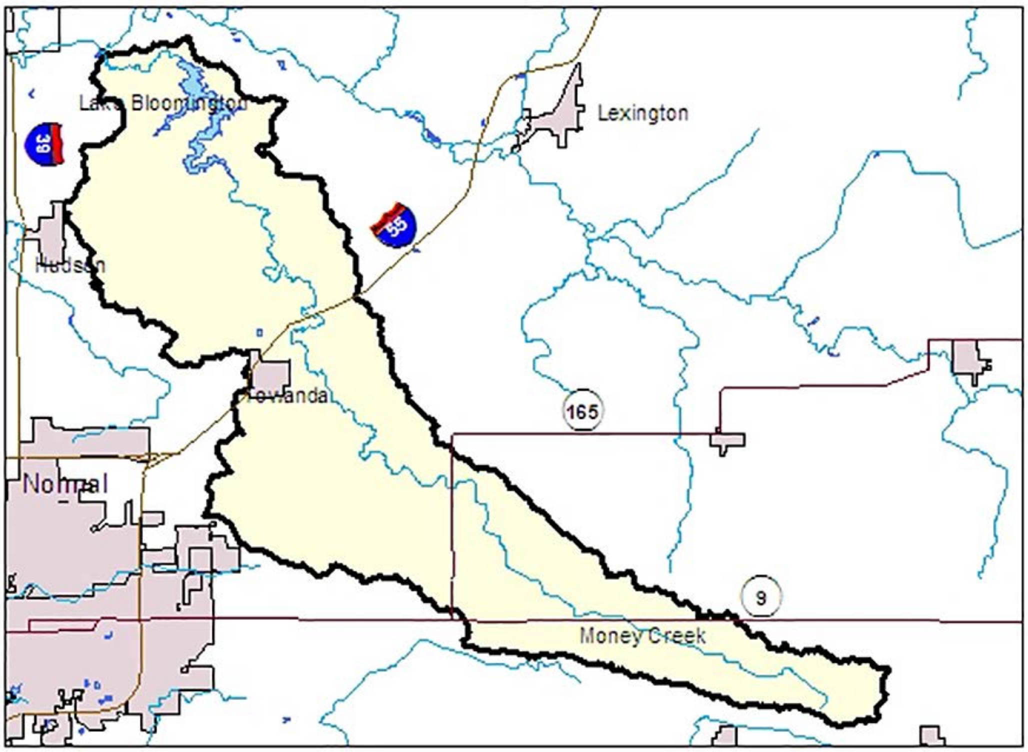
Illinois
Environmental
Protection Agency

Bureau of Water
P.O. Box 19276
Springfield, IL 62794-9276

September 2008

IEPA/BOW/08-010

LAKE BLOOMINGTON WATERSHED TMDL REPORT



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TMDL Development for Lake Bloomington, Illinois

This file contains the following documents:

1) U.S. EPA Approval Letter (dated September 9, 2008-for revised TMDL Report), Decision Document, and Errata Sheet for the Revised Final TMDL Report

2) U.S. EPA Approval Letter (dated September 28, 2007-for original TMDL Report), and Decision Document

3) Stage 1 Report: Watershed Characterization, Data Analysis and Methodology Selection

4) Final TMDL Report

5) TMDL Implementation Plan

UNITED STATES ENVIRONMENTAL PROTECTION AGENCY
REGION 5
77 WEST JACKSON BOULEVARD
CHICAGO, IL 60604-3590

SEP 09 2008

REPLY TO THE ATTENTION OF:

WW-16J

Marcia Willhite, Chief
Bureau of Water
Illinois Environmental Protection Agency
P.O. Box 19276
Springfield, Illinois 62794-9276

RECEIVED
SEP 15 2008
Watershed Management Section
BUREAU OF WATER

Dear Ms. Willhite:

The U. S. Environmental Protection Agency has reviewed the revised Total Maximum Daily Loads from the Illinois Environmental Protection Agency for the Lake Bloomington Watershed and the North Fork Vermilion Watershed in Illinois. The modifications address corrections and changes to the previously approved TMDLs for these watersheds.

Based on this review, EPA has determined that Illinois's revised TMDLs meet the requirements of Section 303(d) of the Clean Water Act and EPA's implementing regulations at 40 C.F.R. Part 130. Therefore, EPA hereby approves the revised TMDLs in the Lake Bloomington Watershed and the North Fork Vermilion Watershed in Illinois. The statutory and regulatory requirements, and EPA's review of Illinois's compliance with each requirement, are described in the enclosed decision document.

We wish to acknowledge Illinois's effort in submitting these revised TMDLs. If you have any questions, please contact Kevin Pierard, Chief of the Watersheds and Wetlands Branch, at 312-886-4448.

Sincerely,

Timothy C. Henry
Acting Director, Water Division

Enclosures

cc: Dean Studer, IEPA

TMDL: Lake Bloomington, Illinois, Phosphorous, Nitrogen TMDL
Effective Date: (original approval 9/28/07)

Revised Decision Document for Approval of Lake Bloomington Watershed TMDL Report

Section 303(d) of the Clean Water Act (CWA) and EPA's implementing regulations at 40 C.F.R. Part 130 describe the statutory and regulatory requirements for approvable TMDLs. Additional information is generally necessary for EPA to determine if a submitted TMDL fulfills the legal requirements for approval under Section 303(d) and EPA regulations, and should be included in the submittal package. Use of the verb "must" below denotes information that is required to be submitted because it relates to elements of the TMDL required by the CWA and by regulation. Use of the term "should" below denotes information that is generally necessary for EPA to determine if a submitted TMDL is approvable. These TMDL review guidelines are not themselves regulations. They are an attempt to summarize and provide guidance regarding currently effective statutory and regulatory requirements relating to TMDLs. Any differences between these guidelines and EPA's TMDL regulations should be resolved in favor of the regulations themselves.

1. Identification of Waterbody, Pollutant of Concern, Pollutant Sources, and Priority Ranking

The TMDL submittal should identify the waterbody as it appears on the State's/Tribe's 303(d) list. The waterbody should be identified/georeferenced using the National Hydrography Dataset (NHD), and the TMDL should clearly identify the pollutant for which the TMDL is being established. In addition, the TMDL should identify the priority ranking of the waterbody and specify the link between the pollutant of concern and the water quality standard (see section 2 below).

The TMDL submittal should include an identification of the point and nonpoint sources of the pollutant of concern, including location of the source(s) and the quantity of the loading, e.g., lbs/per day. The TMDL should provide the identification numbers of the NPDES permits within the waterbody. Where it is possible to separate natural background from nonpoint sources, the TMDL should include a description of the natural background. This information is necessary for EPA's review of the load and wasteload allocations, which are required by regulation.

The TMDL submittal should also contain a description of any important assumptions made in developing the TMDL, such as:

(1) the spatial extent of the watershed in which the impaired waterbody is located;
(2) the assumed distribution of land use in the watershed (e.g., urban, forested, agriculture);
(3) population characteristics, wildlife resources, and other relevant information affecting

the characterization of the pollutant of concern and its allocation to sources; (4) present and future growth trends, if taken into consideration in preparing the TMDL (e.g., the TMDL could include the design capacity of a wastewater treatment facility); and (5) an explanation and analytical basis for expressing the TMDL through *surrogate measures*, if applicable. *Surrogate measures* are parameters such as percent fines and turbidity for sediment impairments; chlorophyl a and phosphorus loadings for excess algae; length of riparian buffer; or number of acres of best management practices.

Comment:

On August 25, 2008, the USEPA received a request from Marcia Wilhite, IEPA, to revise the Lake Bloomington Watershed TMDL. Errors were noted in the TMDL calculations during the development of the implementation plan. IEPA determined that loads from Money Creek, a tributary of Lake Bloomington, were used in the TMDL tables instead of the loads from the entire watershed entering the lake.

IEPA supplied updated TMDL values in a letter dated August 19, 2008. The basis for approving the TMDL have not changed; the revised numbers will still ensure the appropriate water quality is met. The significant changes to this document are in Section 3 and Section 4. The revisions were public noticed from May 12 to June 12, 2008. No comments were received. The language in BOLD contain the revised information.

The Lake Bloomington watershed (ILROD) is located in the central part of McLean County, Illinois, near the City of Bloomington. The watershed drains about 70 square miles. Lake Bloomington is a drinking water reservoir that supplies water to the Villages of Hudson, Towanda, Bloomington Township West Phase, and Bloomington Township Crestewick. Lake Bloomington receives water primarily from Money Creek to the south. Money Creek flows from the southwest to the northeast. Hickory Creek, a tributary of Money Creek, flows into Lake Bloomington from the southwest of the lake. The communities of Towanda and Merna are located in the watershed. Lake Bloomington is located in the northeastern tip of the watershed, about 15 miles south of the City of Bloomington. Figure 2-1 of the TMDL submittal identifies the location of the watershed and the lake.

The land use in the watershed is predominately agriculture cropland. Figure 2-2 of the TMDL submittal presents land use and land use coverage in the Lake Bloomington watershed. Agriculture makes up approximately 93 percent of the total area with the major crops being corn and soybean. Wetlands account for approximately 2.5 percent, urban lands for 2.5 percent, and forestlands are less than 1 percent.

The potential nonpoint sources were identified including animal feedlots and confinement operations, septic systems, lawn fertilizer runoff and agricultural runoff. The amount that is contributed by these sources is a function of the soil type, slope, crop management, precipitation, total amount of cropland, and the distance to the water resource. No CAFO's were identified in the watershed.

There is one active NPDES permitted discharger in the Lake Bloomington watershed, East Bay Camp and Retreat, Permit number IL0025666. The WLA is based on the East Bay Camp and Retreat's design flow of 0.03 million gallons/day and average TP concentration of 3.5mg/l and TN concentration of 15 mg/l. The current permit does not require monitoring for TP or TN. The TMDL used the typical WWTP values to determine the WLA for this permit based on design flow.

The Illinois 303(d) list for 2006 identifies the waterbodies in the Lake Bloomington watershed as a medium priority ranking.

EPA finds that the TMDL document submitted by IEPA satisfies all requirements of this first element.

2. Description of the Applicable Water Quality Standards and Numeric Water Quality Target

The TMDL submittal must include a description of the applicable State/Tribal water quality standard, including the designated use(s) of the waterbody, the applicable numeric or narrative water quality criterion, and the antidegradation policy. (40 C.F.R. ' 130.7(c)(1)). EPA needs this information to review the loading capacity determination, and load and wasteload allocations, which are required by regulation.

The TMDL submittal must identify a numeric water quality target(s) B a quantitative value used to measure whether or not the applicable water quality standard is attained. Generally, the pollutant of concern and the numeric water quality target are, respectively, the chemical causing the impairment and the numeric criteria for that chemical (e.g., chromium) contained in the water quality standard. The TMDL expresses the relationship between any necessary reduction of the pollutant of concern and the attainment of the numeric water quality target. Occasionally, the pollutant of concern is different from the pollutant that is the subject of the numeric water quality target (e.g., when the pollutant of concern is phosphorus and the numeric water quality target is expressed as Dissolved Oxygen (DO) criteria). In such cases, the TMDL submittal should explain the linkage between the pollutant of concern and the chosen numeric water quality target.

Comment:
To assess the designate use support for Illinois waterbodies the IEPA uses rules and regulations adopted by the Illinois Pollution Control Board (IPCB). The following are the use support designations provided by the IPCB for the Lake Bloomington:

a. *General Use Standards* - These standards protect for aquatic life, wildlife, agricultural, primary contact (where physical configuration of the waterbody permits it, any recreational or other water use in which there is prolonged and intimate contact with the water involving considerable risk of ingesting water in quantities sufficient to pose a significant health hazard, such as swimming and water skiing), secondary contact (any recreational or other water use in which contact with the water is either incidental or accidental and in which the probability of ingesting appreciable quantities of water is minimal, such as fishing, commercial and recreational boating, and any limited contact incident to shoreline activity), and most industrial uses. These standards are also designed to ensure the aesthetic quality of the state's aquatic environment.

b. Public and Food Processing Water Supply Standards - These standards protect for any water use in which water is withdrawn from surface waters of the state for human consumption or for processing of food products intended for human consumption.

Illinois is currently developing TMDLs for pollutants that have numeric water quality standards. Lake Bloomington is listed on the Illinois 2006 303(d) list for aesthetic quality use impairment caused by total suspended solids (TSS), and total phosphorus (TP). It is also identified as being impaired for aquatic algae in the 2006 Integrated Report. The lake is also listed as impaired for the designated use of the public and food processing water supplies due to nitrate concentrations. Table 1 below and table 3-1 of the TMDL submittal identified the standards for Lake Bloomington for this TMDL.

Table 1

Parameter	Standard that applies	Limit	Regulatory Section Citation**
Nitrate-Nitrogen	Public and Food Processing Water Supplies	10mg/l	302.304
Total Phosphorus	General Use Water Quality Standard	0.05mg/l*	302.205

*Standard only applies in lakes/reservoirs that are greater than 20 acres in surface area and in any stream at the point where it enters such a lake/reservoir.
** The Illinois Pollution Control Board publishes all IEPA water quality standards.

Excessive algal growth is identified as a cause of impairment in Lake Bloomington in the TMDL submitted report and IEPA's Integrated Report (IR) in Appendix B. IEPA considers algal growth to be a nonpollutant and dose not develop TMDLs for nonpollutants. Chlorophyll-*a* is a plant pigment commonly used to measure algal biomas. There is no state standard for chlorophyll-*a*. However, the chlorophyll-*a* is directly related to the amount of nutrients in the water. For Lake Bloomington the limiting nutrient is TP. By controlling TP this should control the chlorophyll-*a*. This TMDL will address the impairments identified in appendix B of the IR.

As discussed above, IEPA does not develop TMDLs for pollutants that do not have numeric standards. Lake Bloomington is listed in Appendix A of the IR as being impaired for TSS. IEPA believes that the impairment will be addressed during the implementation of controls to reduce the TP loadings. Phosphorus binds to sediment and enters the lakes during nonpoint source runoff. Actions required to control the TP loading to the lake via nonpoint sources will also reduce sediment loads to the lakes.

EPA finds that the TMDL document submitted by IEPA satisfies all requirements of this second element.

3. Loading Capacity - Linking Water Quality and Pollutant Sources

A TMDL must identify the loading capacity of a waterbody for the applicable pollutant. EPA regulations define loading capacity as the greatest amount of a pollutant that a water can receive without violating water quality standards (40 C.F.R. §130.2(f)).

The pollutant loadings may be expressed as either mass-per-time, toxicity or other appropriate measure (40 C.F.R. §130.2(i)). If the TMDL is expressed in terms other than a daily load, e.g., an annual load, the submittal should explain why it is appropriate to express the TMDL in the unit of measurement chosen. The TMDL submittal should describe the method used to establish the cause-and-effect relationship between the numeric target and the identified pollutant sources. In many instances, this method will be a water quality model.

The TMDL submittal should contain documentation supporting the TMDL analysis, including the basis for any assumptions; a discussion of strengths and weaknesses in the analytical process; and results from any water quality modeling. EPA needs this information to review the loading capacity determination, and load and wasteload allocations, which are required by regulation.

TMDLs must take into account *critical conditions* for steam flow, loading, and water quality parameters as part of the analysis of loading capacity. (40 C.F.R. §130.7(c)(1)). TMDLs should define applicable *critical conditions* and describe their approach to estimating both point and nonpoint source loadings under such *critical conditions*. In particular, the TMDL should discuss the approach used to compute and allocate nonpoint source loadings, e.g., meteorological conditions and land use distribution.

Comment:
The loading capacities for Lake Bloomington are summarized in Table 6.1 of the TMDL submittal and Table 2 below. For Lake Bloomington the loading capacity for TP is calculated to be **29.6** lb/day, and for TN **4,213.4** lb/day. This represents a **66** percent reduction in loading to the lake for TP and **34** % for TN.

Table 2 Loading Capacities

	TP lbs/yr	TP lbs/day	TN lbs/yr	TN lbs/day
Existing Load	**31, 923**	**87.5**	**2,330,663**	**6,385.4**
Reduction	**66%**		**34%**	
Loading Capacity	**10,805**	**29.6**	**1,537,874**	**4,213.4**
Load Allocation	**9,945**	**27.2**	**1,382,714**	**3,788.3**
Waste Load Allocation	320	0.9	1,373	3.8
Margin of Safety	**540**	**1.5**	**153,787**	**421.3**

To determine these loads the State used the BATHTUB model. The BATHTUB applies a series of empirical equations derived from assessments of lake data and performs steady state water and nutrient calculations based on lake morphometry and tributary inputs. The BATHTUB model was selected to develop the loading capacity of the lake because it requires fairly simple inputs to predict the parameters of concerns. The model accounts for pollutant transport, sedimentation, and nutrient cycling.

The critical condition of the lake would take place when the highest concentration of TP is present. The highest concentrations of TP and chlorophyll *a* are typically observed in lake in late summer (July/August). The BATHTUB model takes this into account when simulating average annual concentrations of both parameters during the critical year. The highest loadings of TP are in the spring when streamflow is at its highest. This was accounted for because the annual loads used for BATHTUB are based on estimates of daily streamflows and TP concentrations. Implementation efforts used to address the TP loading in the lakes will be effective during these high loading events. Because an average annual basis was used for the TMDL development, it is assumed that any critical condition is accounted for with the analysis.

EPA finds that the TMDL document submitted by IEPA satisfies all requirements of this third element.

4. Load Allocations (LAs)

EPA regulations require that a TMDL include LAs, which identify the portion of the loading capacity attributed to existing and future non-point sources and to natural background. Load allocations may range from reasonably accurate estimates to gross allotments (40 C.F.R. §130.2(g)). Where possible, load allocations should be described separately for natural background and non-point sources.

Comments:
As discussed above, the predominate land use is agricultural cropland. Table 2-3 of Appendix A of the TMDL submittal and Table 3 below identify the land use.

Table 3 Land Use

Land use Description	Approximate Acres	Percentage of coverage
Agricultural	41,666.2	93.2 %
Urban	1,116.0	2.5 %
Wetlands	1,102.5	2.5 %
Forest	380.1	0.85 %
Surface Water	428.8	0.96
Total	44,694.2	100 %

The load allocations for TP and TN are summarized in tables 6-1 and 6-2 of the TMDL and Table 4 below..

Table 4 Load Allocations

	TP lbs/yr	TP lbs/day	TN lbs/yr	TN lbs/day
Load Allocation	**9,945**	**27.2**	**1,382,714**	**3,788.3**

The potential nonpoint sources were identified including animal feedlots and confinement operations, septic systems, lawn fertilizer runoff and agricultural runoff. The amount that is contributed by these sources is a function of the soil type, slope, crop management precipitation, total amount of cropland and the distance to the water resource. No CAFO's were identified in the watershed.

EPA finds that the TMDL document submitted by IEPA satisfies all requirements of this fourth element.

5. Wasteload Allocations (WLAs)

EPA regulations require that a TMDL include WLAs, which identify the portion of the loading capacity allocated to individual existing and future point source(s) (40 C.F.R. §130.2(h), 40 C.F.R. §130.2(i)). In some cases, WLAs may cover more than one discharger, e.g., if the source is contained within a general permit.

The individual WLAs may take the form of uniform percentage reductions or individual mass based limitations for dischargers where it can be shown that this solution meets WQSs and does not result in localized impairments. These individual WLAs may be adjusted during the NPDES permitting process. If the WLAs are adjusted, the individual effluent limits for each permit issued to a discharger on the impaired water must be consistent with the assumptions and requirements of the adjusted WLAs in the TMDL. If the WLAs are not adjusted, effluent limits contained in the permit must be consistent with the individual WLAs specified in the TMDL. If a draft permit provides for a higher load for a discharger than the corresponding individual WLA in the TMDL, the State/Tribe must demonstrate that the total WLA in the TMDL will be achieved through reductions in the remaining individual WLAs and that localized impairments will not result. All permittees should be notified of any deviations from the initial individual WLAs contained in the TMDL. EPA does not require the establishment of a new TMDL to reflect these revised allocations as long as the total WLA, as expressed in the TMDL, remains the same or decreases, and there is no reallocation between the total WLA and the total LA.

Comments:

There is one active NPDES permitted discharger in the Lake Bloomington watershed, East Bay Camp and Retreat, Permit number IL0025666. The WLA is based on the East Bay Camp and Retreat's design flow of 0.03 million gallons/day, the average TP concentration of 3.5mg/l, and the average TN concentration of 15 mg/l. The current permit does not require monitoring for TP or TN. The TMDL used the typical WWTP values to determine the WLA for this permit based on design flow.

Towanda Grade School held a NPDES permit until January 11, 2005, permit number IL0046167. This permit was terminated when a septic system was installed.

The waste load allocations for TP and TN are summarized in tables 6-1 of the TMDL and table 5 below.

Table 5 Waste Load Allocations

	TP lbs/yr	TP lbs/day	TN lbs/yr	TN lbs/day
Waste Load Allocation	320	0.9	1,373	3.8

EPA finds that the TMDL document submitted by IEPA satisfies all requirements of this fifth element.

6. Margin of Safety (MOS)

The statute and regulations require that a TMDL include a margin of safety (MOS) to account for any lack of knowledge concerning the relationship between load and wasteload allocations and water quality (CWA §303(d)(1)(C), 40 C.F.R. §130.7(c)(1)). EPA's 1991 TMDL Guidance explains that the MOS may be implicit, i.e., incorporated into the TMDL through conservative assumptions in the analysis, or explicit, i.e., expressed in the TMDL as loadings set aside for the MOS. If the MOS is implicit, the conservative assumptions in the analysis that account for the MOS must be described. If the MOS is explicit, the loading set aside for the MOS must be identified.

Comments:
The calibrated BATHTUB model was used to identify the reductions in loading needed for TP and TN. For phosphorus the predicted TP was in exceedance of the standard for 6 years of the 10 year simulation period. Input loads were reduced for each model year to meet the target with reductions ranging for 59 to 89 percent. An **66 percent overall** load reduction is needed to meet the TP water quality standard in the year with the highest simulated TP (2000) which will be protective of all other years.

Nitrates (NO_3) are not calculated directly by the BATHTUB model. Therefore, the concentration of TN was conservatively used in this analysis as a surrogate of NO_3. Predicted total TN was in exceedance during two of the ten years simulated. Input loads were reduced for each model year to meet the target with reduction at 18 and 48 percents. A **34 percent overall** load reduction is needed to meet the nitrate water quality standard in the year with the highest simulated TN (1990), which will then be protective of all other years.

The MOS for Lake Bloomington is also explicit. A five percent MOS has been incorporated for TP, and a ten percent MOS was used for TN. These values were chosen based on the average absolute errors associated with the modeling.

EPA finds that the TMDL document submitted by IEPA satisfies all requirements of this sixth element.

7. Seasonal Variation

The statute and regulations require that a TMDL be established with consideration of seasonal variations. The TMDL must describe the method chosen for including seasonal variations. (CWA §303(d)(1)(C), 40 C.F.R. §130.7(c)(1)).

Comments:
Seasonal variation is represented in the Lake Bloomington TMDL as conditions were modeled on an annual basis. Modeling on an annual basis takes into account the seasonal loadings in different quantities during different time periods.

EPA finds that the TMDL document submitted by IEPA satisfies all requirements of this sixth element.

8. Reasonable Assurances

When a TMDL is developed for waters impaired by point sources only, the issuance of a National Pollutant Discharge Elimination System (NPDES) permit(s) provides the reasonable assurance that the wasteload allocations contained in the TMDL will be achieved. This is because 40 C.F.R. §122.44(d)(1)(vii)(B) requires that effluent limits in permits be consistent with Athe assumptions and requirements of any available wasteload allocation@ in an approved TMDL.

When a TMDL is developed for waters impaired by both point and nonpoint sources, and the WLA is based on an assumption that nonpoint source load reductions will occur, EPA's 1991 TMDL Guidance states that the TMDL should provide reasonable assurances that nonpoint source control measures will achieve expected load reductions in order for the TMDL to be approvable. This information is necessary for EPA to determine that the TMDL, including the load and wasteload allocations, has been established at a level necessary to implement water quality standards.

EPA's August 1997 TMDL Guidance also directs Regions to work with States to achieve TMDL load allocations in waters impaired only by nonpoint sources. However, EPA cannot disapprove a TMDL for nonpoint source-only impaired waters, which do not have a demonstration of reasonable assurance that LAs will be achieved, because such a showing is not required by current regulations.

Comments:
For the nonpoint source reductions, IEPA is in the process of developing implementation activities, such as conservation tillage practices, filter strips, and nutrient management. A variety of best management plans (BMPs) are being considered to reduce phosphorus and nitrogen to

Lake Bloomington. IEPA will also investigate mitigation of failing septic systems for homes on the lake.

For the point sources, monitoring requirements for TP and TN will be incorporated into permits when permits are up for renewal.

EPA finds that the TMDL document submitted by IEPA satisfies all requirements of this eighth element.

9. Monitoring Plan to Track TMDL Effectiveness

EPA's 1991 document, *Guidance for Water Quality-Based Decisions: The TMDL Process* (EPA 440/4-91-001), recommends a monitoring plan to track the effectiveness of a TMDL, particularly when a TMDL involves both point and nonpoint sources, and the WLA is based on an assumption that nonpoint source load reductions will occur. Such a TMDL should provide assurances that nonpoint source controls will achieve expected load reductions and, such TMDL should include a monitoring plan that describes the additional data to be collected to determine if the load reductions provided for in the TMDL are occurring and leading to attainment of water quality standards.

Comments:
As part of the implementation plan a monitoring plan will be included. The implementation plan will be developed with stakeholder's involvement. IEPA continues to obtain water quality data through the Ambient Water Quality Monitoring Network, Intensive Basin Survey, and Facility Related Stream Survey programs. These are the same programs through which the water quality data were obtained to identify water quality impairment for the 303(d) list.

EPA finds that the TMDL document submitted by IEPA satisfies all requirements of this ninth element.

10. Implementation

EPA policy encourages Regions to work in partnership with States/Tribes to achieve nonpoint source load allocations established for 303(d)-listed waters impaired by nonpoint sources. Regions may assist States/Tribes in developing implementation plans that include reasonable assurances that nonpoint source LAs established in TMDLs for waters impaired solely or primarily by nonpoint sources will in fact be achieved. In addition, EPA policy recognizes that other relevant watershed management processes may be used in the TMDL process. EPA is not required to and does not approve TMDL implementation plans.

Comment:
A project Implementation Plan will be prepared that will more fully address likely TP and TN sources and potential implementation activities that can achieve the desired reductions in the loading.

EPA finds that the TMDL document submitted by IEPA satisfies all requirements of this tenth element.

11. Public Participation

EPA policy is that there should be full and meaningful public participation in the TMDL development process. The TMDL regulations require that each State/Tribe must subject calculations to establish TMDLs to public review consistent with its own continuing planning process (40 C.F.R. §130.7(c)(1)(ii)). In guidance, EPA has explained that final TMDLs submitted to EPA for review and approval should describe the State/Tribe's public participation process, including a summary of significant comments and the State's/Tribe's responses to those comments. When EPA establishes a TMDL, EPA regulations require EPA to publish a notice seeking public comment (40 C.F.R. §130.7(d)(2)).

Provision of inadequate public participation may be a basis for disapproving a TMDL. If EPA determines that a State/Tribe has not provided adequate public participation, EPA may defer its approval action until adequate public participation has been provided for, either by the State/Tribe or by EPA.

Comments:
Illinois EPA held two public meeting in the development of this TMDL at Davis Lodge on Lake Bloomington on July 18, 2006 and August 8, 2007. IEPA provide public notice for both meetings by placing display ads in the Bloomington Pantagraph. Approximately 72 individuals and organizations were also sent the public notice. The draft TMDL Report was available for review at the Bloomington Public Library, the McLean County Soil and Water Conservation District Office, and on IEPA's web page. The draft TMDL report was public noticed from August 8, 2007 until August 17, 2007.

Public comments were received and adequately addressed by IEPA.

As discussed is Section 1 above, the revised TMDL was available to the public as part of the public notice process for the TMDL implementation plan. The public notice period was from May 12-June 12, 2008. A public meeting was also held regarding the implementation plan and revised TMDL. No comments were received on the revised TMDL.

EPA finds that the TMDL document submitted by IEPA satisfies all requirements of this eleventh element.

12. Submittal Letter

A submittal letter should be included with the TMDL submittal, and should specify whether the TMDL is being submitted for a *technical review* or *final review and approval*. Each final TMDL submitted to EPA should be accompanied by a submittal letter that explicitly states that the submittal is a final TMDL submitted under Section 303(d) of the Clean Water Act for EPA review and approval. This clearly establishes the State's/Tribe's intent to submit, and EPA's duty to review, the TMDL under the statute. The submittal letter, whether for technical review or final review and approval, should contain such identifying information as the name and location of the waterbody, and the pollutant(s) of concern.

Comment:
The U.S. EPA received the formal submittal of the final TMDL for the Lake Bloomington watershed, Illinois on a CD, on September 10, 2007, along with a submittal letter from Marcia T. Whillhite, Chief of the Bureau of Water, dated September 6, 2007. In the submittal letter, IEPA stated that the enclosed submittal of the Lake Bloomington watershed TMDL report is for USEPA final approval. The submittal letter included the name and location of the waterbody (Lake Bloomington) and the pollutants of concern (TP, TN). The letter states that the Lake Bloomington watershed was identified as impaired for the "Aesthetic Quality, with total phosphorus and total suspended solids as the cause and Public Water Supply Use with nitrate as the cause. Since Illinois EPA is only developing TMDLs for parameters that have numeric water quality standards, this report does not include a TMDL for total suspended solids." However implementation needed for the removal of TP should address the TSS impairment.

See Section 1 above regarding the submittal letter of the revised TMDL.

EPA finds that the TMDL document submitted by IEPA satisfies all requirements of this twelfth element.

13. Conclusion

After a full and complete review, EPA finds that the TMDLs for Lake Bloomington watershed, specifically segment RDO, satisfies all of the elements of an approvable TMDL. This document addresses a total of **2** TMDLs and **3** impairments from the 2006 Illinois 303d list as identified in Table 6 below.

Table 6

Waterbody	Waterbody ID	TMDL Pollutants	Impairments Addressed	Appendix B impairments
Lake Bloomington	RDO	Total Phosphorus, Total Nitrogen	Total Phosphorus, Nitrate-Nitrogen, Total Suspended Solids	Algae

EPA's approval of this TMDL extends to the waterbody which is identified in this document and the TMDL with the exception of any portions of the waterbody that is within Indian Country, as defined in 18 U.S.C. Section 1151. EPA is taking no action to approve or disapprove the State's TMDL with respect to those portions of the water at this time. EPA, or eligible Indian Tribes, as appropriate, will retain responsibilities under Section 303(d) for those waters.

TMDL: North Fork Vermilion River and Lake Vermilion TMDL, Illinois
Effective Date: (originally approved 12/29/06)

Revised Decision Document for Approval of North Fork Vermilion River and Lake Vermilion TMDL Report

Section 303(d) of the Clean Water Act (CWA) and EPA's implementing regulations at 40 C.F.R. Part 130 describe the statutory and regulatory requirements for approvable TMDLs. Additional information is generally necessary for EPA to determine if a submitted TMDL fulfills the legal requirements for approval under Section 303(d) and EPA regulations, and should be included in the submittal package. Use of the verb "must" below denotes information that is required to be submitted because it relates to elements of the TMDL required by the CWA and by regulation. Use of the term "should" below denotes information that is generally necessary for EPA to determine if a submitted TMDL is approvable. These TMDL review guidelines are not themselves regulations. They are an attempt to summarize and provide guidance regarding currently effective statutory and regulatory requirements relating to TMDLs. Any differences between these guidelines and EPA's TMDL regulations should be resolved in favor of the regulations themselves.

1. Identification of Water body, Pollutant of Concern, Pollutant Sources, and Priority Ranking

The TMDL submittal should identify the water body as it appears on the State's/Tribe's 303(d) list. The water body should be identified/georeferenced using the National Hydrography Dataset (NHD), and the TMDL should clearly identify the pollutant for which the TMDL is being established. In addition, the TMDL should identify the priority ranking of the water body and specify the link between the pollutant of concern and the water quality standard (see section 2 below).

The TMDL submittal should include an identification of the point and nonpoint sources of the pollutant of concern, including location of the source(s) and the quantity of the loading, e.g., lbs/per day. The TMDL should provide the identification numbers of the NPDES permits within the water body. Where it is possible to separate natural background from nonpoint sources, the TMDL should include a description of the natural background. This information is necessary for EPA's review of the load and wasteload allocations, which are required by regulation.

The TMDL submittal should also contain a description of any important assumptions made in developing the TMDL, such as:

(1) the spatial extent of the watershed in which the impaired water body is located;
(2) the assumed distribution of land use in the watershed (e.g., urban, forested, agriculture);
(3) population characteristics, wildlife resources, and other relevant information affecting the characterization of the pollutant of concern and its allocation to sources;
(4) present and future growth trends, if taken into consideration in preparing the TMDL (e.g., the TMDL could include the design capacity of a wastewater treatment facility); and
(5) an explanation and analytical basis for expressing the TMDL through *surrogate*

measures, if applicable. *Surrogate measures* are parameters such as percent fines and turbidity for sediment impairments; chlorophyll a and phosphorus loadings for excess algae; length of riparian buffer; or number of acres of best management practices.

Comment:

On August 25, 2008, the USEPA received a request from Marcia Wilhite, IEPA, to revise the North Fork Vermilion River Watershed TMDL. Errors were noted in the TMDL calculations during the development of the implementation plan. IEPA determined that rounding errors and typographical errors had occurred in the calculations of the loads. In addition, the waste load allocations for Lake Vermilion were revised to account for changes in individual waste load allocations.

IEPA supplied updated TMDL values in a letter dated August 19, 2008. The basis for approving the TMDL have not changed; the revised numbers will still ensure the appropriate water quality is met. The significant changes to this document are in Sections 3, 4, and 5. The revisions were public noticed from May 12 to June 12, 2008. No comments were received. The language in BOLD contain the revised information.

Introduction:

This TMDL decision document approves four TMDLs in the North Fork Vermilion River watershed: North Vermilion River Segment BPG-09 for fecal coliform; North Fork Vermilion River Segment BPG-05 for nitrate/nitrogen; and Lake Vermilion (RBG) for total phosphorus and nitrates.

Location/Description/Spatial Extent:

The North Fork Vermilion River Watershed is located in central Illinois along the Illinois-Indiana border.
Most of the watershed is located in Vermilion County, Illinois, with portions extending to Iroquois County in Illinois, and to Warren and Benton Counties in Indiana. The watershed drains approximately 295 square miles, with about 200 square miles in Illinois and 95 square miles in Indiana. North Fork Vermilion River segment BPG09 starts at the confluence with Painter Creek and extends downstream 5.91 miles, directly flowing into BPG05 (Figure 2-1 of the TMDL). North Fork Vermilion River segment BPG05 extends downstream to Lake Vermilion, and is about 9.82 miles in length. This TMDL Report focuses on the subwatersheds that drain to the listed North Fork Vermilion River segments BPG09, BPG05, and Lake Vermilion (RBD).

The distribution of watershed area by county is shown in Table 2-1 of the TMDL and below.

County, State	**Area of Watershed in County** (square Miles)	**Percent of Watershed in County** (percent)
Vermilion County, Illinois	190	64

Iroquois County, Illinois	10	3
Warren County, Indiana	66	23
Benton County, Indiana	29	10

Lake Vermilion (RBD) is located in the southern portion of the watershed, 1 mile northwest of the City of Danville, about 5.2 miles upstream of the confluence of the North Fork Vermilion River with Vermilion River.

Land Use:

Table 2-7 of the TMDL Report summarizes land use for the BPG09 subwatershed of North Fork Vermilion River. It is predominantly agricultural crop land, which accounts for 89.6 percent of the total watershed area. Pasture land accounts for about 6.5 percent, and forest land accounts for 1.8 percent. Agricultural lands are mostly located upstream near the headwater area.

Table 2-8 of the TMDL Report summarizes the land use of the BPG05 subwatershed. The BPG05 subwatershed represents the drainage area upstream of Lake Vermilion, which includes BPG09 subwatershed plus the lateral contributing area along the BPG05 segment. The land use distribution is similar to BPG09 subwatershed, with cropland at 88 percent, pasture at 7 percent, forest at 2.5 percent, and urban at 1.1 percent. Wetland, grassland, water, and barren or mining together account for about 1.4 percent.

The RBD subwatershed is the portion of the Vermilion River Watershed upstream of Lake Vermilion, including BPG05 watershed and the area that drains directly to the lake. Table 2-9 of the TMDL report summarizes the land use for the RBD subwatershed that drains directly to the lake. The area surrounding Lake Vermilion is also predominately agricultural land which includes 86% cropland, 7.4% pasture, 3.1% forest and 1.4% urban land.

Problem Identification/Pollutant of Concern:

In 2004, IEPA determined that these segments are impaired using its 2002 assessment methodology and data collected in 2000 from Lake Vermilion and North Fork Vermilion River. The causes of the impairments are as follows:

The North Fork Vermilion River segment BPG09 is listed in Illinois' 2004 Section 303(d) list for pathogens. Fecal coliform will be used as the indicator for pathogens and will be considered the pollutant of concern for this segment.

The North Fork Vermilion River segment BPG05 is listed in Illinois' 2004 Section 303(d) list for nutrients with nitrate/nitrogen as the pollutant of concern for this segment.

Lake Vermilion is listed in the Illinois' 2004 Section 303(d) list for nutrients, algal growth, siltation, and TSS with total phosphorus and nitrates being the pollutants of concern.

The designated uses and the causes of impairment addressed in this TMDL are summarized in the table below and in Table 1-1 of the TMDL Report. When a waterbody is assessed as partial support for a designated use, one violation of an applicable Illinois water quality standard at an Intensive Basin Surveys (IBS) or Facility-Related Stream Surveys (FRSS) site or one violation over three years at an Ambient Water Quality Monitoring Network (AWQMN) station is considered a basis for listing the violating parameter as a potential cause.

Segment	Designated Use (support status)	Causes of Impairment	Impairments Addressed in TMDL
North Fork Vermilion River (BPG09)	Primary Contact (Not supporting)	Fecal Coliform	Pathogen
North Fork Vermilion River (BPG05)	Drinking water supply (partial)	Nitrogen/nitrate	Nutrients
Lake Vermilion (RBD)	Overall use (partial)	Total Phosphorus/Nitrate	Nutrients

Source Identification:

The Source Assessment section of the TMDL report discusses nonpoint and point sources that potentially contribute to the impairment of the North Fork Vermilion River and Lake Vermilion.

Nonpoint Sources:

The Illinois 2004 Section 303(d) List identified agriculture (crop related, non-irrigated crop production) and hydrologic/habitat modification (flow regulation, stream bank modification, destabilization, recreation, salt storage, and unknown sources) as sources of nutrient loads to Lake Vermilion. Specific sources of pathogens to the North Fork Vermilion River have not been identified. Row crop agriculture is a common source of sediment and nutrient loads and is prevalent in the watershed. Overall, about 96% of the watershed is agricultural land. Crops primarily consist of corn and soybean rotations. Fertilizers commonly used in the watershed include anhydrous ammonia, ammonium phosphate, and potash. Fertilizers are applied in the fall and spring with a variety of application methods. Animal feedlots are another potential source of nutrient loads and pathogens; however, none of them were large enough to be considered a Confined Animal Feeding Operation (CAFO).

Soils in the North Fork Vermilion River watershed have a relatively low permeability of 0.5 inch per hour. Rainfall does not easily infiltrate low permeability soils, and the resulting overland runoff rates may be high. Increased overland runoff typically results in larger nutrient and sediment loads to receiving water bodies. The absence of cropland buffer and filter strips in agricultural areas may not allow for adequate trapping of particles, uptake of dissolved nutrients, and infiltration of water and nutrients. Furthermore, grazing areas and pastureland may be crossed by small tributaries that are damaged and degraded by livestock. This TMDL Report indicates that about 15 percent of the points (locations) surveyed are still exceeding tolerable soil loss levels. Vermilion County recorded 13 percent of the survey points exceeding tolerable soil loss levels, slightly lower than the state average. Vermilion County, however, has a high percentage (89 %) of conventional tillage in corn fields, compared to the state average of 35.5%. The need for soil management is warranted to lower the soil loss level. IEPA observed that the State average ephemeral and/or gully erosion increased in the past 8 years. Although this may be partially attributed to heavy rainfall intensity, the disturbance of the soil surface may have contributed to the increased erosion.

Private septic systems in Vermilion County are another potential source of nutrient, sediment, and pathogen loads. Septic systems can potentially leach nutrients into the groundwater and can contaminate surface water if the systems are not functioning properly. Except for residents of Danville, Rossville, and Hoopeston, all residents in the watershed use septic systems, for which the population is estimated to be 7,560, based on urban and non-urban population data shown in Tables 2-2 and 2-3 of the TMDL Report. IEPA believes that the non-permitted septic systems may be a significant source of nutrient and fecal coliform loads to the North Fork Vermilion River and Lake Vermilion.

Additionally, IEPA reported that there are about 70 houses located around the shoreline of Lake Vermilion. About 40% of the houses discharge to the Danville wastewater treatment plant. The rest use septic tanks to treat their wastewater. About 95% of the soils in Warren County have severe limitations for conventional septic systems. Some older systems are connected to underground tile drains or discharge directly to drainage ditches. Both practices are illegal in Illinois and Indiana.

Point Sources:

Most facilities in the North Fork Vermilion River watershed discharge a negligible flow and do not discharge loads of pollutants of concern. There are six facilities that either discharge a significant flow or potentially discharge sediment and nutrient loads. These facilities are as follows, listed from upstream to downstream (Table 5-1 and Figure 5-1 of the TMDL Report):

1. **Hoopeston Foods, Inc.** discharges non-contact cooling water and boiler blowdown through two outfalls. Each is monitored for temperature, biological oxygen demand (BOD), pH, and TSS. It is likely that the receiving ditch of the discharge is a tributary to Hoopeston Branch (BPGD), which is listed as impaired by low DO. A new NPDES discharge permit was issued to the facility, which sets 30-day average BOD (5-day) discharge at 10 mg/L and daily maximum at 30 mg/L. Discharge monitoring reports (DMR) for Hoopeston Foods, Inc. will be evaluated as part of the future TMDL development for that segment.

2. **Hoopeston Sewage Treatment Plant** (STP) regularly discharges through one main outfall to the North Fork Vermilion River. The treatment processes include bar screens, grit chambers, two treatment tanks, two oxidation ditches, and four sand filters. The monitoring discharge records from April 2000 to May 2001 show that the maximum discharge rate in the year is about 2.36 MGD. Monthly average CBOD, ammonia, and TSS are included in Table 5-1. The concentrations of these constituents did not exceed the NPDES permitted limits. Hoopeston STP has a year-round disinfection exemption for fecal coliform that includes the entire length of Hoopeston Branch to the point where it enters North Fork Vermilion River.

3. **Rossville STP** discharges regularly through one outfall to the North Fork Vermilion River, which is monitored for pH, TSS, total residual chlorine, and BOD. The treatment facility uses a two-lagoon system for primary and secondary treatment. Two intermittent sand filters polish the effluent before discharge. The average discharge concentrations of BOD and TSS are included in Table 5-1. No discharge violation was reported. Rossville has a year-round disinfection exemption for fecal coliform and discharges to Segment BPG-10.

4. **Alvin Water Treatment Plant** (WTP) discharges regularly through one outfall to the North Fork Vermilion River. The WTP regularly monitors pH, TSS, iron, and total residual chlorine. IEPA has been unable to retrieve the DMRs, so the current impacts are uncertain. The Village of Alvin is an unsewered community.

5. **Bismarck Community Unit School** has an STP outfall that discharges regularly to Painter Creek, a tributary to North Fork Vermilion River. The school uses a septic tank system and two tertiary sand filters to treat the wastewater. The outfall is monitored monthly for pH, TSS, ammonia-nitrogen, total residual chlorine, and BOD. The DMR records from July 2002 to October 2003 show that the average discharge is about 0.005 MGD. The discharges in January 2001 exceeded the NPDES permitted ammonia concentration of 4.00 mg/L.

6. **Bismarck Community Water District** is the water treatment plant for local water supply. The outfall is only monitored for suspended sediment discharge and pH since it probably does not contribute significant nutrient and fecal coliform to the North Fork Vermilion River.

<u>Priority Ranking:</u> North Fork Vermilion River and Lake Vermilion are listed on the 2004 Illinois Section 303(d) List of Impaired Waters and, as such, have been targeted as high priority waterbodies for TMDL development.

<u>Future Growth:</u> Data indicate that the population in the watershed is likely to be decreasing; hence it is not a factor in this TMDL.

EPA finds that the TMDL document submitted by IEPA satisfies all requirements of this first element.

2. Description of the Applicable Water Quality Standards and Numeric Water Quality Target

The TMDL submittal must include a description of the applicable State/Tribal water quality standard, including the designated use(s) of the water body, the applicable numeric or narrative water quality criterion, and the antidegradation policy. (40 C.F.R. §130.7(c)(1)). EPA needs this information to review the loading capacity determination, and load and wasteload allocations, which are required by regulation.

The TMDL submittal must identify a numeric water quality target(s) – a quantitative value used to measure whether or not the applicable water quality standard is attained. Generally, the pollutant of concern and the numeric water quality target are, respectively, the chemical causing the impairment and the numeric criteria for that chemical (e.g., chromium) contained in the water quality standard. The TMDL expresses the relationship between any necessary reduction of the pollutant of concern and the attainment of the numeric water quality target. Occasionally, the pollutant of concern is different from the pollutant that is the subject of the numeric water quality target (e.g., when the pollutant of concern is phosphorus and the numeric water quality target is expressed as Dissolved Oxygen (DO) criteria). In such cases, the TMDL submittal should explain the linkage between the pollutant of concern and the chosen numeric water quality target.

Comment:

Designated Use of Waterbody:

The designated uses and causes of impairment are summarized in Table 1.1 of the TMDL Report. Briefly, designated uses are as follows:
North Fork Vermilion River (BPG05): Drinking water supply
North Fork Vermilion River (BPG09): Primary contact
Lake Vermilion (RBD): Overall use, Primary contact, Secondary contact, Drinking water supply

Water Quality Standards and Numeric Water Quality Targets:

The North Fork Vermilion River Segment BPG09 is listed on the Illinois 2004 Section 303(d) list as impaired due to pathogens. Fecal coliform will be used as the indicator of pathogens. The Illinois fecal coliform water quality standard for general use (35 IAC 302.209) requires that during the months May through October, based on a minimum of five samples taken over not more than a 30-day period, fecal coliform shall not exceed a geometric mean (GM) of 200 colony forming units (cfu) per 100 mL (cfu/100 mL), nor shall more than 10 percent of the samples during any 30 days period exceed 400 cfu/100 mL in protected waters.

The North Fork Vermilion River segment BPG05 is impaired for drinking water and food processing water use by excessive nitrates/nitrogen. The not-to-exceed numeric standard for nitrate/nitrogen is 10 mg/L (35 IAC 302.304).

Lake Vermilion is listed on the Illinois 2004 Section 303(d) list for use impairment caused by nutrients, siltation, organic enrichment, excessive algal growth, nitrates, and suspended solids. To address the impairments due to excessive nutrients, IEPA has determined that total phosphorous and nitrate are the most appropriate pollutants to control. The IEPA water quality standard for total phosphorus is found at 35 IAC 302.205 and the nitrate water quality standard is found at 35 IAC 302.304. Illinois does not have TSS or turbidity numeric standards that could be used for siltation standards impairment. IEPA does not require the TMDL development for constituents without numeric standards; therefore a TSS TMDL will not be developed at this time. IEPA believes that phosphorus load is related to TSS load; hence the measures that will be implemented to address phosphorus loading will also reduce the sediment load to the lake.

The Water Quality Standards for Lake Vermilion are shown in the table below and Table 4-1 of the TMDL Report.

Parameter	Standard
Nitrate	Shall not exceed 10 mg/L
Total Phosphorus (TP)	Phosphorus as TP shall not exceed 0.05 mg/L in any reservoir or lake with a surface area of 8.1 hectares (20 acres) or more, or in any stream at the point where it enters any such reservoir or lake

Excessive algal growth is listed as a cause of impairment in Lake Vermilion. Algal biomass is commonly measured through a surrogate, Chlorophyll-a (Chl-a), which is a plant pigment. The abundance of Chl-a in water highly correlates with the amount of algae present. The State of Illinois does not have a numeric standard for Chl-a. The algal growth is directly related to excessive amounts of limiting nutrients and light availability for photosynthesis. Phosphorus is identified as a limiting nutrient in the TMDL; therefore total phosphorus (TP) can be considered a surrogate indicator for excessive algal growth. IEPA believes that reducing phosphorus will also address the algal growth impairment.

To meet all designated uses, a water body must meet the standards identified for its most sensitive use. TMDL endpoints are the numeric target values of pollutants and parameters for a water body that represent the conditions that will attain water quality standards and restore the water body to its designated uses. The most stringent standards are chosen as the endpoints for the TMDL analysis. The table below summarizes the endpoints that were used in the TMDL development for the North Fork Vermilion River and Lake Vermilion.

Parameter	TMDL End Points	
	North Fork Vermilion	Lake Vermilion
Total Phosphorus(mg/L)	N/A	<0.05 mg/L
Fecal Coliform (cfu/100mL)	<200 (GM)	N/A
Nitrate(mg/L)	10 mg/L	10 mg/L

EPA finds that the TMDL document submitted by IEPA satisfies all requirements of this second element.

3. Loading Capacity - Linking Water Quality and Pollutant Sources

A TMDL must identify the loading capacity of a water body for the applicable pollutant. EPA regulations define loading capacity as the greatest amount of a pollutant that a water can receive without violating water quality standards (40 C.F.R. §130.2(f)).

The pollutant loadings may be expressed as either mass-per-time, toxicity or other appropriate measure (40 C.F.R. §130.2(i)). If the TMDL is expressed in terms other than a daily load, e.g., an annual load, the submittal should explain why it is appropriate to express the TMDL in the unit of measurement chosen. The TMDL submittal should describe the method used to establish the cause-and-effect relationship between the numeric target and the identified pollutant sources. In many instances, this method will be a water quality model.

The TMDL submittal should contain documentation supporting the TMDL analysis, including the basis for any assumptions; a discussion of strengths and weaknesses in the analytical process; and results from any water quality modeling. EPA needs this information to review the loading capacity determination, and load and wasteload allocations, which are required by regulation.

TMDLs must take into account *critical conditions* for steam flow, loading, and water quality parameters as part of the analysis of loading capacity. (40 C.F.R. §130.7(c)(1)). TMDLs should define applicable *critical conditions* and describe their approach to estimating both point and nonpoint source loadings under such *critical conditions*. In particular, the TMDL should discuss the approach used to compute and allocate nonpoint source loadings, e.g., meteorological conditions and land use distribution.

Comment:

Loading Capacity:

As stated previously, nitrates and fecal coliform were identified as the causes of impairment at BPG05 and BPG09, respectively, in the North Fork Vermilion River.

Table 6-2 of the TMDL Report (also included below) summarizes the existing and allowable loads under high, medium, and low flow conditions for nitrate in BPG05.

Flow Zone	**Average Flow (cfs)**	**Allowable Load (lbs/day)**	**Existing Average Load (lbs/day)**	**Reduction on nonpoint source**
Low (75%-100%)	19.8	**1,067**	645	0%
Medium (25%-75%)	138	7,470	13,007	**43%**
High (0-25%)	667	**35,514**	43,283	**18%**

Table 6-3 of the TMDL Report summarizes the existing and allowable average loads under high, medium, and low flow conditions for fecal coliform in BPG09.

Flow Zone	**Average Flow (cfs)**	**Allowable Load (10^9 cfu/day)**	**Existing Average Load Geomean (10^9 cfu/day)**	**Reduction on Nonpoint Sources**
Low (75%-100%)	18.9	93	99	**6%**
Medium (25%-75%)	132	645	1,197	**46%**
High (0-25%)	637	3,150	10,384	70%

For Lake Vermilion, the calibrated BATHTUB model is used to calculate the loading capacities for total phosphorus and nitrate. The load input from tributaries and direct runoff areas are reduced until the average in-lake concentration is equal to or lower than the standards. The BATHTUB model with calibrated nutrient concentrations was used to identify the reduction loading needed for total phosphorous (TP). Predicted TP exceeded the loading capacity in all years (TP > 0.05 mg/L). Tables 7.7 and 7.8 of the TMDL report and also, tables in section 4 of this document summarize the loading capacities.

Method for cause and effect relationship:

In Section 6.2 of the TMDL Report, IEPA discusses the use of the load duration curve to determine the allowable loads and the load reduction needed in the stream segments BPG05 and BPG09 for each parameter. A simplified explanation is provided below.

1. Flow data - First, continuous flow data are required, and are provided by the USGS gage 03338780, at Bismarck, Illinois. The data reflect a range of natural occurrences from extremely high flows to extremely low flows.
2. Water Quality data – The water quality data for nitrate and fecal coliform were obtained from USGS and IEPA. The nitrate data were available from 1988 through 2002 and fecal coliform data were available from 1994 through 2005. For fecal coliform, data from May through October was considered for developing the load duration curves because the Illinois water quality standard for fecal coliform (200cfu/100mL) only applies to those months. The load is then estimated by multiplying the water concentration by daily average flow on the day of sampling and by a unit conversion factor. This is considered a daily load for that specific site and day.
3. Water Quality Duration Curves (Section 6.0 TMDL Report) – These plots are derived from the flow data and water quality data described above. Existing monitored water pollutant loads, represented by the square-shaped points on the plot, are compared to target loads, the water quality standard line. If the existing loads are below (less than) the target line, no reduction needs to occur. Conversely, if the existing loads are above (greater than) the target load, a reduction is necessary to reach the target.
4. Load Duration Curves (Section 6.2 of the TMDL Report) - The final step is to link the geographic locations of load reductions needed to the flow conditions under which the exceedences occur. Specific locations contributing to impairment, represented by the graphs, are identified to determine under what flow conditions the exceedences are occurring.

The load duration curve approach involves calculating the allowable load over the range of flow conditions that occur in the stream. The resulting data points are plotted against the duration interval to produce a TMDL load curve, which represents allowable loads for various flows. Resulting points above the TMDL curve represent the exceedences of the water quality standard, and points below the curves represent compliance with water quality standard. IEPA's approach is based upon the premise that all discharges (point and non-point) must meet the WQS when entering the waterbody. If all sources are meeting the WQS at discharge, then the waterbody should meet the WQS and the designated use. The plots show under what flow conditions the water quality exceedences occur. Those exceedences at the right side of the graph occur during low flow conditions, suspected to be septic systems malfunctions and illicit sewer connections; exceedences on the left side of the graphs occur during higher flow events, such as storm runoff. Using the load duration curve approach allows IEPA to determine which implementation practices are most effective for reducing loads based on flow magnitude. For example, if loads are significant during storm events, implementation efforts can target those best management practices (BMPs) that will most effectively reduce storm water runoff. This allows for a more efficient implementation effort. The target for this TMDL is the water quality standard, and therefore meeting this loading capacity should result in attainment of water quality standards.

The load duration curve is a cost-effective TMDL approach, to address the reductions necessary to meet WQS for fecal coliform. The approach also aids in sharing the responsibility for fecal coliform reductions among various stakeholders in the TMDL watershed, which encourages collective implementation efforts.

Section 6.3 of the TMDL Report discusses the use of a mass-balancing BATHTUB model as a simple approach to link the nutrient loads with water quality in Lake Vermilion. BATHTUB applies a series of empirical eutrophication equations and performs steady-state water and nutrient calculations for a lake. Eutrophication-related water quality conditions (total phosphorus and total nitrogen) are predicted using empirical relationships derived from assessments of lake data. Applications of BATHTUB are limited to steady-state evaluations of relations between nutrient loading, hydrology, and eutrophication responses. BATHTUB performs a nutrient balance analysis in a spatially segmented hydraulic network, linking nutrient load inputs to the lake with the resulting concentration in Lake Vermilion. Empirical relationships previously developed and tested for lake applications are used in BATHTUB to predict water quality conditions related to eutrophication. This model was selected because it requires fairly simple inputs to predict the parameters of concern; it accounts for pollutant transport, sedimentation, and nutrient cycling; and it has been used for lake TMDLs in Illinois.

Critical Condition:

There is no one critical condition for these TMDLs that will assure attainment of WQSs. The Load Duration Curves (LDCs) show that exceedences are occurring under all flow regimes, indicating that the impairment is due to a variety of sources and conditions. BATHTUB was calibrated for various weather and climatic conditions; therefore IEPA believes that it has addressed all of the critical conditions that Lake Vermilion may experience. The TMDL endpoints will thereby ensure that the WQS will be met under all flow and loading conditions.

EPA finds that the TMDL document submitted by IEPA satisfies all requirements of this third element.

4. Load Allocations (LAs)

EPA regulations require that a TMDL include LAs, which identify the portion of the loading capacity attributed to existing and future nonpoint sources and to natural background. Load allocations may range from reasonably accurate estimates to gross allotments (40 C.F.R. §130.2(g). Where possible, load allocations should be described separately for natural background and nonpoint sources.

Comments:

The pollutant loads have been linked to violations of applicable standards through the load duration curves and BATHTUB modeling. The magnitudes of the loads have been determined by a quantitative procedure that is based either on load duration curves for the river segments or in-lake measurements for climate conditions that cover the range of expected precipitation conditions. IEPA stated that a watershed model was not developed for the TMDLs in this report; therefore a load allocation (for specific nonpoint sources) cannot be calculated directly. Instead, the load allocation is calculated by subtracting the margin of safety (MOS) (discussed in Section 7.3) and the waste load allocations (WLA) from the load capacity, as indicated in the following formula:

LA = TMDL – WLA – MOS

The TMDLs were obtained from the load duration curves presented in Figures 6-2 and 6-3 of the TMDL Report and in section 3 above. The WLA is the combination of discharge loads from the known point sources as identified in Chapter 5 of the TMDL Report. After determining the margin of safety, the load allocation (LA) was calculated by using the equation above.

North Fork Vermilion River Segment (BPG09)

The load allocation for fecal coliform was calculated by multiplying the average flows by 200 cfu/100ml and a unit conversion factor. The percent reductions on non-point source loads for high, medium, and low flows are 70, 47 and 8 percents respectively.

Flow Range	High	Mid-range	Low
Flow Interval	0-25%	25%-75%	75%-100%
Existing Load (geomean)	10384.4	1197.30	99.38
Existing Nonpoint Load (G-org/day)	10370.4	1183.30	85.38
TMDL (G-org/day)	3150	645	**93**
Waste Load Allocation (G-org/day)	14	14	14
MOS	implicit	implicit	implicit
Load Allocation	3150-14=3136	645-14=631	**93-14=79**
Reduction	70%	47%	8%

North Fork Vermilion River Segment (BPG05)

As shown in Figure 6-2 of the TMDL Report, the nitrate concentration rarely exceeds the 10 mg/l standard during low flow conditions, which indicates the point sources' contribution is negligible. Therefore, the nitrate contribution from all point sources is not considered in waste load allocations. The allocation of loads for BPG-05 is summarized in Table 7-4 of the TMDL Report and also in the table below. IEPA stated that the impairment is likely to be caused by the agricultural activities in the watershed since a large percentage (96 %) of the land use in the upstream watershed area is agricultural and loads from agricultural areas typically occur during runoff events. A margin of safety (MOS) of 10 percent was used.

Flow Range	High	Mid-range	Low
Flow Interval	0-25%	25%-75%	75%-100%
Existing Load (Average)	43283.18	13007.48	645.65
TMDL (lb/day)	**35514**	**7470**	1067.19
Load Allocation (lb/day)	**31963**	**6723**	960.47
Waste Load Allocation (lb/day)	0.00	0.00	0.00
MOS	**3551**	**747**	106.72
Reduction	**18%**	**43%**	0%

Lake Vermilion (RBD)

The load allocation for Lake Vermilion TP TMDL was calculated based on the maximum percentage reduction from the three years that the model was calibrated. As a result, a reduction of 77% was used for TMDL development. Table 7-7 of the TMDL Report and also the table below show the TMDL allocations for total phosphorus for Lake Vermilion. The existing load is the mean load for the three years modeled and calibrated. The loading capacity represents the 77% reduction in the existing load. The waste load allocation (WLA) is the sum of the waste loads from the treatment plants discharging to Lake Vermilion. An average TP concentration of 3.5 mg/L and average flows from the point sources were used to calculate the WLA. The MOS is calculated as 10% of the load capacity.

Category	TP (lb/day)
Existing Load	581.9
Reduction	77%
Loading Capacity	133.8
Waste Load Allocation	**53.6**
MOS	13.4
Load Allocation	**66.8**

Table 7-8 of the TMDL Report and the table below show the nitrate TMDL allocations for Lake Vermilion. The existing load is the mean load based on concentrations and flows from the samples measured on the same day at the river and the lake. The loading capacity represents the 34% reduction in the existing load, which is the maximum reduction predicted by the model required to meet the water quality standard.

Category	TN (lb/day)
Existing Load	14,627.4
Reduction	34%
Loading Capacity	9,719.7
Waste Load Allocation	0
MOS	972.0
Load Allocation	8,747.7

EPA finds that the TMDL document submitted by IEPA satisfies all requirements of this fourth element.

5. Wasteload Allocations (WLAs)

EPA regulations require that a TMDL include WLAs, which identify the portion of the loading capacity allocated to individual existing and future point source(s) (40 C.F.R. §130.2(h), 40 C.F.R. §130.2(i)). In some cases, WLAs may cover more than one discharger, e.g., if the source is contained within a general permit.

The individual WLAs may take the form of uniform percentage reductions or individual mass based limitations for dischargers where it can be shown that this solution meets WQSs and does not result in localized impairments. These individual WLAs may be adjusted during the NPDES permitting process. If the WLAs are adjusted, the individual effluent limits for each permit issued to a discharger on the impaired water must be consistent with the assumptions and requirements of the adjusted WLAs in the TMDL. If the WLAs are not adjusted, effluent limits contained in the permit must be consistent with the individual WLAs specified in the TMDL. If a draft permit provides for a higher load for a discharger than the corresponding individual WLA in the TMDL, the State/Tribe must demonstrate that the total WLA in the TMDL will be achieved through reductions in the remaining individual WLAs and that localized impairments will not result. All permittees should be notified of any deviations from the initial individual WLAs contained in the TMDL. EPA does not require the establishment of a new TMDL to reflect these revised allocations as long as the total WLA, as expressed in the TMDL, remains the same or decreases, and there is no reallocation between the total WLA and the total LA.

Comments:

As stated previously in Section 1, animal feedlots are another potential source of nutrient loads and pathogens. However, none of the feedlots in the watershed were large enough to be considered a Confined Animal Feeding Operation (CAFO).

<u>North Fork Vermilion River Segment BPG09:</u>

The Hoopeston, Rossville, and Bismarck School sewage treatment plants (STP) are considered potential sources of fecal coliform load to segment BPG09. The three plants have been granted disinfection exemptions by IEPA as a part of each facility's NPDES permit. Each facility should be meeting the 200 cfu/100ml at the end of its respective disinfection exemption stream reach as identified in the permits under all flow conditions. Based on waste stream analysis, IEPA determined that the Alvin water treatment plant, Hoopeston Foods, Inc. and the Bismarck community district water plant do not contribute fecal coliform to the segment and were not considered in the waste load allocation. Table 7-5 of the TMDL Report and the table below summarize the point source discharges and wasteload allocations for fecal coliform in the North Fork Vermilion River Watershed.

Facility Name	Discharge Flow (cfs)	F. Coliform Concentration (cfu/100mL)	F.Coliform Load (10^9cfu/day)
Hoopeston STP	2.56	200	12.52
Rossville STP	0.28	200	1.37
Bismarck Community Unit School	0.01	200	0.05
Total	2.85	200	14

Note: the 200cfu/100mL standard applies to the end of each facility's exempted stream reach

Based on the historical fecal coliform data obtained from each facility used in granting the disinfection exemptions, IEPA determined that the exempted stream reaches for each facility would not adversely impact the North Fork Vermilion River.

North Fork Vermilion River Segment BPG05:

As shown in Figure 6-2 of the TMDL Report, the nitrate concentration rarely exceeds the 10 mg/l standard during low flow conditions (which indicates the contribution from point sources). Therefore, the WLA for nitrate is zero for this segment.

Lake Vermilion:
Total Phosphorus

The waste load allocation (WLA) is the sum of the waste loads from the treatment plants discharging to Lake Vermilion. An average TP concentration of 3.5 mg/L and average flows from the point sources were used to calculate the WLA. See summary tables in section 4 (above) for details.

IEPA has revised the TMDL WLA for phosphorus. Three facilities, Hoopeston Foods, Alvin WTP, and Bismark Community Water District, are now not considered by IEPA to be sources of phosphorus, and therefore the WLAs for these three facilities is now 0.

Facility Name	NPDES permit number	Design average flow (MGD)	Estimated TP Concentration (mg/L)	Phosphorus WLA (lb/day)
Hoopeston Foods, Inc	**IL0022250**	**0.15**	**0**	**0.00**
Hoopeston STP	**IL0024830**	**1.652**	**3.5**	**48.25**
Rossville STP	**ILG580064**	**0.18**	**3.5**	**5.26**
Alvin WTP	**ILG640002**	**0.0006**	**0**	**0.00**
Bismarck Community Unit School	**IL0067156**	**0.004**	**3.5**	**0.12**
Bismarck Community Water District	**ILG640101**	**0.007**	**0**	**0.00**
Total				**53.62**

Nitrate:

The waste load allocation (WLA) is zero for all point sources because it is very small compared to the.
nonpoint source loading.

EPA finds that the TMDL document submitted by IEPA satisfies all requirements of this fifth element.

6. Margin of Safety (MOS)

The statute and regulations require that a TMDL include a margin of safety (MOS) to account for any lack of knowledge concerning the relationship between load and wasteload allocations and water quality (CWA §303(d)(1)(C), 40 C.F.R. §130.7(c)(1)). EPA's 1991 TMDL Guidance explains that the MOS may be implicit, i.e., incorporated into the TMDL through conservative assumptions in the analysis, or explicit, i.e., expressed in the TMDL as loadings set aside for the MOS. If the MOS is implicit, the conservative assumptions in the analysis that account for the MOS must be described. If the MOS is explicit, the loading set aside for the MOS must be identified.

Comments:

The margin of safety (MOS) is an additional factor included in the TMDL to account for scientific uncertainties, growth, etc., such that applicable water quality standards/guidelines are achieved and maintained. The MOS can be included implicitly in the calculations of the WLA and LA or expressed explicitly as a separate value. IEPA calculated the MOS by using the following methods. The BATHTUB model calculated a measure of potential model error (coefficient of variation). This error term was used in combination with the coefficient of variation for percent load reductions in order to meet target water quality goals. The summation of these error terms was used to determine an explicit MOS. The coefficient of variation is a measure of variation in numbers relative to the mean value and can be expressed as either a fraction or percent of the mean. A 10 % margin of safety has been incorporated into the North Fork Vermilion River TMDL for nitrate and the Lake Vermilion TMDL for total phosphorus and nitrate based upon these calculations. A margin of safety for fecal coliform is included implicitly by assuming no rate of decay or no-die-off is occurring and using the more stringent standard of 200 cfu/100 ml. As stated in *EPA's Protocol for Developing Pathogen TMDLs* (EPA 841-R-00-002), many different factors affect the survival of pathogens in water. These factors include, but are not limited to, sunlight, temperature, salinity, and nutrient deficiencies. These factors vary depending on the environmental condition/circumstances of the water, and therefore it would be difficult to assert that the rate of decay caused by any given combination and degree of these environmental variables was sufficient enough to meet the WQS of 200 cfu/100 ml. This is why it is more conservative to apply the Illinois' water quality standard as the margin of safety, because this standard must be met at all times under all environmental conditions.

EPA finds that the TMDL document submitted by IEPA satisfies all requirements of this sixth element.

7. Seasonal Variation

The statute and regulations require that a TMDL be established with consideration of seasonal variations. The TMDL must describe the method chosen for including seasonal variations. (CWA §303(d)(1)(C), 40 C.F.R. §130.7(c)(1)).

Comments:

The Seasonal Variation section of the TMDL Report discussed the seasonality. IEPA stated that while seasonal variation is important for reservoir and lake systems, climate conditions and climate history can have a great effect on transport and transformation processes. Runoff and transport will be affected by the previous year's climate as well as current climate conditions. Flushing or storage in the reservoir will be affected by the climate (amount of precipitation and runoff) and past inputs. IEPA assessed the seasonal variation by using an averaging program (FLUX) to determine yearly flow-weighted average pollutant concentrations, which integrate the effects of seasonal variation and flow. Seasonal variation is modeled implicitly by including coefficients of variation for measured in-lake water quality parameters, which are descriptive of seasonal variations.

For the North Fork Vermilion River, IEPA believes that the impact of seasonal and other short-term variability in nutrient loading will not be significant since the long-term average nutrient concentrations drive the biotic response. Previous investigations of seasonal trends of indicator bacteria densities in surface waters indicate that the summer months typically exhibit the highest densities of any season. This is likely due to the enhanced ability of indicator bacteria to survive in surface waters and sediment when ambient temperatures more closely approximate those of warm-blooded animals, from which the bacteria originate. In addition, resident wildlife populations are likely to be more active during the warmer months and more migratory species are present during summer time. These factors combined result in higher fecal coliform loads in the summer relative to the other seasons. These factors were considered during the TMDL development.

EPA finds that the TMDL document submitted by IEPA satisfies all requirements of this seventh element.

8. Reasonable Assurances

When a TMDL is developed for waters impaired by point sources only, the issuance of a National Pollutant Discharge Elimination System (NPDES) permit(s) provides the reasonable assurance that the wasteload allocations contained in the TMDL will be achieved. This is because 40 C.F.R. 122.44(d)(1)(vii)(B) requires that effluent limits in permits be consistent with "the assumptions and requirements of any available wasteload allocation" in an approved TMDL.

When a TMDL is developed for waters impaired by both point and nonpoint sources, and the WLA is based on an assumption that nonpoint source load reductions will occur, EPA's 1991 TMDL Guidance states that the TMDL should provide reasonable assurances that nonpoint source control measures will achieve expected load reductions in order for the TMDL to be approvable. This information is necessary for EPA to determine that the TMDL, including the load and wasteload allocations, has been established at a level necessary to implement water quality standards.

EPA's August 1997 TMDL Guidance also directs Regions to work with States to achieve TMDL load allocations in waters impaired only by nonpoint sources. However, EPA cannot disapprove a TMDL for nonpoint source-only impaired waters, which do not have a demonstration of reasonable assurance that LAs will be achieved, because such a showing is not required by current regulations.

Comments:

In Section 7.5 of the TMDL report, IEPA discusses the reasonable assurances for point and nonpoint sources.

For point sources, IEPA relies on existing programs, i.e., NPDES permitting program for treatment plants, stormwater permitting and CAFO permitting. The permits for the point source dischargers in the watershed will be modified if necessary to ensure they are consistent with the applicable wasteload allocation.

For nonpoint sources, IEPA stated that it is committed to:

- Convene local experts familiar with nonpoint sources of pollution in the watershed
- Ensure that priority sources are defined and restoration alternatives are identified
- Develop a voluntary implementation plan that includes accountability
- Work with local agencies and institutions with an interest in watershed management throughout the process.

Also, through a grant under Section 319 of the CWA, IEPA supports a watershed liaison with the Association of Illinois Soil and Water Conservation Districts. This liaison works with local experts to either establish a watershed group or work with an established group to develop a watershed-based plan that addresses TMDL pollutant load reductions in the watershed. IEPA has regional watershed experts available to provide technical assistance to these watershed groups as well. These watershed groups are encouraged to apply for EPA Section 319 grant funding. IEPA gives greater priority to applications for Section 319 funding that address TMDL pollutants.

EPA finds that the TMDL document submitted by IEPA adequately addresses this eighth element.

9. Monitoring Plan to Track TMDL Effectiveness

EPA's 1991 document, *Guidance for Water Quality-Based Decisions: The TMDL Process* (EPA 440/4-91-001), recommends a monitoring plan to track the effectiveness of a TMDL, particularly when a TMDL involves both point and nonpoint sources, and the WLA is based on an assumption that nonpoint source load reductions will occur. Such a TMDL should provide assurances that nonpoint source controls will achieve expected load reductions and, such TMDL should include a monitoring plan that describes the additional data to be collected to determine if the load reductions provided for in the TMDL are occurring and leading to attainment of water quality standards.

Comments:

IEPA stated that a formal monitoring plan will be prepared as part of the implementation plan. Illinois' Adaptive Implementation Process is based upon discussions between the IEPA and IEPA Scientific Advisory Committee. The approach consists of the following steps:

1. Use existing data to define overall existing pollutant loads, as opposed to developing a watershed model that might define individual loading sources.
2. Apply relatively simple models (e.g. BATHTUB) to define the load-response relationship and define the maximum allowable pollutant load that the waterbody can assimilate and still attain water quality standards.
3. Compare the maximum allowable load to the existing load to define the extent to which existing loads must be reduced in order to meet water quality standards.
4. Convene local experts to prioritize pollutant sources and identify restoration alternatives.
5. Based upon the results of step 4, develop a voluntary implementation plan that includes both accountability and the potential for adaptive management.

