Illinois
Environmental
Protection Agency

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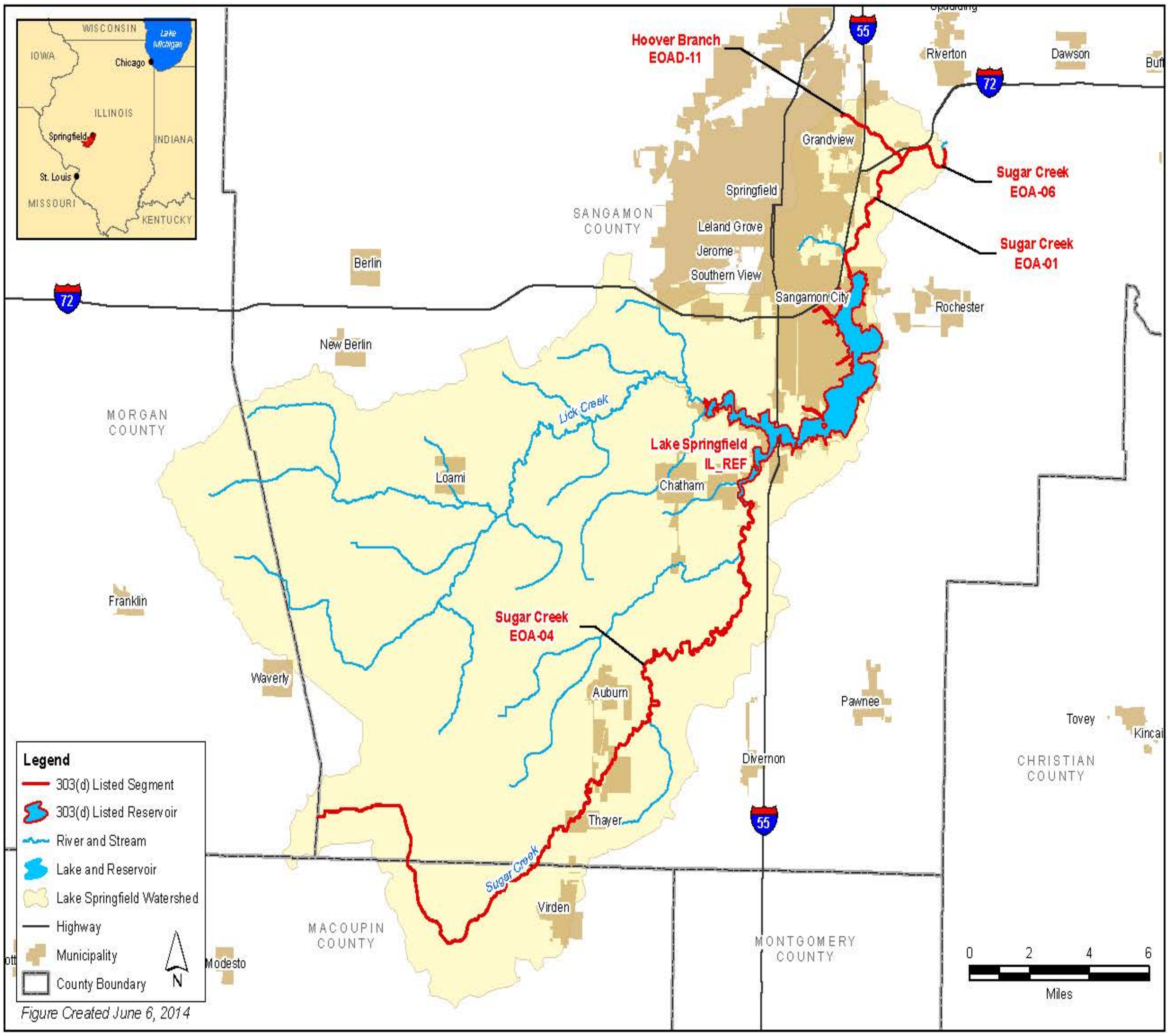
IEPA/BOW/17-003

Lake Springfield and Sugar Creek Watershed TMDL Report



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TMDL Development for the Lake Springfield and Sugar Creek Watershed, Illinois

This file contains the following documents:

1) USEPA Approval Letter and Decision Document for the Final TMDL Report
2) Combined Stage 1-3 TMDL Development Report

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

SEP 29 2017

REPLY TO THE ATTENTION OF:
WW-16J

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

Dear Mr. Sofat:

The U.S. Environmental Protection Agency has conducted a complete review of a final Total Maximum Daily Load (TMDL) for phosphorus for Lake Springfield, including supporting documentation and follow up information. The waterbody is located in west-central Illinois. The TMDL for phosphorus submitted by the Illinois Environmental Protection Agency addresses the impaired designated General Use for the waterbody.

The TMDL meets 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 Illinois's one TMDL for phosphorus as noted in the enclosed decision document. 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 this TMDL and look forward to future TMDL submissions by the State of Illinois. If you have any questions, please contact Mr. Peter Swenson, Chief of the Watersheds and Wetlands Branch, at 312-886-0236.

Sincerely,

Christopher Korleski
Director, Water Division

Enclosure

cc: Abel Haile, IEPA

TMDL: Lake Springfield, Sangamon and Macoupin Counties, Illinois
Date: 09/29/2017

DECISION DOCUMENT FOR THE APPROVAL OF THE LAKE SPRINGFIELD, IL TMDL

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; chlorophyll *a* and phosphorus loadings for excess algae; length of riparian buffer; or number of acres of best management practices.

Comment:

Location Description: The Illinois Environmental Protection Agency (IEPA) developed a TMDL for total phosphorus (TP) for Lake Springfield (Lake ID: REF) in west-central Illinois. Lake Springfield is located in Sangamon County. The lake is a reservoir formed from Sugar Creek and Lick Creek, which were dammed in 1935 to provide a drinking water supply for the City of Springfield as well as cooling water for the city's coal-fired power plant.

The watershed for Lake Springfield is approximately 184,000 acres, most of which is in Sangamon County. Approximately 12% of the watershed is in Macoupin and Morgan Counties. The lake is 4200 acres in size, and averages 18 feet in depth, with a maximum depth of 24 feet. The lake has a volume of approximately 60,000 acre-feet. The lake discharges through a spillway at the northern end of the lake (Figure 1-1 of the TMDL). In addition to Lick Creek and Sugar Creek, the City of Springfield maintains a diversion of water from the South Fork Sangamon River to Lake Springfield. This diversion, knows as the South Fork Diversion, is used to maintain water levels in Lake Springfield.

Distribution of land use: The land use for Lake Springfield is mainly agricultural grassland and forest in nature, with most of the agricultural land use in row crop (corn/soybean). Urban and open space makes up a portion of the watershed around the lake itself (Section 2.3 of the TMDL). Table 1 of this Decision Document contains a summary of the land use for Lake Springfield.

Table 1 Land use in the Lake Springfield Watershed

Land Use	Watershed %
Row Crops	68
Urban and open space	14.3
Grassland/pasture	6.2
Forest	5.8
Other	5.7
Total	100

Problem Identification:

Lake Springfield was added to the 1998 303(d) list for being impaired due to high levels of phosphorus and suspended solids. IEPA reviewed data back to 2000 and determined that the lake had elevated TP average concentrations for 100% of the samples (Table 5-4 of the TMDL). Water quality sampling was performed in 2012-2013 in the tributaries as well, and indicated significant phosphorus loads entering the lake.

Pollutants of Concern:

The pollutant of concern is total phosphorus (TP). However, IEPA determined that reductions in total suspended solids (TSS) will complement the TP reductions needed to fully restore Lake Springfield (Section 5 of the TMDL). IEPA developed Load Reduction Strategies (LRS) to address pollutants that are not being addressed through a TMDL. LRSs have been developed for TSS in Lake Springfield, and for TSS and TP in the tributaries. Although TP reductions are the focus of the TMDL, Sections 8 (Reasonable Assurance) and Section 10 (Implementation Plan) of this Decision Document contain additional discussion of sediment reduction efforts. IEPA noted that the lake is losing volume as more sediment enters the system.

Pollutant:
While TP is an essential nutrient for aquatic life, elevated concentrations of TP can lead to nuisance algal blooms that negatively impact aquatic life and recreation (swimming, boating, fishing, etc.). Algal decomposition depletes oxygen levels which stresses benthic macroinvertebrates and fish. Excess algae can shade the water column which limits the distribution of aquatic vegetation. Aquatic vegetation stabilizes bottom sediments, and also is an important habitat for macroinvertebrates and fish. Furthermore, depletion of oxygen can cause phosphorus release from bottom sediments (i.e. internal loading).

Degradations in aquatic habitats or water quality (ex. low dissolved oxygen) can negatively impact aquatic life use. Increased algal growth, brought on by elevated levels of nutrients within the water column, can reduce dissolved oxygen in the water column, and cause large shifts in dissolved oxygen and pH throughout the day. Shifting chemical conditions within the water column may stress aquatic biota (fish and macroinvertebrate species). In some instances, degradations in aquatic habitats or water quality have reduced fish populations or altered fish communities, from those communities supporting sport fish species, to communities which support more tolerant rough fish species.

Priority Ranking:
The watershed was given priority for TMDL development due to the impairment impacts on public health, the public value of the impaired water resource, the likelihood of completing the TMDL in an expedient manner, the inclusion of a strong base of existing data and the restorability of the water body, the technical capability and the willingness of local partners to assist with the TMDL, and the appropriate sequencing of TMDLs within a watershed or basin.

Source Identification (point and nonpoint sources):
Point Source Identification: IEPA identified five individual point sources located in the watershed, as noted in Table 2 of this Decision Document. Four of the dischargers are municipal waste water treatment facilities (WWTF), and one is a small private systems (Lake Springfield Baptist Camp).

IEPA also identified two municipal separate storm sewer (MS4) dischargers in the watershed (Table 2 of this Decision Document). MS4s can contribute TP through the runoff of stormwater containing organic matter, fertilizer, animal waste, etc. IEPA did not identify any Combined Sewer Overflows (CSO) or Concentrated Animal Feeding Operations (CAFOs) in the watershed.

Table 2: NPDES Permittees in the Lake Springfield Watershed

Permit Number	Facility Name	Type
IL0022403	Auburn STP	WWTF
IL0023426	Virden North STP	WWTF
IL0050253	Lake Springfield Baptist Camp*	WWTF
ILG580260	Thayer STP	WWTF
ILG580275	Loami STP	WWTF
ILR400453	Springfield, City of	MS4
ILR400264	Chaham, City of	MS4

* - private system

<u>Nonpoint Source Identification</u>: The potential nonpoint sources for the Lake Springfield phosphorus TMDL are:

Non-regulated stormwater runoff: Non-regulated stormwater runoff can add phosphorus to the lake. The sources of phosphorus in stormwater include organic material such as leaves, animal/pet wastes, fertilizers, etc. Runoff from row-cop agriculture is a significant source of TP and associated TSS. IEPA noted that tillage practices in the watershed can contribute TSS and TP as there are limited conservation tillage practices occurring in the watershed. Phosphorus-rich soils can erode and wash into the lake, contributing TP to the waterbody.

Animal Operations: Runoff from agricultural lands may contain significant amounts of nutrients, organic material and organic-rich sediment which may lead to impairments in Lake Springfield. Manure spread onto fields is often a source of phosphorus, and can be exacerbated by tile drainage lines, which channelize the stormwater. Tile lined fields and channelized ditches enable particles to move more efficiently into surface waters. Stormwater runoff may contribute nutrients and organic-rich sediment to surface waters from livestock manure, fertilizers, vegetation and erodible soils. Furthermore, livestock with direct access to a waterway can directly deposit nutrients via animal wastes into a waterbody, which may result in very high localized nutrient concentrations. This nutrient deposition may also contribute to downstream impairments.

Failing septic systems: IEPA noted that failing septic systems, where waste material can pond at the surface and eventually flow into surface waters or be washed in during precipitation events, are potential sources of phosphorus. IEPA consulted with the Sangamon County Health Department, and determined that while much of the watershed is served by sewer systems, portions of the watershed are not, and the immediate shoreline around Lake Springfield is served by a mixture of sewer systems and septic systems (Section 5.4.3 of the TMDL). The Springfield CWLP has collected information on septic systems in the immediate watershed, and as of 2014, 214 out of 431 systems discharge through leachfields. Springfield CWLP and the Springfield Metro Sanitary District are working with local landowners to upgrade septic systems and install additional sewer lines.

Internal loading: The release of phosphorus from lake sediments via physical disturbance from wind mixing the water column, and anoxic release of TP from deeper sediments, may contribute internal phosphorus loading to Lake Springfield. Phosphorus may build up in the bottom waters of the lake and may be resuspended or mixed into the water column. Modeling analysis indicates internal loading is a significant source of TP (Section 7.2.1.4 of the TMDL).

South Fork Diversion: Another source of TP into Lake Springfield is the load contained in the diversion of water from the South Fork Sangamon River (Section 5.4.5 of the TMDL). IEPA used data from the river to calculate the amount of loading of TP.

Hunter Lake Diversion (proposed): IEPA also calculated a load for the proposed construction and diversion of water from the South Fork Sangamon River. The City is proposing to build a reservoir (Hunter Lake) in the South Fork Sangamon River watershed to provide additional flow into Lake Springfield.

Population and future growth trends: The population for the watershed is fairly large, over 74,000 people. The immediate area around Lake Springfield is in the City of Springfield, which has a population of over 116,000. IEPA did not account for any future growth other than the proposed Hunter Lake diversion project.

EPA finds that the TMDL document submitted by IEPA satisfies all requirements concerning 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) - 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/Standards: Section 4.1 of the TMDL states that Lake Springfield is not meeting the General Use designation. The applicable water quality standards (WQS) for these waterbodies are established in Illinois Administrative Rules Title 35, Environmental Protection; Subtitle C, Water Pollution; Chapter I, Pollution Control Board; Part 302, Water Quality Standards, Subpart B for General Use Water Quality Standards. The portions of the WQS that applies to Lake Springfield are the General Use and Public and Food Processing Water Supply

Use. The lake is meeting the public water supply use, but is impaired for the General use, specifically the aesthetic quality (Section 4.2 of the TMDL).

Criteria: IEPA has a lake criterion for phosphorus of 0.05 mg/L (Title 35, Section 302.205).

Target: The water quality target for this TMDL is the water quality criterion of 0.05 mg/L TP.

Other pollutants: As noted previously, IEPA has developed LRSs to address pollutants that do not have numeric criteria. While these are not TMDLs, the LRSs will likely reduce other pollutants in the watershed as well as TP loads. For these LRSs, IEPA developed water quality targets as goals to reduce TSS and TP impacts in flowing waters. For these waters, the targets are:

- Sugar Creek: TP < 0.739 mg/L
- Lake Springfield: TSS < 19 mg/L

EPA finds that the TMDL document submitted by IEPA satisfies all requirements concerning 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 stream 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 approach utilized by the IEPA to calculate the loading capacity for Lake Springfield for phosphorus is described in Section 7 of the TMDL.

To determine the watershed loadings into Lake Springfield, IEPA used the "export coefficient" method. This method uses runoff rates for TP for various land uses (measured in pounds/acres/year), and together with flows from the land uses, generates a TP load based upon land use. These loads are then summed together to determine the TP loading into the lake (Section 7.2.1.3 and Appendix C of the TMDL).

To further refine the tributary loadings, IEPA split the Lake Springfield watershed into 5 smaller subwatersheds (Figure 7-1 of the TMDL). Subwatershed 1 is the downstream-most portion of Lake Springfield, and centers around lake sampling point REF-1. Subwatershed 2 is the middle portion of Lake Springfield, and centers around lake sampling point REF-2. Subwatershed 3 is the upstream portion of the watershed, and includes Lick Creek, Polecat Creek, and Sugar Creek. It is represented by lake sampling point REF-3. The TP loads for these subwatersheds were based upon the land use and corresponding export coefficients, and flow.

Subwatershed 4 represents the WWTFs in the watershed, and used the design flows for the facilities. As only one facility currently monitors for TP, the discharge concentration was estimated at 2.424 mg/L, and was based upon similar facilities in the region (Section 7.2.1.3 of the TMDL). Subwatershed 5 represents the inflow from the South Fork Diversion. This inflow has been relatively well monitored, and is based upon the flow data and a TP concentration of 0.218 mg/L.

After the lake tributary loadings were calculated, IEPA used BATHTUB to determine the water quality based upon the TP loading. The BATHTUB model 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 requires fairly simple inputs to predict phosphorus loading. The model accounts for pollutant transport, sedimentation, and nutrient cycling. The model was used to determine the load needed to meet or maintain water quality standards for the lake (Section 7.1 of the TMDL).

The model parameters were adjusted until the model predictions fit the sample data. Once the data were calibrated, the source loads were reduced until the in-lake concentration met the appropriate WQS (Section 8.3 of the TMDL). To account for internal loading of TP, IEPA modeled the impacts of low dissolved oxygen on TP entering the water column from sediments (Section 7.2.1.4 of the TMDL). IEPA determined that internal loading was a factor in the downstream portions of Lake Springfield (REF-1 and REF-2). To better predict water quality, additional internal loading was added (Table 7.4 of the TMDL).

IEPA subdivided the loading capacity among the WLA, LA and MOS components of the TMDL. These calculations were based on the critical condition, the spring/early summer time, which is typically when loading is the highest. Modeling results showed that the current load of TP is above the load needed to meet the WQS. Table 3 of this Decision Document shows the TMDL summary for Lake Springfield. The allocations result in an approximate 96% reduction in watershed loading.

Table 3 TMDL summary for Lake Springfield

	Loading Capacity (lbs/day)	WLA (lbs/day)	LA (lbs/day)	MOS (10%) (lbs/day)	Reserve Capacity* ((lbs/day)	Current Load (lbs/day)	Reduction needed (lbs/day)	Reduction needed (percent)
Internal	25.9		23.3	2.6		161.8	135.9	85.6%
External	53.7	25.5	17.0	5.4	5.8	386.1	332.4	95.6%
Total	**79.6**	**25.5**	**40.3**	**8.0**	**5.8**	**547.9**	**468.3**	**92.7%**

* Proposed Hunter Lake diversion

EPA finds that the TMDL document submitted by IEPA satisfies all requirements concerning 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.

Comment:
The LA for the lake is found in Table 3 of this Decision Document, and was calculated to be 40.3 lbs/day (Section 8.3.1.6 of the TMDL). The sources of TP in the watershed are nonpoint source runoff from row crop agricultural fields, failing septics, unregulated suburban/urban runoff, internal load, and animal operations. IEPA did assign a LA to internal load, but did not subdivide the LA further. As discussed in Sections 8 and 10 of this Decision Document, IEPA did provide further analysis of how reductions from the various sources could be attained.

IEPA did calculate a reserve capacity for the proposed Hunters Lake diversion. Springfield CWLP calculated the additional flow expected under the proposed diversion, and estimated an average annual flow of 6.42 MGD and a maximum annual flow of 13.99 MGD. IEPA used the maximum flow volume to determine the RC. IEPA noted that Hunter Lake will have to meet the TP criteria of 0.05 mg/L, and therefore the RC is based upon the maximum flow and lake TP criteria.

EPA finds that the TMDL document submitted by IEPA satisfies all requirements concerning 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.

Comment:
IEPA determined loads for five WWTFs and two MS4 dischargers in the watershed (Table 4 of this Decision document; Table 8-3 of the TMDL). The WLAs are based upon the facilities design average flow and an estimated TP effluent concentration of 2.425 mg/L. There is only one facility in the watershed currently monitoring for TP, so IEPA reviewed data from similar facilities in the region, and determined an estimated concentration.

Two MS4 permittees are in the watershed, the City of Springfield and the Village of Chatham. The WLAs were calculated based upon the areal coverage of the watershed and the overall runoff load in the watershed. The land area and corresponding WLA for the MS4 dischargers are in Table 4 of this Decision Document. IEPA did not identify any other point sources (CSOs, CAFOS, etc.) in the watershed (WLA = 0).

Table 4 WLAs for the Lake Springfield TMDL

NPDES Permit Number	**Permit Name**	**Type**	**Design Flow** (MGD)	**Permitted Area in Watershed** (sq. miles)	**WLA*** (lbs/day)
IL0022403	Auburn STP	WWTF	0.62	-	12.6
IL0023426	Virden North STP	WWTF	0.2	-	4.1
IL0050253	Lake Springfield Baptist Camp	WWTF	0.015	-	0.30
ILG580260	Thayer STP	WWTF	0.0842	-	1.7
ILG580275	Loami STP	WWTF	0.25	-	5.1
ILR400453	Springfield, City of	MS4	-	61.5	1.5
ILR400624	Chatham, Village of	MS4	-	12.9	0.31
				Total WLA	**25.5**

* WLAs are equivalent to estimates of current waste loads. IEPA's TMDL assumes no changes in current NPDES permit limits in the watershed are imminent.

EPA finds that the TMDL document submitted by IEPA satisfies all requirements concerning 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.

Comment:
The Lake Springfield TMDL incorporated an explicit MOS of 10% of the TMDL (Table 3 of this Decision Document; Section 8.3.1.3 of the TMDL). IEPA noted that the 10% is reasonable due to the results of a comparison between modeled results and observed values. In addition, IEPA explained that an implicit MOS (based upon conservative assumptions in the model) was present. IEPA explained that the technical documentation for BATHTUB discusses how default input values are typically more conservative than site-specific values (Section 8.3.1.3 of the TMDL). IEPA noted that these default values cover a range, and are deliberately set to overestimate model uncertainty. The effect is to over-estimate loadings.

EPA finds that the TMDL document submitted by IEPA has an appropriate MOS satisfying all requirements concerning 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)).

Comment:
IEPA accounted for seasonal variation via the modeling process. As noted in Section 8.3.1.2 of the TMDL, the model inputs focused on the April-October period over 13 years, corresponding to when the lake water quality data were collected, as well as representing the impact of where the TP loadings were the greatest. The BATHTUB model was run to determine annual loads as well as daily loads, to allow Best Management Practices (BMPs) to be utilized year-round.

EPA finds that the TMDL document submitted by IEPA satisfies all requirements concerning 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.

Comment:
Section 9 of the TMDL discusses reasonable assurance for Lake Springfield. IEPA provided information on controls of TP that will be targeted to the watershed.

Section 9.6 of the TMDL discusses various BMPs that, when implemented, will significantly reduce phosphorus to attain WQS. For example, the impacts of buffer strips along Sugar Creek was discussed, and Figures 9.2 and 9.3 of the TMDL include locations where buffer strips could be located to reduce sediment and associated phosphorus runoff from agricultural fields. Further details for TP reductions will be discussed in the Lake Springfield Watershed Management Plan, which is under development through use of CWA Section 319 funds.

Section 9.9 of the TMDL provides a timeline of actions and activities in the watershed that have reduced and are continuing to reduce TP and TSS loads into Lake Springfield. The Springfield CWLP began actions to reduce sediment inflow into the lake in 1983, when studies showed the lake had lost over 13% of capacity since 1934. Actions have continued since 1983 to reduce TP and TSS loads, which have slowed but not stopped the inflow into the lake. A cost-share program was set up by Springfield CWLP to assist in the development of such practices as stream buffers, lakeshore buffers, sediment basins, and other best management practices (BMPs) to reduce TP and sediment loads.

IEPA has also developed Load Reduction Strategies (LRS) for various pollutants in the watershed. These LRSs address impairments where numeric criteria have not been developed (such as for TSS, or TP in streams). Although these are not TMDLs, the LRSs discuss sources and reductions needed for the various pollutants that have either a direct (TP) or indirect (TSS) impact on Lake Springfield. IEPA has concluded that reducing these pollutants will improve water quality in Lake Springfield and assist in implementing BMPs in the watershed.

IEPA provided detailed cost estimates for various BMPs in Section 9.12 of the TMDL. These cost estimates are calculated per acre or per project, and also identify the program and sponsor for the BMPs.

EPA finds that this criterion has been adequately addressed.

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.

Comment:
The TMDL contains discussion on future monitoring and milestones (Section 9.13 of the TMDL). There were three lake monitoring sites used to gather data for the TMDL. The TMDL document recommends monitoring continue at these sites. Springfield CWLP conducts monitoring to ensure water quality for continued operations of the plant.

EPA finds that this criterion has been adequately addressed.

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:
Numerous implementation options are discussed in Section 9 of the TMDL. These options are directed for sediment reductions as well as TP reductions.

The potential BMPs are:

- Cover crops
- No-till/strip till
- Water and Sediment Control Basins (WASCB)
- Grassed waterways
- Filter strip, grass conversion, and field borders
- Streambank stabilization
- Shoreline stabilization
- Detention basin/pond
- Septic Systems
- Nutrient management

For most of these BMPs, IEPA provided some watershed analysis on the impacts these BMPs may have on TP and TSS loads. For example, the effectiveness of filter strips along streambanks was discussed. IEPA noted that the upper portion of the tributaries in the watershed are bordered by cropland. Compared to the land use maps in the TMDL, IEPA determined about 15,000 acres could benefit from filter strip BMPs and 1600 acres that could benefit from riparian buffers (Section 9.6.2 of the TMDL).

IEPA determined that Lake Springfield needs significant reductions in internal loading of TP. In Section 9.6.2 of the TMDL, IEPA explains the three options for addressing internal loading; hypolimnetic (bottom) aeration, alum treatment, and dredging. IEPA noted that alum treatments and dredging are expensive, and may have other negative impacts on the biology of the lake. Aeration may help in addressing the low DO concerns in Lake Springfield, but may be difficult to implement in a highly-used lake. IEPA will likely do additional studies before implementing internal load BMPs.

EPA reviews, but does not approve, implementation plans. EPA finds that this criterion has been adequately addressed.

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.

Comment:
An initial public meeting was held on March 27, 2014, to describe the watershed plan and TMDL process. The public comment period for the draft TMDL opened on March 7, 2017 and closed on April 8, 2017. A public meeting was held on March 7, 2017, in Springfield, Illinois.

The public notices were published in the local newspaper and interested individuals and organizations received copies of the public notice. A hard copy of the TMDL was made available at the Chatham Public Library, Auburn Public Library, and the Springfield CWLP. The draft TMDL was also made available at the website http://www.epa.state.il.us/water/tmdl/. Several public comments were received.

IEPA developed a response summary to address the comments submitted. EPA reviewed the comments and responses, and has determined that IEPA responded appropriately to the comments. A brief overview is provided below.

Several comments discussed the amount of reasonable assurance (RA) provided in the TMDL, and that sufficient RA was not provided. IEPA noted that that there have been numerous implementation actions pursued in the watershed, and BMPs have been installed over several years. EPA has determined it is reasonable to expect that further RA efforts will continue, as IEPA and local watershed groups have continued to pursue CWA Section 319 grants and other funding mechanisms to develop and implement future BMPs.
Several comments were raised over the lack of monitoring for POTWs in the watershed, and that no reductions were expected from these sources. IEPA explained that the facilities do not monitor for TP at this time, and therefore little data is available to determine current loading. The WLAs are based upon an estimated effluent concentration, and IEPA stated that the permittees will be required to monitor for TP in their next NPDES permit. Once additional data are gathered for the dischargers, the TMDL can be reopened and the WLAs adjusted.

One commentor raised several questions on how their MS4 allocation was calculated, and what the effect would be on their MS4 permit. IEPA explained that the WLA was based upon the areal extent of the MS4 entity, and the impacts upon Lake Springfield, not Sugar Creek. The LRS for Sugar Creek is voluntary in nature, as it is not an official TMDL. The commentor also requested that further monitoring be performed upstream and downstream to asses impacts from the MS4. IEPA noted that the monitoring is beyond the TMDL effort, but could be useful in obtaining additional data before the MS4 permit is modified.

EPA finds that the TMDL document submitted by IEPA satisfies all requirements concerning 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:
On July 25, 2017, EPA received the Lake Springfield, Illinois TMDL, and a submittal letter from Sanjay Sofat, IEPA to Chris Korleski, EPA. In the submittal letter, IEPA stated it was submitting the TMDL report for EPA's final approval. The submittal letter included the name and location of the waterbody and the pollutant of concern.

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

Conclusion
After a full and complete review, EPA finds that the TMDL for Lake Springfield satisfies all of the elements of an approvable TMDL. This approval is for one TMDL for phosphorus for one waterbody.

EPA's approval of this TMDL does not extend to those waters that are within Indian Country, as defined in 18 U.S.C. Section 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 the CWA Section 303(d) for those waters.

Lake Springfield and Sugar Creek Watershed TMDL Stage 3 Final Report

Prepared for Illinois EPA

July 2017

CDM Smith

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Acronyms

ACEP	Agricultural Conservation Easement Program
BMPs	best management practices
CDL	Cropland Data Layer
cfs	cubic feet per second
CPESC	Certified Professional in Erosion and Sediment Control
CPP	Conservation Cost-Share Practices Program
CREP	Conservation Reserve Enhancement Program
CRP	Conservation Reserve Program
CSP	Conservation Stewardship Program
CWA	Clean Water Act
CWLP	[Springfield] City Water, Light and Power
DAF	design average flow
DO	dissolved oxygen
EQIP	Environmental Quality Incentives Program
FRSS	facility related stream survey
FSA	Farm Service Agency
GIS	geographic information system
GRP	Grasslands Reserve Program
HUC	Hydrologic Unit Code
IDA	Illinois Department of Agriculture
Illinois EPA	Illinois Environmental Protection Agency
IPCB	Illinois Pollution Control Board
ISWS	Illinois State Water Survey
LA	load allocation
LC	loading capacity
LRS	load reduction strategy
LSW	Lake Springfield and Sugar Creek Watershed
LSWMRP	Lake Springfield and Sugar Creek Watershed Maintenance and Restoration Program
LSWRPC	Lake Springfield and Sugar Creek Watershed Resources Planning Committee
µg/L	micrograms per liter
mg/L	milligrams per liter
MGD	million gallons per day
MS4	municipal separate storm sewer system
MOS	margin of safety
NASS	National Agricultural Statistics Service
NCDC	National Climatic Data Center
NED	National Elevation Dataset
NMP	nutrient management plan
NPDES	National Pollutant Discharge Elimination System
NRCS	Natural Resources Conservation Service
NVSS	non-volatile suspended solids
PAC	powdered activated carbon
POTW	publicly owned treatment works
RC	reserve capacity
RUSLE	Revised Universal Soil Loss Equation
SAFE	State Acres for Wildlife Enhancement
SMSD	Springfield Metro Sanitary District

SSURGO	Soil Survey Geographic Database
STORET	USEPA's Storage and Retrieval System
STP	sewage treatment plant
SWCD	Soil and Water Conservation District
TMDL	total maximum daily load
TSS	total suspended solids
USDA	United States Department of Agriculture
USEPA	United States Environmental Protection Agency
USGS	U.S. Geological Survey
WASCOB	water and sediment control basin
WLA	waste load allocation
WREP	Wetland Reserve Enhancement Partnership

Section 1

Goals and Objectives for the Lake Springfield and Sugar Creek Watershed

1.1 Total Maximum Daily Load Overview

A total maximum daily load, or TMDL, is a calculation of the maximum amount of a pollutant that a water body can receive and still meet water quality standards. TMDLs are a requirement of Section 303(d) of the Clean Water Act (CWA). To meet this requirement, the Illinois Environmental Protection Agency (Illinois EPA) must identify water bodies not meeting water quality standards and then establish TMDLs for restoration of water quality. Illinois EPA develops a list known as the "303(d) list" of water bodies not meeting water quality standards every 2 years, and it is included in the Integrated Water Quality Report. Water bodies on the 303(d) list are then targeted for TMDL development. The Illinois EPA's most recent Integrated Water Quality Report was submitted to the United States Environmental Protection Agency (USEPA) in March 2014. In accordance with USEPA's guidance, the report assigns all waters of the state to one of five categories. 303(d) listed water bodies make up category five in the integrated report (**Appendix A** of the Integrated Report).

In general, a TMDL is a quantitative assessment of water quality impairments, contributing sources, and pollutant reductions needed to attain water quality standards. The TMDL specifies the amount of pollutant or other stressor that needs to be reduced to meet water quality standards, allocates pollutant control or management responsibilities among sources in a watershed, and provides a scientific and policy basis for taking actions needed to restore a water body.

Water quality standards are laws or regulations that states authorize to enhance water quality and protect public health and welfare. Water quality standards provide the foundation for accomplishing two of the principal goals of the CWA. These goals are:

- Restore and maintain the chemical, physical, and biological integrity of the nation's waters
- Where attainable, to achieve water quality that promotes protection and propagation of fish, shellfish, and wildlife, and provides for recreation in and on the water

Water quality standards consist of three elements:

- The designated beneficial use or uses of a water body or segment of a water body
- The water quality criteria necessary to protect the use or uses of that particular water body
- An antidegradation policy

Examples of designated uses are primary contact (swimming), protection of aquatic life, and public and food processing water supply. Water quality criteria describe the quality of water that will support a designated use. Water quality criteria can be expressed as numeric limits or as a narrative statement. Antidegradation policies are adopted so that water quality improvements are conserved, maintained, and protected.

1.2 TMDL Goals and Objectives for the Lake Springfield and Sugar Creek Watershed

The Illinois EPA has a three-stage approach to TMDL development. The stages are:

Stage 1 – Watershed Characterization, Data Analysis, Methodology Selection

Stage 2 – Data Collection (optional)

Stage 3 – Model Calibration, TMDL Scenarios, Implementation Plan

This report presents all stages of TMDL development for the Lake Springfield and Sugar Creek Watershed. Stage 1 was completed in late 2014. Data collection under Stage 2 was not performed as it is an optional stage that is typically completed when data are lacking to develop TMDLs. No data gaps were identified during Stage 1. Stage 3 documentation was completed in early 2016.

For the purposes of this TMDL, Illinois EPA has included all lands contained in the 10 digit U.S. Geological Survey (USGS) Hydrologic Unit Code (HUC) basin 0713000707 in the overall Lake Springfield TMDL watershed **Figure 1-1**. Illinois EPA regularly uses the naming convention of applying the name of the largest water body in a basin to the TMDL watershed name. In this case, the TMDL title is not intended to limit the TMDL watershed boundaries to waters flowing into Lake Springfield, but also includes the waters in the Sugar Creek watershed flowing to points along Sugar Creek downstream of the dam. Following are the impaired water body segments in the Lake Springfield and Sugar Creek watershed:

- Sugar Creek (EOA-01)
- Sugar Creek (EOA-04)
- Sugar Creek (EOA-06)
- Hoover Branch (EOAD-11)
- Lake Springfield (REF)

These impaired water body segments are shown on **Figure 1-1**. There are five impaired water body segments within the watershed for which TMDLs and/or a load reduction strategy (LRS) were developed. **Table 1-1** lists the water body segment, water body size, and potential causes and sources of impairment for the water body.

Table 1-1 Impaired Water Bodies in Lake Springfield and Sugar Creek Watershed

Segment ID	Segment Name	Water Body Size	Potential Causes of Impairment	Designated Use	Potential Sources (as identified by the 2012 303(d) list)
EOA-01	Sugar Creek	4.04 miles	**Boron**[1]	Aquatic Life	Industrial Point Source Discharges
EOA-04	Sugar Creek	34.28 miles	*Phosphorus (Total)*	Aquatic Life	Municipal Point Source Discharges, Crop Production
EOA-06	Sugar Creek	3.20 miles	**Boron**[1]	Aquatic Life	Industrial Point Source Discharges
			Phosphorus (Total)	Aquatic Life	Municipal Point Source Discharges, Crop Production
EOAD-11	Hoover Branch	2.95 miles	*Sedimentation/ Siltation*	Aquatic Life	Urban Runoff/Storm Sewers, Crop Production
REF	Lake Springfield	4,200 acres	**Phosphorus (Total)**	Aesthetic Quality	Crop Production[2], Golf Courses, Runoff from Forest/Grassland/Parkland
			Total Suspended Solids (TSS)	Aesthetic Quality	Crop Production[2], Golf Courses, Littoral/shore Area Modifications, Other Recreational Pollution Sources, Runoff from Forest/Grassland/Parkland
			Aquatic Algae[3]	Aesthetic Quality	Crop Production[2], Golf Courses, Runoff from Forest/Grassland/Parkland

Note: Bold Causes of Impairment have numeric water quality standards and TMDLs were calculated where appropriate. Italicized Causes of Impairment do not have numeric water quality standards and LRSs were developed where appropriate. Some italicized causes of impairment did not have a LRS developed as it is likely that implementing strategies to reduce the loading of other parameters of concern (e.g. reducing phosphorus loading to lakes) will result in reduced loading of additional parameters of concern (e.g. aquatic algae in lakes).

1 TMDLs for boron in Sugar Creek were not developed as the impairment is being addressed through the National Pollution Discharge Elimination System (NPDES) permitting program. See further discussion in Sections 5, 7, 8 and 9.

2 Potential source not shown in 303(d) list tables.

3 Although algae is not a pollutant, it has been listed as a cause of impairment. Excess algae is often linked to high nutrient levels and its presence depletes oxygen levels in lakes leading to eutrophication.

Illinois EPA has previously only developed TMDLs for parameters that have numeric water quality standards while deferring development of TMDLs for parameters without numeric water quality standards until those criteria have been developed and adopted. For potential causes that do not have numeric water quality standards as noted in **Table 1-1**, TMDLs were not developed. However, LRSs (similar to TMDLs) were developed based on target values established by Illinois EPA. In addition, some of these potential causes may be addressed by implementation of controls for the pollutants with numeric water quality standards.

The TMDLs for the segments listed above specify the following elements:

- Loading Capacity (LC) or the maximum amount of pollutant loading a water body can receive without violating water quality standards
- Waste Load Allocation (WLA) or the portion of the TMDL allocated to existing or future point sources
- Load Allocation (LA) or the portion of the TMDL allocated to existing or future nonpoint sources and natural background
- Margin of Safety (MOS) or an accounting of uncertainty about the relationship between pollutant loads and receiving water quality

- Reserve Capacity (RC) or a portion of the load explicitly set aside to account for growth in the watershed

These elements are combined into the following equation:

$$\mathbf{TMDL = LC = \Sigma WLA + \Sigma LA + MOS + RC}$$

As part of the TMDL development process, Illinois EPA started to include LRSs in TMDL watershed projects in 2012 for those pollutants that do not currently have a numeric water quality standards. Developing an LRS involves determining the LC and load reduction that is needed in order for the water body to meet "Full Use Support" for its designated uses. In an LRS, the LC is not divided into WLA, LA, or MOS. These TMDL components are represented by one number as a target concentration for load reduction within each unique watershed. The LRS provides guidance (with no regulatory requirements) for voluntary nonpoint source reduction efforts by implementing agricultural and urban stormwater best management practices (BMPs). TMDL and LRS development also takes into account the seasonal variability of pollutant loads so that water quality standards are met during all seasons of the year. Also, reasonable assurance that the TMDL and LRS targets will be achieved is described in the implementation plan. The implementation plan for the Lake Springfield and Sugar Creek Watershed describes how water quality standards and targets will be met and attained. This implementation plan includes recommendations for implementing BMPs, cost estimates, institutional needs to implement BMPs and controls throughout the watershed, and a timeframe for completion of implementation activities.

1.3 Report Overview

The remaining sections of this report contain:

- **Section 2 Lake Springfield and Sugar Creek Watershed Description** provides a description of the watershed's location, topography, geology, land use, soils, population, and hydrology.
- **Section 3 Lake Springfield and Sugar Creek Watershed Public Participation** discusses public participation activities that occurred throughout TMDL development.
- **Section 4 Lake Springfield and Sugar Creek Watershed Water Quality Standards** defines the water quality standards for the impaired water bodies.
- **Section 5 Lake Springfield and Sugar Creek Watershed Characterization** presents the available water quality data needed to develop TMDLs, discusses the characteristics of the impaired stream segments in the watershed, and also describes the point and nonpoint sources with potential to contribute to the watershed load.
- **Section 6 Approach to Developing TMDLs and Identification of Data Needs** makes recommendations for the models and analysis that are needed for TMDL development and also discusses Stage 2 data collection efforts.
- **Section 7 Methodology Development for the Lake Springfield and Sugar Creek Watershed** details the development of the TMDLs and LRSs for each impaired waterbody.

