM

OTHER AREAL SOURCES	Affected Lake Area (ha)	P Export Coefficient (kg/ha/yr)	N Export Coefficient (kg/ha/yr)	TSS Export Coefficient (kg/ha/yr)
Atmospheric Deposition				
from Forested Area	14.1	0.20	6.52	32.0
from Agricultural/Rural Area	0	0.30	13.13	66.0
from Urban/Industrial Area	0	1.00	21.36	107.0
Internal Loading	14.1	2.00	5.00	1.0

NON-AREAL SOURCES	Number of Source Units	Volume (cu.m/yr)	P Load (kg/unit/yr)	N Load (kg/unit/yr)	TSS Load (kg/unit/yr)	P Load (ppm)	N Load (ppm)	TSS Load (ppm)
Waterfowl	40		0.20	0.95	5			
Point Sources								
PS-1 - IL0048542 Forest Preserve - Camp Reinberg		5526.68	2	5		4.00	20.00	
PS-2 - IL0051934 ALDEN LONG GROVE REHAB		56337.4	2	5		4.00	20.00	
PS-3						0.00	0.00	0.0

Basin in which Point Source occurs (0=NO 1=YES)

	BASIN 1	BASIN 2	BASIN 3	BASIN 4	BASIN 5	BASIN 6	BASIN 7	BASIN 8	BASIN 9	BASIN 10
PS-1	0	0	0	1	0	0	0	0	0	0
PS-2	0	0	1	0	0	0	0	0	0	0
PS-3	0	0	0	0	0	0	0	0	0	0

SEPTIC SYSTEM LOAD	Number of Dwellings	Number of People/ Dwelling	Atten Factor Phos	Mean TP Conc (mg/L)	P Load (kg/person/ yr)	P Load kg/yr		Water Gallons/Person/Day	Number of Days	Water Load cu.m/yr
Septic System										
Year Round Septic Systems (125' zone	0	2.5	0.1	8	0.72	0.00		65	365	0.00
Seasonal Septic Systems (125' zone)	0	2.5	0.1	8	0.18	0.00		65	90	0.00
Total Septic System Loading						**0.00**				**0.00**

Buffalo Creek Lake LLRM

BASIN AREAS										
	BASIN 1	BASIN 2	BASIN 3	BASIN 4	BASIN 5	BASIN 6	BASIN 7	BASIN 8	BASIN 9	BASIN 10
LAND USE	AREA (HA)	AREA (HA)	AREA (HA)	AREA (HA)	AREA (HA)	AREA (HA)	AREA (HA)	AREA (HA)	AREA (HA)	AREA (HA)
Urban 1 (LDR)		0.51								
Urban 2 (MDR/Hwy)		44.3	0.45							
Urban 3 (HDR/Com)	892.9	1320.4	449.3	412.97						
Urban 4 (Ind)	4.8	33.3	5.01							
Urban 5 (P/I/R/C)										
Agric 1 (Cvr Crop)	0.81	0.41	0.38	0.81						
Agric 2 (Row Crop)	6.87	31.7	12.99	0.11						
Agric 3 (Grazing)			1.3	16.17						
Agric 4 (Feedlot)										
Forest 1 (Upland)										
Forest 2 (Wetland)	40	18.9	33.4	13.1						
Open 1 (Wetland/Lake)	27.6	51.7	6.81	9.43						
Open 2 (Meadow)	129.4	1031.1	143.84	73.89						
Open 3 (Excavation)										
Other 1										
Other 2										
Other 3										

Buffalo Creek Lake LLRM

ROUTING PATTERN (Which basin flows to which)										
					PASSES THROUGH...					
1=YES 0=NO XXX=BLANK	BASIN 1 (CU.M/YR)	BASIN 2 (CU.M/YR)	BASIN 3 (CU.M/YR)	BASIN 4 (CU.M/YR)	BASIN 5 (CU.M/YR)	BASIN 6 (CU.M/YR)	BASIN 7 (CU.M/YR)	BASIN 8 (CU.M/YR)	BASIN 9 (CU.M/YR)	BASIN 10 (CU.M/YR)
INDIVIDUAL BASIN	1	1	1	1	1	1	1	1	1	1
BASIN 1 OUTPUT	XXX	0	1	0	0	0	0	0	0	0
BASIN 2 OUTPUT	0	XXX	0	0	0	0	0	0	0	0
BASIN 3 OUTPUT	0	0	XXX	0	0	0	0	0	0	0
BASIN 4 OUTPUT	0	0	1	XXX	0	0	0	0	0	0
BASIN 5 OUTPUT	0	0	0	0	XXX	0	0	0	0	0
BASIN 6 OUTPUT	0	0	0	0	0	XXX	0	0	0	0
BASIN 7 OUTPUT	0	0	0	0	0	0	XXX	0	0	0
BASIN 8 OUTPUT	0	0	0	0	0	0	0	XXX	0	0
BASIN 9 OUTPUT	0	0	0	0	0	0	0	0	XXX	0
BASIN 10 OUTPUT	0	0	0	0	0	0	0	0	0	XXX

WATER ROUTING AND ATTENUATION										
	BASIN 1	BASIN 2	BASIN 3	BASIN 4	BASIN 5	BASIN 6	BASIN 7	BASIN 8	BASIN 9	BASIN 10
SOURCE	(CU.M/YR)	(CU.M/YR)	(CU.M/YR)	(CU.M/YR)	(CU.M/YR)	(CU.M/YR)	(CU.M/YR)	(CU.M/YR)	(CU.M/YR)	(CU.M/YR)
INDIVIDUAL BASIN	6969407.45	14667210.3	4044100.85	3321632.28	0	0	0	0	0	0
BASIN 1 OUTPUT	XXX	0	6620937.08	0	0	0	0	0	0	0
BASIN 2 OUTPUT	0	XXX	0	0	0	0	0	0	0	0
BASIN 3 OUTPUT	0	0	XXX	0	0	0	0	0	0	0
BASIN 4 OUTPUT	0	0	2657305.83	XXX	0	0	0	0	0	0
BASIN 5 OUTPUT	0	0	0	0	XXX	0	0	0	0	0
BASIN 6 OUTPUT	0	0	0	0	0	XXX	0	0	0	0
BASIN 7 OUTPUT	0	0	0	0	0	0	XXX	0	0	0
BASIN 8 OUTPUT	0	0	0	0	0	0	0	XXX	0	0
BASIN 9 OUTPUT	0	0	0	0	0	0	0	0	XXX	0
BASIN 10 OUTPUT	0	0	0	0	0	0	0	0	0	XXX
CUMULATIVE TOTAL	6969407.5	14667210.3	13322343.8	3321632.3	0.0	0.0	0	0	0	0
BASIN ATTENUATION	0.95	0.95	0.95	0.80	1.00	1.00	1.00	1.00	1.00	1.00
OUTPUT VOLUME	6620937.1	13933849.8	12656226.6	2657305.8	0.0	0.0	0	0	0	0

Buffalo Creek Lake LLRM

LOAD ROUTING AND ATTENUATION: PHOSPHORUS				
	BASIN 1 (KG/YR)	BASIN 2 (KG/YR)	BASIN 3 (KG/YR)	BASIN 4 (KG/YR)
BASIN 1 INDIVIDUAL	1440.8	2442.8	983.7	692.6
BASIN 1 OUTPUT	XXX	0.0	1152.7	0.0
BASIN 2 OUTPUT	0.0	XXX	0.0	0.0
BASIN 3 OUTPUT	0.0	0.0	XXX	0.0
BASIN 4 OUTPUT	0.0	0.0	346.3	XXX
BASIN 5 OUTPUT	0.0	0.0	0.0	0.0
BASIN 6 OUTPUT	0.0	0.0	0.0	0.0
BASIN 7 OUTPUT	0.0	0.0	0.0	0.0
BASIN 8 OUTPUT	0.0	0.0	0.0	0.0
BASIN 9 OUTPUT	0.0	0.0	0.0	0.0
BASIN 10 OUTPUT	0.0	0.0	0.0	0.0
CUMULATIVE TOTAL	1440.8	2442.8	2482.6	692.6
BASIN ATTENUATION	0.80	0.80	0.90	0.50
OUTPUT LOAD	1152.7	1954.2	2234.4	346.3

LOAD AND CONCENTRATION SUMMARY: PHOSPHORUS				
	BASIN 1	BASIN 2	BASIN 3	BASIN 4
OUTPUT (CU.M/YR)	6620937	13933850	12656227	2657306
OUTPUT (KG/YR)	1152.7	1954.2	2234.4	346.3
OUTPUT (MG/L)	0.174	0.140	0.177	0.130
REALITY CHECK CONC.				
(Based on real data)				
TERMINAL DISCHARGE?	0	1	1	0
(1=YES 2=NO)				
LOAD TO RESOURCE				
WATER (CU.M/YR)	0	13933850	12656227	0
PHOSPHORUS (KG/YR)	0.0	1954.2	2234.4	0.0
PHOSPHORUS (MG/L)	0.000	0.140	0.177	0.000
BASIN EXPORT COEFFICIENT	0.00	0.77	3.42	0.00

DIRECT LOADS TO LAKE	P	N
ATMOSPHERIC (KG/YR)	2.8	91.9
INTERNAL (KG/YR)	28.2	70.5
WATERFOWL (KG/YR)	8.0	38.0
SEPTIC SYSTEM (KG/YR)	0.0	
WATERSHED LOAD (KG/YR)	4188.6	78965.2
TOTAL LOAD TO LAKE (KG/YR)	4227.6	79165.6
(Watershed + direct loads)		
TOTAL INPUT CONC. (MG/L)	0.158	2.961

Buffalo Creek Lake LLRM

THE MODELS				
	PHOSPHORUS	**PRED.**	**PERMIS.**	**CRITICAL**
		CONC.	**CONC.**	**CONC.**
NAME	**FORMULA**	**(ppb)**	**(ppb)**	**(ppb)**
Mass Balance	TP=L/(Z(F))*1000	158		
(Maximum Conc.)				
Kirchner-Dillon 1975	TP=L(1-Rp)/(Z(F))*1000	153	7	14
(K-D)				
Vollenweider 1975	TP=L/(Z(S+F))*1000	158	7	15
(V)				
Larsen-Mercier 1976	TP=L(1-Rlm)/(Z(F))*1000	148	7	14
(L-M)				
Jones-Bachmann 1976	TP=0.84(L)/(Z(0.65+F))*1000	132	6	12
(J-B)				
Reckhow General (1977)	TP=L/(11.6+1.2(Z(F)))*1000	125	6	12
(Rg)				
Average of Model Values		143	7	13
(without mass balance)				

Countryside Lake LLRM

EXPORT MODEL INPUT AND CALCULATIONS

STD. WATER YIELD (CFS/SQ.MI)	1.5
PRECIPITATION (in M)	1.04

COEFFICIENTS			RUNOFF EXPORT COEFF.			BASEFLOW EXPORT COEFF.		
LAND USE	Runoff Coefficient (Fraction)	Baseflow Coefficient (Fraction)	P Export Coefficient (kg/ha/yr)	N Export Coefficient (kg/ha/yr)	TSS Export Coefficient (kg/ha/yr)	P Export Coefficient (kg/ha/yr)	N Export Coefficient (kg/ha/yr)	TSS Export Coefficient (kg/ha/yr)
Urban 1 (LDR)	0.40	0.25	1.10	5.50	93	0.050	7.50	0.3
Urban 2 (MDR/Hwy)	0.50	0.15	1.10	9.97	93	0.050	15.00	0.3
Urban 3 (HDR/Com)	0.60	0.05	1.50	9.97	93	0.050	30.00	0.3
Urban 4 (Ind)	0.60	0.05	1.10	5.50	93	0.050	7.50	0.3
Urban 5 (P/I/R/C)	0.40	0.25	1.10	5.50	93	0.050	7.50	0.3
Agric 1 (Cvr Crop)	0.15	0.30	1.00	6.08	100	0.050	2.50	0.3
Agric 2 (Row Crop)	0.30	0.30	1.00	9.00	250	0.050	2.50	0.3
Agric 3 (Grazing)	0.30	0.30	0.40	5.19	100	0.050	5.00	0.3
Agric 4 (Feedlot)	0.45	0.30	224.00	2923.20	15000	0.050	25.00	0.3
Forest 1 (Upland)	0.30	0.40	0.05	2.46	16	0.050	0.50	0.3
Forest 2 (Wetland)	0.05	0.40	0.05	2.46	16	0.050	0.50	0.3
Open 1 (Wetland/Lake)	0.05	0.40	0.20	2.46	16	0.050	0.50	0.3
Open 2 (Meadow)	0.15	0.30	0.20	2.46	16	0.050	0.50	0.3
Open 3 (Excavation)	0.40	0.20	0.80	5.19	1000	0.050	0.50	0.3
Other 1	0.10	0.40	0.20	2.46	16	0.050	0.50	0.3
Other 2	0.35	0.25	1.10	5.50	93	0.050	5.00	0.3
Other 3	0.60	0.05	2.20	9.00	250	0.050	20.00	0.3

Countryside Lake LLRM

OTHER AREAL SOURCES				
	Affected Lake Area (ha)	P Export Coefficient (kg/ha/yr)	N Export Coefficient (kg/ha/yr)	TSS Export Coefficient (kg/ha/yr)
Atmospheric Deposition				
from Forested Area	57.4	0.20	6.52	32.0
from Agricultural/Rural Area	0	0.30	13.13	66.0
from Urban/Industrial Area	0	1.00	21.36	107.0
Internal Loading	25	2.00	5.00	1.0

NON-AREAL SOURCES								
	Number of Source Units	Volume (cu.m/yr)	P Load (kg/unit/yr)	N Load (kg/unit/yr)	TSS Load (kg/unit/yr)	P Load (ppm)	N Load (ppm)	TSS Load (ppm)
Waterfowl	50		0.20	0.95	5			
Point Sources								
PS-1		0				0.00	0.00	0.0
PS-2		0				0.00	0.00	0.0
PS-3		0				0.00	0.00	0.0

Basin in which Point Source occurs (0=NO 1=YES)	BASIN 1	BASIN 2	BASIN 3	BASIN 4	BASIN 5	BASIN 6	BASIN 7	BASIN 8	BASIN 9	BASIN 10
PS-1	0	0	0	0	0	0	0	0	0	0
PS-2	0	0	0	0	0	0	0	0	0	0
PS-3	0	0	0	0	0	0	0	0	0	0

SEPTIC SYSTEM LOAD										
	Number of Dwellings	Number of People/ Dwelling	Atten Factor Phos	Mean TP Conc (mg/L)	P Load (kg/person/ yr)	P Load kg/yr		Water Gallons/Per son/Day	Number of Days	Water Load cu.m/yr
Septic System										
Year Round Septic Systems (125' zone	0	2.5	0.1	8	0.72	0.00		65	365	0.00
Seasonal Septic Systems (125' zone)	0	2.5	0.1	8	0.18	0.00		65	90	0.00
Total Septic System Loading						**0.00**				**0.00**

Countryside Lake LLRM

BASIN AREAS										
	BASIN 1	BASIN 2	BASIN 3	BASIN 4	BASIN 5	BASIN 6	BASIN 7	BASIN 8	BASIN 9	BASIN 10
LAND USE	AREA (HA)	AREA (HA)	AREA (HA)	AREA (HA)	AREA (HA)	AREA (HA)	AREA (HA)	AREA (HA)	AREA (HA)	AREA (HA)
Urban 1 (LDR)										
Urban 2 (MDR/Hwy)							28.67			
Urban 3 (HDR/Com)	13.94	30.73	42.83	35.29	44.8	143.95	124.39			
Urban 4 (Ind)							1.8			
Urban 5 (P/I/R/C)										
Agric 1 (Cvr Crop)	0.68	0.95	0.02				0.81			
Agric 2 (Row Crop)	13.12	0.13	0.29		2.86	0.68	25.85			
Agric 3 (Grazing)	7.91	17.97								
Agric 4 (Feedlot)										
Forest 1 (Upland)										
Forest 2 (Wetland)	4.6	2.39	6.57	0.99	2.29	1.79	3.39			
Open 1 (Wetland/Lake)	11.67			1.51		55.99	13.24			
Open 2 (Meadow)	44.05	29.8	1.82	7.34	10.72	34.39	62.02			
Open 3 (Excavation)										
Other 1										
Other 2										
Other 3										

Countryside Lake LLRM

ROUTING PATTERN (Which basin flows to which)										
					PASSES THROUGH...					
1=YES 0=NO XXX=BLANK	BASIN 1	BASIN 2	BASIN 3	BASIN 4	BASIN 5	BASIN 6	BASIN 7	BASIN 8	BASIN 9	BASIN 10
	(CU.M/YR)	(CU.M/YR)	(CU.M/YR)	(CU.M/YR)	(CU.M/YR)	(CU.M/YR)	(CU.M/YR)	(CU.M/YR)	(CU.M/YR)	(CU.M/YR)
INDIVIDUAL BASIN	1	1	1	1	1	1	1	1	1	1
BASIN 1 OUTPUT	XXX	0	0	0	1	0	0	0	0	0
BASIN 2 OUTPUT	0	XXX	0	0	1	0	0	0	0	0
BASIN 3 OUTPUT	0	0	XXX	0	1	0	0	0	0	0
BASIN 4 OUTPUT	0	0	0	XXX	1	0	0	0	0	0
BASIN 5 OUTPUT	0	0	0	0	XXX	0	0	0	0	0
BASIN 6 OUTPUT	0	0	0	0	0	XXX	0	0	0	0
BASIN 7 OUTPUT	0	0	0	0	0	1	XXX	0	0	0
BASIN 8 OUTPUT	0	0	0	0	0	0	0	XXX	0	0
BASIN 9 OUTPUT	0	0	0	0	0	0	0	0	XXX	0
BASIN 10 OUTPUT	0	0	0	0	0	0	0	0	0	XXX