Adaptive management will be conducted through the implementation of a long-term monitoring plan designed to assess the effectiveness of pollution controls as they are implemented as well as progress towards attaining water quality standards. This approach is designed to accelerate the pace at which TMDLs are being developed for sites dominated by nonpoint sources, which will allow implementation activities (and water quality improvement) to begin sooner.

The approach also places decisions on the types of nonpoint source controls to be implemented at the local level, which will allow those with the best local knowledge to prioritize sources and identify restoration alternatives. Finally, the adaptive management approach to be followed recognizes that models used for decision-making are approximations, and that there is never enough data to completely remove uncertainty. The adaptive process allows decision-makers to proceed with initial decisions based on modeling, and then to update these decisions as experience and knowledge improve. IEPA has completed steps 1-3, as described in Section 6 of the TMDL Report for these TMDLs. Upon receipt of public comments and approval of the TMDL, IEPA will conduct steps 4 and 5.

EPA finds that the TMDL document submitted by IEPA adequately addresses this ninth element.

10. Implementation

EPA policy encourages Regions to work in partnership with States/Tribes to achieve nonpoint source load allocations established for 303(d)-listed waters impaired by nonpoint sources. Regions may assist States/Tribes in developing implementation plans that include reasonable assurances that nonpoint source LAs established in TMDLs for waters impaired solely or primarily by nonpoint sources will in fact be achieved. In addition, EPA policy recognizes that

other relevant watershed management processes may be used in the TMDL process. EPA is not required to and does not approve TMDL implementation plans.
Comment:

Section 7.6 of the TMDL Report discusses the implementation of these TMDLs. IEPA stated that the approach it will take for TMDL implementation is based upon the discussions with the Scientific Advisory Committee (also discussed in section 9). The approach consists of the following steps:

1. Develop a voluntary implementation plan that includes both accountability and the potential for adaptive management. IEPA will develop a general watershed implementation plan for the local agencies and institutions to use as a guideline.

2. Carry out adaptive management through the implementation of a long-term monitoring plan designed to assess the effectiveness of pollution controls as they are implemented as well as progress towards attaining water quality standards.

The adaptive management approach places decisions on the types of nonpoint source controls to be implemented at the local level, which will allow those with the best local knowledge to prioritize sources
and identify restoration alternatives. In addition, the adaptive management approach addresses the uncertainty resulting from model approximation and data inadequacy. The adaptive process allows decision-makers to proceed with initial decisions based on modeling, and then to update these decisions as experience and knowledge improve.

EPA finds that the TMDL document submitted by IEPA adequately addresses this tenth element.

11. Public Participation

EPA policy is that there should be full and meaningful public participation in the TMDL development process. The TMDL regulations require that each State/Tribe must subject calculations to establish TMDLs to public review consistent with its own continuing planning process (40 C.F.R. §130.7(c)(1)(ii)). In guidance, EPA has explained that final TMDLs submitted to EPA for review and approval should describe the State's/Tribe's public participation process, including a summary of significant comments and the State's/Tribe's responses to those comments. When EPA establishes a TMDL, EPA regulations require EPA to publish a notice seeking public comment (40 C.F.R.§130.7(d)(2)).

Provision of inadequate public participation may be a basis for disapproving a TMDL. If EPA determines that a State/Tribe has not provided adequate public participation, EPA may defer its approval action until adequate public participation has been provided for, either by the State/Tribe or by EPA.

Comments:
Public meetings were held in the City of Danville on December 14, 2005, and in the Village of Rossville on August 16, 2006 for these TMDLs. The Illinois EPA provided public notice for the

August 16, 2006 meeting by placing display ads in the Danville Commercial News. 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. Approximately 338 individuals and organizations were also sent the public notice by first class mail. The draft TMDL Report was available for review on the Agency's web page at http://www.epa.state.il.us/public-notices. Hardcopies were available upon request. The public meeting started at 6:00 p.m. on Wednesday, August 16, 2006. It was attended by approximately 15 people and concluded at 7:30 p.m. with the meeting record remaining open until midnight, August 30, 2006. A total of ten comments were received during the public meeting. These questions/comments were addressed in the draft final report.

As discussed is Section 1 above, the revised TMDL was available to the public as part of the public notice process for the TMDL implementation plan. The public notice period was from May 12-June 12, 2008. A public meeting was also held regarding the implementation plan and revised TMDL. No comments were received on the revised TMDL.

EPA finds that the TMDL document submitted by IEPA satisfies all requirements of this eleventh element.

12. Submittal Letter

A submittal letter should be included with the TMDL submittal, and should specify whether the TMDL is being submitted for a *technical review* or *final review and approval*. Each final TMDL submitted to EPA should be accompanied by a submittal letter that explicitly states that the submittal is a final TMDL submitted under Section 303(d) of the Clean Water Act for EPA review and approval. This clearly establishes the State's/Tribe's intent to submit, and EPA's duty to review, the TMDL under the statute. The submittal letter, whether for technical review or final review and approval, should contain such identifying information as the name and location of the water body, and the pollutant(s) of concern.

Comment:

The transmittal letter was dated September 7, 2006, from Marcia T. Willhite, Chief, Bureau of Water, IEPA, to Kevin Pierard, Branch Chief of Watersheds and Wetlands Branch/ Water Division, Region 5 EPA. The letter stated clearly that this was a final TMDL submittal under Section 303(d) of the CWA. The letter also contains the name of the watershed as it appears on the Illinois Section 303(d) list, and the pollutants of concern.

EPA finds that the TMDL document submitted by IEPA satisfies all requirements of this twelfth element.

13. Conclusion

After a full and complete review, EPA finds that the TMDLs for the North Fork Vermilion River watershed satisfy all of the elements of an approvable TMDL. This approval document is for North Fork Vermilion River segments BPG-09, BPG-05 and Lake Vermilion (RBD). North

Fork Vermilion River segment BPG-09 is impaired for pathogens with total fecal coliform as the pollutant; segment BPG-05 is impaired for nutrients, with nitrate as the pollutant; and Lake Vermilion (RBD) is impaired for nutrients, algal growth, siltation and TSS with total phosphorus and nitrates as the pollutants. This TMDL decision addresses four TMDLs addressing six impairments as listed in table below. EPA's approval of these TMDLs does not extend to those waters that are within Indian Country, as defined in 18 U.S.C. 1151. EPA is taking no action to approve or disapprove TMDLs for those waters at this time. EPA or eligible Indian Tribes, as appropriate, will retain responsibilities under Section 303(d) of the CWA for those waters.

Water body	Segment	Pollutant	Impairment
North Vermilion River	BPG-05	Nitrates	Nutrients
North Vermilion River	BPG-09	Fecal Coliform	Pathogens
Lake Vermilion	RBD	Total Phosphorus, Nitrates	Nutrients, Algal growth, Siltation, TSS.

Trevor

ILLINOIS ENVIRONMENTAL PROTECTION AGENCY

1021 NORTH GRAND AVENUE EAST, P.O. BOX 19276, SPRINGFIELD, ILLINOIS 62794-9276 – (217) 782-3397
JAMES R. THOMPSON CENTER, 100 WEST RANDOLPH, SUITE 11-300, CHICAGO, IL 60601 – (312) 814-6026

ROD R. BLAGOJEVICH, GOVERNOR   DOUGLAS P. SCOTT, DIRECTOR

217/782-3362

AUG 1 9 2008

Mr. Kevin Pierard
USEPA, Region V (WW-16J)
77 West Jackson Blvd
Chicago, Illinois 60604

Re: Lake Bloomington TMDL Errata Sheet

Dear Mr. Pierard:

Please find the attached errata sheet for the Lake Bloomington Watershed TMDL. TMDLs for Total Phosphorus and Total Nitrogen were approved for Lake Bloomington by USEPA on September 28, 2007. During development of the implementation plan, it was discovered that an error occurred in calculating the TMDL. The errata sheet details the error and presents the correct TMDLs for Total Phosphorus and Total Nitrogen (a surrogate for Nitrates). The corrected TMDLs result in load changes for the Loading Capacity, Load Allocation, and Margin of Safety. Please note that the Waste Load Allocation remains unchanged.

This errata sheet was presented and discussed during a public meeting held on May 12, 2008. The comment period ended June 12, 2008. No public comments were received regarding the errata sheet. The final report for the Lake Bloomington Watershed TMDL has been updated to reflect the new TMDL as presented in the errata sheet.

If you have any questions, please contact Dean Studer at (217) 782-3362.

Sincerely,

Marcia T. Willhite

Marcia T. Willhite
Chief
Bureau of Water

ERRATA SHEET FOR LAKE BLOOMINGTON TMDL
February 19, 2008

After completion of the Stage Three TMDL development report for Lake Bloomington, the following corrections were found to be necessary:

Section 5.1.3 Load Reduction

The load reductions reported in this section of the TMDL (89 percent for TP and 48 percent for TN) represent the maximum load reductions applied to Money Creek (the major tributary) to achieve water quality standards in Lake Bloomington. However, when accounting for the other loads (Hickory Creek, precipitation, and direct runoff to the lake) the Money Creek load reductions translate into overall load reductions to the lake of 66 percent for TP and 34 percent for TN. These are the load reductions that should have been reported as they more accurately convey what is needed to achieve water quality standards in the lake. Similarly, Tables 5-5 and 5-6 should be replaced with the following that show the overall loads to the lake rather than just the Money Creek loads:

Table 5-5. Predicted TP Concentrations in Lake Bloomington with 66 Percent Reduction in Overall Loads.

Year	Total TP Load Entering Lake Following 66 Percent Reduction (lb/yr)	Predicted Lake Bloomington TP (mg/L)
1990	10,805	0.050
1998	5,475	0.029
1999	6,607	0.046
2000	7,482	0.048
2004	7,319	0.041
2005	4,222	0.035

Table 5-6. Predicted TN Concentrations in Lake Bloomington with 34 Percent Reduction in Overall Loads.

Year	Total TN Load Entering Lake Following 66 Percent Reduction (lb/yr)	Lake Bloomington TN (mg/L)
1988	730,852	8.0
1990	1,537,874	10.0

Section 6.1 Loading Capacity

Based on the previous discussion Section 6.1 of the report should be corrected to the following:

The loading capacity of Lake Bloomington is the pounds per year of TP and TN that can be allowed as input to the lake and still meet the water quality standard of 0.05 mg/L total *phosphorus and 10 mg/L nitrate nitrogen. The BATHTUB model was used to identify the load reductions necessary to achieve a target concentration of total phosphorus and total nitrogen. A 66 percent reduction is needed to meet the TP target during all modeled years and a 34 percent reduction is needed to meet the TN target during all modeled years. The loading capacities of the lake for the critical modeled years are therefore 10,805 lbs/yr of TP and 1,537,874 lbs/yr of TN.*

Section 6.2 Allocations

Based on the previous discussion Section 6.2 of the report should be corrected to the following:

The allocations of TP and TN loads for the Lake Bloomington TMDL are summarized in Tables 6-1 and 6-2. The existing loads to the lake are the loads for the critical year (i.e., the year in which the greatest load reductions were needed to achieve water quality standards). The WLA is based on the East Bay Camp and Retreat's permitted design flow of 0.03 million gallons per day and an average TP concentration of 3.5 mg/L and TN concentration of 15 mg/L (see Section 4.2). Because the actual concentrations of TP and TN are unknown, it is recommended that the facility start sampling its effluent to determine its loading rates to the lake. These monitoring requirements can be included as a condition in the NPDES permit upon renewal. Ten percent of the loading capacity is reserved for a margin of safety for TN and 5% for TP.

Table 6-1. TMDL Summary for TP in Lake Bloomington for critical modeled year.

Category	TP (lb/yr)	TP (lb/day)
Existing Load	31,923	87.5
Reduction	66%	66%
Loading Capacity	10,805	29.6
Waste Load Allocation	320	0.9
Margin of Safety (5%)	540	1.5
Load Allocation	9,945	27.2

Table 6-2. TMDL Summary for TN in Lake Bloomington for critical modeled year.

Category	TN (lb/yr)	TN (lb/day)
Existing Load	2,330,663	6,385.4
Reduction	34%	34%
Loading Capacity	1,537,874	4,213.4
Waste Load Allocation	1,373	3.8
Margin of Safety (10%)	153,787	421.3
Load Allocation	1,382,714	3,788.3

UNITED STATES ENVIRONMENTAL PROTECTION AGENCY
REGION 5
77 WEST JACKSON BOULEVARD
CHICAGO, IL 60604-3590

RECEIVED
OCT 04 2007
Watershed Management Section
BUREAU OF WATER

REPLY TO THE ATTENTION OF:

SEP 28 2007

WW-16J

Marcia T. Willhite, Chief
Bureau of Water
Illinois Environmental Protection Agency
1021 North Grand Ave. East
P.O. Box 19276
Springfield, IL 62794-9276

Dear Ms. Willhite:

The United States Environmental Protection Agency (U.S. EPA) has conducted a complete review of the final Total Maximum Daily Loads (TMDLs) submittal, including supporting documentation and information, for total phosphorus (TP) addressing the Aesthetic Quality, total nitrogen (TN) and Public Water Supply use impairments in Lake Bloomington, located in McLean County, Illinois. Based on this review, U.S. EPA has determined that Illinois' TMDLs for TP and TN meet the requirements of Section 303(d) of the Clean Water Act (CWA) and U.S. EPA's implementing regulations at 40 C.F.R. Part 130. Therefore, by this letter, U.S. EPA hereby approves Illinois' TMDLs for TP and TN for Lake Bloomington (ID# RDO). The statutory and regulatory requirements, and U.S. EPA's review of Illinois' compliance with each requirement, are described in the enclosed decision document.

We appreciate your hard work in this area and the submittal of the TMDL as required. If you have any questions, please contact Dean Maraldo, TMDL Program Manager at 312-353-2098.

Sincerely yours,

Kevin M. Pierard
Acting Director, Water Division

Enclosure

cc: Trevor Sample, IEPA
Dean Studder, IEPA

TMDL: Lake Bloomington, Illinois, Phosphorous, Nitrogen TMDL
Effective Date: SEP 2 0 2007

Decision Document for Approval of Lake Bloomington Watershed TMDL Report

Section 303(d) of the Clean Water Act (CWA) and EPA's implementing regulations at 40 C.F.R. Part 130 describe the statutory and regulatory requirements for approvable TMDLs. Additional information is generally necessary for EPA to determine if a submitted TMDL fulfills the legal requirements for approval under Section 303(d) and EPA regulations, and should be included in the submittal package. Use of the verb Amust@ below denotes information that is required to be submitted because it relates to elements of the TMDL required by the CWA and by regulation. Use of the term Ashould@ below denotes information that is generally necessary for EPA to determine if a submitted TMDL is approvable. These TMDL review guidelines are not themselves regulations. They are an attempt to summarize and provide guidance regarding currently effective statutory and regulatory requirements relating to TMDLs. Any differences between these guidelines and EPA's TMDL regulations should be resolved in favor of the regulations themselves.

1. Identification of Waterbody, Pollutant of Concern, Pollutant Sources, and Priority Ranking

The TMDL submittal should identify the waterbody as it appears on the State's/Tribe's 303(d) list. The waterbody should be identified/georeferenced using the National Hydrography Dataset (NHD), and the TMDL should clearly identify the pollutant for which the TMDL is being established. In addition, the TMDL should identify the priority ranking of the waterbody and specify the link between the pollutant of concern and the water quality standard (see section 2 below).

The TMDL submittal should include an identification of the point and nonpoint sources of the pollutant of concern, including location of the source(s) and the quantity of the loading, e.g., lbs/per day. The TMDL should provide the identification numbers of the NPDES permits within the waterbody. Where it is possible to separate natural background from nonpoint sources, the TMDL should include a description of the natural background. This information is necessary for EPA's review of the load and wasteload allocations, which are required by regulation.

The TMDL submittal should also contain a description of any important assumptions made in developing the TMDL, such as:

(1) the spatial extent of the watershed in which the impaired waterbody is located;
(2) the assumed distribution of land use in the watershed (e.g., urban, forested, agriculture);

(3) population characteristics, wildlife resources, and other relevant information affecting the characterization of the pollutant of concern and its allocation to sources;
(4) present and future growth trends, if taken into consideration in preparing the TMDL (e.g., the TMDL could include the design capacity of a wastewater treatment facility); and
(5) an explanation and analytical basis for expressing the TMDL through *surrogate measures*, if applicable. *Surrogate measures* are parameters such as percent fines and turbidity for sediment impairments; chlorophyl a and phosphorus loadings for excess algae; length of riparian buffer; or number of acres of best management practices.

Comment:

The Lake Bloomington watershed (ILROD) is located in the central part of McLean County, Illinois, near the City of Bloomington. The watershed drains about 70 square miles. Lake Bloomington is a drinking water reservoir that supplies water to the Villages of Hudson, Towanda, Bloomington Township West Phase, and Bloomington Township Crestewick. Lake Bloomington receives water primarily from Money Creek to the south. Money Creek flows from the southwest to the northeast. Hickory Creek, a tributary of Money Creek, flows into Lake Bloomington from the southwest of the lake. The communities of Towanda and Merna are located in the watershed. Lake Bloomington is located in the northeastern tip of the watershed, about 15 miles south of the City of Bloomington. Figure 2-1 of the TMDL submittal identifies the location of the watershed and the lake.

The land use in the watershed is predominately agriculture cropland. Figure 2-2 of the TMDL submittal presents land use and land use coverage in the Lake Bloomington watershed. Agriculture makes up approximately 93 percent of the total area with the major crops being corn and soybean. Wetlands account for approximately 2.5 percent, urban lands for 2.5 percent, and forestlands are less than 1 percent.

The potential nonpoint sources were identified including animal feedlots and confinement operations, septic systems, lawn fertilizer runoff and agricultural runoff. The amount that is contributed by these sources is a function of the soil type, slope, crop management, precipitation, total amount of cropland, and the distance to the water resource. No CAFO's were identified in the watershed.

There is one active NPDES permitted discharger in the Lake Bloomington watershed, East Bay Camp and Retreat, Permit number IL0025666. The WLA is based on the East Bay Camp and Retreat's design flow of 0.03 million gallons/day and average TP concentration of 3.5mg/l and TN concentration of 15 mg/l. The current permit does not require monitoring for TP or TN. The TMDL used the typical WWTP values to determine the WLA for this permit based on design flow.

The Illinois 303(d) list for 2006 identifies the waterbodies in the Lake Bloomington watershed as a medium priority ranking.

EPA finds that the TMDL document submitted by IEPA satisfies all requirements of this first element.

2. Description of the Applicable Water Quality Standards and Numeric Water Quality Target

The TMDL submittal must include a description of the applicable State/Tribal water quality standard, including the designated use(s) of the waterbody, the applicable numeric or narrative water quality criterion, and the antidegradation policy. (40 C.F.R. ' 130.7(c)(1)). EPA needs this information to review the loading capacity determination, and load and wasteload allocations, which are required by regulation.

The TMDL submittal must identify a numeric water quality target(s) B a quantitative value used to measure whether or not the applicable water quality standard is attained. Generally, the pollutant of concern and the numeric water quality target are, respectively, the chemical causing the impairment and the numeric criteria for that chemical (e.g., chromium) contained in the water quality standard. The TMDL expresses the relationship between any necessary reduction of the pollutant of concern and the attainment of the numeric water quality target. Occasionally, the pollutant of concern is different from the pollutant that is the subject of the numeric water quality target (e.g., when the pollutant of concern is phosphorus and the numeric water quality target is expressed as Dissolved Oxygen (DO) criteria). In such cases, the TMDL submittal should explain the linkage between the pollutant of concern and the chosen numeric water quality target.

Comment:

To assess the designate use support for Illinois waterbodies the IEPA uses rules and regulations adopted by the Illinois Pollution Control Board (IPCB). The following are the use support designations provided by the IPCB for the Lake Bloomington:

a. *General Use Standards* - These standards protect for aquatic life, wildlife, agricultural, primary contact (where physical configuration of the waterbody permits it, any recreational or other water use in which there is prolonged and intimate contact with the water involving considerable risk of ingesting water in quantities sufficient to pose a significant health hazard, such as swimming and water skiing), secondary contact (any recreational or other water use in which contact with the water is either incidental or accidental and in which the probability of ingesting appreciable quantities of water is minimal, such as fishing, commercial and recreational boating, and any limited contact incident to shoreline activity), and most industrial uses. These standards are also designed to ensure the aesthetic quality of the state's aquatic environment.

b. Public and Food Processing Water Supply Standards - These standards protect for any water use in which water is withdrawn from surface waters of the state for human consumption or for processing of food products intended for human consumption.

Illinois is currently developing TMDLs for pollutants that have numeric water quality standards. Lake Bloomington is listed on the Illinois 2006 303(d) list for aesthetic quality use impairment caused by total suspended solids (TSS), and total phosphorus (TP). It is also identified as being impaired for aquatic algae in the 2006 Integrated Report. The lake is also listed as impaired for the designated use of the public and food processing water supplies due to nitrate concentrations. Table 1 below and table 3-1 of the TMDL submittal identified the standards for Lake Bloomington for this TMDL.

Table 1

Parameter	Standard that applies	Limit	Regulatory Section Citation**
Nitrate-Nitrogen	Public and Food Processing Water Supplies	10mg/l	302.304
Total Phosphorus	General Use Water Quality Standard	0.05mg/l*	302.205

*Standard only applies in lakes/reservoirs that are greater than 20 acres in surface area and in any stream at the point where it enters such a lake/reservoir.
** The Illinois Pollution Control Board publishes all IEPA water quality standards.

Excessive algal growth is identified as a cause of impairment in Lake Bloomington in the TMDL submitted report and IEPA's Integrated Report (IR) in Appendix B. IEPA considers algal growth to be a nonpollutant and dose not develop TMDLs for nonpollutants. Chlorophyll-*a* is a plant pigment commonly used to measure algal biomas. There is no state standard for chlorophyll-*a*. However, the chlorophyll-*a* is directly related to the amount of nutrients in the water. For Lake Bloomington the limiting nutrient is TP. By controlling TP this should control the chlorophyll-*a*. This TMDL will address the impairments identified in appendix B of the IR.

As discussed above, IEPA does not develop TMDLs for pollutants that do not have numeric standards. Lake Bloomington is listed in Appendix A of the IR as being impaired for TSS. IEPA believes that the impairment will be addressed during the implementation of controls to reduce the TP loadings. Phosphorus binds to sediment and enters the lakes during nonpoint source runoff. Actions required to control the TP loading to the lake via nonpoint sources will also reduce sediment loads to the lakes.

EPA finds that the TMDL document submitted by IEPA satisfies all requirements of this second element.

3. Loading Capacity - Linking Water Quality and Pollutant Sources

A TMDL must identify the loading capacity of a waterbody for the applicable pollutant. EPA regulations define loading capacity as the greatest amount of a pollutant that a water can receive without violating water quality standards (40 C.F.R. ' 130.2(f)).

The pollutant loadings may be expressed as either mass-per-time, toxicity or other appropriate measure (40 C.F.R. ' 130.2(i)). If the TMDL is expressed in terms other than a daily load, e.g., an annual load, the submittal should explain why it is appropriate to express the TMDL in the unit of measurement chosen. The TMDL submittal should describe the method used to establish the cause-and-effect relationship between the numeric target and the identified pollutant sources. In many instances, this method will be a water quality model.

The TMDL submittal should contain documentation supporting the TMDL analysis, including the basis for any assumptions; a discussion of strengths and weaknesses in the analytical process; and results from any water quality modeling. EPA needs this information to review the loading capacity determination, and load and wasteload allocations, which are required by regulation.

TMDLs must take into account *critical conditions* for steam flow, loading, and water quality parameters as part of the analysis of loading capacity. (40 C.F.R. ' 130.7(c)(1)). TMDLs should define applicable *critical conditions* and describe their approach to estimating both point and nonpoint source loadings under such *critical conditions*. In particular, the TMDL should discuss the approach used to compute and allocate nonpoint source loadings, e.g., meteorological conditions and land use distribution.

Comment:

The loading capacities for Lake Bloomington are summarized in Table 6.1 of the TMDL submittal and Table 2 below. For Lake Bloomington the loading capacity for TP is calculated to be 2.2 lb/day, and for TN 1,663.2 lb/day. This represents an 89 percent reduction in loading to the lake for TP and 48% for TN.

Table 2 Loading Capacities

	TP lbs/yr	TP lbs/day	TN lbs/yr	TN lbs/day
Existing Load	7,193	19.7	1,167,421	3198.4
Reduction	89%		48%	
Loading Capacity	791	2.2	607,059	1,663.2
Load Allocation	431	1.2	544,980	1,493.1
Waste Load Allocation	320	0.9	1,373	3.8
Margin of Safety	40	0.1	60,706	166.3

To determine these loads the State used the BATHTUB model. The BATHTUB applies a series of empirical equations derived from assessments of lake data and performs steady state water and nutrient calculations based on lake morphometry and tributary inputs. The BATHTUB model was selected to develop the loading capacity of the lake because it requires fairly simple inputs to predict the parameters of concerns. The model accounts for pollutant transport, sedimentation, and nutrient cycling.

The critical condition of the lake would take place when the highest concentration of TP is present. The highest concentrations of TP and chlorophyll *a* are typically observed in lake in late summer (July/August). The BATHTUB model takes this into account when simulating average annual concentrations of both parameters during the critical year. The highest loadings of TP are in the spring when streamflow is at its highest. This was accounted for because the annual loads used for BATHTUB are based on estimates of daily streamflows and TP concentrations. Implementation efforts used to address the TP loading in the lakes will be effective during these high loading events. Because an average annual basis was used for the TMDL development, it is assumed that any critical condition is accounted for with the analysis.

EPA finds that the TMDL document submitted by IEPA satisfies all requirements of this third element.

4. Load Allocations (LAs)

EPA regulations require that a TMDL include LAs, which identify the portion of the loading capacity attributed to existing and future non-point sources and to natural background. Load allocations may range from reasonably accurate estimates to gross allotments (40 C.F.R. ' 130.2(g)). Where possible, load allocations should be described separately for natural background and non-point sources.

Comments:

As discussed above, the predominate land use is agricultural cropland. Table 2-3 of Appendix A of the TMDL submittal and Table 3 below identify the land use.

Table 3 Land Use

Land use Description	Approximate Acres	Percentage of coverage
Agricultural	41,666.2	93.2 %
Urban	1,116.0	2.5 %
Wetlands	1,102.5	2.5 %
Forest	380.1	0.85 %
Surface Water	428.8	0.96
Total	44,694.2	100 %

The load allocations for TP and TN are summarized in tables 6-1 and 6-2 of the TMDL and Table 4 below.

Table 4 Load Allocations

	TP lbs/yr	TP lbs/day	TN lbs/yr	TN lbs/day
Load Allocation	431	1.2	544,980	1,493.1

The potential nonpoint sources were identified including animal feedlots and confinement operations, septic systems, lawn fertilizer runoff and agricultural runoff. The amount that is contributed by these sources is a function of the soil type, slope, crop management precipitation, total amount of cropland and the distance to the water resource. No CAFO's were identified in the watershed.

EPA finds that the TMDL document submitted by IEPA satisfies all requirements of this fourth element.

5. Wasteload Allocations (WLAs)

EPA regulations require that a TMDL include WLAs, which identify the portion of the loading capacity allocated to individual existing and future point source(s) (40 C.F.R. ' 130.2(h), 40 C.F.R. ' 130.2(i)). In some cases, WLAs may cover more than one discharger, e.g., if the source is contained within a general permit.

The individual WLAs may take the form of uniform percentage reductions or individual mass based limitations for dischargers where it can be shown that this solution meets WQSs and does not result in localized impairments. These individual WLAs may be adjusted during the NPDES permitting process. If the WLAs are adjusted, the individual effluent limits for each permit issued to a discharger on the impaired water must be consistent with the assumptions and requirements of the adjusted WLAs in the TMDL. If the WLAs are not adjusted, effluent limits contained in the permit must be consistent with the individual WLAs specified in the TMDL. If a draft permit provides for a higher load for a discharger than the corresponding individual WLA in the TMDL, the State/Tribe must demonstrate that the total WLA in the TMDL will be achieved through reductions in the remaining individual WLAs and that localized impairments will not result. All permittees should be notified of any deviations from the initial individual WLAs contained in the TMDL. EPA does not require the establishment of a new TMDL to reflect these revised allocations as long as the total WLA, as expressed in the TMDL, remains the same or decreases, and there is no reallocation between the total WLA and the total LA.

Comments:

There is one active NPDES permitted discharger in the Lake Bloomington watershed, East Bay Camp and Retreat, Permit number IL0025666. The WLA is based on the East Bay Camp and Retreat's design flow of 0.03 million gallons/day, the average TP concentration of 3.5mg/l, and the average TN concentration of 15 mg/l. The current permit does not require monitoring for TP or TN. The TMDL used the typical WWTP values to determine the WLA for this permit based on design flow.

Towanda Grade School held a NPDES permit until January 11, 2005, permit number IL0046167. This permit was terminated when a septic system was installed.

The waste load allocations for TP and TN are summarized in tables 6-1 of the TMDL and table 5 below.

Table 5 Waste Load Allocations

	TP lbs/yr	TP lbs/day	TN lbs/yr	TN lbs/day
Waste Load Allocation	320	0.9	1,373	3.8

EPA finds that the TMDL document submitted by IEPA satisfies all requirements of this fifth element.

6. Margin of Safety (MOS)

The statute and regulations require that a TMDL include a margin of safety (MOS) to account for any lack of knowledge concerning the relationship between load and wasteload allocations and water quality (CWA ' 303(d)(1)(C), 40 C.F.R. ' 130.7(c)(1)). EPA's 1991 TMDL Guidance explains that the MOS may be implicit, i.e., incorporated into the TMDL through conservative assumptions in the analysis, or explicit, i.e., expressed in the TMDL as loadings set aside for the MOS. If the MOS is implicit, the conservative assumptions in the analysis that account for the MOS must be described. If the MOS is explicit, the loading set aside for the MOS must be identified.

Comments:

The calibrated BATHTUB model was used to identify the reductions in loading needed for TP and TN. For phosphorus the predicted TP was in exceedance of the standard for 6 years of the 10 year simulation period. Input loads were reduced for each model year to meet the target with reductions ranging for 59 to 89 percent. An 89 percent load reduction is needed to meet the TP water quality standard in the year with the highest simulated TP (2000) which will be protective of all other years.

Nitrates (NO_3) are not calculated directly by the BATHTUB model. Therefore, the concentration of TN was conservatively used in this analysis as a surrogate of NO_3. Predicted total TN was in exceedance during two of the ten years simulated. Input loads were reduced for each model year to meet the target with reduction at 18 and 48 percents. A 48 percent load reduction is needed to meet the nitrate water quality standard in the year with the highest simulate TN (1990), which will then be protective of all other years.

The MOS for Lake Bloomington is also explicit. A five percent MOS has been incorporated for TP, and a ten percent MOS was used for TN. These values were chosen based on the average absolute errors associated with the modeling.

EPA finds that the TMDL document submitted by IEPA satisfies all requirements of this sixth element.

7. Seasonal Variation

The statute and regulations require that a TMDL be established with consideration of seasonal variations. The TMDL must describe the method chosen for including seasonal variations. (CWA ' 303(d)(1)(C), 40 C.F.R. ' 130.7(c)(1)).

Comments:

Seasonal variation is represented in the Lake Bloomington TMDL as conditions were modeled on an annual basis. Modeling on an annual basis takes into account the seasonal loadings in different quantities during different time periods.

EPA finds that the TMDL document submitted by IEPA satisfies all requirements of this sixth element.

8. Reasonable Assurances

When a TMDL is developed for waters impaired by point sources only, the issuance of a National Pollutant Discharge Elimination System (NPDES) permit(s) provides the reasonable assurance that the wasteload allocations contained in the TMDL will be achieved. This is because 40 C.F.R. 122.44(d)(1)(vii)(B) requires that effluent limits in permits be consistent with Athe assumptions and requirements of any available wasteload allocation@ in an approved TMDL.

When a TMDL is developed for waters impaired by both point and nonpoint sources, and the WLA is based on an assumption that nonpoint source load reductions will occur, EPA's 1991 TMDL Guidance states that the TMDL should provide reasonable assurances that nonpoint source control measures will achieve expected load reductions in order for the TMDL to be approvable. This information is necessary for EPA to determine that the TMDL, including the load and wasteload allocations, has been established at a level necessary to implement water quality standards.

EPA's August 1997 TMDL Guidance also directs Regions to work with States to achieve TMDL load allocations in waters impaired only by nonpoint sources. However, EPA cannot disapprove a TMDL for nonpoint source-only impaired waters, which do not have a demonstration of reasonable assurance that LAs will be achieved, because such a showing is not required by current regulations.

Comments:

For the nonpoint source reductions, IEPA is in the process of developing implementation activities, such as conservation tillage practices, filter strips, and nutrient management. A variety of best management plans (BMPs) are being considered to reduce phosphorus and nitrogen to Lake Bloomington. IEPA will also investigate mitigation of failing septic systems for homes on the lake.

For the point sources monitoring requirements for TP and TN will be incorporated into permits when permits are up for renewal.

EPA finds that the TMDL document submitted by IEPA satisfies all requirements of this eighth element.

9. Monitoring Plan to Track TMDL Effectiveness

EPA's 1991 document, *Guidance for Water Quality-Based Decisions: The TMDL Process* (EPA 440/4-91-001), recommends a monitoring plan to track the effectiveness of a TMDL, particularly when a TMDL involves both point and nonpoint sources, and the WLA is based on an assumption that nonpoint source load reductions will occur. Such a TMDL should provide assurances that nonpoint source controls will achieve expected load reductions and, such TMDL should include a monitoring plan that describes the additional data to be collected to determine if the load reductions provided for in the TMDL are occurring and leading to attainment of water quality standards.

Comments:

As part of the implementation plan a monitoring plan will be included. The implementation plan will be developed with stakeholder's involvement. IEPA continues to obtain water quality data through the Ambient Water Quality Monitoring Network, Intensive Basin Survey, and Facility Related Stream Survey programs. These are the same programs through which the water quality data were obtained to identify water quality impairment for the 303(d) list.

EPA finds that the TMDL document submitted by IEPA satisfies all requirements of this ninth element.

10. Implementation

EPA policy encourages Regions to work in partnership with States/Tribes to achieve nonpoint source load allocations established for 303(d)-listed waters impaired by nonpoint sources. Regions may assist States/Tribes in developing implementation plans that include reasonable assurances that nonpoint source LAs established in TMDLs for waters impaired solely or primarily by nonpoint sources will in fact be achieved. In addition, EPA policy recognizes that other relevant watershed management processes may be used in the TMDL process. EPA is not required to and does not approve TMDL implementation plans.

Comment:

A project Implementation Plan will be prepared that will more fully address likely TP and TN sources and potential implementation activities that can achieve the desired reductions in the loading.

EPA finds that the TMDL document submitted by IEPA satisfies all requirements of this tenth element.

11. Public Participation

EPA policy is that there should be full and meaningful public participation in the TMDL development process. The TMDL regulations require that each State/Tribe must subject calculations to establish TMDLs to public review consistent with its own continuing planning process (40 C.F.R. ' 130.7(c)(1)(ii)). In guidance, EPA has explained that final TMDLs submitted to EPA for review and approval should describe the State/Tribe's public participation process, including a summary of significant comments and the State's/Tribe's responses to those comments. When EPA establishes a TMDL, EPA regulations require EPA to publish a notice seeking public comment (40 C.F.R. §130.7(d)(2)).

Provision of inadequate public participation may be a basis for disapproving a TMDL. If EPA determines that a State/Tribe has not provided adequate public participation, EPA may defer its approval action until adequate public participation has been provided for, either by the State/Tribe or by EPA.

Comments:

Illinois EPA held two public meeting in the development of this TMDL at Davis Lodge on Lake Bloomington on July 18, 2006 and August 8, 2007. IEPA provide public notice for both meetings by placing display ads in the Bloomington Pantagraph. Approximately 72 individuals and organizations were also sent the public notice. The draft TMDL Report was available for review at the Bloomington Public Library, the McLean County Soil and Water Conservation District Office, and on IEPA's web page. The draft TMDL report was public noticed from August 8, 2007 until August 17, 2007.

Public comments were received and adequately addressed by IEPA.

EPA finds that the TMDL document submitted by IEPA satisfies all requirements of this eleventh element.

12. Submittal Letter

A submittal letter should be included with the TMDL submittal, and should specify whether the TMDL is being submitted for a *technical review* or *final review and approval.* Each final TMDL submitted to EPA should be accompanied by a submittal letter that explicitly states that the submittal is a final TMDL submitted under Section 303(d) of the Clean Water Act for EPA review and approval. This clearly establishes the State's/Tribe's intent to submit, and EPA's duty to review, the TMDL under the statute. The submittal letter, whether for technical review or final review and approval, should contain such identifying information as the name and location of the waterbody, and the pollutant(s) of concern.

Comment:

The U.S. EPA received the formal submittal of the final TMDL for the Lake Bloomington watershed, Illinois on a CD, on September 10, 2007, along with a submittal letter from Marcia T. Whillhite, Chief of the Bureau of Water, dated September 6, 2007. In the submittal letter, IEPA stated that the enclosed submittal of the Lake Bloomington watershed TMDL report is for USEPA final approval. The submittal letter included the name and location of the waterbody (Lake Bloomington) and the pollutants of concern (TP, TN). The letter states that the Lake Bloomington watershed was identified as impaired for the "Aesthetic Quality, with total phosphorus and total suspended solids as the cause and Public Water Supply Use with nitrate as the cause. Since Illinois EPA is only developing TMDLs for parameters that have numeric water quality standards, this report does not include a TMDL for total suspended solids." However implementation needed for the removal of TP should address the TSS impairment.

EPA finds that the TMDL document submitted by IEPA satisfies all requirements of this twelfth element.

13. Conclusion

After a full and complete review, EPA finds that the TMDLs for Lake Bloomington watershed, specifically segment RDO, satisfies all of the elements of an approvable TMDL. This document addresses a total of **2** TMDLs and **3** impairments from the 2006 Illinois 303d list as identified in Table 6 below.

Table 6

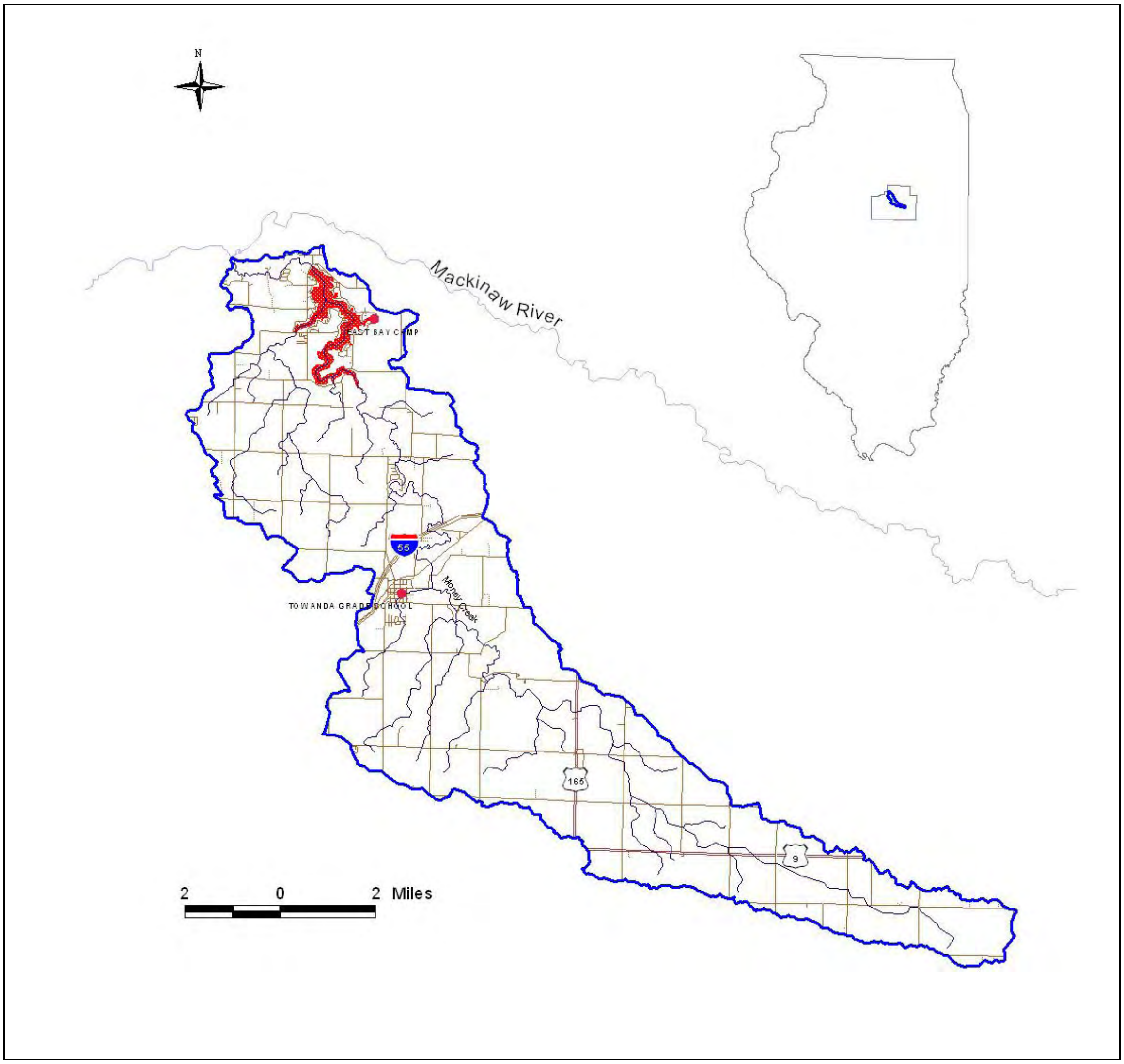
Waterbody	Waterbody ID	TMDL Pollutants	Impairments Addressed	Appendix B impairments
Lake Bloomington	RDO	Total Phosphorus, Total Nitrogen	Total Phosphorus, Nitrate-Nitrogen, Total Suspended Solids	Algae

EPA's approval of this TMDL extends to the waterbody which is identified in this document and the TMDL with the exception of any portions of the waterbody that is within Indian Country, as defined in 18 U.S.C. Section 1151. EPA is taking no action to approve or disapprove the State's TMDL with respect to those portions of the water at this time. EPA, or eligible Indian Tribes, as appropriate, will retain responsibilities under Section 303(d) for those waters.

LAKE BLOOMINGTON TMDL

Final
Stage 1 Report: Watershed Characterization, Data Analysis, and Methodology Selection

Submitted to:
Illinois Environmental Protection Agency



TETRA TECH EM INC.

November 13, 2006

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EXECUTIVE SUMMARY

The Illinois 2006 303(d) list identifies Lake Bloomington (RDO) segments for impairment of designated uses. This report documents the analysis and findings in Stage 1 of the TMDL development for the water segment – watershed characterization, data analysis, and methodology selection.

The Lake Bloomington Watershed is located in McLean County, Illinois, near the City of Normal - Bloomington. The watershed drains about 70 square miles. Lake Bloomington is a drinking water reservoir that supplies water to the Village of Hudson, Towanda, Bloomington TWP West Phase, and Bloomington TWP Crestewicke. Lake Bloomington receives water primarily from Money Creek to the south. Hickory Creek, a tributary of Money Creek, flows into Lake Bloomington from the southwest of the Lake. The land use in the watershed is predominantly agriculture cropland.

Water quality data were gathered from IEPA, USGS NWIS and USEPA STORET database. The data analysis was performed for the listed segments. A review of the available water quality data confirms the causes of impairments in Lake Bloomington. The water quality data also verified that total phosphorus is a limiting nutrient in the lake and frequently exceeded the 0.05 mg/L water quality standard. The average annual concentrations exceeded the lake phosphorus standard at all sampling locations in almost every year. Therefore, a TMDL will be developed for phosphorus.

Nitrate nitrogen is listed as another cause for impairment in Lake Bloomington. Because nitrite nitrogen seldom appears in concentration greater than 1 mg/L and tends to transform to nitrate, the nitrate plus nitrite nitrogen concentration data is used to verify the exceedance. The maximum observed nitrate plus nitrite concentration exceeded the standard of 10 mg/L in the segment. A TMDL will be developed for nitrate.

There are two minor point sources in the Lake Bloomington watershed. Nonpoint sources appear to be predominant sources for cause of impairments in the Lake. Potential nonpoint sources include agricultural runoff, urban runoff, wildlife, animal feedlots, and possible manure applications. The runoff from fertilized lawns in residential areas is also potential nonpoint sources for nutrients. A number of private septic systems are present in the watershed. Septic system failure is also a potential source of nutrients. Septic systems can potentially leach nutrients into the shallow groundwater that eventually reach surface water.

It is recommended that both simple and sophisticated modeling approaches are considered for the development of TMDL in the segment. While the simple approach allows for a quick and efficient calculation of TMDL, the detailed modeling provides insight and meaningful load allocation and placement of BMPs. The availability of data, past studies, and the stakeholder interest favors a detailed modeling approach. The final selection will be made after the review of Stage 1 report and follow-up discussion with IEPA.

Data review shows that available flow and water quality data meet the basic needs for TMDL development of Lake Bloomington. A tremendous amount of water quality and quantity data is available from the Lake Bloomington Water Treatment Plant, NRCS field office, and other local organizations. Additional water quality sampling is not needed for TMDL development. The next step will be to finalize the modeling approach and develop TMDLs.

1.0 INTRODUCTION

Section 303(d) of the Clean Water Act (CWA) and the U.S. Environmental Protection Agency (USEPA) Water Quality Planning and Management Regulations (40 CFR Part 130) require states to identify water bodies that do not meet water quality standards and to determine the Total Maximum Daily Load (TMDL) for pollutants causing the impairment. A TMDL is the total amount of pollutant load that a water body can receive and still meet the water quality standards. It is the sum of the individual waste load allocation for point sources, load allocations for nonpoint sources, natural background, and a margin of safety. The CWA establishes the process for completing TMDLs to provide more stringent, water-quality based controls when technology-based controls are not sufficient to achieve state water quality standards. A TMDL is also required to be developed with seasonal variations and must include a margin of safety that addresses the uncertainty in the analysis. The overall goals and objectives in developing the TMDLs include:

- Assess the water quality of the impaired waterbodies and identify key issues associated with the impairments and potential pollutant sources.
- Use the best available science and available data to determine the maximum load the waterbodies can receive and fully support all of their designated uses.
- Use the best available science and available data to determine current loads of pollutants to the impaired waterbodies.
- If current loads exceed the maximum allowable load, determine the load reduction that is needed.
- Identify feasible and cost-effective actions that can be taken to reduce loads.
- Inform and involve the public throughout the project to ensure that key concerns are addressed and the best available information is used.
- Submit a final TMDL report to USEPA for review and approval.

IEPA has adopted three-stage approach to develop TMDLs for a watershed: Stage 1 – Watershed Characterization, Data Analysis, Methodology Selection; Stage 2 – Data Collection if necessary; and Stage 3 – Model Calibration, TMDL Scenarios, and Implementation Plan. IEPA only requires a TMDL be developed for the chemical parameters with numeric water quality standards. Under Section 303(d) of the CWA, the State of Illinois prepares a list of waters that are not meeting state water quality standards (hereafter referred to as the "303(d) list") in each 2-year cycle. In the 2006 cycle, Illinois Section 303(d) list is combined with the Illinois Water Quality Report, known as the Integrated Report, according to new federal guidance. Lake Bloomington (RDO) is listed as impaired because of excessive nitrate and phosphorus in the water (IEPA, 2006).

This report documents the analysis and findings in a Stage 1 characterization of overall hydrology and water quality for the Lake Bloomington watershed. The purposes of the watershed characterization and data analysis report are to (1) confirm impairments in the listed water body by comparing observed data with water quality standards or appropriate targets; (2) evaluate spatial and temporal water quality variation; (3) evaluate any identifiable relationships between pollutants of concern and other environmental measurements and conditions (for example, water quality and stream flow condition); (4) provide a preliminary assessment of sources contributing to impairments; (5) describe potential TMDL development approaches; and (6) identify data needs and recommendations for additional data collection.

This chapter discusses the rationale for beneficial use designations and impairments for waters of the State of Illinois, and specifically, for the listed Lake Bloomington in central Illinois. Chapter 2 describes the characteristics of the watershed and water bodies, and chapter 3 addresses the climate and hydrology conditions. Chapter 4 describes the water quality standards and water quality assessment. Chapter 5 discusses the potential nonpoint and point sources that may cause the impairment. Chapter 6 describes the methodology selection for the TMDL development. Finally, chapter 7 identifies data gaps and provides recommendations for additional data collection.

All waters of Illinois are assigned one of the following designations: 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. All Illinois waters must meet general use water quality standards unless they are subject to another specific designation (CWA Section 302.201). The general use standards protect the state's water for aquatic life (except as provided in Illinois Water Quality Standard Section 302.213), wildlife, agricultural use, secondary contact use, aesthetics quality, and most industrial uses. Primary contact uses are protected for all general use waters where the physical configuration permits such use. Unless otherwise specifically provided for and in addition to the general use standards, waters of the state must meet the public and food processing water quality standards at the points of water withdrawal for treatment and distribution as a potable supply or for food processing.

Lake Bloomington (RDO) is the drinking water supply for the Village of Hudson, Towanda, Bloomington TWP West Phase, and Bloomington TWP Crestewicke. Table 1-1 summarizes the listed impairments, pollutant causes, and potential sources based on the Illinois Integrated Water Quality and Section 303(d) List - 2006. The Public and Food Processing Water Supplies designated use is impaired due to excess concentrations of nitrate. This nitrate standard applies to raw (untreated) water at any point at which water is withdrawn from the waterbody for treatment and distribution as a potable water supply or for food processing. In the lake, aquatic life and fish consumption uses are fully supported, while aesthetic quality is not supported. The aesthetic quality use is impaired because of excessive concentrations of total phosphorus and total suspended solids. Primary and secondary contact uses were not assessed. One purpose of this report is to verify the causes of impairment by comparing the available data to water quality standards. TMDLs will be developed for total phosphorus and nitrate nitrogen since numeric water quality standards exist for these two pollutants.

TABLE 1-1 LAKE BLOOMINGTON LISTED IMPAIRMENTS AND CAUSES

Designated Use	Pollutant	Potential Sources
Aesthetic Quality	Total Phosphorus (TP)	Crop Production (Crop Land or Dry Land), Other Recreational Pollution Sources, Runoff from Forest/Grassland/Parkland
	Total Suspended Solids (TSS)	Crop Production (Crop Land or Dry Land), Littoral/shore Area Modifications (Non-riverine), Other Recreational Pollution Sources, Site Clearance (Land Development or Redevelopment)
	Aquatic Algae	Crop Production (Crop Land or Dry Land), Other Recreational Pollution Sources, Runoff from Forest/Grassland/Parkland
Public and Food Processing Water Supplies	Nitrogen, Nitrate	Crop Production (Crop Land or Dry Land), Other Recreational Pollution Sources, Runoff from Forest/Grassland/Parkland

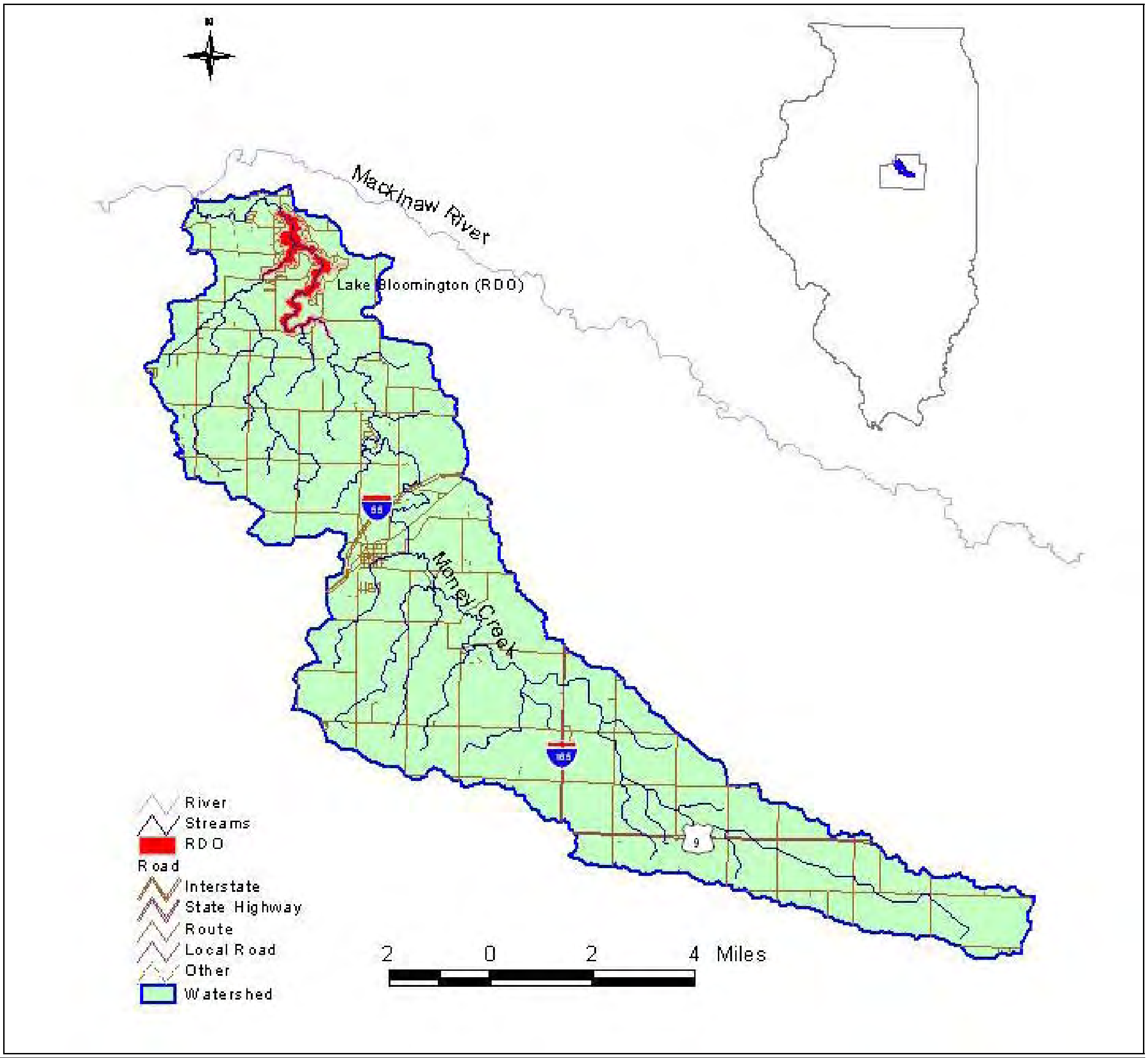
2.0 WATERSHED AND WATER BODY CHARACTERISTICS

This chapter describes the general hydrological characteristics of the Lake Bloomington watershed and water bodies, including their location, population, land use and cover, topography and geology, and soils. The discussion of general watershed characteristics is followed by specific information for the listed segments of the creek and the lake.

2.1 LOCATION

The Lake Bloomington Watershed is located in the central part of McLean County, Illinois as shown on Figure 2-1. The main tributary to the lake is Money Creek, which flows from southeast to northwest in the watershed, and is a tributary in the Mackinaw River Basin (Hydrologic Unit Code 07130004). The size of the watershed is approximately 44,694 acres. The communities of Towanda and Merna are located within the watershed. Lake Bloomington is located in the northern tip of the watershed, about 15 miles north of the City of Bloomington (USDA 1991). Appendix B presents representative photos from the watershed.

FIGURE 2-1 LAKE BLOOMINGTON WATERSHED



2.2 POPULATION

Total watershed population data is not directly available but population estimates may be calculated from the 2000 U.S. Census data (U.S. Census Bureau 2000). The total population in the watershed is approximately 4,575. Table 2-1 and Figure 2-2 show the population density in the watershed by zip code.

TABLE 2-1 POPULATION DENSITY BY ZIP CODE

Zip Code	Area (acre)	Population Per Acre	Population
61753	1,386.98	0.05427	75
61753	305.06	0.05427	17
61748	9,227.02	0.09313	859
61744	573.61	0.00000	0
61776	10,135.64	0.06899	699
61776	9.35	0.06899	1
61776	7.45	0.06899	1
61730	2,234.78	0.02134	48
61730	7.21	0.02134	0
61704	5246.61	0.45282	2,376
61704	285.63	0.45282	129
61761	12.69	2.55611	32
61761	5.71	2.55611	15
61758	6,769.12	0.01182	80
61737	6,921.8	0.03038	210
61722	1,606.08	0.02049	33
Total	44,734		4,575

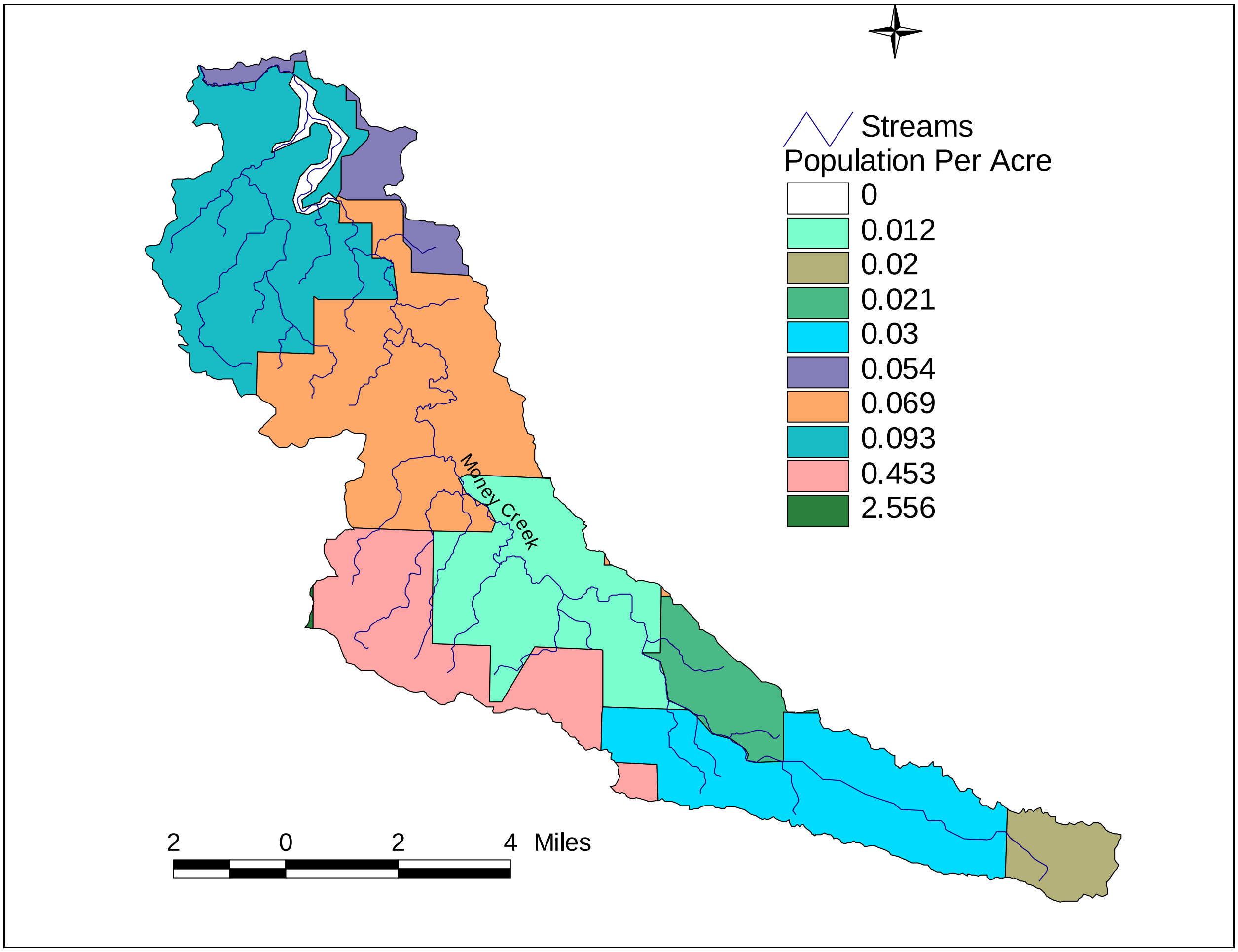
Population information was not available by zip code in the watershed for the 1990 census so that the growth trend can not be defined by postal zip code. The county's population increased from 129,180 in 1990 to 150,433 in 2000, by about 16.5 percent (Table 2-2). Hudson, Towanda, Bloomington Township (TWP) West Phase, Bloomington TWP Crestewicke, Meadows, and Hilltop MHPs are consumers of water taken from Lake Bloomington.

TABLE 2-2 POPULATION CHANGE IN MCLEAN COUNTY

County in the Watershed	1990 Population	2000 Population	Absolute Change	Percent Change
McLean	129,180	150,433	21,253	16.5 %

Sources: U.S Census Bureau 1990 and 2000

FIGURE 2-2 POPULATION DENSITY



2.3 LAND USE AND LAND COVER

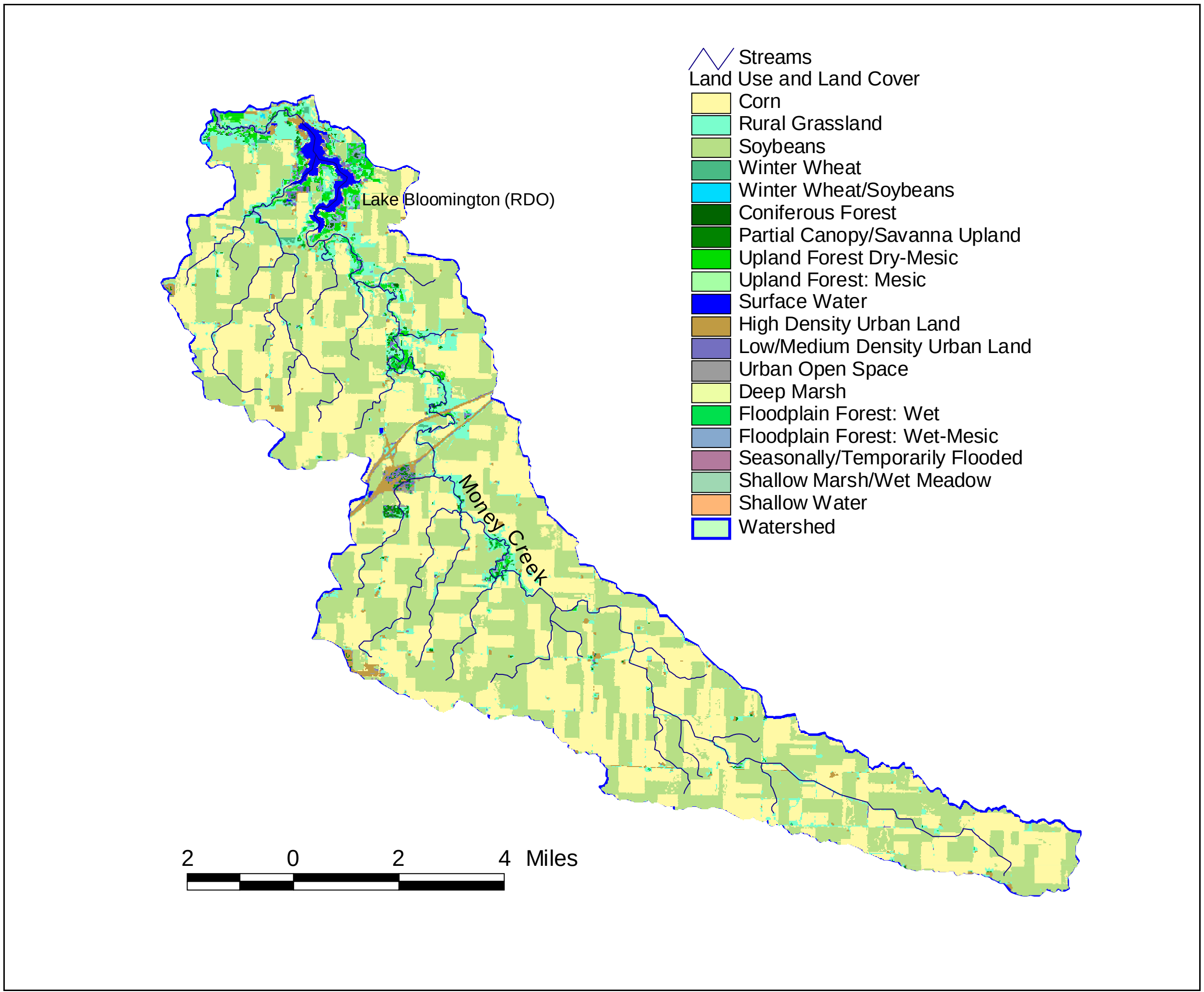
Figure 2-3 presents land use and land cover in the Lake Bloomington watershed. Land use data for the Lake Bloomington watershed was obtained from the Illinois Gap Analysis Program (GAP) which provides detailed classification of land use and land cover. Table 2-3 summarizes the land use for the Lake Bloomington watershed. It shows agricultural land uses are dominant in the Lake Bloomington watershed, making up 93.2 percent (41,666.2 acres) of the total area. Major crops are corn and soybeans. Wetlands account for approximately 2.5 percent (1,102.5 acres) of the Lake Bloomington watershed. Approximately 1.8 percent (808.9 acres) of the watershed area consists of forest or surface water. Urban land use accounts for 2.5 percent (1,116 acres) of the watershed land use area.

TABLE 2-3 LAND USES IN LAKE BLOOMINGTON WATERSHED

Land Cover Description	Watershed Area	
	Acres	Percentage
AGRICULTURAL:		
Corn	19,095.0	42.72
Soybeans	19,439.9	43.5
Rural Grassland	3,076.2	6.88
Winter Wheat	45.8	0.1
Winter Wheat/Soybean Double Cropped	9.3	0.02
Subtotal	**41,666.2**	**93.2**
URBAN:		
High Density	780.2	1.75
Low/Medium Density	263.3	0.59
Open Spaces	72.5	0.16
Subtotal	**1,116.0**	**2.5**
WETLAND:		
Floodplain Forest	325.8	0.73
Seasonal/Temporarily Flooded	21.6	0.05
Wetland: Shallow Water	11.8	0.03
Shallow Marsh/Wet Meadow	2.7	0.01
Deep Marsh	6.2	0.01
Dry Mesic Forest	482.2	1.08
Floodplain Wet Mesic	252.2	0.56
Subtotal	**1,102.5**	**2.5**
Forest:		
Partial Canopy/Savanna Upland	281.6	0.63
Coniferous	13.3	0.03
Upland	85.2	0.19
Subtotal	**380.1**	**0.85**
OTHER: Surface Water	428.8	0.96
Total	**44,694.2**	**100**

Data Date: 2000

FIGURE 2-3 LAND USE AND LAND COVER MAP



2.4 TOPOGRAPHY AND GEOLOGY

The uppermost bedrock within the Lake Bloomington watershed is mostly Pennsylvanian age. These Pennsylvanian formations are made of cyclic beds of sandstone, siltstone, shale, limestone, coal, and clay. These rocks contain 1-2 percent coal by volume. Much of the Pennsylvanian bedrock is covered by Quaternary deposits up to 500 feet thick.

McLean County is mostly on a loess-covered till plain. Glacial movements, running water, and windblown deposits have contributed to the formation of the land within the county. The county also consists of a series of glacial deposits formed about 15,000 to 20,000 years ago by Wisconsinan glacial movements. As the ice sheets moved south, they began to melt and recede, leaving deposits. The deposits are characterized by concentric bands of moraines and ridges starting in the northwest and traveling to the southeast. One of the largest moraines in Illinois is the Bloomington Moraine which runs just south of the watershed. The land to the north of the Bloomington Moraine is mainly gently sloping and sloping, except near the Mackinaw River, which lies just north of the watershed (USGS 1998 and USDA 2002).

2.5 SOILS

Soils data and GIS files from the Natural Resources Conservation Service (NRCS) were used to characterize soils in the Lake Bloomington 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 done by the Natural Resources Conservation Service (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 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. USDA (2002) has defined four hydrologic groups for soils as listed in Table 2-4.

TABLE 2-4 NRCS HYDROLOGIC SOIL GROUP

Hydrologic Soil Group	Description
A	Soils with high infiltrations rates. Usually deep, well drained sands or gravels. Little runoff.
B	Soils with moderate infiltration rates. Usually moderately deep, moderately well drained soils.
C	Soils with slow infiltration rates. Soils with finer textures and slow water movement.
D	Soils with very slow infiltration rates. Soils with high clay content and poor drainage. High amounts of runoff.

Soils may be assigned to dual groups if drainage is feasible and practical. Dual hydrologic groups, A/D, B/D, and C/D, are given for certain wet soils that can be adequately drained. The first letter applies to the drained condition, the second to the undrained. Only soils that are rated D in their natural condition are assigned to dual classes. Figure 2-4 displays the SSURGO hydrologic soil group map for the Lake Bloomington watershed. For the Lake Bloomington watershed, Hydrologic Soil Group B covers 38.7 percent and dominates the south-eastern portion of the watershed and is found adjacent to Lake Bloomington and the middle and northern sections of Money Creek. Group B/D accounts for 59.8 percent and is evenly spaced throughout the watershed and found adjacent to the southern section of Money Creek. Group C covers 0.6 percent and is found in small areas surrounding Lake Bloomington and the northern section of Money Creek upstream from the lake. Group C/D accounts for 0.9 percent is found sparingly throughout the watershed.

A commonly used soil attribute of interest is the K-factor, a coefficient used in the USLE (Wischmeier and Smith, 1978). The K-factor is a dimensionless 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 distribution of K-factor values in the Lake Bloomington watershed is shown in Figure 2-5. The figure indicates that soils with erosion K-Factor range from 0.20 to 0.55; 23.4 percent of the watershed area has a K-factor of 0.24, 12.7 percent has a K-factor of 0.28, and 10 percent has a K-factor of 0.32, 21.2 percent has a K-factor of 0.37, 6.1 percent has a K-factor of 0.43, 2.6 percent has a K-factor of 0.49, and 23.9 percent has a K-factor of 0.55. Southern and middle sections surrounding Money Creek have a K-factor of 0.28. The northern section of Money Creek just upstream of Lake Bloomington has K-factors ranging from 0.28 to 0.37. The areas adjacent to Lake Bloomington have K-factor values ranging from 0.37 to 0.43. The highly erodible soils with a K-factor 0.55 are evenly distributed throughout the watershed.

This watershed is heavily tiled to promote agricultural drainage. The drain tile system increases the possibility for soluble nitrogen to reach the surface water. In addition, some private septic systems may be connected with the drain tile system and provide a direct load to the streams, especially under low flow conditions.

