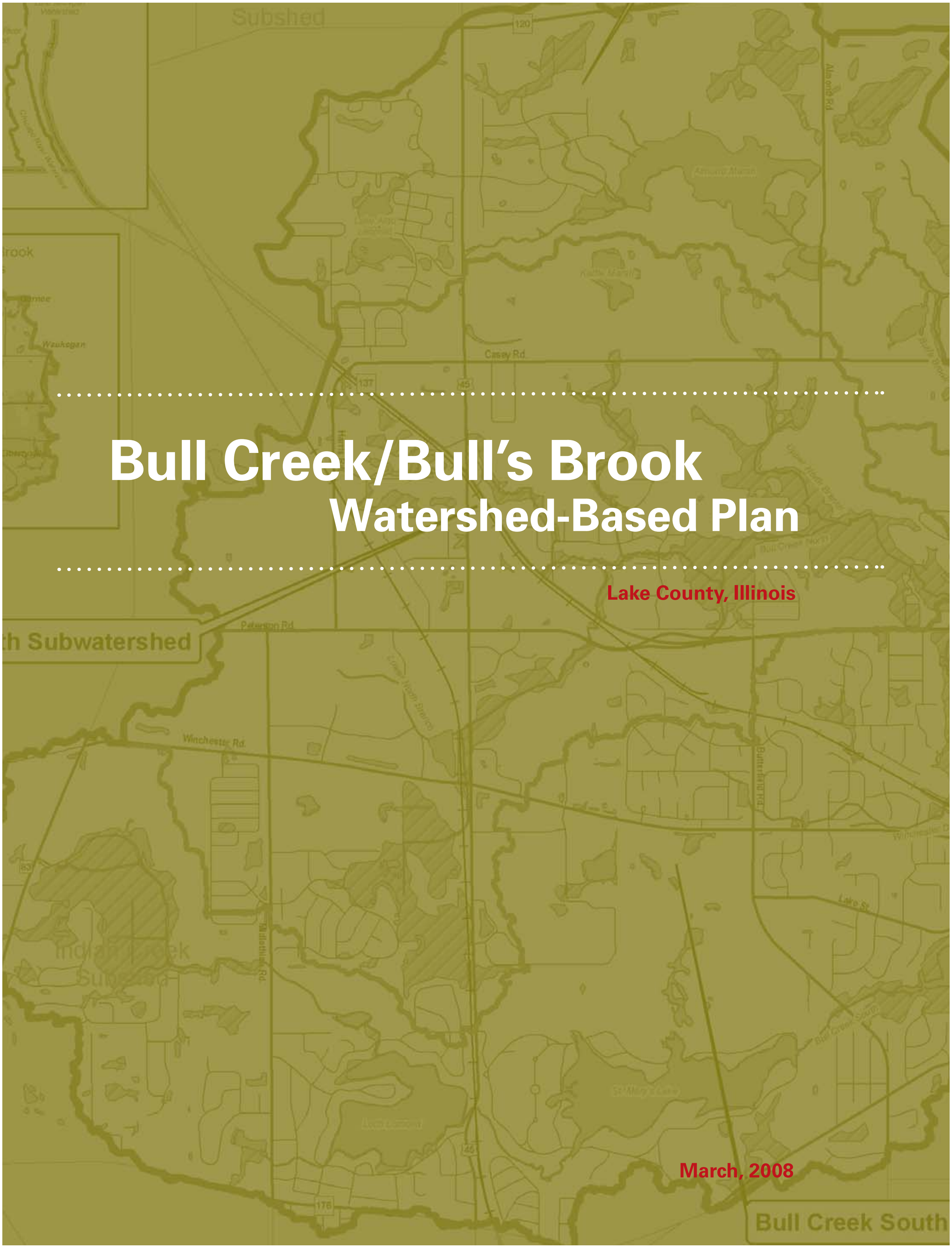
Bull Creek–Bull's Brook Watershed-Based Plan

A Strategy for Protecting and Restoring the Watershed

August 2008



Bull Creek/Bull's Brook
Watershed-Based Plan

Lake County, Illinois

March, 2008

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Several agencies and individuals provided significant contributions to this plan, including Bull Creek/Bull's Brook watershed stakeholders, whose members include representatives from municipalities, homeowners associations, and interested groups and individuals from throughout the watershed. Of particular mention are Patty Werner, LCSMC Bull Creek/Brook Watershed Plan Project Manager/Planner; Tony Wolf, LCSMC Chief Engineer; and all watershed stakeholders whose interest in protecting, restoring, and enhancing the Bull Creek/Bull's Brook watershed has been critical to the success of this plan.

Applied Ecological Services, Inc. (AES) prepared the watershed plan. Steve Zimmerman, Staff Ecologist, acted as Project Manager. Kevin McCaffery and John Roll, Environmental Engineers, completed watershed analyses including pollutant loading, pollutant reduction, and hydrologic and hydraulic modeling. Jason Carlson and Rio Roland, GIS/Environmental Analysts provided all GIS analysis. Staff Ecologists, Kara Miller, Chris Prah, and Meagan Droessler prepared, finalized, and formatted sections of the report. Administrative Assistant Alan Snopek and intern, Nancy-Jeanne Bachmann, also helped finalize and format sections of the report. Mark O'Leary, Senior Ecologist, provided project direction throughout the planning process. The following people attended and provided input at Bull Creek/Bull's Brook Planning Committee meetings:

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Executive Summary August 2008

Why this Watershed Plan?

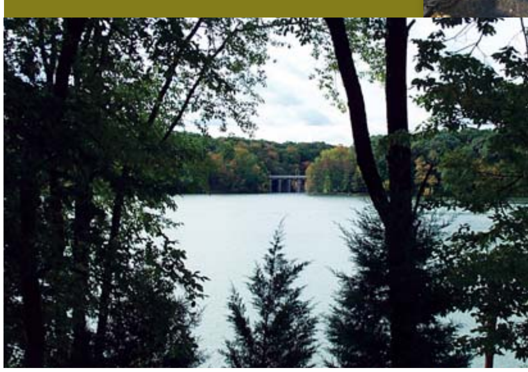
Water is elemental to our lives. Our bodies are largely composed of water—and we need to consume clean water for our survival. Plants and animals also need water—and we in turn depend on these plants and animals for food, medicines, fuel and the everyday products we use. Although elemental to our individual lives, our communities and our planet, we sometimes take water for granted.

This plan is important to you because it specifically addresses water problems (and promises) here in your community within the Bull Creek-Bull's Brook watershed. Because clean and abundant water, healthy lakes and streams, and safety from flooding are important for residents and businesses—and generally the economic and environmental health of our community—it is also important to community leaders.

> As a resident, landowner, business or community official your actions make a difference in keeping water in our creeks and lakes clean, reducing flooding, and protecting natural areas that help do both as well as providing habitat and places for people to recreate.

How water flows and collects in streams, wetlands and lakes is based on landform. Because water flow generally does not follow political jurisdiction boundaries, we recognize that most water resource problems need to be addressed at the watershed level, which frequently involves several political jurisdictions. The watershed planning process for Bull Creek & and Bull's Brook brought the municipalities, townships, county and the broader community of homeowner associations, businesses, institutions, non-profit organizations and residents that live or work in the watershed together to plan for managing and improving the land, lakes, streams and wetlands of the watershed.

Clockwise from top: Bull Creek South, Libertyville; Aldo Leopold Lake, Prairie Crossing, Grayslake; St. Mary's Lake, Mundelein



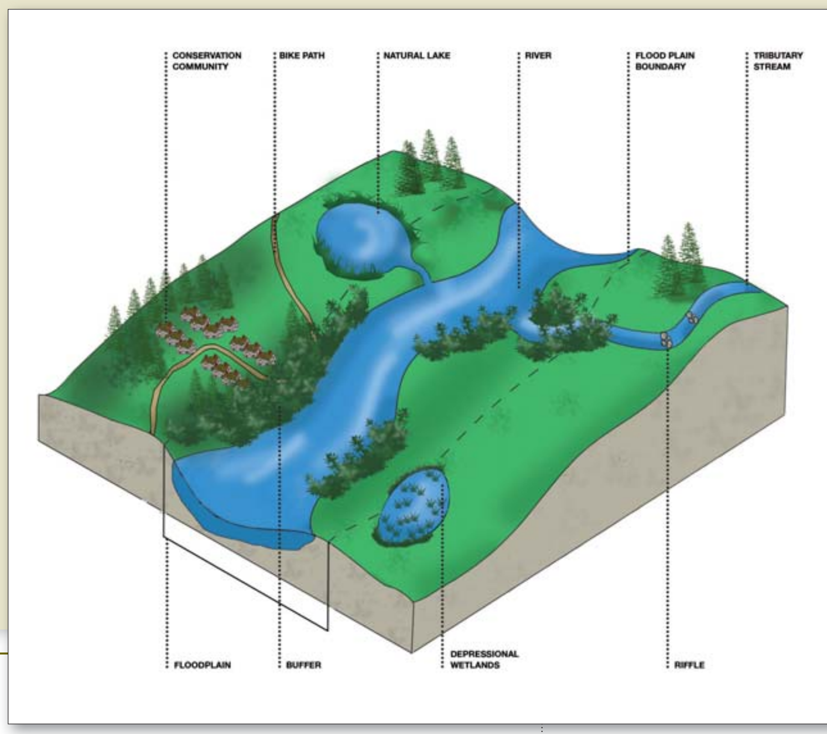
As a resident, landowner, business or community official, your actions make a difference in keeping water in our creeks and lakes clean, reducing flooding, and protecting natural areas that help do both as well as providing habitat and places for people to recreate. The Bull Creek/Bull's Brook Watershed Plan was created to help stakeholders better understand the watershed and to identify what actions need to be taken to prevent and reduce flood damage, improve water quality, and protect and enhance natural resources, greenways, and recreational opportunities. This comprehensive management plan summarizes the overall condition of the watershed (present day and into the future) and recommends actions as best practices that you as a stakeholder, individually or in collaboration with others, can take to protect watershed resources that are still in good shape—and restore those that are degraded.

What is a Watershed?

After a rain drop or snowflake falls on the land, it may infiltrate into the soil or it may run off over the land surface to a low spot in the landscape, which is usually a body of water (lake, stream or river). A watershed is the area of land that drains to a particular stream, river or lake.

The health of a waterbody is a direct reflection of how the land in the watershed is used and managed. Some of the benefits of a healthy watershed are:

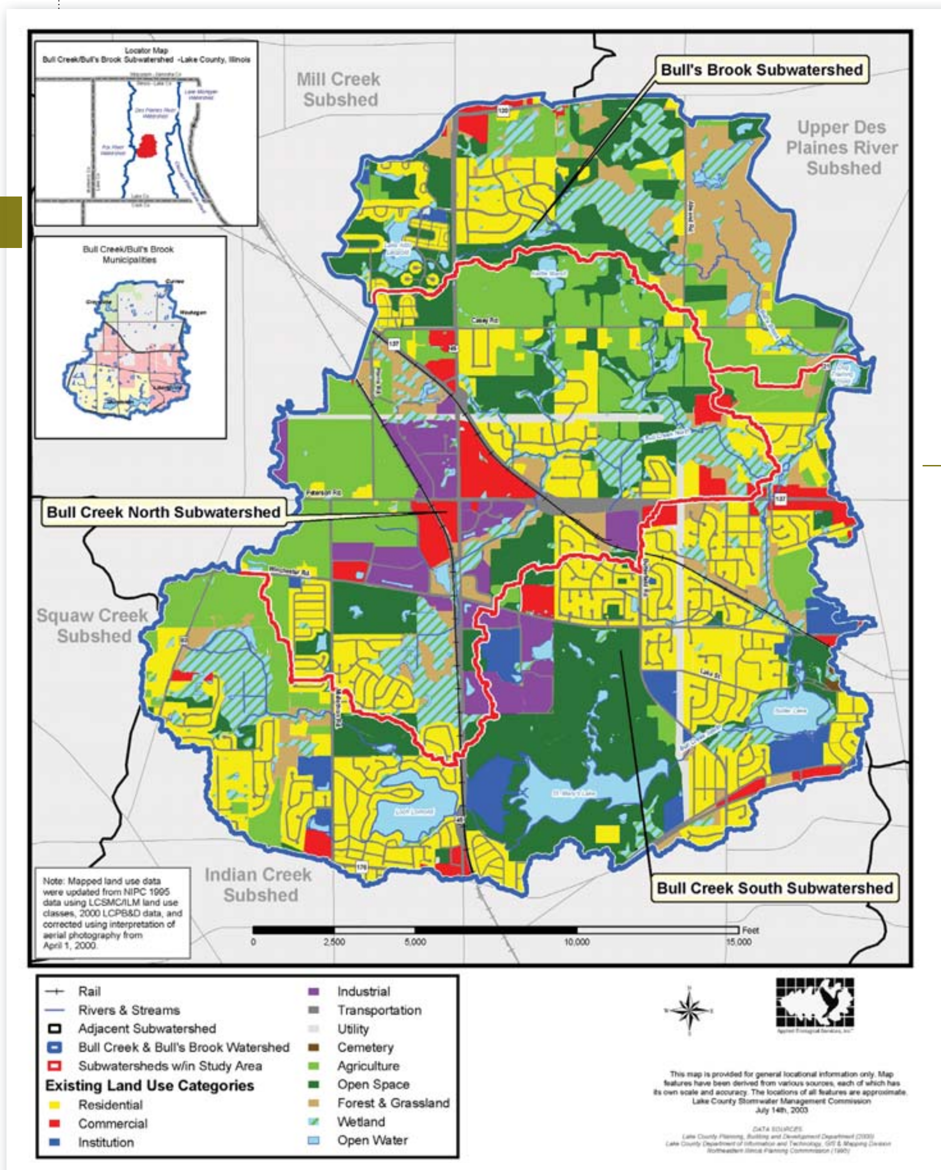
- **improved water quality**
- **fewer flooding problems**
- **enhanced wildlife habitat**
- **provides opportunities for education and recreation**



Do you live or work in Bull Creek-Bull's Brook Watershed?

Bull Creek–Bull's Brook Watershed, located in central Lake County, is part of the Des Plaines River Basin in northeastern Illinois. Three subwatersheds comprise the larger Bull Creek–Bull's Brook watershed and together they drain approximately 14 square miles to three tributaries: Bull's Brook; Bull Creek North; and Bull Creek South. In addition to the stream system, the natural landscape of the watershed is a complex of lakes, wetlands and upland prairies, savannas and woodlands. Interspersed with these natural features are farms, subdivisions of homes, commercial/industrial centers, area schools, St. Mary's University, and recreation facilities (golf courses, soccer and ball fields, playgrounds etc.). The Villages of Libertyville, Mundelein and Grayslake are the predominate watershed jurisdictions along with unincorporated areas of Libertyville and Warren Townships. Approximately 43% of the watershed is in developed land uses.

2004 Land Use Data



What is special about the Bull Creek-Bull's Brook Watershed?

The landscape we see today was created over 10,000 years ago by the last retreat of the Wisconsin Glacier. As the giant ice sheets melted and retreated, they carved out and left behind unique glacial features such as the moraines, ridges, kettle holes (Butler Lake), and the outwash till plains still visible throughout the watershed, but especially in the northern half that is less-developed.

Remnants, some large and some small, of the pre-settlement landscape and plant and animal communities of the watershed remain today. They are the biodiversity of the watershed. These water and natural resources, along with several significant cultural resources are worth protection and restoration. A short list includes:

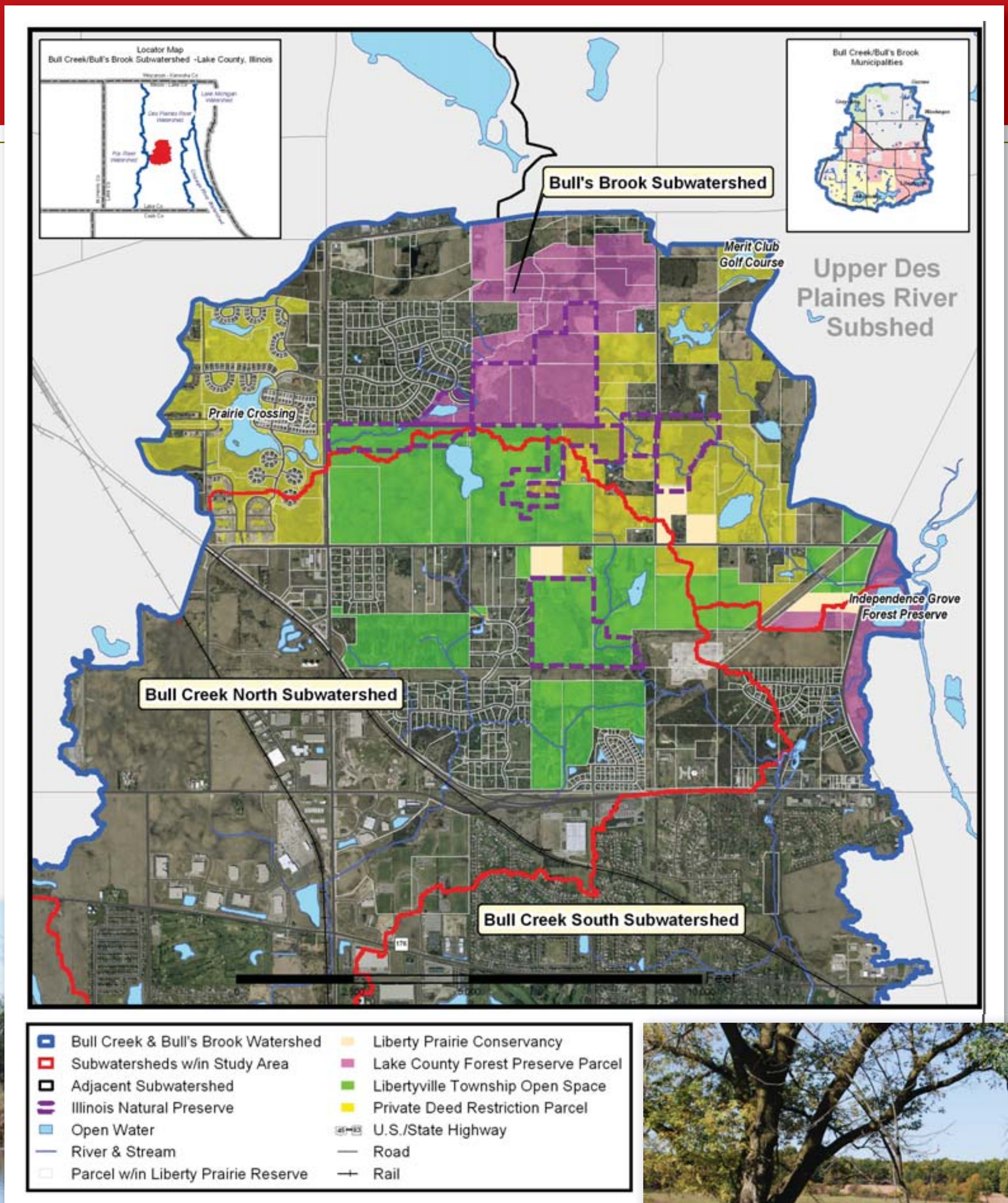
- The South Branch of Bull Creek has a series of lakes: Loch Lomond, St. Mary's and Butler Lakes that are significant features of the communities they are in and the watershed as a whole. St. Mary's University also has one of the largest woodland plant communities in the watershed and central Lake County.
- The North Branch of Bull Creek includes Liberty Prairie, a dedicated nature preserve and one of the remaining few remnant prairies in the state, and extensive high quality wetlands along the creek.
- Bull's Brook includes Sanctuary Pond (a nursery for endangered fish), Leopold Lake, Oak Openings Nature Preserve, and Almond Marsh, which is also a dedicated nature preserve and is home to a number of threatened and endangered species and a significant heron rookery.

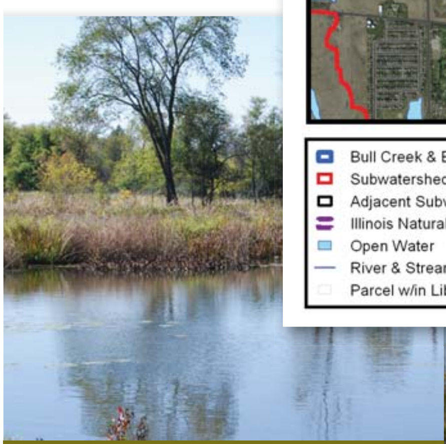
Watershed Goals

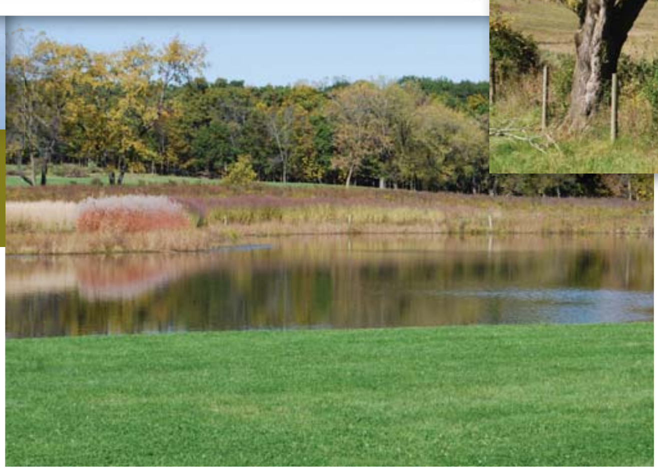
- **Protect and restore natural resources**
- **Improve water quality**
- **Reduce flood damage**
- **Enhance and restore stream health**
- **Guide new development to benefit watershed goals**
- **Preserve green infrastructure**
- **Enhance education and stewardship**
- **Improve watershed coordination and collaboration**

Left: Almond Marsh; Right: Bull's Brook at Oak Openings Nature Preserve

Unique to the Bull Creek-Bull's Brook watershed is the Liberty Prairie Reserve. The Reserve is a 5,800 acre area in central Lake County, of which 3,200 acres of public and private farmland and natural areas are permanently protected from further development.







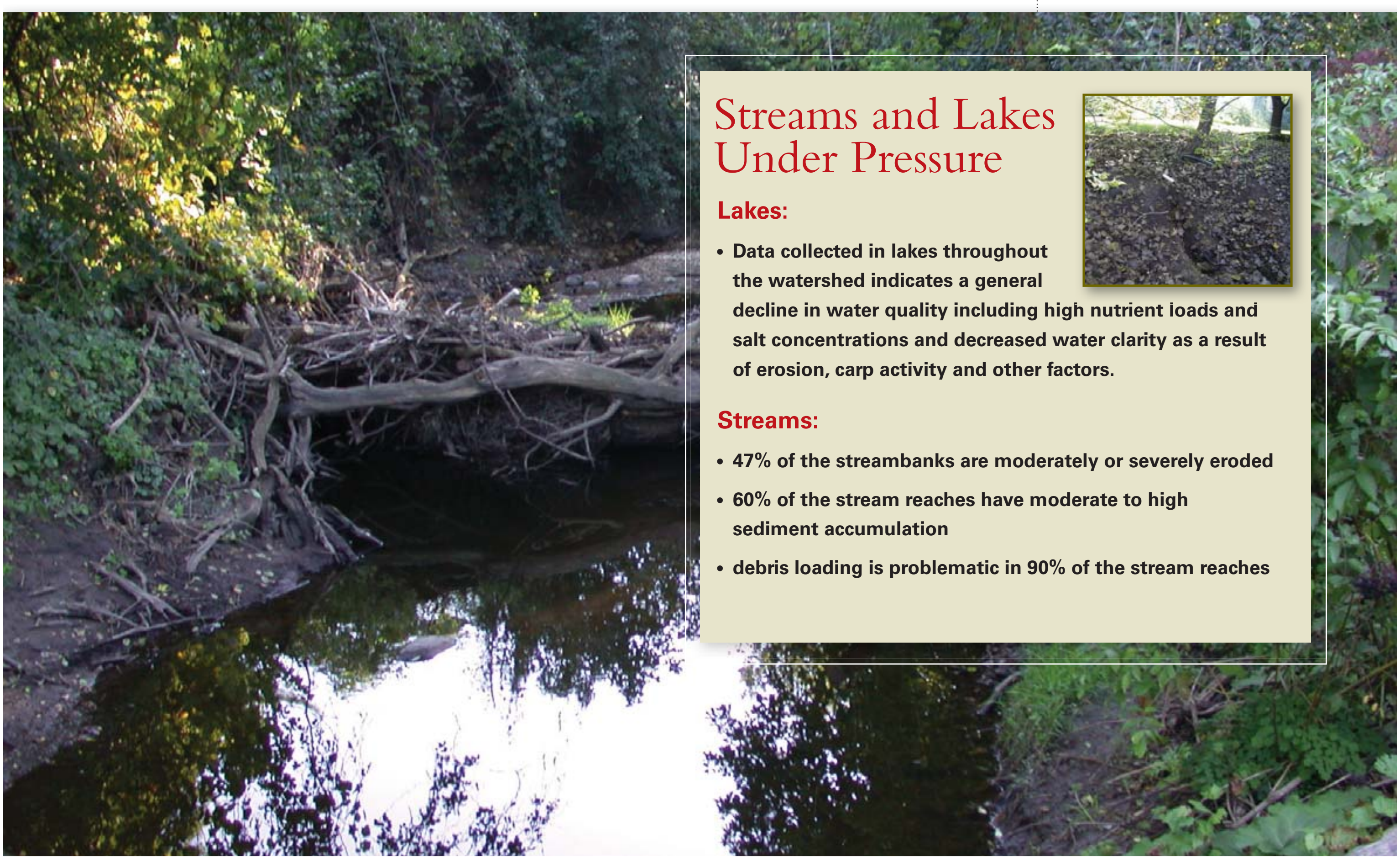
Legally protected private open lands within the Liberty Prairie Reserve

What are the current challenges to watershed health?

Lakes and ponds in the watershed are impaired or becoming impaired by high loads of nutrients in stormwater runoff and high salt concentrations from winter de-icing. Streams are degraded by pollutants in stormwater runoff, erosion caused by the higher volume of runoff to creeks from impervious surfaces such as building roof-tops, roads, parking lots etc., and as a consequence of poor riparian or streamside property management and lack of stream maintenance.

More specifically watershed threats include:

- **Erosion, excess nutrients, and road salt are the biggest threats to water quality**
- **Natural resources are threatened by adjacent and upstream development**
- **Stream channels are degrading due to lack of maintenance**
- **Lakes and streams are threatened by greater volumes of stormwater runoff and pollution**
- **Poor development practices negatively impact water and other natural resources**
- **Automobile "habitat" creates disproportionately more runoff and pollution**
- **Watershed stakeholders lack the knowledge, skills and resources that they need to address watershed issues**
- **Lack of communication, coordination and collaboration among watershed stake-holders to maintain/improve watershed health**



Streams and Lakes Under Pressure

Lakes:

- **Data collected in lakes throughout the watershed indicates a general decline in water quality including high nutrient loads and salt concentrations and decreased water clarity as a result of erosion, carp activity and other factors.**

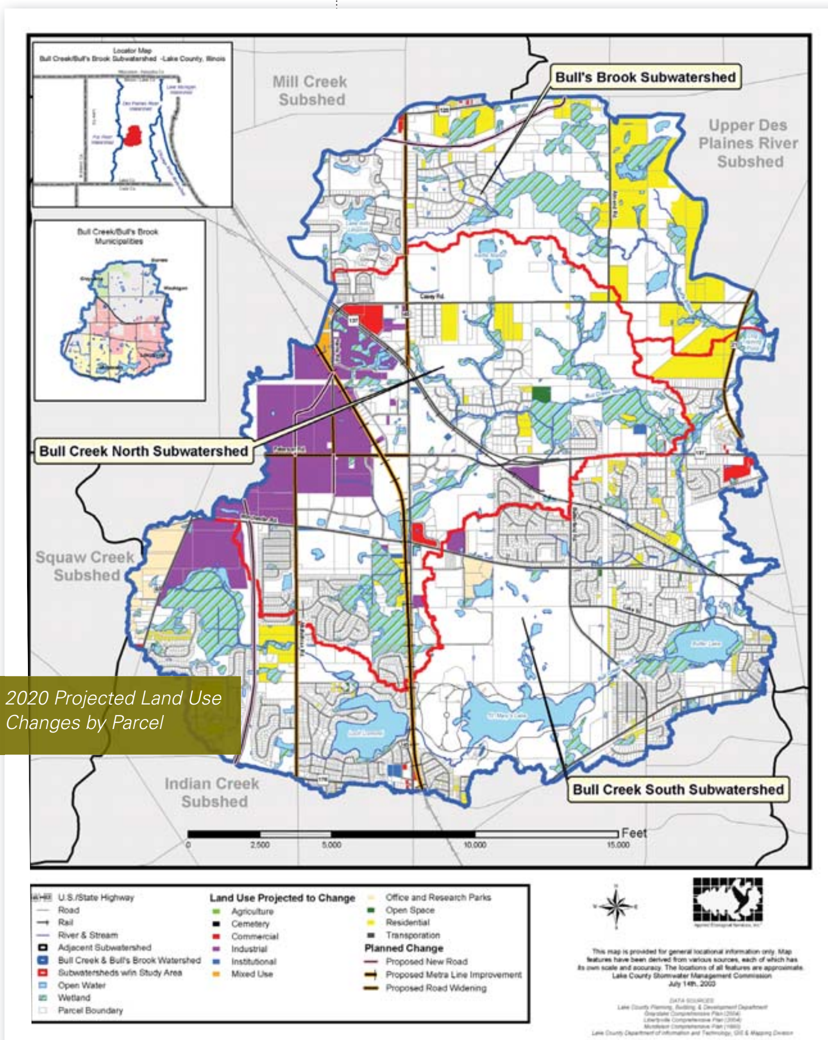
Streams:

- **47% of the streambanks are moderately or severely eroded**
- **60% of the stream reaches have moderate to high sediment accumulation**
- **debris loading is problematic in 90% of the stream reaches**

The Future of the Watershed: What is at Risk?

Impervious Cover Impacts Water Resources

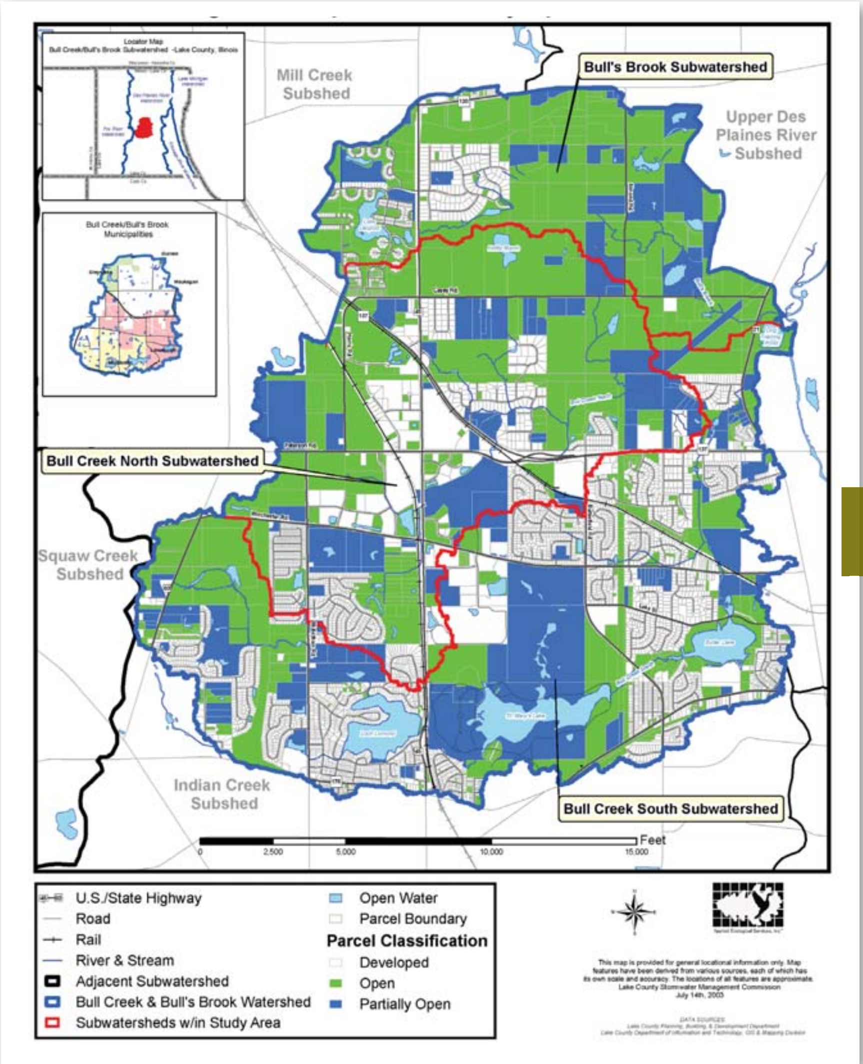
An analysis of the watershed's vulnerability based on the effect of impervious cover on stream and lake quality and flooding was evaluated using the proposed future development in the Bull Creek-Bull's Brook Watershed. Increased impervious cover typically results in more stormwater runoff, which carries pollutants to streams and lakes and causes erosion. Increased volumes of runoff also translate into more frequent flooding and a larger floodplain in some locations. More than 50 homes, businesses and schools are within the mapped 100 year floodplain in the watershed. All of these, and potentially other structures currently outside the floodplain boundary, may be at risk of flood damage in a 100-year flood event. (There is a 26% chance of a 100-year flood damaging your home within the timeframe of a 30-year home mortgage.)



2020 Projected Land Use Changes by Parcel

Looking into the future—the number of households in the watershed is expected to increase by 22% and the number of jobs by 90% between 2000 and 2030. Consequently, impervious cover is expected to increase in the watershed as land continues to be developed for these new homes, businesses and their accompanying transportation and parking needs. To reduce the negative impacts on the environment, the watershed plan recommends converting development practices from the

Traditional residential development in Libertyville.



Green Infrastructure
Open and Partially Open Parcels

traditional stormwater collection and conveyance systems to low impact development practices that reduce and infiltrate stormwater runoff.

Loss of Green Infrastructure

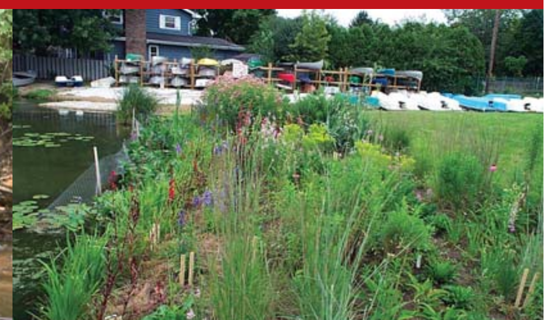
Green infrastructure serves an important function in the Bull Creek-Bull's Brook Watershed. It not only forms an interconnected network of natural areas that absorb and infiltrate precipitation, but also includes the wetlands and streams that make up the natural drainage system of the watershed and the green roofs, detention basins and swales of the built stormwater infrastructure.

A parcel level inventory of the watershed's green infrastructure was conducted, and a total of 5,789 acres of open or partially open land was identified. Future land use projections predict that approximately 1,200 acres of this land will be developed over the next 20-30 years (roughly 21%). The hydrology functions that this open land currently provides to the watershed (absorbing, infiltrating, evapotranspiring and storing precipitation) will have to be replaced within the developed lands using low impact development practices so that increases in runoff and its negative environmental and flood damage impacts on the watershed can be avoided.

Good Things are Beginning to Happen in the Watershed

Watershed partners are taking the lead and moving forward with implementing best management projects and educational activities recommended in the watershed plan. Join the watershed team and take the lead on a project in your neighborhood or community.

Stream Maintenance ➤
Liberty Prairie Area Homeowners Association: Stream cleanup of Bull Creek North with assistance from Libertyville Township and the youth conservation corps.



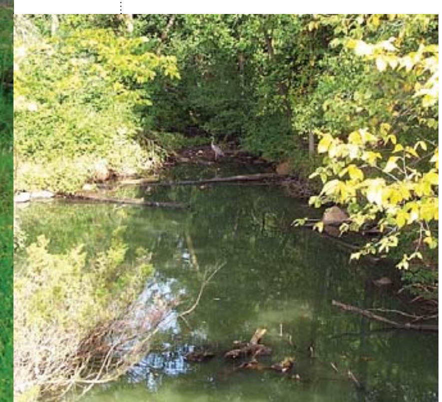
Pollutant Filter
Loch Lomond Property Owners Association: Banned phosphorus in fertilizers; conducts lake education days; and planted native shoreline plants as a demonstration project.

Natural Area Restoration
Liberty Prairie Conservancy and Libertyville Township: Sedge Meadow Wetland restoration at Liberty Prairie.

Low Impact Development

Lake County is constructing a central permit facility in Libertyville that includes a bioswale, vegetated swales, rain gardens, wetland detention and a green roof to capture, filter and infiltrate runoff.

Shoreline Stabilization/Pollutant Filter
Libertyville Parks Department: Regraded and stabilized shoreline with native buffer around Butler Lake



Stream Restoration
St. Mary's University: Has been awarded a grant to restore Bull Creek South Stream reach on their property.

Runoff Reduction
Mundelein Park District: Aquatic center developed with parking lot bioswale and landscaping with deep rooted plants to infiltrate runoff.

What can we do?

...the 10 best things that could happen in the next 10 years.

Watershed council

- Educate and motivate residents, businesses, institutions and communities to reduce the amount of pollutants they contribute.
- Work with communities to develop a collaborative green infrastructure preservation strategy

Communities & county

- Adopt the watershed plan
- Require low impact development standards
- Retrofit stormwater facilities, government properties and transportation corridors to reduce runoff and improve water quality
- Use less road salt and look to use of alternative de-icers
- Ban phosphorus in fertilizers

Residents and businesses

- Convert large areas of yards, commercial and institutional, lawns, and stormwater facilities to native landscaping
- Create rain gardens and disconnect your rooftop runoff from the storm sewer system

Lake and streamside property owners

- Establish/maintain native plant buffers along shorelines and stream channels

Prairie Corridor, Native roadside plantings

Conservation Development, Prairie Crossing

Education, Watershed tour

Stewardship, Liberty Prairie

CHAPTER 1.0

Introduction

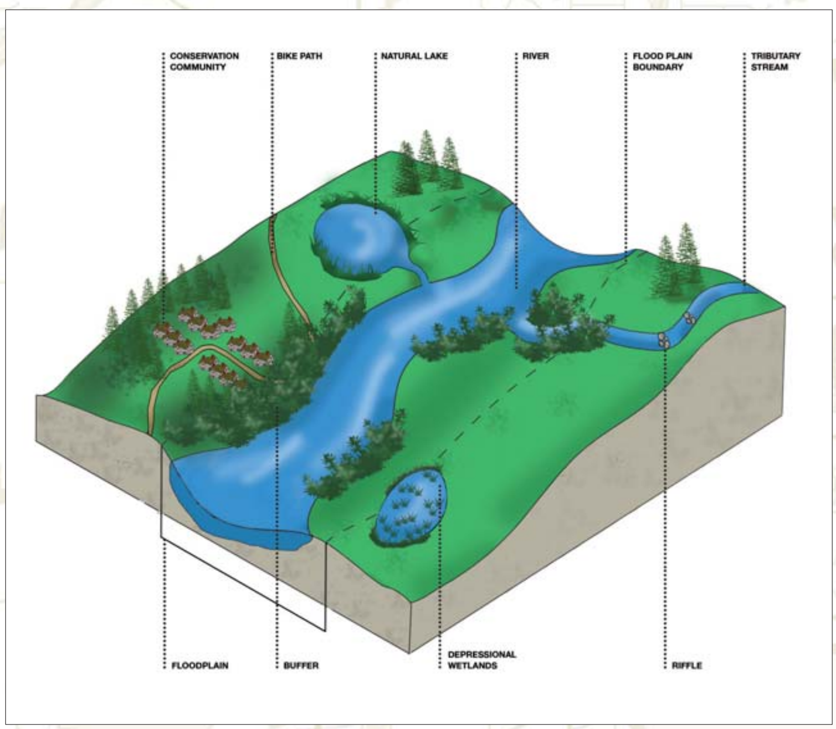
What is a Watershed?

Watersheds cover the planet and whether we know it or not, each of us lives in a watershed. A watershed is the area of land drained by a river/stream system or body of water. Other common names given to watersheds include ***drainage basins*** (or ***Subwatershed Management Units (SMUs)***. As simple as the definition sounds, a watershed is actually a complex interaction between ground, climate, water, vegetation, and animals. In today's developed watersheds, other elements such as sewage, agricultural drainage, impervious surfaces, stormwater and ***erosion*** are all detrimental to the health of the watershed.

Drainage basin: *Land surface region drained by a length of stream channel; usually 1,000 to 10,000 square miles in size.*

Subwatershed Management Unit (SMU): *Small unit of a watershed or subwatershed that is used in watershed planning efforts. An example of an SMU would be the drainage area for an individual lake located in the watershed.*

Erosion: *Displacement of soil particles on the land surface due to water or wind action.*



Subwatershed: *A smaller basin within a larger drainage area that all drains to a central point of the larger watershed.*

Natural community: *an assemblage of plants and animals interacting with one another in a particular ecosystem*

Watershed: *Land area that drains to a given stream or river. The land area above a given point on a waterbody (river, stream, lake, wetland) that contributes runoff to that point is considered the watershed.*

Prairie: *A type of grassland characterized by low annual moisture and rich black soil characteristics.*

Savanna: *A type of woodland characterized by open spacing between its trees and by intervening grassland.*

Wetland: *Wetlands are land that is inundated or saturated by surface or ground water at a frequency and duration sufficient to support and under normal conditions, do support a prevalence of plants adapted for life in saturated soil conditions.*

European settlement: *A period in the early 1800's when European settlers moved across the United States in search of better lives. During this movement, natural plant communities were altered for farming and related development.*

Channel: *Any river, stream, creek, brook, ditch, gully, ravine, swale or wash, into which surface or groundwater flows, either perennially or intermittently.*

Open space: *Any land that is not developed with roadways, buildings or other structures.Open space is important to a watershed's hydrology, habitat, water quality, and biodiversity.*

Impervious cover/surface: *A constructed solid surface where water can not infiltrate underlying soils (e.g. parking lots, roads, houses, patios, swimming pools, tennis courts, etc.).*

Infiltration: *That portion of rainfall or surface runoff that moves downward into the subsurface soil.*

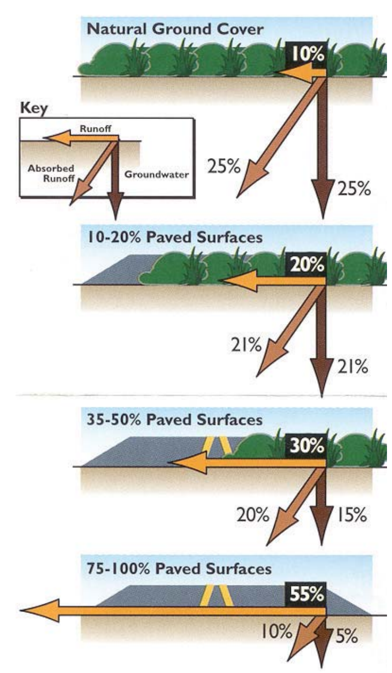
The Bull Creek/Bull's Brook ***subwatershed*** of the larger Des Plaines River Basin encompasses approximately 14 square miles (8,970 acres) in central Lake County. According to presettlement ***natural community*** mapping, the ***watershed*** possessed high-quality open spaces such as ***prairies, savannas,*** and ***wetlands.*** These communities likely worked in unison to infiltrate and treat precipitation, which minimized surface stormwater runoff and provided excellent water quality conditions. Following ***European settlement*** in the early 1800's, most of the watershed was altered for agricultural purposes. This resulted in the clearing of woodlands and prairies and installation of drain tiles to convey water off the farmland and into stream ***channels.***

Today, the watershed is comprised of portions of Grayslake, Libertyville, and Mundelein in Avon, Warren, Fremont, and Libertyville townships. Smaller areas of Gurnee and Waukegan are also located in the watershed. These municipalities are interspersed with unincorporated areas.

Noteworthy **Urbanization Increases Runoff**

s farms, fields and woodlands in the watershed are developed into more urban land uses, ***open spaces*** are converted to commercial and residential uses. Urban development results in increased ***impervious surfaces*** and reduces the amount of land available for the natural ***infiltration*** of precipitation into the ground. As impervious surfaces increase so does the volume of stormwater runoff, which can result in flooding and degraded water quality and habitat. In the absence of sensitive development practices, projected development trends over the next 20–30 years are expected to worsen flooding and water quality problems, and decrease open space areas.

Increased Runoff from Increased Construction



Note: *Percentage of evapotranspiration not shown.*

Source: *Water Resources Protection Technology" A Handbook of Measures to protect Water Resources in land Development*, by Toby Tourbier and Richard Westmacott, The Urban Land Institute, Washington, D.C., 1981.

The Lake County Stormwater Management Commission (LCSMC) hired ***Applied Ecological Services, Inc. (AES)*** to assist in developing a watershed plan for the Bull Creek/Bull's Brook watershed. This plan identifies ***Best Management Practices (BMPs)*** to remedy/ ***mitigate*** water quality degradation, and flood damages (losses of natural resources). The plan also makes recommendations for preventive actions to address potential future water quality and flood damage problems.

1.1 LCSMC Watershed Planning Authority

LCSMC's authority for stormwater management for Lake County and development of this Watershed Plan is provided in 55 ILCS 5/5-1062. This state-level enabling legislation was enacted in response to the major flooding that occurred in October 1986 and August 1987 that caused widespread damages and dislocations across northeastern Illinois.

Lake County established the Lake County Stormwater Management Planning Committee in December 1987; a municipal/county partnership made up of six municipal members and six County Board members. In response to the enabling legislation at the state and county level, Lake County developed and adopted a Comprehensive Stormwater Management Plan in June 1990 and adopted an update of that plan in 2002. This watershed plan will be adopted as an amendment to the 2002 Comprehensive Plan.

LCSMC's authority for stormwater management enables it to:

- Enact and implement a countywide stormwater management plan that includes the management of natural and man-made drainageways and incorporates watershed plans
- Prescribe and enforce rules and regulations for watershed management, floodplains and control of stormwater runoff countywide
- Levy up to a 0.20% annual tax to implement the stormwater management plan

1.2 Watershed Plan Review and Adoption Process

Once completed and reviewed by LCSMC staff and the watershed planning committee, the LCSMC approved the start of an official 60-day public review and comment period for the draft watershed plan. The plan was also submitted to the ***Illinois Department of Natural Resources (IDNR)*** Offices of Water Resources and Resource Conservation and ***Chicago Metropolitan Agency for Planning (CMAP;*** formerly known as the Northeastern Illinois Planning Commission NIPC), for review and recommendations. Any subsequent amendments to the plan will also be submitted to Illinois Department of Natural Resources and Chicago Metropolitan Agency for Planning for review.

A public hearing was held at the county seat during the 60-day public comment period. Notice of the hearing was published in the Lake County News Sun (a newspaper of general circulation in the county) prior to the hearing. The Lake County Stormwater Management Commission will review and consider the comments received and may amend or approve the plan and recommend it to the county board for adoption. The county board may then enact the proposed plan by ordinance as an amendment to the Lake County Comprehensive Stormwater Management Plan.

1.3 Scope and Project Approach

The primary scope of this project is the development of a comprehensive watershed management plan for the Bull Creek/Bull's Brook watershed that identifies actions

Lake County Stormwater Management Commission: *Agency created to coordinate the stormwater management activities of over 90 jurisdictions throughout Lake County.*

Applied Ecological Services Inc.: *A broad-based ecological consulting, contracting, and restoration firm.*

Best Management Practices (BMPs): *BMPs are practices aimed to reduce stormwater runoff and avoid adverse development impacts by storing or treating stormwater runoff to mitigate flood damage and reduce pollution.*

Mitigation: *Measures taken to eliminate or minimize damage from development activities and natural hazards.*

Illinois Department of Natural Resources): *State agency that manages, protects and sustains Illinois' natural and cultural resources.*

Chicago Metropolitan Agency for Planning: *CMAP is a northeastern Illinois regional planning authority based in Chicago that develops regional land use and transportation plans and provides technical assistance and training opportunities to local governments.*

to improve water quality, protect and enhance natural resources, and reduce flood risks. The primary purpose is to help stakeholders better understand the watershed and spur implementation of watershed improvement projects and programs that will accomplish the goals and objectives established by this plan.

Regular meetings of the Bull Creek Planning Committee (BCPC) were held to encourage participation of interested parties and to develop planning and support for watershed improvement projects. Many of these stakeholders expressed an avid interest in and support for the project, and formed the watershed committee. Once the Planning Committee was in place, the next step was to assess the overall condition of the watershed and meet to develop a list of goals and objectives.

Several previous studies of the watershed led to biological, habitat, water quality, and demographic/geographic data. This information was analyzed and summarized to reach conclusions regarding the condition of the resources in the watershed. The Bull Creek Planning Committee identified interests, issues, and opportunities to be addressed in the plan process and plan report. The plan acknowledges the importance of maintaining open space to prevent future flooding, protect water quality, and preserve natural resources, and provides scientific and practical rationale for protecting high quality open parcels as ***green infrastructure.*** This watershed plan includes:

- A characterization of the watershed and subwatersheds;
- A problems assessment of land use impacts, water quality, and flood damage conditions in the watershed;
- An open space inventory and a parcel prioritization used to rank open space potential for a green infrastructure system to meet project goals;
- An Information/Education Plan designed to help stakeholders to take action to meet water quality and other watershed-based goals and objectives;
- A programmatic and site-specific action plan that includes recommendations for best management policies and practices (BMPs) to reduce flood damage, and identify critical areas to focus remedial and preventive BMPs to improve water quality and to improve the condition of natural resources.
- Potential funding sources for implementation and an implementation schedule;
- Monitoring programs to track water quality progress and evaluate the effectiveness of the implementation efforts over time with respect to the established criteria and milestones;
- ***Non Point Source pollutant*** load reduction estimates following implementation of recommended BMPs within ***critical areas***;
- Schedule and procedure for evaluation, review and update of the plan including milestones for each of the major plan goals.

__Green infrastructure:__ On the local scale, green infrastructure may consist of best management practices (such as naturalized detention facilities, vegetated swales, porous pavements, rain gardens, and green roofs) that are designed to maintain natural hydrologic functions by absorbing and infiltrating precipitation where it falls. On the regional scale, green infrastructure is the interconnected network of open spaces and natural areas (such as forested areas, floodplains and wetlands, greenways, parks, and forest preserves) that mitigate stormwater runoff, naturally recharge aquifers, improve water quality while providing recreational opportunities and wildlife habitat.

__Non Point Source pollution:__ Refers to pollutants that accumulate in waterbodies from a variety of sources including runoff from the land, impervious surfaces, the drainage system and deposition of air pollutants.

__Critical areas:__ drainage areas or specific sites where pollutants are originating that require remedial action to reduce non-point source pollution loads to waterways. Examples of critical areas in this watershed include: areas of highly erodible soils, streambank and lakeshore erosion, and land uses that contribute high pollutant loads.

1.4 Watershed Planning Process

WATERSHED STAKEHOLDER PLANNING COMMITTEE

To initiate the planning process, the LCSMC invited watershed stakeholders to participate on a Bull Creek Planning Committee. This committee met 21 times during

Table 1. Bull Creek/Bull's Brook Stakeholder Planning Committee (BCPC) meeting schedule

Meeting #	Date	Subject	Topic
1	5/26/2004	Information/Education	Education regarding watershed plan process and potential interest, issues, and opportunities
2	6/23/2004	Information/Education	Future land use, population, environmental resources, priority watershed issues
3	7/29/2004	Information/Education	mosquito control, prioritization of watershed issues
4	8/25/2004	Information/Education	Flood damage/risk, watershed priorities, drafting goals and objectives
5	9/29/2004	Inventory/Analysis	Lake's Water Quality
6	11/3/2004	Inventory/Analysis	Stream function, restoration, and maintenance
7	1/26/2005	Inventory/Analysis	Watershed Vulnerability Analysis
8	3/2/2005	Inventory/Analysis	large-scale natural resource planning, open space inventory, parcel prioritization
9	5/25/2005	Inventory/Analysis; Goals & Objectives	Watershed assessment summary, develop goals and objectives for action plan
10	8/24/2005	Goals & Objectives	Review and approve goals and objectives
11	9/28/2005	Goals & Objectives	Review and approve goals and objectives
12	10/26/2005	Goals & Objectives	Review and approve goals and objectives
13	11/23/2005	Information/Education; Goals & Objectives	Stormwater utilities, approve goals and objectives
14	12/15/2005	Action Plan	Review programmatic action plan
15	2/22/06	Action Plan	Review programmatic action plan
16	3/15/06	Action Plan	Review programmatic action plan
17	5/24/06	Inventory/Analysis	Update on floodplain study
18	7/19/06	Education	Review education plan
19	8/23/06	Plan Implementation	Review milestones
20	9/20/06	Plan Implementation	Finalize milestones and evaluation criteria
21	10/31/07	Draft Plan Review	Understand organization and content of plan and develop plan review schedule

the process and included representatives from municipalities, townships, county government, state and federal agencies, non profit organizations, businesses, homeowner associations, and watershed residents. The Bull Creek Planning Committee played an important role in developing goals and objectives for the watershed and identifying problem areas and opportunities. Meetings generally covered one or two watershed subjects. Several meetings were devoted to watershed assessment findings, development of goals and objectives, and action plan items. A list of the meetings is included in Table 1. Complete meeting minutes are included in Appendix A.

DEVELOPMENT OF GOALS AND OBJECTIVES

Watershed stakeholders identified and listed issues and opportunities that the Bull Creek/Bull's Brook watershed plan should address at the May 26 and July 29, 2004 meetings then voted to identify which of the issues/opportunities were the highest priority for the planning team to address in developing goals and objectives for the watershed plan. These issues/opportunities along with scoring totals are included in Section 2.0 (Goals and Objectives). The results were used in drafting the goals and objectives during four meetings held during the latter half of 2005.

DATA COLLECTION AND WATERSHED ASSESSMENT

__Topography:__ The relative elevations of a landscape describing the configuration of its surface (for example where hills and valleys occur).

__Geographic Information System (GIS):__ A computer-based approach to associating information spatially resulting in a way to quickly analyze and query data for a geographic location or area.

__Partially open parcel:__ Parcels that have been developed to some extent, but still offer some open space benefits and opportunities for Best Management Practice (BMP) implementation.

The condition of the Bull Creek/Bull's Brook watershed is summarized in Section 3.0 of this report. It includes an overall assessment of the ***topography***, soils, land use, jurisdictions/demographics, green infrastructure/open space, streams, lakes, wetlands, floodplains, transportation, and water quality. Background information for these topics was obtained from existing reports, existing ***Geographic Information System (GIS)*** data, and from physical surveys of streams, lakes, ponds, and detention basins. In addition, data obtained from the watershed assessment was used to develop a problems assessment including land use impacts, water quality problems, and flooding. The problem assessment is located in Section 4.0.

GREEN INFRASTRUCTURE PARCEL PRIORITIZATION

Section 5.0 includes a detailed look at open and ***partially open parcels*** throughout the watershed which were identified and analyzed for their importance in reducing flood damage, improving water quality, and protecting/enhancing natural resources, greenways, and recreation.

WATERSHED INFORMATION/EDUCATION PROGRAMS

Section 6.0 includes Watershed Information/Education (I/E) Programs that are a vital component to any watershed planning effort because they inform the general public and communities on how to become more aware of the effects of human actions on the quality of a watershed, and how to help make a positive change.

PLAN IMPLEMENTATION SCHEDULE AND EVALUATION OF PLAN PERFORMANCE

Section 7.0 provides a list of key stakeholders with the potential to form watershed partnerships for watershed improvement projects, description of the implementation schedule, and discussion of potential funding sources. Section 9.0 includes milestones for each of the major plan goals that can be used to track plan progress through time.

PRIORITIZED ACTION PLAN

Section 8.0 presents a Prioritized Action Plan developed to provide stakeholders with action items for watershed-wide improvements and to direct stakeholders toward specific sites in the watershed where BMP implementation would result in the greatest watershed benefits.

The Prioritized Action Plan is divided into a Programmatic Action Plan and a Site Specific Action Plan. The Programmatic Action Plan recommends action items with general applicability throughout the watershed. Action items are based on goals and objectives developed by the Bull Creek Planning Committee (see Section 2.0). The Site Specific Action Plan identifies specific sites where flooding, water quality, or green infrastructure protection issues have been identified. A priority ranking was assigned to both programmatic action recommendations and site-specific action recommendations.

GLOSSARY OF TERMS AND APPENDIX

The Glossary of Terms (Section 10.0) includes definitions or descriptions of technical words or agencies that the user may find useful when reading or using the document. All words that appear in the Glossary show up as bold and italicized (i.e. ***Glossary of Terms***).

The Appendix to this report is available on CD. It contains original raw data, methodologies, inventory data, and other information. Of particular mention is the Toolbox of Watershed Best Management Practices (Appendix B). This Toolbox contains watershed restoration and management techniques that can be used to help achieve the watershed goals and objectives identified in the Bull Creek/Bull's Brook watershed plan.

1.5 CMAP/USEPA Watershed-Based Plan Upgrades

In October 2003, the United States Environmental Protection Agency (USEPA) released watershed protection guidance for developing Watershed-Based Plans entitled "Nonpoint Source Program and Grant Guidelines for States and Territo-

Noteworthy Watershed-Based Plan Elements

Under USEPA guidance, nine elements are required in order for a Watershed-Based Plan to be eligible for Section 319 funding. The nine elements are as follows:

1) Identification of the causes and sources or groups of similar sources of pollution that will need to be controlled to achieve the pollutant load reductions estimated in the watershed-based plan;
2) Estimate of the pollutant load reductions expected following implementation of the management measures described under number 3 below;
3) Description of the nonpoint source management measures that will need to be implemented to achieve the load reductions estimated under number 2 above and an identification of the critical areas in which those measures will be needed to implement the plan;
4) Estimate of the amounts of technical and financial assistance needed, associated costs, and/or the sources and authorities that will be relied upon, to implement the plan;
5) Public information/education component that is designed to change social behavior;
6) Plan implementation schedule;
7) Description of interim, measurable milestones;
8) Set of criteria that can be used to determine whether pollutant loading reductions are being achieved over time;
9) Monitoring component to evaluate the effectiveness of the implementation efforts over time.

Section 319: *Section 319 of the Clean Water Act encourages and provides cost-share funds for nonpoint source pollution reduction projects..*

ries". The document was created to ensure that ***Section 319*** funded projects make progress towards restoring waters impaired by nonpoint source pollution. Having a watershed-based plan will allow Bull Creek/Bull's Brook partners to continue to access Section 319 grant funding for restoration projects recommended in this plan.

The original scope of work for this plan already satisfied or partially satisfied some of the nine elements but because the plan lacked sufficient detail to address some elements, it was eligible for funding to upgrade the plan in order to satisfy all nine Elements. In 2005, Applied and Ecological Services and the Stormwater Management Commission prepared an approach to upgrade the plan. The application was accepted and additional monies were awarded to address the nine elements.

1.6 Watershed Setting

Discharging (streamflow): *The volume of water passing through a channel during a given time, usually measured in cubic feet per second (cfs).*

The Bull Creek/Bull's Brook watershed is located in northeast Illinois in central Lake County *(Figure 1)*. Three subwatersheds comprise the watershed and drain approximately 8,970 acres (14 square miles) from west to east via Bull's Brook and Bull Creek before ***discharging*** into the Des Plaines River through Independence Grove Forest Preserve *(Figure 2)*. The Bull Creek/Bull's Brook watershed is a subwatershed of the larger Des Plaines River Basin (HUC 07120004) that covers 854,669 acres (1,336.5 square miles) in Kenosha County, Wisconsin and Lake, Cook, DuPage, and Will Counties in Illinois. The Des Plaines River flows south through urban Chicagoland and eventually joins the Kankakee River near Morris, Illinois. The combined Des Plaines and Kankakee rivers form the Illinois River. The Illinois River flows into the Mississippi River just north of St. Louis, Missouri.

The watershed is comprised of several tributary streams, lakes, and significant wetland complexes *(Figure 2)*. Three major stream branches extend over 14 miles and include Bull's Brook, Bull Creek North, and Bull Creek South (mainstem).

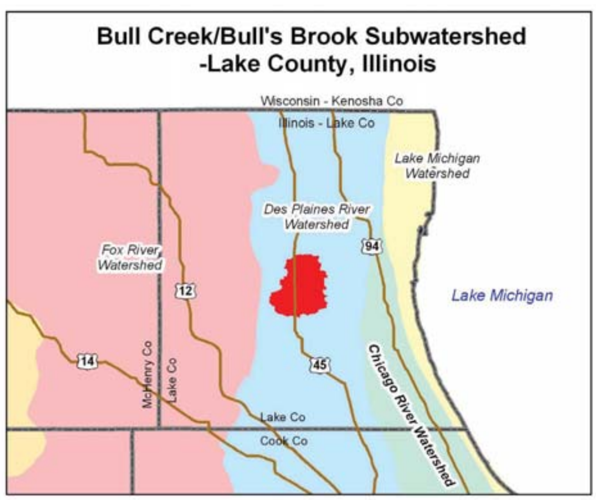
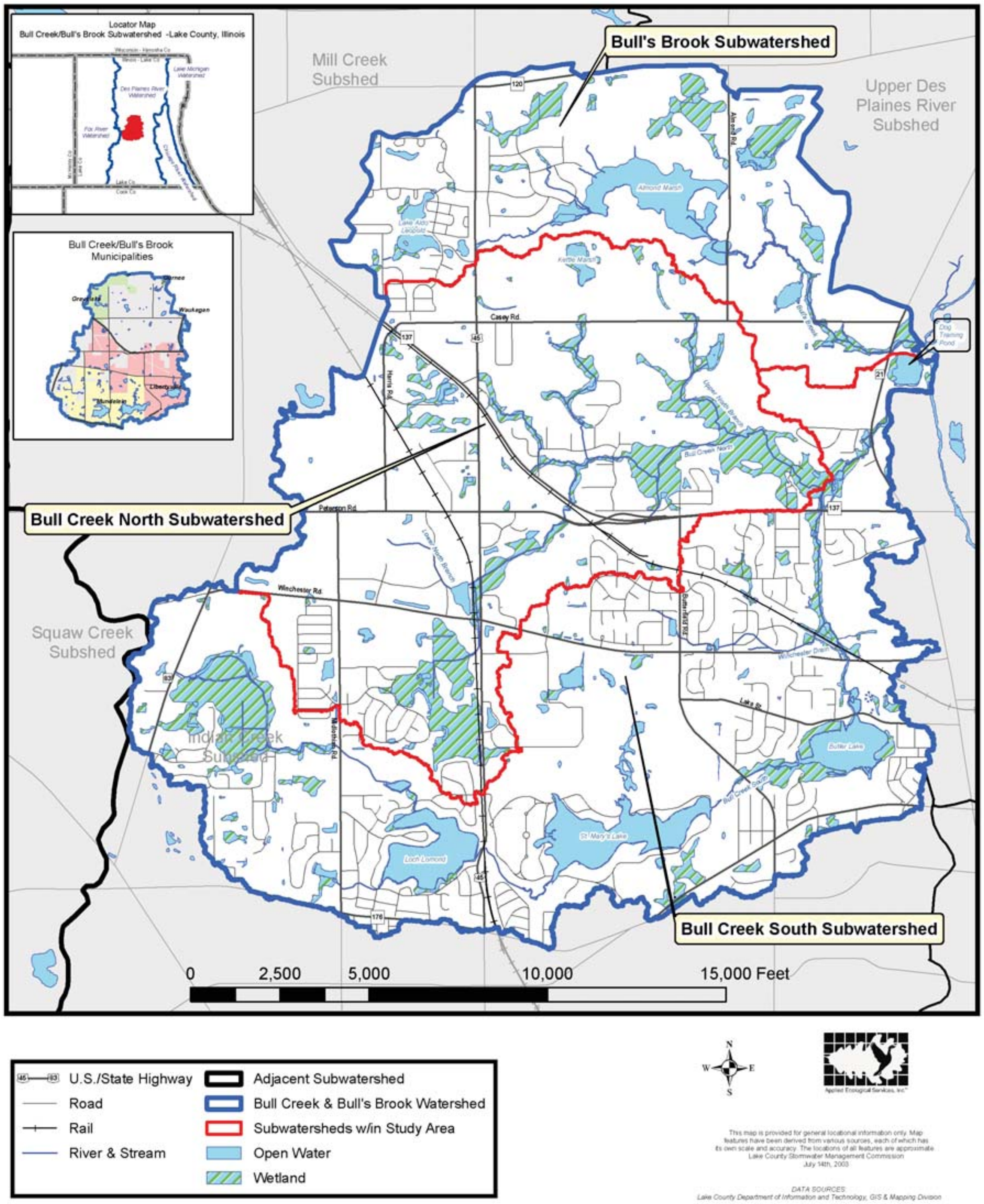


Figure 1: Project Locator Maps
The Bull Creek/Bull's Brook watershed lies in central Lake County in northeastern Illinois.

Figure 1.2: Water Resources



Approximately 400 acres of open water (lakes and ponds) are found in the watershed including 4 major lakes that are online with stream channels. Residential land is the most abundant land use comprising 22% of the watershed. Open and partially open space comprises an additional 42% of the watershed. Municipalities comprise 5,214.6 acres (58% of watershed) and include Libertyville, Mundelein, Grayslake, Gurnee, and Waukegan. Unincorporated areas comprise 3,755.7 acres (42% of watershed).

Loess: *A fine-grained unstratified accumulation of clay and silt deposited by wind.*

Outwash: *Sand and gravel deposits removed or washed out from a glacier.*

Till: *A hetergeneous mixture of clay, silt, sand, gravel, stones, and boulders deposited directly by and underneath a glacier without stratification.*

Recessional moraines: *An end moraine formed during a temporary but significant halt in the final retreat of a glacier.*

Natural divisions: *Large land areas that are distinguished from each other by bedrock, glacial history, topography, soils, and distribution of plants and animals.*

Flora: *Collectively, the plants of a particular region, geological period, or environment.*

Faunal: *Animals of a particular region or period, considered as a group.*

GEOLOGY

The geologic setting within the watershed was formed during the most recent glacial period known as the Pleistocene Era or "Ice Age" that began approximately 70,000 years ago and ended 10-14,000 years ago. During this time, 80% of Illinois was covered with one or more sheets of glacial ice (Neely and Heister 1987). Although the study area was most likely glaciated repeatedly during the Ice Age, the last glacial retreat, the Wisconsin Glacier, resulted in almost all of the geologic features present today (Fryxell 1927). Some of these features include ***loess, outwash*** gravels and sands, and ***till.*** The Lake Michigan lobe of the Wisconsin glaciation extended as far south as Shelbyville, Illinois. As this lobe retreated, ground moraines, till plains, and ***recessional moraines*** formed. These formations presently appear as concentric belts around southern Lake Michigan and the Chicago region.

The state of Illinois has 14 geographic or ***natural divisions.*** Each division is unique from other divisions by its geology and distribution of ***flora*** and ***fauna.*** The Bull Creek/Bull's Brook watershed is located in the Northeastern Morainal Division

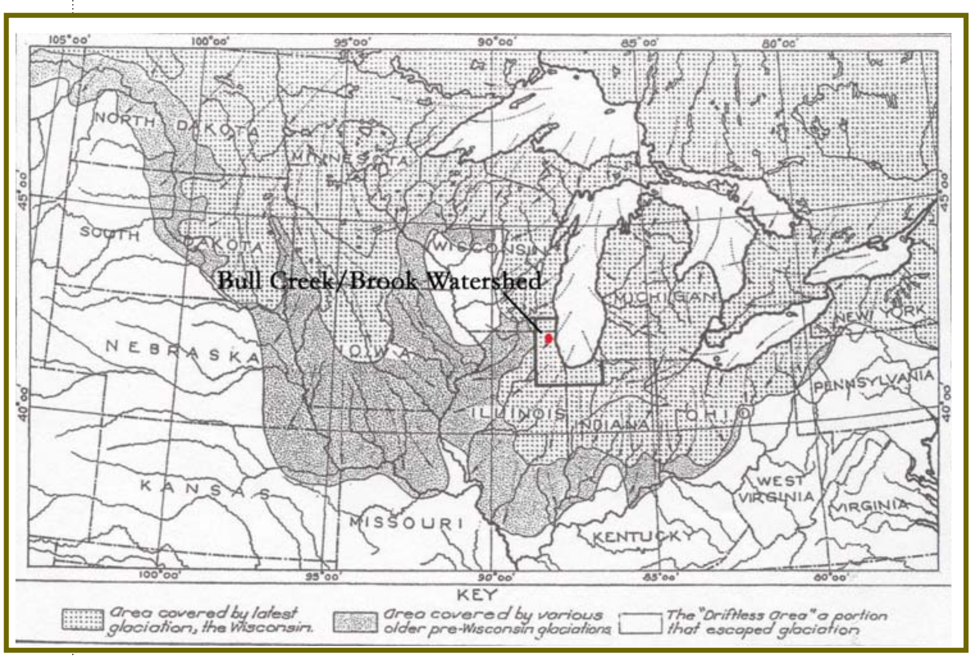


Figure 3. The land within the Bull Creek/Bull's Brook watershed was most recently carved by ice during the Wisconsin glacial period as well as during older, pre-Wisconsin periods of glaciation. Source: The Physiography of the Region of Chicago (Fryxell 1927)

(Neely and Heister 1987), a region that was covered by the Lake Michigan Lobe of the Wisconsin ice sheet *(Figure 3)*.

When the Wisconsin ice sheet receded approximately 14,000 years ago, it deposited the Valparaiso and Lake Border moraines *(Figure 4)*. As a result, the study area is characterized by rough, glacial landform topography. The study area is also unique in Illinois because the soils are derived from ***glacial drift*** that lead to the development of poorly drained soils and many natural lakes and stream systems.

Figure 4. Moraine deposits in the Bull Creek/Bull's Brook watershed developed from advancing and retreating glaciers, the latest being the Wisconsin glacier.

Source: The Physiography of the Region of Chicago (Fryell 1927)

Glacial Drift: *Earth and rocks which have been transported by moving ice or land ice.*

Bedrock: *The solid rock that underlies loose material, such as soil, sand, clay, or gravel.*

The ***bedrock*** of the study area is composed primarily of dolomite, limestone, sandstone, shale, and coal. Fossils indicate that bedrock was formed during a geologic period known as the Silurian that began approximately 440 million years ago. Rock formed during this period is found at the surface only in the northern third of the state. Today, these rock formations are economically important because they yield limestone and other important minerals.

Noteworthy **Northern Illinois Climate**

The northern Illinois climate can be described as temperate with cold winters and warm summers. Lake Michigan does influence the study area. The Lake generally reduces the heat of summer and buffers (warms) the cold of winter. Surges of polar air moving southward or tropical air moving northward cause daily and seasonal temperature fluctuations. The action between these two air masses fosters the development of low-pressure centers that generally move eastward and frequently pass over Illinois, resulting in abundant rainfall. Prevailing winds are generally from the southwest, but are more persistent and blow from a northerly direction during winter.

The National Climatic Data Center (NCDC) provides an excellent summary of climate statistics including normals and extremes for selected sites in Illinois that were selected based on length of record and completeness of data. The National Climatic Data Center has compiled average temperature and precipitation data from the past 30 years and daily extremes since 1923.

CLIMATE

Data collected in Waukegan, Illinois (located in Lake County) best represents the climate and weather patterns experienced in the study area. The winter months are cold, averaging 24°F (-4.5°C); winter lows average 16°F (-9°C). The coldest temperature on record is -27°F (-33°C) recorded on January 19, 1985. Summers are warm, averaging 67°F (20°C); summer highs average 77°F (25°C). The highest recorded temperature, 108°F (43°C) occurred on July 24, 1934.

PRECIPITATION

From the early 1970's to early 2000's, an average of just over 34 inches of precipitation per year was recorded at Waukegan ***rain gauge station***. Most of this precipitation falls during the ***2-year recurrence interval storm event***. Flows in streams occurring after two-year rain events form the stream channel dimensions observed today. The 10 and 100-year recurrence interval rain events define peak flows for major flood events and potential flooding locations. The most precipitation received in one month (15.11 inches) occurred in September of 1986. The least amount of precipitation received in one month (0.0 inches) occurred in January of 1987 and October of 1952. The one-day maximum precipitation (4.0 inches) occurred on June 20, 1972.

Rain gauge station: *Location where a specialized rain gauge (cup or cylindrical device) has been installed to collect and measure the amount of liquid precipitation over a period of time.*

2-year recurrence interval storm event *A two-year event has a 50% probability of occurring in any year; 2-year rain events are important because they form the general shape of our stream systems and are the cause for much of the pollutant loading.*

Noteworthy Natural Communities

A natural community is made up of all living things in a particular ecosystem but is usually named by its dominant vegetation type. Prior to European settlement in the 1830's, when the Potawatomie was the last of several Native American tribes who called the area home, Lake County exhibited a mix of natural communities including prairies, savannas, ***oak woodlands, dune complexes***, and wetlands.

Oak woodland: *A type of ecosystem characterized by open spacing between oak trees and intervening areas of grassland.*

Dune complex: *Sandy areas formed by the various stages of Lake Michigan. Dune complexes appear as beach ridges that parallel one another and contain lakes, marshes, and wetlands between them.*

NATURAL COMMUNITIES IN THE WATERSHED

Pre-European settlement, the Bull Creek/Bull's Brook watershed was comprised mostly of prairie communities while tracts of savanna, oak woodland, and wetlands were present around lake and ***stream corridors*** *(Figure 5)*. European settlement resulted in many forests being cleared, wetlands being drained, and streams being straightened in an attempt to farm the rich soils. Today, ***remnants*** of natural communities still exist but most are highly fragmented isolated islands surround by human communities.

Stream corridor: *The area of land that runs parallel to a stream.*

Remnant: *A small fragmented portion of the former dominant vegetation or landscape which once covered the area before being cleared for human land use.*


Left: High quality oak woodland/savanna; **Right:** High quality wetland/wet prairie
Source: Lake County Forest Preserve District.

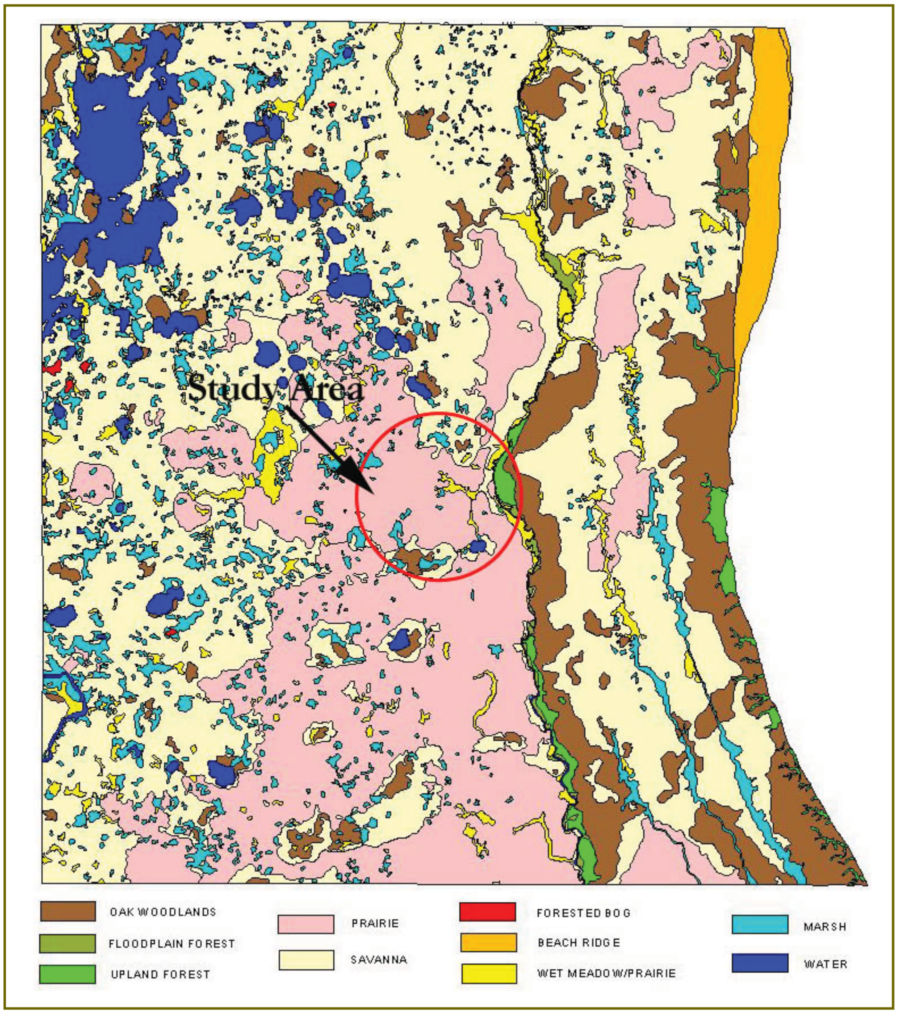


Figure 5. The historical government survey (1838-1840) of the pre-settlement natural communities in the Bull Creek/Bull's Brook watershed includes oak woodlands, wet meadow/prairie, marsh, prairie, savanna, and upland forest.

Noteworthy **Historical Hydrology and Hydraulics**

Prior to the late 1830's, most prairie streams of the Midwest did not have conspicuous channels and were not as readily identifiable as they are today. In fact, smaller streams were identified as ***vegetated swales***, wetlands, wet prairies, and swamps in the original land survey records of the U.S. General Land Office. European settlement land use changes in the Midwest resulted in clearing, tilling, draining, and building which in turn altered the overland flow of surface water following rain events. With drainage improvements, the historically slow overland flow changed to concentrated flows where the water is not allowed to infiltrate into the ground. The result is increased ***runoff*** to stream channels thereby increasing ***sediment*** loads (transport) and other pollutants that originate from eroded stream banks and polluted stormwater runoff.

Vegetated swale: *An open channel drainageway used along residential streets and highways to convey stormwater and filter pollutants in lieu of conventional storm sewers.*

Sediment: *Soil particles that have been transported from their natural location by wind or water action.*

Runoff: *The portion of rain or snow that does not percolate into the ground and is discharged into streams by flowing over the ground instead.*


Left: Typical historic stream channel; **Right:** Typical altered stream channel

Hydrology: *Study of the properties, circulation and distribution, and effects of water on the earth's surface, in the ground, and in the atmosphere.*

Hydraulics: *The study of the flow of fluids, mainly water, in rivers, streams etc.*

Water yield: *The total water that flows out from all or part of a drainage basin through either surface channels or subsurface aquifers within a given time frame, such as a year.*

Stormwater management: *A set of actions taken to control stormwater runoff with the objectives of providing controlled surface drainage, flood control and pollutant reduction in runoff.*

Stream reach: *A stream segment having fairly consistent channel riparian cover and surrounding land use characteristics.*

Pollutant load: *The amount of any pollutant deposited into waterbodies from all runnoff and discharge sources.*

Aquatic habitat: *Structures such as stream substrate, woody debris, aquatic vegetation, and overhanging vegetation that is important to the survival of fish and macroinvertebrates.*

Ecosystem: *An ecological community together with its environment, functioning as a unit.*

Groundwater recharge: *Primary mechanism for aquifer replenishment.*

Base flow: *Stream discharge that is not directly attributable to direct runoff or melting snow. It is usually sustained by groundwater.*

HYDROLOGY AND HYDRAULIC CHANGES IN THE WATERSHED

Historical literature suggests that highly significant changes in the ***hydrology, hydraulics***, and ***water yield*** in the Bull Creek/Bull's Brook watershed and surrounding area have occurred since European settlement. Pre-European settlement "natural" landscapes in the watershed and surrounding area "managed" stormwater very differently than humans manage stormwater today. Historical data for the Des Plaines River watershed (includes the Bull Creek/Bull's Brook watershed) indicates that a relatively small percentage of the precipitation in the watershed and surrounding area actually resulted in measurable runoff and water leaving the watershed. Rather precipitation that fell on the land was used by plants and animals or absorbed. Present-day ***stormwater management*** strategies involve collecting, concentrating, and managing the release of water via curbs/gutters, stormdrains, and ditches to detention basins, streams, lakes, and wetlands to improve drainage.