WATER ROUTING AND ATTENUATION										
	BASIN 1	BASIN 2	BASIN 3	BASIN 4	BASIN 5	BASIN 6	BASIN 7	BASIN 8	BASIN 9	BASIN 10
SOURCE	(CU.M/YR)	(CU.M/YR)	(CU.M/YR)	(CU.M/YR)	(CU.M/YR)	(CU.M/YR)	(CU.M/YR)	(CU.M/YR)	(CU.M/YR)	(CU.M/YR)
INDIVIDUAL BASIN	510941.6	475774	330699.2	284611.6	381581.2	1408700.8	1580030.4	0	0	0
BASIN 1 OUTPUT	XXX	0	0	0	459847.44	0	0	0	0	0
BASIN 2 OUTPUT	0	XXX	0	0	428196.6	0	0	0	0	0
BASIN 3 OUTPUT	0	0	XXX	0	281094.32	0	0	0	0	0
BASIN 4 OUTPUT	0	0	0	XXX	270381.02	0	0	0	0	0
BASIN 5 OUTPUT	0	0	0	0	XXX	0	0	0	0	0
BASIN 6 OUTPUT	0	0	0	0	0	XXX	0	0	0	0
BASIN 7 OUTPUT	0	0	0	0	0	1264024.32	XXX	0	0	0
BASIN 8 OUTPUT	0	0	0	0	0	0	0	XXX	0	0
BASIN 9 OUTPUT	0	0	0	0	0	0	0	0	XXX	0
BASIN 10 OUTPUT	0	0	0	0	0	0	0	0	0	XXX
CUMULATIVE TOTAL	510941.6	475774.0	330699.2	284611.6	1821100.6	2672725.1	1580030.4	0	0	0
BASIN ATTENUATION	0.90	0.90	0.85	0.95	0.95	0.95	0.80	1.00	1.00	1.00
OUTPUT VOLUME	459847.4	428196.6	281094.3	270381.0	1730045.6	2539088.9	1264024.32	0	0	0

Countryside Lake LLRM

LOAD ROUTING AND ATTENUATION: PHOSPHORUS							
	BASIN 1 (KG/YR)	BASIN 2 (KG/YR)	BASIN 3 (KG/YR)	BASIN 4 (KG/YR)	BASIN 5 (KG/YR)	BASIN 6 (KG/YR)	BASIN 7 (KG/YR)
BASIN 1 INDIVIDUAL	54.0	64.5	67.8	57.0	75.4	246.6	275.0
BASIN 1 OUTPUT	XXX	0.0	0.0	0.0	48.6	0.0	0.0
BASIN 2 OUTPUT	0.0	XXX	0.0	0.0	58.1	0.0	0.0
BASIN 3 OUTPUT	0.0	0.0	XXX	0.0	44.1	0.0	0.0
BASIN 4 OUTPUT	0.0	0.0	0.0	XXX	51.3	0.0	0.0
BASIN 5 OUTPUT	0.0	0.0	0.0	0.0	XXX	0.0	0.0
BASIN 6 OUTPUT	0.0	0.0	0.0	0.0	0.0	XXX	0.0
BASIN 7 OUTPUT	0.0	0.0	0.0	0.0	0.0	178.7	XXX
BASIN 8 OUTPUT	0.0	0.0	0.0	0.0	0.0	0.0	0.0
BASIN 9 OUTPUT	0.0	0.0	0.0	0.0	0.0	0.0	0.0
BASIN 10 OUTPUT	0.0	0.0	0.0	0.0	0.0	0.0	0.0
CUMULATIVE TOTAL	54.0	64.5	67.8	57.0	277.5	425.4	275.0
BASIN ATTENUATION	0.90	0.90	0.65	0.90	0.95	0.95	0.65
OUTPUT LOAD	48.6	58.1	44.1	51.3	263.6	404.1	178.7

LOAD AND CONCENTRATION SUMMARY: PHOSPHORUS							
	BASIN 1	BASIN 2	BASIN 3	BASIN 4	BASIN 5	BASIN 6	BASIN 7
OUTPUT (CU.M/YR)	459847	428197	281094	270381	1730046	2539089	1264024
OUTPUT (KG/YR)	48.6	58.1	44.1	51.3	263.6	404.1	178.7
OUTPUT (MG/L)	0.106	0.136	0.157	0.190	0.152	0.159	0.141
REALITY CHECK CONC.							
(Based on real data)							
TERMINAL DISCHARGE?	0	0	0	0	1	1	0
(1=YES 2=NO)							
LOAD TO RESOURCE							
WATER (CU.M/YR)	0	0	0	0	1730046	2539089	0
PHOSPHORUS (KG/YR)	0.0	0.0	0.0	0.0	263.6	404.1	0.0
PHOSPHORUS (MG/L)	0.000	0.000	0.000	0.000	0.152	0.159	0.000
BASIN EXPORT COEFFICIENT	0.00	0.00	0.00	0.00	4.34	1.71	0.00

DIRECT LOADS TO LAKE	P	N
ATMOSPHERIC (KG/YR)	11.5	374.2
INTERNAL (KG/YR)	50.0	125.0
WATERFOWL (KG/YR)	10.0	47.5
SEPTIC SYSTEM (KG/YR)	0.0	
WATERSHED LOAD (KG/YR)	667.7	14249.1
TOTAL LOAD TO LAKE (KG/YR)	739.2	14795.9
(Watershed + direct loads)		
TOTAL INPUT CONC. (MG/L)	0.152	3.041

Countryside Lake LLRM

THE MODELS				
	PHOSPHORUS	**PRED.**	**PERMIS.**	**CRITICAL**
		CONC.	**CONC.**	**CONC.**
NAME	**FORMULA**	**(ppb)**	**(ppb)**	**(ppb)**
Mass Balance	TP=L/(Z(F))*1000	152		
(Maximum Conc.)				
Kirchner-Dillon 1975	TP=L(1-Rp)/(Z(F))*1000	85	19	39
(K-D)				
Vollenweider 1975	TP=L/(Z(S+F))*1000	152	34	69
(V)				
Larsen-Mercier 1976	TP=L(1-Rlm)/(Z(F))*1000	104	24	47
(L-M)				
Jones-Bachmann 1976	TP=0.84(L)/(Z(0.65+F))*1000	112	25	51
(J-B)				
Reckhow General (1977)	TP=L/(11.6+1.2(Z(F)))*1000	59	13	27
(Rg)				
Average of Model Values		103	23	46
(without mass balance)				

Diamond Lake LLRM

EXPORT MODEL INPUT AND CALCULATIONS

STD. WATER YIELD (CFS/SQ.MI)	1.5
PRECIPITATION (in M)	0.93

COEFFICIENTS			RUNOFF EXPORT COEFF.			BASEFLOW EXPORT COEFF.		
LAND USE	Runoff Coefficient (Fraction)	Baseflow Coefficient (Fraction)	P Export Coefficient (kg/ha/yr)	N Export Coefficient (kg/ha/yr)	TSS Export Coefficient (kg/ha/yr)	P Export Coefficient (kg/ha/yr)	N Export Coefficient (kg/ha/yr)	TSS Export Coefficient (kg/ha/yr)
Urban 1 (LDR)	0.40	0.25	1.10	5.50	93	0.050	7.50	0.3
Urban 2 (MDR/Hwy)	0.50	0.15	1.10	9.97	93	0.050	15.00	0.3
Urban 3 (HDR/Com)	0.60	0.05	0.75	9.97	93	0.050	30.00	0.3
Urban 4 (Ind)	0.60	0.05	1.10	5.50	93	0.050	7.50	0.3
Urban 5 (P/I/R/C)	0.40	0.25	1.10	5.50	93	0.050	7.50	0.3
Agric 1 (Cvr Crop)	0.15	0.30	1.00	6.08	100	0.050	2.50	0.3
Agric 2 (Row Crop)	0.30	0.30	0.75	9.00	250	0.050	2.50	0.3
Agric 3 (Grazing)	0.30	0.30	0.40	5.19	100	0.050	5.00	0.3
Agric 4 (Feedlot)	0.45	0.30	224.00	2923.20	15000	0.050	25.00	0.3
Forest 1 (Upland)	0.30	0.40	0.05	2.46	16	0.050	0.50	0.3
Forest 2 (Wetland)	0.05	0.40	0.05	2.46	16	0.050	0.50	0.3
Open 1 (Wetland/Lake)	0.05	0.40	0.20	2.46	16	0.050	0.50	0.3
Open 2 (Meadow)	0.15	0.30	0.20	2.46	16	0.050	0.50	0.3
Open 3 (Excavation)	0.40	0.20	0.80	5.19	1000	0.050	0.50	0.3
Other 1	0.10	0.40	0.20	2.46	16	0.050	0.50	0.3
Other 2	0.35	0.25	1.10	5.50	93	0.050	5.00	0.3
Other 3	0.60	0.05	2.20	9.00	250	0.050	20.00	0.3

Diamond Lake LLRM

OTHER AREAL SOURCES	Affected Lake Area (ha)	P Export Coefficient (kg/ha/yr)	N Export Coefficient (kg/ha/yr)	TSS Export Coefficient (kg/ha/yr)	
Atmospheric Deposition					
from Forested Area	62	0.20	6.52	32.0	
from Agricultural/Rural Area	0	0.30	13.13	66.0	
from Urban/Industrial Area	0	1.00	21.36	107.0	97% of shoreline is developed
Internal Loading	8.04	2.00	5.00	1.0	

NON-AREAL SOURCES	Number of Source Units	Volume (cu.m/yr)	P Load (kg/unit/yr)	N Load (kg/unit/yr)	TSS Load (kg/unit/yr)	P Load (ppm)	N Load (ppm)	TSS Load (ppm)
Waterfowl			0.20	0.95	5			
Point Sources								
PS-1		0				0.00	0.00	0.0
PS-2		0				0.00	0.00	0.0
PS-3		0				0.00	0.00	0.0

Basin in which Point Source occurs (0=NO 1=YES)	BASIN 1	BASIN 2	BASIN 3	BASIN 4	BASIN 5	BASIN 6	BASIN 7	BASIN 8	BASIN 9	BASIN 10
PS-1	0	0	0	0	0	0	0	0	0	0
PS-2	0	0	0	0	0	0	0	0	0	0
PS-3	0	0	0	0	0	0	0	0	0	0

SEPTIC SYSTEM LOAD	Number of Dwellings	Number of People/ Dwelling	Atten Factor Phos	Mean TP Conc (mg/L)	P Load (kg/person/ yr)	P Load kg/yr		Water Gallons/Person/Day	Number of Days	Water Load cu.m/yr
Septic System										
Year Round Septic Systems (125' zone	100	2.5	0.1	8	0.72	17.96		65	365	22452.22
Seasonal Septic Systems (125' zone)	0	2.5	0.1	8	0.18	0.00		65	90	0.00
Total Septic System Loading						**17.96**				**22452.22**

Diamond Lake LLRM

BASIN AREAS										
	BASIN 1	BASIN 2	BASIN 3	BASIN 4	BASIN 5	BASIN 6	BASIN 7	BASIN 8	BASIN 9	BASIN 10
LAND USE	AREA (HA)	AREA (HA)	AREA (HA)	AREA (HA)	AREA (HA)	AREA (HA)	AREA (HA)	AREA (HA)	AREA (HA)	AREA (HA)
Urban 1 (LDR)										
Urban 2 (MDR/Hwy)			0.91							
Urban 3 (HDR/Com)	30.64	167.8	136.4							
Urban 4 (Ind)	0.1	1.4	7.28							
Urban 5 (P/I/R/C)										
Agric 1 (Cvr Crop)		0.4								
Agric 2 (Row Crop)	27.49	17.81	24.89							
Agric 3 (Grazing)										
Agric 4 (Feedlot)										
Forest 1 (Upland)										
Forest 2 (Wetland)	3.4	12.6	3.3							
Open 1 (Wetland/Lake)	3.03	8.1	61.2							
Open 2 (Meadow)	138.3	132.9	24.5							
Open 3 (Excavation)										
Other 1										
Other 2										
Other 3										

Diamond Lake LLRM

ROUTING PATTERN (Which basin flows to which)										
					PASSES THROUGH...					
1=YES 0=NO XXX=BLANK	BASIN 1 (CU.M/YR)	BASIN 2 (CU.M/YR)	BASIN 3 (CU.M/YR)	BASIN 4 (CU.M/YR)	BASIN 5 (CU.M/YR)	BASIN 6 (CU.M/YR)	BASIN 7 (CU.M/YR)	BASIN 8 (CU.M/YR)	BASIN 9 (CU.M/YR)	BASIN 10 (CU.M/YR)
INDIVIDUAL BASIN	1	1	1	1	1	1	1	1	1	1
BASIN 1 OUTPUT	XXX	1	0	0	0	0	0	0	0	0
BASIN 2 OUTPUT	0	XXX	1	0	0	0	0	0	0	0
BASIN 3 OUTPUT	0	0	XXX	0	0	0	0	0	0	0
BASIN 4 OUTPUT	0	0	0	XXX	0	0	0	0	0	0
BASIN 5 OUTPUT	0	0	0	0	XXX	0	0	0	0	0
BASIN 6 OUTPUT	0	0	0	0	0	XXX	0	0	0	0
BASIN 7 OUTPUT	0	0	0	0	0	0	XXX	0	0	0
BASIN 8 OUTPUT	0	0	0	0	0	0	0	XXX	0	0
BASIN 9 OUTPUT	0	0	0	0	0	0	0	0	XXX	0
BASIN 10 OUTPUT	0	0	0	0	0	0	0	0	0	XXX

WATER ROUTING AND ATTENUATION										
SOURCE	BASIN 1 (CU.M/YR)	BASIN 2 (CU.M/YR)	BASIN 3 (CU.M/YR)	BASIN 4 (CU.M/YR)	BASIN 5 (CU.M/YR)	BASIN 6 (CU.M/YR)	BASIN 7 (CU.M/YR)	BASIN 8 (CU.M/YR)	BASIN 9 (CU.M/YR)	BASIN 10 (CU.M/YR)
INDIVIDUAL BASIN	944912.55	1766683.8	1385397.75	0	0	0	0	0	0	0
BASIN 1 OUTPUT	XXX	850421.295	0	0	0	0	0	0	0	0
BASIN 2 OUTPUT	0	XXX	2355394.59	0	0	0	0	0	0	0
BASIN 3 OUTPUT	0	0	XXX	0	0	0	0	0	0	0
BASIN 4 OUTPUT	0	0	0	XXX	0	0	0	0	0	0
BASIN 5 OUTPUT	0	0	0	0	XXX	0	0	0	0	0
BASIN 6 OUTPUT	0	0	0	0	0	XXX	0	0	0	0
BASIN 7 OUTPUT	0	0	0	0	0	0	XXX	0	0	0
BASIN 8 OUTPUT	0	0	0	0	0	0	0	XXX	0	0
BASIN 9 OUTPUT	0	0	0	0	0	0	0	0	XXX	0
BASIN 10 OUTPUT	0	0	0	0	0	0	0	0	0	XXX
CUMULATIVE TOTAL	944912.6	2617105.1	3740792.3	0.0	0.0	0.0	0	0	0	0
BASIN ATTENUATION	0.90	0.90	0.85	1.00	1.00	1.00	1.00	1.00	1.00	1.00
OUTPUT VOLUME	850421.3	2355394.6	3179673.5	0.0	0.0	0.0	0	0	0	0

Diamond Lake LLRM

LOAD ROUTING AND ATTENUATION: PHOSPHORUS			
	BASIN 1	BASIN 2	BASIN 3
	(KG/YR)	(KG/YR)	(KG/YR)
BASIN 1 INDIVIDUAL	82.3	187.0	160.2
BASIN 1 OUTPUT	XXX	49.4	0.0
BASIN 2 OUTPUT	0.0	XXX	177.3
BASIN 3 OUTPUT	0.0	0.0	XXX
BASIN 4 OUTPUT	0.0	0.0	0.0
BASIN 5 OUTPUT	0.0	0.0	0.0
BASIN 6 OUTPUT	0.0	0.0	0.0
BASIN 7 OUTPUT	0.0	0.0	0.0
BASIN 8 OUTPUT	0.0	0.0	0.0
BASIN 9 OUTPUT	0.0	0.0	0.0
BASIN 10 OUTPUT	0.0	0.0	0.0
CUMULATIVE TOTAL	82.3	236.4	337.5
BASIN ATTENUATION	0.60	0.75	0.50
OUTPUT LOAD	49.4	177.3	168.8

LOAD AND CONCENTRATION SUMMARY: PHOSPHORUS			
	BASIN 1	BASIN 2	BASIN 3
OUTPUT (CU.M/YR)	850421	2355395	3179673
OUTPUT (KG/YR)	49.4	177.3	168.8
OUTPUT (MG/L)	0.058	0.075	0.053
REALITY CHECK CONC.			
(Based on real data)			
TERMINAL DISCHARGE?	0	0	1
(1=YES 2=NO)			
LOAD TO RESOURCE			
WATER (CU.M/YR)	0	0	3179673
PHOSPHORUS (KG/YR)	0.0	0.0	168.8
PHOSPHORUS (MG/L)	0.000	0.000	0.053
BASIN EXPORT COEFFICIENT	0.00	0.00	0.65

DIRECT LOADS TO LAKE	P	N
ATMOSPHERIC (KG/YR)	12.4	404.2
INTERNAL (KG/YR)	16.1	40.2
WATERFOWL (KG/YR)	0.0	0.0
SEPTIC SYSTEM (KG/YR)	18.0	
WATERSHED LOAD (KG/YR)	168.8	12587.9
TOTAL LOAD TO LAKE (KG/YR)	215.2	13032.3
(Watershed + direct loads)		
TOTAL INPUT CONC. (MG/L)	0.057	3.449

Diamond Lake LLRM

THE MODELS				
	PHOSPHORUS	**PRED.**	**PERMIS.**	**CRITICAL**
		CONC.	**CONC.**	**CONC.**
NAME	**FORMULA**	**(ppb)**	**(ppb)**	**(ppb)**
Mass Balance	TP=L/(Z(F))*1000	57		
(Maximum Conc.)				
Kirchner-Dillon 1975	TP=L(1-Rp)/(Z(F))*1000	27	19	39
(K-D)				
Vollenweider 1975	TP=L/(Z(S+F))*1000	57	41	81
(V)				
Larsen-Mercier 1976	TP=L(1-Rlm)/(Z(F))*1000	34	24	48
(L-M)				
Jones-Bachmann 1976	TP=0.84(L)/(Z(0.65+F))*1000	37	26	52
(J-B)				
Reckhow General (1977)	TP=L/(11.6+1.2(Z(F)))*1000	18	13	26
(Rg)				
Average of Model Values		35	25	49
(without mass balance)				