- **Section 8 Total Maximum Daily Loads for the Lake Springfield and Sugar Creek Watershed** provides the results of the TMDL and LRS analyses for each impaired stream segment.
- **Section 9 Implementation Plan for the Lake Springfield and Sugar Creek Watershed** makes recommendations for implementation actions, point source controls, management measures, and BMPs that can be used to address water quality issues in the watershed.
- **Section 10 References**

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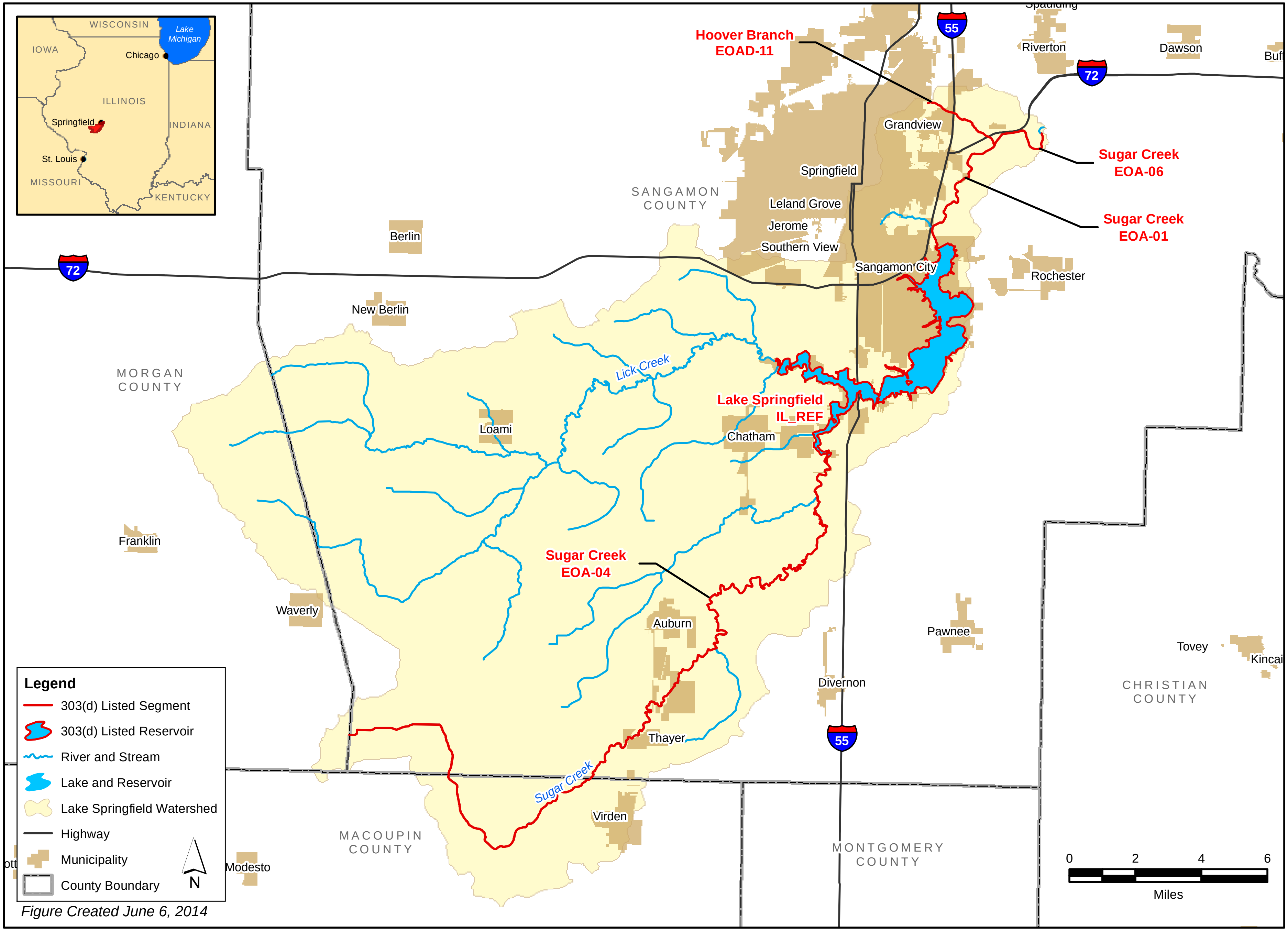

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Lake Springfield and Sugar Creek TMDL Watershed

FIGURE 1-1

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Section 2

Lake Springfield and Sugar Creek Watershed

2.1 Lake Springfield and Sugar Creek Watershed Location

The Lake Springfield and Sugar Creek Watershed, including the portion draining to Sugar Creek below the Lake Springfield dam, (Figure 1-1) is located in central Illinois, flows in a northeasterly direction, and drains approximately 184,000 acres[1]. Approximately 170,800 acres of the watershed drain to Lake Springfield. Approximately 160,600 acres (87.5 percent of the total watershed) lie in Sangamon County, 12,100 acres (6.5 percent of the total watershed) lie in northeastern Macoupin County, and 10,900 acres (6 percent of the total watershed) lie in southeastern Morgan County.

2.2 Topography

Topography is an important factor in watershed management because stream types, precipitation, and soil types can vary dramatically by elevation. National Elevation Dataset (NED) coverages containing 30-meter grid resolution elevation data are available from the USGS for each 1:24,000-topographic quadrangle in the United States. Elevation data for the Lake Springfield and Sugar Creek Watershed were obtained by overlaying the NED grid onto the geographic information system (GIS)-delineated watershed. **Figure 2-1** shows the elevations found within the watershed.

Elevation in the Lake Springfield and Sugar Creek watershed ranges from 716 feet above sea level in the southwestern portion of the watershed at the headwaters of Sugar Creek to 511 feet at the confluence of Spring Creek and the Sangamon River downstream on the western edge of the watershed. The surface elevation of Lake Springfield is approximately 560 feet at full volume.

2.3 Land Use

Land use data for the Lake Springfield and Sugar Creek watershed were extracted from the U.S. Department of Agriculture's (USDA) National Agriculture Statistics Service (NASS) 2013 Cropland Data Layer (CDL), The CDL is a raster based, geo-referenced, crop-specific land cover data layer created to provide acreage estimates to the Agricultural Statistics Board for the state's major commodities and to produce digital, crop-specific, categorized geo-referenced output products. This information is made available to all agencies and to the public free of charge and represents the most accurate and up-to-date land cover datasets available at a national scale. The most recent available CDL dataset was produced in 2013 and includes 34 separate land use classes applicable to the watershed. The available resolution of the land cover dataset is 30 square meters. The 2013 CDL and extensive metadata are available at http://www.nass.usda.gov/research/Cropland/SARS1a.htm

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[1] *Watershed areas calculated with ArcGIS software and based on USGS 10-meter digital elevation model data.*

Land use characteristics of the watershed were determined by overlaying the Statewide 2013 CDL data layer onto the GIS-delineated watershed. **Table 2-1** contains the land uses contributing to the Lake Springfield and Sugar Creek watershed, based on the 2013 CDL land cover categories and also includes the area of each land cover category and percentage of the watershed area. **Figure 2-2** illustrates the land uses of the watershed.

Table 2-1 Land Cover and Land Use in Lake Springfield and Sugar Creek Watershed as provided by the USDA NASS 2013 CDL

Land Cover Category	**Area (Acres)**	**Percentage**
Corn	79,530	43%
Soybeans	46,810	25%
Developed/Low Intensity	12,621	6.9%
Grass/Pasture	11,460	6.2%
Deciduous Forest	10,577	5.8%
Developed/Open Space	9,549	5.2%
Developed/Med Intensity	6,311	3.4%
Open Water	4,061	2.2%
Developed/High Intensity	1,481	0.8%
Winter Wheat	351	0.19%
Woody Wetlands	206	0.11%
Alfalfa	169	0.09%
Barren	122	0.07%
Dbl Crop WinWht/Soybeans	104	0.06%
Other Hay/Non Alfalfa	94	0.05%
Herbaceous Wetlands	63	0.03%
Clover/Wildflowers	28	0.02%
Dry Beans	27	0.01%
Cabbage	26	0.01%
Dbl Crop Corn/Soybeans	15	0.01%
Sod/Grass Seed	5.8	<0.01%
Sweet Corn	2.4	<0.01%
Rye	2.4	<0.01%
Dbl Crop WinWht/Sorghum	2.2	<0.01%
Fallow/Idle Cropland	2.0	<0.01%
Barley	1.6	<0.01%
Grapes	1.1	<0.01%
Pop or Orn Corn	0.7	<0.01%
Evergreen Forest	0.7	<0.01%
Oats	0.7	<0.01%
Pumpkins	0.4	<0.01%
Herbs	0.4	<0.01%
Sorghum	0.2	<0.01%
Walnuts	0.2	<0.01%
Grand Total	**183,627**	**100%**

The land cover data reveal that approximately 138,635 acres, representing over 75 percent of the total watershed area, are devoted to agricultural activities. Cultivated crops and pasture/hay fields account for 69 percent and 6.3 percent of the watershed area, respectively. Approximately 16.4 percent of the watershed area (30,085 acres) is developed, urbanized land. Forest, grassland, and upland areas represent a total of 5.8 percent of the watershed (10,577 acres). Wetlands, marshes, and open water make up the remaining 3 percent (4,330 acres) of the watershed.

2.4 Soils

The physical and chemical makeup of the soils that occur in a given watershed can play an integral role in the resulting water quality of surface waters in the watershed. Soils continually enter lakes and streams through overland runoff caused by precipitation events. The extent of the soils transported into a waterbody and the potential impacts to water quality are highly dependent on the existing soil types and their distribution throughout a watershed. Regional soils data are available through the Soil Survey Geographic (SSURGO) database. For SSURGO data, field mapping methods using national standards are used to construct the soil maps. Mapping scales generally range from 1:12,000 to 1:63,360 making SSURGO the most detailed level of soil mapping done by the Natural Resources Conservation Service (NRCS).

Attributes of the spatial coverage can be linked to the SSURGO databases, which provide information on various chemical and physical soil characteristics for each map unit and soil series. Of particular interest for TMDL development are the hydrologic soil groups as well as the K-factor of the Universal Soil Loss Equation. The following sections describe and summarize the specified soil characteristics for the Lake Springfield and Sugar Creek watershed.

2.4.1 Lake Springfield and Sugar Creek Watershed Soil Characteristics

Appendix A contains a table of the SSURGO soil series for the watershed. A total of 72 soil types exist in the watershed, although two types, Ipava silt loam (0-2 percent slopes) and Virden silty clay loam (0-2 percent slopes), cover more than 50 percent of the watershed (35.9 and 15.1 percent, respectively). All other individual soil types represent less than 10 percent of the total watershed area. The table also contains the area, dominant hydrologic soil group, and k-factor range. Each of these characteristics is described in more detail in the following paragraphs.

Figure 2-3 shows the hydrologic soils groups found within the Lake Springfield and Sugar Creek Watershed. Hydrologic soil groups are used to estimate runoff from precipitation. Soils are assigned to one of four groups. These soils are grouped according to the ability of water to infiltrate them when these soils are thoroughly saturated, and of the ability of these soils to receive precipitation during long duration storm events:

Group A: Soils in this group have low runoff potential when thoroughly wet. Water is transmitted freely through the soil.

Group B: Soils in this group have moderately low runoff potential when thoroughly wet. Water transmission through the soil is unimpeded.

Group C: Soils in this group have moderately high runoff potential when thoroughly wet. Water transmission through the soil is somewhat restricted.

Group D: Soils in this group have high runoff potential when thoroughly wet. Water movement through the soil is restricted or very restricted.

While hydrologic soil groups B, C, D, B/D, and C/D are all found within the watershed, groups B and B/D are the most common types and represent 65.6 and 28.1 percent of the watershed, respectively. Group C, D, and C/D cover a much smaller portion of the watershed at 2.1, 1.0, and 0.3 percent of the watershed, respectively. Group B soils are defined as having "moderately low runoff potential when thoroughly wet." These soils have a moderate rate of water transmission. Group C soils are defined as having "moderately high runoff potential when thoroughly wet." These soils have a slow rate of water transmission. Group D soils are defined as having "high runoff potential when thoroughly wet." These soils have a very slow rate of water transmission. Group B/D soils are "placed in group D based on the presence of a water table within 24 inches of the surface"; however, if these soils can be adequately drained, then they are assigned to dual hydrologic groups (A/D, B/D, C/D) based on their saturated hydrologic conductivity and the water table depth when drained. The first letter applies to the drained condition and the second to the undrained condition. For the purpose of hydrologic soil group, adequately drained means that the seasonal high water table is kept 24 inches below the surface in a soil where it would be higher in a natural state. (NRCS 2009).

A commonly used soil attribute is the soil erodibility factor (K-factor). The K-factor indicates the susceptibility of a soil to sheet and rill erosion by water. The K-factor is one of the factors used in the Revised Universal Soil Loss Equation (RUSLE) to predict the average annual rate of soil loss by sheet and rill erosion. Losses are expressed in tons per acre per year. These estimates are based primarily on percentage of silt, sand, and organic matter and on soil structure and permeability. Values of K range from 0.02 to 0.69. The higher the value, the more susceptible the soil is to sheet and rill erosion by water (Web Soil Survey 2013). The distribution of K-factor values in the Lake Springfield and Sugar Creek watershed range from 0.24 to 0.49.

2.5 Population

The Census 2010 TIGER/Line data from the U.S. Census Bureau were retrieved. Geographic shapefiles of census blocks were downloaded for the entire state of Illinois. All census blocks that have geographic center points (centroids) within the watershed were selected and tallied in order to provide an estimate of populations in all census blocks both completely and partially contained by the watershed boundary. Approximately 74,300 people reside in the Lake Springfield and Sugar Creek Watershed. The major municipalities in the watershed are shown in **Figure 1-1**. The largest urban development is in the northeastern extent of the watershed and consists of portions of the city of Springfield (population of approximately 116,000) and the surrounding metropolitan area. Additional communities within the watershed include: Chatham (pop. 11,946), Loami (pop. 753), Auburn (pop. 4,826), Thayer (pop. 694), and Virden (pop. 3,492).

2.6 Climate, Pan Evaporation, and Streamflow

2.6.1 Climate

Central Illinois has a temperate climate with hot summers and cold, snowy winters. Monthly precipitation data from Springfield, Illinois (station id. 93822) in Sangamon County were extracted from the National Climatic Data Center (NCDC) database for the years of 1901 through 2013. The data station in Springfield, Illinois was chosen to be representative of precipitation throughout the Lake Springfield and Sugar Creek watershed.

Table 2-2 contains the average monthly precipitation along with average high and low temperatures for the period of record. The average annual precipitation is approximately 35.3 inches. May and June are historically the wettest months while January and February are typically the driest months.

Table 2-2 Average Monthly Climate Data in Springfield, Illinois

Month	Total Precipitation (inches)	Maximum Temperature (degrees F)	Minimum Temperature (degrees F)
January	1.9	34.8	26.9
February	1.8	38.8	30.6
March	3.0	50.7	41.5
April	3.6	63.6	53.2
May	4.0	74.4	63.8
June	4.0	83.5	73.0
July	3.3	87.6	77.1
August	3.1	85.3	75.0
September	3.2	78.8	67.7
October	2.7	66.9	56.2
November	2.5	51.5	42.8
December	2.1	38.4	31.0
Total	**35.3**	**62.8**	**53.2**

In addition to the NCDC data, Monthly precipitation data from three rain gages within the watershed were also available from a database created by the Springfield City Water, Light, and Power (CWLP). This dataset has a shorter period of record (1995 through 2013) but the three rain gages monitored by CWLP are distributed across the watershed (at Lake Springfield Filter Plant), and along the Lick Creek and Sugar Creek tributaries upgradient of the lake) and provide a representation of average monthly precipitation totals for the watershed as a whole (**Table 2-3**).

Table 2-3 Average Monthly Precipitation Data (inches) from three CWLP Rain Gages within the Lake Springfield and Sugar Creek Watershed (1995-2013)

Month	Filter Plant (inches)	Lick Creek (inches)	Sugar Creek (inches)	Watershed Average (inches)
January	2.0	0.8	0.4	1.1
February	1.8	2.1	0.6	1.5
March	2.4	1.8	1.9	2.0
April	3.4	3.3	2.1	2.9
May	4.8	3.8	2.7	3.8
June	3.9	2.7	4.3	3.6
July	2.7	2.3	2.1	2.4
August	2.8	0.9	1.4	1.7
September	2.7	2.8	1.8	2.4
October	3.1	1.3	2.1	2.2
November	2.6	1.6	1.7	2.0
December	1.8	0.8	1.4	1.3
Total	**34.1**	**24.2**	**22.4**	**26.9**

2.6.2 Pan Evaporation

Through the Illinois State Water Survey (ISWS) website, pan evaporation data are available from nine locations across Illinois (ISWS 2007). The Springfield station was chosen to be representative of pan evaporation conditions for the Lake Springfield and Sugar Creek watershed. This station was chosen for its proximity to the 303(d)-listed water bodies in central Illinois and the completeness of the dataset. The average monthly pan evaporation at the Springfield station for the years 1980 to 1990 yields an average annual pan evaporation of 49.2 inches. Actual evaporation is typically less than pan evaporation, so the average annual pan evaporation was multiplied by 0.75 to calculate an average annual evaporation of 36.9 inches (ISWS 2007). However, this estimate of pan evaporation is considerably lower than estimates of annual precipitation in the Lake Springfield and Sugar Creek watershed and is likely an overestimate as a result of the limited period of record of pan-evaporation data.

In order to create a more viable estimate of pan evaporation in the watershed, data from another nearby pan evaporation station in Urbana, Illinois were included along with the data from the Springfield pan-evaporation station in the monthly pan-evaporation estimates for the watershed. This station includes a longer period of record that goes through 2014. As a result of including data from both stations, an average annual pan-evaporation estimate for the Lake Springfield and Sugar Creek watershed was calculated to be approximately 32.1 inches.

2.6.3 Streamflow

Analysis of the Lake Springfield and Sugar Creek watershed requires an understanding of flow throughout the drainage area. One gage (USGS gage 05576250) operated in cooperation between the National Weather Service, the USGS, and the Springfield Metro Sanitary District is located on Sugar Creek downstream of the Lake Springfield dam near the Route 29 bridge (**Table 2-4**). However, the relatively short period of record for this gage (2010-2016) provides limited functionality in any future comparison of flow conditions at the time of sample collection events prior to 2010. An additional USGS gaging station was installed in the watershed in 2015 (USGS 05576100 Lick Creek near Woodside Road) and may provide useful flow data for future assessments.

Table 2-4 Streamflow Gages identified for Use in the Lake Springfield and Sugar Creek Watershed TMDL

Gage Number	Name	POR
SUG12 (NWS)/USGS 05576250	Sugar Creek near Springfield, IL	2010-2014
USGS 05576100	Lick Creek near Woodside Road	2015-2016
USGS 05579500	Lake Fork near Cornland, IL	1948-2016

As a result of the very short period of record for gages in the watershed, a surrogate gage with a longer period of record was needed to estimate historical flows in the Lake Springfield and Sugar Creek watershed for segments with flows that aren't regulated by the Lake Springfield dam. Following assessment of a number of nearby gaging stations, USGS gage 5579500, Lake Fork near Cornland, Illinois, was determined to be the most appropriate surrogate. This gage is located approximately 12 miles northeast of the Lake Springfield and Sugar Creek watershed in a basin of similar size and with similar land-use characteristics. The period of record for flow measurements at this gage extends from 1948.

Because of the gage data limitations within the watershed, flow data for each impaired stream segment was estimated and compared to historical values during Stage 3 using data from the surrogate gage (USGS 05579500) and the drainage area ratio method, represented by the following equation.

$$Q_{gaged}\left(\frac{Area_{ungaged}}{Area_{gaged}}\right) = Q_{ungaged}$$

where Qgaged = Streamflow of the gaged basin
Qungaged = Streamflow of the ungaged basin
Areagaged = Area of the gaged basin
Areaungaged = Area of the ungaged basin

The assumption behind the equation is that the flow per unit area is equivalent in sub-watersheds with similar characteristics. Therefore, the flow per unit area in the gaged watershed multiplied by the area of the ungaged watershed estimates the flow for the ungaged watershed.

Flow data for the surrogate gage for the available period of record is further adjusted to account for point source influence in the watershed upstream of the gaging station. Average daily flows from all National Pollutant Discharge Elimination System (NPDES) permitted facilities upstream of the surrogate USGS gage are subtracted from the gaged flow prior to flow-per-unit-area calculations. The resulting estimates account for flows associated with precipitation and overland runoff only. Average daily flows from permitted NPDES discharges upstream of the impaired segments in the watershed can then be added back into the equation to more accurately reflect estimated daily streamflow conditions in a given segment.

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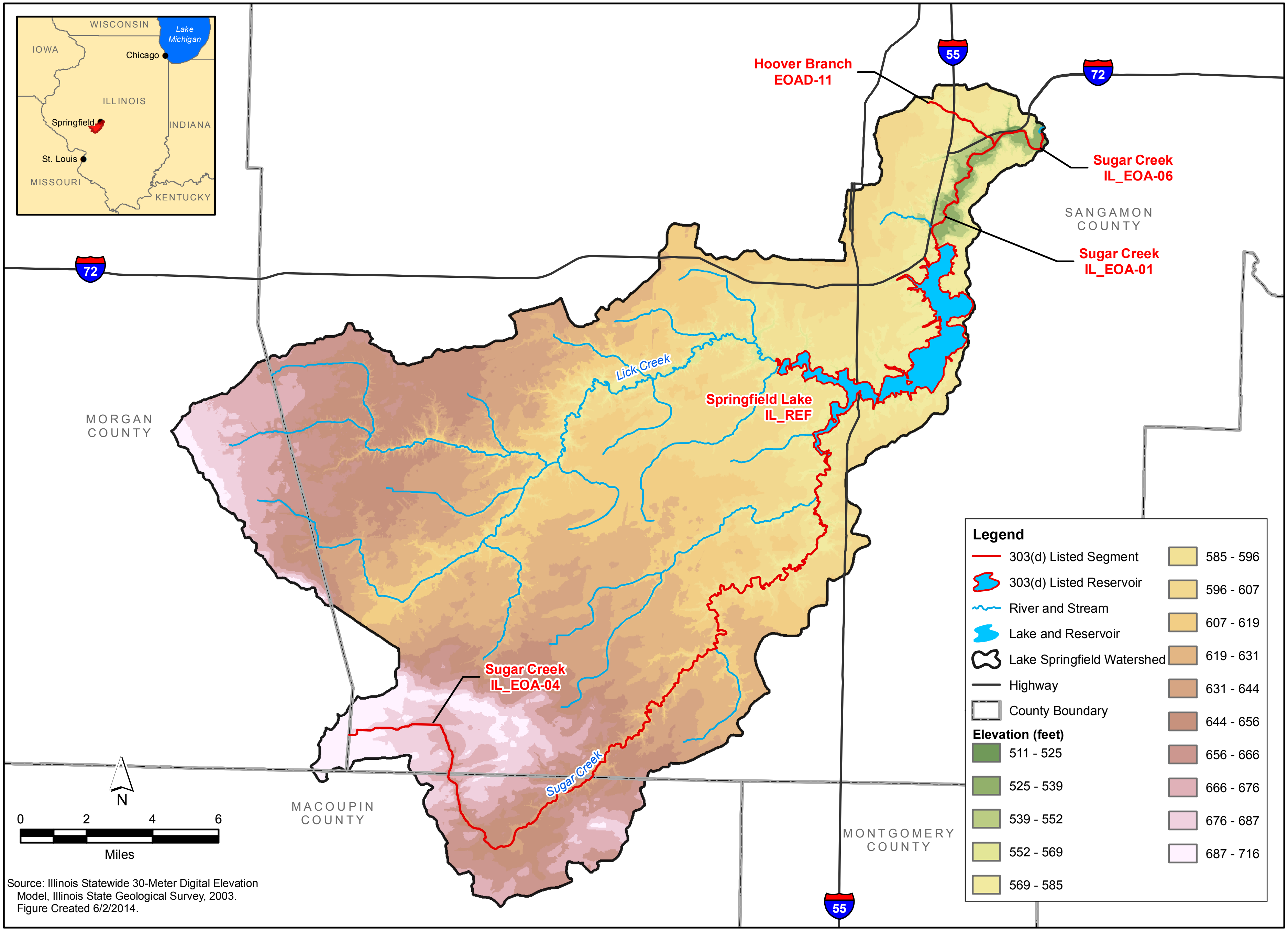

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Lake Springfield and Sugar Creek Watershed Elevation

FIGURE 2-1

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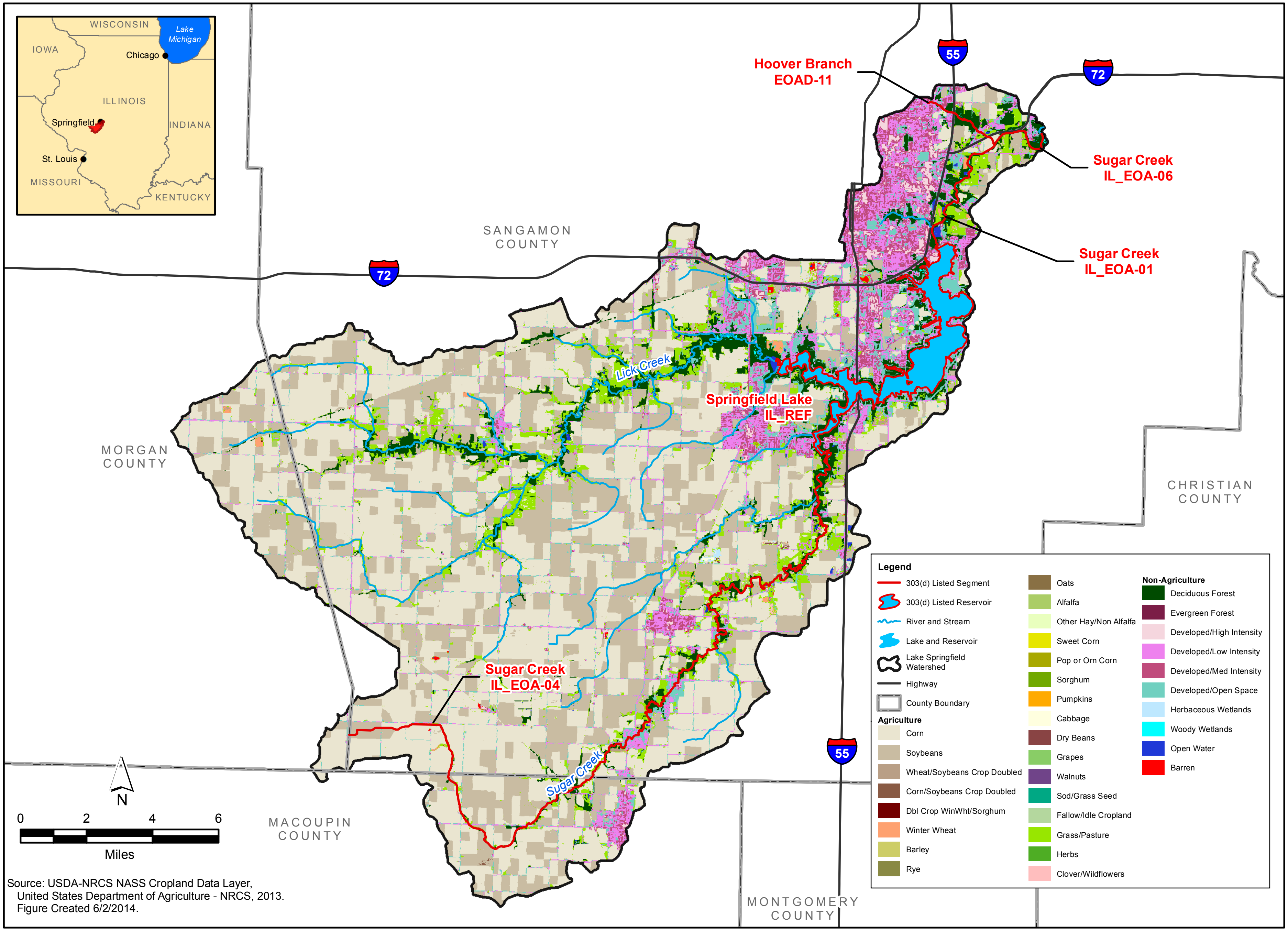

Lake Springfield and Sugar Creek Watershed Land Use

FIGURE 2-2

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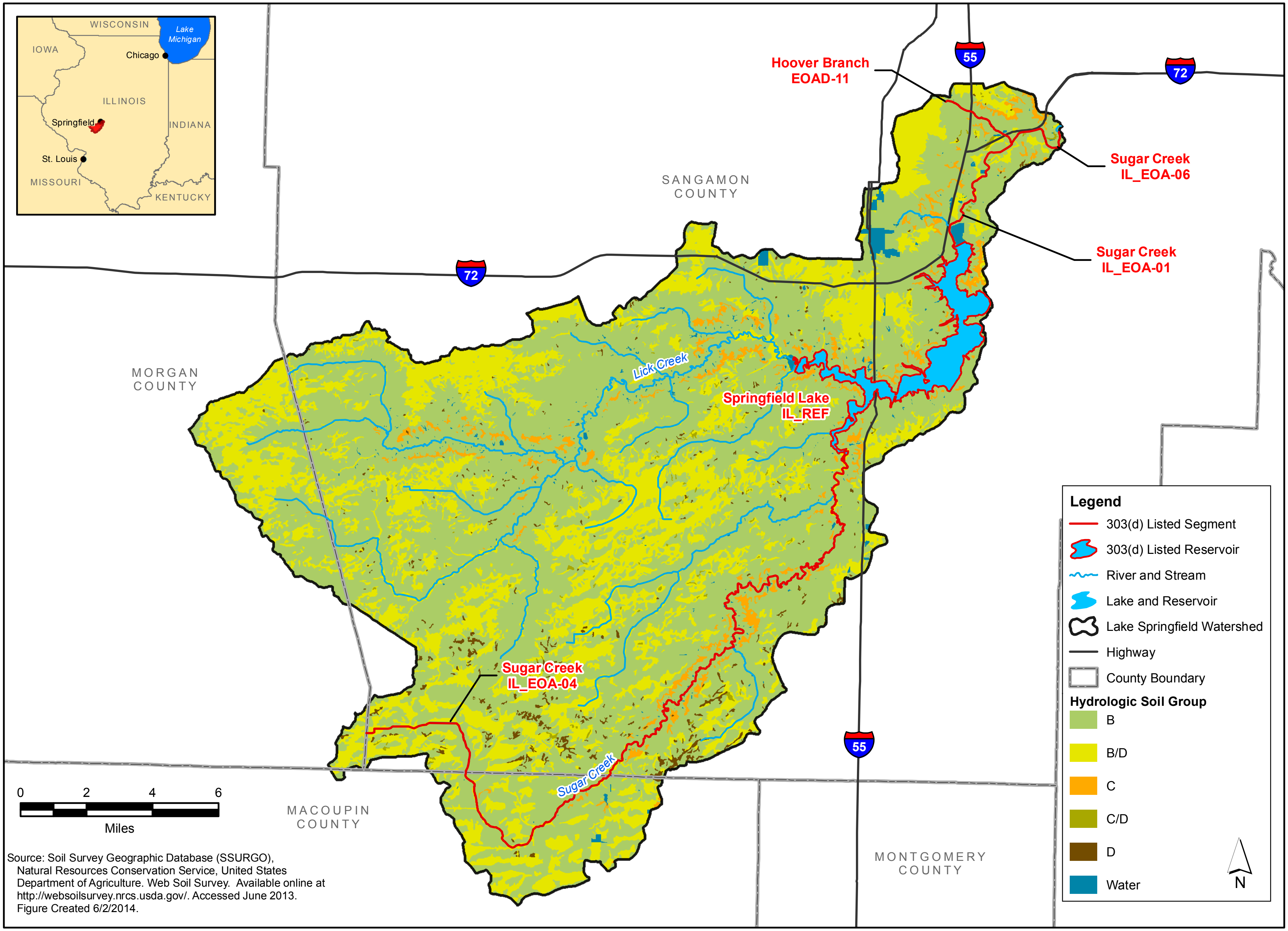

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Lake Springfield and Sugar Creek Watershed Soils

FIGURE 2-3

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Section 3

Lake Springfield and Sugar Creek Watershed Public Participation

3.1 Lake Springfield and Sugar Creek Watershed Public Participation and Involvement

Public knowledge, acceptance, and follow-through are necessary to implement a plan to meet recommended TMDLs. It is important to involve the public as early in the process as possible to achieve maximum cooperation and counter concerns as to the purpose of the process and the regulatory authority to implement any recommendations.

The Stage 1 public meeting was held in Springfield, Illinois on March 27, 2014 at the Lincoln Land Community College Trutter Center. Comments received at the meeting, or following the meeting during the 30-day comment period, have been incorporated into this document.

An additional public meeting was held in Springfield on March 7, 2017 following publication of the draft Stage 3 report. Comments received during the public comment period were incorporated into the Final Lake Springfield and Sugar Creek Watershed TMDL Report. A responsiveness summary addressing comments received during the TMDL process is included in **Appendix E**.

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Section 4

Lake Springfield and Sugar Creek Watershed Water Quality Standards

4.1 Illinois Water Quality Standards

Water quality standards are developed and enforced by the state to protect the "designated uses" of the state's waterways. In the state of Illinois, setting the water quality standards is the responsibility of the Illinois Pollution Control Board (IPCB). Illinois is required to update water quality standards every three years in accordance with the CWA. The standards requiring modifications are identified and prioritized by Illinois EPA, in conjunction with USEPA. New standards are then developed or revised during the three-year period.

Illinois EPA is also responsible for developing scientifically based water quality criteria and proposing them to the IPCB for adoption into state rules and regulations. The Illinois water quality standards are established in the Illinois Administrative Rules Title 35, Environmental Protection; Subtitle C, Water Pollution; Chapter I, Pollution Control Board; Part 302, Water Quality Standards.

4.2 Designated Uses

The waters of Illinois are classified by designated uses, which include: General Use, Public and Food Processing Water Supplies, Lake Michigan, and Secondary Contact and Indigenous Aquatic Life Use (Illinois EPA 2013). The designated uses applicable to the Lake Springfield and Sugar Creek Watershed are the General Use and Public and Food Processing Water Supplies Use.

4.2.1 General Use

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

4.2.2 Public and Food Processing Water Supplies

The Public and Food Processing Water Supplies Use is defined by IPCB as standards that are "cumulative with the general use standards of Subpart B and must be met in all waters designated in Part 303 at any point at which water is withdrawn for treatment and distribution as a potable supply or for food processing."

4.3 Illinois Water Quality Standards

To make 303(d) listing determinations for aquatic life uses, Illinois EPA first collects biological data and if these data suggest that impairment to aquatic life exist, a comparison of available water quality data with water quality standards will then occur. For public and food processing water supply waters, Illinois EPA compares available data with water quality standards to make impairment determinations. **Tables 4-1** and **4-2** present the numeric water quality standards of the potential causes of impairment for both lakes and streams in the Lake Springfield and Sugar Creek watershed. Only constituents with numeric water quality standards will have TMDLs developed at this time.

Table 4-1 Summary of Numeric Water Quality Standards for Lakes and Reservoirs in the Lake Springfield and Sugar Creek Watershed

Parameter	Units	General Use Water Quality Standard	Regulatory Reference	Public and Food Processing Water Supplies	Regulatory Reference
Total Phosphorus	mg/L	0.05[1]	302.205	No numeric standard	NA

mg/L = milligrams per liter
NA = Not Applicable
(1) Standard applies to inland lakes and reservoirs (greater than 20 acres) and in any stream at the point where it enters any such lake or reservoir.

Table 4-2 Summary of Numeric Water Quality Standards for Streams in the Lake Springfield and Sugar Creek Watershed

Parameter	Units	General Use Water Quality Standard	Regulatory Reference	Public and Food Processing Water Supplies	Regulatory Reference
Boron (total)	µg /L	Acute standard = 40,100 Chronic standard = 7,600	302.208(e)	1,000	302.304

µg/L = micrograms per liter

4.4 Water Quality Targets

As mentioned in Section 1.2, Illinois EPA began including LRSs in TMDL watershed projects in 2012 for pollutants that do not currently have a numeric water quality standards. Developing an LRS involves determining the loading capacity and load reduction necessary that is needed in order for the water body to meet "Full Use Support" for its designated uses. The load capacity is not divided into WLA, LA, or MOS, these are represented by one number as a target concentration for load reduction within each unique watershed. The LRS provides guidance (with no regulatory requirements) for voluntary nonpoint source reduction efforts by implementing agricultural and urban stormwater BMPs.

The LRS targets are based on data from all stream segments within the HUC-10 basins of the watershed, as well as stream segments or lakes which closely border the watershed in neighboring HUC-10 basins, in order to best represent the land use, hydrologic, and geologic conditions unique to the watershed. Load reduction targets were calculated by Illinois EPA using data from stream segments whose most current assessment shows full support for aquatic life and data that has passed quality assurance and quality checks within Illinois EPA and are in accordance with state and federal laws. Applicable LRS target values developed by Illinois EPA for the Lake Springfield and Sugar Creek watershed are provided in **Table 4-3**.

Table 4-3 LRS Target Values for the Lake Springfield and Sugar Creek Watershed

Segment Name	Segment ID	Potential Causes of Impairment	LRS Target Value
Sugar Creek	EOA-04 & EOA-06	Total Phosphorus	0.739 mg/L
Hoover Branch	EOAD-11	Sedimentation & siltation	23.1 mg/L (non-volatile suspended solids)
Lake Springfield	REF	Total Suspended Solids (TSS)	19 mg/L
		Aquatic Algae	n/a[1]

[1] Aquatic algae is directly related to excess nutrients and are addressed through the total phosphorus TMDL developed for Lake Springfield.

4.5 Potential Pollutant Sources

In order to properly address the conditions within the watershed, potential pollutant sources must be investigated for the pollutants where TMDLs will be developed. The following is a summary of the potential sources associated with the listed potential causes for the 303(d) listed segments in this watershed.

Table 4-4 Impaired Water Bodies in Lake Springfield and Sugar Creek Watershed

Segment ID	Segment Name	Potential Causes of Impairment	Potential Sources (as identified by the 2012 303(d) list)
EOA-01	Sugar Creek	**Boron***	Industrial Point Source Discharges
EOA-04	Sugar Creek	*Phosphorus (Total)*	Municipal Point Source Discharges, Crop Production, Septic Systems[3]
EOA-06	Sugar Creek	**Boron***	Industrial Point Source Discharges
		Phosphorus (Total)	Municipal Point Source Discharges, Crop Production
EOAD-11	Hoover Branch	*Sedimentation/ Siltation*	Urban Runoff/Storm Sewers, Crop Production
REF	Lake Springfield	**Phosphorus (Total)**	Crop Production[1], Golf Courses, Runoff from Forest/Grassland/Parkland
		TSS	Crop Production[1], Golf Courses, Littoral/shore Area Modifications, Other Recreational Pollution Sources, Runoff from Forest/Grassland/Parkland, Urban Runoff[3]
		Aquatic Algae[2]	Crop Production[1], Golf Courses, Runoff from Forest/Grassland/Parkland

Bold Causes of Impairment have numeric water quality standards and TMDLs were calculated where appropriate. *TMDLs for boron in Sugar Creek were not developed as the impairment is being addressed through the National Pollution Discharge Elimination System (NPDES) permitting program. See further discussion in Sections 5, 7, 8 and 9. Italicized Causes of Impairment do not have numeric water quality standards and LRSs were developed where appropriate. Some italicized causes of impairment did not have a LRS developed as it is likely that implementing strategies to reduce the loading of other parameters of concern (e.g. reducing phosphorus loading to lakes) will result in reduced loading of additional parameters of concern (e.g. aquatic algae in lakes).

1 Potential source not shown in 303(d) list tables.

2 Although algae is not a pollutant, it has been listed as a cause of impairment. Excess algae is often linked to high nutrient levels and its presence depletes oxygen levels in lakes leading to eutrophication.

3 Potential sources identified through the TMDL process not included in 303(d) listing documentation

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Section 5

Lake Springfield and Sugar Creek Watershed Characterization

In order to further characterize the Lake Springfield and Sugar Creek watershed, a wide range of data were collected and reviewed. Water quality data for impaired stream segments in the Sugar Creek watershed and for Lake Springfield, as well as information on potential point and nonpoint sources within the watershed, were compiled from a number of data sources. This information is presented and discussed in further detail in the remainder of this section.

5.1 Water Quality Data

Data from a total of 15 historical water quality stations located on Lake Springfield, and on impaired stream segments within the Lake Springfield and Sugar Creek watershed, were identified and reviewed for this report. Water quality data used in this report were primarily provided by the Illinois EPA and Springfield CWLP; however, some additional water quality data produced by USGS and other sources were pulled from USEPA's Storage and Retrieval (STORET) database. Co-located stations and stations within close proximity of each other were combined for use in this report. **Figure 5-1** shows the water quality data stations within the watershed that contain data relevant to the impaired segments.

The impaired water body segments in the Lake Springfield and Sugar Creek watershed were presented in **Section 1**. Refer to **Table 1-1** for impairment information specific to each segment. The following sections address both stream and lake impairments to be addressed in this TMDL report. Data are summarized by impairment and discussed in relation to the relevant Illinois numeric water quality standard. Data summaries provided in this section include all available date ranges of collected data, in some cases dating back to the late 1970s. However, data analyses used to support TMDL development in Sections 7 and 8 was limited to a subset of more reliable, recently collected datasets. The information presented in this section is a combination of USEPA STORET database and Illinois EPA database data. The following sections will first discuss data for the impaired stream segments in the watershed followed by data for Lake Springfield.

5.1.1 Stream Water Quality Data

There are four impaired stream segments (**Figure 5-1**) within the Lake Springfield and Sugar Creek Watershed (including the portion of the Sugar Creek watershed downstream of the Lake Springfield dam): Sugar Creek segments EOA-01, EOA-04, and EOA-06, and Hoover Branch segment EOAD_11. Two of the stream segments (EOA-01 and EOA-06) have causes of impairment based on a constituent (boron) with numeric water quality standards that are typically addressed through the development of a TMDL. Segments EOA-04 and EOA-06 of Sugar Creek are listed for impairment by total phosphorus and Segment EOAD-11 of Hoover Branch is impaired by sedimentation/siltation. There are currently no numeric criteria established in Illinois for total phosphorus or sedimentation/siltation in streams and therefore, LRSs were developed for these parameters in lieu of a TMDL assessment.