Many of the ***stream reaches*** in the Bull Creek/Bull's Brook watershed changed when European settlers tile-drained and ditched them for agricultural purposes. Increases in tile-drained agricultural land result in an increased volume of stormwater runoff. Drainage tiles ultimately carry water to ditches, streams, or lakes thereby increasing

Noteworthy **Flashy Hydrology**

Flashy stream conditions result when a rapid increase in the stream water level occurs followed by a rapid decrease after a storm event. As a result, streambank and streambed erosion occurs thereby releasing pollutants downstream (***pollutant loading***). Degradation to streams results in degraded ***aquatic habitat*** vital to the health of a stream ***ecosystem***. Increased impervious surfaces also decrease water from infiltrating into the ground (***groundwater recharge***), depleting groundwater, and ultimately reducing slow release of water (***base flow***) to streams. This condition causes baseflow levels that are below predevelopment conditions.

peak flows that can lead to stream channel degradation (***downcutting*** and widening) and flooding downstream. Figure 6 depicts the effects of impervious surface on streamflow.

The natural drainage system began to experience more changes as community expansion resulted in more residential, commercial, and industrial land uses. With increased impervious surface and extensive stormsewer networks, ***flashy hydrology*** became common throughout the adjacent stream systems.

Additional changes in the natural hydrology occurred as portions of major stream branches were dammed to create lakes, ponds, and other impoundments. Lowhead dams have been installed to create 4 of the 5 primary lakes in the watershed including Loch Lomond, St. Mary's Lake, Butler Lake, and Leopold Lake. Dams control the water level in the lake thereby affecting the hydrology of the system. This further disrupts the natural conveyance of water in the watershed.

Studies have been conducted that document the results of hydrology changes over time. A recent ***United States Geological Society (USGS)*** runoff study using ***Hydrologic Simulation Program-Fortran (HSPF)*** (Dunker, USGS, 1995) concluded that Bull Creek South is highly affected by impervious surfaces because storm flow ***hydrographs*** reveal steep rises and receding water levels. ***Integrated Lakes Management*** (ILM, 2003) found that following a drought period in 2002, Bull Creek North and Bull Creek South went to dryness. Integrated Lakes Management suggests that dry channel conditions could be the result of increased impervious surface that ultimately leads to less precipitation being infiltrated into the ground, thereby reducing base flow conditions from groundwater.

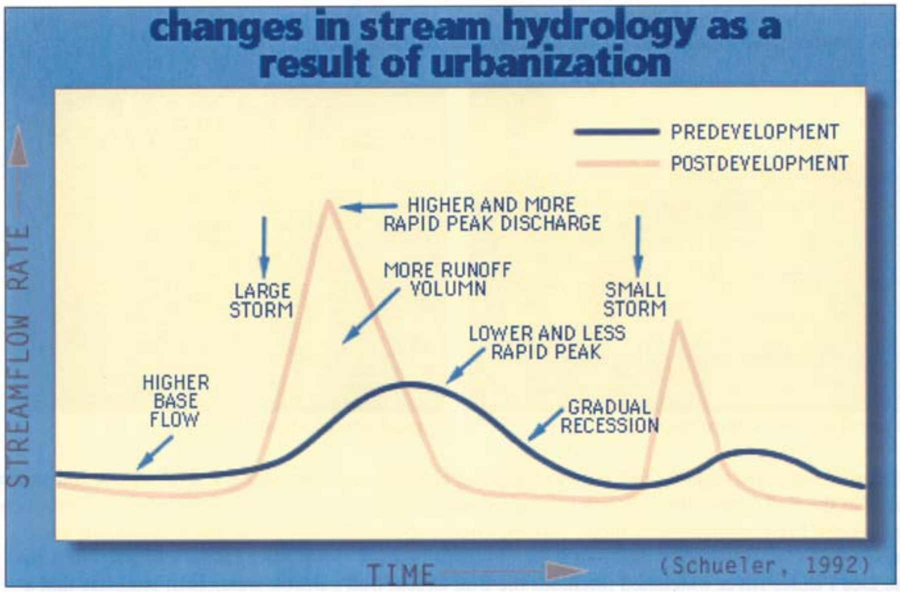


Figure 6. The effect of impervious surface runoff on streamflow from land development.

Downcutting: *The action of a stream to deepen itself, often as a result from channelization.*

Flashy hydrology: *A quickly rising and falling of water in stream channels that is usually the result of increased runoff from impervious surface in the watershed.*

United States Geological Survey: *Agency established to provide reliable scientific information to describe and understand the Earth. USGS responsibilities include managing water resources.*

Hydrologic Simulation Program-Fortran: *Computer program that simulates for extended periods of time the hydrologic, and associated water quality, processes on pervious and impervious land surfaces and in streams.*

Hydrograph: *A way of measuring and graphing stream flow, or discharge, as it varies with time.*

Integrated Lakes Management: *A midwest consulting agency that specializes in environmental consulting, lake and pond management, and ecological restoration.*

Lake County Health Department-Lakes Management Unit: *Monitoring the quality of Lake County's lakes and beaches.*

Illinois Department of Transportation: *State agency that focuses on Illinois' transportation system and is responsible for state highways*

Upper Des Plaines River Ecosystem Partnership: *Non-profit collaborative partnership of diverse organizations and private landowners who share an interest in protecting the natural resources and improving the quality of life within the upper Des Plaines watershed.*

Illinois Environmental Protection Agency: *Government agency established to safeguard environmental quality in the State of Illinois.*

1.7 Prior Studies and Plans

The Bull Creek/Bull's Brook watershed has been studied extensively through a number of inventories and reports. This watershed plan attempts to compile, analyze, and summarize work that has been completed by others as well as integrate new data and information. Agencies and organizations including the Lake County Stormwater Management Commission (LCSMC), ***Lake County Health Department (LCHD)-Lakes Management Unit, Liberty Prairie Conservancy (LPC),*** Chicago Metropolitan Agency for Planning (CMAP), formerly known as Northeastern Illinois Plan Commission (NIPC), ***US Army Corps of Engineers (USACE),*** United States Geological Survey (USGS), ***Illinois Department of Transportation (IDOT),*** Illinois Department of Natural Resources (IDNR), ***Upper Des Plaines River Ecosystem Partnership (UDPREP),*** Integrated Lakes Management (ILM), Applied Ecological Services (AES), Lake County Forest Preserve (LCFPD), and ***Illinois Environmental Protection Agency (IEPA)*** have completed studies to assess the condition of, and aid in the ecological restoration of, the Bull Creek/Bull's Brook watershed.

Noteworthy Prior Studies

1. In 1978, Lake Management Consultants conducted hydrologic, nutrient budget, and two fisheries studies for Butler Lake. The study also included recommended management alternatives.
2. The United States Geological Survey measured water stage and crest stage in Libertyville (Bull's Brook subwatershed-#05528030) from 1962-1976 and from October 1989 to September 1993. A gage located at the Route 137 culvert was used to calculate discharge and water heights. In 1995 the USGS released the results of a hydrology study of Bull Creek South. The Hydrologic Simulation Program-Fortran (HSPF) model was used during the analysis to measure runoff versus land use conditions. In addition, the USGS conducted water quality sampling in Bull Creek at Route 21 in 2000.
3. In 1987, 1991, and 2000, the Illinois Environmental Protection Agency's Volunteer Lake Monitoring Program collected water chemistry data on Loch Lomond and Butler Lakes. Data obtained from these surveys was used when developing the Illinois 2004 Section 305(b) Water Quality Reports and Illinois Section 303(d) impaired waters lists.
3. A number of studies have been completed and data collected for the Liberty Prairie Reserve (LPR), which comprises a large portion of the northern half of the watersheds. These reports include:

   — Oak Prairie Reserve Protection and Management Plan, 1991

   — Oak Prairie Reserve Natural and Cultural Resource Inventory, 1991

   — Water Quality at Oak Prairie Reserve, 1990

- Hydrologic Simulation Program FORTRAN Analysis for Oak Prairie Reserve Watershed, 1996
- Annual Monitoring Reports for Oak Openings Riparian Corridor Restoration, 1998, 1999, 2000 and 2001
- Baseline 1997 Analysis of the Qualities of Selected Surface and Ground Waters of the Liberty Prairie Reserve, Lake County, IL
- Liberty Prairie Reserve Agricultural Project, 2005: Integrated Lakes Management completed an Agricultural Impact Study of the Liberty Prairie Reserve for the Liberty Prairie Conservancy. The study included water quality monitoring and interviews with farmers to assess the influence of agricultural land runoff on the water quality within the reserve.

4. Illinois Department of Natural Resources stream biologists sampled the fish community in Bull Creek (Station GV-01) in 1983, 1997, and 2002. Fish data was used to calculate Index of Biotic Integrity (IBI) scores to evaluate the biological health and water quality of streams in the watershed. Data obtained from these surveys are used in Illinois 2004 Section 305(b) Water Quality Reports and Illinois 303(d) impaired waters lists.
5. In 1996, LCSMC completed a Flood Problem Areas Inventory (FPAI) of Lake County. The FPAI compiled information on flood problems in the 26 subwatersheds of the county including Bull Creek and Bull's Brook. Two flood problem areas were identified in the watershed.
6. In 1997 and 2002, the Illinois Environmental Protection Agency (IEPA) collected water chemistry samples at a designated station (GV-01: Bull Creek) within the Bull Creek/Bull's Brook watershed. These samples are generally collected on a five-year cycle as part of the Intensive Basin Survey Program. Data obtained from these surveys are used in Illinois 2004 Section 305(b) Water Quality Reports and Illinois Section 303(d) impaired waters lists.
7. IDNR RiverWatch volunteers and IEPA biologists sampled the macroinvertebrate community at 3 different locations within the watershed from 1997 to 2001. Volunteers and biologists calculated Macroinvertebrate Biotic Index (MBI) scores to evaluate the biological health and water quality of streams in the watershed.
8. In 1997, Applied Ecological Services, Inc. studied baseline water quality at 12 sites within Liberty Prairie Reserve (LPR). This study was undertaken to assess potential impacts of nutrients, road salts, and certain metals on the biota of Almond Marsh and the creeks which drain the LPR area.
9. In 1997, the Illinois Department of Transportation (IDOT) subcontracted the IL Natural History Survey to conduct a faunal study for the Route 21 roadway project/study.
10. The Lake County Health Department-Lakes Management Unit completed studies on Butler Lake (1995, 2001, & 2005), St. Mary's Lake (1995, 2002, & 2005) and Loch Lomond (1988, 1999, & 2005). Lake reports include historical lake uses, summary of limnological data, aquatic plant assessments, shoreline and wildlife assessments, and a summary of lake quality problems and recommendations for potential objectives for lake management.
11. Integrated Lakes Management collected water quality data (unpublished) for Leopold Lake and the Upper Pond at Prairie Crossing from 1996-2002. Integrated Lakes Management also

completed aquatic plant mapping, collected water quality samples, and developed a dredging feasibility report for Butler Lake.

12. In August 2000, the Northeastern Illinois Planning Commission, in cooperation with the Upper Des Plaines Ecosystem Partnership, completed a draft plan for improving water quality in the Upper Des Plaines River Watershed. The Bull Creek/Bull's Brook watershed was included in the Watershed Restoration Action Strategy (WRAS). This regional strategy was produced to begin the planning and implementation process for improving water quality in the watershed.
13. In February 2001, Lake County Stormwater Management Commission completed the Des Plaines River Wetland Restoration Study that identified potential wetland restoration sites in the entire Des Plaines River watershed including several in the Bull Creek/Bull's Brook watershed.
14. During summers of 2001,2005 and 2006, the Lake County Stormwater Management Commission completed a stream inventory of the Bull Creek/Bull's Brook watershed. The inventory involved walking the stream reaches collecting measurements, taking photos, and noting in-stream, streambank, and riparian corridor characteristics. A ***Global Positioning System (GPS)*** was used to locate points of interest to be incorporated into a Geographic Information System (GIS) database.
15. Liberty Prairie Conservancy contracted with Integrated Lakes Management (ILM) to complete a water quality study for Bull Creek and Bull's Brook watersheds in 2002. A watershed report was completed for this study in 2003. This report includes an extensive map atlas depicting soils, wetlands, topography, a ***Digital Elevation Model (DEM)***, flow pathways, subwatersheds, stream order, floodplain, pollutant loading (BASIN model) and land use. This project also produced a corresponding report that addresses water quality issues in the watershed. A ***Radial Environmental Report*** was also compiled from Environmental Data Resources data for this project report.
16. The hydrology and hydraulics components of the Bull Creek/Bull's Brook watershed plan were completed in 2004 under a USACE contract for Des Plaines Phase II and a subsequent LCSMC contract for floodplain mapping. The results are used in this study to predict flooding, ***carrying capacity*** of streams and lakes, and effects on the future built out conditions of the watershed.
17. Lake County geographic information for the Bull Creek/Bull's Brook watershed was compiled over the past years and is accessible via the Lake County Mapping Services (GIS). The database contains information including wetlands, soils, land use, and other relevant data.
18. The USACE compiled GIS data for the development of a Phase II Study of the entire upper Des Plaines River watershed including Bull Creek and Bull's Brook.
19. Under the IDNR C2000 program, a Strategic Subwatershed Identification Process (SSIP) was compiled in 2003-2004 for the Upper Des Plaines River Ecosystem Partnership (UDREP). The study covered the entire Upper Des Plaines River watershed including Bull Creek and Bull's Brook.

Global Positioning System (GPS): *Satellite mapping systems that enables locators and mapping to be created via satellite.*

Digital Elevation Model (DEM): *Regularly spaced grid of elevation points used to produce elevation maps.*

Radial Environmental Report: *Report that identifies sites within subwatersheds that are listed on government-generated, environmental databases. The report contains information on sites that may pose environmental threats due to locations where hazardous materials have been released.*

Carrying capacity (streams): *The maximum amount of water that a stream channel can support without overtopping its banks.*

CHAPTER 2.0

Goals and Objectives

Issues and Opportunities

The Bull Creek/Bull's Brook Watershed Planning Committee identified and listed issues and opportunities that the Bull Creek/Bull's Brook watershed plan should address. After reviewing the list, planning committee participants added additional issues and opportunities to complete the list, and then voted to identify which of the issues/opportunities are the highest priority for the planning team to address in developing goals and objectives for the watershed plan and to focus on in the watershed assessment.

The voting process entailed each participant voting for his or her top 5 issues/opportunities. Each assigned 5 points to their highest priority, 4 points to their second priority, 3 points for their third priority, 2 points for their fourth priority, and 1 point to their fifth priority on the list. Points were totaled for each issue/opportunity that received a vote, and the total number of people voting for each was tallied.

Based on this process, the four highest priority issues are:

1. Natural resource protection–30 points
2. Private/public cooperation (including municipal/private cooperation–29 points
3. Funding opportunities *(for watershed improvement projects)*–24 points
4. Flood damage reduction and control–23 points

The complete list of all of the problems and opportunities that were identified during the May 25, 2004 meeting is located in Appendix A. The prioritization process does not limit watershed planning to only the four high priority issues/opportunities, but rather allows the watershed plan development team to focus their efforts and make sure that each of the high priority issues are adequately addressed in the planning process and within this watershed plan report. Also note, there were several interests of watershed participants from the list that did not end up on the final watershed issues/opportunities list. These interests were also included in the watershed assessment process and in drafting the goals and objectives for the watershed plan.

Nine goals were established for the Bull Creek/Bull's Brook watershed to address the issues and opportunities raised by the BCPC. Goals ultimately lead to the development of action plan items. And, "measurable" objectives are assigned to each goal to help measure future progress toward meeting each goal. The Action Plan section of this report is geared toward addressing watershed goals. It contains recommended programmatic actions to address each goal and site specific recommendations that generally address water quality, flooding, and green infrastructure goals at specific problem locations identified during inventories. The goals and objectives are also examined in more detail when evaluating the watershed plan's performance and progress by evaluating milestones related to measurable goal objectives.

2.2 Watershed Goals and Objectives

GOAL A: **Protect and restore the natural resource components of the watershed's natural drainage system, including:**

- Bodies of water such as wetlands, lakes, ponds and streams;
- Highly erodible and hydric soils; and
- Natural prairie, wetland, savanna, and woodland landscapes,

These components also benefit native plant and animal communities and provide important habitats for threatened and endangered species.

OBJECTIVES:

A.1 Channel new development into the least sensitive areas—those parcels identified as low and medium priority for green infrastructure protection.

A.2 Identify, map and protect important natural communities.

A.3 Restore degraded natural communities, both terrestrial and aquatic (lakes, wetlands and streams), to ecological health with natural practices and native plants to improve habitat.

A.4 Provide adequate native plant buffers between developed areas and natural communities.

GOAL B: **Improve overall water quality in the lakes, ponds, streams and wetlands of the watershed.**

OBJECTIVES:

B.1 Lakes and streams shall at minimum attain state water quality standards to "fully support designated" uses.

B.2 Reduce sediment accumulation in surface waters by reducing streambank, shoreline, and construction–related erosion throughout the watershed.

B.3 Reduce point source pollutant loadings.

B.4 Implement storm water management practices that minimize runoff volumes, velocities and pollutants to the creek through infiltration of rainwater on-site using best stormwater management and landscaping practices such as raingardens, bioretention and open swales.

B.5 Improve agricultural practices to reduce, sediment, chemical and nutrient transport to Bull Creek/Brook, lakes and wetlands.

B.6 Retrofit existing stormwater management structures such as detention ponds to provide or enhance water quality improvement.

B.7 Tie National Pollutant Discharge Elimination System (NPDESII) minimum control measures into watershed plan objectives.

B.8 Examine the impacts of road salt usage on water quality and aquatic life and develop recommendations for education related to road salt alternatives and application best management practices (BMPs).

GOAL C: **Reduce flood damage in the Bull Creek/Brook Watershed and prevent flooding from worsening in the watershed and along the Des Plaines River downstream.**

OBJECTIVES:

C.1 Protect and maximize use of the natural drainage system and establish regular maintenance programs for retention and conveyance.

C.2 Identify and restore wetlands where feasible to provide additional storage in the watershed.

C.3 Identify and provide regional scale multi-objective floodwater storage sites for new development that may be funded by fees assessed to permit applicants in lieu of constructing on-site stormwater storage ("fee-in-lieu").

C.4 Identify the properties that flood and the source of flooding for flood damage sites that repetitively flood and mitigate existing flood damage.

C.5 Reduce the rate and volume of stormwater runoff from areas that are already developed.

C.6 Reduce the rates and volume of runoff from new development – maintain pre-development hydrology.

GOAL D: **Protect, restore, and enhance stream health and channel function and conveyance.**

OBJECTIVES:

D.1 Develop a planning, funding and implementation mechanism to provide channel maintenance on public and private property and across multiple political jurisdictions.

D.2 Remove excessive debris loads in channels following American Fisheries Society standards.

D.3 Stabilize streambanks along stream reaches identified as having moderate to high streambank erosion.

D.4 Increase in-stream aquatic habitat.

D.5 Maintain and expand where desirable high quality native riparian buffers and restore native riparian buffers along those stream reaches identified as having a high or medium level of need for improvement in the stream inventory.

D.6 Identify locations where beaver are impacting the stream channel and specify the best practices for controlling beaver damage where control is needed.

GOAL E: **Guide new development and redevelopment to benefit rather than impair watershed goals to reduce flood damage, improve water quality and protect natural resources.**

OBJECTIVES:

E.1 Maintain or re-create the pre-development hydrology in stormwater plans for new development.

E.2 Increase infiltration and absorption in order to decrease runoff from developed areas.

E.3 Identify and protect sensitive resources during future development.

E.4 Watershed jurisdictions will evaluate their regulatory requirements to determine if they are adequate to protect the watershed and will make changes where needed.

E.5 Monitor the percent of non-mitigated impervious cover and evaluate the impact impervious areas are having on the watershed on a regular basis to insure that additional impervious cover does not degrade subwatershed management units to the "non-supporting" category.

E.6 Implement conservation design developments that cluster development to protect open space as green infrastructure.

GOAL F: **Implement a "Green Infrastructure" plan to guide preservation, restoration, and management activities in the watershed.**

OBJECTIVES:

F.1 Protect greater than 50% of the watershed as pervious open land by preserving open and partial open space.

F.2 Identify areas critical for a greenway of open land in each subwatershed management unit as green infrastructure to mitigate the negative impacts of impervious cover and allow for flood damage reduction, water quality improvement, natural resource protection, and wetland restoration.

F.3 Identify, prioritize, and preserve open land with permeable soils, depressional storage, floodplain, wetlands, hydric soils, important natural communities, or significant cultural features within the watershed greenway.

F.4 Preserve open space that provides important trail or habitat corridor connections and provide passive recreational opportunities such as hiking, fishing, biking, riding, canoeing, and environmental interpretation/education as part of the greenway.

F.5 Preserve farmland as green infrastructure and implement conservation plans approved by agencies such as the Lake County Soil and Water Conservation District and Natural Resource Conservation Service.

F.6 Prioritize protection of greenway infrastructure segments (i.e. acquisition, conservation easements, etc.)

GOAL G: **Provide watershed stakeholders with the knowledge, skills, and motivation needed to take action on implementing the watershed plan.**

OBJECTIVES:

G.1 Update watershed residents about the ecological health of the watershed by developing and disseminating a watershed report card in years 3, 7, and 10 of plan implementation.

G.2 Provide communities with the tools they need to prevent flood damage from worsening by using the "no adverse impact standard" and maintaining floodplain as open space.

G.3 Provide floodplain/flood problem area property owners with the information they need to take appropriate measures to reduce their flood risk.

G.4 Use infiltration practices to reduce runoff and pollution:
Communities will revise watershed development/subdivision ordinances to include requirement, credit or incentive for infiltration.
Homeowner and lake associations will sponsor/host a neighborhood level "how to" rain garden demonstration/workshop.

G.5 Develop a pollution prevention campaign that engages multiple watershed partners in reducing/eliminating pollution inputs associated with landscape maintenance and agricultural production.

G.6 Facilitate training and engage students, lake associations and homeowner associations in volunteer lake and stream stewardship.

G.7 Provide landowners with the technical assistance they need to retrofit the existing drainage system to improve water quality treatment.

G.8 Develop a technical resource, conduct an outreach campaign and provide training to landowners and government jurisdictions on riparian buffers and stream restoration and maintenance.

G.9 Promote the use of native plants and the removal of invasive plants by establishing demonstration sites and training activities for landowner, landscape service and government audiences.

G.10 Calculate/estimate the value of green infrastructure in the watershed and convey to watershed residents and jurisdictions.

GOAL H: **Identify, develop and capitalize on potential funding sources for implementing watershed projects and programs recommended in the action plan.**

OBJECTIVES:

H.1 Identify and disseminate information to stakeholders on funding sources and mechanisms for implementing watershed projects.

H.2 Add watershed improvement functions to ongoing activities and gray infrastructure projects (i.e. streets, the manmade drainage system etc.).

GOAL I: **Improve coordination between municipalities, townships, special districts (i.e. parks, schools, forest preserves, etc.), county agencies and other local government units, federal, state, regional agencies, and private business, non-profits, citizen stakeholders, and the general public in watershed plan implementation, monitoring, enhancement, and protection.**

OBJECTIVES:

I.1 Facilitate cost-sharing arrangements among jurisdictions for projects that benefit more than one jurisdiction.

I.2 Establish a sustainable watershed council that will meet regularly, promote and guide watershed plan implementation within respective jurisdictions, and initiate and coordinate inter-jurisdictional activities and projects.

I.3 Jurisdictions will consider watershed recommendations when making land use change decisions.

CHAPTER 3.0

Watershed Characteristic Assessment

Topography

3.1 Topography & Watershed Planning

Topography defines the boundaries of the Bull Creek/Bull's Brook watershed. Topographic data is used in the planning process to develop ***Hydrologic & Hydraulic (H&H) models***, floodplain maps, water quality models, flood mitigation recommendations, Subwatershed Management Units (SMUs), ***Digital Elevation Models (DEMs)*** and regionally significant ***depressional storage areas***. Ultimately, topography is an essential component in the watershed planning process.

Glaciers formed the landscape of the Bull Creek/Bull's Brook watershed. In fact, the watershed lies in a portion of Illinois that was repeatedly glaciated during the Pleistocene Era or "Ice Age." The Lake Michigan lobe of the last Wisconsin glaciation and the deposits left by the lobe shaped much of the landscape found in the watershed. The landscape created by these conditions is called a ***moraine.*** Common topographic features left on moraine landscapes include ***knobby hills***, ***ridges***, and ***kettle holes*** (ponds and lakes). The watershed ultimately drains to the east. The highest point in the western portion of the watershed is approximately 856 feet above mean sea level, while the lowest point in the eastern portion of the watershed is approximately 650 feet above mean sea level *(Figure 7)*. This reflects a 206-foot change in elevation across four miles of the watershed.

Hydrologic & hydraulic (H & H) models: *Engineering analysis that predicts expected flood flows and flood elevations based on land characteristics and rainfall events.*

Digital Elevation Model (DEM): *Regularly spaced grid of elevation points used to produce elevation maps.*

Depressional Storage Area: *Non-riverine depressions where stormwater collects.*

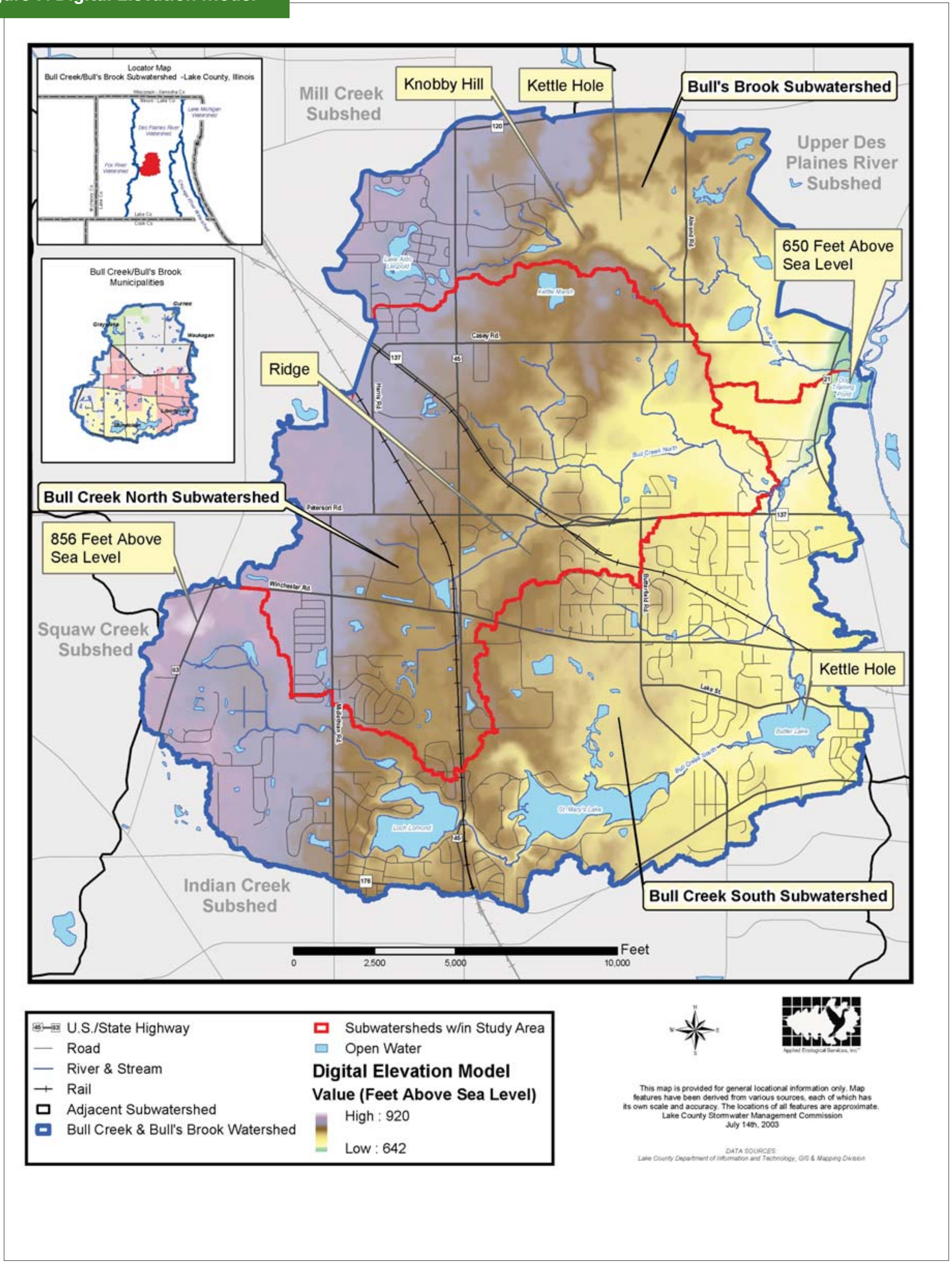
Moraine: *A prominent ridge of rock debris dumped at the end of a glacier and formed of unsorted boulders, sand, gravel and clay.*

Knobby hill: *Glacial formation by which melting ice deposits material forming irregularly shapes.*

Ridge: *A line connecting the highest points along a landscape and separating drainage basins or small-scale drainage systems from one another.*

Kettle hole: *A depression in the surface of a ground moraine, caused by the melting of a block of subsurface ice after the moraine had formed.*

Figure 7: Digital Elevation Model



3.2 Soils

Soils provide the key to wetland restoration potential, define the water-holding capacity, ***infiltration*** capabilities, and the ***erosion*** potential of a site. The Natural Resources Conservation Service's (NRCS) Soil Survey of Lake County was used to conduct a soil analysis for the Bull Creek/Bull's Brook watershed. The data was utilized to determine the diversity of soil types, the extent of ***hydric soils,*** soil susceptibility to erosion, and the infiltration capacity.

Deposits left by glaciers that covered the Bull Creek/Bull's Brook watershed approximately 14,000 years ago are the raw materials of present soil types. These raw materials, also known as drift, include till (debris) and outwash. A combination of physical, biological, and chemical variables such as topography, drainage patterns, climate, and vegetation, have interacted over centuries to form the complex variety of soils found in the watershed. Most soils formed under wetland, forest, and prairie vegetation communities. Figure 8 displays each of the soil series coverages as determined by the NRCS's Soil Survey of Lake County (NRCS 1970). Table 2 contains information on these soil series including hydric status, total acres, and percent of watershed covered.

Soil types (series) are differentiated based on amounts and size of particles making up the soil, water holding capacity, the slopes on which they occur, permeability characteristics, and by organic content. Every soil series is given a different name. Markham, Elliott, Morley, Mundelein, Ashkum, and Beecher soils are dominant soil series in the watershed. Markham, Morley, and Mundelein soils are found on uplands and are generally well drained and suitable for development. Historic native vegetation growing on these areas consisted primarily of prairie and hardwood trees. Elliott, Ashkum, and Beecher soils are generally found in wetlands or drained wetlands and are poorly drained. These types of soils are considered to be hydric. Hydric soils are wet frequently enough to produce conditions that are devoid of oxygen (anaerobic) thereby influencing the plant species that can grow there. These areas provide opportunities for wetland restoration/enhancement and stormwater storage. Historic native vegetation in these areas consisted of water tolerant grasses, forbs, shrubs, and trees.

Infiltration: *That portion of rainfall or surface runoff that moves downward into the subsurface soil.*

Erosion: *Displacement of soil particles on the land surface due to water or wind action.*

Hydric soil: *Soil units that are wet frequently enough to periodically produce anaerobic conditions, thereby influencing the species composition or growth, or both, of plants on those soils.*

Figure 8: Soil Series

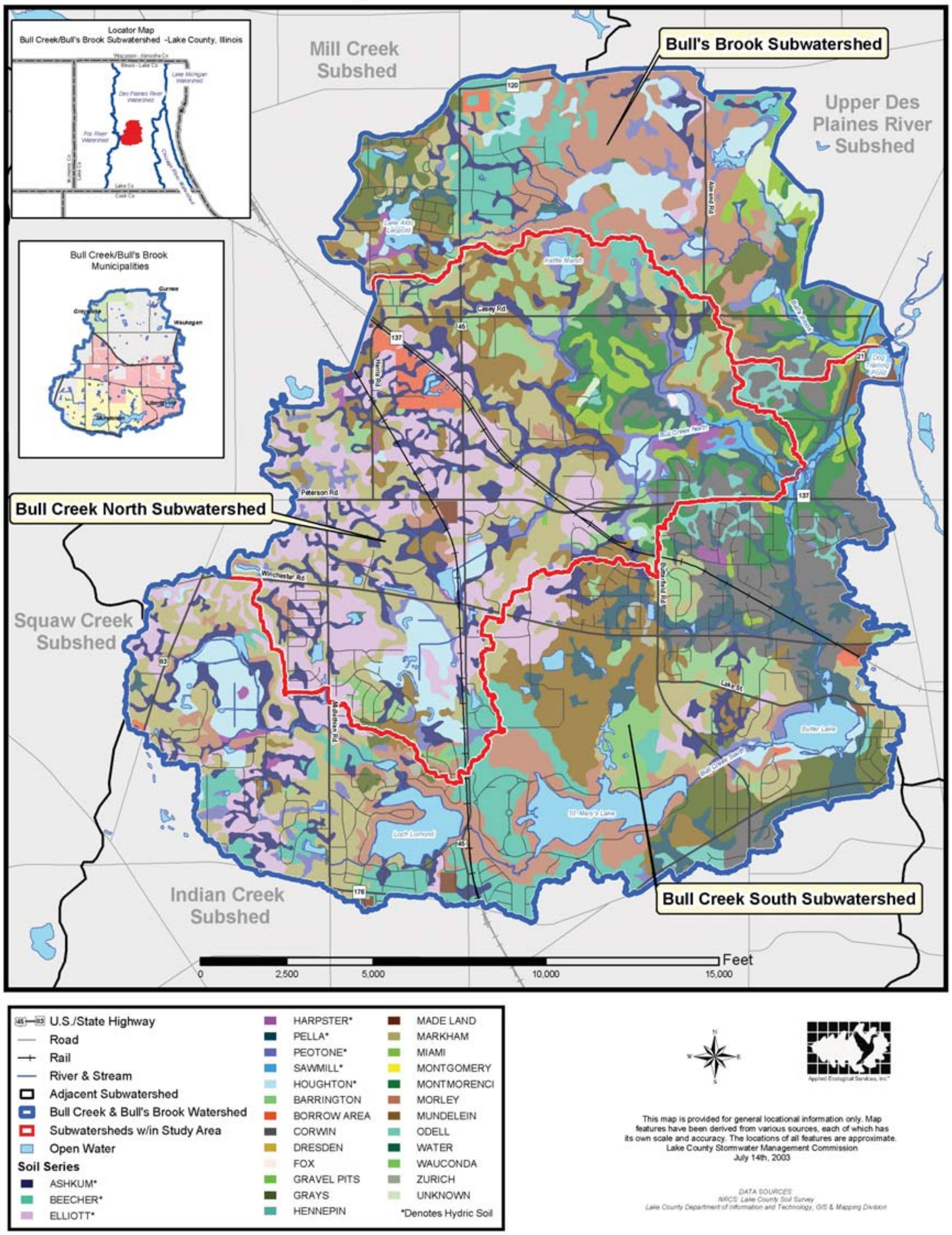


Table 2. Dominant soil types in the Bull Creek/Bull's Brook watershed

Soils Series	Soil Unit	Hydric (Y/N)	Highly Erodible (Y/N)	Hydrologic Soil Group	Total Area	% of Watershed
Ashkum	232	Y	N	C	708.7	7.9%
Barrington	443	N	N	C	349.7	3.9%
Beecher	298	Y	N	B	642.5	7.2%
Borrow Area	Ba	N	N	B	66.4	0.7%
Corwin	495	N	N	B	569.0	6.3%
Dresden	325	N	N	B	3.5	0.04%
Elliott	146	Y	N	B	908.2	10.1%
Fox	327	N	Y	B	1.8	0.02%
Gravel Pits	Gp	N	N	D	22.4	0.2%
Grays	698	N	N	B	294.8	3.3%
Harpster	67	Y	N	D	68.1	0.8%
Hennepin	25F	N	N	C	10.2	0.1%
Houghton	103	Y	N	B	470.3	5.2%
Made Land	Ml	N	N	B	42.6	0.5%
Markham	531	N	Y	D	1,319.2	14.7%
Miami	27	N	Y	B	182.2	2.0%
Montmorenci	57	N	Y	B	287.5	3.2%
Morley	194	N	Y	B	910.2	10.1%
Mundelein	442	N	N	C	759.6	8.5%
Odell	490	N	N	C	95.2	1.1%
Pella	153	Y	N	C	497.8	5.6%
Peotone	330	Y	N	D	274.3	3.1%
Sawmill	107	Y	N	C	86.9	1.0%
Unknown	n/a	n/a	N	B	40.1	0.4%
Water	W	N	N	Impervious	241.4	2.7%
Wauconda‹	978	N	N	B	95.7	1.1%
Zurich	696	N	Y	B	22.0	0.2%
Totals					**8,970.4**	**100%**

Source: US DOT, FHWA, Report No. FHWA/RD-84/057-060, June 1987

HYDRIC SOILS

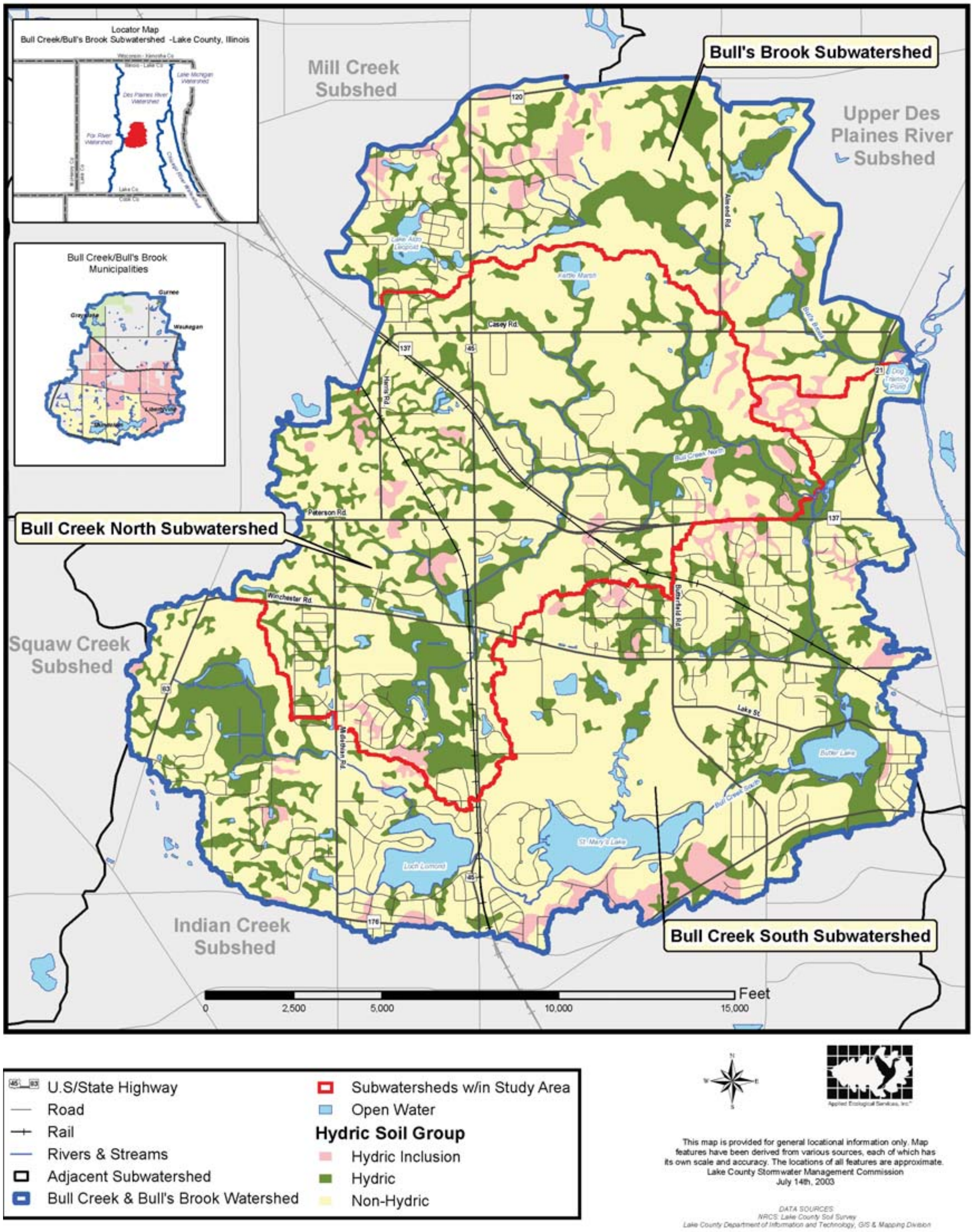
Hydric inclusion: A soil unit (usually adjacent to hydric soils) that are not wet enough to form hydric properties but do have some hydric properties.

Hydric soils are important because they indicate the potential presence of existing or drained wetlands and are an extremely useful indicator of depressional areas and potential wetland restoration sites. See Sections 3.13 and 3.14 for more information regarding Potential Wetland Restoration Sites and Potential Regional Storage. Historically, wetland soils formed over poorly drained clay material associated with wet prairies and other wetlands and accumulated organic matter from decomposing surface vegetation. Figure 9 shows hydric, ***hydric inclusion,*** and non-hydric soils of the Bull Creek/Bull's Brook watershed. Table 3 identifies all the NRCS-mapped hydric soils in the watershed. Table 2 displays the average area (acres), total area (acres), and percentage of watershed for each soil type. Hydric soils comprise 2,347.6 acres (26.2%) of the watershed while hydric inclusion soils and non-hydric soils comprise 437.4 acres (4.9%) and 6,185.4 acres (68.9%) of the watershed respectively.

Table 3. Percent coverage of hydric soils, hydric inclusion soils, and non-hydric soils by watershed and subwatershed

Soils	Average Acreage of soil polygon	Total Acreage (percent watershed)	Total Acreage by Subwatershed		
			Bull's Brook	Bull Creek North	Bull Creek South
Hydric Soil	8.8	2,347.6 (26.2%)	445.9 (25.4%)	877.7 (27.2%)	1,024 (26%)
Hydric Inclusion Soil	6.5	437.4 (4.9%)	122 (6.9%)	106.2 (3.3)	208.3 (5.2%)
Non-Hydric Soil	8.6	6,185.4 (68.9%)	1,189.7 (67.7%)	2,242.4 (69.5%)	2,754.3 (69%)
Totals		**8,970.4 (100%)**			

Figure 9: Hydric Soil Groups



SOIL ERODIBILITY

Runoff: *The portion of rain or snow that does not percolate into the ground and is discharged into streams by flowing over the ground instead.*

Total suspended solids (TSS): *The organic and inorganic material suspended in the water column and greater than 0.45 micron in size.*

Silt: *Fine mineral particles intermediate in size between clay and sand.*

Noteworthy Soil Erodibility and Pollution

Soil characteristics, especially the tendency of soil particles to become detached and mobilized by water ***runoff,*** have considerable impact on water quality. For instance, sandy soils are more prone to erosion than clayey soils, although pollutants are more likely to be attached to clay particles. It is important to map highly erodible soils because they represent areas that may potentially contribute high amounts of ***total suspended solids (TSS)*** to streams and lakes. High TSS levels can result in stream degradation as a result of ***silt*** deposition and pollution. Some pollutants frequently attach to TSS particles and wash into lakes and streams, polluting the water and sediments and decreasing water clarity.

A highly erodible soils map was created by selecting soils from a list provided by LCSMC *(Figure 10)*. Highly erodible soil series in the watershed include Fox, Markham, Miami, Montmorenci, Morely, and Zurich. Based on the mapping, 2,270 acres (25% of watershed) is considered highly erodible. Erodible soils along stream channels/lake shorelines, on agricultural lands, and on potential construction sites are extremely susceptible to erosion and are depicted on Figure 10. Streambank or lakeshore restoration in areas determined to be moderately or highly eroded would reduce soil erosion and associated pollutant loading. Existing agriculture is associated with many highly erodible areas and accounts for approximately 434 acres. Waterways adjacent to agricultural fields with extensive erodible soils would benefit from practices that minimize erosion such as filter strips. Much of the projected development in the watershed is expected to occur on land that is currently agricultural. When and if these areas are developed, developers will be required to follow the ***National Pollution Discharge Elimination System (NPDES)*** and Watershed Development Ordinance (WDO) regulations regarding erosion control.

National Pollutant Discharge Elimination System (NPDES Phase II): *Clean Water Act law requiring smaller communities and public entities that own and operate a municipal separate storm water system to apply and obtain an NPDES permit for stormwater discharges. Permittees at a minimum must develop, implement, and enforce a stormwater program designed to reduce the discharge of pollutants from the MS4 to the maximum extent practicable. The stormwater management program must include these six minimum control measures:*

1. Public education and outreach on stormwater impacts

2. Public involvement/participation

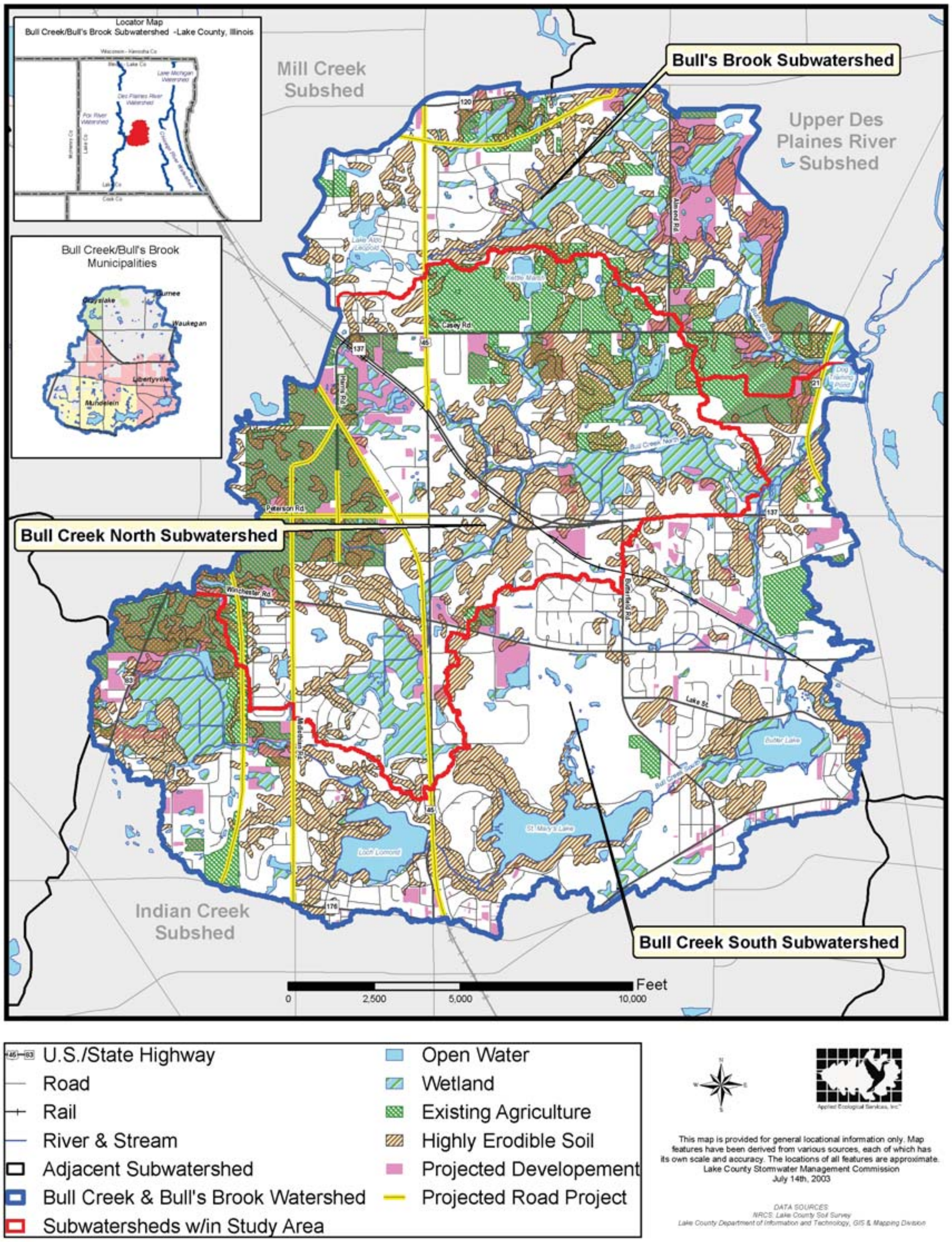
3. Illicit discharge detection and elimination

4. Construction site stormwater runoff control

5. Post-construction stormwater management in new development and redevelopment

6. Pollution prevention/good housekeeping for municipal operations

Figure 10: Highly Erodible Soils and Projected Land Use Changes



Noteworthy Defining Hydrologic Soil Groups

Hydrologic Soil Groups (HSGs) are based on a soil's infiltration and transmission (permeability) rates and are used to calculate ***runoff curve numbers.*** The Hydrologic Soil Group's are classified into four categories, A, B, C, and D. Group A is composed of the most permeable soil types (i.e. sandy soils) and has the least runoff potential while group D includes the most impermeable soil types (i.e. clay) and has the greatest runoff potential. Best Management Practices (BMPs) are often recommended based on infiltration and permeability rates of a particular HSG.

__Runoff curve numbers:__ Numbers developed to classify the runoff potential of different soil types with different land cover. The curve numbers are a function of Hydrologic Soil Groups, land cover or usage, and antecedent soil moisture conditions. The curve number value can be a number from 0 to 100 although the typical range is between 25 through 98. A curve number value of 98 is considered to be an impervious land cover such as pavement or a building roof. A low curve number value would indicate conditions with a very low runoff potential.

The Hydrologic Soil Groups (HSGs) and their corresponding soil texture, drainage description, runoff potential, infiltration rate, and transmission rate are shown in Table 4. In general, around half of the Bull Creek-Bull's Brook watershed is moderately well-drained while the remainder is poorly drained. Poorly drained clayey soils make the implementation of BMPs such as pervious paving and other infiltration techniques difficult without amending the soil with more pervious material such as sand or rock. Figure 11 depicts the location of each HSG found in the watershed while Table 5 summarizes the acreage and percent of watershed for each HSG. According to the analysis, HSG-B comprises 54.2% of the watershed followed by C (26.1%) and D (17%) respectively. Open water (streams and lakes) comprise the remaining 2.7% of the watershed.

A closer look at the hydrologic soil groups in the watershed reveals potential locations appropriate for infiltration that would help reduce runoff and increase groundwater recharge. Many of these areas are found on existing open space in the northern and southern portions of the watershed. Most of the land just north and south of Casey Road contains soils that provide moderate infiltration. The land east of Almond Road is also permeable. Extensive permeable soils are also located within open space north and south of St. Mary's Lake. Agriculture land in the far west portion of the watershed does provide infiltration opportunities but they are not as extensive as other open space areas.

Table 4. Hydrologic Soil Groups and their corresponding attributes

HSG	Soil Textures	Drainage Description	Runoff Potential	Infiltration Rate	Transmission Rate
A	Sand, Loamy Sand, or Sandy Loam	Well to Excessively Drained	Low	High	High
B	Silt Loam or Loam	Moderately Well to Well Drained	Moderate	Moderate	Moderate
C	Sandy Clay Loam	Somewhat Poorly Drained	High	Low	Low
D	Clay Loam, Silty Clay Loam, Sandy Clay Loam, Silty Clay, or Clay	Poorly Drained	High	Very Low	Very Low

Source: North Branch Chicago River Watershed Assessment (LCSMC 2000).

Figure 11: Hydrolic Soil Groups

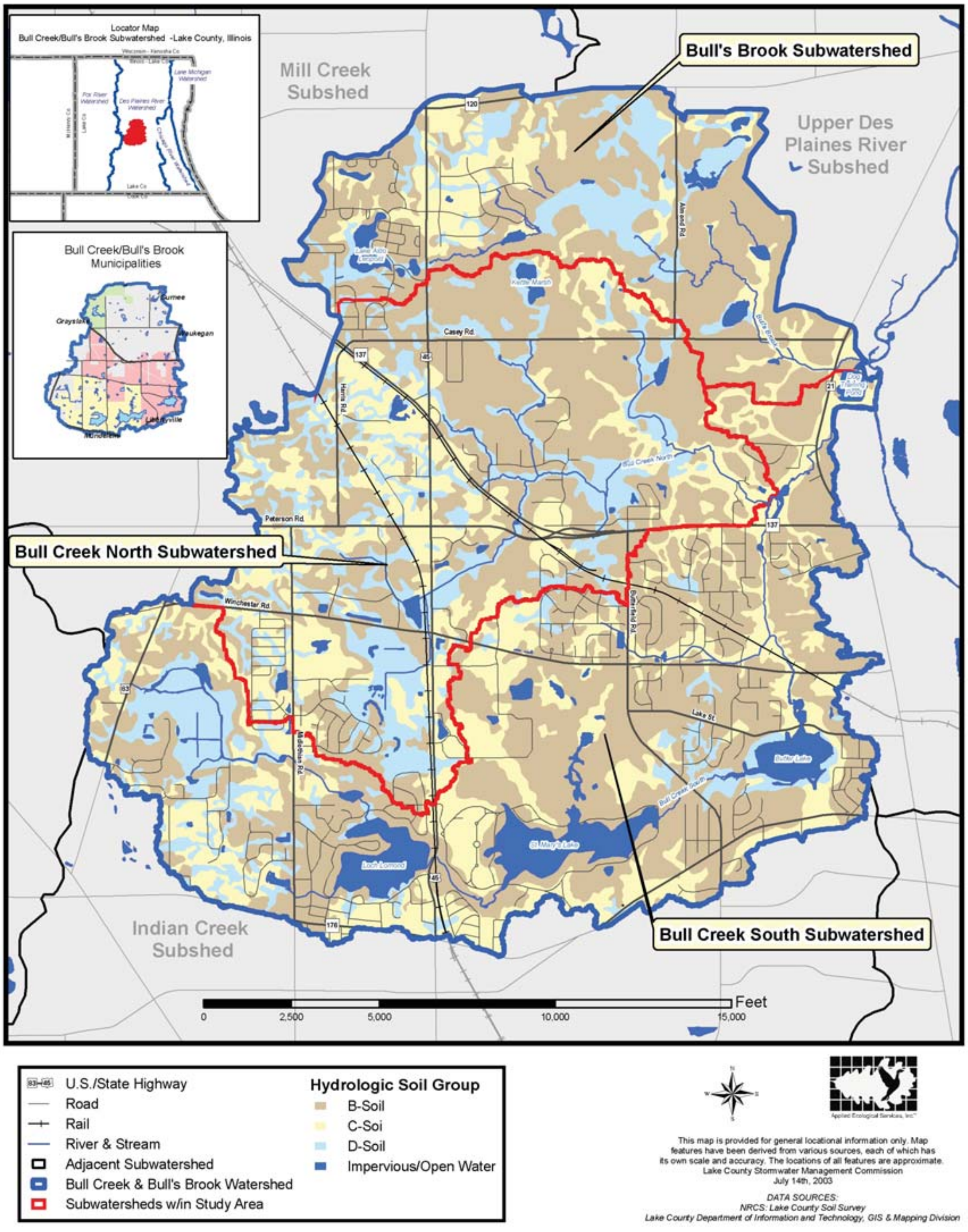


Table 5. Hydrologic Soil Groups including acreage and percent of watershed and subwatershed

Hydrologic Soil Group	Total Acreage (percent watershed)	Total Acreage by Subwatershed (Percent of Subwatershed)		
		Bull's Brook	Bull Creek North	Bull Creek South
B	4,866.9 (54.2%)	1,065.8 (60.6%)	1,594.4 (49.4%)	2,206.2 (55.3%)
C	2,340.7 (26.1%)	353.1 (20.1%)	870.8 (27.0%)	1,116.8 (28.0%)
D	1,521.4 (17.0%)	332.9 (18.9%)	751.7 (23.3%)	436.8 (11.0%)
Open Water	241.4 (2.7%)	5.8 (0.3%)	9.2 (0.3%)	226.3 (5.7%)
Totals	8,970.4 (100%)	1,757.6 (100%)	3,226.1 (100%)	3,549.3 (100%)

3.3 Watershed Jurisdictions

JURISDICTIONAL BODIES

The Bull Creek/Bull's Brook watershed is comprised of several political jurisdictions including Lake County, portions of 6 municipalities, and 4 townships *(Table 6, Figure 12)*. The municipalities that occupy the largest portions of the watershed are Libertyville (2,589 acres) and Mundelein (1,957 acres). The City of Waukegan is the smallest municipality occupying only 6 acres. The remaining municipalities, the Villages of Grayslake and Gurnee, comprise 620 and 36 acres respectively. All remaining land in the watershed (3,833.4 acres) is unincorporated and part of Avon (204.5 acres), Warren (746.8 acres), Fremont (819.1 acres), and Libertyville (2,063) Townships.

Additional entities with jurisdiction are shown on Figures 13 and 14 and include:

1. Lake County Forest Preserve District (391.7 acres/4.4% of watershed)
2. Park Districts (Grayslake, Mundelein, Libertyville) (129 acres/1.4% of watershed)
3. State Senatorial and Representative Districts *(see Table 6)*
4. County Board Districts *(see Table 6)*
5. Lake County Soil and Water Conservation District (entire watershed)
6. US Congressional Districts *(see Table 6)*

Watershed protection in Lake County is a shared responsibility of both public and private interests. City and county level governments oversee developments that could affect water resources via the Lake County Watershed Development Ordinance within incorporated areas and the Unified Development Ordinance in unincorporated areas that is enforced by the Lake County Planning, Building and Development Department.

Multiple jurisdictions with varying interests and responsibilities can present watershed coordination challenges for implementing Best Management Practice (BMP) projects and for providing program, policy and regulatory consistency. For example communities may typically have comprehensive municipal land use plans, while separate but associated parks departments or districts may also have plans. And, while Lake County does land use planning and development approval in unincorporated Lake County, the Townships are frequently more active as project partners for BMP projects than Lake County government. With multiple jurisdictions in the watershed, coordination challenges can be a limiting factor in completing BMP projects, especially in the case of large inter or multijurisdictional projects. Chapter 4 (Watershed Problems Assessment) contains information related to improving jurisdictional coordination among the responsible parties in the watershed.

Table 6. Major jurisdictional bodies in the Bull Creek/Bull's Brook watershed

Jurisdiction Body	Acres	Percent Watershed	Incorporated Acres	Unincorporated Acres
Municipalities				
Grayslake	620.1	7%		
Gurnee	36.5	0.4%		
Libertyville	2,588.6	29%		
Mundelein	1,957.3	22%		
Waukegan	6.2	0.1%		
Unincorporated Lake Co.	3,761.6	41.9%		
Townships				
Avon Township	205.3	2.3%	204.5	.8
Warren Township	961.9	10.9%	215.4	746.8
Fremont Township	2,820.4	32.1%	2,001.3	819.1
Libertyville Township	4,982.8	55.5%	2,919.8	2,063
Park Districts	129	1.4%		
County Board Districts				
10th District	2,117	23.6%		
11th District	4,243	47.3%		
15th District	2,610.3	29.1%		
Congressional Districts				
8th District	3,830.3	42.7%		
10th District	5,131.1	57.2%		
State Senate				
26th District	7,795.3	86.9%		
31st District	1,175.1	13.1%		
State House				
51st District	7,795.3	86.9%		
62nd District	1,175.1	13.1%		

Source: Lake County Stormwater Management Commission and Lake County Department of Information and Technology

Figure 12: Municipalities & Townships

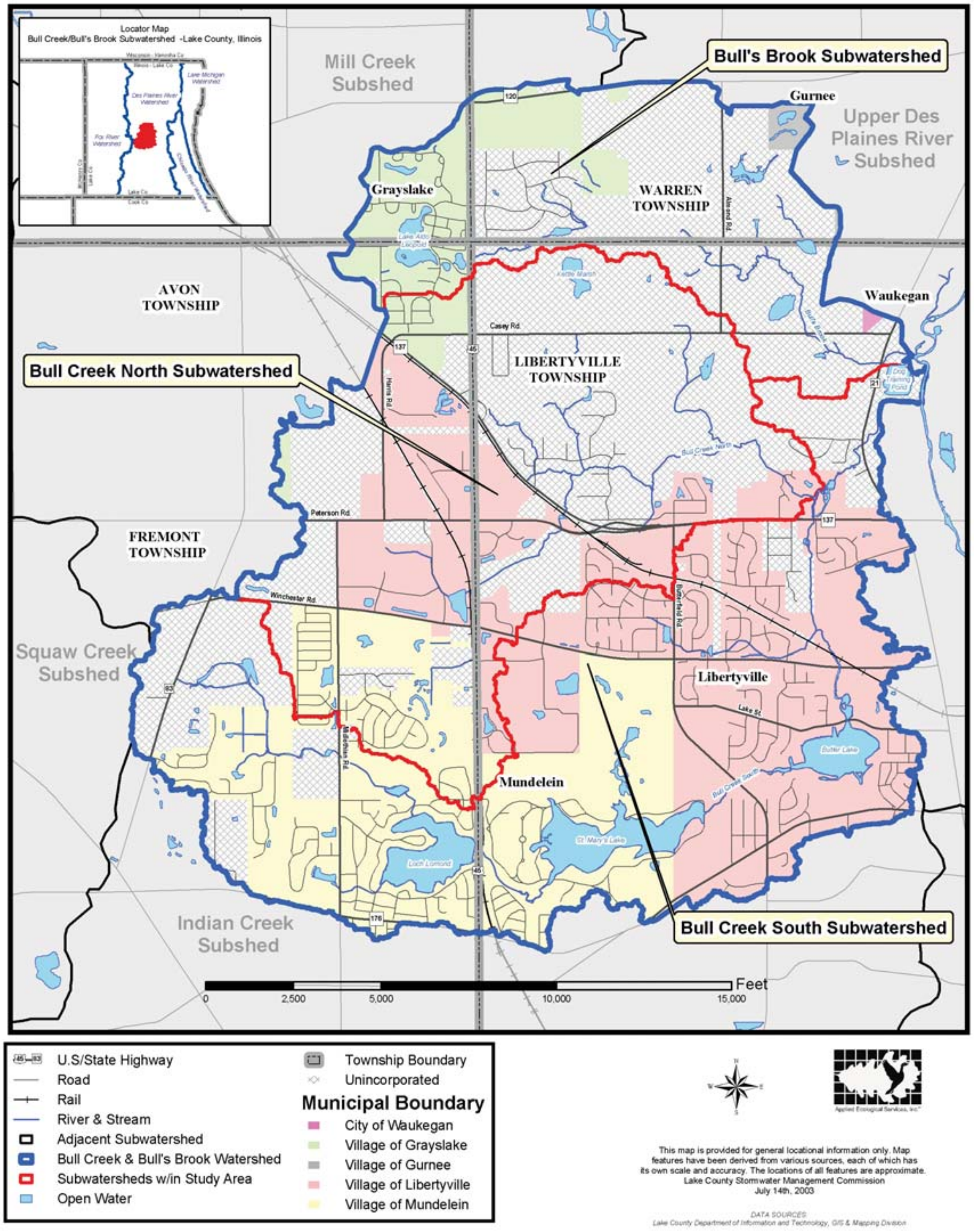


Figure 13: Forest Preserve and Park District Boundaries

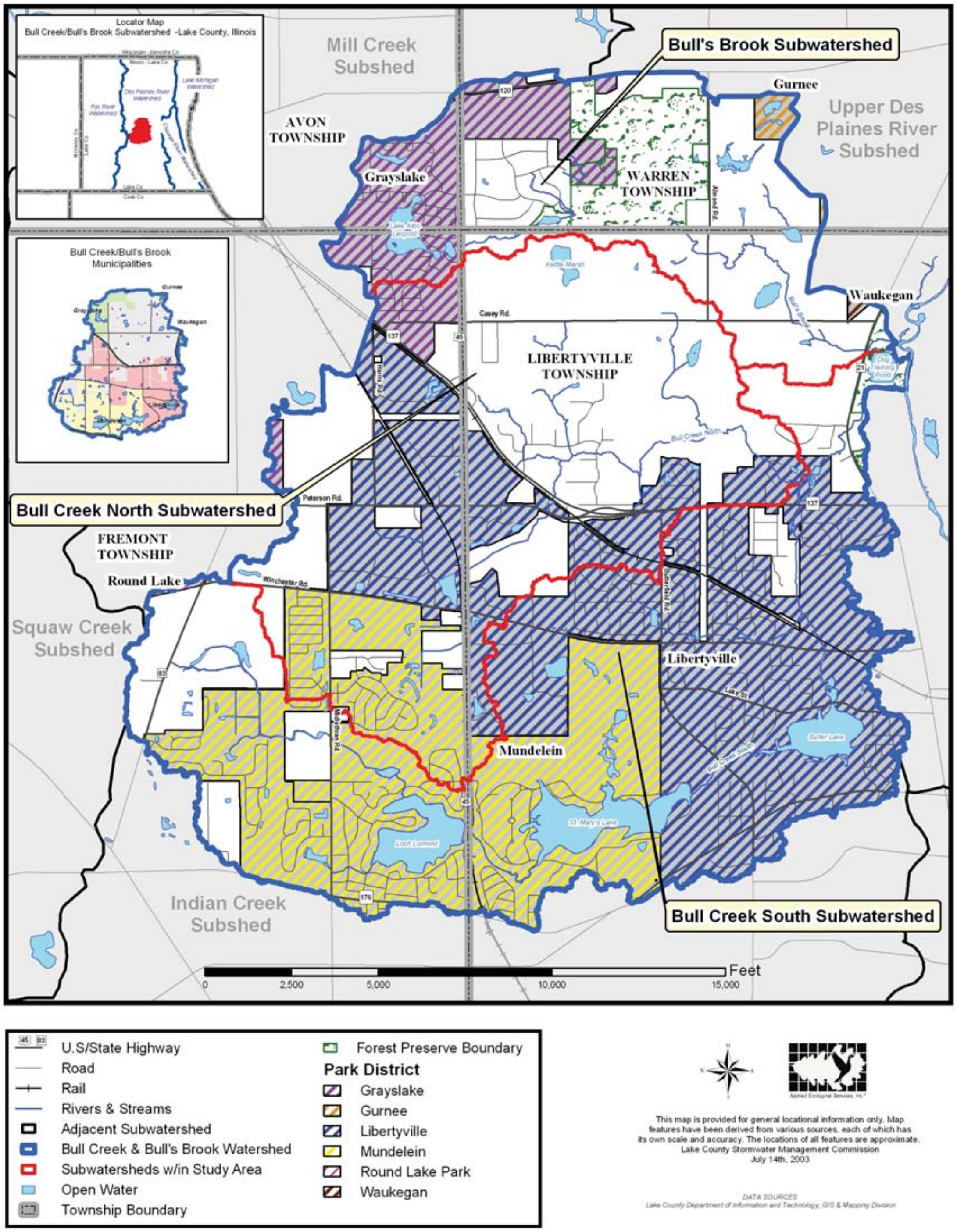
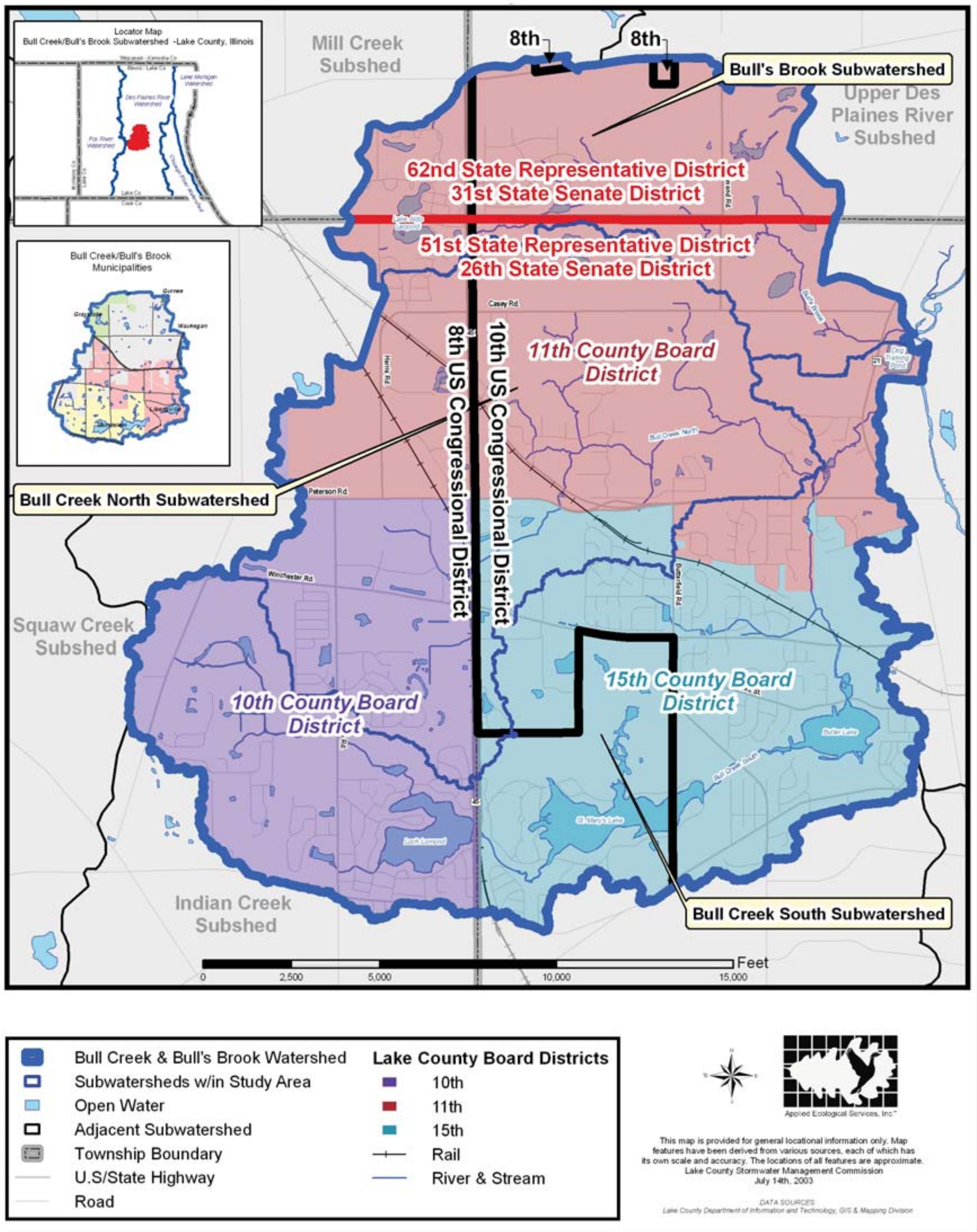


Figure 14: State Senatorial, Representative, U.S. Congressional and County Board District Boundaries



3.4 Watershed Demographics

Noteworthy About Demographic Forecasts

The forecasts are developed by first generating region-wide estimates for population, households, and employment using results obtained from the Regional Economics Application Laboratory. Next, CMAP meets with local governments to determine future land development patterns within each jurisdiction. After data is collected from local governments, adjustments must be made to the data in situations where there is overlapping or contradictory information. Forecasts are then projected for quarter sections, which are 160-acre tracts of land.

Noteworthy Lake County Demographic

According to the U.S. Census Bureau, the population of Lake County was 644,356 in 2000 and grew to 713,076 in 2006. The Chicago Metropolitan Agency for Planning (CMAP) is responsible for the region's official forecasts of population, households and employment, since the merger of the Northeastern Illinois Planning Commission (NIPC) and the Chicago Area Transportation Study (CATS) in 2005.

In September 2006 CMAP revised its forecasts for population, households and employment for the six-county Chicago region. The Lake County 2030 population forecast is 841,860. This represents a projected 30.7% increase in population from 2000 to 2030. CMAP is projecting that the number of households in Lake County is expected to increase by 34.5% and employment opportunities will increase by 31.4%.

Table 7 includes NIPC's 2004 data estimates for population, households, and employment forecast changes between 2000 and 2030 for the approximate area of the watershed. The population of the watershed is estimated to increase by 15.5%; households by 21.8%; and employment by 90.1% between the years 2000 and 2030.

Table 7. NIPC's 2000 data and 2030 forecast data for the Bull Creek/Bull's Brook watershed

	2000	2030 Forecast	Forecast Change (2000–2030)	Percent Change (2000–2030)
Population	34,777	40,172	5,395	15.5%
Households	11,931	14,534	2,603	21.8%
Employment	15,816	30,064	14,248	90.1%

Source: Northeast Illinois Planning Commission 2030 Forecasts (2003).

Note: AES used GIS to overlay the watershed boundary onto NIPC's quarter section data. If any part of a quarter section fell inside the watershed boundary, the statistics for the entire quarter section were included in the analysis. Therefore, the numbers in Table 7 are likely overstated.

Figures 15-17 detail by quarter section the population, household, and employment changes that are forecasted in the watershed. It is important to note that demographic changes are represented for entire quarter sections, even though only portions of some are within the watershed map boundaries. According to the NIPC forecasts for population, the southwest portion of the watershed will experience increases in population and households because remaining agricultural land in this area is quickly being converted to residential housing. Other significant population growth is expected to occur in the northern portion of the watershed in areas that are currently open space. According to future projected landuse (Section 3.5), much of the population increase will result from residential large lot development.

In general, employment opportunities are expected to significantly increase in the western portion of the watershed along Route 45, Route 83, Peterson Road, and south of Route 120. These changes are a result of expected increases in commercial and industrial land uses along major arterial roads in the watershed. Households and employment in most other areas of the watershed are expected to remain relatively stable with small increases or decreases.

Figure 15: Population Change Year 2000–2030

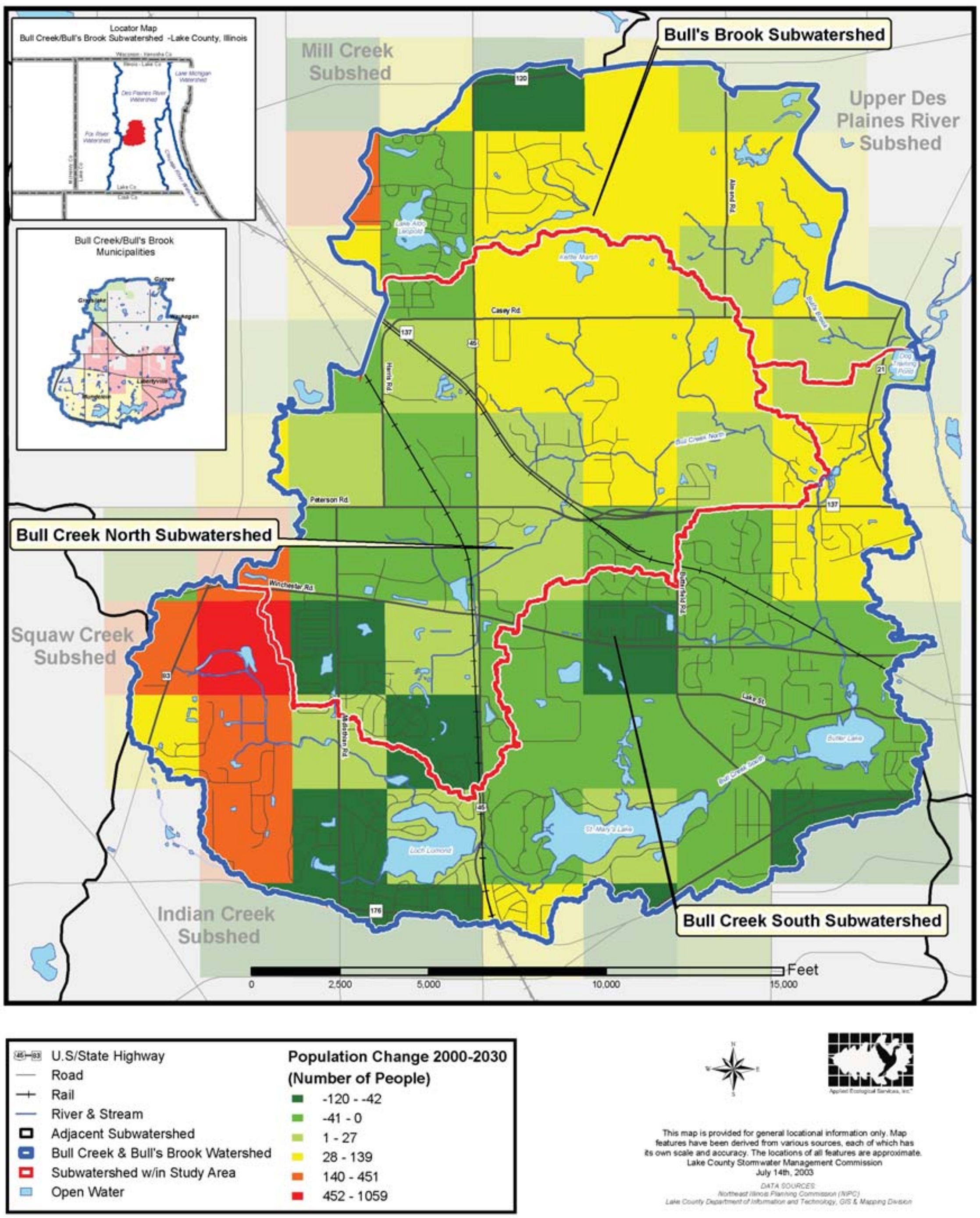


Figure 16: Household Change Year 2000–2030

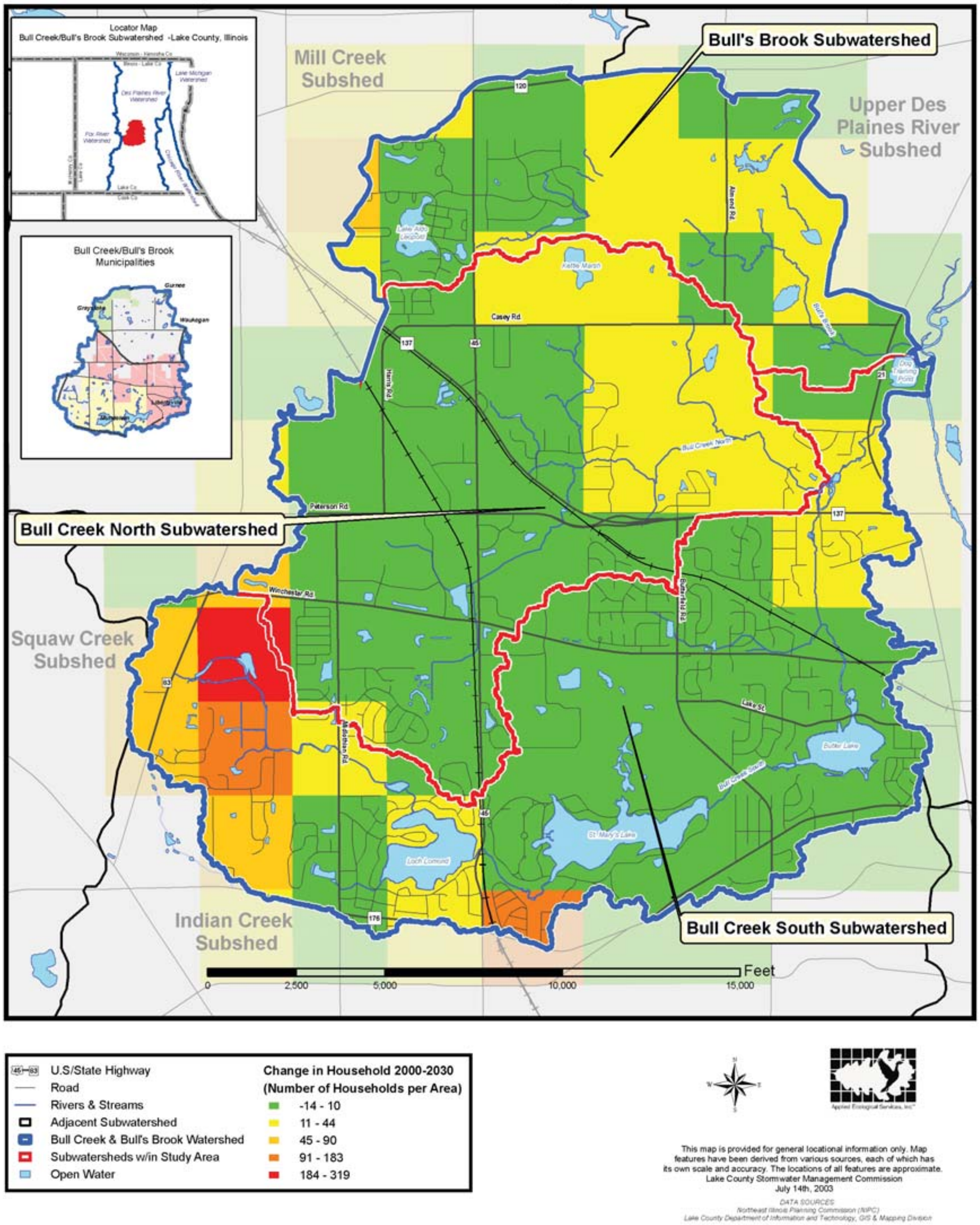
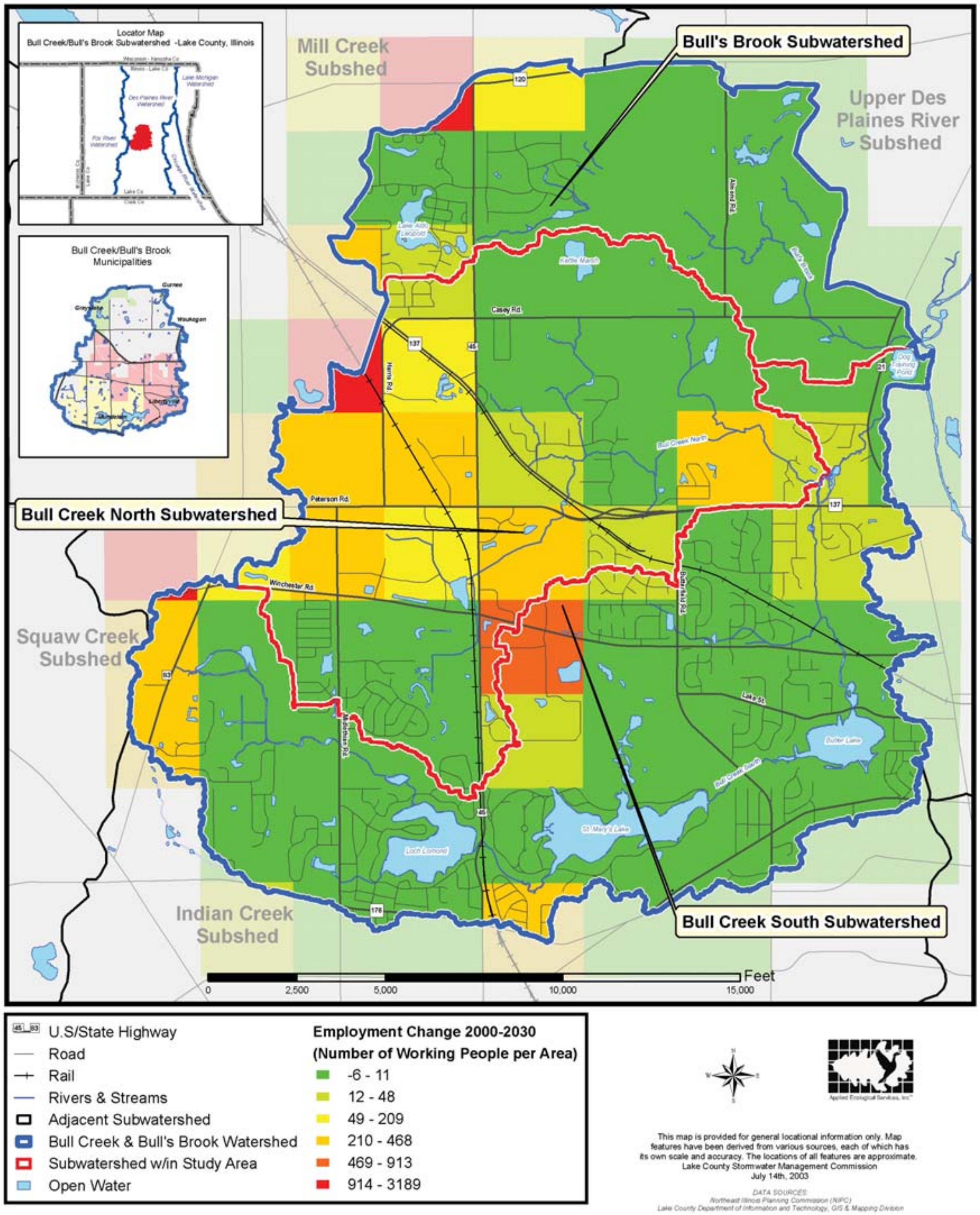


Figure 17: Employment Change Year 2000–2030



3.5 Land Use/Land Cover

HISTORIC LAND COVER

Wet meadow: *A type of wetland away from stream or river influence with water made available by general drainage and consisting of non-woody vegetation.*

Marsh: *An area of soft, wet, low-lying land, characterized by grassy vegetation and often forming a transition zone between water and land.*

The historical government survey (1838-1840) of the pre-settlement natural communities (presettlement vegetation) in the Bull Creek/Bull's Brook watershed include a network of oak woodlands, ***wet meadow/prairie, marsh***, prairie, savanna, and ***upland forest***. These communities are shown on Figure 18. Prairies dominated the watershed. Following European settlement, most of this land was converted to agricultural practices followed by residential and commercial land uses.