FIGURE 2-4 HYDROLOGIC SOIL GROUP MAP

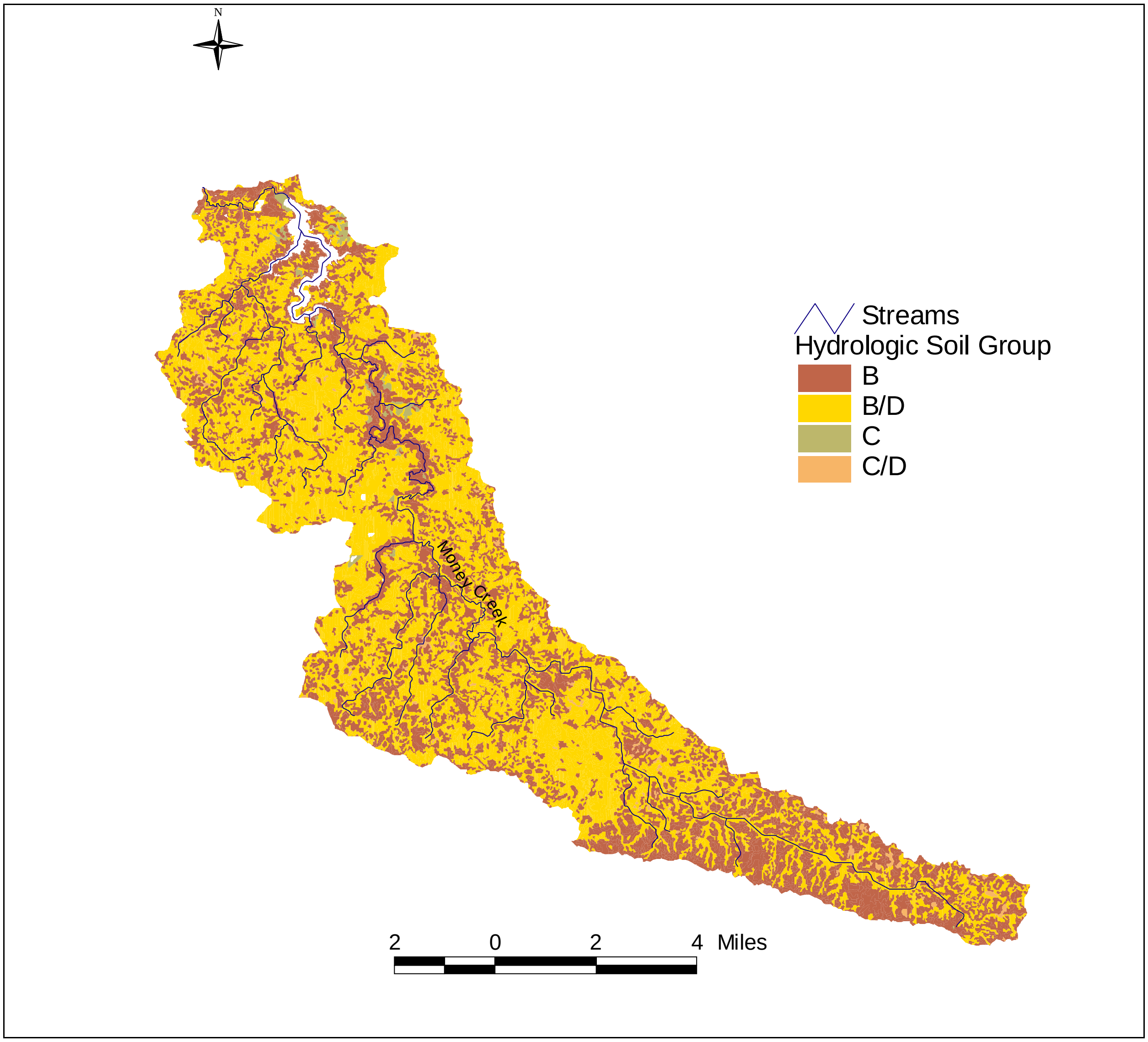
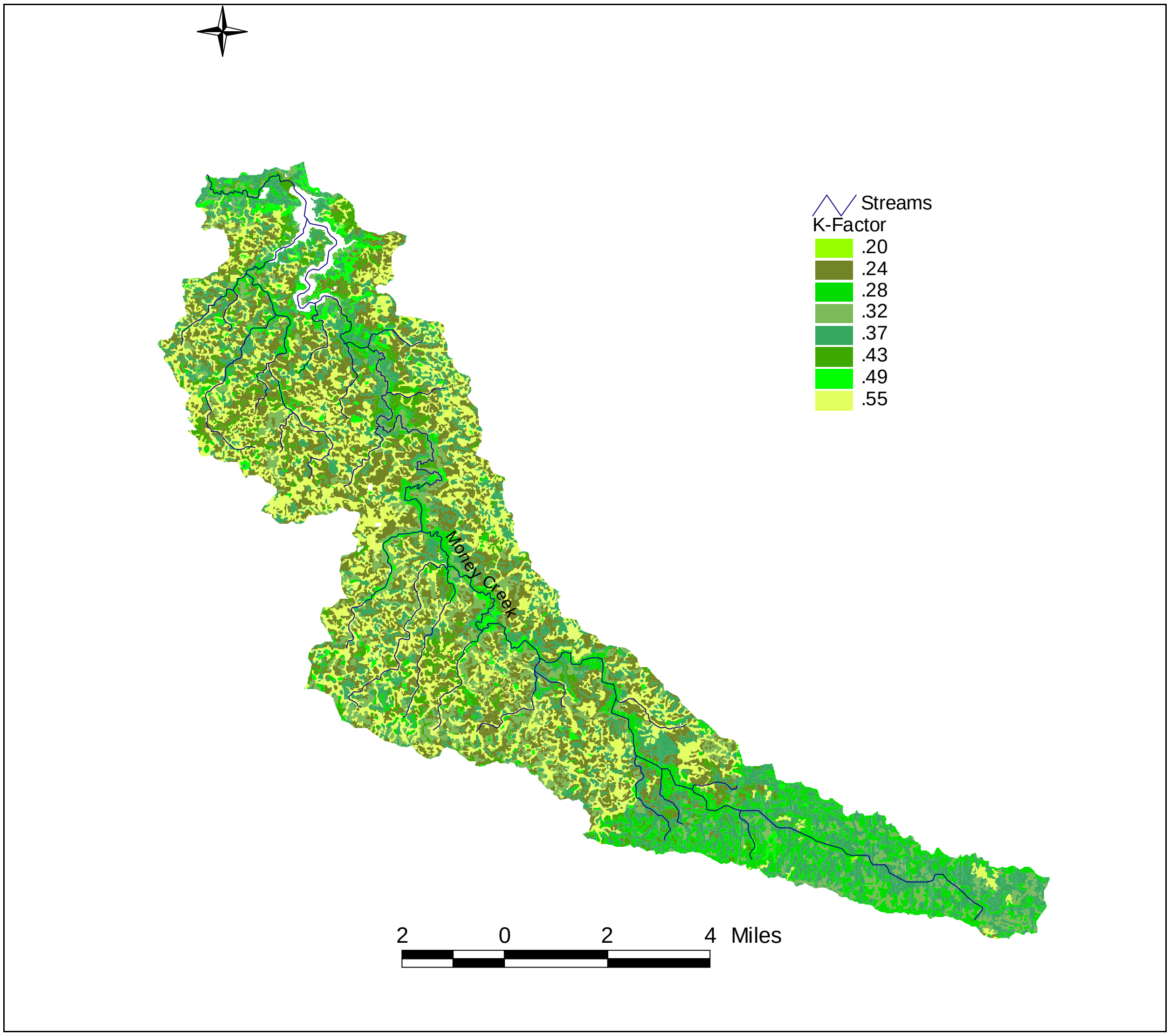


FIGURE 2-5 SOIL EROSION K-FACTOR MAP



2.6 WATERBODY CHARACTERISTICS

Lake Bloomington is a drinking water reservoir located north of Bloomington, Illinois. The lake was constructed in 1929 by impounding Money Creek in the northern area of the lake. The lake was built to expand the city's water supply and its primary use is as a water supply for domestic, commercial, industrial, and agricultural purposes. The lake is also used for recreational purposes as well as a residential development. Lake Bloomington is fed by Money Creek to the south. Hickory Creek, a tributary of Money Creek, empties into Lake Bloomington from the southwest (Figure 2-1). In 1957, the lake's capacity was increased by raising the dam 5 feet. Table 2-5 summarizes characteristics of Lake Bloomington.

TABLE 2-5 LAKE BLOOMINGTON CHARACTERISTICS

Characteristic	Value
Drainage area	69.5 square miles
Water surface	572 acres[b]
Maximum storage	8,760 acre-feet[a]
Normal storage	7,380 acre-feet[b]
Shoreline length	9.5 miles[a]
Average depth	12.9 feet[b]
Maximum depth	35 feet[b]

Notes:
a Source: USDA 1991
b Source: ISWS 1994

USGS station gage 05565500 is located 1300 feet downstream from the dam and 2.1 miles upstream from the mouth of Money Creek. Based on the lake discharge data from 1956 to 1958, the minimum discharge from the lake is zero, the average discharge from the lake is 23.98 cfs, and the maximum discharge of 1,090 cfs was recorded in April 1957 (USGS 2006). The higher discharge usually occurred in the months from April to August.

The annual average pan evaporation was 37.8 inches from 1980 to 2002, based on the records at Hennepin Power Plant station located approximately 60 miles northwest of the lake. Actual evaporation is usually less than pan evaporation, so the average annual pan evaporation was multiplied by 0.75 to give an annual average evaporation of 28.4 inches (ISWS 2002). The Lake Bloomington Water Treatment Plant is located adjacent to the dam. In 1987, a new water treatment plant was built next the old one. Water is pumped directly from the lake to the plant. The treatment plant has a maximum daily pumpage ranging from 18 to 20 million gallon per day (28 to 31 cfs) and sees an average of 14 MGD (21.7 cfs). Water is withdrawn from Lake Evergreen when the water quality in Lake Bloomington is poor or when the lake is drawn down five feet. Lake Evergreen is located approximately 6 miles west of Lake Bloomington.

In October 1991, a 30-horsepower, 480 volt, three-phase Dobbs floating pump was installed near the plant water intake and operated from May to October 1992. Poor water quality became a problem since the 1988 drought due to high temperature, increased retention time, algal blooms, and intense anoxic conditions. The pump was installed in attempts to destratify the lake and improve water quality (ISWS 1994).

3.0 CLIMATE AND HYDROLOGY

This section discusses the climate of the watershed and its hydrology.

3.1 CLIMATE

The central portion of Illinois has a continental climate with cold, rather dry winters, and warm humid summers. Table 3-1 summarizes climate characteristic near Lake Bloomington based on data at Normal, Illinois and Peoria, Illinois. All temperature, precipitation, and snowfall data were taken from the weather station in Normal. All other data was taken from the weather station in Peoria. The average annual precipitation at Normal, Illinois is 37.5 inches. Monthly average precipitation is about 3.1 inches. The wet months are between March and August and have average precipitation between 3.83 and 4.52 inches per month. Months from September to March are relatively dry and have average precipitation between 1.71 and 3.06 inches per month. The average number of days with precipitation per year is 113 days. Severe droughts are infrequent, but prolonged dry periods during a part of the growing season are not unusual. For example, McLean County experienced a severe 2-year drought in the spring of 1988 causing lake water levels to drop by more than 30 feet. The average annual temperature at Normal, Illinois is approximately 50.7 °F. The maximum and minimum average temperatures range from 85.6 to 13.7 °F.

TABLE 3-1 CLIMATE CHARACTERISTICS NEAR NORMAL, ILLINOIS

Climate Variable	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	Average
Average temp[1]. (°F)	22.4	27.3	38.6	50.5	61.8	71.8	75.2	73.2	65.6	53.7	39.8	28.1	50.7
High temperature[1] (°F)	31.0	36.4	48.4	61.2	72.8	82.6	85.6	83.6	77.2	65.1	48.8	36.3	60.8
Low temperature[1] (°F)	13.7	18.2	28.8	39.7	50.8	60.9	64.7	62.8	54	42.3	30.8	19.9	40.6
Precipitation[1] (in)	1.73	1.71	2.87	3.83	4.52	3.88	3.95	3.83	2.95	2.71	3.06	2.41	37.5 (total)
Days with Precip[1]	9	8	11	12	12	10	9	8	8	8	9	9	9.4
Wind speed[2] (mph)	10.9	10.9	11.7	11.6	9.9	8.9	7.8	7.3	8.3	9.3	10.6	10.6	9.8
Morning humidity[3] (%)	80	81	80	77	81	82	86	89	87	84	83	83	83
Afternoon humidity (%)	72	70	66	60	61	62	64	66	64	63	69	74	66
Sunshine[4] (%)	47	50	51	55	60	67	69	67	64	61	43	42	56
Days clear of clouds[4]	7	7	6	6	7	7	9	10	11	11	7	7	7.9
Partly cloudy days[4]	6	6	7	8	10	11	12	10	9	8	6	6	8.3
Cloudy days[4]	18	16	18	16	14	12	10	10	10	12	17	19	14.3
Snowfall (in)	7.7	5.4	2	0.8	0	0	0	0	0	.1	0.7	5.2	21.9 (total)

Notes:

°F Degrees Fahrenheit
in Inch
mph Miles per hour
% Percent
Source: * http://www.sws.uiuc.edu
All others: http://www.ncdc.noaa.gov

Data Period:

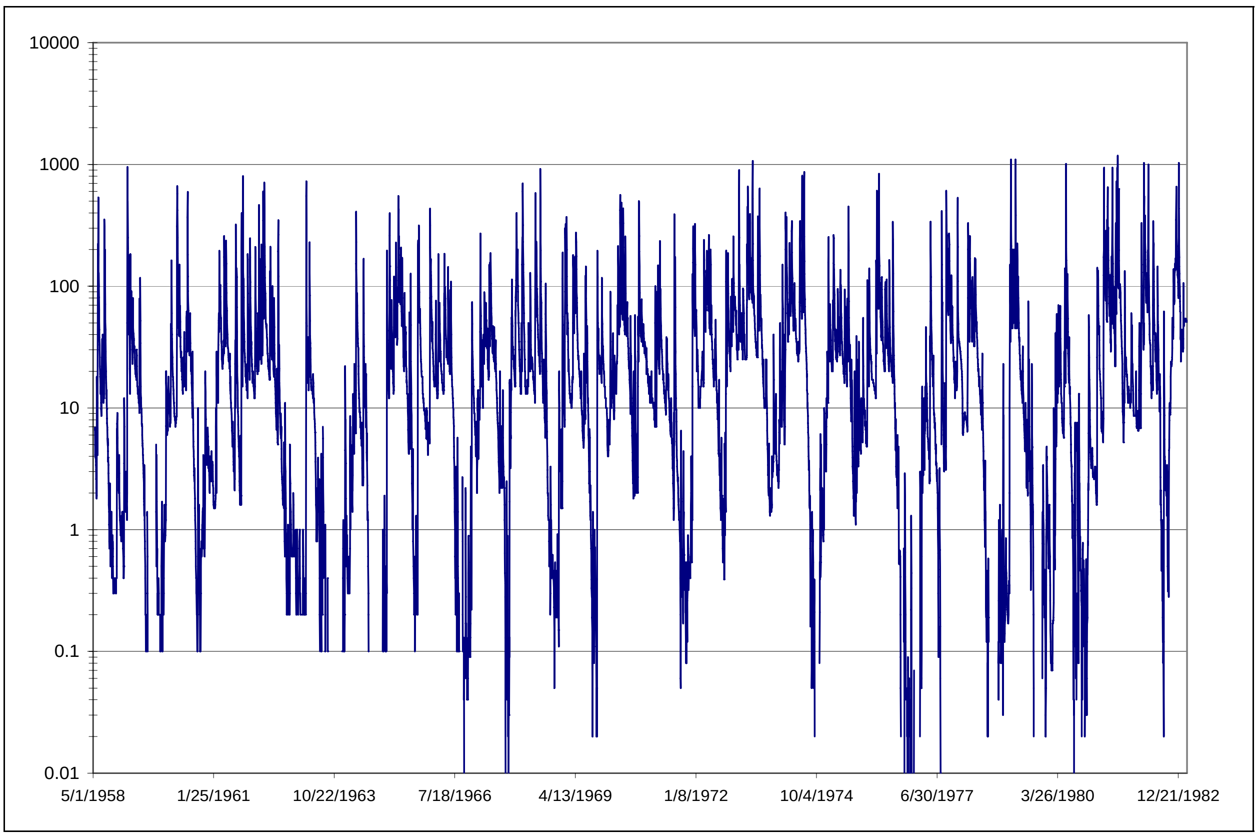
[1] 1971-2000
[2] 1943-2004
[3] 1959-2004
[4] 1952-2004

The region has daily high temperature range of greater than 90 °F about 20 days per year and below freezing 126 days per year. Annual average snowfall is a total of 21.9 inches with large variations in snowfall occurring from year to year. The summer months average about 68 percent sunshine per month while the winter months average about 46 percent sunshine per month. Precipitation occurs an average of 9 days per month with snowfall occurring from October to April (NCDC 2006 and ISWS 2006b).

3.2 HYDROLOGY

USGS station 0556440 is located on Money Creek 8.3 miles upstream from the confluence of the Mackinaw River, 3 miles north of Towanda and 5 miles east of Hudson. It is on the right bank, 25 feet downstream from the County Highway 12 Bridge. Figure 3-1 shows the daily flows from the station measured from June 1958 to February 1983. The mean flow is 36.14 cfs, and the median flow is 13.0 cfs. The maximum flow of 1,180 cfs was recorded in August 6, 1981 during a major flood. The minimum flow of 0 cfs was recorded various times throughout the sampling period (USGS 2006).

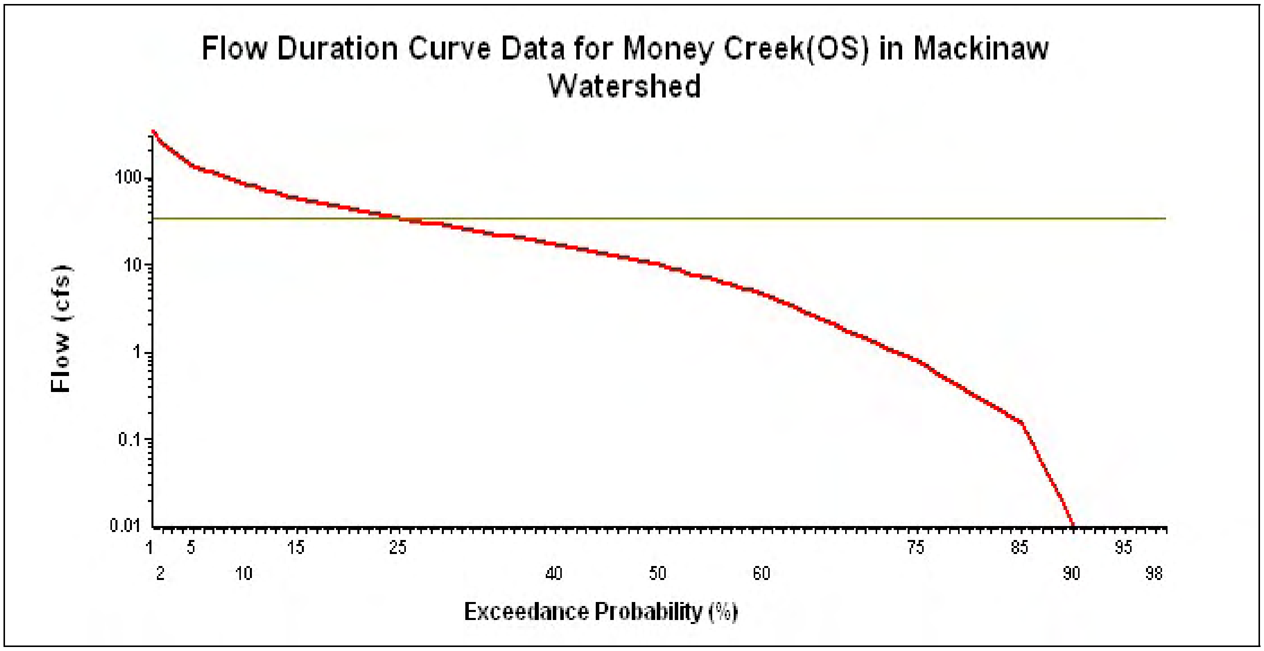
FIGURE 3-1 MONEY CREEK FLOW (1958 TO 1983) AT STATION 05564400



Source: http://nwis.waterdata.usgs.gov/

Figure 3-2 presents a flow frequency curve for Money Creek, based on flow data from 1945 to 2001. It shows the 25-percentile flow of 0.8 cfs and 75-percentile flow of 34.0 cfs. The flow in the river is greater than 11.0 cfs 50 percent of the time (ISWS 2006a).

FIGURE 3-2 FLOW FREQUENCY CURVE OF MONEY CREEK AT 05564400



- **Flow** - **Mean Flow = 33.3**

Source: http://gismaps.sws.uiuc.edu/ilsam/

4.0 WATER QUALITY

This chapter discusses applicable water quality standards and the pollutants of concern in Lake Bloomington. The available water quality data is assessed to verify impairments in the water body by comparing the data with the water quality standards. The spatial and temporal water quality variation as well as the correlation among the constituents is assessed.

4.1 WATER QUALITY STANDARDS AND END POINTS

This section describes applicable water quality standards for Lake Bloomington. Based on the standards, TMDL endpoints were identified as numeric water quality targets.

4.1.1 Lake Water Quality Standards

Lake Bloomington is listed on the Illinois 2006 303(d) list for use impairment caused by nitrate, total suspended solids (TSS), total phosphorus (TP), and aquatic algae. Table 4-1 summarizes the applicable water quality standards for Lake Bloomington. The State of Illinois does not have numeric standards for TSS that could be used as a surrogate for siltation impairment.

At this time, IEPA does not develop TMDLs for parameters that do not have numeric water quality standards. Therefore, a TMDL will not be developed for TSS at this time. Sedimentation is a concern in Lake Bloomington. Since 1957 the lake lost 1,450 acre-feet of storage capacity. The storage loss rate is about 0.5 percent per year (USDA 1991). Because phosphorus load is largely associated with TSS load, the measures implemented for phosphorus reduction may also reduce the sediment load to the lake and decrease the storage loss rate.

TABLE 4-1 WATER QUALITY STANDARDS FOR LAKE BLOOMINGTON

Parameter	Standard
Nitrate	Shall not exceed 10 mg/L
Total Phosphorus	Phosphorus as TP shall not exceed 0.05 mg/L in any reservoir or lake with a surface area of 8.1 hectares (20 acres) or more or in any stream at the point where it enters any such reservoir or lake

Excessive algal growth is listed as a cause of impairment in Lake Bloomington. Chlorophyll-a (Chl-a) is a plant pigment commonly used to measure algal biomass. The Chl-a in water correlates with the amount of algae in the water body. There is no numeric standard in the State of Illinois for Chl-a. The algal growth is directly related to an excessive amount of limiting nutrients and light availability for photosynthesis. Phosphorus is identified as a limiting nutrient in this report. Consequently, TP can be considered a surrogate indicator for excessive algal growth.

4.1.2 TMDL Endpoints

In order for a water body to be listed as Full Support, it must meet all of its applicable designated uses. Water quality standards are designed to protect those designated uses. A pollutant's numeric water quality standard is used as the endpoint for establishing a TMDL. Table 4-2 summarizes the endpoints that will be used in the TMDL development for Lake Bloomington.

TABLE 4-2 TMDL ENDPOINTS

Parameter	TMDL Endpoint	Indicator
Nitrate (mg/L)	10	Direct measurement
Total Phosphorus (mg/L)	<0.05	Direct Measurement

4.2 DATA AVAILABILITY

Four sampling sites are located in Lake Bloomington as shown in Figure 4-1. In 1973, USGS collected single water samples at Station 170301 (downstream of the dam) and 170302. From 1977 to 2001, IEPA collected water samples from the three other sites in Lake Bloomington. The three sampling sites used in this report are RDO-1, RDO-2, and RDO-3. Water quality parameters tested include TP, nitrite plus nitrate, dissolved phosphorus (DP), ammonia nitrogen, and chlorophyll-a. All data was retrieved from the USEPA STORET site. RDO-1 is located in the north section of the lake near the Lake Bloomington dam. RDO-2 is located in the middle, western portion of the lake. RDO-3 is located in the southern portion of the lake. In addition, Lake Bloomington Water Treatment Plant has provided water quality and lake level data from 1999 through 2005. These data will be incorporated for the TMDL development in the Stage 3 report.

4.3 ASSESSMENT OF WATER QUALITY DATA

This section discusses the pollutants of concern for Lake Bloomington. The available water quality data is analyzed, assessed, and compared with water quality standards to verify the impairments of the lake. The water quality conditions in the lake are evaluated by sampling location and time variations.

4.3.1 Phosphorus

Figure 4-2 presents TP data collected at various sites in the lake from 1977 to 2003. The figure shows that the maximum concentrations exceed the standard at all locations. The average concentrations exceed the water quality standard of 0.05 mg/L at stations RDO-1 and RDO-3 and meet the standard at RDO-2.

FIGURE 4-1 WATER QUALITY SAMPLING SITES

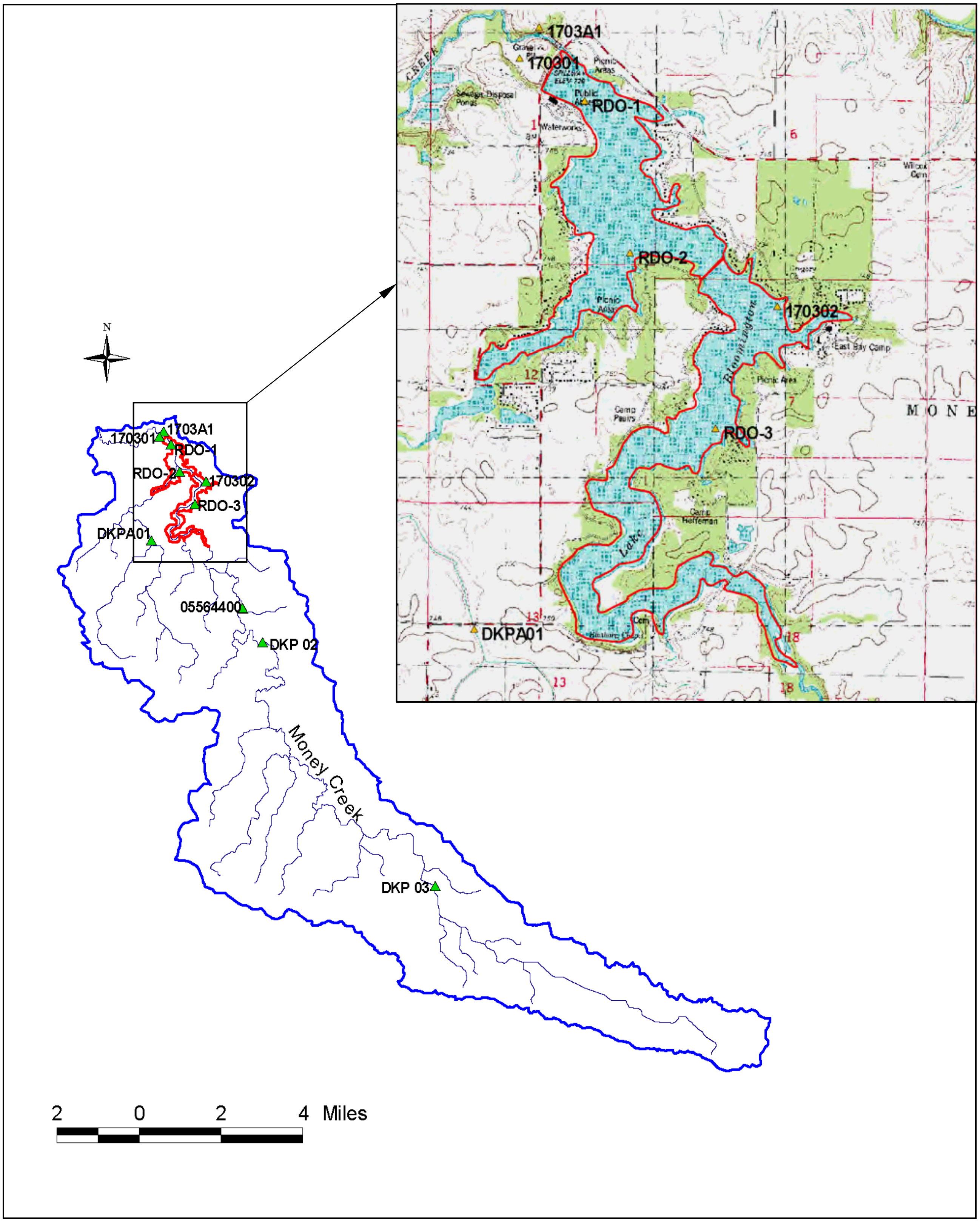


FIGURE 4-2 TOTAL PHOSPHORUS CONCENTRATIONS IN LAKE BLOOMINGTON (1977-2003)

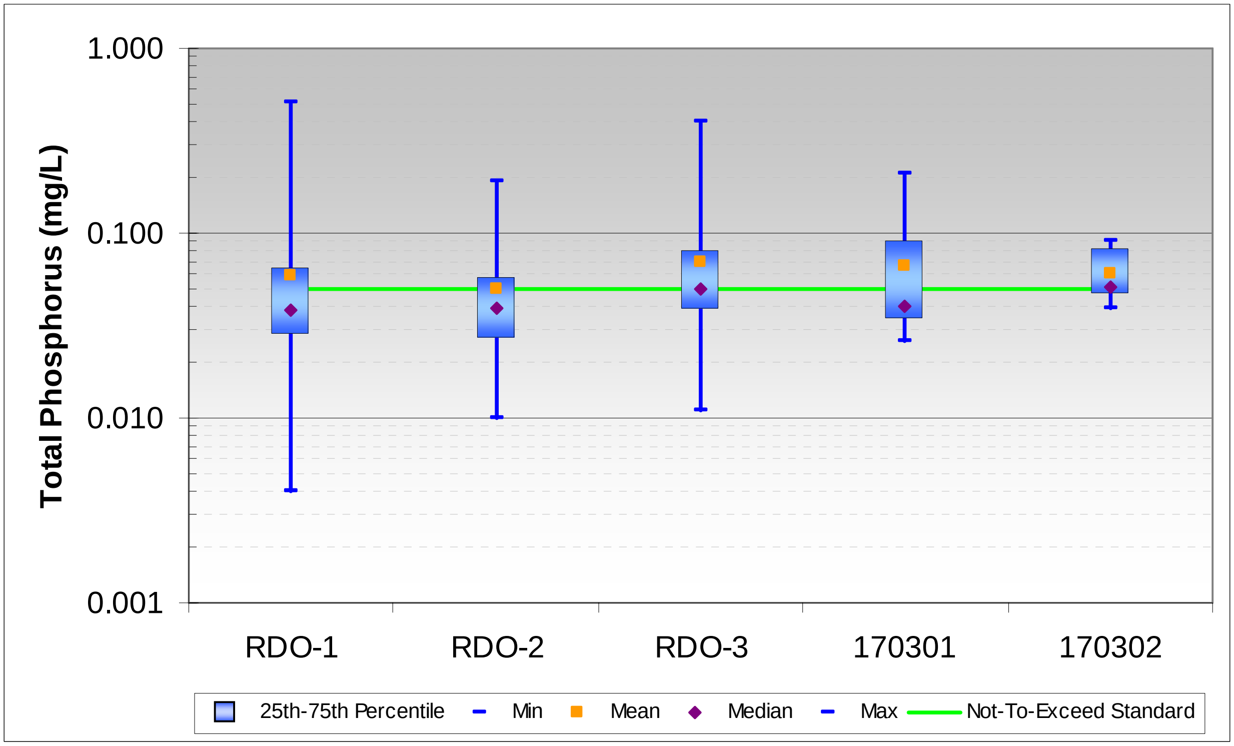


Figure 4-3 presents a scatter plot of all TP concentration data points, measured at 1-foot from water surface in Lake Bloomington. There are 163 TP measurements, 61 of which (37 percent) exceeded the water quality standard of 0.05 mg/L. The data also indicate that the TP concentrations before 1984 are mostly in compliance with the water quality standards. Activities after 1984 may have resulted in the elevated TP concentration in the lake.

FIGURE 4-3 TP CONCENTRATION DATA POINT SCATTER PLOT (1977-2003)

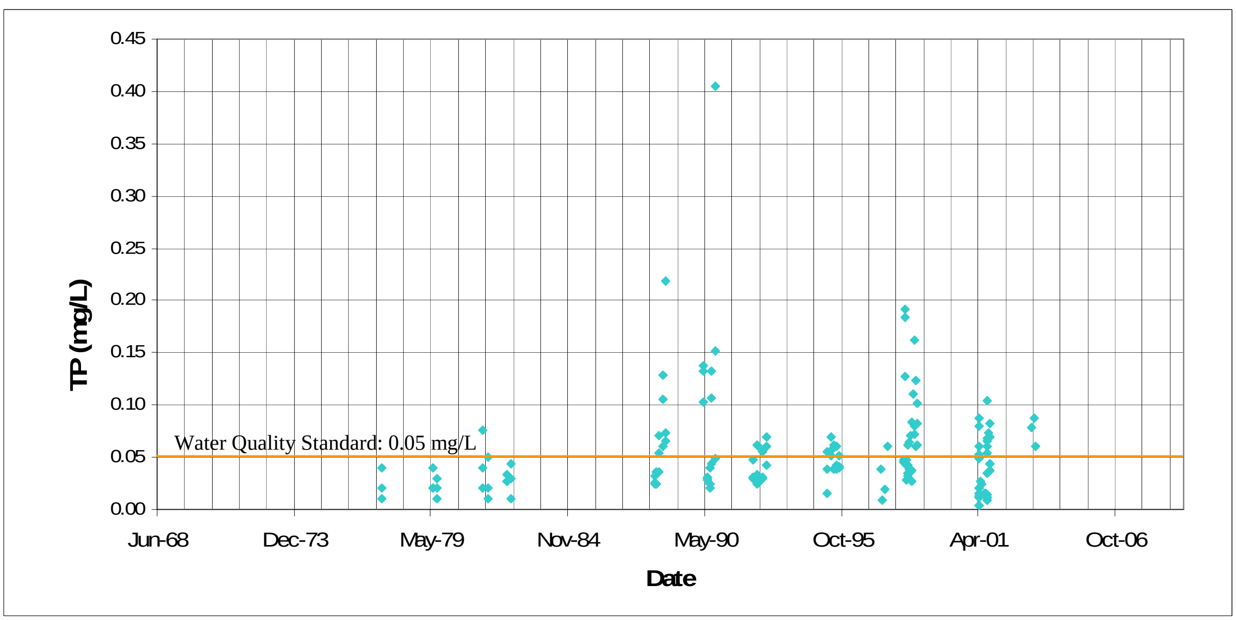
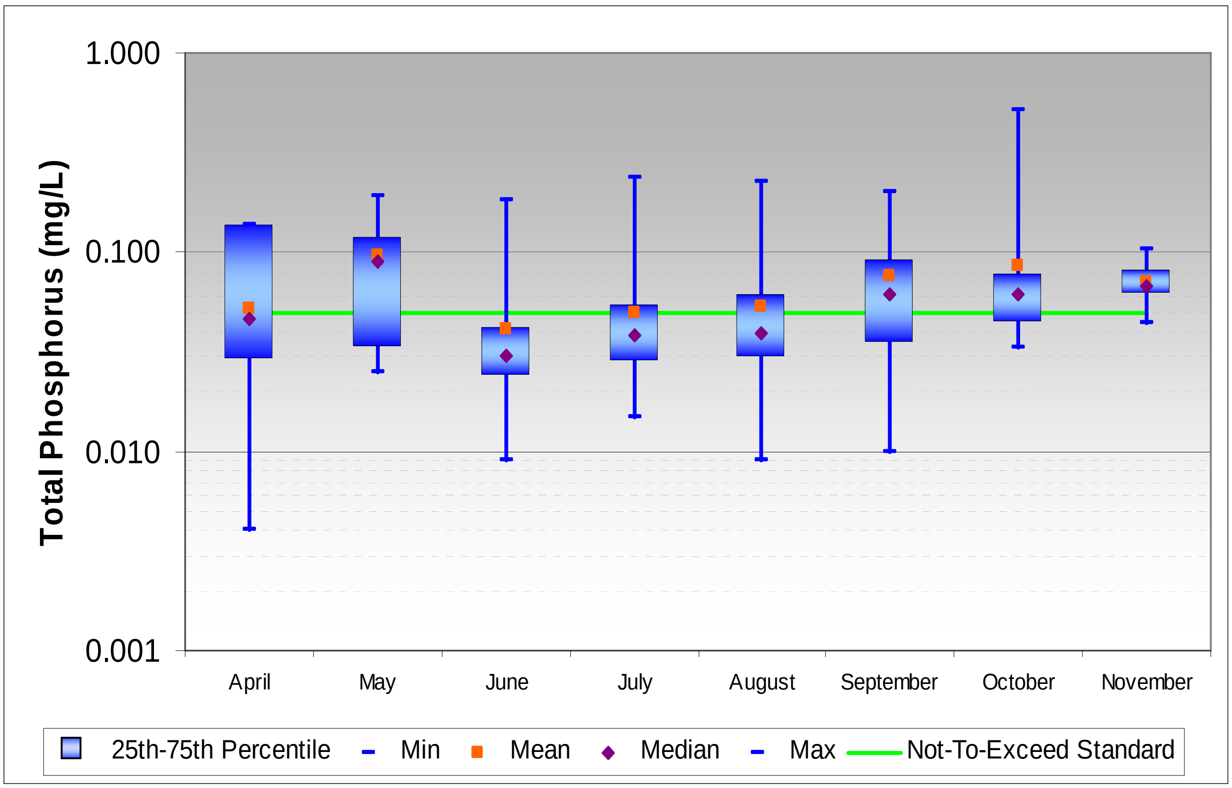


Figure 4-4 presents the variation of monthly average TP concentrations from all locations in Lake Bloomington. The monthly average TP concentrations exceed the Illinois water quality standard from April to November, except for the month of June. The monthly average TP concentrations are significantly elevated in Spring and Fall. The monthly average TP concentration is highest in May which indicates that run-off potentially plays a major role in the TP load in the lake, since May has the most precipitation of any month in the region.

FIGURE 4-4 MONTHLY AVERAGE TOTAL PHOSPHORUS CONCENTRATION IN LAKE BLOOMINGTON (1977-2003)



Dissolved Phosphorus (DP) is the portion of TP that is biologically available for plant uptake. It is the soluble form of phosphorus that is not adsorbed to soil particles. In rivers and lakes with short retention time, DP concentration is crucial for plant growth. Table 4-3 summarizes the monthly DP and TP concentrations in the lake. The average monthly DP is about 0.02 mg/l versus TP at 0.06 mg/l, meaning that an average 33 percent of TP concentration is in the dissolved form. This ratio implies that nonpoint sources other than soil erosion may contribute to TP.

TABLE 4-3 MONTHLY AVERAGE DISSOLVED PHOSPHORUS AND TOTAL PHOSPHORUS CONCENTRATIONS IN LAKE BLOOMINGTON

Month	DP (mg/l)	TP (mg/l)	Percent DP
Apr	0.02	0.05	40
May	0.01	0.10	10
Jun	0.02	0.04	50
Jul	0.02	0.05	40
Aug	0.01	0.05	20
Sep	0.03	0.08	38
Oct	0.04	0.09	44
Average	**0.02**	**0.06**	**33**

Source: IEPA 2001 and STORET

The availability, concentration, location, and form of chemicals (nutrients) are greatly affected by lake mixing dynamics. Phosphorus settles out of the water column to the lake bottom as particulate-phosphorus and is bound to the lake bottom sediment. The phosphorus generally is unavailable for algal uptake and growth and is not a water quality problem. However, anoxic conditions at the lake bottom can result in the release of bound phosphorus. If no mixing occurs in the water column, the released phosphorus will remain at the bottom of the lake. If mixing occurs (from wind action, tributary inflow, fish activity, or seasonal lake turnover following thermal stratification), the dissolved phosphorus is brought up to the surface, where it is available for algal uptake and growth.

There are only five TP data points available in Money Creek, which are presented in Table 4-4. The data indicates that Money Creek delivers significant TP loads to Lake Bloomington. The Illinois Integrated Water Quality and Section 303(d) List – 2006 lists Money Creek as Full Support.

TABLE 4-4 TP CONCENTRATIONS IN MONEY CREEK AT STATION DKP 02

Date	Concentration (mg/L)
Jul-87	0.24
Sep-94	0.12
Oct-94	0.27
Nov-94	0.07
Jul-00	0.04

4.3.2 Nitrate Nitrogen

Nitrate nitrogen is a listed cause of impairment in Lake Bloomington. The water quality standard for drinking water supply sources in Illinois is 10 mg/L. Because nitrite nitrogen seldom appears in concentration greater than 1 mg/L and tends to transform to nitrate, the nitrate plus nitrite concentration data is used to verify the exceedance. Figure 4-5 presents the nitrate plus nitrite levels by station. The maximum observed nitrate plus nitrite concentration at each station exceeds the standard, however, the average concentration at each station is lower than the standard.

FIGURE 4-5 NITRITE PLUS NITRATE CONCENTRATIONS IN LAKE BLOOMINGTON (1977-2003)

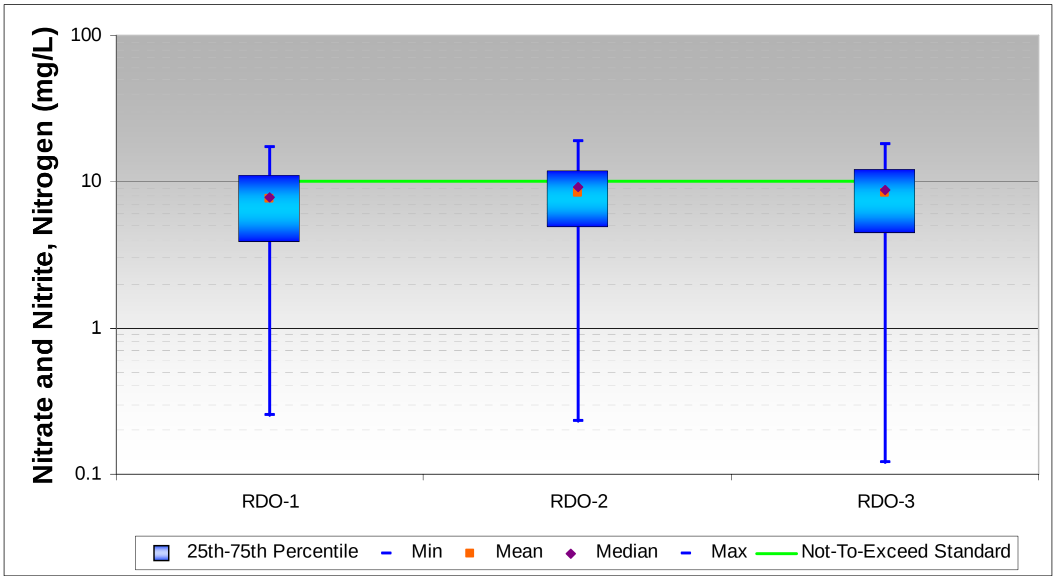
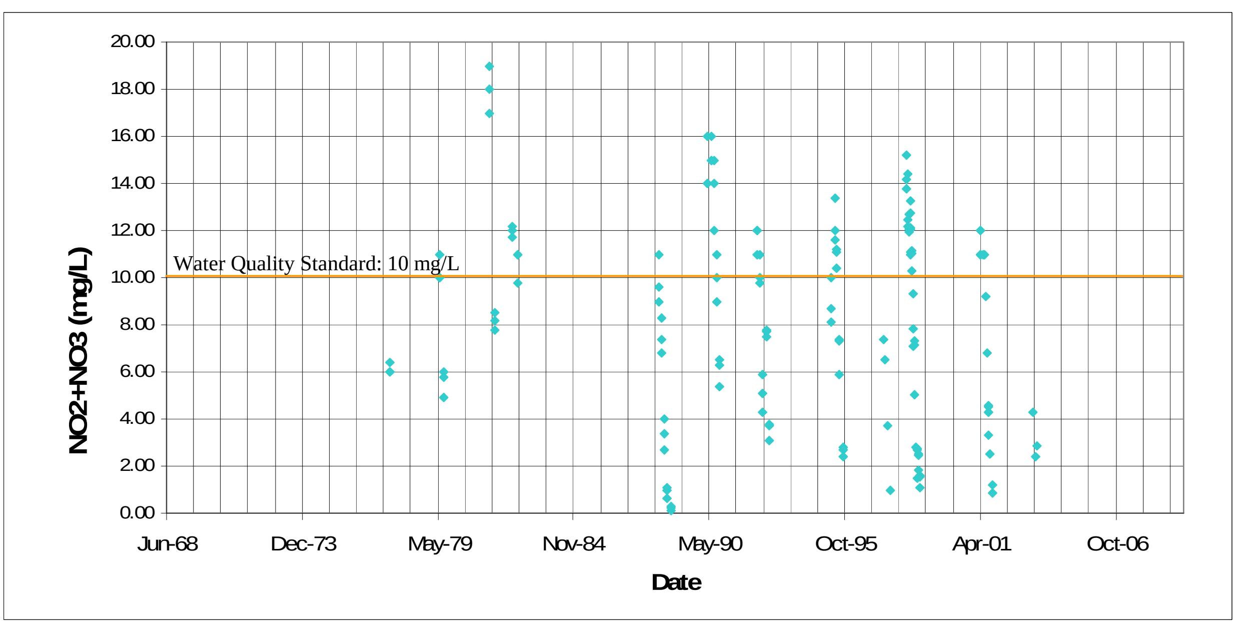


Figure 4-6 presents a scatter plot of all nitrite plus nitrate concentration data points, measured at 1-foot from water surface in Lake Bloomington, in Lake Bloomington. There are 139 nitrite plus nitrate measurements, 55 of which (40 percent) exceeded the water quality standard of 10 mg/L.

FIGURE 4-6 NITRITE PLUS NITRATE CONCENTRATION DATA POINT SCATTER PLOT (1977-2003)



4.3.3 Limiting Nutrients

A limiting nutrient is a nutrient that plants need to grow, but is not available in large enough quantities for the plants and algae to grow in excess. If a limiting nutrient is added to an ecosystem, algae populations will increase until nutrients are limited or other environmental factors, such as light or water temperature, curtail the population growth. Controlling the limiting nutrient can lower the eutrophication level and improve conditions in the water body. The stoichiometry ratio of nitrogen to phosphorus (TN:TP) in phytoplankton biomass is about 7.2:1. If the N:P ratio in a water body is less than 7.2, nitrogen is the limiting nutrient. Otherwise, phosphorus is the limiting nutrient. Table 4-5 summarizes the average TN:TP ratio in the Lake Bloomington, based on the IEPA 2001 sampling data and STORET. The average TN:TP ratio is about 138.81. Therefore, phosphorus is considered to be the limiting nutrient for plant growth in Lake Bloomington. TP contributes to lake eutrophication (fertility) and algal blooms. Nitrogen is also necessary for plant growth, but it is generally abundant and does not limit algae growth, especially in water systems with low retention times (fast-flowing systems). With large amounts of available nitrogen, an increase in the limiting nutrient, TP, results in excessive algal growth.

TABLE 4-5 AVERAGE TOTAL PHOSPHORUS AND TOTAL NITROGEN CONCENTRATIONS IN LAKE BLOOMINGTON

Station	TN (mg/L)	TP (mg/L	TN:TP
RDO-1	7.66	0.06	128.75
RDO-2	8.41	0.05	169.06
RDO-3	8.29	0.07	118.62
Average	8.12	0.06	138.81

4.3.4 Trophic State Index

Trophic status (or "fertility" status) describes the nutrient enrichment status of a lake ecosystem. A higher the trophic status correlates to more available nutrients and higher productivity. The best environment for supporting aquatic life and a wide range of other uses, such as swimming or boating, are lakes classified as mesotrophic to eutrophic. Excessive nutrient loads can lead to bothersome algal blooms and unwanted turbitity. A low nutrient status can limit the lakes ability to support aquatic life. Carlson Trophic State Index (TSI) values are used as indicators of trophic status, which can be calculated using TP concentrations, Chl-a concentrations, or Secchi disk depth respectively (Carlson 1977). Generally, TP is considered the best indicator of *potential* trophic status, especially when the TP is the limiting nutrient. The diagram in Figure 4-5 depicts the relationship between the TSI, trophic status, and nutrient status.

Table 4-6 summarizes the TSI in Lake Bloomington, based on TP, Chl-a, and Secchi disk depth. Using the TP-based TSI, Lake Bloomington is classified as eutropic.

FIGURE 4-5 TSI RELATIONSHIP TO LAKE FERTILITY

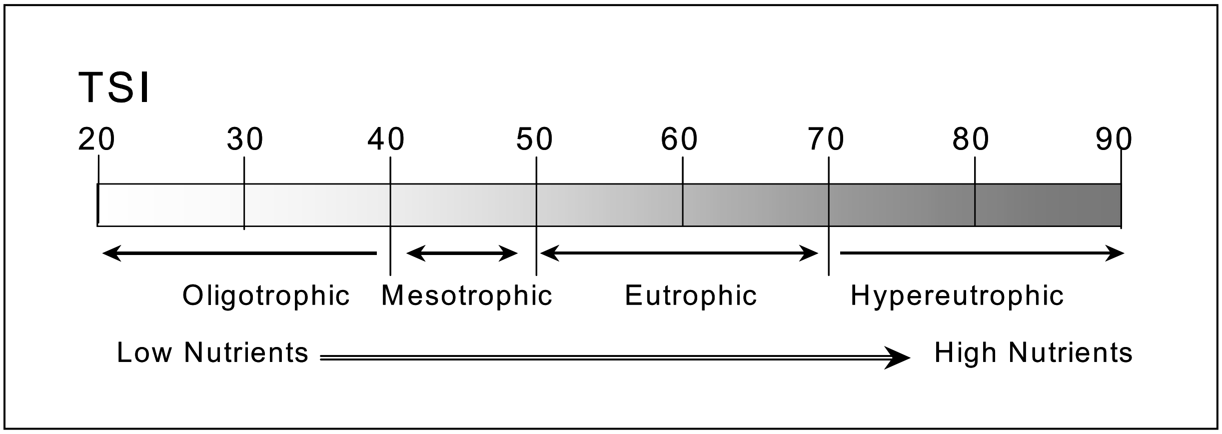


TABLE 4-6 TROPHIC STATE INDEX FOR LAKE BLOOMINGTON

Location	TSI (for Total Phosphorus)	TSI (for Chl-a)	TSI (for Secchi Depth)
RDO-1	63.1	62.3	62.5
RDO-2	60.5	63.2	59.1
RDO-3	65.4	66.3	63.1
Average	63.1	63.9	61.5

4.3.5 Excessive Algal Growth/Chlorophyll-a

Illinois water quality standard states that the waters of the state shall be free from sludge or bottom deposits, floating debris, visible oil, odor, plant or algal growth, color or turbidity of other than natural origin. Lake Bloomington is listed for impairment by excessive algal growth. Chl-a is the dominant pigment in the algae cell and is used as an indicator for algal growth. Chl-a is used as a surrogate for algae biomass. Chl-a is a good indicator because algae blooms are generally the result of excess nutrient enrichment. The water quality standard requires that the waters of the State of Illinois shall be free from algal growth other than natural origin. Figure 4-7 shows the average Chl-a concentration at three sampling locations. Chl-a concentrations do not show large variations from station to station. The maximum Chl-a concentration of 101 ug/L occurred at station RDO-3.

Figure 4-8 shows monthly average Chl-a concentration data collected in Lake Bloomington. The figure indicates that the Chl-a concentration is higher in spring and late fall.

FIGURE 4-7 CHLOROPHYLL-A CONCENTRATIONS IN LAKE BLOOMINGTON (1982-2001)

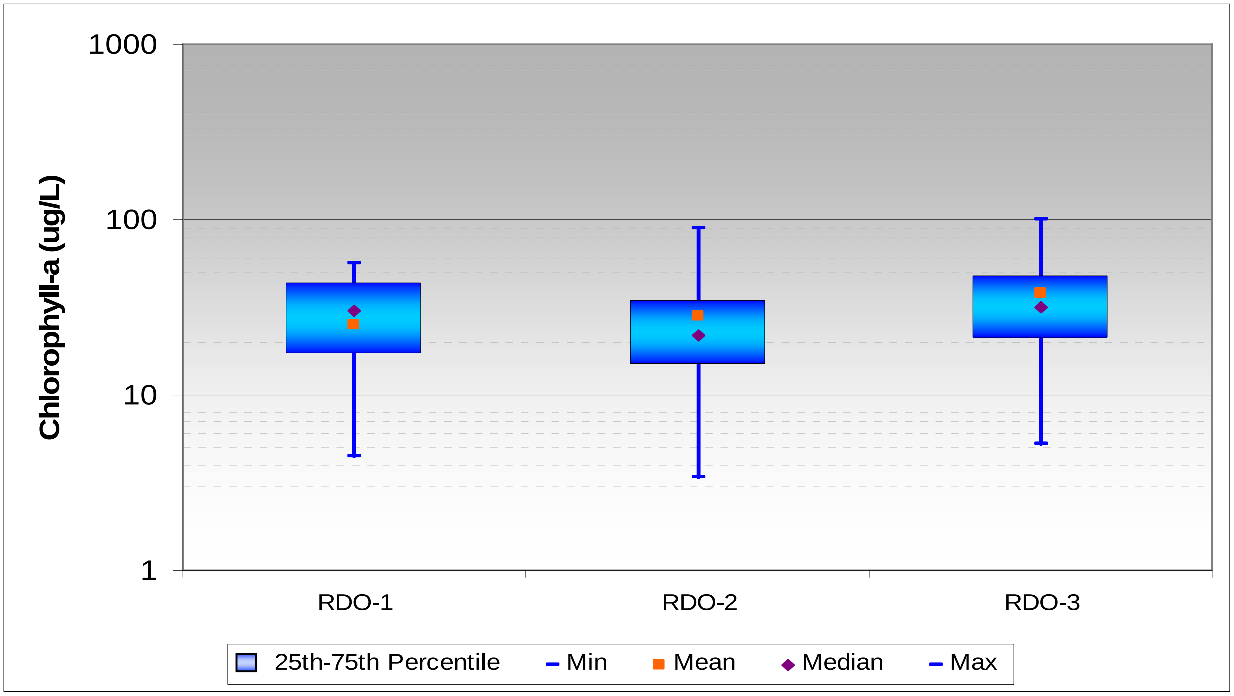
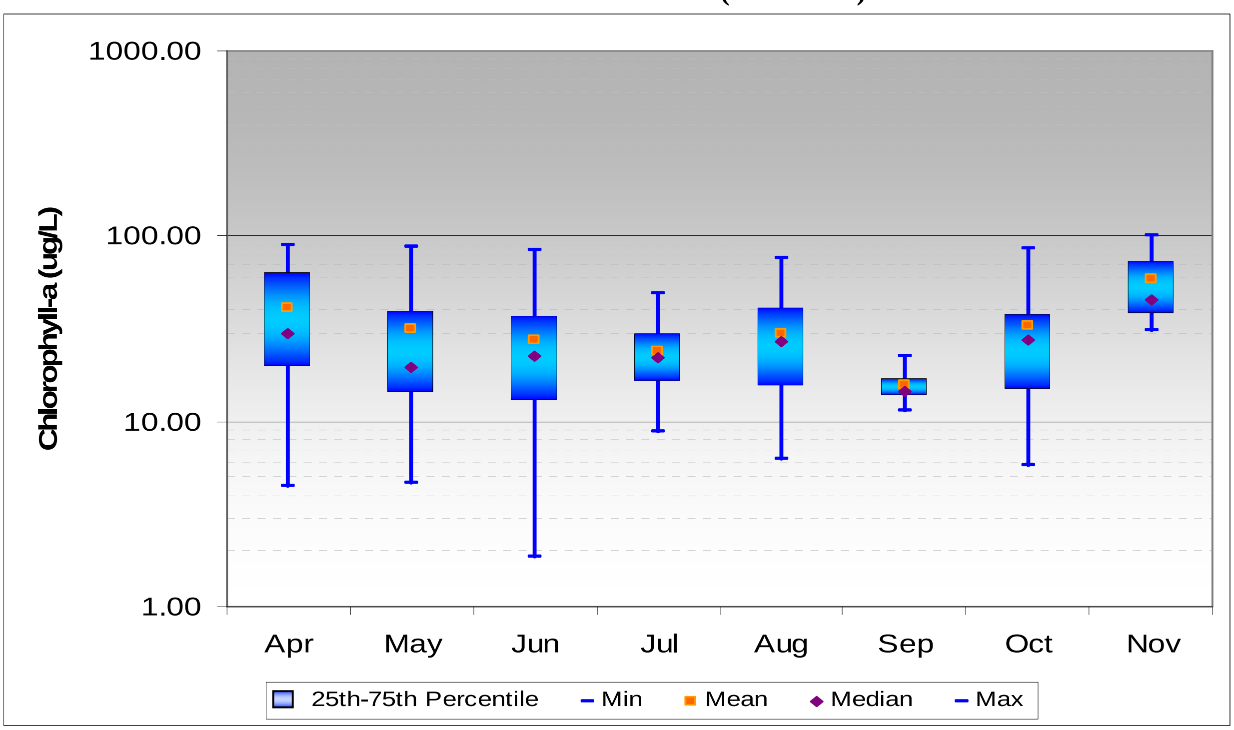


FIGURE 4-8 MONTHLY AVERAGE CHLOROPHYLL-A CONCENTRATIONS IN LAKE BLOOMINGTON (1982-2001)



5.0 SOURCE ASSESSMENT

This section discusses point and nonpoint sources that potentially contribute to the impairment of the Lake Bloomington.

5.1 NONPOINT SOURCES

The Illinois 2006 303(d) List identified crop production (crop land or dry land), site clearance (land development or redevelopment), littoral/shore area modification (non-riverine), recreational pollution, and runoff from forest/grassland/parkland as sources of nutrient loads to Lake Bloomington. Row crop agriculture is a common source of sediment and nutrient loads and is prevalent in the watershed. About 93.2 percent of the watershed is agricultural land. The row crops corn and soybeans are the dominant crop within the watershed. Fertilizers commonly used in the watershed include nitrogen, phosphorus, and potash. Fertilizers are applied in the fall and spring with a variety of application methods. Fertilizer runoff from lawns is also a potential nonpoint source to the impairment, which will be further investigated in Stage 3.

Animal feedlots and confinement operations are other potential sources for nutrient loads. According to local NRCS staff, 8 confinement operations for hogs and 3 feedlots for cattle existed in the Lake Bloomington watershed in 1998. The exact number of animals in the watershed was not determined. Table 5-1 presents the estimated number of animals in the watershed, excluding those in the above-mentioned feedlots or confinement operations.

TABLE 5-1 LIVESTOCK WITHIN LAKE BLOOMINGTON WATERSHED (1998)

Livestock	Number
Cattle	899
Swine	15
Horse	46
Sheep	82
Other	200
Total	**1242**

Source: Tetra Tech 2006a

Soils in the Lake Bloomington watershed range from poorly drained to well drained. Rainfall does not permeate in poorly drained soils which can result in high rates of runoff. A high rate of runoff can lead to water bodies receiving heavy loads of nutrients and sedimentation. The 2004 Illinois Soil Conservation Transect Survey Summary indicates that about 15 percent of the points (locations) surveyed in Illinois are still exceeding tolerable soil loss level (USDA, 2004). Table 5-2 summarizes the tillage percentage for agricultural lands in McLean County. McLean County recorded a slightly lower than state average of 13 percent of the survey points exceeding tolerable soil loss level. McLean County has a relatively high percentage (64 percent) of conventional tillage in corn fields, compared to the state average of 35.5 percent. A soil management adjustment is desirable in order to lower soil loss levels.

TABLE 5-2 TILLAGE PERCENTAGE IN MCLEAN COUNTY, IL

Agriculture Land Use	Conventional	**Reduced-till**	**Mulch-till**	**No-till**
Corn	64	10	14	12
soybean	4	8	54	35
small grain	0	0	33	67

Nearly all households within the Lake Bloomington watershed use a private septic system. Septic systems are another potential source of a nutrient and sediment loads. Septic systems can contaminate surface water or leach into groundwater if the system is malfunctioning.

According to the McLean County Health Department, there are 353 active individual septic systems under permit in 10 subdivisions that are in the immediate area of Lake Bloomington. These septic systems are usually 50 to several hundred feet away from the lake front and most of them have valid permits. There are 607 active septic systems in the Village of Hudson, which has a small portion located in Lake Bloomington watershed. Along Money Creek, there are 90 septic systems near the southeast side of the lake (subdivision). Appendix D presents maps of septic systems in the Lake Bloomington watershed. The potential influence of septic tank effluent on the lake will be further investigated during Stage 3.

5.2 POINT SOURCES

There are two NPDES permit facilities in Lake Bloomington watershed as shown in Figure 5-1. The two facilities are identified as follows, listed from upstream to downstream (see Table 5-3)

1. **Towanda Grade School.** This permit was terminated on January 11, 2005 since a septic system was installed. The village of Towanda does not have a sewer system. It is assumed that the homes have septic systems.

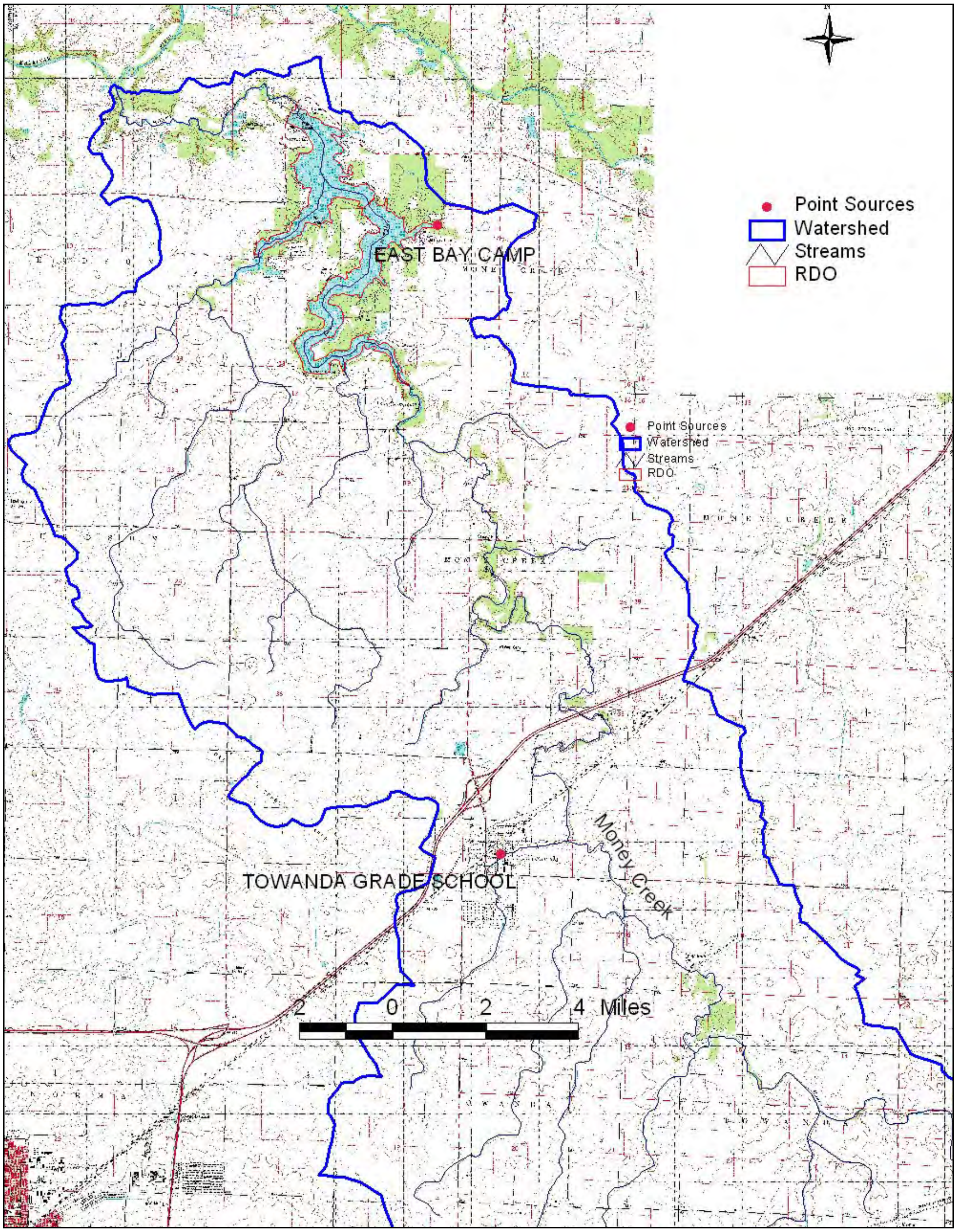
2. **East Bay Camp and Retreat** discharges through one outfall into Lake Bloomington. The average flow is included in Table 5-3. The facility is monitored for pH, TSS, dissolved oxygen (DO), flow, ammonia nitrogen, 5 day BOD, chlorine residual and fecal coliform. No violations have been reported.

TABLE 5-3 POINT SOURCES DISCHARGER IN LAKE BLOOMINGTON WATERSHED

Facility Name	Location	NPDES No.	Receiving Waterbody	Discharge Rate (MGD)
Towanda Grade School	Towanda, IL	ILL046167	Unknown	N/A
East Bay Camp and Retreat	Hudson, IL	IL0025666	Lake Bloomington	0.03

Source: USEPA 2006

FIGURE 5-1 POINT SOURCE LOCATION MAP



6.0 METHODOLGY SELECTION

This chapter discusses the methodology that may be used for the development of TMDLs for Lake Bloomington (RDO). Although a simpler approach is able to meet the minimum requirements of a TMDL, a detailed watershed modeling approach is sometimes advantageous to determine the individual nonpoint sources based on land uses and support a TMDL-guided and site-specific implementation plan. The large amount of watershed data, past studies, and extensive stakeholder interests seems to favor a relatively sophisticated modeling approach. Therefore, both a simple approach and a modeling approach are discussed here. The final selection of a methodology will be determined with consultation with the IEPA based on following factors:

1) Fundamental requirements of a defensible and approvable TMDL
2) Data availability
3) Fund availability
4) Public acceptance
5) Complexity of water body

A simpler approach shall be used as long as it meets TMDL requirement since it is more economical. On the other hand, a sophisticated model approach is often used to establish a scientific link between the pollutant sources and the water quality indicators for the attainment of designated uses. Models enable the prediction of water body response to the pollutant loads and comparison of the various reduction scenarios. The linkage allows for the evaluation of management options and the selection of the option that will achieve the desired load reductions.

Section 6.1 discusses the simple approach. Section 6.2 discusses the sophisticated modeling approach, describes the criterion for the model selection and preliminary model selection, followed by brief descriptions of each model. Section 6.3 discusses model calibration. Section 6.4 discusses sensitivity analysis.

6.1 SIMPLE APPROACH

A simple approach such as a loading curve is considered for the TMDL development in Lake Bloomington based on flow data in Money Creek. In order to use a loading curve, both flow and water quality data is needed through long-term sampling to trace where the major sources of pollution are coming from. The duration curve approach is not labor intensive and can be used efficiently to meet time constrain. The method, however, is not able to link the loadings and water quality response and allocate loads to specific sources based on transport mechanisms. While a flow duration approach appears to be a good tool for screening and gaining an overall picture of watershed conditions and meets the requirements of a TMDL, a more complex modeling may be used for TMDL development to better represent watershed processes and calculate more accurate load allocations (Miller-McClellan, 2003).

A mass-balancing BATHTUB model may be considered as a simple approach to link the nutrient loads and water quality parameters such as nitrate and phosphorus. BATHTUB applies a series of empirical eutrophication equations and performs steady-state water and nutrient balance calculations in a lake. Eutrophication-related water quality conditions (total phosphorus and total nitrogen) are predicted using empirical relationships derived from assessments of lake data. Applications of BATHTUB are limited to steady-state evaluations of relations between nutrient loading, hydrology, and eutrophication responses.

6.2 SOPHISTICATED MODELING APPROACH

Generally, the sophisticated modeling approach will consist of two steps: (1) use of a watershed model to simulate hydrology and estimate pollutant loads to each water body as a function of land use and pollutant export, and (2) use of a water quality model to predict pollutant concentrations and other responses in the water body as a function of pollutant loads. The following criteria should be used to select watershed and water body models for developing Lake Bloomington TMDLs:

- Capable of simulating watershed hydrology and loading process
- Capable of simulating pollutant (particularly, fecal coliform, nitrogen, and phosphorus) transport and water quality
- Capable of simulating best management practices (BMP) scenarios
- East to use and calibrate
- Well tested and documented

6.2.1 Watershed Model

The Soil Water Assessment Tool (SWAT) model is considered as a watershed model to calculate nonpoint sources loading. SWAT is specifically developed for agriculture areas. It simulates both hydrology and water quality continuously and predicts the effect of land management practices. Compared to Hydrologic Simulation Program in Fortran (HSPF), SWAT is not as parameter intensive and its hydrologic algorithm is based on well-known NRCS Curve Number, which can be varied as surface moisture changes. In addition, SWAT is capable of simulating the pollutants of concern in the Lake Bloomington Watershed, such as nitrogen and phosphorus. A SWAT model can be developed for the entire Lake Bloomington watershed, including the Money Creek drainage area. The SWAT model calculates flow and loads to be used in a water body model.

6.2.2 Water Body Model

The water body model has to be able to simulate pollutant fate and transport in Money Creek as well as eutrophication in Lake Bloomington. Because the river and lake are connected, it is more natural to simulate the river and lake as a whole system and predict the response to loads from both point and nonpoint sources. Water Quality Analysis Simulation Program (WASP) is selected to simulate the water quality for the Lake Bloomington if detailed modeling is selected. WASP is a dynamic compartment-modeling program for aquatic systems such as rivers, estuaries, and lakes, widely used throughout the United States for the development of TMDL and load allocations. WASP enables the 1-, 2-, or 3-D analysis of eutrophication and toxicants to meet the need to understand the water quality kinetics in the river and lake. The model includes the algorithms for simulating eutrophication and temperature. The time varying processes of advection, dispersion, point and diffuse mass loading and boundary exchange are represented in the model. WASP can be linked with a hydrodynamic model (such as CE-QUAL-W2 and EFDC) that can provide flows, depth, velocities, and temperature for lake circulation. The WASP model provides good temporal and spatial resolution, which is needed to represent the water quality variation within the two water bodies. With compartment segmentation, the WASP represents spatial nutrient gradient in the lake. It also accounts for seasonal variation in nutrient concentrations at various monitoring locations. The combination of the SWAT watershed model and the WASP water quality model not only provides the framework for TMDL development, but also has a potential to be enhanced into a management tool for Lake Bloomington.

6.3 MODEL CALIBRATION AND VALIDATION

Calibration involves minimizing the deviation between measured and simulated water quality indicators by adjusting model parameters. Data required for calibration include a set of known input values along with corresponding field observations. Although model calibration is critical, Tetra Tech believes that significant effort should be focused on sound source characterization and sensitivity analysis. A good characterization of source loadings results in a more efficient, scientifically sound, and justifiable calibration process. Tetra Tech will identify data sets for water quality calibration, identify model adjustment needs based on past experience, and work closely with IEPA to fully characterize sources and address calibration issues and their impacts on final TMDL allocations. The performance of model calibration will be assessed based on statistical methods and professional judgments.

Validation involves the use of a second set of independent information to check model calibration. Data used for model validation consist of field measurements of the same type as the data output from the model. Models are tested based on their predictions of mean values, variability, extreme values, and all predicted values. If the model is calibrated properly, model predictions should be acceptably close to field observations.

6.4 SENSITIVITY ANALYSIS

A thorough sensitivity analysis provides a number of benefits, including the following:

- Assistance on proper parameter selection
- Improved understanding of the model and related assumptions
- Evaluation of different TMDL scenarios
- Evaluation of model accuracy
- Justification of selection of Margin of Safety

The results of a sensitivity analysis will provide information regarding those parameters with the greatest effect on outputs. Tetra Tech will perform a sensitivity analysis on multiple model runs based on selected parameter range and load range. In addition to evaluating the sensitivity of the technical approach to the different sources, it is also important to estimate (either qualitatively or quantitatively) the accuracy or reliability of model predictions. This estimate of the model's accuracy will be an important factor in deciding how to use the model results in estimating the TMDL values.

An important step in the TMDL process is to evaluate the relative significance of the various source-loading estimates on model results. For example, potential sources of total phosphorus contributing to the impairment of the water body include municipal treatment plants, failing septic systems, livestock operations, and urban runoff. It will be important to evaluate the sensitivity of the model to loadings from each of these sources. For example, there is no known relationship that can be used to predict the contribution of failing septic systems to a stream. If the analysis indicates that the model is especially sensitive to this source, it might be necessary to revise the loading estimates to a daily or seasonal basis.

7.0 IDENTIFICATION OF DATA GAPS

TMDL development relies on pollutant- and site-specific data and sometimes it can become data intensive. Sufficient flow and water quality data are required to evaluate current water conditions and calibrate model parameters. To a certain degree, data availability dictates the modeling approach used for the Lake Bloomington watershed. Five types of data are crucial for the TMDL development:

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

The Lake Bloomington watershed has been studied extensively in the past. A considerable amount of climatic, hydrologic, and water quality data is available. In addition to the data included in this report, the following data and information are available for the TMDL development:

- Daily precipitation data in past 10-years from 6 rain gages
- Nitrate data from 30 subsurface tile outlets
- Nutrient Control Implementation Plan
- Stream Inventory for Money Creek and tributaries
- Phosphorus load from stream bank erosion
- Source Water Protection and Watershed Management Plan
- Watershed specific tillage information
- Lake Bloomington Clean Lakes Study Draft
- Continuous lake level data

These data meet the basic needs for developing a defensive and approvable TMDL for Lake Bloomington. The may also be useful for developing a calibrated, predictive hydrologic and watershed loading model as a management tools for the local stakeholders to track and monitor the effectiveness of an implementation plan.

Data gaps are mainly related to source characteristics. Obtaining these data does not always require on-site sampling; instead, coordination with local governments, agencies, and watershed groups may help in gathering of needed data. IEPA will be consulted to determine the efforts to be included as part of actual TMDL development. The following information and data will be obtained if possible.