The source of excess boron in segments EOA-01 and EOA-06 of Sugar Creek has been identified by Illinois EPA as an industrial point source discharge in the watershed. Although these impairments will be addressed through the NPDES permitting program, a data summary and inventory of the boron impairments in this watershed are included in this report. All historical water quality data for the impaired segments in the Lake Springfield and Sugar Creek Watershed are available in **Appendix B**.

5.1.1.1 Boron in Sugar Creek

Sugar Creek segments EOA-01 and EOA-06 are listed for impairment of the aquatic life use by elevated boron concentrations. **Table 5-1** summarizes available historical boron data for these segments. The current general use water quality standards include both an acute and a chronic limit for total boron concentrations. The chronic standard for total boron is 7,600 µg/L (7.6 mg/L), which shall not be exceeded by the arithmetic average of at least four consecutive samples collected over at least 4 days. The acute standard of 40,100 µg/L (40.1 mg/L) shall not be exceeded at any time. However, adjusted standard 94-9 (enacted December 1, 1994) applies varying local limits to two sections of Sugar Creek that encompass both impaired segments. The adjusted standard sets a limit of 11,000 µg/L (11 mg/L), and applies to the section of Sugar Creek from the Lake Springfield dam to the Springfield Metro Sanitary District –Sugar Creek Sewage Treatment Plant-(STP) outfall. This section of Sugar Creek includes much of impaired segment EOA-01 and the 11,000 µg/L standard is currently in effect. Adjusted standard 94-9 once applied a local limit of 5,500 µg/L for total boron to the section of Sugar Creek from the outfall to the confluence with the Sangamon River, which includes segment EOA-06. This adjusted standard has since been eclipsed by the newly adopted General Use standards of 7,600 µg/L chronic and 40,100 µg/L acute, enacted May 21, 2009.

The summary of data presented in **Table 5-1** reflects all available total boron data for segments EOA-01 and EOA-06. The available dataset for segment EOA-01 is fairly robust with 160 samples collected from 1980-2008. However, the 2008 sample represents the most recent available data at the time of the Stage 1 report. A total of 10 of the total boron samples collected during this time period exceed the currently applicable standard for this segment of 11,000 µg/L. Exceedances for total boron occur throughout the dataset's period of record (**Figure 5-2**).

Table 5-1 Existing Total Boron Data for the Lake Springfield and Sugar Creek Watershed Impaired Stream Segments

Segment	Monitoring Locations	Illinois Water Quality Standard (µg/L)*	Period of Record and Number of Data Points	Mean	Max	Min	Number of Exceedances
Sugar Creek EOA-01	EOA-01 EOA-SS-A1	11,000	1980-2008; 160	3,988	17,000	49	10
Sugar Creek EOA-06	EOA-SS-C2 EOA-SS-C1	7,600	1996; 2	3,600	4,100	3,100	0

*Adjusted standard 94-9 applies to these segments of Sugar Creek. This standard is 11,000 µg/L from the Lake Springfield dam to the Sugar Creek Wastewater Treatment Plant outfall along segment EOA-01 and is currently in effect. An adjusted standard of 5,500 µg/L was once applied to the section of Sugar Creek from the outfall to the confluence with the Sangamon River, which includes segment EOA-6. This adjusted standard has since been eclipsed by the newly adopted General Use standards of 7,600 µg/L chronic and 40,100 µg/L acute.

Data availability for total boron collected from segment EOA-06 was limited to a single facility related stream survey (FRSS) conducted August 8-9, 1996. Both analytical results for total boron collected were in excess of the standard of 1,000 µg/L applicable to that segment at the time of the FRSS event. However, neither sample result was in excess of the adjusted standard of 5,500 µg/L or the currently applicable general use standards of 7,600 µg/L (chronic) and 40,100 µg/L (acute). Based on the available dataset and the currently applicable water quality standards, segment EOA-06 of Sugar Creek should be considered for delisting of impairment due to total boron.

5.1.1.2 Total Phosphorus in Sugar Creek

Sugar Creek segments EOA-04 and EOA-06 are listed for impairment of the aquatic life designated use caused by elevated total phosphorus concentrations. There is not a numeric water quality standard for total phosphorus in streams. Illinois EPA has developed a watershed-specific target value of 0.739 mg/L of total phosphorus to aid in LRS development for this impairment.

A total of six total phosphorus sample results exist for segment EOA-04 of Sugar Creek. Three samples were collected in the summer and fall of 2003. Three additional samples were collected along with other data to assess habitat quality and aquatic life quality in May through October of 2008 as a part of the most recent Intensive Basin Survey performed by Illinois EPA in this watershed. Data availability for total phosphorus collected from segment EOA-06 was limited to a single FRSS conducted August 8-9, 1996. Both analytical results for total phosphorus exceeded the target value. A summary of the available total phosphorus data for both impaired segments of Sugar Creek is provided in **Table 5-2** and presented graphically in **Figure 5-3**.

Table 5-2 Total Phosphorus Data for the Lake Springfield and Sugar Creek Watershed Impaired Stream Segments

Segment	Monitoring Locations	LRS Target Value (mg/L)	Period of Record and Number of Data Points	Mean (mg/L)	Max (mg/L)	Min (mg/L)	Number of Exceedances of Target Value
Sugar Creek EOA-04	EOA-04	0.739	2003-2008; 6	0.422	0.656	0.132	0
Sugar Creek EOA-06	EOA-SS-C2 EOA-SS-C1	0.739	1996; 2	1.07	1.20	0.940	2

5.1.1.3 Sedimentation and Siltation in Hoover Branch

Hoover Branch Segment EOAD-11 is listed for impairment of the aquatic life designated use as a result of excessive sedimentation and siltation. No numeric standard exists for sedimentation and siltation in streams; however, Illinois EPA has developed a watershed-specific LRS target value to address sedimentation and siltation impairments that is based on the instream concentrations of non-volatile suspended solids (NVSS). The LRS target value developed for sedimentation and siltation in stream segments within the Lake Springfield and Sugar Creek watershed is 23.1 mg/L of NVSS. Although a target value for NVSS has been established for streams in the watershed, no NVSS data have been collected for segment EOAD-11 of the Hoover Branch.

Illinois EPA's protocol for addressing impairments that are associated with narrative standards such as sedimentation and siltation was developed after publication of the initial Stage 1 TMDL report for this watershed. As a result, additional data collection to address LRS impairments was not conducted. Due to the lack of site-specific water quality data for this impairment, percent reductions needed to meet LRS target values are not provided in this report. Discussion of possible load reduction strategies for reducing sediment loads in this segment is included in the implementation plan provided in Section 9 of this report.

5.1.2 Lake Springfield Water Quality Data

Lake Springfield is listed for impairment of aesthetic quality by total phosphorous, TSS, and excess aquatic algae. Total phosphorus and TSS data are available from five separate water quality sampling locations distributed across Lake Springfield (see **Figure 5-1**). Data specifically collected to assess aquatic algae is not available; however, this impairment is directly related to excess nutrients and is addressed through the total phosphorus TMDL and associated implementation plan. An inventory of all available data associated with the impairments in Lake Springfield is presented in **Table 5-3**. This table includes data collected at all available sample depths as well as sample results reported as alternate forms of phosphorus (dissolved and in bottom deposits) that may be useful in model calibration but are not directly relatable to the water quality standard.

Table 5-3 Lake Springfield Data Inventory for Impairments

Lake Springfield Segment REF; Sample Locations REF-1, REF-2, REF-3, REF-5, and REF-6		
REF-1 (Station REF-1)	**Period of Record**	**Number of Samples**
Phosphorus, Total	2001-2013	83
Phosphorus, Dissolved	2002-2013	47
Phosphorus in Bottom Deposits	2005-2005	1
TSS	2000-2013	264
REF-2 (Station REF-2)		
Phosphorus, Total	2002-2013	42
Phosphorus, Dissolved	2002-2013	22
TSS	2000-2013	178
REF-3 (Station REF-3)		
Phosphorus, Total	2001-2013	53
Phosphorus, Dissolved	2002-2013	22
Phosphorus in Bottom Deposits	2005-2005	1
TSS	2000-2013	217
REF-5 (Station REF-5)		
Phosphorus, Total	2012-2013	8
Phosphorus, Dissolved	2012-2013	8
TSS	2000-2013	150
REF-6 (Station REF-6)		
Phosphorus, Total	2012-2013	8
Phosphorus, Dissolved	2012-2013	8
TSS	2000-2013	150

5.1.2.1 Total Phosphorus in Lake Springfield

The applicable water quality standard for total phosphorus in Lake Springfield is 0.05 mg/L. Compliance with the total phosphorus standard is assessed using samples collected at a 1-foot depth from the lake surface. The average total phosphorus concentrations at a 1-foot depth for each year of available data at each monitoring site in Lake Springfield are presented in **Table 5-4**.

Table 5-4 Sample Counts, Exceedances of Water Quality Standard (0.05 mg/L), and Average Total Phosphorus Concentrations (mg/L) in Lake Springfield at 1-Foot Depth

Year	REF-1		REF-2		REF-3		REF-5		REF-6		Lake Average	
	Data Count; Number of Exceedances	Avg	Data Count; Number of Exceedances	Avg	Data Count; Number of Exceedances	Avg	Data Count; Number of Exceedances	Avg	Data Count; Number of Exceedances	Avg	Data Count; Number of Exceedances	Avg
2001	6; 6	0.31			6; 6	0.42					12; 12	0.36
2002	9; 9	0.23	4; 4	0.14	9; 9	0.23					22; 22	0.21
2005	5; 5	0.43	5; 5	0.41	5; 5	0.54					15; 15	0.46
2006	5; 5	0.49	5; 5	0.44	5; 5	0.49					15; 15	0.47
2007	5; 5	0.41	5; 5	0.43	5; 5	0.48					15; 15	0.44
2008	5; 5	0.24	5; 5	0.25	5; 5	0.23					15; 15	0.24
2009	5; 5	0.26	5; 5	0.26	5; 5	0.26					15; 15	0.26
2011	5; 5	0.26									5; 5	0.26
2012	4; 4	0.43	5; 5	0.40	5; 5	0.47	4; 4	0.61	4; 4	0.69	22; 22	0.51
2013	4; 4	0.26	8; 8	0.27	7; 7	0.35	4; 4	0.26	4; 4	0.28	27; 27	0.29

All of the available sample data for total phosphorus collected at 1-foot depth in Lake Springfield exceeded the total phosphorous water quality standard of 0.05 mg/L, often by a large margin. Total phosphorus concentrations were consistently high and average values are a number of times higher than the water quality standard for all sampling stations on Lake Springfield (**Figure 5-4**).

Table 5-5 contains information on data availability for other parameters that may be useful in data needs analysis and future modeling efforts for phosphorus TMDL development for Lake Springfield. The inventory presented in **Table 5-5** represents data collected at all depths within the lake. Springfield CWLP regularly collects water quality information from Lake Springfield in cooperation with the Illinois EPA's Volunteer Lake Monitoring Program. Data collected includes vertical profiles of temperature and dissolved oxygen concentrations at various locations throughout the lake. The Springfield CWLP dataset goes back over 20 years, and much of the data has yet to be digitized, validated, and incorporated into the basin-wide water quality database. All relevant and usable data in the Springfield CWLP dataset collected since 2000 have been utilized as appropriate during TMDL development. A summary of incorporated data points and periods of record for the CWLP dataset are included along with the Illinois EPA data in the table below (**Table 5-5**).

A data inventory for additional phosphorus and suspended sediment data collected in 2012-2013 near the confluences of Lake Springfield and three major tributaries (Sugar Creek EOA-98, Lick Creek EOAA-04, and Polecat Creek EOAE-04) are also included in **Table 5-5**. While not directly related to impaired stream segments, this data is useful in providing nutrient and sediment inflow estimates into the lake. The relative locations of each of the tributary sampling stations are also shown in **Figure 5-1**.

Table 5-5 Lake Springfield Data Availability for Data Needs Analysis and Future Modeling Efforts

Lake Springfield Segment REF; Sample Locations REF-1, REF-2, REF-3, REF-5, and REF-6		
REF-1	**Period of Record**	**Number of Samples**
Chlorophyll a, corrected	2000-2013	88
Depth, bottom	2002-2005	16
Dissolved Oxygen	2000-2013	2265
Temperature, Water	2000-2013	2264
REF-2		
Chlorophyll a, corrected	2002-2013	43
Depth, bottom	2005-2005	3
Dissolved Oxygen	2000-2013	1733
Temperature, Water	2000-2013	1732
REF-3		
Chlorophyll a, corrected	2000-2013	78
Depth, bottom	2005-2005	3
Dissolved Oxygen	2000-2013	1102
Temperature, Water	2000-2013	1104
REF-5		
Dissolved Oxygen	2000-2013	714
Temperature, Water	2000-2013	715
REF-6		
Dissolved Oxygen	2000-2013	822
Temperature, Water	2000-2013	822
Lake Springfield Tributaries; Sample Locations EOA-98, EOAA-04, and EOAE-04		
Sugar Creek (EOA-98)		
Phosphorus, Total	2012-2013	10
Phosphorus, Dissolved	2012-2013	10
Total Suspended Solids (TSS)	2012-2013	10
Lick Creek (EOAA-04)		
Phosphorus, Total	2012-2013	10
Phosphorus, Dissolved	2012-2013	10
Total Suspended Solids (TSS)	2012-2013	10
Polecat Creek (EOAE-04)		
Phosphorus, Total	2012-2013	9
Phosphorus, Dissolved	2012-2013	9
Total Suspended Solids (TSS)	2012-2013	9

5.1.2.2 TSS in Lake Springfield

The watershed-specific LRS target value for TSS in Lake Springfield is 19 mg/L. The average TSS concentration for each year of available data at each monitoring site in Lake Springfield are presented in **Table 5-6.** TSS concentrations in excess of the LRS target value occur frequently across all years, especially at monitoring locations in the upper portion of the reservoir (REF-3, REF-5, REF-6) as shown in **Figure 5-5**.

Table 5-6 TSS Sample Counts, Exceedances of LRS Target Value (19 mg/L), and Average TSS Concentrations (mg/L) in Lake Springfield

	REF-1		REF-2		REF-3		REF-5		REF-6		Lake Average	
Year	Data Count; Number of Exceedances	Avg	Data Count; Number of Exceedances	Avg	Data Count; Number of Exceedances	Avg	Data Count; Number of Exceedances	Avg	Data Count; Number of Exceedances	Avg	Data Count; Number of Exceedances	Avg
2000	16; 0	11.7	15; 6	19.8	16; 9	25.4	11; 8	32.2	11; 7	31.4	69; 30	23.0
2001	22; 0	11.2	13; 3	27.1	25; 17	47.1	13; 11	37.6	13; 11	38.9	86; 42	32.2
2002	55; 19	19.8	23; 9	31.0	35; 27	36.3	13; 13	48.1	13; 12	49.6	139; 80	31.2
2003	25; 0	9.4	13; 2	15.6	25; 18	54.9	13; 10	35.3	13; 10	55.2	89; 40	33.6
2004	15; 1	10.2	11; 2	15.0	13; 8	24.4	11; 10	36.8	11; 11	30.9	61; 32	22.6
2005	43; 2	11.3	20; 6	15.2	20; 14	25.3	12; 11	32.5	12; 8	28.5	107; 41	19.0
2006	11; 1	8.5	11; 2	14.1	11; 9	21.1	11; 11	34.5	11; 10	27.9	55; 33	21.2
2008	11; 0	13.0	11; 4	16.8	11; 8	30.4	11; 10	40.0	11; 9	83.7	55; 31	36.8
2009	16; 1	10.9	16; 1	12.5	16; 5	16.8	11; 8	20.9	11; 7	20.7	70; 22	15.7
2010	11; 0	12.0	11; 0	13.7	11; 1	14.3	11; 5	20.9	11; 4	19.4	55; 10	16.1
2011	16; 2	12.3	11; 2	15.5	11; 7	21.3	11; 9	29.9	11; 8	27.4	60; 28	20.5
2012	11; 0	11.4	11; 2	15.9	11; 10	26.8	10; 9	44.0	10; 10	56.1	53; 31	30.1
2013	12; 1	12.7	12; 3	16.2	12; 11	38.1	12; 11	47.0	12; 12	63.8	60; 38	35.5

5.2 Reservoir Characteristics

Lake Springfield is located in Sangamon County, southeast of the city of Springfield. The reservoir was constructed and filled between 1931-1935 by the city of Springfield and the CWLP to provide a reliable source of drinking water as well as to provide cooling water for the city's coal-fired power plant. Lake Springfield is the largest body of water in the watershed and the largest municipally owned waterbody in Illinois with a surface area of 4,200 acres and a volume of roughly 60,000 acre feet.

In addition to capturing overland and tributary flow originating within its contributing watershed, Lake Springfield receives supplementary flow from the South Fork of the Sangamon River via the South Fork diversion. Springfield CWLP administers this diversion to help maintain the water levels in Lake Springfield during dry periods. Historical records (1999-2014) indicate that the average diversion flow is 9.32 MGD (as averaged over the entire year). During that time period, water was diverted 0 to 221 days a year with an average of 81 days per year. Additional discussion of the South Fork diversion and a figure of the diversion location is provided in **Section 7.2.3.3.**

Following a sedimentation study in 1984 (Fitzpatrick et al. 1985), portions of the lake were dredged to remove sediment that had reduced the lake's overall capacity by as much as 13 percent since its construction 50 years prior. This loss of capacity through siltation highlights a need for erosion control in the watershed. Currently, Lake Springfield has an estimated maximum depth of 24 feet and an average depth of 18 feet (**Table 5-7**).

Table 5-7 Average Depths (Feet) for Lake Springfield Segment REF

Monitoring Location	Average Depth (feet)
REF-1	21
REF-2	17
REF-3	9
REF-5	7
REF-6	8

Lake Springfield's 57 miles of shoreline is partially developed and includes more than 735 residential sites along with a number of public parks, boat docks, and launches. Lake Springfield is a popular recreational destination hosting more than 600,000 recreational visitors per year.

5.3 Point Sources

There are eight active NPDES permitted point sources located within the Lake Springfield and Sugar Creek watershed. **Table 5-8** contains permit information for these point sources while **Figure 5-5** shows the locations of outfalls for each facility.

Table 5-8 Permitted Facilities Discharging to or Upstream of Impaired Segments in the Lake Springfield and Sugar Creek Watershed

Facility ID	Facility Name	Impaired Segment
IL0021971	Springfield MSD – Sugar Creek STP	Sugar Creek EOA-01 and 06
IL0022403	Auburn STP	Sugar Creek EOA-04
IL0023426	Virden North STP	Sugar Creek EOA-04
IL0024767	Springfield CWLP	Lake Springfield, Sugar Creek EOA-01 and 06
IL0048241	Lincoln Trails Mobile Home Park	Hoover Branch
IL0050253	Lake Springfield Baptist Camp	Lake Springfield
ILG580260	Thayer STP	Sugar Creek EOA-04
ILG580275	Loami STP	Lake Springfield

Municipal separate storm sewer (MS4) permits within the watershed exist for the city of Springfield; the villages of Chatham, Grandview, and Southern View; and for Clear Lake township (**Table 5-9**). MS4 discharges have the potential to impact Lake Springfield and Sugar Creek segments EOA-1 and EOA-6. Lake Springfield is impaired for total phosphorus, which is a potential concern in storm water discharges. Nutrient data pertaining to potential MS4 discharges into Lake Springfield are included in the TMDL process. The impairments at Sugar Creek segments EOA-1 and EOA-6 are caused by elevated boron concentrations, which have been previously linked by Illinois EPA to a NPDES permitted point source and are unlikely to be influenced by storm water discharges.

Table 5-9 MS4 Permits in the Lake Springfield and Sugar Creek Watershed

Municipality	MS4 Permit Number	Permit Name	Drainage Area (Sq. Miles)
Springfield	ILR400453	Springfield, City of	61.4
Chatham	ILR400624	Chatham, Village of	5.0
Clear Lake[(1)]	ILR400555	Clear Lake Township	0.1
Grandview[(1)]	ILR400201	Grandview Village	0.3
Southern View[(1)]	ILR400246	Southern View Village	0.5

1 MS4 permittee located within the lower Sugar Creek portion of the watershed downstream of Lake Springfield.

5.4 Nonpoint Sources

A variety of nonpoint sources of pollutant loading to the impaired segments have been identified in the Lake Springfield and Sugar Creek Watershed. This section discusses factors potentially impacting nonpoint source loads such as site-specific cropping practices, animal operations, and area septic systems. Data were collected through communication with the local NRCS, Soil and Water Conservation District (SWCD), public health departments, and county tax department officials. In addition, internal nutrient loading and nutrient contributions to Lake Springfield through the South Fork diversion are discussed.

5.4.1 Crop Information

Agricultural practices are important nonpoint sources to consider in TMDL development because of their potential to contribute sediments through soil loss and erosion and nutrients through fertilization. More than 75 percent of the land found within the Lake Springfield and Sugar Creek watershed is devoted to agricultural activities. Of the agricultural lands, corn and soybean farming account for 40 percent and 35 percent of the watershed, respectively. Tillage practices can be categorized as conventional till, reduced till, mulch till, and no till. Each tillage practice leaves varying levels of crop residue after planting (see detailed discussion in Section 9). Tillage practices directly relate to water quality through their effects on soil loss. Soil can be an instream pollutant (sedimentation/siltation and TSS) and can also carry pollutants (for example, nutrients) to receiving waters. . The percentage of each tillage practice for corn, soybeans, and small grains by county are generated by the Illinois Department of Agriculture (IDA) from County Transect Surveys. Data from the 2013 survey were provided by the Sangamon County SWCD and the NRCS (**Table 5-10**).

Table 5-10 Tillage Practices in the Lake Springfield and Sugar Creek Watershed

Tillage System	Corn	Soybean	Small Grain
Conventional	73%	61%	0%
Reduced - Till	17%	7%	0%
Mulch - Till	1%	6%	0%
No - Till	9%	26%	100%

Note: Numbers taken from Spring 2013 Sangamon County SWCD Transect Survey 118 points sampled in Lake Springfield and Sugar Creek Watershed.

5.4.2 Animal Operations

Information on commercial animal operations is available from the NASS. However, only-county-wide data are available for Sangamon, Macoupin, and Morgan counties and data specific to the Lake Springfield and Sugar Creek Watershed were not available. Knowing the number of animal units in a watershed is useful in TMDL development as grazing animals have the potential to increase erosion and contribute nutrients through manure and manure spreading practices. The Lake Springfield and Sugar Creek Watershed is comprised of only small portions of each county and only rough interpolations of animal numbers are possible based on this dataset, which is available through the USDA website (http://www.nass.usda.gov/Data_and_Statistics/County_Data_Files/Livestock_County_Estimates/index.asp).

Watershed-specific data on livestock populations in Sangamon County were provided by the Sangamon County SWCD and CWLP and are based on real-time monitoring of agricultural activities within the Lake Springfield and Sugar Creek Watershed conducted as part of the Watershed Resource Plan developed for this basin. Although similar data are not available for portions of the watershed in the other two counties, the data provided in **Table 5-11** are expected to be reasonably representative of the entire watershed due to the large proportion of the watershed (87 percent) within Sangamon County. The Sangamon County SWCD notes that the livestock estimates shown in **Table 5-11** are based on discussions with several of the larger livestock producers in the watershed. The Sangamon County SWCD states that overall livestock populations in the watershed are gradually dwindling, likely due to the high cost of production and loss of grasslands due to rural urbanization.

Table 5-11 Lake Springfield and Sugar Creek Watershed within Sangamon County - Animal Population (2013 Sangamon County SWCD and CWLP Data)

Livestock Type	2013
Beef Cattle and Calves	1,200
Dairy	200
Hogs and Pigs	2,500
Poultry-Free Range	50
Sheep and Lambs	250
Horses and Ponies	800

Note: Estimates of current livestock populations provided by SCSWD and Springfield CWLP staff during a data collection/stakeholder meeting in December 2013.

5.4.3 Septic Systems

Approximately 17 percent of the Lake Springfield and Sugar Creek Watershed consists of developed or urbanized land, primarily in the Springfield Metropolitan Area. A majority of businesses, residences, and other structures in the Springfield area are served by the Springfield Metropolitan Sanitary District. Septic systems are common in rural areas of the watershed area.

A high percentage of households in rural areas of the watershed are not connected to municipal sewers and use onsite sewage disposal systems, or septic systems. Most commonly, a household septic system is composed of a septic tank that drains to a septic field, where nutrient removal occurs. However, the degree of nutrient removal is limited by soils and system upkeep and maintenance.

Septic systems have been found to be a significant source of phosphorous pollution throughout the country. Information on the extent of sewered and non-sewered residences and municipalities was obtained from the Sangamon County Health Department. Outside of the Springfield metropolitan area, Auburn, Loami, and Thayer have municipal sewer systems, while Curran and Lowder are served entirely by private systems. The Springfield Metro Sanitary District serves Springfield and surrounding areas, including Chatham, Grandview, Jerome, Leland Grove, Rochester, Sherman, and Southern View. However, health department officials indicated that some areas, particularly the areas surrounding Lake Springfield, have a mix of public and private systems.

Springfield CWLP has collected information of septic system use in properties directly adjacent to Lake Springfield. As of 2014, a total of 431 septic systems are known to exist on the marginal lands of the lake. A total of 214 of those are open systems that discharge directly to the lake. The remaining 217 septic systems adjacent to the lake are closed systems that use closed drainfields to treat wastewater biologically onsite. Currently 339 properties around the perimeter of the lake are sewered and additional sewer lines are being installed to further reduce the number of septic systems in use around the perimeter of the lake.

In addition, the Springfield Metro Sanitary District (SMSD) has an ongoing program to eliminate septic systems around Lake Springfield. The SMSD and Springfield CWLP will each provide a maximum of $5,000 toward the installation of a private pump station to be installed to pump sanitary sewage from unsewered homes and businesses to the SMSD collection system in proximity to Lake Springfield. As of April 2014, 27 individual private pump stations have been installed or permitted for installation under this program.

According to Morgan County public health department officials, within the portion of the county encompassed by the Lake Springfield and Sugar Creek Watershed, only Waverly has municipal sewage collection; other areas are served by private sewage disposal systems.

Macoupin County public health department officials indicated that, within the portion of the county encompassed by the Lake Springfield and Sugar Creek Watershed, only Virden has municipal sewage collection; other areas are served by private systems.

5.4.4 Internal Phosphorus Loading in Lakes

An additional potential nonpoint source of nutrients in Lake Springfield is lake sediments. Nutrients can be bound to soils and as soils erode throughout the drainage area, they accumulate at the bottom of downstream lakes. Internal phosphorus loading can occur when the water above the sediments becomes anoxic causing the release of phosphorus from the sediment in a form which is available for plant uptake. The addition of bioavailable phosphorus in the water column stimulates more plant growth and die-off, which may perpetuate or create anoxic conditions and enhance the subsequent release of phosphorus into the water. Internal phosphorus loading can also occur in shallow lakes through release from sediments by the physical mixing and reintroduction of sediments into the water column as a result of wave action, winds, boating activity, and other means.

5.4.5 Loading from South Fork Diversion

As discussed above, Lake Springfield receives additional flow from the South Fork of the Sangamon River via the South Fork diversion. Springfield CWLP administers this diversion to help maintain the water levels in Lake Springfield during dry periods. Historical records (1999-2014) indicate that the average diversion flow is 9.32 MGD (as averaged over the entire year). During that time period, water was diverted 0 to 221 days a year with an average of 81 days per year. Based on data from station EO-03 on the South Fork Sangamon River (2001-2008, 88 data points), the average total phosphorus concentration in South Fork Sangamon River is 0.2 mg/L with a maximum recording of 0.8 mg/L. Station EO-03 is located approximately 1 mile downstream of the point of diversion and was chosen based on data availability and period of record.

5.5 Watershed Studies and Other Watershed Information

As previously discussed, the Springfield CWLP has maintained a fairly extensive water quality assessment program on Lake Springfield for over 25 years. Much of these data have been incorporated into the watershed-wide water quality database and were taken into consideration during the TMDL development process. A number of other studies have been performed in the Lake Springfield and Sugar Creek Watershed (LSW), as described in the following timeline covering the history of the LSW[1].

1934 – Construction of Lake Springfield was completed to serve as the public drinking water supply for the City of Springfield and several surrounding communities, as well as the source of condenser cooling water for the city's coal-fired power plant.

Four sedimentation surveys (1948, 1965, 1977, and 1984) of Lake Springfield have been conducted by the ISWS for the city of Springfield since it was built.

1982 –CWLP began its Lake Springfield Watershed Maintenance and Restoration Program (LSWMRP) to:

- Remove sediment from the Lake
- Provide shoreline stabilization and watershed protection

1983 – CWLP provides cost share funds to the Sangamon County SWCD for conservation to reduce erosion and improve water quality in the LSW through their LSWMRP. It began in 1983 with the purchase of a no-till corn planter, and subsequently a no-till drill for watershed farmers to rent before investing in this expensive equipment for their farming operations. Within a few years, many farmers had made the switch to no-till/minimum till equipment and this equipment rental program was no longer needed. This cost-share program then evolved to establishment of conservation practices such as grass waterways, terraces, grade stabilization structures, dry dams, water and sediment control basins (WASCOBs) and ponds, along with stream bank stabilization, and continues to this day. Over $500,000 in assistance from CWLP has been made available to watershed producers for these conservation practices over the past 30 years and is

[1] Information provided by SCSWD, Lake Springfield and Sugar Creek Watershed Resource Planning Committee, and Springfield CWLP

administered by the Sangamon County SWCD under the same guidelines as the State of Illinois' Conservation Cost-Share Practices Program (CPP).

1984 - Lake Springfield lost over 3 billion gallons of water storage (13 percent of the lake's original volume) over the period 1934 to 1984. On average, the lake lost 50 million gallons of storage capacity a year because of the deposition of 130,000 tons of sediment a year, according to the November, 1986 "Hydrologic Investigation of the Watershed of Lake Springfield," Springfield, Illinois completed by the ISWS for the city of Springfield.

1987 – The Clean Lakes Program Phase I Diagnostic/Feasibility Study for Lake Springfield Restoration Plan, CWLP, March, 1987 identified sedimentation, nutrients and shoreline erosion as major issues for the lake and its watershed. The 3-phase lake restoration program initiated by CWLP to address these problems included:

- Establishment of a soil conservation grant program in the LSW (watershed conservation practices)
- Sediment removal from the Lake by hydraulic dredging
- Shoreline stabilization around the Lake

1986-2013 – Over 20 miles of the lake's 57 miles of shoreline, and the islands, have been cleared and stabilized with rip rap protection. Over this 28-year time period, lake homeowners have spent over $6.4 million on approximately 56,000 feet of steel seawalls. In addition, an average of $10,292 a year, totaling $288,000, has been spent on rip rap, along with other methods of stabilization, to protect their residential shorelines.

From 1987 – 1990, The City spent $7.8 million on a dredging project which:

- Removed 3.2 million cubic yards of sediment from the upper reaches of Lake Springfield, west of the I-55 bridge
- Re-established the natural sedimentation basins of the Lake and
- Restored nearly one-half billion gallons of lost storage capacity.

1990 - The Lake Springfield Watershed Resources Planning Committee (LSWRPC) was formed to address the sedimentation of Lake Springfield as its primary resource concern, followed by nutrient concerns (phosphorus and nitrogen). There was little mention of pesticide use, only concerns about the persistence of those historically used pesticides and their breakdown products (dieldrin, chloradane, and heptachlor epoxide). This group's goal was to develop and apply a comprehensive resource management plan, involving both agricultural and urban communities, which would provide a framework for the protection and improvement of Lake Springfield and its watershed. This plan has served as the guide for implementation of BMPs throughout the LSW.

1994 - There was a near violation of Illinois EPA's drinking water requirement of an average running quarterly atrazine concentration of 3 ppb or less in the finished water supply of drinking water for the City of Springfield and its customers.

1995 – An addendum to the original LSW Plan was adopted to address pesticide runoff in the LSW. Atrazine was the preferred herbicide of use because it was the most effective weed control herbicide available for corn and the most economical. At this time, the LSW was approximately a 50/50 split on corn and soybean acres and the majority of farms were under 50/50 crop lease arrangements between landowners and their tenants. The following action items adopted by LSW producers, with great cooperation from the local agricultural retailers, helped the city achieve compliance with Illinois EPA's drinking water standards:

- Implementation of a two-pass atrazine application program
- Reduction in rates of any single atrazine application
- Incorporation of alternative herbicides for corn acres
- Establishment of buffer strips
- Adoption of no-till and/or minimum till farming practices

In addition, the city's annual costs for removing atrazine with powdered activated carbon (PAC) from the lake's raw water were drastically reduced from $143,000 in 1994 to four consecutive years of $0 from 2004-2007. There were slight increases in atrazine concentrations from 2008-2011 primarily due to consecutive extremely wet years, a sizeable increase in corn-on-corn acreage, versus the traditional 50 percent corn/soybean rotation, and a significant increase in the cost of PAC. In 2012, there were zero dollars spent by CWLP to treat for atrazine. In 2013, this cost was $137,000 due to another extremely wet spring shortly after most of the herbicides had been applied to the corn fields.

1995 – Through a Section 319 grant awarded to the Sangamon County SWCD, urban erosion control practices were established in a new subdivision (Piper Glen) in the LSW. The target audience for this demonstration project was real estate developers, land contractors, home builders, home owners and the general public. Urban erosion control products such as erosion control blankets, silt fence, critical area/temporary seedings, etc. were installed to demonstrate proper installation, how these practices function, and the importance of having them in place on sites at all times prior to, during and after construction of new homes when developing new subdivisions.

1997 – A 5-year field-scale research study "Assessment of Best Management Practices' (BMPs) Effectiveness on Water Quality and Agronomic Production in the Lake Springfield and Sugar Creek Watershed" began:

- To conduct long-term research assessing BMPs on an entire watershed
- To document the effectiveness of specific BMPs for improving surface water quality
- To identify BMPs which significantly reduce movement of sediment, pesticides and nutrients from agricultural fields

Partners in this study were: USDA Agricultural Research Service, Novartis Crop Protection, Inc. (now Syngenta), USDA NRCS, IL State Water Survey, University of IL Extension, City of Springfield-CWLP, LSWRPC, and Sangamon County SWCD. Results from this study identified vegetative buffer strips and no-till farming to be the most effective BMPs in reducing soil erosion, pesticide and nutrient movement through surface water runoff from agricultural fields.

2000 – The USDA Conservation Reserve Enhancement Program (CREP) was approved for portions of 16 counties in Lower Sangamon River Basin, including all of Sangamon County and portions of Macoupin County. This program provides significant financial incentives to landowners for taking cropland that is located in the 100-year floodplain and qualifying adjacent acres out of production. In return, the landowners must establish conservation practices which will reduce soil erosion and surface water runoff (native grasses, shrubs, trees, etc.) while providing quality habitat for wildlife. These CREP contracts are for a minimum of 15 years. There are about 92 federal CREP contracts in the LSW, in addition to another 173 Conservation Reserve Program (CRP) contracts as of 4/16/2014.

2000 – The Sangamon County SWCD formed The Sangamon Conservancy Trust, an Internal Revenue Service approved 501(c)(3) not-for-profit charitable organization, which can apply for and administer grants, accept and hold conservation easements, etc. Its goals mirror those of the Sangamon County SWCD to reduce soil erosion and promote water quality, implement BMPs not funded through current programs, fund special conservation education programs, promote land stewardship and farmland protection, and conserve soil, water and related resources. This Trust currently holds eight agricultural conservation easements on 2,712 acres. Two of those easements (513 acres) are in the LSW and are protected from residential, commercial and industrial development forever. One of these easements (113 acres) is immediately adjacent to Lake Springfield and has been taken out of crop production by the landowner and planted to native grasses and trees. The other agricultural conservation easement (400 acres) is in a prime development area of the LSW. These landowners are excellent stewards of their land and have established many conservation practices such as grade stabilization structures, grassed waterways, riparian buffers and field borders on their farm.

2003 – With the 5-year BMP research study results in hand, the Sangamon County SWCD applied and received a Section 319 grant (40 percent match from city of Springfield) to establish vegetative filter strips throughout the LSW. A $200/acre incentive payment was awarded to landowners who established these filter strips through the USDA CRP program for a minimum of 15 years, instead of a normal 10-year CRP contract. Twenty-nine miles of unprotected stream corridors were protected under 75 CRP contracts, with landowners establishing about 600 acres of filter strips. Estimated total annual pollutant loadings were reduced by approximately 6,500 tons of sediment, 8,700 pounds of phosphorus, and 18,000 pounds of nitrogen. Almost 200 acres of these filter strips were along Sugar Creek, with a reduction of approximately 1,934 tons of sediment, 2,688 pounds of phosphorus, and 5,316 pounds of nitrogen. Illinois EPA is waiting on final notification from USEPA that alterations in stream-side or littoral vegetative covers and organic enrichment/dissolved oxygen will be removed as causes of impairment for Sugar Creek in the 2012 Illinois Integrated Water Quality Report.

Also to be noted was the huge shift from 50/50 crop share farm leases to cash rent per acre farm leases with landowners. Cash rents paid by producers began to sky rocket and the opportunity to farm the land in the LSW became, and is still, very competitive. Many producers who had been farming the same farm for years lost this opportunity with this shift to cash rent. Several "mega" farm operations emerged in the LSW as a result of this change. With cash rent leases, the producer has control of the farm for that year, pays for all of the crop production expenses, and receives income from the entire harvested crop, along with the USDA program payments available to that farm. Establishment of conservation practices and water quality improvement in the LSW took a back seat to crop production for several reasons:

1. No longer any direct landowner involvement in the day-to-day management of their farm.
2. The producer's need to farm every acre possible to cover the cash rent payments and crop production expenses.
3. USDA program payments became more lucrative for corn acres.
4. A major shift from a corn/soybean rotation to multiple years of planting corn-on-corn began, which means more fertilizer (nitrogen and phosphorus) and corn pesticide use.
5. Government cost-share payments (based on soil rental rates) for establishing conservation practices were not high enough to compete with cash rents per acre.
6. Significant rise in farmland prices.

2004 – The most recent sedimentation survey, "Sedimentation Survey of Lake Springfield, Springfield, Illinois," September, 2007, was conducted by the City of Springfield, CWLP, Land and Water Resources Department, indicating a seven percent decline in the erosion rate over the period 1984-2004. With a primary focus on erosion prevention through numerous federal, state, and local cost-share programs, grants and research projects to demonstrate and effectively practice erosion control, LSW producers continue to incorporate BMPs into their farm operations, which seem to be instrumental in reducing the erosion rate of the lake.

2008 – USDA approved a special grant submitted by the Sangamon County SWCD titled "Northern Bobwhite Conservation Quail Initiative" through the USDA State Acres for Wildlife Enhancement (SAFE). This CRP program enables Sangamon County landowners to establish wildlife habitat on 2,000 acres with grassland and forest practices (buffers, trees, and grasses) to benefit quail and many other grassland species, some of them on the state-listed threatened species. The target area for this grant was the LSW, where three wildlife "sanctuaries" exist. SAFE is an additional tool for landowners to help protect Springfield's public water supply. There are about 20 SAFE contracts enrolled in this USDA program in the LSW as of 4/16/2014.

2008 – Through a "Protecting Water Quality in Urban Centers of Illinois" Section 319 grant, the SCSWCD hosted an Urban Water Quality Best Management Practices Tour on 9/25/2008 for key community leaders from Springfield and Sangamon County, representing the Mayor of Springfield, Sangamon County Board, City of Springfield Aldermen, Springfield-Sangamon County Regional Planning Commission, Sangamon County Highway and Public Health Departments, Springfield Area Home Builders Association, Springfield CWLP and Public Works Department, along with federal and state agency personnel. A Certified Professional in Erosion and Sediment Control (CPESC) was the keynote speaker on this tour, discussing and demonstrating urban erosion control practices and the federal/state NPDES rules and regulations for MS4 communities such as Springfield and Sangamon County at each of the stops on the tour. The Sangamon County Sediment and Erosion Control Ordinance was approved by the Sangamon County Board on

December 9, 2008. In March, 2012, the City of Springfield amended The 1988 City of Springfield Code of Ordinances, by adding Chapter 154: Erosion Control Regulations.

2012 – The LSWRPC began work on a revision to their original 1990 LSW plan to reflect the most accurate watershed data, maps, and land use changes now available through the use of GIS technology to identify existing and new agricultural and urban resource issues and to prepare a new comprehensive management plan involving both the agricultural and urban communities. Over 60 people (farmers, fertilizer/chemical retailers, lake home owners, college instructors, conservation land contractors, farm managers and federal, state and local government representatives) are involved with this new planning effort. Twenty agricultural issues and 17 urban issues have been identified by the LSWRPC, many of them the same as those identified in the 1990 LSW plan. Development and implementation of specific strategies to find solutions for the identified resource issues remains the task of the LSWRPC as it was back in 1990.