The southern portion of the watershed once contained several large marshes surrounded by savanna and oak woodlands. Dams have been constructed to create the existing lakes. (Butler Lake is the only natural (glacial) lake in the watershed.) Much of the savanna and oak woodland communities are now developed as residential except around St. Mary's Lake where the woodland has been preserved.

Prior to European settlement nearly all of Bull Creek North and Bull Creek South (downstream from Butler Lake) were wet meadow/prairie. 1939 aerials of the area also suggest the same for much of Bull's Brook. Increases in watershed development and stream alteration (ditching) for farming purposes likely created the defined stream channels and floodplains witnessed today.

The northern portion of the watershed was once dominated by savanna and marsh communities. Although partially developed under residential and agricultural land uses, large areas of native communities have either been preserved or restored within the Liberty Prairie Reserve. The Liberty Prairie Reserve is a 5,800-acre focus area spanning across the northern portion of the watershed and beyond, including 3,200 acres of public and private lands that have been protected from development.

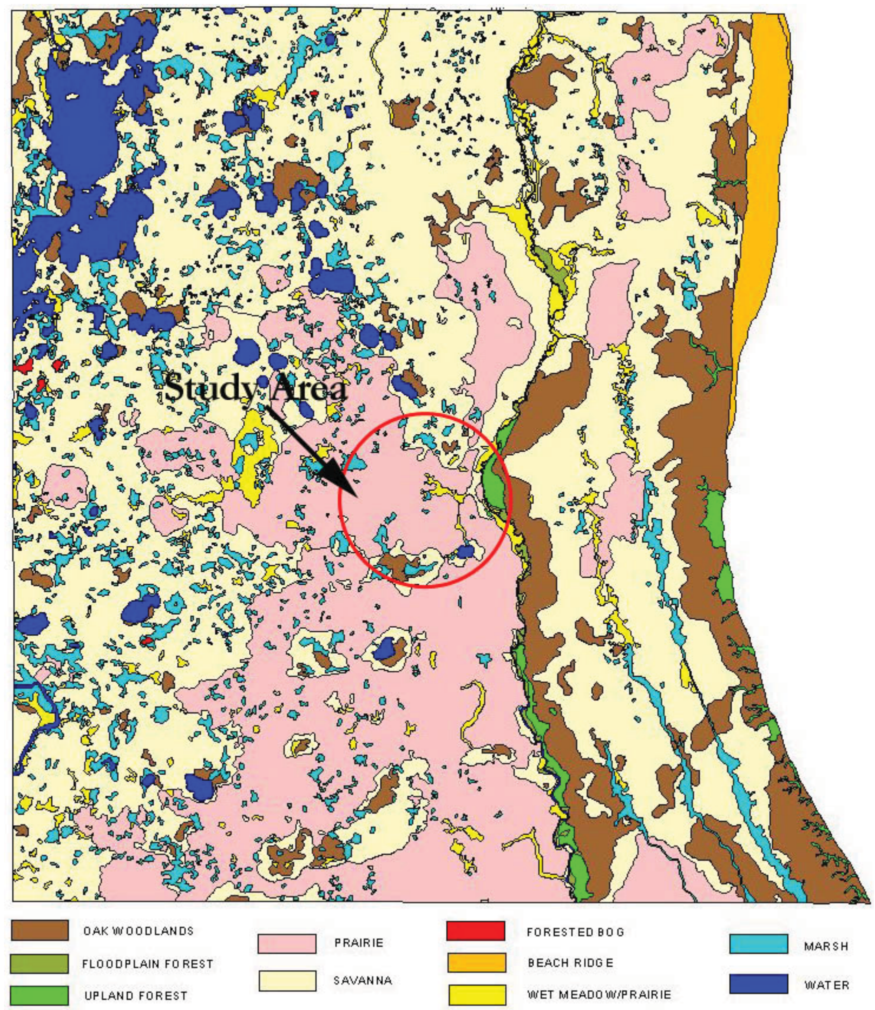


Figure 18. The historical government survey (1838-1840) of the pre-settlement natural communities in the Bull Creek/Bull's Brook watershed includes oak woodlands, wet meadow/prairie, marsh, prairie, savanna, and upland forest.

EXISTING LAKE COUNTY LAND USE

Today, the land cover is very different due to human induced land use changes. The 2004 land use/land cover is shown on Figure 19 and displayed in Table 8. The data was derived from two sources. Land use for Integrated Lakes Management's 2003 water quality report (ILM 2003) was used. This data was developed by updating the 1995 NIPC land use inventory and combining the data into land use/land cover categories established by LCSMC for modeling purposes. Next, overlapping and missing data was cleaned. The second data source was the 2000 Lake County Planning, Building, and Development Department (LCPB&D) parcel-based land use. Wetland, open water, and transportation data from this source was integrated to make the land use more accurate. Recent aerial and ground truthing was also completed for areas where land use or cover was uncertain.

Definitions for Each of the Watershed Land Use/Cover Types:

Residential: Includes single and multifamily residences. These include single family homes, duplex and townhouse units, farmhouses (identified as one acre in size) and immediate residential area around them, apartment complexes and retirement complexes, mobile home parks, and associated parking.

Commercial: Includes shopping malls and associated parking, single structure office/hotels, urban mix (retail trade, such as lumber yards, department stores, grocery stores, gas stations, restaurants) and hotels/motels.

Industrial: Includes industrial, warehousing and wholesale trade, such as mineral extraction, manufacturing and processing, warehousing and distribution centers for wholesale, associated parking areas, truck docks, etc.

Government/Institutional: Includes medical facilities, educational facilities, religious facilities, and others like YMCAs and shelters. (Note: Larger open areas (generally greater than 5 acres) associated with institutions are classified as open space despite being owned by the institution.)

Transportation: Includes railroads and associated stations, rail yards, linear transportation, airport transportation (air fields, hangars, heliports, etc.), automobile parking (off street, non-residential, non-commercial).

Utility: Includes telephone, radio and television towers, dishes, gas, sewage pipeline, ComEd right of ways, etc.

Cemetery: Includes cemeteries and their associated chapels and mausoleums.

Agricultural: Includes out-buildings and barns, row crops, and fallow fields and pasture, dairy and other livestock agricultural processing (not including feed lots-any extensive agricultural processing is coded as manufacturing).

Public/Private Open Space: Includes parks, arboretums, botanical gardens, golf courses and other such as skiing and tobogganing runs, bike trails through open space, etc. that have no more than 50% combined impervious surface and manicured turf. *(Note: this open space land use category differs from open space as defined in Section 3.8: Green Infrastructure Network, where any unimproved parcel is defined as "open space" for inclusion in the green infrastructure inventory.)*

Forest and Grassland: Includes private and some public property that has not been developed for any human purpose, if even to picnic or hike, undeveloped and unused land areas, and non-reserve forests not included in the Public/Private Open Space category. This category may also include bands of forested land or grassland along streams (riparian corridors). *(Note: unimproved parcels are included in the green infrastructure inventory.)*

Wetland: Land cover that includes wetlands on public and private land. *(Note: in some situations, wetlands are mapped under a different land use category such as open space and forest and grassland classifications. Therefore, wetland acreages aggregated in this wetland land cover category do not reflect the total acres of wetlands in the Lake County Wetlands Inventory as reported in the wetlands assessment section of this plan.)*

Open Water: Includes rivers, streams and canals (generally greater than 200 feet in width), lakes, reservoirs, and lagoons.

Figure 19: 2004 Land Use Data

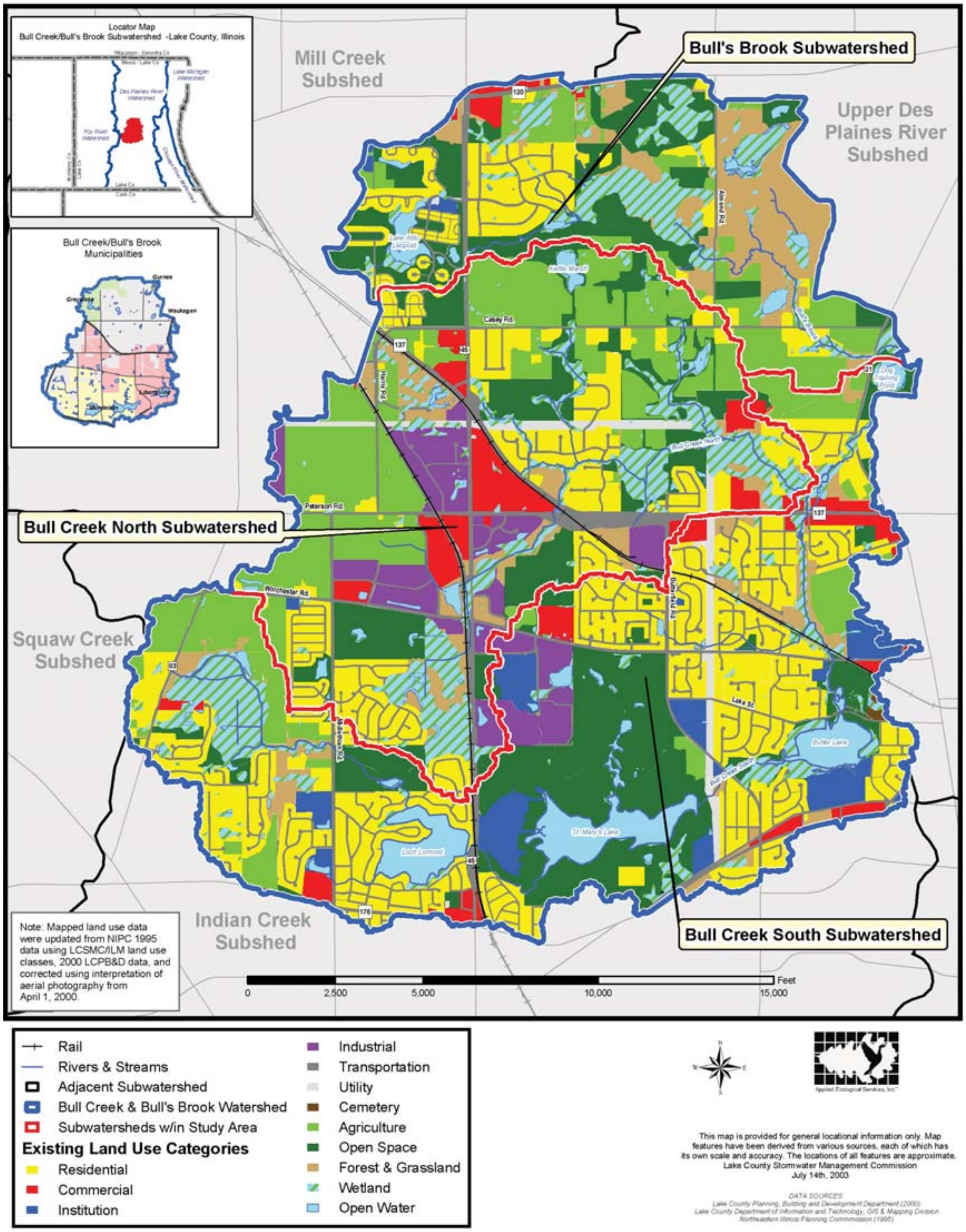


Table 8. 2004 land use updated from 1995 NIPC/2003 ILM land use

Land Use	Area (acres)	Percent of Watershed
Agricultural	1,438.8	16.0
Cemetery	5.5	0.1
Commercial	349.4	3.9
Industrial	351.0	3.9
Institutional	246.2	2.7
Open Space	1,598.4	17.8
Residential	1,959.0	21.8
Transportation	864.2	9.6
Utility	96.6	1.1
Forest & Grassland	622.7	6.9
Wetland*	987.5	11.0
Open Water	423.5	4.7
Unknown	27.6	0.3
Total	**8,942.8**	**100%**

*Note: Land use acreage (8,942.8) does not equal actual watershed acreage (8,970.4) because of small slivers of missing GIS data. *Additional wetland area is present throughout other land use categories*

Residential development dominates the watershed at 21.8% of the total acreage, followed by open space (17.8%), and agricultural land (16.0%). Other substantial land uses include wetland (11%) (Note: this wetland land cover class only includes the wetland areas not included in other land use/cover classes and therefore does not accurately match the Lake County Wetland Inventory (LCWI) acreage described in Section 3.13), transportation (9.6%), and forest & grassland (6.9%). Total open space (including recreational and conservation open space), forest/grassland, agricultural lands, and water resources (including wetlands), comprise approximately 5,071 acres or 56% of the watershed (Note: this open space differs slightly from the open space defined and mapped in Section 3.8: Green Infrastructure Network). This vast amount of remaining open space is a unique feature that stakeholders value. Total developed land including residential, commercial, industrial, institutional, cemetery, utility, and transportation accounts for approximately 3,872 acres or 43% of the watershed. The GIS land use/cover data used for the analysis attributed no data to the remaining 27.6 acres of the watershed. These areas showed up as small slivers of unclassified use located among the known data.

FUTURE LAND USE PROJECTIONS

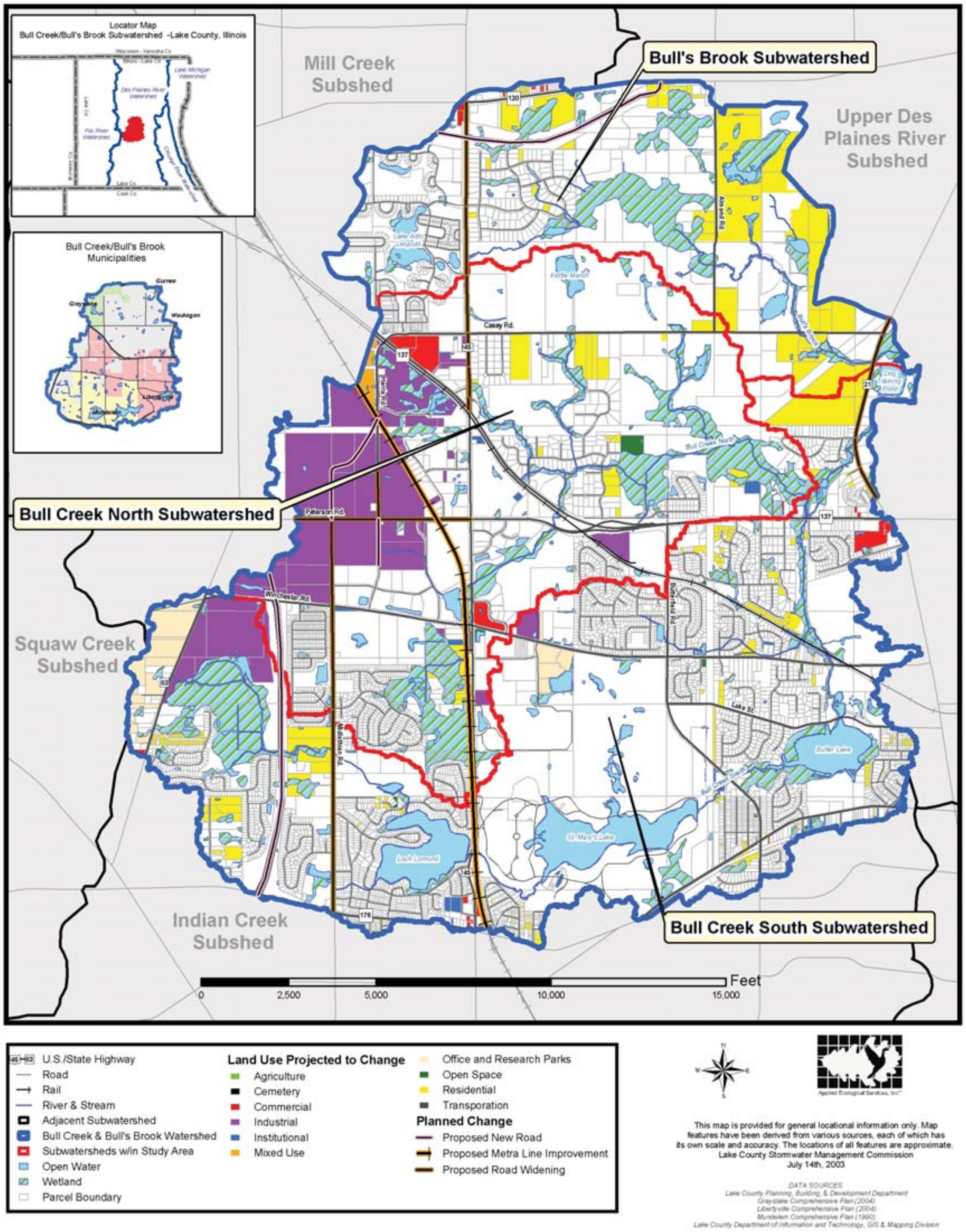
Information on 20-year build out future land use within the watershed was obtained from the Lake County Planning, Building, and Development Department (LCPB&D) and each municipality's planning and/or engineering department where available (Thompson Dyke & Associates, Ltd 1990, Village of Grayslake 2004, Village of Libertyville 2004). The data was analyzed using GIS then mapped to display which areas are projected to change land uses.

The positive value of existing open space and continued open space preservation becomes apparent when examining trends that become apparent in the process of comparing current land use to projected future land use changes in the next 20 years (Table 9; Figure 20). First, most of the agricultural land located in the western portion of the watershed is expected to convert to industrial, office/research parks, and residential land uses. Second, much of the existing unprotected forest/grassland and agricultural land in the northeast portion of the watershed is expected to become large lot residential. Most of these parcels are located within the Liberty Prairie Reserve boundary. Last, two major road extensions are proposed to be constructed on land that is primarily agricultural, open space, or wetland. These include the Route 53 extension in the southwest portion of the watershed and the Route 120 new road corridor in the northern portion of the watershed. Other land uses such as existing cemeteries, commercial, utilities, residential, and water is not expected to change significantly. Approximately 7 acres of wetland are projected to be lost to future development.

Table 9. 2004 and 20-year projected land use, including percent change for each category, in the Bull Creek/Bull's Brook Watershed

Land Use	Current Ares (acres)	Current % of Watershed	Projected % Area (acres)	Projected % of Watershed	Change (acres)	Change (%)
Agriculture	1,438.8	16%	621.4	6.9%	- 817.4	-9.1%
Cemeteries	5.5	0.1%	5.5	0.1%	0	0%
Commercial	349.4	3.9%	348.2	3.9%	-1.18	0%
Industrial	351.0	3.9%	926.4	10.4%	+575.3	+6.5%
Institutional	246.2	2.7%	317.5	3.5%	+71.3	+0.8%
Mixed Use	N/A	N/A	12.0	0.1%	+12.0	+.1%
Office and Research Parks	N/A	N/A	78.0	0.9%	+77.9	+0.9%
Open Space	1598.4	17.8%	1,569.9	17.5%	-28.5	-0.3%
Residential	1,959.0	21.8%	2,352.0	26.3%	+389.3	+4.5%
Transportation	864.2	9.6%	911.6	10.2%	+47.4	0.6%
Utilities	96.6	1.1%	93.6	1.0%	-3.4	-0.1%
Forest & Grassland	622.7	6.9%	326.2	3.6%	-309.5	-3.3%
Wetland	987.5	11%	985.4	11%	-2.1	0%
Open Water	423.5	4.7%	423.5	4.7%	0	0%

Figure 20: 2020 Projected Land Use Changes by Parcel



Noteworthy The Impervious Cover Model: Determining Impervious Cover Impacts on a Watershed

Development by humans generally increases the amount of impervious cover for a given area and reduces the amount of open space for infiltrating and storing precipitation. Rain and snowmelt cannot soak into ground that has become impervious because it has been paved for a road or parking lot, or that has buildings. It instead becomes quickly channeled into sewers in increasingly high amounts. Imperviousness is an indicator used to measure the impacts of urban land uses on aquatic systems. Specifically, increases in imperviousness generally have negative implications on the natural functions of streams, including water quality, hydrology and flows, flooding and depressional storage, and habitat. The following paragraphs describe the implications of increased imperviousness on natural stream functions. Section 4.1 (Land Use Impacts) identifies those areas that are more susceptible to the effects of the land use impacts listed below.

WATER QUALITY

Imperviousness can (generally) affect water quality in streams and lakes by increasing pollutant loads and water temperature. Impervious surfaces accumulate pollutants from the atmosphere, vehicles, roof surfaces, lawns and other sources. During a storm, pollutants such as fertilizer (nitrogen and phosphorus), metals, oil and grease, and bacteria from animal droppings are delivered to streams and lakes. According to monitoring and modeling studies, increased imperviousness is directly related to increased urban pollutant loads (Schueler 1994). Furthermore, since rooftops, asphalt roads, and parking lots get hot, impervious surfaces can increase stormwater runoff temperature as much as 12 degrees compared to vegetated areas (Galli, 1990). According to the Illinois Pollution Control Board (IPCB), water temperatures exceeding 90°F (32.2°C) can be lethal to aquatic faunas. During summer months heated runoff could cause water temperatures to exceed lethal levels.

HYDROLOGY AND FLOWS

Hydrology and flows are severely altered by the amount of impervious cover in a watershed. More impervious cover generally translates to more water entering drainage systems such as streams, and if unmitigated, will result in higher floodplain elevations (Schueler 1994). In fact, studies have shown that increases of imperviousness, even by low percentages (5% to 10%), can cause peak discharge rates to increase by a factor of 5 to 10, even for small storm events. Impervious areas come in two forms: disconnected and directly connected. Disconnected impervious areas are represented primarily by rooftops, so long as the rooftop runoff does not get funneled to impervious driveways or the stormsewer system. Significant portions of runoff from disconnected surfaces usually infiltrate into soils more readily than directly connected impervious areas that typically end up as stormwater runoff directed to a stormsewer system that discharges directly to a waterbody.

FLOODING AND DEPRESSIONAL STORAGE

Flooding is an obvious consequence of increased flows resulting from high impervious cover. As stated under Hydrology and Flows, unmitigated increased impervious cover leads to higher water levels, greater runoff volumes, and high floodplain elevations. Higher floodplain elevations usually result in more flood problem areas. Furthermore, as development increases, wetlands and other open space decrease. A loss of these areas increases flows because wetlands and open space typically soak up and capture rainfall and release it slowly to streams and lakes. Fortunately, detention basins minimize flooding in highly impervious areas by regulating the discharge rate of stormwater runoff, but unfortunately, detention basins do not reduce the overall increase in runoff volume.

HABITAT

Increased impervious cover from development negatively impacts stream habitat and its associated biological communities. When a stream receives more severe and frequent runoff volumes compared to historical conditions, channel dimensions often respond through the process of erosion by widening, downcutting, or both, thereby, enlarging the channel to handle the increased flow. Channel instability leads to a cycle of streambank erosion and sedimentation that results in physical habitat degradation (Schueler 1994). Streambank erosion is one of the leading causes of sediment suspension and deposition in streams. Sediment suspension causes turbid conditions that frequently result in undesirable changes to aquatic life (Waters 1995). Physical habitat degradation also occurs when high and frequent flows result in loss of riffle-pool complexes, loss of overhead cover, and decreased in-stream structures. Booth and Reinelt (1993) found that a threshold in habitat quality exists at approximately 10% to 15% imperviousness. In addition, sediment deposition alters habitat for aquatic plants and animals by filling interstitial spaces in substrates important to macroinvertebrates and some fish species.

IMPERVIOUS COVER ESTIMATE DESCRIPTIONS

Imperviousness is generally defined as the sum of roads, parking lots, sidewalks, rooftops, and other surfaces of an urban landscape that prevent infiltration of precipitation (Schueler 1994). Imperviousness can be used as an indicator used to measure the impacts of urban land uses on water quality, hydrology and flows, flooding and depressional storage, and habitat related to streams. Studies from several geographic areas yield a similar result: streams begin to degrade when the watershed reaches approximately 10% impervious cover (Schueler 1994). As a result of increased impervious surface, runoff increases and groundwater recharge decreases. Stream shape responds to increased runoff by widening and downcutting, and losing riffle-pool sequences. Runoff over impervious surfaces also collects pollutants and warms the water before it enters a stream. As a result, biological communities shift from sensitive species to ones that are more tolerant of pollution and hydrologic stress and species diversity decreases. Some species disappear altogether.

Impervious Cover Model
Simple urban stream classification model based on impervious cover and stream quality. The classification system contains three stream categories, based on the percentage of impervious cover that predicts the existing and future quality of streams based on the measurable change in impervious cover. The three categories include sensitive, impacted, and non-supporting.

Based on studies pointing to the relationship between impervious thresholds and stream quality (Schueler 1994), the CWP developed an ***Impervious Cover Model***. The model is used to classify Subwatershed Management Units (SMUs) and associated streams into one of three categories: Sensitive, Impacted, or Non-Supporting. Each category exhibits characteristics as shown below. They are also depicted in Table 10 Figure 21.

Sensitive SMUs generally exhibit very little impervious cover (< 10%). Therefore, they usually have stable stream channels, excellent stream habitat, better water quality, and more diverse biological communities.

Impacted SMUs generally possess moderate impervious cover (11-25%). As the impervious cover exceeds 10%, stream channels begin to degrade, habitat is altered, water quality decreases, and the diversity of biological communities decreases.

Non-Supporting SMUs generally have high impervious cover (> 25%). Impervious cover that exceeds 25% leads to highly degraded stream channels, degraded habitat, poor water quality, and poor-quality biological communities.

Table 10. Impervious categories and descriptions based on the Impervious Cover Model

Category	% Impervious Cover	Description
Sensitive	Less than 10%	Subwatershed generally exhibits very little impervious cover (≤10%), stable stream channels, excellent habitat, good water quality, and diverse biological communities.
Impacted	Greater than 10% less than 25%	Subwatershed generally possesses moderate impervious cover (11-25%), and somewhat degraded stream channels, altered habitat, decreasing water quality, and fair-quality biological communities.
Non-Supporting	Greater than 25%	Subwatershed generally has high impervious cover (>25%), and highly degraded stream channels, degraded habitat, poor water quality, and poor-quality biological communities.

Source: (Zielinski 2002)

CALCULATING IMPERVIOUS COVER

Calculating existing and projected impervious area at the watershed, subwatershed, and Subwatershed Management Unit (SMU) level begins with an analysis at the parcel level. For this study, existing and 20-year build out projected land uses (by parcel) were used as the basis of the impervious analysis. Parcel data was used because future land use projections were based on parcels. An existing land use map was created based on parcels. Each parcel was assigned a land use based on a comparison with existing land use maps and verification of the actual land uses using the most recent 2002 color aerials as well as by field checking uncertainties in the data.

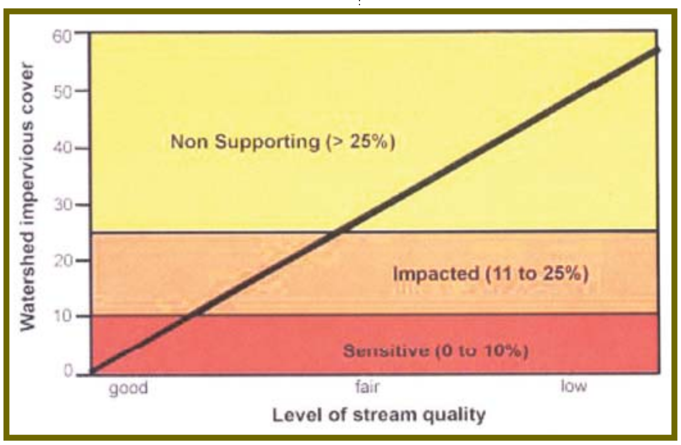


Figure 21: The Impervious Cover Model predicts Sensitive streams will begin to degrade when impervious surfaces exceed 10% of a subwatershed's area and will become Non Supporting at 25% imperviousness.

(EPA) TR55: A single event rainfall-runoff hydrologic model designed for small watersheds and developed by the USDA-NRCS and EPA.

Existing impervious cover was calculated by assigning an impervious cover percentage for each parcel based upon the Environmental Protection Agency ***(EPA) TR55*** paper *(Table 11)*. Next, GIS analysis was used to estimate the impervious cover in each SMU. Future impervious cover was calculated in the same manner.

Table 11. Summary of EPA's TR55 land uses and associated imperviousness

Land Use/Projected Land Use Classification	Percent Impervious
Cemeteries	20
Commercial	85
Government	72
Industrial	72
Institutional	72
Office Campus	72
Open Space	0
Residential	
<1/8 acre lot size	65
1/4 acre lot size	38
1/3 acre lot size	30
1/2 acre lot size	25
1 acre lot size	20
2 acre lot size	12
> 2 acre lot size	5
Transportation (includes ROW)	75
Utilities	10
Forest & Grassland	0
Water	100*
Wetland	0

Source: EPA TR 55 paper
*Water is technically 100% impervious however, 0% impervious was used when calculating impervious cover because it is a natural feature of the landscape.

BULL CREEK/BULL'S BROOK WATERSHED IMPERVIOUS COVER ESTIMATES

According to the existing impervious cover analysis using zoned land use parcel data, the entire Bull Creek/Bull's Brook watershed is estimated to have approximately 22.5% impervious cover. An analysis of each of the subwatersheds was completed to better understand how imperviousness affects the watershed.

BULL'S BROOK SUBWATERSHED: SENSITIVE

The Bull's Brook subwatershed, comprising the northern third of the study watershed, is approximately 10% impervious, more than 12% less than the watershed average *(Figure 22)*. According to Schueler (1994), this subwatershed would be categorized as Sensitive. A Sensitive watershed usually exhibits very little impervious cover, stable stream channels, excellent habitat, good water quality, and diverse biological communities. Minimal impervious cover is the result of expansive open space in areas that are part of the Liberty Prairie Reserve.

BULL CREEK NORTH SUBWATERSHED: IMPACTED

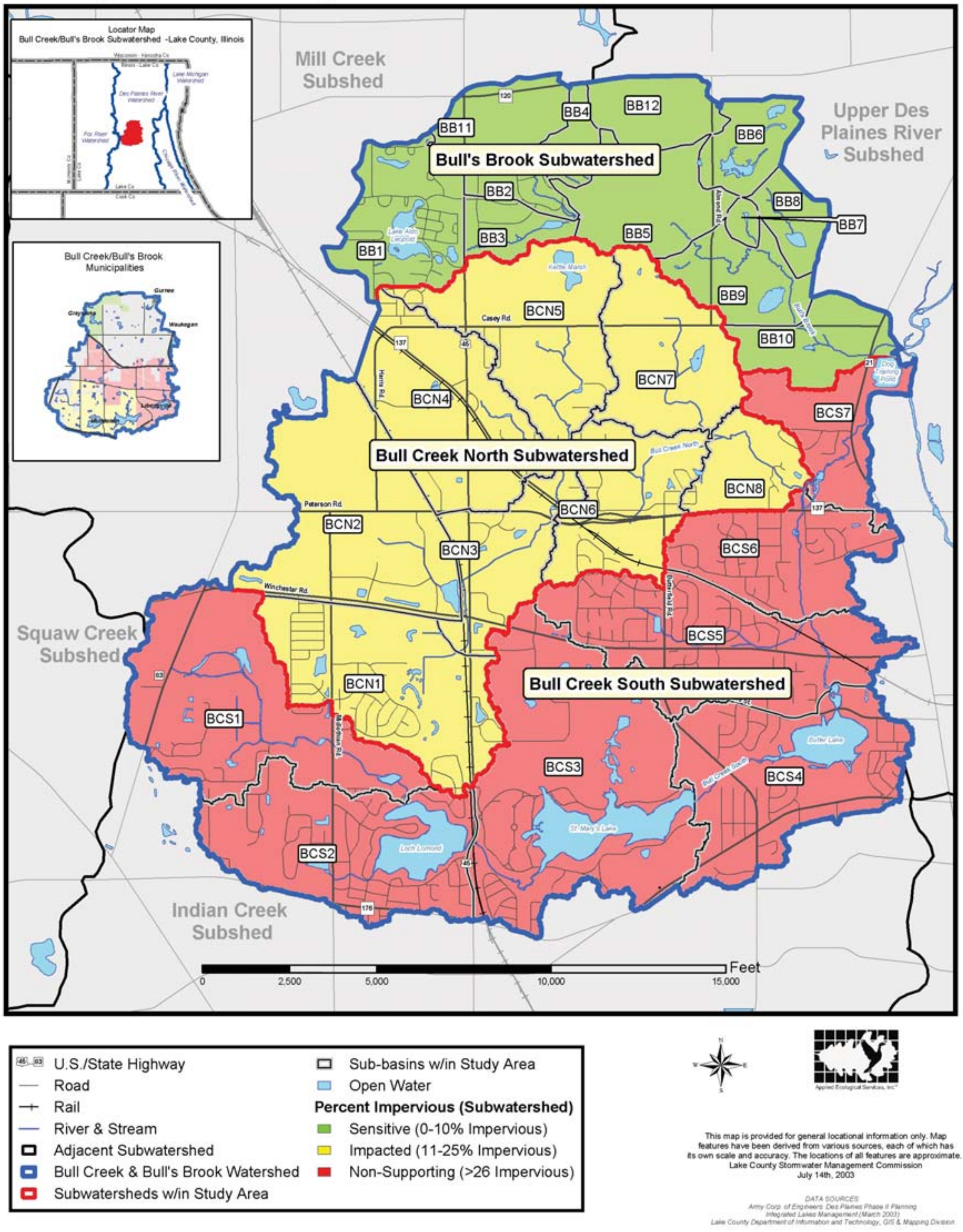
The Bull Creek North subwatershed; the area comprising the central third of the study watershed, is 25% impervious, 3 percent greater than the watershed average (Figure 22). Most of the imperviousness in this subwatershed is a result of residential, commercial, and industrial land uses in Libertyville. According to Schueler (1994), Bull Creek North would be classified as Impacted, actually occurring on the high end of this category range. Impacted subwatersheds generally possess moderate impervious cover, and somewhat degraded stream channels, altered habitat, decreasing water quality, and fair-quality biological communities.

BULL CREEK SOUTH SUBWATERSHED: NON-SUPPORTING

The Bull Creek South subwatershed is located in the southern third of the watershed and is 26% impervious, 4% greater than the watershed average (Figure 22). Impervious areas in this subwatershed can be attributed to the extent of development in both Libertyville and Mundelein. According to the impervious cover model, this subwatershed should exhibit highly degraded conditions, but it occurs on the low end of the non-support range, and the stream inventory conducted by SMC in 2000 reveal conditions that fit better under the Impacted category. Many factors mitigate for impervious surface in urban landscapes, which may account for more positive stream condition than expected. Some of these factors include adequate stream buffers, vegetated streambanks, and detention/infiltration practices (naturalized detention basins) in the surrounding subwatershed.

Impervious cover was also modeled at the Subwatershed Management Unit (SMU) level for each of the subwatersheds in Section 4.1 (Land Use Impacts). SMUs are smaller drainage areas or catchments located within each subwatershed. Section 4.1 contains a study dedicated to describing vulnerability to future development across the watershed based on impervious cover estimates and other selected field criteria. The vulnerability analysis focuses on existing and projected impervious cover as the driving forces impacting stream quality within a watershed. Using the impervious cover estimates in consideration of field conditions, SMUs were identified that are recommended for immediate management and others that are projected to require management in the future.

Figure 22: 2004 Impervious Cover at the Subwatershed Level



3.6 Transportation

EXISTING AND PROJECTED TRANSPORTATION NETWORK

The Bull Creek/Bull's Brook watershed is traversed by many arterial roads, highways, rail lines and a diverse trail system *(Figure 23).* U.S. Highway 45 is the main north-south highway bisecting the watershed *(Figure 23)*. State Highway 137 runs roughly northwest to east through the watershed. State Highway 176 and 120 are main east-west routes along the southern and northern borders of the watershed respectively. Both highways connect to I-94 directly to the east, just beyond the watershed boundary. State Highways 21 and 83 run north-south along the east and west edges of the watershed, respectively. The Metra North Central Service (NCS) and Milwaukee District North (MD-N) lines bisect the watershed, with stations in Libertyville and Prairie Crossing, providing an alternative mode of transportation for commuters to and from downtown Chicago.

TRAILS

Segments of 13 existing, proposed, or unknown status (conceptual/early planning stage or missing information; personal contact: Tom Murtha (CMAP)) trails are located in the Bull Creek/Bull's Brook watershed (Table 12; Figure 23). If constructed, many of the proposed or unknown status trails would connect and network existing trails outside the watershed such as the Des Plaines River Trail, Rollins Savanna Corridor Trail, and the North Shore Bike Path eventually connecting to the Green Bay Trail running along Lake Michigan. The Northeastern Illinois Planning Commission (NIPC) Trail 1 is a fragment of the conceptual plan for the Grand Illinois Trail that bisects the Chicago region and extends as far west as Galena and Moline Illinois. In addition, Trails 1, 2, 7, and 9 are incorporated in NIPC's Greenways Plan. There is only one existing greenway without a trail running through it. All other existing or proposed greenways are bisected by existing, unknown status, or proposed trails. Trails 12 and 13 are part of the Lake County Division of Transportation's Year 2020 Transportation Priority Plan; as such they are yet unnamed. Section 3.6 (Green Infrastructure Inventory) examines open and partially open space parcels and ownership necessary to design and connect proposed trails to the existing system.

Table 12. Existing, proposed, and unknown status trails and greenways

Trail/Greenway #	Name	Status	Type*
1	Fox Lake Metra Corridor	Existing/Proposed/Unknown	LBG
2	Grayslake Bike Path	Existing/Proposed/Unknown	LBG
3	Prairie Crossing Bike Path	Existing	LCT
5	Libertyville Township Trail	Existing	LCT
4/6/10	Oak Springs Trail, Des Plaines River System and Trail	Existing/Proposed	LBG;WBG;GIT
7	Libertyville Bike Path	Existing	LCT
8	North Shore Bike Path	Proposed	LBG;GIT
9	Route 53 Corridor (proposed I-355 extension) Bike Trail	Proposed	LBG
11	Prairie Crossing Bike Path	Proposed	LCT
12	Unknown	Proposed	LCT
13	Unknown	Proposed	LCT

Source: NIPC's Northeaster Illinois Regional Greenways and Trails Implementation Program (2004); Lake County Division of Transportation
*GIT-A segment of the Grand Illinois Trail; WBG-Water Based Greenway; LBG-Land Based Greenway; LCT-Lake County Trail

ROADS

There are plans to construct new roads and improve existing roads and rail lines throughout the watershed *(Table 13; Figure 24)*. Route 53 may be extended from its current terminus at the Cook/Lake County line to the north through the watershed *(Figure 24)*. This new route will intersect several agricultural areas thereby opening these areas to new development. Other new road corridors include an extension of Midlothian Road and Harris Road in the western portion of the watershed. If constructed, the proposed Route 120 bypass along the northern portion of the watershed will traverse open space adjacent to nature/forest preserves and private open space associated with the Liberty Prairie Reserve. Proposed track improvements to the Metra NCS line will most likely have little or no impact on environmental conditions.

Additional road improvements have recently been completed or are planned to accommodate the increasing traffic in the watershed. Butterfield Road was widened from Huntington Drive to Ridgewood Lane in 2003 and improvements are being completed for Butterfield Road at Metra MD-N Railroad in Libertyville. Butterfield Road was also widened up to Route 137. Other road widening projects may occur along Route 45 (north of Route 137), Route 21, Peterson Road (west of Route 45), and Midlothian Road (south of Peterson Road).

Figure 23: Transportation

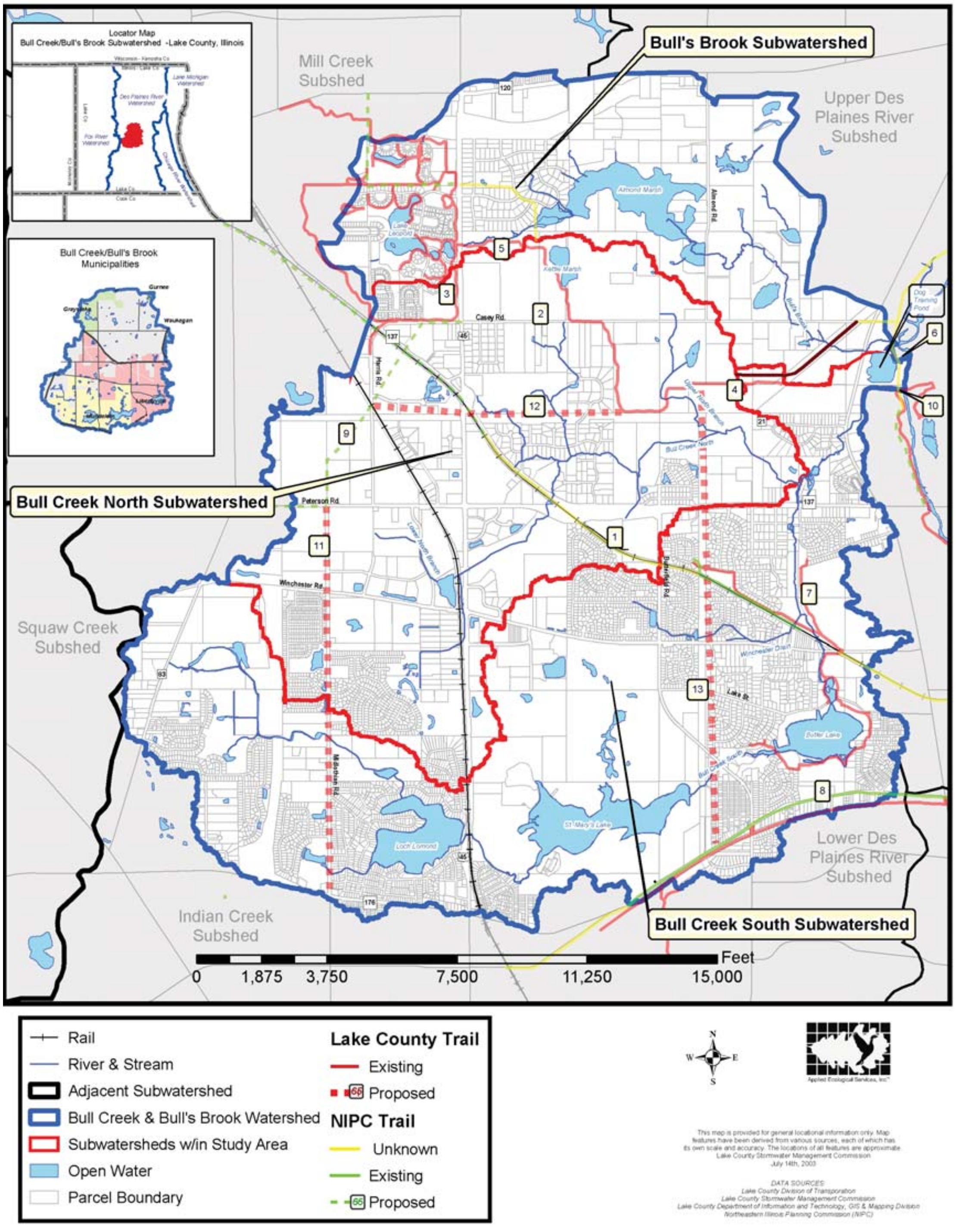


Table 13. Proposed new roads and road improvement projects

Map Number	Route/Rail Line Name	Project Location	Description
1	Route 53	Southwest corner of watershed	Road extension
2	Midlothian Road	North of Peterson Road	Road extension
3	Route 120	Northern portion of watershed	New road corridor
4	Harris Road	South of Peterson Road	Road extension
5	Harris Road	North of Peterson Road	Road upgrade
6	Route 45	Between Rt. 137 and Rt. 120	Road widening
7	Route 21	Between Rt. 137 and Rt. 120	Road widening
8	Peterson Road	Between Rt. 45 and Rt. 83	Road widening
9	Midlothian Road	Between Peterson Road and Rt. 137	Road widening
10	Metra NCS Line	Throughout watershed	Track Improvements

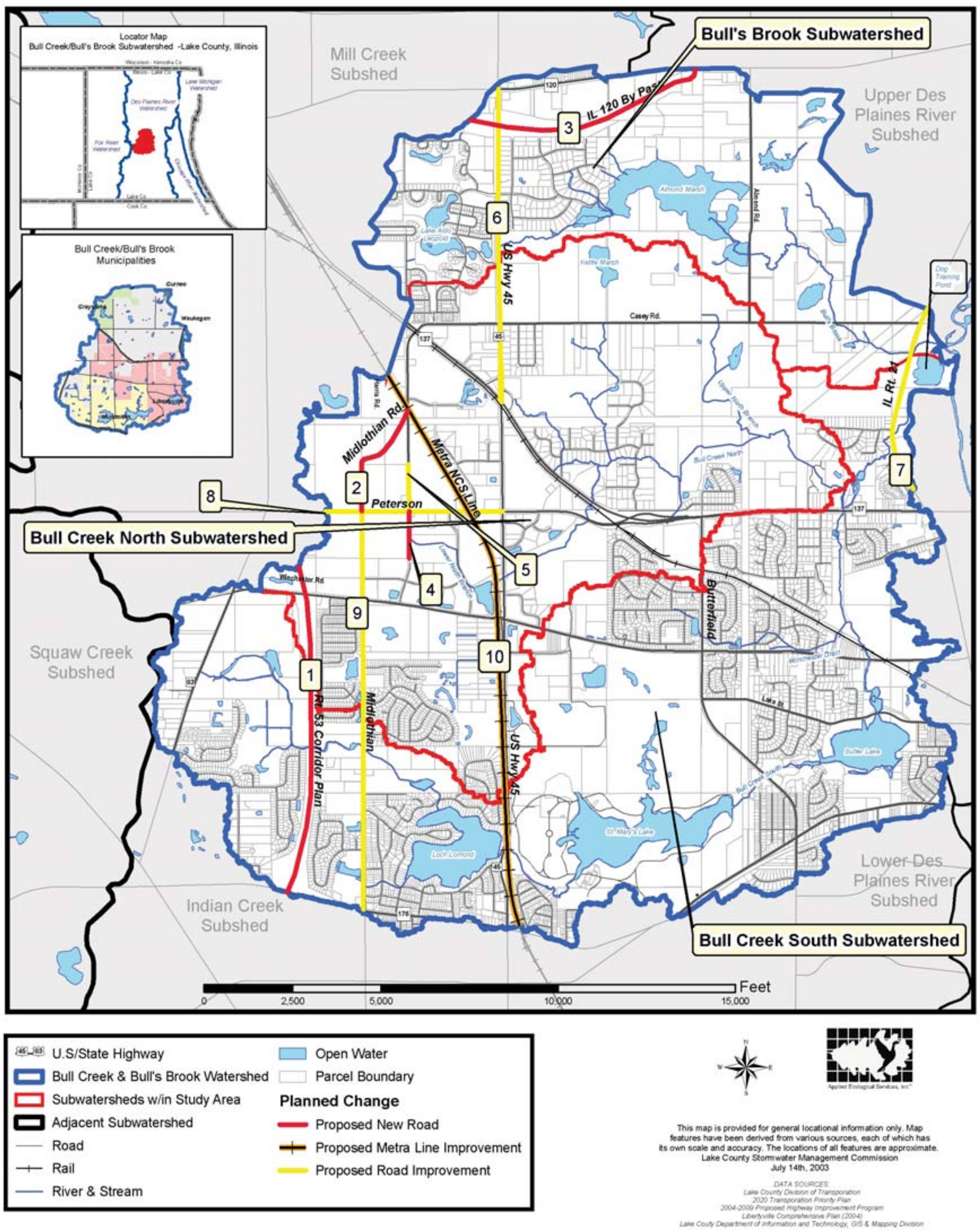
Source: Lake County Road Improvement Program, Libertyville Comprehensive Plan, Mundelein Comprehensive Plan, Year 2020 Transportation Priority Plan

POTENTIAL IMPACTS

To accommodate increased commuter use, Metra is making improvements to its NCS line, including the installation of double tracks, conversion of freight lines to passenger lines, and building of additional stations and parking lots. Ultimately, it is hoped that additional Metra services will alleviate some of the burden placed on the roads in the watershed.

Road improvement and construction projects are vital to economic stability and growth but can result in negative impacts to the surrounding environment if not constructed using Best Management Practices. Road construction and road widening increase the amount of impervious surface in the watershed, resulting in increased runoff and potential for water quality degradation if not mitigated. Road construction also greatly increases the chances for soil erosion to nearby streams and lakes if soil erosion control measures are not properly installed before, during and after construction. Third, roads decrease open space. If the Route 53 corridor and Route 120 bypass are constructed as proposed, significant areas of open space will be lost and habitat corridors interrupted in the northern and southwestern portions of the watershed. New roads also intersect wetlands and streams. The proposed Route 53 corridor and Route 120 bypass are slated to intersect several isolated wetlands and a portion of the Bull Creek South stream branch. The wetland will most likely need to be filled and a bridge crossing constructed over Bull Creek South. In addition to environmental impacts, a plan was initiated in 2007 to widen I-94. This is located to the east of the Bull Creek/Bull's Brook Watershed, but may result in increased traffic on roads within the watershed as the area becomes more accessible.

Figure 24: Proposed New and/or Improved Transportation



Noteworthy Streets and Non-Point Source Pollution

When considering non-point source pollution, streets were found to be the single most important source area in residential, commercial and industrial areas based on a Wisconsin study of stormwater pollutant sources. "Not only did streets produce some of the highest concentrations of phosphorus, suspended solids, bacteria and several metals, but they also generated a disproportionate amount of the total runoff volume. Consequently, streets typically contributed four to eight times the pollutant load than would have been expected if all source areas contributed equally."

A number of factors contribute to high pollutant loading from streets. Streets are directly connected to the drainage system, resulting in a high runoff coefficient, and the curb and gutter system tends to trap and retain fine particles that blow into them and are then flushed off in stormwater during a rain event. Streets also tend to be the collection point for pollutants delivered from sidewalks, driveways, lawns and rooftops, as well as from vehicular traffic emissions and leaks. Table 14 includes a list of the types of constituents in highway runoff that are sources of pollution.

Table 14. Highway runoff constituents and their primary sources

Constituents	Primary Sources
Particulates	Pavement wear, vehicles, atmosphere, maintenance
Nitrogen, Phosphorus	Atmosphere, roadside fertilizer application
Lead	Leaded gasoline (auto exhaust), tire wear (lead oxide filler material, lubricating oil and grease, bearing wear)
Zinc	Tire wear (filler material), motor oil (stabilizing additive), grease
Iron	Auto body rust, steel highway structures (guard rails etc), moving engine parts
Copper	Metal plating, bearing and bushing wear, moving engine parts, brake lining wear, fungicides and insecticides
Cadmium	Tire wear (filler material), insecticide application
Chromium	Metal plating, moving engine parts, brake lining wear
Nickel	Diesel fuel and gasoline (exhaust), lubricating oil, metal plating, bushing wear, brake lining wear, asphalt paving
Manganese	Moving engine parts
Cyanide	Anticake compound (ferric ferrocyanide, sodium ferrocyanide, yellow prussiate of soda) used to keep deicing salt granular
Sodium, Calcium, Chloride	Deicing salts
Sulphate	Roadway beds, fuel, deicing salts
Petroleum	Spills, leaks or blow-by of motor lubricants, antifreeze and hydraulic fluids, asphalt surface leachate
PCB	Spraying of highway rights-of-way, background atmospheric deposition, PCB catalyst in synthetic tires

Source: US DOT, FHWA, Report No. FHWA/RD-84/057-060, June 1987

3.7 Natural Resources

Several sources of information were consulted in an attempt to list and map important natural resource areas and ***Threatened & Endangered (T&E) species*** locations in the watershed. The Illinois Natural Heritage Database (INHD) provides information on the presence of the state's T&E plants and animals, ***Illinois Natural Areas Inventory (INAI)*** sites, ***Illinois Nature Preserves***, Forest Preserves, and Illinois Nature Preserves Commission (INPC) lands. The database was developed to assist resource planners, including land use planners and engineers, conservationists, and regulatory authorities, in setting management priorities in areas where special species or habitats exist. The database contains information gathered during the INAI inventory conducted in the mid 1970's as well as more recent information collected by IDNR biologists, resource managers, and volunteers.

Other T&E species observations were made during Lake County Health Department-Lakes Management Unit water quality and plant sampling activities and by Integrated Lake Management in a 2003 report on water quality (ILM 2003). For a 1997 report, field investigations were conducted for populations of T&E species within the Liberty Prairie Reserve, including northern portions of the Bull Creek/Bull's Brook watershed. In addition, data from the Lake County Forest Preserve District (LCFPD) was also queried and includes sightings made in the last 20 years by staff, IDNR EOR reports, and credible volunteers or hired consultants.

THREATENED AND ENDANGERED SPECIES

State listed T&E species are designated "endangered" if in danger of extinction as a breeding species, while a "threatened" species includes any breeding species which is likely to become an endangered species within the foreseeable future. Figure 25 shows the general location of all known T&E species within the watershed. In most cases, T&E species are located within ecologically significant/protected areas. These ecologically significant areas are also mapped on Figure 25 and include all INAI sites, Illinois Nature Preserves, Lake County Forest Preserves, and ADID wetlands. A more detailed discussion of ecologically significant areas is discussed below. Table 15 lists each T&E species or high quality habitats and provides additional information such as the site location, status, and source of data.

Several ***Element Occurrence Records (EORs)*** that contain locations of four T&E species, and six high quality natural communities/natural resource features are mapped by the IDNR (Figure 25, Table 15). The high quality natural areas include wet prairie, wet mesic prairie, marsh, sedge meadow, mesic prairie, and a rookery. T&E species include slender bog arrow-grass *(Triglochin palustris)*, Sandhill crane *(Grus canadensis)*, Blanding's turtle *(Emydoidea blandingii),* and Queen of the prairie *(Filipendula rubra)*.

The Lake County Health Department notes the presence of two state endangered bird species in recent summary reports for Butler Lake and Loch Lomond. The state endangered black-crowned night heron *(Nycticorax nycticorax)* was identified at St.

Threatened and Endangered Species (T&Es): *An "endangered" species is one that is in danger of extinction throughout all or a significant portion of its range. A "threatened" species is one that is likely to become endangered in the foreseeable future.*

Illinois Natural Areas Inventory (INAI): *A survey conducted by the Illinois Department of Natural Resources to catalogue high quality natural areas, threatened and endangered species and unique plant, animal and geologic communities for the purpose of maintaining biodiversity.*

Illinois Nature Preserves: *State-protected areas that are provided the highest level of legal protection, and have management plans in place.*

Element Occurrence Records (EORs): *Species, communities, or other biological features are referred to as "elements" in Natural Heritage Programs and Conservation Data Centers. Each "element occurrence" represents a compendium of available information about the feature on the ground.*

Mary's Lake. A juvenile black-crowned night heron was identified at Loch Lomond in 2004. A state endangered osprey *(Pandion heliaetus)* was identified at Butler Lake.

Several T&E fish species are found in several locations in the watershed (Figure 25). In the mid 1990's, Integrated Lakes Management (ILM) stocked the Sanctuary Pond at Prairie Crossing with five State T&E fish species including blackchin shiners *(Notropis heterodon)*, blacknose shiners *(Notropis heterolepis)*, banded killifish (Fundulus diaphanous), Iowa darters *(Etheostoma exile)*, and pugnose shiners *(Notropis anogenus)*. Iowa darters were also found in Butler Lake by Integrated Lakes Management. In 2004 the IDNR identified blackchin shiners and Iowa darters between Casey Road and Route 21 in Bull's Brook. This recent finding suggests that the blackchin shiners and Iowa darters may be making their way from Sanctuary Pond at Prairie Crossing to the Des Plaines River via Bull's Brook. In addition, the Lake County Forest Preserve District (LCFPD) introduced blackchin shiners into Dog Training Pond in October, 2007, and a pond located in Almond Marsh Forest Preserve (Heron Rookery Pond). The LCFPD also introduced banded killifish and blacknose shiners in extremely low numbers.

An extensive list of T&E species and natural areas is included in the AES 1997 natural resource study and data from the LCFPD (Table 15, Figure 25). AES/LCFPD materials is mostly a compilation of existing data including sightings made in the last 20 years by staff, IDNR EOR reports, and credible volunteers or hired consultants.

Figure 25: Threatened/Endangered Species and Ecologically Significant Areas

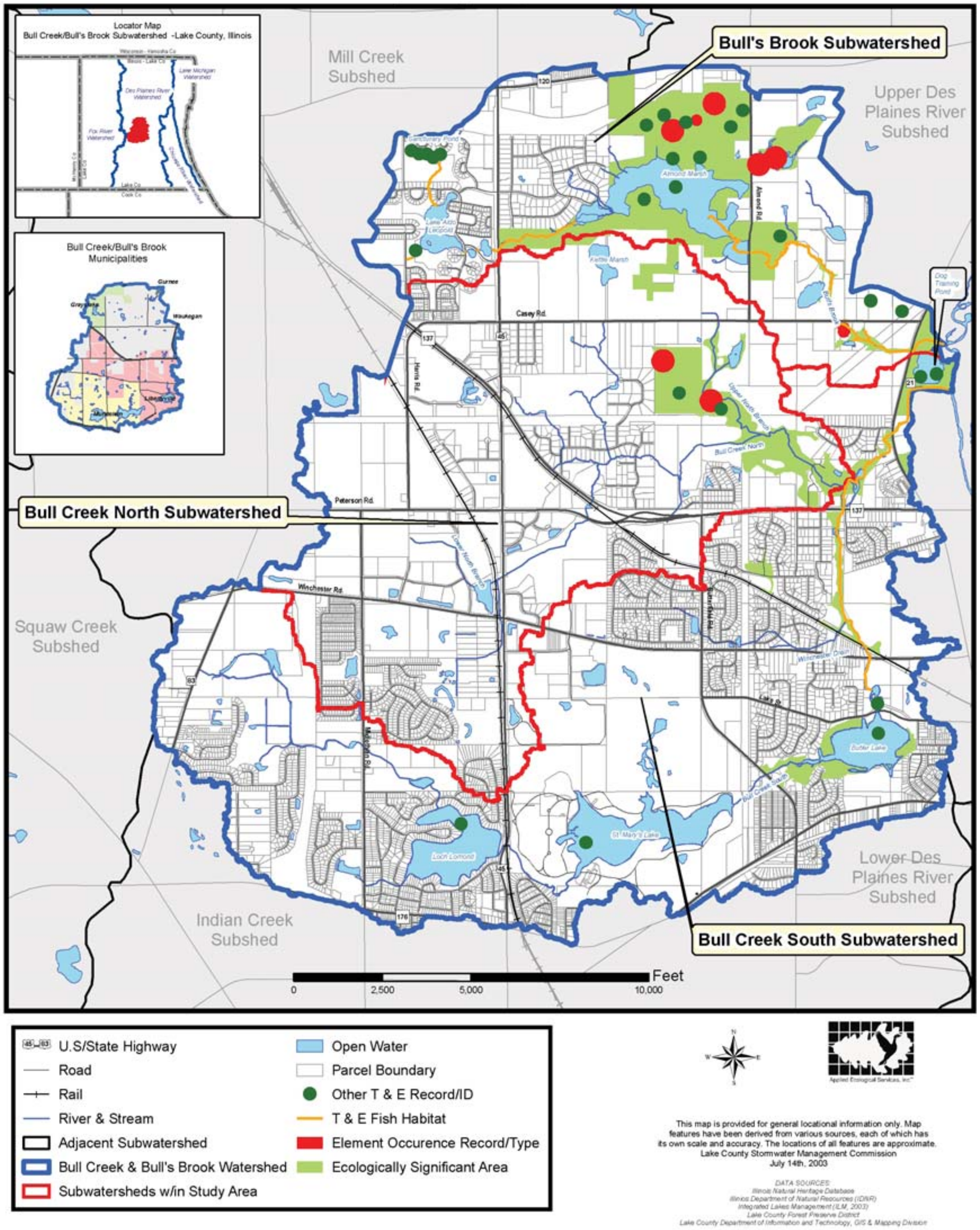


Table15. List of T&E species and natural communities identified in the Bull Creek/ Bull's Brook Watershed

Common Name or Natural Area	Scientific Name	Site Name	Status*	Source
Common moorhen	Gallinula chloropus LCFPD Planning Office	Cattail Marsh North of	ST	AES 1997
Sandhill crane	Grus canadensis	Almond Marsh	ST	AES 1997 & LCFPD
Yellow-headed blackbird xanthocephalus	Xanthocephalus	Almond Marsh	SE	AES 1997 & LCFPD
Yellow-headed blackbird xanthocephalus	Xanthocephalus	Lynch Property	SE	AES 1997
Snowy egret	Egretta thula	Prairie Crossing	SE	AES 1997
Northern harrier	Circus cyaneus	Almond Marsh	SE	AES 1997 & LCFPD
American bittern	Botaurus lentiginosus	Almond Marsh	SE	AES 1997 & LCFPD
Slender bog arrow-grass	Triglochin palustris	Liberty Prairie Nature Preserve	ST	AES 1997
Pale vetchling	Lathyrus ochroleucus	Field Prairie Grove	ST	AES 1997
Small sundrops	Oenothera parennis	Field Prairie Grove	ST	AES 1997
Blackshin Shiner	Notropis heterodon & Heron Rookery Pond	Dog Training Pond	ST	LCFPD
Iowa darter	Etheostoma exile	Bull Creek	SE	AES 1997
Iowa darter	Etheostoma exile	Sanctuary Pond	SE	ILM
Blackchin shiner	Notropis heterodon	Sanctuary Pond	ST	ILM
Blacknose shiner	Notropis heterolepis	Sanctuary Pond	SE	ILM
Banded killifish	Fundulus diphanus	Sanctuary Pond	ST	ILM
Pugnose shiner	Notropis anogenus	Sanctuary Pond	ST	ILM
Iowa darter	Etheostoma exile	Butler Lake	SE	ILM
High quality marsh	N/A	Almond Marsh	N/A	IDNR
Central midwest type sedge/wet meadow	N/A	Almond Marsh	N/A	IDNR
High quality wet prairie and graminoid fen	N/A	Almond Marsh	N/A	IDNR
High quality wet-mesic prairie	N/A	Liberty Prairie Nature Preserve	N/A	IDNR
Slender bog arrow-grass	Triglochin palustris	Liberty Prairie Nature Preserve	ST	IDNR
High quality mesic prairie	N/A	Liberty Prairie Nature Preserve	N/A	IDNR
Sandhill crane	Grus canadensis	Almond Marsh	ST	IDNR
Blanding's turtle	Emydoidea blandingii	Almond Marsh	ST	IDNR
Rookery	N/A	Almond Marsh	N/A	IDNR
Black-crowned night heron	Nycticorax nycticorax	St. Mary's Lake	SE	LCHD
Osprey	Pandion haliaetus	Butler Lake	SE	LCHD
Blanding's turtle	Emydoidea blandingii	Almond Marsh	ST	LCFPD
Common moorhen	Gallinula chloropus	Almond Marsh	ST	LCFPD
Black-crowned night heron	Nycticorax nycticorax	Almond Marsh	SE	LCFPD

* ST=State Threatened; SE= State Endangered

(**Table15.** Continued)

Common Name or Natural Area	Scientific Name	Site Name	Status*	Source
Pretty sedge	Carex woodii	Independence Grove	ST	LCFPD
Blackchin shiner	Notropis heterodon	Bull's Brook	ST	IDNR
Iowa darter	Etheostoma exile	Bull's Brook	SE	IDNR
Black-crowned night heron (juvenile)	Nycticorax nycticorax	Loch Lomond	SE	LCHD
Queen of the prairie	Filipendula rubra	Private Property	SE	INPC, LPC

* ST=State Threatened; SE= State Endangered

ECOLOGICALLY SIGNIFICANT AREAS

Several ecologically significant areas are located in the watershed including 11 ADID (high quality) wetlands, 2 INAI sites, 3 nature preserves, and 2 forest preserves (Figure 26). Nature preserves are often home to INAI sites, other natural areas, or T&E species and have the highest level of legal protection. Additional overlap occurs in a natural area designated as the Liberty Prairie Reserve.

Noteworthy ADID Wetlands

The Advanced Identification (ADID) process involves collecting information on the values and functions of wetlands identifying those of high value based on their habitat, water quality, and stormwater storage functions. The EPA conducts the process in cooperation with the U.S. Army Corps of Engineers (USACE). Designation as an ADID wetland results in a more rigorous permitting review when drainage or filling alteration is proposed. Alterations of ADID wetlands are strongly discouraged as a result. Local communities can use the ADID inventory to help them better understand the values and functions of wetlands under their jurisdiction and to help applicants know in advance if a wetland can or cannot be filled.

Eleven (11) Advanced Identification (ADID) wetlands are located in the watershed. ADID wetlands are mapped on Figure 26. A separate map of these wetlands and amore detailed description of their ecological significance are found in Section 3.13 (Wetlands Inventory).

Noteworthy INAI Sites

Illinois Natural Area Inventory (INAI) is a designation established in the 1970's by the Illinois Nature Preserve Commission (INPC) to identify "high quality" examples of the natural features found in Illinois. Included in the INAI inventory was a system to classify natural communities, a grading scale related to the quality of natural areas, and the inventory itself.

Two Illinois Natural Area Inventory (INAI) sites are located in the watershed. These include Almond Marsh Forest Preserve/Oak Openings Nature Preserve, and the Liberty Prairie Nature Preserve.s These INAI sites are home to many of the T&E species and natural communities discussed above. Figure 26 depicts the location of both INAI sites in the watershed.

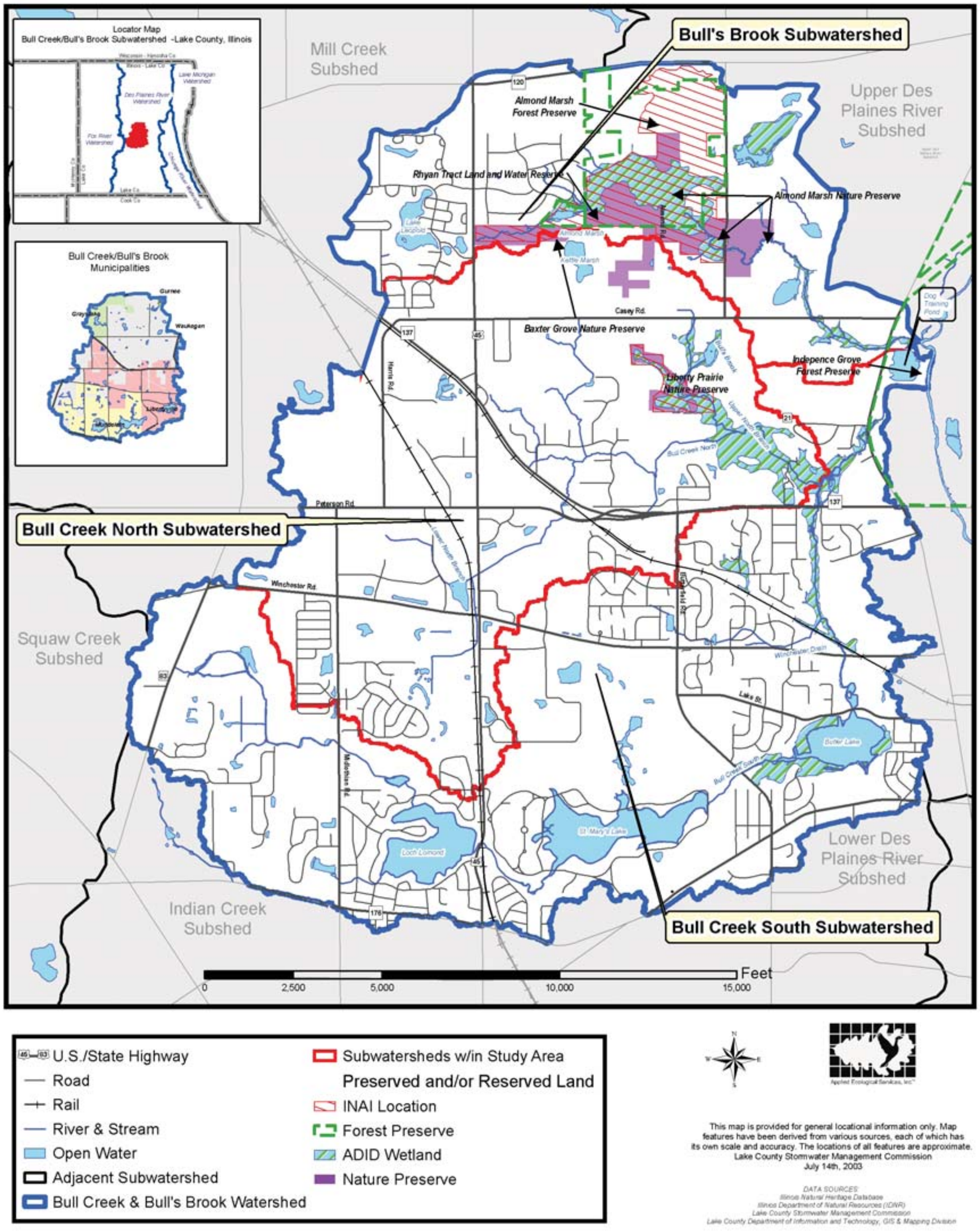
NATURE PRESERVES/FOREST PRESERVES

Several Illinois Nature Preserves (INP) and forest preserves are located in the watershed *(Figure 26)*. These areas offer the highest level of protection for T&E species and natural communities. Forest preserves are county owned. The Almond Marsh Nature Preserve is located in the northern portion of the watershed. The Almond Marsh Forest Preserve overlaps the Almond Marsh Nature Preserve and extends north beyond the preserve. Oak Openings Nature Preserve includes an upstream reach of Bull's Brook. It is owned by Libertyville Township Open Space District (LTOSD) and is adjacent to Almond Marsh Nature Preserve, which it is intended to buffer. Baxter Grove Nature Preserve is also owned by LTOSD and is south of Almond Marsh. Another nature preserve, Liberty Prairie Nature Preserve, also owned by LTOSD, comprises a large portion of the Upper North Branch of the Bull Creek North headwaters. This preserve is home to high quality mesic, wet mesic, wet prairies and graminoid fen, as well as one T&E species. Located just east of Route 21 is the Independence Grove Forest Preserve. Most of the preserve is located outside the watershed but is home to many T&E species.

LIBERTY PRAIRIE RESERVE

The ***Liberty Prairie Reserve (LPR***) is a mostly unincorporated area located between Grayslake, Libertyville, Gurnee and Waukegan where public agencies, private landowners, and other community groups have partnered together to preserve and enhance a significant amount of open land. Private landowners, concerned that the area's natural resources and rural character were in danger of being lost, began working together to keep the LPR area as open space as early as the 1950s. From about 1985, the value of the area became more apparent to local government bodies and public agencies and they worked with local residents to create institutions to take more proactive steps to preserve the landscape of the area. A key moment in the development of the Reserve was in 1991 when the Lake County Forest Preserve District, Libertyville Township, and private landowners commissioned an ecologi-

Figure 26: High Quality Natural Areas



Liberty Prairie Reserve (LPR): *5,800-acre area in central Lake County that contains three Illinois Nature Preserves and nearly 3,200 acres of protected open space.*

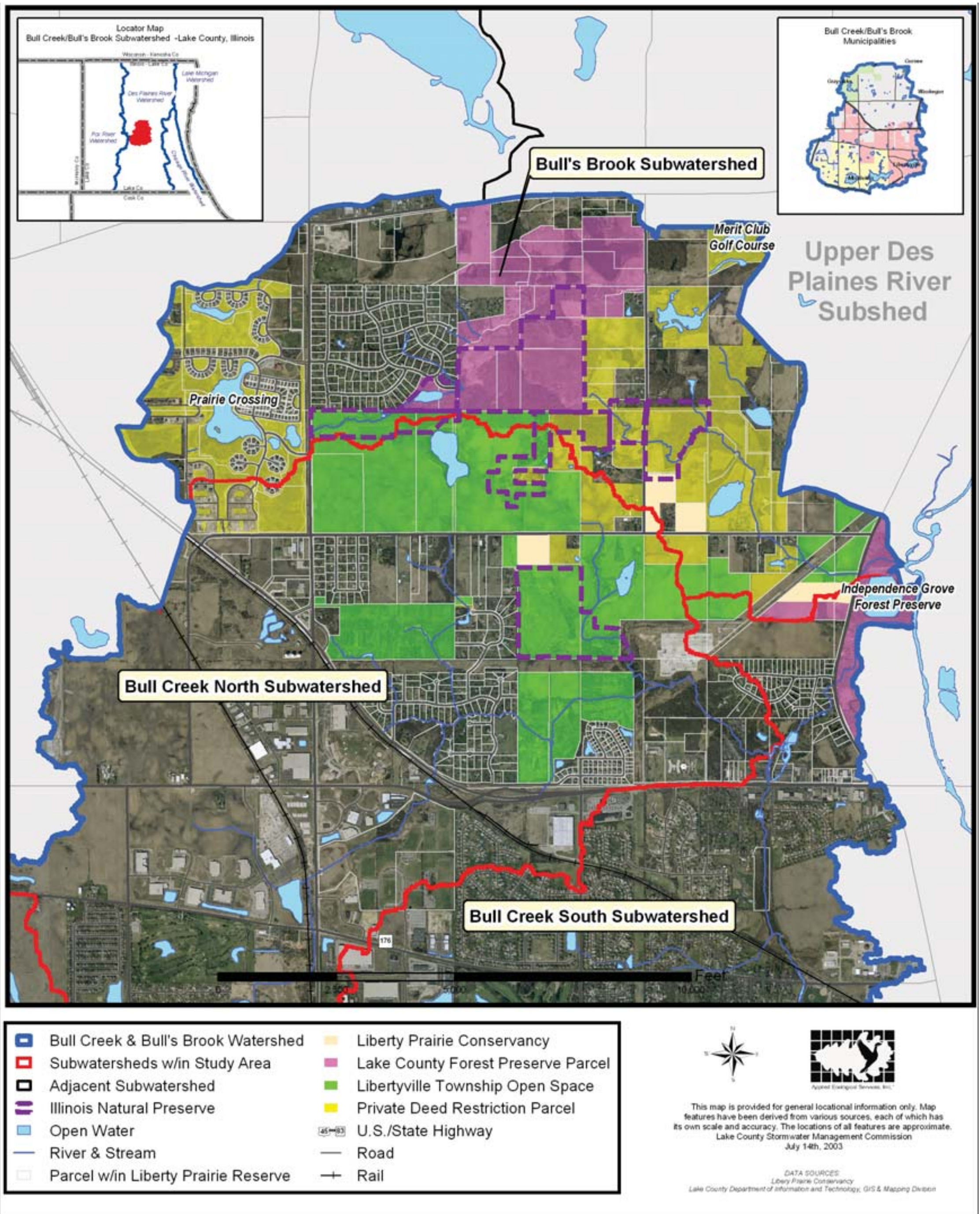
cal survey of lands in the heart of the area. The survey identified a surprisingly wide variety of unique and rare Illinois ecosystems and species that would be harmed or destroyed if the remaining open lands were developed. The survey resulted in the development of a natural resources management plan for the Reserve.