Forest Lake LLRM

EXPORT MODEL INPUT AND CALCULATIONS

STD. WATER YIELD (CFS/SQ.MI)	1.5
PRECIPITATION (in M)	1.07

COEFFICIENTS			RUNOFF EXPORT COEFF.			BASEFLOW EXPORT COEFF.		
LAND USE	Runoff Coefficient (Fraction)	Baseflow Coefficient (Fraction)	P Export Coefficient (kg/ha/yr)	N Export Coefficient (kg/ha/yr)	TSS Export Coefficient (kg/ha/yr)	P Export Coefficient (kg/ha/yr)	N Export Coefficient (kg/ha/yr)	TSS Export Coefficient (kg/ha/yr)
Urban 1 (LDR)	0.40	0.25	1.10	5.50	93	0.050	7.50	0.3
Urban 2 (MDR/Hwy)	0.50	0.15	1.70	9.97	93	0.050	15.00	0.3
Urban 3 (HDR/Com)	0.60	0.05	1.70	9.97	93	0.050	30.00	0.3
Urban 4 (Ind)	0.60	0.05	1.70	5.50	93	0.050	7.50	0.3
Urban 5 (P/I/R/C)	0.40	0.25	1.10	5.50	93	0.050	7.50	0.3
Agric 1 (Cvr Crop)	0.15	0.30	0.80	6.08	100	0.050	2.50	0.3
Agric 2 (Row Crop)	0.30	0.30	2.20	9.00	250	0.050	2.50	0.3
Agric 3 (Grazing)	0.30	0.30	0.80	5.19	100	0.050	5.00	0.3
Agric 4 (Feedlot)	0.45	0.30	224.00	2923.20	15000	0.050	25.00	0.3
Forest 1 (Upland)	0.30	0.40	0.05	2.46	16	0.050	0.50	0.3
Forest 2 (Wetland)	0.05	0.40	0.05	2.46	16	0.050	0.50	0.3
Open 1 (Wetland/Lake)	0.05	0.40	0.20	2.46	16	0.050	0.50	0.3
Open 2 (Meadow)	0.15	0.30	0.20	2.46	16	0.050	0.50	0.3
Open 3 (Excavation)	0.40	0.20	0.80	5.19	1000	0.050	0.50	0.3
Other 1	0.10	0.40	0.20	2.46	16	0.050	0.50	0.3
Other 2	0.35	0.25	1.10	5.50	93	0.050	5.00	0.3
Other 3	0.60	0.05	2.20	9.00	250	0.050	20.00	0.3

Forest Lake LLRM

OTHER AREAL SOURCES	Affected Lake Area (ha)	P Export Coefficient (kg/ha/yr)	N Export Coefficient (kg/ha/yr)	TSS Export Coefficient (kg/ha/yr)
Atmospheric Deposition				
from Forested Area	15.9	0.20	6.52	32.0
from Agricultural/Rural Area	0	0.30	13.13	66.0
from Urban/Industrial Area	0	1.00	21.36	107.0
Internal Loading	0	2.00	5.00	1.0

NON-AREAL SOURCES	Number of Source Units	Volume (cu.m/yr)	P Load (kg/unit/yr)	N Load (kg/unit/yr)	TSS Load (kg/unit/yr)	P Load (ppm)	N Load (ppm)	TSS Load (ppm)
Waterfowl	100		0.20	0.95	5			
Point Sources								
PS-1		0				0.00	0.00	0.0
PS-2		0				0.00	0.00	0.0
PS-3		0				0.00	0.00	0.0

Basin in which Point Source occurs (0=NO 1=YES)

	BASIN 1	BASIN 2	BASIN 3	BASIN 4	BASIN 5	BASIN 6	BASIN 7	BASIN 8	BASIN 9	BASIN 10
PS-1	0	0	0	0	0	0	0	0	0	0
PS-2	0	0	0	0	0	0	0	0	0	0
PS-3	0	0	0	0	0	0	0	0	0	0

SEPTIC SYSTEM LOAD	Number of Dwellings	Number of People/ Dwelling	Atten Factor Phos	Mean TP Conc (mg/L)	P Load (kg/person/ yr)	P Load kg/yr		Water Gallons/Person/Day	Number of Days	Water Load cu.m/yr
Septic System										
Year Round Septic Systems (125' zone	0	2.5	0.1	8	0.72	0.00		65	365	0.00
Seasonal Septic Systems (125' zone)	0	2.5	0.1	8	0.18	0.00		65	90	0.00
Total Septic System Loading						**0.00**				**0.00**

Forest Lake LLRM

BASIN AREAS										
	BASIN 1	BASIN 2	BASIN 3	BASIN 4	BASIN 5	BASIN 6	BASIN 7	BASIN 8	BASIN 9	BASIN 10
LAND USE	AREA (HA)	AREA (HA)	AREA (HA)	AREA (HA)	AREA (HA)	AREA (HA)	AREA (HA)	AREA (HA)	AREA (HA)	AREA (HA)
Urban 1 (LDR)	1.44									
Urban 2 (MDR/Hwy)										
Urban 3 (HDR/Com)	19.65	13.74	40.68	49	21.1					
Urban 4 (Ind)	0.73	0.3	4.5		0.31					
Urban 5 (P/I/R/C)										
Agric 1 (Cvr Crop)	0.4									
Agric 2 (Row Crop)	3.22	9.89	1.39	0.02						
Agric 3 (Grazing)	0.12	0.19								
Agric 4 (Feedlot)										
Forest 1 (Upland)										
Forest 2 (Wetland)			4.4	1.6						
Open 1 (Wetland/Lake)					15.2					
Open 2 (Meadow)	5.5	7.5	2.15	10.4						
Open 3 (Excavation)										
Other 1										
Other 2										
Other 3										

Forest Lake LLRM

ROUTING PATTERN (Which basin flows to which)										
					PASSES THROUGH...					
1=YES 0=NO XXX=BLANK	BASIN 1	BASIN 2	BASIN 3	BASIN 4	BASIN 5	BASIN 6	BASIN 7	BASIN 8	BASIN 9	BASIN 10
	(CU.M/YR)	(CU.M/YR)	(CU.M/YR)	(CU.M/YR)	(CU.M/YR)	(CU.M/YR)	(CU.M/YR)	(CU.M/YR)	(CU.M/YR)	(CU.M/YR)
INDIVIDUAL BASIN	1	1	1	1	1	1	1	1	1	1
BASIN 1 OUTPUT	XXX	0	0	0	1	0	0	0	0	0
BASIN 2 OUTPUT	0	XXX	0	0	1	0	0	0	0	0
BASIN 3 OUTPUT	0	0	XXX	0	1	0	0	0	0	0
BASIN 4 OUTPUT	0	0	0	XXX	1	0	0	0	0	0
BASIN 5 OUTPUT	0	0	0	0	XXX	0	0	0	0	0
BASIN 6 OUTPUT	0	0	0	0	0	XXX	0	0	0	0
BASIN 7 OUTPUT	0	0	0	0	0	0	XXX	0	0	0
BASIN 8 OUTPUT	0	0	0	0	0	0	0	XXX	0	0
BASIN 9 OUTPUT	0	0	0	0	0	0	0	0	XXX	0
BASIN 10 OUTPUT	0	0	0	0	0	0	0	0	0	XXX

WATER ROUTING AND ATTENUATION										
	BASIN 1	BASIN 2	BASIN 3	BASIN 4	BASIN 5	BASIN 6	BASIN 7	BASIN 8	BASIN 9	BASIN 10
SOURCE	(CU.M/YR)	(CU.M/YR)	(CU.M/YR)	(CU.M/YR)	(CU.M/YR)	(CU.M/YR)	(CU.M/YR)	(CU.M/YR)	(CU.M/YR)	(CU.M/YR)
INDIVIDUAL BASIN	201609.4	198474.3	354688.95	398703.4	222094.55	0	0	0	0	0
BASIN 1 OUTPUT	XXX	0	0	0	191528.93	0	0	0	0	0
BASIN 2 OUTPUT	0	XXX	0	0	188550.585	0	0	0	0	0
BASIN 3 OUTPUT	0	0	XXX	0	283751.16	0	0	0	0	0
BASIN 4 OUTPUT	0	0	0	XXX	318962.72	0	0	0	0	0
BASIN 5 OUTPUT	0	0	0	0	XXX	0	0	0	0	0
BASIN 6 OUTPUT	0	0	0	0	0	XXX	0	0	0	0
BASIN 7 OUTPUT	0	0	0	0	0	0	XXX	0	0	0
BASIN 8 OUTPUT	0	0	0	0	0	0	0	XXX	0	0
BASIN 9 OUTPUT	0	0	0	0	0	0	0	0	XXX	0
BASIN 10 OUTPUT	0	0	0	0	0	0	0	0	0	XXX
CUMULATIVE TOTAL	201609.4	198474.3	354689.0	398703.4	1204887.9	0.0	0	0	0	0
BASIN ATTENUATION	0.95	0.95	0.80	0.80	0.95	1.00	1.00	1.00	1.00	1.00
OUTPUT VOLUME	191528.9	188550.6	283751.2	318962.7	1144643.5	0.0	0	0	0	0

Forest Lake LLRM

LOAD ROUTING AND ATTENUATION: PHOSPHORUS					
	BASIN 1 (KG/YR)	BASIN 2 (KG/YR)	BASIN 3 (KG/YR)	BASIN 4 (KG/YR)	BASIN 5 (KG/YR)
BASIN 1 INDIVIDUAL	46.4	48.9	83.2	88.6	41.3
BASIN 1 OUTPUT	XXX	0.0	0.0	0.0	41.7
BASIN 2 OUTPUT	0.0	XXX	0.0	0.0	44.0
BASIN 3 OUTPUT	0.0	0.0	XXX	0.0	62.4
BASIN 4 OUTPUT	0.0	0.0	0.0	XXX	70.8
BASIN 5 OUTPUT	0.0	0.0	0.0	0.0	XXX
BASIN 6 OUTPUT	0.0	0.0	0.0	0.0	0.0
BASIN 7 OUTPUT	0.0	0.0	0.0	0.0	0.0
BASIN 8 OUTPUT	0.0	0.0	0.0	0.0	0.0
BASIN 9 OUTPUT	0.0	0.0	0.0	0.0	0.0
BASIN 10 OUTPUT	0.0	0.0	0.0	0.0	0.0
CUMULATIVE TOTAL	46.4	48.9	83.2	88.6	260.2
BASIN ATTENUATION	0.90	0.90	0.75	0.80	0.90
OUTPUT LOAD	41.7	44.0	62.4	70.8	234.2

LOAD AND CONCENTRATION SUMMARY: PHOSPHORUS					
	BASIN 1	BASIN 2	BASIN 3	BASIN 4	BASIN 5
OUTPUT (CU.M/YR)	191529	188551	283751	318963	1144644
OUTPUT (KG/YR)	41.7	44.0	62.4	70.8	234.2
OUTPUT (MG/L)	0.218	0.233	0.220	0.222	0.205
REALITY CHECK CONC.					
(Based on real data)					
TERMINAL DISCHARGE?	0	0	0	0	1
(1=YES 2=NO)					
LOAD TO RESOURCE					
WATER (CU.M/YR)	0	0	0	0	1144644
PHOSPHORUS (KG/YR)	0.0	0.0	0.0	0.0	234.2
PHOSPHORUS (MG/L)	0.000	0.000	0.000	0.000	0.205
BASIN EXPORT COEFFICIENT	0.00	0.00	0.00	0.00	6.40

DIRECT LOADS TO LAKE	P	N
ATMOSPHERIC (KG/YR)	3.2	103.7
INTERNAL (KG/YR)	0.0	0.0
WATERFOWL (KG/YR)	20.0	95.0
SEPTIC SYSTEM (KG/YR)	0.0	
WATERSHED LOAD (KG/YR)	234.2	4252.1
TOTAL LOAD TO LAKE (KG/YR)	257.4	4450.7
(Watershed + direct loads)		
TOTAL INPUT CONC. (MG/L)	0.196	3.385

Forest Lake LLRM

THE MODELS				
	PHOSPHORUS	**PRED.**	**PERMIS.**	**CRITICAL**
		CONC.	**CONC.**	**CONC.**
NAME	**FORMULA**	**(ppb)**	**(ppb)**	**(ppb)**
Mass Balance	TP=L/(Z(F))*1000	196		
(Maximum Conc.)				
Kirchner-Dillon 1975	TP=L(1-Rp)/(Z(F))*1000	109	19	39
(K-D)				
Vollenweider 1975	TP=L/(Z(S+F))*1000	196	35	69
(V)				
Larsen-Mercier 1976	TP=L(1-Rlm)/(Z(F))*1000	139	25	49
(L-M)				
Jones-Bachmann 1976	TP=0.84(L)/(Z(0.65+F))*1000	148	26	53
(J-B)				
Reckhow General (1977)	TP=L/(11.6+1.2(Z(F)))*1000	75	13	27
(Rg)				
Average of Model Values		133	24	47
(without mass balance)				

Halfday Pit LLRM

EXPORT MODEL INPUT AND CALCULATIONS

STD. WATER YIELD (CFS/SQ.MI)	1.5
PRECIPITATION (in M)	0.81

COEFFICIENTS			RUNOFF EXPORT COEFF.			BASEFLOW EXPORT COEFF.		
LAND USE	Runoff Coefficient (Fraction)	Baseflow Coefficient (Fraction)	P Export Coefficient (kg/ha/yr)	N Export Coefficient (kg/ha/yr)	TSS Export Coefficient (kg/ha/yr)	P Export Coefficient (kg/ha/yr)	N Export Coefficient (kg/ha/yr)	TSS Export Coefficient (kg/ha/yr)
Urban 1 (LDR)	0.30	0.25	2.50	5.50	93	0.050	7.50	0.3
Urban 2 (MDR/Hwy)	0.40	0.15	2.50	9.97	93	0.050	15.00	0.3
Urban 3 (HDR/Com)	0.50	0.05	3.00	9.97	93	0.050	30.00	0.3
Urban 4 (Ind)	0.60	0.05	2.50	5.50	93	0.050	7.50	0.3
Urban 5 (P/I/R/C)	0.40	0.25	2.50	5.50	93	0.050	7.50	0.3
Agric 1 (Cvr Crop)	0.15	0.30	1.08	6.08	100	0.050	2.50	0.3
Agric 2 (Row Crop)	0.30	0.30	4.46	9.00	250	0.050	2.50	0.3
Agric 3 (Grazing)	0.30	0.30	1.50	5.19	100	0.050	5.00	0.3
Agric 4 (Feedlot)	0.45	0.30	300.70	2923.20	15000	0.050	25.00	0.3
Forest 1 (Upland)	0.30	0.40	0.24	2.46	16	0.050	0.50	0.3
Forest 2 (Wetland)	0.05	0.40	0.24	2.46	16	0.050	0.50	0.3
Open 1 (Wetland/Lake)	0.05	0.40	0.40	2.46	16	0.050	0.50	0.3
Open 2 (Meadow)	0.05	0.30	0.40	2.46	16	0.050	0.50	0.3
Open 3 (Excavation)	0.40	0.20	1.50	5.19	1000	0.050	0.50	0.3
Other 1	0.10	0.40	0.24	2.46	16	0.050	0.50	0.3
Other 2	0.35	0.25	1.91	5.50	93	0.050	5.00	0.3
Other 3	0.60	0.05	4.46	9.00	250	0.050	20.00	0.3

Halfday Pit LLRM

OTHER AREAL SOURCES	Affected Lake Area (ha)	P Export Coefficient (kg/ha/yr)	N Export Coefficient (kg/ha/yr)	TSS Export Coefficient (kg/ha/yr)
Atmospheric Deposition				
from Forested Area	0	0.20	6.52	32.0
from Agricultural/Rural Area	0	0.30	13.13	66.0
from Urban/Industrial Area	5.7	1.00	21.36	107.0
Internal Loading	5	2.00	5.00	1.0

NON-AREAL SOURCES	Number of Source Units	Volume (cu.m/yr)	P Load (kg/unit/yr)	N Load (kg/unit/yr)	TSS Load (kg/unit/yr)	P Load (ppm)	N Load (ppm)	TSS Load (ppm)
Waterfowl	100		0.20	0.95	5			
Point Sources								
PS-1 (Direct to Lake)		1126791.28				0.15	0.00	0.0
PS-2		0				0.00	0.00	0.0
PS-3		0				0.00	0.00	0.0

Basin in which Point Source occurs (0=NO 1=YES)

	BASIN 1	BASIN 2	BASIN 3	BASIN 4	BASIN 5	BASIN 6	BASIN 7	BASIN 8	BASIN 9	BASIN 10
PS-1	0	0	0	0	0	0	0	0	0	0
PS-2	0	0	0	0	0	0	0	0	0	0
PS-3	0	0	0	0	0	0	0	0	0	0

SEPTIC SYSTEM LOAD	Number of Dwellings	Number of People/ Dwelling	Atten Factor Phos	Mean TP Conc (mg/L)	P Load (kg/person/ yr)	P Load kg/yr		Water Gallons/Per son/Day	Number of Days	Water Load cu.m/yr
Septic System										
Year Round Septic Systems (125' zone	0	2.5	0.1	8	0.72	0.00		65	365	0.00
Seasonal Septic Systems (125' zone)	0	2.5	0.1	8	0.18	0.00		65	90	0.00
Total Septic System Loading						**0.00**				**0.00**

Halfday Pit LLRM

BASIN AREAS						
LAND USE	BASIN 1 AREA (HA)	BASIN 2 AREA (HA)	BASIN 3 AREA (HA)	BASIN 4 AREA (HA)	BASIN 5 AREA (HA)	BASIN 6 AREA (HA)
Urban 1 (LDR)						
Urban 2 (MDR/Hwy)						
Urban 3 (HDR/Com)	2.07500647					
Urban 4 (Ind)						
Urban 5 (P/I/R/C)						
Agric 1 (Cvr Crop)						
Agric 2 (Row Crop)						
Agric 3 (Grazing)						
Agric 4 (Feedlot)						
Forest 1 (Upland)						
Forest 2 (Wetland)						
Open 1 (Wetland/Lake)	4.96067526					
Open 2 (Meadow)	22.3737208					
Open 3 (Excavation)						
Other 1						
Other 2						
Other 3						