- Septic tank investigation (distribution, upgrade, failure incidents)
- Drain tile data (existing condition, distribution, and density)
- Groundwater discharge and quality data
- Livestock assessment
- Wildlife assessment
- Channel geometry

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APPENDIX A
LIST OF CONTACTS

Organization	Contact Name	Phone Number or E-mail
McClean County SWCD	Jim Rutherford	(309) 452-0830 ext. 3
City of Bloomington Water	Jill Mayes	(309) 434-2153
City of Bloomington Water	Rick Twait	(309) 434-2150
IL State Water Survey	Laure Keefer	lkeefer@uiuc.edu
US Army Corps of Engineers	Brad Thompson	Bradley.e.thompson@usace.army.mil
McLean County Health Dept.	John Hendershott	john.hendershott@mcleancountyil.gov

APPENDIX B
PHOTOGRAPHIC LOG

Lake Bloomington Spillway

Money Creek near Sampling Site DKP01

Money Creek near DKP02

Lake Bloomington from Carver Road Bridge Looking North

Lake Bloomington from Carver Road Bridge Looking South

Filter Strip along Money Creek near Sampling Site DKP01

APPENDIX C
WATER QUALITY DATA

WB_ID	StationID	Date	Parameter	Sample Depth (ft)	Value	Units
RDO	RDO-1	6/16/1981	Chlorophyll a	7	1.87	ug/l
RDO	RDO-1	9/3/1981	Chlorophyll a	7	11.48	ug/l
RDO	RDO-1	6/1/1982	Chlorophyll a	3	10.65	ug/l
RDO	RDO-1	8/11/1982	Chlorophyll a	10	6.56	ug/l
RDO	RDO-1	5/5/1988	Chlorophyll a	5	19.54	ug/l
RDO	RDO-1	6/8/1988	Chlorophyll a	7	19.24	ug/l
RDO	RDO-1	7/12/1988	Chlorophyll a	6	18.31	ug/l
RDO	RDO-1	8/30/1988	Chlorophyll a	3	14.64	ug/l
RDO	RDO-1	10/19/1988	Chlorophyll a	4	31.56	ug/l
RDO	RDO-1	4/12/1990	Chlorophyll a	4	4.50	ug/l
RDO	RDO-1	6/11/1990	Chlorophyll a	8	13.91	ug/l
RDO	RDO-1	7/17/1990	Chlorophyll a	8	30.38	ug/l
RDO	RDO-1	8/21/1990	Chlorophyll a	6	29.37	ug/l
RDO	RDO-1	10/11/1990	Chlorophyll a	5	6.85	ug/l
RDO	RDO-1	4/22/1992	Chlorophyll a	8	21.17	ug/l
RDO	RDO-1	6/4/1992	Chlorophyll a	7	23.36	ug/l
RDO	RDO-1	7/8/1992	Chlorophyll a	7	8.90	ug/l
RDO	RDO-1	8/28/1992	Chlorophyll a	7	15.50	ug/l
RDO	RDO-1	10/20/1992	Chlorophyll a	6	27.42	ug/l
RDO	RDO-1	4/11/1995	Chlorophyll a	4	39.23	ug/l
RDO	RDO-1	4/11/1995	Chlorophyll a	6	56.07	ug/l
RDO	RDO-1	6/7/1995	Chlorophyll a	7	51.04	ug/l
RDO	RDO-1	7/5/1995	Chlorophyll a	6	29.67	ug/l
RDO	RDO-1	8/8/1995	Chlorophyll a	8	42.90	ug/l
RDO	RDO-1	10/4/1995	Chlorophyll a	6	27.17	ug/l
RDO	RDO-1	7/31/1997	Chlorophyll a	7	18.69	ug/l
RDO	RDO-1	9/5/1997	Chlorophyll a	6	14.24	ug/l
RDO	RDO-1	4/24/1998	Chlorophyll a	4	70.76	ug/l
RDO	RDO-1	5/19/1998	Chlorophyll a	6	41.83	ug/l
RDO	RDO-1	6/1/1998	Chlorophyll a	7	51.62	ug/l
RDO	RDO-1	6/24/1998	Chlorophyll a	5	36.49	ug/l
RDO	RDO-1	7/1/1998	Chlorophyll a	9	12.00	ug/l
RDO	RDO-1	7/23/1998	Chlorophyll a	8	22.70	ug/l
RDO	RDO-1	8/5/1998	Chlorophyll a	8	23.40	ug/l
RDO	RDO-1	10/15/1998	Chlorophyll a	5	12.00	ug/l
RDO	RDO-1	11/18/1998	Chlorophyll a	4	30.70	ug/l
RDO	RDO-1	6/28/1979	Chlorophyll a	14	13.00	ug/l
RDO	RDO-1	8/30/1979	Chlorophyll a	8	13.00	ug/l
RDO	RDO-1	5/20/1997	Chlorophyll a	8	4.67	ug/l
RDO	RDO-1	6/10/1997	Chlorophyll a	11	12.68	ug/l
RDO	RDO-1	4/30/2001	Chlorophyll a	1	87.60	ug/l
RDO	RDO-1	6/12/2001	Chlorophyll a	10	8.25	ug/l
RDO	RDO-1	6/14/2001	Chlorophyll a	14	12.80	ug/l
RDO	RDO-1	6/14/2001	Chlorophyll a	14	12.80	ug/l
RDO	RDO-1	7/16/2001	Chlorophyll a	10	12.80	ug/l
RDO	RDO-1	7/18/2001	Chlorophyll a	1	17.20	ug/l
RDO	RDO-1	8/6/2001	Chlorophyll a	8	8.58	ug/l
RDO	RDO-1	8/23/2001	Chlorophyll a	1	76.30	ug/l
RDO	RDO-1	10/9/2001	Chlorophyll a	1	13.10	ug/l

WB_ID	StationID	Date	Parameter	Sample Depth (ft)	Value	Units
RDO	RDO-3	8/8/1995	Phosphorus as P	1	0.06	mg/L
RDO	RDO-3	10/4/1995	Phosphorus as P	1	0.04	mg/L
RDO	RDO-3	4/24/1998	Phosphorus as P	1	0.05	mg/L
RDO	RDO-3	5/19/1998	Phosphorus as P	1	0.13	mg/L
RDO	RDO-3	6/1/1998	Phosphorus as P	1	0.03	mg/L
RDO	RDO-3	6/24/1998	Phosphorus as P	1	0.06	mg/L
RDO	RDO-3	7/1/1998	Phosphorus as P	1	0.04	mg/L
RDO	RDO-3	7/23/1998	Phosphorus as P	1	0.06	mg/L
RDO	RDO-3	8/5/1998	Phosphorus as P	1	0.07	mg/L
RDO	RDO-3	8/24/1998	Phosphorus as P	1	0.08	mg/L
RDO	RDO-3	9/16/1998	Phosphorus as P	1	0.11	mg/L
RDO	RDO-3	10/7/1998	Phosphorus as P	1	0.16	mg/L
RDO	RDO-3	10/15/1998	Phosphorus as P	1	0.12	mg/L
RDO	RDO-3	11/18/1998	Phosphorus as P	1	0.10	mg/L
RDO	RDO-3	6/16/1977	Phosphorus as P	0	0.04	mg/L
RDO	RDO-3	6/28/1979	Phosphorus as P	11	0.05	mg/L
RDO	RDO-3	4/30/2001	Phosphorus as P	1	0.011	mg/L
RDO	RDO-3	4/30/2001	Phosphorus as P	1	0.01	mg/L
RDO	RDO-3	4/30/2001	Phosphorus as P	1	0.09	mg/L
RDO	RDO-3	6/14/2001	Phosphorus as P	11	0.037	mg/L
RDO	RDO-3	6/14/2001	Phosphorus as P	11	0.04	mg/L
RDO	RDO-3	6/14/2001	Phosphorus as P	11	0.02	mg/L
RDO	RDO-3	7/18/2001	Phosphorus as P	5	0.026	mg/L
RDO	RDO-3	7/18/2001	Phosphorus as P	5	0.03	mg/L
RDO	RDO-3	7/18/2001	Phosphorus as P	5	0.04	mg/L
RDO	RDO-3	8/23/2001	Phosphorus as P	1	0.035	mg/L
RDO	RDO-3	8/23/2001	Phosphorus as P	1	0.04	mg/L
RDO	RDO-3	8/23/2001	Phosphorus as P	1	0.10	mg/L
RDO	RDO-3	10/9/2001	Phosphorus as P	1	0.044	mg/L
RDO	RDO-3	10/9/2001	Phosphorus as P	1	0.08	mg/L
RDO	RDO-3	10/9/2001	Phosphorus as P	1	0.04	mg/L

WB_ID	StationID	Date	Parameter	Sample Depth (ft)	Value	Units
RDO	RDO-2	8/5/1998	Phosphorus as P	1	0.04	mg/L
RDO	RDO-2	8/24/1998	Phosphorus as P	1	0.03	mg/L
RDO	RDO-2	10/7/1998	Phosphorus as P	19	0.09	mg/L
RDO	RDO-2	10/7/1998	Phosphorus as P	1	0.08	mg/L
RDO	RDO-2	10/15/1998	Phosphorus as P	1	0.06	mg/L
RDO	RDO-2	11/18/1998	Phosphorus as P	15	0.04	mg/L
RDO	RDO-2	11/18/1998	Phosphorus as P	1	0.08	mg/L
RDO	RDO-2	6/16/1977	Phosphorus as P	0	0.02	mg/L
RDO	RDO-2	6/28/1979	Phosphorus as P	24	0.04	mg/L
RDO	RDO-2	4/30/2001	Phosphorus as P	1	0.013	mg/L
RDO	RDO-2	4/30/2001	Phosphorus as P	1	0.01	mg/L
RDO	RDO-2	4/30/2001	Phosphorus as P	1	0.05	mg/L
RDO	RDO-2	6/14/2001	Phosphorus as P	11	0.024	mg/L
RDO	RDO-2	6/14/2001	Phosphorus as P	11	0.02	mg/L
RDO	RDO-2	6/14/2001	Phosphorus as P	11	0.02	mg/L
RDO	RDO-2	7/18/2001	Phosphorus as P	5	0.02	mg/L
RDO	RDO-2	7/18/2001	Phosphorus as P	5	0.02	mg/L
RDO	RDO-2	7/18/2001	Phosphorus as P	5	0.02	mg/L
RDO	RDO-2	8/23/2001	Phosphorus as P	1	0.014	mg/L
RDO	RDO-2	8/23/2001	Phosphorus as P	1	0.01	mg/L
RDO	RDO-2	8/23/2001	Phosphorus as P	1	0.07	mg/L
RDO	RDO-2	10/9/2001	Phosphorus as P	1	0.037	mg/L
RDO	RDO-2	10/9/2001	Phosphorus as P	1	0.07	mg/L
RDO	RDO-2	10/9/2001	Phosphorus as P	1	0.04	mg/L
RDO	RDO-3	6/28/1979	Phosphorus as P	1	0.02	mg/L
RDO	RDO-3	8/30/1979	Phosphorus as P	10	0.04	mg/L
RDO	RDO-3	8/30/1979	Phosphorus as P	1	0.03	mg/L
RDO	RDO-3	6/16/1981	Phosphorus as P	1	0.08	mg/L
RDO	RDO-3	9/3/1981	Phosphorus as P	1	0.05	mg/L
RDO	RDO-3	6/1/1982	Phosphorus as P	1	0.03	mg/L
RDO	RDO-3	8/11/1982	Phosphorus as P	1	0.04	mg/L
RDO	RDO-3	5/5/1988	Phosphorus as P	1	0.03	mg/L
RDO	RDO-3	6/8/1988	Phosphorus as P	1	0.04	mg/L
RDO	RDO-3	7/12/1988	Phosphorus as P	1	0.07	mg/L
RDO	RDO-3	8/30/1988	Phosphorus as P	1	0.13	mg/L
RDO	RDO-3	10/19/1988	Phosphorus as P	1	0.22	mg/L
RDO	RDO-3	4/12/1990	Phosphorus as P	1	0.10	mg/L
RDO	RDO-3	6/11/1990	Phosphorus as P	1	0.03	mg/L
RDO	RDO-3	7/17/1990	Phosphorus as P	1	0.04	mg/L
RDO	RDO-3	8/21/1990	Phosphorus as P	1	0.04	mg/L
RDO	RDO-3	10/11/1990	Phosphorus as P	1	0.41	mg/L
RDO	RDO-3	4/22/1992	Phosphorus as P	1	0.05	mg/L
RDO	RDO-3	6/4/1992	Phosphorus as P	1	0.06	mg/L
RDO	RDO-3	7/8/1992	Phosphorus as P	1	0.06	mg/L
RDO	RDO-3	8/28/1992	Phosphorus as P	1	0.06	mg/L
RDO	RDO-3	10/20/1992	Phosphorus as P	1	0.07	mg/L
RDO	RDO-3	4/11/1995	Phosphorus as P	1	0.04	mg/L
RDO	RDO-3	6/7/1995	Phosphorus as P	1	0.07	mg/L
RDO	RDO-3	7/5/1995	Phosphorus as P	1	0.06	mg/L

WB_ID	StationID	Date	Parameter	Sample Depth (ft)	Value	Units
RDO	RDO-1	10/9/2001	Phosphorus as P	6	0.045	mg/L
RDO	RDO-1	10/9/2001	Phosphorus as P	6	0.051	mg/L
RDO	RDO-1	10/9/2001	Phosphorus as P	6	0.044	mg/L
RDO	RDO-1	10/9/2001	Phosphorus as P	6	0.05	mg/L
RDO	RDO-1	10/9/2001	Phosphorus as P	6	0.07	mg/L
RDO	RDO-1	10/9/2001	Phosphorus as P	6	0.05	mg/L
RDO	RDO-1	10/9/2001	Phosphorus as P	6	0.07	mg/L
RDO	RDO-1	10/9/2001	Phosphorus as P	6	0.07	mg/L
RDO	RDO-1	10/9/2001	Phosphorus as P	6	0.04	mg/L
RDO	RDO-1	6/11/2003	Phosphorus as P	1	0.08	mg/L
RDO	RDO-1	7/17/2003	Phosphorus as P	1	0.09	mg/L
RDO	RDO-1	8/5/2003	Phosphorus as P	1	0.06	mg/L
RDO	RDO-2	6/28/1979	Phosphorus as P	1	0.02	mg/L
RDO	RDO-2	8/30/1979	Phosphorus as P	20	0.03	mg/L
RDO	RDO-2	8/30/1979	Phosphorus as P	1	0.01	mg/L
RDO	RDO-2	6/16/1981	Phosphorus as P	1	0.04	mg/L
RDO	RDO-2	9/3/1981	Phosphorus as P	1	0.02	mg/L
RDO	RDO-2	6/1/1982	Phosphorus as P	1	0.03	mg/L
RDO	RDO-2	8/11/1982	Phosphorus as P	1	0.03	mg/L
RDO	RDO-2	5/5/1988	Phosphorus as P	1	0.03	mg/L
RDO	RDO-2	6/8/1988	Phosphorus as P	1	0.03	mg/L
RDO	RDO-2	7/12/1988	Phosphorus as P	1	0.05	mg/L
RDO	RDO-2	8/30/1988	Phosphorus as P	1	0.11	mg/L
RDO	RDO-2	10/19/1988	Phosphorus as P	1	0.07	mg/L
RDO	RDO-2	4/12/1990	Phosphorus as P	1	0.13	mg/L
RDO	RDO-2	6/11/1990	Phosphorus as P	1	0.03	mg/L
RDO	RDO-2	7/17/1990	Phosphorus as P	1	0.03	mg/L
RDO	RDO-2	8/21/1990	Phosphorus as P	1	0.11	mg/L
RDO	RDO-2	10/11/1990	Phosphorus as P	1	0.05	mg/L
RDO	RDO-2	4/22/1992	Phosphorus as P	1	0.03	mg/L
RDO	RDO-2	6/4/1992	Phosphorus as P	1	0.02	mg/L
RDO	RDO-2	7/8/1992	Phosphorus as P	1	0.03	mg/L
RDO	RDO-2	8/28/1992	Phosphorus as P	1	0.03	mg/L
RDO	RDO-2	10/20/1992	Phosphorus as P	1	0.06	mg/L
RDO	RDO-2	4/11/1995	Phosphorus as P	1	0.06	mg/L
RDO	RDO-2	6/7/1995	Phosphorus as P	1	0.05	mg/L
RDO	RDO-2	7/5/1995	Phosphorus as P	1	0.04	mg/L
RDO	RDO-2	8/8/1995	Phosphorus as P	1	0.04	mg/L
RDO	RDO-2	10/4/1995	Phosphorus as P	1	0.05	mg/L
RDO	RDO-2	4/24/1998	Phosphorus as P	1	0.05	mg/L
RDO	RDO-2	5/19/1998	Phosphorus as P	23	0.19	mg/L
RDO	RDO-2	5/19/1998	Phosphorus as P	1	0.19	mg/L
RDO	RDO-2	6/1/1998	Phosphorus as P	22	0.09	mg/L
RDO	RDO-2	6/1/1998	Phosphorus as P	1	0.04	mg/L
RDO	RDO-2	6/24/1998	Phosphorus as P	1	0.04	mg/L
RDO	RDO-2	7/1/1998	Phosphorus as P	21	0.06	mg/L
RDO	RDO-2	7/1/1998	Phosphorus as P	1	0.04	mg/L
RDO	RDO-2	7/23/1998	Phosphorus as P	1	0.04	mg/L
RDO	RDO-2	8/5/1998	Phosphorus as P	21	0.03	mg/L

WB_ID	StationID	Date	Parameter	Sample Depth (ft)	Value	Units
RDO	RDO-1	8/24/1998	Phosphorus as P	15	0.04	mg/L
RDO	RDO-1	8/24/1998	Phosphorus as P	1	0.04	mg/L
RDO	RDO-1	10/7/1998	Phosphorus as P	25	0.06	mg/L
RDO	RDO-1	10/7/1998	Phosphorus as P	1	0.07	mg/L
RDO	RDO-1	10/15/1998	Phosphorus as P	23	0.18	mg/L
RDO	RDO-1	10/15/1998	Phosphorus as P	12	0.08	mg/L
RDO	RDO-1	10/15/1998	Phosphorus as P	1	0.06	mg/L
RDO	RDO-1	11/18/1998	Phosphorus as P	22	0.07	mg/L
RDO	RDO-1	11/18/1998	Phosphorus as P	1	0.06	mg/L
RDO	RDO-1	6/16/1977	Phosphorus as P	0	0.01	mg/L
RDO	RDO-1	6/28/1979	Phosphorus as P	28	0.03	mg/L
RDO	RDO-1	4/30/2001	Phosphorus as P	1	0.021	mg/L
RDO	RDO-1	4/30/2001	Phosphorus as P	1	0.016	mg/L
RDO	RDO-1	4/30/2001	Phosphorus as P	1	0.004	mg/L
RDO	RDO-1	4/30/2001	Phosphorus as P	1	0.08	mg/L
RDO	RDO-1	4/30/2001	Phosphorus as P	1	0.02	mg/L
RDO	RDO-1	4/30/2001	Phosphorus as P	1	0.06	mg/L
RDO	RDO-1	4/30/2001	Phosphorus as P	1	0.02	mg/L
RDO	RDO-1	4/30/2001	Phosphorus as P	1	0.05	mg/L
RDO	RDO-1	4/30/2001	Phosphorus as P	1	0.00	mg/L
RDO	RDO-1	5/29/2001	Phosphorus as P	1	0.03	mg/L
RDO	RDO-1	6/12/2001	Phosphorus as P	1	0.02	mg/L
RDO	RDO-1	6/14/2001	Phosphorus as P	11	0.029	mg/L
RDO	RDO-1	6/14/2001	Phosphorus as P	11	0.016	mg/L
RDO	RDO-1	6/14/2001	Phosphorus as P	11	0.01	mg/L
RDO	RDO-1	6/14/2001	Phosphorus as P	11	0.03	mg/L
RDO	RDO-1	6/14/2001	Phosphorus as P	11	0.03	mg/L
RDO	RDO-1	6/14/2001	Phosphorus as P	11	0.02	mg/L
RDO	RDO-1	6/14/2001	Phosphorus as P	11	0.02	mg/L
RDO	RDO-1	6/14/2001	Phosphorus as P	11	0.01	mg/L
RDO	RDO-1	6/14/2001	Phosphorus as P	11	0.03	mg/L
RDO	RDO-1	7/16/2001	Phosphorus as P	1	0.02	mg/L
RDO	RDO-1	7/18/2001	Phosphorus as P	5	0.021	mg/L
RDO	RDO-1	7/18/2001	Phosphorus as P	5	0.028	mg/L
RDO	RDO-1	7/18/2001	Phosphorus as P	5	0.02	mg/L
RDO	RDO-1	7/18/2001	Phosphorus as P	5	0.05	mg/L
RDO	RDO-1	7/18/2001	Phosphorus as P	5	0.05	mg/L
RDO	RDO-1	7/18/2001	Phosphorus as P	5	0.03	mg/L
RDO	RDO-1	8/6/2001	Phosphorus as P	1	0.02	mg/L
RDO	RDO-1	8/23/2001	Phosphorus as P	1	0.012	mg/L
RDO	RDO-1	8/23/2001	Phosphorus as P	1	0.011	mg/L
RDO	RDO-1	8/23/2001	Phosphorus as P	1	0.009	mg/L
RDO	RDO-1	8/23/2001	Phosphorus as P	1	0.01	mg/L
RDO	RDO-1	8/23/2001	Phosphorus as P	1	0.06	mg/L
RDO	RDO-1	8/23/2001	Phosphorus as P	1	0.01	mg/L
RDO	RDO-1	8/23/2001	Phosphorus as P	1	0.07	mg/L
RDO	RDO-1	8/23/2001	Phosphorus as P	1	0.05	mg/L
RDO	RDO-1	8/23/2001	Phosphorus as P	1	0.01	mg/L
RDO	RDO-1	9/11/2001	Phosphorus as P	1	0.07	mg/L

WB_ID	StationID	Date	Parameter	Sample Depth (ft)	Value	Units
RDO	RDO-1	6/11/1990	Phosphorus as P	1	0.03	mg/L
RDO	RDO-1	7/17/1990	Phosphorus as P	29	0.23	mg/L
RDO	RDO-1	7/17/1990	Phosphorus as P	1	0.02	mg/L
RDO	RDO-1	8/21/1990	Phosphorus as P	28	0.23	mg/L
RDO	RDO-1	8/21/1990	Phosphorus as P	1	0.13	mg/L
RDO	RDO-1	10/11/1990	Phosphorus as P	27	0.51	mg/L
RDO	RDO-1	10/11/1990	Phosphorus as P	1	0.15	mg/L
RDO	RDO-1	4/22/1992	Phosphorus as P	28	0.03	mg/L
RDO	RDO-1	4/22/1992	Phosphorus as P	1	0.03	mg/L
RDO	RDO-1	6/4/1992	Phosphorus as P	27	0.02	mg/L
RDO	RDO-1	6/4/1992	Phosphorus as P	1	0.03	mg/L
RDO	RDO-1	7/8/1992	Phosphorus as P	27	0.04	mg/L
RDO	RDO-1	7/8/1992	Phosphorus as P	1	0.03	mg/L
RDO	RDO-1	8/28/1992	Phosphorus as P	28	0.03	mg/L
RDO	RDO-1	8/28/1992	Phosphorus as P	1	0.03	mg/L
RDO	RDO-1	10/20/1992	Phosphorus as P	26	0.09	mg/L
RDO	RDO-1	10/20/1992	Phosphorus as P	1	0.04	mg/L
RDO	RDO-1	4/11/1995	Phosphorus as P	28	0.03	mg/L
RDO	RDO-1	4/11/1995	Phosphorus as P	1	0.02	mg/L
RDO	RDO-1	6/7/1995	Phosphorus as P	27	0.11	mg/L
RDO	RDO-1	6/7/1995	Phosphorus as P	1	0.06	mg/L
RDO	RDO-1	7/5/1995	Phosphorus as P	27	0.04	mg/L
RDO	RDO-1	7/5/1995	Phosphorus as P	1	0.04	mg/L
RDO	RDO-1	8/8/1995	Phosphorus as P	28	0.04	mg/L
RDO	RDO-1	8/8/1995	Phosphorus as P	1	0.04	mg/L
RDO	RDO-1	10/4/1995	Phosphorus as P	26	0.04	mg/L
RDO	RDO-1	10/4/1995	Phosphorus as P	1	0.04	mg/L
RDO	RDO-1	5/20/1997	Phosphorus as P	1	0.04	mg/L
RDO	RDO-1	6/10/1997	Phosphorus as P	1	0.01	mg/L
RDO	RDO-1	7/31/1997	Phosphorus as P	1	0.02	mg/L
RDO	RDO-1	9/5/1997	Phosphorus as P	1	0.06	mg/L
RDO	RDO-1	4/24/1998	Phosphorus as P	28	0.03	mg/L
RDO	RDO-1	4/24/1998	Phosphorus as P	15	0.05	mg/L
RDO	RDO-1	4/24/1998	Phosphorus as P	1	0.05	mg/L
RDO	RDO-1	5/19/1998	Phosphorus as P	29	0.19	mg/L
RDO	RDO-1	5/19/1998	Phosphorus as P	1	0.18	mg/L
RDO	RDO-1	6/1/1998	Phosphorus as P	28	0.18	mg/L
RDO	RDO-1	6/1/1998	Phosphorus as P	1	0.05	mg/L
RDO	RDO-1	6/24/1998	Phosphorus as P	28	0.16	mg/L
RDO	RDO-1	6/24/1998	Phosphorus as P	15	0.03	mg/L
RDO	RDO-1	6/24/1998	Phosphorus as P	1	0.04	mg/L
RDO	RDO-1	7/1/1998	Phosphorus as P	27	0.23	mg/L
RDO	RDO-1	7/1/1998	Phosphorus as P	1	0.03	mg/L
RDO	RDO-1	7/23/1998	Phosphorus as P	28	0.04	mg/L
RDO	RDO-1	7/23/1998	Phosphorus as P	1	0.03	mg/L
RDO	RDO-1	7/23/1998	Phosphorus as P	15	0.04	mg/L
RDO	RDO-1	8/5/1998	Phosphorus as P	27	0.06	mg/L
RDO	RDO-1	8/5/1998	Phosphorus as P	1	0.04	mg/L
RDO	RDO-1	8/24/1998	Phosphorus as P	27	0.07	mg/L

WB_ID	StationID	Date	Parameter	Sample Depth (ft)	Value	Units
RDO	RDO-3	10/20/1992	Nitrogen, Nitrite (NO2) + Ni	1	3.10	mg/L
RDO	RDO-3	4/11/1995	Nitrogen, Nitrite (NO2) + Ni	1	10.00	mg/L
RDO	RDO-3	6/7/1995	Nitrogen, Nitrite (NO2) + Ni	1	13.40	mg/L
RDO	RDO-3	7/5/1995	Nitrogen, Nitrite (NO2) + Ni	1	10.40	mg/L
RDO	RDO-3	8/8/1995	Nitrogen, Nitrite (NO2) + Ni	1	5.90	mg/L
RDO	RDO-3	10/4/1995	Nitrogen, Nitrite (NO2) + Ni	1	2.40	mg/L
RDO	RDO-3	4/24/1998	Nitrogen, Nitrite (NO2) + Ni	1	15.20	mg/L
RDO	RDO-3	5/19/1998	Nitrogen, Nitrite (NO2) + Ni	1	14.40	mg/L
RDO	RDO-3	6/1/1998	Nitrogen, Nitrite (NO2) + Ni	1	12.71	mg/L
RDO	RDO-3	6/24/1998	Nitrogen, Nitrite (NO2) + Ni	1	12.72	mg/L
RDO	RDO-3	7/1/1998	Nitrogen, Nitrite (NO2) + Ni	1	13.28	mg/L
RDO	RDO-3	7/23/1998	Nitrogen, Nitrite (NO2) + Ni	1	10.30	mg/L
RDO	RDO-3	8/5/1998	Nitrogen, Nitrite (NO2) + Ni	1	7.06	mg/L
RDO	RDO-3	8/24/1998	Nitrogen, Nitrite (NO2) + Ni	1	5.03	mg/L
RDO	RDO-3	9/16/1998	Nitrogen, Nitrite (NO2) + Ni	1	2.81	mg/L
RDO	RDO-3	10/7/1998	Nitrogen, Nitrite (NO2) + Ni	1	1.46	mg/L
RDO	RDO-3	10/15/1998	Nitrogen, Nitrite (NO2) + Ni	1	1.81	mg/L
RDO	RDO-3	11/18/1998	Nitrogen, Nitrite (NO2) + Ni	1	1.06	mg/L
RDO	RDO-3	6/16/1977	Nitrogen, Nitrite (NO2) + Ni	0	6.40	mg/L
RDO	RDO-3	6/28/1979	Nitrogen, Nitrite (NO2) + Ni	11	10.00	mg/L
RDO	RDO-3	4/30/2001	Nitrogen, Nitrite (NO2) + Ni	1	12.00	mg/L
RDO	RDO-3	6/14/2001	Nitrogen, Nitrite (NO2) + Ni	11	15.00	mg/L
RDO	RDO-3	7/18/2001	Nitrogen, Nitrite (NO2) + Ni	5	7.70	mg/L
RDO	RDO-3	8/23/2001	Nitrogen, Nitrite (NO2) + Ni	1	3.30	mg/L
RDO	RDO-3	10/9/2001	Nitrogen, Nitrite (NO2) + Ni	1	0.83	mg/L
RDO	RDO-1	6/28/1979	Phosphorus as P	1	0.04	mg/L
RDO	RDO-1	8/30/1979	Phosphorus as P	28	0.05	mg/L
RDO	RDO-1	8/30/1979	Phosphorus as P	1	0.02	mg/L
RDO	RDO-1	6/16/1981	Phosphorus as P	29	0.04	mg/L
RDO	RDO-1	6/16/1981	Phosphorus as P	1	0.02	mg/L
RDO	RDO-1	9/3/1981	Phosphorus as P	30	0.20	mg/L
RDO	RDO-1	9/3/1981	Phosphorus as P	1	0.01	mg/L
RDO	RDO-1	6/1/1982	Phosphorus as P	29	0.03	mg/L
RDO	RDO-1	6/1/1982	Phosphorus as P	1	0.03	mg/L
RDO	RDO-1	8/11/1982	Phosphorus as P	28	0.03	mg/L
RDO	RDO-1	8/11/1982	Phosphorus as P	1	0.01	mg/L
RDO	RDO-1	5/5/1988	Phosphorus as P	29	0.03	mg/L
RDO	RDO-1	5/5/1988	Phosphorus as P	1	0.03	mg/L
RDO	RDO-1	6/8/1988	Phosphorus as P	27	0.03	mg/L
RDO	RDO-1	6/8/1988	Phosphorus as P	1	0.02	mg/L
RDO	RDO-1	7/12/1988	Phosphorus as P	24	0.05	mg/L
RDO	RDO-1	7/12/1988	Phosphorus as P	1	0.04	mg/L
RDO	RDO-1	8/30/1988	Phosphorus as P	19	0.07	mg/L
RDO	RDO-1	8/30/1988	Phosphorus as P	1	0.06	mg/L
RDO	RDO-1	10/19/1988	Phosphorus as P	15	0.06	mg/L
RDO	RDO-1	10/19/1988	Phosphorus as P	1	0.07	mg/L
RDO	RDO-1	4/12/1990	Phosphorus as P	28	0.14	mg/L
RDO	RDO-1	4/12/1990	Phosphorus as P	1	0.14	mg/L
RDO	RDO-1	6/11/1990	Phosphorus as P	28	0.03	mg/L

WB_ID	StationID	Date	Parameter	Sample Depth (ft)	Value	Units
RDO	RDO-2	6/7/1995	Nitrogen, Nitrite (NO2) + Ni	1	12.00	mg/L
RDO	RDO-2	7/5/1995	Nitrogen, Nitrite (NO2) + Ni	1	11.10	mg/L
RDO	RDO-2	8/8/1995	Nitrogen, Nitrite (NO2) + Ni	1	7.30	mg/L
RDO	RDO-2	10/4/1995	Nitrogen, Nitrite (NO2) + Ni	1	2.70	mg/L
RDO	RDO-2	4/24/1998	Nitrogen, Nitrite (NO2) + Ni	1	14.15	mg/L
RDO	RDO-2	5/19/1998	Nitrogen, Nitrite (NO2) + Ni	23	12.01	mg/L
RDO	RDO-2	5/19/1998	Nitrogen, Nitrite (NO2) + Ni	1	12.44	mg/L
RDO	RDO-2	6/1/1998	Nitrogen, Nitrite (NO2) + Ni	22	11.52	mg/L
RDO	RDO-2	6/1/1998	Nitrogen, Nitrite (NO2) + Ni	1	11.94	mg/L
RDO	RDO-2	6/24/1998	Nitrogen, Nitrite (NO2) + Ni	1	11.08	mg/L
RDO	RDO-2	7/1/1998	Nitrogen, Nitrite (NO2) + Ni	21	9.44	mg/L
RDO	RDO-2	7/1/1998	Nitrogen, Nitrite (NO2) + Ni	1	12.13	mg/L
RDO	RDO-2	7/23/1998	Nitrogen, Nitrite (NO2) + Ni	1	11.04	mg/L
RDO	RDO-2	8/5/1998	Nitrogen, Nitrite (NO2) + Ni	21	9.15	mg/L
RDO	RDO-2	8/5/1998	Nitrogen, Nitrite (NO2) + Ni	1	7.83	mg/L
RDO	RDO-2	8/24/1998	Nitrogen, Nitrite (NO2) + Ni	1	7.12	mg/L
RDO	RDO-2	10/7/1998	Nitrogen, Nitrite (NO2) + Ni	19	2.38	mg/L
RDO	RDO-2	10/7/1998	Nitrogen, Nitrite (NO2) + Ni	1	2.67	mg/L
RDO	RDO-2	10/15/1998	Nitrogen, Nitrite (NO2) + Ni	1	2.47	mg/L
RDO	RDO-2	11/18/1998	Nitrogen, Nitrite (NO2) + Ni	15	1.53	mg/L
RDO	RDO-2	11/18/1998	Nitrogen, Nitrite (NO2) + Ni	1	1.54	mg/L
RDO	RDO-2	6/16/1977	Nitrogen, Nitrite (NO2) + Ni	0	6.00	mg/L
RDO	RDO-2	6/28/1979	Nitrogen, Nitrite (NO2) + Ni	24	10.00	mg/L
RDO	RDO-2	4/30/2001	Nitrogen, Nitrite (NO2) + Ni	1	12.00	mg/L
RDO	RDO-2	6/14/2001	Nitrogen, Nitrite (NO2) + Ni	11	12.00	mg/L
RDO	RDO-2	7/18/2001	Nitrogen, Nitrite (NO2) + Ni	5	8.30	mg/L
RDO	RDO-2	8/23/2001	Nitrogen, Nitrite (NO2) + Ni	1	4.30	mg/L
RDO	RDO-2	10/9/2001	Nitrogen, Nitrite (NO2) + Ni	1	1.18	mg/L
RDO	RDO-3	6/28/1979	Nitrogen, Nitrite (NO2) + Ni	1	10.00	mg/L
RDO	RDO-3	8/30/1979	Nitrogen, Nitrite (NO2) + Ni	10	4.60	mg/L
RDO	RDO-3	8/30/1979	Nitrogen, Nitrite (NO2) + Ni	1	4.90	mg/L
RDO	RDO-3	6/16/1981	Nitrogen, Nitrite (NO2) + Ni	1	18.00	mg/L
RDO	RDO-3	9/3/1981	Nitrogen, Nitrite (NO2) + Ni	1	8.50	mg/L
RDO	RDO-3	6/1/1982	Nitrogen, Nitrite (NO2) + Ni	1	12.20	mg/L
RDO	RDO-3	8/11/1982	Nitrogen, Nitrite (NO2) + Ni	1	9.80	mg/L
RDO	RDO-3	5/5/1988	Nitrogen, Nitrite (NO2) + Ni	1	11.00	mg/L
RDO	RDO-3	6/8/1988	Nitrogen, Nitrite (NO2) + Ni	1	6.80	mg/L
RDO	RDO-3	7/12/1988	Nitrogen, Nitrite (NO2) + Ni	1	2.70	mg/L
RDO	RDO-3	8/30/1988	Nitrogen, Nitrite (NO2) + Ni	1	0.63	mg/L
RDO	RDO-3	10/19/1988	Nitrogen, Nitrite (NO2) + Ni	1	0.12	mg/L
RDO	RDO-3	4/12/1990	Nitrogen, Nitrite (NO2) + Ni	1	16.00	mg/L
RDO	RDO-3	6/11/1990	Nitrogen, Nitrite (NO2) + Ni	1	16.00	mg/L
RDO	RDO-3	7/17/1990	Nitrogen, Nitrite (NO2) + Ni	1	14.00	mg/L
RDO	RDO-3	8/21/1990	Nitrogen, Nitrite (NO2) + Ni	1	9.00	mg/L
RDO	RDO-3	10/11/1990	Nitrogen, Nitrite (NO2) + Ni	1	5.40	mg/L
RDO	RDO-3	4/22/1992	Nitrogen, Nitrite (NO2) + Ni	1	12.00	mg/L
RDO	RDO-3	6/4/1992	Nitrogen, Nitrite (NO2) + Ni	1	9.80	mg/L
RDO	RDO-3	7/8/1992	Nitrogen, Nitrite (NO2) + Ni	1	4.30	mg/L
RDO	RDO-3	8/28/1992	Nitrogen, Nitrite (NO2) + Ni	1	7.50	mg/L

WB_ID	StationID	Date	Parameter	Sample Depth (ft)	Value	Units
RDO	RDO-1	11/18/1998	Nitrogen, Nitrite (NO2) + Ni	1	1.61	mg/L
RDO	RDO-1	6/16/1977	Nitrogen, Nitrite (NO2) + Ni	0	6.00	mg/L
RDO	RDO-1	6/28/1979	Nitrogen, Nitrite (NO2) + Ni	28	7.20	mg/L
RDO	RDO-1	6/28/1979	Nitrogen, Nitrite (NO2) + Ni	1	10.00	mg/L
RDO	RDO-1	4/30/2001	Nitrogen, Nitrite (NO2) + Ni	1	11.00	mg/L
RDO	RDO-1	4/30/2001	Nitrogen, Nitrite (NO2) + Ni	1	11.00	mg/L
RDO	RDO-1	4/30/2001	Nitrogen, Nitrite (NO2) + Ni	1	11.00	mg/L
RDO	RDO-1	5/29/2001	Nitrogen, Nitrite (NO2) + Ni	1	11.00	mg/L
RDO	RDO-1	6/12/2001	Nitrogen, Nitrite (NO2) + Ni	1	11.00	mg/L
RDO	RDO-1	6/14/2001	Nitrogen, Nitrite (NO2) + Ni	11	11.00	mg/L
RDO	RDO-1	6/14/2001	Nitrogen, Nitrite (NO2) + Ni	11	11.00	mg/L
RDO	RDO-1	6/14/2001	Nitrogen, Nitrite (NO2) + Ni	11	11.00	mg/L
RDO	RDO-1	7/16/2001	Nitrogen, Nitrite (NO2) + Ni	1	9.20	mg/L
RDO	RDO-1	7/18/2001	Nitrogen, Nitrite (NO2) + Ni	5	7.70	mg/L
RDO	RDO-1	7/18/2001	Nitrogen, Nitrite (NO2) + Ni	5	6.90	mg/L
RDO	RDO-1	8/6/2001	Nitrogen, Nitrite (NO2) + Ni	1	6.80	mg/L
RDO	RDO-1	8/23/2001	Nitrogen, Nitrite (NO2) + Ni	1	4.60	mg/L
RDO	RDO-1	8/23/2001	Nitrogen, Nitrite (NO2) + Ni	1	4.30	mg/L
RDO	RDO-1	8/23/2001	Nitrogen, Nitrite (NO2) + Ni	1	4.50	mg/L
RDO	RDO-1	9/11/2001	Nitrogen, Nitrite (NO2) + Ni	1	2.50	mg/L
RDO	RDO-1	10/9/2001	Nitrogen, Nitrite (NO2) + Ni	6	1.16	mg/L
RDO	RDO-1	10/9/2001	Nitrogen, Nitrite (NO2) + Ni	6	1.12	mg/L
RDO	RDO-1	10/9/2001	Nitrogen, Nitrite (NO2) + Ni	6		mg/L
RDO	RDO-1	6/11/2003	Nitrogen, Nitrite (NO2) + Ni	1	4.26	mg/L
RDO	RDO-1	7/17/2003	Nitrogen, Nitrite (NO2) + Ni	1	2.39	mg/L
RDO	RDO-1	8/5/2003	Nitrogen, Nitrite (NO2) + Ni	1	2.85	mg/L
RDO	RDO-2	6/28/1979	Nitrogen, Nitrite (NO2) + Ni	1	11.00	mg/L
RDO	RDO-2	8/30/1979	Nitrogen, Nitrite (NO2) + Ni	20	4.50	mg/L
RDO	RDO-2	8/30/1979	Nitrogen, Nitrite (NO2) + Ni	1	5.80	mg/L
RDO	RDO-2	6/16/1981	Nitrogen, Nitrite (NO2) + Ni	1	19.00	mg/L
RDO	RDO-2	9/3/1981	Nitrogen, Nitrite (NO2) + Ni	1	8.20	mg/L
RDO	RDO-2	6/1/1982	Nitrogen, Nitrite (NO2) + Ni	1	12.00	mg/L
RDO	RDO-2	8/11/1982	Nitrogen, Nitrite (NO2) + Ni	1	11.00	mg/L
RDO	RDO-2	5/5/1988	Nitrogen, Nitrite (NO2) + Ni	1	9.60	mg/L
RDO	RDO-2	6/8/1988	Nitrogen, Nitrite (NO2) + Ni	1	7.40	mg/L
RDO	RDO-2	7/12/1988	Nitrogen, Nitrite (NO2) + Ni	1	3.40	mg/L
RDO	RDO-2	8/30/1988	Nitrogen, Nitrite (NO2) + Ni	1	1.00	mg/L
RDO	RDO-2	10/19/1988	Nitrogen, Nitrite (NO2) + Ni	1	0.23	mg/L
RDO	RDO-2	4/12/1990	Nitrogen, Nitrite (NO2) + Ni	1	14.00	mg/L
RDO	RDO-2	6/11/1990	Nitrogen, Nitrite (NO2) + Ni	1	15.00	mg/L
RDO	RDO-2	7/17/1990	Nitrogen, Nitrite (NO2) + Ni	1	15.00	mg/L
RDO	RDO-2	8/21/1990	Nitrogen, Nitrite (NO2) + Ni	1	11.00	mg/L
RDO	RDO-2	10/11/1990	Nitrogen, Nitrite (NO2) + Ni	1	6.30	mg/L
RDO	RDO-2	4/22/1992	Nitrogen, Nitrite (NO2) + Ni	1	12.00	mg/L
RDO	RDO-2	6/4/1992	Nitrogen, Nitrite (NO2) + Ni	1	10.00	mg/L
RDO	RDO-2	7/8/1992	Nitrogen, Nitrite (NO2) + Ni	1	5.10	mg/L
RDO	RDO-2	8/28/1992	Nitrogen, Nitrite (NO2) + Ni	1	7.70	mg/L
RDO	RDO-2	10/20/1992	Nitrogen, Nitrite (NO2) + Ni	1	3.70	mg/L
RDO	RDO-2	4/11/1995	Nitrogen, Nitrite (NO2) + Ni	1	8.70	mg/L

WB_ID	StationID	Date	Parameter	Sample Depth (ft)	Value	Units
RDO	RDO-1	4/22/1992	Nitrogen, Nitrite (NO2) + Ni	1	11.00	mg/L
RDO	RDO-1	6/4/1992	Nitrogen, Nitrite (NO2) + Ni	27	10.00	mg/L
RDO	RDO-1	6/4/1992	Nitrogen, Nitrite (NO2) + Ni	1	11.00	mg/L
RDO	RDO-1	7/8/1992	Nitrogen, Nitrite (NO2) + Ni	27	5.40	mg/L
RDO	RDO-1	7/8/1992	Nitrogen, Nitrite (NO2) + Ni	1	5.90	mg/L
RDO	RDO-1	8/28/1992	Nitrogen, Nitrite (NO2) + Ni	28	6.00	mg/L
RDO	RDO-1	8/28/1992	Nitrogen, Nitrite (NO2) + Ni	1	7.80	mg/L
RDO	RDO-1	10/20/1992	Nitrogen, Nitrite (NO2) + Ni	26	3.70	mg/L
RDO	RDO-1	10/20/1992	Nitrogen, Nitrite (NO2) + Ni	1	3.80	mg/L
RDO	RDO-1	4/11/1995	Nitrogen, Nitrite (NO2) + Ni	28	8.30	mg/L
RDO	RDO-1	4/11/1995	Nitrogen, Nitrite (NO2) + Ni	1	8.10	mg/L
RDO	RDO-1	6/7/1995	Nitrogen, Nitrite (NO2) + Ni	27	11.80	mg/L
RDO	RDO-1	6/7/1995	Nitrogen, Nitrite (NO2) + Ni	1	11.60	mg/L
RDO	RDO-1	7/5/1995	Nitrogen, Nitrite (NO2) + Ni	27	10.50	mg/L
RDO	RDO-1	7/5/1995	Nitrogen, Nitrite (NO2) + Ni	1	11.20	mg/L
RDO	RDO-1	8/8/1995	Nitrogen, Nitrite (NO2) + Ni	28	7.00	mg/L
RDO	RDO-1	8/8/1995	Nitrogen, Nitrite (NO2) + Ni	1	7.40	mg/L
RDO	RDO-1	10/4/1995	Nitrogen, Nitrite (NO2) + Ni	26	2.80	mg/L
RDO	RDO-1	10/4/1995	Nitrogen, Nitrite (NO2) + Ni	1	2.80	mg/L
RDO	RDO-1	5/20/1997	Nitrogen, Nitrite (NO2) + Ni	1	7.40	mg/L
RDO	RDO-1	6/10/1997	Nitrogen, Nitrite (NO2) + Ni	1	6.50	mg/L
RDO	RDO-1	7/31/1997	Nitrogen, Nitrite (NO2) + Ni	1	3.70	mg/L
RDO	RDO-1	9/5/1997	Nitrogen, Nitrite (NO2) + Ni	1	0.99	mg/L
RDO	RDO-1	4/24/1998	Nitrogen, Nitrite (NO2) + Ni	28	14.08	mg/L
RDO	RDO-1	4/24/1998	Nitrogen, Nitrite (NO2) + Ni	15	13.83	mg/L
RDO	RDO-1	4/24/1998	Nitrogen, Nitrite (NO2) + Ni	1	13.80	mg/L
RDO	RDO-1	5/19/1998	Nitrogen, Nitrite (NO2) + Ni	29	9.11	mg/L
RDO	RDO-1	5/19/1998	Nitrogen, Nitrite (NO2) + Ni	1	12.19	mg/L
RDO	RDO-1	6/1/1998	Nitrogen, Nitrite (NO2) + Ni	28	8.99	mg/L
RDO	RDO-1	6/1/1998	Nitrogen, Nitrite (NO2) + Ni	1	12.06	mg/L
RDO	RDO-1	6/24/1998	Nitrogen, Nitrite (NO2) + Ni	28	8.04	mg/L
RDO	RDO-1	6/24/1998	Nitrogen, Nitrite (NO2) + Ni	1	10.99	mg/L
RDO	RDO-1	6/24/1998	Nitrogen, Nitrite (NO2) + Ni	15	11.19	mg/L
RDO	RDO-1	7/1/1998	Nitrogen, Nitrite (NO2) + Ni	27	7.20	mg/L
RDO	RDO-1	7/1/1998	Nitrogen, Nitrite (NO2) + Ni	1	12.03	mg/L
RDO	RDO-1	7/23/1998	Nitrogen, Nitrite (NO2) + Ni	28	11.09	mg/L
RDO	RDO-1	7/23/1998	Nitrogen, Nitrite (NO2) + Ni	15	10.82	mg/L
RDO	RDO-1	7/23/1998	Nitrogen, Nitrite (NO2) + Ni	1	11.12	mg/L
RDO	RDO-1	8/5/1998	Nitrogen, Nitrite (NO2) + Ni	27	2.19	mg/L
RDO	RDO-1	8/5/1998	Nitrogen, Nitrite (NO2) + Ni	1	9.31	mg/L
RDO	RDO-1	8/24/1998	Nitrogen, Nitrite (NO2) + Ni	27	2.49	mg/L
RDO	RDO-1	8/24/1998	Nitrogen, Nitrite (NO2) + Ni	15	7.07	mg/L
RDO	RDO-1	8/24/1998	Nitrogen, Nitrite (NO2) + Ni	1	7.33	mg/L
RDO	RDO-1	10/7/1998	Nitrogen, Nitrite (NO2) + Ni	25	2.65	mg/L
RDO	RDO-1	10/7/1998	Nitrogen, Nitrite (NO2) + Ni	1	2.73	mg/L
RDO	RDO-1	10/15/1998	Nitrogen, Nitrite (NO2) + Ni	23	2.46	mg/L
RDO	RDO-1	10/15/1998	Nitrogen, Nitrite (NO2) + Ni	1	2.50	mg/L
RDO	RDO-1	10/15/1998	Nitrogen, Nitrite (NO2) + Ni	12	2.47	mg/L
RDO	RDO-1	11/18/1998	Nitrogen, Nitrite (NO2) + Ni	22	1.58	mg/L

WB_ID	StationID	Date	Parameter	Sample Depth (ft)	Value	Units
RDO	RDO-3	10/11/1990	Dissolved Phosphorus	1	3.30E-01	mg/L
RDO	RDO-3	4/22/1992	Dissolved Phosphorus	1	8.00E-03	mg/L
RDO	RDO-3	6/4/1992	Dissolved Phosphorus	1	9.00E-03	mg/L
RDO	RDO-3	7/8/1992	Dissolved Phosphorus	1	1.00E-02	mg/L
RDO	RDO-3	8/28/1992	Dissolved Phosphorus	1	1.10E-02	mg/L
RDO	RDO-3	10/20/1992	Dissolved Phosphorus	1	1.70E-02	mg/L
RDO	RDO-3	4/11/1995	Dissolved Phosphorus	1	1.00E-03	mg/L
RDO	RDO-3	6/7/1995	Dissolved Phosphorus	1	1.20E-02	mg/L
RDO	RDO-3	7/5/1995	Dissolved Phosphorus	1	5.00E-03	mg/L
RDO	RDO-3	8/8/1995	Dissolved Phosphorus	1	1.10E-02	mg/L
RDO	RDO-3	10/4/1995	Dissolved Phosphorus	1	7.00E-03	mg/L
RDO	RDO-3	4/24/1998	Dissolved Phosphorus	1	3.00E-03	mg/L
RDO	RDO-3	6/24/1998	Dissolved Phosphorus	1	8.00E-03	mg/L
RDO	RDO-3	7/23/1998	Dissolved Phosphorus	1	8.00E-03	mg/L
RDO	RDO-3	8/24/1998	Dissolved Phosphorus	1	8.00E-03	mg/L
RDO	RDO-3	10/15/1998	Dissolved Phosphorus	1	2.50E-02	mg/L
RDO	RDO-3	6/28/1979	Dissolved Phosphorus	11	1.00E-02	mg/L
RDO	RDO-3	6/28/1979	Dissolved Phosphorus	1	1.00E-02	mg/L
RDO	RDO-1	8/30/1979	Nitrogen, Nitrite (NO2) + Ni	28	1.10	mg/L
RDO	RDO-1	8/30/1979	Nitrogen, Nitrite (NO2) + Ni	1	6.00	mg/L
RDO	RDO-1	6/16/1981	Nitrogen, Nitrite (NO2) + Ni	29	15.00	mg/L
RDO	RDO-1	6/16/1981	Nitrogen, Nitrite (NO2) + Ni	1	17.00	mg/L
RDO	RDO-1	9/3/1981	Nitrogen, Nitrite (NO2) + Ni	30	4.60	mg/L
RDO	RDO-1	9/3/1981	Nitrogen, Nitrite (NO2) + Ni	1	7.80	mg/L
RDO	RDO-1	6/1/1982	Nitrogen, Nitrite (NO2) + Ni	29	11.20	mg/L
RDO	RDO-1	6/1/1982	Nitrogen, Nitrite (NO2) + Ni	1	11.70	mg/L
RDO	RDO-1	8/11/1982	Nitrogen, Nitrite (NO2) + Ni	28	4.00	mg/L
RDO	RDO-1	8/11/1982	Nitrogen, Nitrite (NO2) + Ni	1	11.00	mg/L
RDO	RDO-1	5/5/1988	Nitrogen, Nitrite (NO2) + Ni	29	8.60	mg/L
RDO	RDO-1	5/5/1988	Nitrogen, Nitrite (NO2) + Ni	1	9.00	mg/L
RDO	RDO-1	6/8/1988	Nitrogen, Nitrite (NO2) + Ni	27	6.90	mg/L
RDO	RDO-1	6/8/1988	Nitrogen, Nitrite (NO2) + Ni	1	8.30	mg/L
RDO	RDO-1	7/12/1988	Nitrogen, Nitrite (NO2) + Ni	24	2.00	mg/L
RDO	RDO-1	7/12/1988	Nitrogen, Nitrite (NO2) + Ni	1	4.00	mg/L
RDO	RDO-1	8/30/1988	Nitrogen, Nitrite (NO2) + Ni	19	1.10	mg/L
RDO	RDO-1	8/30/1988	Nitrogen, Nitrite (NO2) + Ni	1	1.10	mg/L
RDO	RDO-1	10/19/1988	Nitrogen, Nitrite (NO2) + Ni	15	0.25	mg/L
RDO	RDO-1	10/19/1988	Nitrogen, Nitrite (NO2) + Ni	1	0.26	mg/L
RDO	RDO-1	4/12/1990	Nitrogen, Nitrite (NO2) + Ni	28	14.00	mg/L
RDO	RDO-1	4/12/1990	Nitrogen, Nitrite (NO2) + Ni	1	14.00	mg/L
RDO	RDO-1	6/11/1990	Nitrogen, Nitrite (NO2) + Ni	28	15.00	mg/L
RDO	RDO-1	6/11/1990	Nitrogen, Nitrite (NO2) + Ni	1	15.00	mg/L
RDO	RDO-1	7/17/1990	Nitrogen, Nitrite (NO2) + Ni	29	12.00	mg/L
RDO	RDO-1	7/17/1990	Nitrogen, Nitrite (NO2) + Ni	1	12.00	mg/L
RDO	RDO-1	8/21/1990	Nitrogen, Nitrite (NO2) + Ni	28	12.00	mg/L
RDO	RDO-1	8/21/1990	Nitrogen, Nitrite (NO2) + Ni	1	10.00	mg/L
RDO	RDO-1	10/11/1990	Nitrogen, Nitrite (NO2) + Ni	27	6.20	mg/L
RDO	RDO-1	10/11/1990	Nitrogen, Nitrite (NO2) + Ni	1	6.50	mg/L
RDO	RDO-1	4/22/1992	Nitrogen, Nitrite (NO2) + Ni	28	12.00	mg/L

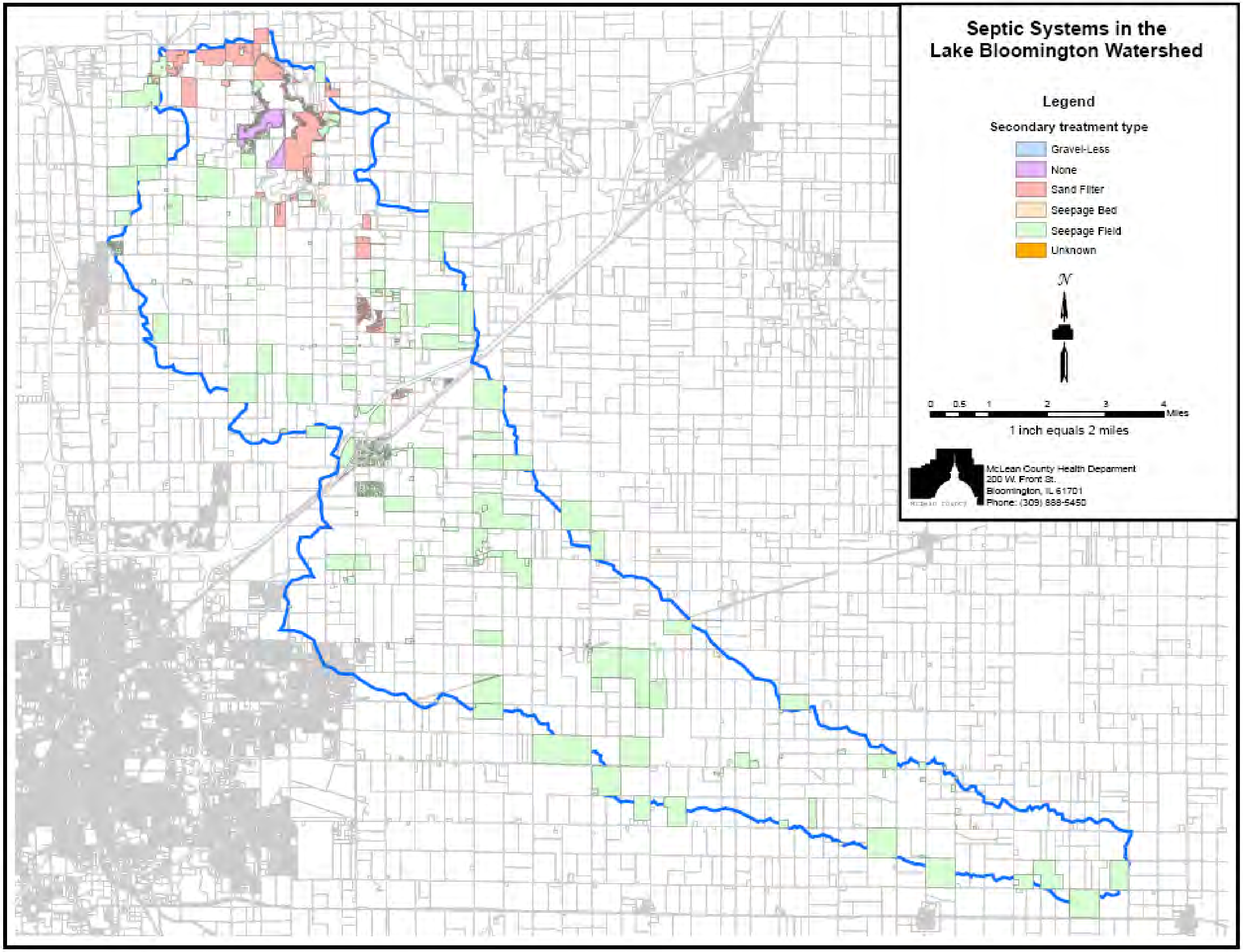
WB_ID	StationID	Date	Parameter	Sample Depth (ft)	Value	Units
RDO	RDO-1	6/28/1979	Dissolved Phosphorus	1	4.00E-02	mg/L
RDO	RDO-2	8/30/1979	Dissolved Phosphorus	20	1.00E-02	mg/L
RDO	RDO-2	8/30/1979	Dissolved Phosphorus	1	1.00E-02	mg/L
RDO	RDO-2	6/16/1981	Dissolved Phosphorus	1	0.00E+00	mg/L
RDO	RDO-2	9/3/1981	Dissolved Phosphorus	1	0.00E+00	mg/L
RDO	RDO-2	6/1/1982	Dissolved Phosphorus	1	1.00E-03	mg/L
RDO	RDO-2	8/11/1982	Dissolved Phosphorus	1	2.00E-03	mg/L
RDO	RDO-2	5/5/1988	Dissolved Phosphorus	1	1.00E-02	mg/L
RDO	RDO-2	6/8/1988	Dissolved Phosphorus	1	1.00E-02	mg/L
RDO	RDO-2	7/12/1988	Dissolved Phosphorus	1	1.20E-02	mg/L
RDO	RDO-2	8/30/1988	Dissolved Phosphorus	1	2.10E-02	mg/L
RDO	RDO-2	10/19/1988	Dissolved Phosphorus	1	1.20E-02	mg/L
RDO	RDO-2	4/12/1990	Dissolved Phosphorus	1	1.07E-01	mg/L
RDO	RDO-2	6/11/1990	Dissolved Phosphorus	1	9.00E-03	mg/L
RDO	RDO-2	7/17/1990	Dissolved Phosphorus	1	1.00E-02	mg/L
RDO	RDO-2	8/21/1990	Dissolved Phosphorus	1	1.00E-02	mg/L
RDO	RDO-2	10/11/1990	Dissolved Phosphorus	1	3.20E-02	mg/L
RDO	RDO-2	4/22/1992	Dissolved Phosphorus	1	8.00E-03	mg/L
RDO	RDO-2	6/4/1992	Dissolved Phosphorus	1	6.00E-03	mg/L
RDO	RDO-2	7/8/1992	Dissolved Phosphorus	1	2.00E-03	mg/L
RDO	RDO-2	8/28/1992	Dissolved Phosphorus	1	1.10E-02	mg/L
RDO	RDO-2	10/20/1992	Dissolved Phosphorus	1	1.60E-02	mg/L
RDO	RDO-2	4/11/1995	Dissolved Phosphorus	1	1.00E-03	mg/L
RDO	RDO-2	6/7/1995	Dissolved Phosphorus	1	1.30E-02	mg/L
RDO	RDO-2	7/5/1995	Dissolved Phosphorus	1	1.40E-02	mg/L
RDO	RDO-2	8/8/1995	Dissolved Phosphorus	1	6.00E-03	mg/L
RDO	RDO-2	10/4/1995	Dissolved Phosphorus	1	1.00E-02	mg/L
RDO	RDO-2	4/24/1998	Dissolved Phosphorus	1	4.00E-03	mg/L
RDO	RDO-2	6/24/1998	Dissolved Phosphorus	1	9.00E-03	mg/L
RDO	RDO-2	7/23/1998	Dissolved Phosphorus	1	6.00E-03	mg/L
RDO	RDO-2	8/24/1998	Dissolved Phosphorus	1	7.00E-03	mg/L
RDO	RDO-2	10/15/1998	Dissolved Phosphorus	1	2.20E-02	mg/L
RDO	RDO-2	6/28/1979	Dissolved Phosphorus	24	1.00E-02	mg/L
RDO	RDO-2	6/28/1979	Dissolved Phosphorus	1	1.00E-02	mg/L
RDO	RDO-3	8/30/1979	Dissolved Phosphorus	10	1.00E-02	mg/L
RDO	RDO-3	8/30/1979	Dissolved Phosphorus	1	1.00E-02	mg/L
RDO	RDO-3	6/16/1981	Dissolved Phosphorus	1	0.00E+00	mg/L
RDO	RDO-3	9/3/1981	Dissolved Phosphorus	1	1.00E-02	mg/L
RDO	RDO-3	6/1/1982	Dissolved Phosphorus	1	1.00E-03	mg/L
RDO	RDO-3	8/11/1982	Dissolved Phosphorus	1	6.00E-03	mg/L
RDO	RDO-3	5/5/1988	Dissolved Phosphorus	1	1.00E-02	mg/L
RDO	RDO-3	6/8/1988	Dissolved Phosphorus	1	1.00E-02	mg/L
RDO	RDO-3	7/12/1988	Dissolved Phosphorus	1	1.40E-02	mg/L
RDO	RDO-3	8/30/1988	Dissolved Phosphorus	1	2.20E-02	mg/L
RDO	RDO-3	10/19/1988	Dissolved Phosphorus	1	2.20E-02	mg/L
RDO	RDO-3	4/12/1990	Dissolved Phosphorus	1	5.10E-02	mg/L
RDO	RDO-3	6/11/1990	Dissolved Phosphorus	1	1.00E-02	mg/L
RDO	RDO-3	7/17/1990	Dissolved Phosphorus	1	1.00E-02	mg/L
RDO	RDO-3	8/21/1990	Dissolved Phosphorus	1	3.30E-02	mg/L

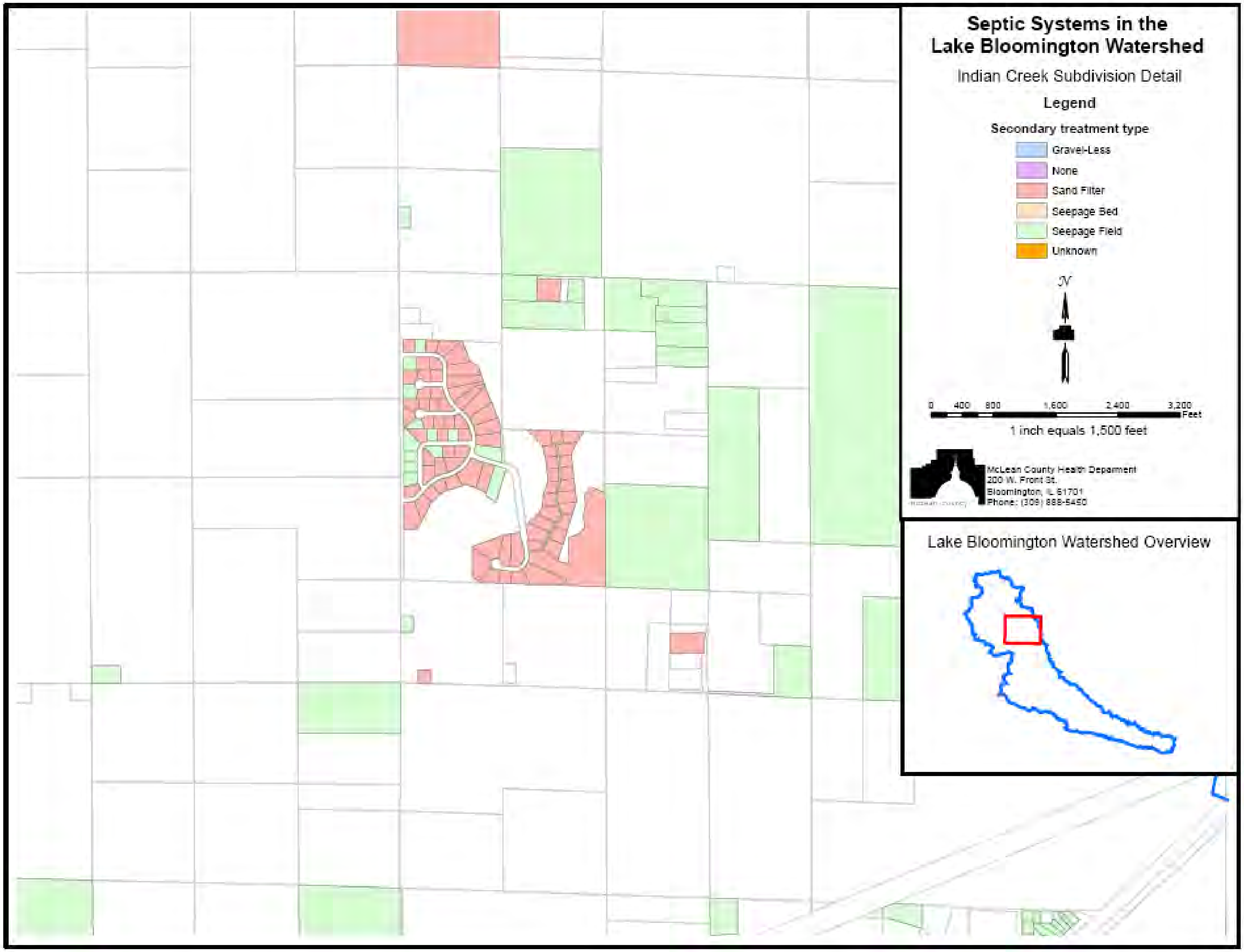
WB_ID	StationID	Date	Parameter	Sample Depth (ft)	Value	Units
RDO	RDO-1	8/30/1988	Dissolved Phosphorus	1	2.10E-02	mg/L
RDO	RDO-1	10/19/1988	Dissolved Phosphorus	15	3.00E-03	mg/L
RDO	RDO-1	10/19/1988	Dissolved Phosphorus	1	1.40E-02	mg/L
RDO	RDO-1	4/12/1990	Dissolved Phosphorus	28	1.10E-01	mg/L
RDO	RDO-1	4/12/1990	Dissolved Phosphorus	1	1.12E-01	mg/L
RDO	RDO-1	6/11/1990	Dissolved Phosphorus	28	1.00E-02	mg/L
RDO	RDO-1	6/11/1990	Dissolved Phosphorus	1	1.10E-02	mg/L
RDO	RDO-1	7/17/1990	Dissolved Phosphorus	29	2.00E-01	mg/L
RDO	RDO-1	7/17/1990	Dissolved Phosphorus	1	1.00E-02	mg/L
RDO	RDO-1	8/21/1990	Dissolved Phosphorus	28	1.12E-01	mg/L
RDO	RDO-1	8/21/1990	Dissolved Phosphorus	1	1.00E-02	mg/L
RDO	RDO-1	10/11/1990	Dissolved Phosphorus	27	1.20E-01	mg/L
RDO	RDO-1	10/11/1990	Dissolved Phosphorus	1	7.00E-02	mg/L
RDO	RDO-1	4/22/1992	Dissolved Phosphorus	28	6.00E-03	mg/L
RDO	RDO-1	4/22/1992	Dissolved Phosphorus	1	6.00E-03	mg/L
RDO	RDO-1	6/4/1992	Dissolved Phosphorus	27	6.00E-03	mg/L
RDO	RDO-1	6/4/1992	Dissolved Phosphorus	1	7.00E-03	mg/L
RDO	RDO-1	7/8/1992	Dissolved Phosphorus	27	6.00E-03	mg/L
RDO	RDO-1	7/8/1992	Dissolved Phosphorus	1	3.00E-03	mg/L
RDO	RDO-1	8/28/1992	Dissolved Phosphorus	28	7.00E-03	mg/L
RDO	RDO-1	8/28/1992	Dissolved Phosphorus	1	8.00E-03	mg/L
RDO	RDO-1	10/20/1992	Dissolved Phosphorus	26	8.00E-03	mg/L
RDO	RDO-1	10/20/1992	Dissolved Phosphorus	1	8.00E-03	mg/L
RDO	RDO-1	4/11/1995	Dissolved Phosphorus	28	2.00E-03	mg/L
RDO	RDO-1	4/11/1995	Dissolved Phosphorus	1	1.00E-03	mg/L
RDO	RDO-1	6/7/1995	Dissolved Phosphorus	27	8.80E-02	mg/L
RDO	RDO-1	6/7/1995	Dissolved Phosphorus	1	1.40E-02	mg/L
RDO	RDO-1	7/5/1995	Dissolved Phosphorus	27	5.00E-03	mg/L
RDO	RDO-1	7/5/1995	Dissolved Phosphorus	1	7.00E-03	mg/L
RDO	RDO-1	8/8/1995	Dissolved Phosphorus	28	3.00E-03	mg/L
RDO	RDO-1	8/8/1995	Dissolved Phosphorus	1	6.00E-03	mg/L
RDO	RDO-1	10/4/1995	Dissolved Phosphorus	26	4.00E-03	mg/L
RDO	RDO-1	10/4/1995	Dissolved Phosphorus	1	1.00E-02	mg/L
RDO	RDO-1	4/24/1998	Dissolved Phosphorus	28	3.00E-03	mg/L
RDO	RDO-1	4/24/1998	Dissolved Phosphorus	15	3.00E-03	mg/L
RDO	RDO-1	4/24/1998	Dissolved Phosphorus	1	4.00E-03	mg/L
RDO	RDO-1	6/24/1998	Dissolved Phosphorus	28	1.37E-01	mg/L
RDO	RDO-1	6/24/1998	Dissolved Phosphorus	15	8.00E-03	mg/L
RDO	RDO-1	6/24/1998	Dissolved Phosphorus	1	8.00E-03	mg/L
RDO	RDO-1	7/23/1998	Dissolved Phosphorus	28	6.00E-03	mg/L
RDO	RDO-1	7/23/1998	Dissolved Phosphorus	15	3.00E-03	mg/L
RDO	RDO-1	7/23/1998	Dissolved Phosphorus	1	5.00E-03	mg/L
RDO	RDO-1	8/24/1998	Dissolved Phosphorus	27	7.00E-03	mg/L
RDO	RDO-1	8/24/1998	Dissolved Phosphorus	1	6.00E-03	mg/L
RDO	RDO-1	8/24/1998	Dissolved Phosphorus	15	5.00E-03	mg/L
RDO	RDO-1	10/15/1998	Dissolved Phosphorus	23	3.00E-02	mg/L
RDO	RDO-1	10/15/1998	Dissolved Phosphorus	12	3.10E-02	mg/L
RDO	RDO-1	10/15/1998	Dissolved Phosphorus	1	2.40E-02	mg/L
RDO	RDO-1	6/28/1979	Dissolved Phosphorus	28	3.00E-02	mg/L