The Liberty Prairie Reserve has since grown to encompass over 5,800 acres of publicly and privately protected land, about half of which is permanently preserved as open space in the Bull Creek/Bull's Brook watershed *(Figure 27)*. LPR features more than 3,200 acres of protected natural areas and farmland as well as a recreational trail system, a nationally renowned conservation community, and the state's first township open space district. LPR contains three Illinois Nature Preserves: Liberty Prairie, Almond Marsh, and Oak Openings. The protected open lands are distributed between Forest Preserve (1,450 acres), private property (1,000 acres), Prairie Crossing conservation community farm and conservation areas (678 acres), and the Merit Golf Club (325 acres), which is managed to maximize natural habitat. LPR offers an innovative model for how a variety of partners can together preserve and enhance open space for the benefit of people and wildlife in their community.

Noteworthy **Liberty Prairie Conservancy**

In 1995 the Liberty Prairie Conservancy (LPC) was established to steward and advocate for the Liberty Prairie Reserve. Today, the Conservancy works throughout Lake County as a land trust to preserve, protect, and restore land. The Conservancy has a significant role in the watershed as a landowner, holder of conservation easements for private landowners, restorer of natural areas, partner in the development of public trails, and educator about nature. The Conservancy is a non-profit group that relies heavily on members and volunteers to support its efforts. Additional information can be accessed at the Conservancy's website (www.libertyprairie.org).

Figure 27: Legally Protected Open Lands within the Liberty



3.8 Green Infrastructure Inventory

Open space: *Any land that is not developed with roadways, buildings or other structures. Open space is important to a watershed's hydrology, habitat, water quality, and biodiversity.*

Conservation easement: *The transfer of land use rights without the transfer of land ownership. Conservation easements can be attractive to property owners who do not want to sell their land now, but would support perpetual protection from further development. Conservation easements can be donated or purchased.*

Partially open space: *Parcels that have been developed to some extent, but still offer some opportunities for open space benefits and opportunities for Best Management Practice (BMP) implementation.*

Noteworthy **What is Green Infrastructure?**

Green infrastructure is defined by the Lake County Stormwater Management Commission at two levels or scales. On the local scale: municipal or neighborhood, green infrastructure consists of site-specific best management practices (such as naturalized detention facilities, vegetated swales, porous pavements, rain gardens, and green roofs) that are designed to maintain natural hydrologic functions by absorbing and infiltrating precipitation where it falls. On the regional scale: green infrastructure consists of the interconnected network of open spaces and natural areas (such as forested areas, flooplains and wetlands, greenways, parks, and forest preserves) that mitigate stormwater runoff, naturally recharge aquifers, improve water quality while providing recreational opportunities and wildlife habitat. Green infrastructure is important to a watershed's hydrology, water quality, habitat, and biodiversity.

Conducting an inventory of the watershed's open space is the first step in planning a green infrastructure system for the Bull Creek/Bull's Brook watershed. Within the context of this planning effort, open space is defined as any land that is not developed (whether publically or privately owned), which includes areas set aside for conservation and recreation purposes. ***Open space*** can be either protected or unprotected. Protected open space differs from unprotected in that it is permanently preserved by outright ownership by a private or public body chartered to permanently save land, or by a permanent deed restriction such as a ***conservation easement.***

INVENTORYING OPEN AND PARTIALLY OPEN PARCELS

There are 5,879 parcels of land in the Bull Creek/Bull's Brook watershed. Property parcel maps, aerial photography, and assessor records were analyzed in a Geographic Information System (GIS) to evaluate these parcels and identify open space. Of the 5,879 parcels, 851 "open space" parcels were identified comprising 3,774 acres or about 42% of the watershed area. The average open space parcel is approximately 4.4 acres. Some of these parcels are already protected public lands, while others are protected private lands that cannot be developed. Some open space parcels are not protected and may be developed in the future. Tables 16 and 17 summarize the open space inventory while Figure 28 depicts the location of these parcels. (Note: this open and partially open space differs from "open space" as defined in Section 3.5: Land Use/Land Cover, which is a subset of open space as defined here).

Some parcels were also classified as "***partially open***" *(Tables 16 and 17, Figure 28*). These parcels have been developed to some extent, but still offer potential open space for implementation of Best Management Practices (BMPs). They typically include private residences with acreage exceeding the surrounding minimum zoning, partly developed industrial sites, or institutions (churches, schools, etc.) with extensive grounds. Partially open parcels were classified on a case-by-case basis considering potential for stormwater detention, proximity to other open space, and potential for ***greenways*** or trail connections. 159 partially open parcels were identified, accounting for approximately 2,015 acres or 22.5% of the watershed. Partially open parcels are nearly three times larger on average than open parcels.

Greenways: *A protected linear open space area that is either landscaped or left in its natural condition. It may follow a natural feature of the landscape such as a river or stream, or it may occur along an unused railway line or some other right of way. Provides wildlife corridors and recreational trails.*

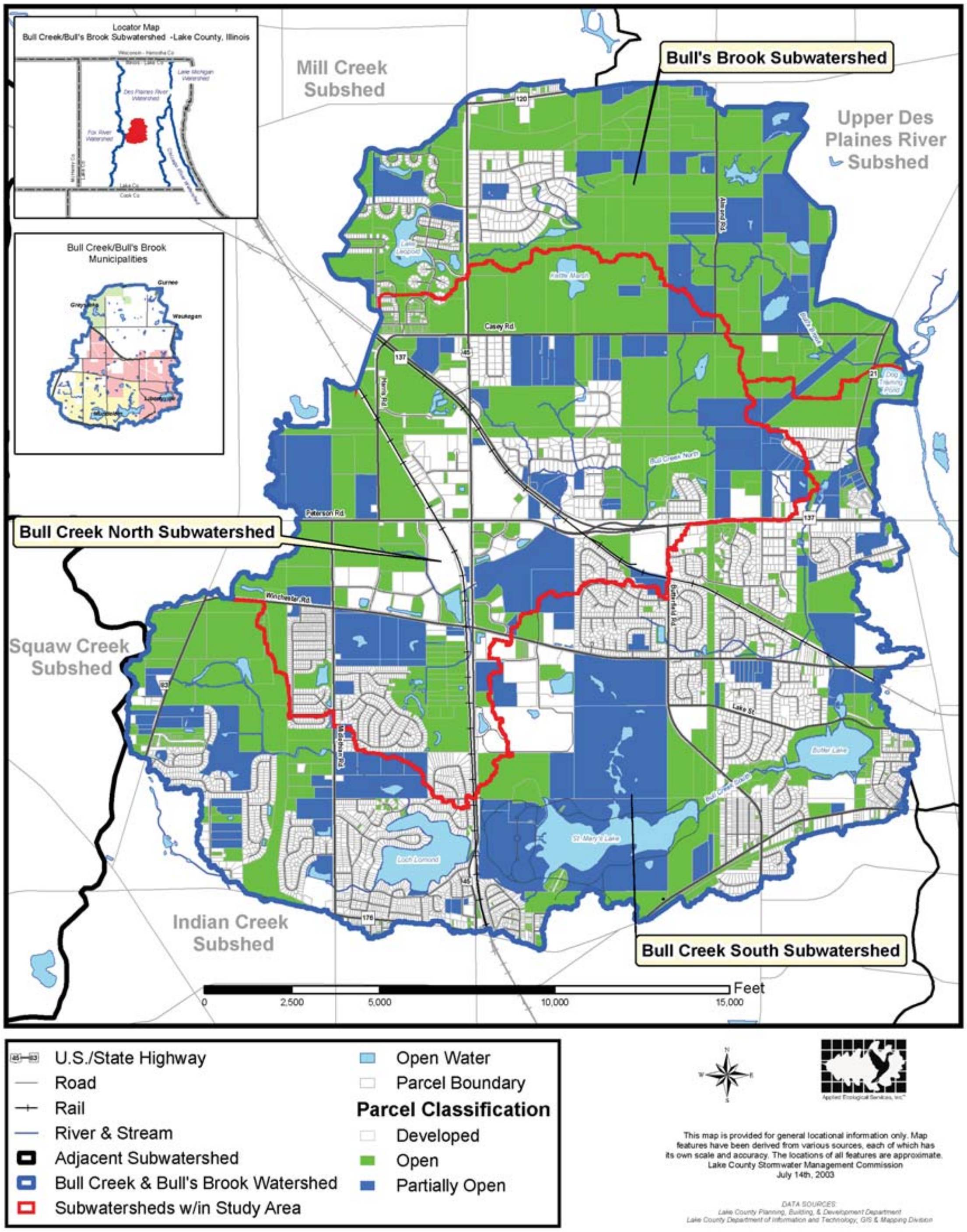
Table16. Summary of open and partially open parcels for the entire Bull Creek/Bull's Brook watershed

	Parcels (n)	Area (acres)	% of Watershed	Average Size (acres)
Closed (developed)	4,869	3,181	35.5%	0.6
Open Space	851	3,774	42.1%	4.4
Partially Open Space	159	2,015	22.5%	12.6
Total Parcels in Watershed	**5,879**	**8,970**	**100%**	**5.9**

Table17. Summary of open and partially open parcels for subwatersheds in the Bull Creek/Bull's Brook watershed

Subwatershed	Parcel Classification	Acres	Percent Watershed
Bull Creek North Subwatershed	Developed	1,123.3	12.5%
	Open	1,438.2	16.0%
	Partially Open	662.2	7.4%
Bull Creek North Subwatershed Total		**3,223.7**	**35.9%**
Bull Creek South Subwatershed	Developed	1,746.9	19.5%
	Open	1,233.2	13.7%
	Partially Open	1,006.4	11.2%
Bull Creek South Subwatershed Total		**3,986.6**	**44.4%**
Bull's Brook Subwatershed	Developed	308.4	3.4%
	Open	1,102.6	12.3%
	Partially Open	346.7	3.9%
Bull's Brook Subwatershed Total		**1,757.7**	**19.6%**
Watershed Total		**8,970**	

Figure 28: Open and Partially Open Parcels



The watershed contains a large amount of open space most of which is located in the northern and western portions. Most of the protected open space to the north is located within the Liberty Prairie Reserve. Most open space in the west is agricultural land. 2030 projected demographics information (Section 3.4: Watershed Demographics) and 20-year projected land use (Section 3.5: Land Use/Land Cover) indicate that the watershed will undergo changes in population and landuse over the next 20-25 years converting land that is currently open or partially open space to developed uses.

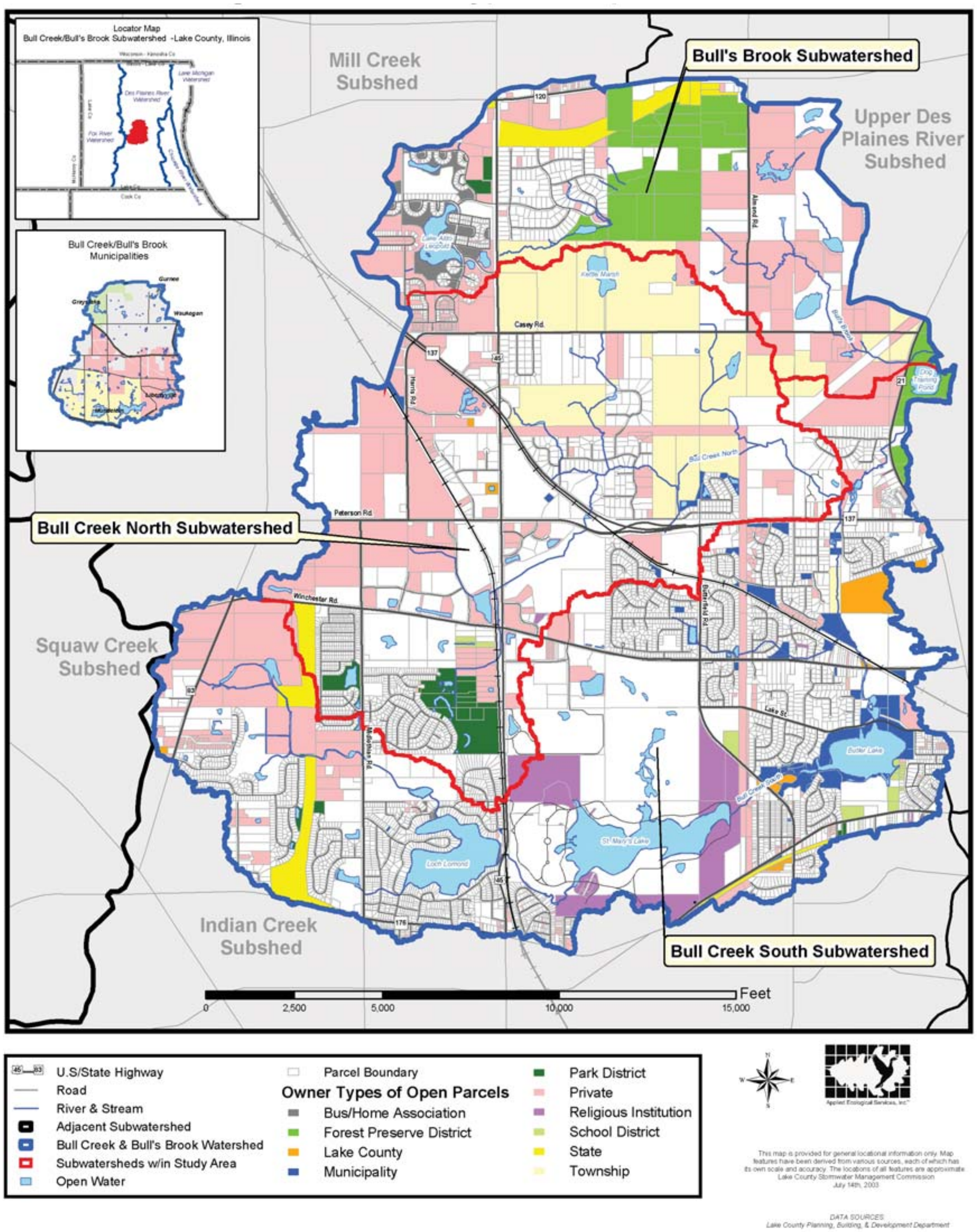
OWNER TYPE OF OPEN PARCELS

Open and partially open parcels in the watershed are owned by several different entities. Table 18 lists the ownership type of all open and partially open parcels in the watershed. Figure 29 displays all ownership types of open parcels only. Most open and partially open parcels are under private ownership (3,783 acres, or 42.2% of watershed). The ownership types with the highest percentage of open space (open parcels) in the watershed are township (704 acres, 7.8% of watershed) and forest preserve (328 acres, 3.7% of watershed).

Table18. Summary of ownership type for open and partially open parcels

	Open Space		Partially Open Space	
Owner Type	**Parcels (n)**	**Area (acres)**	**Parcels (n)**	**Area (acres)**
Public				
Forest Preserve	32	328	4	27
Lake County	23	51	1	33
Municipality	63	186	10	60
Park District	21	111	7	129
School District	18	30	7	47
State	22	180	1	5
Township	26	704	2	114
Totals	**205**	**1,590**	**32**	**415**
Private				
Hospital	3	2		
Homeowner/Business Assoc.	27	153		
Private Landowner	587	1,815	115	991
Religious Institution	29	213	12	609
Totals	**646**	**2,183**	**127**	**1,600**

Figure 29: Owner Types for Open Parcels



PUBLIC/PRIVATE OWNERSHIP OF OPEN AND PARTIALLY OPEN PARCELS

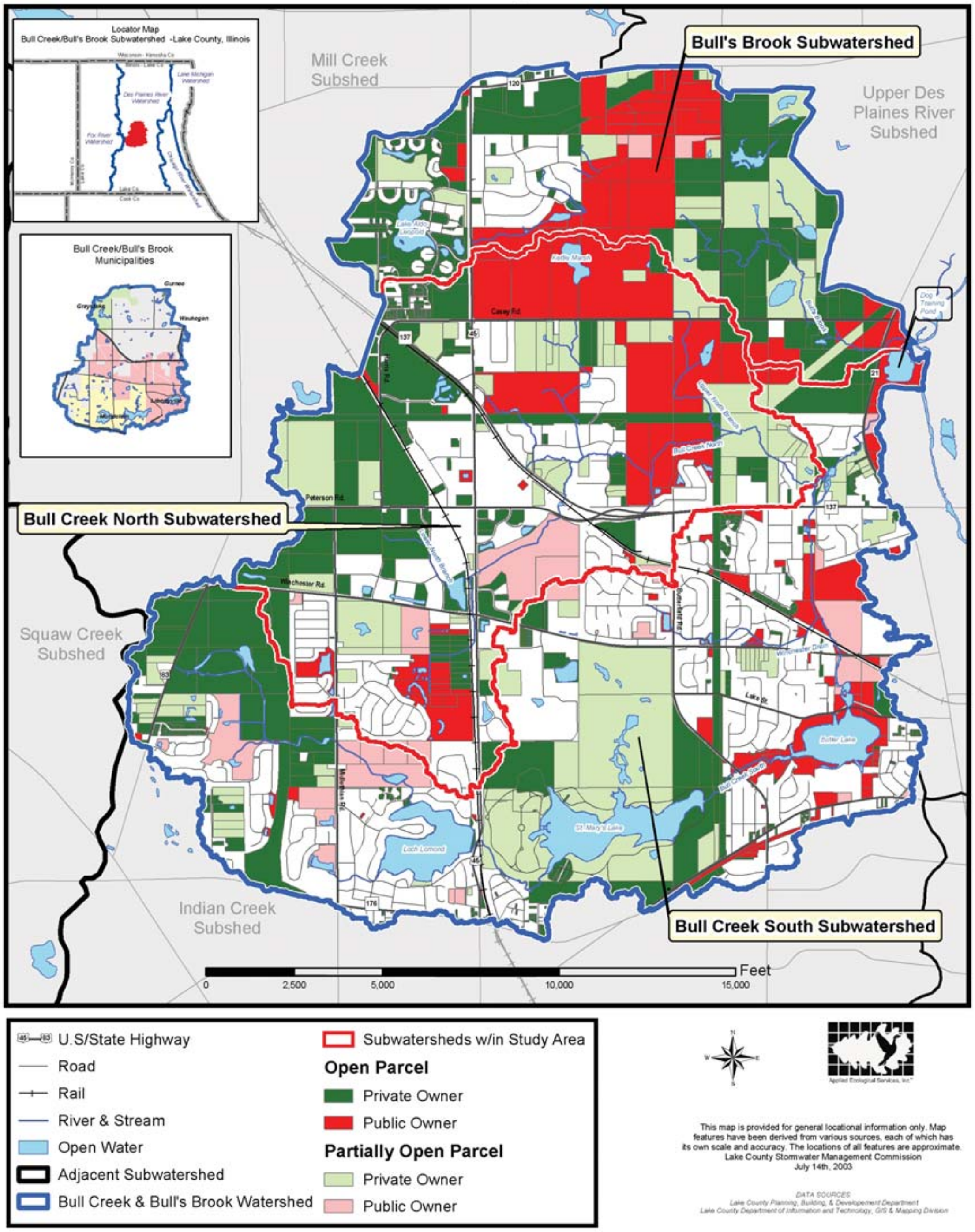
The ownership, either public or private, of each open and partially open parcel was determined from available parcel data. Publicly owned parcels include those owned by the federal, state, county, or municipal government, the Forest Preserve District, park districts, school districts, and townships. Private ownership types include hospitals, homeowners/business associations, land trusts, commercial, residential, private clubs, religious, universities, and utilities.

Table 19 includes a summary of public versus private ownership for open and partially open parcels, and Figure 30 depicts the location of these parcels. 2005 acres (23.5%) of the open and partially open parcels in the watershed are publicly owned. The amount of publicly owned land in the watershed is important because it reduces land acquisition fees for conservation, riparian corridor protection, and stormwater retrofitting. Most of the publicly owned open parcels are presently owned by Libertyville Township and the Forest Preserve District. Much of the publicly owned partially open space is owned by park districts and townships.

Table19. Public versus private ownership of open and partially open parcels

	Parcels (n)	Area (acres)	% of Watershed
Open Parcels			
Private	646	2,183	24.3%
Public	205	1,590	17.7%
Partially Open Parcels			
Private	127	1,600	17.8%
Public	32	415	4.6%
Total	**1,010**	**5,789**	**64.4%**

Figure 30: Public vs. Private Ownership of Open and Partially Open Parcels



PROTECTED STATUS OF OPEN AND PARTIALLY OPEN PARCELS

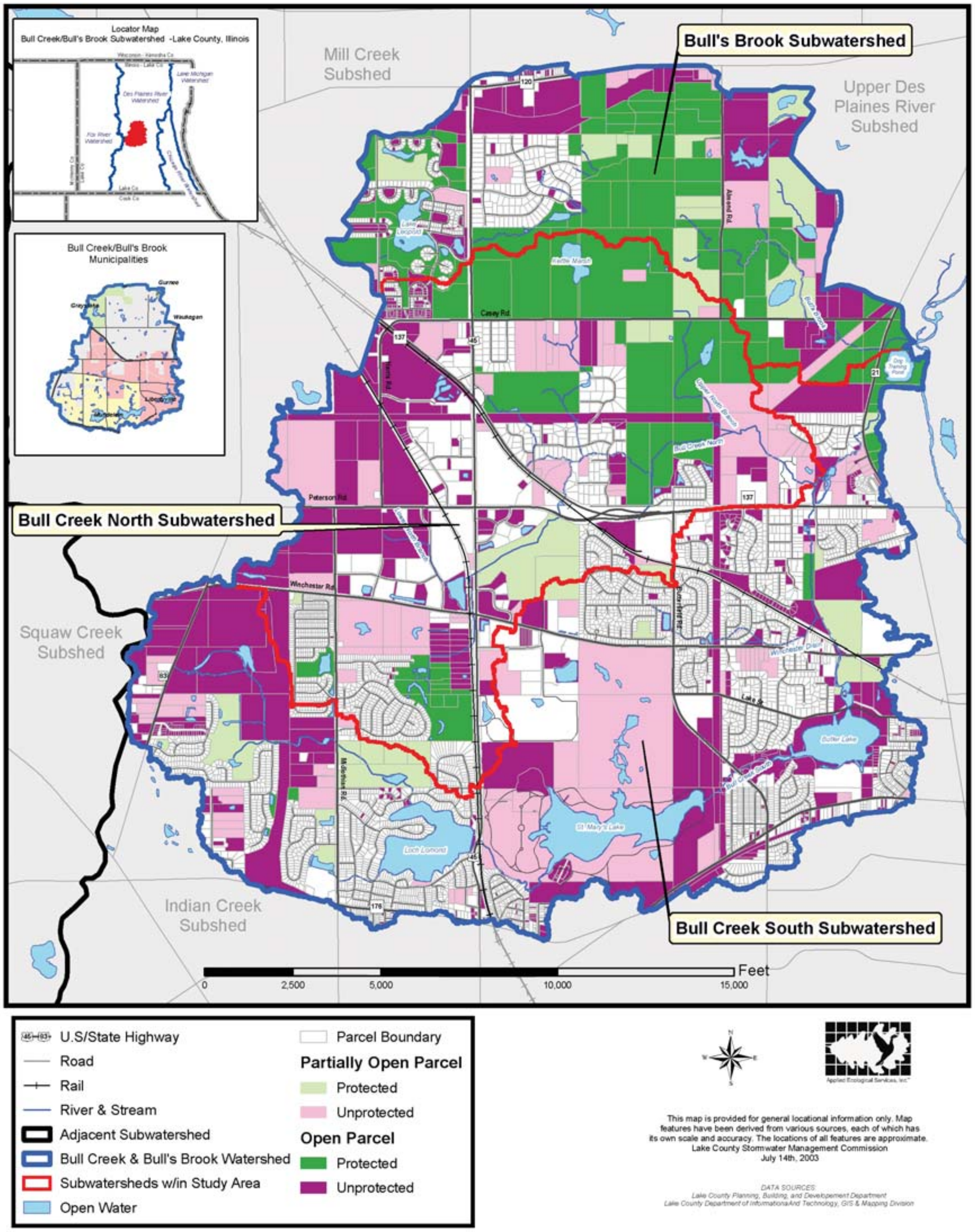
Of the nearly 5,800 acres of open and partially open space in the watershed, 2,110 acres (36.4% of the open space, 23.5% of the watershed) are protected (Table 20, Figure 31). Protected lands include forest preserve districts, state nature preserves, township open space, park districts, homeowners/business association-owned land with deed restrictions or conservation easements, and land owned by land trusts and other conservation organizations.

The loss of existing open and partially open space to other land uses poses the largest threat to the long term health of the watershed. The open space inventory identifies open and partially open parcels. A closer look at the data reveals many opportunities for private and public land protection. First, many unprotected open parcels are located in the far north and northeast portions of the watershed. Most of these areas are presently agricultural or forest/grassland within the Liberty Prairie Reserve boundaries. By protecting or preserving these parcels, additional open and partially open space would be preserved adjacent to existing open space, INAI locations, ADID wetlands, forest preserves, and nature preserves. Section 5.0 (Green Infrastructure Parcel Prioritization) identifies those areas that exhibit the highest priority for open space protection.

Table 20. Protected versus unprotected status of open and partially open parcels

	Parcels (n)	Area (acres)	% of Watershed
Open Parcels			
Protected	109	1,494	16.6%
Unprotected	742	2,280	25.4%
Partially Open Parcels			
Protected	35	616	6.9%
Unprotected	124	1,399	15.6%
Total	**1,010**	**5,789**	**64.5%**

Figure 31: Protection Status of Open and Partially Open Parcels



OPEN AND PARTIALLY OPEN SPACE RELATIVE TO SIGNIFICANT WATERSHED FEATURES

Ecologically Significant Areas and T&E Locations

Most of the T&E locations and Ecologically Significant Areas within the watershed are located on parcels that are open or partially open (Figure 32). A closer look at the ownership of parcels indicates that nearly all of the Ecologically Significant Areas and T&E species in the northern portion of the watershed are located on parcels that are protected and are partners in the Liberty Prairie Reserve. Parcels surrounding St. Mary's Lake (location of two documented endangered bird species) are not protected, but are not expected to be developed within the next 20 years.

Bull Creek South, from its confluence with the Des Plaines River upstream to Butler Lake, was identified by Integrated Lakes Management (ILM 2003) as a stream reach that contains the highest diversity and best stream biology on the Bull Creek system and is believed to be a migration corridor for the state endangered Iowa darter. Although open and partially open parcels border most of this stream reach, many of the parcels are unprotected. Watershed partners should strive to protect this stream corridor (includes Libertyville and unincorporated Lake County) or ensure that proper management is occurring along the stream corridor.

Open and Partially Open Space Relative to Existing, Proposed, and Potential Greenways, Trails and Trail Connections

Greenways serve many functions providing benefits for the community. Most importantly, they connect green infrastructure hubs and regionally and locally significant open lands. Greenways are frequently composed of stream corridors and floodplains. They may also provide trail locations connecting communities.

An extensive network of existing and proposed trails/greenways run through the watershed. Section 3.6 (Transportation) provides a detailed summary of the trail system. Figure 33 displays all Lake County and NIPC (2004) trails and greenways that are within 100 feet of or intersect open and partially open parcels. Generally speaking, most of the proposed and unknown status trails & greenways are located in close proximity to open and partially open parcels. Proposed trails/greenways are associated with new road corridors, existing open space in the northern half of the watershed, and existing utility corridors.

Noteworthy Chicago Area Greenways & Trails

Greenway and trail planning at the regional scale for the Chicago area has been undertaken by Open lands Project and the Northeastern Illinois Planning Commission (NIPC—recently changed to the Chicago Metropolitan Agency for Planning—CMAP). Openlands Project was established nearly 40 years ago with the intent to conserve open space throughout the Chicago region. In the late 1980's Openlands Project's Greenways Division first proposed the Northeastern Illinois Regional Greenways and Trails Plan. In 1992, NIPC adopted the plan. By 1997, NIPC revised the original 1992 plan that is now referred to as the Regional Greenways and Trails Implementation Program. Since the original 1992 plan, the size of the greenway network has nearly tripled to include 4,300 miles of greenways, while trails have doubled from 1,000 miles to nearly 2,000 miles.

Figure 32: Open and Partially Open Parcels that intersect Threatened and Endangered Species Locations or Ecologically Significant Areas

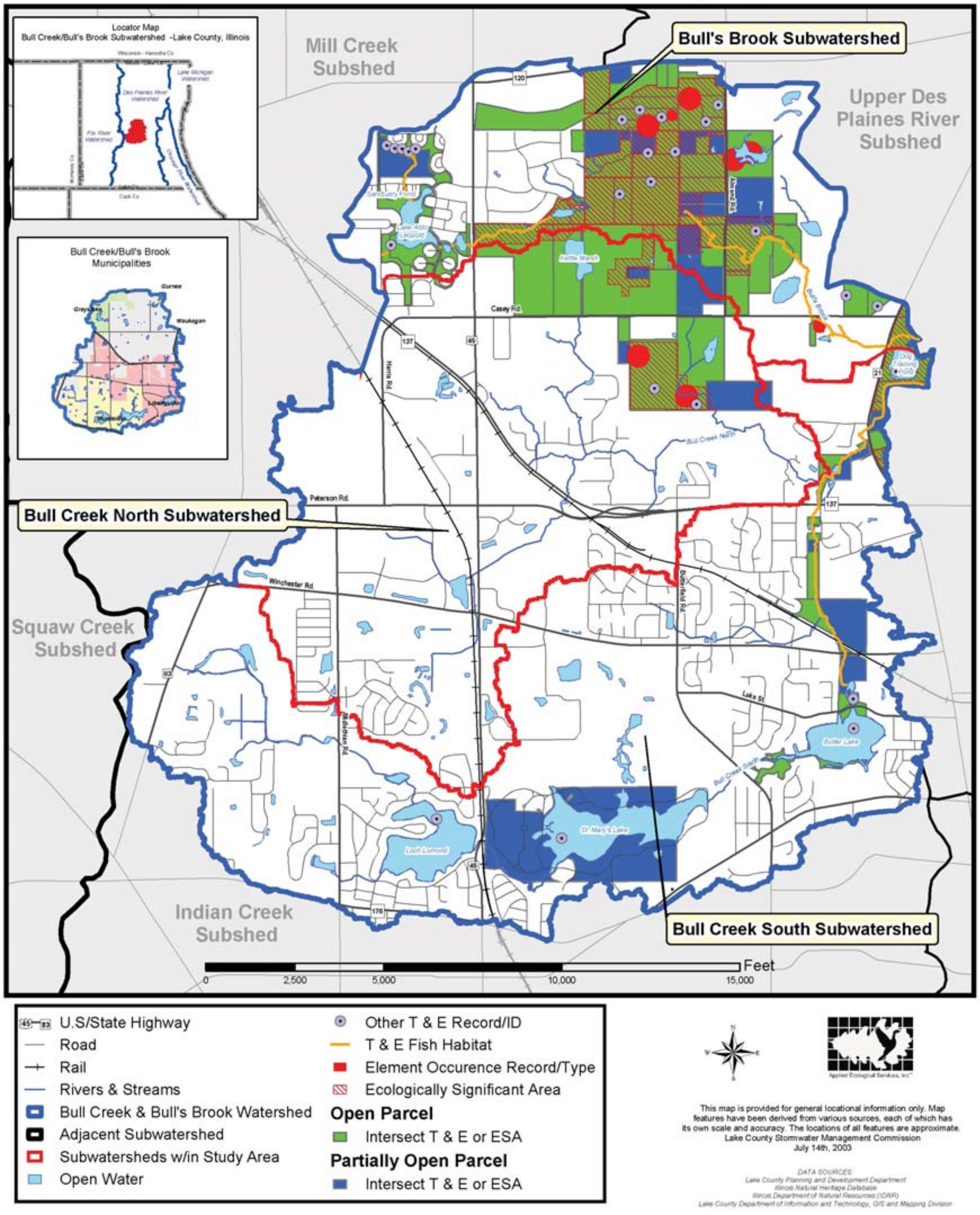
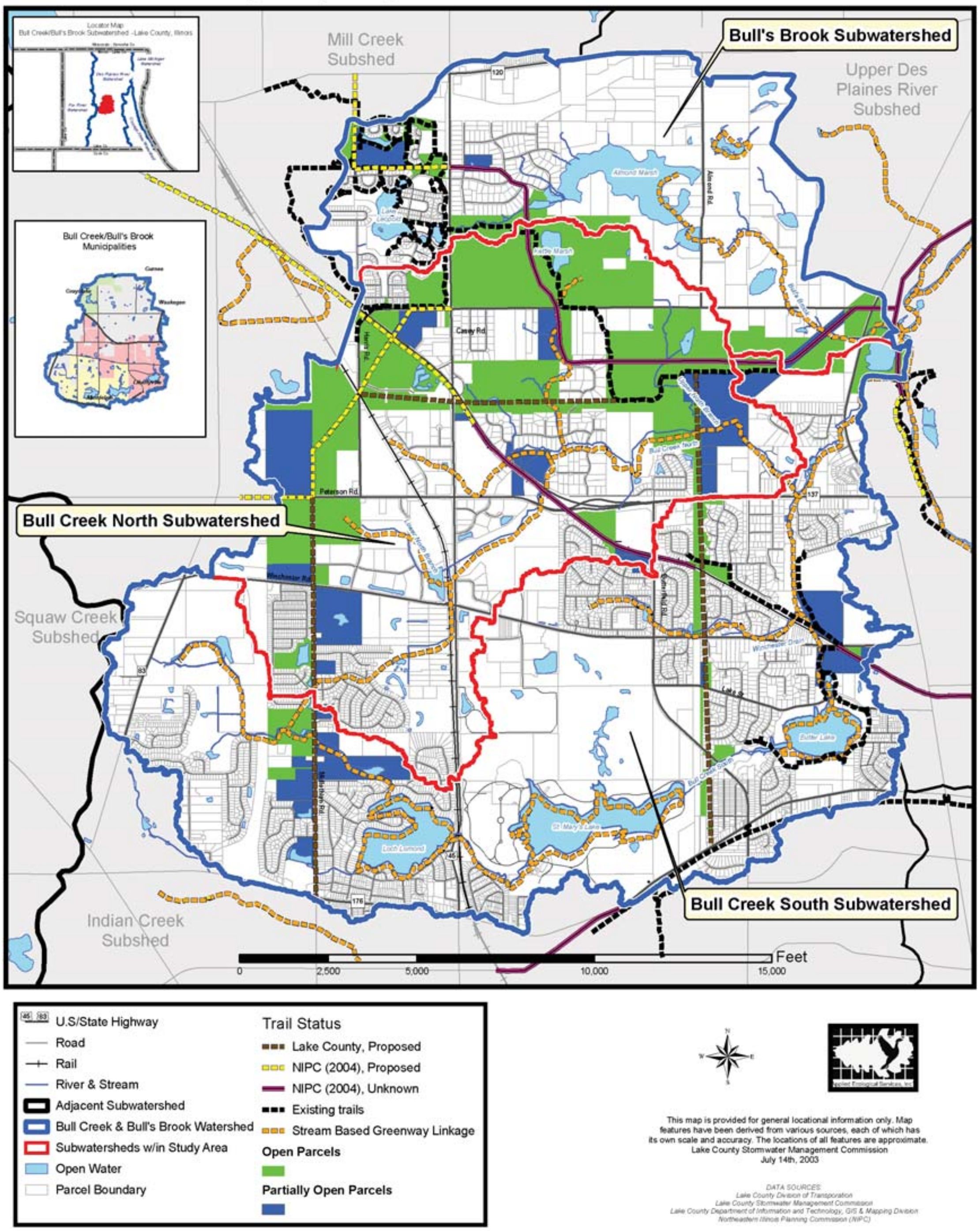


Figure 33: Open and Partially Open Parcels Within 100 feet of NICP (2004) Proposed Trails or Trails of Unknown Status



Waters of the United States (WOUS): *For the purpose of this Ordinance the term Waters of the United States refers to those water bodies and wetland areas that are under the U. S. Army Corps of Engineers jurisdiction.*

Mitigation: *Measures taken to eliminate or minimize damage from development activities, such as construction in wetlands or Regulatory Floodplain filling, by replacement of the resource.*

Lake County Watershed Development Ordinance (WDO): *One part of the adopted Lake County Comprehensive Stormwater Management Plan. It sets forth the minimum requirements for the stormwater management aspects of development in Lake County.*

High Quality Aquatic Resources (HQAR): *Waters of the United States or Isolated Waters of Lake County (unconnected waters) that are determined to be critical due to their uniqueness, scarcity, function or value.*

Open and Partially Open Space Relative to the 100-Year Floodplain and Flood Problem Areas

The Flood Problem Areas Inventory (FPAI), conducted in 1996 and updated in 2003 by the Lake County Stormwater Management Commission (LCSMC), identified two sites where structures are inundated during heavy flooding (Figure 34). Site 13-11 covers nearly 12 acres of depressional area flooding in the northwest portion of the watershed along Arbor Vista Subdivision. Structural flood damage occurs on several lots near the depressional area. The existing depressional area is situated on agricultural open space where it may be feasible to increase flood storage and alleviate flooding to residential homes.

Site 14-01 consists of three separate sites at the downstream end of Bull Creek within the Brookhill Subdivision *(Figure 34)*. Flood damage at Site 14-01 is associated with overbank flooding along Bull Creek and local drainage problems. Three to five homes in this area have their wells and septic systems flooded from water that spills over the stream banks. Land associated with the flooding at Site 14-01 is on partially open space where it is difficult to increase flood storage. While few measures can be taken, flooding can be minimized by increasing flood storage upstream in other open space areas.

Open and Partially Open Space Relative to the Hydric Soils and Wetlands

The Bull Creek/Bull's Brook watershed has an extensive network of existing wetlands and areas of drained wetlands that now remain only as hydric soils. Figure 35 maps all the existing wetlands and hydric soils in relation to open and partially open parcels. Almost all the existing wetlands are directly associated with open or partially open parcels along stream corridors. Many of the drained wetlands (hydric soils) are located in developed areas or open space in the western and northern portions of the watershed that is currently agriculture. These sites are excellent wetland restoration candidates *(See 3.13: Wetlands)*.

Noteworthy Wetlands Regulatory Jurisdiction

Wetlands that are connected to stream systems are considered "***Waters of the U.S.***" and are therefore regulated by the U.S. Army Corps of Engineers (USACE). Effective January 1, 2005 developments are allowed to impact no more than one-tenth of an acre (0.10 acre) of USACE jurisdictional wetland without a permit and ***mitigation***. These policies will ensure that most of the existing wetlands in the watershed are preserved or mitigated for.

Isolated wetlands, wetlands that are not hydrologically connected to "Waters of the U.S." are under the jurisdiction of Lake County Stormwater Management Commission. The ***Lake County Watershed Development Ordinance (WDO)*** (LCSMC 2006) states that mitigation is required for wetland impacts greater than one-tenth of an acre (0.10 acre) to isolated wetlands that are ***high-quality aquatic resources (HQAR)*** and greater than 0.25 acres for isolated wetlands that are not HQARs.

Figure 34: Open and Partially Open Parcels Relative to the 100 Year Floodplain and Flood Problem Areas

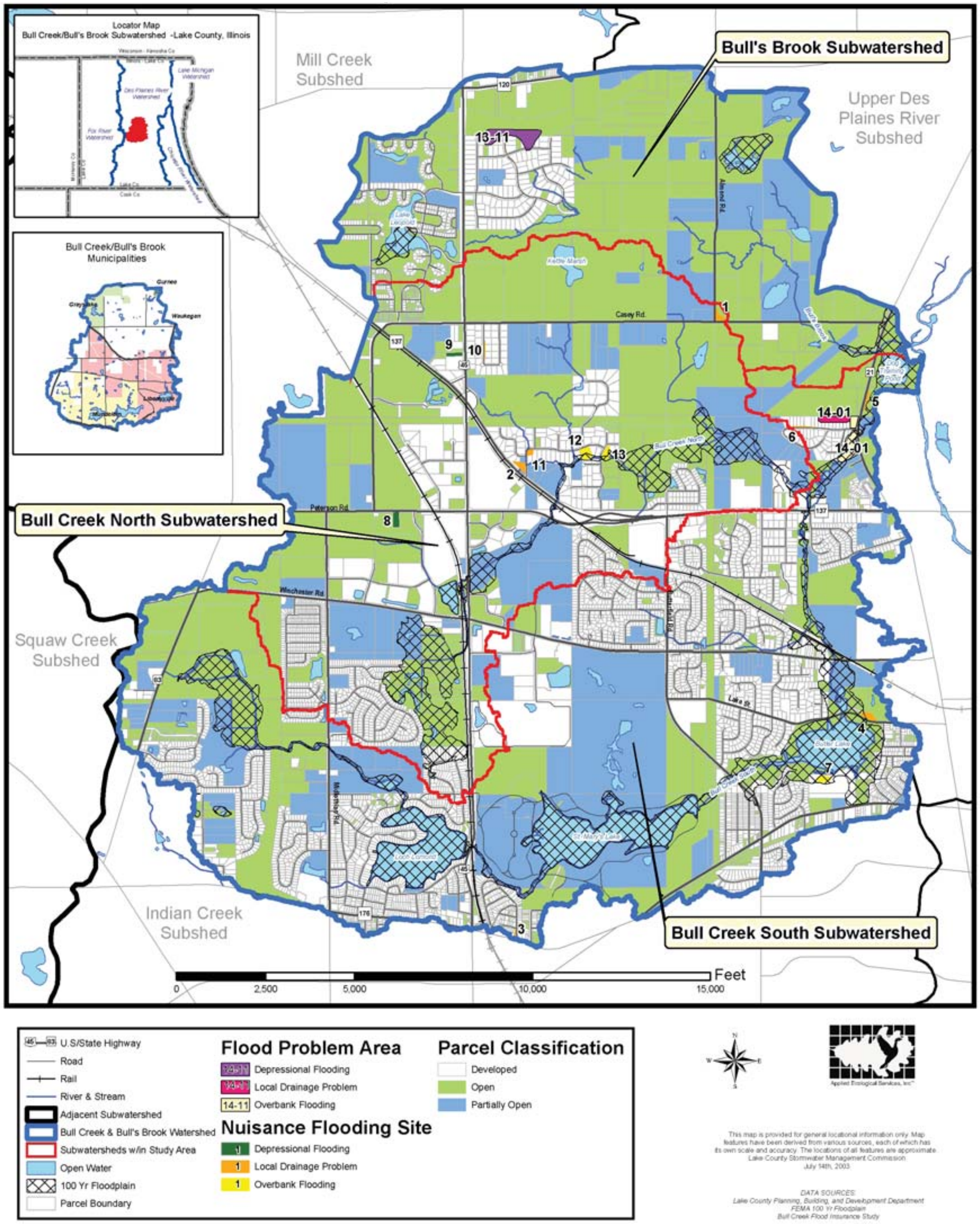
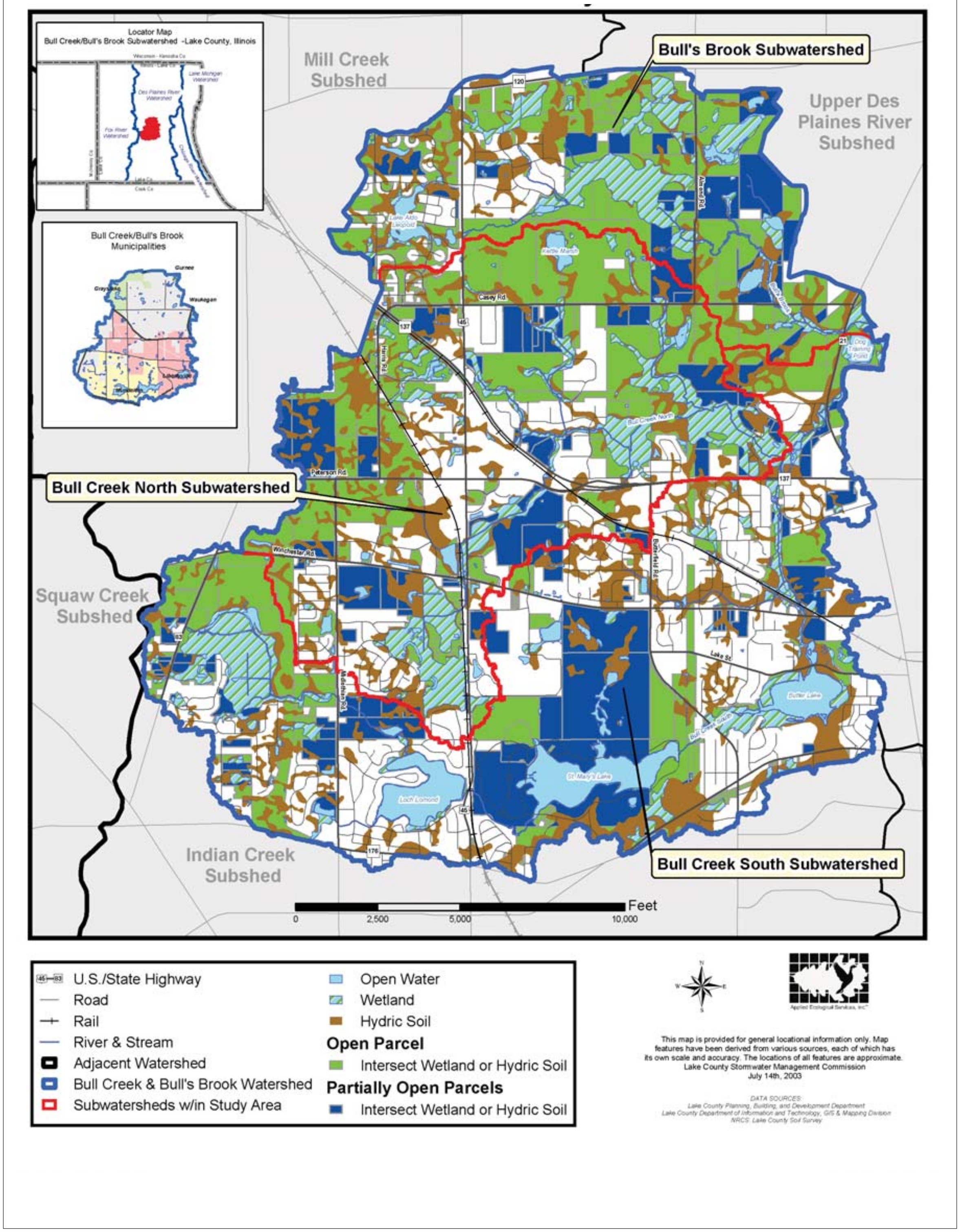


Figure 35: Open and Partially Open Parcels that Intersect Wetlands or Hydric Soils



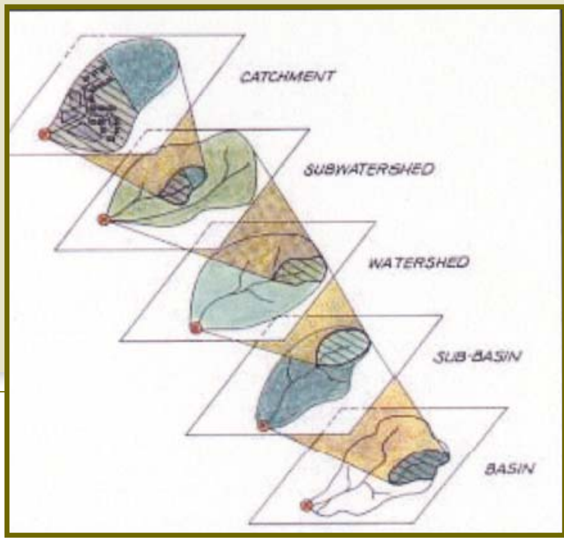
3.9 Watershed Hydrology

DEFINING WATERSHED, SUBWATERSHED, AND SUBWATERSHED MANAGEMENT UNIT BOUNDARIES

Noteworthy **Watershed Units**

Hydrology and ***hydraulics*** are scientific terms used to describe the effects of precipitation including infiltration, runoff, and evaporation on land surfaces that drain to streams and lakes. Hydrology studies in watersheds usually begin with an understanding of how topography naturally delineates the land into watersheds, subwatersheds, and smaller catchments that are referred to as ***Subwatershed Management Units (SMUs)*** in this plan.

As discussed in the Introduction Section of this report, a watershed is the area of land drained by a river/stream system or body of water. ***The Center for Watershed Protection (CWP)*** describes a watershed as an area of land that "contributes runoff to a particular point along a waterway." According to the CWP subwatersheds within a watershed usually contain drainage areas from 2 to 15 square miles.



Right: Relationship between size of drainage areas in a drainage basin

Source: Center for Watershed Protection

The Bull Creek/Bull's Brook watershed comprises approximately 8,970 acres (14 square miles). The Bull Creek/Bull's Brook watershed is made up of 3 subwatersheds (Bulls Brook (2.75 sq. miles), Bull Creek North (5.0 sq. miles), and Bull Creek South (6.2 sq. miles) subwatersheds). Subwatersheds are divided into smaller drainage units called Subwatershed Management Units (SMUs). The Bull Creek/Bull's Brook watershed contains 27 SMUs. Table 21 presents each SMU and its acreage organized by subwatershed. Figure 36 depicts the watershed, subwatershed, and SMUs.

Hydrology: *The scientific study of the properties, distribution, and effects of water on the earth's surface, in the soil and underlying rocks, and in the atmosphere.*

Hydraulics: *A branch of science that deals with practical applications of liquid in motion.*

Subwatershed Management Units: *Small unit of a watershed or subwatershed that is delineated and used in watershed planning efforts because the effects of impervious cover are easily measured, there is less chance for confounding pollutant sources, boundaries have fewer political jurisdictions, and monitoring/mapping assessments can be done in a relatively short amount of time.*

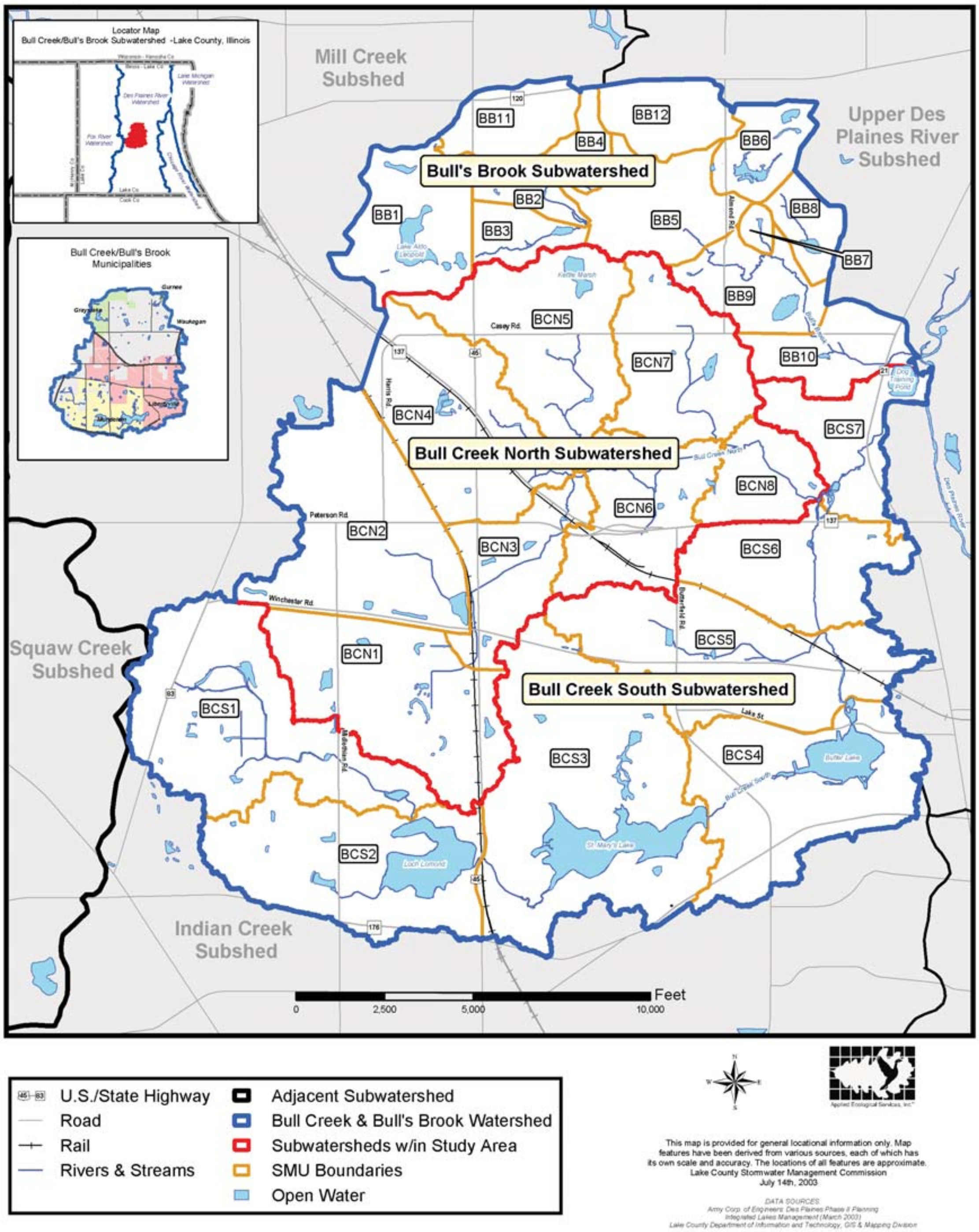
Center for Watershed Protection (CWP): *Non-profit 501(c)3 corporation founded in 1992 that provides local governments, activists, and watershed organizations around the country with the technical tools for protecting some of the nation's most precious natural resources such as streams, lakes and rivers.*

Table 21. SMUs and acreage organized by subwatershed in the Bull Creek/Bull's Brook watershed

Subwatershed	SMU #	Total Acres
Bulls Brook	BB1	303.5
Bulls Brook	BB2	78.0
Bulls Brook	BB3	96.0
Bulls Brook	BB4	74.8
Bulls Brook	BB5	256.3
Bulls Brook	BB6	132.9
Bulls Brook	BB7	24.6
Bulls Brook	BB8	92.9
Bulls Brook	BB9	190.1
Bulls Brook	BB10	187.1
Bulls Brook	BB11	160.8
Bulls Brook	BB12	158.4
Bull's Brook Subtotal		**1,757.7**
Bull Creek North	BCN1	533.8
Bull Creek North	BCN2	602.2
Bull Creek North	BCN3	263.8
Bull Creek North	BCN4	487.2
Bull Creek North	BCN5	468.8
Bull Creek North	BCN6	335.7
Bull Creek North	BCN7	361.3
Bull Creek North	BCN8	173.5
Bull Creek North Subtotal		**3,226.2**
Bull Creek South	BCS1	663.7
Bull Creek South	BCS2	574.8
Bull Creek South	BCS3	972.1
Bull Creek South	BCS4	577.1
Bull Creek South	BCS5	601.3
Bull Creek South	BCS6	351.0
Bull Creek South	BCS7	246.6
Bull Creek South Subtotal		**3,986.5**
Watershed Total		**8,970.4**

The watershed, subwatershed, and SMU boundaries used in this report were obtained from the hydrology and hydraulics model completed for the Bull Creek watershed. The Bull's Brook subwatershed and its SMUs were delineated by Integrated Lakes Management (ILM) (2003) with the addition of two SMUs added by Applied Ecological Services, Inc. (AES) (BB11 and BB12). BB11 was added as a result of findings using updated 2-foot topography data provided by the Illinois Department of Natural Resources (IDNR). BB12, which includes Almond Marsh, was added after discussions with the Lake County Forest Preserve. The Bull Creek North and South subwatersheds and SMUs were provided by the U.S. Army Corps of Engineers (USACE) as part of a USGS Hydrology and Hydraulics modeling effort developed during the Des Plaines Phase II planning process.

Figure 36: Subwatersheds and Subwatershed Management Units



3.10 Streams Inventory

DEFINING FLOW PATHWAYS

The Bull Creek/Bull's Brook watershed is comprised of three primary stream branches: Bull's Brook, Bull Creek North, and Bull Creek South (mainstem) (Figure 37). Bull's Brook flows from west to east across the northern portion of the watershed. It converges with the Des Plaines River just north and east of the Dog Training Pond. The North and South Branches of Bull Creek drain water from the central and southern portions of the watershed. They converge in the eastern portion of the watershed just north of Route 137 and flow to the northeast before eventually discharging into the Des Plaines River just south and east of the Dog Training Pond.

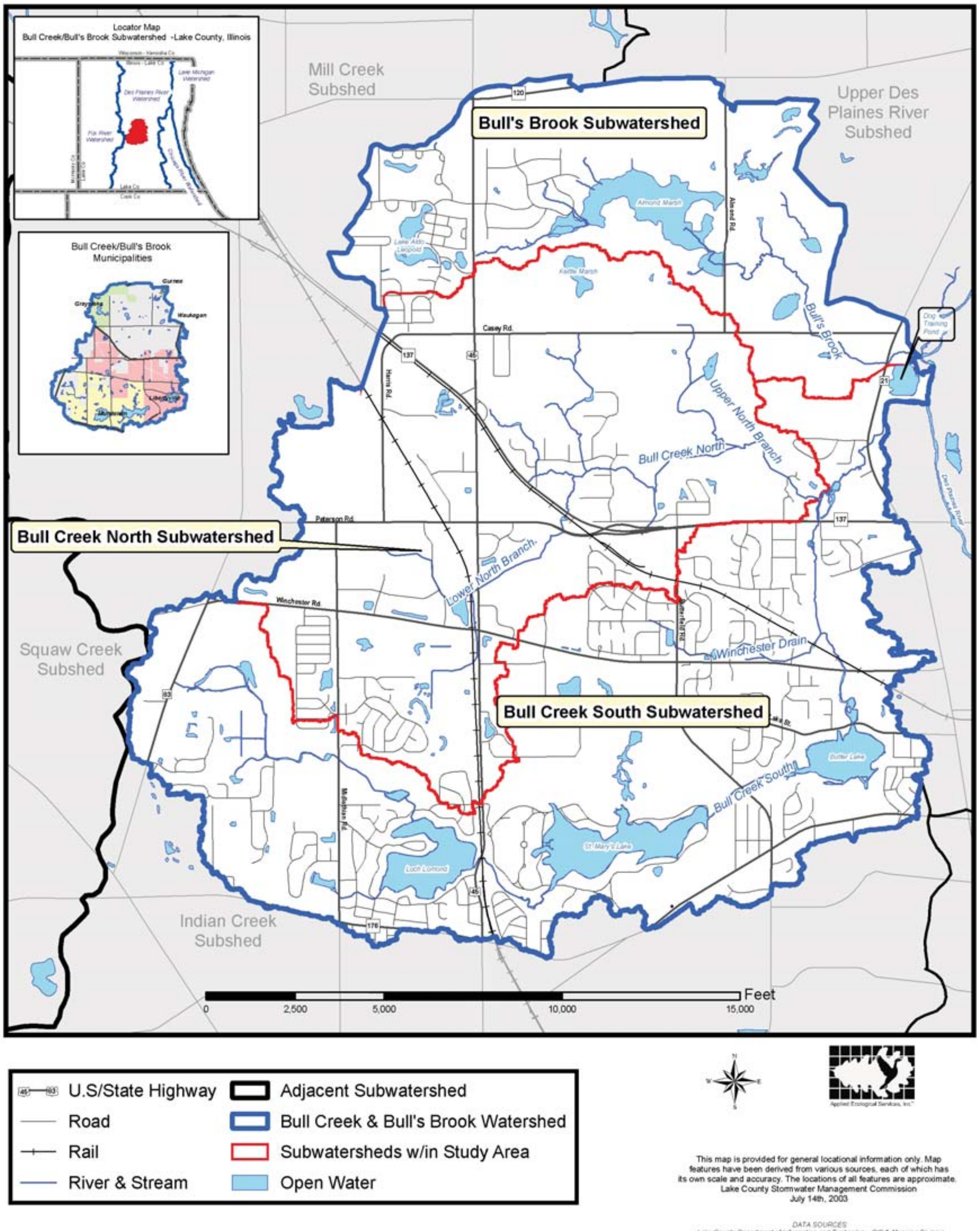
Bull's Brook drains 2.75 square miles in portions of Grayslake and unincorporated areas (Warren and Libertyville Townships) in the northern portion of the watershed. It originates in a series of ponds that receive stormwater runoff within the Prairie Crossing subdivision in the northwest portion of the watershed. From here, the stream flows over a 10-foot drop structure then east under US Route 45 and through the Oak Openings Nature Preserve, into Ryan's Pond, then into Almond Marsh where water levels are established by a natural berm. From the Almond Marsh wetland, Bull's Brook flows to the southeast through agricultural and residential areas before joining the Des Plaines River east of US Route 21. The ten-foot drop structure at Route 45, the Ryan's Pond spillway, and Almond Marsh berm impede migration by aquatic fauna. In addition, Bull's Brook exhibits a fairly high gradient of 38 feet drop in elevation per mile.

The North Branch of Bull Creek is comprised of three primary tributaries that drain approximately 5 square miles in portions of Libertyville and Grayslake, but mostly unincorporated Libertyville Township in the central portion of the watershed (Figure 37). These tributaries include North Branch (mainstem), Upper North Branch, and Lower North Branch. Bull Creek North (mainstem) originates southwest of the intersection of Winchester Road and US Route 45. From here, the stream flows northeast before joining with the Lower North Branch, a small tributary stream that originates west of Butterfield Road then flows along Butterfield Road and drains mostly commercial property. From here, the North Branch flows east through residential areas before joining the Upper North Branch in a wetland complex. After this confluence, Bull Creek North flows southeast before joining the South Branch of Bull Creek north of IL Route 137. The majority of Bull Creek North flows unimpeded allowing aquatic fauna to migrate throughout its reach. The stream gradient is moderate at about 25 feet drop in elevation per mile.

Bull Creek South drains approximately 6.2 square miles and is the mainstem of Bull Creek, which also includes the Winchester Drain tributary *(Figure 37)*. The headwaters of Bull Creek South originate west of IL Route 83. From here, the stream flows southeast through agricultural, recreational, and residential areas prior to entering Loch Lomond. From Loch Lomond, Bull Creek South flows through land owned by St. Mary's Seminary and residential homeowners before forming St. Mary's Lake. From St. Mary's Lake, the stream flows east through residential areas and into wetlands just west of Butler Lake. All three in-line lakes form barriers that impede the movement of aquatic fauna. The stream channel exits Butler Lake to the north where it joins Winchester Drain, a small tributary that flows east along Winchester Road draining residential properties in Libertyville. From here, the stream flows to the northeast where it joins with the Bull Creek's North Branch before flowing east into the Des Plaines River approximately 2,500 feet north and east of the IL Route 21/137 intersection. Bull Creek South exhibits a moderate gradient (24 feet drop in elevation per mile) along its path to the Des Plaines River.

During the summer of 2000, 2004, and fall 2006, the Lake County Stormwater Management Commission (LCSMC) completed stream inventories for Bull Creek North and South, and Bull's Brook. Bull Creek North and South were inventoried during the same time period and divided into a total of 16 inventory reaches (Figure 38). Bull's Brook was inventoried at a later date and divided into 14 study reaches. Several tributaries that flow into Bull Creek North were added to the inventory in 2006. Note: only the results of the 2000 and 2004 surveys are included below. Information related to the tributary survey conducted in fall 2006 can be found in Appendix C: Stream Inventories. In addition to LCSMC stream inventories, the Liberty Prairie Area Homeowners Association (LPAHA) received a Conservation 2000 grant in 2007 to assess portions of Bull Creek North within Bull Creek Subdivision. The major goals of the project include a detailed survey of the stream reaches, characterization of eroded streambanks, and a restoration plan with site specific recommendations. In 2007, Integrated Lakes Management (ILM) completed the survey and produced a report entitled "Bull Creek Subdivision Streambank Restoration Plan". A copy of this document is included in Appendix C: Stream Inventories.

Figure 37: Bull Creek/Bull's Brook Streams and Other Open Water



Debris load: *Natural and man-made debris including leaves, logs, lumber, trash and sediment.*

Hydraulic structures: *Low head dams, culverts, weirs, bridges, levees, and any other structures along the course of the river.*

Discharge (streamflow): *The volume of water passing through a channel during a given time, usually measured in cubic feet per second (cfs).*

Riparian: *Referring to the riverside or riverine environment next to the stream channel, e.g., riparian, or streamside, vegetation.*

Vegetated buffer: *An area of vegetated land to be left open adjacent to drainageways, wetlands, lakes, ponds or other such surface waters for the purpose of eliminating or minimizing adverse impacts to such areas from adjacent land areas.*

Turbidity: *Refers to the clarity of the water, which is a function of how much material, including sediment, is suspended in the water.*

Noteworthy The Bull Creek-Bull's Brook Stream Inventory

Streams were divided into ***stream reaches*** (Figure 38). Stream reaches are defined as stream segments having fairly homogenous hydraulic, geomorphic, riparian cover, and land use characteristics. The stream inventory methodology included walking the stream reaches, collecting channel and hydraulic structure measurements, taking photos, and noting in-stream, streambank, and riparian corridor characteristics. A Global Positioning System (GPS) was used to locate points of interest and the photos to be included into a Geographical Information System (GIS) database. The stream inventory data and photos are available in a software application for viewing from LCSMC. Appendix C contains a summary table of stream reach characteristics in the watershed.

The major stream characteristics inventoried include:

1. Channel conditions (physical size, streambank erosion, sediment accumulation, ***debris load***, riffle-pool development, and ***hydraulic structures***) and ***discharge*** points (channel and stormsewer outfall sizes and locations).
2. ***Riparian corridor*** (land use and ***vegetated buffer*** width and composition).
3. Aquatic habitat (substrate composition, in-stream fish cover, ***turbidity***, and filamentous algae).

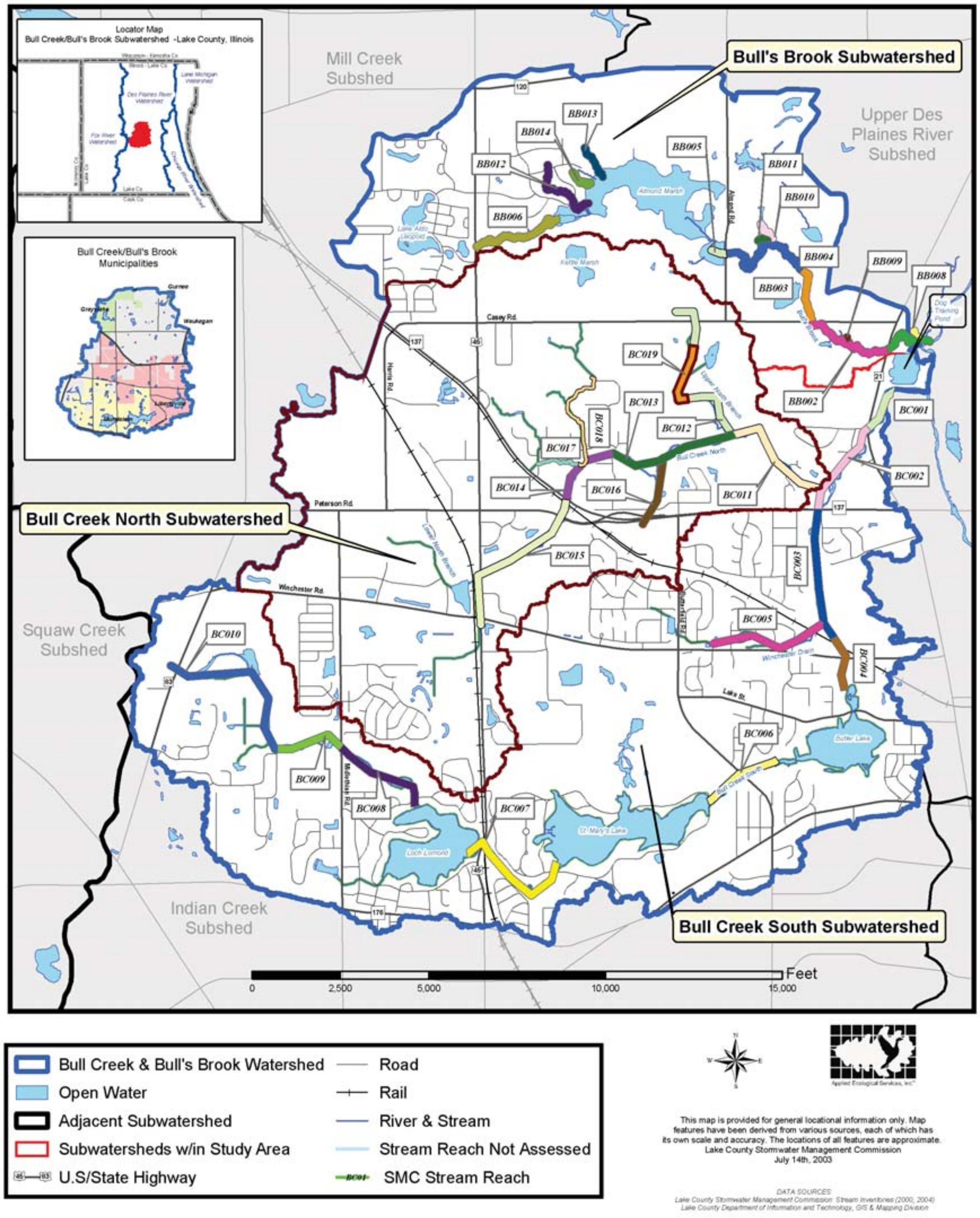
Although some quantitative data were collected within the channel such as outfall and hydraulic structure measurements, the condition of the channel was largely assessed using a qualitative method that involved visually inspecting and rating each stream reach as low, moderate or high for the characteristic being evaluated.

— Low refers to levels affecting less than 33% of the reach;

— Moderate means 33 to 66% was affected;

— High indicates 66 to 100% of the reach was affected.

Figure 38: Stream Reaches in the Bull Creek/Bull's Brook Watershed



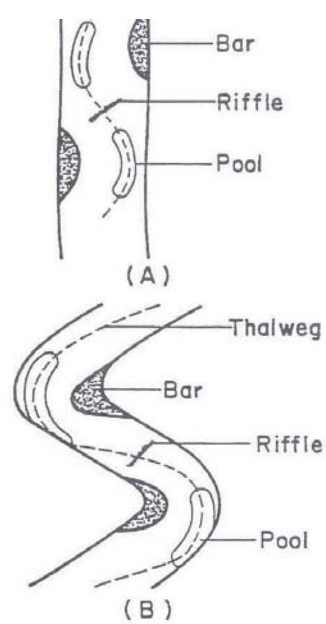
CHANNEL CONDITIONS

The stream channel condition assessment portion of the LCSMC stream inventories measured the variability in channel conditions in the watershed using parameters such as pool/riffle development, streambank erosion, sediment accumulation, debris loads, hydraulic structures, and discharge points. The result of these measured parameters is summarized below.

Noteworthy Stream Geomorphology

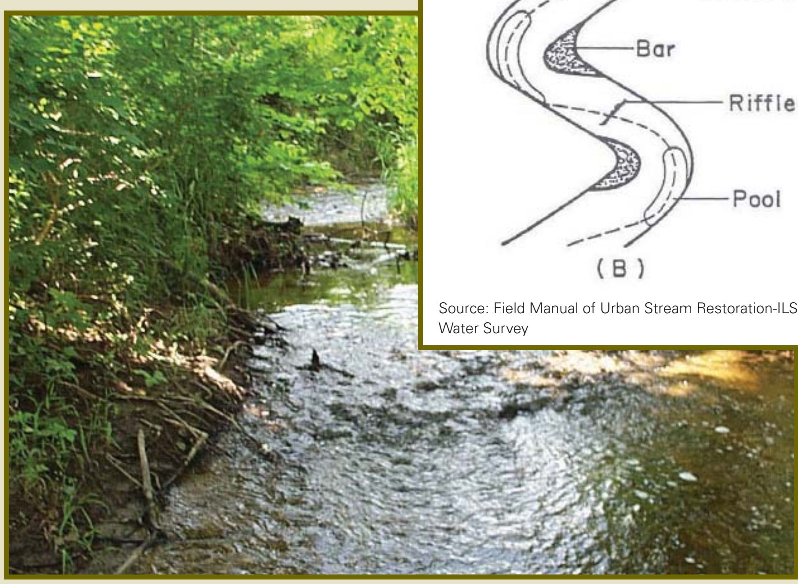
Complex riffle/pool sequences are usually associated with naturally meandering stream channels formed by the energy of the flow. Deeper pools are generally located in the bend of the channel while shallow riffles occur in the runs that connect each pool in the bend. Pool/riffles benefit the stream system by providing various habitats while aerating the water during low flow conditions. ***Channelized streams*** are often void of any riffles and pools depending on the degree of channelization.

TYPICAL STREAM PLATFORM



Source: Field Manual of Urban Stream Restoration-ILState Water Survey

Riffle pool sequence in high quality stream



Riffle/Pool Development

Bull's Brook and tributaries have relatively high riffle/pool development in the downstream reaches and low to moderate development in the central and upstream reaches *(Figure 39)*. In total:

- 39% of the assessed stream reaches comprising Bull's Brook have high riffle/pool development,
- 15% have moderate development,
- 46% have low development,
- No reaches were completely void of riffles and pools *(Figure 39)*.

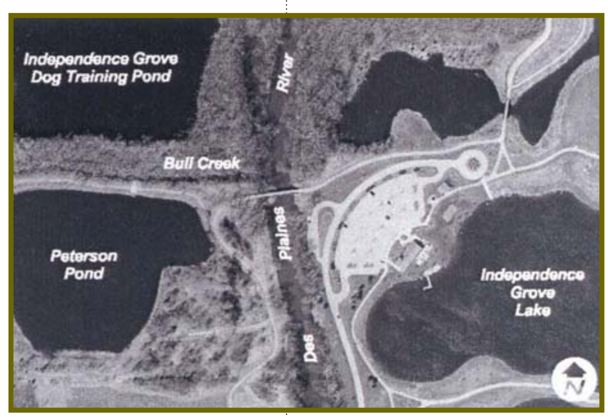
The North and South Branches of Bull Creek have less riffle/pool development than Bull's Brook and therefore are in a more degraded condition *(Figure 39)*. The North Branch includes:

- 17% of the stream reaches have no riffle/pool development,
- 66% show low development,
- 17% are moderately or highly developed.

The South Branch includes:

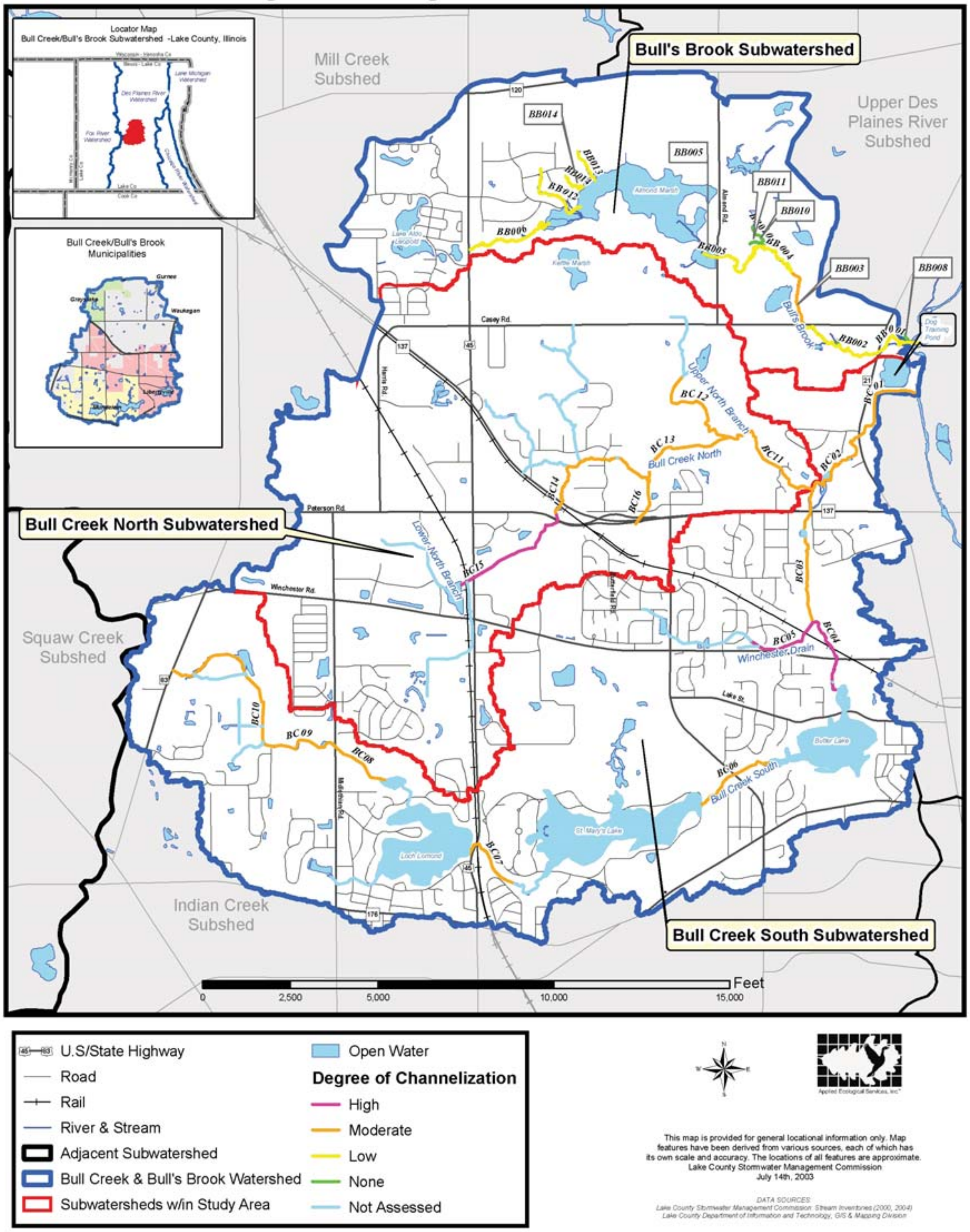
- 20% of the stream reaches have no riffle/pool development,
- 30% have low development,
- 50% of the stream reaches have moderately or highly developed pools & riffles.

One of the most significant channelization efforts in the watershed occurred near the mouth with the Des Plaines River where Bull Creek was re-located around Peterson Pond in the mid-20th century resulting in the formation of a new confluence point with the Des Plaines River approximately 400 feet north of its original location.