Halfday Pit LLRM

ROUTING PATTERN (Which basin flows to which)										
					PASSES THROUGH...					
1=YES 0=NO XXX=BLANK	BASIN 1	BASIN 2	BASIN 3	BASIN 4	BASIN 5	BASIN 6	BASIN 7	BASIN 8	BASIN 9	BASIN 10
	(CU.M/YR)	(CU.M/YR)	(CU.M/YR)	(CU.M/YR)	(CU.M/YR)	(CU.M/YR)	(CU.M/YR)	(CU.M/YR)	(CU.M/YR)	(CU.M/YR)
INDIVIDUAL BASIN	1	1	1	1	1	1	1	1	1	1
BASIN 1 OUTPUT	XXX	0	0	0	0	0	0	0	0	0
BASIN 2 OUTPUT	0	XXX	0	0	0	0	0	0	0	0
BASIN 3 OUTPUT	0	0	XXX	0	0	0	0	0	0	0
BASIN 4 OUTPUT	0	0	0	XXX	0	0	0	0	0	0
BASIN 5 OUTPUT	0	0	0	0	XXX	0	0	0	0	0
BASIN 6 OUTPUT	0	0	0	0	0	XXX	0	0	0	0
BASIN 7 OUTPUT	0	0	0	0	0	0	XXX	0	0	0
BASIN 8 OUTPUT	0	0	0	0	0	0	0	XXX	0	0
BASIN 9 OUTPUT	0	0	0	0	0	0	0	0	XXX	0
BASIN 10 OUTPUT	0	0	0	0	0	0	0	0	0	XXX

WATER ROUTING AND ATTENUATION										
	BASIN 1	BASIN 2	BASIN 3	BASIN 4	BASIN 5	BASIN 6	BASIN 7	BASIN 8	BASIN 9	BASIN 10
SOURCE	(CU.M/YR)	(CU.M/YR)	(CU.M/YR)	(CU.M/YR)	(CU.M/YR)	(CU.M/YR)	(CU.M/YR)	(CU.M/YR)	(CU.M/YR)	(CU.M/YR)
INDIVIDUAL BASIN	90755.3136	0	0	0	0	0	0	0	0	0
BASIN 1 OUTPUT	XXX	0	0	0	0	0	0	0	0	0
BASIN 2 OUTPUT	0	XXX	0	0	0	0	0	0	0	0
BASIN 3 OUTPUT	0	0	XXX	0	0	0	0	0	0	0
BASIN 4 OUTPUT	0	0	0	XXX	0	0	0	0	0	0
BASIN 5 OUTPUT	0	0	0	0	XXX	0	0	0	0	0
BASIN 6 OUTPUT	0	0	0	0	0	XXX	0	0	0	0
BASIN 7 OUTPUT	0	0	0	0	0	0	XXX	0	0	0
BASIN 8 OUTPUT	0	0	0	0	0	0	0	XXX	0	0
BASIN 9 OUTPUT	0	0	0	0	0	0	0	0	XXX	0
BASIN 10 OUTPUT	0	0	0	0	0	0	0	0	0	XXX
CUMULATIVE TOTAL	90755.3	0.0	0.0	0.0	0.0	0.0	0	0	0	0
BASIN ATTENUATION	60.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00
Direct POINT SOURCE	1126791.28									
OUTPUT VOLUME	6572110.1	0.0	0.0	0.0	0.0	0.0	0	0	0	0

Halfday Pit LLRM

LOAD ROUTING AND ATTENUATION: PHOSPHORUS	
	BASIN 1
	(KG/YR)
BASIN 1 INDIVIDUAL	18.6
BASIN 1 OUTPUT	XXX
BASIN 2 OUTPUT	0.0
BASIN 3 OUTPUT	0.0
BASIN 4 OUTPUT	0.0
BASIN 5 OUTPUT	0.0
BASIN 6 OUTPUT	0.0
BASIN 7 OUTPUT	0.0
BASIN 8 OUTPUT	0.0
BASIN 9 OUTPUT	0.0
BASIN 10 OUTPUT	0.0
CUMULATIVE TOTAL	18.6
BASIN ATTENUATION	90.00
Direct Point Source	164.51
OUTPUT LOAD	1841.1

LOAD AND CONCENTRATION SUMMARY: PHOSPH	
	BASIN 1
OUTPUT (CU.M/YR)	6572110
OUTPUT (KG/YR)	1841.1
OUTPUT (MG/L)	0.280
REALITY CHECK CONC.	
(Based on real data)	
TERMINAL DISCHARGE?	1
(1=YES 2=NO)	
LOAD TO RESOURCE	
WATER (CU.M/YR)	6572110
PHOSPHORUS (KG/YR)	1841.1
PHOSPHORUS (MG/L)	0.280
BASIN EXPORT COEFFICIENT	62.60

DIRECT LOADS TO LAKE	P	N
ATMOSPHERIC (KG/YR)	5.7	121.8
INTERNAL (KG/YR)	10.0	25.0
WATERFOWL (KG/YR)	20.0	95.0
SEPTIC SYSTEM (KG/YR)	0.0	
WATERSHED LOAD (KG/YR)	1841.1	147.5
TOTAL LOAD TO LAKE (KG/YR)	1876.8	389.2
(Watershed + direct loads)		
TOTAL INPUT CONC. (MG/L)	0.284	0.059

Halfday Pit LLRM

THE MODELS				
	PHOSPHORUS	**PRED.**	**PERMIS.**	**CRITICAL**
		CONC.	**CONC.**	**CONC.**
NAME	**FORMULA**	**(ppb)**	**(ppb)**	**(ppb)**
Mass Balance	TP=L/(Z(F))*1000	284		
(Maximum Conc.)				
Kirchner-Dillon 1975	TP=L(1-Rp)/(Z(F))*1000	268	9	18
(K-D)				
Vollenweider 1975	TP=L/(Z(S+F))*1000	284	9	19
(V)				
Larsen-Mercier 1976	TP=L(1-Rlm)/(Z(F))*1000	250	8	16
(L-M)				
Jones-Bachmann 1976	TP=0.84(L)/(Z(0.65+F))*1000	235	8	15
(J-B)				
Reckhow General (1977)	TP=L/(11.6+1.2(Z(F)))*1000	218	7	14
(Rg)				
Average of Model Values		251	8	16
(without mass balance)				

Lake Charles LLRM

EXPORT MODEL INPUT AND CALCULATIONS

STD. WATER YIELD (CFS/SQ.MI)	1.5
PRECIPITATION (in M)	1.04

COEFFICIENTS			RUNOFF EXPORT COEFF.			BASEFLOW EXPORT COEFF.		
LAND USE	Runoff Coefficient (Fraction)	Baseflow Coefficient (Fraction)	P Export Coefficient (kg/ha/yr)	N Export Coefficient (kg/ha/yr)	TSS Export Coefficient (kg/ha/yr)	P Export Coefficient (kg/ha/yr)	N Export Coefficient (kg/ha/yr)	TSS Export Coefficient (kg/ha/yr)
Urban 1 (LDR)	0.40	0.25	1.10	5.50	93	0.050	7.50	0.3
Urban 2 (MDR/Hwy)	0.50	0.15	1.10	9.97	93	0.050	15.00	0.3
Urban 3 (HDR/Com)	0.60	0.05	0.85	9.97	93	0.050	30.00	0.3
Urban 4 (Ind)	0.60	0.05	0.85	5.50	93	0.050	7.50	0.3
Urban 5 (P/I/R/C)	0.40	0.25	1.10	5.50	93	0.050	7.50	0.3
Agric 1 (Cvr Crop)	0.15	0.30	1.00	6.08	100	0.050	2.50	0.3
Agric 2 (Row Crop)	0.30	0.30	2.20	9.00	250	0.050	2.50	0.3
Agric 3 (Grazing)	0.30	0.30	0.40	5.19	100	0.050	5.00	0.3
Agric 4 (Feedlot)	0.45	0.30	224.00	2923.20	15000	0.050	25.00	0.3
Forest 1 (Upland)	0.30	0.40	0.05	2.46	16	0.050	0.50	0.3
Forest 2 (Wetland)	0.05	0.40	0.05	2.46	16	0.050	0.50	0.3
Open 1 (Wetland/Lake)	0.05	0.40	0.20	2.46	16	0.050	0.50	0.3
Open 2 (Meadow)	0.15	0.30	0.10	2.46	16	0.050	0.50	0.3
Open 3 (Excavation)	0.40	0.20	0.80	5.19	1000	0.050	0.50	0.3
Other 1	0.10	0.40	0.20	2.46	16	0.050	0.50	0.3
Other 2	0.35	0.25	1.10	5.50	93	0.050	5.00	0.3
Other 3	0.60	0.05	2.20	9.00	250	0.050	20.00	0.3

Lake Charles LLRM

OTHER AREAL SOURCES	Affected Lake Area (ha)	P Export Coefficient (kg/ha/yr)	N Export Coefficient (kg/ha/yr)	TSS Export Coefficient (kg/ha/yr)
Atmospheric Deposition				
from Forested Area	15.9	0.20	6.52	32.0
from Agricultural/Rural Area	0	0.30	13.13	66.0
from Urban/Industrial Area	0	1.00	21.36	107.0
Internal Loading	0	2.00	5.00	1.0

NON-AREAL SOURCES	Number of Source Units	Volume (cu.m/yr)	P Load (kg/unit/yr)	N Load (kg/unit/yr)	TSS Load (kg/unit/yr)	P Load (ppm)	N Load (ppm)	TSS Load (ppm)		
Waterfowl	50		0.20	0.95	5					
Point Sources										
PS-1		0				0.00	0.00	0.0		
PS-2		0				0.00	0.00	0.0		
PS-3		0				0.00	0.00	0.0		
Basin in which Point Source occurs (0=NO 1=YES)										
	BASIN 1	BASIN 2	BASIN 3	BASIN 4	BASIN 5	BASIN 6	BASIN 7	BASIN 8	BASIN 9	BASIN 10
PS-1	0	0	0	0	0	0	0	0	0	0
PS-2	0	0	0	0	0	0	0	0	0	0
PS-3	0	0	0	0	0	0	0	0	0	0

SEPTIC SYSTEM LOAD	Number of Dwellings	Number of People/ Dwelling	Atten Factor Phos	Mean TP Conc (mg/L)	P Load (kg/person/ yr)	P Load kg/yr		Water Gallons/Per son/Day	Number of Days	Water Load cu.m/yr
Septic System										
Year Round Septic Systems (125' zone	0	2.5	0.1	8	0.72	0.00		65	365	0.00
Seasonal Septic Systems (125' zone)	0	2.5	0.1	8	0.18	0.00		65	90	0.00
Total Septic System Loading						**0.00**				**0.00**

Lake Charles LLRM

BASIN AREAS										
	BASIN 1	BASIN 2	BASIN 3	BASIN 4	BASIN 5	BASIN 6	BASIN 7	BASIN 8	BASIN 9	BASIN 10
LAND USE	AREA (HA)	AREA (HA)	AREA (HA)	AREA (HA)	AREA (HA)	AREA (HA)	AREA (HA)	AREA (HA)	AREA (HA)	AREA (HA)
Urban 1 (LDR)										
Urban 2 (MDR/Hwy)			9.69							
Urban 3 (HDR/Com)	138.66	143.65	436.4							
Urban 4 (Ind)	20.55	8.48	51.1							
Urban 5 (P/I/R/C)										
Agric 1 (Cvr Crop)										
Agric 2 (Row Crop)	6.5									
Agric 3 (Grazing)										
Agric 4 (Feedlot)										
Forest 1 (Upland)										
Forest 2 (Wetland)			6.6							
Open 1 (Wetland/Lake)	1.5		18.9							
Open 2 (Meadow)	29.9	7.1	141.5							
Open 3 (Excavation)										
Other 1										
Other 2										
Other 3										

Lake Charles LLRM

ROUTING PATTERN (Which basin flows to which)										
					PASSES THROUGH...					
1=YES 0=NO XXX=BLANK	BASIN 1 (CU.M/YR)	BASIN 2 (CU.M/YR)	BASIN 3 (CU.M/YR)	BASIN 4 (CU.M/YR)	BASIN 5 (CU.M/YR)	BASIN 6 (CU.M/YR)	BASIN 7 (CU.M/YR)	BASIN 8 (CU.M/YR)	BASIN 9 (CU.M/YR)	BASIN 10 (CU.M/YR)
INDIVIDUAL BASIN	1	1	1	1	1	1	1	1	1	1
BASIN 1 OUTPUT	XXX	1	0	0	0	0	0	0	0	0
BASIN 2 OUTPUT	0	XXX	1	0	0	0	0	0	0	0
BASIN 3 OUTPUT	0	0	XXX	0	0	0	0	0	0	0
BASIN 4 OUTPUT	0	0	0	XXX	0	0	0	0	0	0
BASIN 5 OUTPUT	0	0	0	0	XXX	0	0	0	0	0
BASIN 6 OUTPUT	0	0	0	0	0	XXX	0	0	0	0
BASIN 7 OUTPUT	0	0	0	0	0	0	XXX	0	0	0
BASIN 8 OUTPUT	0	0	0	0	0	0	0	XXX	0	0
BASIN 9 OUTPUT	0	0	0	0	0	0	0	0	XXX	0
BASIN 10 OUTPUT	0	0	0	0	0	0	0	0	0	XXX

WATER ROUTING AND ATTENUATION										
	BASIN 1	BASIN 2	BASIN 3	BASIN 4	BASIN 5	BASIN 6	BASIN 7	BASIN 8	BASIN 9	BASIN 10
SOURCE	(CU.M/YR)	(CU.M/YR)	(CU.M/YR)	(CU.M/YR)	(CU.M/YR)	(CU.M/YR)	(CU.M/YR)	(CU.M/YR)	(CU.M/YR)	(CU.M/YR)
INDIVIDUAL BASIN	1263771.6	1061626.8	4142564.4	0	0	0	0	0	0	0
BASIN 1 OUTPUT	XXX	1200583.02	0	0	0	0	0	0	0	0
BASIN 2 OUTPUT	0	XXX	2149099.33	0	0	0	0	0	0	0
BASIN 3 OUTPUT	0	0	XXX	0	0	0	0	0	0	0
BASIN 4 OUTPUT	0	0	0	XXX	0	0	0	0	0	0
BASIN 5 OUTPUT	0	0	0	0	XXX	0	0	0	0	0
BASIN 6 OUTPUT	0	0	0	0	0	XXX	0	0	0	0
BASIN 7 OUTPUT	0	0	0	0	0	0	XXX	0	0	0
BASIN 8 OUTPUT	0	0	0	0	0	0	0	XXX	0	0
BASIN 9 OUTPUT	0	0	0	0	0	0	0	0	XXX	0
BASIN 10 OUTPUT	0	0	0	0	0	0	0	0	0	XXX
CUMULATIVE TOTAL	1263771.6	2262209.8	6291663.7	0.0	0.0	0.0	0	0	0	0
BASIN ATTENUATION	0.95	0.95	0.90	1.00	1.00	1.00	1.00	1.00	1.00	1.00
OUTPUT VOLUME	1200583.0	2149099.3	5662497.4	0.0	0.0	0.0	0	0	0	0

Lake Charles LLRM

LOAD ROUTING AND ATTENUATION: PHOSPHORUS			
	BASIN 1	BASIN 2	BASIN 3
	(KG/YR)	(KG/YR)	(KG/YR)
BASIN 1 INDIVIDUAL	162.8	138.0	476.5
BASIN 1 OUTPUT	XXX	138.4	0.0
BASIN 2 OUTPUT	0.0	XXX	234.9
BASIN 3 OUTPUT	0.0	0.0	XXX
BASIN 4 OUTPUT	0.0	0.0	0.0
BASIN 5 OUTPUT	0.0	0.0	0.0
BASIN 6 OUTPUT	0.0	0.0	0.0
BASIN 7 OUTPUT	0.0	0.0	0.0
BASIN 8 OUTPUT	0.0	0.0	0.0
BASIN 9 OUTPUT	0.0	0.0	0.0
BASIN 10 OUTPUT	0.0	0.0	0.0
CUMULATIVE TOTAL	162.8	276.3	711.4
BASIN ATTENUATION	0.85	0.85	0.55
OUTPUT LOAD	138.4	234.9	391.3

LOAD AND CONCENTRATION SUMMARY: PHOSPHORUS			
	BASIN 1	BASIN 2	BASIN 3
OUTPUT (CU.M/YR)	1200583	2149099	5662497
OUTPUT (KG/YR)	138.4	234.9	391.3
OUTPUT (MG/L)	0.115	0.109	0.069
REALITY CHECK CONC.			
(Based on real data)			
TERMINAL DISCHARGE?	0	0	1
(1=YES 2=NO)			
LOAD TO RESOURCE			
WATER (CU.M/YR)	0	0	5662497
PHOSPHORUS (KG/YR)	0.0	0.0	391.3
PHOSPHORUS (MG/L)	0.000	0.000	0.069
BASIN EXPORT COEFFICIENT	0.00	0.00	0.59

DIRECT LOADS TO LAKE	P	N
ATMOSPHERIC (KG/YR)	3.2	103.7
INTERNAL (KG/YR)	0.0	0.0
WATERFOWL (KG/YR)	10.0	47.5
SEPTIC SYSTEM (KG/YR)	0.0	
WATERSHED LOAD (KG/YR)	391.3	14552.2
TOTAL LOAD TO LAKE (KG/YR)	404.4	14703.4
(Watershed + direct loads)		
TOTAL INPUT CONC. (MG/L)	0.069	2.523