2012 –Land Use Plan for Lake Springfield and Its Marginal Properties, February 1991 was revised in 2005 and again in 2012 to keep current the defined uses and guidance for the management of lake lands and its marginal lands. This plan provides for five land use categories: administrative, leased, parks and recreational, green space and wildlife preserves. Each category has a specific list of activities which are allowed. CWLP plans to limit development around the Lake and dedicate unleased lands for public uses as green spaces and natural areas. The guidelines developed in this plan are based on CWLP's priorities for Lake Springfield in order of importance:

1. Protection of the quality of the water.
2. Retention of the storage capacity of the lake.
3. Preservation of the aesthetics and the unique character of the lake and its environs.
4. Provision of residential and recreational opportunities.

2013 – The city of Springfield was awarded a Priority Lake and Watershed Improvement Project grant from Illinois EPA to help reduce sediment runoff and nutrient loading into the Lake. Rip rap was installed on 2,756 feet of highly visible, highly eroded Lake Springfield shoreline at the confluence of Lick and Sugar Creeks, which traps over 50 percent of the incoming sediment to the lake. This project reduced phosphorus loading by 453 pounds, nitrogen by 904 pounds, and sediment load reduction by 453 tons per year.

2013 – A special 3-year nitrogen management program and study began through a partnership with the Illinois Council on Best Management Practices, city of Springfield, CWLP, Sangamon County SWCD, Lincoln Land Community College, local agricultural retailers and LSW producers to reduce the nitrate-N concentration in Lake Springfield. The goal of this project is to maintain the nitrate-N concentration in Lake Springfield at 50 percent below Illinois EPA's drinking water standard of 10 parts per million throughout the year. This study will work with local agricultural retailers and producers to identify nitrate-N levels in their crop fields and show them how to minimize environmental impact, optimize harvest yield and maximize input utilization. A multiple application approach to N management utilizing the 4-Rs of nutrient management (Right source, Right rate, Right time and Right place) will minimize the risk of nitrogen loss prior to crop utilization. Establishment of cover crops for nitrogen fixation, soil erosion control, and other water quality benefits will also be part of this project. Primary funding sources for this project are provided by the National Fish and Wildlife Foundation and the City of Springfield's CWLP.

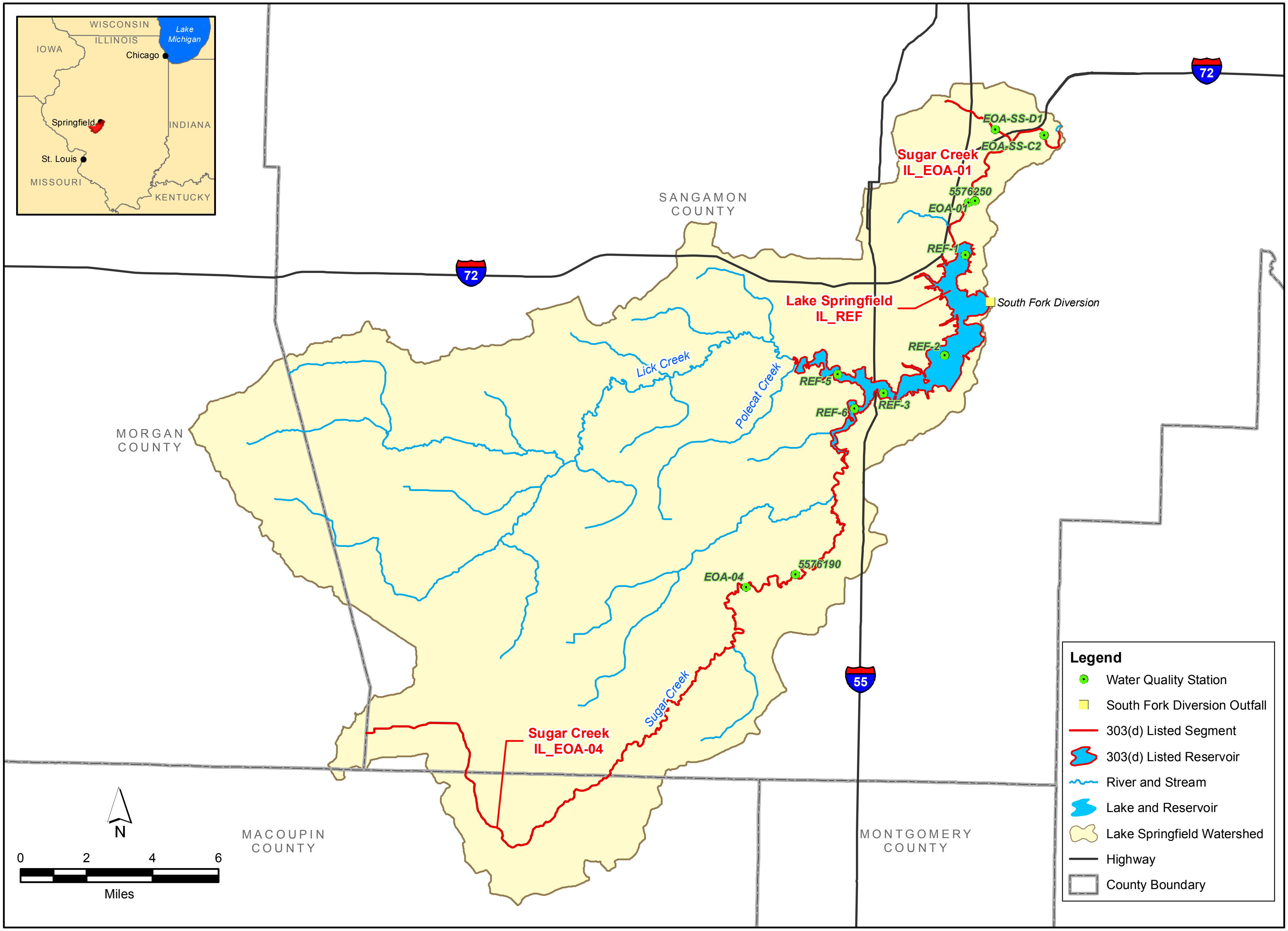
2013 – A Lake Springfield and Sugar Creek Watershed BMP Implementation Section 319 grant proposal was submitted to Illinois EPA for the implementation of agricultural and urban BMPs throughout the LSW. This project will implement recommendations from the 1990 LSW Resource Plan 2012 Revision and the 1987 Lake Springfield Diagnostic Feasibility Study to improve the water quality of Lake Springfield and its watershed by:

- Reducing nonpoint source pollution
- Controlling soil erosion, and
- Reducing nutrient and sediment loadings

While Sugar Creek sub-watershed will be the primary target area, BMPs will be implemented throughout the entire watershed. NRCS technical staff will assist with inventory and evaluation, survey and design of agricultural BMPs. The Illinois Council on Best Management Practices and local agricultural retailers will work with LSW producers to develop and implement nitrogen management systems utilizing the N-WATCH program and establishment of cover crops. Nutrient management plans and additional cover crops are important BMPs in this grant to address two of the sources of impairments (nitrates and phosphorus).

2013 – An Illinois Green Infrastructure Grant proposal was submitted to Illinois EPA for implementation of urban BMPs at the Ball-Chatham School District #5 Middle School complex. This school complex is immediately adjacent to Lake Springfield. BMPs to be installed are porous pavement parking lots, dissipaters, bioswales, and shoreline stabilization with rock rip rap.

2013 – A TMDL study for five impaired water body segments of the LSW, including Lake Springfield, three segments of Sugar Creek and the Hoover Branch segment north of Spaulding Dam, was initiated by Illinois EPA. Potential causes of impairment are total phosphorus, boron, TSS, and sedimentation/siltation. The first draft TMDL Stage 1 Report was made public at an information meeting held on March 27, 2014. Personnel from the city of Springfield, CWLP, and Sangamon County SWCD have taken an active role in reviewing the information in this report for completeness and accuracy and provided their comments to Illinois EPA. This group will continue to work closely with Illinois EPA throughout the TMDL development process and implementation planning.



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Lake Springfield and Sugar Creek Water Quality Stations

FIGURE 5-1

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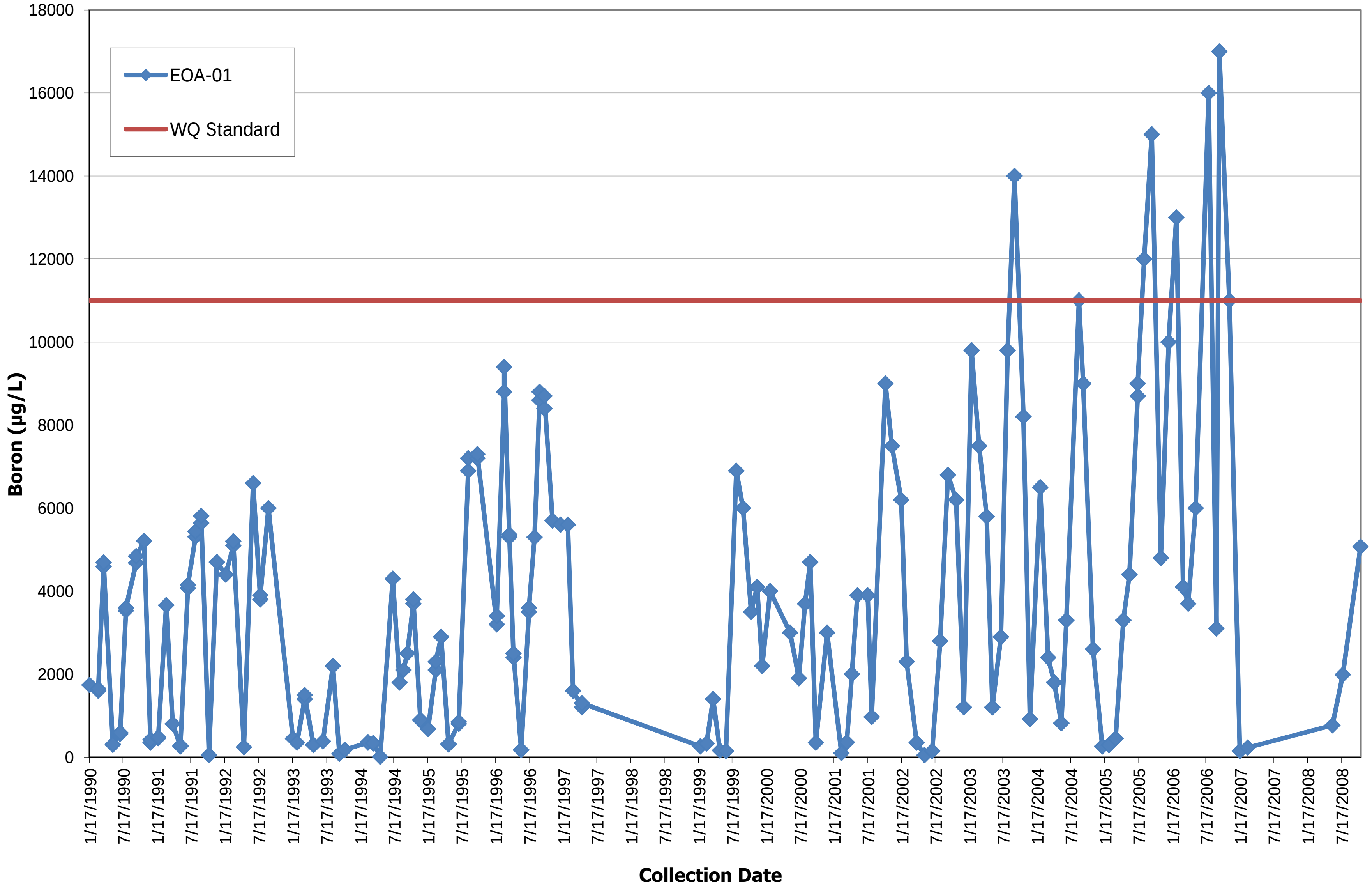

Figure 5-2
Total Boron
Sugar Creek Segment EOA-01

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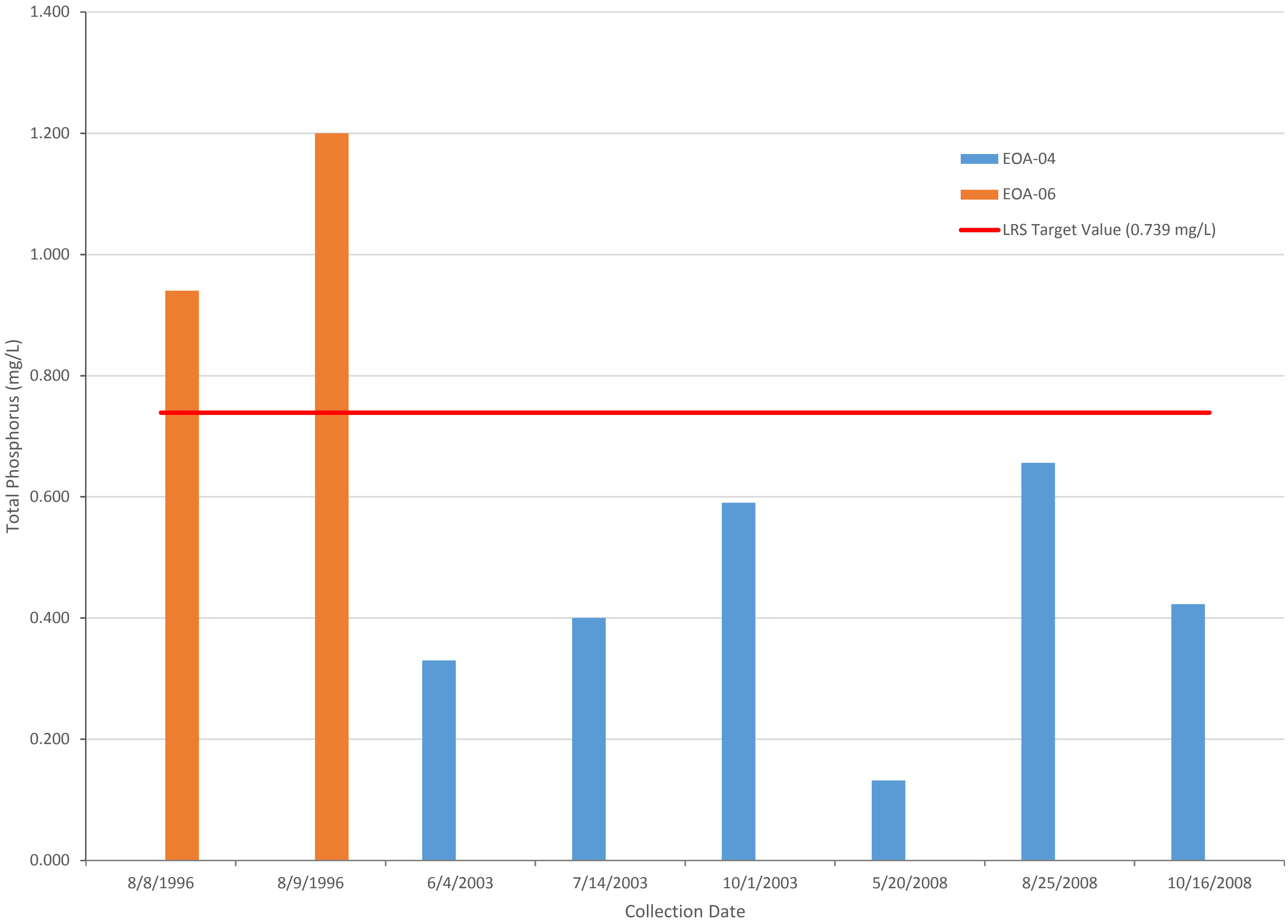

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Figure 5-3
Total Phosphorus
Sugar Creek Segments EOA-04 and EOA-06

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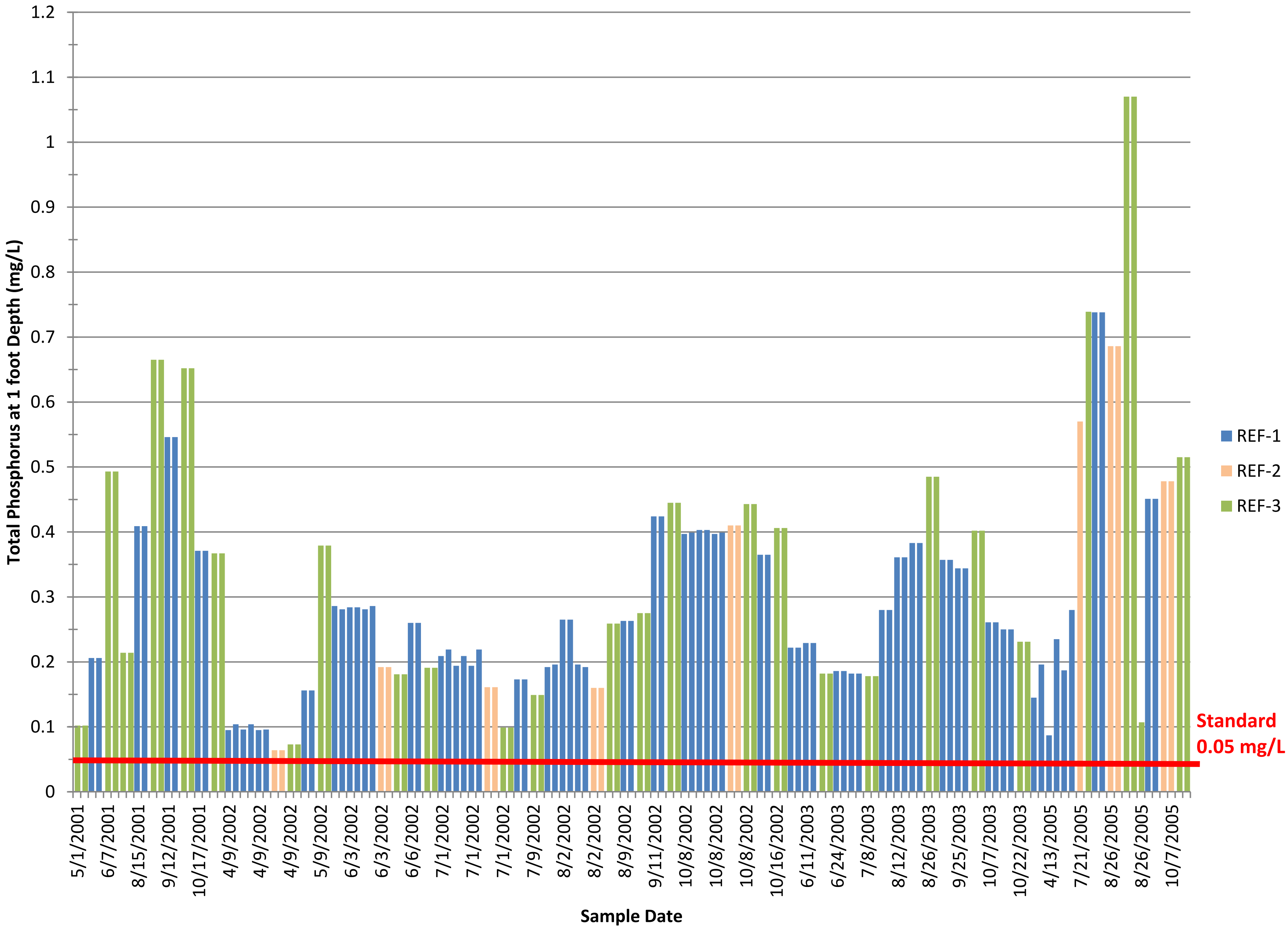

Figure 5-4
Total Phosphorus at 1-Foot Depth
Lake Springfield (REF)

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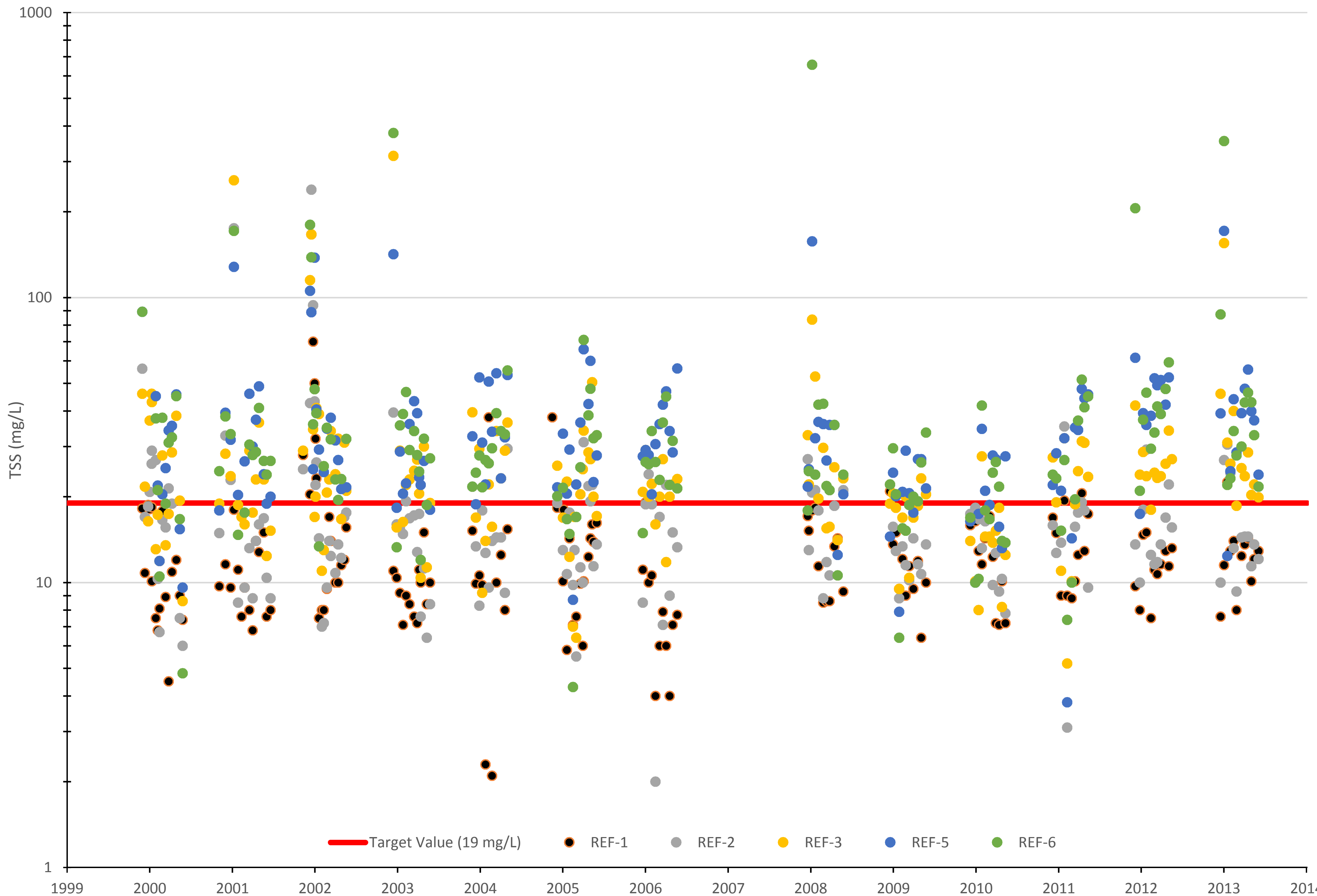

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Figure 5-5
Total Suspended Solids (TSS)
Lake Springfield

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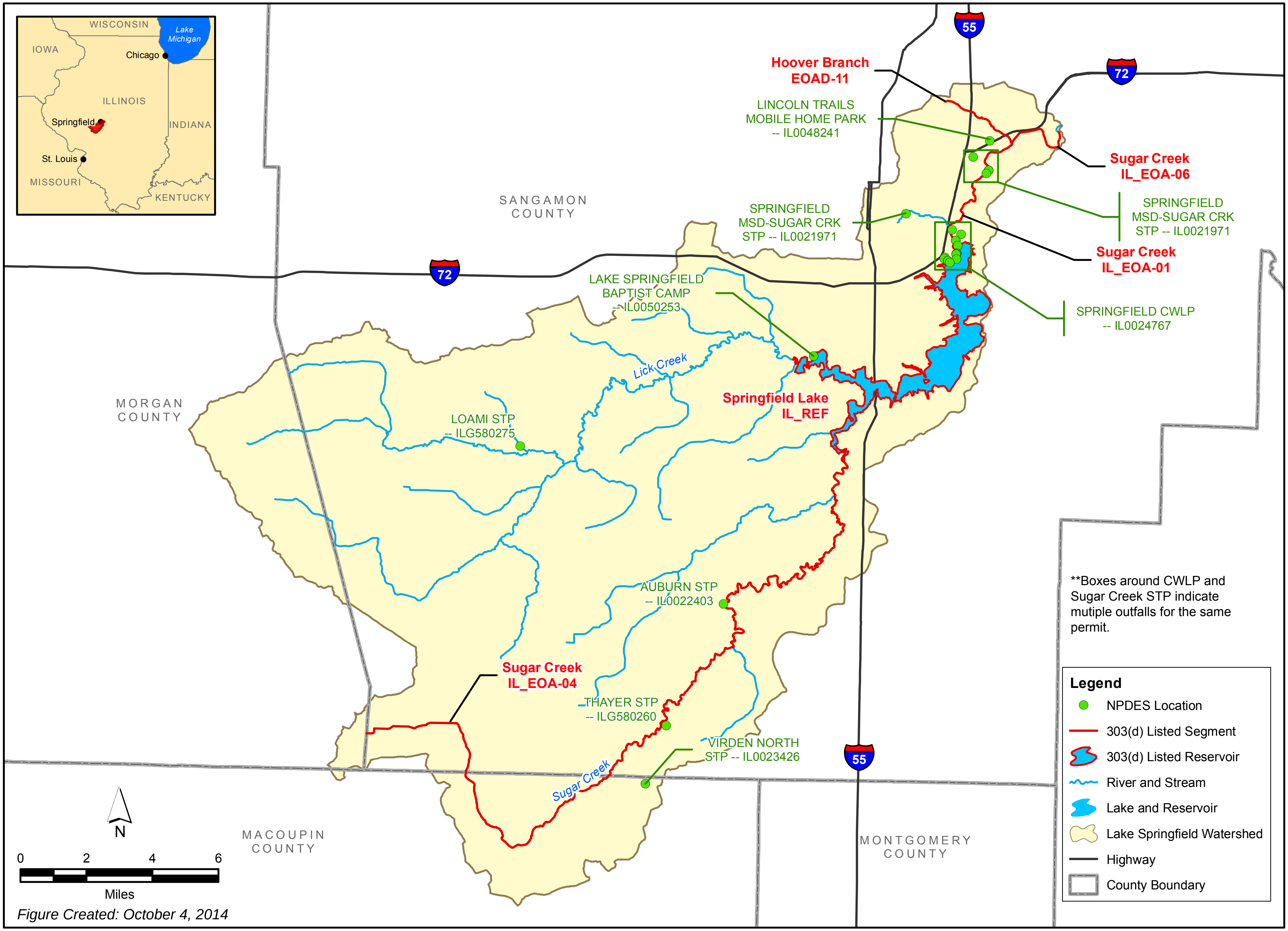

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Lake Springfield and Sugar Creek NPDES Locations

FIGURE 5-6

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Section 6

Approach to Developing TMDLs and Identification of Data Needs

Illinois EPA is currently developing TMDLs for pollutants that have numeric water quality standards. The impairments to stream segments in the Lake Springfield and Sugar Creek watershed are attributed to boron, total phosphorus, and sedimentation/siltation, and numeric water quality standards currently only exist for boron in stream segments. Lake Springfield is listed for impairment by total phosphorus and TSS; however, numeric water quality standards currently only exist for total phosphorus in lakes and reservoirs (refer to **Table 1-1** for a full list of potential causes of impairment). Illinois EPA believes that addressing the parameters with numeric standards should lead to an overall improvement in water quality due to the interrelated nature of the other listed pollutants. Additional analyses were completed for total phosphorus in streams and TSS in Lake Springfield. The recommended technical approaches for developing TMDLs and LRSs for streams and lakes are presented in this section. Additional data needs are also discussed.

6.1 Simple and Detailed Approaches for Developing TMDLs

The range of analyses used for developing TMDLs varies from simple to complex. Examples of a simple approach include mass-balance, load-duration, and simple watershed and receiving water models. Detailed approaches incorporate the use of complex watershed and receiving water models. Simplistic approaches typically require less data than detailed approaches and therefore these are the analyses recommended for the watershed. Establishing a link between pollutant loads and resulting water quality is one of the most important steps in developing a TMDL. As discussed above, this link can be established through a variety of techniques. The objective of the remainder of this section is to recommend approaches for establishing these links for the constituents of concern in the Lake Springfield and Sugar Creek Watershed.

6.2 Approaches for Developing TMDLs and LRSs for Stream Segments in Lake Springfield and Sugar Creek Watershed

6.2.1 Recommended Approach for Boron in Sugar Creek Segments EOA-01 and EOA-06

Table 6-1 contains summary information regarding data availability for the boron impairments in stream segments in the Lake Springfield and Sugar Creek watershed.

Table 6-1 Stream Impairment Data Availability for Boron in Sugar Creek

Waterbody Name	Segment ID	Impairment	Data Count	Period of Record	Number of Exceedances Reported
Sugar Creek	EOA-01	Boron, Total	160	1980-2008	10
	EOA-06	Boron, Total	2	1996	0

As discussed in **Section 5** of this report, an adjusted standard (94-9) has been previously developed and applied to both impaired segments of Sugar Creek. The adjusted standard applied a local limit of 5,500 µg/L for total boron to the section of Sugar Creek from the outfall to the confluence with the Sangamon River, which includes segment EOA-6. However, in 2009, the adjusted standard for this section of Sugar Creek has since been eclipsed by the newly adopted General Use standards for boron, which establish chronic and acute standards of 7,600 µg/L and 41,000 µg/L, respectively. Based on the currently applicable standard, no exceedances of the boron limit have been reported in segment EOA-06. It was recommended that this segment be delisting from the 303(d) list of impaired water bodies.

Adjusted standard 94-9 also set a limit of 11,000 µg/L for the section of Sugar Creek from the Lake Springfield dam to the Sugar Creek STP outfall, which includes much of impaired segment EOA-01. The adjusted standard is currently applicable to this section of Sugar Creek. Illinois EPA has identified an NPDES permitted point source operated by Springfield CWLP (NPDES permit number IL0024767) as the primary source of excess boron concentrations. As such, Illinois EPA will work with the permittee to address the boron loading through the NPDES permitting system. Significant changes in the permittee's operations have reduced boron loading since the latest available stream sampling data were collected in 2008. No TMDL was developed for boron in segment EOA-01 at this time.

6.2.2 Recommended Approach for Sedimentation/Siltation and Total Phosphorus Impairments in Sugar Creek and Hoover Branch

The recommended approach for developing LRSs for these segments and parameters is the load-duration curve method. Load duration curves are used for assessment and comparison of the range of loads allowable throughout the flow regime of a stream. The load-duration methodology uses the cumulative frequency distribution of stream flow and pollutant concentration data to estimate the allowable loads for a water body. This approach was used to characterize the current loading of total phosphorus to impaired segments EOA-04 of Sugar Creek; however, due to limited total phosphorus data for segment EOA-06 of Sugar Creek and uncertainty regarding the historical flow regime below Lake Springfield dam, a simplified empirical analysis may be employed for to calculate the percent reduction needed to reach the LRS target value associated with total phosphorus loads.

While the load duration curve approach can be applied to assessment of sedimentation and siltation impairments in Hoover Branch EOAD-11, sufficient data are not available for this assessment. Although Illinois EPA has developed a watershed specific LRS target value to address sedimentation and siltation impairments of 23.1 mg/L of NVSS, NVSS data are not available for this segment. In lieu of NVSS data for the impaired segment, a general discussion of the LRS target and of reducing loads associated with this target value is provided in Section 8 of this report and implementation measures to reduce erosion and sedimentation are provided in Section 9.

6.3 Approaches for Developing TMDLs and LRSs for Lake Springfield

6.3.1 Recommended Approach for Total Phosphorus TMDL

Lake Springfield is currently listed for impairment by total phosphorus. The BATHTUB model is recommended for TMDL development for impairments caused by excess total phosphorus in lakes or reservoirs. The BATHTUB model performs steady-state water and nutrient balance calculations in a spatially segmented hydraulic network that account for advective and diffusive transport, and nutrient sedimentation. The model relies on empirical relationships to predict lake trophic conditions and subsequent dissolved oxygen (DO) conditions as functions of total phosphorus and nitrogen loads, residence time, and mean depth (USEPA 1997). Oxygen conditions in the model are simulated as metalimnetic and hypolimnetic depletion rates, rather than explicit concentrations. Watershed loadings to Lake Springfield will be estimated using event mean concentration data, precipitation data, and estimated flows within the watershed. The available data set for Lake Springfield is fairly robust and no additional data collection is required. Implementation strategies to meet these reduction goals for phosphorus within the watershed of Lake Springfield will include BMPs to reduce TSS from surrounding agriculture and urban areas as well as strategies to reduce erosion. Nutrient loading is closely linked to the loading of solids and implementation planning for the watershed will include strategies to improve both.

6.3.2 Recommended Approach for TSS LRS

A simple spreadsheet approach was used to calculate the reduction in TSS loading into Lake Springfield required to meet the target value established by Illinois EPA. The calculations utilize the watershed flow estimates developed as part of the BATHTUB model, the relative proportion of the lake watershed made up by each subbasin, measured in-lake TSS concentrations, and the target value developed by Illinois EPA to calculate the current daily load of TSS into the lake (lbs/day), the target load (lbs/day), and the percent reduction needed in order to meet the LRS target. This simplified approach is appropriate for LRS development as it does not require the explicit assessment of WLA and LA.

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Section 7

Methodology Development for the Lake Springfield and Sugar Creek Watershed

7.1 Methodology Overview

Table 7-1 contains information on the methodologies selected and used to develop TMDLs and LRSs for impaired waterbodies within the Lake Springfield and Sugar Creek watershed.

Table 7-1 Methodology Overview

Segment ID	Segment Name	Potential Causes of Impairment	Assessment Type	Methodology
EOA-01	Sugar Creek	**Boron[1]**	**No TMDL Developed**	Addressed through NPDES program
EOA-06	Sugar Creek	**Boron[1]**	**No TMDL Developed**	Addressed through NPDES program
		Phosphorus (Total)	LRS	Empirical Assessment of Reductions needed
EOAD-11	Hoover Branch	Sedimentation/Siltation	No LRS Developed	Target developed, narrative discussion due to lack of analytical data
REF	Lake Springfield	**Phosphorus (Total)**	**TMDL**	BATHTUB
		TSS	LRS	Spreadsheet model for target reductions
		Aquatic Algae	TMDL for TP	Addressed through total phosphorus TMDL

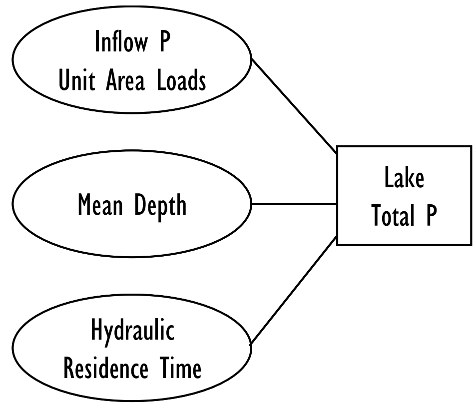
Note: Bold Causes of Impairment have numeric water quality standards and TMDLs were calculated as noted in the table. Italicized Causes of Impairment do not have numeric water quality standards and LRSs were developed where appropriate. Some italicized causes of impairment did not have a LRS developed as it is likely that implementing strategies to reduce the loading of other parameters of concern (e.g. reducing phosphorus loading to lakes) will result in reduced loading of additional parameters of concern (e.g. aquatic algae in lakes).

[1]No TMDLs were developed for Boron in Sugar Creek as the impairment is being addressed through the National Pollution Discharge Elimination System (NPDES) permitting program.

7.1.1 BATHTUB Model Overview

USEPA's BATHTUB model was used to develop the total phosphorus TMDL for Lake Springfield and the related impacts of excess aquatic algae. This model requires inputs from several data sources including online databases and GIS-compatible data. The BATHTUB model performs steady-state water and nutrient balance calculations in a spatially segmented hydraulic network that account for advective and diffusive transport and nutrient sedimentation. The model relies on empirical relationships to predict lake trophic conditions and subsequent DO conditions as functions of total phosphorus and nitrogen loads, residence time, and average lake depths (USEPA 1997). Oxygen conditions in the model are simulated as meta- and hypolimnetic depletion rates, rather than explicit concentrations. Watershed loadings to the lake were estimated using event mean concentration data, precipitation data, and estimated runoff flows within the contributing watersheds.

Schematic 1 outlines the basic data inputs for the BATHTUB model that were used to calculate the TMDL. Subbasin flows can be entered based on measured tributary values or estimated using the area ratio method and phosphorus loadings to the reservoir from the surrounding watershed were estimated using the unit area load method, also known as the "export coefficient" method (USEPA 2001). This method is based on the assumption that, on an annual basis and normalized to area, a roughly constant runoff pollutant loading can be expected for a given land use type. This method also requires that unit area loads are not applied to watersheds that differ greatly in climate, hydrology, soils, or ecology from those from which the parameters were derived (USGS 1997). Data used for all model inputs are available in **Appendix C** and are further discussed in **Section 7.2.3.**



Schematic 1

7.1.2 Load Reduction Strategy Overview for TSS in Lake Springfield

A simple spreadsheet approach was used to calculate the reduction in TSS loading into Lake Springfield required to meet the target value established by Illinois EPA. The calculations utilize the watershed flow estimates developed as part of the BATHTUB model, the relative proportion of the lake watershed made up by each subbasin, measured in-lake TSS concentrations, and the target value developed by Illinois EPA to calculate the current daily load of TSS into the lake (lbs/day), the target load (lbs/day), and the percent reduction needed in order to meet the LRS target. This simplified approach is appropriate for LRS development as it does not require the explicit assessment of WLA and LA.

7.1.3 Empirical Analysis of Total Phosphorus in Sugar Creek Segment EOA-06

While a load duration curve analysis was initially intended to be used to gain understanding of the range of total phosphorus loads allowable throughout the flow regime of Sugar Creek in segment EOA-06, insufficient data were available to develop a load-duration curve as this segment is located below the Lake Springfield dam. Flows in this segment of Sugar Creek are regulated by releases from Lake Springfield and the available flow data specific to this reach (USGS gage 05576250 - Sugar Creek near Springfield) has a very limited period of record dating from 2010-2015. The available period of record for this gage does not include the period of record for water quality data available on this reach (all samples collected in 1996). The influence of the dam on stream flows also precludes the use of a surrogate gage for estimating flows at the time of sample collection. As a result, no reasonable estimate of flows at the time of sample collection could be determined and a load duration curve was not developed for this segment.

Only two samples were available between the two sampling locations on the segment, both of which exceed the LRS target value. The load reduction needed to meet the water quality target was determined through simple empirical analysis to calculate the percent reduction needed for each sample to reach the LRS target value.

7.1.4 Assessment of Sedimentation/Siltation Impairment in Hoover Branch Segment EOAD-11

Load duration curve analysis is conceptually applicable for gaining an understanding of the impacts various flow regimes can have on the sedimentation and siltation impairment in Hoover Branch segment EOAD-11. As discussed in **Section 5.1.1.3**, Illinois EPA has developed LRS target values to address sedimentation and siltation impairments that are based on the instream concentrations of NVSS. The watershed specific LRS target value for NVSS that applies to this segment is 23.1 mg/L. However, no NVSS concentration data have been collected on this segment to date and analysis of this impairment in Hoover Branch is not currently possible. Illinois EPA recently developed a policy for addressing impairments that are associated with narrative standards. This policy development occurred after finalization of the initial Stage 1 TMDL report for this watershed, therefore, additional data collection to address LRS impairments was not recommended for Stage 2 of the TMDL process.

Because data for NVSS are not available for segment EOAD-11, the percent reduction needed to meet the LRS target cannot be calculated. A narrative discussion of reducing loads associated with this target value is provided in **Section 8** of this report while implementation measures to reduce erosion and sedimentation are provided in **Section 9**.

7.2 Methodology Development

The following sections further discuss and describe the methodologies utilized to examine total phosphorus concentrations and the related aquatic algae impairments in Lake Springfield.

7.2.1 BATHTUB Development for Lake Springfield

Lake Springfield is a relatively large reservoir with an approximate surface area of 3,800 acres. Lake Springfield is listed as impaired for total phosphorus with a TMDL target concentration of 0.05 mg-P/L. The reservoir is also listed as impaired for excess aquatic algae. A well-established link exists between excess nutrients like phosphorus and increased algal productivity in lakes and reservoirs. Excess loading of nutrients to lakes and reservoirs provides food to aquatic plants and algae. The CWLP has the following information posted on its website: *Water clarity can be affected by the amount of algae production in the lake. Some of the nutrients, specifically nitrogen and phosphorus, that are applied as fertilizers to farm fields enter the lake with eroded soils and runoff water. The result is that products intended to grow healthy corn and soybeans end up fertilizing aquatic vascular plants and algae, creating a rapid growth situation that results in algae "blooms." These blooms can often be seen as films on the water or as a green or brown coloration of the water.* Although no numeric targets exist for excess aquatic algae, reductions in total phosphorus to meet the water quality standard will likely result in reductions in nuisance algae growth in the waterbody.