Left: Mouth of Bull Creek at Des Plaines River—1939; **Right:** Mouth of Bull Creek at Des Plaines River—2006

Figure 39: Degree of Channelization



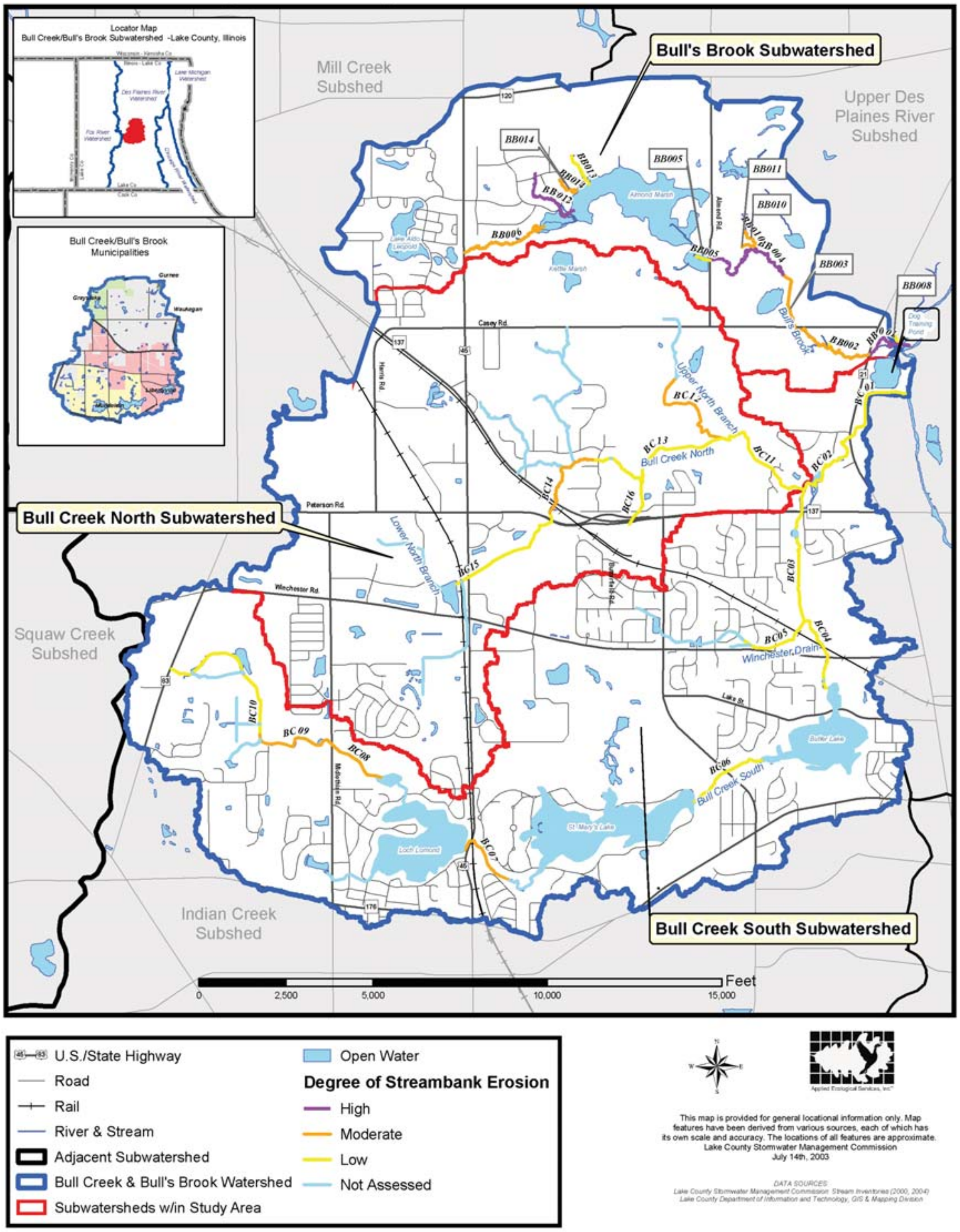
Severe streambank erosion along Reach BB04.

Streambank Erosion

Streambank erosion and its associated sediment accumulation and transport downstream can cause significant water quality problems in any watershed. Problematic erosion in streams can occur for several reasons but moderate to high gradients in combination with increased flows and channel incision often cause bank sloughing. According to the stream inventories, 47% of the streambanks in the watershed have moderate or high degrees of erosion *(Figure 40).* Streambank erosion is most severe at the confluence of Bull's Brook and the Des Plaines River (Reach BB001), east of Almond Road (Reach BB004), and along a tributary to Almond Marsh (Reach BB012). Almost all other reaches along Bull's Brook are considered moderately eroded. Erosion in Bull's Brook is common for a number of reasons. First, this stream is considered a relatively high gradient system that maintains many of its natural meandering characteristics. As adjacent open land is altered and is unable to absorb stormwater, the stream levels rise higher than historic conditions leading to channel incision and bank sloughing.

The most severe cases of streambank erosion along Bull Creek North and South occur between St. Mary's Lake and Kettering Road (Reach BC07) and between Countryside Road and IL Route 137 (BC14). Other streambank erosion hotspots are located along the streambanks of the Upper North Branch of Bull Creek (BC16) and along the Bull Creek's mainstem both upstream and downstream of Midlothian Rd (Reaches BC08 and BC09). Streambank stabilization opportunities are abundant in the watershed and are among the best BMPs for reducing erosion and pollutant loading downstream.

Figure 40: Degree of Streambank Erosion



Sediment Accumulation and Debris Loads

Sediment accumulation in streams is usually associated with streambank erosion and the gradient of the stream. Higher gradient streams tend to transport sediment more readily than lower gradient streams. However, other factors such as debris loads (blockages) and impoundments also cause ***sedimentation***. Sedimentation negatively impacts streams because fine silty particles settle out of the water column to the stream bottom and smother the natural gravel or cobble substrates thereby reducing habitat quality for fish and macroinvertebrates. The stream inventories for Bull Creek and Bull's Brook reveal:

- 60% of stream reaches exhibit moderate or high sedimentation;
- 37% have low sediment accumulation;
- only 3% show no sedimentation *(Figure 41)*.

Sedimentation: *The process that deposits soils, debris and other materials either on other ground surfaces or in bodies of water or watercourses.*

American Fisheries Society (AFS): *Stream Obstruction Removal Guidelines: Document describing environmentally sound techniques to maintaining natural stream characteristics when dealing with channelization, clearing, snagging, or other severe stream modifications. Document can be found in Appendix D.*

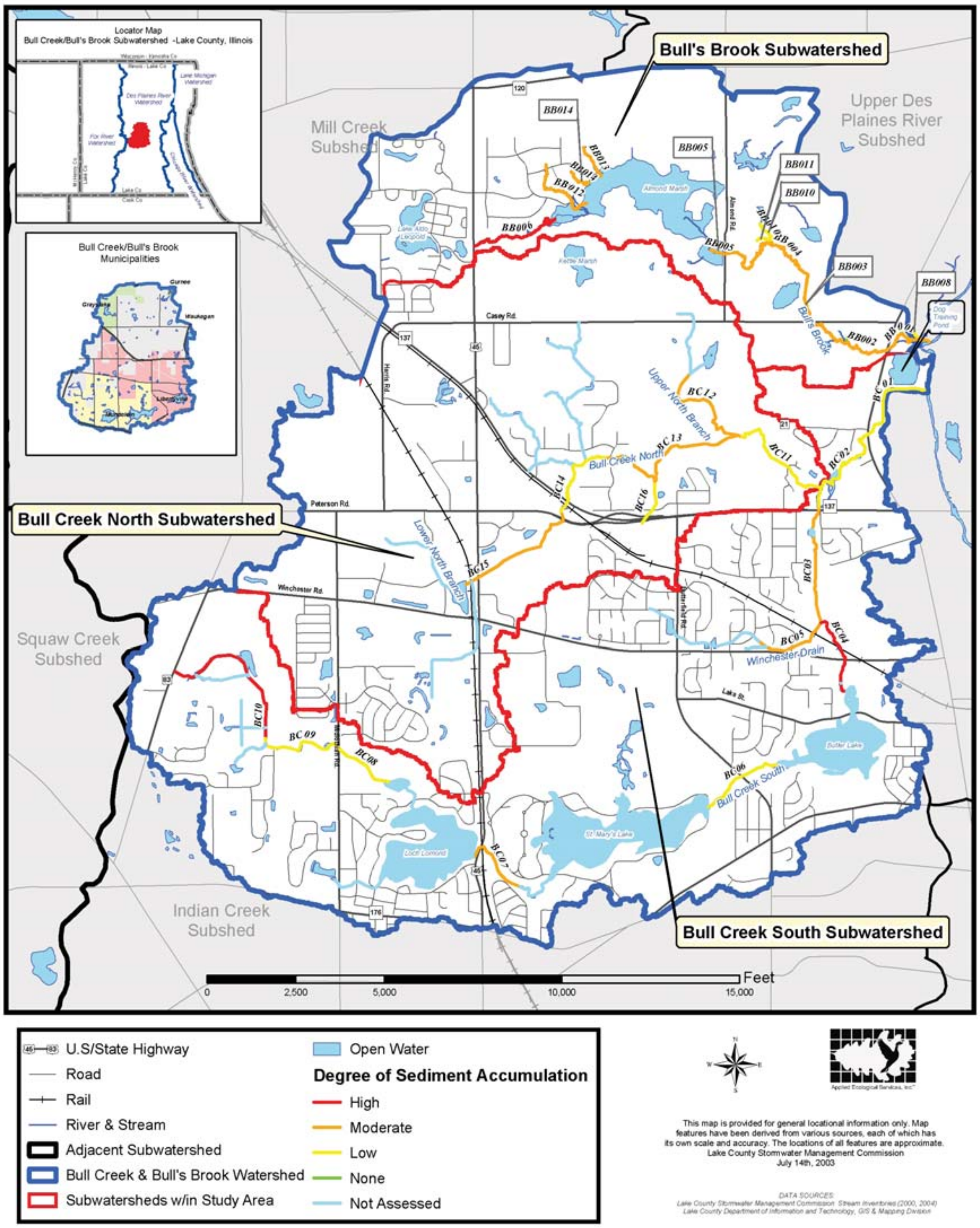
One particular stream reach of interest is BB006 located just east of Route 45 and downstream from Lake Leopold. This reach was identified as the only high sediment accumulation reach along Bull's Brook. Discussions with Tim Girmsheid (Liberty Prairie Conservancy) and Mike Sands (Prairie Crossing) provided insight regarding the history of this stream reach and why sediment accumulation is present. Historically, Prairie Crossing was an agricultural field with drain tiles that drained directly into BB006. Reports indicate sediment and water were under such pressure leaving the tile system that it severely eroded the streambanks. The combination of sediment in drain tiles and streambank erosion led to the high sediment accumulation seen today especially within Ryan's Pond located downstream. Today, artificial riffles and streambank stabilization practices have been installed to stop erosion and sedimentation downstream.

Natural and human-made debris loads refer to debris accumulation and blockages, both instream and overbank, that can alter the natural flow regime in streams and contribute to streambank erosion and sediment accumulation. Reaches that failed the in-stream or overbank test were usually characterized as having large accumulations of lodged debris across the stream channel and over the banks. Problematic debris loading was prevalent in 27 o f the 30 (90%) inventory reaches. This is a significant flow and conveyance problem in the watershed. All jurisdictions in the watershed should pursue coordinating a maintenance program to remove problematic debris jams following procedures included in the "***American Fisheries Society Obstruction Removal Guidelines***" (SRGC 1983) *(Appendix D)*. These guidelines employ debris removal techniques based on the severity and type of obstruction. Additional stream maintenance/monitoring guidelines are included in Section 4.3.

Top: Example debris jam (Beaver Dam) in Reach BC02.

Bottom: Artificial riffle and streambank protection practices

Figure 41: Degree of Sediment Accumulation



HYDRAULIC STRUCTURES

Problem Hydraulic Structure (fallen bridge) in Reach BC13

Hydraulic structures including bridges, culverts, dams, or weirs often cause flooding, negative impacts to aquatic fauna, and streambank erosion within the stream channel. Some poorly constructed hydraulic structures cause these problems by restricting flow, or inhibiting flow by causing debris blockages within the channel at the structure. Dams can be extremely detrimental to the natural processes of streams. They impound water and act as migration impediments for fish and other aquatic fauna. According to Integrated Lakes Management (ILM 2003) low head dams on Loch Lomond, St. Mary's, and Butler Lakes as well as dams at Winchester Road, the drop structure at Prairie Crossing, the spillway at Ryan's Pond, and the dam at Almond Marsh all inhibit fish migration.

According to the stream inventory results, Bull Creek South contains the highest density of hydraulic structures with 10 structures/stream mile. Bull Creek North and Bull's Brook both have 8 structures per stream mile. Bridges and culverts are the most prevalent hydraulic structures although dams are common in Bull Creek South because they were constructed to create online lakes. Twenty of the total 131 structures are problematic *(Tables 22 & 23; shown on Figure 42)*. Problematic structures are those that negatively impact aquatic fauna and contribute to streambank erosion. Appendix C contains a detailed list of all hydraulic structures identified during the County's stream inventory. The Action Plan makes recommendations for addressing each problematic hydraulic structure.

Table 22. Hydraulic structures categorized by stream branch in the Bull Creek/Bull's Brook watershed

Hydraulic Structures	Bull Creek South (5.75 miles)	Bull Creek North (4 miles)	Bull's Brook (4 .5 miles)
Bridges	12	9	11
Culverts	31	22	15
Dams	8	0	2
Weirs	2	1	0
Other	8	1	9
Total Hydraulic Structures	**61**	**33**	**37**
Hydraulic Structures/ stream mile	10	8	8
Problem Hydraulic Structures	9	5	6

Source: LCSMC's Stream Inventory for Bull Creek and Bull's Brook.

Figure 42: Problem Hydraulic Structures

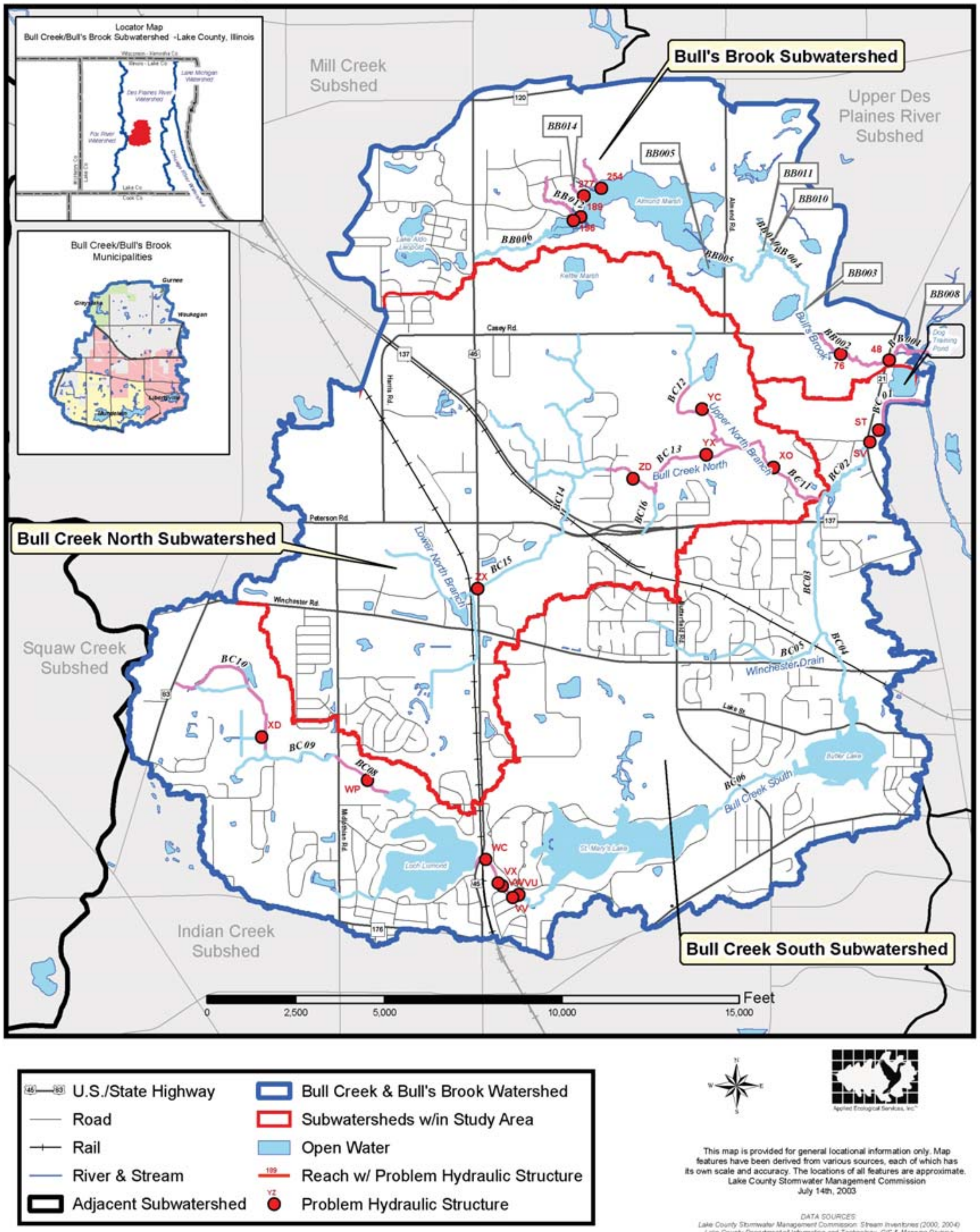


Table 23. Problematic hydraulic structure ID numbers, type, and problem

Problem ID	Hydraulic Structure Type	Problem
Bull's Brook		
48	Fence	Wire fence across stream could cause debris jams
76	Fence	Wire fence across stream could cause debris jams
189	Wooden Plank	Wooden Plank across stream channel could cause debris jams
196	Pipe	Steel pipe across stream channel could cause debris jams
254	Fence	Wire fence across stream could cause debris jams
277	Bridge	Wood foot bridge currently causing streambank erosion
Bull Creek North		
XO	Fence	Wire fence across stream could cause debris jams
YC	Culvert	Corrugated metal pipe with left bank erosion
YX	Bridge	Collapsed concrete bridge and channel alteration
ZD	Culvert	Poorly constructed corrugated metal culvert
ZX	Culvert	Route 45 culvert submerged and silted in
Bull Creek South		
ST	Dam	Concrete dam causing impoundment of channel
SV	Fence	Wire fence across stream could cause debris jams
VU	Fence	Wire fence across stream could cause debris jams
VV	Fence	Wire fence across stream could cause debris jams
VW	Fence	Wire fence across stream could cause debris jams
VX	Fence	Wire fence across stream could cause debris jams
WC	Fence	Wire fence across stream could cause debris jams
WP	Culvert	Half silted in culvert
XD	Culvert	Submerged and silted in corrugated metal culvert

Source: LCSMC's Stream Inventory for Bull Creek and Bull's Brook.

This bridge recently constructed over Bull Creek South in the Hampton Reserve subdivision provides a wide span over the creek channel maintaining the natural stream substrate and allowing for the free flow of Bull Creek.

DISCHARGE POINTS

Discharge points are defined by the LCSMC as open channels and outfall pipes greater than 4 inches in diameter that drain into a stream channel. The stream inventories located a total of 161 discharge points into Bull Creek and Bull's Brook *(Table 24)*. Twenty-three (23) of the 161 discharge points were considered problematic. Problematic discharges include erosion at a pipe outfall, erosion of an open channel, polluted or suspicious discharges, and failing outfall structures. Problem discharges are listed in Tables 24 & 25 and shown on Figure 43.

Bull Creek South has the highest density of discharge points with 15 per stream mile. Bull Creek North and Bull's Brook have only 9 and 8 discharge points per stream mile respectively. A detailed table listing of the parameters collected during the survey of discharge points can be found in Appendix C. The Action Plan makes recommendations for addressing each problem discharge point.

Eroded Discharge Point along Bull's Brook

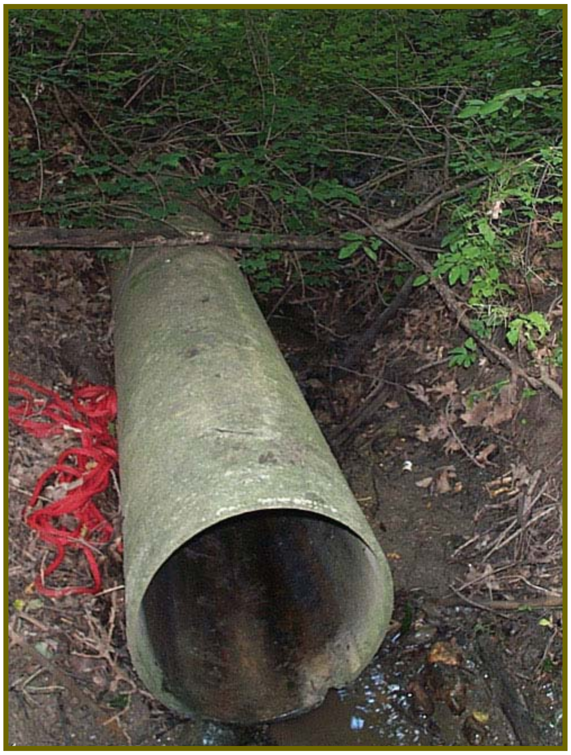


Table 24. Discharge points into Bull Creek North, Bull Creek South, and Bull's Brook

Discharge Points	Bull Creek South (5.75 miles)	Bull Creek North (4 miles)	Bull's Brook (4.5 miles)
Tributaries	2	5	5
Swales & Gullies	42	18	14
Pipes	44	13	16
Other Outfalls (hoses, overflow channels, etc)	0	0	2
TOTAL Discharge Points	**88**	**36**	**37**
Discharge points/stream mile	15	9	8
Problem Discharge Points	6	2	15

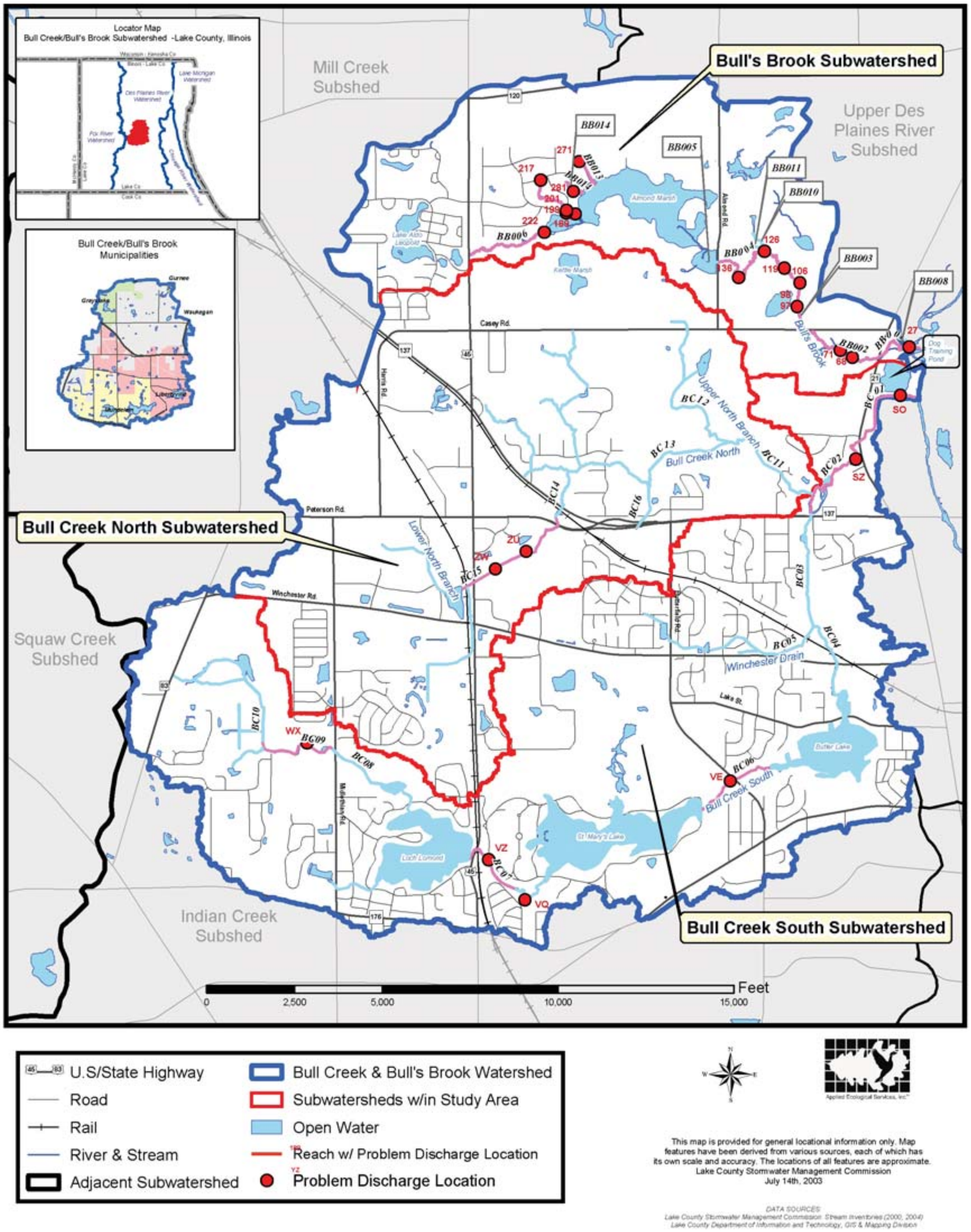
Source: LCSMC's Stream Inventory for Bull Creek and Bull's Brook.

Table 25. Problematic discharge point ID numbers, type, and problem

Problem ID	Hydraulic Structure Type	Problem
Bull's Brook		
27	Tributary overflow	New channel forming due to debris at confluence
68	Swale	Swale may be dewatering wetland
71	Tributary	Erosion at tributary confluence
97	Pipe	Pipe partially blocked by silt and discharging into eroded swale
98	Pipe	Concrete pipe discharging into eroded swale
106	Pipe	Pipe extended into main channel
119	Swale	Eroded swale to main channel
126	Tributary	Eroded tributary to main channel
136	Swale	Eroded swale that drains adjacent agricultural land
189	Hose	Rubber hose drains hot tub
199	Pipe	Sump pump discharge
217	Pipe	Concrete pipe with erosion
222	Pipe	Submerged corrugated metal pipe
271	Pipe	Pipe discharging soapy substance
281	Pipe	Pipe extending into main channel
Bull Creek North		
ZU	Pipe	Agricultural drain tile with severe right bank erosion
ZW	Pipe	Submerged pipe drains wetland on right bank
Bull Creek South		
SO	Pipe	Pipe draining detention basin with bank erosion
SZ	Pipe	Drains residential property/greenhouse with whitish substance
VE	Pipe	Erosion along right bank at pipe outfall
VQ	Pipe	Drains residential property on right bank with severe erosion
VZ	Pipe	Drains seminary on right bank with erosion
WX	Pipe	Drains agricultural land on right bank with erosion

Source: LCSMC's Stream Inventory for Bull Creek and Bull's Brook

Figure 43: Problem Discharge Locations



RIPARIAN CORRIDOR

Riparian corridors buffer waterbodies by infiltrating surface flows, filtering pollutants from runoff and by providing beneficial wildlife habitat. Land use within 100 feet of either side of the stream channel was assessed during the stream inventories by summarizing the percentage of land falling under six land use categories: agricultural, recreational, residential, vacant/open space, commercial/ industrial, and other. In general the vacant/open space land use category dominated the riparian corridor followed by recreational and residential land uses. In addition to identifying adjacent land use, the streambank vegetation within 10 feet of each bank was also recorded. Non-native grasses (21%), lawn (8%), trees (34%), and shrubs (25%) were recorded along the streambanks. Historically, the streambanks were comprised of mostly native wetland grasses, sedges, shrubs, and some trees. Because of this shift in species composition from historical conditions, there are many opportunities for brush maintenance and native vegetation establishment along the streams.

Noteworthy Stream Buffers

The width and condition of vegetated riparian corridor buffers was also assessed during Lake County's stream inventory and used to identify those stream reaches that need buffer improvements. The Lake County Watershed Development Ordinance (WDO) requires that new developments along a stream corridor maintain a minimum 30-foot wide vegetated buffer when more than one square mile is draining to the stream and a minimum 50-foot buffer for headwater stream reaches.

All stream reaches exhibiting less than a 30-foot buffer on either side of the stream or reaches with other notable problems such as heavy invasive cover are characterized in Figure 44 below as high priority for improvement. Streams reaches with fewer buffer improvement needs are also shown on Figure 44. The Action Plan makes recommendations for improving buffers.

AQUATIC HABITAT

Aquatic habitat is the last of the three stream characteristics assessed during LCSMC's stream inventory. Stream substrate, in-stream fish cover, and water quality indicators were assessed to reflect the quality of aquatic habitat. Habitats with silt free substrates, good water quality indicators, and in-stream cover are important to macroinvertebrates and fish.

The inventory found that silt, organic matter, sand, and gravel were the most common substrate types in watershed streams. The substrate of the North Branch of Bull Creek is the most impacted by silt and organic matter, while Bull Creek South and Bull's Brook had a higher percentage of sand and gravel. Four stream reaches along Bull's Brook's (BB002, BB003, BB004, and BB006) have more than 25% cobble, an excellent substrate for fish and macroinvertebrates.

In-stream habitat along Bull's Brook

Lake County's stream inventories also note the presence or absence of eight in-stream habitat types within each stream reach. These include undercut banks, pools, macrophytes, logs, overhanging vegetation, rootwads, boulders, and backwaters. These habitat types were used to develop a rating system for mapping good, adequate, and poor-quality habitat stream reaches within the watershed *(Figure 45)*.

- Stream reaches exhibiting 3 or fewer habitat types are considered poor,
- Reaches with between 4 and 6 habitat types are considered adequate,
- Reaches with 7 or 8 habitat types provide good habitat.

The inventory results indicate nearly all stream reaches comprising Bull's Brook and Bull Creek contain at least adequate habitat availability. Integrated Lakes Management (ILM) (2003) indicates that the stream reaches between Butler Lake and the Des Plaines River have the highest diversity and best stream biology on the Bull Creek stream system, and that Iowa darters (state T&E fish) use this stream reach as a migration corridor. ILM also collected macroinvertebrates and fish at several locations throughout the watershed and found that species were dominated by those typically found in headwater streams. Macroinvertebrate populations were limited in some samples despite excellent habitat. This implies that some form of pollution may be entering the water near these sites.

Fallen logs provide turtle habitat in Bull Creek downstream of Butler Lake

Figure 44: Riparian Buffer Improvements

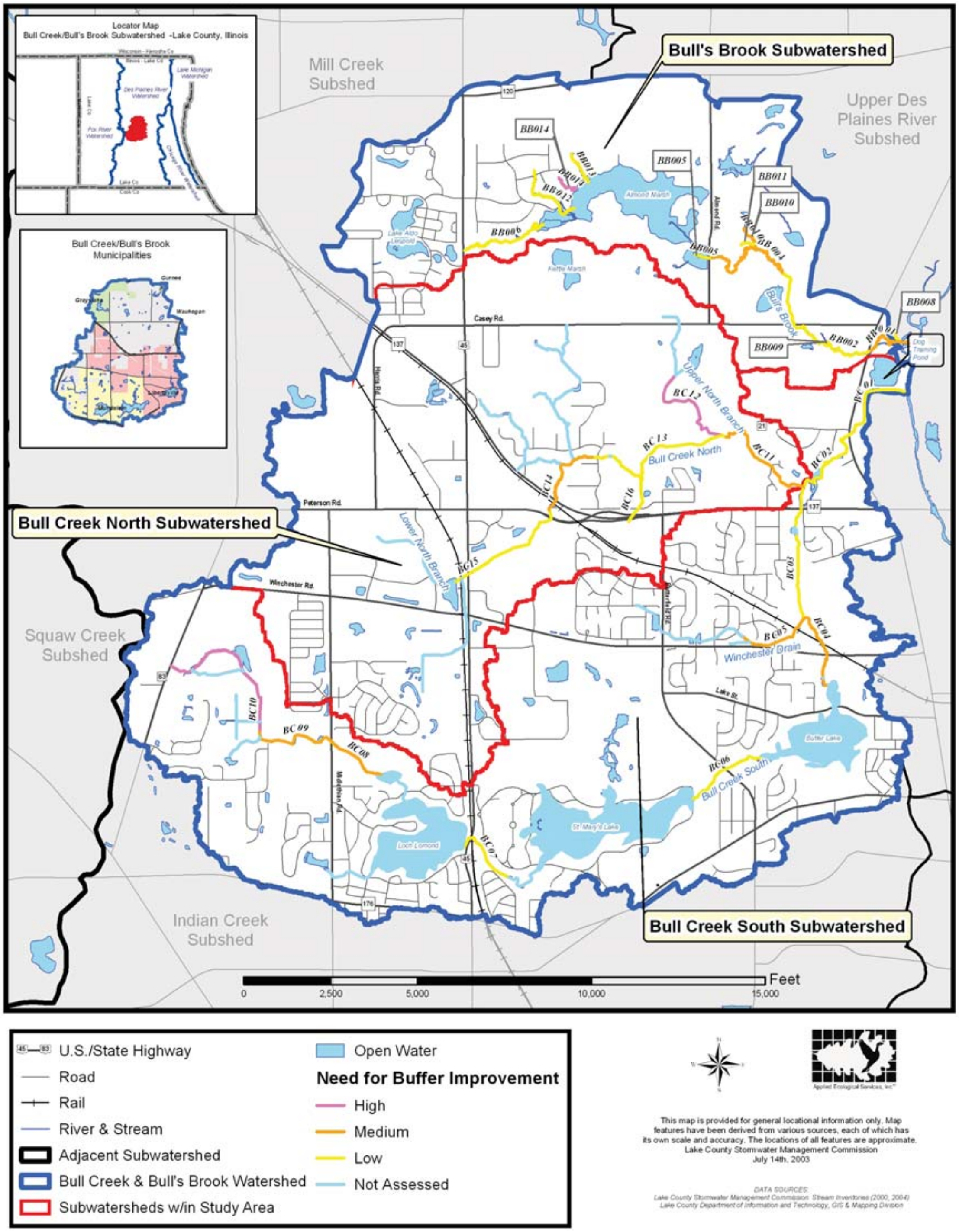
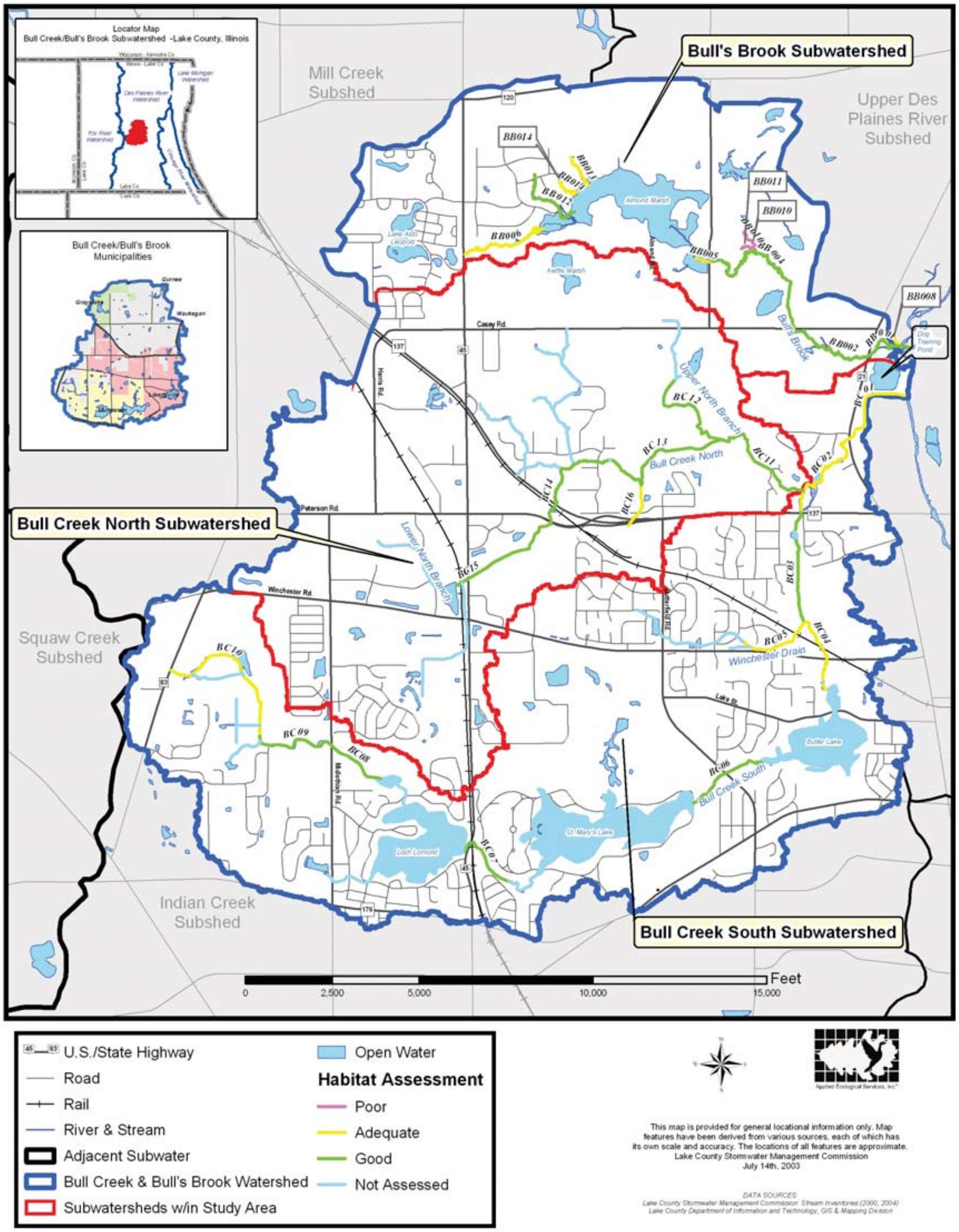


Figure 45: Instream Habitat Quality



WATER QUALITY

Bull Creek's confluence with the Des Plaines River: At the time this photo was taken in September 2006, Bull Creek water was more turbid than the background level in the Des Plaines River."

Water quality was qualitatively assessed by visually inspecting and documenting indicators including turbidity, presence of filamentous algae, and grease/oil in the water column. No stream reaches were highly turbid in Bull Creek North or Bull Creek South during baseflow conditions. However, 88% of the stream reaches were categorized as moderately turbid. Only 2 reaches had low turbidity. In contrast, nearly 75% of Bull's Brook stream reaches exhibited low turbidity. No highly turbid reaches were identified.

The presence of algae usually indicates the presence of high nutrient levels, especially phosphorus, in the water column. According to the inventories, only 3 reaches along Bull Creek South (BC04, BB05, and BC07) and one reach along Bull Creek North (BC12) experience algae problems. No algae problems were identified in Bull's Brook.

Grease/oil accumulations in either the water column or sediment were seen in 16 of the 30 reaches (53%) comprising Bull Creek North, South, and Bull's Brook. Grease and oil are likely the result of runoff from pipes that drain nearby roads and parking lots.

CURRENT STREAM MANAGEMENT ACTIVITY

- Sediment dispersal and removal was recently conducted in Bull Creek South along Cass Avenue to improve flow, drainage, erosion control, wetland improvement, and property beautification.
- In 2005, Applied Ecological Services, Inc. (AES) assessed and developed a stream restoration concept plan for a segment of Bull Creek South between Midlothian Road and the online detention basin approximately 1,500 linear feet downstream on Mundelein Park District land. The assessment was completed so that the park district could incorporate the plan into the proposed aquatic center and recreation facility.
- Libertyville Township continues to manage a segment of Bull's Brook just east of Route 45 in Oak Openings Nature Preserve. Management has included the installation of stream channel stabilization BMPs in the past, and currently includes exotic and invasive species removal along the streambanks.
- The Liberty Prairie Area Homeowners Association (LPAHOA) in cooperation with Libertyville Township applied for and received grant funds to develop a conceptual restoration plan and budget to restore Bull Creek (BC14) on private property through the LPAHOA area.

3.11 Lakes Inventory

The Bull Creek/Bull's Brook Watershed includes close to 400 acres of open water (*Figure 46*). Open water generally includes all lakes, ponds, and wetlands with open water surfaces. Bull's Brook subwatershed has over 60 acres of open water, Bull Creek North subwatershed has about 45 acres of open water, and Bull Creek South subwatershed has close to 300 acres of open water. Six primary lakes are located in the watershed: Loch Lomond, St. Mary's Lake, Butler Lake, Dog Training Pond, Aldo Leopold Lake, and the International Mining & Chemical Company (IMC) Lake. Loch Lomond, St. Mary's Lake, and Butler Lake are all in-line lakes created by installation of low head dams on Bull Creek South. Also Aldo Leopold Lake is the only other in-line lake and is the headwaters of Bull's Brook. The Dog Training Pond is off-line and drained by culverts to Bull Creek. IMC Lake is also offline and drained via stormsewer networks eventually to Bull Creek South.

The data collected during lake studies was used to assess shoreline conditions, aquatic vegetation, water quality, and available wildlife habitat for each lake. Figure 47 shows the percentage of lakeshore erosion that was documented during recent LCHD and ILM lake assessments. The LCHD lake reports contain detailed information regarding shoreline erosion.

PHOSPHORUS

Table 26 below summarizes documented phosphorus concentrations, TSIp number, and TSIp Category for each assessed lake in the watershed. Loch Lomond, St. Mary's and IMC lakes exceed the state general use standard of 0.05 mg/l for phosphorus. The water clarity (secchi depth) is also shown in Table 26. Figure 48 maps the water clarity and trophic state classifications. Water clarity is directly related to phosphorus levels. The state of Illinois set the secchi depth (water clarity) standard at 4 feet for swimming and 1.5 feet for general water quality. All lakes meet the general water quality secchi depth standard. Butler Lake, Dog Training Pond, and Aldo Leopold Lake meet the standard for swimming.

Table 26. Secchi depths, phosphorus concentrations, and TSIp values/categories for assessed lakes in the Bull Creek/Bull's Brook watershed

Lake	Year Assessed	Secchi Depth (ft)	Phosphorus (mg/l)	TSIp	TSIp Category
Lake County Median	2000-05	3.17	0.063	65.8	
Loch Lomond	2005	2.17	0.295	86.2	Hypereutrophic
St. Mary's Lake	2005	2.79	0.067	64.7	Eutrophic
Butler Lake	2005	4.35	0.053	61.3	Eutrophic
Dog Training Pond	2005	14.9	0.022	52	Eutrophic
Aldo Leopold Lake	2006	6.5	0.047	55	Eutrophic
IMC Lake	2005	3.08	0.095	69.8	Eutrophic

Source: Lake County Health Department Lake Management Reports; Integrated Lakes Management (2003)
Secchi Depth Standard = 4 ft for swimming, 1.5 ft for general water quality
Total Phosphorus Standard = 0.05 mg/l for General Use Water Quality

Reports completed by LCHD and ILM indicate that in general most Bull Creek/Bull's Brook watershed lakes are in average condition when compared to other County lakes. Most lakes have eroded shorelines that are dominated by invasive plant species. Copies of detailed lake reports can be obtained from: (www.co.lake.il.us/health/ehs/lmureports.asp.).

Noteworthy Shoreline Erosion and Invasive Plants

Shoreline erosion usually increases as deep-rooted native vegetation is replaced by shallow-rooted non-native vegetation such as turf grass. Erosion not only results in loss of shoreline, but also negatively influences the lake's overall water quality by contributing nutrients, sediment, and pollutants into the water. Additionally, turf grasses or constructed seawalls provide little habitat for wildlife and do not serve as a natural buffer to filter runoff.

As humans remove native plant species from lake shorelines for development purposes, invasive, non-native species often move in and alter the original landscape. Most often, non-native, pioneer species such as buckthorn or reed-canary grass are the first to occupy disturbed areas.

Limnology: *The scientific study of bodies of fresh water for their biological, physical, and geological properties.*

Trophic State Index (TSI): *Trophic State is a measure of the degree of plant material in of a body of water. It is usually measured using one of several indices (TSI) of algal weight (biomass): water transparency (Secchi Depth), algal chlorophyll, and total phosphorus.*

Oligotrophic: *A waterbody with the lowest level of biological productivity. Oligotrophic waterbodies typically have clear water, few aquatic plants, and few fish.*

Mesotrophic: *A waterbody with moderate levels of biological productivity. These waterbody's commonly have clear water with beds of submerged aquatic plants and medium levels of nutrients.*

Eutrophic: *A waterbody having a high level of biological productivity which is usually a result of high nutrient loads.*

Hypereutrophic: *A waterbody having the highest level of biological productivity. They typically have very low water clarity, potential for many fish and other wildlife, and may have an abundance of aquatic plants.*

Noteworthy **Phosphorus & the Trophic State Index**

Total phosphorus (TP) concentrations are important to a lake's productivity and health. The State of Illinois General Use Standard for TP is 0.05 mg/l while the Lake County average is 0.066 mg/l. When TP levels exceed 0.05 mg/l lake wide algal blooms can occur. Increases in algal blooms lead to decreased water clarity, a decrease in light penetration, and increase in total suspended solids. In other words, the biological productivity of the lake increases. ***Limnologists*** measure biological productivity by computing a ***Trophic State Index (TSI)***. The single index number derived from the TSI is then compared to numerical ranges for the four trophic states discussed below. The most common TSI used to assess Lake County Lakes is the phosphorus based TSI (TSIp). This uses phosphorus as the primary indicator. The TSIp categories include: ***oligotrophic*** (lacking biological productivity), ***mesotrophic*** (moderate biological productivity), ***eutrophic*** (high biological productivity), and ***hypereutrophic*** (overabundant biological productivity).

The trophic state of a lake is important because managers can choose effective strategies to meet the goals of a lake and set reasonable expectations regarding the waterbody's true potential. For example, oligotrophic and mesotrophic lakes are better managed for swimming than eutrophic lakes because they are generally clearer and contain less biological productivity. Eutrophic lakes are better managed for fishing and bird watching.

Hypereutrophic lakes (TSIp >70) are generally characterized as having extremely high nutrient concentrations as well as extensive algal blooms and low water clarity. Eutrophic lakes (TSIp 50-69) have high biologically productivity. They possess high nutrient concentrations and are able to support algal blooms and extensive rooted plant populations. Eutrophic lakes often lack oxygen in the bottom waters during summer stratification. This lack of oxygen limits the habitat potential of the system. Mesotrophic lakes (TSIp 40-49) are characterized by intermediate nutrient concentrations and intermediate productivity. These lakes can support algae but the severe blooms associated with eutrophic and hypereutrophic lakes are not common. Similarly, mesotrophic systems support some rooted plants but not at nuisance levels. No mesotrophic or oligotrophic lakes (TSIp <40) are found in the watershed.

Figure 46: Lakes and Other Open Water

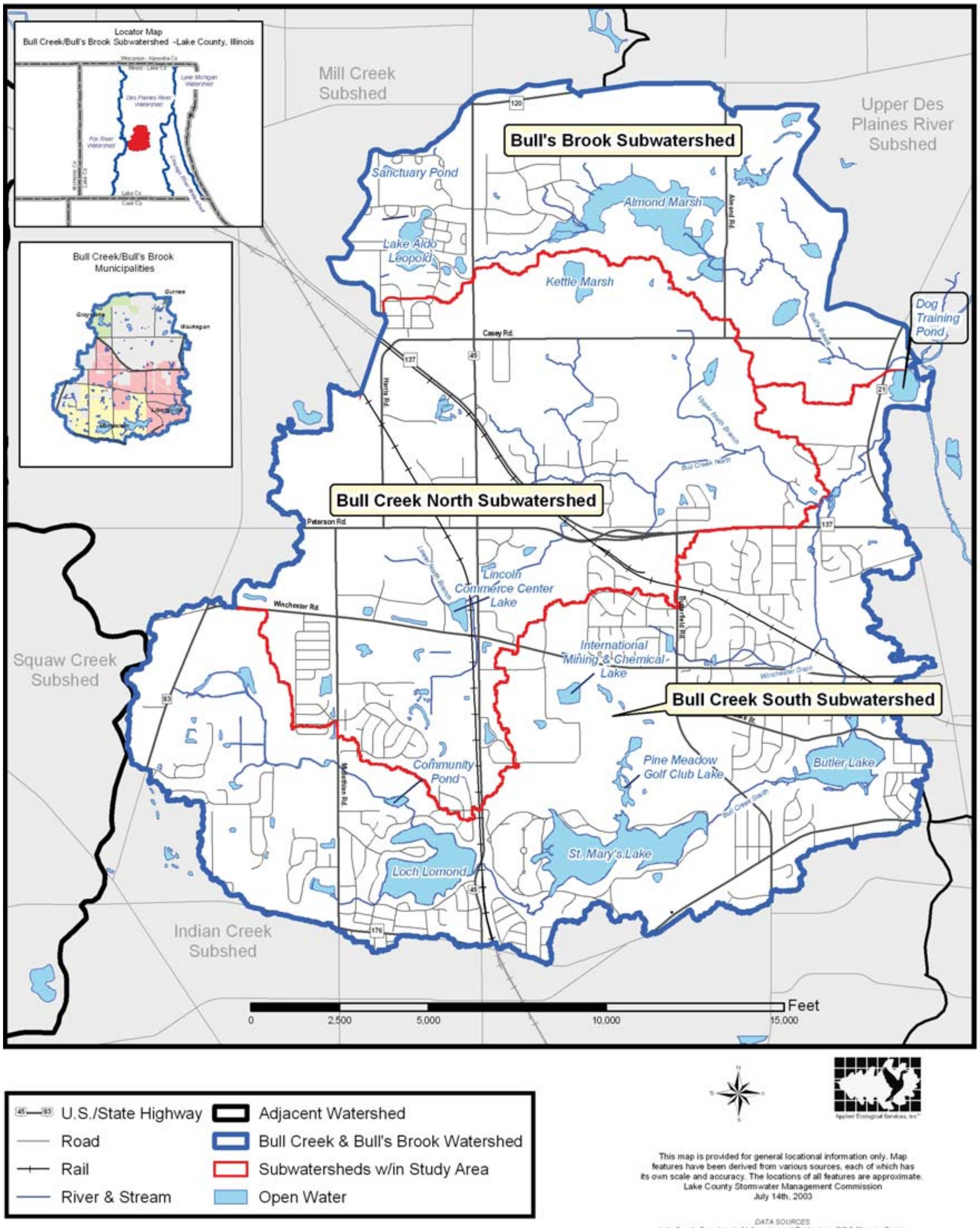


Figure 47: Shoreline Erosion and Invasive Plant Species Abundance Along Lakes

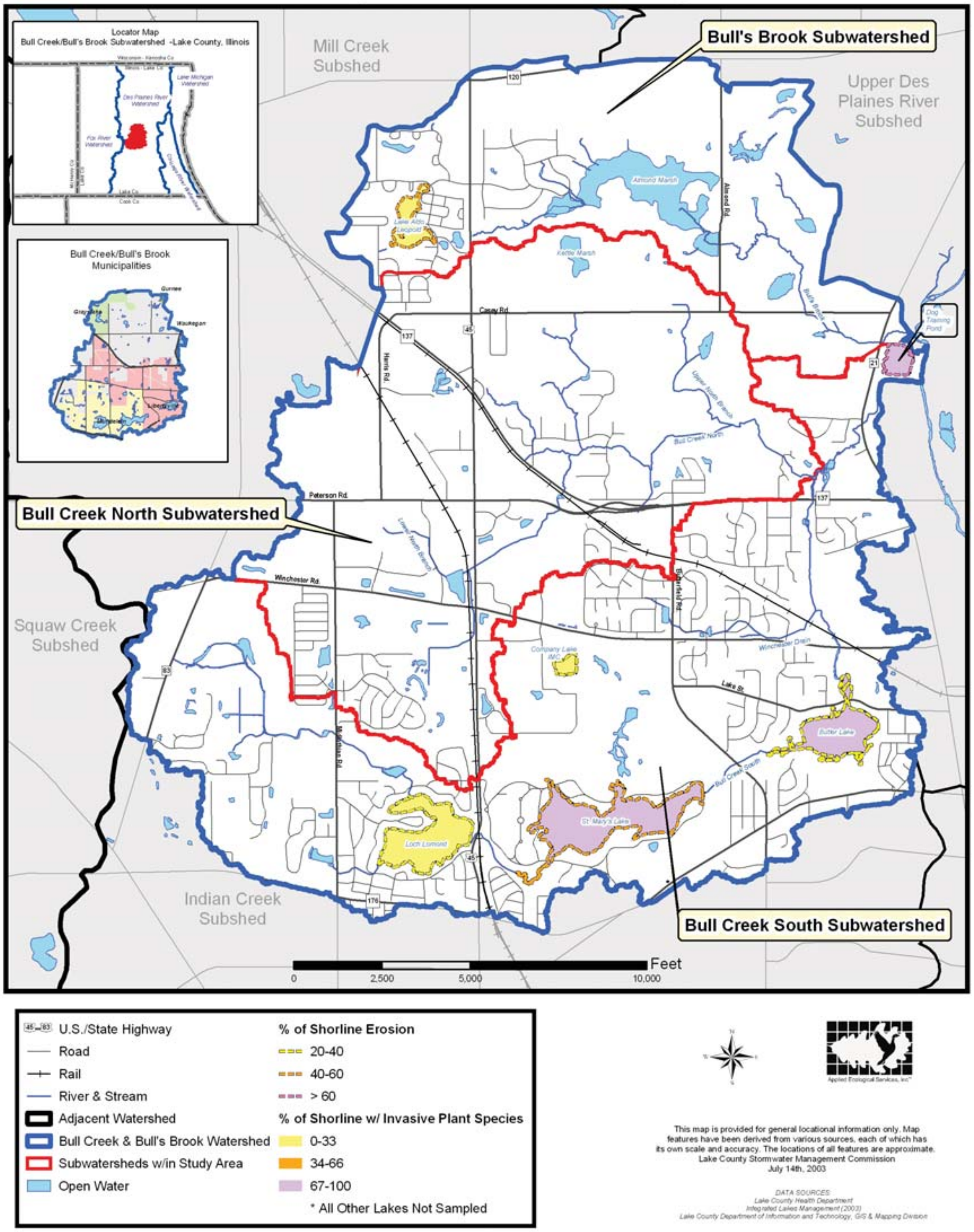
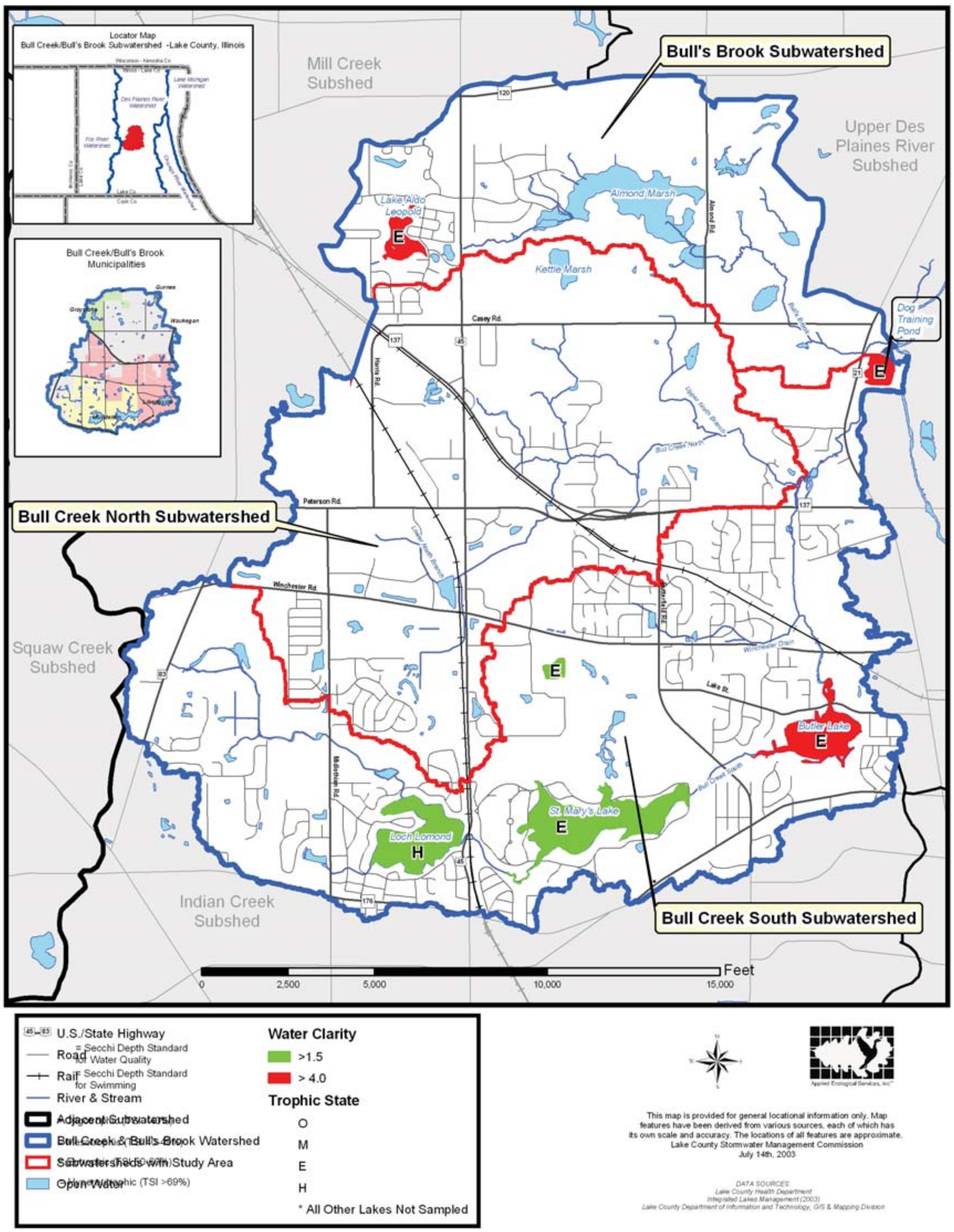


Figure 48: Trophic State Classifications and Water Clarity Standards



Individual Lake Summaries

LOCH LOMOND

Loch Lomond was created in 1955 when the Arthur T. McIntosh Company constructed a dam across the south branch of Bull Creek to create a centerpiece for residential development. Loch Lomond drains an area of 1,439 acres, covers approximately 75 acres, is 0.6 miles long, and has 2.2 miles of shoreline, which is 100% developed. It is the most upstream of the three in-line lakes along Bull Creek South (Figure 46). When full, Loch Lomond contains 123 million gallons of water. It can be 4-6" lower during drought conditions, and is seldom more than a few inches higher following the heaviest rainfall. The lake is used primarily for boating (non-motorized), fishing, and swimming.

Loch Lomond subdivision consists of approximately 600 homes, roughly 100 of which are lakefront property. The Loch Lomond Property Owners Association owns the lake, the dam, and two small beach areas. The 550-foot dam and 50-foot concrete spillway were originally planned to be a roadway connecting the north and south sections of the surrounding subdivision.

Mouth of Bull Creek at Loch Lomond.

Extremely high phosphorus levels (0.295 mg/l) are the primary cause for degraded water quality conditions in Loch Lomond. The high phosphorous content results in recurring algal blooms in the summer months, and water quality is rated near the bottom of all Lake County lakes (157 of 162 evaluated lakes). According to Integrated Lakes Management (ILM), the majority of phosphorus is originating from internal sources; the second highest contributor is from near shore runoff. A small pond just north of Loch Lomond could also be a source of phosphorus. The Trophic State Index (TSIp) for Loch Lomond was 86.2 in 2005, classifying it as hypereutrophic (overabundant biological productivity) (Figure 48).

The average secchi depth in Loch Lomond is 2.17 feet. This meets the state standard for general water quality which is 1.5 feet but not for swimming which is 4 feet *(Table 26)*. ILM (2003) indicates that historically, the lake has been dominated by algae and carp, which kept the lake turbid. Carp eradication and aquatic plant control methods are common lake management practices used for this lake. Loch Lomond exhibits little erosion (0-33%) but for different reasons than Butler Lake. Rather than being surrounded by wetland, Loch Lomond's shoreline is heavily residential and lined mostly by seawalls and riprap and as a result contains little native or non-native plant species (0%-33%) (Figure 47). The LCHD identified five aquatic plant species within Loch Lomond in 2005 although extensive beds of vegetation were scarce.

In the past, Loch Lomond was rotenoned to kill the problematic carp that kept the lake turbid. This kill-off resulted in an abundance of aquatic plants. In the early

1990's grass carp were stocked and herbicides were applied to control the vegetation. As a result, aquatic vegetation was reduced to nearly zero. Today, Loch Lomond is currently managed with limited chemical treatments for algae and rooted aquatic vegetation using copper sulphate with a goal of obtaining 30%-40% coverage of aquatic vegetation as recommended by the Lake County Lakes Management Unit. In addition, the Loch Lomond Lake Association completed a Watershed-based Plan for the lake and hopes to receive IEPA 319 grant funding to implement native plant buffers in shoreline demonstration areas, aquatic plant restoration, and education projects. This Plan is included in Appendix R.

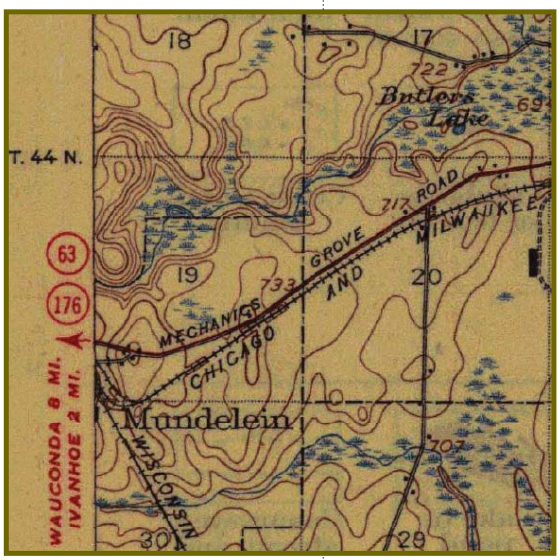
ST. MARY'S

St. Mary's Lake is a 106-acre in-line lake with a maximum depth of 18 feet that is located on Bull Creek South between Loch Lomond and Butler Lake (Figure 46). The 1908 U.S.G.S. 15-minute quadrangle shows the lake basin as a ravine system and bottomland marsh associated with a perennial and free-flowing Bull Creek. Bull Creek was dammed sometime between 1915 and 1920, creating the lake. St. Mary's is a private lake owned by St. Mary's Seminary and is surrounded by native woodland, but the shorelines contain between 40% and 60% non-native plants. The seminary manages the lake, which is used by students for fishing, boating, and aesthetics. However, the Seminary reports very minimal management over the past several years (Stan Rys-personal contact). Present management includes some trash clean up, tree removal, and minor bank stabilization.

According to the Lake County Health Department Lakes Management Unit 2005 Summary Report, St. Mary's Lake has very low levels of aquatic plant growth, possibly a result of carp activity, the shape and structure of the lakebed, or rocky substrate. High levels of suspended solids and total phosphorus have been correlated to algal blooms that occur periodically throughout the summer and early autumn. Phosphorus levels measured by LCHD in 2005 indicate elevated levels at 0.067 mg/l *(Table 26)*. These phosphorus levels lead to a Trophic State Index (TSIp) in the eutrophic category (TSIp = 64.7) *(Figure 48)*. The LCHD believes non-point sources of phosphorus are minimal and that the source of high phosphorus concentrations is not clear. Phosphorus is most likely entering St. Mary's Lake via Bull Creek South, which flows into and out of Loch Lomond or from the St. Mary's Sewage Treatment Plant, which currently has a NPDES permit in place. The wastewater treatment plant, located on the seminary grounds, treats waste for approximately half of the campus and discharges to the lake. Based on the 0.030 million gallons per day (MGD) design average flow (DAF), approximately 91.4 pounds of phosphorus enters St. Mary's Lake each year from the treatment plant.

View of St. Mary's Lake

High total suspended solids measured in 2005 were likely due to moderate and severe erosion along the north and south shorelines. According to the shoreline assessment conducted by LCHD, St. Mary's Lake has between 40% and 60% shoreline erosion *(Figure 47)*. A large carp population documented by LCHD also causes high suspended solids by the constant stirring of the lake bottom during feeding. High phosphorus concentrations are also a likely contributor to the high TSS because it can cause algae blooms. Road salt is also a contributor to high TSS. A 73% increase in conductivity from 1995-2002 indicates an increase in road salt usage presumably from Route 45 and other nearby roads that eventually drains to St. Mary's Lake. Increased road salt concentrations can negatively affect aquatic organisms such as fish, macroinvertebrates, algae populations, and native plants thus changing the composition of the lake and making it susceptible to invasion by non-native or invasive species.



Portion of 1908 U.S.G.S. 15-minute quad showing the location of St. Mary's and Butler Lakes. The modern lake inundated Bull Creek and the associated marshland and small pond southwest (below-left) of "Butler's" Lake.

BUTLER LAKE

Butler Lake is 58 acres with a maximum depth of 9 feet, and is the third in-line lake located along Bull Creek South (Figure 46). Although a natural glacial lake, Butler was dammed around 1940, presumably to maintain a higher and more stable water level. Unlike Loch Lomond and St. Mary's Lake, Butler Lake is publicly owned by the Village of Libertyville and managed by the Libertyville Parks and Recreation Department who conducts herbicide treatments, introduces grass carp as needed, and conducts mechanical vegetation removal methods to control algae and rooted vegetation. The lake is considered an ADID (advanced identification—high quality) wetland by the EPA and is surrounded by mostly natural land uses. Because of its natural shoreline, little shoreline erosion (0%-33%) was noted by the LCHD *(Figure 47)*. And, this natural shoreline has few (0%-33%) invasive species. The primary uses of the lake include aesthetics, fishing, ice skating, and boating (non-motorized). Winter fish kills have been reported in the past, the most recent occurring in 2000-2001. Such events suggest a lack of dissolved oxygen in the water column, usually resulting from aquatic plant mortality caused by snow cover on the lake ice surface. The bacteria that consume this organic material consume the available oxygen in the water, leaving an insufficient amount for other forms of aquatic life, such as fish. The Village of Libertyville Parks and Recreation Department has installed an aeration system that should curb the problem of winter fish kills.

LCHD reports approximately 95% of the lake bottom is covered with aquatic plants. The plant assessment in 2005 found 15 species; coontail and white water lily were the most common. Two of 15 species, Eurasian water milfoil and curlyleaf pondweed are exotic but were not found in significant numbers. Butler Lake's aquatic plant community is considered better than average compared to other lakes in the county (24 of 151 lakes sampled). This abundant vegetation community also comes as a result of phosphorus levels (0.053 mg/l) that classify the lake as eutrophic (TSIp=61.3) *(Table 26, Figure 48)*.

High conductivity levels were also detected by LCHD in 2005 and are likely the result of high organic matter and road salts in the water column. In fact, the conductivity measured in 2001 and 2005 was nearly twice the level recorded in 1995, indicating a worsening problem.

The Army Corps of Engineers funded a hydraulic dredging project on Butler Lake in 2006. Dredging activities have occurred several times in the past, with the most recent dredging (prior to the recent project) taking place in either the late 1960s (US Army Corps of Engineers website) or early 1980s (2001 LCHD Lakes Management Unit Lake Report), depending upon the historical source.

Postcard of Butler Lake, ca. 1915. ©Lake County Discovery Museum

In addition to the lake studies that the Health Department performed on Butler Lake, two other groups; Lake Management Consultants and the Northeast Illinois Planning Commission (NIPC) studied Butler Lake in 1978 and 1992 respectively. Lake Management Consultants found poor secchi levels, high phosphorus concentrations, and high suspended solids. The NIPC study also showed high phosphorus concentrations but increased secchi levels/decreased total suspended solids.

DOG TRAINING POND

The LCHD conducted it's most recent study of the Dog Training Pond in 2005. The waterbody is a 13-acre lake with a maximum depth of 19 feet that was originally excavated as a gravel pit in 1903. The gravel mined from this pit was used to build I-94. It is now owned by the Lake County Forest Preserve District and is part of the dog training/exercise area of Independence Grove Forest Preserve. No boating or fishing is allowed. Water is allowed to drain from the lake through culverts into Bull Creek just west of the junction with the Des Plaines River. Although about 95% of the shoreline is not developed, the County's shoreline assessment of the lake noted greater than 60% shoreline erosion and between 67% and 100% dominance by invasive species such as buckthorn, reed canary grass, purple loosestrife, and honeysuckle species *(Figure 47)*. Also, the 2005 report notes increased shoreline erosion compared to 2001. Dogs that are entering and leaving the water are increasing the severity of erosion. An examination of the aquatic plants in 2001 and 2005 noted several changes. Eight species were documented in 2001. Curlyleaf pondweed was the only exotic found but in small percentages. Eurasion water milfoil, a common exotic, was not documented. But in 2005, milfoil was the second most abundant species. Curlyleaf pondweed was no longer present in 2005.

The Dog Training Pond exhibits the lowest phosphorus levels (0.022 mg/l) and Trophic State Index (TSIp = 52) in the watershed *(Table 26, Figure 48)*. However, phosphorus and the TSIp score have increased since measurements were last recorded in 2001 when the lake was rated first (lowest phosphorus levels) among all lakes monitored in Lake County. At that time, the lake was considered mesotrophic. The slight increase in phosphorus levels now classifies the lake as eutrophic *(Figure 48)*. Despite the increase in phosphorus between 2001 and 2005, water clarity (secchi depth) remains around 15 feet *(Table 26)*. A wildlife survey around the lake noted good numbers of species, especially birds. No fish surveys were completed but many small bluegill were observed in 2005. This could be a sign that the system lacks predatory fish such as largemouth bass that help sustain the fishery. According to the LCFPD (Ken Klick-personal contact), no known management is or has occurred in or around the lake.

View of Dog Training   from parking Lot

ALDO LEOPOLD LAKE

Treatment Train: *Several BMPs used together to improve water quality, infiltration and reduce sedimentation.*

Aldo Leopold Lake is a 23-acre lake created in 1995 and located within the Prairie Crossing Subdivision in the headwaters of the Bull's Brook subwatershed. The Lake was created in 1995 for stormwater storage and as a recreational lake incorporated into a conservation development. A "***Treatment Train***" system for treating stormwater prior to discharge into the lake was implemented. The Treatment Train uses a series of prairies, vegetated swales, and wetlands to filter stormwater before it enters the lake. The result is a lake with good water quality that harbors four species of endangered and threatened fish introduced by Integrated Lakes Management (ILM). This introduction represents the first Illinois refuge for state endangered and threatened non-game species. It began when ILM biologists captured approximately 200 indi-

Storm water treatment train designed by AES for Prairie Crossing conservation community.

viduals of each T&E species (blacknose shiner, banded killifish, Iowa darter, blacknose shiner) from nearby lakes and transported them to Sanctuary Pond, a 2-acre lake also located within Prairie Crossing. In 2000, the fish were recaptured and transplanted into Aldo Leopold Lake where populations are doing well. Several of these species have been found downstream near Almond Marsh suggesting migration through Bull's Brook.

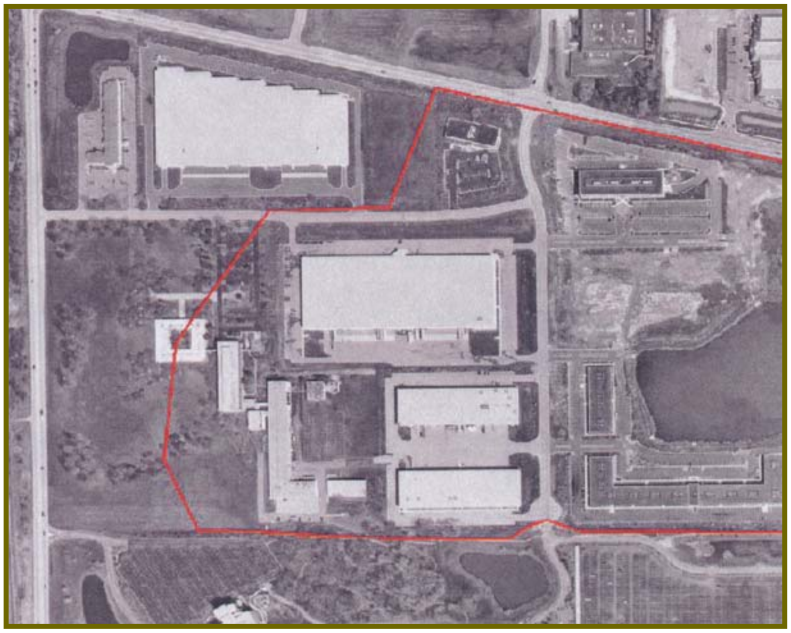
Despite having good water quality, Aldo Leopold Lake does exhibit between 40% and 60% moderate shoreline erosion and contains between 34% and 66% invasive species dominance along the banks *(Figure 47)*. ILM's 2006 water quality monitoring report for Aldo Leopold Lake summarizes plant community and general water quality data. According to the report, two non-native aquatic plant species, Eurasian water milfoil and curly leaf pondweed were dominant in the lake in 2005. Introduction of Eurasian water milfoil weevils and herbicide treatments greatly reduced these populations in 2006.

Vegetated swale at Prairie Crossing

The water quality in Aldo Leopold Lake is good and meets all state standards. Since 2001, when the Village of Grayslake took over maintenance of subdivision streets, chloride concentrations have slowly increased suggesting that the lake is accumulating salt. In 2006, ILM measured chloride concentrations at 346 mg/l which is approaching the state standard of 500 mg/l. Limiting or restricting salt application to nearby roads during winter months would likely reduce salt concentration over time. Aldo Leopold Lake exhibits phosphorus levels (0.047 mg/l) below the state standard (0.05 mg/l) correlating to a Trophic State Index of 55 which classifies the lake as eutrophic (Table 26, Figure 48). The water clarity is greater than 4 feet, the state standard for swimming.

View of Leopold Lake

Approximate watershed delineation for IMC Lake (LCHD 2005)



INTERNATIONAL MINING & CHEMICAL COMPANY (IMC) LAKE

The LCHD conducted its most recent study of the International Mining & Chemical Company (IMC) Lake in 2005. A study was also conducted in 2003. The IMC Lake is not on-line with any major stream or tributary system, rather it obtains its water via six stormwater inlets that drain an 80+ acre watershed dominated by highly impervious industrial and institutional land uses. The 6.7 acre lake was created as a detention pond and for aesthetic enjoyment in a historical wetland area.

Chloride originating from road salt is extremely high in IMC Lake and set the Lake County maximum in 2005 with an average concentration of 1,852 mg/l. This exceeds by more than triple the IEPA standard of 500 mg/l thereby negatively impacting aquatic life. LCHD indicates negative changes in several water quality parameters between 2003 and 2005; total suspended solids (TSS) doubled, Secchi disk measurements decreased from 4.9 to 3.1 feet, and chloride levels have tripled. Phosphorus levels are also elevated (0.095 mg/l) 50% higher than the county average. All of these changes are attributed primarily to urban development and stormwater discharge that began around 1998.

The Trophic State Index based on phosphorus levels is 69.8 classifying the system at the upper limits of eutrophic. Plant sampling conducted in 2005 indicates relatively few species and dominance by curlyleaf pondweed, a non-native species. Coontail, a native species was also abundant. Eurasion watermilfoil, another non-native was also observed. According to LCHD's 2003 study, the majority of the shoreline was not eroding. However, in 2005 a follow up survey noted moderately eroded areas along the south side of the lake that is attributed to wave and ice damage, and rising and falling water levels following significant rain events. In addition to shoreline erosion, LCHD also noted the presence of non-native plant species along the shoreline, although not in abundance.

3.12 Water Quality

Water quality in Bull Creek and Bull's Brook is primarily impacted by ***Non-point source pollution*** as documented in Illinois Environmental Protection Agency (IEPA) studies, Lake County Health Department (LCHD) studies, and other studies conducted by private entities. Nonpoint pollutants are transported to streams and lakes from agricultural and urban runoff and by in-stream erosion. ***Point source pollutants*** come from wastewater discharges.

Non Point Source pollution: *Refers to pollutants that accumulate in waterbodies from a variety of sources including runoff from the land, impervious surfaces, the drainage system and deposition of air pollutants.*

Point source pollution: *Refers to discharges from a single source such as an outfall pipe conveying wastewater from an industrial plant or wastewater treatment facility.*

Noteworthy Land Use & Water Quality

Studies have shown that land use has a direct effect on water quality. Generally, the higher the percent of connected impervious cover of a land use, the greater the pollution load it generates. Pollutants from a variety of diverse and diffuse sources collect on impervious surfaces and are flushed into rivers and streams when it rains. Urban lawns, driveways, rooftops, parking lots and streets are the source areas of these pollutants, while the causes include: vehicles, road surface applications, direct atmospheric deposition, fertilizer; pesticides/herbicides, general litter (including pet litter), vegetative decay; and soil erosion from construction sites. Urban runoff also carries pollutants such as oil and grease, metals and pathogens such as fecal coliform. Runoff from impervious surfaces can be 10-12 degrees warmer than runoff from land in a natural state, which combined with reduced summer flows results in higher in-stream water temperatures. Table 27 is a comparison of pollutant loads from a number of nonpoint sources representing different land uses based on extensive monitoring for a Wisconsin study.

Table 27. Geometric Mean Concentrations of Pollutants in Stormwater Runoff from Urban Areas

Source Area	Total Phosphorus (mg/l)	Solids (mg/l)	E. coli (c/100ml)	Zinc (µ/l)	Cadmium (µ/l)	Copper (µ/l)
Residential feeder street	1.31	662	92,000	220	0.8	46
Residential collector street	1.07	326	56,000	339	1.4	56
Commercial arterial street	0.47	232	9,600	508	1.8	46
Industrial collector street	1.5	763	8,380	479	3.3	76
Industrial arterial street	0.94	690	4,600	575	2.5	74
Residential roofs	0.15	27	290	149	ND	15
Commercial roofs	0.2	15	1,117	330	ND	9
Industrial roofs	0.11	41	144	1,155	ND	6
Residential lawns	2.67	397	42,000	59	ND	13
Driveways	1.16	173	34,000	107	0.5	17
Commercial parking	0.19	58	1,758	178	0.6	15
Industrial parking	0.39	312	2,705	304	1	41

Adopted from Bannerman ET. AL. , 1993
*Table reproduced from Watershed Techniques Vol. 1, No. 1

TYPICAL PARAMETERS SAMPLED AND PREVIOUS SAMPLE LOCATIONS

Water quality studies have been completed by several agencies within the Bull Creek/Bull's Brook watershed *(Table 28)*. The majority of recent stream water quality sampling has been conducted by the IEPA. The most recent lake sampling has been conducted by the Lake County Health Department (Loch Lomond, St. Mary's Lake, Butler Lake, Dog Training Pond, and IMC Lake); Integrated Lakes Management has done extensive monitoring of Aldo Leopold Lake located in Prairie Crossing. Other data has been collected by agencies and companies including Graef, Anhalt, Schloemer and Assoc. (GAS), Applied Ecological Services, Inc. (AES), United Stages Geological Survey (USGS), Lake Management Consultants, and Northeastern Illinois Planning Commission (NIPC) from 1978 to the present for private lakes and portions of Bull Creek and Bull's Brook *(Table 28; Figure 49)*. A brief summary of finding in these studies can be found in Appendix Q: Water Quality. The location of each water quality sample site is shown on Figure 49.

Noteworthy Water Quality Monitoring

Water quality monitoring is conducted in both lakes and streams but differs depending on the parameters measured. Lake studies usually monitor for nutrients, suspended solids, water clarity, and dissolved oxygen. These measurements can be analyzed and used to develop Trophic State Indexes (TSI). A TSI provides an indicator of lake quality and helps lake managers determine and implement appropriate management strategies and practices. Like lakes, stream testing often includes analysis of nutrients, dissolved oxygen, and suspended solids. However, flows can also be examined so that pollutant loading estimates for various constituents can be calculated and compared over varying storm events and years.

Limnologists evaluate the ecological health of a waterbody and the probable biological productivity by measuring a variety of chemical water quality parameters. The overall objective of water quality sampling and monitoring is to assess existing conditions in an attempt to restore or maintain the chemical, physical, and biological integrity of the stream or lake. A list of typical chemical monitoring parameters measured is listed below. A more detailed description of each is included in Appendix Q: Water Quality. The typical parameters measured are usually compared to "***General Use***" ***water quality standards*** as defined by the ***Illinois Pollution Control Board (IPCB)*** (IPCB 2002). General use standards are designed to protect the Illinois's water for aquatic life, wildlife, agricultural uses, secondary contact, and most industrial uses. In other words, General Use standards are established to protect "***Designated Uses***".