Lake Charles LLRM

THE MODELS				
	PHOSPHORUS	**PRED.**	**PERMIS.**	**CRITICAL**
		CONC.	**CONC.**	**CONC.**
NAME	**FORMULA**	**(ppb)**	**(ppb)**	**(ppb)**
Mass Balance	TP=L/(Z(F))*1000	69		
(Maximum Conc.)				
Kirchner-Dillon 1975	TP=L(1-Rp)/(Z(F))*1000	59	14	28
(K-D)				
Vollenweider 1975	TP=L/(Z(S+F))*1000	69	17	33
(V)				
Larsen-Mercier 1976	TP=L(1-Rlm)/(Z(F))*1000	57	14	27
(L-M)				
Jones-Bachmann 1976	TP=0.84(L)/(Z(0.65+F))*1000	57	13	27
(J-B)				
Reckhow General (1977)	TP=L/(11.6+1.2(Z(F)))*1000	46	11	22
(Rg)				
Average of Model Values		58	14	27
(without mass balance)				

Little Bear Lake LLRM

EXPORT MODEL INPUT AND CALCULATIONS

STD. WATER YIELD (CFS/SQ.MI)	1.5
PRECIPITATION (in M)	0.93

COEFFICIENTS			RUNOFF EXPORT COEFF.			BASEFLOW EXPORT COEFF.		
LAND USE	Runoff Coefficient (Fraction)	Baseflow Coefficient (Fraction)	P Export Coefficient (kg/ha/yr)	N Export Coefficient (kg/ha/yr)	TSS Export Coefficient (kg/ha/yr)	P Export Coefficient (kg/ha/yr)	N Export Coefficient (kg/ha/yr)	TSS Export Coefficient (kg/ha/yr)
Urban 1 (LDR)	0.40	0.25	1.10	5.50	93	0.050	7.50	0.3
Urban 2 (MDR/Hwy)	0.50	0.15	1.10	9.97	93	0.050	15.00	0.3
Urban 3 (HDR/Com)	0.60	0.05	1.35	9.97	93	0.050	30.00	0.3
Urban 4 (Ind)	0.60	0.05	1.10	5.50	93	0.050	7.50	0.3
Urban 5 (P/I/R/C)	0.40	0.25	1.10	5.50	93	0.050	7.50	0.3
Agric 1 (Cvr Crop)	0.15	0.30	1.00	6.08	100	0.050	2.50	0.3
Agric 2 (Row Crop)	0.30	0.30	2.20	9.00	250	0.050	2.50	0.3
Agric 3 (Grazing)	0.30	0.30	0.40	5.19	100	0.050	5.00	0.3
Agric 4 (Feedlot)	0.45	0.30	224.00	2923.20	15000	0.050	25.00	0.3
Forest 1 (Upland)	0.30	0.40	0.05	2.46	16	0.050	0.50	0.3
Forest 2 (Wetland)	0.05	0.40	0.05	2.46	16	0.050	0.50	0.3
Open 1 (Wetland/Lake)	0.05	0.40	0.20	2.46	16	0.050	0.50	0.3
Open 2 (Meadow)	0.15	0.30	0.10	2.46	16	0.050	0.50	0.3
Open 3 (Excavation)	0.40	0.20	0.80	5.19	1000	0.050	0.50	0.3
Other 1	0.10	0.40	0.20	2.46	16	0.050	0.50	0.3
Other 2	0.35	0.25	1.10	5.50	93	0.050	5.00	0.3
Other 3	0.60	0.05	2.20	9.00	250	0.050	20.00	0.3

Little Bear Lake LLRM

OTHER AREAL SOURCES	Affected Lake Area (ha)	P Export Coefficient (kg/ha/yr)	N Export Coefficient (kg/ha/yr)	TSS Export Coefficient (kg/ha/yr)
Atmospheric Deposition				
from Forested Area	0	0.20	6.52	32.0
from Agricultural/Rural Area	0	0.30	13.13	66.0
from Urban/Industrial Area	0	1.00	21.36	107.0
Internal Loading	0	2.00	5.00	1.0

NON-AREAL SOURCES	Number of Source Units	Volume (cu.m/yr)	P Load (kg/unit/yr)	N Load (kg/unit/yr)	TSS Load (kg/unit/yr)	P Load (ppm)	N Load (ppm)	TSS Load (ppm)
Waterfowl	50		0.20	0.95	5			
Point Sources								
PS-1		0				0.00	0.00	0.0
PS-2		0				0.00	0.00	0.0
PS-3		0				0.00	0.00	0.0

Basin in which Point Source occurs (0=NO 1=YES)

	BASIN 1	BASIN 2	BASIN 3	BASIN 4	BASIN 5	BASIN 6	BASIN 7	BASIN 8	BASIN 9	BASIN 10
PS-1	0	0	0	0	0	0	0	0	0	0
PS-2	0	0	0	0	0	0	0	0	0	0
PS-3	0	0	0	0	0	0	0	0	0	0

SEPTIC SYSTEM LOAD	Number of Dwellings	Number of People/ Dwelling	Atten Factor Phos	Mean TP Conc (mg/L)	P Load (kg/person/ yr)	P Load kg/yr		Water Gallons/Person/Day	Number of Days	Water Load cu.m/yr
Septic System										
Year Round Septic Systems (125' zone	0	2.5	0.1	8	0.72	0.00		65	365	0.00
Seasonal Septic Systems (125' zone)	0	2.5	0.1	8	0.18	0.00		65	90	0.00
Total Septic System Loading						**0.00**				**0.00**

Little Bear Lake LLRM

BASIN AREAS										
	BASIN 1	BASIN 2	BASIN 3	BASIN 4	BASIN 5	BASIN 6	BASIN 7	BASIN 8	BASIN 9	BASIN 10
LAND USE	AREA (HA)	AREA (HA)	AREA (HA)	AREA (HA)	AREA (HA)	AREA (HA)	AREA (HA)	AREA (HA)	AREA (HA)	AREA (HA)
Urban 1 (LDR)										
Urban 2 (MDR/Hwy)			9.69							
Urban 3 (HDR/Com)	138.66	143.65	436.4	114.568485	69.6091199					
Urban 4 (Ind)	20.55	8.48	51.1	13.2734014	0.75364096					
Urban 5 (P/I/R/C)										
Agric 1 (Cvr Crop)				0.44256842						
Agric 2 (Row Crop)	6.5									
Agric 3 (Grazing)										
Agric 4 (Feedlot)										
Forest 1 (Upland)										
Forest 2 (Wetland)			6.6		4.21994674					
Open 1 (Wetland/Lake)	1.5		18.9	10.0343057	16.044239					
Open 2 (Meadow)	29.9	7.1	141.5	73.9537009	27.6844585					
Open 3 (Excavation)										
Other 1										
Other 2										
Other 3										

Little Bear Lake LLRM

ROUTING PATTERN (Which basin flows to which)										
					PASSES THROUGH...					
1=YES 0=NO XXX=BLANK	BASIN 1	BASIN 2	BASIN 3	BASIN 4	BASIN 5	BASIN 6	BASIN 7	BASIN 8	BASIN 9	BASIN 10
	(CU.M/YR)	(CU.M/YR)	(CU.M/YR)	(CU.M/YR)	(CU.M/YR)	(CU.M/YR)	(CU.M/YR)	(CU.M/YR)	(CU.M/YR)	(CU.M/YR)
INDIVIDUAL BASIN	1	1	1	1	1	1	1	1	1	1
BASIN 1 OUTPUT	XXX	1	0	0	0	0	0	0	0	0
BASIN 2 OUTPUT	0	XXX	1	0	0	0	0	0	0	0
BASIN 3 OUTPUT	0	0	XXX	1	0	0	0	0	0	0
BASIN 4 OUTPUT	0	0	0	XXX	1	0	0	0	0	0
BASIN 5 OUTPUT	0	0	0	0	XXX	0	0	0	0	0
BASIN 6 OUTPUT	0	0	0	0	0	XXX	0	0	0	0
BASIN 7 OUTPUT	0	0	0	0	0	0	XXX	0	0	0
BASIN 8 OUTPUT	0	0	0	0	0	0	0	XXX	0	0
BASIN 9 OUTPUT	0	0	0	0	0	0	0	0	XXX	0
BASIN 10 OUTPUT	0	0	0	0	0	0	0	0	0	XXX

WATER ROUTING AND ATTENUATION										
	BASIN 1	BASIN 2	BASIN 3	BASIN 4	BASIN 5	BASIN 6	BASIN 7	BASIN 8	BASIN 9	BASIN 10
SOURCE	(CU.M/YR)	(CU.M/YR)	(CU.M/YR)	(CU.M/YR)	(CU.M/YR)	(CU.M/YR)	(CU.M/YR)	(CU.M/YR)	(CU.M/YR)	(CU.M/YR)
INDIVIDUAL BASIN	1130103.45	949339.35	3704408.55	1126146.16	626007.965	0	0	0	0	0
BASIN 1 OUTPUT	XXX	1073598.28	0	0	0	0	0	0	0	0
BASIN 2 OUTPUT	0	XXX	1921790.75	0	0	0	0	0	0	0
BASIN 3 OUTPUT	0	0	XXX	5063579.37	0	0	0	0	0	0
BASIN 4 OUTPUT	0	0	0	XXX	5570752.98	0	0	0	0	0
BASIN 5 OUTPUT	0	0	0	0	XXX	0	0	0	0	0
BASIN 6 OUTPUT	0	0	0	0	0	XXX	0	0	0	0
BASIN 7 OUTPUT	0	0	0	0	0	0	XXX	0	0	0
BASIN 8 OUTPUT	0	0	0	0	0	0	0	XXX	0	0
BASIN 9 OUTPUT	0	0	0	0	0	0	0	0	XXX	0
BASIN 10 OUTPUT	0	0	0	0	0	0	0	0	0	XXX
CUMULATIVE TOTAL	1130103.5	2022937.6	5626199.3	6189725.5	6196760.9	0.0	0	0	0	0
BASIN ATTENUATION	0.95	0.95	0.90	0.90	0.95	1.00	1.00	1.00	1.00	1.00
OUTPUT VOLUME	1073598.3	1921790.7	5063579.4	5570753.0	5886922.9	0.0	0	0	0	0

Little Bear Lake LLRM

LOAD ROUTING AND ATTENUATION: PHOSPHORUS					
	BASIN 1	BASIN 2	BASIN 3	BASIN 4	BASIN 5
	(KG/YR)	(KG/YR)	(KG/YR)	(KG/YR)	(KG/YR)
BASIN 1 INDIVIDUAL	237.2	211.9	707.5	189.7	106.9
BASIN 1 OUTPUT	XXX	201.7	0.0	0.0	0.0
BASIN 2 OUTPUT	0.0	XXX	351.5	0.0	0.0
BASIN 3 OUTPUT	0.0	0.0	XXX	582.5	0.0
BASIN 4 OUTPUT	0.0	0.0	0.0	XXX	501.9
BASIN 5 OUTPUT	0.0	0.0	0.0	0.0	XXX
BASIN 6 OUTPUT	0.0	0.0	0.0	0.0	0.0
BASIN 7 OUTPUT	0.0	0.0	0.0	0.0	0.0
BASIN 8 OUTPUT	0.0	0.0	0.0	0.0	0.0
BASIN 9 OUTPUT	0.0	0.0	0.0	0.0	0.0
BASIN 10 OUTPUT	0.0	0.0	0.0	0.0	0.0
CUMULATIVE TOTAL	237.2	413.6	1059.0	772.2	608.8
BASIN ATTENUATION	0.85	0.85	0.55	0.65	0.60
OUTPUT LOAD	201.7	351.5	582.5	501.9	365.3

LOAD AND CONCENTRATION SUMMARY: PHOSPHORUS					
	BASIN 1	BASIN 2	BASIN 3	BASIN 4	BASIN 5
OUTPUT (CU.M/YR)	1073598	1921791	5063579	5570753	5886923
OUTPUT (KG/YR)	201.7	351.5	582.5	501.9	365.3
OUTPUT (MG/L)	0.188	0.183	0.115	0.090	0.062
REALITY CHECK CONC.					
(Based on real data)					
TERMINAL DISCHARGE?	0	0	0	0	1
(1=YES 2=NO)					
LOAD TO RESOURCE					
WATER (CU.M/YR)	0	0	0	0	5886923
PHOSPHORUS (KG/YR)	0.0	0.0	0.0	0.0	365.3
PHOSPHORUS (MG/L)	0.000	0.000	0.000	0.000	0.062
BASIN EXPORT COEFFICIENT	0.00	0.00	0.00	0.00	3.09

DIRECT LOADS TO LAKE	P	N
ATMOSPHERIC (KG/YR)	0.0	0.0
INTERNAL (KG/YR)	0.0	0.0
WATERFOWL (KG/YR)	10.0	47.5
SEPTIC SYSTEM (KG/YR)	0.0	
WATERSHED LOAD (KG/YR)	365.3	12485.6
TOTAL LOAD TO LAKE (KG/YR)	375.3	12533.1
(Watershed + direct loads)		
TOTAL INPUT CONC. (MG/L)	0.064	2.129

Little Bear Lake LLRM

THE MODELS				
	PHOSPHORUS	**PRED.**	**PERMIS.**	**CRITICAL**
		CONC.	**CONC.**	**CONC.**
NAME	**FORMULA**	**(ppb)**	**(ppb)**	**(ppb)**
Mass Balance	TP=L/(Z(F))*1000	64		
(Maximum Conc.)				
Kirchner-Dillon 1975	TP=L(1-Rp)/(Z(F))*1000	57	12	24
(K-D)				
Vollenweider 1975	TP=L/(Z(S+F))*1000	64	13	27
(V)				
Larsen-Mercier 1976	TP=L(1-Rlm)/(Z(F))*1000	51	11	22
(L-M)				
Jones-Bachmann 1976	TP=0.84(L)/(Z(0.65+F))*1000	52	11	22
(J-B)				
Reckhow General (1977)	TP=L/(11.6+1.2(Z(F)))*1000	45	10	19
(Rg)				
Average of Model Values		54	11	23
(without mass balance)				

Pond-A-Rudy LLRM

EXPORT MODEL INPUT AND CALCULATIONS

STD. WATER YIELD (CFS/SQ.MI)	1.5
PRECIPITATION (in M)	0.99

COEFFICIENTS			RUNOFF EXPORT COEFF.			BASEFLOW EXPORT COEFF.		
LAND USE	Runoff Coefficient (Fraction)	Baseflow Coefficient (Fraction)	P Export Coefficient (kg/ha/yr)	N Export Coefficient (kg/ha/yr)	TSS Export Coefficient (kg/ha/yr)	P Export Coefficient (kg/ha/yr)	N Export Coefficient (kg/ha/yr)	TSS Export Coefficient (kg/ha/yr)
Urban 1 (LDR)	0.40	0.25	1.10	5.50	93	0.050	7.50	0.3
Urban 2 (MDR/Hwy)	0.50	0.15	1.10	9.97	93	0.050	15.00	0.3
Urban 3 (HDR/Com)	0.60	0.05	1.75	9.97	93	0.050	30.00	0.3
Urban 4 (Ind)	0.60	0.05	1.10	5.50	93	0.050	7.50	0.3
Urban 5 (P/I/R/C)	0.40	0.25	1.10	5.50	93	0.050	7.50	0.3
Agric 1 (Cvr Crop)	0.15	0.30	1.00	6.08	100	0.050	2.50	0.3
Agric 2 (Row Crop)	0.30	0.30	2.75	9.00	250	0.050	2.50	0.3
Agric 3 (Grazing)	0.30	0.30	0.40	5.19	100	0.050	5.00	0.3
Agric 4 (Feedlot)	0.45	0.30	224.00	2923.20	15000	0.050	25.00	0.3
Forest 1 (Upland)	0.30	0.40	0.05	2.46	16	0.050	0.50	0.3
Forest 2 (Wetland)	0.05	0.40	0.05	2.46	16	0.050	0.50	0.3
Open 1 (Wetland/Lake)	0.05	0.40	0.20	2.46	16	0.050	0.50	0.3
Open 2 (Meadow)	0.15	0.30	0.20	2.46	16	0.050	0.50	0.3
Open 3 (Excavation)	0.40	0.20	0.80	5.19	1000	0.050	0.50	0.3
Other 1	0.10	0.40	0.20	2.46	16	0.050	0.50	0.3
Other 2	0.35	0.25	1.10	5.50	93	0.050	5.00	0.3
Other 3	0.60	0.05	2.20	9.00	250	0.050	20.00	0.3

Pond-A-Rudy LLRM

OTHER AREAL SOURCES	Affected Lake Area (ha)	P Export Coefficient (kg/ha/yr)	N Export Coefficient (kg/ha/yr)	TSS Export Coefficient (kg/ha/yr)
Atmospheric Deposition				
from Forested Area	5.63	0.20	6.52	32.0
from Agricultural/Rural Area	0	0.30	13.13	66.0
from Urban/Industrial Area	0	1.00	21.36	107.0
Internal Loading	0	2.00	5.00	1.0

NON-AREAL SOURCES	Number of Source Units	Volume (cu.m/yr)	P Load (kg/unit/yr)	N Load (kg/unit/yr)	TSS Load (kg/unit/yr)	P Load (ppm)	N Load (ppm)	TSS Load (ppm)
Waterfowl	25		0.20	0.95	5			
Point Sources								
PS-1		0				0.00	0.00	0.0
PS-2		0				0.00	0.00	0.0
PS-3		0				0.00	0.00	0.0

Basin in which Point Source occurs (0=NO 1=YES)	BASIN 1	BASIN 2	BASIN 3	BASIN 4	BASIN 5	BASIN 6	BASIN 7	BASIN 8	BASIN 9	BASIN 10
PS-1	0	0	0	0	0	0	0	0	0	0
PS-2	0	0	0	0	0	0	0	0	0	0
PS-3	0	0	0	0	0	0	0	0	0	0

SEPTIC SYSTEM LOAD	Number of Dwellings	Number of People/ Dwelling	Atten Factor Phos	Mean TP Conc (mg/L)	P Load (kg/person/ yr)	P Load kg/yr		Water Gallons/Per son/Day	Number of Days	Water Load cu.m/yr
Septic System										
Year Round Septic Systems (125' zone	0	2.5	0.1	8	0.72	0.00		65	365	0.00
Seasonal Septic Systems (125' zone)	0	2.5	0.1	8	0.18	0.00		65	90	0.00
Total Septic System Loading						**0.00**				**0.00**