The BATHTUB model was used to develop the total phosphorus TMDL for Lake Springfield. BATHTUB has three primary input interfaces: global, reservoir segment(s), and watershed inputs. The individual inputs for each of these interfaces are described in the following sections along with watershed and operational information for the lake.

7.2.1.1 Global Inputs

Global inputs represent atmospheric contributions of precipitation, evaporation, and atmospheric phosphorus. Based on precipitation and evaporation rates discussed **Section 2.6** of this report, the long-term average annual precipitation in the watershed near the Lake Springfield dam is estimated at 35.3 inches based on the 1901-2013 NCDC dataset (see **Section 2.6.1**) and the average annual evaporation in the watershed is estimated to be 36.9 inches. However, these data points would represent an extreme case of evaporation far exceeding precipitation. This scenario is not a realistic representation of the evaporation-precipitation scenario in the watershed and is likely to introduce significant error in the water balance portion of the BATHTUB model for the lake. The discrepancy is likely a result of the limited period of record for the ISWS Springfield pan-evaporation study station (limited data points and all data collected prior to 1990). As a result, data from the second-nearest pan evaporation station near Urbana, Illinois were included along with the data from the Springfield pan-evaporation station in the monthly pan-evaporation estimates for the watershed. This station includes a larger period of record that goes through 2014. As a result, the average annual pan-evaporation input into the BATHTUB model for Lake Springfield was estimated at 32.1 inches.

The default atmospheric phosphorus deposition rate suggested in the BATHTUB model was used in absence of site-specific data, which is a value of 30 kilograms per square kilometer ($kg/km^{2)}$-year (U.S. Army Corps of Engineers [USACE] 1999). This value is based on a compilation of available historical data and Illinois EPA believes that it is appropriate for use in this watershed where site-specific rates of deposition are not available.

7.2.1.2 Reservoir Segment Inputs

Reservoir segment inputs in BATHTUB are used for physical characterization of the reservoir. Lake Springfield is modeled with three segments in BATHTUB. The segment boundaries are shown on **Figure 7-1**. Segmentation was established based on the availability of necessary data from the three primary water quality sampling locations in the lake (REF-1, REF-2, and REF-3), as well as consideration of lake morphology. Water quality stations REF-5 and REF-6 did not include sufficient data to justify further subdivision of the reservoir for modeling purposes. Segment inputs to the model include average depth, surface area, overall length, and average total phosphorus concentration near the surface of the lake. The lake depths were represented by the average of all depth measurements taken at each of the 3 primary water quality sampling stations in the main channel of the lake. Segment length and surface area were determined in GIS. These data are shown below (**Table 7-2**) for reference.

Table 7-2 Lake Springfield Segment Input Data

Segment	Surface Area (km^2)	Segment Length (km)	Average Depth (m)	Average TP at Surface (mg/L)
REF-1	4.74	4.2	6.6	0.290
REF-2	6.51	5.8	5.1	0.348
REF-3	4.22	5.48	2.8	0.379

7.2.1.3 Tributary Inputs

Tributary inputs to BATHTUB include drainage area, flow, and total phosphorus loading. The drainage area of each tributary is equivalent to the basin or subbasin it represents, which was determined with GIS analyses. **Figure 7-1** also shows the subbasin boundaries. The watershed was broken up into five tributaries for purposes of the model. Tributaries 1 through 3 represent all of the stream and overland flow into each respective segment of the lake (REF-1 through REF-3) and cumulatively include all runoff and stream flow from the entire lake's watershed. The fourth tributary input represents the sum of estimated flow and total phosphorus loads into the watershed by all NPDES point source discharges located upgradient of the lake. The fifth tributary input used in the model represents the flow and total phosphorus loads associated with the water diverted into segment REF-1 of Lake Springfield from the South Fork of the Sangamon River via the South Fork diversion (**Figure 7-1**).

To estimate phosphorus loads, it is necessary to estimate flows corresponding to each tributary input. This was accomplished using the area-ratio method. Two active USGS stream gages currently exist in the Lake Springfield and Sugar Creek watershed; however, as discussed in **Section 2.6.3** of this report, the available period of record for flow data from each of these gages is extremely limited. The longest period of record amongst gages in the watershed exists at USGS 05576250 Sugar Creek near Springfield, with data reported from 2010-2015. The remaining watershed gage, USGS 05576100 Lick Creek near Woodside, IL was not installed until 2015.

Because of the very short period of record for gages in the watershed, a surrogate gage with a longer period of record was used to estimate flows in the Lake Springfield and Sugar Creek watershed for segments with flows that aren't regulated by the Lake Springfield dam: USGS gage 5579500 Lake Fork near Cornland, Illinois. This gage is located approximately 12 miles northeast of the Lake Springfield and Sugar Creek watershed in a basin of similar size and with similar land-use characteristics. The period of record for flow measurements at this gage extends from 1948 through the present with average monthly flows ranging from 46 cubic feet per second (cfs) in September to 301 cfs in May. The drainage area to this gage is approximately 214 square miles. Data from this gage were used to estimate flow values at all locations in the Lake Springfield and Sugar Creek Watershed using the drainage area ratio method represented by the following equation:

$$Q_{gaged}\left(\frac{Area_{ungaged}}{Area_{gaged}}\right) = Q_{ungaged}$$

where Q_{gaged} = Streamflow of the gaged basin
$Q_{ungaged}$ = Streamflow of the ungaged basin
$Area_{gaged}$ = Area of the gaged basin
$Area_{ungaged}$ = Area of the ungaged basin

The assumption behind the equation is that the flow per unit area is equivalent in watersheds with similar characteristics. Therefore, the flow per unit area in the gaged watershed multiplied by the area of the ungaged watershed estimates the flow for the ungaged watershed.

Data downloaded through the USGS for the surrogate gage for the available period of record were adjusted to account for point source influence in the watershed upstream of the gaging station. Average daily flows from all NPDES permitted facilities upstream of the surrogate USGS gages are typically subtracted from the gaged flow prior to flow-per unit-area calculations; however, in this case no permitted point sources exist upstream of the surrogate gage. Average daily flows from permitted NPDES discharges upstream of the impaired segments in the Lake Springfield and Sugar Creek watershed were then added back into the equation to more accurately reflect estimated daily streamflow conditions in each tributary.

The total mean overland flow into Lake Springfield is estimated to be 212 cfs. Flow from point sources in the watershed was estimated by summing the average reported flow discharging from each of the NPDES permitted point sources upstream of the lake as reported in the facilities' discharge monitoring reports from 2007-2015. Flow estimates for the South Fork diversion are based on the average daily flows calculated using total discharge volume data recorded at the South Fork diversion. The estimated flow from each tributary is shown in **Table 7-3**.

Table 7-3 Lake Springfield Tributary Inputs and Estimated Flows

Tributary	Tributary Description	Estimated Average Flow Rate (cfs)	Estimated Average Total Phosphorus Concentration (mg/L)
Tributary 1	REF-01 Tributaries and overland flow	7.6	0.131
Tributary 2	REF-02 Tributaries and overland flow	7.1	0.147
Tributary 3	REF-03 Tributaries and overland flow	199	0.311
Tributary 4	NPDES permitted discharges	1.8	2.425
Tributary 5	South Fork Diversion	14.4	0.218
	TOTAL	**229.9**	

Flow rates estimated using the area-ratio method as discussed in Section 7.2.1 and TP concentrations estimated using the unit area load method, also known as the "export coefficient" method (USEPA 2001). Data available for review in Appendix C

Because there are limited available historical tributary concentration data, phosphorus loads from the contributing watershed were estimated based on land use data and the median annual export coefficients for each land use. Export coefficients for each land use category found in the Lake Springfield and Sugar Creek Watershed were extracted from the USEPA's PLOAD version 3.0 user's manual. This document provides an extensive list of phosphorus export coefficients for various land uses in several regions of the country compiled from a number of sources in the literature. The export coefficients for each land use are reported in lbs/acre/year which can then be multiplied by the number of acres of each land use in each of the lake segment's watersheds to provide a total median phosphorus load into the reservoir (**Table 7-3**).

Only one of the point sources in the watershed is currently required to sample for total phosphorus concentrations in the discharge effluent. As a result, the total load of phosphorus from all the point sources in the watershed that make up the Tributary 4 model input was estimated by applying the available average discharge concentration of total phosphorus to each discharger in the basin. All of the point sources in the watershed above of the lake are small (<1 million gallons per day [MGD]) and utilize similar treatment processes, adding a degree of confidence to this estimate. The effluent concentration used in the model input (2.425 mg/L) also falls within the range of typical total phosphorus concentrations reported by similar facilities throughout the region (typically 2-4 mg/L).

The estimated total phosphorus concentration input into the BATHTUB model for the South Fork Diversion flows (Tributary 5), was calculated using available water quality data from Illinois EPA water quality station EO-03 on the South Fork Sangamon River. This station is located immediately downstream of the diversion dam used to provide flow to the diversion pumping station and is representative of the water diverted into the lake. A relatively robust water quality dataset is available for this station with 88 samples collected for total phosphorus since 2001. The model input value for total phosphorus in Tributary 5 was 0.218 mg/L (**Table 7-3**).

Although no data is available on the total number of septic systems in the watershed, the geographic range of influence TP loads from septic systems is typically quite limited with TP loads not extending more than a few hundred feet from source when septic systems are fully operational (USEPA 2002). However, as discussed in Section 5.4.3, a total of 431 known septic systems currently exist in proximity to Lake Springfield and this figure was used to estimate potential phosphorus loads into Lake Springfield from septic systems. Typical total phosphorus loads for residential septic systems are reported in the literature as approximately 1.0 to 2.7 grams/person/year (EPA 2002). Given an average of four individuals per residential septic system, this equates to an estimated 3.8-10.3 lbs/day (median of 7.0 lbs/day) of total phosphorus entering the Lake from septic systems, which is implicitly included in the current load and LA for Lake Springfield.

7.2.1.4 BATHTUB Confirmatory Analysis

Historical water quality data for Lake Springfield are summarized in **Section 5.1.2** of this report. These data were used to help confirm model calculations. Although the analyses presented below do lend confidence to the modeling, they should not be considered a true model "calibration." Additional lake and tributary water quality and flow data are required to fully calibrate the model.

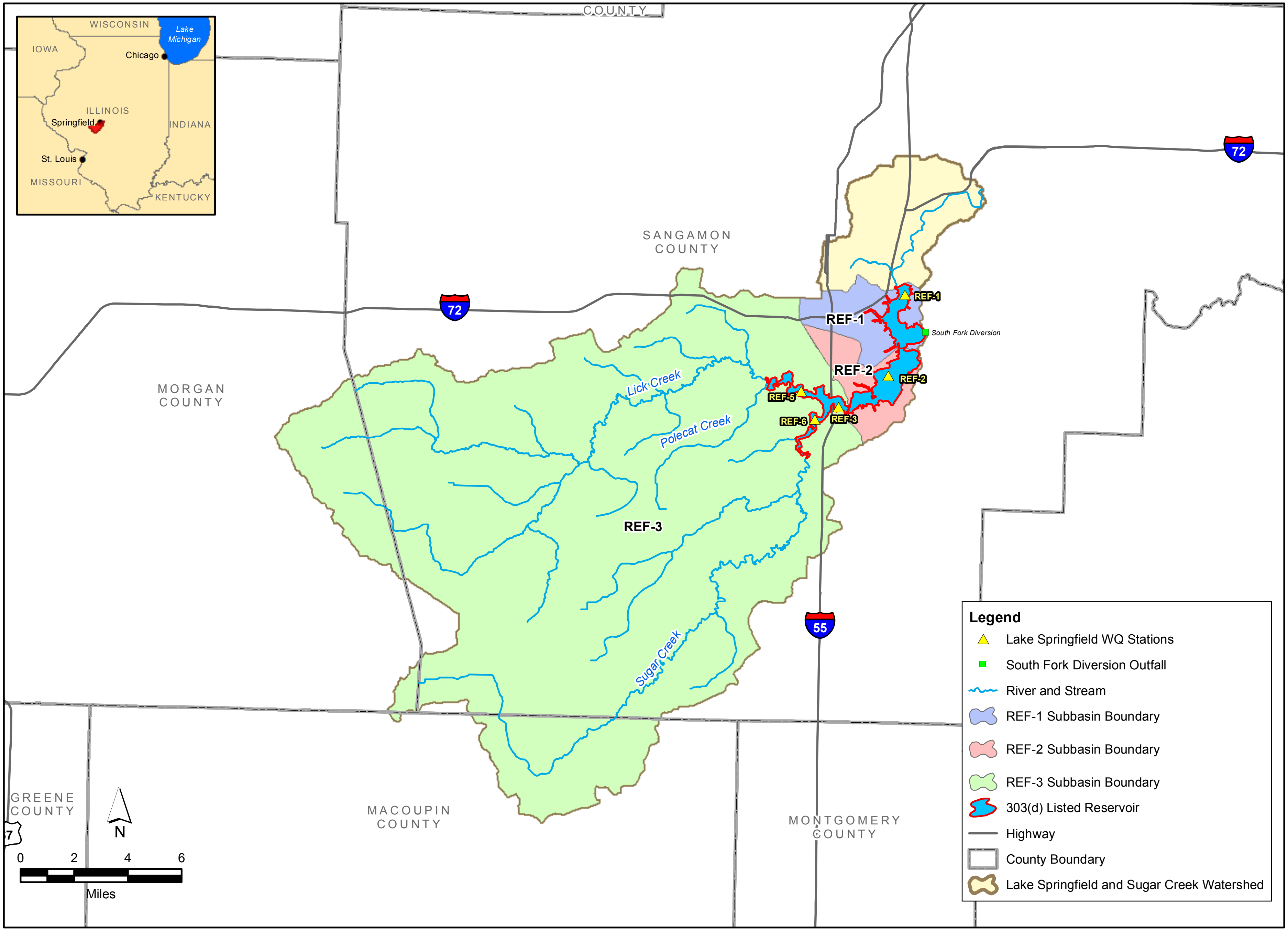
The Lake Springfield BATHTUB model was initially simulated assuming default phosphorus kinetic parameters (assimilation and decay) and no internal phosphorus loading. When using these parameter settings, the BATHTUB model under-predicted the concentrations when compared to actual water quality data. To achieve a better match with actual water quality data, the internal loading and sedimentation coefficients were iteratively adjusted within reasonable ranges established in the available literature. Internal loading rates reflect nutrient recycling from bottom sediments while sedimentation coefficients reflect variations in sedimentation (settling) rates of individual reservoirs and portions of the reservoir as a function of flows, climate, morphology, and other factors.

Because the lower portions of the reservoir are relatively deep, a review of historic dissolved oxygen levels recorded at depths near the lake bottom was performed to investigate the potential for sediment loading of phosphorus. The data show that during summer months, the lake bottom waters in segments REF-1 and REF-2 regularly have dissolved oxygen levels near zero. This lends confidence to the potential for internal loading. As can be seen in **Table 7-4**, an excellent match was achieved, lending significant support to the predictive ability of this simple model. A printout of the BATHTUB model files is provided in **Appendix C** of this report.

Table 7-4 Summary of Model Confirmatory Analysis Lake Springfield Total Phosphorus (mg/L)

Lake Site	Observed	Predicted	Internal Loading Rate (mg/m2-day)*
REF-1	0.290	0.290	8.90
REF-2	0.348	0.348	4.15
REF-3	0.379	0.379	0.28

*Note that the internal loading rates shown in Table 7-4 are model input values that were used for calibrations. Internal loads (lbs/day) for the lake are presented in the TMDL discussion in Section 8.3.1



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CDM Smith

Lake Springfield and Sugar Creek Watershed

Lake Springfield Segmentation and Subbasin Delineation for BATHTUB Modeling

FIGURE 7-1

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Section 8

Total Maximum Daily Loads for the Lake Springfield and Sugar Creek Watershed

8.1 TMDL Endpoints for the Lake Springfield and Sugar Creek Watershed

The TMDL endpoints and LRS target values for total phosphorous, TSS, and sedimentation/siltation are summarized in **Table 8-1**. The total phosphorus and sedimentation/siltation in streams endpoints are based on protection of aquatic life in the impaired stream segments. The TMDL endpoints established for total phosphorus and TSS in Lake Springfield are based on protection of the aesthetic quality designated use. Parameters with numeric water quality standards are assessed via the TMDL process and the TMDL endpoints directly correlate to the lowest applicable water quality standard established for a given parameter. Parameters without numeric water quality standards were assigned a watershed-specific LRS target value by Illinois EPA. These target values are not legally binding, but are intended to serve as planning tools for overall water quality improvement strategies in the watershed.

Table 8-1 TMDL Endpoints and Average Observed Concentrations for Impaired Constituents in the Lake Springfield and Sugar Creek Watershed

Segment ID	Segment Name	Potential Causes of Impairment	Assessment Type	TMDL Endpoint or Target Value
EOA-01	Sugar Creek	**Boron**	**No TMDL Developed**[1]	11,000 ug/L[3]
EOA-06	Sugar Creek	**Boron**	**No TMDL Developed**[1]	7,600 ug/L[3]
		Phosphorus (Total)	*LRS*	0.739 mg/L
EOAD-11	Hoover Branch	*Sedimentation & siltation*	*No LRS Developed*	23.1 mg/L (NVSS)
REF	Lake Springfield	**Phosphorus (Total)**	**TMDL**	0.05 mg/L
		TSS	*LRS*	19 mg/L
		Aquatic Algae	*TMDL for TP*	0.05 mg/L TP[2]

[1] Boron exceedances are being addressed through the NPDES permitting program
[2] Aquatic algae is directly related to excess nutrients and will be addressed through the total phosphorus TMDL
[3] IPCB-Approved Adjusted Standards (94-9) for Springfield CWLP Plant IL0024767

8.2 Pollutant Sources and Linkages

Potential pollutant sources for impaired lakes and streams in the Lake Springfield and Sugar Creek Watershed include both point and nonpoint sources as described in Section 5 of this report. The relative proportion of loads under various hydraulic conditions can be useful in determining the primary pollutant sources. **Table 8-2** shows the example source area/hydrologic condition consideration developed by USEPA.

Table 8-2 Example Source Area/Hydrologic Condition Considerations (USEPA 2007)

Contributing Source Area	Duration Curve Zone				
	High Flow	**Moist**	**Mid-Range**	**Dry**	**Low Flow**
Point Source				M	H
Onsite Wastewater System			H	M	
Riparian Areas		H	H	H	
Stormwater: Impervious Areas		H	H	H	
Combined sewer overflows	H	H	H		
Stormwater: Upland	H	H	M		
Bank Erosion	H	M			

Note: potential relative importance of source area to contribute loads under given hydrologic conditions (H: High; M: Medium)

Potential sources for total phosphorus and their linkages to Lake Springfield were established through the BATHTUB modeling as discussed in Section 7. Modeling indicated that loads of total phosphorus may originate from internal and external sources. Overall potential sources of nutrients in the impaired lake watershed include permitted point sources, water transfers, and nonpoint sources such as runoff from surrounding agricultural land, urban areas, forests and parkland, and internal loading from lake sediments. Nutrients bound in eroded soils and plant materials are introduced to the waterbodies through runoff from precipitation events. Once in the waterbodies, nutrients are introduced to the water column and/or nutrient rich soils and plant materials settle to the bottom perpetuating the internal cycling of nutrients. As discussed in Section 7.2.3, excess nutrients are also the main contributor to excess algae and are associated with algal blooms previously seen in Lake Springfield.

Runoff from the surrounding watershed is also a primary source of TSS loading into Lake Springfield. Potential nonpoint sources of TSS were presented and discussed in Section 5. As part of the LRS process, a spreadsheet model was developed to assess current conditions and to calculate the reduction in TSS loads necessary to meet the LRS target values in each segment of the lake.

Impairment caused by total phosphorus in segment EOA-06 of Sugar Creek could not be assessed via development of a load duration curve model as initially planned due to a lack of useable flow data and an extremely limited water quality dataset, as discussed in Section 7.2.2. However, many of the potential pollutant sources established through the total phosphorus TMDL developed for Lake Springfield directly apply to this segment as well. Pollutant loads to this segment likely come from a combination of outflows from Lake Springfield as well as point sources and overland runoff originating from the watershed below the lake.

Segments EOA-01 and EOA-06 are listed as impaired by boron. A TMDL was not developed for these impairments at this time because the source of boron has been identified as an industrial discharge located in the watershed. Excess boron in the discharge from this facility is being addressed by Illinois EPA through the NPDES program and as the facility meets its effluent limits, boron impairment will no longer be an issue. Further pollutant source discussion is provided throughout this section and implementation activities to reduce loading from the potential sources are outlined in Section 9.

8.3 Allocation

As explained in Section 1of this report, the TMDLs for impaired segments in the Lake Springfield and Sugar Creek Watershed will address the following equation:

$$\text{TMDL} = \text{LC} = \Sigma\text{WLA} + \Sigma\text{LA} + \text{MOS} + \text{RC}$$

where:	LC	=	Loading capacity - the maximum amount of pollutant loading a water body can receive without violating water quality standards
	WLA	=	Waste load allocation - the portion of the TMDL allocated to existing or future point sources
	LA	=	Load allocation – the portion of the TMDL allocated to existing or future nonpoint sources and natural background
	MOS	=	Margin of safety - an accounting of uncertainty about the relationship between pollutant loads and receiving water quality
	RC	=	Reserve capacity – the portion of the load explicitly set aside for future population growth and additional development in the watershed

Each of these elements will be discussed in this section as well as consideration of seasonal variation in the TMDL calculation.

8.3.1 Total Phosphorus TMDL for Lake Springfield

8.3.1.1 Loading Capacity

The LC of Lake Springfield reflects the maximum mass (in pounds) of total phosphorus that can be allowed as input to the lake each day without resulting in exceedances of the applicable water quality standard of 0.05 mg/L of total phosphorus (allowable load). The allowable load of total phosphorus that can be generated in the watershed and still maintain water quality standards was determined with the BATHTUB model for Lake Springfield developed as discussed in Section 7. To calculate the LC, the current total phosphorus loads into the lake were first calculated in the model using average values from the historical data. The current calculated loads from internal and external sources were then iteratively reduced in the model until the water quality standards were met. The total allowable load of total phosphorus into Lake Springfield as determined through the BATHTUB modeling effort is 79.6 lbs/day with 25.9 lbs/day allocated to internal sources and 53.7 lbs/day allocated to external sources.

8.3.1.2 Seasonal Variation

A season is represented by significant and prolonged changes in weather; for example, a season can be classified as warm or cold as well as wet or dry. Seasonal variation is accounted for in the Lake Springfield TMDL by developing the model and performing all calculations of load on an annual basis. Data used for modeling included the historical record of daily flows and monthly precipitation and evapotranspiration. 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 agricultural processes occurring at different times of year, combined with seasonal changes in precipitation, result in different runoff characteristics at different times of year), the loadings for this TMDL are focused on average annual loadings converted to daily loads rather than specifying different loadings by season. Lake Springfield will most likely experience critical conditions pertaining to phosphorus concentrations each year in mid to late summer based on the growing season. Because an average annual basis was used for TMDL development, it is assumed that the critical condition is accounted for within the analysis.

8.3.1.3 Margin of Safety

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. The MOS for the Lake Springfield total phosphorus TMDL is both implicit and explicit in nature. As an overall conservative measure, an explicit MOS of 10% was included to account for the lack of, or very limited nature of, any site-specific data available within the watershed. It is believed that the inclusion of an explicit MOS of 10% is adequate as the modeled values were in generally good agreement with the observed data (see **Table 7-4**).

In addition to the explicit MOS of 10%, the analyses completed for these waterbodies were conservative as a result of the default coefficients and values used in each BATHTUB model, which were developed to be conservative in nature in the absence of site-specific information. Default model values, such as dispersion rates, are based on scientific data accumulated from a large survey of lakes. Wherever site-specific data are not available, default model rates are used which are based on error analysis calculations. The BATHTUB model and the default values incorporated within the model provide a conservation range of where the predictions could fall and provide confidence in the predicted values.

As stated in the BATHTUB technical documentation, "if the model is re-calibrated to site-specific data and the default input values for model error coefficients are used, the procedure (Options 2 or 3) will over-estimate prediction uncertainty (CV's of predicted values)." In this case, all available data were used to perform a limited site-specific calibration, while default error coefficients were maintained in the model. Therefore, the uncertainty presented in the final results is likely an over-estimation of the actual model uncertainty, and thus conservative. In other words, the range of potential outcomes is likely smaller than the range presented. Or, put another way, the high ends of the ranges of predicted phosphorus and chl-a concentrations (worst case concentrations) are likely higher than the actual expected outcomes.

8.3.1.4 Reserve Capacity

Springfield CWLP is currently planning to construct a reservoir (Hunter Lake) in the adjacent South Fork of the Sangamon River watershed to store water for the purpose of augmenting flows into Lake Springfield under certain conditions in the future. When water levels in Lake Springfield drop below a specific elevation (established as the annual average lake elevation for a given time of year), water stored in Hunter Lake will be discharged into the South Fork and subsequently diverted into Lake Springfield via the South Fork diversion[1]. Since this project represents a known significant change to future inputs into Lake Springfield, a RC load was calculated to account for this project in the TMDL calculation.

Springfield CWLP performed calculations of the expected additional volume of water that will be diverted into Lake Springfield from Hunter Lake under the proposed project plan. Calculations were made using the most recent 10 years of lake elevation and South Fork diversion volume data and resulted in an estimated average annual additional flow of 6.42 MGD and an estimated maximum additional annual flow of 13.99 MGD. As a conservative measure, the maximum additional annual flow was used to develop the RC.

Water diverted out of Hunter Lake and into Lake Springfield will be required to meet the established water quality standard for lakes in Illinois of 0.05 mg/L of total phosphorus. Therefore, the maximum additional flow out of Hunter Lake and the maximum allowable concentration of total phosphorus (0.05 mg/L) were used to calculate an estimate of the maximum additional load of total phosphorus into Lake Springfield expected as a result of the Hunter Lake project. This load (5.8 lbs/day) was used to set the RC in the TMDL calculations for Lake Springfield. It should be noted that USEPA has indicated that this TMDL may need to be reopened in the future if/when the diversion proceeds to ensure the new source meets the calculated allocations.

8.3.1.5 Waste Load Allocation

Five publicly owned treatment works (POTWs) exist in the watershed upstream of Lake Springfield (see **Table 8-3**). Although each of these POTWs contribute only a small proportion of the total flow into the lake, the cumulative effect of the POTWs on total phosphorus loading into the lake is significant and warrants the development of a WLA in the TMDL calculation. Each facility's design average flow (DAF) was input into the model for calculation of point source loading. Total phosphorus data for POTWs in the watershed are extremely limited with only one of the five facilities currently required to monitor for total phosphorus concentrations in effluent (IL0050253 Lake Springfield Baptist Camp). None of the POTWs, including IL0050253 have effluent limits for total phosphorus listed in their current NPDES permits.

In order to estimate total phosphorus loading for each POTW, the average total phosphorus concentration was calculated for all available effluent data in the watershed. Based on a review of effluent data and permit language for similar POTWs in the region, the estimated effluent concentration input into the model for each POTW, 2.425 mg/L, is within a reasonable range of expected phosphorus concentrations. Assuming that the contributing facilities are not currently discharging more than this concentration, the WLA will not require additional nutrient removal.

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[1] Current South Fork diversion flows and phosphorus loads into Lake Springfield are incorporated in the model as Tributary 5. Because the source of the phosphorus loads in the diverted water are all outside of the Lake Springfield and Sugar Creek Watershed, the current loads associated with this diversion were set as constant and not adjusted in calculations to establish the load reductions necessary to meet the TMDL. Although not currently accounted for, any future total phosphorus load reductions that may occur in the South Fork watershed will serve to further reduce loads into Lake Springfield and may be considered a conservative measure in the current TMDL calculations.

The estimated flow and total phosphorus concentrations calculated for each POTW in the Lake Springfield watershed were used to calculate WLAs for each facility (**Table 8-3**). These values are summed to provide an estimate of the total WLA for total phosphorus in the Lake Springfield watershed. Future monitoring of total phosphorus concentrations in effluent from each of these POTWs would provide greater certainty to relative impact of POTWs on total phosphorus concentrations in Lake Springfield.

Two NPDES permits for MS4 systems exist in the watershed contributing to Lake Springfield: City of Springfield (ILR400453) and Village of Chatham (ILR400624). WLAs for NPDES-permitted stormwater discharges such as MS4s that do not have numerical effluent limitations are typically expressed as a percent reduction. In this case, estimates of MS4 contributions to phosphorus loads were included in WLA calculations at the current load estimate. Estimates of current loading from MS4s were calculated by subtracting the WLA for NPDES point source dischargers, the margin of safety, and the reserve capacity from the loading capacity of the waterbody to derive the load attributable to all non-point sources including stormwater discharges. The proportion of land in each lake segment's watershed covered under a MS4 permit was then calculated using GIS layers for urbanized MS4 areas and multiplied by the segment's interim load allocation for non-point sources. The resulting value represents an estimate of the proportion of overland runoff load attributable to MS4 systems for each lake segment. As the MS4 loads are from permitted sources, the MS4 load was then subtracted from the overall LA and added to the WLA calculated for POTWs.

Table 8-3 WLAs for Total Phosphorus Loads to Lake Springfield

NPDES Permit Number	Permit Name	Type	Design Flow (MGD)	Permitted Area in Watershed (sq. Miles)	WLA[1] (lbs/day)
IL0022403	Auburn STP	POTW	0.62	-	12.6
IL0023426	Virden North STP	POTW	0.2	-	4.1
IL0050253	Lake Springfield Baptist Camp	POTW	0.015	-	0.30
ILG580260	Thayer STP	POTW	0.0842	-	1.7
ILG580275	Loami STP	POTW	0.25	-	5.1
ILR400453	Springfield, City of	MS4	-	61.5	1.5
ILR400624	Chatham, Village of	MS4	-	12.9	0.31
				Total WLA	**25.5**

[1] WLAs are equivalent to estimates of current waste loads. TMDL assumes no changes in current NPDES permit limits in the watershed are imminent.

8.3.1.6 Load Allocation and TMDL Summary

Table 8-4 shows a summary of the total phosphorus TMDL for Lake Springfield. A total reduction of approximately 93 percent of total phosphorus loads will result in compliance with the applicable water quality standard of 0.05 mg/L to total phosphorus throughout the lake. Percent reductions presented under this scenario assume no imminent change in current NPDES permit limits that would impact current waste loads in the watershed. All necessary reductions are limited to reductions of internal loads and non-permitted nonpoint source loads.

Table 8-4 TMDL Summary for Lake Springfield

	LC (lbs/day)	WLA (lbs/day)	LA (lbs/day)	MOS (10% of LC) (lbs/day)	RC for Additional flow from Hunter Lake (lbs/day)	Current Load (lbs/day)	Reduction Needed (lbs/day)	Reduction Needed (Percent)
Internal	25.9	-	23.3	2.6	-	161.8	135.9	85.6%
External	53.7	25.5	17.0	5.4	5.8	386.1	332.4	95.6%
Total	79.6	25.5	40.3	8.0	5.8	547.9	468.3	92.7%

8.3.2 LRS for Total Phosphorus in Streams

Sugar Creek segment EOA-06 in the Lake Springfield and Sugar Creek Watershed is listed for impairment of the aquatic life use caused by total phosphorus. As no numeric water quality standard exists for total phosphorus in streams in Illinois, a numeric target (0.739 mg/L) was developed by Illinois EPA for this watershed. As previously discussed, a load duration curve could not be constructed for segment EOA-06 due to inadequate data. As a result a more general empirical evaluation of the reductions needed to meet the LRS target value in this segment was developed.

8.3.2.1 Target Loading Capacity

The LC is the maximum amount of total phosphorus the impaired waters can receive and still meet the LRS target value for this watershed. The allowable phosphorus loads that may be generated in the watershed were determined using estimated flow conditions and the numeric LRS target of 0.739 mg/L for total phosphorus, as discussed in Section 7. The total phosphorus loading capacity according to flow is presented in **Table 8-5.**

Table 8-5 Total Phosphorus Loading Capacities in Streams Under Various Flow Conditions in the Lake Springfield and Sugar Creek Watershed

Estimated Mean Daily Flow (cfs)	**Target Load Capacity** (mg/L of Total Phosphorus)
1	4
5	20
10	40
50	199
100	398
500	1,992
1,000	3,984
1,500	5,975
2,000	7,967
5,000	19,918

8.3.2.2 Seasonal Variation

While the LRS assessment developed for segment EOA-06 was significantly limited by the availability of flow and water quality data, many of the assumptions and conclusions made during development of the total phosphorus TMDL for Lake Springfield regarding seasonal variation will apply to this segment as well. Considerations of seasonality are incorporated in the implementation plan (Section 9) for load reduction of total phosphorus in EOA-06.

8.3.2.3 Percent Reduction and LRS Summary

The available dataset for total phosphorus in segment EOA-06 was limited to just two values, both of which were collected as part of a FRSS in August 1996. As previously discussed, this segment is located downstream of the Lake Springfield dam and instream flow conditions at the time of sample collection could not be reliably estimated. Based on the empirical assessment of the limited dataset and simplified LRS target calculations, reductions of total phosphorus loads of approximately 21-39% are needed for segment EOA-06 to meet the watershed-specific LRS target value (**Table 8-6**).

Table 8-6 LRS Targets for Total Phosphorus in Sugar Creek EOA-06

LRS Target Concentration (mg/L)	Actual Concentration in August 1996 (mg/L)	Percent Reduction Needed (%)
0.739	0.940	21.4%
	1.200	38.4%

8.3.3 LRS for TSS in Lake Springfield

Lake Springfield is also listed for impairment of the aesthetic quality use caused by TSS. No numeric water quality standard exists for TSS in lakes or reservoirs in Illinois, so a watershed-specific numeric target (19 mg/L) was developed by Illinois EPA. Determination of the reduction in TSS load needed to meet the water quality target for TSS at five water quality sampling locations in the main body of Lake Springfield with sufficient TSS datasets (REF-1, REF-2, REF-3, REF-5, and REF-6) was performed using a simplified spreadsheet calculation approach.

The spreadsheet approach incorporated the available TSS data for each segment of the lake and estimates of the average daily overland and tributary flow from each subwatershed to produce an estimate of the current average daily TSS load into each lake segment. The current load is compared to the maximum daily load possible without exceeding the watershed-specific TSS target concentration value to calculate the overall percent reduction in daily TSS load into each segment of the lake, and the lake as a whole, necessary to meet the target value (**Table 8-7**). Spreadsheets used for the calculation of the LRS for TSS in Lake Springfield are provided in **Appendix E**.

Table 8-7 LRS Summary for TSS in Lake Springfield (REF)

Site	Target Concentration (mg/L)	Existing Concentration[1] (mg/L)	Average Overland and Tributary Flow (cfs)	Target Loading Capacity (lbs/day)	Actual Load[1] (lbs/day)	Percent Reduction Needed (%)
REF-1	19	19.3	7.6	779	789	1.3%
REF-2	19	26.5	7.1	726	1,011	28.2%
REF-3	19	41.2	3.5	363	786	53.8%
REF-5	19	53.4	120.4	12,336	34,670	64.4%
REF-6	19	47.8	74.9	7,672	19,298	60.2%
Lake Total	19	41.0	213.6	21,876	47,206	53.7%

[1] Existing Concentration was calculated using the 90th percentile of observed TSS concentrations in a given location (USEPA 2007)

8.3.4 LRS for Sedimentation/Siltation in Streams

Hoover Branch (EOAD-11) is listed for impairment of the aquatic life use caused by sedimentation/siltation. No numeric water quality standard exists for sedimentation/siltation impairments in Illinois, so a watershed-specific numeric target value was developed by Illinois. Illinois EPA uses (NVSS concentrations as a surrogate for sedimentation/siltation impairments in order to facilitate the establishment of a numeric target for LRS development. The NVSS concentration target for this watershed is 23.1 mg/L of NVSS.

A detailed search for NVSS, VSS, and TSS data collected in Hoover Branch was conducted. No data were found. As a result, the percent reduction in NVSS required to meet the LRS target value could not be calculated. Future data collection is recommended and implementation strategies to reduce erosion and sedimentation/siltation in the future are presented in Section 9.

8.3.5 Other Impairments in the Lake Springfield and Sugar Creek Watershed

Segments EOA-01 and EOA-06 of Sugar Creek are listed for impairment of the aquatic life designated use caused by boron concentrations. A single potential source of boron loading in the watershed was identified by Illinois EPA as an industrial discharger. These impairments are therefore being addressed through the NPDES permitting program and no TMDLs have been calculated for boron in Sugar Creek.

In addition to the total phosphorus and TSS impairments addressed in this report for Lake Springfield, excess aquatic algae has been identified as an additional cause for impairment of the aesthetic quality designated use in the lake. Excess algae growth in Lake Springfield is a direct result of the high concentrations of total phosphorus reported in the lake (refer to discussion in Sections 7.2.3). Impairments caused by excess total phosphorus loads have been assessed through BATHTUB modeling used for the TMDL development process, as discussed in this report. Therefore, numeric LRS development or target load reduction specifically for aquatic algae growth was not performed. As excess algae growth is a response to excessive nutrient loads, steps taken to reduce nutrient loads and meet the total phosphorus TMDL for Lake Springfield will likely result in elimination of exceedances of the narrative excess algae growth criteria in the lake.

Section 9

Implementation Plan for the Lake Springfield and Sugar Creek Watershed

9.1 Implementation Overview

The goal of this watershed plan is to identify BMPs to be implemented in the Lake Springfield and Sugar Creek watershed that will provide reasonable assurance that impaired waters in the watershed will meet water quality criteria developed to ensure waterbodies are able to support their designated uses.

The USEPA has identified nine minimum elements that a watershed-based plan for impaired waters is expected to include. A watershed plan is expected to:

1. Identify causes and sources of pollution that will need to be controlled to achieve pollutant load reduction requirements estimated within the watershed plan.
2. Estimate pollutant load reductions expected as a result of implementation of management measures described in #3 below.
3. Describe the nonpoint source management measures that will need to be implemented to achieve load reductions estimates and identify the critical areas where measures need to be implemented.
4. Estimate the level of technical assistance, associated costs, potential funding sources and parties that will be relied upon to implement the prescribed measures.
5. Include a public information/education component designed to change social behavior.
6. Develop an implementation schedule for the plan.
7. Develop a description of interim, measureable milestones.
8. Identify indicators that can be used to determine whether pollutant loading reductions are being achieved over time.
9. Develop a monitoring component to evaluate the effectiveness of the implementation efforts over time.

Element 1 has been addressed in Sections 5, 7, and 8 of this report. The Sangamon County Soil and Water Conservation District is concurrently developing the *2016 Lake Springfield Watershed Management Plan*. The Lake Springfield Watershed Management Plan details specific actions required to reduce sediment and nutrient loading to Lake Springfield. It reflects stakeholder concerns and priorities and will serve as a road map for future implementation, outreach and education activities. This additional detailed assessment of implementation activities is anticipated to be available in October 2016.

9.2 Adaptive Management

An adaptive management or phased approach is recommended for the implementation of management practices designed to meet the TMDLs and LRSs developed for the Lake Springfield and Sugar Creek watershed. Adaptive management conforms to the USEPA guidelines outlined above as it is a systematic process for continually improving management policies and practices through learning from the outcomes of operational programs. Some of the defining characteristics of adaptive management include:

- Acknowledgement of uncertainty about what policy or practice is "best" for the particular management issue
- Thoughtful selection of the policies or practices to be applied (the assessment and design stages of the cycle)
- Careful implementation of a plan of action designed to reveal the critical knowledge that is currently lacking
- Monitoring of key response indicators
- Analysis of the management outcomes in consideration of the original objectives and incorporation of the results into future decisions (British Columbia Ministry of Forests 2000)

Implementation actions, point source controls, management measures, and/or BMPs are used to control the generation or distribution of pollutants within a watershed. BMPs are either structural; such as wetlands, sediment basins, fencing, or filter strips; or managerial, such as conservation tillage practices, nutrient management plans, or crop rotation. Both structural and managerial BMPs require effective management to be successful in reducing pollutant loading to water resources (Osmond et al. 1995).

It is typically most effective to install a combination of point source controls and BMPs or a BMP system. A BMP system is a combination of two or more individual BMPs that are used to control pollutants from a single critical source. If the watershed has more than one identified pollutant, but the transport mechanism is the same, then a BMP system that establishes controls for the transport mechanism can be employed (Osmond et al. 1995).

To assist in development of an adaptive management program; implementation actions, management measures, available assistance programs, and recommended continued monitoring are all discussed throughout the remainder of this section. The point source controls described below are generally required through the NPDES program administered by Illinois EPA and typically already being implemented although some modifications may be appropriate. Illinois EPA will work with dischargers in the watershed as NPDES permits come up for renewal. The nonpoint source BMPs are entirely voluntary based on the landowner’s preference.