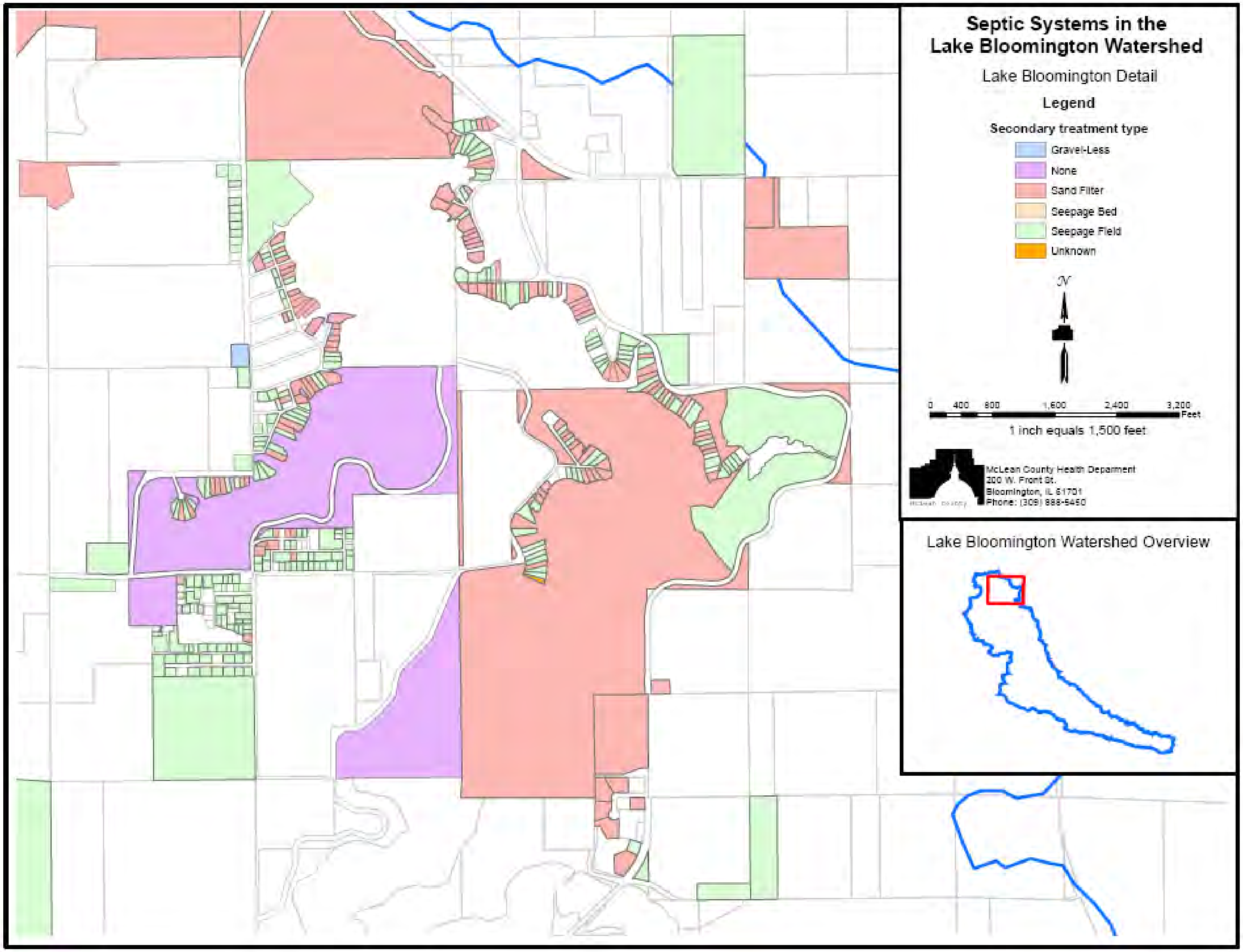
WB_ID	StationID	Date	Parameter	Sample Depth (ft)	Value	Units
RDO	RDO-3	8/30/1988	Chlorophyll a	1	47.60	ug/l
RDO	RDO-3	10/19/1988	Chlorophyll a	2	78.70	ug/l
RDO	RDO-3	4/12/1990	Chlorophyll a	3	18.33	ug/l
RDO	RDO-3	6/11/1990	Chlorophyll a	6	29.84	ug/l
RDO	RDO-3	7/17/1990	Chlorophyll a	4	48.95	ug/l
RDO	RDO-3	8/21/1990	Chlorophyll a	5	36.16	ug/l
RDO	RDO-3	4/22/1992	Chlorophyll a	4	27.25	ug/l
RDO	RDO-3	6/4/1992	Chlorophyll a	4	43.94	ug/l
RDO	RDO-3	7/8/1992	Chlorophyll a	4	14.75	ug/l
RDO	RDO-3	8/28/1992	Chlorophyll a	3	27.11	ug/l
RDO	RDO-3	10/20/1992	Chlorophyll a	3	60.82	ug/l
RDO	RDO-3	4/11/1995	Chlorophyll a	2	14.83	ug/l
RDO	RDO-3	6/7/1995	Chlorophyll a	6	37.38	ug/l
RDO	RDO-3	7/5/1995	Chlorophyll a	4	25.59	ug/l
RDO	RDO-3	8/8/1995	Chlorophyll a	5	46.60	ug/l
RDO	RDO-3	10/4/1995	Chlorophyll a	3	28.93	ug/l
RDO	RDO-3	4/24/1998	Chlorophyll a	4	78.76	ug/l
RDO	RDO-3	5/19/1998	Chlorophyll a	4	14.69	ug/l
RDO	RDO-3	6/1/1998	Chlorophyll a	4	72.09	ug/l
RDO	RDO-3	6/24/1998	Chlorophyll a	4	66.75	ug/l
RDO	RDO-3	7/1/1998	Chlorophyll a	5	20.40	ug/l
RDO	RDO-3	7/23/1998	Chlorophyll a	4	47.20	ug/l
RDO	RDO-3	8/5/1998	Chlorophyll a	4	53.40	ug/l
RDO	RDO-3	10/15/1998	Chlorophyll a	3	85.40	ug/l
RDO	RDO-3	11/18/1998	Chlorophyll a	2	101.00	ug/l
RDO	RDO-3	6/28/1979	Chlorophyll a	6	16.00	ug/l
RDO	RDO-3	8/30/1979	Chlorophyll a	3	34.00	ug/l
RDO	RDO-3	4/30/2001	Chlorophyll a	1	29.70	ug/l
RDO	RDO-3	6/14/2001	Chlorophyll a	14	34.60	ug/l
RDO	RDO-3	6/14/2001	Chlorophyll a	14	34.60	ug/l
RDO	RDO-3	7/18/2001	Chlorophyll a	1	28.30	ug/l
RDO	RDO-3	10/9/2001	Chlorophyll a	1	14.80	ug/l
RDO	RDO-1	8/30/1979	Dissolved Phosphorus	28	1.00E-02	mg/L
RDO	RDO-1	8/30/1979	Dissolved Phosphorus	1	1.00E-02	mg/L
RDO	RDO-1	6/16/1981	Dissolved Phosphorus	29	0.00E+00	mg/L
RDO	RDO-1	6/16/1981	Dissolved Phosphorus	1	0.00E+00	mg/L
RDO	RDO-1	9/3/1981	Dissolved Phosphorus	30	9.00E-02	mg/L
RDO	RDO-1	9/3/1981	Dissolved Phosphorus	1	0.00E+00	mg/L
RDO	RDO-1	6/1/1982	Dissolved Phosphorus	29	1.00E-03	mg/L
RDO	RDO-1	6/1/1982	Dissolved Phosphorus	1	1.00E-03	mg/L
RDO	RDO-1	8/11/1982	Dissolved Phosphorus	28	2.00E-03	mg/L
RDO	RDO-1	8/11/1982	Dissolved Phosphorus	1	1.00E-03	mg/L
RDO	RDO-1	5/5/1988	Dissolved Phosphorus	29	1.00E-02	mg/L
RDO	RDO-1	5/5/1988	Dissolved Phosphorus	1	1.00E-02	mg/L
RDO	RDO-1	6/8/1988	Dissolved Phosphorus	27	1.00E-02	mg/L
RDO	RDO-1	6/8/1988	Dissolved Phosphorus	1	1.00E-02	mg/L
RDO	RDO-1	7/12/1988	Dissolved Phosphorus	24	8.00E-03	mg/L
RDO	RDO-1	7/12/1988	Dissolved Phosphorus	1	1.00E-03	mg/L
RDO	RDO-1	8/30/1988	Dissolved Phosphorus	19	3.00E-02	mg/L

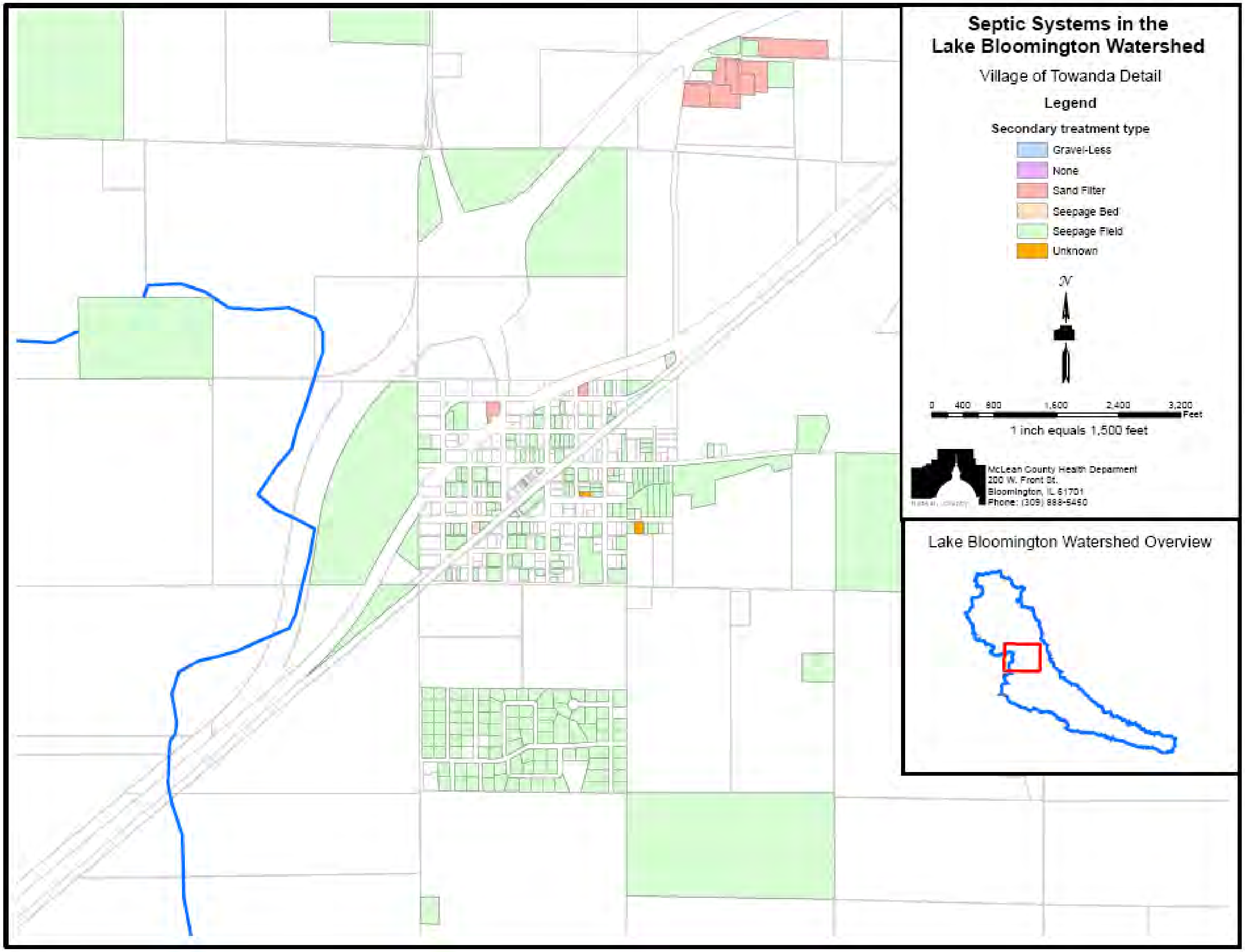
WB_ID	StationID	Date	Parameter	Sample Depth (ft)	Value	Units
RDO	RDO-1	6/11/2003	Chlorophyll a	5	42.70	ug/l
RDO	RDO-1	7/17/2003	Chlorophyll a	5	44.10	ug/l
RDO	RDO-1	8/5/2003	Chlorophyll a	6	40.90	ug/l
RDO	RDO-2	6/16/1981	Chlorophyll a	8	3.39	ug/l
RDO	RDO-2	9/3/1981	Chlorophyll a	6	15.07	ug/l
RDO	RDO-2	6/1/1982	Chlorophyll a	4	9.79	ug/l
RDO	RDO-2	8/11/1982	Chlorophyll a	10	6.32	ug/l
RDO	RDO-2	5/5/1988	Chlorophyll a	5	14.33	ug/l
RDO	RDO-2	6/8/1988	Chlorophyll a	7	16.56	ug/l
RDO	RDO-2	7/12/1988	Chlorophyll a	3	16.91	ug/l
RDO	RDO-2	8/30/1988	Chlorophyll a	2	33.38	ug/l
RDO	RDO-2	10/19/1988	Chlorophyll a	3	38.00	ug/l
RDO	RDO-2	4/12/1990	Chlorophyll a	4	6.13	ug/l
RDO	RDO-2	6/11/1990	Chlorophyll a	7	22.59	ug/l
RDO	RDO-2	7/17/1990	Chlorophyll a	6	22.12	ug/l
RDO	RDO-2	8/21/1990	Chlorophyll a	7	22.04	ug/l
RDO	RDO-2	10/11/1990	Chlorophyll a	4	5.77	ug/l
RDO	RDO-2	4/22/1992	Chlorophyll a	6	20.96	ug/l
RDO	RDO-2	6/4/1992	Chlorophyll a	7	30.23	ug/l
RDO	RDO-2	7/8/1992	Chlorophyll a	6	11.33	ug/l
RDO	RDO-2	8/28/1992	Chlorophyll a	7	14.22	ug/l
RDO	RDO-2	10/20/1992	Chlorophyll a	5	49.49	ug/l
RDO	RDO-2	6/7/1995	Chlorophyll a	6	41.83	ug/l
RDO	RDO-2	7/5/1995	Chlorophyll a	6	35.91	ug/l
RDO	RDO-2	8/8/1995	Chlorophyll a	7	34.71	ug/l
RDO	RDO-2	10/4/1995	Chlorophyll a	4	34.18	ug/l
RDO	RDO-2	4/24/1998	Chlorophyll a	4	89.44	ug/l
RDO	RDO-2	5/19/1998	Chlorophyll a	5	66.75	ug/l
RDO	RDO-2	6/1/1998	Chlorophyll a	5	84.11	ug/l
RDO	RDO-2	6/24/1998	Chlorophyll a	5	28.48	ug/l
RDO	RDO-2	7/1/1998	Chlorophyll a	9	10.60	ug/l
RDO	RDO-2	7/23/1998	Chlorophyll a	8	22.00	ug/l
RDO	RDO-2	8/5/1998	Chlorophyll a	8	25.40	ug/l
RDO	RDO-2	10/15/1998	Chlorophyll a	5	25.40	ug/l
RDO	RDO-2	11/18/1998	Chlorophyll a	4	45.40	ug/l
RDO	RDO-2	6/28/1979	Chlorophyll a	14	10.00	ug/l
RDO	RDO-2	8/30/1979	Chlorophyll a	7	16.00	ug/l
RDO	RDO-2	4/30/2001	Chlorophyll a	1	49.80	ug/l
RDO	RDO-2	6/14/2001	Chlorophyll a	14	18.20	ug/l
RDO	RDO-2	6/14/2001	Chlorophyll a	14	18.20	ug/l
RDO	RDO-2	7/18/2001	Chlorophyll a	1	23.50	ug/l
RDO	RDO-2	8/23/2001	Chlorophyll a	1	60.70	ug/l
RDO	RDO-2	10/9/2001	Chlorophyll a	1	15.90	ug/l
RDO	RDO-3	6/16/1981	Chlorophyll a	6	5.27	ug/l
RDO	RDO-3	9/3/1981	Chlorophyll a	6	22.50	ug/l
RDO	RDO-3	8/11/1982	Chlorophyll a	3	18.93	ug/l
RDO	RDO-3	5/5/1988	Chlorophyll a	4	14.04	ug/l
RDO	RDO-3	6/8/1988	Chlorophyll a	6	27.28	ug/l
RDO	RDO-3	7/12/1988	Chlorophyll a	3	37.08	ug/l

APPENDIX D
SEPTIC SYSTEM IN LAKE BLOOMINGTON WATERSHED


Septic Systems in the
Lake Bloomington Watershed
Legend
Secondary treatment type
Gravel-Less
None
Sand Filter
Seepage Bed
Seepage Field
Unknown
N
0
0.5
1
2
3
4
Miles
1 inch equals 2 miles
McLean County Health Deparment
200 W. Front St.
Bloomington, IL 61701
Phone: (309) 888-5450


Septic Systems in the
Lake Bloomington Watershed
Indian Creek Subdivision Detail
Legend
Secondary treatment type
Gravel-Less
None
Sand Filter
Seepage Bed
Seepage Field
Unknown
N
0 400 800 1,600 2,400 3,200 Feet
1 inch equals 1,500 feet
McLean County Health Department
200 W. Front St.
Bloomington, IL 61701
Phone: (309) 888-5450
Lake Bloomington Watershed Overview

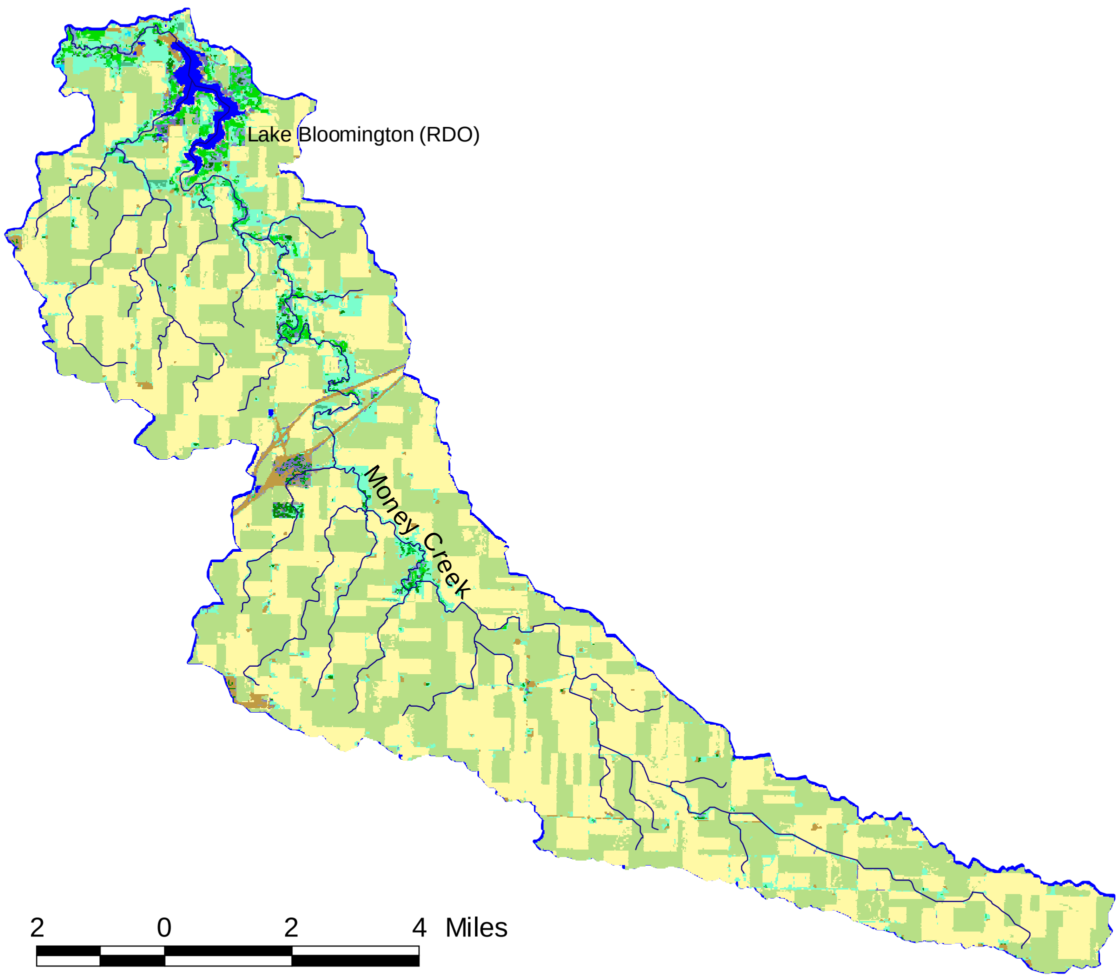

Septic Systems in the
Lake Bloomington Watershed
Lake Bloomington Detail
Legend
Secondary treatment type
Gravel-Less
None
Sand Filter
Seepage Bed
Seepage Field
Unknown
N
0
400
800
1,600
2,400
3,200
Feet
1 inch equals 1,500 feet
McLean County Health Deparment
200 W. Front St.
Bloomington, IL 61701
Phone: (309) 888-5450
Lake Bloomington Watershed Overview



Septic Systems in the
Lake Bloomington Watershed
Village of Towanda Detail
Legend
Secondary treatment type
Gravel-Less
None
Sand Filter
Seepage Bed
Seepage Field
Unknown
N
0
400
800
1,600
2,400
3,200
Feet
1 inch equals 1,500 feet
McLean County Health Depament
200 W. Front St.
Bloomington, IL 61701
Phone: (309) 888-5450
Lake Bloomington Watershed Overview

TMDL Development for the Lake Bloomington Watershed, Illinois

Final Report
September 5, 2007



TETRA TECH

Illinois Environmental Protection Agency

TMDL Development for Lake Bloomington Watershed, Illinois

Stage Three Report: TMDL Development

FINAL REPORT

September 5, 2007

Submitted to:
Illinois Environmental Protection Agency
1021 N. Grand Avenue East
Springfield, IL 62702

Submitted by:
Tetra Tech, Inc.
Water Resources TMDL Center

CONTENTS

TABLES

FIGURES

KEY FINDINGS

As part of the Section 303(d) listing process, the Illinois Environmental Protection Agency has identified Lake Bloomington as impaired for a variety of parameters (IEPA, 2006). Many of the 303(d) listings are for parameters without numeric water quality standards and therefore TMDLs are not being developed at this time. Of the pollutants impairing Lake Bloomington, total phosphorus and nitrate are the only parameter with numeric water quality standards. Illinois water quality standards require that total phosphorus and nitrate concentrations not exceed 0.05 mg/L and 10 mg/L, respectively. The water quality data verified that total phosphorus is a limiting nutrient in the lake and frequently exceeded the 0.05 mg/L water quality standard. The nitrate plus nitrite nitrogen concentration data is used to verify the exceedance because nitrite nitrogen seldom appears in concentration greater than 1 mg/L and tends to transform to nitrate. The maximum observed nitrate plus nitrite concentration exceeded the standard of 10 mg/L in Lake Bloomington.

The U.S. Army Corps of Engineers BATHTUB model V6.1 was selected to develop the loading capacity of the lake because it requires fairly simple inputs to predict the parameters of concern; it accounts for pollutant transport, sedimentation, and nutrient cycling; and it has been widely used for lake TMDLs in Illinois and other states. BATHTUB applies a series of empirical equations derived from assessments of lake data and performs steady-state water and nutrient calculations based on lake morphometry and tributary inputs.

Loads to the lake were estimated using the BATHTUB model to simulate observed average annual concentrations. The BATHTUB model was then used to determine the load reductions necessary to meet the water quality standards for total phosphorus (TP) and total nitrogen (TN). The BATHTUB analysis indicated that an 66 percent reduction in TP loads is necessary to meet the 0.05 mg/L standard during all modeled years. A 34 percent reduction in TN load is necessary to meet the 10 mg/L water quality standard. Based on these reductions, the loading capacity of Lake Bloomington is 10,805 lb/yr of TP and 1, 537, 874 lb/yr of TN.

The sources of TP and TN are briefly discussed in this report. The East Bay Camp and Retreat is the only current point source with a current National Pollutant Discharge Elimination System (NPDES) permit in the watershed. Potential nonpoint sources were identified including animal feedlots and confinement operations, septic systems, lawn fertilizer runoff, and agricultural runoff. The amount that is contributed by these sources is a function of the soil type, slope, crop management, precipitation, total amount of cropland, and the distance to the water resource. An Implementation Plan will be prepared that fully addresses all potential sources and discusses alternatives for achieving the desired load reductions.

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1.0 INTRODUCTION

Section 303(d) of the Clean Water Act (CWA) and the U.S. Environmental Protection Agency (USEPA) Water Quality Planning and Management Regulations (40 CFR Part 130) require states to identify water bodies that do not meet water quality standards and to determine the Total Maximum Daily Load (TMDL) for pollutants causing the impairment. A TMDL is the total amount of pollutant load that a water body can receive and still meet the water quality standards. It is the sum of the individual waste load allocation for point sources, load allocations for nonpoint sources, natural background, and a margin of safety that addresses the uncertainty in the analysis. The CWA establishes the process for completing TMDLs to provide more stringent, water-quality based controls when technology-based controls are not sufficient to achieve state water quality standards. The overall goals and objectives in developing the TMDLs include:

- Assess the water quality of the impaired waterbodies and identify key issues associated with the impairments and potential pollutant sources.
- Use the best available science and available data to determine the maximum load the waterbodies can receive and fully support all of their designated uses.
- Use the best available science and available data to determine current loads of pollutants to the impaired waterbodies.
- If current loads exceed the maximum allowable load, determine the load reduction that is needed.
- Identify feasible and cost-effective actions that can be taken to reduce loads.
- Inform and involve the public throughout the project to ensure that key concerns are addressed and the best available information is used.
- Submit a final TMDL report to USEPA for review and approval.

The Illinois Environmental Protection Agency (IEPA) only requires a TMDL be developed for the chemical parameters with numeric water quality standards. Under Section 303(d) of the CWA, the State of Illinois prepares a list of waters that are not meeting state water quality standards (hereafter referred to as the “303(d) list”) in each 2-year cycle. Lake Bloomington (waterbody ID RDO) is listed as impaired because of excessive nitrate and phosphorus in the water (IEPA, 2006).

IEPA implements its TMDL Program in three stages. Stage One was completed in November 2006 and involved the characterization of the watershed, an assessment of the available water quality data, and an identification of potential technical approaches (Tetra Tech, 2006; see Appendix A). Stage Two involves additional data collection which was not required for Lake Bloomington. Stage Three involves model development and calibration, TMDL scenarios, and implementation planning. This report documents the modeling and TMDL components of Stage Three and briefly describes the implementation plan.

This chapter discusses the rationale for beneficial use designations and impairments for Lake Bloomington which is located in central Illinois. Chapter 2 describes the characteristics of the watershed and water bodies. Chapter 3 describes the water quality standards and water quality assessment of existing data. Chapter 4 summarizes the nonpoint and point sources in Lake Bloomington. Chapter 5 describes the technical approach used for the TMDL development including modeling approach and calibration. Chapter 6 presents the TMDL components including load allocations. Finally, Chapter 7 briefly describes the implementation plan.

1.1 Confirmation of Impairment

A review of the available water quality data from the Stage One report (Appendix A) confirms the causes of impairments in Lake Bloomington. Of the pollutants impairing Lake Bloomington, total phosphorus and nitrate are the only parameter with numeric water quality standards. The water quality data also verified that total phosphorus is a limiting nutrient in the lake and frequently exceeded the 0.05 mg/L water quality standard. The nitrate plus nitrite nitrogen concentration data is used to verify the exceedance because nitrite nitrogen seldom appears in concentration greater than 1 mg/L and tends to transform to nitrate. The maximum observed nitrate plus nitrite concentration exceeded the standard of 10 mg/L in Lake Bloomington.

All Illinois waters must meet general use water quality standards unless they are subject to another specific designation (CWA Section 302.201). The general use standards protect the state's water for aquatic life (except as provided in Illinois Water Quality Standard Section 302.213), wildlife, agricultural use, secondary contact use, aesthetics quality, and most industrial uses.

Lake Bloomington (RDO) is the drinking water supply for the City of Bloomington, the Village of Hudson, Towanda, Bloomington Township West Phase, Bloomington Township West Phase Crestwicke, and the Meadows of Bloomington and Hilltop manufactured home parks. Table 1-1 summarizes the designated uses, cause of impairment and potential sources based on the Illinois Integrated Water Quality and Section 303(d) List - 2006. The Public and Food Processing Water Supplies designated use is impaired due to excess concentrations of nitrate. This nitrate standard applies to raw (untreated) water at any point at which water is withdrawn from the waterbody for treatment and distribution as a potable water supply or for food processing. In the lake, aquatic life and fish consumption uses are fully supported, while aesthetic quality is not supported. The aesthetic quality use is impaired because of excessive concentrations of total phosphorus and total suspended solids. Primary and secondary contact uses were not assessed. TMDLs were developed for total phosphorus and nitrate nitrogen in Lake Bloomington since numeric water quality standards exist for these two pollutants.

Table 1-1 Lake Bloomington (ROD) Listed Impairments and Causes

Designated Use	Cause of Impairment	Potential Sources
Aesthetic Quality	Total Phosphorus (TP)	Crop Production (Crop Land or Dry Land), Other Recreational Pollution Sources, Runoff from Forest/Grassland/Parkland
	Total Suspended Solids (TSS)	Crop Production (Crop Land or Dry Land), Littoral/shore Area Modifications (Non-riverine), Other Recreational Pollution Sources, Site Clearance (Land Development or Redevelopment)
	Aquatic Algae	Crop Production (Crop Land or Dry Land), Other Recreational Pollution Sources, Runoff from Forest/Grassland/Parkland
Public and Food Processing Water Supplies	Nitrogen, Nitrate	Crop Production (Crop Land or Dry Land), Other Recreational Pollution Sources, Runoff from Forest/Grassland/Parkland

Source: IEPA, 2006

2.0 DESCRIPTION OF WATERBODIES AND WATERSHED CHARACTERISTICS

This chapter describes the general characteristics of the Lake Bloomington watershed and water bodies, including their location, population, land use and cover, topography and geology, soils, climate and hydrology. A more in depth description of Lake Bloomington and its watershed can be found in Stage One report (Appendix A).

2.1 Location

The Lake Bloomington Watershed is located in the central part of McLean County, Illinois as shown on Figure 2-1. The main tributary to the lake is Money Creek, which flows from southeast to northwest in the watershed, and is a tributary in the Mackinaw River Basin (Hydrologic Unit Code 07130004). Hickory Creek, a small tributary of Money Creek, also flows into Lake Bloomington from southwest of the Lake. The communities of Towanda and Merna are located within the watershed. Lake Bloomington is located in the northern tip of the watershed, about 15 miles north of the City of Bloomington (USDA 1991).

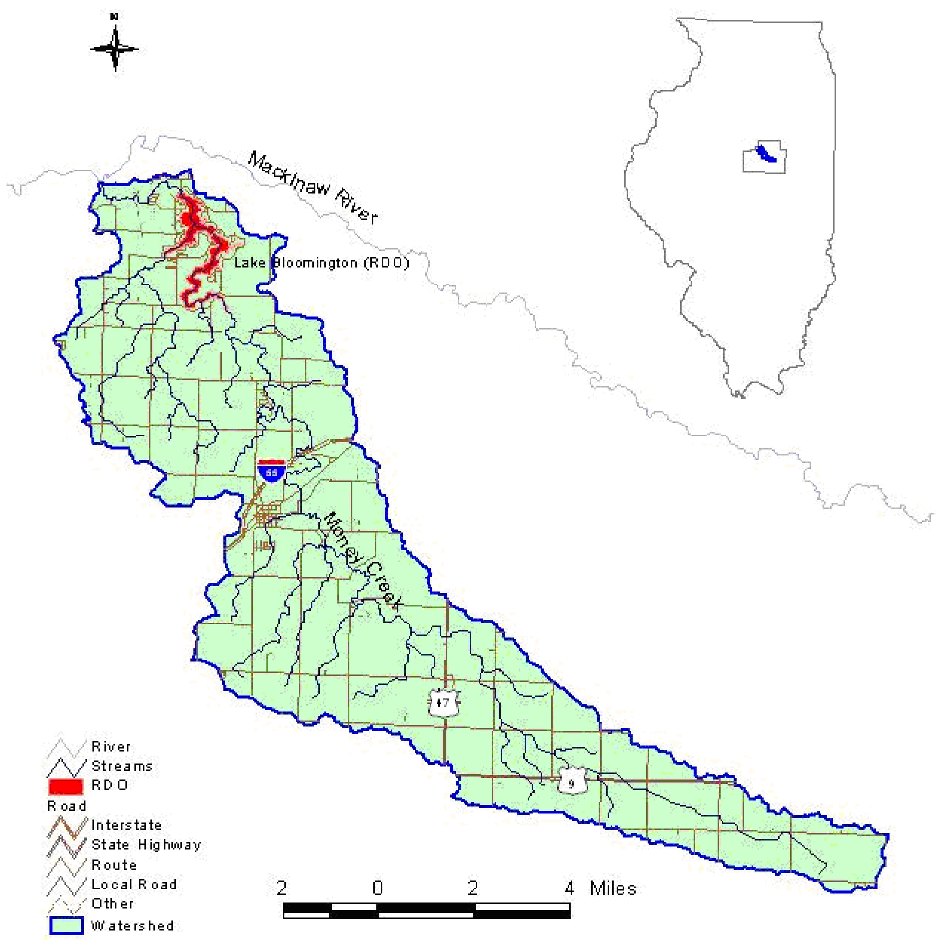

Figure 2-1 Lake Bloomington Watershed

2.2 Population

Total watershed population data is not directly available but population estimates were calculated from the 2000 U.S. Census data (U.S. Census Bureau 2000). The total population in the watershed is estimated to be approximately 4,575. According to the US Census Bureau, the county's population increased from 129,180 in 1990 to 150,433 in 2000, by about 16.5 percent. The City of Bloomington, Hudson, Towanda, Bloomington Township West Phase, Bloomington Township West Phase Crestwicke, and the Meadows of Bloomington and Hilltop manufactured home parks are consumers of water taken from Lake Bloomington.

2.3 Land Use and Land Cover

Figure 2-2 presents land use and land cover in the Lake Bloomington watershed. Land use data for the Lake Bloomington watershed was obtained from the Illinois Gap Analysis Program (GAP) which provides detailed classification of land use and land cover. Agricultural land uses are dominant in the Lake Bloomington watershed, making up 93.2 percent (41,666 acres) of the total area, with the major crops being corn and soybeans. Wetlands account for approximately 2.5 percent (1,103 acres) of the watershed, urban lands accounts for 2.5 percent (1,116 acres), and forest lands (380 acres) are less than 1 percent.

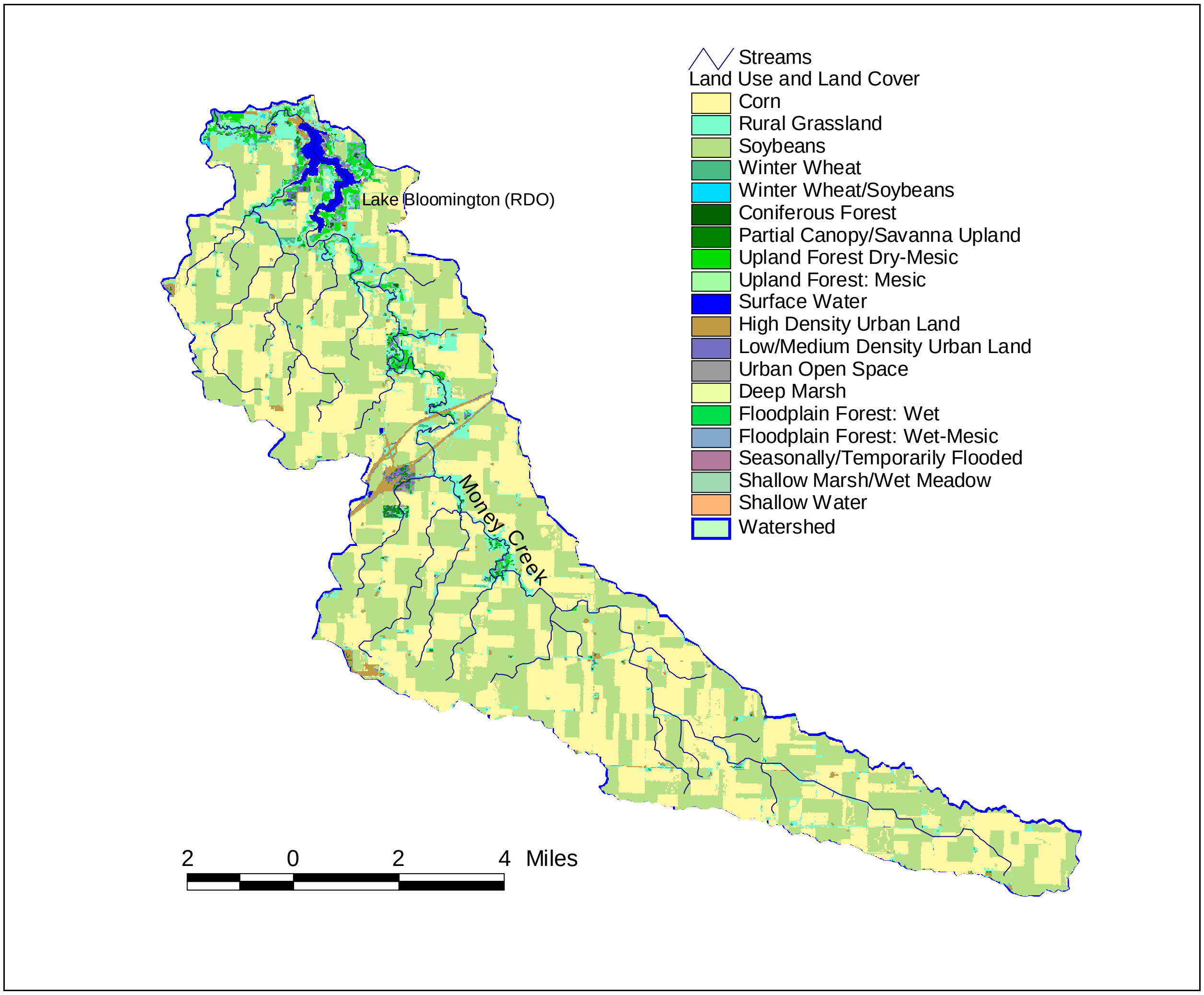

Figure 2-2 Land Use and Land Cover Map

2.4 Soil and Topography

The uppermost bedrock within the Lake Bloomington watershed is mostly Pennsylvanian age. These Pennsylvanian formations are made of cyclic beds of sandstone, siltstone, shale, limestone, coal, and clay. Much of the Pennsylvanian bedrock is covered by Quaternary deposits up to 500 feet thick.

According to the McLean County soil survey, "McLean County is mainly on a loess-covered till plain characterized by numerous terminal glacial moraines cutting diagonally across the county from northwest to southeast." The county also consists of a series of glacial deposits characterized by concentric bands of moraines and ridges starting in the northwest and traveling to the southeast. One of the largest moraines in Illinois is the Bloomington Moraine which runs just south of the watershed (USDA 2002).

General soils data and map unit delineations for the country are provided as part of the Soil Survey Geographic (SSURGO) database, which was used to characterize soils in the Lake Bloomington watershed. USDA (2002) has defined four hydrologic groups for soils based on their infiltration rates and runoff characteristics. Soil group A has high infiltrations rates. Soil group B has moderate infiltration rates. Soil group C has slow infiltration rates and soil group D has very slow infiltration rates.

Dual hydrologic groups, A/D, B/D, and C/D, are given for certain wet soils that can be adequately drained. The first letter applies to the drained condition and the second letter to the undrained condition. Figure 2-3 displays the SSURGO hydrologic soil group map for the Lake Bloomington watershed. Hydrologic Soil Group B covers 38.7 percent and dominates the south-eastern portion of the watershed and is found adjacent to Lake Bloomington and the middle and northern sections of Money Creek. Group B/D accounts for 59.8 percent and is evenly spaced throughout the watershed and found adjacent to the southern section of Money Creek. Group C covers 0.6 percent and is found in small areas surrounding Lake Bloomington and the northern section of Money Creek upstream from the lake. Group C/D accounts for 0.9 percent and is found sparingly throughout the watershed.

This watershed is heavily tiled to promote agricultural drainage. The drain tile system increases the possibility for soluble nitrogen to reach the surface water. In addition, some private septic systems may be connected with the drain tile system and provide a direct load to the streams, especially under low flow conditions. In Illinois, subsurface drainage pipes are typically installed at a depth of 3 to 4 feet and at a spacing of 80 to 120 feet.

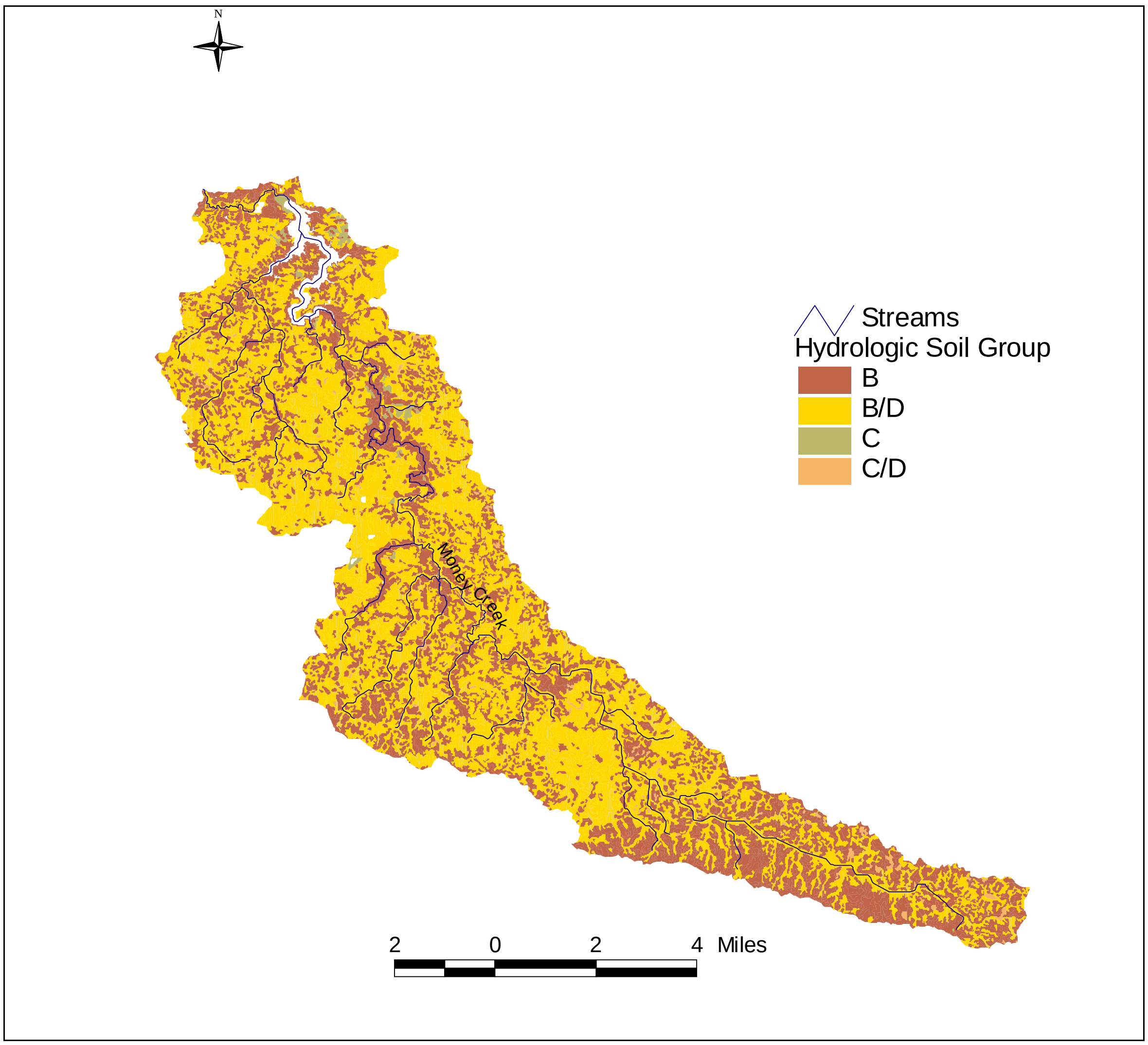

Figure 2-3 Hydrologic Soil Group Map

2.5 Waterbody Characteristics

Lake Bloomington is a drinking water reservoir located north of Bloomington, Illinois. The lake was constructed in 1929 by impounding Money Creek in the northern area of the lake. The lake was built to expand the city's water supply and its primary use is as a water supply for domestic, commercial, industrial, and agricultural purposes. The lake is also used for recreational purposes as well as a residential development. Lake Bloomington is fed by Money Creek to the south. Hickory Creek, a small tributary of Money Creek, drains into Lake Bloomington from the southwest. In 1957, the lake's capacity was increased by raising the dam 5 feet. The drainage area of the watershed is 69.5 square miles and the water surface area is 572 acres. The maximum storage capacity is 8,760 acre-feet. The average depth of the lake is 12.9 feet and the maximum depth is 35 feet.

2.6 Climate

The central portion of Illinois has a continental climate with cold, rather dry winters, and warm humid summers. The average annual precipitation at Normal, Illinois is 37.5 inches. Monthly average precipitation is about 3.1 inches. The wet months are between March and August and have average precipitation between 3.83 and 4.52 inches per month. Months from September to March are relatively dry and have average precipitation between 1.71 and 3.06 inches per month. The average annual temperature at Normal, Illinois is approximately 50.7 °F. Annual average snowfall is a total of 21.9 inches with large variations in snowfall occurring from year to year.

Figure 2-4 shows the yearly precipitation data collected at Peoria station from 1901 until 2006. The highest precipitation of 55.35 inches was observed in 1990. Average annual precipitation for this station was used in the BATHTUB model, Section 5.1.

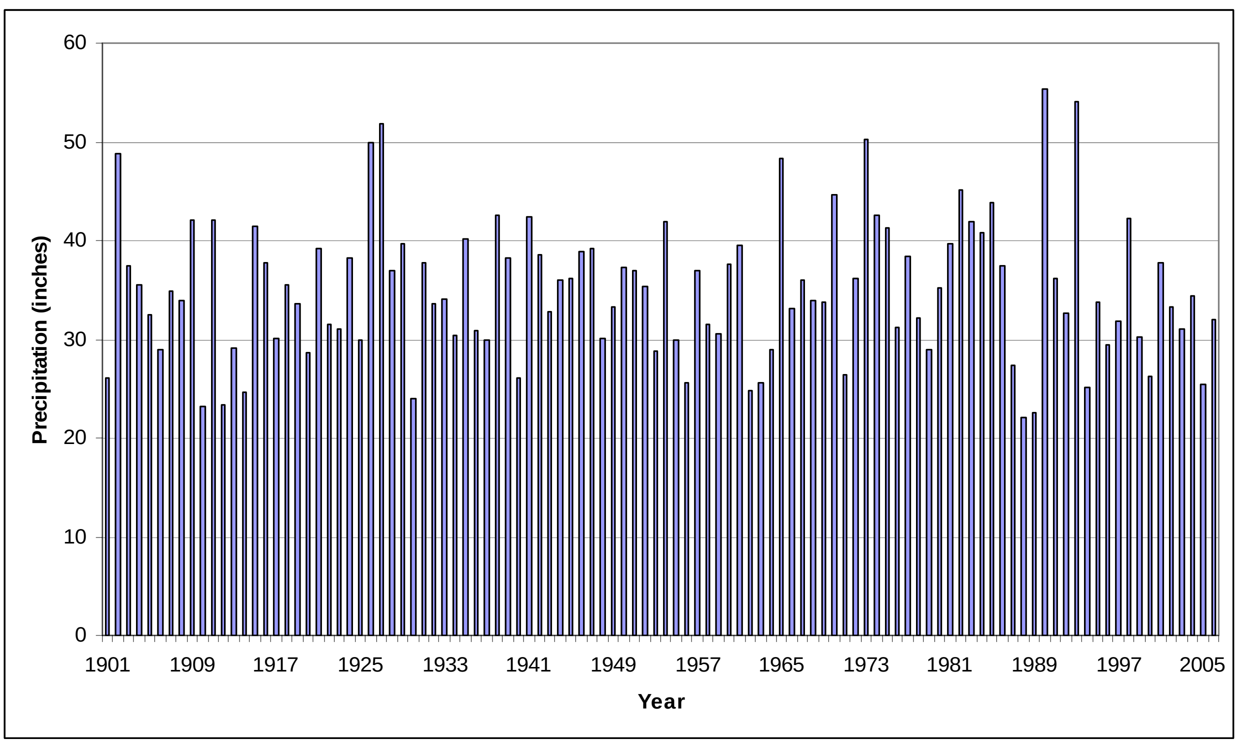

Figure 2-4 Yearly Precipitation Data at Peoria Station (1901-2006)

2.7 Hydrology

USGS station 0556440 is located on Money Creek 8.3 miles upstream from the confluence of the Mackinaw River, 3 miles north of Towanda and 5 miles east of Hudson. Based on the daily flows from the station measured from June 1958 to February 1983, the mean flow is 36.14 cfs, and the median flow is 13.0 cfs. The maximum flow of 1,180 cfs was recorded in August 6, 1981 during a major flood. The minimum flow of 0 cfs was recorded various times throughout the sampling period (USGS 2006).

USGS station gage 05565500 is located 1,300 feet downstream from the dam and 2.1 miles upstream from the mouth of Money Creek. Based on the lake discharge data from 1956 to 1958, the minimum discharge from the lake is zero, the average discharge from the lake is 23.98 cfs, and the maximum discharge of 1,090 cfs was recorded in April 1957 (USGS 2006). USGS station gage 05565000 is located approximately 1,200 feet southwest of Lake Bloomington on Hickory Creek. Based on the Hickory Creek discharge data from 1939 to 1958, the minimum discharge is 43 cfs, the average discharge is 425.4 cfs and the maximum discharge is 1,690 cfs.

The annual average pan evaporation was 37.8 inches from 1980 to 2002, based on the records at Hennepin Power Plant station located approximately 60 miles northwest of the lake (ISWS 2002). Actual evaporation is usually less than pan evaporation, so the average annual pan evaporation was multiplied by 0.75 to give an annual average evaporation of 28.4 inches.

3.0 WATER QUALITY

This chapter discusses applicable water quality standards and an assessment of the pollutants of concern in Lake Bloomington. The available water quality data is evaluated to verify impairments in the water body by comparing the data with the water quality standards. The spatial and temporal water quality variation as well as the correlation among the constituents is analyzed.

3.1 Applicable Lake Water Quality Standards

Lake Bloomington is listed on the Illinois 2006 303(d) list for aesthetic quality use impairment caused by total suspended solids (TSS), total phosphorus (TP), and aquatic algae. Lake Bloomington is also listed for designated use of public and food processing water supplies and is impaired due to nitrate concentrations. Table 3-1 summarizes the applicable numeric water quality standards for Lake Bloomington.

At this time, IEPA does not develop TMDLs for parameters that do not have numeric water quality standards. Therefore, a TMDL will not be developed for TSS at this time even though sedimentation is a concern in Lake Bloomington. Since 1957 the lake lost 1,450 acre-feet of storage capacity. The storage loss rate is about 0.5 percent per year (USDA 1991). Because phosphorus load is largely associated with TSS load, the measures implemented for phosphorus reduction may also reduce the sediment load to the lake and decrease the storage loss rate.

Table 3-1 Water Quality Standards for Lake Bloomington

Parameter	Units	General Use Water Quality Standard	Public and Food Processing Water Supplies	Section for Regulatory Citation[b]
Nitrate-Nitrogen	mg/L	No numeric standard	10 mg/L	302.304
Total Phosphorus	mg/L	0.05[a]	No numeric standard	302.205

[a] Standard only applies in lakes/reservoirs that are greater than 20 acres in surface area and in any stream at the point where it enters such a lake/reservoir.
[b]All IEPA water quality standards are published by the Illinois Pollution Control Board under Title 35: Environmental Protection Subtitle C: Water Pollution Chapter I: Pollution Control Board. Part 302. Water Quality Standards. Subpart A: General Water Quality Provisions.

Excessive algal growth is listed as a cause of impairment in Lake Bloomington. However, algal growth is considered by IEPA to be a non-pollutant and therefore does not require a TMDL. Chlorophyll-a (Chl-a) is a plant pigment commonly used to measure algal biomass. The Chl-a in water correlates with the amount of algae in the water body. There is no numeric standard in the State of Illinois for Chl-a; however, the algal growth is directly related to an excessive amount of limiting nutrients and light availability for photosynthesis. Phosphorus is identified as a limiting nutrient in Lake Bloomington. Consequently, TP can be considered a surrogate indicator for excessive algal growth.

3.2 Assessment of Water Quality Data

This section discusses the pollutants of concern for Lake Bloomington. The available water quality data is analyzed and compared with water quality standards to verify the impairments of the lake. The water quality conditions in the lake are evaluated by sampling location and time variations. Figure 3-1 displays the location of the water quality station with available data.

Water quality data at Lake Bloomington is available from STORET, Illinois EPA, and the Lake Bloomington Water Treatment Plant (WTP). STORET has measured water quality data at stations RDO-1, RDO-2 and RDO-3 from 1977 to 2001. Lake Bloomington WTP has measured water quality data at stations STA-1 (RDO-1), STA-2 (RDO-2), STA-3 and STA-4 (RDO-3) from 1999 to 2005.

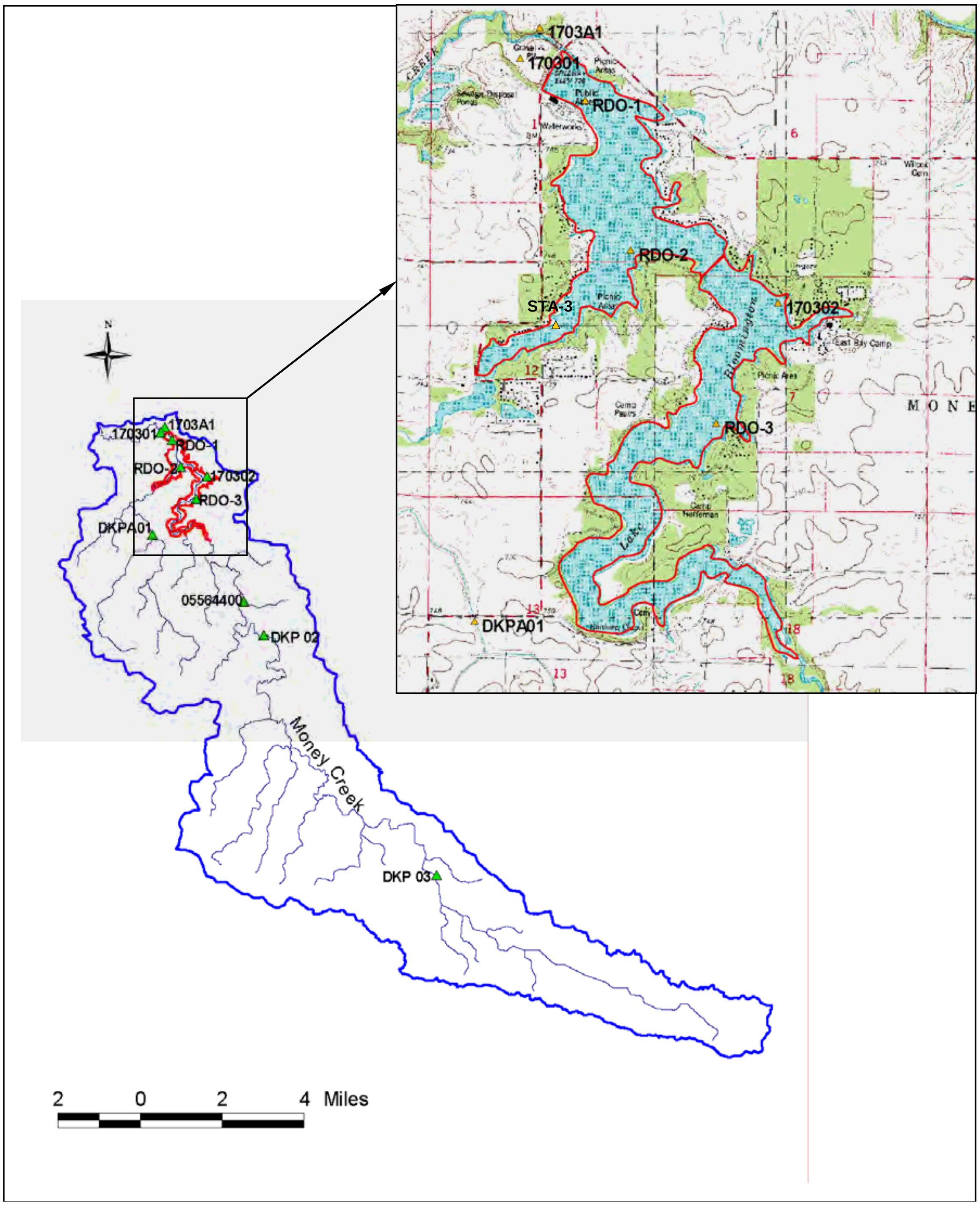

Figure 3-1 Water Quality Sampling Sites

3.2.1 Phosphorus

Figure 3-2 presents TP data collected at different locations in the lake from 1977 to 2005. The figure shows that the maximum concentrations exceed the standard at all locations. The average concentrations also exceed the water quality standard of 0.05 mg/L at all the stations.

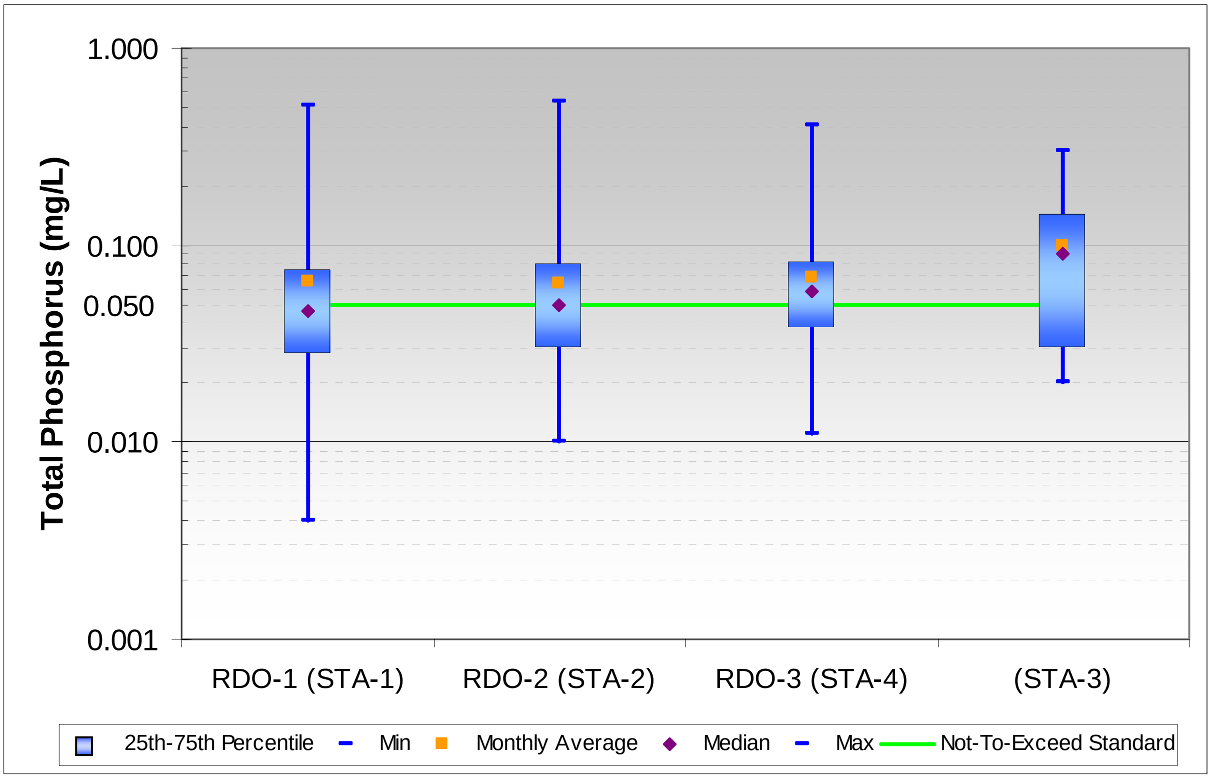

Figure 3-2 Total Phosphorus Concentrations in Lake Bloomington (1977-2005)

There are 474 samples available for the period from 1977 to 2005, 231 of which (48.87 percent) exceeded the water quality standard of 0.05 mg/L. A total of 359 samples were measured from 1988 to 2005, 192 of which (53.48 percent) exceeded the water quality standard of 0.05 mg/L. Data from Illinois EPA are available from 1988 to 1998, 2001, and 2003. Data from the City of Bloomington are available from 1999 to 2005. Figure 3-3 presents a scatter plot of all TP concentration data points in Lake Bloomington.

Table 3-2 Violations of Total Phosphorus Standard in Lake Bloomington

Parameter	Samples (Count), 1977 to 2005	Violations (Count), 1977 to 2005	Percent Violating, 1977 to 2005	Samples (Count), 1998 to 2005	Violations (Count), 1998 to 2005	Percent Violating, 1998 to 2005
Total Phosphorus	474	231	48.87	359	192	53.48

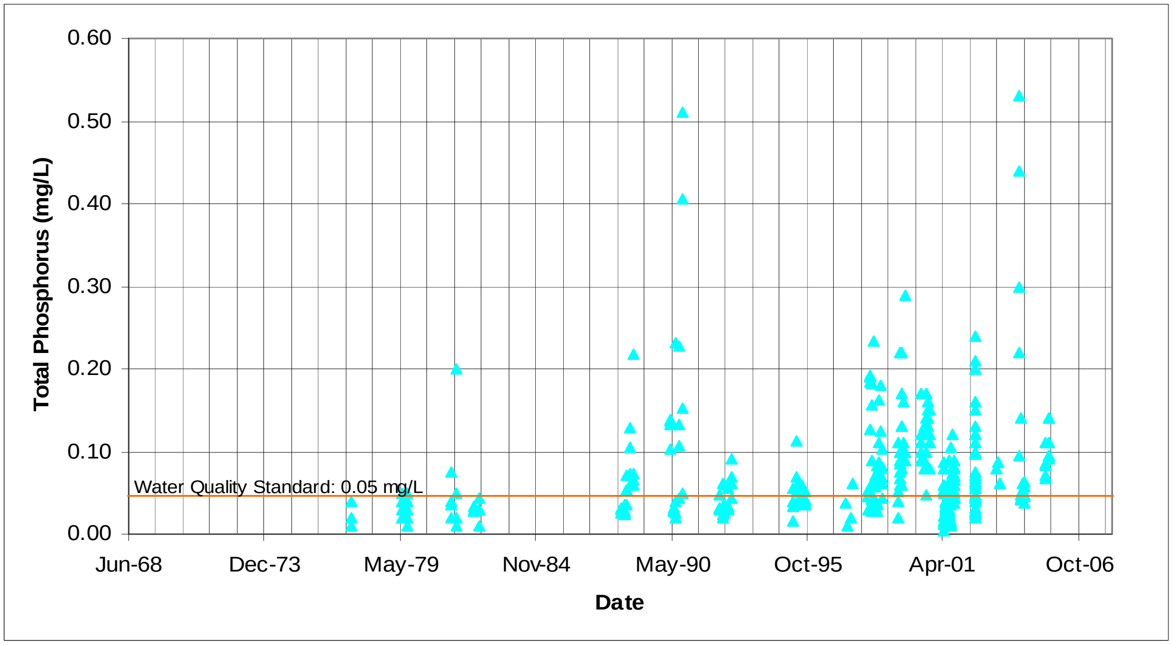

Figure 3-3 Total Phosphorus Concentration Data Point Scatter Plot (1977-2005)

Figure 3-4 presents the variation of monthly average TP concentrations from all locations in Lake Bloomington. The monthly average TP concentrations exceed the Illinois water quality standard from April to November, except for the month of July. However, individual concentrations are violating the standard every month, as shown by the maximum bars in Figure 3-4. The monthly average TP concentrations are elevated in spring and fall. The monthly average TP concentration is highest in October.

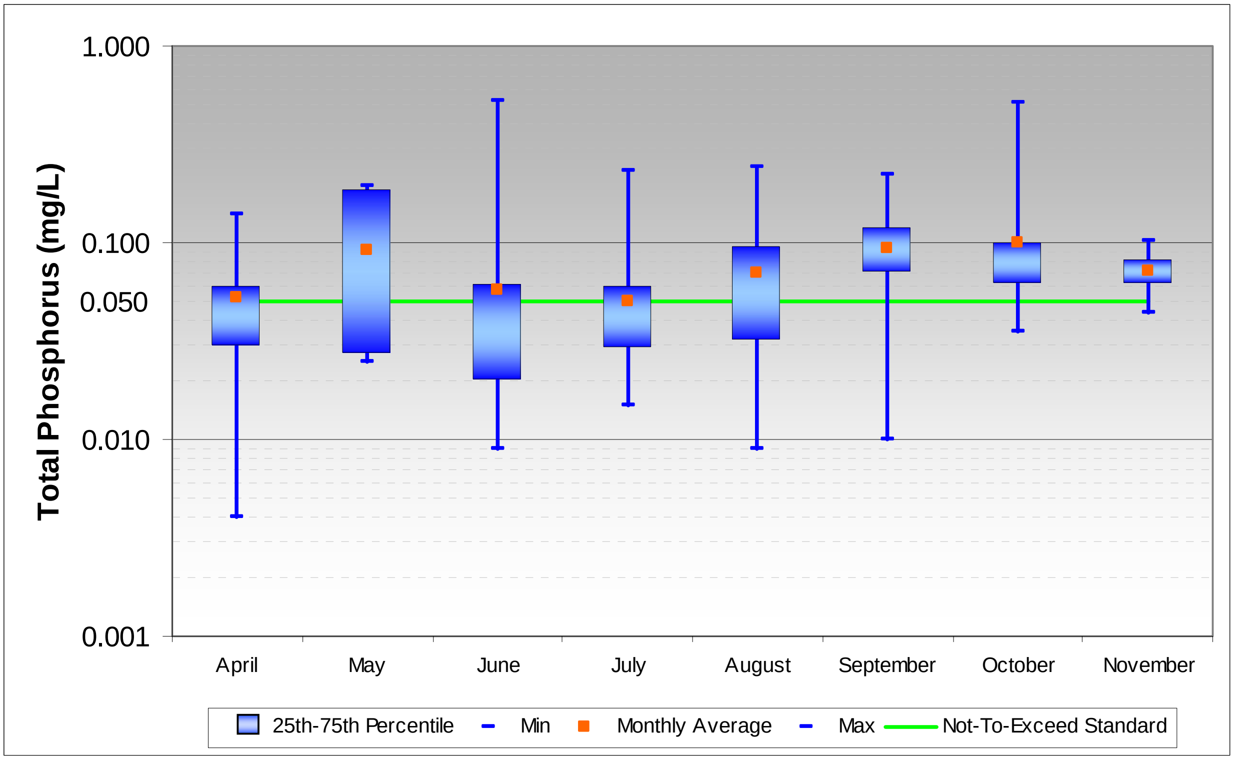

Figure 3-4 Monthly Average Total Phosphorus Concentration in Lake Bloomington (1977-2005)

Dissolved Phosphorus (DP) is the portion of TP that is biologically available for plant uptake. It is the soluble form of phosphorus that is not adsorbed to soil particles. In rivers and lakes with short retention time, DP concentration is crucial for plant growth. Table 3-3 summarizes the monthly DP and TP concentrations in the lake. An average 33 percent of TP concentration is in the dissolved form. This ratio implies that nonpoint sources other than soil erosion may contribute to TP.

Table 3-3 Monthly Average Dissolved Phosphorus (DP) and Total Phosphorus (TP) in Lake Bloomington

Month	DP (mg/l)	TP (mg/l)	Percent DP
Apr	0.02	0.05	40
May	0.01	0.10	10
Jun	0.02	0.04	50
Jul	0.02	0.05	40
Aug	0.01	0.05	20
Sep	0.03	0.08	38
Oct	0.04	0.09	44
Average	**0.02**	**0.06**	**33**

Source: STORET

3.2.2 Nitrate Nitrogen

Nitrate nitrogen is a listed cause of impairment in Lake Bloomington. The water quality standard for drinking water supply sources in Illinois is 10 mg/L. Because nitrite nitrogen seldom appears in concentration greater than 1 mg/L and tends to transform to nitrate, the nitrate plus nitrite concentration data is used to verify the exceedance. Figure 3-5 presents the nitrate plus nitrite levels by station. The maximum observed nitrate plus nitrite concentration at each station exceeds the standard, however, the monthly average concentration at each station is lower than the standard.

Table 3-4 presents violations of nitrite and nitrate standard in Lake Bloomington at various depths. There are 670 sample counts measured from 1977 to 2005, 183 of which (27.31 percent) exceeded the water quality standard of 10 mg/L. There are 557 nitrite plus nitrate measurements taken from 1998 to 2005, 145 of which (26.03 percent) exceeded the water quality standard of 10 mg/L. Data from Illinois EPA are available from 1988 to 1998, 2001, and 2003. Data from the City of Bloomington are available from 1999 to 2005. Figure 3-6 shows a scatter plot of all nitrite plus nitrate concentration data points in Lake Bloomington.

Table 3-4 Violations of Nitrite and Nitrate Standard in Lake Bloomington

Parameter	Samples (Count), 1977 to 2005	Violations (Count), 1977 to 2005	Percent Violating, 1977 to 2005	Samples (Count), 1998 to 2005	Violations (Count), 1998 to 2005	Percent Violating, 1998 to 2005
Nitrite and Nitrate	670	183	27.31	557	145	26.03

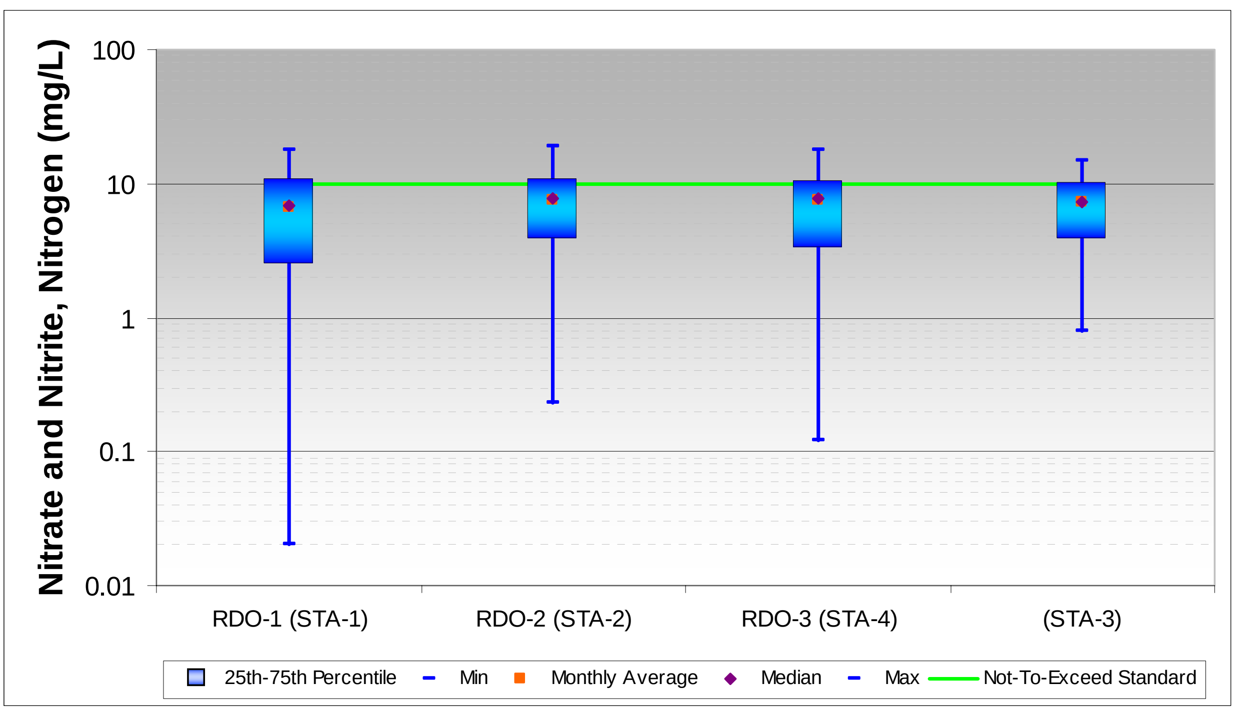

Figure 3-5 Nitrite plus Nitrate Concentrations in Lake Bloomington (1977-2005)

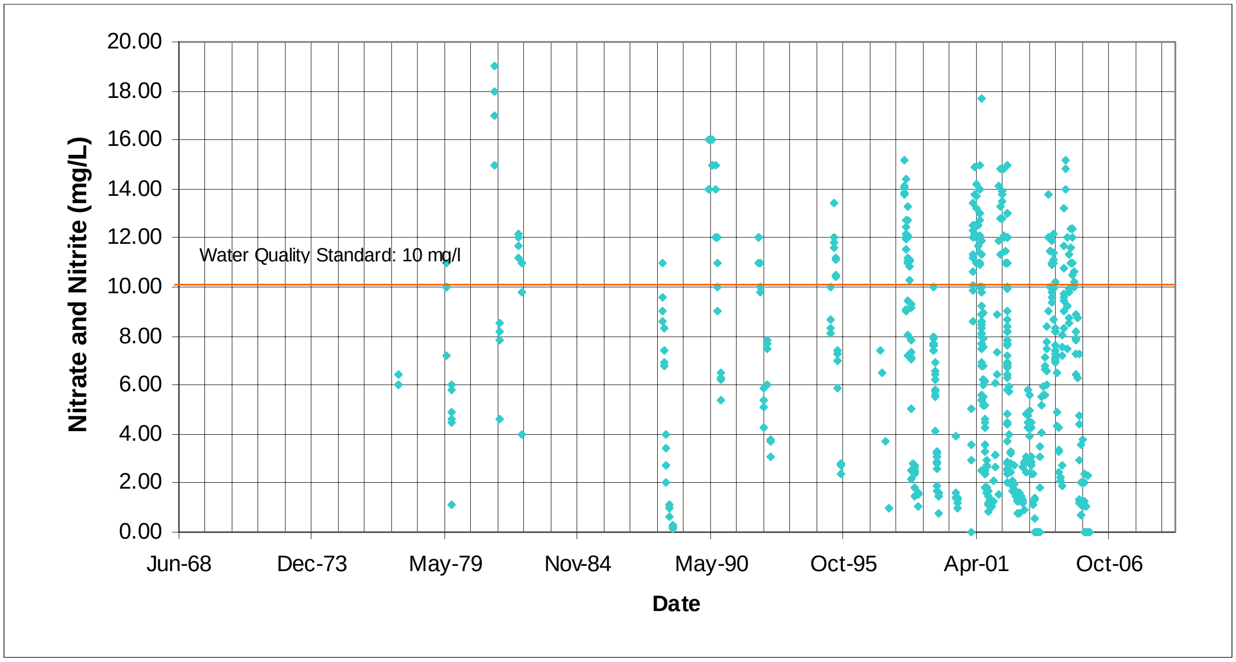

Figure 3-6 Nitrite Plus Nitrate Concentration Data Point Scatter Plot (1977-2005)

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4.0 SOURCE ASSESSMENT

This section briefly discusses point and nonpoint sources that potentially contribute to the impairment of the Lake Bloomington. A detail discussion addressing the pollution sources will be included in the implementation plan.