Pond-A-Rudy LLRM

BASIN AREAS										
	BASIN 1	BASIN 2	BASIN 3	BASIN 4	BASIN 5	BASIN 6	BASIN 7	BASIN 8	BASIN 9	BASIN 10
LAND USE	AREA (HA)	AREA (HA)	AREA (HA)	AREA (HA)	AREA (HA)	AREA (HA)	AREA (HA)	AREA (HA)	AREA (HA)	AREA (HA)
Urban 1 (LDR)										
Urban 2 (MDR/Hwy)										
Urban 3 (HDR/Com)	6.88	12.1	7.49							
Urban 4 (Ind)										
Urban 5 (P/I/R/C)										
Agric 1 (Cvr Crop)										
Agric 2 (Row Crop)	8.22	2.36	1.57							
Agric 3 (Grazing)										
Agric 4 (Feedlot)										
Forest 1 (Upland)										
Forest 2 (Wetland)		0.55	0.71							
Open 1 (Wetland/Lake)			5.32							
Open 2 (Meadow)	0.18	4.26	5.8							
Open 3 (Excavation)										
Other 1										
Other 2										
Other 3										

Pond-A-Rudy LLRM

ROUTING PATTERN (Which basin flows to which)										
					PASSES THROUGH...					
1=YES 0=NO XXX=BLANK	BASIN 1	BASIN 2	BASIN 3	BASIN 4	BASIN 5	BASIN 6	BASIN 7	BASIN 8	BASIN 9	BASIN 10
	(CU.M/YR)	(CU.M/YR)	(CU.M/YR)	(CU.M/YR)	(CU.M/YR)	(CU.M/YR)	(CU.M/YR)	(CU.M/YR)	(CU.M/YR)	(CU.M/YR)
INDIVIDUAL BASIN	1	1	1	1	1	1	1	1	1	1
BASIN 1 OUTPUT	XXX	1	0	0	0	0	0	0	0	0
BASIN 2 OUTPUT	0	XXX	1	0	0	0	0	0	0	0
BASIN 3 OUTPUT	0	0	XXX	0	0	0	0	0	0	0
BASIN 4 OUTPUT	0	0	0	XXX	0	0	0	0	0	0
BASIN 5 OUTPUT	0	0	0	0	XXX	0	0	0	0	0
BASIN 6 OUTPUT	0	0	0	0	0	XXX	0	0	0	0
BASIN 7 OUTPUT	0	0	0	0	0	0	XXX	0	0	0
BASIN 8 OUTPUT	0	0	0	0	0	0	0	XXX	0	0
BASIN 9 OUTPUT	0	0	0	0	0	0	0	0	XXX	0
BASIN 10 OUTPUT	0	0	0	0	0	0	0	0	0	XXX

WATER ROUTING AND ATTENUATION										
	BASIN 1	BASIN 2	BASIN 3	BASIN 4	BASIN 5	BASIN 6	BASIN 7	BASIN 8	BASIN 9	BASIN 10
SOURCE	(CU.M/YR)	(CU.M/YR)	(CU.M/YR)	(CU.M/YR)	(CU.M/YR)	(CU.M/YR)	(CU.M/YR)	(CU.M/YR)	(CU.M/YR)	(CU.M/YR)
INDIVIDUAL BASIN	93901.5	113310.45	110226.6	0	0	0	0	0	0	0
BASIN 1 OUTPUT	XXX	75121.2	0	0	0	0	0	0	0	0
BASIN 2 OUTPUT	0	XXX	169588.485	0	0	0	0	0	0	0
BASIN 3 OUTPUT	0	0	XXX	0	0	0	0	0	0	0
BASIN 4 OUTPUT	0	0	0	XXX	0	0	0	0	0	0
BASIN 5 OUTPUT	0	0	0	0	XXX	0	0	0	0	0
BASIN 6 OUTPUT	0	0	0	0	0	XXX	0	0	0	0
BASIN 7 OUTPUT	0	0	0	0	0	0	XXX	0	0	0
BASIN 8 OUTPUT	0	0	0	0	0	0	0	XXX	0	0
BASIN 9 OUTPUT	0	0	0	0	0	0	0	0	XXX	0
BASIN 10 OUTPUT	0	0	0	0	0	0	0	0	0	XXX
CUMULATIVE TOTAL	93901.5	188431.7	279815.1	0.0	0.0	0.0	0	0	0	0
BASIN ATTENUATION	0.80	0.90	0.90	1.00	1.00	1.00	1.00	1.00	1.00	1.00
OUTPUT VOLUME	75121.2	169588.5	251833.6	0.0	0.0	0.0	0	0	0	0

Pond-A-Rudy LLRM

LOAD ROUTING AND ATTENUATION: PHOSPHORUS			
	BASIN 1	BASIN 2	BASIN 3
	(KG/YR)	(KG/YR)	(KG/YR)
BASIN 1 INDIVIDUAL	35.4	29.5	20.7
BASIN 1 OUTPUT	XXX	24.8	0.0
BASIN 2 OUTPUT	0.0	XXX	48.9
BASIN 3 OUTPUT	0.0	0.0	XXX
BASIN 4 OUTPUT	0.0	0.0	0.0
BASIN 5 OUTPUT	0.0	0.0	0.0
BASIN 6 OUTPUT	0.0	0.0	0.0
BASIN 7 OUTPUT	0.0	0.0	0.0
BASIN 8 OUTPUT	0.0	0.0	0.0
BASIN 9 OUTPUT	0.0	0.0	0.0
BASIN 10 OUTPUT	0.0	0.0	0.0
CUMULATIVE TOTAL	35.4	54.3	69.6
BASIN ATTENUATION	0.70	0.90	0.90
OUTPUT LOAD	24.8	48.9	62.7

LOAD AND CONCENTRATION SUMMARY: PHOSPHORUS			
	BASIN 1	BASIN 2	BASIN 3
OUTPUT (CU.M/YR)	75121	169588	251834
OUTPUT (KG/YR)	24.8	48.9	62.7
OUTPUT (MG/L)	0.330	0.288	0.249
REALITY CHECK CONC.			
(Based on real data)			
TERMINAL DISCHARGE?	0	0	1
(1=YES 2=NO)			
LOAD TO RESOURCE			
WATER (CU.M/YR)	0	0	251834
PHOSPHORUS (KG/YR)	0.0	0.0	62.7
PHOSPHORUS (MG/L)	0.000	0.000	0.249
BASIN EXPORT COEFFICIENT	0.00	0.00	3.00

DIRECT LOADS TO LAKE	P	N
ATMOSPHERIC (KG/YR)	1.1	36.7
INTERNAL (KG/YR)	0.0	0.0
WATERFOWL (KG/YR)	5.0	23.8
SEPTIC SYSTEM (KG/YR)	0.0	
WATERSHED LOAD (KG/YR)	62.7	762.6
TOTAL LOAD TO LAKE (KG/YR)	68.8	823.0
(Watershed + direct loads)		
TOTAL INPUT CONC. (MG/L)	0.224	2.676

Pond-A-Rudy LLRM

THE MODELS				
	PHOSPHORUS	**PRED.**	**PERMIS.**	**CRITICAL**
		CONC.	**CONC.**	**CONC.**
NAME	**FORMULA**	**(ppb)**	**(ppb)**	**(ppb)**
Mass Balance	TP=L/(Z(F))*1000	224		
(Maximum Conc.)				
Kirchner-Dillon 1975	TP=L(1-Rp)/(Z(F))*1000	101	19	39
(K-D)				
Vollenweider 1975	TP=L/(Z(S+F))*1000	224	43	85
(V)				
Larsen-Mercier 1976	TP=L(1-Rlm)/(Z(F))*1000	181	35	69
(L-M)				
Jones-Bachmann 1976	TP=0.84(L)/(Z(0.65+F))*1000	181	35	69
(J-B)				
Reckhow General (1977)	TP=L/(11.6+1.2(Z(F)))*1000	67	13	26
(Rg)				
Average of Model Values		151	29	58
(without mass balance)				

Salem Reed Lake LLRM

EXPORT MODEL INPUT AND CALCULATIONS

STD. WATER YIELD (CFS/SQ.MI)	1.5
PRECIPITATION (in M)	1.04

COEFFICIENTS			RUNOFF EXPORT COEFF.			BASEFLOW EXPORT COEFF.		
LAND USE	Runoff Coefficient (Fraction)	Baseflow Coefficient (Fraction)	P Export Coefficient (kg/ha/yr)	N Export Coefficient (kg/ha/yr)	TSS Export Coefficient (kg/ha/yr)	P Export Coefficient (kg/ha/yr)	N Export Coefficient (kg/ha/yr)	TSS Export Coefficient (kg/ha/yr)
Urban 1 (LDR)	0.40	0.25	1.10	5.50	93	0.050	7.50	0.3
Urban 2 (MDR/Hwy)	0.50	0.15	1.10	9.97	93	0.050	15.00	0.3
Urban 3 (HDR/Com)	0.60	0.05	2.40	9.97	93	0.050	30.00	0.3
Urban 4 (Ind)	0.60	0.05	1.10	5.50	93	0.050	7.50	0.3
Urban 5 (P/I/R/C)	0.40	0.25	1.10	5.50	93	0.050	7.50	0.3
Agric 1 (Cvr Crop)	0.15	0.30	2.20	6.08	100	0.050	2.50	0.3
Agric 2 (Row Crop)	0.30	0.30	3.00	9.00	250	0.050	2.50	0.3
Agric 3 (Grazing)	0.30	0.30	0.80	5.19	100	0.050	5.00	0.3
Agric 4 (Feedlot)	0.45	0.30	224.00	2923.20	15000	0.050	25.00	0.3
Forest 1 (Upland)	0.30	0.40	0.20	2.46	16	0.050	0.50	0.3
Forest 2 (Wetland)	0.05	0.40	0.20	2.46	16	0.050	0.50	0.3
Open 1 (Wetland/Lake)	0.05	0.40	0.20	2.46	16	0.050	0.50	0.3
Open 2 (Meadow)	0.15	0.30	0.20	2.46	16	0.050	0.50	0.3
Open 3 (Excavation)	0.40	0.20	0.80	5.19	1000	0.050	0.50	0.3
Other 1	0.10	0.40	0.20	2.46	16	0.050	0.50	0.3
Other 2	0.35	0.25	1.10	5.50	93	0.050	5.00	0.3
Other 3	0.60	0.05	2.20	9.00	250	0.050	20.00	0.3

Salem Reed Lake LLRM

OTHER AREAL SOURCES	Affected Lake Area (ha)	P Export Coefficient (kg/ha/yr)	N Export Coefficient (kg/ha/yr)	TSS Export Coefficient (kg/ha/yr)
Atmospheric Deposition				
from Forested Area	6	0.20	6.52	32.0
from Agricultural/Rural Area	0	0.30	13.13	66.0
from Urban/Industrial Area	9.4	1.00	21.36	107.0
Internal Loading	5	2.00	5.00	1.0

NON-AREAL SOURCES	Number of Source Units	Volume (cu.m/yr)	P Load (kg/unit/yr)	N Load (kg/unit/yr)	TSS Load (kg/unit/yr)	P Load (ppm)	N Load (ppm)	TSS Load (ppm)
Waterfowl	100		0.20	0.95	5			
Point Sources								
PS-1		0				0.00	0.00	0.0
PS-2		0				0.00	0.00	0.0
PS-3		0				0.00	0.00	0.0

Basin in which Point Source occurs (0=NO 1=YES)	BASIN 1	BASIN 2	BASIN 3	BASIN 4	BASIN 5	BASIN 6	BASIN 7	BASIN 8	BASIN 9	BASIN 10
PS-1	0	0	0	0	0	0	0	0	0	0
PS-2	0	0	0	0	0	0	0	0	0	0
PS-3	0	0	0	0	0	0	0	0	0	0

SEPTIC SYSTEM LOAD	Number of Dwellings	Number of People/ Dwelling	Atten Factor Phos	Mean TP Conc (mg/L)	P Load (kg/person/ yr)	P Load kg/yr		Water Gallons/Person/Day	Number of Days	Water Load cu.m/yr
Septic System										
Year Round Septic Systems (125' zone	0	2.5	0.1	8	0.72	0.00		65	365	0.00
Seasonal Septic Systems (125' zone)	0	2.5	0.1	8	0.18	0.00		65	90	0.00
Total Septic System Loading						**0.00**				**0.00**

Salem Reed Lake LLRM

BASIN AREAS										
LAND USE	BASIN 1 AREA (HA)	BASIN 2 AREA (HA)	BASIN 3 AREA (HA)	BASIN 4 AREA (HA)	BASIN 5 AREA (HA)	BASIN 6 AREA (HA)	BASIN 7 AREA (HA)	BASIN 8 AREA (HA)	BASIN 9 AREA (HA)	BASIN 10 AREA (HA)
Urban 1 (LDR)										
Urban 2 (MDR/Hwy)										
Urban 3 (HDR/Com)	23.903958									
Urban 4 (Ind)										
Urban 5 (P/I/R/C)										
Agric 1 (Cvr Crop)	0.02107579									
Agric 2 (Row Crop)	5.56368905									
Agric 3 (Grazing)										
Agric 4 (Feedlot)										
Forest 1 (Upland)										
Forest 2 (Wetland)	1.23663025									
Open 1 (Wetland/Lake)	15.2748771									
Open 2 (Meadow)	6.62120949									
Open 3 (Excavation)										
Other 1										
Other 2										
Other 3										

Salem Reed Lake LLRM

ROUTING PATTERN (Which basin flows to which)										
					PASSES THROUGH...					
1=YES 0=NO XXX=BLANK	BASIN 1	BASIN 2	BASIN 3	BASIN 4	BASIN 5	BASIN 6	BASIN 7	BASIN 8	BASIN 9	BASIN 10
	(CU.M/YR)	(CU.M/YR)	(CU.M/YR)	(CU.M/YR)	(CU.M/YR)	(CU.M/YR)	(CU.M/YR)	(CU.M/YR)	(CU.M/YR)	(CU.M/YR)
INDIVIDUAL BASIN	1	1	1	1	1	1	1	1	1	1
BASIN 1 OUTPUT	XXX	0	0	0	0	0	0	0	0	0
BASIN 2 OUTPUT	0	XXX	0	0	0	0	0	0	0	0
BASIN 3 OUTPUT	0	0	XXX	0	0	0	0	0	0	0
BASIN 4 OUTPUT	0	0	0	XXX	0	0	0	0	0	0
BASIN 5 OUTPUT	0	0	0	0	XXX	0	0	0	0	0
BASIN 6 OUTPUT	0	0	0	0	0	XXX	0	0	0	0
BASIN 7 OUTPUT	0	0	0	0	0	0	XXX	0	0	0
BASIN 8 OUTPUT	0	0	0	0	0	0	0	XXX	0	0
BASIN 9 OUTPUT	0	0	0	0	0	0	0	0	XXX	0
BASIN 10 OUTPUT	0	0	0	0	0	0	0	0	0	XXX

WATER ROUTING AND ATTENUATION										
	BASIN 1	BASIN 2	BASIN 3	BASIN 4	BASIN 5	BASIN 6	BASIN 7	BASIN 8	BASIN 9	BASIN 10
SOURCE	(CU.M/YR)	(CU.M/YR)	(CU.M/YR)	(CU.M/YR)	(CU.M/YR)	(CU.M/YR)	(CU.M/YR)	(CU.M/YR)	(CU.M/YR)	(CU.M/YR)
INDIVIDUAL BASIN	304667.925	0	0	0	0	0	0	0	0	0
BASIN 1 OUTPUT	XXX	0	0	0	0	0	0	0	0	0
BASIN 2 OUTPUT	0	XXX	0	0	0	0	0	0	0	0
BASIN 3 OUTPUT	0	0	XXX	0	0	0	0	0	0	0
BASIN 4 OUTPUT	0	0	0	XXX	0	0	0	0	0	0
BASIN 5 OUTPUT	0	0	0	0	XXX	0	0	0	0	0
BASIN 6 OUTPUT	0	0	0	0	0	XXX	0	0	0	0
BASIN 7 OUTPUT	0	0	0	0	0	0	XXX	0	0	0
BASIN 8 OUTPUT	0	0	0	0	0	0	0	XXX	0	0
BASIN 9 OUTPUT	0	0	0	0	0	0	0	0	XXX	0
BASIN 10 OUTPUT	0	0	0	0	0	0	0	0	0	XXX
CUMULATIVE TOTAL	304667.9	0.0	0.0	0.0	0.0	0.0	0	0	0	0
BASIN ATTENUATION	0.70	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00
OUTPUT VOLUME	213267.5	0.0	0.0	0.0	0.0	0.0	0	0	0	0

Salem Reed Lake LLRM

LOAD ROUTING AND ATTENUATION: PHOSPHORUS	
	BASIN 1
	(KG/YR)
BASIN 1 INDIVIDUAL	81.4
BASIN 1 OUTPUT	XXX
BASIN 2 OUTPUT	0.0
BASIN 3 OUTPUT	0.0
BASIN 4 OUTPUT	0.0
BASIN 5 OUTPUT	0.0
BASIN 6 OUTPUT	0.0
BASIN 7 OUTPUT	0.0
BASIN 8 OUTPUT	0.0
BASIN 9 OUTPUT	0.0
BASIN 10 OUTPUT	0.0
CUMULATIVE TOTAL	81.4
BASIN ATTENUATION	0.90
OUTPUT LOAD	73.2

LOAD AND CONCENTRATION SUMMARY: PHOSPH	
	BASIN 1
OUTPUT (CU.M/YR)	213268
OUTPUT (KG/YR)	73.2
OUTPUT (MG/L)	0.343
REALITY CHECK CONC.	
(Based on real data)	
TERMINAL DISCHARGE?	1
(1=YES 2=NO)	
LOAD TO RESOURCE	
WATER (CU.M/YR)	213268
PHOSPHORUS (KG/YR)	73.2
PHOSPHORUS (MG/L)	0.343
BASIN EXPORT COEFFICIENT	1.39