9.3 BMP Recommendations for Reducing Sedimentation/Siltation in Hoover Branch

Sedimentation/siltation issues were identified by Illinois EPA as causing impairment on the Hoover Branch impaired stream segment EOAD-11. Illinois EPA began developing LRSs for parameters without numeric water quality standards in 2012. The agency identified NVSS as a surrogate measure for sedimentation/siltation. Although no NVSS data currently exist for the impaired segment and no LRS could be calculated at this time, implementation strategies to reduce sediment loading to Hoover Branch are presented below..

Nonpoint source runoff from agricultural areas and unstable streambanks are likely significant contributors to high sediment loads in the impaired stream segment. As such, nonpoint source controls designed to reduce erosion are expected to reduce sedimentation/siltation in streams as well as provide a secondary benefit of reducing other contaminants such as total phosphorus that may be entering waterways via erosive processes. The BMPs discussed below are applicable to TSS and/or sedimentation/siltation impairments within the listed subbasin. Additionally, municipalities covered by MS4s are encouraged to review their stormwater plans to ensure that effective BMPs are being used within their systems.

Filter Strips: Filter strips are vegetative riparian buffers planted along waterways that can serve as a control to reduce both pollutant loads from runoff and sedimentation to impaired stream segments. Filter strips implemented along stream segments slow and filter runoff and provide bank stabilization thereby decreasing erosion and re-sedimentation. Grass filter strips have been shown to remove as much as 65 percent of sediment and 75 percent of total phosphorus loads from runoff (USEPA 2003). Riparian vegetation also provides bank stability that further reduces sediment loading to the stream. The installation of filter strips adjacent to the impaired stream segments, as well as any contributing tributaries, can result in considerable reduction of overland contributions of sediments and suspended solids to an impaired waterbody.

The Illinois NRCS Conservation Practice Standard 393 (June 2003) describes filter strip requirements based on land slope; the requirements are designed to achieve a minimum flow through time of 15 to 30 minutes at a one-half inch depth. **Table 9-1** provides a summary of the guidance for filter strip width, or flow length, as a function of slope (NRCS 2003).

Table 9-1 Filter Strip Flow Lengths Based on Land Slope

Percent Slope	0.5%	1.0%	2.0%	3.0%	4.0%	5.0% or greater
Minimum (feet)	36	54	72	90	108	117
Maximum (feet)	72	108	144	180	216	234

GIS land use and topographic data, described in Section 2 of this report, were used in conjunction with soil slope data to provide an estimate of acreage where filter strips could be installed. As discussed in Section 2.4.1, a total of 72 soil types exist in the watershed. The two most common types (Ipava silt loam and Virden silty clay loam) show 0-2 percent slopes and cover more than 50 percent of the overall watershed while all other soil types each represent less than 10 percent of the total watershed area. Given the prevalence of the two most common types, the maximum values associated with 2 percent or less slopes could be used for this analysis; however, there does still remain some variability in soil type and corresponding slope values across the watershed.

In conjunction with the available land use, topography, and soil information discussed in Section 2, mapping software was used to buffer impaired stream segments and their major tributaries to an appropriate and reasonable width to determine the total area found in each subbasin. Due to the range of soil types and slopes found throughout the watershed, the appropriate buffer widths estimated in GIS were based on the average slope of land within the maximum buffer areas of each impaired segment's major tributaries. These average slopes were then used to calculate approximate buffer distances using a best-fit equation to interpolate between the slope percentages to buffer width relationships provided in the NRCS guidance.

Not all land use types within the buffer areas are candidates for conversion to buffer strips. Existing forests and undisturbed grasslands already function as filter strips and conversion of developed residential or commercial lands is often infeasible. In general, agricultural lands are the land use type most conducive to conversion to buffer strips and will likely provide the greatest benefit to water quality once converted. Therefore, GIS software was used to extract the approximate acreage of agricultural lands within the appropriate buffer area for each impaired stream segment and its tributaries. The calculated overall buffer areas and acreage of agricultural land within the buffer distances for each impaired stream segment and its tributaries are provided in **Table 9-2**. These data represent an approximation of the maximum acreage of land potentially available for conversion to filter strips. More detailed assessment of a given property is necessary to determine the exact size and extent of convertible lands likely to provide the greatest benefit to instream water quality following conversion to filter strips.

There are approximately 146 total acres within the recommended filter strip flow length buffer surrounding impaired stream segment EOAD-11 and its tributaries, an estimated 12 acres of which is categorized as agricultural land where filter strips could potentially be installed. While not impaired for TSS or sedimentation/siltation, values for Sugar Creek segments EOA-01 and EOA-06 are included in **Table 9-2** for reference during later discussions within this section. Landowners should be encouraged to evaluate their land adjacent to impaired streams and their tributaries to determine the practicality of installing or extending filter strips to achieve effective flow lengths as described in the NRCS guidance summarized in **Table 9-1**. Figures depicting the buffered areas and agricultural lands suitable for conversion to filter strips are provided as **Figures 9-1** through **9-3**.

Table 9-2 Average Slopes, Filter Strip Flow Length, Total Buffer Area, and Area of Agricultural Land Within Buffers Potentially Suitable for Conversion to Filter Strips, by Stream Segment

Stream Name	**Segment ID**	**Average Slope Adjacent to Streams** (%)	**Filter Strip Flow Length** (feet)	**Total Area in Buffer** (Acres)	**Agricultural Land in Buffer** (Acres)
Hoover Branch	EOAD-11	18%	2341	146	12
Sugar Creek	EOA-01	8.5%	2341	15,226	8,978
Sugar Creek	EOA-06	9.0%	2341	15,756	9,043

1 Maximum of the minimum filter strip flow lengths recommended by NRCS (slope >5%).

Water and Sediment Control Basins (WASCOBs) and/or Stormwater Retention Ponds: Control basins and ponds ("dry" or "wet") may be used for flood control and treatment of stormwater. Both systems function to settle suspended sediments and other solids typically present in stormwater runoff.

Stormwater ponds are also called retention ponds or "wet" ponds and they hold back water similar to water behind a dam. The pond has a permanent pool of water that fluctuates in response to precipitation and runoff from the contributing areas. Maintaining a pool discourages resuspension and keeps deposited sediments at the bottom of the holding area. USEPA's 1993 Nationwide Urban Runoff Program (NURP) indicated that up to two-thirds of the sediment, nutrients and trace metals can be removed via sedimentation within 24 hours, while two weeks are required to remove a significant amount of phosphorus. A wet detention basin must receive and retain enough water from rain, runoff, and groundwater to maintain a permanent pool in the deeper areas of the basin. Most sources recommend a minimum drainage area of ten acres to sustain a constant inflow. Wet detention basins should be sized to treat the water quality volume and detain and release the 100-year event. The permeability of hydrologic soil groups "C" and "D" is suitable for a wet basin without modification. The side slopes of a wet detention basin should be no steeper than 5:1 above the normal water level (DuPage County, 2008).

Sediment control basins are typically earthen embankments installed along drainages that act similarly to a terrace. The "dry" basin traps water and sediment running off cropland upgradient from the structure, and reduces gully erosion by controlling flow within the drainage area. The basin then releases water slowly, which also helps to decrease streambank erosion in the receiving water.

Sediment control basins are usually designed to capture drainage from an area of 30 acres or less and are typically designed to be large enough to control runoff from at least a 10-year, 24-hour storm. Locations are determined based on slopes, tillage, and crop management, and the local NRCS personnel can often provide information and advice for design and installation. Maintenance includes reseeding or planting the basins in order to maintain vegetation and periodically checking them, especially after large storms, to determine the need for embankment repairs or mechanical removal of excess sediment.

Grassed Waterways: Grassed waterways are natural or constructed broad, shallow, and heavily vegetated channels designed to move surface water across farmland without causing soil erosion. The vegetative cover within the waterway reduces peak discharge and protects the channel surface from rill and gully erosion. Waterways are often constructed in natural depressions where the water collects and flows to an outlet. In addition to reducing erosion, grassed waterways can positively affect water quality through uptake of other pollutants attached to soils such as nutrients. The NRCS recommends these maintenance measures for grassed waterways:

- If possible, bring row crop patterns into the waterway nearly on the contour, or use it as the turn area. Don't plant end rows along the side of the waterway.
- Plant good quality NRCS-approved seed and fertilize periodically.

- Inspect the area frequently for eroding areas and places needing reseeding. Repair minor rills or gullies by reshaping and reseeding.
- Maintain the width of the grass area when tilling and planting adjacent fields.
- Avoid spraying herbicides in the waterway.
- Avoid driving up and down grassed waterways, especially during wet conditions. The ruts caused by tire tracks can lead to gullies.
- Maintain outlets to prevent gullies from forming. This may include reshaping and reseeding the outlet, or repairing components of structural outlets.

Saturated Buffers: A saturated buffer is a riparian buffer in which the water table is artificially raised by diverting subsurface drainage along the buffer accomplished by installing a water control structure in the main drainage outlet. Instead of water flowing through a farm tile straight to an outflow point, water is directed to a lateral tile which runs parallel to a ditch. A grass buffer is created at the edge of the field above this lateral tile, which takes up the water and nutrients in the water, before it leaves the field. Buffers also provide wildlife habitat, sequester carbon, reduce greenhouse gas emissions, stabilize stream banks and potentially reduce flood impacts. Cost of buffers can vary greatly depending on width, type of vegetation and the amount of earthwork required (Illinois Council on Best Management Practices, 2016).

The following list contains some insights about the site selection process that were gained from research conducted by the Agricultural Drainage Management Coalition:

- Get in the channel and walk the section of ditch/stream where the proposed saturated buffer will go, preferably when the water level is at base flow or lower. Look for and mark all outlets.
- Verify the tile system you are intercepting has a large enough drainage area to justify the cost of installing a saturated buffer treatment system.
- In addition to using soil maps, take soil cores to verify high organic matter and lack of coarse materials within the buffer.
- Sites with shallow ditches that are frequently flooded may not produce satisfactory results.

The full research report and additional information and videos pertaining to saturated buffer systems can be found at www.saturatedbufferstrips.com

Cover Crops: Cover crops are grasses, legumes or small grains grown between regular grain crop production periods for the purpose of protecting and improving the soil. Cover crops improve soil health by building soil organic matter, reducing erosion, holding nutrients in place, and providing those nutrients for the next year's crop. This also reduces soil and nutrient losses into nearby waterways, improving water quality. The benefits of cover crops take time and proper management. The Illinois Council on Best Management Practices lists ten key planning items to ensure cover crop success (http://illinoiscbmp.org/Blog/Posts/44/Cover-Crops/2016/7/Planning-the-Key-to-Cover-Crop-Success/):

- Plan early. Ideally, a plan for cover crop seed and management strategies should be in place before spring planting begins. July 1st at the latest. Maintain outlets to prevent gullies from forming. This may include reshaping and reseeding the outlet, or repairing components of structural outlets.
- In early spring, contact your county NRCS district conservationist to see if you can sign up for a program that includes payments for planting cover crops the next fall.
- Choose the best field to start growing cover crops. Think smaller acres when you start planting cover crops for the first time. Focus on your best drained fields first to minimize management complications and maximize water quality benefits.
- Select your cover crops for fall in early spring. Choose the specie or species of cover crop to fit your rotation, field issues and field conditions. Identify one that will help correct any problems: wet soils, compaction, nutrient loss, etc. Plan to leave a check strip without cover crops for an area of comparison.
- For cover crop selection and management advice contacting a CBMP cover crop specialist, local Extension agronomist, NRCS DC, crop consultant or go to mccc.msu.edu and select the "cover crop decision tool". It will have most of the information you need, seeding dates by county, seeding rates and cover crop characteristics. Consider an easy, terminal mix such as oats and radish if trying cover crops for the first time.
- Purchase high quality seed and named varieties from a reputable cover crop seed source at the end of the spring planting of your cash crops (June and no later than July -some varieties may require ordering before April). There is a large difference in different cover crop varieties, so buy varieties not VNS seed whenever possible.
- Contact your herbicide retailer to help you choose herbicides compatible with the species you have chosen in the early spring prior to fall seeding of the cover crop. Some herbicides can last until fall cover crop planting and the result is poor or no stands of cover crops after seeding. Look at labels, notice planting date restrictions to next crop. Watch for high pH soils as some herbicides will be much more active and cause cover crop damage in the fall. Discuss termination options for the next crop year.
- Decide how you are going to seed the cover crop. Consider aerial or in crop seeding starting in mid to late August. After corn black layers and has sunlight on the ground or soybeans are starting to turn yellow is the time to seed. Contact your aerial applicator early in the summer if aerial seeding is your choice or make sure you have your drill field ready. Plant or aerially seed in a timely manner for maximum fall growth and consider adding some N following corn for quicker establishment and growth.
- Remember radish, rapeseed, clovers, annual ryegrass will all need to be seeded by September 15 for best results. Oats can be seeded until October 1. Cereal rye, triticale or wheat can be planted much later in October. If this is your first time to over wintering

cover crops, consider seeding at a lower rate to make it easier to kill and plant into next spring.

- Poorly managed cover crops virtually always will result in poor results. Make sure you are willing to devote the time to learn, go to meetings and try small fields before jumping in with lots of acres.

Streambank Stabilization/Erosion Control: Soil erosion is the process of moving soil particles or sediment by flowing water or wind. Additionally, eroding soil transports pollutants that can potentially degrade water quality. Four available approaches to potentially decrease nonpoint TSS, sedimentation/siltation, and/or pollutant source loads, as well as helping to stabilize eroding banks include the following:

- Stone Toe Protection: Non-erodible materials are used to protect the eroding banks of a stream. Meandering bends found in the watershed could potentially be stabilized by placing the hard armor only on the toe of the bank. Stone toe protection is most commonly implemented "using stone quarry stone that is sized to resist movement and is placed on the lower one third of the bank in a windrow fashion" (STREAMS 2005).

- Rock Riffle Grade Control: Naturally stable stream systems typically have an alternating riffle-pool sequence that helps to dissipate stream energy. Riffle rock grade control places loose rock grade control structures at locations where natural riffles would occur to create and enhance the riffle-pool flow sequence of stable streams. By installing riffle rock in an incised channel, the riffles will raise the water surface elevation resulting in lower effective bank heights, which increases the bank stability by reducing the tractive force on the banks (Kinney 2005).

- Floodplain Excavation: Rather than raising the water level, Floodplain Excavation lowers the floodplain to create a more stable stream. Floodplain Excavation uses mechanical means to restore the floodplain by excavating and utilizing the soil that would eventually be eroded away and deposited in the stream (STREAMS 2005).

- Rock chutes: Rock chutes are riprap lined water conveyance structures used to move water down a slope in a non-erosive manner. The main purpose of a rock chute is to reduce channel flow velocity by dissipating energy and to provide a stable grade at the outlet to prevent erosion.

The extent of streambank erosion within the Hoover Branch subbasin is unknown. Further investigation is recommended to determine the extent that erosion control measures could help manage TSS and/or sedimentation/siltation loads in the reaches.

Pasture Management/Fencing: As discussed in Section 5.4.2 of this report, livestock are present within the watershed, but these animals are primarily pastured and no high concentration feed operations exist in the watershed. Some basic pasture management strategies can be implemented to improve soil and reduce erosion. For example, pasture fencing can greatly enhance the efficiency of your farming operation. When livestock are penned up in the same field or paddock for the entire grazing season, the plants in that area are grazed too short or even down to bare earth which increases the likelihood of soil loss. Guidance for rotation suggests livestock be moved into a grazing enclosure when the forage is around six inches high and moved off again when it is two inches high. This will also encourage the growth of the forage and will sometimes break the life cycle of parasites. As more pasture is divided into smaller paddocks, the utilization of forages by grazing livestock can increase. As utilization of forages is increased and cattle are moved more frequently, the ungrazed paddocks will have fresh forage available for grazing and the previously grazed paddocks will have time to rest. Rest periods from grazing allow forage regrowth and prevent overgrazing, which can lead to increased storm water runoff and unnecessary sediment and nutrient loss.

In addition to aiding in healthy pastures, fencing can also be an effective way to restrict livestock from streams. It is unknown to what extent livestock have access to Hoover Branch or its tributaries. Reduction of livestock access to streams, however, is recommended to limit damage to streambanks. Access of livestock and other animals to streams can increase bank erosion, trample filter strips and riparian buffers causing short circuiting of pollutant treatment. Exclusion or restricting pet, livestock, and wildlife access to streams with fencing helps reduce pollutant loads.

9.4 BMP Recommendations for Reducing TSS in Lake Springfield

TSS and/or sedimentation/siltation load reductions are needed for Lake Springfield (REF) in order to meet the watershed-specific LRS target value. The percent reduction needed for TSS in Lake Springfield (REF) is discussed in Section 8.3.3.

Nonpoint source runoff from agricultural areas and unstable streambanks and shorelines are contributors to high sediment loads in the impaired waterbodies. Therefore, as with streams, nonpoint source controls designed to reduce erosion are expected to reduce TSS and sedimentation/siltation in lakes as well as provide a secondary benefit of reducing other contaminants such as total phosphorus that may be entering waterways via erosive processes. The BMPs discussed in Section 9.3 are also applicable to TSS and/or sedimentation/siltation impairments within the lake; i.e., the following:

- Filter strips
- WASCOBs
- Grassed waterways
- Streambank stabilization/erosion control
- Cover Crops
- Pasture Management/Fencing
- Saturated Buffers

For the filter strips, potential tributary and shoreline buffer areas were calculated using average slopes in the subbasin as described in Section 9.3. The average slopes, appropriate filter strip flow lengths, and calculated areas within the buffer distances for each waterbody are provided in **Table 9-3**. While there are only an estimated 11 acres of agricultural land surrounding the shores of Lake Springfield, an additional 8,923 acres of agricultural land exists adjacent to the reservoir's major tributaries where filter strips could potentially be installed to limit nutrient and sediment inflows into the reservoir. Landowners should be encouraged to evaluate their land adjacent to the impaired lake to determine the practicality of installing or extending filter strips to achieve effective flow lengths as previously described. A figure depicting the buffered areas and agricultural lands suitable for conversion to filter strips in the lake's subbasin is provided as **Figure 9-3**.

Table 9-3 Average Slopes, Filter Strip Flow Length, Total Buffer Area, and Area of Agricultural Land Within Buffers Potentially Suitable for Conversion to Filter Strips, Lake Springfield

Waterbody Name	**Segment ID**	**Average Slope** (%)	**Filter Strip Flow Length** (feet)	**Total Area in Buffer** (Acres)	**Agricultural Land in Buffer** (Acres)
Lake Springfield	REF	9.5	234	15,204	8,934

1 Maximum of minimum filter strip flow lengths recommended by NRCS (slope >5%).

The extent of shoreline erosion surrounding the lake has been assessed by CWLP. Continued investigation is recommended to determine the extent that erosion control measures could help manage TSS and/or sedimentation/siltation loads in the waterbody.

9.5 BMP Recommendations for Reducing Total Phosphorus in Sugar Creek Impaired Segment EOA-06

Sugar Creek segment EOA-06 is listed for impairment of aquatic life due to total phosphorus. Phosphorus is a nutrient critical to healthy ecosystems at low concentrations; however, over enrichment of phosphorus can result in aquatic ecosystem degradation when nitrogen is also available in sufficient quantities. Nutrient enrichment can result in rapid algal growth as available nutrients and carbon dioxide are consumed. This response can alter pH, decrease DO (which is critical to other aquatic biota), alter the diurnal DO pattern, and even create anoxic conditions. In addition, nutrient enrichment can reduce water clarity and light penetration and is aesthetically displeasing. Oxygen levels must be considered when evaluating BMPs for phosphorus because phosphorus is released from sediment at higher rates under anoxic conditions; increased water temperature and photosynthesis decrease DO levels and create anoxic conditions.

Inputs of phosphorus originate from both point and nonpoint sources. Most of the phosphorus discharged by point sources is soluble. Phosphorus from point sources also typically has a continuous impact and is human in origin; for example, effluents from municipal sewage treatment plants and permitted industrial discharges. The contribution from failed onsite waste water treatment (septic) systems can also be significant (nonpoint sources), especially if they are concentrated in a small area. Phosphorus from nonpoint sources is generally insoluble or particulate. Most of this phosphorus is bound tightly to soil particles and enters streams from erosion although some may come from sources such as tile drainage. The impact from phosphorus discharged by nonpoint sources is typically intermittent and is most often associated with stormwater runoff. Sedimentation can impact the physical attributes of the stream and act as a transport mechanism for phosphorus.

The total phosphorus reductions needed for the Sugar Creek segment EOA-06 are discussed in Section 8.3.2. To achieve a reduction of total phosphorus for the EOA-06 segment, management measures should address loading through point-source discharge and, in particular, nonpoint source sediment and surface runoff controls.

9.5.1 Point Sources of Phosphorus

Table 5-8 lists eight active NPDES permitted facilities within the Lake Springfield watershed. The two facilities discharging to EOA-06 are:

- Springfield MSD-Sugar Creek STP (IL0021971) – EOA-06
- Springfield CWLP (IL0024767) – EOA-06 (and lake)

WLAs for the Auburn STP, Thayer STP, and Virden North STP were calculated as part of the phosphorus TMDL for Lake Springfield as discussed in Section 8.3.1.5 and shown in **Table 8-3**. WLAs were not calculated for the EOA-06 facilities because they are downstream of Lake Springfield and the LRS for stream phosphorus does not include a WLA (see Section 8.3.2).

In addition to the point sources discussed above, approximately 30,000 acres (16 percent) of the land within the watershed is urbanized and consists of low, medium, and high density residential land uses which may contribute to stormwater runoff entering the impacted waterbodies. Five of the townships in the watershed have MS4 permits, as listed in **Table 5-9**. Two of the municipalities (City of Springfield and Village of Chatham) contribute stormwater within the Lake Springfield drainage basin. **Table 8-3** also contains the WLAs calculated for the City of Springfield and Village of Chatham MS4s.

Illinois EPA will evaluate the need for point source controls through the NPDES permitting program as each facility's permit is due for renewal. It is recommended that monitoring for phosphorus be included in future permits so that Illinois EPA permitting staff can accurately gage point source loading and evaluate the need for future limits or permit revisions.

9.5.2 Nonpoint Sources of Phosphorus

Nonpoint sources of phosphorus include septic systems and both urban and rural land runoff. BMPs that could be used for treatment of these nonpoint sources include:

- Conservation tillage
- Filter Strips and Riparian Buffers
- Saturated Buffers
- Nutrient management
- Cover Crops
- Wetlands
- WASCOBs and/or Stormwater Retention Ponds

- Pasture Management/Fencing
- Phosphorus-based lawn fertilizer restrictions

Conservation Tillage Practices: Conservation tillage practices could help reduce nutrient and sediment loads into the impaired stream segments by reducing erosion of soils. **Table 9-4** shows the area (acres) in the Lake Springfield watershed that is under cultivation, along with the percent of the corresponding watershed area which is cultivated. In conservation tillage, at least 30 percent of the soil surface retains cover by residue after planting. Crop residuals or living vegetation cover on the soil surface protects against soil detachment from water and wind erosion.

Table 9-4 Cultivated Areas for the Lake Springfield and Sugar Creek Watershed

Land Cover Area (Acres)	**Cultivated Area** (Acres)	**Percent Cultivated**
183,627	127,138	69%

Conservation tillage practices are grouped into three types: no-till, ridge-till, and mulch-till. No one method is best for all fields; instead, the decision on the type of conservation tilling to be used should be based on factors such as the severity of the erosion problem, the soil type, crop rotation, and available equipment. No-till leaves the soil undisturbed from harvest to planting thus leaving a high percentage of surface covered by crop residues. No-till planting can be done successfully in chemically-killed sod, in crop residues from the previous year, or when double-cropping after a small grain. The planting is done in a narrow (usually 6 inches or less) seedbed or slot created by coulters, row cleaners, disk openers, in-row chisels, or roto-tillers. A press-wheel follows to provide firm soil-seed contact. Herbicides are the primary method of weed control, although cultivation may be used for emergency weed control.

Ridge-till involves planting into a seedbed prepared on ridges with sweeps, disk openers, coulters, or row cleaners. The ridges are rebuilt during cultivation and, except for nutrient injection, the soil is left undisturbed from harvest to planting. Ridge-till systems therefore leave residue on the surface between ridges so the degree of soil conservation depends on the amount of residue and the row direction. Planting on the contour and increased surface coverage greatly reduce soil loss. Ridge-till works best on nearly level, poorly drained soils. The ridges speed up drainage and soil warm-up. Cultivation controls weeds along with some herbicides.

Mulch-till uses chisel plows, field cultivators, disks, sweeps, or blades to till the soil before planting. The tillage does not invert the soil but leaves it rough and cloddy. Various chisel points or sweeps attached to the shanks affect the amount of residue cover left on the soil surface. The effectiveness of mulch-till systems in reducing erosion depends on surface roughness, amount of residue, and tillage direction. Fall chiseling should be done to a depth of 8-10 inches, and spring chiseling should be no deeper than 6 inches. Disking or other shallow tillage operation can be used in seed bed preparation. A standard, or tandem, disk does not till as deep and leaves more residue on the surface compared to heavy (offset) disks. Herbicides and/or cultivation control weeds in a mulch-till system.

Conservation tillage practices can remove up to 45 percent of the dissolved and total phosphorus from runoff and approximately 75 percent of the sediment. Additionally, studies have found around 93 percent less erosion occurred from no-till acreage compared to acreage subject to moldboard plowing (USEPA 2003). Tillage practices in the Lake Springfield watershed should be assessed and possibly improved upon to reduce sediment loads.

Filter Strips: As discussed in Sections 9.3, filter strips can be used as a control to reduce both pollutant loads from runoff, such as phosphorus, and sedimentation to impaired waterbodies. Filter strip areas for nutrient control are calculated as described in Section 9.3. Based on those calculations, and as noted in **Table 9-2**, there are approximately 9,043 acres of agricultural land within the 234-foot buffer delineated for EOA-06 (see **Figure 9-2**).

Riparian Buffers: Riparian corridors, including both the stream channel and adjacent land areas, are important components of watershed ecology. Riparian vegetation, specifically the shade-producing variety, plays a significant role in controlling stream temperature change. The shade provided will reduce both solar radiation loading to the stream and peak temperatures during the growing season which can in turn increase the water body DO saturation level. Furthermore, preserving natural vegetation along stream corridors can effectively reduce water quality degradation associated with development. The root structure of the vegetation in a buffer enhances infiltration of runoff and subsequent trapping of nonpoint source pollutants, such as phosphorus. The buffers are only effective in this manner, however, when the runoff enters the buffer as a slow moving, shallow sheet. Concentrated flow in a ditch or gully will quickly pass through the buffer offering minimal opportunity for retention and uptake of pollutants.

Even more important than the filtering capacity of the buffers is the protection they provide to streambanks. The rooting systems of the vegetation serve as reinforcements in streambank soils, which help to hold streambank material in place and minimize erosion. Due to the increase in stormwater runoff volume and peak rates of runoff associated with agriculture and other land development, stream channels are subject to greater erosional forces during stormflow events. Thus, preserving natural vegetation along stream channels minimizes the potential for water quality and habitat degradation due to streambank erosion as well as that additional pollutant or sediment load entering the stream.

Converting land adjacent to streams for the creation of riparian buffers will provide stream bank stabilization, stream shading, and nutrient uptake and trapping from adjacent areas. Minimum buffer widths of 25 feet are required for water quality benefits. Higher removal rates are provided with greater buffer widths. The USEPA (2003) reports phosphorus removal rates of approximately 25 to 30 percent for 30-foot-wide buffers and 70 to 80 percent for 60- to 90-foot-wide buffers. Riparian corridors can typically treat a maximum of 300 feet of adjacent land before runoff forms small channels that short circuit treatment. In addition to the treated area, the land converted from agricultural land to buffer strip will generate up to a 90 percent lower nutrient load based on data presented in Haith et al. (1992).

Land use data were clipped to 25 feet buffer zones created around the impaired stream segments. Grassland, forest, and agricultural areas within the 25 foot buffer zones are shown in **Table 9-5**. There are 1,690 acres within 25 feet of EOA-06 and its tributaries; approximately 894 of these acres are existing grassland or forest while 510 acres are currently classified as cultivated.

Landowners should assess parcels adjacent to the stream channels and maintain or improve existing riparian areas or potentially convert cultivated lands.

Table 9-5 Total Area and Area of Grassland, Forest, and Cultivated Land Within 25-Foot Buffer, by Stream Segment

Stream Name	Segment ID	Area in 25 ft Buffer (Acres)	Grassland in 25 ft Buffer (Acres)	Forest in 25 ft Buffer (Acres)	Cultivated Land in 25 ft Buffer (Acres)
Sugar Creek	EOA-06	1,690	344	550	510

Saturated Buffers: As discussed in Sections 9.3, saturated buffer are riparian buffers in which the water table is artificially raised by diverting subsurface drainage along the buffer and is accomplished by installing a water control structure in the main drainage outlet. Instead of water flowing through a farm tile straight to an outflow point, water is directed to a lateral tile which runs parallel to a ditch. A grass buffer is created at the edge of the field above this lateral tile, which takes up the water and nutrients in the water, before it leaves the field. Saturated buffers can filter nutrients attached to sediments through overland flow as well as help remove the dissolved portion through plant uptake. Cost of buffers can vary greatly depending on width, type of vegetation and the amount of earthwork required (Illinois Council on Best Management Practices, 2016).

Nutrient Management: Nutrient management programs could result in reduced nutrient loads to the impaired stream segments in the Lake Springfield watershed. Crop management of nitrogen and phosphorus originating in the agricultural portions of the watershed can be accomplished through Nutrient Management Plans (NMPs) that focus on increasing the efficiency with which applied nutrients are used by crops, thereby reducing the amount available to be transported to both surface water and groundwater. As indicated in **Table 9-4**, approximately 137,138 acres in the Lake Springfield watershed are under cultivation; these areas may benefit from NMPs.

The overall goal of nutrient reduction from agriculture should be to increase the efficiency of nutrient use by balancing nutrient inputs in feed and fertilizer with outputs in crops and animal produce as well as to manage the concentration of nutrients in the soil. The four "Rs" of nutrient management are applying the right fertilizer source at the right rate at the right time and in the right place. It is not unusual for crops in fields or portions of fields to show nutrient deficiencies during periods of the growing season, even where an adequate NMP is followed. The fact that nutrients are applied does not necessarily mean they are available. Plants obtain most of their nutrients and water from the soil through their root system. Any factor that restricts root growth and activity has the potential to restrict nutrient availability and result in increased nutrient runoff.

Reducing nutrient loss in agricultural runoff may be brought about by source and transport control measures, such as filter strips or grassed waterways. The NMPs account for all inputs and outputs of nutrients to determine reductions. NMPs typically include the following measures:

- A review of aerial photography and soil maps

- Recommendation for regular soil testing – Traditionally, soil testing has been used to decide how much lime and fertilizer to apply to a field. With increased emphasis on precision agriculture, economics, and the environment, soil tests have become a logical tool to determine areas where adequate or excessive fertilization has taken place. Additionally, they can be used to monitor nutrient buildup in soils due to past fertility practices and aid in determining maintenance fertilization requirements. Appropriate soil sampling and analysis techniques are described in the Illinois Agronomy Handbook (http://extension.cropsciences.illinois.edu/handbook/).

- A review of current and/or planned crop rotation practices

- Establishment of yield goals and associated nutrient application rates – Matching nutrient applications to crop needs will minimize the potential for excessive buildup of phosphorus soil tests and reallocate phosphorus sources to fields or areas where they can produce agronomic benefits.

- Development of nutrient budgets with planned application rates (which may be variable), application methods, and timing and form of nutrient application

- Identification of sensitive areas and restrictions on application when land is snow covered, frozen or saturated

Phosphorus is listed as a potential cause of impairment in some areas of the Lake Springfield watershed. Regional differences in phosphorus-supplying power (the soil's ability to supply phosphorus) are shown in Figure 8-4 of the Illinois Agronomy Handbook (http://extension.cropsciences.illinois.edu/handbook/). The differences were broadly defined primarily based on variability in parent material, degree of weathering, native vegetation, and natural drainages. For example, soils developed under forest cover appear to have more available subsoil phosphorus than those developed under grass. In the Lake Springfield watershed in central Illinois, soils are generally considered to have medium to high phosphorus-supplying power; therefore, little to no buildup and maintenance of phosphorus levels are usually needed in this area. Application amounts should be determined by periodic soil testing; however, excessively high-phosphorus soil test levels should not be maintained.

While soil test procedures were designed to predict where phosphorus was needed, not to predict environmental problems, the likelihood of phosphorus loss increases with high-phosphorus test levels. Environmental decisions regarding phosphorus applications should include such factors as distance from a significant lake or stream, infiltration rate, slope, and residue cover. One possible problem with using soil test values to predict environmental problems is in sample depth. Normally samples are collected to a 7-inch depth for predicting nutritional needs. For environmental purposes, it would often be better to collect the samples from a 1- or 2-inch depth, which is the depth that will influence phosphorus runoff. Another potential problem is variability in soil test levels within fields in relation to the dominant runoff and sediment-producing zones. Several fertilizer placement recommendations are described in the Illinois Agronomy Handbook (http://extension.cropsciences.illinois.edu/handbook/). However, given the propensity of phosphorus to bind tightly to soil particles and subsequently enter streams through erosion, the deep fertilizer placement technique may be most appropriate in phosphorus impaired areas. Under the deep placement technique, the fertilizer is placed 4 to 8 inches deep into the soil rather than being spread near the surface.

Cover Crops: Cover crops are grasses, legumes or small grains grown between regular grain crop production periods for the purpose of protecting and improving the soil. Cover crops improve soil health by building soil organic matter, reducing erosion, holding nutrients in place, and providing those nutrients for the next year's crop. This also reduces soil and nutrient losses into nearby waterways, improving water quality. Further discussion of cover crops is provided in Section 9.3.

Pasture Management/Fencing: Pasture management and fencing for livestock was previously presented in Section 9.3 with relation to soil loss reduction. Pasture management also reduces nutrient loss by maintaining fresh forage and keeping nutrients bound in stable soils and healthy plants. Additional fencing measures can also restrict livestock access to area waterways which also prevents soil instability and eliminates a direct pathway for livestock waste to enter water.

Wetlands: The use of wetlands as a structural control is applicable to nutrient reduction. To treat loads from agricultural runoff, such as phosphorus, wetlands could potentially be constructed at select locations where more focused runoff from fields occurs; e.g., downstream of a tile drainage system. Wetlands are effective BMPs for phosphorus and sediment control because they:

- Prevent floods by temporarily storing water, allowing the water to evaporate or percolate into the ground
- Improve water quality through natural pollution control such as plant nutrient uptake
- Filter sediment
- Slow overland flow of water thereby reducing soil erosion (NRCS 2004)

A properly designed and functioning wetland can provide very efficient treatment of pollutants, such as phosphorus. Design of wetland systems is critical to the sustainable functionality of the system and should consider soils in the proposed location, hydraulic retention time, and space requirements. In general, soils classified as hydric are most suitable for wetland construction. The current extent of soils classified as hydric by the NRCS as well the current extent of existing United States Fish and Wildlife Service classified wetlands in the Lake Springfield watershed are shown in **Figure 9-4**. Areas near waterways that are not currently classified as wetlands but have hydric soils present are typically strong candidates for potential wetland construction. Existing wetland areas may also be candidates for reconstruction or enhancement to improve their nutrient uptake capacity. These data layers are developed on a large-scale and onsite soil investigation and wetland delineation is typically necessary for verification of the suitability of a given area for wetland construction.

Constructed wetlands, which comprise the second or third stage of a nonpoint source treatment system, can be very effective at improving water quality. Studies have shown that artificial wetlands designed and constructed specifically to remove pollutants from surface water runoff have removal rates of greater than 90 percent for suspended solids, up to 90 percent for total phosphorus, 20 to 80 percent of orthophosphate, and 10 to75 percent for nitrogen species (Johnson, Evans, and Bass 1996; Moore 1993; USEPA 2003; Kovosic et al. 2000). Although the removal rate for phosphorus is low in long-term studies, the rate can be improved if sheet flow is maintained to the wetland and vegetation and substrate are monitored to ensure the wetland is operation optimally. Sediment or vegetation removal may be necessary if the wetland removal efficiency is lessened over time (USEPA 2003). Guidelines for wetland design suggest a wetland to watershed ratio of 0.6 percent for nutrient and sediment removal from agricultural runoff.

WASCOBs and/or Stormwater Retention Ponds: As discussed in Section 9.3, these basins are “dry” or “wet” and are designed to trap sediments (and the pollutants bound to the sediment) prior to reaching a receiving water. WASCOBS and stormwater retention ponds can therefore be effective in reducing phosphorus loads to water bodies by capturing pollutant-laden water and sediment before it reaches the waterbody and allowing the contaminants to settle out.

Phosphorus-Based Lawn Fertilizer Restrictions: Runoff from urban areas may include phosphorus-based fertilizers applied to residential lawns, golf courses, and other surfaces. If used too close to a receiving waterbody, phosphorus present in stormwater runoff will enter the waterbody. Illinois has a statute in place which governs the use of phosphorus-based fertilizers in urban areas: Lawn Care Products Application and Notice Act (415 ILCS 65). This act includes the following prohibitions for phosphorus-based fertilizers (see act for limited exceptions):

- They shall not be applied to lawns unless it can be demonstrated by soil test that the lawn is lacking in phosphorus when compared against the standard established by the University of Illinois; see the act for exceptions
- They shall not be applied to impervious surfaces
- They shall not be applied within 3 feet of any waterbody if a spray, drop, or rotary spreader is used. If other equipment is used, the fertilizer may not be applied within 15 feet of a water body.
- They shall not be applied when the ground is frozen or saturated
- Appropriate lawn markers for the application event and notifications to potentially affected adjacent properties are required

Private Septic System Inspection and Maintenance Program: Failing or leaking septic systems can be a significant source of phosphorus pollution. A program that actively manages functioning systems and addresses non-functioning systems could be implemented to reduce the potential phosphorus loads from septic systems in the watershed. The USEPA has developed guidance for managing septic systems, which includes assessing the functionality of systems, public health, and environmental risks (USEPA 2005). It also introduces procedures for selecting and implementing a management plan.

To reduce the discharge of excessive amounts of contaminants from a faulty septic system, a scheduled maintenance plan that includes regular pumping and maintenance of the septic system should be followed. The majority of failures originate from excessive suspended solids, nutrients, and biochemical oxygen demand loading to the septic system. Reduction of solids entering the tank can be achieved by limiting the use of garbage disposals.

Septic system management practices can extend the life, and maintain the efficiency, of a septic system. Water conservation practices, such as limiting daily water use or using low flow toilets and faucets, are the most effective methods to maintain a properly functioning septic system. Additionally, septic systems should not be used for the disposal of solids, such as cigarette butts, cat litter, cotton swabs, coffee grounds, disposable diapers, etc. Physical damage to the drain field can be prevented by:

- Maintaining a vegetative cover over the drain field to prevent erosion
- Avoiding construction over the system
- Protecting the area down slope of the system from excavation
- Landscape the area to divert surface flow away from the drain field (Johnson 1998)

The cost of each management measure is highly variable and site-specific data on septic systems and management practices do not exist for the watershed; therefore, homeowners with septic systems should contact their county health department for septic system management costs.

Current protocols in Illinois for addressing failing septic systems in the rural areas noted above should adhere to the Illinois Private Sewage Disposal Licensing Act and Code "to prevent the transmission of disease organisms, environmental contamination and nuisances resulting from improper handling, storage, transportation and disposal from private sewage disposal systems". Any new, replaced, or renovated system must be installed by a licensed contractor or the homeowner and permitted through the county health department. The department must receive both an application for permit and the appropriate fee from the contractor/homeowner. Once reviewed and approved, a permit is issued and an inspection of the system is conducted during and after construction. The county health department also investigates private sewage disposal system complaints.

A long-range solution to failing septic systems is connection to a municipal sanitary sewer system. Connection to a sanitary sewer line would reduce existing phosphorus sources by replacing failing septic systems with municipal treatment and will allow communities to develop without further contribution of contaminants to the impaired areas of the Lake Springfield watershed. Costs for the installation are generally paid over a period of several years (average of 20 years) and help to avoid forcing homeowners to shoulder the entire initial cost of installing a new septic system. In addition, costs are sometimes shared between the community and the utility responsible for treating the wastewater generated from replacing the septic tanks. The planning process is involved and requires participation from townships, cities, counties, businesses, and citizens.

It is unknown at this time how many septic systems are present within the watershed. As indicated in Section 2.3, approximately 16.4 percent of the Lake Springfield watershed consists of developed or urbanized land. Many businesses, residences, and other structures in the developed areas are served by a municipal sewer district and septic systems are uncommon in these areas. However, many households in rural areas of Illinois that are not connected to municipal sewers make use of onsite sewage disposal systems, or septic systems. The degree of nutrient removal in these systems is limited by soils and system upkeep and maintenance.

As discussed in Section 2.5, approximately 74,300 people reside in the Lake Springfield watershed with the largest portion in the city of Springfield (population of approximately 116,000) and the surrounding metropolitan area (including Grandview, Jerome, Leland Grove, Sangamon City, and Southern View). Additional communities within the watershed include: Chatham (pop. 11,946), Loami (pop. 753), Auburn (pop. 4,826), Thayer (pop. 694), and Virden (pop. 3,492).