Typical Chemical Monitoring Parameters

— Temperature
— pH
— Dissolved Oxygen (DO)
— Total Suspended Solids (TSS)/Turbidity
— Total Dissolved Solids (TDS)
— Metals (Cadmium, Chromium, Copper, Iron, Lead, Manganese, Mercury, Silver, Zinc)
— Biological and Chemical Oxygen Demand (BOD & COD)
— Nitrogen (N) (& orthophosphorus and total kjeldahl nitrogen, nitrate + nitrite, and ammonia nitrogen)
— Total Phosphorus (TP)
— Fecal Coliform (E. coli)
— Water Clarity/Light Penetration
— Conductivity

Trophic State Index (TSI): *Trophic State is a measure of the degree of plant material in of a body of water. It is usually measured using one of several indices (TSI) of algal weight (biomass): water transparency (Secchi Depth), algal chlorophyll, and total phosphorus.*

General Use Water Quality Standards (State): *The Illinois Pollution Control Board (IPCB), a sister Agency to the Illinois EPA, develops water quality standards in Illinois. These standards serve to protect aquatic life, human health or wildlife, although wildlife based criteria have not yet been derived.*

Illinois Pollution Control Board (IPCB): *An independent agency created in 1970 by the Environmental Protection Act. The Board is responsible for adopting Illinois' environmental regulations and deciding contested environmental cases.*

Designated Use: *EPA requirements that States and authorized Indian Tribes specify appropriate water uses to be achieved and protected. Appropriate uses are identified by taking into consideration the use and value of the water body for public water supply, for protection of fish, shellfish, and wildlife, and for recreational, agricultural, industrial, and navigational purposes. In designating uses for a water body, States and Tribes examine the suitability of a water body for the uses based on the physical, chemical, and biological characteristics of the water body, its geographical setting and scenic qualities, and economic considerations. Each water body does not necessarily require a unique set of uses. Instead, the characteristics necessary to support a use can be identified so that water bodies having those characteristics can be grouped together as supporting particular uses.*

Table 28. List of chemical (H2O) and biological (BIO) water quality studies conducted in the Bull Creek/Bull's Brook Watershed

Map Code	Sampling Agency/Vendor	Years	Locations	Frequency
H2O 1& 2	ILM	1995-2002; 2005; 2006	Prairie Crossing Sanctuary Pond and Aldo Leopold Lk.	7 times/season
H2O 3-8	Graef, Anhalt, Schloemer and Assoc.	1998-2000	Oak Openings Nature Preserve	2 times/season, 5 stations
H2O 9-17	J. Ludwig Applied Ecological Services	1997	12 stations from Rt. 45 to the stream underpass at St. Rt. 21	3-4 times across sampling season
H2O 18	USGS	2000	At Rt. 21	1 visit
H2O 19	IEPA	1983	Above and below Rt. 21	4 visits
H2O 20	Lake County Health Dept	1988, 1999, 2004, 2005	Loch Lomond Lake	6 -10 times/season
H2O 21	IEPA, Volunteer Lake Monitoring Program	1991	Loch Lomond	3 sites/10 visits
H2O 22	Lake County Health Dept	1995,2002, 2005	St. Mary's Lake	10 times
H2O 23	IEPA, Volunteer Lake Monitoring Program	1987	Butler Lake	3 sites 10 visits
H2O 24	Lake County Health Dept.	1995,2001, 2005	Butler Lake	10 times/season
H2O 25	Lake Management Consultants	1978	Butler Lake	Less than 1 full year
H2O 26	Northeastern Illinois Planning Committee (NIPC)	1992	Butler Lake	1 date, 3 sites
H2O 27	Lake County Health Dept	2001, 2005	Dog Training Pond	5/season
H2O 28-34	Integrated Lakes Management Unit	2004	Wetlands and streams in LPR	Grab Sample: 4 visits Composite: 2 visits
H2O 35	Lake County Health Dept	2005	IMC Lake	Monthly May-Sept.
N/A	IEPA 305b report	Cycle yr. 2004	Butler Lk. (1992),)Loch Lomond (2002), Bull Creek at Rt. 21 (1997	1 visit
N/A	ILM	2002	Subwatershed scale	Annual load estimates
N/A	Eppich Modeling (HSPF)	1996	Entire Bull's Brook subwatershed	Continuous
BIO 1	IEPA	1997	Bull Creek at Rt 21 (GV-01)	1 visit
BIO 2	IDNR RiverWatch	2001, 2002	NE Section 8, 11E, 44N (R0213301)	1 visit per year
BIO 3	IDNR RiverWatch	2001	SW Section 4, 11E, 44N (R0213302)	1 visit
BIO 4	IDNR	1983, 1997, 2001, 2003	Bull Creek upstream of Rt 21 (GV-01)	1 visit
BIO 5	IDNR RiverWatch	2000, 2001	NW Section 6 T11E R44N Bull's Brook (R0214801)	1 visit
BIO 6	IDNR RiverWatch	2000, 2001	NW Section 5 T11E R44N Bull's Brook (R0214802)	1 visit
BIO 7	IDNR	2001	Bull Creek South-Peterson Road	1 visit
BIO 8	IDNR	2001	Upper North Branch-Bull Creek North	1 visit

Source: Modified from Integrated Lakes Management (2003).

Key:

NH3 = ammonia nitrogen	TDS = total dissolved solids	Secchi= water clarity	K= potassium	DO = dissolved oxygen
NO3 = nitrate nitrogen	TVS = total volatile solids	Cl = chloride	Turb.= turbidity	Total P = total phosphorus
TKN = kjeldahl nitrogen	TSS = total suspended solids	Fe = iron	pH=acid/base scale	Ortho P = orthophosphorus

Purpose	Parameters
Tracking general condition of lakes E/T fish status chlor. a, algae, zooplankton, cond.	DO, Cl, Tot.P, pH, alk., NH3, NO3, TKN, temp., cond., secchi, TSS, TSVS, Ortho. P, fecal coliform,
Sampling support for assessing effectiveness of erosion control practices	pH, temp., flow, cond., TSS, TDS, DO, salinity
Baseline data for BB subwatershed	pH, alk., temp., cond., turb., Cl.,Fe.,Pb.K.Na.t.P,NH3,NO2
Water quality and sediment	DO, temp., pH, Cl, cond., NH3, NO2, TKN, Ortho P, Tot. P, K, Na, Fe, SO4, Fl, Ca, Mn, Mg, TDS, chlor.a, metals
Water quality and sediment	DO, temp., pH, cond., NH3, NO2, TKN, Ortho P, Tot. P, TSS, TSVS, turb., TDS, metals
Lake assessment & sediment study	DO, temp., Tot. P, Ortho. P, pH, alk., NH3-N, NO3-N, TKN, temp., cond., secchi, TSS, TSVS, TDS, metals
Baseline lake water quality	Secchi depth, NO3, NH3, TKN, Tot. P, TSS, TSVS, assess color, algae & weeds.
Lake assessment study	DO, temp., Tot. P, Ortho. P, pH, alk., NH3-N, NO3-N, TKN, temp., cond., secchi, TSS, TSVS, TDS
Baseline lake water quality	Secchi depth, Trophic State Index (TSI), assess color, algae, weeds
Lake assessment study	DO, temp., Tot. P, Ortho. P, pH, alk.., NH3-N, NO3-N, TKN, temp., cond., secchi, TSS, TSVS, TDS
Lake assessment and management alternatives	Tot. P, TSS, Tot. solids, secchi
Lake assessment study	DO, temp., Tot. P, Ortho. P , TSI, pH, alk., NH3, NO3, TKN, temp., cond., secchi, TSS, TSVS
Lake assessment	DO, temp., Tot. P, Ortho. P, pH, alk.., NH3-N, NO3-N, TKN, temp., cond., secchi, TSS, TSVS, TDS
Influence of agricultural lands on water quality	Temp, DO, pH, Ortho NH3-N, NO3-N, P, TSS, Atrazine, Chlorimuron, Lactofen, Rimsulfuron, Tebupirimfos, 2,4-D, Dicamba
Lake assessment study	DO, temp., Tot. P, Ortho. P, pH, alk., N, NO3-N, TKN, temp., cond., secchi, TSS, TSVS, TDS
Determine causes and sources of impairment	Analysis of previously collected data
Load Estimates	TSS, metals, salts, flow, nutrients
Hydrologic and loading study	Rainfall, flow, sediment, chloride
Macroinvertebrate Survey	Macroinvertebrate water quality data
Macroinvertebrate Survey	Macroinvertebrate water quality data
Macroinvertebrate Survey	Macroinbertebrate water quality data
Fish Survey	Fish water quality data
Macroinvertebrate Survey	Macroinvertebrate water quality data
Macroinvertebrate Survey	Macroinvertebrate water quality data
Fish Survey	Fish water quality data
Fish Survey	Fish water quality data

Fe = iron
F = Fluorine
Temp = temperature

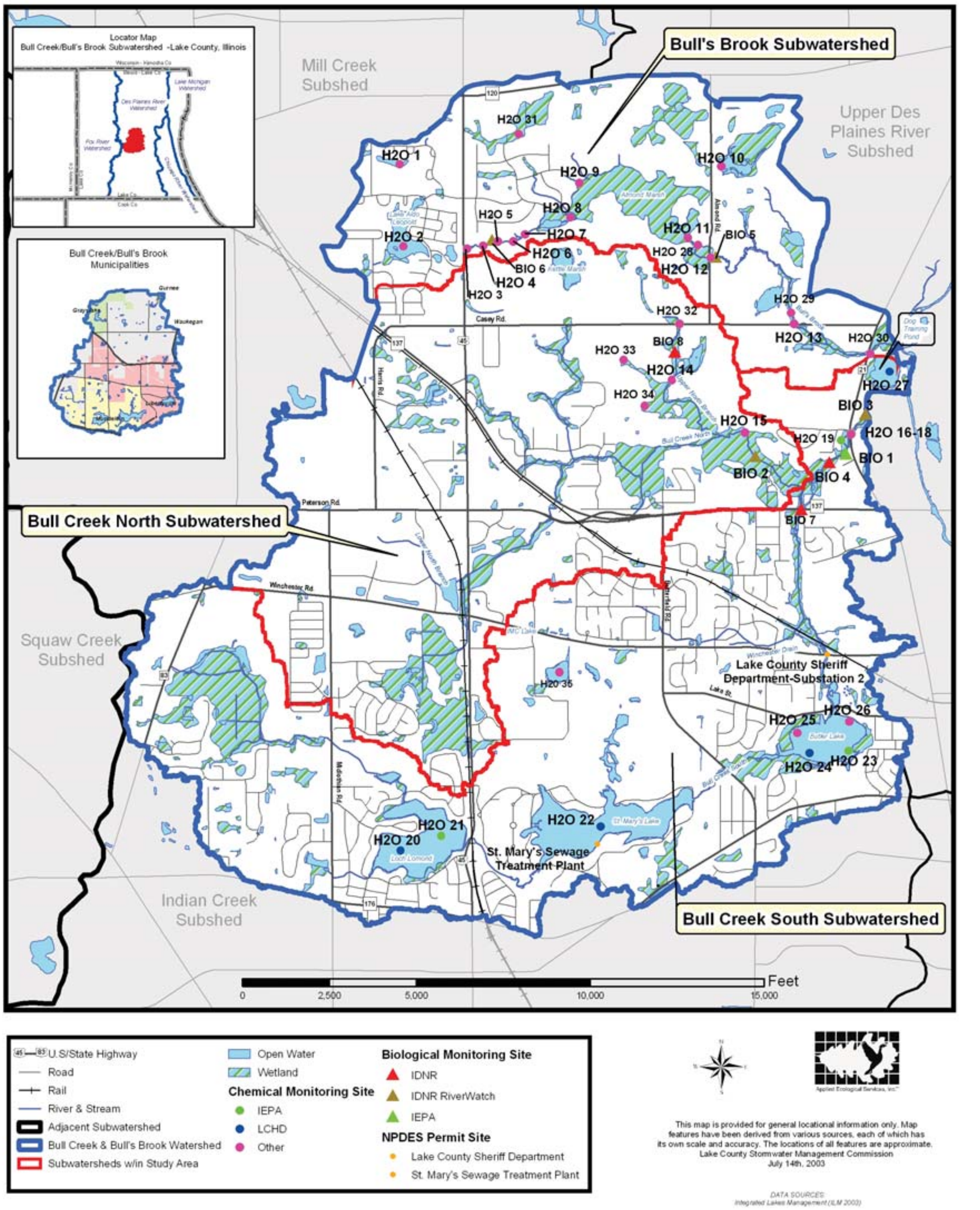
Cond.= conductivity
Ca = calcium
P = phosphorus

Alk.= alkalinity
Mn = manganese

Na = sodium
Mg = magnesium

SO4 = sulfate
Chlor a = chlorophyll *a*

Figure 49: Water Quality Sample Sites



The IEPA uses the results of water quality sampling to generate reports documenting water quality and the location of degraded streams and lakes throughout Illinois. These reports are known as the Section 305 (b) 2004 Water Quality Report and Illinois Section 303 (d) 2004 Impaired Waters List. The Section 303 (d) List specifies which lakes and streams do not meet "Designated Uses" by comparing water quality monitoring results to state standards. A comprehensive summary of IEPA water quality data is included in Appendix Q. A general summary of water quality in the watershed is included below.

Finding: DECLINING LAKE QUALITY

Data collected in lakes throughout the watershed indicates a general decline in water quality including nutrient loading, high salt concentrations (chloride), decreased water clarity (caused by shoreline erosion, carp activity, and other factors).

PHOSPHORUS

Three of the 6 lakes studied (Loch Lomond, St. Mary's Lake, and IMC Lake) exhibit elevated phosphorus levels that exceed the state standard (0.05 mg/l). Loch Lomond has the highest phosphorus concentrations in the watershed, which are likely caused by internal sources and near shore runoff. Water leaving Loch Lomond enters St. Mary's Lake just downstream via Bull Creek South. St. Mary's Lake is also plagued by high phosphorus levels contributed from Loch Lomond and St. Mary's Sewage Treatment Plant. Butler Lake is located just downstream from St. Mary's Lake but has phosphorus levels that are at the state standard (0.053 mg/l). IMC Lake is hydrologically connected to the St. Mary's-Butler Lake chain via drainage through the Pine Meadows golf course into the north side of St Mary's Lake and exhibits high phosphorus attributed to surrounding industrial development that began around 1998. The Dog Training Pond has the best water quality in the watershed with phosphorus levels below state standards. But, phosphorus levels have increased slightly from 2001 to 2005 indicating the possible ill effects of surrounding runoff. Leopold Lake in Prairie Crossing also exhibits phosphorus levels below the state standard likely due to runoff infiltration and the filtering process of the treatment train that has been installed around the surrounding development.

CHLORIDES

Salt concentrations in lakes throughout the watershed are becoming a major problem. Loch Lomond, St. Mary's Lake, Butler Lake, and Leopold Lake are all experiencing problems with elevated conductivity readings from salt that is applied to roads during winter months. Loch Lomond has only slightly elevated conductivity reading compared to the County average but has increased in recent years due to increased residential development upstream and use of more road salts during winter months. St. Mary's Lake experienced a 73% increase in conductivity from 1995-2002 indicating an increase in road salt usage presumably from Route 45 and other nearby roads that eventually drain to the lake. Butler Lake's conductivity levels are also high and are likely the result of high organic matter and road salt in the water column; the conductivity measured in 2001 and 2005 was nearly twice the level recorded in 1995. Since 2001, chloride concentrations have increased in Leopold Lake suggesting that the lake is accumulating salt. In 2006, measured chloride concentrations increased to 346 mg/l, which is beginning to approach the state standard of 500 mg/l. Chloride concentrations in IMC Lake set the County maximum at 1,852 mg/l in 2005.

WATER CLARITY

Poor water clarity is common among the lakes in the watershed and is gradually becoming worse. A simple device called a secchi disk is used to measure water clarity. Secchi reading less than 1.5 feet do not meet the state standard for general water quality. Measurements less than 4 feet do not meet the state standard for swimming. Loch Lomond's secchi depth is 2.17 thereby exceeding general water quality standards but not swimming standards. Reduced clarity is attributed to algae blooms and carp activity that stirs the lake bottom sediments. St. Mary's secchi depth is 2.79 and also below swimming standards. Like Loch Lomond, reduced clarity is attributed to carp but also to sediment contribution from moderate and severe shoreline erosion along the north and south banks. Butler Lake and Leopold Lake both exhibit good water clarity (4.35 and 6.5 respectively) that exceeds the state standard for swimming. The Dog Training Pond has excellent water clarity (14.9 feet) and has not changed in recent years.

STREAM WATER QUALITY

Finding: Average Stream Quality

Water quality in watershed streams is average based on cumulative chemical, physical, and biological indicators.

Assessment findings:

- According to an ILM study in 2005 (ILM 2005), several sites near agricultural fields along Bull's Brook and Bull Creek North tested high for nitrate, phosphorus, and suspended solids. Also, atrazine, an agricultural chemical detrimental to aquatic life, was detected in Bull Creek North and Bull's Brook.
- According to ILM (2004) salt concentrations are typical for urban streams. However, Applied Ecological Services (AES) (1997) found high chloride concentrations in 7 of 12 sample locations.
- E. coli was high on only one occasion as tested by the IEPA near Route 21.
- Graef, Anhalt, Schloemer & Associates, Inc (2000) sampled water at five locations along Bull's Brook and found relatively high suspended solid concentrations, and noted that Bull's Brook dried up in late summer/early fall. ILM (2004) reports intermittent streams allow toxins to concentrate in pools where aquatic life congregates. This can cause problems for aquatic life differing from perennial streams where toxins are diluted.
- AES (1997) found relatively high iron concentrations at 12 monitoring locations that are likely the result of leaching from the groundwater. AES also found one occurrence of lead.

Biological monitoring in streams reveals a wide range of conditions depending on sampling location. Fish sampling indicates moderate (IBI 31-40) to restricted (IBI <20) biotic stream resources. Macroinvertebrate sampling indicates good water quality (MBI<6.0) but on the cusp between good and fair. One factor affecting biological communities is the finding by Integrated Lakes Management in 2001 that portions of all three major stream branches dried up. Fish and macroinvertebrate sampling results are discussed in more detail in the following section.

BIOLOGICAL MONITORING

IEPA and IDNR biologists as well as IDNR RiverWatch volunteers conducted several macroinvertebrate and fish community surveys aimed at assessing water quality within the streams of the Bull Creek/Bull's Brook watershed throughout the 1980's and into the 2000's (Table 28; Figure 49). Biologists and volunteers utilized two biological indices including the ***Macroinvertebrate Biotic Index (MBI)*** (IEPA 1987) and the ***Index of Biotic Integrity (IBI)*** (Karr 1981; Karr et al.1986; IEPA 2000) to evaluate the water quality and biological health of streams and to detect and understand change in biological systems. Collectively, the MBI and IBI are valuable monitoring tools because stream biota integrate cumulative effects of sediment/nutrient pollution and respond to habitat degradation (Ohio EPA 1999).

Noteworthy Macroinvertebrate Biotic Index (MBI)

The MBI is designed to evaluate water quality based on the benthic macroinverte-***brates*** found in the stream. Macroinvertebrates demonstrate varying tolerances for pollution, some taxa can only be found in streams with good water quality while others can tolerate living in streams with poor water quality. Following collection, macroinvertebrates are identified and given a predetermined pollution tolerance rating. The MBI is calculated by taking an average of tolerance ratings weighted by the number of individuals in the sample. The MBI scale is from 1 to 10, with 1 being the highest stream quality indicator and 10 being the worst. Scores lower than 6 represent good water quality while scores greater than 9 indicate very poor water quality. As with fish, the presence of pollution intolerant macroinvertebrate species is an indicator of good water quality. Since macroinvertebrates are less mobile than fish, the MBI is a good index to evaluate upstream/downstream impacts of point source discharges. Results of macroinvertebrate studies is summarized below.

Table 29. Water Quality Correlation to Macroinvertebrate Biotic Index (MBI) Score

Macroinvertebrate Biotic Index	Water Quality
< 6.0	Good
6.1–7.5	Fair
7.6-8.9	Poor
> 9.0	Very Poor

Index of Biotic Integrity (IBI): *The IBI is based on fish surveys with the rating dependent on the abundance and composition of the fish species in a stream. Fish communities are useful for assessing stream quality because fish represent the upper level of the aquatic food chain and therefore reflect conditions in the lower levels of the food chain. Fish population characteristics are dependent on the physical habitat, hydrologic and chemical conditions of the stream, and are considered good indicators of overall stream quality because they reflect stress from both chemical pollution and habitat perturbations. For example, the presence of fish species that are intolerant of pollution are an indicator that water quality is good. The IBI is calculated on a scale of 12 to 60, the higher the score the better the stream quality.*

Benthic: *Bottom dwelling (often referring to macroinvertebrates).*

MACROINVERTEBRATE SURVEY WATER QUALITY DATA

IDNR RiverWatch volunteers and IEPA biologists sampled the macroinvertebrate community and calculated MBI scores 8 times at 5 different locations along Bull Creek and Bull's Brook since 1997 (Figure 49). Table 31 presents the IEPA (1987) water quality correlation to MBI score while resulting MBI scores for each site are given in Table 32. Streams classified as "Good" likely possess little organic pollution and good habitat while streams classified as "Fair" probably possess some organic pollution and increased habitat degradation. According to MBI scores at 3 sampling locations along Bull Creek (BIO 1, 2, 3), the water quality is good with low organic pollution. Bull's Brook also has good water quality according to MBI data collected at 2 separate sampling locations (BIO 5 & 6). ILM (2003) discovered very poor macroinvertebrate representation along Bull Creek South below Loch Lomond and St. Mary's Lake.

Table 30. Macroinvertebrate Biotic Index (MBI) and Index of Biotic Integrity (IBI) scores and categories at IDNR and IEPA macroinvertebrate and fish survey sites

Site	Source	Year	Stream Branch	Location/Agency Code	MBI	IBI	Category
BIO 1	IEPA	1997	Bull Creek (co-joined)	@ Route 21/GV-01 (BC02)	5.71	N/A	Good
BIO 2	RiverWatch	2001	Bull Creek	NE Section 8 T11E R44N/ R0213301 (BC11)	5.73	N/A	Good
BIO 2	RiverWatch	2002	Bull Creek	NE Section 8 T11E R44N/ R0213301 (BC11)	4.81	N/A	Good
BIO 3	RiverWatch	2001	Bull Creek	SW Section 4 T11E R44N/ R0213302 (BC01)	5.30	N/A	Good
BIO 4	IDNR	1983	Bull Creek (co-joined)	Upstream of Route 21/GV-01 (BC02)	N/A	23	D= Limited Aquatic Resource
BIO 4	IDNR	1997	Bull Creek (co-joined)	Upstream of Route 21/GV-01 (BC02)	N/A	28	D= Limited Aquatic Resource
BIO 4	IDNR	2001	Bull Creek (co-joined)	Upstream of Route 21/GV-01 (BC02)	N/A	34	C= Moderate Aquatic Resource
BIO 4	IDNR	2003	Bull Creek (co-joined)	Upstream of Route 21/GV-01 (BC02)	N/A	37	C= Moderate Aquatic Resource
BIO 5	RiverWatch	2000	Bull's Brook	NW Section 6 T11E R44N/ R0214801 (BB004)	4.23	N/A	Good
BIO 5	RiverWatch	2001	Bull's Brook	NW Section 6 T11E R44N/ R0214801 (BB004)	5.7	N/A	Good
BIO 6	RiverWatch	2000	Bull's Brook	NW Section 5 T11E R44N (R0214802)	5.65	N/A	Good
BIO 6	RiverWatch	2001	Bull's Brook	NW Section 5 T11E R44N/ R0214802 (BB006)	4.85	N/A	Good
BIO 7	IDNR	2001	Bull Creek South	Peterson Road/GV-PR (BC03)	N/A	11	E= Restricted Aquatic Resource
BIO 8	IDNR	2001	Bull Creek North	Cass Park/GV-CP (BC12)	N/A	13	E= Restricted Aquatic Resource

IDNR STREAM FISH SURVEY WATER QUALITY DATA

From 1983 to 2003, IDNR biologists sampled the fish community of Bull Creek 6 times at 3 different locations (BIO 4, 7, & 8; Table 32) and calculated an IBI score at each site (Figure 49). Table 33 presents Hite and Bertrands' (1989) ***Biological Stream Characterization (BSC)*** summary while the IBI scores calculated for Bull Creek are given in Table 32. Class A streams are usually comparable to the best situations without human intervention. Comparatively, Class E streams usually contain very few fish and no sport fishery.

Biological Stream Characterization (BSC): *A multi-tiered stream quality classification based primarily on the attributes of lotic fish communities. The predominant stream quality indicator used in this process is the Index of Biotic Integrity (IBI), comprised of 12 metrics, which form a basis for describing the health or integrity of the fish community. When insufficient fishery data are available for calculating an IBI value, BSC criteria allow the use of sport fishing information or macroinvertebrate data to rate streams. BSC provides a uniform process of characterizing streams statewide and is used by a variety of sources for stream protection, restoration and planning efforts.*

Noteworthy **Index of Biotic Integrity (IBI)**

The IBI is based on fish surveys with the rating dependent on the abundance and composition of the fish species in a stream. The IBI is designed to assess biological health directly through several attributes of fish communities. Fish communities are useful for assessing stream quality because fish represent the upper level of the aquatic food chain and therefore reflect conditions in the lower levels of the food chain. Fish population characteristics are dependent on the physical habitat, hydrologic and chemical conditions of the stream, and are considered good indicators of overall stream quality because they reflect stress from both chemical pollution and habitat perturbations. For example, the presence of fish species that are intolerant of pollution are an indicator that water quality is good. The IBI is calculated on a scale of 12 to 60, the higher the score, the better the stream quality.

Table 31. Biological Stream Characterization (BSC) criteria for the classification of Illinois Streams

IBI	Class	BSC Category	Biotic Resource Quality Description
51-60	A	Unique Aquatic Resource	Excellent. Comparable to the best situations without human disturbance.
41-50	B	Highly Valued Aquatic Resource	Good. Good fishery for important game fish species; species richness may be somewhat below expectations for stream size or geographic region.
31-40	C	Moderate Aquatic Resource	Fair. Fishery consists predominantly of bullhead, sunfish, and carp. Species diversity and number of intolerant fish reduced. Trophic structure skewed with increased frequency of omnivores, green sunfish, or tolerant species.
21-30	D	Limited Aquatic Resource	Poor. Fishery predominantly for carp; fish community dominated by omnivores and tolerant forms. Species richness may be notably lower than expected for geographic area, stream size or available habitat.
≤20	E	Restricted Aquatic Resource	Very poor. Few fish of any species present; no sport fishery exists.

Source: (Hite and Bertrand 1989)

Site BIO 4 is located along Bull Creek (co-joined channel) just upstream of Route 21. This station is designed to assess the cumulative affects of water quality in the entire Bull Creek watershed. The IBI scores calculated at Site BIO 4 have remained fairly constant from 1983 to 2003. According to the data, IBI scores indicate a stream that is between a Class D (Limited or Restricted Aquatic Resources) and Class C (Moderate Aquatic Resource). Streams of this nature are usually of poor condition, dominated by omnivores and tolerant species. Interestingly, MBI scores were good in this location. Various factors could result in these differences but the mostly likely cause is lack of appropriate fish habitat and potentially poor fish community in the Des Plaines River just downstream that is migrating into Bull Creek. Sites BIO 7 and 8 are located upstream from BIO 4 and are designed to assess the water quality in the smaller tributaries to Bull Creek. According to IBI scores at these sites, the tributaries are Class E streams (Restricted Aquatic Resources). Streams of this nature are very poor with few of any species present.

During the 2002 field season, ILM (2003) noted that both Bull Creek North and Bull Creek South dried up past their confluence with Route 21. Bull's Brook nearly dried up past Almond Marsh. Because of the intermittent condition of Bull Creek and Bull's Brook, biological integrity measurements such as the IBI are more difficult to rate. Therefore, the IBI data for these streams may not be appropriately applicable. In addition, the IDNR notes that habitat in the lower reaches of Bull Creek is excellent while the smaller tributary streams are low gradient and do not have high quality habitat. A significant number of culverts also fragment the tributary streams from the lower reaches. Flashy conditions may also be disrupting the ability for higher quality fish communities to become established.

POINT SOURCE POLLUTION

EDR and Hazardous Materials Sites

The following summary was extracted from Integrated Lakes Management's (ILM) 2004 report (ILM 2004) that uses an environmental database search report from Environmental Data Resources (EDR), Inc (EDR 2002) to identify sites within the Bull Creek/Bull's Brook watershed that are listed in government-generated, environmental databases. The purpose of this information is to determine locations with the potential for release of hazardous materials or where hazardous materials have actually been released. ILM assigned a high, medium, and low priority to all sites in the database. High priority sites are those with an open file or otherwise not resolved. Table 29, generated by ILM, lists all high priority sites, their location, and comments on the conditions of each.

Based on ILM's review, one Emergency Response Notification System (ERNS) site, seven Leaking Underground Storage Tank (LUST) sites, and two Site Remediation Program (SRP) sites appear to have the greatest potential for impact. They are all sites where releases have occurred, and all but the ERNS site have an active status (ERNS sites do not receive agency closure.) It should be noted that these sites were assigned a high priority for their potential to impact water quality. ILM recommends that future water quality monitoring include analysis for the chemical constituents in these releases.

Table 32. High priority hazardous materials sites with open files

Subwatershed	Site Name and Address	Database	Commentsy
BB Casey Rd. E of Almond Rd.	17135 Casey Rd.	*ERNS	50 gallons of oil was released to a gravel surface from a transform er/bushing failure. The material was cleaned up and drummed. No further agency files available.
BBNW of Almond & Casey Rds.	18202 West Casey Rd.	**LUST	Unleaded gasoline released in1992. Determined not to be a LUST for regulatory purposes. No closure letter. Small file (correspondence) available from IEPA.
BCS Winchester Rd. W of Route 21	Lake Cty. Dept. of Transp 600 Winchester Rd.	**LUST	Diesel fuel released in 1991. No closure letter. Large file (reports and correspondence) available from IEPA.
BCS Winchester Rd. W of Route 21	Illinois Dept. of Transp. 600 Winchester Rd.	**LUST	Used oil released in 1999. No closure letter. Large file (reports and correspondence) available from IEPA.
BCS Near Butler Lake	Newton Instrument Co. 400 W. Lake St.	**LUST	Petroleum released in 1996. No closure letter. Correspondence on file with IEPA.
BCS Route 176 W of Route 21	Libertyville High School 708 W. Park Ave.	**LUST	Unleaded gasoline released 1989. No closure letter. Small file (correspondence) available from IEPA.
BCS Route 176 and Butterfield Rd.	Mobil Oil #05AWF 1185 W. Park/Butterfield	**LUST	Unleaded gasoline released in 1988. No closure letter. Large file (reports and correspondence) available from IEPA.
BCS E of Route 45	600 Greenwood St.	**LUST	Diesel fuel released in 1998. No closure letter. Small file (correspondence) available from IEPA.
BCN Peterson Rd. W of Route 45	Wisconsin Central Ltd. 1228 Peterson Rd.	***SRP	Active status in the Site Remediation Program. 0.03 acres affected. File available from IEPA.
BCS Winchester Rd. W of Route 21	Lake Cty. Highway Dept. 600 W. Winchester Rd.	***SRP	Active status in the Site Remediation Program. 206 acres affected. File available from IEPA.

Source: ILM 2004
*ERNS: Emergency Response Notification System
**LUST: Leaking Underground Storage Tank
***SRP: Site Remediation Program

Noteworthy Pollution Permits

National Pollutant Discharge Elimination System (NPDES) permits regulate wastewater and are administered by the IEPA under the federal Clean Water Act to reduce pollutants to our nation's waters. Two types of wastewater discharges are controlled by NPDES permits including industrial process ***(point source)*** and stormwater ***(non point source)***. An NPDES permit may be required at one business for either type of wastewater or for both. Wastewater includes almost any discharge of water that is generated from any process industry, manufacturing, trade, or business and can also include solids, liquid or gaseous waste, or other substances where discharge would cause water pollution or a violation of the effluent or water quality standards of the State set forth by the Illinois Pollution Control Board (IPCP). ..

National Pollutant Discharge Elimination System (NPDES Phase II): *Clean Water Act law requiring smaller communities and public entities that own and operate an municipal separate storm water system to apply and obtain an NPDES permit for stormwater discharges. Permittees at a minimum must develop, implement, and enforce a stormwater program designed to reduce the discharge of pollutants from the MS4 to the maximum extent practicable. The stormwater management program must include these six minimum control measures:*

1. Public education and outreach on stormwater impacts
2. Public involvement/participation
3. Illicit discharge detection and elimination
4. Construction site stormwater runoff control
5. Post-construction stormwater management in new development and redevelopment
6. Pollution prevention/good house-keeping for municipal operations

IEPA NATIONAL POLLUTION DISCHARGE ELIMINATION SYSTEM (NPDES)

Under the NPDES program, the University of St. Mary of the Lake Sewage Treatment Plant (STP) (Figure 49) is currently the only running, permitted point discharge into the Bull Creek/Bull's Brook watershed, emptying into St. Mary's Lake (Table 30). It is unusual to have a STP discharge to a lake considering most STPs discharge to streams and rivers. Lakes usually accumulate nutrients in bottom sediments that are discharged by STPs. Disturbance of the sediment releases phosphorus that is taken up by algae and other plants.

Running approximately 273 days per year, the STP has an average discharge limit of 0.03 million gallons per day (MGD). A 3.5-year average from January 1999–June 2002 was slightly above permit limits at 0.031 MGD. Total phosphorus limits are not listed on the NPDES permit for the site but typically, 1.0 mg/l is the standard limit. The permit allows for 1.5 mg/l monthly average (April-October) and 2.8 mg/l monthly average (November-March) for ammonia nitrogen. Ammonia nitrogen measured in the lake by LCHD in 2005 was less than 0.1 mg/l, well below the IEPA standard. Integrated Lakes Management (ILM 2003) notes only one violation when ammonia nitrogen averaged 4.49 in December 1999. According to ILM, other parameters such as total suspended solids, fecal coliform, pH, Biological Oxygen Demand, and chlorine were not high and the plant is well maintained.

The IEPA has tentatively determined to issue a NPDES permit for a new facility (Lake County Sheriff Department Substation 2) for which the Lake County Human Resources and Risk Management would act as discharger (Table 30, Figure 49). Wastewater from the plant is generated from a leaking underground storage tank of leaded gasoline and discharged into Bull Creek just north of Butler Lake. Average discharge is not to exceed 0.00288 MGD of gasoline contaminated groundwater.

Table 33. NPDES permitted and proposed discharge to the Bull Creek/Bull's Brook watershed.

Facility ID	Receiving Water	Facility Name	Facility Address (Main Office)	Type of Facility
IL0024350	St. Mary's Lake	LCDPW-University of St. Mary of the Lake STP	1000 East Maple Avenue, Mundelein, IL 60060	Sewage Treatment Plant
IL0077119*	Bull Creek	Lake County Sheriff Department – Substation 2	470 West Winchester Road, Libertyville, IL 60048	Waste Water

* Proposed IEPA permitted discharge site

3.13 Wetlands Inventory

Wetlands provide a variety of functions. They provide areas where groundwater is recharged by surface water and where groundwater is discharged to the land surface. They also filter sediments and nutrients in runoff, provide wildlife habitat, reduce flooding, and help maintain water levels in streams. By performing these functions, wetlands improve water quality and biological health of streams and lakes located downstream and protect public safety.

Noteworthy Lake County Wetlands Inventory

The ***Lake County Wetlands Inventory (LCWI)*** of wetlands within Lake County was developed by a multi-agency team using a combination of information sources including: USDA/Soil Conservation Service wetland inventory maps, ***National Wetland Inventory (NWI)*** maps, soil survey of Lake County, and other low altitude aerial photography. It identifies nine different wetland types, based on the criteria established by the Natural Resource Conservation Service (NRCS): ***artificial wetland, converted wetland, farmed wetland,*** farmed wetland not regulated under the 1985 Food Security Act, non-wetland, non-wetland prior converted, prior converted, urban converted, and wetland. The inventory is intended to improve the understanding and management of the County's wetland resources.

European settlers to the region altered much of the Bull Creek/Bull's Brook watershed's natural hydrology and wetland processes. Settlers drained wet areas, channelized streams, and cleared forests in order to farm the rich soils. Based on hydric soils mapping in the Lake County Soil Survey, there were approximately 2,348 acres of wetlands in the watershed prior to European settlement. According to the LCWI, 1,316 acres or 56% of the pre-settlement wetlands remain. Of this, 1,316 acres, 1,258.5 acres is classified as wetland (includes ADID wetlands), 57 acres is farmed wetland, and 0.35 acres is artificial wetland.

Lake County Wetland Inventory (LCWI): *An inventory of wetlands in Lake County, Illinois that shows approximate wetland boundaries using the off-site delineation methodology in the 1989 "Federal Manual for Identifying and Delineating Jurisdictional Wetlands." The LCWI was completed by a group of federal, state and county agencies and published in March 1993.*

National Wetland Inventory (NWI): *U.S. Fish and Wildlife Service study that provides information on the characteristics, extent, and status of U.S. wetlands and deepwater habitats and other wildlife habitats.*

Artificial wetland: *A designed wetland, created for human use, such as wastewater or sewage treatment, as habitat to attract wildlife, or for land reclamation after mining or other disturbance.*

Converted Wetland: *Wetlands that were drained, dredged, filled, leveled, or otherwise manipulated, including the removal of woody vegetation to make production of an agricultural commodity possible, and that (1) do not meet specific hydrologic criteria, (2) have had an agricultural commodity planted or produced at least once prior to December 23, 1985, and (3) have not since been abandoned. Activities occurring in prior converted cropland are not regulated under Swampbuster or Section 404 of the CWA.*

Noteworthy High Functional Quality Wetlands

In 1992, Lake County implemented the ***Advanced Identification (ADID)*** process in an attempt to identify high functionality wetlands that should be protected because of their high quality plant communities and/or functional values. The ADID program is a United States Environmental Protection Agency (USEPA) program developed to provide information to local governments. Three primary functions were used by the USEPA and U.S. Army Corp of Engineers (USACE) (Chicago District) to evaluate wetlands during the ADID process including ecological value (i.e. wildlife habitat and plant species diversity), hydrologic functional value (i.e. stormwater storage or bank stabilization), and water quality value (i.e. sediment, and nutrient removal)..

Figure 50 depicts the location of existing wetlands including Advanced Identification (ADID) wetlands and their associated identification numbers as documented during the LCWI. According to the ADID wetland identification process, 11 wetlands comprising 431 acres are identified as high functional quality (*Figure 50*). Data for each ADID wetland is summarized in Table 34.

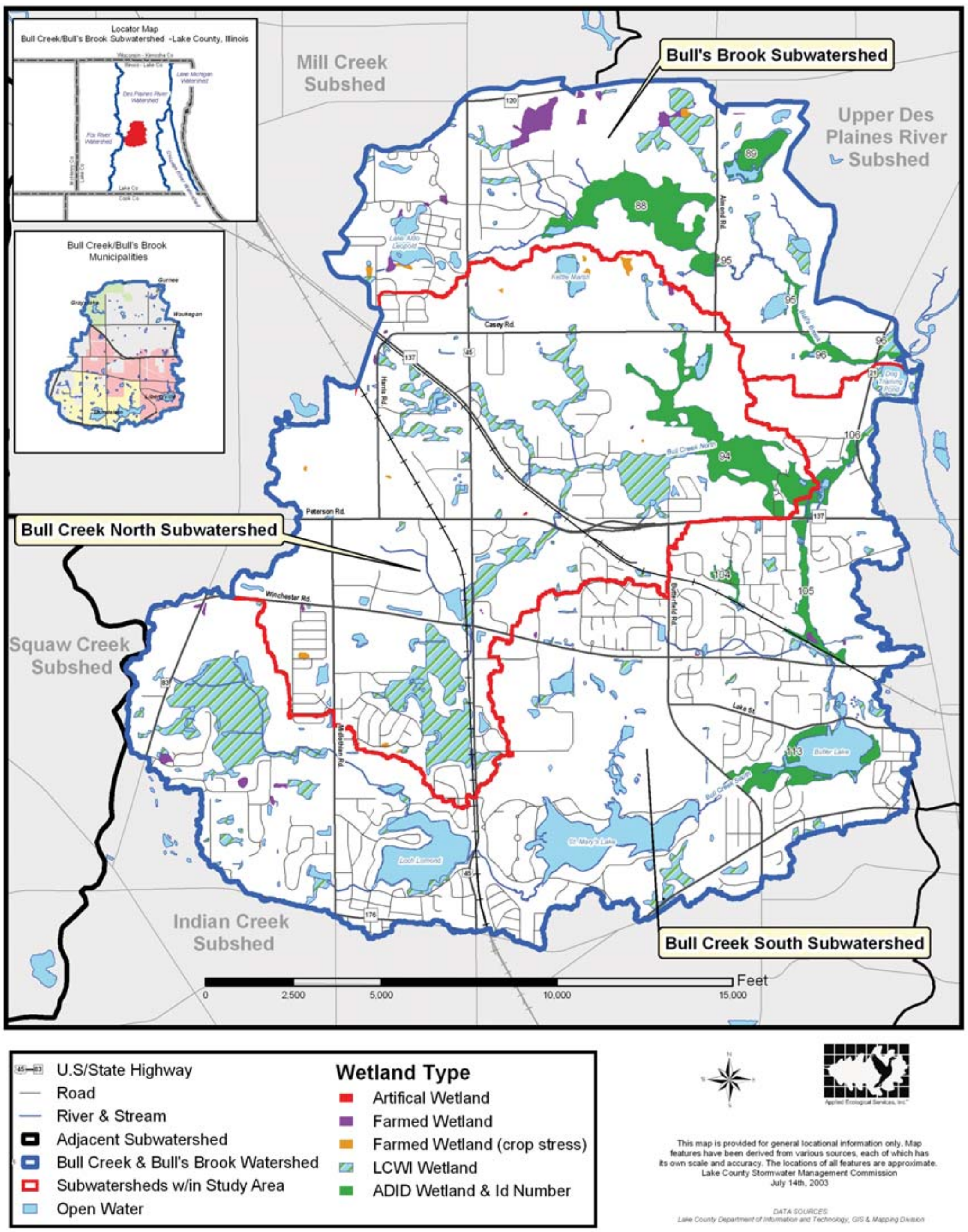
Three ADID wetlands (#104, #105, and #94) have been filled by residential and commercial development. ADID wetland #104 includes a high quality plant community that was impacted by Wineberry Estates residential development. ADID wetland #105 includes endangered fish species and wetlands capable of important sediment and toxicant removal. This wetland was partially impacted by commercial development at 333 Peterson Road. ADID wetland #94 contains state threatened and endangered species, and high quality habitat that was impacted by commercial development at 540 and 550 Peterson Road.

Table 34. ADID Wetland and Attributes

ADID ID #	Name	Acres	ADID Attributes
113	Butler Lake	92.9	Sediment/toxicant retention and nutrient removal
104	n/a	7.7	High quality plant community — Impacted by Wineberry Estates residential development
105	Bull Creek South	24.1	Endangered fish species and sediment/toxicant retention- Impacted by Commercial encroachment at 333 Peterson Road.
106	Bull Creek	1.6	State endangered fish species
96	Bull's Brook	2.6	High quality stream habitat
94	Bull Creek North	137.0	State threatened or endangered species of plants; Illinois Natural Area Inventory Site with wet prairie, graminoid fen, and sedge meadow — Impacted by residential (Forest Creek) & commercial (540 & 550 Peterson Road) development
96	Bull's Brook	12.4	High quality stream habitat
95	Bull's Brook	7.1	High quality stream habitat
95	Bull's Brook	0.4	High quality stream habitat
88	Almond Marsh	112.6	State threatened or endangered plant and bird species; stormwater storage and sediment/toxicant retention
89	Potter's Swamp	32.6	High quality wildlife habitat (hemi-marsh); stormwater and sediment storage

Source: Lake County Wetland Inventory (LCWI)

Figure 50: Lake County Wetland Inventory



Noteworthy Wetlands Protection

Some protection of wetlands is provided under existing regulatory programs including federal and state floodplain development restrictions, the USACE section 404 Clean Water Act wetland permit program, and the Lake County Watershed Development Ordinance (WDO-effective January 10,2006). Lake County requires a minimum 30-50 foot buffer around/along wetlands depending on drainage area and type of wetland (linear vs. water body) as follows:

Linear Buffers

— 50-foot wide buffers along linear waterbodies (streams) draining 20 acres but less than on square mile;

— 30-foot wide buffers along linear waterbodies (streams) with greater than one square mile drainage;

— 100-foot wide minimum buffer for high quality (ADID) linear wetlands or with Index of Biotic Integrity (IBI) greater than 40.

Water Body Buffers

— 30-foot wide buffer around all water bodies with a total surface area greater than 1/3 acre but less than one acre;

— 40-foot wide buffer around all water bodies with a total surface area greater one acre but less than 2.5 acres;

— 50-foot wide buffer around all water bodies greater than 2.5 acres;

— 100-foot minimum buffer around all water bodies that are high quality (ADID).

The USACE requires a 50-foot wide buffer around all non ADID wetlands determined to be under their jurisdiction and 100-foot wide buffers around all ADID wetlands. The USACE also will generally require an individual permit for modifications to all ADID sites. ADID sites are generally considered unsuitable for filling activities. In rare cases where mitigation is allowed for ADID wetlands, a 3:1 mitigation ratio is required in Lake County.

CURRENT MANAGEMENT ACTIVITIES

Limited current wetland management activities are occurring in the watershed. Information was available for the following sites:

The Liberty Prairie Conservancy (LPC) received grant money to restore a wetland just southwest of the intersection of Casey and Almond Roads near the headwaters of a tributary stream to Bull Creek North. The wetland, owned by Libertyville Township Open Space District, had been buried beneath upland soils by past farmers. The restoration included planting adjacent farmland to prairie, uncovering the wetland and planting it to native species.

Noteworthy Wetland Mitigation

Future projected development will likely result in relatively small wetland impacts because of permit restrictions and mitigation requirements in the Clean Water Act and the Lake County Watershed Development Ordinance. In many cases however, wetland fill over the USACE 0.1-acre or 0.1 acre (isolated and high quality wetlands)/0.25 acre (non-high quality wetlands) WDO impact thresholds will be unavoidable, and mitigation will be required to create/restore new wetlands to replace those that are impacted.

Wetland creation and restoration is not only important for mitigation purposes. It can also prove extremely beneficial in restoring basic environmental functions that historic wetlands once provided. Wetland restoration can positively influence the environment by reducing flood volumes and rates, increasing biodiversity, and improving water quality conditions. Wetlands restored in agricultural areas can reduce phosphorus levels in runoff by 60% and nitrates by 40%. This results in cleaner water entering stream and lake systems and a potential decrease in algal blooms and aquatic vegetation overgrowth.

POTENTIAL WETLAND RESTORATION SITES

Potential wetland restoration sites were identified using a Geographic Information Systems (GIS) exercise and specific criteria determined to be essential for restoration of a functional and beneficial wetland. Applied Ecological Services, Inc. (AES) used two criteria to locate potential wetland restoration sites; 1) site contains at least 2.5 acres of drained hydric soils, and 2) site is located on an open or partially open parcel. These criteria were used for a variety of reasons. First, the easiest and most common wetland restorations typically occur on areas that were once wetland but have since been drained, usually for agricultural practices. When a wetland is drained, the soil characteristics often remain intact and are referred to as hydric soils. Wetlands can be restored on drained hydric soils when drain tiles or other wetland dewatering systems are disabled. The 2.5 acre size class was used because this acreage of wetland restoration will typically retain large amounts of stormwater and hold the water for a long period of time, allowing plants, soils, and other factors to infiltrate and clean the water. This size is also large enough to support a variety of wildlife. In addition, open and partially open parcels with the required 2.5 acres were chosen because they provide the most feasible opportunities for wetland restoration. Public open or partially open parcels are typically more feasible areas than private open or partially open parcels.

The analysis resulted in 71 potential wetland restoration sites (Figure 51; Table 35). Most of these sites are located in the northern and western portions of the watershed on land that is currently farmed. Many potential restoration sites are located adjacent to existing wetlands thereby increasing the possibility of expansion. Some of the potential sites identified will not be feasible or will have limited feasibility for wetland restoration.

Examples of this include sites located on golf courses or other areas that have since been built out or are already restored such as those in Prairie Crossing. Applied Ecological Services, Inc. (AES) reviewed recent aerial photography, parcel ownership maps, and existing land use information to determine the feasibility of each identified potential wetland restoration site. The analysis resulted in 9 "Limited Feasibility" sites (proposed development sites, private land, partially developed sties, etc), 21 sites that are "Not Feasible" because they are already built out, and 41 sites that are considered "Potentially Feasible" (areas located in open space with no development). A more detailed site-specific feasibility study, beyond the scope of this assessment, will need to be completed prior to the restoration of any wetland.

In February 2001, LCSMC completed the Des Plaines River Wetland Restoration Study (DPRWRS 2001) that identified potential wetland restoration sites in the entire Des Plaines River watershed including several in the Bull Creek/Bull's Brook subwatershed. The study focused on locating wetland restoration sites that were:

1) Greater than 16 acres

2) Within 50 meters of NIPC greenway and/or trail

3) Within NIPC or LCSMC's "open space" category or Lake County Forest Preserve ownership

The study resulted in 114 potential wetland restoration sites within the Des Plaines River Watershed Wetland Restoration Study area. Twelve (12) of these sites are located in the Bull Creek/Bull's Brook Watershed and coincide with the GIS analysis conducted for this study. The DPRWRS sites are indicated in Table 35 with an asterisk.

Figure 51: Potential Wetland Restoration Sites

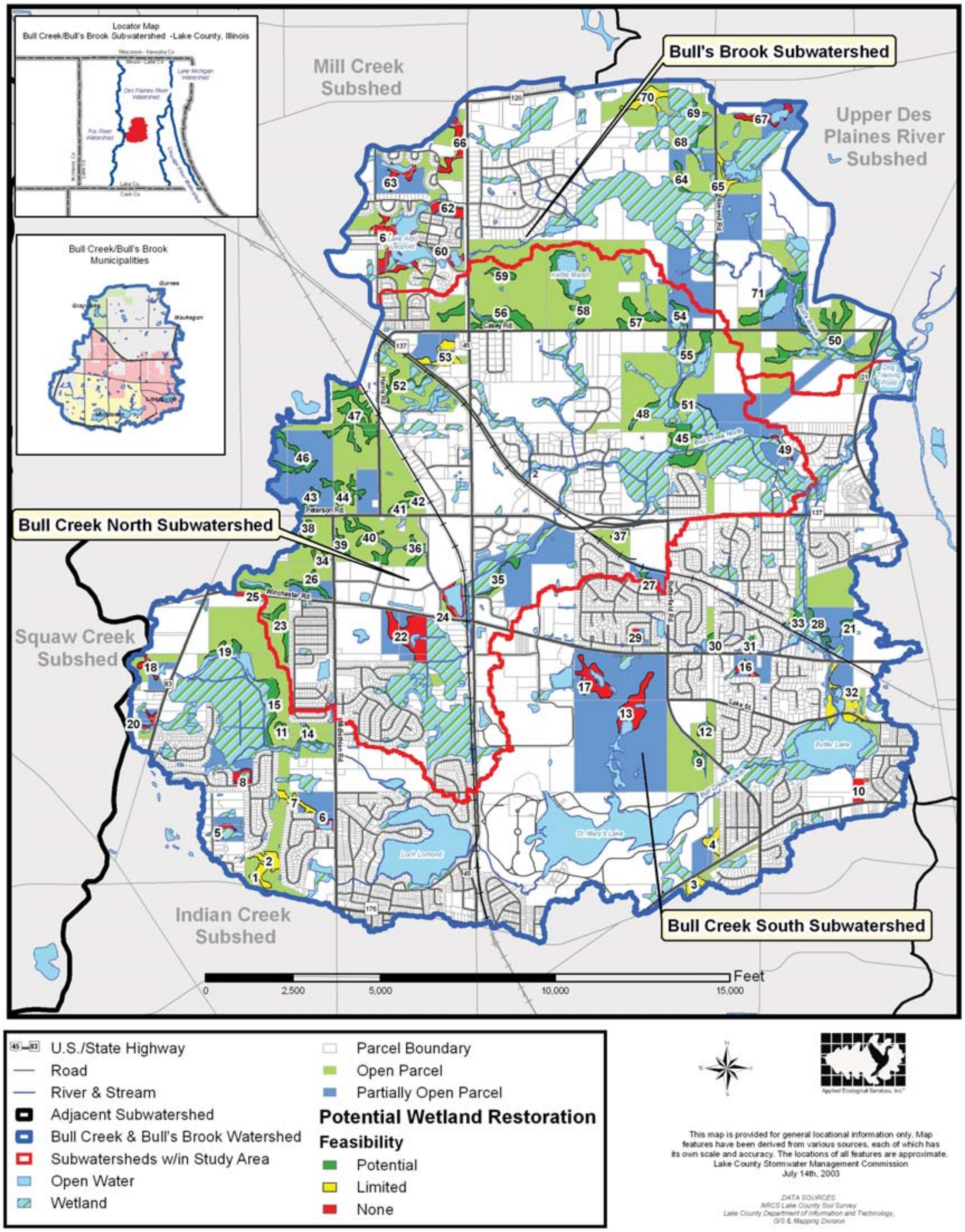


Table 35. Potential wetland restoration sites including acreage and restoration potential based on property vacancy and ownership status

ID #	Area (Acres)	Feasibility	Existing Condition
1	3.78	Limited feasibility	Proposed Route 53 Corridor-State owned
2	4.90	Limited feasibility	Proposed Route 53 Corridor-State owned
3	3.55	Limited feasibility	Private owner
4	4.34	Limited feasibility	Private owner
5	2.91	Not feasible	Existing large lot development
6	2.69	Not feasible	Existing detention basin
7	4.40	Limited feasibility	Proposed Route 53 Corridor-State owned
8	5.44	Not feasible	Existing ball fields
9	3.36	Potentially feasible	Private agricultural field
10	5.46	Not feasible	Existing ball fields
11	3.37	Potentially feasible	Private agricultural field
12	3.33	Potentially feasible	Publicly owned/utility corridor
13	14.58	Not feasible	Existing golf course
14	3.47	Potentially feasible	Private agricultural land
15	8.49	Potentially feasible	Private agricultural land
16	3.20	Not feasible	Existing large lot residential
17	12.68	Not feasible	Existing golf course
18	3.04	Not feasible	Private large lot residential
19	4.63	Potentially feasible	Private agricultural land
20	2.78	Not feasible	Existing large lot residential
21	2.66	Potentially feasible	Publicly owned land
22*	22.2	Not feasible	Existing golf course (*DPRWRS # FBUL5)
23*	6.8	Potentially feasible	Agricultural land (*DPRWRS #FBUL4)
24	10.9	Not feasible	Existing detention basin
25	3.08	Potentially feasible	Agricultural land
26	6.22	Potentially feasible	Agricultural land
27	2.67	Potentially feasible	Partially open public land
28	4.77	Potentially feasible	Publicly owned land
29	3.14	Not feasible	Existing dry detention basin
30	3.34	Potentially feasible	Utility corridor
31	2.75	Potentially feasible	Public land
32*	16.71	Limited feasibility	Butler Lake Park (*DPRWRS #LBUL2)
27	5.11	Not feasible	Existing detention basin
29	2.67	Potentially feasible	Partially open public land
30	4.77	Potentially feasible	Publicly owned land
31	3.14	Not feasible	Existing dry detention basin
32	3.34	Potentially feasible	Utility corridor
33	3.67	Potentially feasible	Publicly owned land
34	2.82	Potentially feasible	Agricultural land
35	4.58	Potentially feasible	Township open space
36*	5.68	Potentially feasible	Agricultural land (*DPRWRS #FBUL5)
37	3.02	Potentially feasible	Private open space
38	2.82	Potentially feasible	Agricultural land

ID #	Area (Acres)	Feasibility	Existing Condition
33	2.75	Potentially feasible	Public land
37	3.67	Potentially feasible	Publicly owned land
38	2.68	Potentially feasible	Agricultural land
39	2.61	Potentially feasible	Agricultural land
40*	10.09	Potentially feasible	Agricultural land (*DPRWRS #FBUL5)
41	3.56	Potentially feasible	Agricultural land
42	2.67	Potentially feasible	Agricultural land
43	2.61	Potentially feasible	Agricultural land
44	9.88	Potentially feasible	Agricultural land
45*	16.81	Potentially feasible	Township open space (*DPRWRS #LBUL1)
46*	9.46	Potentially feasible	Agricultural land (*DPRWRS #FBUL3)
47*	20.62	Potentially feasible	Agricultural land (*DPRWRS #FBUL2)
48	3.58	Potentially feasible	Township open space (Note: already restored in INP)
49	2.77	Not feasible	Existing residential development
50*	18.99	Potentially feasible	Township open space and private residence (*DPRWRS #LUDP3)
51	2.51	Potentially feasible	Township open space
52	5.18	Potentially feasible	Agricultural/open space
53	9.13	Limited feasibility	Partial developed as commercial
54	4.28	Potentially feasible	Agricultural field in Liberty Prairie Reserve (deed restriction parcel)
55	6.07	Potentially feasible	Township open space
56* & 57	15.55	Potentially feasible	Prairie crossing HOA and Libertyville Township in Liberty Prairie Reserve open space (*DPRWRS #FBUL2)
57	9.12	Potentially feasible	Agricultural field in Liberty Prairie Reserve (Township Land)
58	10.59	Potentially feasible	Agriculture adjacent to Kettle Marsh in Liberty Prairie Reserve (Township Land)
59	3.48	Potentially feasible	Agricultural land in Liberty Prairie Reserve (Township Land)
60	2.92	Not feasible	Land previously converted to wetland in Prairie Crossing open space
61*	22.79	Not feasible	Land previously converted to wetland in Prairie Crossing open space (*DPRWRS #AVUDP2)
62	5.43	Not feasible	Partially developed in Prairie Crossing
63	5.43	Not feasible	Land previously converted to wetland in Prairie Crossing open space
64	3.79	Potentially feasible	Lake County Forest Preserve Land
65	3.52	Limited feasibility	Private owner
66*	7.82	Not feasible	Land previously converted to wetland in Prairie Crossing open space (*DPRWRS #AVUDP1)
67	7.19	Not feasible	Existing golf course (Merit Golf Course)
68	2.78	Potentially feasible	Lake County Forest Preserve Land
69	2.53	Potentially feasible	Lake County Forest Preserve Land
70	8.74	Limited feasibility	Proposed Route 120 bypass-State owned
71*	21.5	Potentially feasible	Private protected parcels in Liberty Prairie Reserve (*DPRWRS #LUDP1)
36*	5.68	Potentially feasible	Agricultural land (*DPRWRS #FBUL5)
37	3.02	Potentially feasible	Private open space
38	2.82	Potentially feasible	Agricultural land

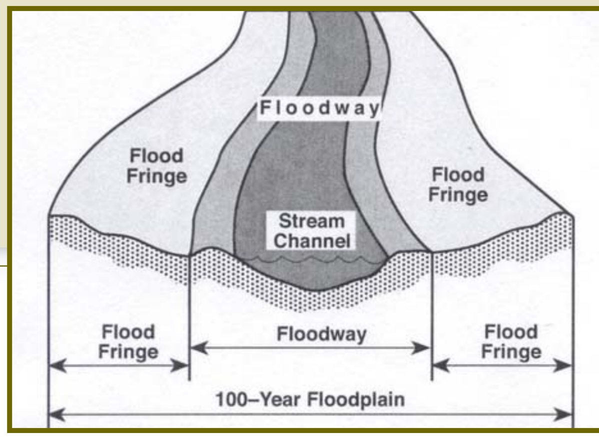
*Identified in Des Plaines River Wetland Restoration Study (DPRWRS 2001)

3.14 Flooding

Noteworthy **Floodplain**

Floodplains along stream and river corridors perform a variety of benefits. Some of these benefits include aesthetic value, flood storage, water quality, and plant and wildlife habitat. The most important function however, many would argue, is the capacity of the floodplain to hold water during significant rain events to minimize flooding issues.

The ***100-year floodplain*** is defined as the area that would be inundated during a flood event that has a one percent chance of occurring in any given year (100-year flood). However, 100-year floods can and do occur more frequently. The 100-year flood has become the accepted national standard for floodplain regulatory purposes and was developed in part to guide floodplain development to lessen the damaging effects of floods. The 100-year floodplain also includes the floodway. The floodway is the portion of the stream or river channel that includes the adjacent land areas that must be reserved to convey the 100-year flood without increasing the water surface.



Depiction of 100-year floodplain and floodway

100-year floodplain: *A flood inundates a floodplain. A 100-year flood is a flood that has a 1-percent chance of being equaled or exceeded in any given year. A 100-year flood may also be referred to as the base flood. The area inundated during the base flood is called the 100-year floodplain.*

Flood Insurance Study (FIS): *Studies conducted by the Federal Emergency Agency (FEMA) to determine areas that have the highest probability for flooding.*

Flood Insurance Rate Map (FIRM): *A map prepared by the Federal Emergency Management Agency that depicts the special flood hazard area (SFHA) within a community. The FIRM includes zones for the 100-year and 500-year floodplains and may or may not depict Regulatory Floodways.*

FLOOD RISK

Studies conducted by the Federal Emergency Management Agency (FEMA) to determine areas that have the highest probability for flooding are called Flood Insurance Studies (FIS). ***Flood Insurance Rate Maps (FIRM)*** are produced from the studies and used to determine the level of risk to people in a certain area with respect to the dangers of flooding. FIRM maps are also used to determine the cost and requirements for the purchase of flood insurance. Note: Section 4.4 (Flooding) summarizes flood problem and flood risk locations in the Bull Creek/Bull's Brook watershed.

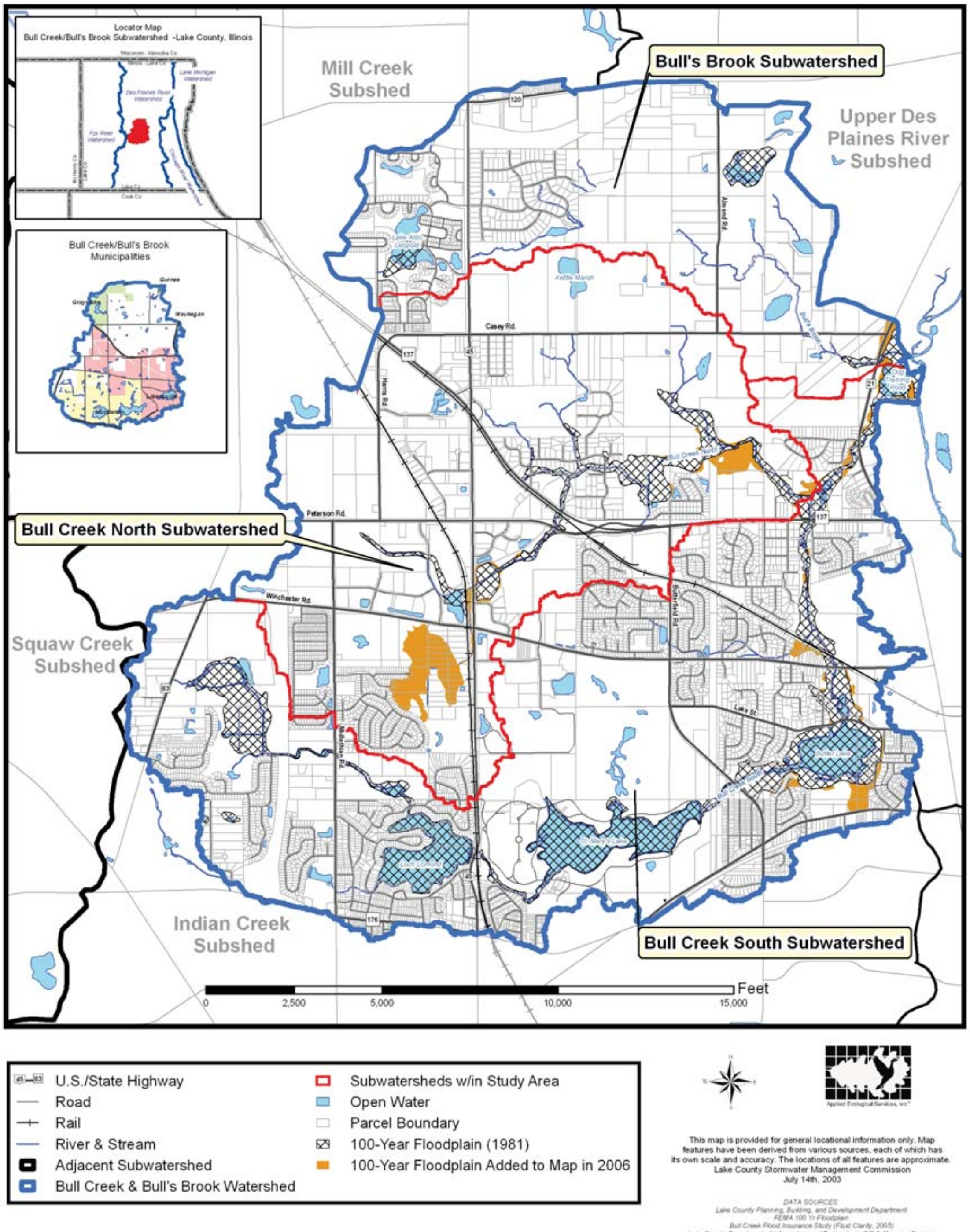
Until recently, the effective FIS for Bull Creek/Bull's Brook was developed in 1981. Significant land use and development changes in the watershed since 1981 prompted the Lake County Stormwater Management Commission (LCSMC) to complete an updated floodplain study for a portion of the watershed. The watershed changes include a population increase from 12,800 people in 1980 to 34,800 people in 2000 (205% increase) and increase in number of households from 3,900 in 1980 to 11,900 households in 2000.

The updated floodplain study was completed for Bull Creek North and Bull Creek South downstream of Butler Lake as part of the Des Plaines Phase II planning process (see Appendix E). Bull's Brook and Bull Creek South upstream of Butler Lake were not included in the study. The updated floodplain study is based on an updated hydrology and hydraulics study completed by the United States Army Corps of Engineers (USACE). A revised 100-year floodplain and floodway were created with the updated study. Figure 52 depicts the old and newly revised 100-year floodplain. According to the mapping, the older 1981 FEMA floodplain occupied 719.8 acres (8%) of the watershed. The revised 2006 100-year floodplain occupies 773.8 acres (8.6%) of the watershed, a 54.1 acre increase from the 1981 floodplain. Table 36 below breaks down these acreages by subwatershed and compares the differences between the old and new floodplain boundaries. Section 4.4 contains information related to the number of structures located within the 100-year floodplain and a discussion of known flood problem areas and nuisance flooding locations in the watershed.

Table 36. Comparison of old (1981) versus new revised (2006) floodplain

Subwatershed	1981 Acreage	2006 Acreage	Difference (Acres)
Bull Creek North	139.7	181.5	+41.8
Bull Creek South	527.1	531.9	+4.8
Total	**719.7**	**773.8**	**+54.1**

Figure 52: 100-Year Floodplain



CONSTRUCTED DRAINAGE SYSTEM

Many of the soils in Lake County are hydric or have hydric soil inclusions indicating that they are wetlands, or were historically wetlands. In fact, over 30% of the soils in the Bull Creek/Bull's Brook watershed are hydric. As settlers in the past converted the watershed's natural landscape to agriculture, they improved the drainage of the poorly drained and wetland soils for farming using drain tiles. Likewise, as land owners today convert natural and farmed lands to residential, industrial and commercial land uses they improve the drainage of the landscape with stormsewer systems to maximize the land's development potential and to reduce the likelihood of localized drainage or flooding problems.

Noteworthy **Agricultural Drainage Tile Network**

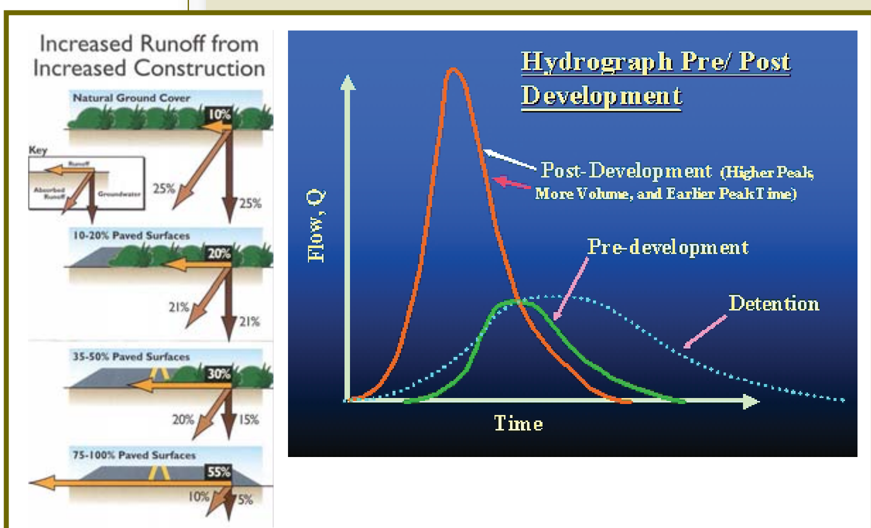
The natural drainage system of overland flow paths and wetlands draining to streams and lakes in the watershed began to change when European settlers discovered the potential for productive cropland. Most of these soils remain wet for several days following a rain event. This causes a significant problem on agricultural lands. Saturated soils do not provide sufficient aeration for crop root development and leads to crop stress. In the Late 1800's European settlers began using primitive agricultural drainage tile systems and ditches to remove standing or excess water from poorly drained lands. In the 1960's and 1970's, drainage tiles became the standard for removing unwanted water from the land. Drainage tiles ultimately carry water to ditches, streams, or lakes thereby increasing peak flows and the duration of bankful flows that can lead to stream channel degradation (downcutting and widening) and flooding downstream.

As expected, most tile networks are found in the northern and western portion of the watershed where agricultural practices were and still are common. Other tile networks are located on land that is no longer agricultural. If not removed when developed, these tiles are most likely no longer functional. Because most drain tiles are located in depressional areas on agricultural fields, they provide excellent opportunities for wetland restoration projects. Breaking and/or removing sections of old field tile is one of the most effective and cost-efficient means to restore hydrology to former wetlands. When tiles are disabled, hydrology and wetland plants (both native and non-native) naturally return to areas that were historically wetland. Higher quality wetlands that provide water quality improvement and contain native species beneficial to wildlife are often created when restoration strategies such as plantings are used along with tile disablement.

Noteworthy Storm Sewer System and Detention Basins

The natural drainage system began to experience more changes as residential, commercial, and industrial land uses increased. Early urban development was constructed without detention basins. During this time, stormwater was directed to streams and lakes, via ditches and storm-sewer systems. The goal was to remove runoff from developed areas as quickly as possible. More recently, land planners and engineers have realized the benefits of storing stormwater runoff in detention basins. Detention basins are designed to capture stromwater runoff from a surrounding development and release the water slowly over a given amount of time, thereby reducing "peak" flows. If designed with native plants and other features, detention basins can also provide wildlife habitat and improve water quality.

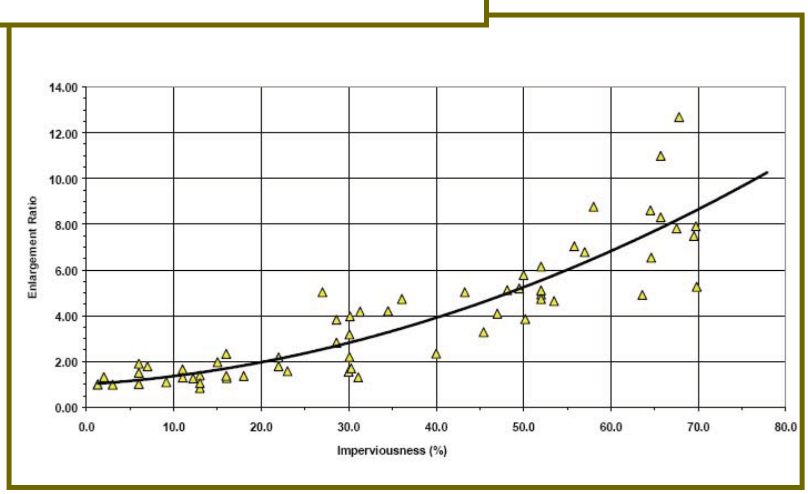
With increased amounts of impervious surface and extensive stormsewer networks, flashy hydrology became common throughout adjacent stream systems. Flashy hydrology results when the water level in streams rises quickly during a storm event and falls quickly following the storm event. This causes channel degradation such as down-cutting and channel widening as well as flooding and unstable conditions that are not suitable to most fish and invertebrates.



Source: Roger Bannerman presentation on rain gardens

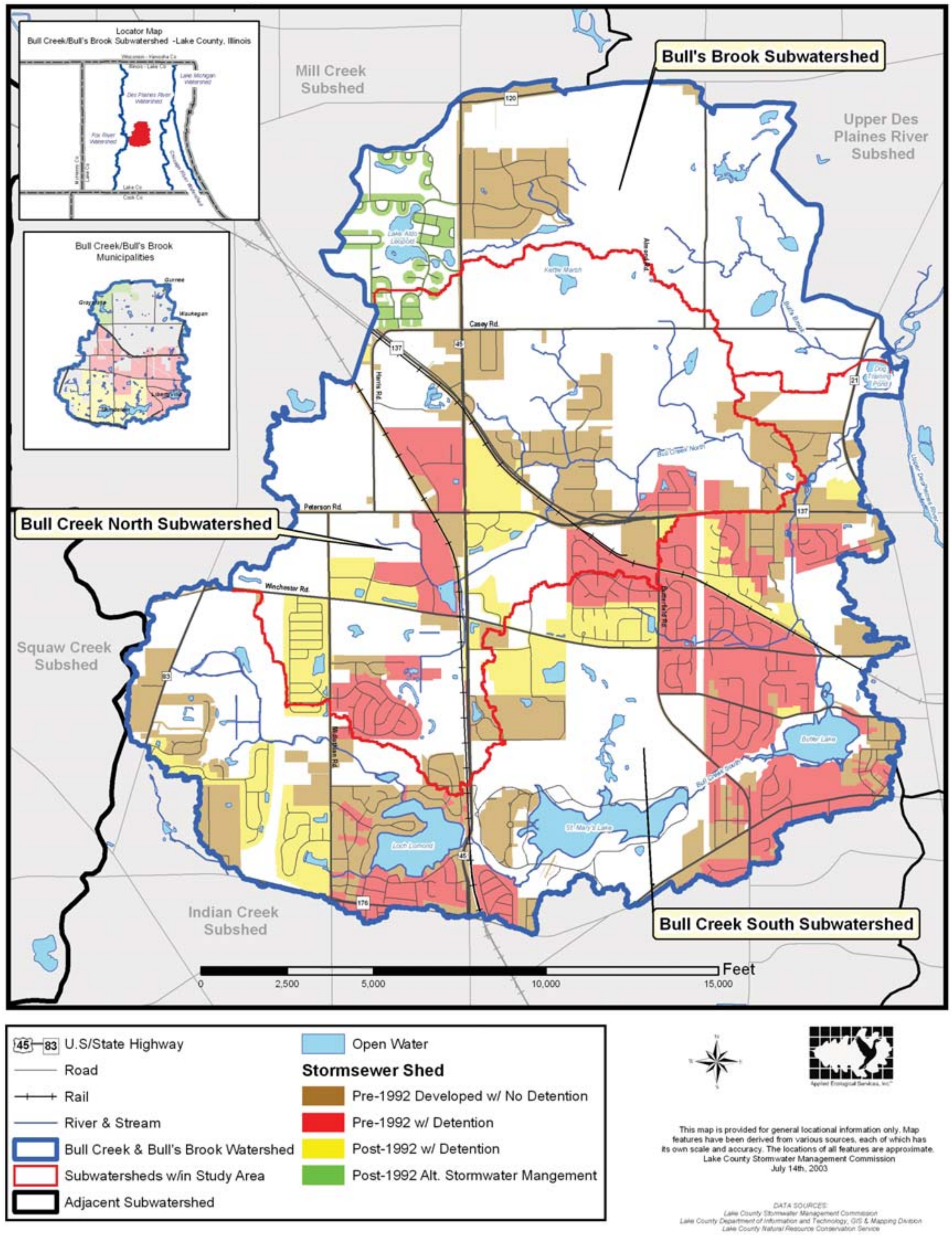
Top: Effects of urbanization on surface runoff and streamflow

Bottom: Impervious cover effects on stream channel stability



Source: The Practice of Watershed Protection: Center for Watershed Protection

Figure 53: Stormsewersheds Network



Noteworthy **Watershed Development Ordinance + Detention**

In 1992, Lake County adopted a comprehensive stormwater management ordinance (the ***Watershed Development Ordinance (WDO)***) governing the entire County, which restricted stormwater release rates for all new development within the County and was generally more restrictive than many of the Municipal ordinances that superseded it. The ordinance limited release rates from the 2-year recurrence interval design storm to 0.04 cfs/acre of development area and limited release rates from the 100-year recurrence interval design storm to 0.15 cfs per development acre. Limited release from the more frequent storms more closely approximated the ***bankfull*** capacity of stream channels in Lake County. Detention basin retrofits for pre-1992 constructed basins often include examining the feasibility to remove the existing outfall restrictor and replace it with a restrictor that limits release rates from the 2–year storm event.

Watershed Development Ordinance (WDO): *One part of the adopted Lake County Comprehensive Stormwater Management Plan. It sets forth the minimum requirements for the stormwater management aspects of development in Lake County.*

Bankfull: *The point at which water flow in a stream fills the channel to the top of its banks just to the point where water begins to overflow onto the adjacent floodplain. Bankfull stage flows transport the greatest quantity of soil and stone over time, because the bankfull stage occurs about once every year or two.*

Stormsewershed: *An area of land whose stormwater drains into a common storm sewer system*

STORMSEWER

In the developed areas of the watershed, a stormsewer network (***stormsewershed***) drains runoff directly to a stream or lake, or into a detention basin, which collects and holds the water for a period of time before discharging it to a stream or lake. Stormsewer networks (stormsewersheds) were delineated in the watershed by reviewing municipal and stormsewer maps. Figure 53 identifies:

- areas in the watershed that are not developed,
- areas developed and sewered/detained prior to 1992 (and the Watershed Development Ordinance requirements),
- areas developed and sewered/detained after 1992, and
- areas that are developed and not sewered/detained.

Undeveloped areas, agricultural land uses, and most older residential developments are not detained. Older developments were built before detention basins were required by ordinances and consequently were constructed without detention. The northern half of the watershed has limited sewer/detention due in large part to less residential development and expansive open space and agricultural lands. There are several older residential subdivisions on unincorporated lands located along Bull Creek North that were constructed prior to detention requirements.

Most of the sewered/detained watershed is located in the central areas where more recent development was initiated and continues to expand. New developments are constructed with sewer/detention systems designed in accordance with the 1992 Watershed Development Ordinance. In addition, Prairie Crossing Subdivision, located in the northwest corner of the watershed, is detained with post 1992 detention restrictions but contains fewer sewer networks. Rather, an alternative Stormwater Treatment Train approach was constructed. The treatment train approach includes the installation of several BMPs such as overland swales planted with native vegetation to slow and treat stormwater prior to entering the lakes and stream system.

There are 97 stormsewersheds in the Bull Creek/Brook watershed. Table 37 below lists acreage totals for sewered and unsewered areas by subwatershed. According to the data, Arbor Vista subdivision and the Village Green portion of Prairie Crossing have the only stormsewer networks in the Bull's Brook Subwatershed. Most of the stormsewersheds are located in the more highly developed Bull Creek North and Bull Creek South subwatersheds.

Table 37. Stormsewersheds and acres by subwatershed

	Total # of SSS	Total Developed Acres	Total Undeveloped Acres	Total Sewered Acres	% of Sub-watershed	Total Unsewered	% Unsewered
Bull's Brook	2	194	1,564	87	5	1,666	95
Bull Creek North	25	353	2,873	710	22	2,499	78
Bull Creek South	71	1,116	2,870	1,313	33	2,698	67
Totals	**97**	**1,663**	**7,307**	**2,023**	**n/a**	**6,950**	**n/a**

Stormsewersheds were assigned with the criteria of having its center in a subwatershed.
Note: Sewered acres are greater than developed acres for Bull Creek North and Bull Creek South because different GIS data were used. Total developed acres was derived from land use data (see section 3.5). Total sewered acres data was created from information obtained from local governing bodies and by using aerial and topographic means.