DIRECT LOADS TO LAKE	P	N
ATMOSPHERIC (KG/YR)	10.6	239.9
INTERNAL (KG/YR)	10.0	25.0
WATERFOWL (KG/YR)	20.0	95.0
SEPTIC SYSTEM (KG/YR)	0.0	
WATERSHED LOAD (KG/YR)	73.2	1033.7
TOTAL LOAD TO LAKE (KG/YR)	113.8	1393.6
(Watershed + direct loads)		
TOTAL INPUT CONC. (MG/L)	0.305	3.732

Salem Reed Lake LLRM

THE MODELS				
	PHOSPHORUS	**PRED.**	**PERMIS.**	**CRITICAL**
		CONC.	**CONC.**	**CONC.**
NAME	**FORMULA**	**(ppb)**	**(ppb)**	**(ppb)**
Mass Balance	TP=L/(Z(F))*1000	305		
(Maximum Conc.)				
Kirchner-Dillon 1975	TP=L(1-Rp)/(Z(F))*1000	82	17	34
(K-D)				
Vollenweider 1975	TP=L/(Z(S+F))*1000	305	64	128
(V)				
Larsen-Mercier 1976	TP=L(1-Rlm)/(Z(F))*1000	174	37	73
(L-M)				
Jones-Bachmann 1976	TP=0.84(L)/(Z(0.65+F))*1000	187	39	79
(J-B)				
Reckhow General (1977)	TP=L/(11.6+1.2(Z(F)))*1000	51	11	21
(Rg)				
Average of Model Values		160	34	67
(without mass balance)				

Sylvan Lake LLRM

EXPORT MODEL INPUT AND CALCULATIONS

STD. WATER YIELD (CFS/SQ.MI)	1.5
PRECIPITATION (in M)	0.99

COEFFICIENTS			RUNOFF EXPORT COEFF.			BASEFLOW EXPORT COEFF.		
LAND USE	Runoff Coefficient (Fraction)	Baseflow Coefficient (Fraction)	P Export Coefficient (kg/ha/yr)	N Export Coefficient (kg/ha/yr)	TSS Export Coefficient (kg/ha/yr)	P Export Coefficient (kg/ha/yr)	N Export Coefficient (kg/ha/yr)	TSS Export Coefficient (kg/ha/yr)
Urban 1 (LDR)	0.40	0.25	1.10	5.50	93	0.050	7.50	0.3
Urban 2 (MDR/Hwy)	0.50	0.15	1.10	9.97	93	0.050	15.00	0.3
Urban 3 (HDR/Com)	0.60	0.05	1.40	9.97	93	0.050	30.00	0.3
Urban 4 (Ind)	0.60	0.05	1.10	5.50	93	0.050	7.50	0.3
Urban 5 (P/I/R/C)	0.40	0.25	1.10	5.50	93	0.050	7.50	0.3
Agric 1 (Cvr Crop)	0.15	0.30	1.00	6.08	100	0.050	2.50	0.3
Agric 2 (Row Crop)	0.30	0.30	1.00	9.00	250	0.050	2.50	0.3
Agric 3 (Grazing)	0.30	0.30	0.80	5.19	100	0.050	5.00	0.3
Agric 4 (Feedlot)	0.45	0.30	224.00	2923.20	15000	0.050	25.00	0.3
Forest 1 (Upland)	0.30	0.40	0.05	2.46	16	0.050	0.50	0.3
Forest 2 (Wetland)	0.05	0.40	0.05	2.46	16	0.050	0.50	0.3
Open 1 (Wetland/Lake)	0.05	0.40	0.20	2.46	16	0.050	0.50	0.3
Open 2 (Meadow)	0.15	0.30	0.20	2.46	16	0.050	0.50	0.3
Open 3 (Excavation)	0.40	0.20	0.80	5.19	1000	0.050	0.50	0.3
Other 1	0.10	0.40	0.20	2.46	16	0.050	0.50	0.3
Other 2	0.35	0.25	1.10	5.50	93	0.050	5.00	0.3
Other 3	0.60	0.05	2.20	9.00	250	0.050	20.00	0.3

Sylvan Lake LLRM

OTHER AREAL SOURCES	Affected Lake Area (ha)	P Export Coefficient (kg/ha/yr)	N Export Coefficient (kg/ha/yr)	TSS Export Coefficient (kg/ha/yr)
Atmospheric Deposition				
from Forested Area	12.95	0.20	6.52	32.0
from Agricultural/Rural Area	0	0.30	13.13	66.0
from Urban/Industrial Area	0	1.00	21.36	107.0
Internal Loading		2.00	5.00	1.0

NON-AREAL SOURCES	Number of Source Units	Volume (cu.m/yr)	P Load (kg/unit/yr)	N Load (kg/unit/yr)	TSS Load (kg/unit/yr)	P Load (ppm)	N Load (ppm)	TSS Load (ppm)		
Waterfowl	20		0.20	0.95	5					
Point Sources										
PS-1		0				0.00	0.00	0.0		
PS-2		0				0.00	0.00	0.0		
PS-3		0				0.00	0.00	0.0		
Basin in which Point Source occurs (0=NO 1=YES)										
	BASIN 1	BASIN 2	BASIN 3	BASIN 4	BASIN 5	BASIN 6	BASIN 7	BASIN 8	BASIN 9	BASIN 10
PS-1	0	0	0	0	0	0	0	0	0	0
PS-2	0	0	0	0	0	0	0	0	0	0
PS-3	0	0	0	0	0	0	0	0	0	0

SEPTIC SYSTEM LOAD	Number of Dwellings	Number of People/ Dwelling	Atten Factor Phos	Mean TP Conc (mg/L)	P Load (kg/person/ yr)	P Load kg/yr		Water Gallons/Per son/Day	Number of Days	Water Load cu.m/yr
Septic System										
Year Round Septic Systems (125' zone	0	2.5	0.1	8	0.72	0.00		65	365	0.00
Seasonal Septic Systems (125' zone)	0	2.5	0.1	8	0.18	0.00		65	90	0.00
Total Septic System Loading						**0.00**				**0.00**

Sylvan Lake LLRM

BASIN AREAS										
	BASIN 1	BASIN 2	BASIN 3	BASIN 4	BASIN 5	BASIN 6	BASIN 7	BASIN 8	BASIN 9	BASIN 10
LAND USE	AREA (HA)	AREA (HA)	AREA (HA)	AREA (HA)	AREA (HA)	AREA (HA)	AREA (HA)	AREA (HA)	AREA (HA)	AREA (HA)
Urban 1 (LDR)										
Urban 2 (MDR/Hwy)	28.67									
Urban 3 (HDR/Com)	124.39									
Urban 4 (Ind)	1.8									
Urban 5 (P/I/R/C)										
Agric 1 (Cvr Crop)	0.81									
Agric 2 (Row Crop)	25.85									
Agric 3 (Grazing)										
Agric 4 (Feedlot)										
Forest 1 (Upland)										
Forest 2 (Wetland)	3.39									
Open 1 (Wetland/Lake)	13.24									
Open 2 (Meadow)	62.02									
Open 3 (Excavation)										
Other 1										
Other 2										
Other 3										

Sylvan Lake LLRM

ROUTING PATTERN (Which basin flows to which)										
					PASSES THROUGH...					
1=YES 0=NO XXX=BLANK	BASIN 1	BASIN 2	BASIN 3	BASIN 4	BASIN 5	BASIN 6	BASIN 7	BASIN 8	BASIN 9	BASIN 10
	(CU.M/YR)	(CU.M/YR)	(CU.M/YR)	(CU.M/YR)	(CU.M/YR)	(CU.M/YR)	(CU.M/YR)	(CU.M/YR)	(CU.M/YR)	(CU.M/YR)
INDIVIDUAL BASIN	1	1	1	1	1	1	1	1	1	1
BASIN 1 OUTPUT	XXX	0	0	0	0	0	0	0	0	0
BASIN 2 OUTPUT	0	XXX	0	0	0	0	0	0	0	0
BASIN 3 OUTPUT	0	0	XXX	0	0	0	0	0	0	0
BASIN 4 OUTPUT	0	0	0	XXX	0	0	0	0	0	0
BASIN 5 OUTPUT	0	0	0	0	XXX	0	0	0	0	0
BASIN 6 OUTPUT	0	0	0	0	0	XXX	0	0	0	0
BASIN 7 OUTPUT	0	0	0	0	0	0	XXX	0	0	0
BASIN 8 OUTPUT	0	0	0	0	0	0	0	XXX	0	0
BASIN 9 OUTPUT	0	0	0	0	0	0	0	0	XXX	0
BASIN 10 OUTPUT	0	0	0	0	0	0	0	0	0	XXX

WATER ROUTING AND ATTENUATION										
	BASIN 1	BASIN 2	BASIN 3	BASIN 4	BASIN 5	BASIN 6	BASIN 7	BASIN 8	BASIN 9	BASIN 10
SOURCE	(CU.M/YR)	(CU.M/YR)	(CU.M/YR)	(CU.M/YR)	(CU.M/YR)	(CU.M/YR)	(CU.M/YR)	(CU.M/YR)	(CU.M/YR)	(CU.M/YR)
INDIVIDUAL BASIN	1504067.4	0	0	0	0	0	0	0	0	0
BASIN 1 OUTPUT	XXX	0	0	0	0	0	0	0	0	0
BASIN 2 OUTPUT	0	XXX	0	0	0	0	0	0	0	0
BASIN 3 OUTPUT	0	0	XXX	0	0	0	0	0	0	0
BASIN 4 OUTPUT	0	0	0	XXX	0	0	0	0	0	0
BASIN 5 OUTPUT	0	0	0	0	XXX	0	0	0	0	0
BASIN 6 OUTPUT	0	0	0	0	0	XXX	0	0	0	0
BASIN 7 OUTPUT	0	0	0	0	0	0	XXX	0	0	0
BASIN 8 OUTPUT	0	0	0	0	0	0	0	XXX	0	0
BASIN 9 OUTPUT	0	0	0	0	0	0	0	0	XXX	0
BASIN 10 OUTPUT	0	0	0	0	0	0	0	0	0	XXX
CUMULATIVE TOTAL	1504067.4	0.0	0.0	0.0	0.0	0.0	0	0	0	0
BASIN ATTENUATION	0.80	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00
OUTPUT VOLUME	1203253.9	0.0	0.0	0.0	0.0	0.0	0	0	0	0

Sylvan Lake LLRM

LOAD ROUTING AND ATTENUATION: PHOSPHORUS	
	BASIN 1
	(KG/YR)
BASIN 1 INDIVIDUAL	262.6
BASIN 1 OUTPUT	XXX
BASIN 2 OUTPUT	0.0
BASIN 3 OUTPUT	0.0
BASIN 4 OUTPUT	0.0
BASIN 5 OUTPUT	0.0
BASIN 6 OUTPUT	0.0
BASIN 7 OUTPUT	0.0
BASIN 8 OUTPUT	0.0
BASIN 9 OUTPUT	0.0
BASIN 10 OUTPUT	0.0
CUMULATIVE TOTAL	262.6
BASIN ATTENUATION	0.50
OUTPUT LOAD	131.3

LOAD AND CONCENTRATION SUMMARY: PHOSPHORUS	
	BASIN 1
OUTPUT (CU.M/YR)	1203254
OUTPUT (KG/YR)	131.3
OUTPUT (MG/L)	0.109
REALITY CHECK CONC.	
(Based on real data)	
TERMINAL DISCHARGE?	1
(1=YES 2=NO)	
LOAD TO RESOURCE	
WATER (CU.M/YR)	1203254
PHOSPHORUS (KG/YR)	131.3
PHOSPHORUS (MG/L)	0.109
BASIN EXPORT COEFFICIENT	0.50

DIRECT LOADS TO LAKE	P	N
ATMOSPHERIC (KG/YR)	2.6	84.4
INTERNAL (KG/YR)	0.0	0.0
WATERFOWL (KG/YR)	4.0	19.0
SEPTIC SYSTEM (KG/YR)	0.0	
WATERSHED LOAD (KG/YR)	131.3	0.0
TOTAL LOAD TO LAKE (KG/YR)	137.9	103.4
(Watershed + direct loads)		
TOTAL INPUT CONC. (MG/L)	0.104	0.078

Sylvan Lake LLRM

THE MODELS				
	PHOSPHORUS	**PRED.**	**PERMIS.**	**CRITICAL**
		CONC.	**CONC.**	**CONC.**
NAME	**FORMULA**	**(ppb)**	**(ppb)**	**(ppb)**
Mass Balance	TP=L/(Z(F))*1000	104		
(Maximum Conc.)				
Kirchner-Dillon 1975	TP=L(1-Rp)/(Z(F))*1000	63	19	38
(K-D)				
Vollenweider 1975	TP=L/(Z(S+F))*1000	104	31	62
(V)				
Larsen-Mercier 1976	TP=L(1-Rlm)/(Z(F))*1000	90	27	54
(L-M)				
Jones-Bachmann 1976	TP=0.84(L)/(Z(0.65+F))*1000	86	26	52
(J-B)				
Reckhow General (1977)	TP=L/(11.6+1.2(Z(F)))*1000	44	13	27
(Rg)				
Average of Model Values		77	23	47
(without mass balance)				

Appendix I

USDA-NRCS Grant Information Summary for Conservation Projects

INTRODUCTION

FOR THE LATEST VERSION OF THIS SUMMARY WITH HYPERLINKS, PLEASE VISIT THE USDA-NRCS WEBSITE AT: http://www.il.nrcs.usda.gov

This summary is intended to assist individuals, groups, and local units of government in search of funding or other financial incentives for community-based conservation projects in Illinois. The list is divided into five categories: federal funding sources, state funding sources, other public/private sources, and private sources. A key has been developed to identify eligible groups for each grant after the title of the grant:

Key to group eligibility:

"I" individuals eligible
"G" local units of government
"O" all organizations eligible to apply
"P" private not-for-profit (501C3) groups only eligible
"E" educational institutions
"U" unknown or eligibility varies, need to contact administrators.

For the purposes of this document, conservation is defined as holistically as possible to include grants or financial incentives that enhance the wise use and management of natural and cultural resources in urban, suburban, and rural communities. Some of these grants may not have conservation as a specific goal, but could be used to achieve multiple objectives that include conservation.

The intent of this document is to provide the reader with examples of what is available in financial incentives. Many other funding alternatives exist, and may better fit local needs. This document is provided as a public service and does not constitute a recommendation or endorsement of any particular grant or program; also note that the absence of any particular grant or program does not constitute a negative endorsement. While an effort has been made to provide an accurate listing, funding information is constantly changing and omissions or errors may occur. Please recycle previous editions. For corrections, comments or additional copies of this summary, please contact:

USDA- Natural Resources Conservation Service (NRCS)
ATTN: Keith Eichorst, NRCS Community Planner
313-J Plainfield-Naperville Road, Plainfield, IL 60544
Email: Keith.Eichorst@il.usda.gov

Other sources of information should be consulted and evaluated to insure an informed choice is made before actions are taken.
This section was updated in April 2002.
NRCS IL April 2002
urbapp_G.doc

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FEDERAL FUNDING SOURCES

The federal government is an excellent place to investigate funding resources for conservation projects. Once you identify your specific requirements, the Catalog of Federal Domestic Grants (CFDA) is the single best place to look for federal funding sources-the catalog should be available at your local library or you can view the CFDA on-line:

Catalog of Federal Domestic Assistance:
http://www.cfda.gov

Web site for federal forms and grant administration procedures:
http://www.whitehouse.gov/omb/grants/index.html

Web sites of federal agencies may give you more information about individual government programs as well as provide information on other opportunities for assistance:

United States Department of Agriculture (USDA) Illinois Natural Resources Conservation Service (NRCS):
http://www.il.nrcs.usda.gov

Federal Emergency Management Agency (FEMA)
http://www.fema.gov

United States Department of Housing and Urban Development (HUD):
http://www.hud.gov

United States Environmental Protection Agency (USEPA)
http://www.epa.gov/ogd

USEPA Catalog of Funding Sources for Watershed Protection
http://www.epa.gov/owowwtr1/watershed/wacademy/fund/wfund.pdf

Partners for Fish and Wildlife: O, I, E, G.
-Eligible projects include restoration or enhancement of wildlife habitat, does not fund land acquisition or salaries.
-Need to call for application deadlines.
-Matching or in-kind services preferred, 10-year habitat development agreement required.
-Contact the US Fish and Wildlife Service (USFWS) at 847-381-2253 or 309-793-5800 for information.

Northeastern Illinois Wetlands Conservation Account: I, G, O, P, E.
-Eligible projects include restoration, enhancement, and preservation of wetlands. Other eligible projects include those that promote understanding, appreciation, and stewardship of wetlands
-Application deadlines vary. $5,000-$150,000 grant range.
-Matching funds preferred but not required. Limited to Northeastern Illinois area.
-Contact the U.S. Fish and Wildlife Service at 847-381-2253 for information.

Challenge Grant Program: O, I, E, G.
-Purpose for wildlife habitat restoration, streambank stabilization, or education.
-Application deadlines from June to August. Grant ranges vary up to $10,000.
-50% Match required.
-Contact U.S. Fish and Wildlife Service at 847-381-2253 or 309-793-5800.

US Environmental Protection Agency - Environmental Education Grants: E, P, G.
-Eligible projects include environmental education activities such as curricula design or dissemination, designing or demonstrating educational field methods, and training educators.

-November deadline.
-Requires a minimum of 25% matching funds or in-kind services.
-Contact US Environmental Protection Agency (USEPA) at 312-353-5282.
http://www.epa.gov/region5/enved.

Environmental Justice Small Grants: E, P.

-Projects include those that use community-based approaches for environmental protection.
-Project grants shall not exceed $20,000.
-Contact USEPA at 1-312-353-1440 or 1-800-962-6215.
http://www.epa.gov/seahome/resources

Community based Environmental Protection for Communities: U

-Purpose is to provide place-based approaches to address community and environmental approaches to slow the loss of open space, habitat, and wetlands.
-Matching share required.
-Need to call for deadlines
-Contact USEPA at 312-886-4856
http://www.epa.gov/ecocommunity

Section 1135 Project Modifications for the Improvement of the Environment: G, P, U.

-Federal funds and technical assistance available for studies, planning, engineering, construction and administration.
-Cost-share up to $5 million plus non-federal match, 25% for project costs.
-Contact Army Corps of Engineers at 312-353-6400, 309-794-5590 or 314-331-8404.