4.1 Nonpoint Sources

The Illinois 2006 303(d) List identified crop production (crop land or dry land), site clearance (land development or redevelopment), littoral/shore area modification (non-riverine), recreational pollution, and runoff from forest/grassland/parkland as sources of nutrient loads to Lake Bloomington. About 93.2 percent of the watershed is agricultural land. Agricultural land uses potentially contribute sediment, TSS, nitrogen, phosphorus, and biochemical oxygen demand (BOD) loads to the water resource loading. The amount that is contributed is a function of the soil type, slope, crop management, precipitation, total amount of cropland, and the distance to the water resource (Muir et al. 1997).

Row crop agriculture is a common source of sediment and nutrient loads and is prevalent in the watershed. The row crops corn and soybeans are the dominant crop within the watershed. Fertilizers commonly used in the watershed include nitrogen, phosphorus, and potash. Fertilizers are applied in the fall and spring with a variety of application methods. Fertilizer runoff from lawns is also a potential nonpoint source to the impairment.

Animal feedlots and confinement operations are other potential sources for nutrient loads. According to local NRCS staff, 8 confinement operations for hogs and 3 feedlots for cattle existed in the Lake Bloomington watershed in 1998. The exact number of animals in the watershed was not determined.

Shoreline erosion is a potential source of nutrients to Lake Bloomington and a shoreline erosion study was completed in 2005 (Midwest Streams Inc., 2005). The study categorized approximately 50 percent of the shoreline as class 1 (lowest erosion rate), 20 percent as class 2, and 12 percent as class 6 (highest erosion rate). The rest of the shoreline was categorized as class 3 or 5. Shoreline categorized as Class 6 was estimated to contribute approximately 3,756 tons of sediments per year.

Soils in the Lake Bloomington watershed range from poorly drained to well drained. Rainfall does not permeate in poorly drained soils which can result in high rates of runoff. A high rate of runoff can lead to water bodies receiving heavy loads of nutrients and sedimentation.

Nearly all households within the Lake Bloomington watershed use a private septic system. Septic systems are another potential source of nutrient and sediment loads. Septic systems can contaminate surface water or leach into groundwater if the system is malfunctioning. According to the McLean County Health Department, there are 353 active individual septic systems under permit in 10 subdivisions that are in the immediate area of Lake Bloomington. These septic systems are usually 50 to several hundred feet away from the lake front and most of them have valid permits. There are 607 active septic systems in the Village of Hudson, which has a small portion located in Lake Bloomington watershed. Along Money Creek, there are 90 septic systems near the southeast side of the lake.

4.2 Point Sources

There are two NPDES permitted facilities in Lake Bloomington watershed. The two facilities are identified as follows.

1. **Towanda Grade School.** This permit (which had been permit number IL0046167) was terminated on January 11, 2005 when a septic system was installed.

2. **East Bay Camp and Retreat** discharges through one outfall into Lake Bloomington. The facility is monitored for pH, TSS, dissolved oxygen (DO), flow, ammonia nitrogen, 5 day BOD, chlorine residual and fecal coliform. No violations have been reported. The NPDES permit number is IL0025666 and the design flow is 0.03 million gallons per day (MGD), although reported flows are typically much less (0.007 MGD during the winter and 0.018 MGD during the summer). Typical WWTP values of 3.5 mg/L TP and 15 mg/L TN were used to estimate existing loads of TP and TN from this facility in the absence of monitoring data (Litke, 1999; USEPA, 1997).

5.0 TECHNICAL ANALYSIS

Establishing the link between pollutant loads and resulting water quality is one of the most important steps in developing a TMDL. This link can be established through a variety of techniques ranging from simple mass balance analyses to sophisticated computer modeling. The objective of this section of the report is to describe the approach that was used to link the estimates of TP and nitrate loading with the resulting concentrations in Lake Bloomington.

5.1 BATHTUB Model Development

The U.S. Army Corps of Engineers BATHTUB model V6.1 was used to link tributary nutrient loads with observed water quality for Lake Bloomington. BATHTUB applies a series of empirical equations derived from assessments of lake data and performs steady-state water and nutrient calculations based on lake morphometry and tributary inputs. This model was selected because it requires fairly simple inputs to predict the parameters of concern; it accounts for pollutant transport, sedimentation, and nutrient cycling; and it has been used for lake TMDLs in Illinois and other states.

This section explains the technical approach used to develop TMDLs for the nutrients causing impairment in Lake Bloomington. TMDLs were developed for total phosphorus and nitrate. The State of Illinois lake water quality numeric standards specified for these nutrients are as follows:

- Total Phosphorus (TP) shall not exceed 0.05 mg/L
- Nitrate (NO_3) shall not exceed 10 mg/L

The BATHTUB model requires inputs of observed inlake concentrations of total and organic phosphorus and nitrogen concentrations for comparison to simulated values. Total nitrogen (TN) is typically calculated from laboratory data by summing total Kjeldahl nitrogen (TKN), nitrite nitrogen (NO_2), and nitrate nitrogen (NO_3). Organic nitrogen is calculated by subtracting ammonia from TKN; organic phosphorus is calculated by subtracting ortho-phosphorus from total phosphorus.

A relationship between the concentrations of TKN and NO_3+NO_2 is not evident in Lake Bloomington: the mean TKN concentration is 1.8 mg/L for all ranges of NO_3+NO_2. Thus, changes in total nitrogen concentration are mostly due to fluctuations in NO_3+NO_2. In addition, the majority of the observed total nitrogen in the lake is in the nitrate plus nitrite form.

5.1.1 Model Setup

The BATHTUB model requires inputs of reservoir and tributary data such as lake bathymetry, inlake water quality concentrations, and tributary flows and concentrations. Lake Bloomington was divided into four segments, or reservoir zones, linked in a network according to the lake's morphometric features. Lake bathymetry data were available from 1989 contour data provided by the City of Bloomington and from a sedimentation survey conducted by Hanson Engineers in August 1999.

Figure 5-1 depicts the segmented areas used for modeling Lake Bloomington and the location of the water quality monitoring stations. One water quality monitoring station is located in each segment. Table 5-1 shows the segment names with their respective water quality station and morphometric parameters used to set up the model.

Dissolved oxygen (DO) concentrations and temperature profiles measured at Lake Bloomington during the summer months of 2002, 2004 and 2005 were used to estimate the hypolimnetic and mixed layer depths. Thermal stratification in the lake was apparent from the temperature and DO profiles at segments STA1 and STA2. The profiles show the upper layer (epilimnetic zone) is isolated from the lower layer (hypolimnetic zone) by a temperature/DO gradient or thermocline from June to August. The thermocline is used to estimate the mixed layer depth for segments STA1 and STA2. The mixed layer depth for segments STA3 and STA4 was calculated using the BATHTUB regression model since a direct estimate was not available.

Table 5-1 Lake Bloomington Morphometry for BATHTUB

Station	Segment	Surface Area	Mean Depth	Length	Mean Hypolimnetic Depth	Mixed Layer Depth
		(km^2)	(m)	(km)	(m)	(m)
4	Upper Lake MC	1.017	2.743	3.902	-	2.7
2	Mid Lake MC	0.543	6.706	1.734	2.4	1.2
3	Upper Lake HC	0.370	4.267	1.423	-	4.1
1	Lower Lake Dam	0.634	8.534	1.373	3.0	3.0

Notes:
* Mixed layer depth estimated using BATHTUB regression model

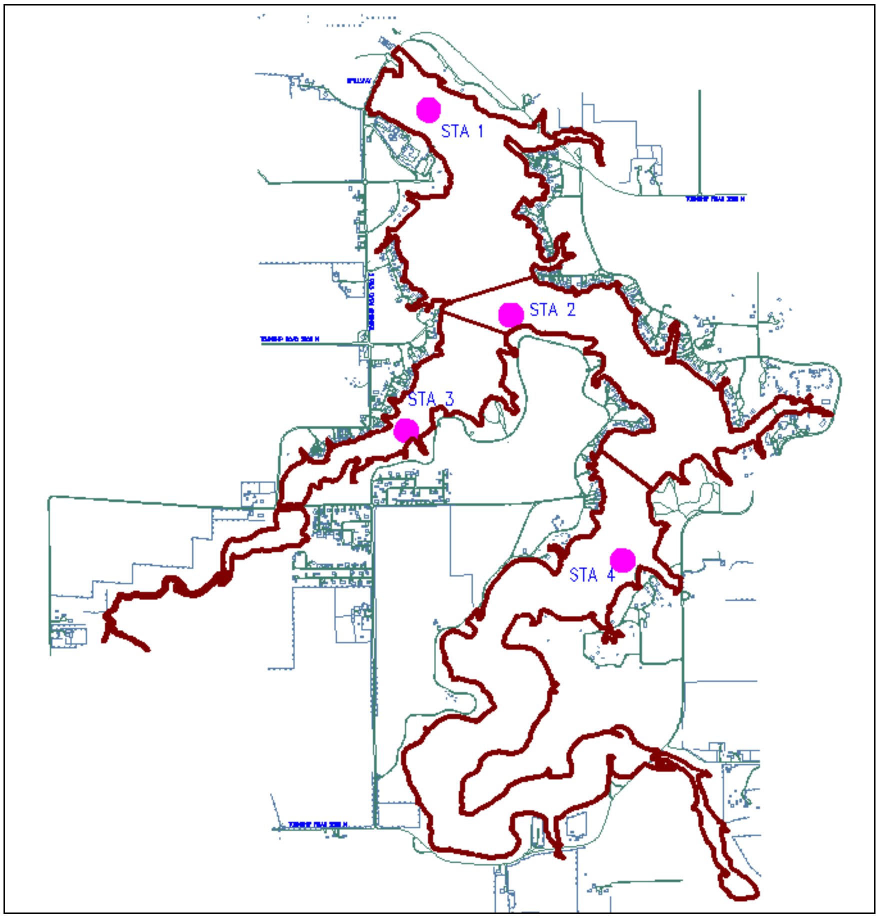

Figure 5-1 Lake Bloomington Segments for BATHTUB

Hydrologic data needed for the model include precipitation, evaporation, and increase in storage. Total annual precipitation data from Peoria, Illinois were available from 1901 to 2006. Figure 5-2 illustrates the seasonal variability of rainfall and flows in Lake Bloomington.

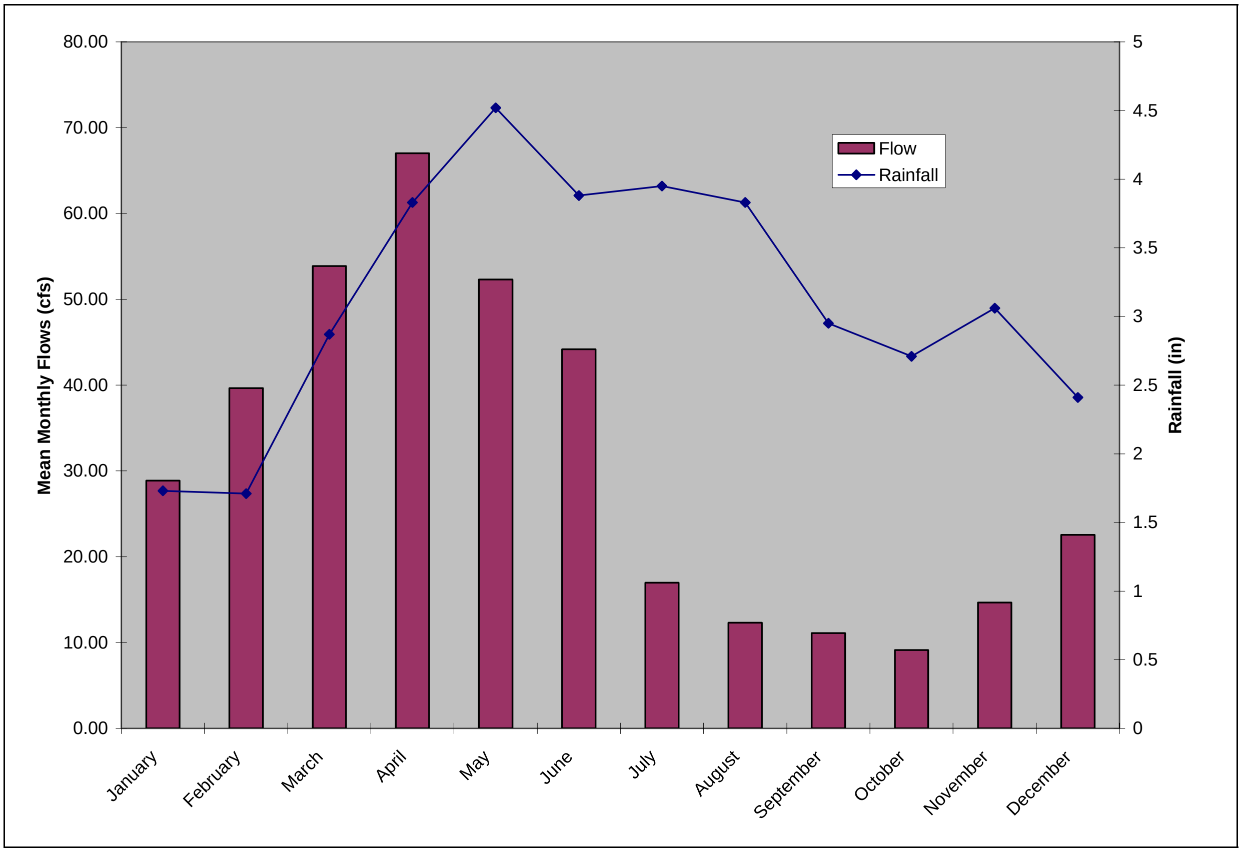

Figure 5-2 Mean Monthly Flow and Rainfall for Lake Bloomington

The annual average pan evaporation was 37.8 inches from 1980 to 2002, based on the records at Hennepin Power Plant station located approximately 60 miles northwest of the lake (ISWS, 2002). The average annual pan evaporation was multiplied by 0.75 to give an annual average evaporation of 28.4 inches.

Money Creek is the main tributary discharging into Lake Bloomington, draining approximately 75 percent of the watershed. Hickory Creek is a smaller tributary that also flows into Lake Bloomington and drains approximately 14 percent of the watershed. Flow and concentration data for Money Creek and Hickory Creek are very limited.

Money Creek daily flows were measured at two locations upstream of Lake Bloomington. Flows at USGS Station 05564500 are available from 1933 to 1958 and at USGS Station 05564400 from 1958 to 1983. Hickory Creek daily flows are available from USGS station 05565000 from 1939 to 1958. Tributary flows for the Lake Bloomington drainage area were estimated from these USGS stations based on the ratio of drainage area. The drainage area for the USGS station on Money Creek is 49 mi^2 and the drainage area of this tributary to Lake Bloomington is 52.2 mi^2. Thus, the USGS stream flows were multiplied by 1.06 to estimate daily flow from Money Creek.

Mean annual flows were then calculated and extrapolated to represent the most recent years when water quality concentrations are available in the lake. The mean annual flows from 1984 to 2005 were extrapolated using runoff coefficients, land use and rainfall data. Flows were scaled based on annual precipitation. In addition, the runoff coefficient for agricultural land use was adjusted so that observed flows from 1933 to 1983 match calculated flows resulting in an average 8 percent error. Withdrawals for the Lake Bloomington Water Treatment Plant were accounted for in the BATHTUB global variables as increase/decrease in storage for each year.

Money Creek water quality data for TP and NO_3+NO_2 were measured upstream in the watershed during 1987, 1988, 1994, 2000, and 2005. There are only nine water quality data points available at Money Creek. Hickory Creek was measured in 1988 with two data points available.

Table 5-2 Tributaries TN and TP Concentrations

Year	Money Creek		Hickory Creek	
	TP mg/L	TN mg/L	TP mg/L	TN mg/L
1987	0.24	0.12	-	-
1988	0.03	14.70	0.05	14.65
1994	0.15	0.15	-	-
2000	0.04	7.40	-	-
2005	0.20	4.88	-	-

BATHTUB has several models to predict inlake concentrations. Total phosphorus was predicted using the 2nd order, available P model. Total nitrogen was predicted using the 2nd order, available N model. These two models provide generally accurate second-order sedimentation coefficients. Chlorophyll-a (Chl-a) was predicted using phosphorus, light, and flushing because phosphorus and light are the limiting factors for this lake (this is also the default model for Chl-a simulation). Transparency versus chlorophyll-a and turbidity was computed. Longitudinal dispersion was calculated based on the Fischer equation. Mass balance and phosphorus and nitrogen calibrations were performed using predicted concentrations. Model input data for each year is included in Appendix C.

The duration selected for the mass balance calculations is one year, which accounts for seasonal variability. The annual averaging period was adequate because of the relatively long phosphorus residence time for Lake Bloomington. Concentrations and loadings are predicted on an annual basis for 10 selected years with available lake water quality data between 1988 and 2005.

5.1.2 Model Calibration

The BATHTUB model was calibrated based on two years (1988 and 2005) when water quality data were available for both the tributaries and the lake. Mean annual concentrations and flows were used for the simulation periods. Predicted concentrations in the lake were calibrated against observed concentrations by adjusting the model calibration factors in BATHTUB.

Mean annual concentrations and estimated flows for 1988 and 2005 were used to calibrate the Lake Bloomington nutrient response. Global calibration factors were adjusted to match observed lake concentrations for 1988 and 2005 independently. The global calibration factors are multiplied by the predicted concentrations in all segments. The calibration factors for both years were averaged to develop the calibrated model for Lake Bloomington. Phosphorus, nitrogen, and chlorophyll-a calibration factors used in the model are 1.2, 2.8, and 1.7, respectively. Nutrient calibration factors were adjusted within the acceptable ranges for phosphorus (0.5 to 2.0) and nitrogen (0.33 to 3). A calibration factor of 1 indicates that no adjustment of the empirical formula is needed for that parameter.

Nutrients can be released from the lake bottom sediments in the summer months during lake stratification and the empirical data within the BATHTUB model implicitly take these loads into account; however, the BATHTUB model does not provide an estimate of internal loads. The Nürnberg method (1984) was therefore used to obtain an approximate estimate of the internal load. This method uses mean depth, flushing rate, average inflow, and average outflow concentrations to estimate internal load. The accuracy of the method is dependent on the available tributary data, which are relatively limited for Lake Bloomington. Results for the available data in 1988 suggest that internal loading may be significant (12 percent of the total load) whereas the results for 2005 suggest that internal loading is not significant (less than 1 percent of the total load).

BATHTUB also performs statistical comparisons of observed and predicted concentrations in each model segment using the Student's t-Statistic testing (t-test) with alternative error terms (T1, T2, and T3). The t-test results are low confirming that the calibration is appropriate. T-test results are included in Appendix C.

The calibrated model was then used to estimate the loads to the lake for the years between 1988 and 2005. Predicted and observed concentrations are area weighted mean values for all the segments in the lake, as computed by BATHTUB. Figure 5-3 and Figure 5-4 indicate that the predicted concentrations reasonably match the observed concentration for both TP and TN in most years.

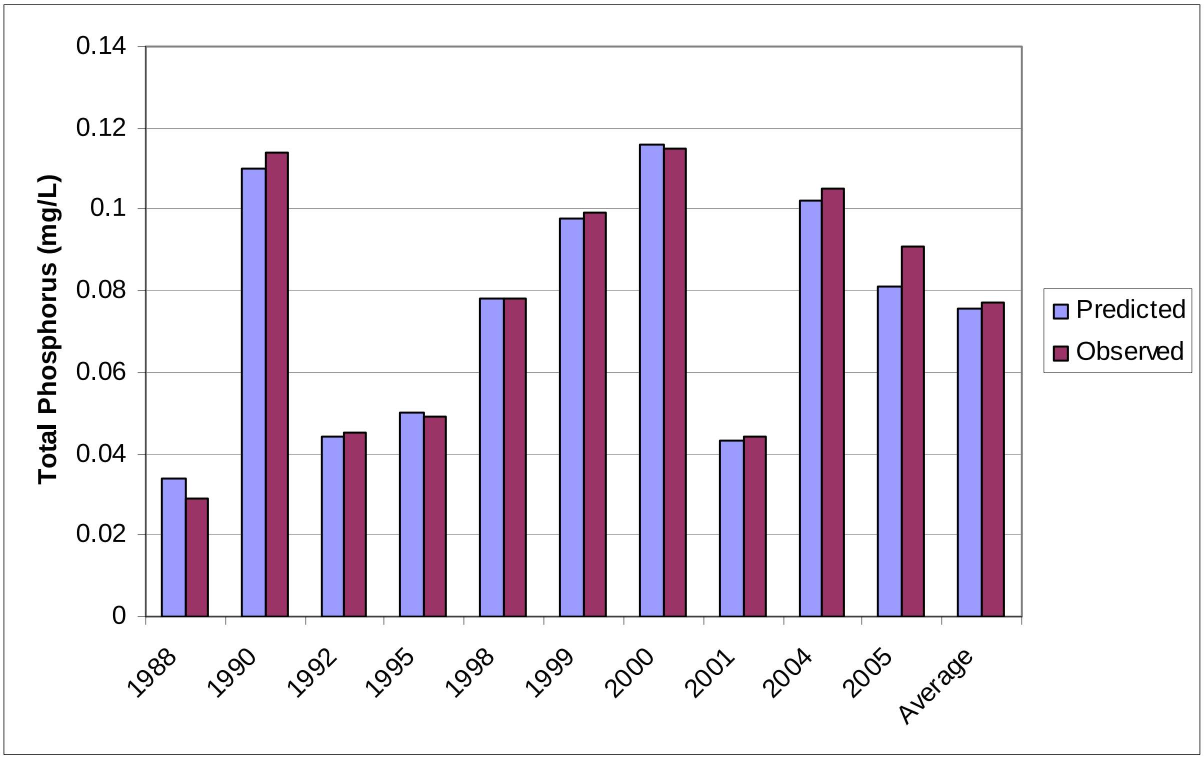

Figure 5-3 Observed and Predicted Concentrations of Total Phosphorus in Lake Bloomington

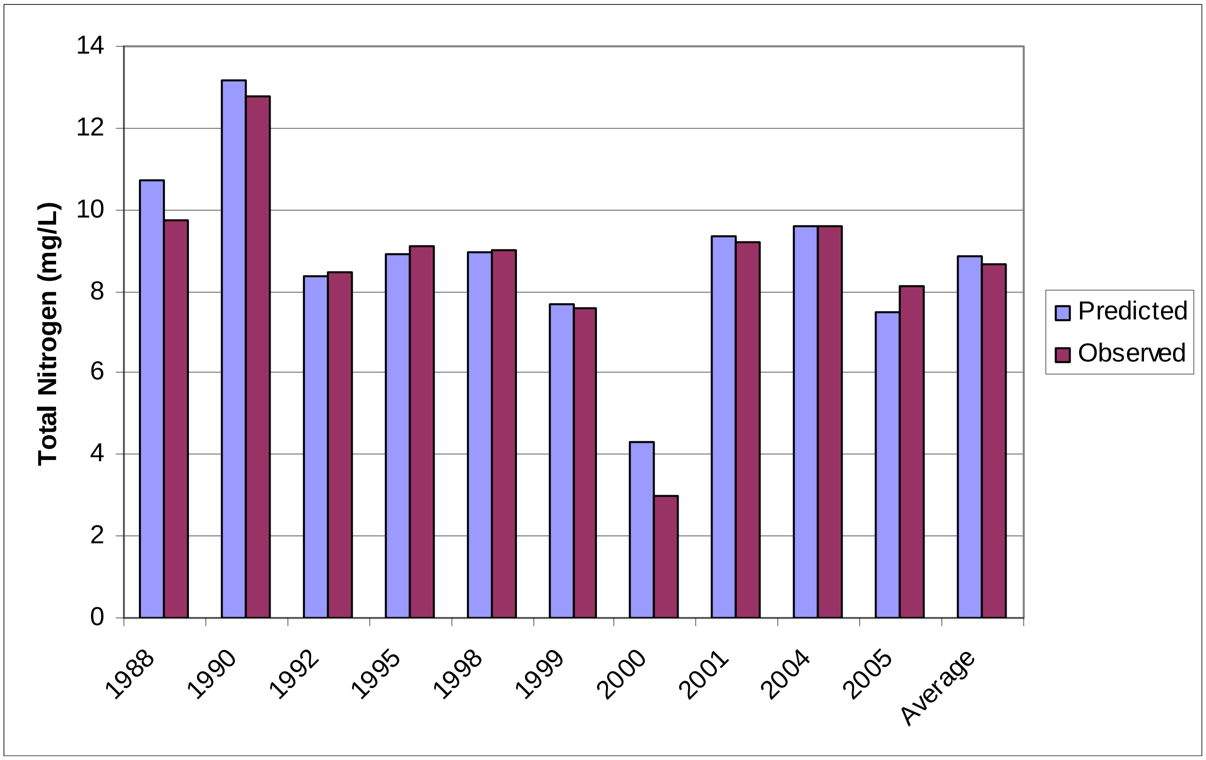

Figure 5-4 Observed and Predicted Concentrations of Total Nitrogen in Lake Bloomington

Predicted and observed average concentrations for Lake Bloomington are also shown in Table 5-3 and additional details are provided in Appendix C. Table 5-4 summarizes the predicted and observed loads for all modeled years.

Table 5-3 Predicted and Observed Nutrient Concentrations in Lake Bloomington for Current Conditions

Year	TP Concentrations		%	TN Concentrations		%
	Predicted mg/L	Observed mg/L	Relative Error	Predicted mg/L	Observed mg/L	Relative Error
1988	0.034	0.029	16	10.73	9.74	10
1990	0.110	0.114	-4	13.19	12.77	3
1992	0.044	0.045	-2	8.36	8.46	-1
1995	0.050	0.049	2	8.91	9.12	-2
1998	0.078	0.078	-0.8	8.96	9.00	-0.4
1999	0.098	0.099	-1	7.68	7.60	1
2000	0.116	0.115	1	4.29	2.99	44
2001	0.043	0.044	-1	9.34	9.18	2
2004	0.102	0.105	-2	9.57	9.58	-0.2
2005	0.081	0.091	-11	7.50	8.15	-8

Table 5-4 Predicted Loads and Stream Flows to Lake Bloomington for Current Conditions

Year	Current Loads		Money Creek Mean Annual Flow (cfs)
	TP lb/yr	TN lb/yr	
1988	3,679	1,107,613	22.36
1990	31,923	2,330,663	55.86
1992	6,424	917,918	32.87
1995	7,703	1,021,072	34.04
1998	16,177	1,147,913	42.69
1999	19,522	788,376	30.55
2000	22,106	405,768	26.45
2001	6,792	1,165,347	38.06
2004	21,623	1,150,658	34.77
2005	12,474	731,674	25.65

As shown in Table 5-3, the predicted in-lake average annual concentration of total phosphorous exceeds the target concentration of 0.05 mg/L for six years during the simulation period. In contrast, the predicted average annual concentration of total nitrogen, used conservatively as a surrogate for nitrate, exceeds the target concentration of 10 mg/L in only two of the ten years simulated. The predicted TP and TN average annual concentrations are not exceeded in some years. However, the individual concentrations do exceed the Illinois standards every year as shown in Section 3.2.

5.1.3 Load Reduction

The calibrated BATHTUB model was used to identify the reductions in loading needed for TP and TN. The load reduction percentages were applied to Money Creek, which is the major tributary to Lake Bloomington.

Predicted total phosphorous (TP) was in exceedance of the standard (TP > 0.05 mg/L) six years out of the 10 year simulation period. Input loads were reduced for each modeled year to meet the target with reductions ranging from 59 to 66 percent. A 66 percent load reduction is needed to meet the TP water quality standard in the year with the highest simulated TP (1990) which will then be protective of all other years. Table 5-5 shows the input TP loads to Lake Bloomington and the simulated in-lake concentration after the overall load reduction of 66 percent.

Table 5-5 Predicted TP Concentrations in Lake Bloomington with 66 Percent Reduction in Overall Loads

Year	Total TP Load Entering Lake Following 66 Percent Reduction (lb/yr)	Predicted Lake Bloomington TP (mg/L)
1990	10,805	0.050
1998	5,475	0.029
1999	6,607	0.046
2000	7,482	0.048
2004	7,319	0.041
2005	4,222	0.035

Nitrates (NO_3) are not calculated directly by the BATHTUB model. Therefore, the concentration of TN was conservatively used in this analysis as a surrogate for NO_3. Predicted total nitrogen (TN) was in exceedance (TN > 10 mg/L) during two of the ten years simulated. Input loads were reduced for each modeled year to meet the target with reductions at 18 and 34 percents. A 34 percent load reduction is needed to meet the nitrate water quality standard in the year with the highest simulated TN (1990) which will then be protective of all other years. Table 5-6 shows the input TN loads to Lake Bloomington and the simulated in-lake concentration after the load reduction of 34 percent.

Table 5-6 Predicted TN Concentrations in Lake Bloomington with 34 Percent Reduction in Overall Loads

Year	Total TN Load Entering Lake Following 66 Percent Reduction (lb/yr)	Lake Bloomington TN (mg/L)
1988	730,852	8.0
1990	1,537,874	10.0

6.0 TMDL

This section of the report presents the various components of the TMDL, as required by the Clean Water Act.

6.1 Loading Capacity

The loading capacity of Lake Bloomington is the pounds per year of TP and TN that can be allowed as input to the lake and still meet the water quality standard of 0.05 mg/L total phosphorus and 10 mg/L nitrate nitrogen. The BATHTUB model was used to identify the load reductions necessary to achieve a target concentration of total phosphorus and total nitrogen. A 66 percent reduction is needed to meet the TP target during all modeled years and a 34 percent reduction is needed to meet the TN target during all modeled years. The loading capacities of the lake for the critical modeled years are therefore 10,805 lbs/yr of TP and 1,537,874 lbs/yr of TN.

6.2 Allocations

The load allocation is calculated using the following equation:

LA = TMDL - WLA - MOS

Where WLA (Waste Load Allocation) is the loading assigned to point sources, LA (Load Allocation) is the loading assigned to nonpoint sources, TMDL (loading capacity) is the allowable load to Lake Bloomington and MOS (Margin of Safety) is to account for any lack of knowledge, uncertainty, and potential errors.

The allocations of TP and TN loads for the Lake Bloomington TMDL are summarized in Tables 6-1 and 6-2. The existing loads to the lake are the loads for the critical year (i.e., the year in which the greatest load reductions were needed to achieve water quality standards). The WLA is based on the East Bay Camp and Retreat's permitted design flow of 0.03 million gallons per day and an average TP concentration of 3.5 mg/L and TN concentration of 15 mg/L (see Section 4.2). Because the actual concentrations of TP and TN are unknown, it is recommended that the facility start sampling its effluent to determine its loading rates to the lake. These monitoring requirements can be included as a condition in the NPDES permit upon renewal. Ten percent of the loading capacity is reserved for a margin of safety for both TP and TN.

Table 6-1. TMDL Summary for TP in Lake Bloomington for critical modeled year

Category	TP (lb/yr)	TP (lb/day)
Existing Load	31,923	87.5
Reduction	66%	66%
Loading Capacity	10,805	29.6
Waste Load Allocation	320	0.9
Margin of Safety (5%)	540	1.5
Load Allocation	9,945	27.2

Table 6-2. TMDL Summary for TN in Lake Bloomington for critical modeled year

Category	TN (lb/yr)	TN (lb/day)
Existing Load	2,330,663	6,385.4
Reduction	34%	34%
Loading Capacity	1,537,874	4,213.4
Waste Load Allocation	1,373	3.8
Margin of Safety (10%)	153,787	421.3
Load Allocation	1,382,714	3,788.3

6.3 Seasonal Variation

Section 303(d)(1)(C) of the CWA and USEPA's regulations on 40 CFR 130.7(c)(1) require that a TMDL be established that addresses seasonal variations normally found in natural systems. A season is represented by changes in weather. Seasonal variation is represented in the Lake Bloomington TMDL as conditions were modeled on an annual basis. Modeling on an annual basis takes into account the seasonal effects the lake will undergo during a given year. Since the pollutant source can be expected to contribute loadings in different quantities during different time periods (e.g., various portions of the agricultural season resulting in different runoff characteristics), the loadings for this TMDL will focus on average annual loadings rather than specifying different loadings by season. Because an average annual basis was used for TMDL development, it is assumed that any critical condition is accounted for within the analysis.

The TMDL scenario simulated by the BATHTUB model is predicted to meet the compliance targets, and thus contains source loads that are consistent with the lake's loading capacity. The key to achieving water quality standards is the set of management practices that will achieve the proposed load reductions and their impact is best summarized in terms of monthly and annual loading rates by source. However, the TMDL must include daily load allocations as required by USEPA. To specify a daily maximum load that achieves the loading capacity, the annual loads were simply divided by 365 days. The daily load expression, while required by law, is thus a supplementary expression to the longer term loading capacity and allocations that form the essential part of achieving use support in the lake.

6.4 Margin of Safety

Section 303(d) of the Clean Water Act and USEPA's regulations on 40 CFR 130.7 require that "TMDLs shall be established at levels necessary to attain and maintain the applicable narrative and numerical water quality standards with seasonal variations and a margin of safety which takes into account any lack of knowledge concerning the relationship between effluent limitation and water quality." The margin of safety (MOS) is an additional factor included in the TMDL to account for scientific uncertainties, growth, etc., such that applicable water quality standards/guidelines are achieved and maintained. The MOS can be implicit (incorporated into the TMDL analysis through conservative assumptions) or explicit (expressed in the TMDL as a portion of the loadings) or a combination of both. An implicit MOS is associated with setting the WLA for the East Bay Camp and Retreat facility based on its maximum permitted flow of 0.030 MGD when actual discharges are typically on the order of 0.007 MGD to 0.018. A five percent and ten percent explicit margin of safety have been incorporated into the Lake Bloomington TMDL by reserving a portion of the loading for total phosphorus and total nitrogen, respectively. The margin of safety was calculated based on the average absolute errors associated with the modeling.

7.0 IMPLEMENTATION

A project Implementation Plan will be prepared that will fully address TP and TN sources and potential implementation activities that can achieve the desired load reductions. The implementation plan will include a range of alternatives along with their expected costs and benefits. IEPA will work with local agencies and stakeholder groups to identify best management practices that will result in meeting water quality goals. A separate public meeting will be held to specifically discuss issues related to implementation once the Implementation Plan is completed.

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APPENDIX A – BATHTUB MODEL DATA

Available upon request

Contact Illinois EPA at 217-782-3362

APPENDIX B – ERRATA SHEET

The final Stage Three report incorporates the changes described in the errata sheet.

ERRATA SHEET FOR LAKE BLOOMINGTON TMDL
February 19, 2008

After completion of the Stage Three TMDL development report for Lake Bloomington, the following corrections were found to be necessary:

Section 5.1.3 Load Reduction

The load reductions reported in this section of the TMDL (89 percent for TP and 48 percent for TN) represent the maximum load reductions applied to Money Creek (the major tributary) to achieve water quality standards in Lake Bloomington. However, when accounting for the other loads (Hickory Creek, precipitation, and direct runoff to the lake) the Money Creek load reductions translate into overall load reductions to the lake of 66 percent for TP and 34 percent for TN. These are the load reductions that should have been reported as they more accurately convey what is needed to achieve water quality standards in the lake. Similarly, Tables 5-5 and 5-6 should be replaced with the following that show the overall loads to the lake rather than just the Money Creek loads:

Table 5-5. Predicted TP Concentrations in Lake Bloomington with 66 Percent Reduction in Overall Loads.

Year	Total TP Load Entering Lake Following 66 Percent Reduction (lb/yr)	Predicted Lake Bloomington TP (mg/L)
1990	10,805	0.050
1998	5,475	0.029
1999	6,607	0.046
2000	7,482	0.048
2004	7,319	0.041
2005	4,222	0.035

Table 5-6. Predicted TN Concentrations in Lake Bloomington with 34 Percent Reduction in Overall Loads.

Year	Total TN Load Entering Lake Following 66 Percent Reduction (lb/yr)	Lake Bloomington TN (mg/L)
1988	730,852	8.0
1990	1,537,874	10.0

Section 6.1 Loading Capacity

Based on the previous discussion Section 6.1 of the report should be corrected to the following:

The loading capacity of Lake Bloomington is the pounds per year of TP and TN that can be allowed as input to the lake and still meet the water quality standard of 0.05 mg/L total phosphorus and 10 mg/L nitrate nitrogen. The BATHTUB model was used to identify the load reductions necessary to achieve a target concentration of total phosphorus and total nitrogen. A 66 percent reduction is needed to meet the TP target during all modeled years and a 34 percent reduction is needed to meet the TN target during all *modeled years. The loading capacities of the lake for the critical modeled years are therefore 10,805 lbs/yr of TP and 1,537,874 lbs/yr of TN.*

Section 6.2 Allocations

Based on the previous discussion Section 6.2 of the report should be corrected to the following:

The allocations of TP and TN loads for the Lake Bloomington TMDL are summarized in Tables 6-1 and 6-2. The existing loads to the lake are the loads for the critical year (i.e., the year in which the greatest load reductions were needed to achieve water quality standards). The WLA is based on the East Bay Camp and Retreat's permitted design flow of 0.03 million gallons per day and an average TP concentration of 3.5 mg/L and TN concentration of 15 mg/L (see Section ***4.2****). Because the actual concentrations of TP and TN are unknown, it is recommended that the facility start sampling its effluent to determine its loading rates to the lake. These monitoring requirements can be included as a condition in the NPDES permit upon renewal. Ten percent of the loading capacity is reserved for a margin of safety for both TP and TN.*

Table 6-3. TMDL Summary for TP in Lake Bloomington for critical modeled year.

Category	TP (lb/yr)	TP (lb/day)
Existing Load	31,923	87.5
Reduction	66%	66%
Loading Capacity	10,805	29.6
Waste Load Allocation	320	0.9
Margin of Safety (5%)	540	1.5
Load Allocation	9,945	27.2

Table 6-4. TMDL Summary for TN in Lake Bloomington for critical modeled year.

Category	TN (lb/yr)	TN (lb/day)
Existing Load	2,330,663	6,385.4
Reduction	34%	34%
Loading Capacity	1,537,874	4,213.4
Waste Load Allocation	1,373	3.8
Margin of Safety (10%)	153,787	421.3
Load Allocation	1,382,714	3,788.3

APPENDIX C – RESPONSIVENESS SUMMARY

Responsiveness Summary

This responsiveness summary responds to substantive questions and comments received during the public comment period from July 26 through August 17, 2007 postmarked, including those from the August 8, 2007 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 Lake Bloomington watershed 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 thereunder.

Background

The watershed targeted for TMDL development is Lake Bloomington (RDO), located in McLean County. The watershed encompasses an area of approximately 44,694 acres (70 square miles). Land use in the watershed is predominately agriculture. Lake Bloomington consists of 635 surface acres and is used as a water source for the city of Bloomington and surrounding towns. The water body is listed on the Illinois EPA 2006 Section 303(d) List as being impaired for nitrate, total phosphorus and total suspended solids. 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. Therefore, a TMDL was developed for total phosphorus and nitrates. The Illinois EPA contracted with Tetra Tech, Inc. to prepare a TMDL report for the Lake Bloomington watershed.

Public Meetings

Public meetings were held at Davis Lodge on Lake Bloomington on July18, 2006, and August 8, 2007. The Illinois EPA provided public notice for both meetings by placing display ads in the Bloomington Pantagraph. 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. Approximately 72 individuals and organizations were also sent the public notice by first class mail. The draft TMDL Report was available for review at the Bloomington Public Library, The McLean County Soil and Water Conservation District office, and also on the Agency's web page at http://www.epa.state.il.us/public-notices/

A public meeting started at 6:00 p.m. on Wednesday, August 8, 2007. It was attended by approximately 13 people and concluded at 7:00 p.m. with the meeting record remaining open until midnight, August 17, 2007.

Questions and Comments

1. Where do we stand in the watershed with the existing NPDES-permitted facility as far as phosphorus and nitrate?

   Response: The East Bay Camp and Retreat facility is not monitored for phosphorus or nitrate and so the existing loads from this facility are unknown. For modeling purposes, reported flows from the facility and typical WWTP values of 3.5 mg/L TP and 15 mg/L TN were used to estimate existing loads of TP and TN to the lake in the absence of monitoring data.

2. Can the implementation plan realistically reduce the pollutants by the high percentages needed in an agricultural watershed in order to meet water quality standards?

   Response: Information on pollutant reductions will be provided in the implementation plan. Considerable uncertainty exists in quantifying the effectiveness of individual best management practices, so it is difficult to answer this question conclusively. This is why an adaptive management approach will be suggested in the implementation plan.

3. The City of Bloomington has made some improvements at the lake. Have those actions shown any results?

   Response: We are aware of the City's efforts and would expect that they have already had or will eventually lead to improved water quality. However, there are many variables that make it difficult to assess the short-term impacts of such improvements. For example, in any one year the weather will have the largest impact on water quality conditions within the lake, making it difficult to assess short-term trends. The lake should continue to be monitored to obtain water quality data that in the future can be used to analyze water quality improvements before and after BMP implementation.

4. Do we have enough data to explain why total phosphorus concentrations in the lake fluctuate from year to year?

   Response: Higher TP concentrations in the lake are generally associated with wetter years (and thus increased loading to the lake). However, there are other factors that affect annual total phosphorus concentrations that are more difficult to characterize.

5. Can septic permit data be correlated to these fluctuations?

Response: No. There are inadequate data on the performance of individual septic systems in the watershed (and how these fluctuate from year to year) to be able to make such a correlation.

6. As long as Lake Bloomington is listed as impaired, does that mean future NPDES permits for TMDL quantified pollutants will not be issued? Does that mean that renewal of existing permits will not occur? Or that existing permits can be renewed, but not increased in terms of allowable load? Or that renewed or future applicants will be required to monitor for phosphorus? These questions are central to determining the urgency of response by local governmental entities as impacts on future growth can be a powerful motivation to seek attainment of standards.

   Response: The TMDL should identify pollutant loading and load reductions necessary to remedy the impairment. Implementation strategies to achieve those reductions will be developed around known and anticipated loads within the tributary watershed. For existing sources whose permits are expiring and scheduled for renewal, the agency will incorporate whatever additional monitoring may be needed to support development of the TMDL and upon approval by USEPA of a TMDL, any effluent load reductions specified for those specific sources in the TMDL will be incorporated into each permit. Should new point sources emerge that were not anticipated in the TMDL, a review and possible revision of the TMDL may be necessary. It is very difficult if not impossible to speculate at this stage what ultimate requirements may be placed upon new sources. It would be prudent that anyone proposing new development explore alternatives that do not necessitate additional discharge tributary to Lake Bloomington. If new loading is determined to be necessary it may require revision of the TMDL and affiliated load allocations.

7. The draft Stage 3 TMDL report does not account for septic system contributions to the lake. By not mentioning septic loads in the report, does that mean that Illinois EPA does not consider them to be significant contributors of phosphorus and nitrates? All of the houses surrounding the lake have septic systems, and it seems they would be significant contributors, given their proximity to the lake.

   Response: The Stage 3 TMDL report indirectly accounts for septic system contributions to the lake and septic systems are acknowledged as a potential source of nutrient loads. Contributions from the nonpoint pollutant sources (including septic systems) were lumped and input to the lake model as a general loading category. As stated throughout the Stage 1 and Stage 3 reports, failing septic systems are considered a potential source of impairment. Septic systems with subsurface discharges are considered nonpoint sources for pollutants, including nitrates and phosphorus. Point source pollutants enter a

water through a discharge pipe, whereas nonpoint source pollutants come from the soil either through direct erosion or by soluble pollutants leaching out of the soil. Since septic systems are designed for the soil to absorb the effluent wastewater and the pollutants in them, nitrates and phosphorus from a properly operating septic system should be entering the lake only through nonpoint source mechanisms. As with virtually all nonpoint source pollution, it is very difficult to directly measure the quantity of a pollutant entering a water from a specific area. The amount of nitrates and phosphorus entering the lake from septic systems is further complicated because a portion of these nutrients are bound to the soil (phosphorus), are converted to volatile compounds through soil microbial activities (nitrates), and are utilized by vegetation growing in the soil (phosphorus and nitrates). Due to these factors, potential loadings from septic systems were not explicitly incorporated into the model, and were considered a component of the nonpoint source load. The forthcoming implementation plan will recommend best management practices for ensuring properly functioning septic systems.

8. If we can't readily identify and quantify the pollutants from each nonpoint source, how can we get the most "bang for the buck" as far as implementation goes?

   Response: The contribution of the various sources may be more fully explored during development of the implementation plan, along with a cost/benefit analysis of the various BMPs that could be used to address those sources.

9. It is disturbing that so much reliance is on flow data from years ago (Money Creek: 19331958 for one station, 1958-1983 for another; Hickory Creek: 1939-1958). It seems likely that climate change has altered flows in the more recent decades. While you can only deal with the data you have, I wonder how deficient you think this makes the conclusions of the model.

   Response: Even though the flow data are old, the model was calibrated to recent observed total phosphorus and total nitrogen concentrations in Lake Bloomington, which implicitly reflect the incoming flows. The relatively good match between the simulated and observed in-lake concentrations provides some evidence that the estimated flows are reasonable.

10. Why was a site in the Illinois River valley, Peoria, chosen as the source for precipitation data instead of using data from sites in McLean County where Lake Bloomington is located? The Midwestern Regional Climate Center provides some closer stations. Also, why didn't you use precipitation data from just the last 30 years? We know that precipitation

has been changing due to climate change, so using data from the first half of the 20th century may not accurately represent the situation in the second half.

Response: The closest precipitation station to the watershed with long-term records is located in Normal, IL. However, the Normal station did not have precipitation records dating back to 1935, which were needed to correlate to the observed flow data from (Money Creek: 1933-1983) and Hickory Creek (1939-1958). As mentioned in the response to comment #8, the model was calibrated to observed total phosphorus and total nitrogen concentrations in Lake Bloomington, which implicitly reflect the incoming flows. The relatively good match between the simulated and observed in-lake concentrations provides some evidence that the estimated flows are reasonable despite the impacts of climate change.

11. Why was a site in the Illinois River valley, at Hennepin, chosen as the source for pan evaporation data? The Midwestern Regional Climate Center provides some closer or more geographically appropriate stations. Also, why didn't you use pan evaporation data from just the last 30 years? We know that evaporation has been changing due to global climate change.

    Response: The Hennepin Power Plant was the closest station with significant evaporation data. Other stations with sufficient evaporation data (in Urbana, IL and Springfield, IL) are located farther away from the watershed. Evaporation rates are also not expected to be dramatically different given the climate and topography of this area of Illinois and also do not have a large impact on the modeling results.

12. Why was just flow data from the two streams used and not flow data estimated from the 353 active septics located fifty to several hundred feet from the lake and the 90 near the southeast side of the lake (443 total)? Using figures from an AWWA Research Foundation national study (http://www.awwarf.org/research/topicsandprojects/execSum/241.aspx), we can estimate that 27,183,366 gallons per year are entering septics (average of 61,362 gallons per househould per year for indoor use times 443), and some of that must be reaching the lake with nutrients.

    Response: As discussed in the response to comment #7, the Stage 3 TMDL report indirectly accounts for septic system contributions to the lake. The contribution of the various sources, including septic systems, may be more fully explored during development of the implementation plan. It is also important to note that the performance of the septic systems is as important as their number,

effluent volume, and location. Fully functioning septic systems are not considered to contribute significant loads of total phosphorus due to soil retention in the leach field.

13. Why didn't you use WAM to model tributary discharge into Lake Bloomington?

    Response: The Watershed Assessment Model (WAM) is one of many watershed models (e.g., Soil and Water Assessment Tool, Hydrologic Simulation Program in Fortran, Generalized Watershed Loading Functions model) that could have been used to estimate tributary loads to Lake Bloomington. However, IEPA's Science Advisory Committee has recommended against the use of such watershed models when developing TMDLs

14. Have critical conditions been taken into account in the development of this TMDL? In terms of loading, spring runoff periods are considered critical because wet weather events can transport significant quantities of non point source loads to the lake. Usually the water quality ramifications of these nutrient loads are most severe during middle or late summer.

    Response: Yes, critical conditions were accounted for in the TMDL because the simulations were made for individual years and the TMDL is based on meeting water quality standards in the critical year (the year with the highest nitrate and TP concentrations). We agree with the comment that loads are most likely greatest during the spring whereas the critical problem manifests itself in the lake during the late summer. The spring loading is accounted for in the analysis through the use of daily flows to estimate tributary loads and the summer water quality in the lake is accounted for by the BATHTUB model. Setting the TMDL based upon an annual average TP concentration (rather than a daily TP concentration) is considered appropriate because lake eutrophication issues are more of a chronic than an acute problem.

15. Phosphorus loss rates in BATHTUB rates reflect a typical "net settling rate" (i.e. settling minus sediment release) observed over a range of reservoirs. Under-prediction of observed phosphorus concentrations can occur in cases of elevated phosphorus release from lake sediments. Since the Nurnberg method chosen to approximate the internal load provided ambiguous results, can you utilize another method to approximate the internal load?

    Response: The best way to estimate internal loads would be to monitor them. Short of that, the Nurnberg method is one of very few tools available for estimating the significance of internal phosphorus

loading. Other methods, to be explored during the development of the implementation plan, are based more upon a "weight of evidence" approach (e.g., evaluating the number of days of anoxia, assessing TP concentrations in the sediment and at the bottom of the lake).

16. How are atmospheric nitrate and phosphorous inputs specified?

    Response: The BATHTUB model includes default rates of direct deposition to the lake surface for total nitrogen and total phosphorus.

17. Why aren't dissolved and particulate phosphorus broken out?

    Response: The BATHTUB modeling is based upon both dissolved and particulate phosphorus. Only total phosphorus is reported in the TMDL to be consistent with the water quality standard.

18. In paragraph 4, under the list of potential nonpoint sources, no mention is made of lawn fertilizer run-off despite the heavy residential development around much of the lake. Lawn fertilizer runoff was mentioned later in section 4.1. Does the lack of it in the Key Findings section mean the authors consider it to be negligible?

    Response: Thank you for this comment. Lawn fertilizer runoff was added as a potential source in the Key Findings section of the final report.

19. The list of entities that utilize Lake Bloomington as a water supply does not include the City of Bloomington, unless the City is included within "Bloomington Township West Phase". Actually, I have no idea what "West Phase" refers to. Also, this list does not include receiving entities mentioned later in section 2.2.

    Response: The "West Phase" service area is the name given to the Bloomington Township Public Water District (PWD) that provides water service to the unincorporated areas around the City of Bloomington. The City of Bloomington and the Meadows of Bloomington and Hilltop manufactured home parks will be added to the report.

20. Crestwicke is mispelled here and elsewhere.

    Response: Thank you for your comment. This will be corrected in the final report.

21. Table 1-1. This table omits some of the potential sources that are mentioned in other sections of the document. Potential sources for both TP

and Nitrogen Nitrate should include septics and lawn fertilizer runoff.

Response: The list of potential sources in Table 1-1 is taken directly from the Illinois EPA Integrated Report and is considered a screening-level assessment of potential sources made at the time of the original listing. One of the purposes of the TMDL effort was to better identify specific sources, which now includes septics and lawn fertilizer runoff.

22. In Section 2.3 Land Use and Land Cover, Paragraph 1 you refer to Figure 2-3, but you mean Figure 2-2. It is puzzling why two categories, forest and surface water, were lumped together ("1.8 percent...consists of forest or surface water"), when there would be great value in keeping them separated. Finally, it should be stated that the Illinois GAP data came from the Land Cover of Illinois 1999-2000 source so that the reader knows the relative time frame in which the data was collected.

    Response: The reference to Figure 2-2 will be corrected in the report. The paragraph in question will also be corrected to read "Wetlands account for approximately 2.5 percent (1,103 acres) of the watershed, urban lands accounts for 2.5 percent (1,116 acres), and forest lands (380 acres) are less than 1 percent."

23. In Section 2.4 Soil and Topography, page 6, second paragraph. "...some private septic systems may be connected with the drain tile system..." Any idea how prevalent this is likely to be? Is this informed speculation?

    Response: We do not have any specific information on private septic systems within the watershed that are known to be connected to the drain tile system. However, such systems have been documented in other watersheds in Illinois and it is reasonable to believe that they might exist within the Lake Bloomington watershed as well. If so, they can be a potentially important source of nutrients.

24. In Section 3.2 Assessment of Water Quality Data, Figure 3-1 is confusing. STA-3 that is referred to in the text is not on the map. Other figures on the map (e.g., DKP 03) are not defined in the text.

    Response: Thank you for this comment. Station STA-3 has been added to Figure 3-1 in the final report. The intent of this figure is to show all of the water quality stations with available data in the watershed whereas the text is referring to only those stations with a significant amount of data that were used in the analysis.

25. In Section 4.1 Nonpoint Sources Paragraph 6. It states that "most of them have valid permits", implying that some do not. Do we know how many do not?

Response: No, we do not know how many septic systems don't have valid permits. The McLean County Health Department's Environmental Health Division estimated there are approximately 939 permitted septic systems in the County. Comparing the number of residences in the watershed with the estimated number of permitted systems on file may be explored during development of the implementation plan.

26. In Section 4.1 Point Sources page 18, Towanda Grade School. It states that "it is assumed that the homes [in Towanda] have septic systems." After the earlier detailed septic information regarding Hudson and Lake Bloomington environs, I'm surprised that there is no data regarding Towanda.

    Response: The reference to septic systems in Towanda will be deleted from this section of the report as it is not directly related to the main topic (i.e., permitted point sources). It is our understanding that the homes in Towanda are served by septic systems.

Lake Bloomington Watershed TMDL Implementation Plan

FINAL REPORT

June 25, 2008

Submitted to:
Illinois Environmental Protection Agency
1021 N. Grand Avenue East
Springfield, IL 62702

Submitted by:
Tetra Tech

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KEY FINDINGS

The Illinois Environmental Protection Agency (IEPA) has identified Lake Bloomington as impaired by total phosphorus and nitrate because sampling indicates that the water quality standards are frequently exceeded. As required by the Clean Water Act, a Total Maximum Daily Load (TMDL) was developed to address total phosphorus and nitrate impairments. The TMDL was based on the application of the U.S. Army Corps of Engineers BATHTUB model which determined that a 66 percentage reduction in phosphorus loads and a 34 percent reduction in nitrate loads are needed to meet the applicable water quality standards.

The major sources of phosphorus to Lake Bloomington are estimated to be agriculture land uses, onsite wastewater treatment systems, and shoreline erosion. There are approximately 38,535 acres of agriculture cropland in the watershed. Phosphorus loadings from this source range from 5,780 to 16,185 lb/yr and nitrogen loadings range from 289,013 to 574,172 lb/yr. The cost-effective BMPs that have been identified for agricultural land uses include nutrient management plans, conservation tillage, grassed waterways, filter strips and the installation of outlet control structures on tile drain systems. These BMPs can each be implemented at a cost ranging from $1.00 to $6.50/ac/yr and may be sufficient to meet the water quality standards if they are used widely across the watershed.

There are approximately 1,989 septic tank systems in the watershed. Phosphorus loadings from failing systems range from 610 to 2,614 lb/yr and nitrogen loadings range from 17,957 to 18,055 lb/yr. The cost-effective BMP includes maintenance, inspection and replacement of septic tank systems. This BMP can be implemented at a cost ranging from $168 to $459/system/yr and may be sufficient to meet the water quality standard for phosphorus.

Shoreline erosion is a potential source of nutrients to Lake Bloomington. A shoreline erosion study of Lake Bloomington was completed in 2005 and estimated a total load of sediment to the lake of 3,756 ton/yr. Using literature values for phosphorus enrichment ratios, the potential phosphorus load from shoreline erosion is estimated to be between 3,300 lb/yr to 6,200 lb/yr. The shoreline study recommends Stone Toe Protection (STP) applied along the eroding sections to provide stability and prevent additional recession of the bank line. The estimated STP cost for class 6 areas (highest erosion rate) is $7,000 per year assuming a useful life of 50 years or a cost of $3.25/yr per pound of soil saved.

Phase I of this implementation plan will provide education and incentives to landowners in the watershed to encourage the use of these BMPs. Phase II will involve the voluntary participation of landowners to continue to implement BMPs and will continue and expand the water quality monitoring efforts. Phase III may or may not be required depends on the results of Phase II monitoring. This phase includes evaluating the BMPs in place and re-assessing management strategies if goals are not being met.
As agricultural BMPs are implemented, failing septic systems are corrected, and shoreline erosion is reduced, water quality in Lake Bloomington should improve accordingly and eventually meet the required water quality standards.

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1.0 INTRODUCTION

The Clean Water Act and USEPA regulations require that states develop Total Maximum Daily Loads (TMDLs) for waters identified as impaired on the Section 303(d) lists. Lake Bloomington is listed on the Illinois EPA 2006 303(d) list as described in Table 1-1.

IEPA is implementing their TMDL projects in three stages:

- Stage One, completed in the Spring of 2006 for Lake Bloomington, involves the characterization of the watershed, an assessment of the available water quality data, and identification of potential technical approaches.
- Stage Two involves additional data collection for waters where a TMDL could not yet be developed. Stage Two was not necessary for Lake Bloomington.
- Stage Three involves model development and calibration, submittal of a TMDL report to USEPA for approval, and implementation planning. The model development and TMDL report submittal for Lake Bloomington were completed in the Fall of 2007. This report fulfills the final portion of the project—the development of an implementation plan.

Table 1-1. Impaired waters within the Lake Bloomington Watershed

Segment	Designated Use (Support Status)	Causes of Impairment	Potential sources of Impairment
Lake Bloomington (RDO)	Aesthetic Quality	Total Phosphorus (TP)	Crop Production (Crop Land or Dry Land), Other Recreational Pollution Sources, Runoff from Forest/Grassland/Parkland
	Public and Food Processing Water Supplies	Nitrogen, Nitrate (NO_3)	Crop Production (Crop Land or Dry Land), Other Recreational Pollution Sources, Runoff from Forest/Grassland/Parkland

Note: During the TMDL development process other potential sources of impairment, including point sources and failing septic systems, have been identified

This report presents an implementation plan that identifies feasible and cost effective management measures capable of reducing pollutant loads to the levels identified by the TMDL analysis. The intent of the plan is to provide information to local stakeholders regarding the selection of cost-effective best management practices (BMPs). It should be noted that a great deal of effort has already been made to assess BMPs for the Lake Bloomington watershed. Previous studies include:

- Use of Created Wetlands to Improve Water Quality in the Midwest – Lake Bloomington Case Study (Kovacic, 2006)
- Lake Bloomington Watershed Plan – DRAFT (Lake Bloomington Planning Committee, 2008)
- Water Quality Improvement Case Study: Assessment of the Lake Bloomington Watershed (David et al, 2008)
- Fertilizer Nitrogen Management to Optimize Water Quality (Smiciklas and Moore, 1999)
- Lake Bloomington Shoreline Erosion Study (Midwest Streams, 2008)

These previous studies have been referenced during development of this implementation plan with the intent that they can all complement one another. In a relatively few instances the information presented in this report might differ from something reported in one of the other studies (e.g., the reported effectiveness for a particular BMP). In such cases the reader should use his or her best judgment as to the usefulness of the information. Final selection of the appropriate BMPs must be made at the local level and should take into account cost-effectiveness as well as other important criteria (e.g., social acceptance of the various BMPs). Effective implementation will require an adaptive management approach in which BMPs are placed on the ground, monitored for effectiveness, and then adjusted accordingly in the future.

This section of the report provides an overview of the TMDL development process and provides information on the impaired water bodies in the Lake Bloomington watershed. The remaining sections of this report describe the water bodies and watershed characteristics (Section 2.0); present the water quality standards and the TMDL summary (Section 3.0); identify the pollutions sources and implementation activities (Section 4.0); prioritize the implementation activities (Section 5.0); provide information on measuring and documenting progress (Section 6.0) and reasonable assurance (Section 7.0); and present a draft implementation time line (Section 8.0).

2.0 DESCRIPTION OF WATERBODY AND WATERSHED CHARACTERISTICS

This section of the report provides a brief summary of the general characteristics of the Lake Bloomington watershed and water bodies. A detailed description of this watershed can be found in the Stage One Report (IEPA, 2006).

The Lake Bloomington watershed is located in the central part of McLean County, Illinois as shown on Figure 1-1. The main tributary to the lake is Money Creek, which flows from southeast to northwest in the watershed, and is a tributary to the Mackinaw River Basin (Hydrologic Unit Code 07130004). Hickory Creek, a small tributary of Money Creek, also flows north into Lake Bloomington. The communities of Towanda and Merna are located within the watershed. Lake Bloomington is located in the northern portion of the watershed, about 15 miles north of the City of Bloomington.

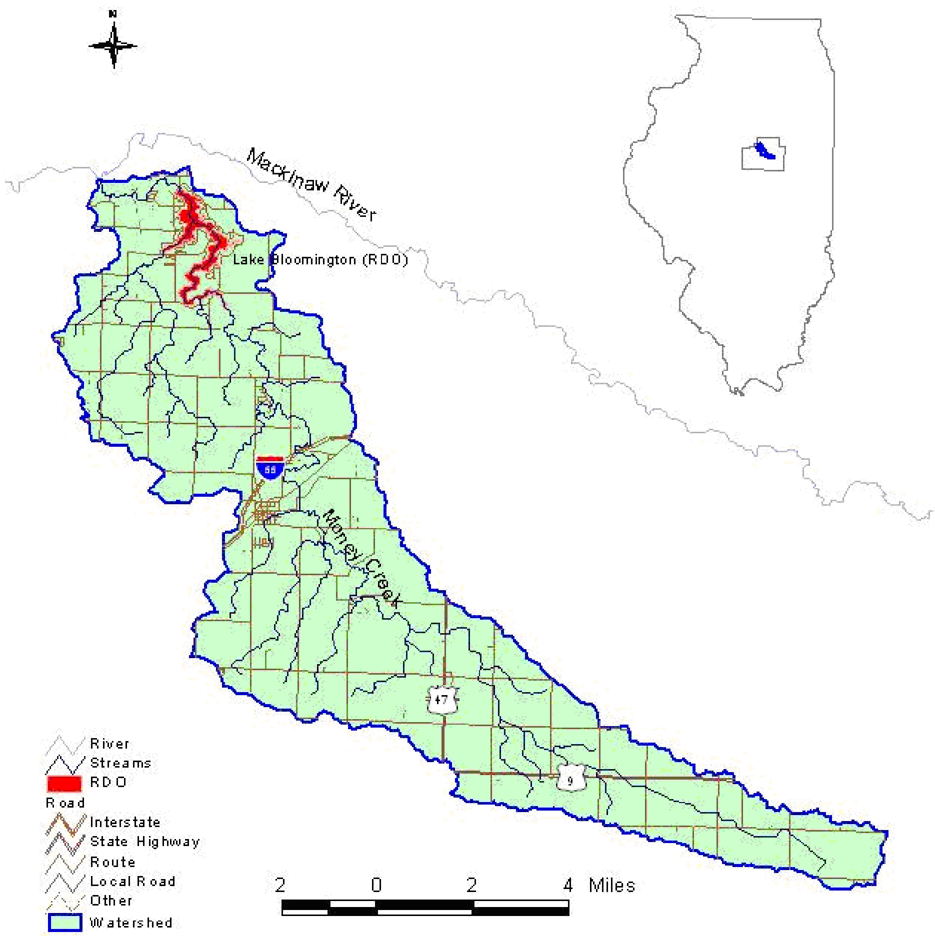


Figure 1-1 Lake Bloomington Watershed

The total population in the watershed is estimated to be approximately 4,500. According to the 2000 US Census Bureau, McLean County's population increased from 129,180 in 1990 to 150,433 in 2000 (or about 17 percent). There were approximately 1,490 dwelling units in the watershed in 2006 compared to 976 dwellings found in 1994, which reflects an increase of 53 percent (Lake Bloomington Planning Committee, 2008). Most of these dwellings were built within the Bloomington/Normal urban area.

Agricultural land uses are dominant in the Lake Bloomington watershed, making up 93.2 percent (41,666 acres) of the total area, with the major crops being corn and soybeans. Wetlands and open water account for approximately 3.5 percent (1,103 acres) of the watershed, urban lands accounts for 2.5 percent (1,116 acres), and forest lands (380 acres) are less than 1 percent.

The uppermost bedrock within the Lake Bloomington watershed is mostly Pennsylvanian age and in certain locations is covered by Quaternary deposits that are up to 500 feet thick. The watershed is heavily tiled to promote agricultural drainage.

Hydrologic Soil Group B covers 38.7 percent of the watershed, primarily in the southeastern portion of the watershed, adjacent to Lake Bloomington, and in the middle and northern sections of Money Creek. Soil Group B/D[1] covers approximately 59.8 percent and is found throughout the watershed and adjacent to the southern section of Money Creek. Soil Group C covers only 0.6 percent of the watershed and is found in small areas surrounding Lake Bloomington and the northern section of Money Creek upstream from the lake. Soil Group C/D accounts for 0.9 percent of the watershed and is found in various locations.

Lake Bloomington (RDO) is the drinking water supply for the City of Bloomington, the Village of Hudson, Towanda, Bloomington Township West Phase, Bloomington Township West Phase Crestwicke, and the Meadows of Bloomington and Hilltop manufactured home parks. The lake is also used for recreational purposes and is surrounded by approximately 215 single family homes within 300 feet of the lake. Existing development surrounding the lake is mainly residential with few commercial establishments (Lake Bloomington Planning Committee, 2008).

The drainage area for Lake Bloomington is 69.5 square miles and the water surface area for the lake is 572 acres. The maximum storage capacity of the lake is 8,760 acre-feet, the average depth is 12.9 feet and the maximum depth is 35 feet. The average annual precipitation is 35 inches and the estimated annual average evaporation from the lake is 28.4 inches.

[1] Within Illinois soils designated with dual classifications (e.g., B/D) denote the presence of tile drainage which allow the soil to take on the attribute of a Class B soil (Dennis McKenna, Illinois Department of Agriculture, personal communications, December 15, 2004).

3.0 WATER QUALITY STANDARDS AND TMDL SUMMARY

This section of the report presents the applicable water quality standards, a summary of the historic water quality data, and a summary of the findings of the TMDL analysis. A more detailed discussion of the available water quality data and the TMDL is included in the Stage Three Report (IEPA, 2007).

3.1 Applicable Water Quality Standards

Lake Bloomington is listed on the Illinois 2006 303(d) list for aesthetic quality use impairment caused by total suspended solids (TSS), total phosphorus (TP), and aquatic algae. Lake Bloomington is also listed as impaired for the public and food processing water supply designated use due to high nitrate concentrations. Table 3-1 summarizes the applicable numeric water quality standards for Lake Bloomington.

At this time, IEPA does not develop TMDLs for parameters that do not have numeric water quality standards. Therefore, a TMDL was not developed for TSS. Because the total phosphorus load is largely associated with TSS load, the measures implemented for phosphorus reduction may also reduce the sediment load to the lake and decrease the storage loss rate.

Table 3-1. Water Quality Standards for Lake Bloomington

Parameter	Units	General Use Water Quality Standard	Public and Food Processing Water Supplies	Section for Regulatory Citation[b]
Nitrate-Nitrogen	mg/L	No numeric standard	10 mg/L	302.304
Total Phosphorus	mg/L	0.05[a]	No numeric standard	302.205

[a] Standard only applies in lakes/reservoirs that are greater than 20 acres in surface area and in any stream at the point where it enters such a lake/reservoir.
[b]All IEPA water quality standards are published by the Illinois Pollution Control Board under Title 35: Environmental Protection Subtitle C: Water Pollution Chapter I: Pollution Control Board. Part 302. Water Quality Standards. Subpart A: General Water Quality Provisions.

3.2 Water Quality Assessment

From 1977 to 2005, a total of 474 samples for total phosphorus were collected within Lake Bloomington. Based on the more recent data (those collected between 1998 to 2005) 53.5 percent exceeded the TP standard of 0.05 mg/L. Similarly, from 1977 to 2005, a total of 670 samples of nitrate nitrogen were collected. Based on the more recent data (those collected between 1998 and 2005) approximately 26.0 percent exceeded the standard of 10 mg/L. A more detailed analysis of the available water quality data can be found in the Stage 3 report (IEPA, 2007).

3.3 TMDL Summary

The Lake Bloomington TMDL was based on the application of the U.S. Army Corps of Engineers BATHTUB model which determined that a 66 percent reduction in total phosphorus loads and a 34 percent reduction in nitrate loads are needed to meet the applicable water quality standards. Table 3-2 summarizes the TMDL results.

Table 3-2. TMDL Summary for TP and TN in Lake Bloomington

Category	TP (lb/yr)	TN (lb/yr)
Existing Load	31,923	2,330,663
Loading Capacity	10,805	1,537,874
Waste Load Allocation	320	1,373
Margin of Safety	540	153,787
Load Allocation	9,945	1,382,714
Reduction	66%	34%

Table 3-2 shows the TMDL results for TP and TN. TN loads were used as surrogate for nitrate loads because the BATHTUB model does not calculates loads for nitrate directly. This approach is justified because the available data indicate that the majority of the TN content in the lake is from nitrates.

4.0 POLLUTION SOURCES AND IMPLEMENTATION ACTIVITIES

This section of the report describes the potential sources of nitrogen and phosphorus within the Lake Bloomington watershed and presents information on appropriate best management practices (BMPs) for each source.

Most of the land in the Lake Bloomington watershed is used for agricultural production. Therefore, agricultural activities are one of the most significant sources of pollutants. Other potential sources include the lake sediments themselves, wastewater treatment plants, onsite wastewater treatment systems, stream channel erosion, and shoreline erosion. Table 4-1 summarizes the BMPs discussed in this report for various source categories that have been identified.

Table 4-1. Summary of BMPs and associated impairment

Source	BMP	Nitrogen	Phosphorus
Agricultural Land Uses	Nutrient Management Plan	✓	✓
	Conservation Tillage	✓	✓
	Cover Crops	✓	✓
	Filter Strips	✓	✓
	Grassed Waterways	✓	✓
	Restoration of Riparian Buffers	✓	✓
	Controlled Drainage	✓	✓
	Wetland Systems	✓	✓
Lake Sediments	Lake Bottom Sediments		✓
	Shoreline Erosion	✓	✓
Onsite Wastewater Treatment Systems	Pumping	✓	✓
	Inspection	✓	✓
	Replacement	✓	✓
	Public outreach	✓	✓
Stream Channel Erosion	Filter Strips	✓	✓
	Grassed Waterways	✓	✓
	Restoration of Riparian Buffers	✓	✓

4.1 Agricultural Activities

The Lake Bloomington watershed is predominantly agricultural with 86 percent of the watershed used for cropland (primarily corn and soybeans) and 7 percent potentially used for pasture[2]. Row crop agriculture

[2] Approximately 3,076 acres are classified by the 2001 GAP land use coverage as rural grassland, which is the only category of land use that might include pasture.

is a common nonpoint source of nutrient loads and sediments, with rain and snow melt events delivering the majority of pollutant loads to streams and lakes.