DETENTION BASINS

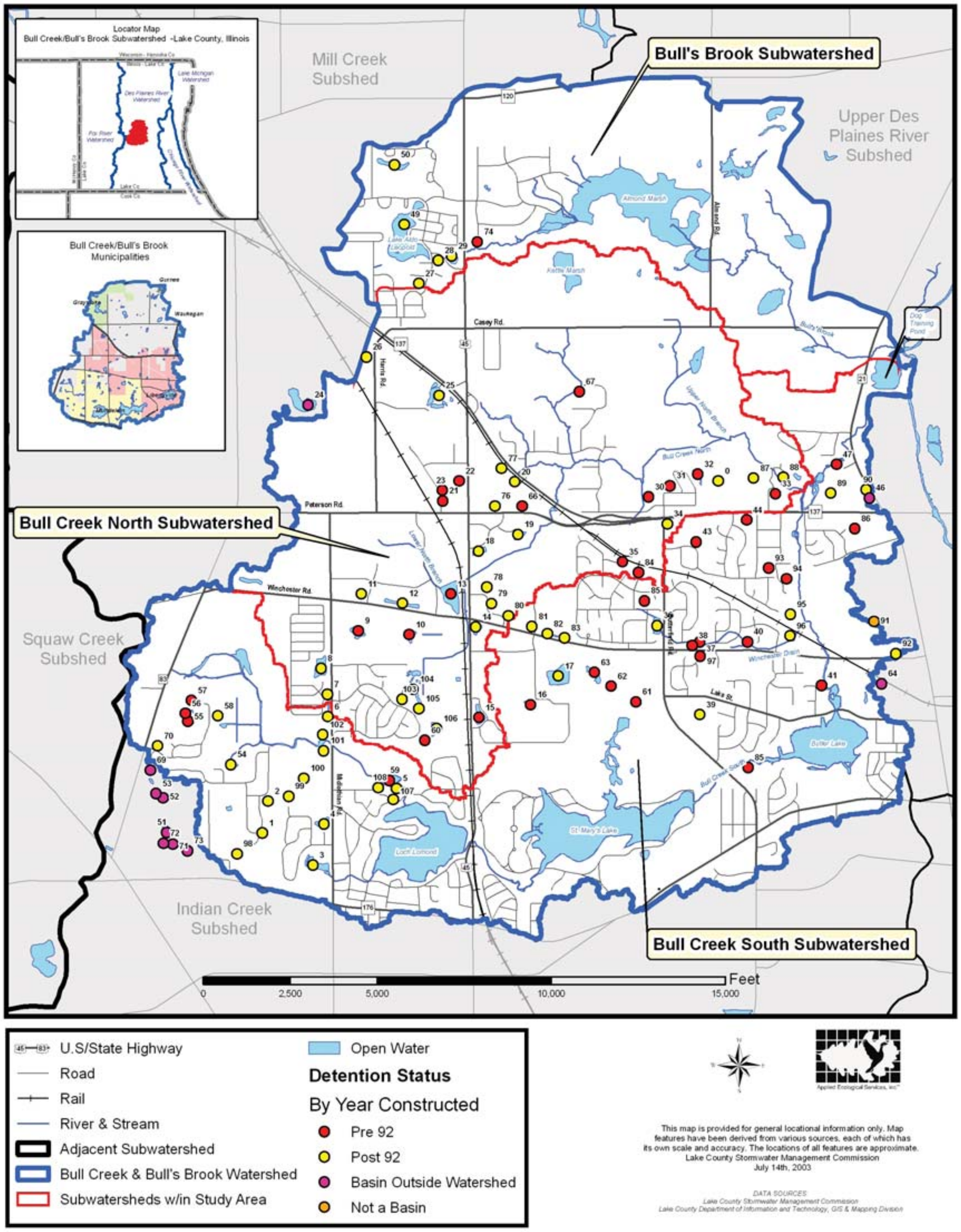
In 2004, the Lake County Stormwater Management Commission (LCSMC) conducted an inventory for all known detention basins (108) in the watershed. Appendix F contains the results for detention basins inventoried. The location of all detention basins within the watershed is shown on Figure 54. Each basin is identified with a number that corresponds with the detention basin inventory summary table (Appendix F). The detention basin inventory also noted estimated storage volume for each of the 108 basins, which is approximately 17,944 cubic feet.

Each basin underwent a rigorous review process developed by LCSMC. Information was collected on the following:

- Location
- Size and drainage characteristics
- Design features
- Maintenance/design problems
- Other observations such as safety
- Retrofit opportunities

The results of the survey indicate that 64 of 108 (59%) basins would benefit from improvements such as conversion from dry bottom to wet bottom, repair of short-circuiting problems, replacement of turf grass with native vegetation, and water quality improvements such as treatment of algae. A more detailed summary of detention basins needing improvements for water quality is included in Section 4: Watershed Problems Assessment. All recommended detention basin retrofit improvements are summarized in Section 8.2: Site Specific Action Plan.

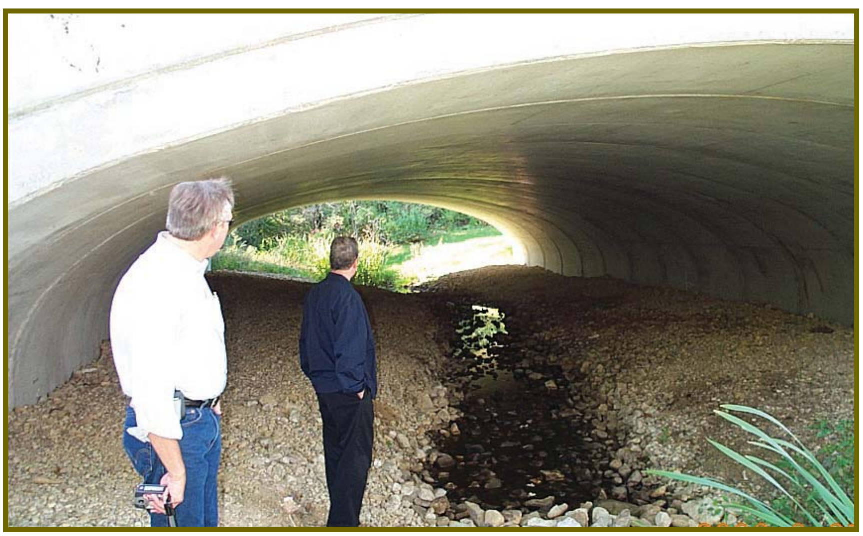
Figure 54: Detention Constructed Pre & Post 1992



HYDRAULICS/IMPOUNDMENTS

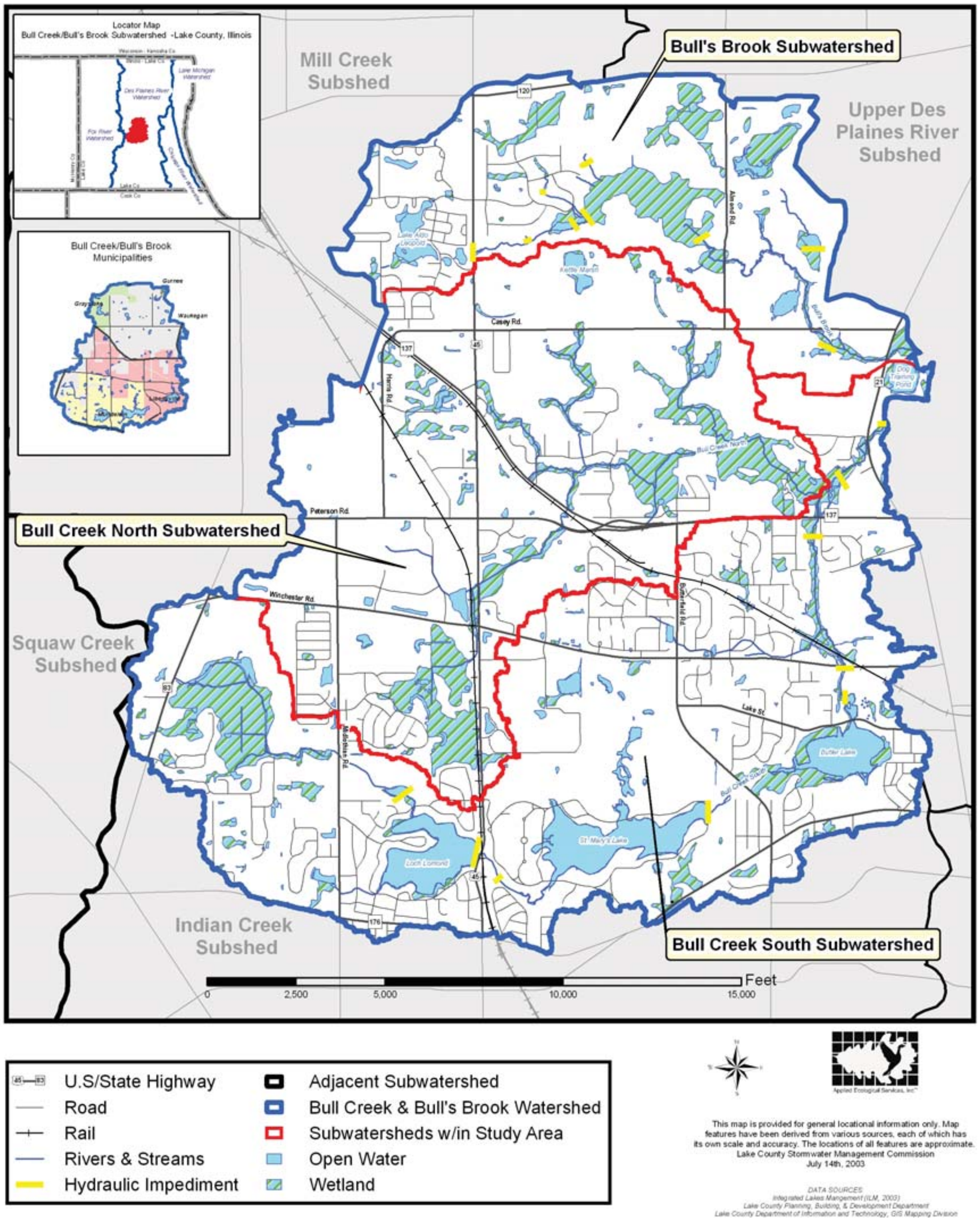
Additional changes in the natural hydrology occurred as portions of major stream branches were dammed to create lakes, ponds, and other impoundments. Dams have been installed to create or control 4 of the 5 primary lakes in the watershed including Loch Lomond, St. Mary's Lake, Butler Lake, and Leopold Lake. Additional dams and other hydraulic impediments are in place throughout the watershed. Figure 55 provides the location of all known lowhead dams and other hydraulic impediments such as the culvert at Winchester Road, the 10 foot drop structure under Route 45 just east of Prairie Crossing, and spillway at Rhyan's Pond to the east. Newer developments are constructing wide-span bridges over streams to preserve the natural channel and allow for a small floodplain during heavy rain events. An example of this is at a Pulte Homes development off of Midlothian Road.

Generally speaking, in addition to affecting the hydrology of wetlands upstream of bridges and culverts by backing up water or creating pinch points, dams and other hydraulic impediments inhibit the migration of fish and macroinvertebrates up and down stream thus interfering with the natural ecological processes of the stream. In many cases, small dams and impediments could be removed with little to no impact to the stream. Larger dams that were built to create lakes and large ponds are not feasible for removal. Some of the smaller migration impediments shown on Figure 55 should be studied in more detail to assess the potential positive or negative impacts of removal. The Heinz Center published a book in 2002 entitled "Dam Removal-Science and Decision Making" that provides objective insight on the numerous issues involved with dam removal. Information in this book can be used to assess the safety, environmental, legal, social, economic, and management issues surrounding the decision making process of dam removal.



Conspan bridge at Pulte development off Midlothian Road

Figure 55: Hydraulic Impediments in the Bull Creek/Bull's Brook Watershed



REGIONALLY SIGNIFICANT STORAGE LOCATIONS

For this study, ***Regionally Significant Storage Locations*** (RSSLs) are defined as existing or created depressional areas that are presently storing, or potentially could store stormwater runoff to decrease flooding in the watershed. Flood reduction is only one benefit of creating stormwater storage areas. Potential storage locations could also be created for mitigation of wetland losses (wetland restoration), channel protection, and water quality protection. Areas in the watershed such as the Bull's Brook subwatershed exhibit few flooding issues. In these areas, created storage locations would provide many benefits including reduced runoff to streams thus reducing channel erosion and reduced runoff to the Des Plaines River. If designed and planted as a wetland restoration, storage areas would improve water quality and habitat as well as increase groundwater recharge. The criteria used to identify existing and potential storage locations are summarized below. Detailed methods for identifying these areas are outlined in Appendix G.

Regionally Significant Storage Locations (RSSL): *Existing or created depressional areas on the landscape within a watershed.*

Existing Storage Areas Criteria:

- include all existing open water (streams and lakes), wetlands, detention basins, and 100-year floodplains;
- exclude parcels less than 1/3 acre, transportation, and building footprints;
- only include locations greater than 5 acres (5 acres is needed to create LCSMC 10 acre-feet of storage assuming depressional area is on average 2 feet deep);
- delineate tributary area of each 5 acre location to determine if drainage area is at least 100 acres;
- calculate estimated storage assuming 2 feet of storage volume at each location.

Potential Storage Areas Criteria:

- include all areas with 1% slope or less on all open and partially open parcels;
- exclude parcels less than 1/3 acre, transportation, building footprints, and existing storage locations;
- only include locations greater than 5 acres (5 acres is needed to create LCSMC 10 acre-feet of storage assuming depressional area is on average 2 feet deep);
- delineate tributary area of each 5 acre location to determine if drainage area is at least 100 acres;
- calculate estimated storage assuming 2 feet of storage volume (created by constructing a 2-foot high berm).

The location of each existing regional storage site is shown on Figure 56 and listed in Table 38.

Thirty-four (34) existing storage locations were identified in the watershed comprising 1,419 acres with the potential to store 2,839 acre-feet of water assuming 2 feet of storage at each site. Fifty-three (53) potential storage areas comprise an additional 1,334 acres and 2,668 acre-feet assuming 2 feet of storage (Figure 56; Table 38). As expected, many of the larger lakes, wetlands, and floodplain areas have the potential to store the most water under existing conditions.

Several potentially large storage areas could be created in other portions of the watershed by constructing a 2-foot berm, which if built at the lowest elevation along each identified potential storage area could allow these areas to hold additional water and become shallow storage areas/wetlands. A 2-foot berm was selected because it can potentially hold back enough water to provide the optimum depth to support a functioning hemi marsh-type wetland that has the potential to harbor various wetland plant and animal species as well as store stormwater. Water surface fluctuations greater or less than 2 feet in a hemi-marsh wetland encourage growth of non-native/invasive species such as cattails in areas that are designed to be open water.

The largest potential storage locations are outlined in yellow and red on Figure 57 and Table 38. Smaller sites are shown in blue, orange, and green. Sites 27, 26, 14, 31, 50, and 4 range in size from approximately 40 to 77 acres with the potential to provide between 80 and 154 acre-feet of storage. Site 27 is located south of St. Mary's Lake on land that is currently open space. Sites 4, 14, 50, 26, and 31 are located on land that is currently agricultural. Of these, 4 and 14 are slated to become industrial land in the next 20 years. Site 26 is expected to be intersected by the proposed Route 120 bypass in the near future. Therefore, Site 50 (Lake County Government Land) is most feasible for creating stormwater storage/mitigation. In addition, Sites 26 and 47 provide opportunities to mitigate for existing flooding at Flood Problem Area Sites 13-11 and 14-01 identified by the Lake County Stormwater Management Commission (LCSMC).

Sites 7, 22, and 47 represent the largest potential storage locations. They range in size from 129 to 179 acres and have the potential to store between 258 and 357 acre-feet of water. All are located on existing agricultural land. Site 7 is projected to become industrial while much of Site 47 is expected to be developed to residential housing in the next 20 years. Only site 22 is expected to remain agricultural land as part of the Liberty Prairie Reserve (LPR). Therefore, Site 22 possesses great potential for future stormwater storage/wetland mitigation in the watershed.

Several of the smaller potential storage locations (shown in blue, orange, and green) could also help mitigate flooding in the watershed. Many of these are located in existing agricultural fields and other open space.

Figure 56: Existing Regional Storage Locations

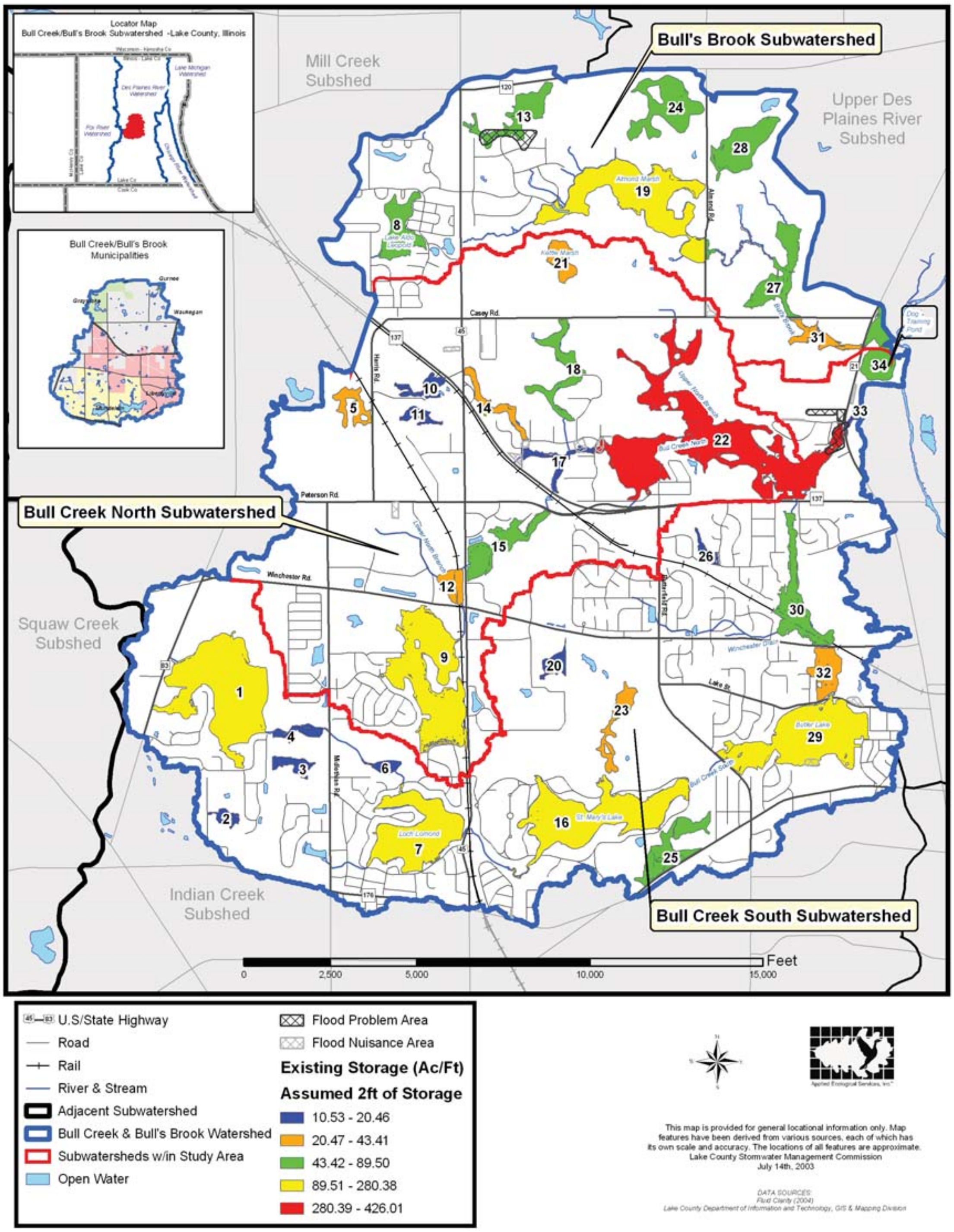


Figure 57: Potential Regional Storage Locations

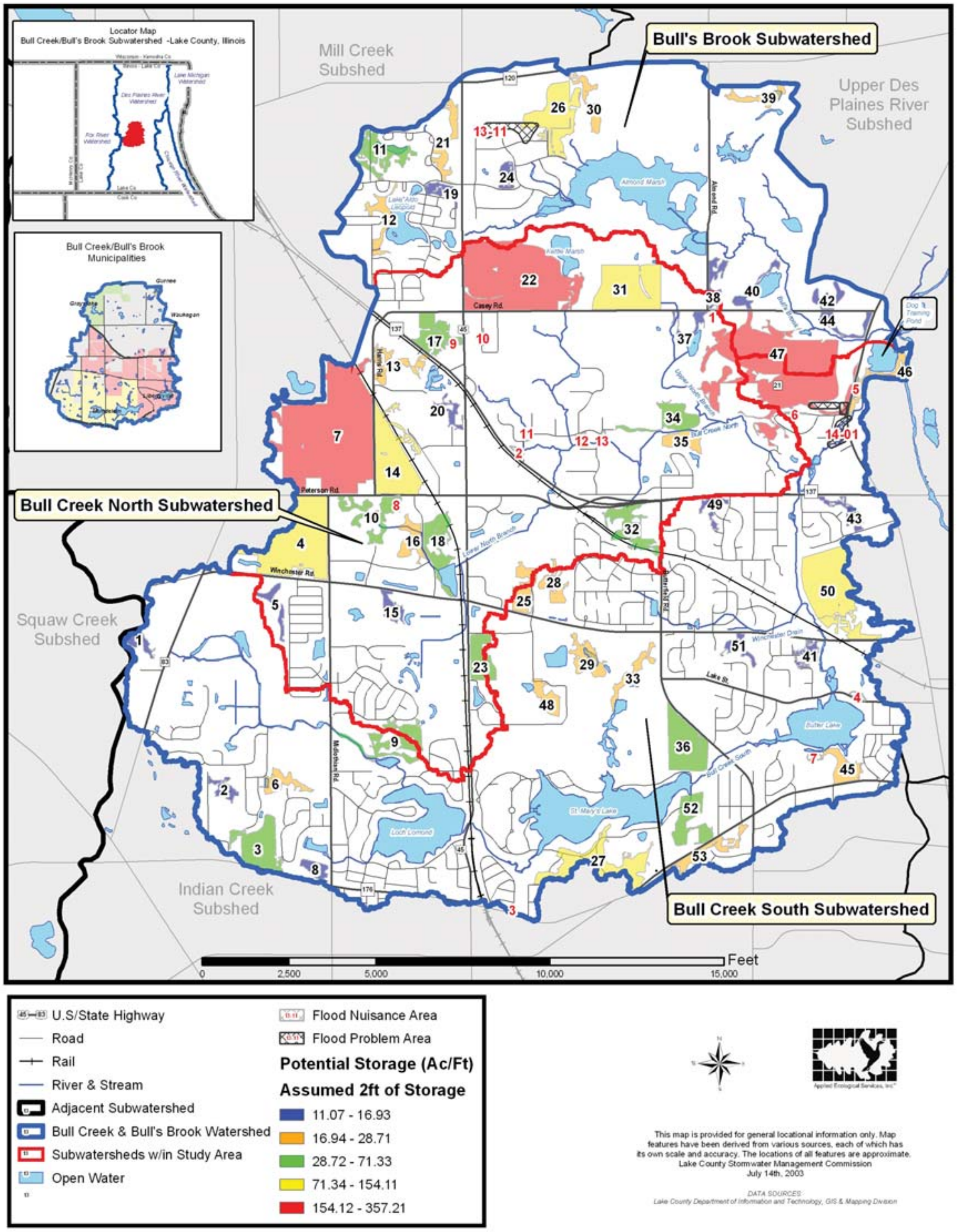


Table 38. Ranking of existing and potential storage locations based on 2-foot depressional storage volume (acre-feet)

Existing Storage			Potential Storage		
ID	**Acres**	**2-Foot Depressional Volume (Acre-Feet)**	**ID**	**Acres**	**2-Foot Depressional Volume (Acre-Feet)**
26	5.3	10.5	40	5.5	11.1
2	5.3	10.5	1	5.6	11.3
33	5.4	10.8	51	5.6	11.3
6	5.7	11.4	49	5.7	11.4
11	6.5	13.0	2	5.9	11.9
4	8.5	17.0	37	6.2	12.5
3	8.8	17.6	8	6.4	12.7
20	8.9	17.7	24	6.4	12.8
10	9.7	19.5	41	6.6	13.2
17	10.2	20.5	19	6.7	13.4
12	12.7	25.3	42	6.8	13.6
31	13.2	26.3	5	6.9	13.7
5	13.4	26.8	43	7.0	13.9
14	13.6	27.2	20	7.0	14.0
21	14.8	29.5	44	7.5	15.1
23	17.8	35.5	15	7.9	15.9
32	21.7	43.4	38	8.5	16.9
18	25.8	51.7	39	9.1	18.2
34	28.4	56.9	46	9.3	18.5
13	29.4	58.7	28	9.7	19.4
15	30.4	60.9	33	9.7	19.5
8	30.8	61.7	30	9.9	19.7
25	32.7	65.4	48	9.9	19.9
27	36.6	73.1	6	10.2	20.4
28	37.6	75.2	12	10.8	21.5
30	40.6	81.2	35	11.1	22.3
24	44.8	89.5	13	11.7	23.4
7	83.4	166.8	16	12.0	24.0
29	113.8	227.5	45	12.3	24.7
16	114.2	228.4	21	13.1	26.2
19	115.5	231.0	53	13.2	26.5
9	120.8	241.7	29	14.3	28.7
1	140.2	280.4	25	14.4	28.7
22	213.0	426.0	23	17.3	34.6
	1,419.3	**2,838.7**	34	17.4	34.8

Existing Storage			Potential Storage		
ID	**Acres**	**2-Foot Depressional Volume (Acre-Feet)**	**ID**	**Acres**	**2-Foot Depressional Volume (Acre-Feet)**
			10	18.7	37.4
			17	20.1	40.2
			32	20.2	40.5
			52	20.9	41.7
			18	20.9	41.8
			11	22.7	45.3
			9	24.3	48.6
			3	29.6	59.3
			36	35.7	71.3
			27	39.8	79.6
			26	40.9	81.8
			14	51.0	102.0
			31	52.4	104.7
			50	67.1	134.1
			4	77.1	154.1
			22	128.9	257.7
			47	157.6	315.2
			7	178.6	357.2
				1,334.2	**2,668.4**

CHAPTER 4.0

Watershed Problem Assessment

This section of the report is a more detailed assessment of the problems identified in the watershed characteristics assessment *(Section 3.0)*. The following subsections describe how further analysis was used to assess how land use impacts are affecting the water quality, natural resources, and flooding conditions in the Bull Creek/Bull's Brook watershed. The watershed assessment section identifies several current and potential future problems in the watershed:

— Land use impacts on watershed related to impervious cover, pollutant loading, and soil erosion
— Stream degradation (both physical and chemical)
— Lake degradation (both physical and chemical)
— Flood damage/flood risk associated with land development impacts and wetland loss
— Lack of jurisdictional coordination

4.1 Land Use Impacts

THE PROBLEM: Hydrology changes in the watershed related to human land uses have resulted in lake and stream degradation, increased flood damage (currently limited), and nonpoint source pollution. Several of the lakes in the watershed are plagued by high nutrients, increasing salt concentrations, relatively low biological diversity, and shoreline erosion/poor buffers. The streams in the watershed are primarily experiencing streambank erosion, nutrient loading, habitat alteration, and decreased biological productivity. Although flooding is not a serious problem, flood risk is a problem. 104 structures were identified in the 100-year floodplain and 2 Flood Problem areas and 13 nuisance flooding areas have been identified. In addition, hydrology changes are leading to debris loading in stream channels that can lead to flooding and sediment deposition.

PRIMARY CAUSE: Increased surface runoff due to impervious cover. The Center for Watershed Protection's "Watershed Vulnerability Analysis" was used to locate specific subdrainage areas in the watershed that are contributing most to the problems associated with impervious surfaces..

Noteworthy **Watershed Vulnerability Analysis**

In 1998, the ***Center for Watershed Protection (CWP)*** published the *Rapid Watershed Planning Handbook*. This document introduced rapid assessment methodologies for watershed planning. Recently, the CWP released the ***Watershed Vulnerability Analysis*** as a refinement of the techniques used in the *Rapid Watershed Planning Handbook* (Zielinski 2002). The vulnerability analysis focuses on existing and projected impervious cover as the driving forces impacting potential stream quality within a watershed. A detailed discussion of land use and impervious cover impacts on watershed conditions is summarized in Section 3.5: Land Use/Land Cover.

Center for Watershed Protection (CWP): *Non-profit 501(c)3 corporation founded in 1992 that provides local governments, activists, and watershed organizations around the country with the technical tools for protecting some of the nation's most precious natural resources such as streams, lakes and rivers.*

Watershed Vulnerability Analysis: *Rapid planning tool for application to watersheds and subwatersheds that estimates impervious cover and assesses waterhshed's vulnerability to water resource degradation.*

A modified watershed Vulnerability Analysis was used to compare Subwatershed Management Unit (SMU) quality across the Bull Creek/Bull's Brook watershed, and to evaluate the vulnerability of the SMU and stream quality to projected impervious cover associated with future land use changes. For the analysis, four steps were followed to generate four primary outcomes for use by watershed planners and resource managers. The four steps/outcomes are listed below and described in more detail in the following pages and Appendix H:

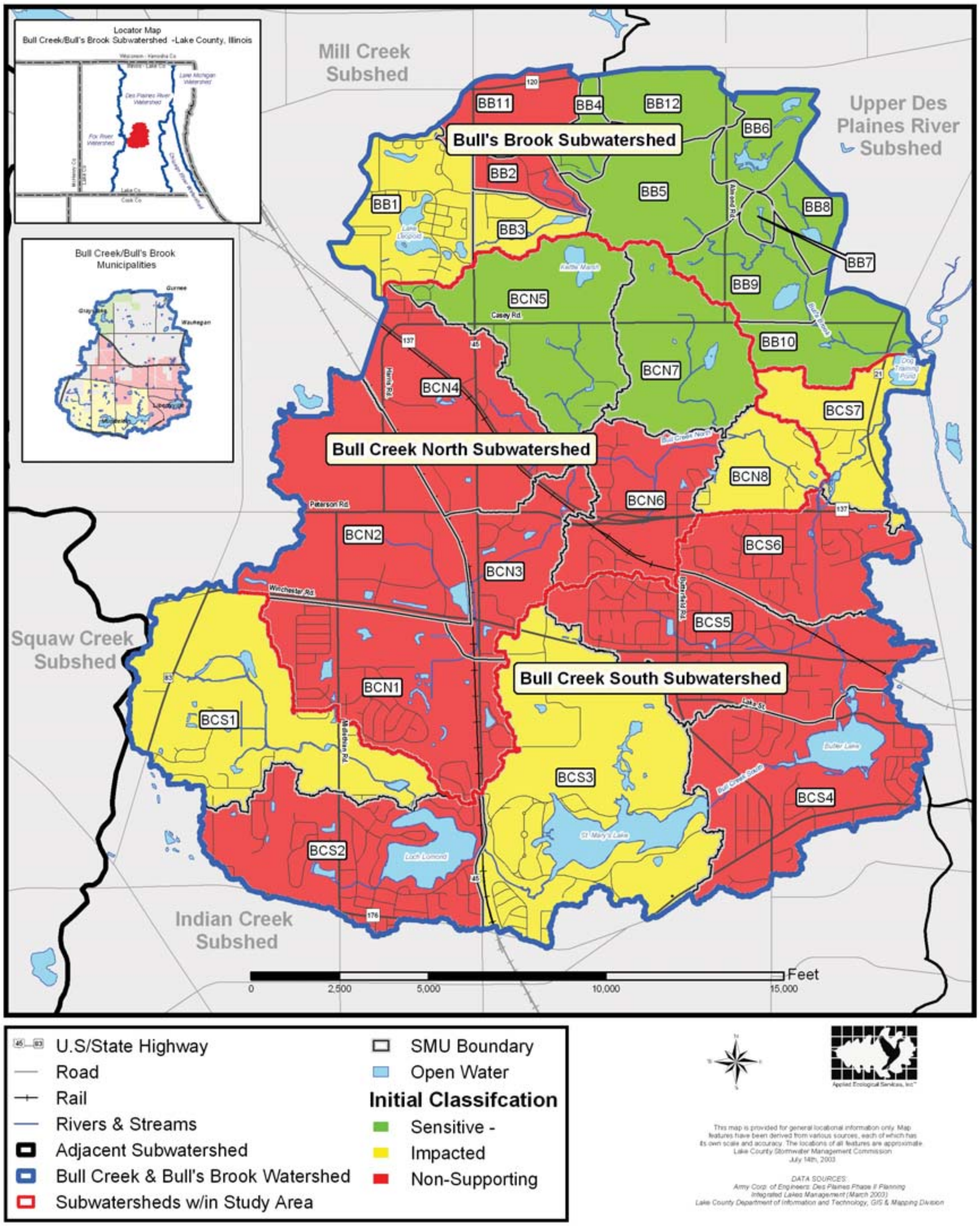
1. Initial classification of SMUs based on current impervious cover estimates.
2. Final classification and assessing the restorable potential of borderline SMUs using a field criteria analysis.
3. Ranking the most vulnerable SMUs based on projected impervious cover.
4. Ranking of priority SMUs for immediate planning and BMP implementation.

STEP 1: INITIAL CLASSIFICATION

The first step in the *vulnerability analysis* involves an initial classification of each SMU based on existing estimated impervious cover *(See Appendix H for methodology; also see impervious cover description in Section 3.5)*. Ten SMUs were initially classified as ***Sensitive***, 5 as ***Impacted***, and 12 as ***Non-Supporting*** (*Figure 58*). The majority of the Sensitive SMUs are located in the northern portion of the watershed in open space areas that are part of the Liberty Prairie Reserve (LPR). Impacted SMUs are associated with areas of minimal to moderate development (agricultural land or partially open space) or conservation development (such as Prairie Crossing in SMU BB1), which unlike other developments in the watershed contains less impervious area due to specific design elements aimed at preserving open space. Most of the Non-Supporting SMUs are located in the central and southern portions of the watershed and are associated with residential, commercial, and industrial development that did not use conservation or low impact development techniques. Table 1a *(Appendix H)* lists existing impervious cover percentage and existing impervious classifications for all 27 SMUs.

Impervious Area	*Classification*
≤ 10%	*sensitive*
> 10%–25%	*impacted*
> 25%	*non-support*

Figure 58: Initial Classification of SMUs Based on Existing Impervious Cover



STEP 2: FINAL CLASSIFICATION AND RESTORATION POTENTIAL

Analysis using existing impervious cover does not always reflect actual stream or SMU conditions because the impact of imperviousness can be somewhat mitigated by other factors such as the width and quality of riparian buffers along stream channels. Therefore, field criteria (available stream and SMU scale assessments) is analyzed in Step 2 of the vulnerability assessment process so that borderline SMUs are more accurately categorized into one of 6 final classifications that also reflect restoration potential. Borderline Sensitive SMUs are those with an impervious range between 8-10%. Borderline Impacted SMUs have impervious ranges between 11-13% (low end of impacted range) or 23–25% (high end of impacted range). |Borderline Non-Supporting SMUs have between 26–28% impervious area.

For this report, 9 of the field criteria used by the Center for Watershed Protection (CWP) for examining borderline SMUs were examined in the Bull Creek/Bull's Brook watershed. The field criteria are as follows:

1. SMU contains more than 10% wetland area.
2. SMU contains more than 40% open space.
3. SMU contains documented threatened and endangered (T & E) plants or animals.
4. Most of the stream corridor within the SMU is vegetated and has at least 30' wide on both sides of stream reach and/or the lake shoreline is at least 75% buffered.
5. Less than 30% of land in SMU is developed and undetained (does not utilize stormwater detention practices).
6. The majority of the stream channel in the SMU shows little alteration (ditching, moderate or high erosion, channelization) as documented during Lake County Stormwater Management Commission's and Integrated Lakes Management's stream inventories.
7. The stream channel within the SMU contains high quality habitat to support sensitive aquatic faunas. High quality habitat was assessed during Lake County Stormwater Management Commission's stream inventories, in Integrated Lakes Management's 2003 Water Quality Report, and during Lake County Health Department lake inventories.
8. No barriers impede movement of fish between the SMUs. The location of barriers was documented in Integrated Lakes Management's 2003 Water Quality Report.
9. Inventoried conservation areas (ADID wetlands, Illinois Natural Area Inventory (INAI) sites, nature preserves, Libertyville Township open space parcels, and private deed restriction parcels) comprise more than 10% of the SMU.

Table 39 outlines the final classification guidelines for adjusting borderline initial SMU classifications using field criteria. If, for example, a borderline Impacted SMU (11-13% imperviousness) meets greater than 50% of the field criteria, the SMU is re-classified as Sensitive. Likewise, if the same borderline Impacted SMU meets only 1-4 field criteria, the SMU is re-classified as Restorable Sensitive.

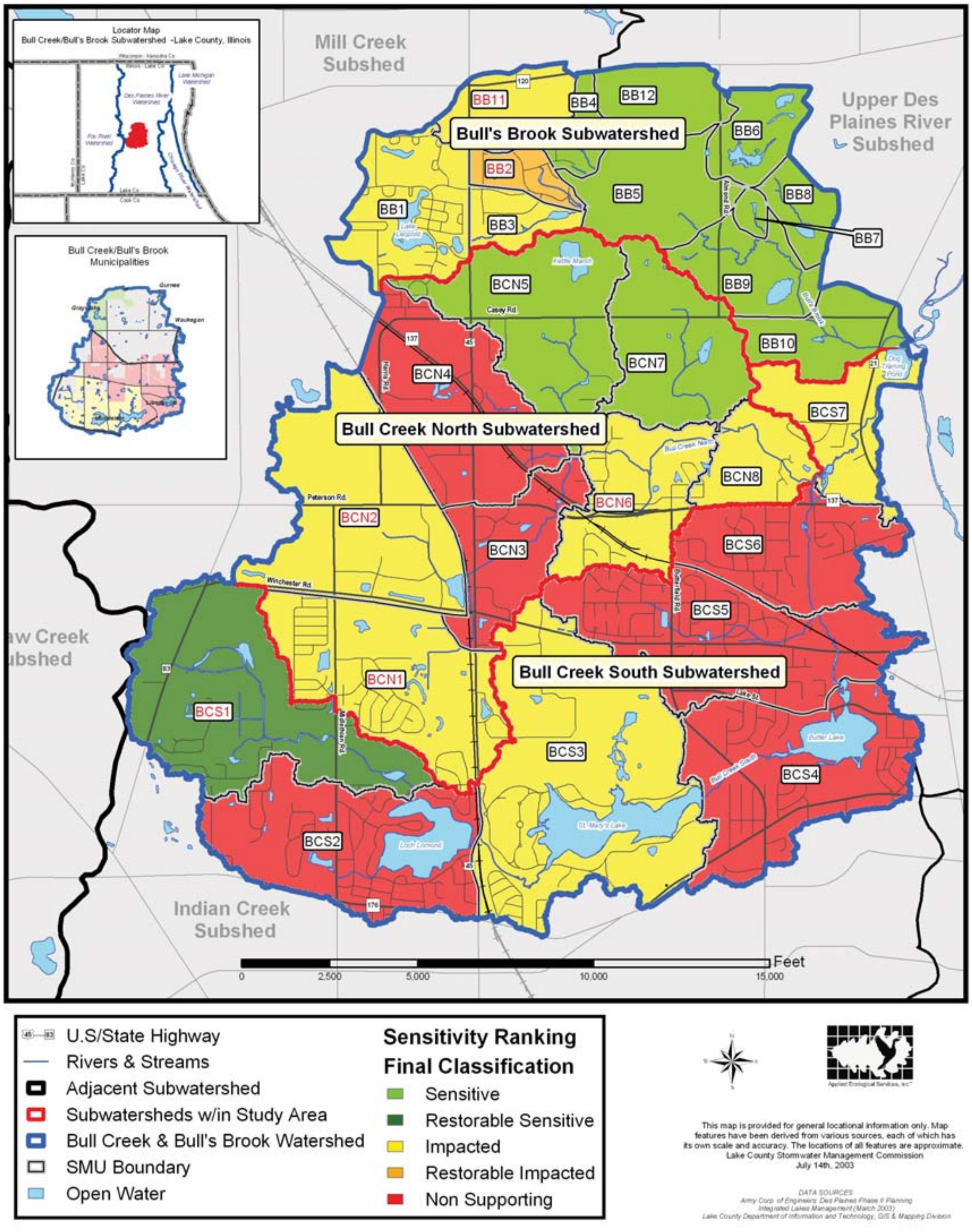
Table 39. Final classification guides for borderline SMUs

Category	Field Criteria Analysis
Sensitive	(8–13% impervious & ≥50% field criteria met)
Restorable Sensitive	(8–10% impervious & <50% criteria met) or (11–13% impervious & ≥50% field criteria met)
Impacted	(11–13% impervious & no field criteria met) or (23–25% impervious & ≥50% field criteria met) or (26–28% impervious & ≥50% field criteria met)
Restorable Impacted	(23–25% impervious & <50% criteria met) or (26–28% impervious & ≥50% field criteria met)
Non-Supporting	(26–28% impervious & no field criteria met)
Restorable Non-Supporting	(>28% impervious & ≥50% field criteria met)

*A SMU must have data for 5 or more field critria to qualify for the analysis

Nine borderline SMUs were subjected to the field criteria analysis. Based on this analysis, 6 of the borderline SMUs were given adjusted final classifications (Figure 59; Appendix H: Table 1a). Note: red SMU ID numbers on Figure 59 indicate SMUs that changed classification. One Impacted borderline SMU (BCS1) was re-classified to Restorable Sensitive. One Non-Supporting borderline SMU (BB2) was reclassified as Restorable Impacted (this SMU only met 2 of 9 field criteria). Four Non-Supporting borderline SMUs (BB11, BCN1, BCN2, and BCN6) were reclassified to Impacted. These SMUs met more than 50% of the field criteria and therefore received a full classification change.

Figure 59: Final Classification/Restorable Potential of SMUs Based on Field Criteria



STEP 3: PROJECTED IMPERVIOUS COVER AND VULNERABILITY RANKING

Future Classification

Projected impervious cover was evaluated during the third step of the vulnerability analysis process. For this study, projected imperviousness was based on land use changes projected in 20-year comprehensive plans and parcel/zoning information available through the Lake County Planning and Building Department and local municipalities. Like the initial classification, future impervious cover is estimated using the Lake County Stormwater Management Commission (LCSMC) landuse/land cover table based on projected land use changes, then a projected classification of Sensitive, Impacted, or Non-Supporting is assigned to each SMU. This analysis is important when trying to identify the Sensitive and Impacted SMUs that are most vulnerable to future development pressure.

The future classification, based on projected impervious cover, resulted in 10 Sensitive SMUs, 4 Impacted SMUs, and 13 Non-Supporting SMUs (Figure 60; Appendix H: Table 1a). Only BCN8 and BCS1 (indicated with red SMU ID numbers on Figure 60) are projected to change to a more impervious classification compared to existing conditions. BCN8 is projected to change from 25% impervious (Impacted) to 27% (Non-Supporting). This is only a small change in impervious compared to BCS1. BCS1 is projected to change from 11% (Impacted) to 31% impervious. This is a 20% point change in impervious cover over the next 20 years.

Vulnerability

The vulnerability of each SMU was determined by considering the following questions:

1. Will the SMU classification change? (e.g. shift from sensitive to impacted);
2. Does the SMU classification come close to changing (within 2% of a new classification)? (e.g. future impervious cover is projected at 24%);
3. What is the absolute change in impervious cover? (e.g. a SMU that shifts from 5% to 14% may be more vulnerable than a SMU that shifts from 6% to 12%.

A vulnerability of low, medium, or high was assigned to each SMU (Appendix H: Table 1a ; Figure 61) based on the following:

- Low = no change in classification, <5% point change in impervious cover
- Medium = classification close to changing or changes from borderline to more impacted and/or 5–10% point change in impervious cover
- High = change in classification and/or >10% point change in impervious cover

The vulnerability analysis resulted in 13 low, 10 medium, and 4 high ranked SMUs (Figure 61). BB11 and BB4 were ranked medium because the proposed Route 120 bypass and proposed residential areas associated with it is expected to increase impervious cover. Proposed residential development of open space in BB6, BB7, BB8, BCN5, BCN6, BCN7, BCN10, and BCS6 will also increase impervious cover. BCN2, BCN4, BCN8, BCN6, and BCS1 are highly vulnerable. This is a result of proposed industrial, commercial, and institutional developments that are projected to result in significant increases in impervious cover. Figure 20 in Section 3.5 includes a more detailed map of actual parcels projected to change landuse/land cover.

Figure 60: Projected Impervious Cover of SMUs Based on Proposed 20-year Built Out Conditions

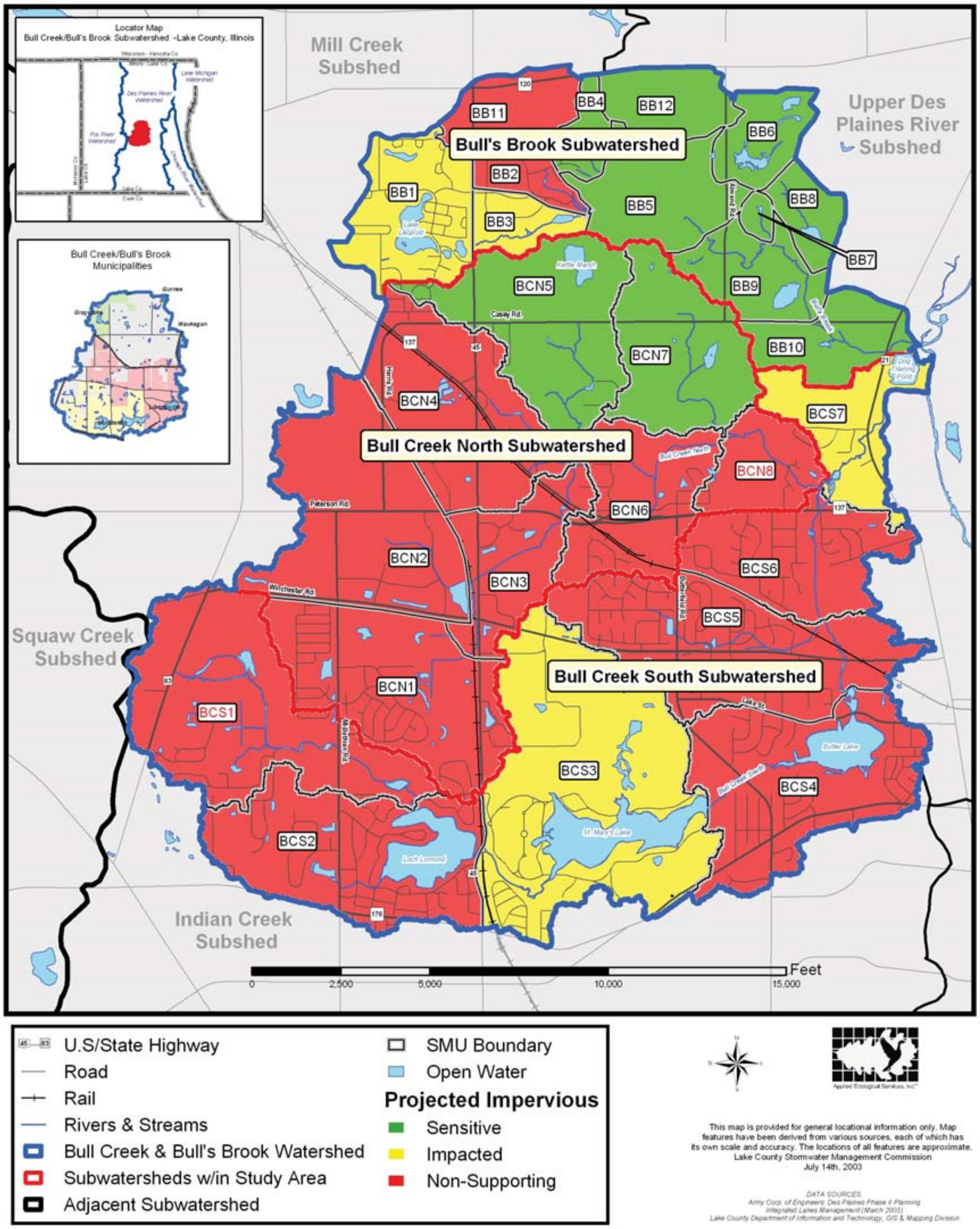
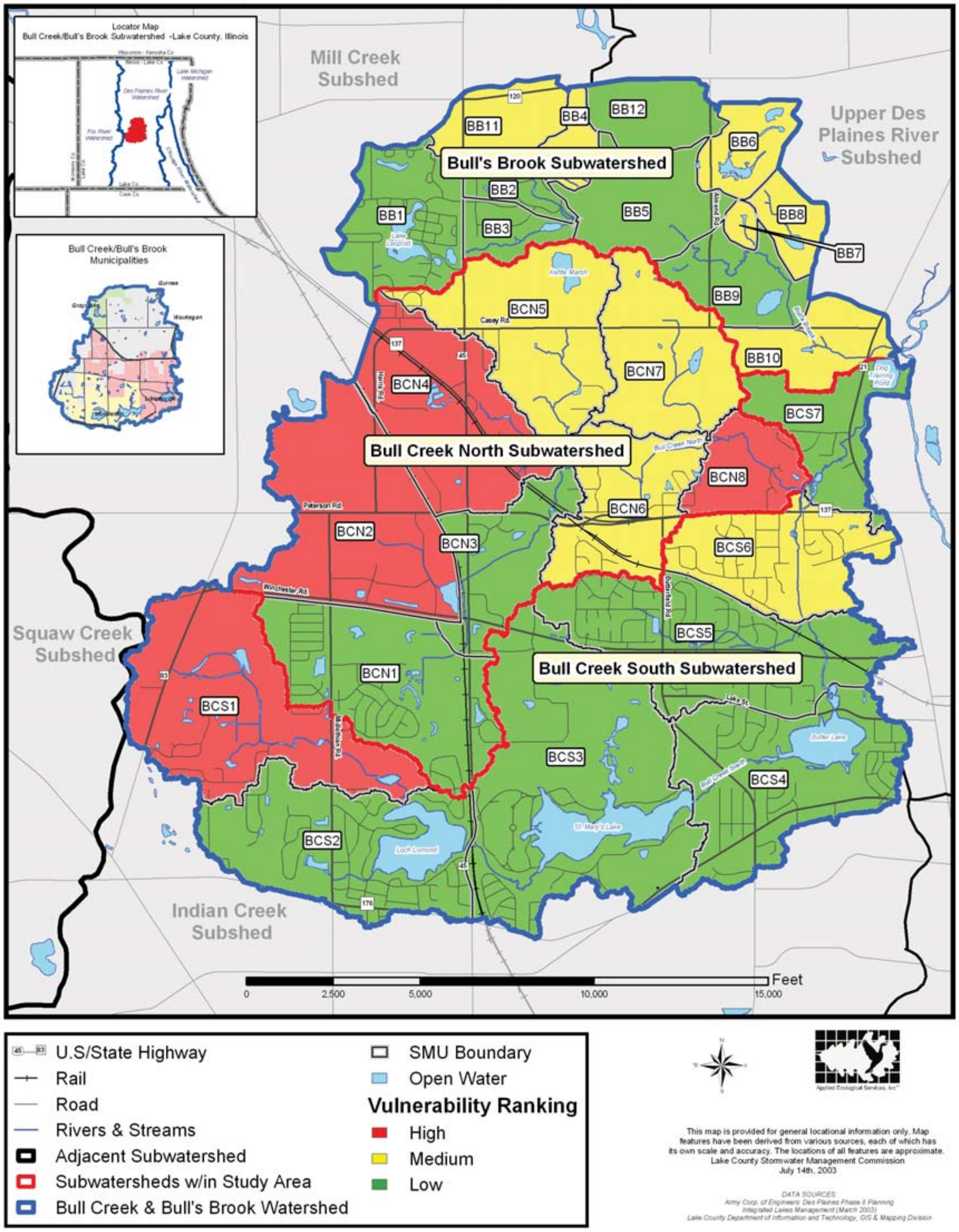


Figure 61: Vulnerability Ranking of SMUs



STEP 4: PRIORITY RANKING

The last step in the analysis includes a ranking of priority SMUs based on results obtained from Steps 1, 2, and 3. This is accomplished by creating a priority ranking that identifies the most vulnerable SMUs in need of immediate BMP implementation, open space protection, or restoration. The following criteria are used to rank each SMU as Low, Medium, or High Priority (more vulnerable) relative to the other SMUs in the watershed:

1. Vulnerability, as determined under Step 3.
2. Designated use of the receiving water within the SMU.
3. The presence of aquatic endangered species habitat.
4. Fraction (Percent) of SMU that is conservation area (protected open space in conservation use).
5. Development pressure within the SMU, as determined by the fraction (percent) of land that is projected to change to a more impervious land use in the next 20 years.
6. Fraction (Percent) of land that is publicly owned.

The priority ranking analysis identified 7 high, 17 medium, and 3 low priority SMUs. The results of the priority ranking are shown in Table 1b (*Appendix H*) and depicted in Figure 62.

Bull's Brook

BB4 is the only SMU in the Bull's Brook subwatershed that is designated high priority. Reasons for this include the construction of the proposed Route 120 bypass project that will decrease the amount of large publicly owned conservation areas.

Bull Creek North

Four SMUs within the Bull Creek North subwatershed are ranked high priority. These include BCN4, BCN6, BCN7, and BCN8. BCN4 is vulnerable to proposed commercial and industrial development pressure; BCN6 and BCN7 exhibit extensive conservation and publicly owned land; BCN8 is highly vulnerable to a large proposed institutional development relative to the size of the SMU.

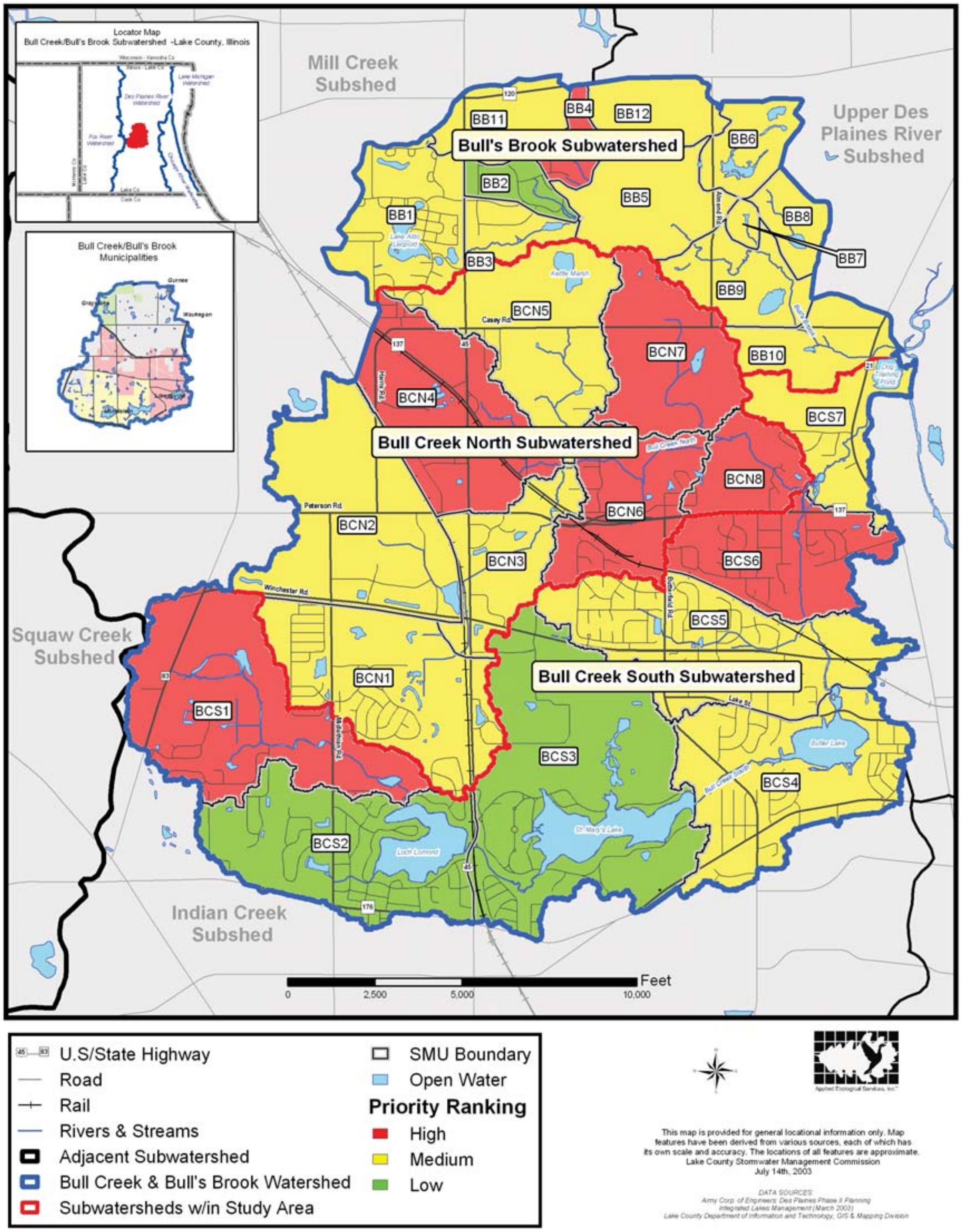
Bull Creek South

BCS1 and BCS6 are high priority SMUs in the Bull Creek South Subwatershed. BCSI is highly vulnerable to development pressure in existing agricultural fields. BCS6 is threatened by expansion of development on Lake County Farm property.

Medium priority SMUs comprise the majority of the watershed. Most medium priority SMUs are located in the northern two-thirds of the watershed and are built out or are expected to experience more built out conditions in the future. Medium priority SMUs in the northern half of the watershed are not expected to experience heavy development but are important because much of the land has conservation areas/T&E species and is publicly owned or protected.

Only 3 SMUs were designated low priority and include BB2, BCS2, and BCS3. BB2 and BCS2 are mostly built out and do not contain extensive conservation areas or publicly owned land. BCS3 is ranked low priority for different reasons. This SMU contains extensive private open space owned by St. Mary's Seminary. The St. Mary's Seminary land is not protected. However, it is not projected to be developed in the next 20 years.

Figure 62: Priority Ranking of SMUs



REDUCING LAND USE IMPACTS

Development Regulations/Policy

Among the primary goals of the Bull Creek/Bull's Brook Watershed Plan are recommended actions for protecting and restoring natural resources, improving water quality, and reducing and preventing flood damage in the watershed. These actions include both remedial and preventative measures. Among the most significant and influential preventative measures is policy and regulatory change. Changes to the Watershed Development Ordinance (WDO) and local municipal ordinances that benefit all watersheds in Lake County would consequently benefit the Bull Creek/Bull's Brook watershed. But to maximize protection for the watershed, Lake County Stormwater Management Commission (LCSMC) and local municipalities should consider developing and administering watershed-specific regulations to meet goals and technical issues of concern in the watershed.

The primary technical issues of concern in Bull Creek/Bull's Brook watershed are:

- Increased impervious surface, particularly in the southern half of the watershed;
- Impacted and non-supporting stream conditions that lead to erosion, flooding, and poor water quality *(Section 4.1)*;
- Lack of watershed-wide stream maintenance program;
- Development related non-point source pollution *(Section 4.2)*;
- Loss of wetlands and other natural drainage system components—this contributes to increased flooding *(Section 4.4)*

Certified Community: *A municipality that is certified by LCSMC to enforce the provisions of the Lake County Watershed Development Ordinance (WDO). The municipality's designated Enforcement Officer enforces the provisions in the ordinance.*

Development affecting water resources (streams, lakes, isolated wetlands, and floodplains) in the Bull Creek/Bull's Brook watershed is most significantly regulated by the ***Lake County Watershed Development Ordinance*** (WDO), which is administered and enforced by the Lake County Stormwater Management Commission (LCSMC) or a ***certified community***. Within the watershed, the Villages of Libertyville, Grayslake, Mundelein, and Gurnee along with the City of Waukegan are certified to administer and enforce the basic provisions of the WDO, while Lake County is certified to administer both the standard and the isolated wetlands provisions of the ordinance, therefore, Lake County Stormwater Management Commission for the most part does not review development proposals in the watershed. Local community staff could assist developers in the site review process by assessing each new development site for proper BMP selection, and implementation of stormwater management practices that best minimize runoff volumes and velocities. The WDO was developed to uniformly and consistently enforce stormwater management throughout the county, and as a result, except for a few instances[1] is not watershed specific. Local municipal ordinances also affect watershed issues and may be the best avenue for incorporating watershed-specific development standards and practices.

[1] For example: the WDO includes a customized release rate for the Squaw Creek Watershed that is more stringent than the county-wide release rate. Also, the Villages of Green Oaks and Mettawa have adopted moe stringent release rates.

Some local policy and ordinance recommendations are included below.

Impervious Surface/Runoff Reduction

1. The WDO should first and foremost require specific stormwater BMPs that reduce impervious surface.
2. Secondly, the WDO municipal and county development ordinances should provide incentives for developers to conserve natural resources and utilize existing water resource features as additional site stormwater BMPs.
   - Incentives might include a reduced fee for developers who propose a development project that keeps impervious surface below 25% of the project area (i.e. a conservation development),
   - reduce detention requirements for use of permeable paving practices,
   - preservation of at least one wetland, prairie, floodplain or woodland community as the primary course for filtering stormwater,
   - reduced landscape requirements where the development proposes to utilize only native species within channels or swales that convey stormwater, or
   - another, often more critical incentive for developers, would be to give priority review status to development proposals that propose one or more ways to reduce runoff volume or use other conservation measures.

Protecting Stream Channels

Streambank erosion, flooding, and poor water quality are problems for many stream reaches in the Bull Creek/Bull's Brook watershed. Although less than half of the modeled stream reaches exhibit flows that exceed 4 feet per second (the threshold of normal stream bank erosion), nearly all exhibit flows that will exceed channel depths for existing conditions during 10 and 100-year rain events, leading to flooding and bank sloughing (erosion). Based on Lake County Stormwater Management Commission's stream inventory, 60% of stream reaches in the watershed exhibit moderate or high sedimentation, and 47% are considered to have moderate or high degrees of erosion. These conditions warrant watershed-specific regulations to minimize future impacts to streams.

The current maximum allowable release rates are designed to be sufficient to control flooding and prevent bank erosion for stream reaches for the 2-year storm event. However, flooding could be prevented and water quality could be improved by reducing release rates for the 100-year storm event. This is because a common problem with rate-based stormwater management criteria occurs when allowable release rate criteria are met, but higher flow rates persist for longer durations than they would have under existing conditions. Reduced release rates for the 100-year storm would still result in longer durations of higher flows but less than existing conditions. Reduced release rates would also reduce flashy hydrology conditions that cause shear stresses. Site specific stormwater analysis would be needed to determine the appropriate reduced rates for subwatersheds with detention basins adjacent to streams that currently experience excess velocities and flows during the 100-year storm.

Flooding upstream is a potential risk associated with reducing the release rate of detention basins that already adhere to the WDO maximum allowable rate, and for this reason detailed site analysis and both upstream and downstream hydraulic and hydrologic modeling is encouraged for specific sites that may benefit from an additional rate reduction.

Adopt Guidelines for Public and Private Stream Maintenance.

Stream maintenance is critical to clear obstructions, remove vulnerable trees, and repair failed pipes before they cause blowouts. Ninety percent of the streams in Bull Creek/Bull's Brook watershed exhibit problematic debris loading (Section 3.10: Streams). More than 50% are deemed in this report as medium or high priority for restoration (Figure 84 in Section 8.2: Site Specific Action Plan). Maintenance of both existing and restored streams is critical to reduce sedimentation and erosion in the watershed. Lake County Stormwater Management Commission should, in cooperation with private firms or other government units, develop county-wide stream maintenance standards for both existing and restored streams. Lake County Stormwater Management Commission should encourage local government to adopt interim stream maintenance guidelines or develop their own water quality ordinance.

In addition, long term stream maintenance is often overlooked or deemed unnecessary following a successful stream restoration project. For restored streams, more active maintenance is needed for several years following installation to ensure the stream functions as designed and riparian plantings are successful. Long term maintenance is also needed. A recommended long term maintenance program with standards for regular stream maintenance is provided in Section 4.3 and Appendix O.

Reduce Non-Point Source Pollution

Enhance buffer requirements Buffers are excellent for reducing non-point source pollution. Buffer requirements for wetlands are currently based on size. Lake County Stormwater Management Commission could consider adopting a formula for calculating buffer widths based additionally on wetland quality. Kane County, for example, considers both wetland size and floristic quality in determining the required buffer width for non-lineal wetlands. High quality (FQI>16), medium quality (7<FQI<16), and low quality (FQI<7) wetlands have their own buffer ratio, or percent of wetland size, that is multiplied by the total wetland acreage. The county requires a buffer equivalent to 50% of the total wetland size for high quality wetlands, 40% for medium quality wetlands, and 30% for low quality wetlands. ADID wetlands in Lake County often have FQI values greater than 16. Buffer areas equivalent to greater than 50% of wetland size should be considered for these higher quality wetlands. For example a 100 acre high quality wetland should have at least 50 acres of surrounding buffer. This type of buffer requirement will add even more protection to the ADID wetlands within the Bull Creek/Bull's Brook watershed.

Lake County also has the opportunity to incorporate additional measures in the equation for calculating buffer widths yet to be adopted by other counties. These measures might include one or more of the following:

- extent of wetland fill/protection on site (allow a narrower buffer for protected wetlands vs. created wetlands);
- existing adjacent land use;
- proposed adjacent land use (allow averaging or below average width if adjacent land uses are parks or other protected open space as compared to development);
- topography of adjacent land (wider buffers on steeper slopes);
- habitat quality (measured using the Modified Michigan Department of Natural Resources Method or equivalent); and
- extent of habitat for threatened and endangered species.

It should be noted that WDO buffer requirements are considered to be the minimum standard for the county. Individual communities have the option of adopting wider buffer requirements, therefore these buffer enhancements may be adopted by watershed communities even if they are not amended in the WDO. Communities could identify, compile, and adopt habitat buffer guidelines between developments and high quality terrestrial or aquatic natural communities.

No Net Loss of Wetlands

Under current WDO regulations, wetlands lost to new development must be replaced in Lake County, but not necessarily in the same watershed where the loss occurred (although this is the preferred approach—wetland mitigation outside the watershed doubles the required mitigation acres). A rising trend for developers is to buy wetland credits from a U.S. Army Corp of Engineers (USACE)-approved mitigation bank rather than create wetlands on or off-site of the development project. For watersheds like Bull Creek/Bull's Brook, which lack mitigation banks, this trend results in a net loss of wetlands for the watershed.

Efforts should be made at the regulatory level to preserve remaining wetlands for the simple reason that they naturally function in flood control and water quality. A joint agreement between permitting agencies (LCSMC, USACE) and the U.S. Fish and Wildlife Service (USFWS) and the Natural Resources Conservation Service (NRCS) to mitigate for all wetland losses in the same Subwatershed Management Unit (SMU) as the impact should be pursued as the optimal action to achieve a no net loss policy for all watersheds.

Other Recommendations

In addition to the ordinance recommendations that address identified watershed problems, local community ordinances should update stormwater requirements for water quality BMPs to insure that current ordinance codes do not preclude use of native vegetation. Local communities should also review any ordinances that disallow the use of native plants in home and business landscaping. Finally, Lake County Stormwater Management Commission and/or local municipalities should develop standardized 5-year and long term maintenance and monitoring protocols for the drainage system and natural areas within new developments and require developers to provide an endowment to fund long term implementation of the plans.

4.2 Streams and Lakes: Water Quality Problems

THE PROBLEM: Land use changes in the watershed are leading to additional runoff that is carrying pollutants such as nutrients, salt, sediment, and other pollutants into lake and stream systems. High nutrient and salt runoff are largely human induced and originate from developed/altered land and from salt applications applied in winter months. Fertilizer used on residential lawns and agricultural fields can run off into water systems, which further increases nutrient loading. Hydrology changes are causing streambank erosion that increases sedimentation. Sedimentation is also originating from construction sites with poor erosion control practices and from highly erodible soils in agricultural fields that do not use filter strips. Currently, several of the lakes in the watershed are plagued by high nutrients and increasing salt concentrations. The streams in the watershed are primarily experiencing streambank erosion, nutrient loading, habitat alteration, and decreased biological productivity.

PRIMARY CAUSE: Not properly controlling runoff and filtering of stormwater, particularly in agricultural areas and areas exhibiting expanses of impervious cover. Land management practices associated with land use, including use of excessive fertilizers, pesticides, and road salt are a primary cause.

POLLUTANT LOADING ANALYSIS

A pollutant loading analysis developed by the USEPA was used to assess pollutant loading in the watershed in more detail and to pinpoint subdrainage areas that are contributing the most to pollutant loading. Non-point source pollutants are carried to the watershed's streams and lakes via stormwater runoff from a number of sources in the watershed including roads, parking lots, rooftops, lawns etc. A non-point source pollutant-loading model was used to assess the non-point pollution sources and estimate pollutant loads from each Subwatershed Management Unit (SMU). A non-point source pollutant loading analysis was completed for the watershed as part of the 2002 Integrated Lakes Management (ILM) Report (ILM, 2002). The analysis was updated for this study because the SMU boundaries were re-delineated for new hydrologic and hydraulic (H & H) models that were completed subsequent to the ILM report.

The U.S. Environmental Protection Agency's (USEPA) Simple Method approach was utilized to calculate pollutant loading estimates for Total Suspended Solids (TSS), Total Dissolved Solids (TDS), Biological Oxygen Demand (BOD), Chemical Oxygen Demand (COD), Total Nitrogen (N), Total Kjeldahl Nitrogen (TKN), Dissolved Phosphorus (DIS P), Total Phosphorus (Tot P), Cadmium (Cd), Lead (Pb), Copper (Cu), and Zinc (Zn) from each SMU. Detailed methodology used to derive the pollutant loading estimates is included in Appendix I.

The results were used to identify, prioritize, and map SMU's by their respective degree of pollutant loading. The "hotspot" pollutant loading map (Figure 63) reflects the Bull Creek/Bull's Brook SMUs, where the 12 modeled pollutants are summed and ranked by predicted relative abundance in the SMU on a concentration basis (mg/L). The loading calculations were used to group each modeled pollutant, allowing for assignment of categories to the SMUs (i.e., High, Medium, and Low predicted loading levels). The "High" category contains the SMUs with a level above the IEPA Water Quality Standard or other water quality guideline. The "Medium" category contains the SMUs with loadings that are less than the Water Quality Standard, but at least half of its value. The "Low" category contains the SMUs with loadings that are less than half of the Water Quality Standard. Table 40 lists IEPA standards by pollutant and those SMUs exhibiting high, medium, or low levels, for each pollutant.

Table 40. IEPA 2004 Water Quality Standards and pollutant loading points analysis

Pollutant	IEPA Standard	High	Medium	Low
Total Suspended Solids (TSS)	750 ppm	BCN3-4, BCS2, BCS4-6	BB1-4, BB11, BCN1-2, BCN6, BCN8, BCS3, BCS7	BB5-10, BB12, BCN5, BCN7, BCS1
Total Dissolved Solids (TDS)	1500 mg/l	BB11, BCN3-4, BCN6, BCS2, BCS5-6	BB1-4, BCN1-2, BCN8, BCS1, BCS3-4, BCS7	BB5-10, BB12, BCN5, BCN7
Biological Oxygen Demand (BOD)	5.0 mg/l	BB1-4, BB9-11, BCN1-8, BCS1-7	None	BB5-8, BB12
Chemical Oxygen Demand (COD)	30 mg/l	BB1-6, BB9-12, BCN1-8, BCS1-7	None	BB7-8
Total Nitrogen (N)	15 mg/l	None	None	All SMUs
Total Kjeldahl Nitrogen (TKN)	10 mg/l	None	BB2, BCN3-4, BCN6, BCS2, BCS4-6	BB1, BB3-12, BCN1-2, BCN5, BCN7-8, BCS1, BCS3, BCS7
Dissolved Phosphorus (DIS P)	0.025 mg/l	All SMUs	None	None
Total Phosphorus (Tot P)	0.05 mg/l	All SMUs	None	None
Cadmium (Cd)	0.15 mg/l	All SMUs	None	None
Lead (Pb)	0.1 mg/l	All SMUs except BB7-8	None	BB7-8
Copper (Cu)	1.0 mg/l	None	None	All SMUs
Zinc (Zn)	1.0 mg/l	BB2, BCN3-4, BCN6, BCS2, BCS4-6	BB1, BB3-4, BB11, BCN1-2, BCN8, BCS1, BCS7	BB5-10, BB12, BCN5, BCN7, BCS3

Source: IEPA 2004

The cumulative results of the existing conditions pollutant loading analysis was used to develop a map of the watershed that depicts pollutant loading "hotspots", which are considered "critical areas" (Figure 63). The cumulative pollutant loading "hotspot" map was created by assigning points to each SMU based on the results of the individual pollutant analysis (Table 41). Each SMU received a point value High= 3, Medium=2, Low=1 for each of the 12 pollutants modeled. The total of all the points for all 12 pollutants was then added for each SMU. The totals were divided into three categories to develop the High, Medium, and Low categories for the "hotspot" map.

According to the analysis, 9 SMU's are considered High priority "hotspots", 13 SMUs are Medium priority, and 5 SMU's are Low priority (Figure 63; Table 41).

- High priority "hotspot" SMUs include: BB2, BB11, BCN3-4, BCN6, BCS2, and BCS4-6. Combined, these SMUs total 3,429.7 acres and 38.2% of the entire watershed. Most of these SMUs have high TSS, TDS, BOD, COD, Dis P, Tot P, Pb (lead), and Zn (zinc).
- Medium priority SMUs include: BB1, BB3-4, BB9-10, BCN1-2, BCN5, BCN7-8, BCS1, BCS3, and BCS7. These 13 SMUs comprise 4,875.5 acres (49.8% of entire watershed).
- Low priority SMUs include: BB5, 6, 7, 8, and 12. They show low contributions to non-point source pollution. Their combined acreage is 665.2 or 7.4% of the watershed.

Figure 63: Pollutant Loading Analysis — "Hot Spots" at the SMU Level

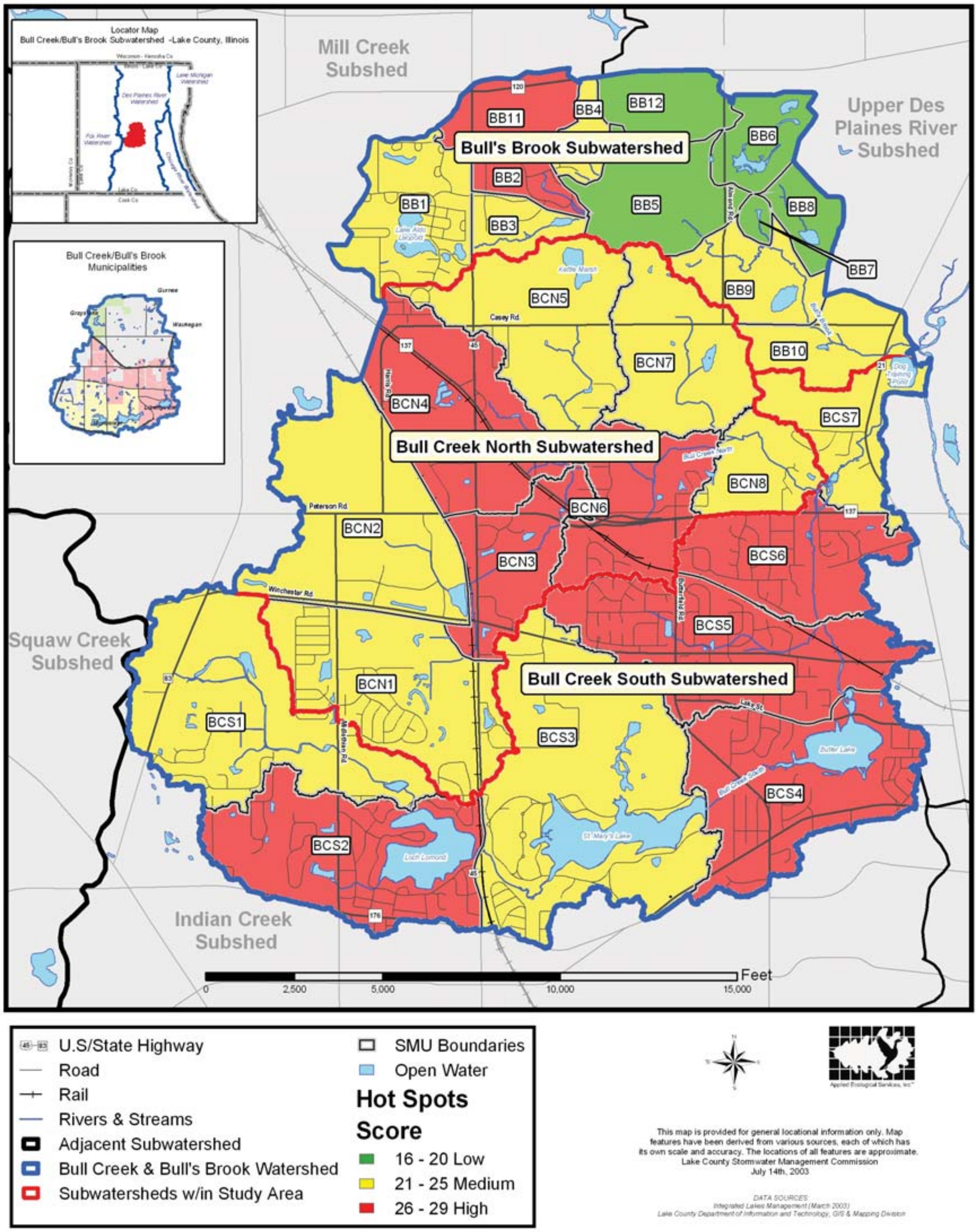


Table 41. Subwatershed analysis of pollutant loading (all pollutant loading units are in mg/L)

SMU ID	Acres	TSS	TDS	BOD	COD	TOT N	TOT KN
Bull's Brook Pollutant Loading Analysis							
BB1	305.5	551.84 M	1318.52 M	18.45 H	215.89 H	4.89 L	4.66 L
BB2	78	702.51 M	1537.85 M	30.25 H	294.24 H	8.30 L	6.41 M
BB3	96	452.52 M	1116.48 M	18.41 H	191.90 H	5.11 L	4.23 L
BB4	74.8	380.62 M	874.23 M	16.97 H	154.80 H	4.61 L	3.32 L
BB5	256.3	92.69 L	371.61 L	3.46 L	40.11 H	1.09 L	1.06 L
BB6	132.9	92.64 L	383.96 L	2.67 L	39.35 H	0.85 L	1.01 L
BB7	24.6	21.06 L	251.69 L	0.35 L	13.34 L	0.25 L	0.46 L
BB8	92.9	20.83 L	247.00 L	0.36 L	13.16 L	0.24 L	0.45 L
BB9	190.1	165.36 L	465.89 L	5.11 H	58.83 H	1.48 L	1.49 L
BB10	187.1	298.14 L	642.74 L	7.99 H	90.44 H	2.18 L	2.28 L
BB11	160.8	626.08M	1583.75 H	26.81 H	262.62 H	6.79 L	4.74 L
BB12	158.4	65.91L	399.34 L	1.89 L	35.16 H	0.69 L	0.91 L
Bull Creek North Pollutant Loading Analysis							
BCN1	533.8	537.29 M	1287.25 M	18.89 H	209.66 H	5.17 L	4.53 L
BCN2	602.2	636.28 M	1249.84 M	21.33 H	199.68 H	5.60 L	3.95 L
BCN3	263.8	874.64 H	2008.99 H	30.67 H	317.63 H	8.11 L	5.96 M
BCN4	487.2	918.97 H	2060.38 H	35.84 H	345.39 H	9.35 L	6.33 M
BCN5	468.8	315.74 L	728.07 M	10.19 H	110.57 H	2.81 L	2.63 L
BCN6	335.7	710.45 M	1710.15 H	23.53 H	271.80 H	6.39 L	5.70 M
BCN7	361.3	227.36 L	526.80 M	7.28 H	73.86 H	2.00 L	1.80 L
BCN8	173.5	439.40 M	1083.66 M	24.32 H	201.01 H	6.30 L	3.56 L
Bull Creek South Pollutant Loading Analysis							
BCS1	663.7	334.73 L	797.86 M	12.36 H	127.95 H	3.40 L	2.91 L
BCS2	574.8	772.12 H	1610.91 H	31.08 H	304.51 H	8.11 L	6.28 M
BCS3	972.1	479.25 M	768.24 M	17.63 H	146.44 H	4.45 L	2.95 L
BCS4	577.1	777.84 H	1476.94 M	29.70 H	286.91 H	7.50 L	5.91 M
BCS5	601.3	858.62 H	1729.05 H	33.71 H	330.69 H	8.73 L	6.88 M
BCS6	351	722.84 H	1722.99 H	30.17 H	301.59 H	7.89 L	5.92 M
BCS7	246.6	432.69 M	984.07 M	19.90 H	175.53 H	5.21 L	3.44 L

DIS P	TOT P	Cd	Pb	Cu	Zn	Total Points (Classification)
Bull's Brook Pollutant Loading Analysis						
0.171 H	0.718 H	0.004 L	0.561 H	0.112 L	0.863 M	25 medium
0.292 H	1.098 H	0.006 L	0.705 H	0.146 L	1.438 H	27 high
0.188 H	0.736 H	0.004 L	0.449 H	0.094 L	0.891 M	25 medium
0.192 H	0.615 H	0.003 L	0.314 H	0.066 L	0.686 M	25 medium
0.068 H	0.204 H	0.000 L	0.053 H	0.013 L	0.159 L	20 low
0.049 H	0.149 H	0.001 L	0.070 H	0.016 L	0.140 L	20 low
0.028 H	0.046 H	0.000 L	0.006 M	0.002 L	0.028 L	16 low
0.028 H	0.045 H	0.000 L	0.006 M	0.002 L	0.028 L	16 low
0.086 H	0.251 H	0.001 L	0.101 H	0.023 L	0.232 L	22 medium
0.133 H	0.386 H	0.001 L	0.158 H	0.037 L	0.345 L	22 medium
0.234 H	0.704 H	0.005 L	0.589 H	0.122 L	0.896 M	28 high
0.046 H	0.181 H	0.000 L	0.051 H	0.012 L	0.108 L	20 low
Bull Creek North Pollutant Loading Analysis						
0.192 H	0.717 H	0.005 L	0.561 H	0.112 L	0.906 M	25 medium
0.276 H	0.678 H	0.006 L	0.565 H	0.105 L	0.721 M	25 medium
0.312 H	0.902 H	0.010 L	0.996 H	0.184 L	1.179 H	29 high
0.352 H	0.994 H	0.010 L	0.992 H	0.187 L	1.287 H	29 high
0.141 H	0.462 H	0.002 L	0.218 H	0.048 L	0.459 L	22 medium
0.228 H	0.846 H	0.007 L	0.780 H	0.154 L	1.131 H	28 high
0.121 H	0.339 H	0.001 L	0.112 H	0.027 L	0.277 L	22 medium
0.227 H	0.628 H	0.003 L	0.408 H	0.083 L	0.774 M	25 medium
Bull Creek South Pollutant Loading Analysis						
0.149 H	0.496 H	0.002 L	0.271 H	0.058 L	0.556 M	24 medium
0.284 H	1.021 H	0.006 L	0.759 H	0.150 L	1.279 H	29 high
0.221 H	0.616 H	0.004 L	0.460 H	0.069 L	0.469 L	24 medium
0.275 H	0.967 H	0.005 L	0.747 H	0.138 L	1.090 H	28 high
0.311 H	1.132 H	0.006 L	0.842 H	0.162 L	1.358 H	29 high
0.267 H	0.916 H	0.006 L	0.713 H	0.147 L	1.213 H	29 high
0.210 H	0.611 H	0.003 L	0.351 H	0.074 L	0.693 M	25 medium

DETENTION BASINS NEEDING REMEDIAL WATER QUALITY RETROFITS

Large developed areas in the central and southern portions of the watershed drain primarily to detention basins and stormsewer networks prior to release into streams, wetlands, and lakes. These areas also contribute high pollutant loads as documented in the Pollutant Loading Analysis in the previous section. Pollutants in stormwater are collected in these basins, and if not adequately treated, flow out of these basins polluting receiving waters. Section 3.14 (Flooding) includes a brief summary and a map of the detention basin inventory conducted by Lake County Stormwater Management Commission (LCSMC) in 2004. (Appendix F contains detailed detention inventory results.) The inventory noted 64 of 108 basins that lack preferred native vegetation and other design features that could potentially reduce pollutant loads from developed areas through transformation or infiltration. Some of these potential water quality retrofits include:

- convert 25 existing dry basins to wet or wetland basins that do a better job of trapping and filtering pollutants;
- replace turf grass and rip rap with native vegetation around 52 basins for improved filtration;
- treat excess algae in 10 basins.