Section 206 Aquatic Ecosystem Restoration: G, P, U.

-Projects include funding and assistance to carry out ecosystem restoration and enhancement that is documented to be in the public interest, will improve the environment, and is cost effective.
-Federal cost-share of up to $5 million is available, 35% non-federal cost-share required.
-Contact the Army Corps of Engineers at 312-353-6400, 309-794-5590 or 314-331-8404

Scenic Byway Program: U.

-Purpose is to create or preserve treasured American byways or roads.
http://www.byways.org

Federal Tax Incentives for Conservation: I, O, U.

-Owners of environmentally sensitive land that has been donated for conservation purposes, or has been placed in a conservation easement, may qualify for significant federal tax deductions.
-Reference is the Internal Revenue Service (IRS) Code [170(h)].
-Contact the IRS or your federal tax advisor for more information.

STATE FUNDING SOURCES

The State of Illinois administers numerous programs for community-based conservation. Some of the money for these programs originates at the federal level and is "pass-through" funding, but much comes directly from the State.

Useful State websites:

Catalog of State Assistance to Local Governments:

http://www.legis.state.il.us/commission/igcc/catalog1999.pdf

Illinois Dept of Natural Resources (IDNR):

http://www.dnr.state.il.us/finast.htm

Education grants:
http://www.dnr.state.il.us/lands/education/classrm/grant.

Illinois Department of Agriculture (IDOA):
http://www.agr.state.il.us

Illinois Environmental Protection Agency (IEPA):
http://www.epa.state.il.us/

Illinois FIRST Program: U
-Conservation purposes include brownfield cleanups and construction of trails and parks.
-Contact your local state legislative office for application details.
http://www100.state.il.us/state/ilfirst

Hazard Mitigation Assistance Program: G.
-Governments must be enrolled and in good standing with the National Flood Insurance Program (NFIP).
-Eligible initiatives for projects include acquisition of insured structures and underlying real property for open space uses.
-Provides up to 75% of project costs, 25% match required.
-Contact is the Illinois Emergency Management Agency (IEMA) at 217-782-8719.
http://www.state.il.us/iema

Non-point Source Management Program (Section 319 grants): G, O.
-Eligible projects include controlling or eliminating non-point pollution sources.
-Application deadline is August.
-Requires 40% matching funds or in-kind services.
-Contact Illinois Environmental Protection Agency (IEPA) at 217-782-3362.
http://www.epa.state.il.us/water/financial-assistance

Illinois Clean Lakes Program: G.
-Financial assistance available for lakes over 6 acres that are publicly-owned with public access.
-Application deadline is Aug. 31 (pre-approval) and Oct. 31 (final approval).
-Requires 40% match for phase I, 50% local match for phase II.
-Contact IEPA at 217-782-3362.
http://www.epa.state.il.us/water/financial-assistance/index.html

Lake Education Assistance Program: G, E, P.
-Eligible projects include educational programs on inland lakes and lake watersheds.
-Maximum funding of $500 is reimbursed after completion. Deadlines are Sept. & Jan.
-Contact IEPA at 217-782-3362.
http://www.epa.state.il.us/water/financial-assistance/index.html

Priority Lake and Watershed Implementation Program: G.
-Eligible projects include funding to implement protection/restoration practices that improve water quality prioritized publicly-owned lakes.
-Funding up to 100%, projects range from $5,000 to $30,000.
-Contact IEPA at 217-782-3362.
http://www.epa.state.il.us/water/financial-assistance/index.html

Open Space Lands Acquisition and Development (OSLAD) Program & Open Lands Trust Grant Program: G.
-Eligible projects include money for acquisition and development of public parks for passive recreation/open space.
-Application deadlines vary. Conservation easement required with both programs.

-Funding is reimbursable up to 50% of project costs, reimbursable up to $2 million for the Trust Grant.
-Contact Illinois Dept. of Natural Resources (IDNR) for both programs at 217-782-7481.
http://dnr.state.il.us/ocd/

Greenways and Trails Planning Assistance Program: G.
-Eligible units of government include counties and communities > 10,000
-$20,000 maximum awarded, 50% in-kind contribution required.
-Must follow a planning process
-Contact IDNR at 217-782-3715
http://www.dnr.state.il.us/gnthome.htm

Illinois Trail Grant Programs: G,P,O.
-A collection of various trail programs where eligible projects include acquiring or constructing non-motorized bicycle and snowmobile paths and facilities.
-Deadline is March and May.
-0%-50% match required, depending upon which type of trail grant.
-Contact IDNR at 217-782-7481.
http://dnr.state.il.us/ocd/gaoutnew.htm

Urban & Community Forestry Grant Program: G.
-Purpose is to create or enhance local forestry programs in communities with a local forestry ordinance.
-May deadline.
-50% match required, reimbursement up to $5,000.
-Contact IDNR at 217-782-2361.

Illinois Wildlife Preservation Fund (Small Project Program): I, O, U.
-Eligible projects include those that deal with management, site inventories or on-going education programs.
-Deadline is April.
-Funding up to $1,000 per project, match preferred but not required.
-Contact IDNR at 217-785-8774.

Small Projects Fund: G.
-Provides assistance to smaller communities for alleviating locally significant drainage and flood problems.
-Provides funding for planning and implementation of flood control projects in accordance with an adopted plan.
-Grants and technical assistance awarded up to $100,000.
-Contact IDNR-OWR at 217-782-4637.

Schoolyard Habitat Action Grants: E, O.
-Eligible projects include enhancement of wildlife habitat, with emphasis on youth involvement and education.
-Project must involve a trained WILD educator or facilitator, Maximum funding to $600.
-Application deadline is October.
-Contact the IDNR at 217-524-4126.
http://dnr.state.il.us/lands/education/CLASSRM/grants

Conservation 2000 -- Ecosystems Program: O.
-Eligible projects include habitat protection or improvement, technical assistance, and education.
-The Ecosystems Program provides financial and technical support to groups (ecosystem partners) which seek to maintain and enhance ecological and economic conditions in key watersheds of Illinois.
-February deadline, contact IDNR at 217-782-7940.
http://dnr.state.il.us/c2000

Illinois Transportation Enhancement Program: G.
-Eligible projects include those that support alternative modes of transportation and that preserve visual and cultural resources, including historic preservation and landscaping beautification.

-Planning is encouraged to be completed now for new disbursements.
-Local 20% match required for projects, 50% match for land acquisition.
-Contact Illinois Dept. of Transportation (IDOT) at 1-800-493-3434.
http://www.dot.state.il.us

Learn & Serve Illinois: E.
-Eligible projects include those that combine conservation with hands-on learning in public schools.
-Grades K-12 and regional education offices only eligible, similar program exists for colleges/universities.
-Contact is at 312-814-3606 ggreene@isbe.net
http://www.isbe.state.il.us/learnserve

Certified Local Government Program [for historic preservation]: G.
-Eligible projects include historical surveys, education and historical preservation planning.
-October deadline, 40% match required.
-Contact the Illinois Historic Preservation Agency at 217-785-5042.
http://www.state.il.us/hpa

Illinois Heritage Grants [for historic preservation]: G, O.
-Eligible projects are those that entail historical construction.
-40% match required.
-Contact the Illinois Historic Preservation Agency at 217-785-5042
http://state.il.us/hpa

State Tax Incentives for Conservation: O, I.
-Urban land that is environmentally sensitive may qualify for significant property tax reductions:

Real Property Conservation Rights Act (765 ILCS 120/1 et seq.).

- If land is qualified by having a conservation easement, it may be assessed at 8 1/3 fair market value.

Illinois Natural Areas Preservation Act (525 ILCS 30/1 et.seq)/17 Ill Adm. Code.

- If land is qualified by being designated as an Illinois Nature Preserve, it may be assessed at $1/year in perpetuity.

Open Space Assessment (Illinois Property Tax Code Sections 10-155).

- A lower use evaluation is used for land in open space, 10 acre minimum area, not applicable in Cook County.

Preferential Assessment of Common Areas (Illinois Property Tax Code Sections 10-35).

- Purpose is to encourage open space in residential developments, if qualifying, assessment is reduced to $1/year.

Other tax incentives may also apply, contact IDNR regarding the Real Property Conservation Rights Act and the Illinois Natural Areas Preservation Act at 217-785-8774. Contact your local township or county assessor to determine eligibility under the Open Space Assessment and Preferential Assessment of Common Areas.

OTHER PUBLIC/PRIVATE SOURCES

Community Development Assistance Program (Community Development Block Grant): G.
-Eligible projects must include activities that improve community welfare, specifically in moderate or low-income areas. Conservation-related projects can possibly include the acquisition of real property (e.g., flood-prone areas), construction of water or sewer facilities, and initiatives for energy conservation. Funding competition is intense.
-Application deadlines vary; no match required.
-Money originates at the federal level as the Community Development Block Grant and is administered directly to "entitlement" communities such as the urbanized counties in Northeastern Illinois and selected municipalities such as the City of Chicago. In other areas, municipalities and other units of local government should contact their county government to apply for funds from the state under the Community Development Assistance Program. Community groups should work through their local municipality in incorporated areas and the next level of local government (i.e. township or county) in other areas.

Conservation 2000 -- Streambank Stabilization & Restoration Program (SSRP): G, O, I.
-Eligible projects include naturalized stream bank stabilization practices in rural and urban communities.
-Application deadlines are January, May and September.
-25% match required, 20% for qualified watershed planning areas.
-Contact the local Soil & Water Conservation District that services your county. Offices are listed in the phone book under "local government."

Habitat Restoration Fund for the Fox and Kishwaukee River Watersheds: I, O, E, G.
-Eligible projects include native plantings, upland habitat & wetland restoration.
-Deadlines in March and August.
-75% cost-share, up to $5,000.
-Contact the Lake, Kane-DuPage, DeKalb, Boone, McHenry or North Cook Soil and Water Conservation Districts for more information.

Great Lakes Basin Program for Soil Erosion and Sediment Control: U.
-USDA-sponsored projects include protection of Great Lakes Water Quality by controlling erosion and sedimentation (only available in Lake, Cook, and Will Counties). Typical grant amount around $25,000.
-Application deadline in January.
-Contact the Great Lakes Commission at 734-665-9135.
http://www.glc.org/basin/RFP.html

Chicago Wilderness Small Grants: U.
-Eligible projects include natural areas enhancement, education, and research that focus on biological diversity of northeastern Illinois, northwestern Indiana, and the southeastern Wisconsin region.
-Application deadlines vary, need to call
-1:1 matching funds or in-kind services required.
-Contact the Chicago Wilderness at 312-346-8166 ext. 30 for information.

Wetland Restoration Fund: G, U.
-Eligible projects include wetlands and other aquatic ecosystem restorations, projects must be in the six-county Chicago metropolitan area and have either a conservation easement or be owned by a government agency.
-Deadline is March and October
-No match required, project site must have a conservation easement, projects range from $5,000-$100,000
-Contact Corelands at 312-427-4256, ext. 241.

River Network's Watershed Assistance Grants Program: U.
-Eligible projects include community-based partnerships that conserve or restore watersheds.
-Deadlines are February 18 and June 15
-Grant amounts range from $1.500-30,000.
-Contact River Network at 503-241-3506 ext. 47.
http://www.rivernetwork.org wag@rivernetwork.org

Community Tree Planting & Partnership Enhancement Monetary Grant Program: P.
-Eligible projects include community tree plantings with seedlings and grants to organizations for urban areas.
-Seedlings are donated directly to organizations conducting the plantings or monetary grants.
-Seedlings must be maintained and reports required for two years after grant award.
-Contact the National Tree Trust at 202-628-8733/Fax-8735 for more information on both these programs.
http://www.nationaltreetrust.com

National Fish and Wildlife Foundation Grants: U.
-Eligible projects include habitat restoration and protection on private lands
-Deadlines vary per individual program
-Sample grant sizes range from under $5,000 to $75,000.

-Contact is at 202-857-0166
http://www.nfwf.org

North American Lake Management Society: U.
-Grant Programs and other incentives periodically offered to enhance the protection of lake watersheds.
http://www.nalms.org/

America the Beautiful Fund: U.
-Free seeds provided in support of USDA-sponsored initiative
-Phone is at 202-638-1649
http://www.america-the-beautiful.org

Illinois Conservation Foundation: *P, G.*
-Eligible projects include those that enhance natural resources.
-February deadlines.
-Grants up to $5,000.
-Contact is at 312-814-7237
http://www.icf.org

PRIVATE SOURCES

Private sources of funding for community and urban conservation projects include corporations and individuals that have established foundations for charitable purposes. Many corporate foundations focus their philanthropy in areas near their operations, so local retailers, businesses, or the local chamber of commerce might be a source of revenue for your project. Most, but not all, require that the group applying for funding be sponsored by a not-for-profit [501(c)(3)] corporation. Information about private foundations can be identified through organizations that specialize in grant information research. Fees for services or products may be charged by these organizations, so be sure to clarify if charges will be incurred. For "do-it-your-selfers," local grant data collection centers are available throughout Illinois and in convenient Indiana and Missouri locations:

Resources for Global Sustainability
P.O. Box 3665, Cary, NC 27519.
1-800-724-1857
RGS publishes a yearly catalog called
"Environmental Grantmaking Foundations"
http://www.environmentalgrants.com

The Foundation Center.
79 Fifth Street, New York, New York 10003.
1-212-620-4230
http://www.fdncenter.org

Sonoran Institute
Useful web site in identifying resources:
http://www.sonoran.org/cat/search.asp

State Of Illinois Grant Data Collection Centers
Foundation Center Cooperating Collections

The Donor's Forum of Chicago.
-208 S. LaSalle St., Suite 735, Chicago, IL 60604.
-312-578-0175.
http://www.donorsforum.org info@donorsforum.org.

Metropolitan Association for Philanthropy, Inc
1 Metropolitan Square, Suite 1295
211 North Broadway St. Louis, MO 63102
314-621-6220
http://www.mapstl.org

Evanston Public Library.
-1703 Orrington Ave Evanston, IL 60201.
-847-866-0305.

Evansville -Vanderburgh County Public Library
-22 Southeast Fifth St., Evansville, IN 47708
-812-428-8218

Rock Island Public Library
-401 -19th St. Rock Island, IL
-309-732-7323
http://www.rbls.lib.il.us/rip/index.html

University of Illinois at Springfield (Brookens Library)
-Shepherd Rd. Springfield, IL 62794
-217-206-6633
http://www.uis.edu/library/fdc.htm

Vigo County Public Library
-1 Library Sq. Terre Haute, IN 47807
-812-232-1113

Examples of private grant sources for community-based conservation projects include:

Kodak American Greenways Awards Program: P, G.
-Eligible projects include greenway and trail projects.
-Grants range from $500-$2,500.
-Contact Greenways Coordinator at 703-525-6300 or http://www.conservationfund.org
- leighannemcdonald@conservationfund.org.

Chicago Community Trust: P
222 N. LaSalle St. Ste 1400 (Chicago area only)
Chicago, IL 60601 312-372-3356
http://www.cct.org   info@cct.org

Exxon-mobile Educational Foundation: U, P.
-Emphasis is on conservation and education.
-Contact is at 1-972-444-1104.
http://www.exxon.mobile.com

Field Foundation of Illinois: P.
-Funding restricted to six-county Chicago metropolitan area.
-Focus is on prevention and reduction of pollution and preservation and protection of the natural environment.
-Call 312-831-0910 for more information.

Gaylord and Dorothy Donnelley Foundation: U, P.
-Eligible projects primarily conservation. Chicago area only, sample grants from $3,000-$50,000 range.
-Contact for deadlines.
-Contact is at 35 E. Wacker Drive, Ste. 2600, Chicago, IL 60601, ATTN: Judith Stockdale.
-Phone is at 312-977-2700.
http://www.gddf.org

Wildlife Links: I, G, O
-Eligible projects include management & education projects for conservation on golf courses.
-Contact National Fish & Wildlife Foundation at 202-857-0166
http://www.nfwf.org

Appendix J

Responsiveness Summary

<u>Responsiveness Summary</u>
<u>Des Plaines River/ Higgins Creek Watershed</u>

Responsiveness Summary

This responsiveness summary responds to substantive questions and comments received during the public comment period from August 28, 2012 through September 27, 2012 postmarked, including those from the August 28, 2012 public meeting discussed below.

What is a TMDL?

A Total Maximum Daily Load (TMDL) is the sum of the allowable amount of a pollutant that a water body can receive from all contributing sources and still meet water quality standards or designated uses. The Des Plaines River/ Higgins Creek TMDL report contains a plan detailing the actions necessary to reduce pollutant loads to the impaired water bodies and ensure compliance with applicable water quality standards. The Illinois EPA implements the TMDL program in accordance with Section 303(d) of the federal Clean Water Act and regulations there under.

Background

The Des Plaines River watershed is located in northeastern Illinois in Cook, Lake and DuPage Counties. There are fifteen lakes and three river segments that have TMDL allocations developed. The Clean Water Act and USEPA regulations require that states develop TMDLs for waters on the Section 303(d) List. Illinois EPA is currently developing TMDLs for pollutants that have numeric water quality standards. The lakes are impaired mainly due to elevated levels of phosphorus and total suspended solids. The streams are impaired by chloride, low dissolved oxygen and fecal coliform bacteria. Therefore, TMDLs were developed for chloride, dissolved oxygen, fecal coliform, total suspended solids and phosphorus.

Public Meetings

Public meetings were held in the CMS Suburban North Building, 9511 West Harrison, Des Plaines, Illinois May 19, 2009 and on August 11, 2010. An additional public meeting was held at the Des Plaines Public Library, 1501 Ellinwood Street, Des Plaines, on August 28, 2012. The Illinois EPA provided public notice for all meetings. This notice gave the date, time, location, and purpose of the meeting. The notice also provided references to obtain additional information about this specific site, the TMDL Program and other related issues. The draft TMDL Report was available for review at the Des Plaines City Hall, Buffalo Grove Hall, Vernon Hills City Hall and also on the Agency's web page at http://www.epa.state.il.us/water/tmdl. The public meeting started at 2:00 p.m. on August 28, 2012. There were approximately 20 attendees at the meeting and the meeting record remaining open until midnight, September 27, 2012. There were no public comments.