As discussed in Section 5.4.3, Sangamon County health officials indicated that Auburn, Loami, Thayer, and the Springfield metropolitan area have municipal sewer systems. Based on information provided by Springfield CWLP, 431 septic systems were known to exist on the marginal lands of the lake (as of 2014), and 214 of those were open systems that drain through leachfields to the lake. The remaining 217 septic systems adjacent to the lake were closed systems that used closed drainfields to treat wastewater biologically onsite or require tank pump-out. Currently 339 properties around the perimeter of the lake are sewered and additional sewer lines are being installed to further reduce the number of septic systems in use around the perimeter of the lake. The SMSD additionally has an ongoing program to eliminate septic systems around Lake Springfield. As of April 2014, 27 individual private pump stations had been installed or permitted for installation under this program. Morgan and Macoupin County health department officials have indicated that within the portion of each county encompassed by the Lake Springfield watershed, only Waverly and Virden have municipal sewage collection; other areas are served by private systems.

Given this information and assuming that approximately 40 percent of the population for the Springfield metropolitan area resides within the Lake Springfield watershed, up to 6,100 people may be served by private septic systems. If a typical household is assumed to consist of four people, there may be around 1,500 households which have septic systems.

9.6 BMP Recommendations for Reducing Total Phosphorus (and Aquatic Algae) in Lake Springfield

Lake Springfield is listed for aesthetic quality impairment by total phosphorus and aquatic algae. The primary causes of the impairments include both point and nonpoint sources of nutrient loads. Internal cycling of phosphorus from lake sediments can also be a significant contributor to impairments in the lake. Implementation actions initiated for Lake Springfield for total phosphorus load reduction are expected to alleviate aquatic algae issues as well.

Phosphorus loads originate from internal and external sources. Possible external sources of total phosphorus include municipal point sources, agricultural activity, and run off and littoral/shore area modifications. To achieve a reduction of total phosphorus for the lake, management measures should address loading through point-source discharge along with sediment and surface runoff controls. Reduction of phosphorus loads from internal cycling can also help achieve the goal of meeting the established water quality criteria.

9.6.1 Point Sources of Phosphorus

As noted in Section 9.5, five of the facilities listed in **Table 5-8** discharge to or upstream of Lake Springfield. These facilities include the following:

- Auburn STP (IL0022403)
- Virfden North STO (IL0023426)
- Lake Springfield Baptist Church (IL0050253)
- Loami STP (ILG580275)
- Thayer STP (ILG580260)

WLAs for these facilities were calculated as discussed in Section 8.3.1.5 and shown in **Table 8-3**. Currently, only one facility (Lake Springfield Baptist Camp) has monitoring requirements for phosphorus in its permit. MS4 discharges, as discussed in Section 9.5.1 may also contribute to the phosphorus impairment in Lake Springfield.

Illinois EPA will evaluate the need for point source controls through the NPDES permitting program as each facility's permit is due for renewal. It is recommended that, at a minimum, regular monitoring of phosphorus concentrations in effluent be required so that Illinois EPA permitting staff can accurately gage point source loading and evaluate the need for future limits or permit revisions.

9.6.2 Nonpoint Sources of Phosphorus

In addition to non-MS4 urban stormwater, runoff from agricultural land is a potential nonpoint source of phosphorus pollution to Lake Springfield. BMPs evaluated that could be utilized to treat these nonpoint sources are:

- Conservative tillage
- Filter Strips and Riparian Buffers
- Saturated Buffers
- Wetlands
- WASCOBs and/or Stormwater Retention Ponds
- Nutrient management
- Cover Crops
- Pasture Management/Fencing
- Phosphorus-based lawn fertilizer restrictions
- Private septic system inspection and maintenance program
- In-lake management measures

Most of these BMPs are described in previous sections (in particular, please refer to Sections 9.3 and 9.5.2); however, additional details more specific to lakes are provided below (where applicable).

Filter Strips and Riparian Buffers: Filter strips are first discussed in Section 9.3, while riparian buffers were discussed in Section 9.5. The same techniques for evaluating available land were applied to Lake Springfield. Areas along the shoreline which could potentially be converted into filter strips include the following:

- Lake Springfield – 15,204 acres of land within 234-foot buffer established for the lake and its tributaries, of which 8,934 acres are categorized as agricultural

Areas along the shoreline which could potentially be converted into riparian buffers include the following:

- Lake Springfield – 1,641 acres within 25 feet of the lake shoreline or the lake's major tributaries; approximately 824 of these acres are existing grassland or forest while 508 acres are currently classified as cultivated.

Wetlands: To treat loads from agricultural runoff, a wetland could potentially be constructed on the upstream end of the lake or wherever a focused amount of water enters the lake. The use of wetlands as structural controls was discussed in Section 9.5. Hydric soils with potential for wetland construction are shown along with existing wetlands to indicate potential areas where wetlands may be installed for the lake's subbasin in **Figures 9-5.** Areas near waterways that are not currently classified as wetlands but have hydric soils present are typically strong candidates for potential wetland construction. Existing wetland areas may also be candidates for reconstruction or enhancement to improve their nutrient uptake capacity. These data layers are developed on a large-scale and onsite soil investigation and wetland delineation is typically necessary for verification of the suitability of a given area for wetland construction.

WASCOBs: As discussed in Section 9.3, these basins are designed to trap sediments (and the pollutants bound to the sediment) prior to reaching a receiving water. WASCOBS can therefore be effective in reducing phosphorus loads to water bodies by capturing pollutant-laden water and sediment before it reaches the waterbody and allowing the contaminants to settle out. As with wetlands, WASCOBs could potentially be constructed on the upstream end of the lake or wherever a focused amount of water enters the lake.

Phosphorus-Based Lawn Fertilizer Restrictions: Section 9.5 discusses how runoff from urban areas may include phosphorus-based fertilizers which may enter nearby waterbodies if present in stormwater runoff. These fertilizers may also impact the lake, either by phosphorus-enriched runoff flowing directly into the lake or from phosphorus-impaired streams entering the water body.

In-Lake Phosphorus Loading: Internal loading of phosphorus is a significant contributor to overall the phosphorus load in Lake Springfield. A reduction of phosphorus from in-lake cycling through in-lake management strategies is necessary for attainment of the TMDL load allocations. Internal phosphorus loading can occur when the water above the sediments becomes anoxic causing the release of phosphorus from the sediment in a form which is available for plant uptake. The addition of bioavailable phosphorus in the water column stimulates more plant growth and die-off, which may perpetuate or create anoxic conditions and enhance the subsequent release of phosphorus into the water. Internal phosphorus loading can also occur in shallow lakes through release from sediments by the physical mixing and reintroduction of sediments into the water column as a result of wave action, winds, boating activity, and other means.

For lakes experiencing high rates of phosphorus input from bottom sediments, several management measures are available to control internal loading. Three BMP options for the control of internal loading include the installation of an aerator, the addition of aluminum, and dredging. Implementation of one or more of these BMPs can result in the reduction of internal phosphorus loads within Lake Springfield and if implemented at sufficient scale, these BMPs are capable of reducing internal loading of phosphorus by upwards of 90%. However, reductions of external loads will also be necessary to meet the TMDL target as well as to ensure the long-term efficacy of each of these in-lake BMPs.

- **Hypolimnetic (bottom water) aeration** involves an aerator air-release that can be positioned at a selected depth or at multiple depths to increase oxygen transfer efficiencies in the water column and reduce internal loading by establishing aerobic conditions at the sediment-water interface.
- **Phosphorus inactivation by aluminum addition** (specifically aluminum sulfate or alum) to lakes is the most widely-used technique to control internal phosphorus loading. Alum forms a polymer that binds phosphorus and organic matter. The aluminum hydroxide-phosphate complex (commonly called alum floc) is insoluble and settles to the bottom, carrying suspended and colloidal particles with it. Once on the sediment surface, alum floc inhibits phosphate diffusion from the sediment to the water (Cooke et al.1993).
- Phosphorus release from the sediment is greatest from recently deposited layers. **Dredging** approximately one meter of recently deposited phosphorus–rich sediment can remove approximately 80 to 90 percent of the internally loaded phosphorus without the addition of potentially toxic compounds to the reservoir. Dredging may also contribute to reductions in internal phosphorus loading by increasing the depth of large portions of the waterbody, reducing the degree of reintroduction of sediments into the water column through physical mixing. However, dredging is typically more costly than other management options (NRCS 1992).

9.7 BMP Recommendations for Reducing Boron in Sugar Creek Impaired Segments EOA-01 and EOA-06

As discussed in Section 8, the boron impairment shown for Sugar Creek segments EOA-01 and EPOA-06 are due to a single potential source of boron loading. This source was identified by Illinois EPA as a NPDES-permitted discharger: Springfield CWLP (IL0021971).

The elevated levels of boron in the discharge from this facility are being addressed separately by Illinois EPA through the NPDES program. Once the facility meets and maintains its effluent limits, the boron impairments in EOA-01 and EOA-06 are expected to no longer be an issue. BMPs are therefore not needed for the boron impairments at this time.

9.8 Cost Estimates of BMPs

Cost/payment rate estimates for a number of suggested BMPs are provided in the following sections. Information was primarily obtained from the 2016 Illinois EQIP "Payment Scenario Descriptions" document located at (http://www.nrcs.usda.gov/wps/portal/nrcs/main/il/programs/financial/eqip/).

9.8.1 Filter Strips and Riparian Buffers

Several types of filter strip practices are available, including areas for native herbaceous vegetation with or without fertility measures required and areas of introduced species, also with or without fertility measures required. Filter strip implementation that includes seedbed preparation and native seed application ranges from $520/acre to $639/acre depending on the type used, with an average cost of approximately $594/acre.

Riparian buffers consisting of bare-root shrubs cost approximately $1.10 to $1.65 each while direct seeding of trees and/or shrubs costs approximately $741/acre. The direct seeding scenario includes a planting rate of approximately 3,000 to 4,800 seeds per acre as well as the foregone income for the land taken out of crop production. Land preparation, including removing undesirable vegetation and improving site conditions, is estimated at $38/acre. For cases where an herbaceous cover is preferable, such a native grass or certain species of forbs and/or shrubs, costs average $642/acre.

9.8.2 Nutrient Management Plan – NRCS

A significant portion of the agricultural land in the Lake Springfield watershed is comprised of cropland. Costs for nutrient management range from $13/acre (basic) to $45/acre (enhanced nutrient management with deep placement [at least 4 inches below surface] of manure and/or phosphorus fertilizer). The cost for developing a NMP ranges from $1,741 to $2,902/plan depending on the acreage to be managed under the plan and assuming that a comprehensive NMP is not required. NMP preparation includes soil testing, manure analysis, scaled maps, and site-specific recommendations for fertilizer management.

9.8.3 Nutrient Management Plan – IDA and Illinois EPA

The costs associated with development of a NMP co-sponsored by the IDA and the Illinois EPA is estimated at $10/acre paid to the producer and $3/acre for the third party vendor who develops the plan. There is a 200 acre cap per producer. The total plan development cost is estimated at $13/acre.

9.8.4 WASCOBs and Stormwater Retention Ponds

The average cost for a water and sediment basin is approximately $2.70/cubic yard depending on height (greater than or less than 5 ft) and if topsoil stockpiling is necessary. Installation of an underground outlet, plastic conduit, averages $2.27/foot.

If vegetation should be established, costs for a dozer for grading and shaping of small gullies, seedbed preparation with typical tillage implements, grass/legume seed, companion crop, and fertilizer and lime with application are $716.03/acre. Straw mulch or other approved natural material may be applied where needed to facilitate establishment of vegetative cover. The cost for mulching is $238/acre.

Stormwater retention basin costs are often a function of volume/capacity with costs rising exponentially as volume/capacity rises. Costs for a "wet" stormwater pond must consider land acquisition costs, design fees, installation, as well as ongoing operation and maintenance. A study completed by the University of Alabama in 2005 documented costs associated with urban stormwater control practices and includes a compilation of costs associated with urban stormwater ponds from a number of other studies in various parts of the country: http://citeseerx.ist.psu.edu/viewdoc/download?doi=10.1.1.602.86&rep=rep1&type=pdf page 45). Stormwater retention ponds are often funded through stormwater utility rates.

9.8.5 Bank Stabilization/Erosion Controls

Streambank and shoreline protection features include weirs/rock riffles, stream barbs, and bank armor. Weirs/rock riffles range from $2,448 to $6,305 each depending on the size. A stream barb or bendway weir along with a longitudinal peaked stone toe ranges from $27.27 to $52.50/foot. Full bank armor (rip rap) may be use where typical techniques such as stone toe protection or stream barbs are not feasible. The armor is $37.55/cubic yard.

Several types of grade stabilization structures may be used depending on the site-specific conditions and include the following: concrete block chutes, $7.81/square foot, and riprap-lined (rock) chutes, $48.73/cubic yard. A pipe structure, $5.20/cubic yard, may be used to stabilize a classic gully with very erodible soils in a wooded area where vegetative establishment is not possible on most of the backslope. A straight overfall grade stabilization structure may be used to control erosion. The overfall structure may be implemented as a toewall, or any other type of straight overfall including concrete, sheet pile, or gabions. Where the height from the inlet to outlet is less than 5 feet, the cost is $119.11/square foot, and where the height is equal to or greater than 5 feet, the cost is $194.01/square foot. A pipe drop grade stabilization structure, $10.24/square foot, includes earthwork and a principal spillway outlet structure.

9.8.6 Grassed Waterways

Costs for grassed waterways range from $2,568 to $4,916/acre depending on the width, timing of construction (if crop season), and whether checks (fabric or rock) are used.

9.8.7 Conservation Tillage

Conservation tillage is assumed to include tillage practices that preserve at least 30 percent residual cover of the soil after crops are planted. Costs associated with converting to conservation tillage will depend on the extent and degree of conservation tillage practices implemented. A no-till/strip-till system, organic or non-organic, involves managing the amount, orientation, and distribution of crop and other plant residue on the soil surface year-round while limiting soil-disturbing activities used to grow and harvest crops. These systems average approximately $16/acre. Incorporating mulch till in place of conventional till costs $4.21/acre, and applies to both organic and conventional fields. A full-width ridge-till system costs approximately $30/acre. Contour farming is a practice in which row orientation is changed from up and down hill orientation to nearly perpendicular to the flow of runoff. Costs for this practice are $6.06/acre.

9.8.8 Wetlands

The price to establish a wetland is very site specific and depends on factors such as size and type of vegetation used. Examples of costs associated with constructed wetlands include excavation costs, vegetation removal, and revegetation costs. Costs for wetlands created on a flat mineral uplands where surface runoff may be intercepted and ponded by excavation range from $3,186 (no embankment) to $3,680 (with embankment). Some areas may favor a wetlands setting which just needs to be enhanced or restored. In an area of natural depression fed by surface runoff, enhancement/restoration is approximately $2,557/acre. Enhancing or restoring a wetland on a floodplain site that has existing levees and/or ditches may consist of regrading or shaping the land, potentially including levee removal, for $1,167/acre. Constructed wetlands to reduce the pollution potential of runoff and wastewater average $7,725/acre where natural regeneration of wetland plants will be a major contributor to the working vegetation and $10,286/acre where wetland vegetation in the pool area is planted at a denser grid (3-foot by 3-foot or closer). As needed, embankments, water control and grade stabilization structures, and filter strips should be added.

9.8.9 Septic System Maintenance

Septic tanks are designed to accumulate sludge in the bottom portion of the tank while allowing water to pass into the drain field. If the tank is not pumped out regularly, the sludge can accumulate and eventually become deep enough to allow for flow into the drain field. Pumping the tank every three to five years prolongs the life of the system by protecting the drain field from solid material that may cause clogs and system back-ups. In addition, septic systems should not be connected to field tile lines.

The cost to pump a typical septic tank ranges from $250 to $350 depending on how many gallons are pumped out and the disposal fee for the area. If a system is pumped once every three to five years, this expense averages out to less than $100 per year.

The cost of developing and maintaining a watershed-wide database of the onsite wastewater treatment systems in the Lake Springfield watershed depends on the number of systems that need to be inspected and the means by which the systems are inventoried. Education of home and business owners that use onsite wastewater treatment systems should occur periodically. Public meetings; mass mailings; and radio, newspaper, and TV announcements can all be used to remind and inform owners of their responsibility to maintain their systems. The costs associated with education and inspection programs will vary depending on the level of effort required to communicate the importance of proper maintenance and the number of systems in the area. Grand scale estimates of watershed septic systems were included in Section 9.5.2.

9.8.10 Cover Crops

The costs associated with a cover crop will depend on many factors including the previous crop, next crop, tillage system, pesticide practices, cover crop species planted, and cover crop planting method. Regardless of the specific production choices, most of the costs associated with the cover crop will be in its establishment, which includes planting and seed costs. The NRCS has created a free cover crop economics tool to help farmers and others determine the immediate costs and benefits of cover crops on their operation. The tool displays results both numerically and/or graphically. It is available to download: http://1.usa.gov/225TjyR. A general range of costs are available through a number of articles and studies which estimate cover crop costs at $15-$25/acre. The annual cost list from the SWCD of Sangamon County can also be consulted for a range of costs associated with cover crops within the watershed.

9.8.11 Saturated Buffers

A number of recent demonstration projects have been completed to monitor the effectiveness of saturated buffers to remove nutrients in the Mississippi River basin. Results of these studies have shown that saturated buffers are a cost-effective pollutant removal strategy and require

For instance, a recent study documented that the cost was $2,508 for the tile installation, $1,120 for a control box, and $100 for the design. Depreciation over 20 years at 4% interest adds about $1,460. The total cost was $5,188 over 20 years, or $259 annually (Agriculture.com. 2015). A research project conducted by the Agricultural Drainage Management Coalition estimated that the average project installation costs were $3,700.

9.8.12 Pasture Management/Livestock Fencing

Costs for livestock fencing for pasture management and/or exclusion from waterways depend on the type of fencing used. For example, permanent high tensile electric fencing is approximately $0.79/foot for a single strand, $1.16/foot for 2 to 3 strands, $1.42/foot for 4 to 6 strands (with fence post centers no more than 30 feet apart), and $1.78/foot for 7 or more strands (with double H bracing and fence post centers no more than 30 feet apart). A permanent, multi-strand barbed wire fence averages $1.62/foot, and a permanent woven wire fence averages $1.96/foot.

9.8.13 In-Lake Treatments

Nutrient loading from existing lake sediments is a significant source of phosphorus in Lake Springfield. The most common means of reducing in-lake nutrient cycling include hypolimnetic aeration, phosphorus inactivation by alum addition (capping), and dredging. In 2015, USEPA produced a document titled "A Compilation of Cost Data Associated with the Impacts and Control of Nutrient Pollution" (EPA 820-F-15-096) which includes summaries of total and unit-rate cost estimates for each of these processes based on a range of recent existing and proposed projects, as follows:

Hypolimnetic aeration system costs for larger lakes and reservoirs (treated areas greater than 50 acres) range from approximately $580 to $2,100 per acre for capital costs and from $81 to $140 for annual maintenance and operation during the estimate 10 to 20-year lifespan of a reaeration system.

Alum treatment unit costs reported ranged from $816 to $7,700 per acre of treated surface. The costs, estimated life-span, and necessary reapplication rates for alum treatment varies considerably based on the controls on existing inputs, initial alum dose, natural water circulation, and extent of phosphorus pollution/target concentrations or reductions.

Dredging can be used to remove phosphorus trapped in lake-bottom sediment and reduce internal cycling. Dredging is often focused on areas of the waterbody that experience sustained periods of anoxic conditions. Removal depths vary significantly based on the existing sediment thickness and quality in the waterbody. EPA compiled unit costs of sediment removal ranging from $4,205 to over $81,000 per acre of treated area.

Each of these in-lake treatment options requires site-specific significant engineering and design considerations as well as a relatively robust site-specific dataset prior to the development of application cost estimates. The Tables provided above are intended to show the extent of unit-cost variability for each measure, as reported via recently enacted or completed projects. Additional study is necessary for development of cost estimates for each treatment option as they relate to Lake Springfield specifically.

9.9 Ongoing Activities and Reasonable Assurance

As previously discussed, the Springfield CWLP has maintained a fairly extensive water quality assessment program on Lake Springfield for over 25 years. A number of other studies have been performed in the Lake Springfield and Sugar Creek Watershed. The following lists historical activities as well as ongoing water quality programs which show a commitment to improving water quality conditions within the watershed. Please contact Springfield CWLP for additional information on historical projects in the watershed (https://www.cwlp.com/). Additional detail on current and future projects may be found in the forthcoming *2016 Lake Springfield Watershed Management Plan.*

1934 – Construction of Lake Springfield was completed to serve as the public drinking water supply for the City of Springfield and several surrounding communities, as well as the source of condenser cooling water for the city's coal-fired power plant.

Four sedimentation surveys (1948, 1965, 1977, and 1984) of Lake Springfield have been conducted by the ISWS for the city of Springfield since it was built.

1982 –CWLP began its Lake Springfield Watershed Maintenance and Restoration Program (LSWMRP) to:

- Remove sediment from the Lake
- Provide shoreline stabilization and watershed protection

1983 – CWLP provides cost share funds to the Sangamon County SWCD for conservation to reduce erosion and improve water quality in the LSW through their LSWMRP. It began in 1983 with the purchase of a no-till corn planter, and subsequently a no-till drill for watershed farmers to rent before investing in this expensive equipment for their farming operations. Within a few years, many farmers had made the switch to no-till/minimum till equipment and this equipment rental program was no longer needed. This cost-share program then evolved to establishment of conservation practices such as grass waterways, terraces, grade stabilization structures, dry dams, water and sediment control basins (WASCOBs) and ponds, along with stream bank stabilization, and continues to this day. Over $500,000 in assistance from CWLP has been made available to watershed producers for these conservation practices over the past 30 years and is administered by the Sangamon County SWCD under the same guidelines as the State of Illinois' Conservation Cost-Share Practices Program (CPP).

1984 - Lake Springfield lost over 3 billion gallons of water storage (13 percent of the lake's original volume) over the period 1934 to 1984. On average, the lake lost 50 million gallons of storage capacity a year because of the deposition of 130,000 tons of sediment a year, according to the November, 1986 "Hydrologic Investigation of the Watershed of Lake Springfield," Springfield, Illinois completed by the ISWS for the city of Springfield.

1987 – The Clean Lakes Program Phase I Diagnostic/Feasibility Study for Lake Springfield Restoration Plan, CWLP, March, 1987 identified sedimentation, nutrients and shoreline erosion as major issues for the lake and its watershed. The 3-phase lake restoration program initiated by CWLP to address these problems included:

- Establishment of a soil conservation grant program in the LSW (watershed conservation practices)
- Sediment removal from the Lake by hydraulic dredging
- Shoreline stabilization around the Lake

1986-2013 – Over 20 miles of the lake's 57 miles of shoreline, and the islands, have been cleared and stabilized with rip rap protection. Over this 28-year time period, lake homeowners have spent over $6.4 million on approximately 56,000 feet of steel seawalls. In addition, an average of $10,292 a year, totaling $288,000, has been spent on rip rap, along with other methods of stabilization, to protect their residential shorelines.

From 1987 – 1990, The City spent $7.8 million on a dredging project which:

- Removed 3.2 million cubic yards of sediment from the upper reaches of Lake Springfield, west of the I-55 bridge
- Re-established the natural sedimentation basins of the Lake and
- Restored nearly one-half billion gallons of lost storage capacity.

1990 - The Lake Springfield Watershed Resources Planning Committee (LSWRPC) was formed to address the sedimentation of Lake Springfield as its primary resource concern, followed by nutrient concerns (phosphorus and nitrogen). There was little mention of pesticide use, only concerns about the persistence of those historically used pesticides and their breakdown products (dieldrin, chloradane, and heptachlor epoxide). This group's goal was to develop and apply a comprehensive resource management plan, involving both agricultural and urban communities, which would provide a framework for the protection and improvement of Lake Springfield and its watershed. This plan has served as the guide for implementation of BMPs throughout the LSW.

1994 - There was a near violation of Illinois EPA's drinking water requirement of an average running quarterly atrazine concentration of 3 ppb or less in the finished water supply of drinking water for the City of Springfield and its customers.

1995 – An addendum to the original LSW Plan was adopted to address pesticide runoff in the LSW. Atrazine was the preferred herbicide of use because it was the most effective weed control herbicide available for corn and the most economical. At this time, the LSW was approximately a 50/50 split on corn and soybean acres and the majority of farms were under 50/50 crop lease arrangements between landowners and their tenants. The following action items adopted by LSW producers, with great cooperation from the local agricultural retailers, helped the city achieve compliance with Illinois EPA's drinking water standards:

- Implementation of a two-pass atrazine application program
- Reduction in rates of any single atrazine application
- Incorporation of alternative herbicides for corn acres
- Establishment of buffer strips
- Adoption of no-till and/or minimum till farming practices

In addition, the city's annual costs for removing atrazine with powdered activated carbon (PAC) from the lake's raw water were drastically reduced from $143,000 in 1994 to four consecutive years of $0 from 2004-2007. There were slight increases in atrazine concentrations from 2008-2011 primarily due to consecutive extremely wet years, a sizeable increase in corn-on-corn acreage, versus the traditional 50 percent corn/soybean rotation, and a significant increase in the cost of PAC. In 2012, there were zero dollars spent by CWLP to treat for atrazine. In 2013, this cost was $137,000 due to another extremely wet spring shortly after most of the herbicides had been applied to the corn fields.

1995 – Through a Section 319 grant awarded to the Sangamon County SWCD, urban erosion control practices were established in a new subdivision (Piper Glen) in the LSW. The target audience for this demonstration project was real estate developers, land contractors, home builders, home owners and the general public. Urban erosion control products such as erosion control blankets, silt fence, critical area/temporary seedings, etc. were installed to demonstrate proper installation, how these practices function, and the importance of having them in place on sites at all times prior to, during and after construction of new homes when developing new subdivisions.

1997 – A 5-year field-scale research study "Assessment of Best Management Practices' (BMPs) Effectiveness on Water Quality and Agronomic Production in the Lake Springfield and Sugar Creek Watershed" began:

- To conduct long-term research assessing BMPs on an entire watershed
- To document the effectiveness of specific BMPs for improving surface water quality
- To identify BMPs which significantly reduce movement of sediment, pesticides and nutrients from agricultural fields

Partners in this study were: USDA Agricultural Research Service, Novartis Crop Protection, Inc. (now Syngenta), USDA NRCS, IL State Water Survey, University of IL Extension, City of Springfield-CWLP, LSWRPC, and Sangamon County SWCD. Results from this study identified vegetative buffer strips and no-till farming to be the most effective BMPs in reducing soil erosion, pesticide and nutrient movement through surface water runoff from agricultural fields.

2000 – The USDA Conservation Reserve Enhancement Program (CREP) was approved for portions of 16 counties in Lower Sangamon River Basin, including all of Sangamon County and portions of Macoupin County. This program provides significant financial incentives to landowners for taking cropland that is located in the 100-year floodplain and qualifying adjacent acres out of production. In return, the landowners must establish conservation practices which will reduce soil erosion and surface water runoff (native grasses, shrubs, trees, etc.) while providing quality habitat for wildlife. These CREP contracts are for a minimum of 15 years. There are about 92 federal CREP contracts in the LSW, in addition to another 173 Conservation Reserve Program (CRP) contracts as of 4/16/2014.

2000 – The Sangamon County SWCD formed The Sangamon Conservancy Trust, an Internal Revenue Service approved 501(c)(3) not-for-profit charitable organization, which can apply for and administer grants, accept and hold conservation easements, etc. Its goals mirror those of the Sangamon County SWCD to reduce soil erosion and promote water quality, implement BMPs not funded through current programs, fund special conservation education programs, promote land stewardship and farmland protection, and conserve soil, water and related resources. This Trust currently holds eight agricultural conservation easements on 2,712 acres. Two of those easements (513 acres) are in the LSW and are protected from residential, commercial and industrial development forever. One of these easements (113 acres) is immediately adjacent to Lake Springfield and has been taken out of crop production by the landowner and planted to native grasses and trees. The other agricultural conservation easement (400 acres) is in a prime development area of the LSW. These landowners are excellent stewards of their land and have established many conservation practices such as grade stabilization structures, grassed waterways, riparian buffers and field borders on their farm.

2003 – With the 5-year BMP research study results in hand, the Sangamon County SWCD applied and received a Section 319 grant (40 percent match from city of Springfield) to establish vegetative filter strips throughout the LSW. A $200/acre incentive payment was awarded to landowners who established these filter strips through the USDA CRP program for a minimum of 15 years, instead of a normal 10-year CRP contract. Twenty-nine miles of unprotected stream corridors were protected under 75 CRP contracts, with landowners establishing about 600 acres of filter strips. Estimated total annual pollutant loadings were reduced by approximately 6,500 tons of sediment, 8,700 pounds of phosphorus, and 18,000 pounds of nitrogen. Almost 200 acres of these filter strips were along Sugar Creek, with a reduction of approximately 1,934 tons of sediment, 2,688 pounds of phosphorus, and 5,316 pounds of nitrogen. Illinois EPA is waiting on final notification from USEPA that alterations in stream-side or littoral vegetative covers and organic enrichment/dissolved oxygen will be removed as causes of impairment for Sugar Creek in the 2012 Illinois Integrated Water Quality Report.

Also to be noted was the huge shift from 50/50 crop share farm leases to cash rent per acre farm leases with landowners. Cash rents paid by producers began to sky rocket and the opportunity to farm the land in the LSW became, and is still, very competitive. Many producers who had been farming the same farm for years lost this opportunity with this shift to cash rent. Several "mega" farm operations emerged in the LSW as a result of this change. With cash rent leases, the producer has control of the farm for that year, pays for all of the crop production expenses, and receives income from the entire harvested crop, along with the USDA program payments available to that farm. Establishment of conservation practices and water quality improvement in the LSW took a back seat to crop production for several reasons:

1. No longer any direct landowner involvement in the day-to-day management of their farm.
2. The producer's need to farm every acre possible to cover the cash rent payments and crop production expenses.
3. USDA program payments became more lucrative for corn acres.
4. A major shift from a corn/soybean rotation to multiple years of planting corn-on-corn began, which means more fertilizer (nitrogen and phosphorus) and corn pesticide use.
5. Government cost-share payments (based on soil rental rates) for establishing conservation practices were not high enough to compete with cash rents per acre.
6. Significant rise in farmland prices.

2004 – The most recent sedimentation survey, "Sedimentation Survey of Lake Springfield, Springfield, Illinois," September, 2007, was conducted by the City of Springfield, CWLP, Land and Water Resources Department, indicating a seven percent decline in the erosion rate over the period 1984-2004. With a primary focus on erosion prevention through numerous federal, state, and local cost-share programs, grants and research projects to demonstrate and effectively practice erosion control, LSW producers continue to incorporate BMPs into their farm operations, which seem to be instrumental in reducing the erosion rate of the lake.

2008 – USDA approved a special grant submitted by the Sangamon County SWCD titled "Northern Bobwhite Conservation Quail Initiative" through the USDA State Acres for Wildlife Enhancement (SAFE). This CRP program enables Sangamon County landowners to establish wildlife habitat on 2,000 acres with grassland and forest practices (buffers, trees, and grasses) to benefit quail and many other grassland species, some of them on the state-listed threatened species. The target area for this grant was the LSW, where three wildlife "sanctuaries" exist. SAFE is an additional tool for landowners to help protect Springfield's public water supply. There are about 20 SAFE contracts enrolled in this USDA program in the LSW as of 4/16/2014.

2008 – Through a "Protecting Water Quality in Urban Centers of Illinois" Section 319 grant, the SCSWCD hosted an Urban Water Quality Best Management Practices Tour on 9/25/2008 for key community leaders from Springfield and Sangamon County, representing the Mayor of Springfield, Sangamon County Board, City of Springfield Aldermen, Springfield-Sangamon County Regional Planning Commission, Sangamon County Highway and Public Health Departments, Springfield Area Home Builders Association, Springfield CWLP and Public Works Department, along with federal and state agency personnel. A Certified Professional in Erosion and Sediment Control (CPESC) was the keynote speaker on this tour, discussing and demonstrating urban erosion control practices and the federal/state NPDES rules and regulations for MS4 communities such as Springfield and Sangamon County at each of the stops on the tour. The Sangamon County

Sediment and Erosion Control Ordinance was approved by the Sangamon County Board on December 9, 2008. In March, 2012, the City of Springfield amended The 1988 City of Springfield Code of Ordinances, by adding Chapter 154: Erosion Control Regulations.

2012 – The LSWRPC began work on a revision to their original 1990 LSW plan to reflect the most accurate watershed data, maps, and land use changes now available through the use of GIS technology to identify existing and new agricultural and urban resource issues and to prepare a new comprehensive management plan involving both the agricultural and urban communities. Over 60 people (farmers, fertilizer/chemical retailers, lake home owners, college instructors, conservation land contractors, farm managers and federal, state and local government representatives) are involved with this new planning effort. Twenty agricultural issues and 17 urban issues have been identified by the LSWRPC, many of them the same as those identified in the 1990 LSW plan. Development and implementation of specific strategies to find solutions for the identified resource issues remains the task of the LSWRPC as it was back in 1990.

2012 –Land Use Plan for Lake Springfield and Its Marginal Properties, February 1991 was revised in 2005 and again in 2012 to keep current the defined uses and guidance for the management of lake lands and its marginal lands. This plan provides for five land use categories: administrative, leased, parks and recreational, green space and wildlife preserves. Each category has a specific list of activities which are allowed. CWLP plans to limit development around the Lake and dedicate unleased lands for public uses as green spaces and natural areas. The guidelines developed in this plan are based on CWLP's priorities for Lake Springfield in order of importance:

1. Protection of the quality of the water.
2. Retention of the storage capacity of the lake.
3. Preservation of the aesthetics and the unique character of the lake and its environs.
4. Provision of residential and recreational opportunities.

2013 – The city of Springfield was awarded a Priority Lake and Watershed Improvement Project grant from Illinois EPA to help reduce sediment runoff and nutrient loading into the Lake. Rip rap was installed on 2,756 feet of highly visible, highly eroded Lake Springfield shoreline at the confluence of Lick and Sugar Creeks, which traps over 50 percent of the incoming sediment to the lake. This project reduced phosphorus loading by 453 pounds, nitrogen by 904 pounds, and sediment load reduction by 453 tons per year.

2013 – A special 3-year nitrogen management program and study began through a partnership with the Illinois Council on Best Management Practices, city of Springfield, CWLP, Sangamon County SWCD, Lincoln Land Community College, local agricultural retailers and LSW producers to reduce the nitrate-N concentration in Lake Springfield. The goal of this project is to maintain the nitrate-N concentration in Lake Springfield at 50 percent below Illinois EPA's drinking water standard of 10 parts per million throughout the year. This study will work with local agricultural retailers and producers to identify nitrate-N levels in their crop fields and show them how to minimize environmental impact, optimize harvest yield and maximize input utilization. A multiple application approach to N management utilizing the 4-Rs of nutrient management (Right source, Right rate, Right time and Right place) will minimize the risk of nitrogen loss prior to crop utilization. Establishment of cover crops for nitrogen fixation, soil erosion control, and other water quality benefits will also be part of this project. Primary funding sources for this project are provided by the National Fish and Wildlife Foundation and the City of Springfield's CWLP.

2013 – A Lake Springfield and Sugar Creek Watershed BMP Implementation Section 319 grant proposal was submitted to Illinois EPA for the implementation of agricultural and urban BMPs throughout the LSW. This project will implement recommendations from the 1990 LSW Resource Plan 2012 Revision and the 1987 Lake Springfield Diagnostic Feasibility Study to improve the water quality of Lake Springfield and its watershed by:

- Reducing nonpoint source pollution
- Controlling soil erosion, and
- Reducing nutrient and sediment loadings

While Sugar Creek sub-watershed will be the primary target area, BMPs will be implemented throughout the entire watershed. NRCS technical staff will assist with inventory and evaluation, survey and design of agricultural BMPs. The Illinois Council on Best Management Practices and local agricultural retailers will work with LSW producers to develop and implement nitrogen management systems utilizing the N-WATCH program and establishment of cover crops. Nutrient management plans and additional cover crops are important BMPs in this grant to address two of the sources of impairments (nitrates and phosphorus).

2013 – An Illinois Green Infrastructure Grant proposal was submitted to Illinois EPA for implementation of urban BMPs at the Ball-Chatham School District #5 Middle School complex. This school complex is immediately adjacent to Lake Springfield. BMPs to be installed are porous pavement parking lots, dissipaters, bioswales, and shoreline stabilization with rock rip rap.

2013 – A TMDL study for five impaired water body segments of the LSW, including Lake Springfield, three segments of Sugar Creek and the Hoover Branch segment north of Spaulding Dam, was initiated by Illinois EPA. Potential causes of impairment are total phosphorus, boron, TSS, and sedimentation/siltation. The first draft TMDL Stage 1 Report was made public at an information meeting held on March 27, 2014. Personnel from the city of Springfield, CWLP, and Sangamon County SWCD have taken an active role in reviewing the information in this report for completeness and accuracy and provided their comments to Illinois EPA. This group will continue to work closely with Illinois EPA throughout the TMDL development process and implementation planning.

9.10 Information and Education

As discussed in Section 3, public education and participation is a key factor for TMDL and watershed plan implementation. Increased public awareness can increase implementation of BMPs. Small incremental improvements and individual adoption of BMPs can be achieved at a much lower cost compared to the large-scale BMPs identified above. Outreach and education efforts should focus on activities that support the watershed plan goals, including:

- Biological and water quality monitoring
- Lake and stream management
- Encouraging native landscaping including buffers along lakeshores and streambanks
- Buffer strips
- Reducing the use of lawn chemicals (pesticides and phosphorus fertilizers)
- Nutrient management (includes soil testing)
- Water conservation
- Green infrastructure
- Field visit days with demonstrations of agricultural conservation practices

An additional public meeting will be held within the watershed to present the final TMDL results and the implementation plan. Additional recommended activities to support public outreach and education include:

- Websites and social media to publicize meetings, upcoming events and links to resources
- E-mail updates
- Brochures with information on household pollutant reduction, fertilizer use, and septic tanks
- Educational signs to educate viewers on water quality issues, purpose of BMPs, and environmental stewardship
- Public service announcements
- Informational meetings on State and Federal cost share programs

9.11 Project Funding

Cost-share programs at the state and federal level are available to landowners, homeowners, and farmers in the watershed to help offset costs of implementing many of the BMPs recommended in this report. Some of these programs are discussed below. In addition, Springfield CWLP may choose to investigate the potential to fund further implementation of BMPs and other measures to assure the necessary functions of Lake Springfield are met through rate adjustments and/or other revenue sources.

9.11.1 Available State-Level Programs for Nonpoint Sources

State-level programs to encourage landowners to implement resource-conserving practices for water quality and erosion control purposes are discussed in the following paragraphs.

9.11.1.1 Illinois Department of Agriculture and Illinois EPA Nutrient Management Plan Project

The IDA and Illinois EPA co-sponsor a cropland Nutrient Management Plan project in watersheds that have developed or are developing TMDLs. This voluntary project supplies incentive payments to producers to have NMPs developed and implemented. Additionally, watersheds that have sediment or phosphorus identified as a cause for impairment (as is the case in this watershed), are eligible for cost-share assistance in implementing traditional erosion control practices through the Nutrient Management Plan project.

9.11.1.2 Conservation Practices Cost-Share Program

The CPP is a 10-year program. The practices consist of waterways, water and sediment control basins, pasture/hayland establishment, critical area, terrace system, no-till systems, diversions, and grade stabilization structures. The CPP is state-funded through the IDA. There is a project cap of $5,000 per landowner and costs per acre vary significantly from project to project.

9.11.1.3 Streambank Stabilization and Restoration Program

The SSRP was established to address problems associated with streambank erosion, such as loss or damage to valuable farmland, wildlife habitat, and roads; stream capacity reduction through sediment deposition; and degraded water quality, fish, and wildlife habitat. The primary goals of the SSRP are to develop and demonstrate vegetative, stone structure, and other low cost bio-engineering techniques for stabilizing streambanks and to encourage the adoption of low-cost streambank stabilization practices by making available financial incentives, technical assistance, and educational information to landowners with critically eroding streambanks. A cost share of 75 percent is available for approved project components such as willow post installation, bendway weirs, rock riffles, stream barbs/rock, vanes, lunker structures, gabion baskets, and stone toe protection techniques. There is no limit on the total program payment for cost-share projects that a landowner can receive in a fiscal year. However, maximum cost per foot of bank treated is used to cap the payment assistance on a per foot basis and maintain the program's objectives of funding low-cost techniques (IDA 2000). All project proposals must be sponsored and submitted by the local SWCD.

9.11.1.4 Conservation Reserve Enhancement Program

The CREP is a resource to help farmers meet their conservation goals, particularly those who till or graze land along rivers and streams. CREP is a joint effort between the federal, state, and county governments. Many land cover and management practice options are available under CREP, depending on the preference of the landowner and site-specific factors. Some of the more common practices are filter strips, riparian buffers, and wetland restorations.

CREP pays landowners to install filter strips along waterways or to return continually flooded fields to wetlands while leaving the remainder of the adjacent land in agricultural production. The size of land put into CREP varies, with no minimum acreage size required, and can be a strip as narrow as 30 feet wide. This program allows farmers to enroll land as needed and leave the remainder for farming. Enrollment options are either a 15-year agreement or a perpetual easement.