Agriculture is believed to be the primary source of nutrient loads to Lake Bloomington. There are 160 farms in the watershed farming approximately 42,000 acres (University of Illinois Extension, 2001). In this region, tile drainage in agricultural fields is extensively used. Based on the amount of soil classified as poorly drained, the McLean County SWCD estimates that 7,500 acres in Lake Bloomington watershed are tiled (Lake Bloomington Planning Committee, 2008).

Animal feedlots and confinement operations are other potential sources for nutrient loads. A livestock inventory was conducted in Lake Bloomington watershed in 2007. The inventory indicates that a total of 414 head of livestock including cattle, sheep, swine and horses exist in the watershed. There are 25 livestock operations and 3 confinement operations for swine. The total number of swine is unknown (Rutherford, 2007b). Table 4-2 summarizes the total number of animals in the watershed.

Table 4-2. Livestock Inventory within Lake Bloomington Watershed in 2007.

Total Livestock Head	Number
Cattle	286
Sheep	80
Horses	42

This section of the implementation plan describes the mechanisms of nutrient loading from farmland and the best management practices that have been employed in similar watersheds to reduce loadings. This report contains only cost-effective practices that have proven in other watersheds to be effective at reducing nutrient loads.

4.1.1 Source Description and Approximate Loading

Accumulation of nutrients on farmland occurs from decomposition of residual crop material, fertilization with chemical and manure fertilizers, atmospheric deposition, wildlife excreta, irrigation water, and application of waste products from municipal and industrial wastewater treatment facilities. Nutrient losses and transport occur through soil erosion, infiltration to groundwater, infiltration to subsurface flow systems, and surface runoff. Agricultural practices such as application of fertilizers and tile drainage systems are the primary potential source of nutrient loads in the Lake Bloomington watershed.

A sampling program conducted in 1992 and 1993 by the Agriculture Department at Illinois State University showed that the majority of the nitrates entering the lake came from tile drainage fields (Lake Bloomington Planning Committee, 2008).

In Central Illinois the majority of soybean and corn crops rely on commercial fertilizer rather than animal manure to enhance soil fertility. In heavily fertilized areas, nutrient loads have increased significantly over background levels. Studies done by local fertilizer dealers show an average phosphorus level of 37 to 42 lb/ac in agricultural soils (Lake Bloomington Planning Committee, 2008).

Cropland erosion is a potential source of nutrients to Lake Bloomington. The K-factor, a coefficient used in the USLE (Wischmeier and Smith, 1978), is a dimensionless measure of a soil's natural susceptibility to erosion. Factor values may range from 0 for water surfaces to 1.00, with large K-factor values representing greater potential soil erodibility. The distribution of K-factor values in the Lake Bloomington watershed is shown in Figure 4-1 and indicates that average K-factors range from 0.24 to 0.41. Note that several areas to the east of Lake Bloomington have relatively high K-factors and could therefore be targeted for appropriate BMPs.

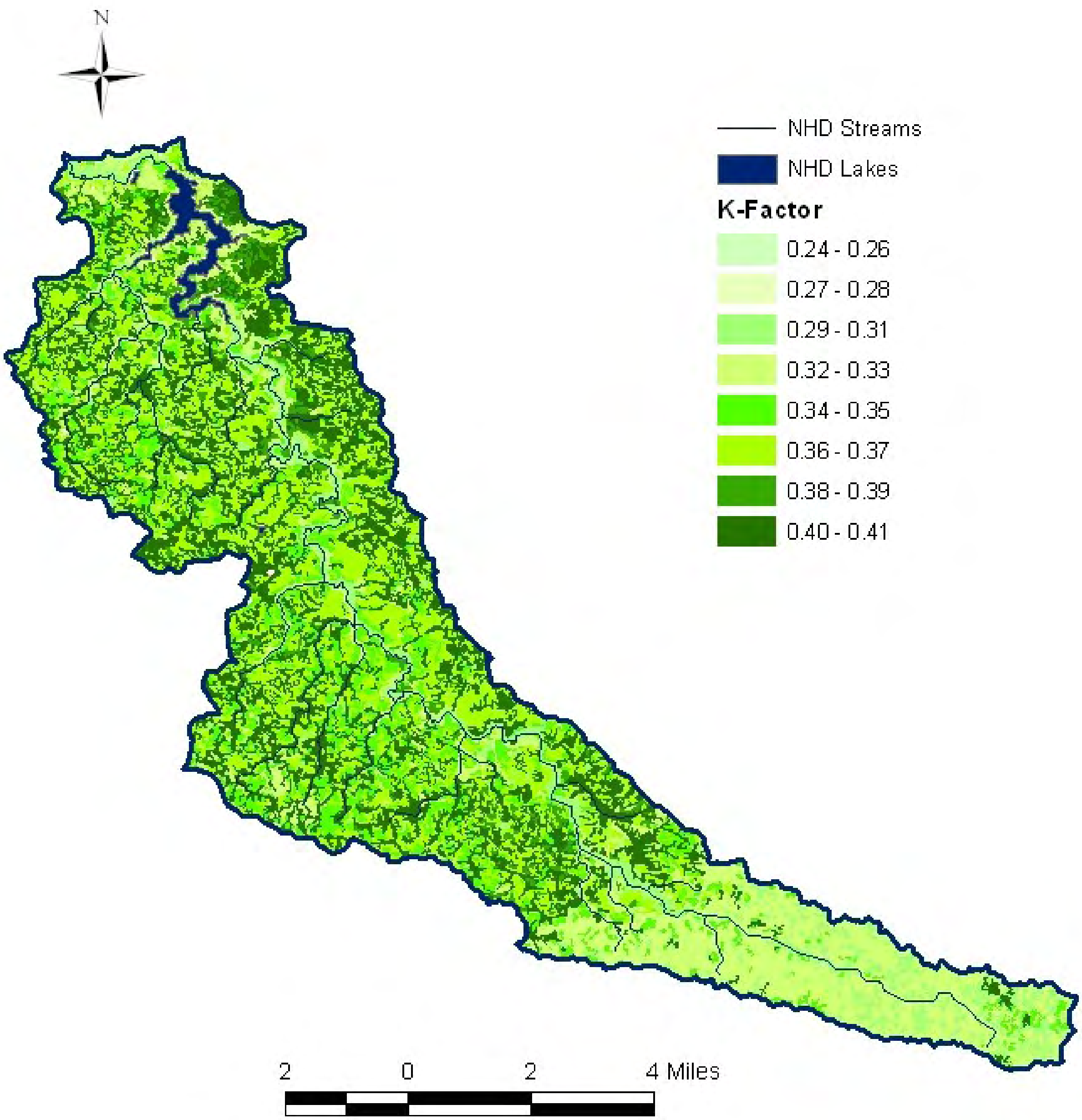


Figure 4-1. Average Soil Erosion K-factors Within the Lake Bloomington Watershed..

Phosphorus and nitrogen loading rates from surface runoff and tile drain systems in agricultural cropland have been measured at two constructed wetlands located adjacent to Lake Bloomington. The constructed wetlands received loadings during 1998 and 1999 from a total agricultural area of 39.7 acres. TP loading rates ranged from 0.15 to 0.42 lb/ac/yr whereas TN loading rates ranged from 7.5 to 14.9 lb/ac/yr (Kovacic et al., 2006). Using these values and the number of cropland acres in the watershed, the estimated phosphorus load from croplands ranges from 5,780 lb/yr to 16,185 lb/yr and the nitrogen load ranges from 289,013 lb/yr to 574,172 lb/yr.

For comparison, the BATHTUB model for Lake Bloomington indicates that the current average total phosphorus loading rate from agricultural land uses in the watershed is 0.82 lb/ac/yr and an average loading rate not greater than 0.22 lb/ac/yr is needed to meet the water quality standard in the lake. For total nitrogen, the current average loading rate is 60.4 lb/ac/yr and a loading rate not greater than 31.1 lb/ac/yr is needed to meet the water quality standard in the lake.

4.1.2 Appropriate BMPs

Several structural and non-structural BMPs have been developed and studied for use in agricultural areas. The following sections provide information on the removal mechanisms, effectiveness, and cost of the BMPs most suited to the Lake Bloomington watershed.

4.1.2.1 Nutrient Management Plans

The development of nutrient management plans optimizes the efficient use of all sources of nutrients, including soil reserves, fertilizers, crop residue, and organic sources and minimizes the potential of water quality degradation by excess nutrient loads. A good nutrient management plan should address the amount, source, placement, methods, and timing nutrient applications. Plans for nutrient management should be developed and comply with applicable federal, state and local NRCS regulations (NRCS, 2002).

Initial soil phosphorus concentrations can be determined by onsite soil testing. Losses through plant uptake are subtracted, and gains from organic sources such as manure application or industrial/municipal wastewater are added. The resulting phosphorus content is then compared to local guidelines to determine if fertilizer should be added to support crop growth and maintain current phosphorus levels. In some cases, the soil phosphorus content is too high, and no fertilizer should be added until levels are reduced by crop uptake to target levels.

The Illinois Agronomy Handbook (IAH) lists guidelines for fertilizer application rates based on the inherent properties of the soil, the initial soil test phosphorus concentration for the field, and the crop type and expected yield. The Lake Bloomington watershed is located in the medium and low zones for inherent phosphorus availability. In the medium-low zone, maximum crop yields are obtained when the available phosphorus levels are maintained at 40 to 45 lb/ac. If the soil test phosphorus concentration is less than 40 to 45 lb/ac, the IAH suggests building up the phosphorus levels over a four year period to achieve a soil test phosphorus concentration of 40 to 45 lb/ac. If the soil test phosphorus concentrations are between 40 to 45 lb/ac and 60 to 65 lb/ac, maintenance-only application rates are recommended. At initial concentrations greater than 60 to 65 lb/ac, the IAH recommends that no phosphorus be applied until subsequent crop uptake reduces the starting value to 40 to 45 lb/ac (IAH, 2002).

Nutrient fertilizers should not be applied to frozen, snow-covered or saturated soils if there is a potential risk of runoff (NRCS, 2002). Researchers studying loads from agricultural fields in east-central Illinois found that fertilizer application to frozen ground or snow followed by a rain event could transport as much as 40 percent of the total annual phosphorus load in a single event (Gentry et al., 2007).

Approximately 36 sites within the Lake Bloomington watershed were monitored for nitrate concentrations from 1993 to 1998. Six agricultural fertilizer nitrogen management techniques were monitored for nitrate release via tile and surface drainage. The study found that applications of fertilizer in the spring reduced nitrate released into tile water while producing equivalent grain yields to that of the fall-applied treatments (Smiciklas et al., 1999).

Nutrient management plans should also address the methods of application. Fertilizer may be applied directly to the surface, placed in bands below and to the side of seeds, or incorporated in the top several inches of the soil profile through drilled holes, injection, or tillage. Incorporation of fertilizer to a minimum depth of two inches prior to planting has shown a decrease in total phosphorus runoff concentrations of 20 percent. Subsurface application, such as deep placement, has reductions in total phosphorus of 20 to 50 percent (HWRCI, 2005). Figure 4-2 shows a deep placement attachment unit.

(Photo Courtesy of CCSWCD)

Figure 4-2. Deep Placement Phosphorus Attachment Unit for Strip-till Toolbar.

The effectiveness of nutrient management plans (application rates, methods, and timing) in reducing nutrient loading from agricultural land is site specific. Average reductions of nutrient loads are reported at 35 percent for total phosphorus and 15 percent for total nitrogen using nutrient management plans (USEPA, 2003).

4.1.2.2 Conservation Tillage Practices

Conservation tillage practices are used to control erosion and surface transport of pollutants from crop fields. Conservation tillage is defined as any tillage practice that results in at least 30 percent coverage of the soil surface by crop residuals after planting. Tillage practices leaving 20 to 30 percent residual cover after planting reduce erosion by approximately 50 percent compared to bare soil. Practices that result in 70 percent residual cover reduce erosion by approximately 90 percent (IAH, 2002). The residuals not only provide erosion control, but also increase the organic and nutrient content in the soil and reduce the amount of carbon in the atmosphere by storing it in the soil.

Tillage practices including no-till systems, strip till, ridge till, and mulch till are commonly used to maintain the suggested 30 percent cover. Table 4-3 shows the most recent county-wide Illinois Soil Transect Survey (IDOA, 2006) for McLean County and indicates that conservation tillage is being used for all crop field types. However, McLean County has a relatively high percentage (64 percent) of corn fields using conventional tillage compared to the state average of 35.5 percent. Figure 4-3 shows a comparison of ground cover under conventional and conservation tillage practices.

Table 4-3. Percentage of Agricultural Fields Surveyed with Indicated Tillage Systems in McLean Counties, Illinois in 2006.

Crop Field Type	Tillage Practice			
	Conventional	Reduced-till	Mulch-till	No-till
Corn	64	6	15	15
Soybean	9	4	45	43
Small Grain	0	0	0	100

Source: Illinois Department of Agriculture, 2006.

Figure 4-3. Comparison of conventional (left) and conservation (right) tillage practices.

Czapar et al. summarize tillage practices in the Midwest and their impacts on erosion control and nutrient delivery. Compared to conventional tillage, strip till practices reduced phosphorus loads by 68 percent and nitrogen loads by 64 percent. No till practices reduced phosphorus loads by 76 percent and nitrogen loads by 73 percent (Czapar et al., 2006). Conservation tillage practices have been reported to reduce total phosphorus loads by 45 percent and total nitrogen loads by 55 percent in sites where soil erosion is not controlled (USEPA, 2003). Somewhat lower levels of effectiveness might be expected for the Lake Bloomington watershed because of the extent of tile drainage (which reduces the importance of erosion as a pollutant pathway).

4.1.2.3 Cover Crop

Cover crops are grasses and legumes established for seasonal cover and conservation purposes to reduce soil erosion, improve soil organic matter, and manage excess nutrients (NRCS, 2002). Grasses tend to have low seed costs and establish relatively quickly. Legumes take longer to establish, but are capable of fixing nitrogen from the atmosphere, thus reducing nitrogen fertilization required for the next cash crop. Legumes, however, are more susceptible to harsh winter environments and may not have adequate survival to offer sufficient erosion protection.

Planting the cash crop in wet soil that is covered by heavy surface residue from the cover crop may impede emergence by prolonging wet, cool soil conditions. Cover crops should be killed off two or three weeks prior to planting the cash crop either by application of herbicide or mowing and incorporation, depending on the tillage practices used. The National Sustainable Agriculture Information Service recommends planting ryegrass after corn harvest and hairy vetch after soybeans (Sullivan, 2003). The use of cover crops is illustrated in Figure 4-4.

(Photo Courtesy of CCSWCD)

Figure 4-4. Use of Cover Crops.

Cover crops have the added benefit of reducing the need for pesticides and fertilizers (OSUE, 1999), and are also used in conservation tillage systems following low residue crops such as soybeans. Cover crops alone may reduce soil and runoff losses by 50 percent, and when used with no-till systems may reduce soil loss by more than 90 percent (IAH, 2002). The use of cover crop in Oklahoma resulted in a phosphorus loss reduction of 70 to 85 percent (HRWCI, 2005). Nitrogen reductions of 5 to 15 percent, using cover crop, were reported in the Neuse River Basin (NCSU, 2001).

4.1.2.4 Vegetative Controls

Other phosphorus and nitrogen control measures for agricultural land use include vegetated filter strips, grassed waterways, and riparian buffers. The USDA (2003) does not advocate using these practices solely to control nutrient loading, but rather as supplemental management measures following operational strategies. USEPA (2003) lists the percent effectiveness of vegetative controls on phosphorus removal at 75 percent.

Vegetated Filter Strips

Filter strips are vegetated surfaces that are designed to treat sheet flow from adjacent surfaces by slowing runoff velocities and filtering out sediment and other pollutants, and by providing some infiltration into underlying soils. If topography allows, filter strips may also be used to treat effluent from tile drain outlets. Filter strips will require maintenance, including grading and seeding, to ensure distributed flow across the filter and protection from erosion. Periodic removal of vegetation will encourage plant growth and uptake and will remove nutrients stored in the plant material.

Filter strip flow length should be determined based on field slope percent and length and filter strip slope percent, erosion rate, amount and particle size distribution of sediment delivered to the filter strip, density, and height of filter strip vegetation, and runoff volume associated with erosion producing events. The minimum flow length should be determined using Table 4-4 (NRCS, 2008).

Filter strips have been found to effectively remove pollutants from agricultural runoff. Loading reductions of 75 percent in total phosphorus and 70 percent in total nitrogen have been reported (USEPA, 2003). Field research on filter strips in Virginia and Maryland showed removal efficiencies for total phosphorus ranged from 0 to 83 percent and for total nitrogen ranged from 27 to 87 percent (OSUE, 1994). In the Neuse River Basin, nitrogen reductions of 40 percent were reported (NCSU, 2001). A grass filter strip is shown in Figure 4-5.

(Photo Courtesy of CCSWCD)

Figure 4-5. Grass Filter Strip Protecting Stream from Adjacent Agriculture.

The effectiveness of buffer strips depends on many parameters. The key parameters include overland flow velocity and depth, vegetation, and width. The choice of vegetation should be based on climate conditions, intended functions of the buffer, desired by-products, and soil characteristics. Filter strips are most effective on sites with mild slopes of less than 6 percent. The NRCS recommends filter widths based on slope and soil texture, as shown in Table 4-4 (NRCS 2004).

Table 4-4. Filter strip flow lengths based on land slope to achieve a minimum flow through time of 15 and 30 minutes respectively at 1/2 inch depth.

Percent Slope	0.5%	1%	2%	3%	4%	5% or greater
Minimum	36	54	72	90	108	117
Maximum	72	108	144	180	216	234

Grassed Waterways

Grassed waterways are natural or constructed channels lined with a vegetated surface. The channel is designed to convey surface water at a non-erosive velocity and to improve water quality by providing infiltration of pollutants. Soil erodibility, slope, runoff velocity, channel depth, vegetation selection, and habitat should be considered during the design of the grassed waterway. Routine maintenance includes regular inspection and repair of damaged vegetation, erosion control, periodic mowing, and weed control. The bottom width of grassed waterways shall not exceed 100 feet (NRCS, 2000). A grassed waterway providing surface drainage for a corn field is shown in Figure 4-6

(Photo Courtesy of CCSWCD)

Figure 4-6. Grassed Waterway.

Load reductions in grassed waterways are reported at 29 percent for total phosphorus (Winer, 2000). No available data was found for total nitrogen load reductions in grass waterways. However, nitrate reductions of 38 percent in grassed waterways were reported (USEPA, 2000).

Riparian Buffers

Riparian buffers are corridors of trees, shrubs and/or grasses located adjacent to and up-gradient from streams and water bodies. Preserving natural vegetation along stream corridors can effectively reduce water quality and habitat degradation associated with development and agricultural practices. The root structure of the vegetation in a buffer enhances infiltration of runoff and subsequent trapping of nonpoint source pollutants. It also serves to reinforce streambank soils, which helps to hold streambank material in place and minimize erosion. The riparian buffers are most effective when the runoff enters the buffer as sheet flow allowing for retention and uptake of pollutants.

Riparian buffers should consist of native species and may include grasses, grass-like plants, forbs, shrubs, and trees. Minimum buffer widths of 25 feet are required for water quality benefits. However, higher removal rates are provided with greater buffer widths (NCSU, 2002). The NRCS recommends riparian buffers consisting of two zones with a minimum width of 66 feet to effectively remove nutrients and sediments from runoff. The first zone consist of tree/shrubs at least 40 feet wide followed by a seeded or grass zone at least 20 feet wide (NRCS, 1999). Riparian corridors typically treat a maximum of 300 ft of adjacent land before runoff forms small channels that short circuit treatment. A riparian buffer protecting the stream corridor from adjacent agricultural areas is shown in Figure 4-7.

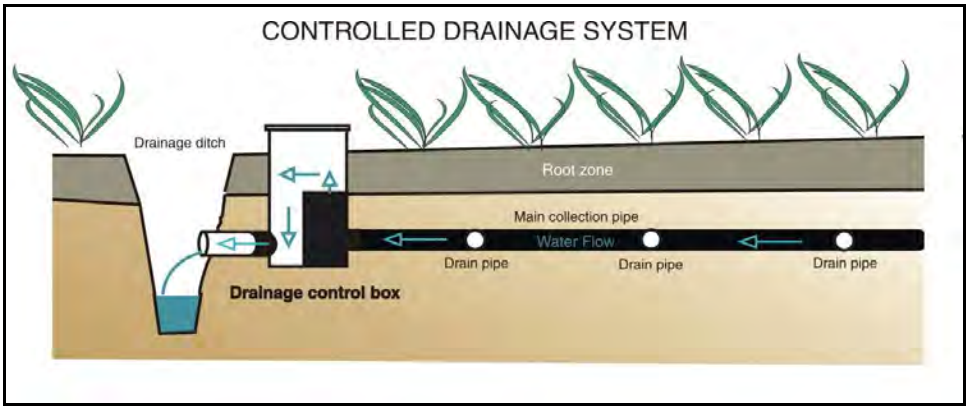
(Photo Courtesy of CCSWCD)

Figure 4-7. Riparian Buffer between Stream Channel and Agricultural Areas.

Buffers with forest and grass zones of 60 to 90 feet wide were studied in North Carolina. Load reductions for phosphorus were estimated at 70 to 80 percent and load reductions for nitrogen were estimated at 74 to 80 percent (NCSU, 2002). In the Lake Bloomington watershed, nitrate loading from tile drainage may bypass the riparian buffers and actual load reductions would be less.

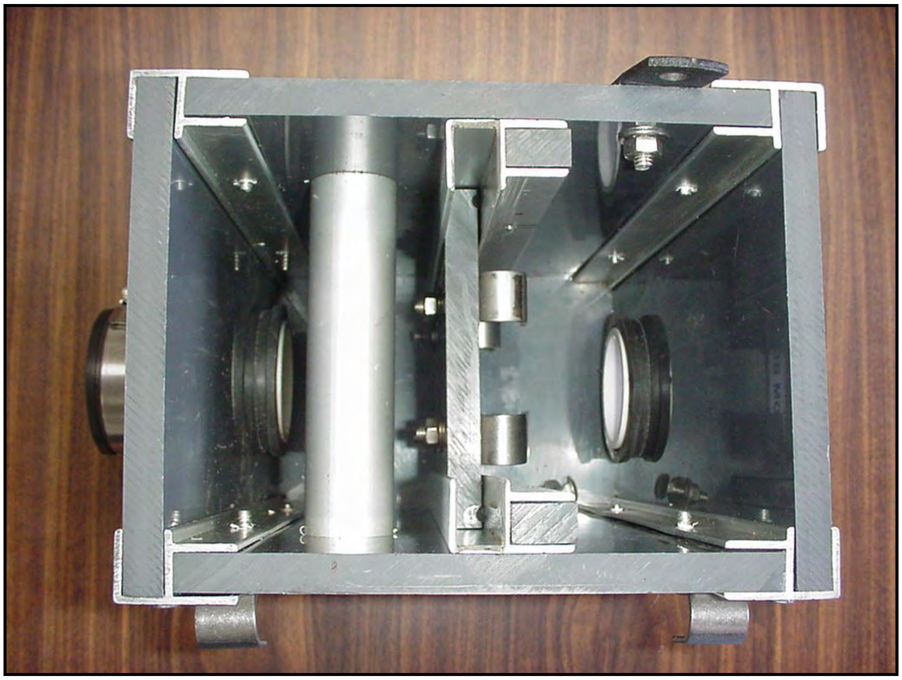
4.1.2.5 Drainage Water Management for Tile Drain Outlets

For drainage water management, control structures are placed at the outlet of a tile system to control the water table in the soil (Figure 4-8 and Figure 4-9). Control structures collect water that has infiltrated from agricultural fields into the root zone. This practice can be used to raise the water level after harvest, thereby reducing nitrate loading from tile effluent, or to retain water in the soil during the growing season. The retained water becomes a source of moisture for plants during dry conditions and undergoes biological, chemical, and physical processes that result in lower nutrient concentrations in the final effluent.



(Illustration Courtesy of the Agricultural Research Service Information Division)

Figure 4-8. Drainage Water Management for a Tile Drain System.



(Photo Courtesy of CCSWCD)

Figure 4-9. Interior View of a Control Structure with Adjustable Baffle Height.

Drainage water management reduces the volume of drainage water leaving a field by 20 to 30 percent on average. However, outflow varies widely depending on soil type, rainfall, type of drainage system, and management intensity. Drainage water management also provides a higher field water table level, which promotes denitrification within the soil profile. In some cases, nitrate-nitrogen concentrations have been 10 to 20 percent lower in outflow from controlled systems compared to uncontrolled-free draining systems. Load reductions of 45 percent for nitrogen and 35 percent for phosphorus were reported in North Carolina (NCSU, 2002).

In Illinois, tiles are installed at a depth of 3 to 4 feet and are spaced 80 to 120 feet from each other (Lake Bloomington Planning Committee, 2008). In fields with drainage water management, the water table control height is typically set to within 6 inches of the soil surface on November 1, and it is lowered to the level of the tile on March 15. Thus, water is held back in the field during the fallow period. In experiments in Illinois, reductions of up to 47 percent for nitrate and 83 percent for phosphate were measured (Cooke, 2005).

4.1.2.6 Wetland Systems

Wetland systems are structural controls that provide nutrient reductions (Figure 4-10). Treatment in wetland systems is achieved through sedimentation and filtration, soil adsorption, chemical precipitation, biological uptake by plants, and microbial transformation of nutrients. Wetlands can be constructed upstream of the lake to treat nutrient loads from runoff. Around Lake Bloomington there are approximately 346 acres of wetlands, according to the 2001 GAP land use coverage.

Figure 4-10. Wetland System in Central Illinois.

A study on wetlands treatment was conducted in Lake Bloomington watershed in 1997. Two constructed wetlands located adjacent to Lake Bloomington were monitored for nutrient removal from tile drains and surface runoff. The wetlands are located approximately 600 feet south of the confluence of Money Creek with Lake Bloomington. Tile flow from the experimental fields and surface flow from the fields is conveyed to the constructed wetlands through control structures. The constructed wetlands received loadings during 1998 and 1999 from a total agricultural area of 39.7 acres. Removal efficiencies were reported at 40 to 79 percent for total phosphorus and 23 to 44 percent for total nitrogen (Kovacic et al., 2006). On average nitrogen was reduced by 36 percent and phosphorus by 53 percent. Most of the phosphorus retention was due to sedimentation within the wetland. Dr Kovacic has documented that filter strips alongside tributary streams can remove another 9 percent of nitrogen (Lake Bloomington Planning Committee, 2008).

Table 4-5 summarizes the best management practices with the estimated nutrient reductions for agricultural land uses.

Table 4-5. Nutrient Removal BMPs for Agricultural Land Uses.

BMP	Nitrogen Reduction	Phosphorus Reduction
Nutrient Management Plan	15% (USEPA, 2003)	20% - 50% (HWRCI, 2005) 35% (USEPA, 2003)
Conservation Tillage	64%- 73% (Czapar et al., 2006) 55% (USEPA, 2003)	68%- 76% (Czapar et al., 2006) 45% (USEPA, 2003)
Cover Crop	5% - 15% (NCSU, 2001)	70% - 85% (HRWCI, 2005).
Filter Strips	70% (USEPA, 2003) 27% - 87% (OSUE, 1994) 40% (NCSU, 2001)	75% (USEPA, 2003) 0% - 83% (OSUE, 1994)
Grassed Waterway	38% NO_3 (USEPA, 2000)	29% (Winer, 2000).
Riparian Buffers	74% - 80% (NCSU, 2002) 85% (Lowrance et. al., 1984)	70% - 80% (NCSU, 2002) 30%-40% (Lowrance et. al., 1984)
Drainage Water Management (outlet structure on tile system)	45% (NCSU, 2002) 47% NO_3 (Cooke, 2005)	35% (NCSU, 2002) 83% PO_4 (Cooke, 2005)
Wetland Systems	23% - 44 % (Kovacic et al., 2006)	40% - 79% (Kovacic et al., 2006)

4.1.2.7 Cattle Exclusion from Streams

Cattle manure is a substantial source of nutrient loading to streams, particularly where direct access is not restricted and/or where cattle feeding structures are located adjacent to riparian areas. Direct deposition of feces into streams may be a primary mechanism of pollutant loading during baseflow periods. During storm events, overbank and overland flow may entrain manure accumulated in riparian areas resulting in pulsed loads of nutrients into streams. In addition, cattle with unrestrained stream access typically cause severe streambank erosion. The impacts of cattle on stream ecosystems are shown in Figure 4-11.

Figure 4-11. Stream Bank Erosion and Manure Deposition to Streams from Cattle.

Allowing limited or no animal access to streams will provide the greatest water quality protection. On properties where cattle need to cross streams to have access to pasture, stream crossings should be built so that cattle can travel across streams without degrading streambanks and contaminating streams with manure as shown in Figure 4-12. The USEPA (2003) reports 15 to 49 percent reductions in total phosphorus loading as a result of cattle exclusion practices.

Figure 4-12. Restricted Cattle Access Point with Reinforced Banks.

4.1.3 Estimated Cost of Implementation

The cost to implement agricultural BMPs includes the cost of construction (for structural BMPs), maintenance costs (seeding, grading, etc.), and operating costs (electricity, fuel, labor, etc). Where applicable, an additional net cost is added to account for the conversion of farm production land into treatment land. This section presents an estimate of the annualized cost per acre, uniformly divided over the service life of the BMP. The cost does not account for the difference between the initial capital cost and the cost incurred over the life span of the BMP. The unit cost is rounded up to the nearest quarter of a dollar.

The costs presented in this section are discussed in year 2006 dollars because this is the latest year for which gross income estimates for corn and soybean production were available when the Plan was prepared. Market prices can fluctuate significantly from year to year based on supply and demand factors, but for simplicity purpose, a straight rate of inflation to convert crop incomes from one year to the next is used for cost estimation. The cost to construct, maintain, and operate the BMPs is assumed to follow a yearly inflation rate of 3 percent since these components are not as dependent on such factors as weather and consumer demand. Therefore, all prices for BMP costs have been converted to year 2006 dollars to develop a net cost for each BMP. Inflated prices are rounded to the nearest quarter of a dollar since most of the reported costs were reported in whole dollars per acre, not dollars and cents.

Gross 2006 income estimates for corn and soybean in Illinois are $571/ac and $325/ac, respectively (IASS, 2006). Accounting for operating and ownership costs results in net incomes from corn and soybean farms of $199/ac and $64/ac. The average net annual income of $132/ac was therefore used to estimate the annual loss from BMPs that take a portion of land out of farm production. The average value is considered appropriate since most farms operate on a 2-year crop rotation. However, it is recognized that net annual farm income can be highly volatile from one year to the next.

4.1.3.1 Nutrient Management Plans

The success of nutrient management plans is highly dependent on the rates, methods, and timing of the fertilizer application. Consultants in Illinois typically charge $6.50 to $19 per acre to determine the appropriate fertilizer rates. This fee includes soil testing, manure analysis, scaled maps, and site specific recommendations for fertilizer management (USEPA, 2003). The savings associated with using less fertilizer are approximately $10.75/ac during each plan cycle (4 years) as estimated by the Champaign County Soil and Water Conservation District. For subsurface application using deep placement, the Heartland Regional Water Coordination Initiative lists the cost of phosphorus fertilizer at $3.75/ac per application, over a 2 year cycle (HRWCI, 2005). This cost, however, may be higher due to recent increases in phosphorus fertilizer. Table 4-6 summarizes the annualized cost for this BMP. The average cost of using nutrient management plans ranges from $1.00/ac/yr to $4.00/ac/yr.

Table 4-6. Costs Calculations for Nutrient Management Plans.

Item	Costs (Savings) ($/ac/yr)
Soil Testing and Determination of Rates	$1.75 - $4.75
Savings on Fertilizer	($2.75)
Deep Placement of Phosphorus	$2.00
Average Annual Costs	**$1.00 - $4.00**

4.1.3.2 Conservation Tillage Practices

Conservation tillage practices generally require fewer trips to the field, saving on labor, fuel, and equipment repair costs, though increased weed production may result in higher pesticide costs relative to conventional till (USDA, 1999). The HRWCI (2005) lists the operating cost for conservation tillage at $0/ac.

Depending on the type of equipment currently used, replacing conventional till equipment with no-till equipment can either result in a net savings or slight cost to the farmer. Converting conventional equipment to no-till equipment costs approximately $1.25 to $2.50/ac/yr. For new equipment, purchasing no-till equipment is less expensive than conventional equipment (Al-Kaisi et al., 2000). Table 4-7 summarizes the average annual cost for this BMP. The average cost of using conservation tillage practices ranges from $1.25/ac/yr to $2.50/ac/yr.

Table 4-7. Costs Calculations for Conservation Tillage.

Item	Costs (Savings) ($/ac/yr)
Conversion of Conventional Equipment to Conservation Tillage Equipment	$1.25 - $2.50
Operating Costs of Conservation Tillage Relative to Conventional Costs	$0
Average Annual Costs	**$1.25 - $2.50**

4.1.3.3 Cover Crop

Researchers at Purdue University estimated the seed cost of ryegrass and hairy vetch at $12.75 and $32.00/ac/yr, respectively. Annual savings in nitrogen fertilizer are $4.00/ac for ryegrass and $30.25/ac for hairy vetch (from Champaign County Soil and Water Conservation District). Herbicide application is estimated to cost $15.25/ac/yr. These costs do not account for yield increases which may offset the overall cost. Table 4-8 summarizes the annual costs and savings associated with ryegrass and hairy vetch. The average cost of using cover crop range from $17.00/ac/yr to $24.00/ac/yr.

Table 4-8. Costs Calculations for Cover Crops.

Item	Ryegrass Cost ($/ac/yr)	Hairy Vetch Cost ($/ac/yr)
Seed Costs	$12.75	$32.00
Nitrogen Fertilizer Savings	($4.00)	($30.25)
Herbicide Costs	$15.25	$15.25
Average Annual Cost:	**$17.00 - $24.00**	

4.1.3.4 Vegetative Controls

Vegetative control BMPs are farm management strategies that are usually applied over large areas. For comparison with other agricultural BMPs, the costs are estimated for each acre of agricultural land operating with the BMP. In addition, the cost of converting farm land to BMP treatment land is included for each BMP.

Filter Strips

Filter strips are seeded with grass and cost approximately $0.35 per sq ft to construct. Assuming the filter strip area is 2 percent of the area drained (OSUE, 1994), 870 square feet of filter strip are required for each acre of agricultural land treated. Assuming a system life of 20 years (Weiss et al., 2007), the construction costs to treat one acre of land are $15.25/ac/yr for seeded strips. Annual maintenance of filter strips is estimated at $0.01 per sq ft (USEPA, 2002b) for an additional cost of $9.25/ac/yr of agricultural land treated. In addition, the area converted from agricultural production to filter strip will result in a net annual income loss of $2.75 (2 percent of annual net income). Table 4-9 summarizes the cost to treat one acre of agricultural land using a seeded filter strip. The average cost of using filter strips is approximately $27.25/ac/yr.

Table 4-9. Costs Calculations for Seeded Filter Strips.

Item	Seeded Filter Strip ($/ac/yr)
Construction Costs	$15.25
Maintenance Costs	$9.25
Income Loss	$2.75
Average Annual Costs	**$27.25**

Grassed Waterways

Grassed waterways cost approximately $0.55 per sq ft to construct (USEPA, 2002b). These stormwater conveyances are best constructed where existing bare ditches transport stormwater, so no income loss from land conversion is expected with this practice. It is assumed that the average area required for a grassed waterway is approximately 0.1 to 0.3 percent of the drainage area, or between 44 and 131 sq ft per acre. Waterways are assumed to remove phosphorus effectively for 20 years before soil, vegetation, and drainage material need to be replaced (Weiss et al., 2007). Assuming a system life of 20 years, the construction costs range from $1.25/yr to $3.75/yr for each acre of agriculture runoff draining to a grassed waterway. Annual maintenance of grassed waterways is estimated at $0.02 per sq ft (Rouge River, 2001) for an additional cost ranging from $1.00/yr to $2.75/yr for each acre of agricultural land treated. Table 4-10 summarizes the annual costs to treat one acre of agricultural land using grassed waterways. The average cost of using grassed waterways ranges from $2.25/ac/yr to $6.50/ac/yr.

Table 4-10. Costs Calculations for Grassed Waterways.

Item	Costs ($/ac/yr)
Construction Costs	$1.25 - $3.75
Maintenance Costs	$1.00 - $2.75
Income Loss	$0
Average Annual Costs	**$2.25 - $6.50**

Riparian Buffers

The cost to construct riparian buffers is approximately $165/ac over the life of the buffer. The annual maintenance cost is $42/ac of buffer or $12.75/ac/yr to treat one acre of land (Wossink and Osmond, 2001). Maintenance of a riparian buffer decreases if forested and native vegetation is used. Assuming a buffer width of 90 ft on either side of the stream channel and an adjacent treated width of 300 ft of agricultural land, one acre of buffer will treat approximately 3.3 acres of adjacent agricultural land. Assuming a system life of 30 years, the annual average construction cost is $5.50/ac of buffer or $1.75/ac/yr to treat one acre of agricultural land. The estimate income loss to convert farm land to riparian buffer is $40.40 (30 percent of the annual net income). Table 4-11 summarizes the cost to treat one acre of agricultural land with riparian buffers. The average cost of using riparian buffers is $59.25/ac/yr.

Table 4-11. Costs Calculations for Riparian Buffers.

Item	Costs ($/ac/yr)
Construction Costs	$1.75
Maintenance Costs	$12.75
Income Loss	$40.40
Average Annual Costs	**$59.25**

4.1.3.5 Drainage Water Management for Tile Drain Outlets

The cost of retrofitting tile drain systems with drainage water management ranges from $20 to $40 per acre. Construction of new tile drain systems with outlet control is approximately $75/ac (Cooke, 2005). Assuming that the outlet control structures have a system life of 30 years, the construction cost for retrofitting ranges from $0.75/ac/yr to $1.50/ac/yr and for new systems is $2.50/ac/yr. Table 4-12 summarizes the cost of retrofitting and installing new tile drain systems with outlet control devices.

Table 4-12. Costs Calculations for Drainage Water Management on Tile Drain Systems.

Item	Costs to Retrofit Existing Systems ($/ac/yr)	Costs to Install a New System ($/ac/yr)
Construction Costs	$0.75 - $1.50	$2.50
Average Annual Costs	**$1.50 - $2.50**	

4.1.3.6 Wetland Systems

Two wetlands located adjacent to Lake Bloomington were constructed to treat a total agricultural area of 39.7 acres. The construction costs for these wetlands ranged from 3 to 3.5 million dollars (Kovacic et al., 2006). Assuming a 50-year useful life, the cost of wetland systems ranges from $1,511/ac/yr to $1,763/ac/yr.

4.1.3.7 Cattle Exclusion from Streams

The costs of excluding cattle from streams depends more on the length of channel that needs to be protected than the number of animals on site. Fencing may also be used in a grazing land protection operation to control cattle access to individual plots. The system life of wire fences is reported as 20 years; the high tensile fence materials have a reported system life of 25 years (Iowa State University, 2005). Fencing materials vary by installation cost, useful life, and annual maintenance cost as presented in Table 4-13.

Table 4-13. Installation and Maintenance Costs of Fencing Material per Foot.

Material	Construction Costs (per ft)	Annual Maintenance Costs (per ft)	Total Annualized Costs (per ft)
Woven Wire	$1.46	$0.25	$0.32
Barbed Wire	$1.19	$0.20	$0.26
High tensile (non-electric) 8-strand	$1.09	$0.14	$0.18
High tensile (electric) 5-strand	$0.68	$0.09	$0.12

NRCS reports that the average operation needs approximately 35 ft of additional fencing per head to protect grazing lands and streams. Table 4-14 presents the capital, maintenance, and annualized costs per head of cattle for four fencing materials based on the NRCS assumptions.

Table 4-14. Installation and Maintenance Costs of Fencing Material per Head.

Material	Capital Costs per Head	Annual Operation and Maintenance Costs per Head	Total Annualized Costs per Head
Woven Wire	$43.50	$3.50	$5.75
Barbed Wire	$33.50	$2.75	$4.50
High Tensile (non-electric) 8-strand	$30.75	$1.75	$3.00
High Tensile (electric) 5-strand	$23.00	$1.50	$2.50

4.1.4 BMP Effectiveness and Estimated Load Reductions

Numerous agricultural BMPs applicable to the Lake Bloomington watershed have been identified and discussed in the previous sections. The selection of BMPs should be determined by taking into account the removal efficiencies, overall cost and effectiveness, which are summarized in Table 4-15.

Table 4-15. Cost and Removal Efficiencies for Agricultural BMPs.

BMP	Nitrogen Reduction %	Phosphorus Reduction %	Cost ($/ac/yr)
Nutrient Management Plan	15	20 - 50	$1.00 - $4.00
Conservation Tillage	55 - 73	45 - 76	$1.25 - $2.50
Cover Crops	5 - 15	70 - 85	$17.00 - $24.00
Filter Strips	27 - 87	0 - 83	$27.25
Grassed Waterways	38	29	$2.25 - $6.50
Restoration of Riparian Buffers	74 - 85	30 - 80	$59.25
Drainage Water Management	45 - 47	35 - 83	$1.50 - $2.50
Wetland Systems	23 - 95	30 - 79	$1,511 - $1,763

According to Table 4-15 the following agricultural BMPs appear to be the most cost effective: nutrient management plans, conservation tillage, and drainage water management. The table also shows that some of the BMPs that provide the maximum benefit (e.g., wetland systems, riparian buffers) are the most expensive to implement.

4.2 Onsite Wastewater Treatment Systems

Onsite wastewater treatment systems are a potential source of nutrient loads to Lake Bloomington because these systems can potentially leach nutrients and pathogens into the groundwater and can contaminate surface water if the system is not functioning properly.

Existing development surrounding the Lake consists primarily of residential with a few commercial establishments. The City of Bloomington owns all lands adjacent to the lakeshore and leases lots to homeowners. The City provides water service via publicly owned and operated water treatment and distribution system. The Lake Bloomington area has no centralized sewer system or wastewater treatment/transfer facility. Each home on the Lake has an individual septic system, which includes a septic tank discharging into leaching fields, sand filters, existing field tiles, cisterns, and/or in a few instances directly into Lake Bloomington. All septic systems ultimately discharge effluent to Lake Bloomington either through direct surface discharge or seepage to groundwater (Lake Bloomington Planning Committee, 2008).

McLean County Health Department has a database of septic systems that have been inspected and permitted. However, this database does not include every septic system in the watershed. At this time, no comprehensive database of all onsite wastewater treatment systems within the watershed is available. According to the McLean County Health Department, there are 353 active permitted individual septic systems in 10 subdivisions that are in the immediate area of Lake Bloomington. These septic systems are usually 50 to several hundred feet away from the lakefront. There are an additional 607 active septic systems in the Village of Hudson, a small portion of which is located in Lake Bloomington watershed. Along Money Creek, there are 90 septic systems near the southeast side of the lake (see Figure 4-13 through Figure 4-16). The location and number of other systems within the watershed is unknown as older systems were not required to obtain permits and so are not included in the Health Department database.

As shown in Figure 4-16, the Village of Towanda, with most of their septic systems being seepage field, is one of the major unsewered communities in Lake Bloomington watershed. The Lake Bloomington area has no centralized sewer system or wastewater treatment facility. In 2006, there were approximately 215 dwelling units located within 300 feet of the lake (Lake Bloomington Planning Committee, 2008).

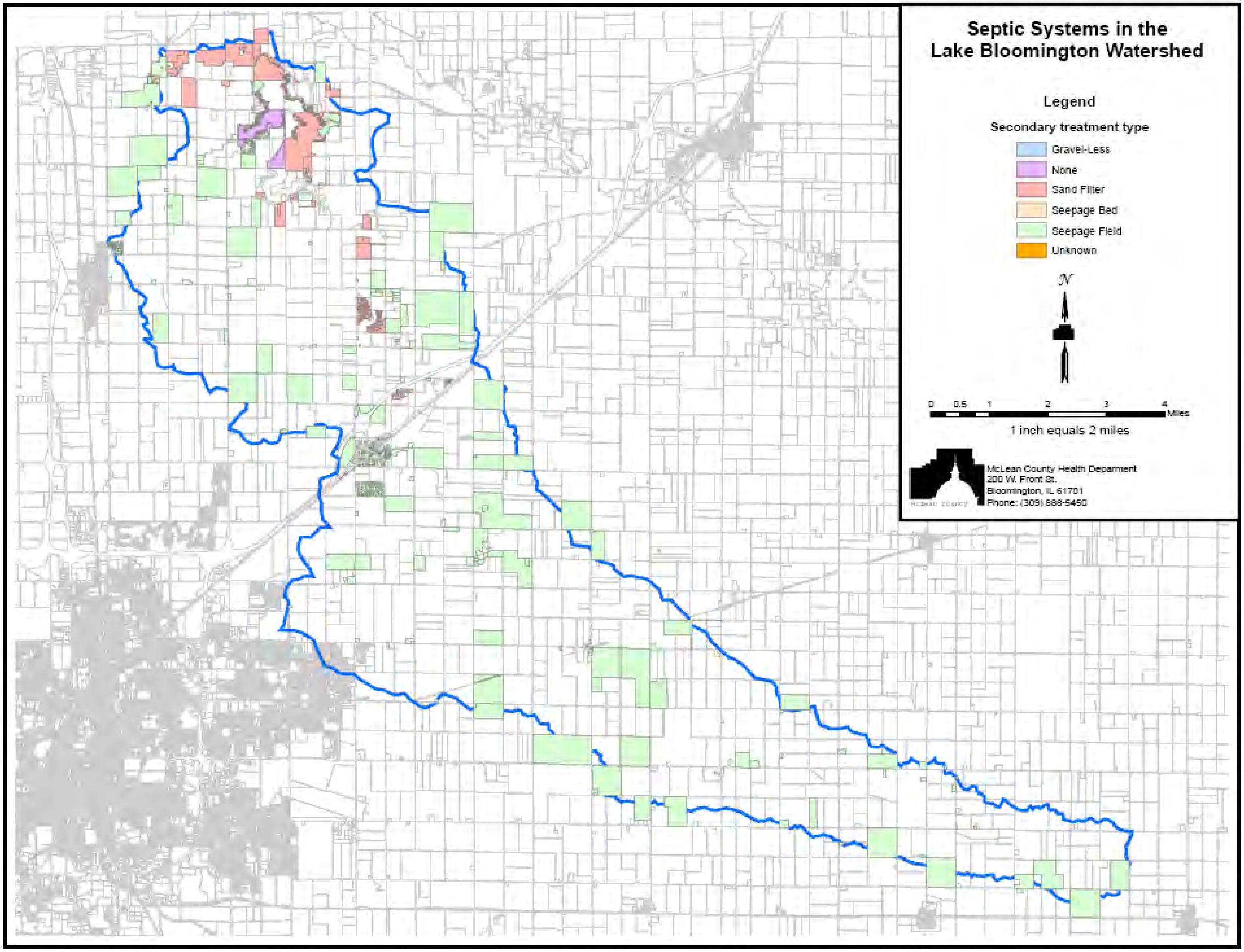


Figure 4-13. Septic Systems in Lake Bloomington Watershed - Overview.

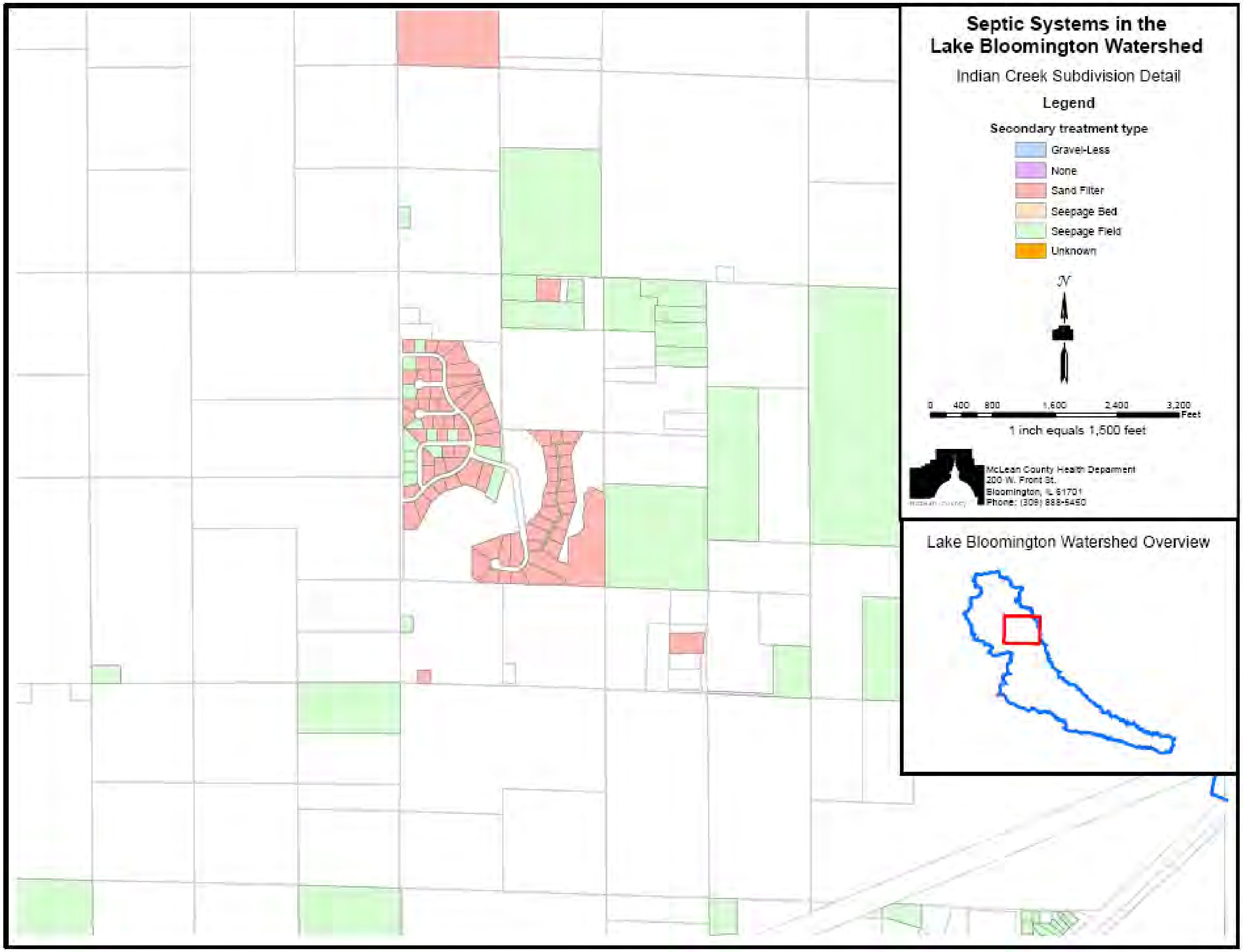


Figure 4-14. Septic Systems in Lake Bloomington Watershed – Indian Creek Subdivision Detail.

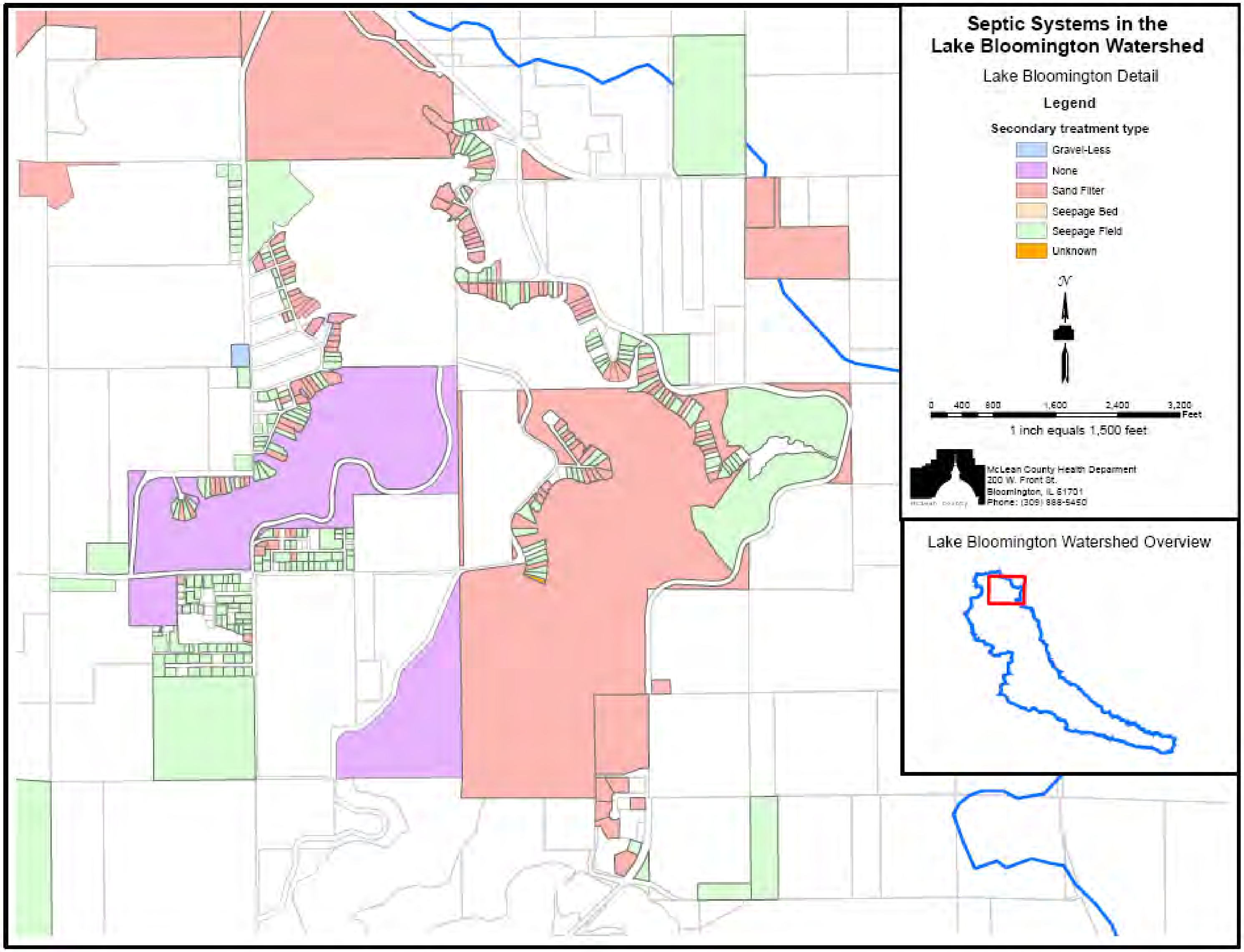


Figure 4-15. Septic Systems in Lake Bloomington Watershed – Lake Bloomington Detail.

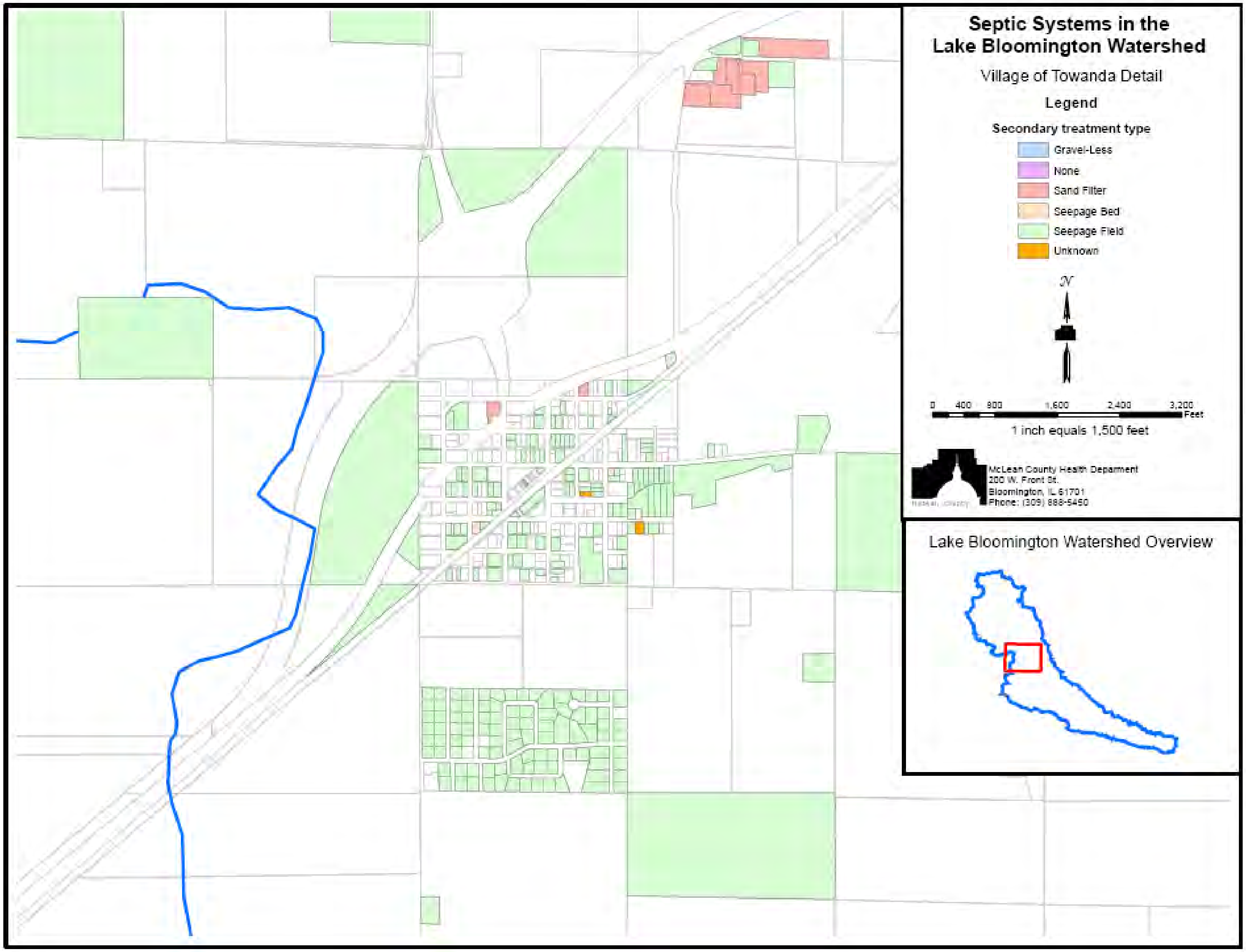


Figure 4-16. Septic Systems in Lake Bloomington Watershed – Village of Towanda Detail.

4.2.1 Source Description and Approximate Loading

In a properly functioning septic system, wastewater effluent leaves the septic tank and percolates through the system drainfield. Phosphorus is removed from the wastewater through adsorption to soil particles whereas nitrogen is converted to nitrate and transported to the streams by groundwater. Some nitrogen can be removed by plant uptake from vegetation growing over the drainfield.

The Lake Bloomington watershed is approximately 69.5 sq. mi. and the population served by septic tank systems is estimated to be approximately 4,575. Because no current database of onsite wastewater treatment systems is available for the entire watershed, the estimate of the number of systems is based on the watershed population and an average household size of 2.3 people per household. This results in estimated 1,989 septic systems. As stated previously, approximately 353 of these are located in close proximity to Lake Bloomington.

All septic systems in the watershed ultimately discharge to Lake Bloomington either through direct surface discharge or seepage to groundwater that reaches the streams and lake. There are two main types of septic systems found near Lake Bloomington: seepage field and sand filters (see Figure 4-15). Seepage fields disperse the septic tank effluent through the soil column, percolating to the groundwater table or seeping into a lake or stream. These systems work better with high hydraulic conductivity soils. Ideally, all the phosphorus is removed in the seepage field, but many factors influence the removal efficiency. Sand filters are used in areas where seepage fields are impractical due to low hydraulic conductivity soils. The septic tank effluent is distributed through layers of gravel and filter sand, collected by a tile at the bottom of the pit, and directed through a chlorinator before being discharged. Sand filters remove 10 to 20 percent total phosphorus and 18 to 33 percent total nitrogen from the septic tank effluent (Lake Bloomington Planning Committee, 2008).

The nutrient loading delivered to a lake or stream from a septic system depends on the type and condition of the septic tank effluent dispersal system. The Lake Bloomington Watershed Plan provides estimates of nutrient loading per household and overall nutrient loading to Lake Bloomington from all septic systems. It estimates 50.6 lb/yr of nitrogen and 11.9 lb/yr of phosphorus per household before secondary treatment. From 402 homes closest to the lake, 249 have seepage fields and 153 have sand filters. The loading estimate assumes no removal of nitrogen occurs in field seepage systems and phosphorus removal varies from 0 to 80 percent. Approximately 1,600 to 2,400 lb/yr of phosphorus and 8,400-9,500 lb/yr of ammonia are being discharged to the watershed from older or malfunctioning septic systems. These loadings represent 1 percent of the required nitrogen reduction and 23 to 35 percent of the required phosphorus reduction, according to the watershed plan (Lake Bloomington Planning Committee, 2008).

4.2.2 Appropriate BMPs

The most effective BMP for managing loads from onsite wastewater systems is a comprehensive management program that includes inspection, regular maintenance, and public outreach. Important measures to reduce pollutant loading from septic systems are listed below (CWP, 2004):

- Systems should be inspected annually even if they do not show failure. An inspection program would help identify failing systems and those systems that are currently connected to tile drain systems. All tanks discharging to tile drainage systems should be disconnected immediately. Systems older than 20 years and those located close to Lake Bloomington should be prioritized for inspection.
- Provide maintenance. Systems should be pumped every 3 to 5 years, depending on the tank size and number of residents per household (USEPA 2002a). Heavy equipment and vehicles should be kept off the system and drainfield. The drainfield should not be covered with impervious surfaces

- Septic system overflow should be prevented by conserving water, not diverting storm drains or basement pumps into septic systems, and not disposing of trash through drains or toilets
- Public outreach should be conducted to educate the homeowner about their systems and their maintenance

Some communities choose to formally regulate septic systems by creating a database of all the systems in the area, similar to the database maintained by the McLean County Health Department. This database usually contains information on the size, age, and type of system. All inspections and maintenance records are maintained in the database through cooperation with licensed maintenance and repair companies. These databases allow the communities to detect problem areas and ensure proper maintenance.

In 2006, IEPA proposed a general NPDES permit (ILG4) for surface discharging private sewage disposal systems to discharge into the waters of the state. All persons who discharge or proposes to discharge from an individual sewage treatment system must apply for coverage under the general permit or apply for an individual permit.

In 2003, the City of Bloomington studied alternative methods to provide conveyance and treatment of septic system effluent from residences surrounding Lake Bloomington. The study presented a pressure sewer collection/conveyance system with aerated and covered with aeration lagoons for treatment at an estimated cost of $9,800,000. Another option presented was a pumping station to pump wastewater from the lake pressure collection system to a pump station owned by the Bloomington and Normal Water Reclamation District at an estimated cost of $10,900,000 (Lake Bloomington Planning Committee, 2008).

4.2.3 Estimated Cost of Implementation

The cost of this BMP includes maintenance, inspection, replacement and public outreach. Maintenance of septic systems is performed by pumping the sludge that has accumulated at the bottom of the tank. The system fails due to overloading if the tank is not pumped out regularly. Pumping costs for septic tanks range from $250 to $350 based on the tank size and disposal fees. Assuming the septic system is pumped once every four years, on average, the annual cost ranges from $65 to $90.

Inspection of septic systems involves developing and maintaining a database of the onsite wastewater treatment systems in the watershed. After the initial inspection of each system and creation of the database, only systems with no subsequent maintenance records would need to be inspected. The cost for each inspection is approximately $175 per septic system (Hajjar, 2000). Assuming that all systems are inspected ones every five years, the cost per system is $35.

When replacement of septic tanks is needed, the estimated replacement cost ranges from $2,000 to $10,000. Assuming the expected useful life of a septic system is 30 years, the replacement cost per year ranges from $67 to $333.

A public outreach program can be accomplished through public meetings; mass mailings; radio, newspaper, and TV announcements to educate the homeowner about their systems and maintenance. The costs associated with outreach programs will vary depending on the level of effort. Assuming education will be given through annual public reminders, the annual cost is estimated at $1 per septic system. Table 4-16 summarizes the average annual cost per septic system. The average cost to implement an onsite wastewater treatment management program ranges from $168/system/yr to $459/system/yr.

Table 4-16. Costs Associated with Maintaining and Replacing an Onsite Wastewater Treatment System.

Action	Cost ($/system/yr)
Pumping	$65 - $90
Inspection	Up to $35
Replacement	$67 -$333
Public outreach	$1
Average Annual Cost	**$168 - $459**

4.2.4 Effectiveness and Estimated Load Reductions

Based on the assumptions above, it was estimated that the phosphorus loading from septic systems ranges from 610 to 2,614 lb/yr and the nitrogen loads range from 17,957 to 18,055 lb/yr. The average annual cost to implement a septic system management program that includes pumping, inspection, replacement, and public outreach cost between $168 and $459 per system. If this management program is implemented, 100 percent load reduction is expected for phosphorus assuming that all systems in the watershed are maintained properly (inspected every 5 years and pumped every 3 to 5 years) and are replaced once every 30 years. Only minimal load reductions are expected for nitrogen.

4.3 National Pollutant Discharge Elimination System Permittees

NPDES controls water pollution by regulating point sources that discharge pollutants into water bodies. Residences that are connected to a municipal sewer system, use a septic system or do not have surface discharge do not need an NPDES permit. However, industrial, municipal and other facilities must obtain permits to discharge into surface waters (Lake Bloomington Planning Committee, 2008).

The East Bay Camp and Retreat is the only one active wastewater treatment facility in the Lake Bloomington watershed that is regulated through the NPDES Program. Table 4-17 contains permit information on this facility.

Table 4-17. Point Source Discharges to Lake Bloomington

Facility Name	Location	NPDES No.	Permit Expiration	DAF (mgd)	DMF (mgd)
East Bay Camp and Retreat	Hudson, IL	IL0025666	12/31/2009	0.01	0.03

Note: DMF: Design Maximum Flow; DAF: Design Average Flow

The East Bay Camp and Retreat Facility is currently discharging into Lake Bloomington and is considered a potential point source of nutrients to the lake. The TMDL estimated the load from the facility at 320 lbs/yr total phosphorus and 1,373 lbs/yr total nitrogen based on the permitted design flow of 0.03 million gallons per day and an average TP concentration of 3.5 mg/L and TN concentration of 15 mg/L ((Litke, 1999; USEPA, 1997). Because the actual concentrations of TP and TN are unknown, it is recommended that the facility start sampling its effluent to determine its loading rates to the lake. These monitoring requirements can be included as a condition in the NPDES permit upon renewal. Following this monitoring IEPA can evaluate the need for point source controls through the NPDES permitting program.

4.4 Lake Bottom Sediments

Sedimentation in lakes is a natural process that can be accelerated or slowed by human interaction in the watershed. Sediments accumulate in lakes as a result of watershed erosion, sediment transport by streams, and sediment deposition into the lake bottom. Phosphorus release from lake bottom sediments are a potential source of pollutants. Releases of phosphorus from bottom sediments to the overlying waters occur during lake stratification when the soil water interface becomes anoxic.

Water quality measurements were taken in Lake Bloomington, at the surface and near the bottom, during the summers of 1991 and 1992 (Raman et al., 1994). Mean nitrate concentrations near the bottom were 25 percent lower than at the surface whereas mean phosphorus concentrations near the bottom were 108 percent higher than at the surface.

Phosphorus release from lake bottom sediments is implicitly taken into account within the BATHTUB model but the model does not provide an estimate of internal loads. The Nürnberg method (1984) was therefore used to obtain an approximate estimate of the internal load. This method uses mean depth, flushing rate, average inflow, and average outflow concentrations to estimate internal load. The accuracy of the method is dependent on the available tributary data, which are relatively limited for Lake Bloomington. Results for the available data in 1988 and 2005 suggest that internal loads of total phosphorus might average around 280 lbs/yr.

On June 1996, the City of Bloomington installed aeration/destratification equipment in Lake Bloomington to improve water quality by preventing thermal stratification, depletion of dissolved oxygen in the lower depths, and release of phosphorus from lake bottom sediments. The destratifier is located at a depth of 35 feet, near the water intake structure. A study conducted from water samples collected in October 2005, at 1 foot and 3 foot depths from the bottom of the lake, estimated a total phosphorus mass of 147 pounds with the destratifier operating. A mass of 797 pounds were estimated if the destratifier was not operating (Lake Bloomington Planning Committee, 2008).

No BMPs to address lake-bottom sediment loadings are suggested at this time for the following reasons:

- Lake bottom phosphorus loads are estimated to be significantly less than other sources, such as agricultural runoff and septic systems.
- Lake bottom phosphorus loads are a direct result of external loads, which should therefore be addressed first.
- Efforts to control lake bottom phosphorus loads can be extremely expensive. For example, alum treatment costs can range from $290/ac to $720/ac (WIDNR, 2003).

An erosion and sedimentation inventory for Lake Bloomington watershed was conducted. In this study, sediment delivery rates (SDR) for each type of erosion were calculated. The results of this can be found in the Lake Bloomington Watershed Plan (Lake Bloomington Planning Committee, 2008).

An in-lake sediment survey was conducted in 2005 by Hanson Engineers Inc. This survey concluded that 2,436 acre-feet of sediment has accumulated in the lake between 1929 and 1999, or about 34.8 acre-feet per year (Lake Bloomington Planning Committee, 2008). A depth volume relationship was developed in this report to calculate water volumes 0-2 feet above the sediment surface and amount of phosphorus in the anoxic zone of the lake. Table 4-18 shows erosion and sediment for Lake Bloomington that comes from different sources on a yearly basis. A total of 26,000 tons suspended sediment is delivered to the lake. Assuming an additional 15 percent comes from the bedload, the total sediment transported to the lake every year is approximately 29,900 tons (Lake Bloomington Planning Committee, 2008).

Table 4-18. Erosion and Sediment for Lake Bloomington

Location	Erosion (tons)	SDR	Sediment Delivered (Tons)
Cropland A/B	93,100	0.18	16,760
Cropland C/C+	1,810	0.55	1,000
Grasslands, CRP, Etc (All Slopes)	3,100	0.25	755
Woodland (All Slopes)	860	0.60	520
Ephemeral	2,000	0.6	1,300
Gully-Lakeside	280	0.85	240
Gully-Money Creek	285	0.70	200
Streambank	1,260	1.0	1,260
Shoreline	3,756	1.0	3,760
Total	106,800		26,000

Source: Lake Bloomington Planning Committee, 2008

4.5 Shoreline Erosion

Shoreline erosion is a potential source of nutrients to Lake Bloomington. Shoreline erosion results when the energy of waves erodes soil particles at or near the water level. Wave action due to wind and power boats is the main cause of shoreline erosion in Lake Bloomington.

Three shoreline erosion surveys have been completed in the past twenty years on Lake Bloomington (Lake Bloomington Planning Committee, 2008). A field reconnaissance survey of Lake Bloomington's shoreline was completed in 1989 by Farnsworth & Wylie/Hanson Engineers. NRCS also completed a shoreline study in 1998. A most recent shoreline erosion study of Lake Bloomington was completed in 2005 (Midwest Streams Inc., 2005). Visual observations of the shoreline were made in October 2005 by walking the shoreline with the water level approximately 10 to 12 feet below normal pool. In addition, a survey of approximately 2,900 feet extending along the north shore near the spillway was completed.

The 2005 survey shows nearly vertical eroding bank heights ranging from 1-2 feet up to 10-12 feet. The overall shoreline length around Lake Bloomington is approximately 14 miles. This study classified shoreline erosion in 6 categories based on the bank height and the width of eroded cobble material left in the wake of the receding bank line. Table 4-19 shows the summary of the 2005 Lake Bloomington shoreline survey. Class one has the lowest erosion and class six the most severe (Lake Bloomington Planning Committee, 2008).

Table 4-19. Lake Bloomington Shoreline Erosion Summary

Erosion Rating	Erosion Class	Total length of Unprotected Bank (ft)	Percent of Total Bank
<10=	Class 1	27,962	50.3%
11-49=	Class 2	10,790	19.4%
50-99=	Class 3	3,256	5.9%
100-149=	Class 4	4,356	7.8%
150-199=	Class 5	2,670	4.8%
>200=	Class 6	6,546	11.3%
Total		**55,580**	**100%**

Source: Lake Bloomington Planning Committee, 2008

Shoreline categorized as Class 6 was estimated to contribute 60 percent of the total sediment generated annually or approximately 2,247 ton/yr of sediment. The total estimated erosion loading to Lake Bloomington is 3,756 ton/yr of sediment.