CREP financial incentives include:

- Cost sharing of conservation practice installation
- Upfront incentive payments
- Annual soil rental payments

Participants on average receive total combined state and federal payments of $2,000 per acre for the 15-year contracts and $2,850 per acre for the perpetual conservation easements over the agreement timeframe. It should be noted that CREP is not currently (2016) available in Illinois due to state budget issues. Both the federal and state CREP are closed for enrollment. This status may change under future budgets.

9.11.2 Available Federal-Level Programs for Nonpoint Sources

There are several voluntary conservation programs established by various federal agencies that encourage landowners to implement resource-conserving practices for water quality and erosion control purposes. These programs apply to crop fields as well as rural grasslands that are presently used for livestock grazing. Federal-level programs are discussed in the following paragraphs. The USEPA manages the Clean Water Act Section 319 Grants. The Farm Service Agency (FSA) oversees the CRP and the Grasslands Reserve Program (GRP). Voluntary conservation programs established through the 2014 U.S. Farm Bill, and managed by the NRCS, include the Agricultural Conservation Easement Program (ACEP), the Conservation Stewardship Program (CSP), and the Environmental Quality Incentives Program (EQIP).

9.11.2.1 Clean Water Act Section 319 Grants

Section 319 was added to the CWA to establish a national program to address nonpoint sources of water pollution. Through this program, each state is allocated Section 319 funds on an annual basis according to a national allocation formula based on the total annual appropriation for the section 319 grant program. The total award consists of two categories of funding: incremental funds and base funds. A state is eligible to receive USEPA 319(b) grants upon the USEPA's approval of the state's Nonpoint Source Assessment Report and Nonpoint Source Management Program. States may reallocate funds through sub-awards (e.g., contracts, sub-grants) to both public and private entities, including local governments, tribal authorities, cities, counties, regional development centers, local school systems, colleges and universities, local nonprofit organizations, state agencies, federal agencies, watershed groups, for-profit groups, and individuals.

USEPA designates incremental funds, a $163-million award in 2016, for the restoration of impaired water through the development and implementation of watershed-based plans and TMDLs for impaired waters. Base funds, funds other than incremental funds, are used to provide staffing and support to manage and implement the state Nonpoint Source Management Program. Section 319 funding can be used to implement activities which improve water quality, such as filter strips, streambank stabilization, etc. (USEPA 2003).

Illinois EPA receives federal funds through Section 319(h) of the CWA to help implement Illinois' Nonpoint Source Pollution Management Program. 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 nonpoint source pollution. The program emphasizes funding for implementing cost-effective corrective and preventative BMPs on a watershed scale; funding is also available for BMPs on a non-watershed scale and the development of information/education nonpoint source pollution control programs.

The maximum Federal funding available is 60 percent of the total cost, with the remaining 40 percent coming from local match. The program period is two years unless otherwise approved. This is a reimbursement program.

Section 319(h) funds are awarded for the purpose of implementing approved nonpoint source management projects. The funding will be directed toward activities that result in the implementation of appropriate BMPs for the control of nonpoint source pollution or to enhance the public's awareness of nonpoint source pollution. Applications are accepted June 1 through August 1.

9.11.2.2 Conservation Reserve Program

The CRP is a voluntary program, administered through the FSA, which encourages landowners to agree to remove environmentally sensitive land from agricultural production and plant long-term resource-conserving cover to improve water quality, prevent soil erosion, and reduce loss of wildlife habitat. The program was initially established in the Food & Security Act of 1985 and is the largest private-lands conservation program in the United States.

Participants can enroll in CRP in two ways and the duration of the contracts under CRP range from 10 to 15 years. The first enrollment method is through a competitive process known as the CRP General Sign-up. These are announced on a periodic basis by the Secretary of Agriculture but do not occur on any fixed schedule. The second enrollment method is through CRP Continuous Sign-up, which is offered on a continuous basis. Continuous sign-up provides management flexibility to farmers and ranchers to implement certain high-priority conservation practices on eligible land. All enrollment offers are processed through the local FSA office.

Certain conditions must be met in order for land to be eligible for CRP enrollment. These conditions include the following:

1. The farmer applying for enrollment must have owned or operated the land for at least 12 months prior to the previous CRP sign-up period (except in cases of a change in ownership due to the previous owner's death, foreclosure, or land purchase by the new owner without the sole intention of placing it in the CRP).

2. Cropland that is planted or considered planted to an agricultural commodity for four of the six most recent crop years (including field margins) and must be physically and legally capable of being planted in a normal manner to an agricultural commodity.

3. Certain marginal pastureland suitable for use as any of the following conservation practices: buffer for wildlife habitat, wetlands buffer or restoration, filter strips, riparian buffer, grass waterway, shelter belt, living snow fence, contour grass strip, salt tolerant vegetation, or shallow water area for wildlife.

In addition to the eligible land requirements, cropland must meet one of the following criteria:

- Have a weighted average erosion index of 8 or higher
- Be expiring CRP acreage
- Be located in a national or state CRP conservation priority area.

The FSA bases rental rates on the relative productivity of soils within each county and the average dryland cash rent or cash-rent equivalent. The maximum rental rate for each offer is calculated in advance of enrollment. Producers may offer land at the maximum rate or at a lower rental rate to increase likelihood of offer acceptance. In addition, the FSA provides cost-share assistance for up to 50 percent of the participant's costs in establishing approved conservation practices (USDA 2016: https://www.fsa.usda.gov/programs-and-services/conservation-programs/prospective-participants/index). CRP annual rental payments may include an additional amount up to $2 per acre per year as an incentive to perform certain maintenance obligations (up to $7 for certain continuous sign-up practice).

Finally, the FSA offers additional financial incentives for certain continuous sign-up practices. Signing Incentive Payment is a one-time incentive payment of $10/acre for each acre enrolled for each full year of the contract. Eligible practices include field windbreaks; grassed waterways; shelter belts; living snow fences; filter strips; riparian buffers; marginal pastureland wildlife and wetland buffers; bottom timber establishment; field borders; longleaf pine establishment; duck nesting habitat; SAFE buffers, wetlands, trees, longleaf pine, and grass; pollinator habitat; and several wetlands practices. The Performance Incentive Payment is a one-time incentive payment made to participants who enroll land in CRP to be devoted to all continuous sign up practices except establishment of permanent vegetative cover on terraces, wetland restoration (including non-floodplain), bottomland timber establishment, and duck nesting habitat.

The maximum annual non-cost share payment that an eligible "person" can receive under the CRP is $50,000 per fiscal year. This is a separate payment limitation applying only to CRP non-cost share payment.

The current extent of land enrolled in CRP within the Lake Springfield watershed is unknown.

9.11.2.3 Conservation Stewardship Program

The CSP helps agricultural producers maintain and improve their existing conservation systems and adopt additional conservation activities to address priority resources concerns. Participants earn CSP payments for conservation performance—the higher the performance, the higher the payment.

Through CSP, participants take additional steps to improve resource conditions including soil quality, water quality and quantity, air quality, habitat quality, and energy. CSP provides two types of payments through 5-year contracts: annual payments for installing new conservation activities and maintaining existing practices; and supplemental payments for adopting a resource-conserving crop rotation. Producers may be able to renew a contract if they have successfully fulfilled the initial contract and agree to achieve additional conservation objectives. Payments are made soon as practical after October 1 of each fiscal year for contract activities installed and maintained in the previous year. In fiscal year 2016, NRCS made $150 million available for producers through the CSP. The cover crop payment fact sheet (http://www.nrcs.usda.gov/Internet/FSE_DOCUMENTS/stelprdb1082778.pdf) shows a maximum annual payment of $40,000 for the CSP program.

Eligible lands include private and Tribal agricultural lands, cropland, grassland, pastureland, rangeland and non-industrial private forest land. CSP is available to all producers, regardless of operation size or type of crops produced, in all 50 states, the District of Columbia, and the Caribbean and Pacific Island areas. Applicants may include individuals, legal entities, joint operations, or Indian tribes that meet the stewardship threshold for at least two priority resource concerns when they apply. They must also agree to meet or exceed the stewardship threshold for at least one additional priority resource concern by the end of the contract. Producers must have effective control of the land for the term of the proposed contract, which include all eligible land in the agricultural operation. Some additional restrictions and program requirements may apply and interested applicants should contact the local NRCS office for more information.

9.11.2.4 Grassland Reserve Program

The purpose of the GRP, administered by the FSA, is to prevent grazing and pasture land from being converted into cropland, used for urban development, or developed for other non-grazing uses. Participants in the program voluntarily limit future development of the land while still being able to use the land for livestock grazing and activities related to forage and seed production. Some restrictions on activities may apply during the nesting season of certain bird species that are in decline or protected under federal or state law.

The GRP has several enrollment options, including a rental contract for 10, 15, or 20 years, or enrollment of the land in a conservation easement for an indefinite period of time. Applications are accepted any time and are processed through the local FSA office.

To be eligible for a rental agreement, the applicant must own or have control of the land for the length of the contract. To enroll in a conservation easement, the applicant must own and be willing to restrict use of the land either in perpetuity or under the maximum length of time under state law. Persons enrolled in GRP receive an annual rental payment for their enrolled acres. Rental payments were not available on the USDA website as of June 2016 (https://www.fsa.usda.gov/programs-and-services/conservation-programs/grassland-reserve/index); however, further information about the program, including payment amounts, eligibility and maintenance criteria, and land requirements may be obtained from the local FSA office.

9.11.2.5 Agricultural Conservation Easement Program

ACEP provides financial and technical assistance to help conserve agricultural lands and wetlands and their related benefits. Under the Agricultural Land Easements component, NRCS helps American Indian tribes, state and local governments, and non-governmental organizations protect working agricultural lands and limit non-agricultural uses of the land. Land protected by agricultural land easements provides additional public benefits, including environmental quality, historic preservation, wildlife habitat, and protection of open space. Under the Wetlands Reserve Easements component, NRCS helps to restore, protect, and enhance enrolled wetlands. Wetland

Reserve Easements provide habitat for fish and wildlife, including threatened and endangered species, improve water quality by filtering sediments and chemicals, reduce flooding, recharge groundwater, protect biological diversity and provide opportunities for educational, scientific and limited recreational activities.

Agricultural Land Easements: NRCS provides financial assistance to eligible partners purchase Agricultural Land Easements that protect the agricultural use and conservation values of eligible land. In the case of working farms, the program helps farmers and ranchers keep their land in agriculture. The program also protects grazing uses and related conservation values by conserving grassland, including rangeland, pastureland and shrubland. Land eligible for agricultural easements includes cropland, rangeland, grassland, pastureland and non-industrial private forest land. NRCS will prioritize applications that protect agricultural uses and related conservation values of the land and those that maximize the protection of contiguous acres devoted to agricultural use.

To enroll land through agricultural land easements, NRCS enters into cooperative agreements with eligible partners. Each easement is required to have an agricultural land easement plan that promotes the long-term viability of the land. Under the Agricultural Land component, NRCS may contribute up to 50 percent of the fair market value of the agricultural land easement. Where NRCS determines that grasslands of special environmental significance will be protected, NRCS may contribute up to 75 percent of the fair market value of the agricultural land easement.

Wetland Reserve Easements: NRCS also provides technical and financial assistance to restore, protect, and enhance wetlands through the purchase of a wetland reserve easement. These agreements include the right for NRCS to develop and implement a wetland reserve restoration easement plan to restore, protect, and enhance the wetland's functions and values. Land eligible for wetland reserve easements includes farmed or converted wetland that can be successfully and cost-effectively restored. NRCS will prioritize applications based the easement's potential for protecting and enhancing habitat for migratory birds and other wildlife. For acreage owned by an Indian tribe, there is an additional enrollment option of a 30-year contract. Through the wetland reserve enrollment options, NRCS may enroll eligible land through one of the following:

- Permanent Easements – These are conservation easements in perpetuity. NRCS pays 100 percent of the easement value for the purchase of the easement. Additionally, NRCS pays between 75 to 100 percent of the restoration costs.
- 30-year Easements – These expire after 30 years. Under 30-year easements, NRCS pays 50 to 75 percent of the easement value for the purchase of the easement. Additionally, NRCS pays between 50 to 75 percent of the restoration costs.
- Term Easements – Term easements are easements made for the maximum duration allowed under applicable State laws. NRCS pays 50 to 75 percent of the easement value for the purchase of the term easement. Additionally, NRCS pays between 50 to 75 percent of the restoration costs.
- 30-year Contracts – 30-year contracts are only available to enroll acreage owned by Indian tribes, and program payment rates are commensurate with 30-year easements.

For wetland reserve easements, NRCS pays all costs associated with recording the easement in the local land records office, including recording fees, charges for abstracts, survey and appraisal fees, and title insurance.

Wetland Reserve Enhancement Partnership – The 2014 Farm Bill replaced the Wetland Reserve Enhancement Program with the Wetland Reserve Enhancement Partnership (WREP) as an enrollment option under ACEP. WREP continues to be a voluntary program through which NRCS signs agreements with eligible partners to leverage resources to carry out high priority wetland protection, restoration, and enhancement and to improve wildlife habitat.

- Partner benefits through WREP agreements include:
  - Wetland restoration and protection in critical areas
  - Ability to cost-share restoration or enhancement beyond NRCS requirements through leveraging
  - Able to participate in the management or monitoring of selected project locations
  - Ability to use innovative restoration methods and practices

In 2016, NRCS made $15 million in financial and technical assistance available to help eligible conservation partners leverage local resources to voluntarily protect, restore, and enhance critical wetlands on private and tribal agricultural land nationwide. The funding is provided through the WREP, a special enrollment option under the Agricultural Conservation Easement Program. Proposals were due to the local NRCS offices by May 16, 2016; however, landowners should check with the NRCS to see about applying in future years. To enroll land eligible partners may submit proposals to the local NRCS office.

9.11.2.6 Environmental Quality Incentive Program

EQIP is a voluntary program that provides financial and technical assistance to agricultural producers to plan and implement conservation practices that improve soil, water, plant, animal, sir, and related natural resources on agricultural land and non-industrial private forestland. Through EQIP, the NRCS develops contracts with agricultural producers to implement conservation practices to address environmental natural resource problems. Persons engaged in livestock or agricultural production and owners of non-industrial private forestland are eligible for the program. Eligible land includes cropland, rangeland, pastureland, private non-industrial forestland, and other farm or ranch lands. Eligible applicants must, at a minimum, meet the following criteria; additional program requirements may apply:

- Be agricultural producer (person, legal entity, or joint operation who has an interest in the agricultural operation, or who is engaged in agricultural production or forestry management).
- Control or own eligible land.

- Comply with adjusted gross income for less than $900,000. Note: Federally recognized Native American Indian Tribes or Alaska Native corporations are exempt from the adjusted gross income payment limitations.
- Be in compliance with the highly erodible land and wetland conservation requirements.
- Develop an NRCS EQIP plan of operations that addresses at least one natural resource concern

Persons interested in entering into a cost-share agreement with the NRCS for EQIP assistance may file an application at any time; however, each state may establish deadlines for one or more application periods in which to consider eligible applications for funding. Applications submitted after the deadlines will be evaluated and considered for funding during later funding opportunities.

As part of the program, a Conservation Activity Plan (can be developed for producers to address a specific natural resource concern on their agricultural operation. Each plan is developed by a certified Technical Service Provider, who is selected by the EQIP participant. Technical assistance payments for Technical Service Providers do not count against the financial assistance aggregate payment limitation or the contract financial assistance payment limitation. The plan becomes the basis of the EQIP contract between NRCS and the participant, and the contracts can be up to 10 years in duration. Financial assistance payments are made to eligible producers once conservation practices are completed according to NRCS requirements. Payment rates are set for each fiscal year and are attached to the EQIP contract when it is approved.

Historically underserved producers (limited resource farmers/ranchers, beginning farmers/ranchers, socially disadvantaged producers, Indian Tribes, and veteran farmer or ranchers) who self-certify on Form NRCS-CPA-1200, Conservation Program Application are eligible for a higher practice payment rate to support implementation of contracted conservation practices and activities. Historically underserved producers may also be issued advance payments up to 50 percent of the established payment rate to go toward purchasing materials or contracting services to begin installation of approved conservation practices. Self-certified socially disadvantaged farmer/rancher, beginning farmer/rancher, and veteran farmer/rancher producers may elect to be evaluated in special EQIP funding pools. More information can be obtained from the local NRCS office.

EQIP provides payments up to 75 percent of the incurred costs and 100 percent estimated income foregone of certain conservation practices and activities. Payments received by producers through EQIP contracts after February 7, 2014 may not exceed $450,000 for all EQIP contracts entered into during the period from 2014 to 2018. Payment limitations for organic production may not exceed an aggregate $20,000 per fiscal year or $80,000 during any 6-year period for installing conservation practices.

Conservation practices eligible for EQIP funding which are recommended BMPs for this watershed TMDL include cover crops, filter strips, conservation tillage, grade stabilization structures, grass waterways, riparian buffers, streambank/shoreline protection, livestock fencingand wetland restoration. More information regarding state and local EQIP implementation can be found at http://www.nrcs.usda.gov/wps/portal/nrcs/main/il/programs/financial/eqip/.

9.11.3 Other Programs

As discussed in Section 5.4.3, the SMSD has an ongoing program to eliminate septic systems around Lake Springfield. Under this program, the SMSD will provide a maximum of $5,000 toward the installation of a private pump station to be installed to pump sanitary sewage from unsewered homes and businesses to the SMSD collection system in proximity to Lake Springfield.

9.11.4 Local Program Contact Information

The FSA administers the CRP and GRP. NRCS administers the ACEP, CSP, and EQIP. Local contact information for counties containing some portion of the Lake Springfield watershed are listed in the **Table 9-6** below.

Table 9-6 Local SWCD, NRCS, FSA, and IDA Contact Information

County	Address	Phone
State FSA Office		
	Illinois State FSA Office 3500 Wabash Avenue Springfield, IL 62711	(217) 241-6600
Local NRCS/Soil and Water Conservation District Office		
Macoupin County	300 Carlinville Plaza Carlinville, IL 62626	(217) 854-2626
Morgan County	1904 W. Lafayette Jacksonville, IL 62650	(217) 243-1535
Sangamon County	2623 Sunrise Drive, Suite 1 Springfield, IL 62703-8302	(217) 241-6635
Local IDA Office for SSRP		
	P.O. Box 19281, State Fairgrounds Springfield, IL 62794-9281	(217) 782-6297

9.12 Planning Level Cost Estimates for Implementation Measures

Cost estimates for different implementation measures are presented in **Table 9-7**. The column labeled "Program" or "Sponsor" lists the financial assistance program or sponsor available for various BMPs (as discussed in Section 9.11). Illinois EPA 319 Grants are applicable to all of the practices. See each program's documentation for details on estimated initial and maintenance costs as well as funding eligibility.

Table 9-7 Cost Estimates of Various BMP Measures

BMP	Units	Installation Cost	Program	Sponsor(s)
Filter strip (seeded)	per ac	$520 - $639, avg $594	CRP	NRCS, IDA
Riparian buffer – bare-root shrubs	each	$1.10 - $1.65	CRP	NRCS, IDA
– forested	per ac	$741		

BMP	Units	Installation Cost	Program	Sponsor(s)
– herbaceous cover	per ac	$642		
– land preparation	per ac	$38		
Saturated Buffer	per project	$3700	EQIP	NRCS
Nutrient management - federal	per plan	$13 - $35	EQIP	NRCS
– state	per plan	$13	NMP Project	IDA, Illinois EPA
Water and sediment control basin	per CY	avg $2.70	CPP	IDA
– underground outlet, plastic	per ft	$2.27		
Stormwater Retention Pond	per pond	varies by volume/capacity	Local Stormwater Utility Fees, State Revolving Fund,	
Bank stabilization	per ac	$27 - $52/ft	SSRP	IDA
– weirs/rock riffles	each	$2,448 - $6,305		
– stream barb/bendway weir with longitudinal peaked stone toe	per ft	$27.27 - $52.50		
– bank armor	per CY	$37.55		
Grade stabilization			CPP, SSRP	IDA
– concrete block chutes	per SF	$7.81		
– rip rap-lined (rock) chute	per CY	$48.73		
– gully pipe structure	per CY	$5.20		
– overfall structure	per SF	$119.11 - $194.01		
– pipe drop grade structure	per SF	$10.24		
Grassed waterway	per ac	$2,568 - $4,916	CPP CRP	IDA NRCS
Pasture Management/Livestock Fencing				
Fencing – permanent high-tensile, 1 strand	per ft	$0.79	EQIP	NRCS
– permanent high-tensile, 2-3 strands	per ft	$1.16		
– permanent high-tensile, 4-6 strands	per ft	$1.42		
– permanent high-tensile, 7 or more strands	per ft	$1.78		
– barbed wire, multi-strand	per ft	$1.62		
– woven wire	per ft	$1.96		
Conservation tillage			EQIP	NRCS, IDA
– no-till/strip-till	per ac	$16		
– mulch-till	per ac	$4.21		
– ridge-till	per ac	$30		
Cover Crop	Per ac	$15-$25	EQIP, CSP	NRCS
Contour farming	per ac	$6.06	EQIP	NRCS
Wetland – enhancement/restoration	per ac	$1,167 - $3,680	ACEP	NRCS
– constructed	per ac	$7,725 - $10,286		

BMP	Units	Installation Cost	Program	Sponsor(s)
Vegetation and mulch as needed for various BMPs, such as alternate water access ramp and WASCOBs	per ac	$716 for vegetation, $238 for mulch	See corresponding program and sponsor listed above	
Septic system maintenance	per event	$250 - $350	Private system owner	
In-Lake Treatment – Hypolimnetic Aeration	per ac	$580 - $2,100	Clean Water Act Section 319 Grants, Private or municipal funds	
– Alum treatment	per ac	$816 - $7,700		
– Dredging	per ac	$4,205 - $81,000		

ac = acre ft = foot CY = cubic yard SF = square foot

9.13 Milestones and Monitoring

9.13.1 Interim Measurable Milestones and Schedule

Successful plan implementation relies on establishing and tracking milestones to measure progress. **Table 9-8** below identifies these milestones and a schedule for meeting each milestone. Stakeholders should evaluate milestone progress on an annual basis and implement adaptive management to modify management measures, milestones, and schedule as necessary.

Implementation of the management actions outlined in this section should occur in phases, often over the course of several years, with effectiveness assessments made as improvements are completed. The process of obtaining funding, and developing and implementing projects designed to improve water quality, can take months or years to complete and once in place, improvements in water quality as a result of BMPs may not be detectable for several years. Continued monitoring and reevaluation of the implementation measures during this time will allow for more expedient adjustment to BMP implementation measures that may result in earlier attainment of water quality targets.

Table 9-8 Implementation Milestones

Milestones	Description	Estimated Schedule
Funding	Develop grant applications	Short term: 2-5 years
Implement Short-term Projects	Identify and implement short-term pilot projects that can be completed (i.e. willing landowners and available funding)	Mid-term: 2-5 years
Monitoring	Implement monitoring plan	Continuous: 1-20 years
Annual Stakeholder meetings	Stakeholders will convene at once a year to gauge progress and discuss evolving needs and planned activities	Annually
Implement Larger Projects	Identify and implement larger projects. These projects are more likely to have multiple funding sources and stakeholders.	Mid- Term: 5-10 years
Education and outreach	Prepare and implement and education and outreach plan. Conduct at least two public meetings annually.	Immediate: 1-2 years

9.13.2 Monitoring Plan

The purpose of the monitoring plan for the Lake Springfield watershed is to assess the overall implementation of management actions outlined in this section. This can be accomplished by conducting the monitoring programs designed to:

- Track implementation of BMPs in the watershed
- Estimate effectiveness of BMPs
- Further monitor point source discharges in the watershed
- Continued monitoring of impaired stream segments and tributaries
- Monitor storm-based high flow events
- Low flow monitoring of total phosphorus, boron, and TSS in impaired streams

Tracking the implementation of management measures can be used to:

- Determine the extent to which management measures and practices have been implemented compared to action needed to meet the TMDL endpoints
- Establish a baseline from which decisions can be made regarding the need for additional incentives for implementation efforts
- Measure the extent of voluntary implementation efforts
- Support work-load and costing analysis for assistance or regulatory programs
- Determine the extent to which management measures are properly maintained and operated

Estimating the effectiveness of the BMPs implemented in the watershed could be completed by monitoring before and after the BMP is incorporated into the watershed. Additional monitoring could be conducted on specific structural systems such as a sediment control basin. Inflow and outflow measurements could be conducted to determine site-specific removal efficiency.

Illinois EPA conducts Intensive Basin Surveys every 5 years. Additionally, select ambient sites are monitored nine times a year. Continuation of this state monitoring program will assess lake and stream water quality as improvements in the watershed are completed. This data will also be used to assess whether water quality standards in the impaired segments are being attained.

9.13.3 Success Criteria

Measuring the plan's success depends largely on tracking the milestones outlined above. Implementing BMPs should equate to improved water quality and attainment of designated uses and water quality standards. Monitoring pollutant-load reductions will be the primary success criteria. Key components include:

- Securing funding for priority projects within 5 years

- Identify and secure additional funding to increase farmer participation
- Meeting the identified milestones
- Meeting 25-50% of target reductions within 10 years
- Meeting 100% of target reductions within 20 years
- Utilizing adaptive management to ensure best practices
- Delisting of the impaired waterbodies

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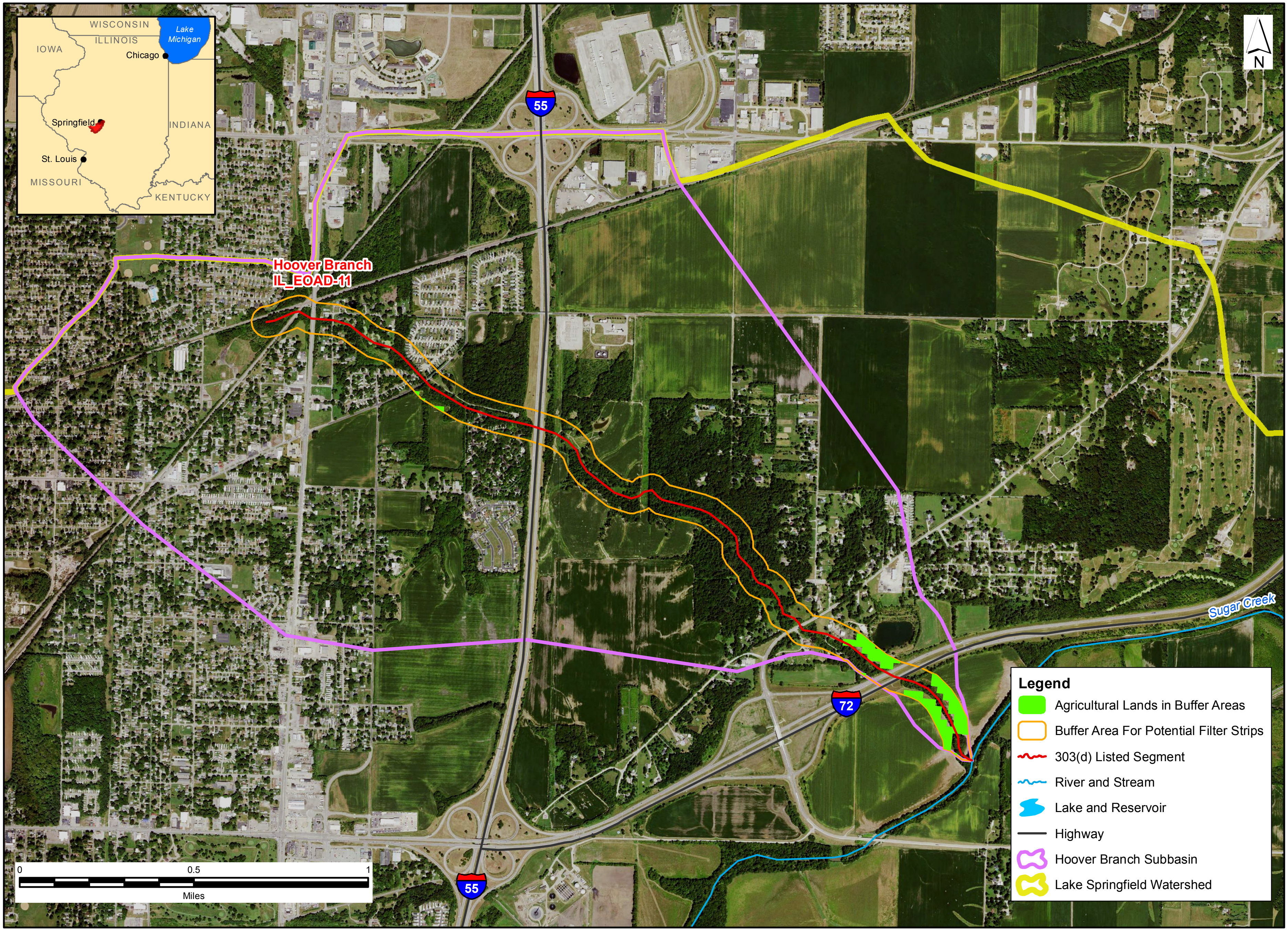

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CDM Smith

Lake Springfield - Hoover Branch (EOAD-11)

Buffer Areas and Agricultural Lands Potentially Suitable for Conversion to Filter Strips

FIGURE 9-1

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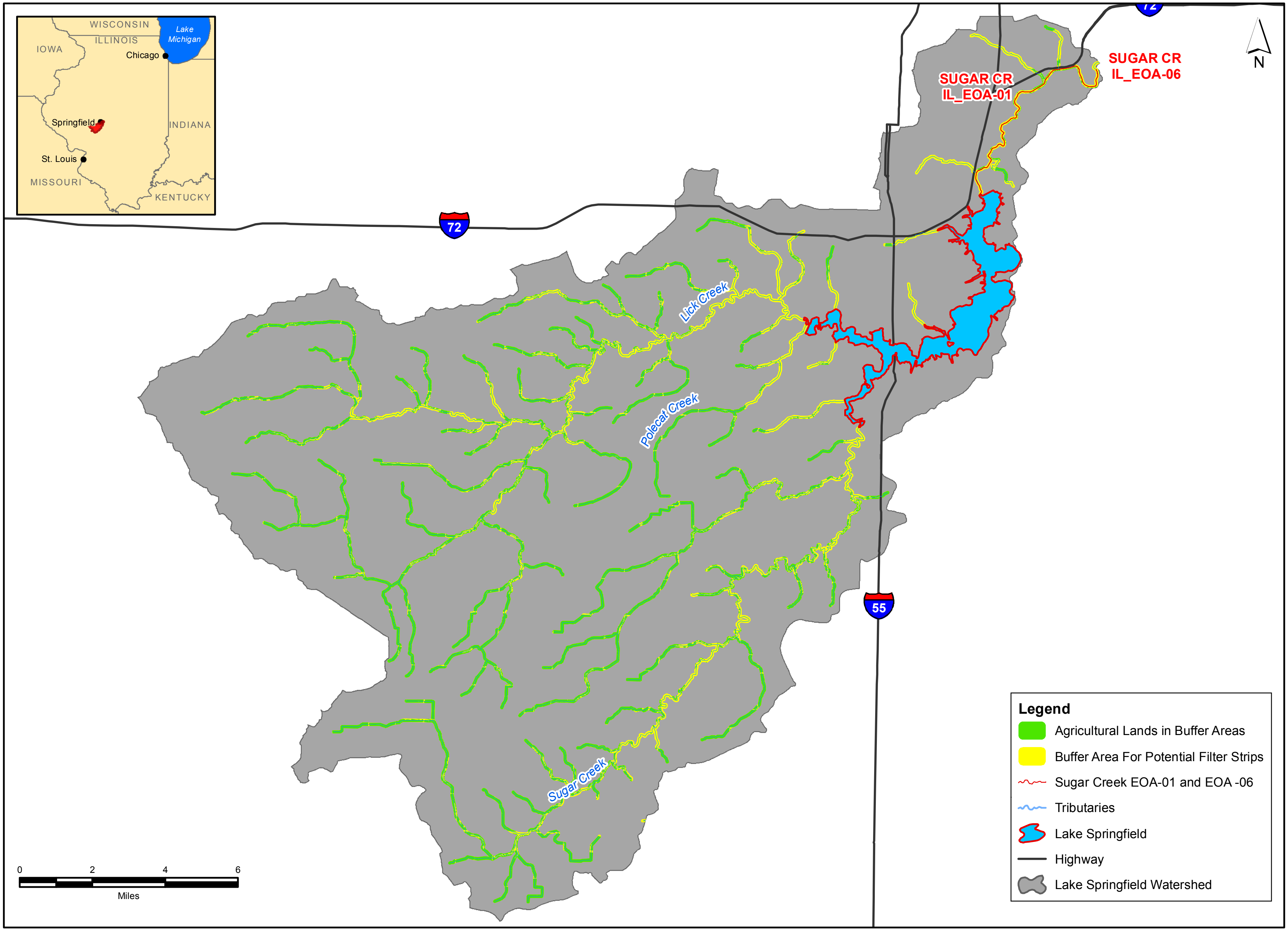

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CDM Smith

Lake Springfield - Sugar Creek Segments EOA-01 and EOA-06
Buffer Areas and Agricultural Lands Potentially Suitable for Conversion to Filter Strips

FIGURE 9-2

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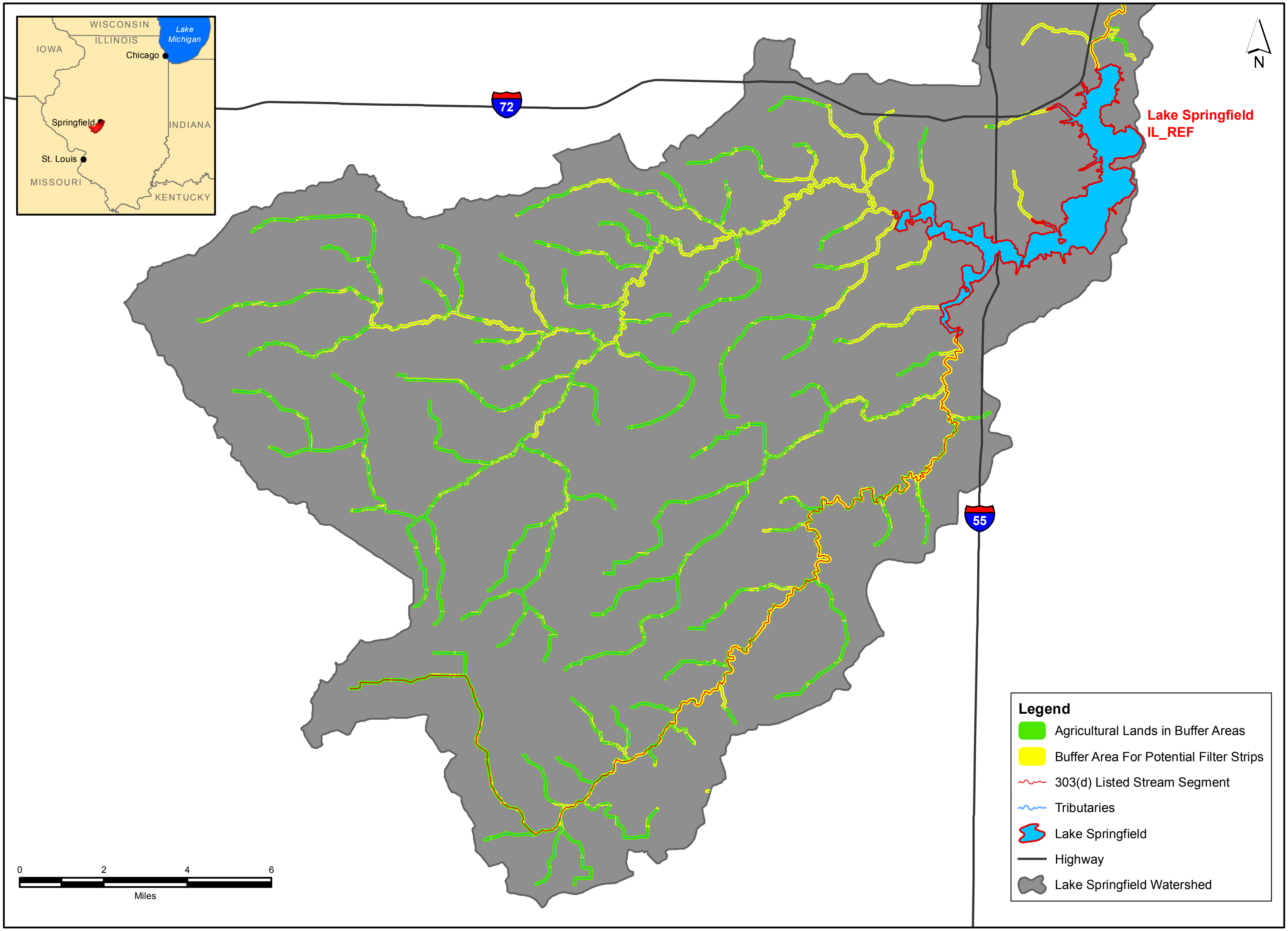

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CDM Smith

Lake Springfield (REF)

Buffer Areas and Agricultural Lands Potentially Suitable for Conversion to Filter Strips

FIGURE 9-3

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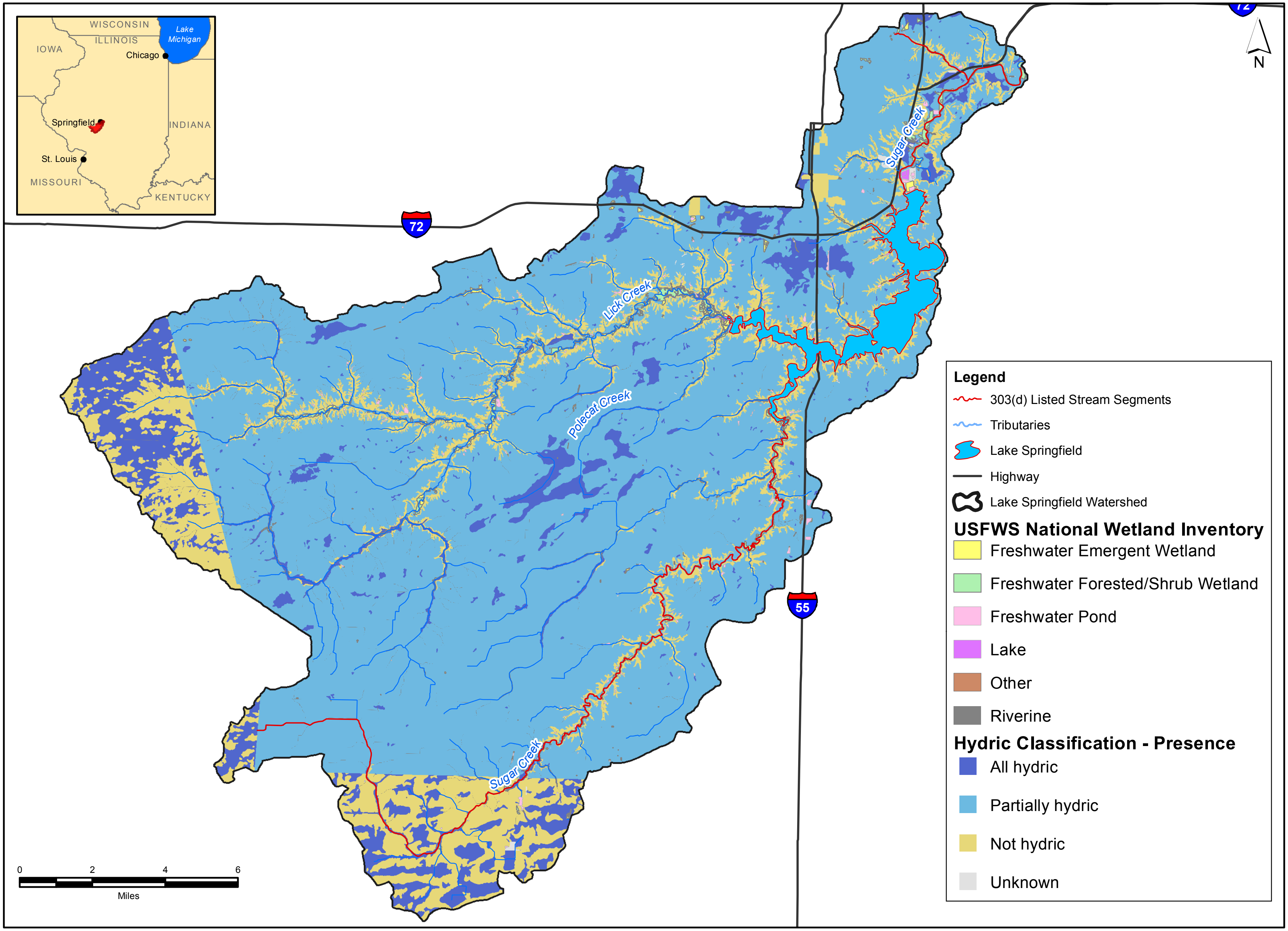

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CDM Smith

Lake Springfield and Sugar Creek Watershed
Existing Wetlands and Hydric Soils

FIGURE 9-4

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Section 10

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