The shoreline in residential areas is approximately 3.5 miles and is mainly protected with seawalls (sheet piling, timber walls, and concrete walls). The 2005 survey also classified the protected shoreline with seawalls as 48 percent in good condition, 26 percent in fair condition, 14 percent in poor condition, and 11 percent in critical condition (Lake Bloomington Planning Committee, 2008).

Phosphorus enters lake or streams bound to sediment particles with the amount of phosphorus varying according to local soil conditions. Information on the phosphorus enrichment ratio for the Lake Bloomington watershed is not available. However, Haith et al. (1992) report that soil phosphorus enrichment ratios within Illinois range from approximately 0.88 lb/ton to 1.65 lb/ton. Using these loading values, the potential phosphorus load from shoreline erosion around Lake Bloomington might vary from 3,300 lb/yr to 6,200 lb/yr.

The 2005 shoreline study recommends Stone Toe Protection (STP) applied along the eroding sections to provide stability and prevent additional recession of the bank line. The estimated STP cost for class 6 of $7,000 per year assuming a useful life of 50 years or a cost of $3.25/yr per pound of soil saved. This cost will stop 60 percent of the sediments from coming into the lake by treating only 12 percent of the shoreline. Other erosion control BMPs considered in the 2005 study include stone bankline below the waterline and extending 2 feet above the waterline and armor stone breakwaters (riprap apron placed on the fore slope) with transitional wetlands (Lake Bloomington Planning Committee, 2008).

A streambank erosion study was conducted in the fall of 2005 in 28 miles of the streams draining into Lake Bloomington (Money Creek and its tributaries). The study quantified the sediment loading from within the stream, evaluated the stability of selected stream segments, located and prioritized critical areas, and provided alternative solutions to reduce sediment loading from Money Creek. The study found that the upper reaches are maintained drainage ditches and have very low sediment contributions. The lower reaches range from natural channels to actively managed drainage ditches and waterways. Streambank erosion was classified into slight to severe erosion loss by estimating the length, height, and lateral recession rate. The most effective an economical treatment is hardening the toe of the eroding bank. STP and rock riffles are the preferred methods. The results of this study and suggested BMPs can be found in the Lake Bloomington Watershed Plan (Lake Bloomington Planning Committee, 2008).

The city of Bloomington has installed erosion control measures around Lake Bloomington and plans to implement extensive shoreline stabilization measures, possibly to include riprap and plantings.

4.6 Lawn Fertilizers

Another potential source of nutrients to Lake Bloomington is lawn fertilizer application from residential properties surrounding the lake. According to the GAP landuse database, there are 565 acres of residential land in the immediate area of Lake Bloomington. Approximately 0.7 of the residential land is urban lawn area. The total nutrient input from lawn fertilizers is unknown but studies indicate that urban fertilization contributes less than 1 percent of the nutrient load to the watershed (Lake Bloomington Planning Committee, 2008).

Nutrients in lawn fertilizers from residential areas can be carried to the lake during precipitation events and can be a major seasonal source of phosphorus and nitrogen. Loading rates from lawn fertilizers (residential landuse) are estimated to range from 4.4 lb/ac/yr to 6.5 lb/ac/yr for total nitrogen and 0.68 lb/ac/yr to 1.96 lb/ac/yr for total phosphorus (Loehr, et.al., 1989). Therefore, the estimated total nitrogen load from lawn fertilizes could range from 2,486 lb/yr to 3,672 lb/yr and the total phosphorus load could range from 384 lb/yr to 1,107 lb/yr.

In August 2007, the members of the Lake Bloomington Homeowners Association were surveyed at their annual dinner meeting on their personal lawn fertilizer use. Seventy out of 200 responded and the results can be found in the Lake Bloomington Watershed Plan (Lake Bloomington Planning Committee, 2008).

The most effective BMP for managing loads from lawn fertilizes is a public outreach program that educates the homeowner about lawn care and the importance of minimizing fertilizer applications. A public outreach program can be accomplished through public meetings; mass mailings; radio, newspaper, and TV announcements to educate individual homeowners. The costs associated with outreach programs will vary depending on the level of effort. Assuming education will be given through annual public reminders, the annual cost is estimated at $1 per household. The average cost to implement an outreach program for lawn fertilizer management is therefore approximately $565/yr assuming an average lot size of 1 acre.

Homeowners and businesses with property near Lake Bloomington can also reduce lawn fertilizer applications by using native vegetation in streamside buffer strips and near lake areas which also reduces maintenance costs. Some lawn fertilizer solutions recommended in the Lake Bloomington Watershed Plan include fertilizers with no phosphorus, slow-release synthetic or organic fertilizers. Other BMPs recommend shifting cool-season turf grass lawns to mixed clover-turfgrass lawns, converting lawn to rain gardens, using rain barrels and native vegetation. (Lake Bloomington Planning Committee, 2008).

4.7 Urban Construction Runoff

Another potential source of nutrients is urban construction runoff that contributes excessive sediment and phosphorus to surrounding surface waters. Construction sites remove the top soil and expose highly susceptible soil to erosion. Rain events on construction sites can contribute 20 times or more the sediment of typical agricultural land if the sites are not protected with erosion and sediment control measures (Lake Bloomington Planning Committee, 2008).

Phosphorus loading from construction sites is calculated from specific analysis of soil data and compliance with recommended NPDES Phase II requirements. Nitrogen loading from eroded soils in construction sites is negligible (Lake Bloomington Planning Committee, 2008).

5.0 PRIORITIZATION OF IMPLEMENTATION

This section of the report compares all the BMPs discussed in Section 4.0 so they can be prioritized based on cost, effectiveness, and loading reduction goals.

5.1 Current Loadings

Managing nutrients loads in the Lake Bloomington watershed should focus on agricultural BMPs and the maintenance of septic systems. Nutrient loads to Lake Bloomington vary yearly and even monthly due to the frequency and intensity of rainfall events and the timing and quantity of fertilizer applications. However, the “ballpark” load estimates summarized in Table 5-1 indicate that agricultural runoff and septic systems are the two most significant sources of both phosphorus and nitrogen. In addition, shoreline erosion is another significant source of phosphorus.

Table 5-1. Lake Bloomington Current Estimated Loads

Source	Total Phosphorus (lb/yr)	Nitrate (lb/yr)
Agricultural Land Uses [1]	5,889 to 16,490	294,468 to 585,008
Onsite Wastewater Treatment Systems	610 to 2,614	17,957 to 18,055
East Bay Camp and Retreat	320	1,373
Lake Bottom Loadings	280	Negligible
Shoreline Erosion	3,300 to 6,200	Negligible
Lawn Fertilizers	384 to 1,107	2,486 to 3,672

[1] Loads calculated based on the acreages of cropland (38,535 ac) minus that potentially subject to conversion to riparian buffers. The area used for the buffers is estimated based on 20 miles of river length and a 300 ft wide treated areas.

5.2 Comparison of BMPs

Table 5-2 and Table 5-3 summarize the potential reduction loading in phosphorus and nitrogen from BMPs for the most significant pollutant sources and the total cost to implement the measures over all applicable areas in the entire watershed. The information in these tables does not imply that BMPs should be built to treat the entire watershed, nor does it account for BMPs already in place. Table 5-2 and Table 5-3 are simply used to compare the potential load reduction from each BMP as well as the cost associated with achieving that reduction.

Table 5-2. Comparison of Phosphorus BMPs in Lake Bloomington Watershed

BMP	Phosphorus Removal Rate (%)	Potential Reduction in Phosphorus Loading (lb/yr)	Annualized Costs for Full Management ($)
Agricultural BMPs for 38,535 Acres of Farmland in the Watershed			
Nutrient Management Plan	20 - 50	1,156 – 8,092	38,540 – 154,140
Conservation Tillage	45 - 76	3,931 – 12,300	48,170 – 96,340
Cover Crops	70 - 85	4,046 – 13,757	655,100 – 924,840
Filter Strips	0 - 83	0 – 13,433	1,050,080 – 1,724,450
Grassed Waterways	29	1,676 – 4,694	86,710 – 250,480
Restoration of Riparian Buffers	70 - 80	76 - 244	2,283,200 – 2,283,200
Drainage Water Management	35 - 83	2,023 – 13,433	96,340 – 144,510
Wetland Systems	40 - 79	2,312 – 12,786	349,4370 – 407,674
Onsite Wastewater Treatment BMPs Assuming 1,989 Systems in the Watershed			
Pumping/ Maintenance	100	610 - 2,614	129,300 – 179,030
Inspection			69,620
Replacement			133,280 – 662,390
Education			1,990

Table 5-3. Comparison of Nitrogen BMPs in Lake Bloomington Watershed

BMP	Nitrogen Removal Rate (%)	Potential Reduction in Phosphorus Loading (lb/yr)	Annualized Costs for Full Management ($)
Agricultural BMPs for 38,535 Acres of Farmland in the Watershed			
Nutrient Management Plan	35	101,154 – 200,960	38,540 – 154,140
Conservation Tillage	55 - 73	158,957 – 419,145	48,170 – 96,340
Cover Crops	5 - 15	14,451 – 86,126	655,100 – 924,840
Filter Strips	27 - 87	78,033 – 499,529	1,050,080 – 1,724,450
Grassed Waterways	38	109,825 – 218,185	86,710 – 250,480
Restoration of Riparian Buffers	74 - 80	4,036 – 8,669	2,283,200 – 2,283,200
Drainage Water Management	45 - 47	130,056 – 269,861	96,340 – 144,510
Wetland Systems	23 - 44	66,473 – 252,635	349,4370 – 407,674
Onsite Wastewater Treatment BMPs Assuming 1,989 Systems in the Watershed			
Pumping/ Maintenance	7	-	129,300 – 179,030
Inspection			69,620
Replacement			133,280 – 662,390
Education			1,990

As shown in Table 5-2 and Table 5-3, implementing nutrient management plans, conservation tillage, grassed waterways, and installing outlet control structures in tile drain systems are the most cost effective agricultural BMPs. The potential load reductions for these BMPs range from 1,156 lb/yr to 13,433 lb/yr for phosphorus and from 101,154 lb/yr to 269,861 lb/yr for nitrogen.

Implementing the septic tank management program to reduce failure of septic systems in the Lake Bloomington watershed would likely reduce phosphorus loads by 610 lb/yr to 2,614 lb/yr, assuming that the current failure rate is no more than 30 percent. In terms of phosphorus load reduction, this management measure results in slightly higher cost compared to the most effective agricultural BMPs (nutrient management plans, conservation tillage, grassed waterways, and drainage water management). However, the cost of these BMPs is comparable to some other agricultural BMPs such as cover crops and wetland systems and would also address a potential health hazard.

5.3 Implementation Strategy for BMPs

Some best management practices have been implemented or are currently being implemented in the Lake Bloomington watershed. These practices include windbreakers to prevent wind erosion, no till, strip till, mulch till, stabilization structures, nutrient management practices, prescribed grazing and drainage water management (Bohnhoff, 2007).

The Lake Bloomington Watershed Plan identified reduction goals for nitrate, phosphorus and sediment loading. The goals were divided in three geographical areas in the watershed: riparian area (lake, shoreline, stream banks, streams), urban area high density developments and agricultural area. Cost for suggested agricultural BMPs was estimated at $1.3 million over a 15 year period using government cost share programs. Cost for urban monitoring program in the Town of Normal will include a capital investment of $366,000 over a 5 year period. Details of each area, suggested BMPs, cost, timeline for implementation, and reduction goals can be found in the watershed plan (Lake Bloomington Planning Committee, 2008).

In 2003, the City of Bloomington prepared a storm water management plan that presented a mix of BMPs to address erosion, sediment, fecal coliform, grease and oil, household and lawn/garden chemicals that could potentially end up in local streams. Public awareness and education activities in the watershed have occurred or are ongoing. Large management and research projects include: nutrient management programs funded by IEPA (2000/01, 2001/02) and Sand County Foundation (2005/06, 2006/07), Lake Bloomington sustainable water program – tile research from 1998 to date (City of Bloomington and ISU), wetlands research on City of Bloomington property from 2000 to date (David Kovacic, UIUC), nitrate research on Money Creek recording and compiling tile data and organic use (City of Bloomington and ISU), and rain reporters volunteers that collect rainfall data in McLean County from 1997 to data (Lake Bloomington Planning Committee, 2008).

Nutrient management planning to determine appropriate fertilizer application rates is currently being used in the watershed as part of the cost-share programs and should be continued. There are approximately 36,000 acres of cropland (corn and soybeans) in the watershed. Approximately 15,148 acres of cropland (68% of the corn acres planted in 2007) in Lake Bloomington watershed were enrolled in the 2006 and 2007 nutrient management program funded by the Sand County Foundation, out of Wisconsin. Different applications were used in the program, including 4,944 acres with fall application, 3,199 acres with split application, and 7,005 acres with spring application. Extending this practice to all cropland fields could reduce phosphorus loading to Lake Bloomington by 20 to 50 percent and nitrogen loading by 35 percent.

Approximately 36 percent of corn fields, 91 percent of soybean fields and 100 percent of small grain fields in McLean County use some form of conservation tillage. Assuming similar levels of participation in the Lake Bloomington watershed, extending conservation tillage practices to the remaining 64 percent of corn fields and 9 percent of soybean fields could reduce phosphorus loading by 45 to 76 percent and nitrogen loadings by 55 to 73.

The City of Bloomington, Pheasants Forever, and the McLean County SWCD have funded filter strips along waterways in Lake Bloomington watersheds. By the beginning of 2007, there were 213 acres of filter strips enrolled in the Conservation Reserve Program (Lake Bloomington Planning Committee, 2008).

The Lake Bloomington watershed has nature preserves, or protected lands that maintain and restore native vegetation. The ParkLands Foundation and the Indian Creek Homeowners Association have established and protected approximately 122 acres.

In June 1996, destratifier units were placed on the bottom of Lake Bloomington as part of the lake management program. The destratifiers reduce the phosphorus concentration by 70 percent in the deep zone and increase the oxygenated zone from 16 to 30 feet (Lake Bloomington Planning Committee, 2008).

Nutrient management planning, conservation tillage practices, grassed waterways, and drainage water management have relatively low implementation cost ranging from $1.00/ac/yr to $6.50/ac/yr. The use of other BMPs such as cover crops, filter strips, and restoration of riparian buffers would be part of supplemental strategies due to their higher cost. Expected costs for these practices range from $17 to $59.25/ac/yr.

With approximately 7,500 acres of cropland having tile drainage systems in Lake Bloomington watershed, it is estimated that installing outlet control systems in the agricultural fields could reduce phosphorus loading by 35 to 83 percent and nitrogen loading by 45 to 47 percent. This practice is only moderately more expensive than some of the other available BMPs at $2.50 to $3.75/acre.

The extent of current implementation of grassed waterways in the watershed is unknown. This technology is applicable watershed-wide and is capable of reducing phosphorus loads by 29 percent and nitrogen by 38 percent.

The installation cost of wetland systems can be considerable but supplementing the cost with cost sharing programs like the Conservation Reserve Program (CRP) and the Wetlands Reserve Program (WRP) greatly increases the feasibility of these BMP.

Proper maintenance and replacement of septic systems is also encouraged. Up to 100 percent phosphorus reductions could be obtained if this BMP is implemented correctly. The expected cost for this practice ranges from $168 to $459/yr per septic system.

6.0 MEASURING AND DOCUMENTING PROGRESS

The Illinois EPA receives federal funds through the U.S. Environmental Protection Agency (USEPA) to conduct various monitoring programs for streams and lakes. Some of the programs available to the Lake Bloomington watershed are described below.

6.1 Ambient Lake Monitoring Program

Illinois EPA conducts an Ambient Lake Monitoring Program (ALMP) annually in approximately 50 lakes throughout the state. This is an intensive monitoring program that collects samples for a large number of water quality parameters. Certain core lakes are monitored every three years. The data are annually summarized and distributed to managers of related lake resources.

The ALMP program is available to Lake Bloomington and monitoring is conducted five times in a year. Monitoring is done in April, June, July, August, October and September. Various parameters including suspended solids, metals, pesticides, organic compound, sediment analysis, chlorophyll, depth and profile on DO are monitored (Ettinger, 2007).

6.2 Voluntary Lake Monitoring Program

The Illinois Environmental Protection Agency (EPA) established the Volunteer Lake Monitoring Program (VLMP) in 1981. The VLMP serves as an educational program for citizens to learn about lake ecosystems, as well as a cost-effective method of gathering fundamental information on Illinois inland lakes. The VLMP utilizes funds provided by the federal Clean Water Act and the state-funded Conservation 2000 Program that increase citizen knowledge and awareness of the factors that affect lake quality and encourage development and implementation of sound lake protection. The city of Bloomington participates in the VLMP and collects samples for temperature and DO at four different sites on Lake Bloomington (Twait, 2007).

The VLMP operates under three levels of monitoring as summarized below:

- Tier 1 – In this tier, volunteers perform Secchi disk transparency monitoring and field observations only. Monitoring is conducted twice per month from May through October typically at three in-lake sites.
- Tier 2 – In addition to the tasks of Tier 1, Tier 2 volunteers collect water samples for nutrient and suspended solid analysis at the representative lake site: Site 1. Water quality samples are taken only once per month in May-August and October in conjunction with one Secchi transparency monitoring trip.
- Tier 3 – This is the most intensive tier. In addition to the tasks of Tier 1, Tier 3 volunteers collect water samples at up to three sites on their lake (depending on lake size and shape). Their samples are analyzed for nutrients and suspended solids. They also collect and filter their own chlorophyll samples. This component may also include DO/Temp. profiles as equipment is available. As in Tier 2, water quality samples are taken only once per month in May-August and October in conjunction with one Secchi transparency monitoring trip.

6.3 Other Monitoring Programs

A monitoring program by the department of Water Treatment Plant of the City of Bloomington collects samples from the Lake Bloomington at the spillway. Samples are collected for parameters like TSS, TP, and TN. More extensive sampling is done in the summer time (Twait, 2007).

In addition to the above mentioned programs, additional data collection programs described below shall be useful in evaluating the effectiveness of the BMPs discussed in Section 4.0:

- Measuring dissolved and total phosphorus concentrations in tile drain effluent.
- Monitoring of septic systems that discharge to tile drains.
- Continuous sampling of nitrate and total phosphorous should be done in dry and wet seasons.
- Inspection of onsite wastewater treatment systems in the watershed to determine rates of failure and approximate contribution to the lake.

Education about the effectiveness of BMPs across the watershed should be of a high priority to get the community involved in achieving the required water quality standard.

The Lake Bloomington Watershed Plan identified data gaps in the watershed. The data gaps include biota information, tile data, discharge from waste systems from adjacent homes to the lake, gauging stations from Money and Hickory creeks restored to collect current data, and inadequacies in modeling using BATHTUB (Lake Bloomington Planning Committee, 2008).

Data collection should take place at strategic locations upstream and downstream of BMPs to determine the impacts and the effectiveness of the BMP in different parts of the watershed. Measuring the effectiveness of these BMPs will require continued sampling of water quality in Lake Bloomington over the next several years. Measurements should continue for a minimum of two monitoring cycles to document progress and direct future management strategies.

7.0 REASONABLE ASSURANCE

Reasonable assurance for reducing the loads identified in the Lake Bloomington TMDL and restoring the water quality of the impaired lake is required by USEPA. For this watershed, the implementation of agricultural BMPs and the maintenance and/or replacement of septic tank systems are the most effective BMPs needed to meet the reduction goals. Therefore, combined participation of farmers and landowners is desirable. There are several educational efforts and cost share programs conducted by various authorities that encourage community participation to protect water quality. Three of the incentive programs discussed below, EQIP, CRP and WRP were administered under the 2002 Farm Bill, which expired September 30, 2007. The Conservation Reserve Program (CRP) will continue to pay out existing contracts, but new enrollments will not be allowed until the bill is reinstated; no official date of reinstatement has been announced. Though the Environmental Quality Incentives Program (EQIP) was also part of the 2002 Farm Bill, it was extended beyond fiscal year 2007 by the Deficit Reduction Act of 2005 (Congressional Research Reports for the People, 2007). New CRP Enrollments are allowed for practices that fall under the continuous signup. A new general signup period has not been announced. At the time of writing, a new Farm Bill is being developed, and the future extent of these programs is unknown.. Some of cost-sharing programs available in the Lake Bloomington watershed are:

7.1 Environmental Quality Incentives Program (EQIP)

NRCS provides cost-share and incentive payment assistance for various conservation practices to treat and reduce pollutant loads from agricultural fields. In Illinois, a cost-share practice must be started within 12 months of contract obligation by the NRCS approving official and the producer is expected to make continuous progress towards implementation. Also, it is required that the BMPs be constructed according to the specifications listed for each conservation practice.

- The program will pay up to $15/ac for up to 3 years, for up to 400 acres per farming operation.
- Use of residue management will earn the farmer $ 15/acre for three years (up to 400 acres per farmer).
- The program will pay a payment rate to the producer of $1,634/ac to construct and seed waterways, up to $491/ac to install riparian buffers and up to $8.05/ft to install windbreaks.
- Drainage water management on tile outlets will earn the farmer $5/ac/yr for three years for the effected drainage area as well as a payment rate of up to $1,036 per structure.
- Use of vegetated filter strips will receive a payment rate of up to $114/ac to establish with no annual payments.

In order to participate in the EQIP cost share program, all BMPs must be constructed according to the specifications listed for each conservation practice. The specifications and program information can be found online at

http://www.il.nrcs.usda.gov/programs/eqip/cspractices.html.

7.2 Conservation 2000

In 1995 the Illinois General Assembly passed the Conservation 2000 bill providing $100 million in funding over a 6-year period for the promotion of conservation efforts. In 1999, legislation was passed to extend the program through 2009. Conservation 2000 currently funds several programs applicable to the watershed through the Illinois Department of Agriculture. General information concerning the Conservation 2000 Program can be found online at

http://www.agr.state.il.us/Environment/conserv/

7.3 Conservation Practices Program (CPP)

The Conservation Practices Cost Share Program, under the Illinois Department of agriculture, Bureau of land, provides payments up to 60 percent of the initial costs for construction of various conservation practices like contour farming establishment, installation of stormwater ponds, filter strips, grassed waterways, terraces, cover crops and no-till planting systems. Landowners in Illinois seeking cost-share assistance should contact the McLean County SWCD office. Recipients of cost-share monies must agree to continue or maintain structural conservation practices and possibly some management practices for at least 10 years. More information concerning the Conservation Practices Program can be found online at:

http://www.agr.state.il.us/Environment/conserv/

7.4 Conservation Reserve Program (CRP)

The Conservation Reserve Program (CRP) is funded through the Commodity Credit Corporation (CCC) and administered by the Farm Service Agency, with NRCS providing technical land eligibility determinations, conservation planning and practice implementation. It encourages landowners to convert highly erodible cropland or other environmentally sensitive acreages to vegetative cover, such as filter strips, grassed waterways or riparian buffers. Landowners receive an annual rental payment for the term of the multi-year contract. The program typically provides 50 percent of the upfront cost to establish vegetative cover and $220/ac/yr for up to 15 years.

The CRP program has helped in the implementation of filter strips up to 120 feet wide in the Lake Bloomington watershed. Multiple choices on selection of grasses are available. Annual payment is provided based on soil type of the farmland. Less productive soil is given less payment where as more productive soil is given high payment up to $220/ac/yr for a 10-15 year contract (Rutherford, 2007a). Under this program, various practices have been implemented in the watershed such filter strips, riparian buffers up to 120 ft wide, grass waterways and grass swales to control erosion. In 2006, 10,500 acres of land in McLean County were enrolled in the CRP program with about 1,450 long-term contracts with landowners (Evers, 2007)

More information about this program is available online at:

http://www.nrcs.usda.gov/programs/crp/

7.5 Nonpoint Source Management Program (NSMP)

Illinois' Nonpoint Source (NPS) Pollution Management Program is funded by Illinois EPA. Illinois EPA receives these funds through Section 319 of the Clean Water Act and administers the program within Illinois. The purpose of the Program is to work cooperatively with local units of government and other organizations toward the mutual goal of protecting the quality of water in Illinois by controlling NPS pollution. The funds are used for the development of information/ education programs and for the implementation of best management practices. The maximum federal funding available is 60 percent, with the remaining 40 percent coming from local match. The program period is two years unless otherwise approved. This is a reimbursement program. Applications are accepted June 1 through August 1. More information about this program is available online at:

http://www.epa.state.il.us/water/financial-assistance/nonpoint.html.

7.6 Illinois Conservation and Climate Initiative (ICCI)

The Illinois Conservation and Climate Initiative (ICCI) is a joint project of the State of Illinois and the Delta Pollution Prevention and Energy Efficiency (P2/E2) Center that allows farmers and landowners to earn carbon credits when they use conservation practices. These credits are then sold to companies or agencies that are committed to reducing their greenhouse gas emissions. Conservation tillage earns 0.5 metric tons (1.1 US ton) of carbon per acre per yr (mt/ac/yr), grass plantings (applicable to filter strips and grassed waterways) earn 0.75 mt/ac/yr, and trees planted at a density of at least 250 stems per acre earn somewhere between 3.5 to 5.4 mt/ac/yr, depending on the species planted and age of the stand.. Administrative fees of $0.14/mt plus 8 percent are subtracted from the sale price.

Exchange rates are available online at http://chicagoclimatex.com. Program enrollment occurs through the P2/E2 Center which can be found online at http://p2e2center.org/. The Association of Illinois Soil and Water Conservation Districts acts as a third party to conduct audits to verify that practices are being maintained where credits are being earned. More information about carbon trading can be found online at:

http://illinoisclimate.org/

7.7 Wetlands Reserve Program (WRP)

The Wetlands Reserve Program (WRP) is a voluntary program under the Natural Resources Conservation Service (NRCS). It provides technical and financial assistance to eligible landowners to restore, enhance, and protect wetlands. Landowners have the option of enrolling eligible lands through permanent easements, 30-year easements, or restoration cost-share agreements. This program offers landowners an opportunity to establish, at minimal cost, long-term conservation and wildlife habitat enhancement practices and protection. WRP has an acreage enrollment limitation rather than a funding limit. Congress determines how many acres can be enrolled in the program and funding is somewhat flexible. The Natural Resources Conservation Service (NRCS) estimates program-funding needs based on the national average cost per acre.

Under permanent easement, the U.S. Department of Agriculture (USDA) pays up to 100 percent of the cost of restoring the wetland. USDA also pays up to 75 percent of restoration costs through 30-Year Easement. USDA pays up to 75 percent of the cost of the restoration activity under Restoration Cost-share Agreement (generally for a minimum of 10 years) to re-establish degraded or lost wetland functions and values. The specifications and program information can be found online at:

http://www.nrcs.usda.gov/programs/wrp/

7.8 Conservation Reserve Enhancement Program (CREP)

The Illinois Conservation Reserve Enhancement Program (CREP) is a voluntary land retirement program that helps agricultural producers protect environmentally sensitive land, decrease erosion, restore wildlife habitat, and safeguard ground and surface water. CREP is being implemented through a federal, state, and local partnership in the Illinois River Basin. The CREP program is restoring and protecting large stretches of floodplain corridors both on the main stem of the Illinois River and along the major tributaries. It is helping landowners, who have only been able to produce crops in the area once or twice in the last decade, to retire these lands from agricultural production. Lake Bloomington watershed is part of the Illinois River Basin and eligible for the Illinois CREP assistance.

CREP contracts require a 10- to 15-year commitment to keep lands out of agricultural production and provide annual per acre rental payment based on the weighted average soil rental rate for the three most common soils on the property enrolled. Cost-share reimbursement for 50percent of eligible costs for approved conservation practices.

- Filter strips and riparian buffers qualify for a one-time Signing Incentive Payment(SIP) of $10 per acre for a maximum of 10 years. These BMPs also qualify for a one time Practice Incentive Payment (PIP) equal to 40 percent of the total eligible cost of installation.
- Wetland restoration qualifies for a one-time payment incentive for 25 percent of the eligible costs associated with hydrologic restoration.
- Land qualified as riparian or wetland restoration area increases the annual per acre rental rate by 30 percent.
- Land qualified as highly erodible land provides a 20 percent increase in the annual per acre rental rate.

Additional information about CREP is available online at:

http://www.ilcrep.org

7.9 Sustainable Agriculture Grant Program (SARE)

The Sustainable Agricultural Grant Program funds research, education, and outreach efforts for sustainable agricultural practices. Private landowners, organizations, educational, and governmental institutions are all eligible for participation in this program. More information concerning the Sustainable Agricultural Grant Program can be found online at:

http://www.sare.org/grants/

Table 7-1 and Table 7-2 summarize the cost share programs available for pollutant reduction using BMPs in the Lake Bloomington watershed.

Table 7-1. Summary of Assistance Programs Available for Landowners in the Lake Bloomington Watershed.

Assistance Program	Program Description	Contact Information
NRCS EQIP	Provides cost-share and incentive payment assistance to farmers statewide who utilize approved conservation practices to reduce pollutant loading from agricultural lands. Applies to nutrient management plans, filter strips, grassed waterways, riparian buffers, and conservation tillage.	USDA Local Service Centers McLean County NRCS 1905-A U.S. 402 N Kay Drive, Normal, IL 61761- 1957 Kent Bohnoff Phone: 309/452-3848 Fax: 309/452-6642
Conservation 2000 CPP	Provides payments up to 60 percent of the initial costs for construction of various conservation practices	McLean County SWCD 1905-A U.S. 402 N Kay Drive, Normal, IL 61761- 1957 Dave Bishop Phone: 309/452-3848 Fax: 309/452-6642
FSA CRP	Cost sharing is provided to establish the vegetative cover practices.	Farm Service Agency (FSA) Local Office 1905-A U.S. 402 N Kay Drive, Normal, IL 61761- 1957 Jonathan Evers Phone: 309/452-3848 Fax: 309/452-6642
NSMP (319)	Provides grant funding for educational programs and implementation of nonpoint source pollution controls.	Illinois Environmental Protection Agency Bureau of Water Watershed Management Section, Nonpoint Source Unit P.O. Box 19276 Springfield, IL 62794-9276 Phone: (217) 782-3362
ICCI	Allows farmers to earn carbon trading credits for use of conservation practices.	McLean County SWCD 1905-A U.S. 402 N Kay Drive, Normal, IL 61761- 1957 Phone: 309/452-3848 Fax: 309/452-6642
WRP	Provides technical and financial assistance to eligible landowners to restore, enhance, and protect wetlands	McLean County NRCS 1905-A U.S. 402 N Kay Drive, Normal, IL 61761- 1957 Phone: 309/452-3848 Fax: 309/452-6642
CREP	Voluntary land retirement program that helps agricultural producers protect sensitive land, decrease erosion, restore wildlife habitat, and safeguard ground and surface water	McLean County SWCD 1905-A U.S. 402 N Kay Drive, Normal, IL 61761- 1957 Phone: 309/452-3848 Fax: 309/452-6642
SARE	Funds educational programs for farmers concerning sustainable agricultural practices.	McLean County SWCD 1905-A U.S. 402 N Kay Drive, Normal, IL 61761- 1957 Dave Bishop Phone: 309/452-3848 Fax: 309/452-6642

Table 7-2. Assistance Programs Available for Agricultural BMPs.

BMP	Cost Share Programs and Incentives
Education and Outreach	Conservation 2000 SARE NSMP
Nutrient Management Plan	EQIP: $15/ac for up to 3 years, 400 ac. max.
Conservation Tillage	EQIP: $15/ac for up to 3 years, 400 ac. max. ICCI: earns 0.5 mt/ac/yr of carbon trading credit
Cover Crops	CPP: cost share of 60 percent
Filter Strips	EQIP: $114/ac to establish with no annual payments CPP: 60 percent of construction costs CRP: 50 percent of the upfront cost to establish vegetative cover and $220/ac/yr for up to 15 years ICCI: earns 0.75 mt/ac/yr of carbon trading credit for each acre planted
Grassed Waterways	EQIP: $1,634/ac to construct and seed waterways CPP: 60 percent of construction costs ICCI: earns 0.75 mt/ac/yr of carbon trading credit for each acre planted
Land Retirement of Highly Erodible Land or Land Near Sensitive Waters	CRP: 50 percent of the costs of establishing vegetative cover and cash incentive of $185/ac/yr for 15 years ICCI: earn between 0.75 and 5.4 mt/ac/yr of carbon trading credit depending on species planted
Drainage Water Management	EQIP: $5/ac/yr for 3 years for effected drainage area, $1,036 per structure
Restoration of Riparian Buffers	EQIP: $491/ac to install riparian buffers CPP: up to 75 percent of construction costs CRP: 50 percent of the costs of establishing vegetative cover and cash incentive of $185/ac/yr for 15 years ICCI: earn between 0.75 and 5.4 mt/ac/yr of carbon trading credit depending on species planted

Note: Cumulative cost shares from multiple programs will not exceed 100 percent of the cost of construction.

8.0 IMPLEMENTATION TIME LINE

This implementation plan for the Lake Bloomington watershed is based on a phased approach (Figure 8-1):

- Phase I of this implementation plan should build on the efforts currently being conducted in the watershed and continue to focus on education. Educating landowners about the benefits of agricultural BMPs on crop yield, soil quality, and water quality as well as cost share programs available in the watershed is highly important. In addition, all property owners of onsite wastewater treatment systems should be informed of their responsibilities to maintain and repair their systems. The McLean County Health Department regulates septic systems in the watershed and could be a lead in providing septic systems education. It is expected that initial education through public meetings, mass mailings, TV and radio announcements, and newspaper articles could be achieved in less than 6 months. As described in Section 7.0, assistance with educational programs is available through the Illinois Environmental Protection Agency Nonpoint Source Management Program (NSMP).
- Phase II of the implementation schedule will involve voluntary participation of landowners in implementing BMPs such as nutrient management planning, conservation tillage, grassed waterways, and drainage water management for tile drain systems. The local Natural Resources Conservation Service and the county SWCD offices will be able to provide technical assistance and cost share information for these BMPs. In addition, initial inspections of all onsite wastewater treatment systems and necessary repairs should be conducted. Ongoing efforts to address shoreline erosion should also be maintained. Monitoring of water quality in Lake Bloomington should continue. This phase of the plan will likely take one to three years.
- Phase III of this implementation plan involves the evaluation of BMP's effectiveness in meeting the water quality reduction goals and/or the reassessment of additional management practices needed to meet the reduction goals. If nutrient concentrations measured during monitoring in Phase II remain above the water quality standard, then Phase III of the implementation plan will be necessary. The load reduction achieved during Phase II should be estimated by 1) summarizing the areas where BMPs are in use, 2) calculating the reductions in loading from specific BMPs, and 3) determining the impacts on nutrient concentrations measured before and after Phase II implementation. If BMPs are not meeting the desirable reduction loads, and additional areas could be incorporated, further efforts to include more stakeholders in the voluntary programs will be needed. If the Phase II BMPs are not having the desired impacts in load reductions and additional areas could not be incorporated, supplemental agricultural BMPs will be needed. Strategic placement of these more expensive BMPs near stream channels and the lake shore will provide maximized benefits. If required, this phase could last for five to ten years.

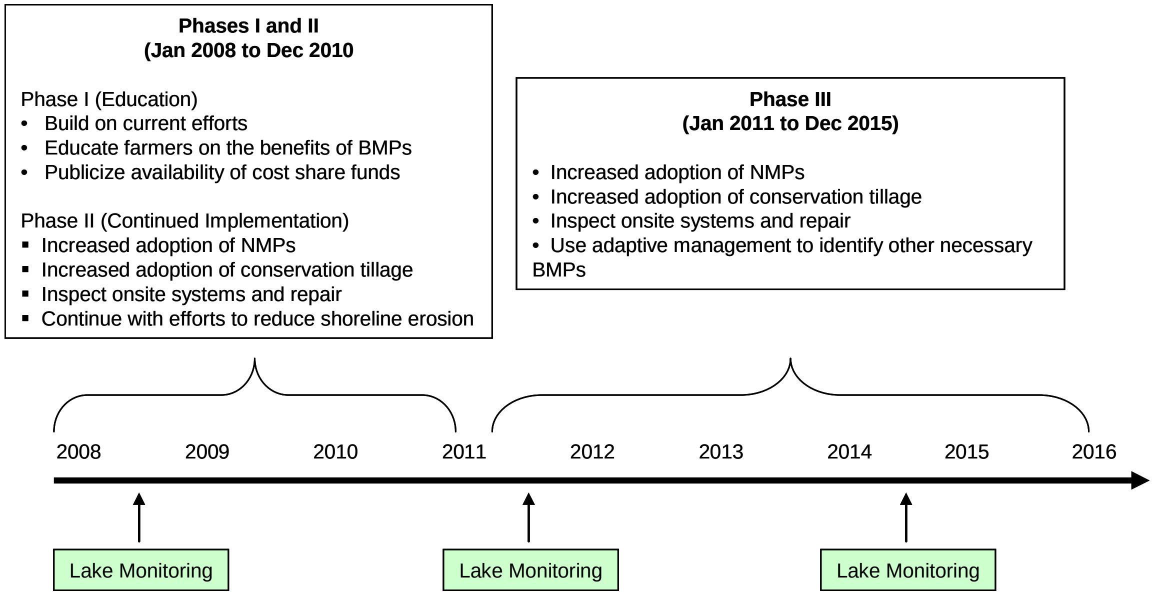


Figure 8-1. Proposed schedule for Lake Bloomington TMDL implementation.

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APPENDIX A: WATER QUALITY IMPROVEMENT CASE STUDY: ASSESSMENT OF THE LAKE BLOOMINGTON WATERSHED

Water Quality Improvement Case Study: Assessment of the Lake Bloomington Watershed

Final Report, March 10, 2008

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Introduction

The goal of this project is to make an assessment of practices that could be used to reduce nitrate and total P loss from agricultural fields to the streams (and then into a reservoir) in a targeted Illinois watershed. This is a case study, illustrating the effects of various practices on reducing nutrient loss in a predominately corn/soybean, tile drained watershed with little or no manure application. Our study is focused on the 18,123 ha (44,764 acres) Lake Bloomington watershed that includes Money Creek, which is representative of the tile-drained, corn and soybean row cropped landscape of central and northern Illinois. This stream and reservoir have high concentrations of both nitrate and total P. The reservoir is used as a municipal water supply for the city of Bloomington. In this system, nitrate loss is through tiles, and P through both surface runoff and tiles.

We established a baseline of current practices and conditions in the watershed, using all data that were available. These data were from county statistics, Nutrient Management Plans for individual fields (NMPs), discussions with various people knowledgeable about the watershed, and a guided tour of the watershed with professionals from the area. These data help us estimate, with some degree of certainty, what practices are being used in the watershed, where these practices occur, and how they contribute to problems with water quality. This information was combined with soil maps and other GIS available data (such as slope) to more fully understand the current scope of agricultural activities.

The final aspect of the project has been to identify changes in management practices that could be implemented in the watershed to best achieve water quality goals. These new practices include specific field methods that would lead to reductions in nitrate and total P export to the stream (and therefore the reservoir). The potential practices that were considered included: N application rate and timing, P fertilization methods and amounts, cover crops, riparian buffer strips, wetlands, water table management, tile bioreactors, alternative cropping systems, and other methods. For each practice, we utilized research-based expert opinion to estimate the effectiveness and costs and to help evaluate and choose best potential practices to be used. The experts consulted include representatives from the USDA-NRCS, Illinois Department of Agriculture, Iowa Department of Agriculture and Land Stewardship, University of Illinois and Iowa State University, all familiar with relevant research literature. For this watershed, we estimated the area on which various new practices could be implemented, where these might be located, and what the potential reductions in nitrate and total P losses would be.

To help focus these estimates, we identified five nutrient reduction targets. Following discussions with the IL Department of Agriculture and examining the TMDL for Lake Bloomington the following scenarios were addressed:

1) Nitrate-N reduction of 30% from last ten-year average

2) Nitrate-N reduction of 50%

3) Total P reduction of 45%

4) Total P reduction of 90%

5) Nitrate-N reduction of 50% and total P reduction of 50%

The 50% reduction in nitrate-N is close to the 45% N reduction suggested by the USEPA SAB on hypoxia and the 48% load reduction predicted in the original TMDL report to meet the drinking water standard for nitrate of 10 mg N L^{-1}. The total P reduction scenario includes a 45% reduction to reflect the draft USEPA Hypoxia Advisory Panel recommendation and 90% following the original TMDL estimate of a 89% reduction of the total P load to meet the lake water quality standard (total $P < 0.05$ mg P L^{-1}).

An error was found in the original Lake Bloomington TMDL report estimating the needed reductions to meet Illinois Environmental Protection Agency water quality standards. This errata sheet is dated February 19, 2008; therefore, the errors were found after we had completed our calculations for this report. TetraTech recalculated the needed reductions based on their revised load estimates, with the new reductions for the watershed now estimated to be 34% for nitrate-N and 66% for total P. We report these new reductions for information only, and have not adjusted our estimates.

Watershed Characteristics and Agricultural Practices

The Lake Bloomington watershed is an 18,123 ha (44,800 acre) area in McLean County, Illinois. It is comprised of Lake Bloomington, a 232 ha (572 acre) reservoir, along with two streams: Money Creek (the main tributary), and Hickory Creek. Ninety-three percent of the land is in row crop agriculture and 2.5% is developed. Poorly drained and somewhat poorly drained soils cover 62% of the watershed; the dominant soil series are Sable, Ipava, and Catlin.

Population centers include the village of Towanda (pop. 500) located near the middle of the watershed with no sewage system and a few housing subdivisions closer to the lake. There are an estimated 649 septic systems that could impact the watershed along Money Creek and near the lake (Tetra Tech, Inc. 2007). East Bay Camp and Retreat is located on the lake and discharges treated sewage through one outfall into Lake Bloomington. It is a seasonal camp with an average discharge of about 0.012 million gallons per day on an annual basis (Tetra Tech, Inc. 2007).

A description of the current management practices and watershed characteristics was compiled using data from the National Agricultural Statistics Service, Natural Resources Conservation Service, Illinois Department of Agriculture, Illinois Council on Best Management Practices (C-BMP), University of Illinois Extension, and the Lake Bloomington Watershed TMDL Stage 3 Draft Report from Tetra Tech Incorporated. Geographical Information Systems (GIS) layers that we have compiled include the watershed boundary, water bodies, digital elevation model, soil types, land cover/land use, land parcels, National Agriculture Imagery Program (aerial imagery), and National Agricultural Statistics Service (land cover data layers). We have enhanced (added attributes to) some layers to include characteristics of the watershed that were not in the data layers we obtained from the above sources.

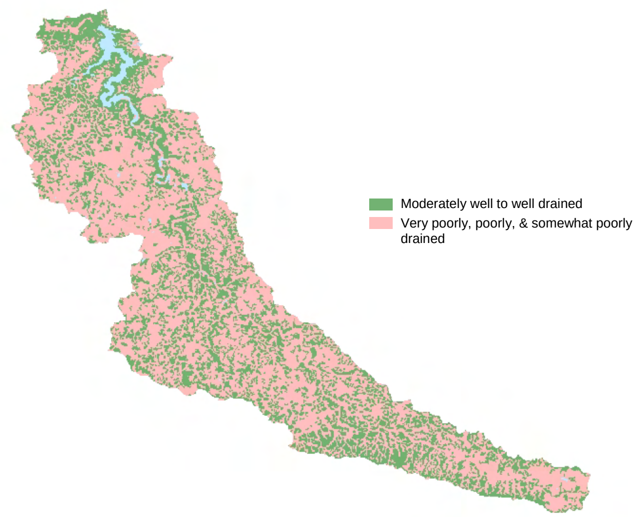

Figure 1. Map of the Lake Bloomington Watershed showing soils divided into two drainage classes.

We added the attribute of soil drainage class to our soil type layer (Figure 1). We were then able to estimate the amount of land that is likely to be drained by subsurface tile. We estimate the Lake Bloomington watershed is 62% tile-drained based on the area of somewhat poor and poorly drained soils. This corresponds well to the estimated 57% tile-drained land for McLean County from the Water Resources Institute (Sugg, 2007).

GIS layers have been constructed using management practice data provided to us by Jodie Tate, University of Illinois Extension, that were collected as part of a project by the Illinois Council on Best Management Practices (CBMP) and the Illinois Department of

Agriculture which provided incentive payments to producers for nutrient management planning, use of a nitrification inhibitor and switching to spring application of nitrogen fertilizer. We used this combination of data layers to apply various conservation and management practices across the watershed spatially.

Many of the approximations of farming practices in the watershed come from a database developed by the Illinois Council on Best Management Practices. This database is a compilation of filed nutrient management plans (NMP) from producers in the Lake Bloomington watershed. NMPs were developed by 87 farmers for 154 fields totaling 4,845 ha (29% of the agricultural land in the watershed). These plans asked farmers for their previous management practices and what they are now practicing with the NMP. The plans follow the 2006 growing season (fall 2005 to harvest 2006).

For their development of the TMDL the Illinois EPA is using the maximum loading capacity of Lake Bloomington of total P and total N that can still meet the water quality standards of 0.05 mg P/L and 10 mg NO_3-N/L. Therefore, their existing load and needed reductions are calculated using the year requiring the largest reduction to meet the standards. Using 10 years of simulations (1988 to 2005), the existing load and subsequent needed reductions are based on the year 1990 estimates. We have based our study on using a long term average.

Using the Stage 3 TMDL report of estimated existing loads to Lake Bloomington, we calculated an average load of approximately 416,000 kg yr^{-1} (917,000 lbs yr^{-1}) and 6,400 kg yr^{-1} (14,100 lbs yr^{-1}) of N and P, respectively. This is based on simulations of 10 years between 1988 and 2005, removing the driest (1988) and wettest (1990) years of simulated streamflow to achieve an 8 year average of the existing nutrient load to Lake Bloomington. The nutrient yields (load/area) for the watershed were 23 kg N ha^{-1} (21 lbs $acre^{-1}$) and 0.35 kg P ha^{-1} (0.31 lbs $acre^{-1}$). The TMDL report stated an average 33% of total P is in the dissolved form. Point sources in the watershed are limited to septic system failures and/or short-circuits including a camp located on the lake discharging treated wastewater. These point sources could contribute <0.5% of N and 3% of P loads to the lake. For this exercise, we considered all nutrient loads to come from non-point sources (agricultural land).

Management Practices Effectiveness

On September 20, 2007 a group of university and state and federal agency experts met to discuss and estimate the nutrient loss reductions expected for various agricultural practices in central Illinois. Practices were categorized into nutrient-use efficiency, in-field management, and off-site measures. We adapted Table 17 from the draft EPA Hypoxia Advisory Report, including only practices we thought could have effects on this watershed, and estimated expected nutrient loss reductions for conditions in the watershed. Some of these numbers were refined following a November 29, 2007 conference call with experts in Iowa.

Nitrogen reduction practices (tile drainage)

Practice	Expected reduction (%)
nitrification inhibitors	10
spring vs. fall fertilization	20
recommended rate vs. above[1]	
no-till vs. conventional	0
cover crops	25
water table management	40
shallow or wide tiles	25
conversion to CRP	95
conversion to perennial crops	80
constructed wetlands (20:1)	50
bioreactors	no data available

[1]Based on recent NMP data from this watershed, most farmers were following recommendations, so no reduction percentage is given because this practice is already in effect. However, N loads calculated for the watershed may have included losses prior to most farmers following the recommendations.

Phosphorus reduction practices

Practice	Expected reduction %	
	Tile drainage	Surface runoff
recommended rate vs. above		5
subsurface vs. surface broadcast		20
cover crops	5	25
shallow or wide tiles	+	-
conversion to CRP	50	75
conversion to perennial crops	50	95
WASCOB installation		75
sedimentation basins		95[1]
riparian buffers		50[2]
constructed wetlands		20[3]

[1]of particulate P
[2]of water entering buffer as sheetflow, which may be limited along many fields
[3]could be temporary

Reduction Practices Discussion

Nitrification inhibitors – Estimating from the Nutrient Management Plans, approximately 77% of the corn fields in the Lake Bloomington watershed have nitrogen fertilizer applied in the fall. NMP guidelines require participants to use a nitrification inhibitor, so the percentage of farmers in the watershed using an inhibitor is unknown. In a four-county region south of Lake Bloomington, an estimated 90 to 95% apply the fertilizer with a nitrification inhibitor (Jeff Morris, United Prairie LLC, personal communication, 2007). The 5-10% who do not apply with the inhibitor are the ones who apply later in the season when the temperatures are much cooler.

Spring versus fall fertilization – Studies by Randall and Vetsch (2005) and Clover (2005) supports our expected reduction of 20% for fertilizer applied in the spring versus the fall across the corn/soybean rotation. This reduction does apply to soybean following corn also. We are suggesting an incentive of $25/acre. CBMP offered $12 per acre for this watershed as an incentive payment, but had only 87 producers participate. We have not evaluated the additional costs to the agricultural community (infrastructure, storage, availability) of applying nitrogen fertilizer in the spring, at planting, or sidedress. Iowa State researchers estimate possibly an infrastructure cost of $0.05 per pound N. At that cost the infrastructure costs for the Lake Bloomington watershed are $190,000.

Recommended N rate - Nearly all of the operators are following the University of Illinois nitrogen application recommendations. The recommendation is 1.2 pounds N per target yield bushel per acre and subtracting credits for the previous crop.

Cover crops - We suggest a conservative estimate of a 25% reduction in N and 10% overall for P. Data from Iowa research suggests the average reductions may be as high as 50% for both total N and total P. We suggest an incentive of $50/acre. This should cover the costs of seed, planting, and herbicide while also providing additional payment associated with risk incurred by the operator. Cover crops are mainly recommended prior to soybean.

Drainage water management - Approximately 10% of the Lake Bloomington watershed could support drainage water management. Don Pitts from the Natural Resources Conservation Service (personal communication, 2007) reports that field N losses can be reduced by about 40% and that the average per acre drained cost for the system to be $250.

Constructed wetlands - Constructed wetlands at the end of large tile systems have been found to reduce N losses to streams by at least 50%. At this time, it is unknown what the long-term P removal would be, if any. We assume that the drainage area to wetland size ratio is 20:1. The estimated cost is two-fold. First, the wetland construction is estimated to be about $6,000 per acre wetland area. The second cost is the wetland land rental costs at $300/acre. Optimal locations for constructed wetlands and drainage water management systems are shown in Figure 2.

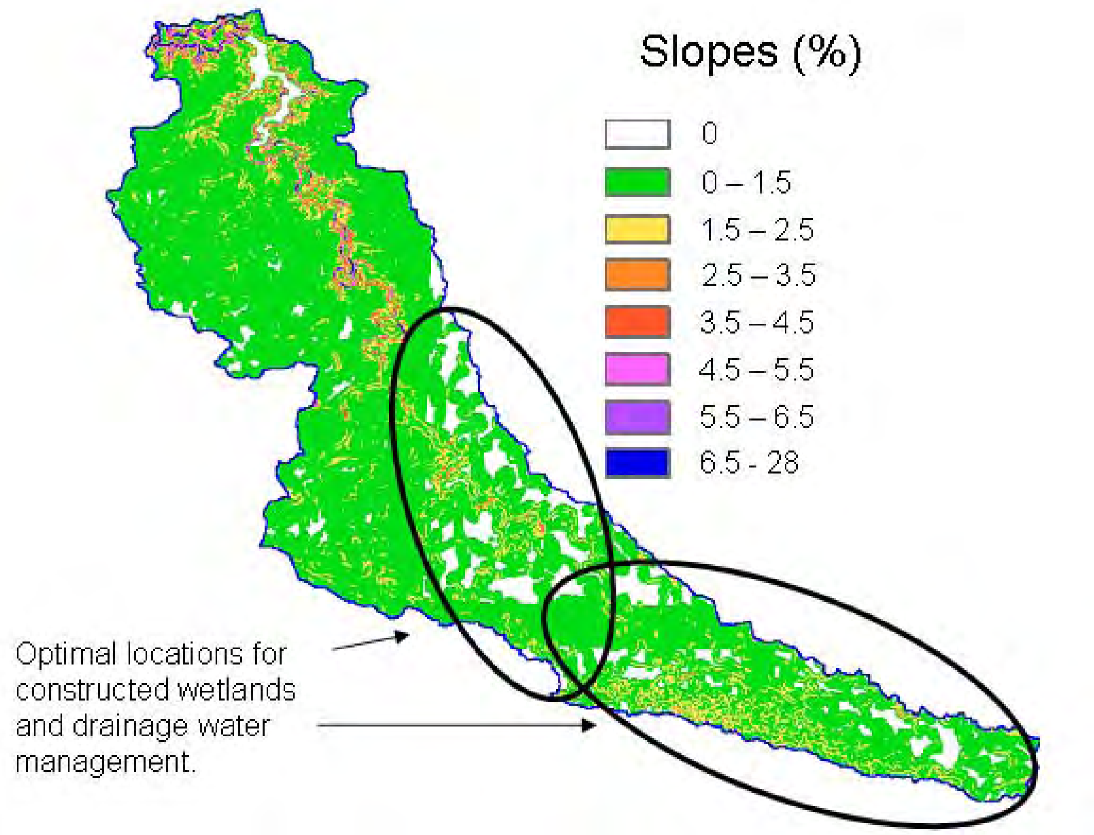

Figure 2. Map of the Lake Bloomington Watershed showing slopes and areas where constructed wetlands and drainage water management could be implemented.

Shallow/wide tiles and bioreactors - Results from recent research suggest that shallow or wide tiles may reduce N losses by 25%. Bioreactors at the end of tiles have shown promise, but their effectiveness is not known over the long-term. With uncertainty in the research and questions as to whether these would be a practical solutions, these practices were not used in this case study.

Conversion to CRP - Enrolling cropland into the Conservation Reserve Program is projected to decrease N and P losses by 95% and 75%, respectively. The current CRP rental costs are $300 per acre in central Illinois. Due to the high cost, this practice was among the last to be used to reach our nutrient reduction goals.

Conversion to perennial crops - Perennial crops, such as hay, switchgrass and *Miscanthus*, can reduce N and P losses by greater than 80%. The cost of such an endeavor is uncertain at this time due to the lack of a market for bioenergy crops. Economic costs for this practice reflect the costs for CRP land rental.

Water and Sediment Control Basins (WASCOB) - WASCOBs have been shown to reduce particulate P losses by about 75% with a maximum drainage area of 30 acres. The land in the Lake Bloomington watershed has enough slope in many areas that WASCOBs are a viable option to reduce P from runoff. The estimated cost of such an installation is about $600 per acre benefited.

Recommended P rate - Forty-three percent of the fields in the Lake Bloomington watershed that were tested for Bray P-1 (P_1) were found to have soil P concentrations (>70 lbs P/acre) at a level where no additional P should be applied for crop production. We estimate that P losses in runoff could be reduced by 5% if soil P tests are conducted every 4 years and P fertilizer applied when needed according to the test. Our assumed incentive payment needed to compensate farmers for adopting this practice is $12/acre.

Subsurface versus surface application - Deep placement as opposed to surface application and 2-inch incorporation can reduce P losses by *at least* 20%. The incentive to cover the costs of this application method is $14 per acre (Dr. Howard Brown, Growmark Inc., personal communication, 2007).

Riparian buffers - Riparian buffers were estimated to reduce P losses in runoff by 50% for sheetflow that passes from an adjoining field through the buffer. The lower portion Lake Bloomington watershed along Money Creek has forested buffers along the natural channel. Money Creek and its tributaries in the upper portion are channelized but grass riparian buffers already protect most streambanks. Consequently, we concluded that there would be little additional nutrient reduction from increasing the area of riparian buffers.

Sedimentation Basin - In 1991, a report (Lake Bloomington Watershed Plan and Environmental Assessment) was issued addressing the water supply, water quality, and recreation concerns for Lake Bloomington (USDA 1991). To address these concerns, the report provided two options. The first was to do nothing and allow sediment to fill in the lake, with the second option to construct sediment basin dams on Money Creek and Hickory Creek. This plan was never implemented. The cost at the time of the report was $1.902 million. Adjusted for inflation the project today would cost around $3.3 million. Based on the trapping efficiencies of the two basins and the portion of particulate P in the streams it is estimated that P loads in the lake would be reduced by about 47%. The wetland aspect of the basins could reduce N loads by at least 20% based on the N loading rate. The USDA Soil Conservation Service (now NRCS) was the lead author of the study.

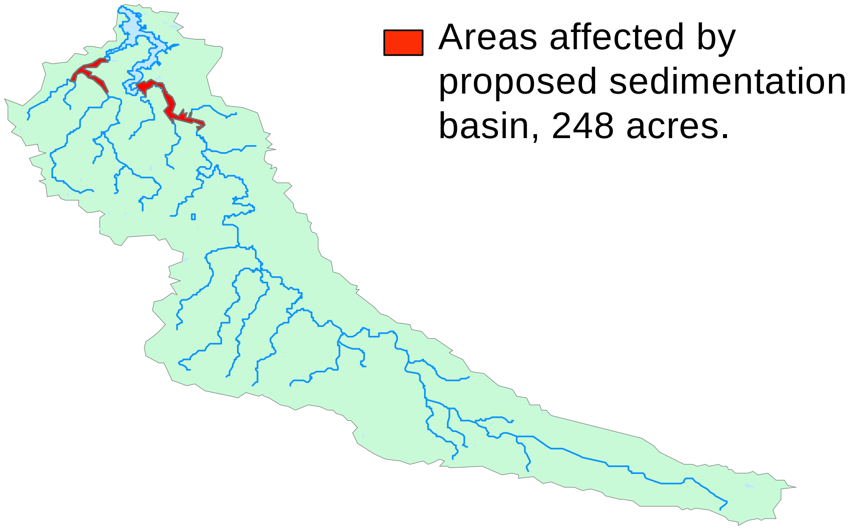

Figure 3. Map of the Lake Bloomington Watershed showing areas where large-scale sedimentation basins would be installed.

Management Application Scenarios

Ideally, conservation practices should be targeted on the land that is producing the greatest N and P yields. There are not enough data available to accurately determine exactly where the greatest P and N loads are originating in the watershed. To estimate the load reductions from the adoption of various practices, we used a lumped estimate, assuming that each hectare of land in the watershed contributes an equal N and P yield prior to the recommended conservation practices. The Lake Bloomington watershed yield for P is 0.35 kg P ha^{-1} (0.31 lbs P $acre^{-1}$). This yield is similar to yields found by Gentry et al. (2007) for similar sized watersheds in central Illinois. The lumped watershed yield for nitrate is 23.0 kg N ha^{-1} (20.5 lbs N $acre^{-1}$). It is well known, however, that considerably more nitrate comes from tile drained land than from non-tile drained land. Consequently, we also estimated nitrate reductions based on an assumed distribution of tile drained land in the watershed. In this distributed estimate, we assume the entire N load to Lake Bloomington is from the 93% of the watershed that is in agricultural land and that it was 50% tile-drained and 50% not drained. Officials from the McLean County Soil and Water Conservation District estimate that only 25% to 40% of the watershed is tile-drained whereas soil survey and elevation maps suggest up to 60% could be tile drained. We decided to split the difference and used 50% tile-drained and 50% not tile-drained. We further assumed that 80% of the total nitrate load came from the tile-drained land and the remaining 20% from the non tile-drained land. This resulted in yields of 39.4 kg N ha^{-1} (35 lbs N $acre^{-1}$) for tile drained areas and 9.9 kg N ha^{-1} (8.8 lbs N $acre^{-1}$) for the land not tile drained.

The baseline data used for this project were collected when corn and soybeans were planted in nearly equal acreages (50%-50%) throughout the watershed and a vast majority of the farmland was planted in a corn-soybean rotation. Our estimates assume this 50-50 split even though during the past two years more cropland is going to a continuous corn or C-C-Sb cropping system due to increased corn prices from ethanol production.

The 30-year cost estimates in the following charts are in 2007 prices with no adjustment for inflation over time. Maintenance costs are included for the constructed wetlands, sedimentation basin, and drainage water management devices. However, land costs have been rapidly increasing due to high crop prices, and our estimates would therefore be underestimated.

Our process to reach the various scenario goals was to first address the timing and amount of nutrients applied in the watershed because they are the least costly practices. They are also the “first line of defense” in reducing nutrient losses. Our second level was to apply practices that change the physical landscape of the watershed and be more costly. Our calculations were made so that the reductions are multiplicative, thus overall reductions decrease with each additional practice due to actual reductions estimated from the previous practice.

SCENARIO 1 – Nitrate-N reduction of 30%

NMPs indicate that most operators in the watershed are following University of Illinois N recommendations, so there is no reduction to be gained from an adoption of recommended amounts. However, application timing is a practice that could be altered. From CBMP data, operators indicated that they fall applied N to 77% of the corn fields enrolled. Our expert panel concluded that spring fertilization could reduce N loss by 20%. We have therefore calculated that if all of the operators fertilized in the spring, the reduction in N loss would be ~60,000 to 64,000 kg N, a 14.4% to 15.4% reduction in the watershed N load. The range shown is estimated with the whole watershed yield (low end reduction) and the tile-drained versus non-drained yields (high end reduction).

The next options we utilized were to either to reduce the N load closest to the source or to reduce the N load before it reaches Lake Bloomington. If the latter is the case, then building the proposed sedimentation basins would achieve the 30% N load reduction to the lake using both yield calculations. If the goal is to reduce N closest to its source, we suggest three practices. The first would be to treat 10% of the watershed (tile-drained area) with wetlands, built at a 20:1 area treated to wetland area ratio. This would add 81 ha (200 acres) of wetlands to the watershed. The second treatment would be to install drainage water management devices to the 10% of the watershed deemed suitable for such a practice. The third practice would be to have 18% percent of the farmland planted in cover crops (35% of the land prior to soybeans). If 70% of the cropland was planted to cover crops that alone with the spring application of N could reach the 30% reduction goal.

Each plan below achieves a 30% reduction in nitrate load:

Plan 1 – based on lumped nitrate yield estimate

Practice	Area (ha)	TN Reduction (kg/yr)	30-yr Cost (2007 basis)	Annual Cost kg^{-1} reduced	Annual Cost lb^{-1} reduced
Fall to Spring fertilization	13,004	59,699	$12,093,720	$6.75	$3.06
Proposed sedimentation basin	16,478	68,032	$4,523,500	$2.22	$1.01
TOTAL		**127,731**	**$16,617,220**	**$4.34**	**$1.97**

Plan 2 – based on distributed nitrate yield estimate

Practice	Area (ha)	TN Reduction (kg/yr)	30-yr Cost (2007 basis)	Annual Cost kg^{-1} reduced	Annual Cost lb^{-1} reduced
Fall to Spring fertilization	13,004	64,065	$12,093,720	$6.29	$2.85
Tile-fed wetlands	1,620 treated	27,008	$3,323,025	$4.10	$1.86
Drainage water management	1,688	20,354	$2,086,368	$3.42	$1.55
Cover crops	2,956	13,328	$13,302,000	$33.27	$15.09
TOTAL		**124,755**	**$30,805,113**	**$8.23**	**$3.73**

Plan 3 – distributed nitrate yield estimate

Practice	Area (ha)	TN Reduction (kg/yr)	30-yr Cost (2007 basis)	Annual Cost kg^{-1} reduced	Annual Cost lb^{-1} reduced
Fall to Spring fertilization	13,004	64,065	$12,093,720	$6.29	$2.85
Cover crops	11,822	61,580	$53,199,000	$28.80	$13.06
TOTAL		**125,645**	**$65,292,720**	**$17.32**	**$7.86**

Plan 1 costs the least amount per unit of N reduced, but over one-half of the N reduction occurs immediately upstream of Lake Bloomington and doesn't address the N loading to Money Creek and Hickory Creek. Plan 2 costs nearly twice as much as the first, but the N is reduced before entering Lake Bloomington's tributaries. However, 81 hectares are taken out of production for wetlands and some land will be used for the drainage water management devices, not to mention the amount of earthwork needed to implement these.

The third option costs twice as much as the second and four times the first, but requires the least amount of earth moving to reduce N field losses.

SCENARIO 2 – Nitrate-N reduction of 50%

The goal of reducing the N load to Lake Bloomington by 50% results in two quite different plans to achieve this depending on which N yield (kg ha^{-1}) approach is used. Both approaches use 10% of the land treated with wetlands and 10% under drainage water management. Also, both approaches require the construction of the proposed sedimentation basins. The distributed N yield estimate reaches its reduction goal when spring fertilization is used and 55% of the land is planted to cover crops. Because the lumped watershed yield approach assumes a slightly lower pre-existing nitrate yield from each agricultural acre, more extensive conservation is needed to achieve the goal. Approximately 2800 ha (6916 acres) would need to be enrolled in CRP, the remaining acreage would need to be fertilized in the spring and 45% of the land planted to cover crops annually, greatly increasing the cost to reduce N.

Each plan below achieves a 50% reduction in nitrate load:

Plan 1 – based on the distributed nitrate yield estimate

Practice	Area (ha)	TN Reduction (kg/yr)	30-yr Cost (2007 basis)	Annual Cost kg^{-1} reduced	Annual Cost lb^{-1} reduced
Fall to Spring fertilization	13,004	64,065	$12,093,720	$6.29	$2.85
Cover crops	9,400	48,972	$42,300,000	$28.79	$13.06
Tile-fed wetlands	1,620 treated	23,250	$3,323,025	$4.76	$2.16
Drainage water management	1,688	17,521	$2,086,368	$3.97	$1.80
Proposed sedimentation basin	16,478	54,443	$4,523,500	$2.77	$1.26
TOTAL		**208,251**	**$64,326,613**	**$10.30**	**$4.67**

Plan 2 – based on the lumped nitrate yield estimate

Practice	Area (ha)	TN Reduction (kg/yr)	30-yr Cost (2007 basis)	Annual Cost kg^{-1} reduced	Annual Cost lb^{-1} reduced
CRP	2,800	61,058	$63,000,000	$34.39	$15.60
Fall to Spring fertilization	10,848	42,491	$10,088,417	$7.91	$3.59
Cover crops	7,700	33,188	$34,650,000	$34.80	$15.79
Tile-fed wetlands	1,620 treated	12,482	$3,323,025	$8.87	$4.03
Drainage water	1,688	9,939	$2,086,368	$7.00	$3.17

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Proposed sedimentation basin	16,478	48,041	$4,523,500	$3.14	$1.42
TOTAL		**207,199**	**$117,671,310**	**$18.93**	**$8.59**

SCENARIO 3 – Total phosphorus reduction of 45%

Sixty-one of the 154 fields with NMP's had performed soil P tests on their fields. Forty-three percent were found to have over 70 lbs $acre^{-1}$ in the top 7 inches, yet they still applied P before following BMP guidelines. As part of their nutrient management plans, these farmers would no longer add P fertilizer as long as their soil tests remained over 70 lbs $acre^{-1}$. NMP results indicated a 28% reduction in the amount of P applied among the surveyed operators when following BMPs. We estimated the loss reduction for farmers not applying P with soil over 70 lbs $acre^{-1}$ to be about 128 kg P (282 lbs P) for the watershed (a 2% reduction in load).

It is estimated that 90% of P is surface applied. We approximate that if farmers were to practice deep band placement of P the losses would be reduced by 600 kg P (1323 lbs P) within the watershed. These application methods alone could reduce the P load to the lake by 11%.

Due to the lack of details and information needed, WASCOBs and moderate sized sedimentation basins along Money Creek were not considered. However, construction of the proposed sedimentation basins immediately upstream of Lake Bloomington would achieve our 45% P reduction goal (49.2% P reduction).

The plan below achieves a 45% reduction in total P load:

Practice	Area (ha)	TP Reduction (kg/yr)	30-yr Cost (2007 basis)	Annual Cost kg^{-1} reduced	Annual Cost lb^{-1} reduced
Soil P testing	7,262	128	$1,633,950	$425.51	$193.01
Deep band placement	8,664	600	$4,548,600	$252.70	$114.62
Proposed sedimentation basin	16,478	2,424	$4,523,500	$62.20	$28.22
TOTAL		**3,152**	**$10,706,050**	**$113.22**	**$51.36**

SCENARIO 4 – Total phosphorus reduction of 90%

The only realistic way seen to achieve the 90% phosphorus load reduction is to plant all of the cropland in the watershed to perennial crops. This practice would lead to an 88.5% reduction in P. To reach the reduction goal, however, the proposed or slightly smaller sedimentation basin would need to be built.

Plan – Total P reduction only

Practice	Area (ha)	TP Reduction (kg/yr)	30-yr Cost (2007 basis)	Annual Cost kg^{-1} reduced	Annual Cost lb^{-1} reduced
Perennial crops	16,888	5,666	$379,980,000	$2,235.44	$1,013.99
Proposed sedimentation basin	16,478	314	$4,523,500	$480.20	$217.82
TOTAL		**5,980**	**$384,503,500**	**$2,143.27**	**$972.18**

These practices would not only reduce the P load by 93% but would also reduce the N load by 79% making the overall nutrient reduction cost per unit somewhat more reasonable. In these combined nutrient reductions it is not possible to assign costs to each nutrient individually.

Plan – 93% total P reduction + 79% total N reduction

Practice	Area (ha)	Nutrient Reduction[1] (kg/yr)	30-yr Cost (2007 basis)	Annual Cost kg^{-1} reduced	Annual Cost lb^{-1} reduced
Perennial crops	16,888	315,787	$379,980,000	$40.11	$18.19
Proposed sedimentation basin	16,478	20,530	$4,523,500	$7.34	$3.33
TOTAL		**336,317**	**$384,503,500**	**$38.11**	**$17.29**

[1]Nutrient reduction for combined total P and nitrate is the sum of both nutrients

SCENARIO 5 – Nitrate-N reduction of 50% and total phosphorus reduction of 50%

There are several paths that lead to the scenario's goal. We present three of them below.

Plan 1 – 50% total N reduction and 52% total P reduction, based on the lumped watershed nitrate yield estimate

Practice	Area (ha)	Nutrient Reduction (kg/yr)	30-yr Cost (2007 basis)	Annual Cost kg^{-1} reduced	Annual Cost lb^{-1} reduced
CRP	2,800	61,800	$63,000,000	$33.98	$15.41
Fall to Spring fertilization	10,848	42,491	$10,088,417	$7.91	$3.59
Cover crops	7,700	33,428	$34,650,000	$34.55	$15.67
Tile-fed wetlands	1,620 treated	12,482	$3,323,025	$8.87	$4.03
Drainage water management	1,688	9,939	$2,086,368	$7.00	$3.17
Proposed sedimentation basin	16,478	51,356	$4,523,500	$2.94	$1.33
TOTAL		**211,496**	**$117,671,310**	**$18.55**	**$8.41**

Plan 2 – 50% total N reduction and 69% total P reduction, based on the lumped watershed nitrate yield estimate

Practice	Area (ha)	Nutrient Reduction (kg/yr)	30-yr Cost (2007 basis)	Annual Cost kg^{-1} reduced	Annual Cost lb^{-1} reduced
Perennial crops	8,650	161,745	$194,625,000	$40.11	$18.19
Proposed sedimentation basin	16,478	50,596	$4,523,500	$2.98	$1.35
TOTAL		**212,341**	**$199,148,500**	**$31.26**	**$14.18**

Plan 3 – 50% total N reduction and 52% total P reduction, based in the distributed watershed nitrate yield estimate

Practice	Area (ha)	Nutrient Reduction (kg/yr)	30-yr Cost (2007 basis)	Annual Cost kg^{-1} reduced	Annual Cost lb^{-1} reduced
Fall to Spring fertilization	13,004	64,065	$12,093,720	$6.29	$2.85
Soil P testing	7,262	128	$1,633,950	$425.51	$193.01
Deep band placement	8,664	600	$4,548,600	$252.70	$114.62
Cover crops	9,400	49,266	$42,300,000	$28.62	$12.98
Tile-fed wetlands	1,620 treated	23,250	$3,323,025	$4.76	$2.16
Drainage water	1,688	17,521	$2,086,368	$3.97	$1.80

management					
Proposed sedimentation basin	16,478	56,741	$4,523,500	$2.66	$1.21
TOTAL		**188,321**	**$70,509,163**	**$12.48**	**$5.66**

Conclusions

There are many different ways to reduce nutrient losses from agricultural watersheds with tile drained and non-tile drained (sloping) land areas. However, estimated load reductions depend upon what practices are currently used and what percent effectiveness is assigned to each new practice. There is considerable uncertainly about both of these aspects in developing reduction scenarios. An overall effectiveness calculation also depends on the pre-treatment nutrient yields (kg ha^{-1}), which are often poorly quantified and variable from year to year. In this study, the effectiveness of the practices and thus costs were greatly affected by the estimated yield used to determine nutrient reductions (see Scenario 2). Based on our results, total P reductions cost much more per unit than nitrate because P concentrations are low relative to nitrate, and reducing these low concentrations is difficult. However, in many of the practices considered to reduce P losses, nitrate losses are also reduced making the total nutrient reductions more cost effective. We found that reduction goals could be achieved, but that costs are considerable. Reducing nitrate loads by 30 to 50% could be accomplished for $16 to $64 million over 30 years, while a $70 million investment could potentially reduce both N and total P by 50%. The only way to achieve the water quality standard of 0.05 mg P L^{-1} in the reservoir would be to convert the entire watershed to perennial vegetation, which would be very expensive ($384 million) and not feasible.

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