The Site Specific Action Plan includes detailed recommendations for water quality detention basin retrofits in the watershed. Water quality retrofits are primarily designed to remove and filter urban chemicals from stormwater runoff such as phosphorus and nitrogen (from fertilizers) and sediments that would otherwise end up in lakes and streams

Noteworthy

Detention basins are designed in a variety of ways and in various locations relative to a development. Basins are often constructed in low areas relative to the surrounding land and contain stormsewer networks that drain to and from them. These basins are either dry bottom or wet bottom. Most dry bottom basins were constructed prior to the early 1990's and are typically lined with manicured turf grass. Dry bottom basins hold water for short periods following rain events but quickly drain and dry. Short residence time and lack of appropriate preferred native vegetation do not serve to improve water quality or promote infiltration.

Wet bottom basins typically hold water that is controlled by the elevation of the outlet pipe. Many older wet bottom basins are lined with turf grass and in many cases have rip rap near the toe of slope (where water meets land). Most newly constructed basins are designed to be wet bottom with side slopes and an emergent zone that is planted with native vegetation to primarily treat stormwater but also promote infiltration, and improve habitat for wildlife. These types of basins are usually refered to as naturalized detention basins.

Top: Typical dry bottom basin.
Bottom: Naturalized Detention Basin

POTENTIAL CAUSES AND SOURCES OF POLLUTION

It is difficult to determine precise causes and sources of non-point pollution. By definition, these pollutants come from a variety of areas and sources within the contributing watershed. That is why it is important to address non-point source pollution issues in terms of the smallest practical watershed unit, which in this study, is the Subwatershed Management Unit (SMU). Water quality managers can then focus on those SMUs with the highest concentrations of pollutant ("hotspots"), and see what can be done within the contributing watershed to reduce those pollutants. Table 42 summarizes many of the potential causes and sources for excessive pollutant loads noted in the pollutant loading analysis as well as "***Designated Uses***" that could be impaired. Levels of Total Suspended Solids (TSS), Total Dissolved Solids (TDS), Total Nitrogen (TOT N), and Total Phosphorus (TP) are all noted problems in many of the lakes and streams in the watershed.

Designated Use: *EPA requirements that States and authorized Indian Tribes specify appropriate water uses to be achieved and protected. Appropriate uses are identified by taking into consideration the use and value of the water body for public water supply, for protection of fish, shellfish, and wildlife, and for recreational, agricultural, industrial, and navigational purposes. In designating uses for a water body, States and Tribes examine the suitability of a water body for the uses based on the physical, chemical, and biological characteristics of the water body, its geographical setting and scenic qualities, and economic considerations. Each water body does not necessarily require a unique set of uses. Instead, the characteristics necessary to support a use can be identified so that water bodies having those characteristics can be grouped together as supporting particular uses.*

Table 42. Pollutants and potential causes and sources

Pollutant	Potential Causes and Sources of Pollution	Designated Use Impairment
E. coli	Causes: Animal and human waste Sources: Public parks, streets, lawns, driveways, parking lots, leaking sanitary lines, etc.	Primary and Secondary Contact
Total Suspended Solids (TSS)	Causes: Eroded soils and other loose debris Sources: Streets, lawns, driveways, parking lots, soil erosion: elevated and highly varied stream flows, improper construction site management of sediment, agricultural practices, increasing land development without proper stormwater management practices	Aquatic life, water supply, primary contact
Total Dissolved Solids (TDS)	Cause: dilution of substances, including road salt, in stormwater Sources: streets, lawns, driveways, parking lots, construction activities, channel erosion	Aquatic life, water supply, primary contact,
Biological Oxygen Demand (BOD)	Cause: Organic materials Sources: Poorly treated wastewater, algae blooms caused by high nutrient loads	Aquatic life
Chemical Oxygen Demand (COD)	Cause: Organic materials Sources: Poorly treated wastewater and stormwater, algae blooms caused by high nutrient loads	Aquatic life
Total Nitrogen (TOT N)	Causes: Excessive concentration in stormwater Sources: Applications of fertilizer, failing septic systems, sewage treatment plant discharges, livestock, nuisance geese	Aquatic life, primary contact, water supply
Total Kjeldahl Nitrogen (TKN)	Causes: Excess concentration in stormwater Sources: Plant and animal decay	Aquatic life, primary contact, water supply
Dissolved Phosphorus (DIS P)	Causes: Excess concentration in stormwater Sources: Streets, residential lawns (lawn fertilizers, grass clippings), driveways, agricultural fertilizers, soil erosion, runoff from animal raising operations, untreated stormwater and wastewater, detergents, inadequate or failing septic systems, lake sediments, nuisance geese	Aquatic life, primary contact, water supply
Total Phosphorous (TOT P)	Causes: Excess concentration in stormwater and attached to soil particles Sources: Streets, residential lawns (lawn fertilizers, grass clippings), driveways, agricultural fertilizers, soil erosion, runoff from animal raising operations, untreated stormwater and wastewater, detergents, inadequate or failing septic systems, lake sediments, nuisance geese	Aquatic life, primary contact, water supply
Cadmium (Cd	Causes: Constituent of alloys, pigments, batteries, metal coatings; for example protective coatings on steel, plastics, smelting of lead, zinc and copper as these occur in mixed ores with cadmium, underground pipes Sources: street, industrial parking, industrial wastewater, tire wear, insecticide application	Aquatic life, primary contact, water supply, fish consumption
Lead (Pb)	Causes: Point source discharges such as industrial, waste water treatment plant discharges, atmospheric deposition, urban stormwater runoff, underground pipes Sources: street, industrial parking (presume it comes from lead pipes in waste waters)	Aquatic life, primary contact, water supply, fish consumption
Copper (Cu)	Causes: Point source discharges such as industrial, waste water treatment plant discharges, atmospheric deposition, urban stormwater runoff, underground pipes, automobiles Sources: street, industrial parking, metal plating, bearing and bushing wear, moving engine parts, brake lining wear, fungicides and insecticides	Aquatic life, primary contact, water supply, fish consumption
Zinc (Zn)	Causes: Point source discharges such as industrial, waste water treatment plant discharges, atmospheric deposition, urban stormwater runoff, underground pipes Sources: Industrial, commercial and residential roofs, streets, driveways, parking lots, tire wear, motor oil	Aquatic life, primary contact, water supply, fish consumption

CRITICAL NON-POINT SOURCE POLLUTION AREAS IDENTIFICATION

For this report, critical areas are defined as drainage areas or specific areas/sites where known or modeled pollutants are originating that require remedial action to reduce non-point source pollution. Several critical areas were identified in the watershed assessment section and problems section of this report. The following categories of critical areas related to non-point source pollution were identified. A brief description of each category is also included below that references other sections of the report for more detailed information regarding critical areas and their contributions to pollutant loading.

- Highly erodible soils on existing agricultural land and future development sites
- Severe lake shoreline erosion
- Severe streambank erosion
- Problematic discharge points to streams
- Poor buffers along stream corridors
- Highly vulnerable land use Subwatershed Management Units (SMUs)
- Pollutant loading hotspot Subwatershed Management Units (SMUs)

Highly Erodible Soils

Section 3.2 (Soils) identifies and maps all of the highly erodible soils in the watershed. Erodible soils on agricultural lands and on potential construction sites are extremely susceptible to erosion. Erosion control BMPs not only keep sediment out of streams and lakes but also reduce pollutants such as phosphorus and nitrogen that may be attached to soil particles. According to the soils assessment, erodible soils on existing agriculture land accounts for 434.2 acres and much of the projected development in the watershed is expected to occur on these agricultural lands.

The Action Plan section of this report makes recommendations for controlling erosion on all existing agricultural and potential development parcels with highly erodible soils that are also located in modeled pollutant loading hotspots SMUs.

Lake Shoreline Erosion

Turbidity and nutrient loading is a major problem in several lakes within the watershed. A primary contributor to turbidity and nutrients is shoreline erosion. Section 3.11 (Lakes Inventory) documents the degree of lake shoreline erosion for all the assessed lakes in the watershed. The most critical erosion is occurring along the southern shoreline of the Dog Training Pond and along portions of the north and south banks at St. Mary's Lake. Lake Leopold is experiencing moderate erosion along 40-60% of its shoreline. IMC Lake, Loch Lomond, and Butler Lake do not have critical erosion problems.

The Action Plan section of this report makes recommendations for controlling erosion around all critical shoreline erosion areas as well as for areas around lakes with less erosion.

Streambank Erosion

Streambank erosion along stream reaches is also a contributor to turbidity and pollutant loading. Section 3.10 (Streams) includes a detailed summary of the streambank conditions along 30 stream reaches delineated and surveyed by Lake County Stormwater Management Commission (LCSMC). LCSMC's survey showed that 47% of the streambanks in the watershed have moderate or high degrees of erosion. Streambank erosion is most severe at the confluence of Bull's Brook and the Des Plaines River (Reach BB001), east of Almond Road (Reach BB004), and along a tributary to Almond Marsh (Reach BB012). Almost all other reaches along Bull's Brook are considered moderately eroded. The most severe cases of streambank erosion along Bull Creek North and South occur between St. Mary's Lake and Kettering Road (Reach BC07) and between Countryside Road and IL Route 137 (BC14). Other streambank erosion critical areas are located along the streambanks of the Upper North Branch of Bull Creek (BC16) and along the Bull Creek's mainstem both upstream and downstream of Midlothian Rd (Reaches BC08 and BC09).

The Action Plan makes recommendations for stabilizing all critical streambank erosion areas as well as reaches exhibiting only moderate and low erosion.

Problematic Discharge Points

LCSMC's stream inventories noted all problematic discharge points to Bull's Brook, Bull Creek North, and Bull Creek South (See Section 3.10: Streams). Twenty-three (23) of the 161 discharge points were considered problematic and can also be considered critical areas.

The Action Plan makes specific recommendations to alleviate problems occurring at problem discharge points.

Poor/Inadequate Buffers Along Stream Corridors

Buffers filter pollutants from runoff and provide beneficial wildlife habitat. LCSMC's stream inventories recorded the width and condition of buffers within 100 feet of either side of all stream reaches. Two stream reaches are in high need of buffer improvement while 8 are in medium need. The information obtained by LCSMC was used to make site specific recommendations in the Action Plan related to improving extremely degraded buffers. All high priority stream reaches needing buffer improvements can be considered critical areas.

Land Use Vulnerability

A land use vulnerability analysis was used to identify SMUs in the watershed that are most prone to degradation by development (see Land Use Vulnerability Analysis earlier in this section). The analysis uses a 4 step process that leads to a final priority ranking of SMUs. The priority ranking identified 7 high, 17 medium, and 3 low priority SMUs. All high priority SMUs (2,310 acres) can be considered critical areas where BMP implementation and low impact development practices could curb the negative effects of development.

The Action Plan makes BMP recommendations related to implementing conservation development techniques as well as recommendations for existing developments such as detention basin retrofits.

Pollutant Loading Hotspots

Land use plays an important role in non-point source pollutant loading in any watershed. Generally speaking, human altered landscapes comprised of agricultural land and impervious surfaces generate higher pollutant loads than do natural landscapes. A non-point source pollutant-loading model was used to assess the non-point pollution sources and estimate pollutant loads from each Subwatershed Management Unit (SMU) (see Pollutant Loading Analysis earlier in this Section). According to the analysis, 9 SMU's (3,899 acres) are considered High priority "hotspots", 13 SMUs are Medium priority, and 5 SMU's are Low priority. All high priority hotspots can be considered critical areas needing water quality BMP projects to reduce pollutant loading.

The Action Plan makes many BMP recommendations to improve water quality such as detention basin retrofits, stream and lake shoreline restoration, preventing soil erosion, repairing problematic discharge points, improving buffers, constructing wetland restoration sites, and protecting open parcels ranked high priority to improve water quality. In addition, A GIS Pollutant Loading Reduction model was used to assess the pollutant reduction efficiencies of several recommended BMP projects from the action plan that are also located in pollutant loading hotspot SMUs. The results are discussed in the following section.

Noteworthy Estimated Pollutant Load Reductions

A Geographic Information System (GIS) interface for estimating pollutant load reductions with BMP implementation at the SMU scale was developed. The GIS tool allows an investigator to rapidly evaluate the pollutant loading reductions at a site for several different BMP types. The data resolution is important to successful use of the tool. It is also important to remember that the calculated load reduction values by the model are projections for comparison and not absolute values to expect in the field.

The BMP tool advances watershed BMP evaluation, but it still requires the investigator to review the results for accuracy and feasibility. For example, the tool evaluates all upstream drainage area to a wetland restoration to determine pollutant load reduction. When wetland restorations are in series the investigator needs to apportion the untreated acreage to each location, or the tool will overestimate the loading reduction for sites downstream. Also, the investigator must choose a BMP that will have sufficient volume or area to properly treat its drainage area, because the GIS tool does not have the capability to make this determination within its programming. **The GIS BMP tool is available from SMC for use in the Bull Creek Watershed Only.**

Section 3.9 (Watershed Hydrology and Hydraulics) delineated the watershed into Subwatershed Management Units (SMUs). In Section 4.2 (Water Quality Problems), the non-point source pollutant loading "hotspots" SMUs were defined. Nine (9) pollutant loading "hotspot" SMUs were identified in the watershed for the existing land use conditions. The "hotspot" SMUs included BB2, BB11, BCN3, BCN4, BCN6, BCS2, BCS4, BCS5, and BCS6. Only the nine "hotspot" SMUs, identified as critical areas, are evaluated in the pollutant load reduction analysis.

The nine pollutant "hotspot" SMUs have higher percentages of land uses with high pollutant loading rates compared to other SMUs. These uses include government, institutional, office, retail/commercial, transportation, residential, and agricultural. Reducing pollutant loading from the "hotspots" can be accomplished by reducing the percentage of impervious surface within each land use, construction of new BMPs, improvements/retrofits to existing pollutant control structures, or any combination of the preceding. Typically, improvements to existing structures can be implemented more quickly, and at lesser cost than the construction of new structures to control pollutant loading. However, retrofitting alone may not provide sufficient reduction to meet the IEPA water quality standards. So, new BMPs and reduction in impervious acreage should be incorporated in the future plans to reduce pollutant loading within the "hotspot" areas.

Chapter 8 is a Prioritized Action Plan with action items for watershed-wide improvements (Programmatic Action Plan) and specific sites in the watershed (Site Specific Action Plan) where BMP implementation would result in the greatest watershed benefits.

The Site Specific Action Plan identifies sites where flooding, water quality, or natural resource problems have been identified using existing data, or where similar problems are expected to occur based on map analysis.

The GIS BMP interface tool was used to estimate water quality pollutant loading reductions for the nine existing "hotspot" SMUs based on applicable water quality BMP recommendations listed in Chapter 8 of the plan. Pollutant load reductions in the GIS BMP tool are based on predicted pollutant removal efficiencies developed by the Indiana Department of Environmental Management (IDEM), Michigan Department of Environmental Quality (MDEQ), Illinois State Water Survey, and Illinois Environmental Protection Agency (IEPA). Table 43 includes a list of BMPs and predicted pollutant removal efficiencies. Appendix I contains the actual pollutant load reduction worksheets used in the GIS BMP tool.

Table 43. USEPA BMP percent pollutant removal efficiencies

	TSS	TDS	BOD	COD	TN	TKN	DP	TP	Cd) (Cadmium)	Pb (Lead)	Cu (Copper)	Zn (Zinc)
Vegetated Filter Strips	73%	*	50.5%	40%	40%	*	*	45%	*	45%	*	60%
Grass Swales	65%	*	30%	25%	10%	*	*	25%	50%	70%	50%	60%
Infiltration Devises	94%	*	83%	*	*	*	*	83%	*		*	*
Extended Wet Detention	86%	*	72%	*	55%	*	*	68.5%	*	40%	*	20%
Wetland Detention	77.5%	*	63%	50%	20%	*	*	44%	*	65%	*	35%
Dry Detention	57.5%	*	27%	20%	30%	*	*	26%	*	50%	*	20%
Settling Basin	81.5%	*	56%	*	*	*	*	51.5%	*		*	*
Sand Filters	82.5%	*	40%	*	*	*	*	37.5%	*		*	*
WQ Inlets	37%	*	13%	5%	20%	*	*	9%	*	15%	*	5%
Weekly Street Sweeping	16%	*	6%	*	*	*	*	6%	*		*	*
Infiltration Basin	75%	*	*	65%	60%	*	*	65%	*	65%	*	65%
Infiltration Trench	75%	*	*	65%	55%	*	*	60%	*	65%	*	65%
Porous Pavement	90%	*	*	80%	85%	*	*	65%	*	1%	*	1%
Concrete Grid Pavement	90%	*	*	90%	90%	*	*	90%	*	90%	*	90%
Sand Filter/Infiltration Basin	80%	*	*	55%	35%	*	*	50%	*	60%	*	65%
WQ Inlet w/ Sand Filter	80%	*	*	55%	35%	*	*		*	80%	*	65%
Oil/Grit Separator	15%	*	*	5%	5%	*	*	5%	*	15%	*	5%
Wet Pond	60%	*	*	40%	35%	*	*	45%	*	75%	*	60%
Agriculture Filter Strip	*	*	*	*	53%	*	*	61%	*		*	*

Streambank and lake shoreline stabilization pollutant removal efficiencies vary depending on bank and lake shoreline stabilization height and lateral recession rates. The USEPA only estimates the removal of sediment, phosphorous and nitrogen for streambank and shoreline stabilization.

Source: IEPA
* No available data

BMP RECOMMENDATIONS FOR WATER QUALITY IMPROVEMENT

A pollutant loading model was used to assess the non-point pollution sources and estimate pollutant loads from each of the 27 Subwatershed Management Units (SMUs). The GIS BMP tool discussed in the previous section was then used for each of nine identified pollutant loading "hotspot" SMUs to estimate pollutant load reductions following implementation of water quality improvement BMP recommendations derived directly from the Site Specific Action Plan (*Section 8.2*). The Site Specific Action Plan includes several BMP categories with primary or secondary water quality benefits: 1) detention basin retrofits; 2) creation of regionally significant storage locations; 3) stream maintenance; 4) restoring wetlands; 5) conducting stream restoration (includes instream and buffer improvement); 6) conducting lake shoreline restoration; and 7) preventing soil erosion on agricultural land and future development.

Next, the estimated reduction in pollutant loading was compiled for the nine pollutant loading "hotspot" SMUs within the watershed. It is important to note however that the pollutant reduction analysis was completed only using those BMP categories that were available via the GIS BMP tool. These BMP categories include streambank and buffer restoration/improvements, lake shoreline restoration, wetland restoration, and water quality detention basin retrofits. BMP categories not assessed via the GIS BMP tool include stream maintenance, preventing soil erosion, and creation of regionally significant storage locations. The following sections summarize the pollutant removal efficiency of applicable water quality BMPs for pollutant loading "hotspots" using BMP recommendations from the Site Specific Action Plan.

STREAMBANK RESTORATION AND LAKE SHORELINE RESTORATION

Figure 64 shows all stream reaches located within pollutant loading "hotspot" SMUs that are recommended for bank restoration in the Site Specific Action Plan (Section 8). Figure 64 also shows lakes with eroded shorelines located within "hotspot" SMUs that are recommended for restoration. The GIS tool was used to estimate loading reductions based on implementing all of the streambank and lake shoreline restoration recommendations within the "hotspot" SMUs only. These calculations can be found in Appendix I: Estimated Load Reductions-Table 1.

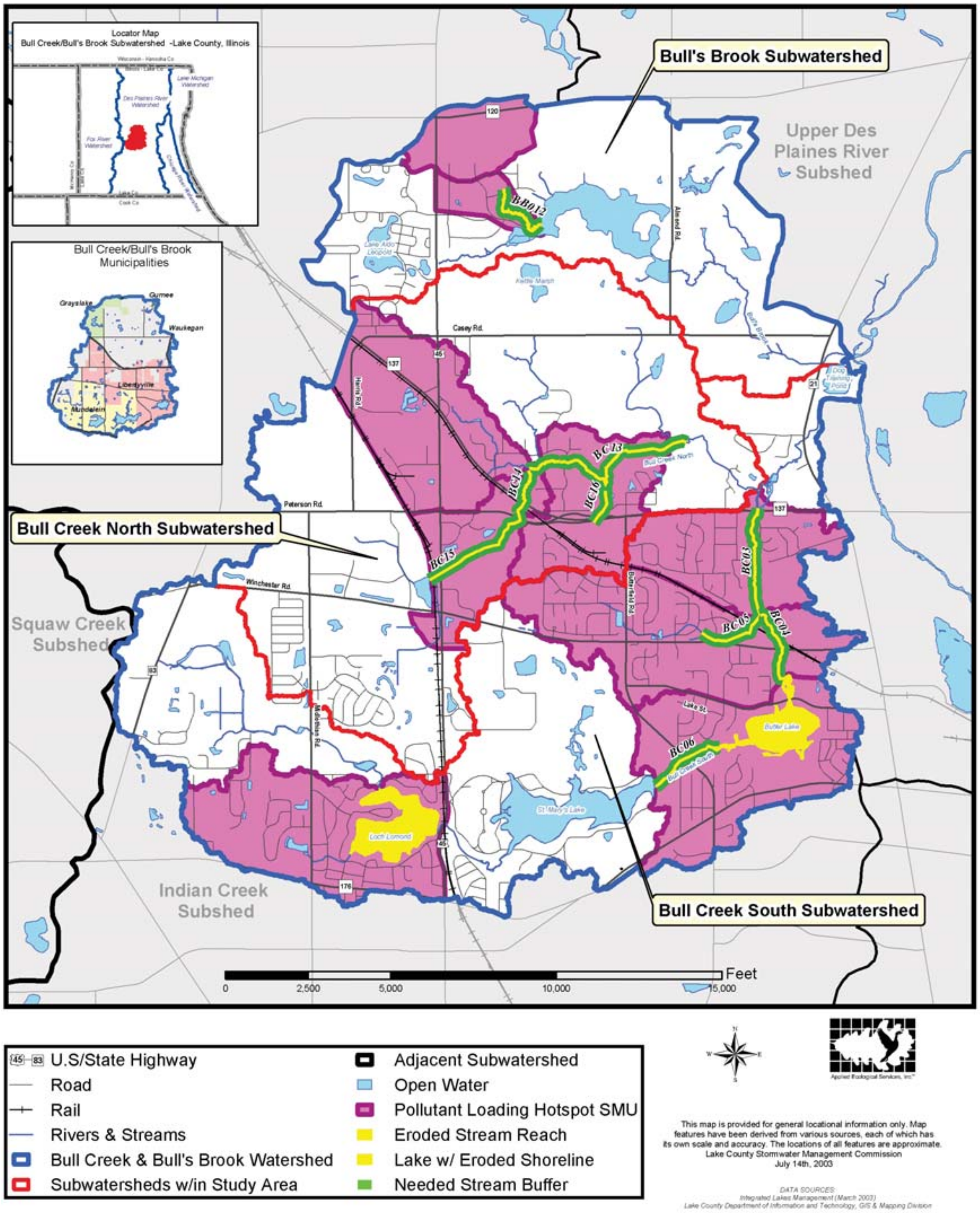
To calculate the loading reductions, the height of streambanks requiring repair and the lateral recession rates must be estimated and input into the GIS interface model. For the pollutant loading reduction estimation, the lakeshore and streambank improvement assumptions were as follows:

- The streambank height listed in the Lake County Stormwater Management Commission (LCSMC) stream inventories (*Appendix C*) was used as the estimated streambank repair height.
- Lake shoreline repair height was estimated using a 2-foot contour map for the lake and adjacent land.

Stream Reaches Requiring Buffer Improvements

Figure 64 shows the location of all stream reaches recommended for improvements or additional vegetative filters/buffers adjacent to the stream within "hotspot" SMUs. These sites were evaluated and the results are listed in Appendix I: Estimated Load Reductions—Table 4. The buffer strips were recommended along both sides of the main stream reach only. The GIS tool was used to estimate load reductions and were summed for each location to give the pollutant loading reduction estimates given on Table 4 in Appendix I.

Figure 64: Eroded Stream Reaches, Lake Shorelines, and Stream Buffer Needs Located within Pollutant Loading "Hotspot" SMU's



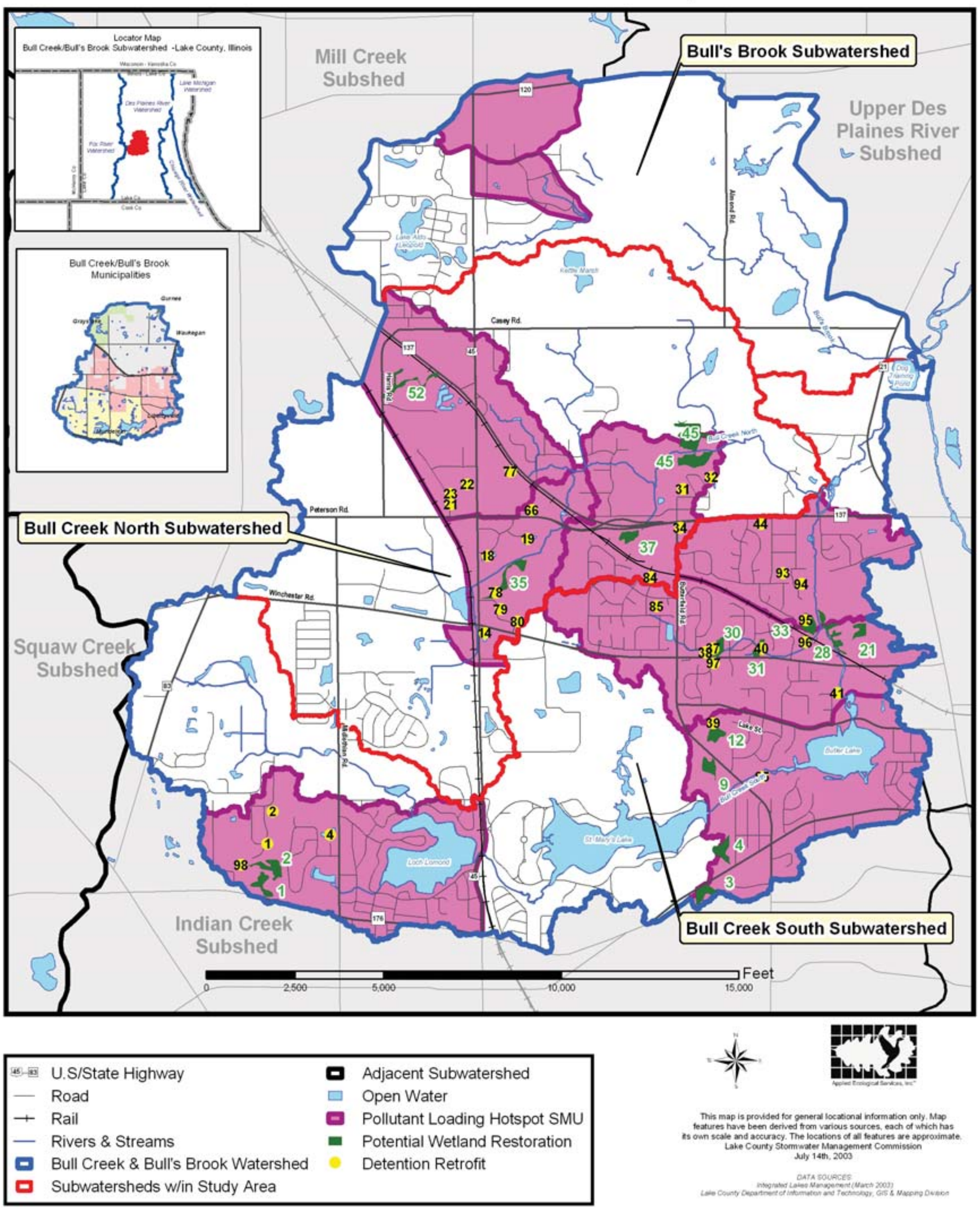
WETLAND RESTORATION SITES

Figure 65 shows the location of recommended wetland restoration projects within pollutant loading "hotspot" SMUs. The recommended amount of wetland area to properly treat runoff and meet the loading reductions is a minimum of one (1%) percent of the area draining to the wetland. There are seventeen probable wetland improvement locations. Four sites had insufficient area available for a constructed wetland and four sites have existing or proposed future use (state highway) that precludes their use. The wetland improvement parcels and the corresponding loading reductions within their SMU's are listed in Appendix I: Estimated Load Reductions-Table 3. Table 3 in Appendix I includes potential wetland improvement sites with sufficient area available to properly treat the runoff for pollutant removal.

DETENTION BASIN RETROFITS

Figure 65 shows the location of all detention basins located within pollutant loading "hotspot" SMUs that are recommended for water quality retrofits. Thirty-three (33) detention basins are recommended for improvement. Three basins are recommended to be changed from dry bottom basins to wet bottom basins. The other 30 detention basins were recommended to be improved by buffer area increase and replacement of existing vegetation with native species or extended detention. Estimated loading reductions were calculated using the GIS tool. The calculations were adjusted to reflect basins in series. The results for the basins within the "hotspot" SMUs are listed in Appendix I: Estimated Load Reductions-Table 4.

Figure 65: Potential Wetland Restoration Sites and Detention Retrofits Located within "Hotspots" SMU's



TOTAL REDUCTIONS IN POLLUTANT LOADING BY "HOTSPOT" SMU FOLLOWING IMPLEMENTATION OF RECOMMENDED BMPS

If all recommended BMP improvements listed in Appendix I: Estimated Load Reductions—Tables 1–4 are implemented, the estimated pollutant loading reductions for each of the nine existing "hotspot" SMUs would decrease as shown in Appendix I: Estimated Load Reductions—Table 5. The predicted reductions in pollutant loadings were used to revise the existing pollutant loading calculations discussed earlier in this chapter (*Section 4.2*). The revised loadings for the nine existing "hotspot" SMUs were recalculated and the changes in the pollutants loading of any one pollutant, due to the implementation of the water quality BMPs, is given in Table 44 below.

Table 44. Estimated "Hotspot" SMU pollutant loading changes following BMP implementation

SMU ID	Status	Acres	TSS	TDS	BOD	COD	TOT N	TOT KN	DIS P	TOT P	Cd	Pb	Cu	Zn	Total Points
BB2	Before BMP	78.0	702.5	1537.9	30.3	294.2	8.3	6.4	0.3	1.1	0.01	0.71	0.15	1.44	28
BB2	After BMP	78.0	0.0	1537.9	28.4	279.2	7.1	6.4	0.3	0.7	0.01	0.66	0.15	1.33	27
BB11	Before BMP	160.8	626.1	1583.8	26.8	262.6	6.8	4.7	0.2	0.7	0.00	0.59	0.12	0.90	28
BB11	After BMP	160.8	626.1	1583.8	26.8	262.6	6.8	4.7	0.2	0.7	0.00	0.59	0.12	0.90	28
BCN3	Before BMP	263.8	874.6	2009.0	30.7	317.6	8.1	6.0	0.3	0.9	0.01	1.00	0.18	1.18	29
BCN3	After BMP	263.8	0.0	2009.0	21.4	257.8	5.1	6.0	0.3	0.1	0.01	0.77	0.18	0.82	26
BCN4	Before BMP	487.2	919.0	2060.4	35.8	345.4	9.3	6.3	0.4	1.0	0.01	0.99	0.19	1.29	29
BCN4	After BMP	487.2	655.0	2060.4	29.3	300.9	7.9	6.3	0.4	0.8	0.01	0.81	0.19	1.05	28
BCN6	Before BMP	335.7	710.4	1710.2	23.5	271.8	6.4	5.7	0.2	0.8	0.01	0.78	0.15	1.13	28
BCN6	After BMP	335.7	192.34	1710.15	21.00	257.11	5.45	5.70	0.228	0.535	0.007	0.734	0.154	1.019	27
BCS2	Before BMP	574.8	772.1	1610.9	31.1	304.5	8.1	6.3	0.3	1.0	0.01	0.76	0.15	1.28	29
BCS2	After BMP	574.8	664.4	1610.9	29.2	291.6	7.7	6.3	0.3	0.9	0.01	0.73	0.15	1.20	28
BCS4	Before BMP	577.1	777.8	1476.9	29.7	286.9	7.5	5.9	0.3	1.0	0.01	0.75	0.14	1.09	28
BCS4	After BMP	577.1	209.7	1476.9	28.8	278.5	6.8	5.9	0.3	0.7	0.01	0.72	0.14	1.06	26
BCS5	Before BMP	601.3	858.6	1729.0	33.7	330.7	8.7	6.9	0.3	1.1	0.01	0.84	0.16	1.36	29
BCS5	After BMP	601.3	0.0	1729.0	4.2	265.5	5.3	6.9	0.3	0.2	0.01	0.51	0.16	1.06	26
BCS6	Before BMP	351.0	722.8	1723.0	30.2	301.6	7.9	5.9	0.3	0.9	0.01	0.71	0.15	1.21	29
BCS6	After BMP	351.0	85.3	1723.0	26.1	302.5	6.6	5.9	0.3	0.5	0.01	0.70	0.15	1.15	27
	Rank value	low = 20 or less, med = 21 to 25, and high = above 25 pts													
	1 pt	Low													
	2 pts	Med	375	750	3	20	10	5	0.015	0.03	0.1	0.05	0.5	0.5	
	3 pts	High	750	1500	5	30	15	10	0.025	0.05	0.15	0.1	1	1	

Within each of the "hotspot" SMUs there are existing detention basins that can be retrofitted (to the most feasible BMP type for a particular basin); locations where sufficient area is available to create wetland treatment; stream reaches where buffer improvements are feasible; and streambank and lake shoreline reaches needing improvement. If all of the recommended BMPs within "hotspot" SMUs (See Appendix I: Load Reduction Table-Table 5) are completed, none of the nine SMUs will change from the high "hotspot" ranking modeled in Section 4.2. (Note: the number of BMP sites within each "hotspot" SMU varies and therefore, the number of existing basins, reaches, or wetland creation sites available for improvement is limited). The ranking points decrease slightly for the SMUs, but it is insufficient to change the assigned "hotspot" ranking category. This means that watershed stakeholders need to consider a detailed evaluation to add additional water quality controls within the "hotspot" SMUs.

The watershed of each "hotspot" SMU needs to be surveyed for potential locations for new basins, (wetlands area available was determined in the improvement analysis) that can be constructed. Basins are site specific and the GIS/BMP tool or a similar procedure is needed to determine the land uses within the drainage area to a structure and calculate the loading reduction for the drainage area. Other alternatives to decrease pollutant loading could be decreasing impervious area in the commercial, industrial, and institutional land uses by a program occurring over a period of years. This will help meet the goals but by itself does not move the "hotspots" into the lower category. More green space in residential areas is another way to reduce loading for the whole watershed. Also, residential land use with more green space will help reduce pollutant loading. New basins are site specific and require design effort to evaluate. Watershed policy decisions to lower impervious percentages within certain land use categories and add green space to residential or other land use would also reduce pollutant loading.

Total Dissolved Solid (TDS), Total Kjeldahl Nitrogen (TKN), and Dissolved Phosphorus (DP) removal by the BMPs are limited for most practices. The management practices for pollutant reduction are not very effective in removal of dissolved contaminants, and this is reflected by low or negligible removal efficiencies. TDS and DP are dissolved parameters and TKN is determined by complete digestion (dissolution) of the sample to recover nitrogen present as ammonium or organic nitrogen. Any nitrate-nitrogen is dissolved and would be included with the TDS measurement. These soluble parameters are relatively unaffected by any BMPs discussed in this report, and are not significantly reduced after BMP installation.

Ideally, the water quality goal for the Bull Creek Watershed would be to decrease the pollutants below established state water quality standards. Based on the nutrient loading present, even after the BMPs are implemented for the "hotspots", reaching the state water quality standards for all pollutants may be unrealistic in the short to medium term (less than ten years). Implementation of the recommended "hotspot" BMPs discussed in this analysis is a first step in meeting that goal, but the evaluation has shown that additional new pollutant reduction in the form of basins or land use changes are necessary. The GIS BMP tool allows planners to quickly estimate the reductions in pollutant loadings for proposed BMPs.

To assist in meeting the water quality improvement goals and objectives, additional water quality BMPs should be installed wherever possible throughout the watershed in non-"hotspot" SMUs. Simply installing BMPs in the "hotspot" SMUs will not solve all of the problems of the watershed. Table 45 lists and compares BMPs designed to achieve water quality goals and standards with their estimated efficiency when implemented within modeled "hotspot" SMUs and other areas. The BMPs are rated as High (H), Medium (M), or Low (L) effectiveness when applied to a particular land use. A blank cell indicates that the effectiveness of that BMP is not known for a particular contaminant or other parameter.

Table 45. List of urban/transitional and agricultural BMPs for reducing pollutant loading

	Contaminant Reduction					Runoff Reduction			
URBAN/TRANSITIONAL	**TSS**	**BOD**	**Oil/Grease**	**TOT N**	**Sediments**	**TOT P**	**Metals**	**Rate**	**Volume**
Developed Sources									
Natural Landscaping	M	M	M	H	M	H	L	H	H
Paved Area Sweeping	M	L	L	L	H	M	M		
Rain Garden Installation		L		L	L	L		M	M
Construction Site Sources									
Polyacrilimide Use	L				M	L	L		
Maintenance of Erosion Control	L				H		L		
Expedited Vegetation Planting	L				M	L	L	L	
Capture, Assimilation and Removal of Contaminants									
Upland Prairie	H	H	H	M	H	H	H	M	M
Swale Systems	M	L	M	L	M	M	M	M	M
Sedimentation Basins	M	L	M	L	H	M	M	H	L
Wetland Treatment	M	M	H	H	H	M	M	H	M
Stormwater Treatment Train	H	H	H	H	H	H	H	H	M
Porous Pavement	H	M	M	M	H	M	M	H	H
Infiltration Systems	H	H	H	H	H	H	H	H	H
Development Re-design (Conservation Development)									
Treatment Train Integration	H	H	H	H	H	H	H	H	H
Naturalized Detention Basins	M	L	M	L	H	M	M	H	L
AGRICULTURAL									
Developed Sources									
Reduced Fertilizer Usage				H		H			
Optimally Timed Fertilizer Use				H		M			
Livestock Exclusion	H	H		H		H			
No-Till Cropping Practices	H							H	H
Capture, Assimilation and Removal of Contaminants									
Stream Buffers	H	H		M		H		L	L
Grassed Waterways	H	L		L		M		M	L
Wetland Conversions	H	H		H		M		H	M
Prairie Conversions	H	H		H		H		H	H

Source: Watershed Diagnostic Study of the Little Calumet-Galien River Watershed (AES, 2001)

4.3 Water Quality Monitoring and Stream Channel Maintenance Programs

THE PROBLEM: The Bull Creek/Bull's Brook watershed generally lacks organized stream water quality programs aimed at assessing general stream conditions and the effects of BMP projects. Organized stream maintenance programs do not currently exist in the watershed. Lake monitoring however has been extensive and conducted in various years. As noted in Section 3.12 (Water Quality) there has been significant water quality monitoring within the watershed for many years. The majority of this monitoring is being conducted by the Lake County Health Department-Lakes Management Unit (LMU), Illinois Environmental Protection Agency (IEPA), Illinois Department of Natural Resources (IDNR), and Integrated Lakes Management (ILM). Data collected by these organizations generally occurs on established time intervals and represents some of the best data for analyzing water quality in the watershed. IEPA and IDNR only do "grab sample" monitoring every five years.

PRIMARY CAUSE: What the watershed lacks are strong stream water quality monitoring programs that will likely involve local units of government and school organizations to implement as well as multijurisdictional cooperation to implement stream channel maintenance programs.

An organized water quality monitoring and stream channel maintenance program should be implemented in the Bull Creek/Bull's Brook watershed to:

- assess the current state of water quality within streams and lakes;
- assess changes in water quality to see how well implemented BMPs are working to remove pollutants for meeting water quality targets and ultimately milestones and project goals;
- assess the public's social behavior related to water quality issues.

Water quality monitoring can be performed by trained personnel collecting physical, chemical, biological and social indicator data related to plan goals and objectives. Stream channel maintenance can be conducted by various municipal, county, township, or private staff trained in proper stream maintenance techniques.

Noteworthy Water Quality and BMP Implementation Criteria about Indicators and Targets

The efforts of water quality sampling and BMP implementation projects can not be fully assessed without establishing a set of environmental and social criteria by which water quality goals and standards can be compared to. Criteria are expressed as indicators with associated target values. The water quality goals and objectives in the watershed plan direct which indicators should be monitored to assess success of the watershed plan implementation.

Watersheds are complex systems with varying degrees of interaction and interconnection between environmental (chemical, physical, biological) and social characteristics. Indicators can be used as a measure of health within the watershed. For example, chemical indicators could include phosphorus or nitrogen concentration; physical indicators could include habitat characteristics in a stream or water temperature; and biological indicators may include fish or invertebrate diversity. Physical habitat indicators are often highly interconnected with hydrologic and morphologic characteristics. Environmental criteria (chemical, physical, and biological indicators) related to water quality are usually easily assessed by way of an established monitoring protocol that has been developed by state or federal agencies.

Social indicators can be measured using demographics and measures of social participation such as the number of cleanup miles along a stream, and other means. Social criteria related to watershed improvement are more difficult to assess, but can and should be assessed to determine effectiveness in informing and engaging watershed residents in behaviors that improve watershed conditions. Examples of social outreach/engagement indicators may include:

- numbers of informational flyers distributed per given time period;
- number of radio or television broadcasts related to water quality improvement projects;
- number of water quality public workshops held per year;
- number of volunteer water quality monitoring and stewardship groups that have been formed or total number of volunteer hours of service performed within the watershed, regardless of group affiliation;
- number of projects completed per year;
- number of stream miles cleaned-up or restored per year.

MONITORING INDICATORS

Monitoring environmental criteria is the most effective way to measure progress toward meeting water quality goals. The watershed plan committee specifically developed a water quality goal with associated objectives during the development of goals and objectives for the plan (Section 2.0). Indictors can be selected for each objective to ascertain whether the water quality goal is being met. Specific values can be set as a target for each indicator to represent the desired conditions that will meet the water quality objective. Targets can be based on water quality criteria, on data analysis, reference conditions, literature values, or expert examination of water quality conditions to identify values representative of conditions that support "Designated Uses" (IEPA 2005) and biological integrity/quality. Evaluation of the progress towards meeting targets indicates whether implemented BMPs are effective. If implemented BMPs are determined to be ineffective, the implementation approach should be reconsidered or changed altogether. Table 46 includes specific indicator and target values for meeting the objectives related to the water quality goal and objectives developed for this plan.

GOAL B: **Improve overall water quality in the lakes, ponds, streams and wetlands of the watershed.**

The indicator and target values listed in Table 46 are linked to all water quality improvement BMP recommendations made in the plan. In other words, water quality BMP recommendations are ultimately made to achieve indicators and targets to meet water quality objectives. The critical areas and estimated pollutant load reduction sections discussed earlier in this chapter identify site specific BMPs that specifically address chemical water quality indicators and targets developed by the IEPA (IEPA Water Quality Standards) for nine identified pollutant loading "hotspots". These BMPs also address indicators and targets related to physical and biological improvement. The Prioritized Action Plan (Section 8.0) includes programmatic and additional site specific BMP recommendations for improving water quality across the entire watershed. All of these recommendations are ultimately linked to meeting indicators and target values listed in Table 46. In addition, Section 9.0 (Evaluating Plan Performance) contains a milestone report card (Report Card: Goal B) specifically designed to evaluate how recommended BMPs meet water quality indicators/target values thereby meeting milestones based on short, medium, and long term objectives.

Table 46. Indicators and targets to meet water quality objectives

Objective	Potential Indicator and Target Value
B.1 Lakes and streams shall at minimum attain state water quality standards to "fully support" designated uses.	*Trophic State Index (Lakes):* Maximum 70 (based on literature) *Water Clarity:* Secchi depth between 1.5 and 4 ft (state General Use standard) *Temperature:* Less than 90 degrees F (based on IEPA standards) *pH:* Between 6.5 and 9 (based on IEPA standards) *Dissolved Oxygen:* No less than 6.0 mg/L (based on IEPA standard) *Macroinvertebrate Biotic Index (MBI):* Less than 7.5 *Index of Biotic Integrity:* Greater than 31 *Chemical Water Quality* Standards: See IEPA water quality stan dards in Table 40. *Qualitative Habitat Evaluation Index (QHEI):* Greater than 60
B.2 Reduce sediment accumulation in surface waters by reducing streambank, shoreline, and construction–related erosion throughout the watershed.	*Total Suspended Solids:* Maximum of 750 ppm (based on state water quality standards) *Turbidity:* Less than 20 Nephelometric Turbidity Units (NTUs) (based on literature values)
B.3 Reduce point source pollutant loadings.	*NPDES Permits:* Reference IEPA permits for each permitted point source
B.4 Implement stormwater management practices that minimize runoff volumes, velocities and pollutants to the creek through infiltration of rainwater on site using best stormwater management and landscaping practices such as raingardens, bioretention, and open swales.	*Percent Impervious:* All development incorporates up to 50% open space for stormwater infiltration purposes. *Stream Flow:* Stream flows do not exceed 4 feet per second in any stream reach.
B.5 Improve agricultural practices to reduce, sediment, chemical and nutrient transport to Bull Creek/Brook.	*Chemical Water Quality Standards:* See IEPA water quality standards in Table 40. *Atrazine:* All farmers eliminate use of atrazine in agricultural practices.
B.6 Retrofit existing stormwater management structures such as detention ponds to provide or enhance water quality improvement.	*Chemical Water Quality Standards:* Stormwater leaving stormwater management structures meets IEPA water quality standards (see IEPA water quality standards in Table 40).
B.7 Tie National Pollutant Discharge Elimination System (NPDESII) minimum control measures into watershed plan objectives.	*NPDES Phase II:* Reference NPDES Phase II documents Community Involvement: No violations for NPDES II communities.
B.8 Examine the impacts of road salt usage on water quality and aquatic life and develop recommendations for education related to road salt alternatives and application best management practices (BMPs).	*Chloride (salt):* less than 500 mg/l (based on state standard) *Macroinvertebrate Biotic Index (MBI):* Less than 7.5 *Index of Biotic Integrity:* Greater than 31 *Education:* All communities and private snow removal contractors in the watershed are aware of alternatives to road salt.

WATER QUALITY AND BMP EFFECTIVENESS MONITORING

As funding allows, actual environmental monitoring data should be collected on a 3-5 year cycle to assess the performance of BMPs for meeting water quality targets and ultimately milestones and project goals. (Note: Lakes will be monitored on a rotating cycle every 5 years by the LCHD LMU. This assessment can be used to determine the overall effectiveness of multiple BMPs on water quality). It is usually necessary to collect and analyze water quality, biological samples, or habitat quality data to determine a BMP's effectiveness. This can be accomplished by either measuring the concentration of a particular parameter in the influent and effluent for the BMP or measuring baseline and post implementation values. BMP effectiveness monitoring can be performed using several methods. BMP monitoring should be conducted by environmental consultants or community staff trained in various BMP monitoring methods. A desired outcome may be an:

- observed pollutant removal efficiency,
- increased infiltration capability,
- increase in other physical parameters such habitat value as measured by the Qualitative Habitat Evaluation Index (QHEI),
- positive changes in stream biological indexes such as Index of Biotic Integrity (IBI) and Macroinvertebrate Biotic Index (MBI).

MONITORING CHANGES TO LAKES AND STREAMS

In addition to defining the pollutant removal efficiency of BMPs, it is important to monitor the hydraulic performance and morphological changes resulting from implementation of the BMP. Urbanized areas typically increase the total volume and rate of stormwater runoff that enters receiving streams and stormsewer systems. This causes changes in both hydrology and morphology. A goal of BMPs is usually to attenuate these flow and morphological impacts. Supplemental morphological measurements of the stream channel such as bank height, channel width, and other parameters should be conducted prior to BMP implementation and evaluated yearly after implementation or after significant rain events.

One potential problem with in-stream indicators is the issue of isolating dependent variables. There are likely many variables influencing the quality of the habitat, so making conclusions with regard to one specific constituent should be done with caution. It should be noted however that the indicators mentioned are excellent for assessing overall changes in a watershed's condition due to BMP implementation and changes in management measures but don't necessarily identify which BMPs are most effective.

Water quality monitoring should also occur in different locations (not specific to individual BMPs) in the watershed to help document the sources of pollutants and reduction of pollutants following multiple BMP implementation. These locations include lakes and stream branches. Appendix O (Water Quality Monitoring and Stream Maintenance Methodology) contains specific recommended procedures by which physical, chemical, and biological monitoring indicators should be collected in the watershed. *(Note: physical monitoring includes stream channel maintenance while monitoring. Recommendations related to stream channel maintenance are also included in Appendix O).*

MONITORING LOCATIONS

The following section indicates where water quality monitoring should be implemented, by whom, and how often it should be conducted. Figure 66 and Table 47 depict existing and recommended locations within the Bull Creek/Bull's Brook watershed where water quality data should be collected and monitored on a continuous cycle (3-5 years) in the future. Figure 66 does not depict recommended sampling locations related to specific BMPs. This monitoring will come later as projects are implemented. The water quality monitoring recommendations include:

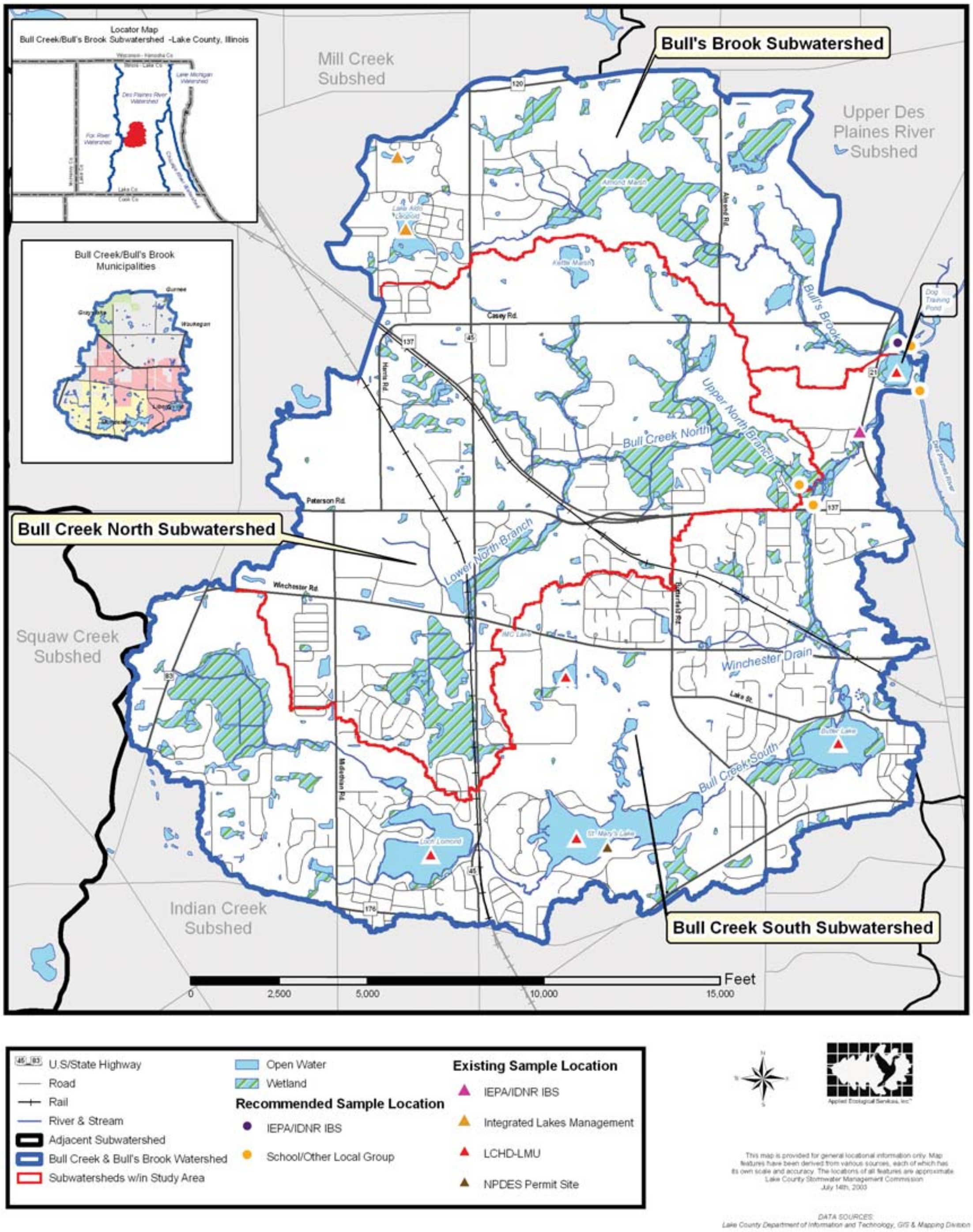
- Lake County Health Department continue to sample lakes in the watershed: Loch Lomond, St. Mary's Lake, Butler Lake, Dog Training Pond, IMC Lake on a 5 year cycle. Ideally, studies for each should be conducted in the same calendar year for comparison purposes.
- Continue to collect water quality and biological data for Sanctuary Pond and Leopold Lake in Prairie Crossing annually.
- School Environmental Programs or other local organization establish a stream monitoring program that includes chemical baseline/low flow and post rain event monitoring at 4 locations conducted every 3-5 years;

  1. Bull Creek South just prior to entering the Des Plaines River,
  2. Bull Creek South just prior to its junction with Bull Creek North,
  3. Bull Creek North just prior to its junction with Bull Creek South.
  4. Bull's Brook just prior to entering the Des Plaines River. All four samples should be collected on the same day. Post rain event monitoring should follow the same major rain event (greater than 1.5 inches).
- IEPA and IDNR Intensive Basin Survey Program continue to collect fish, macroinvertebrate, and water quality data near Route 21 (Bull Creek South) every 5 years.
- IEPA and IDNR Intensive Basin Survey Program establish a second site on Bull's Brook near the confluence with the Des Plaines River.
- Bull Creek Planning Committee (BCPC) review NPDES Permit records for one active wastewater treatment plant on St. Mary's Lake every year to see if effluent limits are being exceeded.
- Entity responsible for funding related to BMP design and implementation monitor pre and post water quality conditions.

Table 47. Recommended water quality monitoring locations, sampling parties, sampling cycle, and indicators to be tested

Site (See Figure 66)	Recommended or Existing Sampling Parties	Sampling Location (See Figure 66)	Sampling Cycle	Indicators Tested
Lake	Lake County Health Department- Lakes Management Unit	Loch Lomond, St. Mary's Lake, Butler Lake, IMC Lake	Every 5 years	Physical; Chemical; Trophic State Index (TSI); Algae/Toxicity in Loch Lomond
Lake	Integrated Lakes Management or other	Sanctuary Pond and Lake Leopold	Every year due to continuous 10-year record.	Physical Chemical; Trophic State Index (TSI) Biological
Stream Branch	School Environmental Programs; Other local organization	See Sampling Locations on Figure 66	Baseline and every 3-5 years. Following rain events.	Physical and Chemical
Bull Creek South (near Rt. 21)	IEPA and IDNR: Intensive Basin Survey	At previously established location	Every 5 years	Physical, Chemical, and Biological
Waste Water Treatment Plants	Owner	At previously established locations	As noted in NPDES Permit	Chemical and biological
BMP Practices	Environmental Consultants, owner/ sponsor	Varies	Pre and post BMP implementation	Physical, Chemical, and Biological

Figure 66: Exising and Recommended Water Quality Sampling Sites



4.4 Flooding

THE PROBLEM: Hydrology changes in the watershed related to human land use impacts play a vital role in increased flooding in any watershed. Increases in impervious surface and wetland loss are two primary reasons for increased flooding. According to the watershed assessment, only 56% of the original pre-settlement wetlands in the watershed remain. Most wetland losses were the result of draining to produce viable agricultural land. Since then, many agricultural parcels have been developed, forever losing the wetlands that once existed. With the development comes impervious surface and an increase in stormwater runoff that enters streams and lakes. Hydrology changes are leading to in-stream erosion and debris loading in stream channels that can result in increased flooding and sediment deposition. In addition, hydrology analysis conducted on Bull Creek South (downstream from Butler Lake) indicated that both a 10 and 100 year rain events would cause flooding outside the stream channel.

PRIMARY CAUSE: Wetland loss and increase in impervious surfaces across the watershed. A Flood Problem Areas Inventory, nuisance flooding assessment, and assessment of structures in the floodplain, was conducted in addition to a hydrology model aimed at determining flooding in different stream reaches. All of these analyses were conducted to better understand the flooding issues in the watershed.

Prior to European settlement, the Bull Creek/Bull's Brook watershed contained approximately 2,348 acres of wetlands. During that time, wetlands were poorly drained or not drained at all and acted as sponges that controlled the amount of water released into streams and lakes. European settlers to the region spent years draining many of these wetlands in an attempt to farm the rich humic soils. Today, approximately 1,316 wetland acres of the original 2,348 acres (56%) remain. The loss of wetlands is a direct result of human alterations to the natural landscape and hydrology of the watershed. Initially clay tiles were used to drain land for farming. Presently, many miles of storm sewers, drainage tile and ditches accommodate the drainage needs of communities and rural areas. Most storm sewer systems and drainage tiles and ditches are able to handle the runoff from low intensity rainfall events. However, as more land is developed with impervious surfaces such as houses, streets, and shopping centers, a greater amount of runoff enters drainage systems. Increased runoff to sewers, ditches, and streams can cause water to collect/back up into depressional areas in the landscape and in the low areas adjacent to waterways. During large or especially intense precipitation events this can result in flooding.

FLOOD PROBLEM AREAS INVENTORY

In 1995/1996, the Lake County Stormwater Management Commission (LCSMC) conducted a Flood Problem Areas Inventory (FPAI) throughout Lake County including the Bull Creek/Bull's Brook watershed. A Flood Problem Area (FPA) is composed of one or more structures that are damaged by flooding. Structures include transportation and utility infrastructure as well as buildings. Well and septic failure caused by flooding are also considered structural damages. Flood damage can be caused by overbank flooding, local drainage problems, flooding in depressional areas, or by sanitary sewer backup. "Nuisance flooding" was not included in the FPAI. Nuisance flooding usually occurs on yards or in open areas and does not cause damage to structures.

The FPAI noted two Flood Problem Areas in the Bull Creek/Bull's Brook watershed. Each FPA is identified by LCSMC code and cause of flooding in Table 48 while Figure 67 locates each flood area in the watershed. Following heavy rain events, Site 13–11 exhibits nearly 12 acres of depressional flooding in the northwest portion of the watershed in and about the Arbor Vista Subdivision. Structural damage occurs in several lots near the flooding. Site 14–01 consists of three separate sites at the downstream end of Bull Creek, within the Brookhill Subdivision. Flood damage at Site 14-01 is associated with overbank flooding along Bull Creek and local drainage problems. Three to five homes in this area have had their basements wells and septic systems flooded by overbanking.

Table 48. Flood Problem Areas identified during LCSMC's Flood Problem Areas Inventory of the Bull Creek/Bull's Brook watershed.

SMC Code/Site	Cause of Flooding	Area (Acres)	Preliminary Mitigation Measures
13–11	Depressional Flooding	11.6	Create additional storage in existing depressional area.
14–01	Overbank Flooding	5.9	*Implement best management practices that reduce runoff from future development. Look for upstream storage opportunity.
14–01	Overbank Flooding	1.5	*Implement best management practices that reduce runoff from future development. Look for upstream storage opportunity.
14–01	Local Drainage Problem	3.3	*Implement best management practices that reduce runoff from future development. Look for upstream storage opportunity.

*Data obtained from Draft Lake County Flood Hazard Mitigation Plan (LCSMC 1999)

Nuisance Flooding Areas Inventory

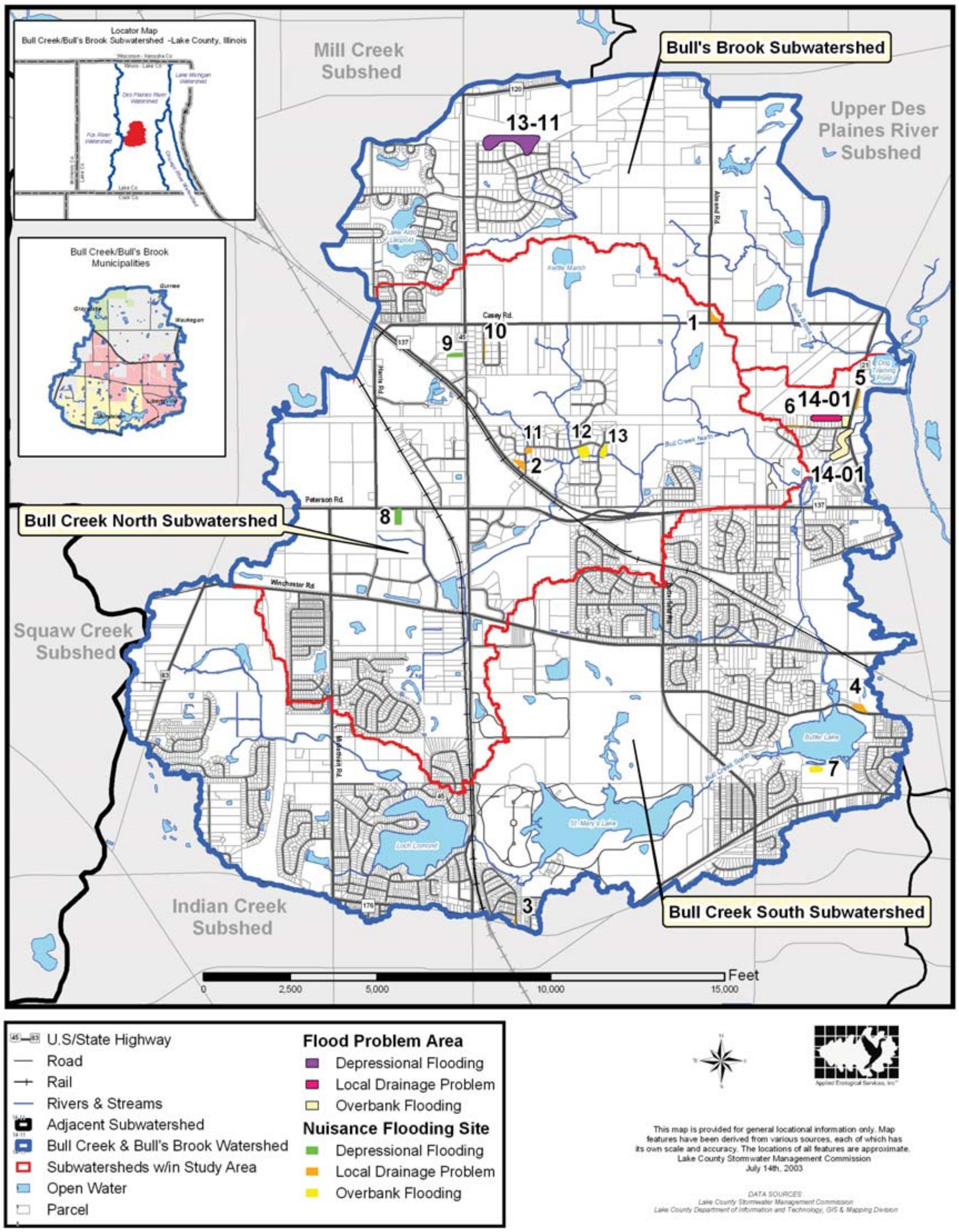
In addition to the LCSMC's Flood Problem Area Inventory, Applied Ecological Services, Inc. (AES) conducted field reconnaissance during the May 2004 flood event. The purpose was to identify nuisance flooding and additional Flood Problem Areas (FPAs) that were not included in the LCSMC's Flood Problem Areas Inventory. Nuisance flooding is usually associated with yard, roadside, and park/field flooding that does not result in any damage to structures. Although the nuisance flooding does not damage structures, it can inhibit the intended use of the area flooded. In addition, a survey of municipalities, townships, and other stakeholders helped identify additional nuisance flooding areas.

During AES's field reconnaissance, 10 nuisance flooding areas were noted. The query of municipalities, townships, and stakeholders noted 3 additional nuisance flood sites. No additional FPAs were located. Each nuisance flood site identified by AES and others is numbered and identified by cause of flooding in Table 49 while Figure 67 locates each flood area in the watershed. Most of the nuisance flooding is the result of local drainage problems associated with roads/highways and overbank flooding. The parking lot behind the Libertyville High School floods as a result of overbank flooding at Butler Lake. Although the parking lot is flooded in this case, it is not considered a Flood Problem Area because no structures are damaged. Depressional flooding at sites 8 and 9 result in lawns becoming inundated with water.

Table 49. Nuisance flood areas identified by AES and others in the Bull Creek/Bull's Brook watershed

AES Site #	Cause of Flooding	Impacts
1	Local Drainage Problem	Flooding on road at intersection of Casey and Almond Roads
2	Local Drainage Problem	Broken tile causes flooding in residential lot
3	Local Drainage Problem	Flooding in residential lot off Route 176
4	Local Drainage Problem	Flooding at Butler Lake Park and street
5	Local Drainage Problem	Poor drainage in swale along Route 21 causes flooding in yards
6	Local Drainage Problem	Poor roadside drainage causes flooding in yards along Brookhill Road
7	Overbank Flooding	Butler Lake flooding in Libertyville High School parking lot
8	Depressional Flooding	Depressional flooding in parcel south of Route 137
9	Depressional Flooding	Depressional Flooding along office building off Route 45
10	Local Drainage Problem	Poor swale drainage causes flooding on road in subdivision
11	Local Drainage Problem	Poor drainage in swale causes water to flow over Bull Creek Drive
12	Overbank Flooding	Overbank flooding causes residential yard flooding
13	Overbank Flooding	Overbank flooding causes residential yard flooding

Figure 67: Flood Problem Areas and Nuisance Flooding Sites



FLOOD RISK ASSESSMENT

Des Plaines Phase II: *Mulit-year, multi-agency, multi-objective feasibility study of the upper Des Plaines River watershed and its tributaries in Wisconsin and Illinois to reduce flood damage, improve water quality and restore ecosystem habitat begun in 2002.*

In 2005, the U.S. Army Corps of Engineers (USACE) completed new hydrologic and hydraulic (H & H) modeling for the North Branch tributary of Bull Creek and the South Branch of Bull Creek downstream of Butler Lake as part of the ***Des Plaines Phase II*** planning process (see Appendix E). New 100-year floodplain mapping was derived from the H & H study.

Bull's Brook and the watershed upstream from Butler Lake was not modeled or remapped in 2005. The current 100-year floodplain as defined by the Federal Emergency Management Agency (FEMA) was used for this assessment. AES compared the floodplain maps with recent (2002) aerial photographs to locate structures in the floodplain.

Flood risk areas are special flood hazard areas where structures have been identified as being at risk for flood damage because of their location in the 100-year floodplain. All structures located within the 100-year floodplain are shown on Figure 68. Many of the identified structures are potential flood problem areas. Table 50 includes a summary of these structures. According to the findings, 104 structures are located in the floodplain. Of these, houses (38), sheds (17), small buildings (14), and garages (11) are the most common. Most of these structures that are at risk of flooding are in the southern portion of the watershed along Bull Creek North and Bull Creek South, and especially around Butler Lake.

Table 50. Structures by type subject to 100-year flood mapping

Structures by Type	Number
House	38
Large building	3
Mid-sized Building	4
Pool House	4
School	2
Shed	17
Small Building	14
Utility Tower	5
Totals	**104**

SITE-SPECIFIC DAMAGE ASSESSMENT

The Flood Problems Area Inventory and flood risk assessment identified structures that have been or may be damaged by flood events. In 2005, the LCSMC sent out flood protection questionnaires to 35 property owners adjacent to the two known Flood Problem Areas identified in the watershed (14-01, 13-11). The purpose was to identify those structures that are at risk of flooding so that watershed plan recommendations can be made that address flood damage reduction. The questionnaire also requested more detailed information about the damage extent and frequency of flooding (*See Appendix P*). Data obtained from these surveys is typically used in more comprehensive flood audits. A complete flood audit was not performed for this study because the reported flood damage levels are not significant enough to warrant an audit.

Figure 68: Structures in the 100-Year Floodplain

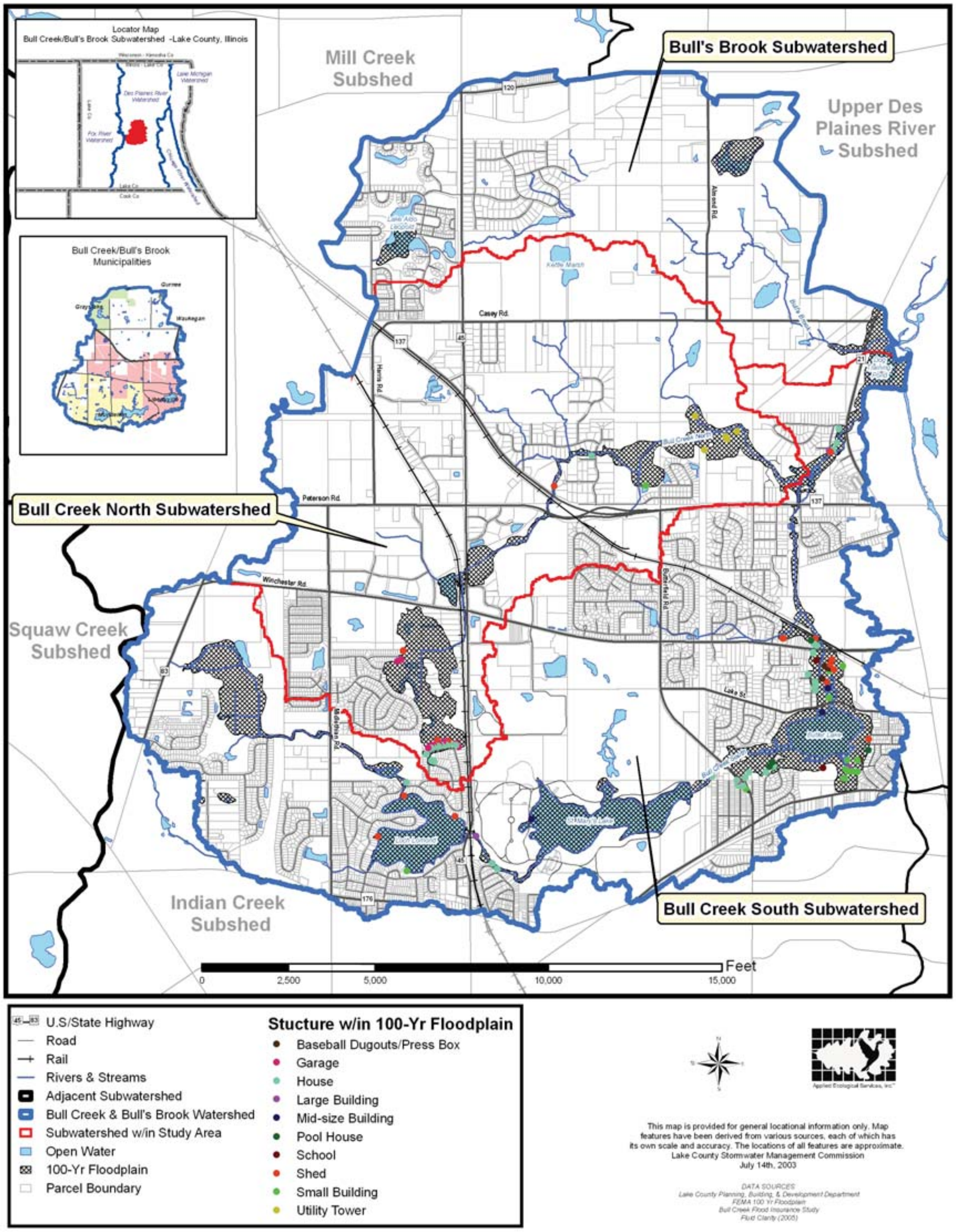


Table 51. Summary of Flood Protection Questionnaires

# of Homes or Properties Flooded	Basement Flooding	Fiirst Floor Flooding	Crawl Space Flooding	Yard Flooding
14	2	0	1	11

Based on 14 questionnaires that were returned to LCSMC, two residents experienced flooding in their basement; one resident experienced flooding in a crawl space; and eleven residents experienced yard flooding only or in addition to other types of flooding (Table 51). No flooding was reported on the first floor of any house or building. Flooding of structures (basements and crawl space) was minimal with 0.5 to 3 inches of water recorded.

2 year-3 year-10 year-100 year flood: *For each river, engineers assign statistical probabilities to different size floods to describe a common or ordinary flood for a particular river versus a less likely or a severe flood for the same river. A 100-year flood is a flood that has a 1-percent chance of being equaled or exceeded in any given year. The 100-year flood, also referred to as the "base flood", is the standard used by the National Flood Insurance Program (NFIP) for floodplain management and is used to determine the need for flood insurance. A structure located within the 100-year special flood hazard area shown on an NFIP map has a 26 percent chance of suffering flood damage during the term of a 30-year mortgage. A two-year flood event has a 50% probability of occurring in any year; 2-year rain events are important because they form the general shape of our stream systems and are the cause for much of the pollutant loading.*

100-year floodplain: *A flood inundates a floodplain. A 100-year flood is a flood that has a 1-percent chance of being equaled or exceeded in any given year. A 100-year flood may also be referred to as the base flood. The area inundated during the base flood is called the 100-year floodplain.*

Base Flood Elevation (BFE): *The elevation delineating the level of flooding resulting from the elevation of the 100-year flood.*

Noteworthy Overbank Flooding and Channel Forming Flows

Hydrologists assign statistical probabilities to different size floods to describe a common or ordinary flood for a particular stream versus a less likely or a severe flood for the same stream. For example: a ***2-year flood event*** has a 50% probability of occurring in any year; a ***100-year flood event*** is a flood that has a 1% chance of being equaled or exceeded in any given year. The 100-year flood, also referred to as the "base flood", is the standard used by the National Flood Insurance Program (NFIP) for determining the ***Base Flood Elevation (BFE)*** for floodplain management and is used to determine the need for flood insurance

AES used new hydrologic and hydraulic (H & H) modeling results for Bull Creek North and Bull Creek South downstream of Butler Lake to predict and map stream reaches where 10 and 100-year rain events cause over bank flooding for existing conditions. (Stream reaches upstream of Butler Lake and Bull's Brook are not included in the new H & H modeling and were not analyzed for this study.) Figures 69 and 70 show stream reaches where flooding is projected to occur during 10 and 100-year rain events. It is clear that most of the modeled stream reaches exhibit flows that will exceed channel depths (potential flood areas) for existing conditions during 10 and 100-year rain events. Modeling data for this exercise is included in Appendix K. (Note: Areas where water levels are modeled to exceed channel depths are all located within the 100-year floodplain)

A hydraulic analysis was also conducted to quantify existing velocities in the modeled stream channels that exceed 4 feet per second during a 2-year rain event. Generally speaking, flows resulting from a 2-year rain event form the channel morphology seen in the streams throughout the watershed. Normal erosion of stream banks occurs when channel flows exceed 4 feet per second. The results of the analysis are shown on Figure 71. Approximately half of Bull Creek North exhibits flows that exceed 4 feet per second for existing conditions. Bull Creek South (up to Butler Lake) shows few stream reaches where velocities exceed 4 feet per second. This information suggests that because Bull Creek South is mostly developed, the stream channel morphology has reached equilibrium with the amount of flows generated during the 2-year rain event. Bull Creek North, on the other hand, is becoming more developed and channel morphology may be changing (widening) to accommodate the increased flows. Modeling data for this exercise is included in Appendix K.

Figure 69: Stream Reaches Where Flooding is Predicted for 10-Year Design Storm

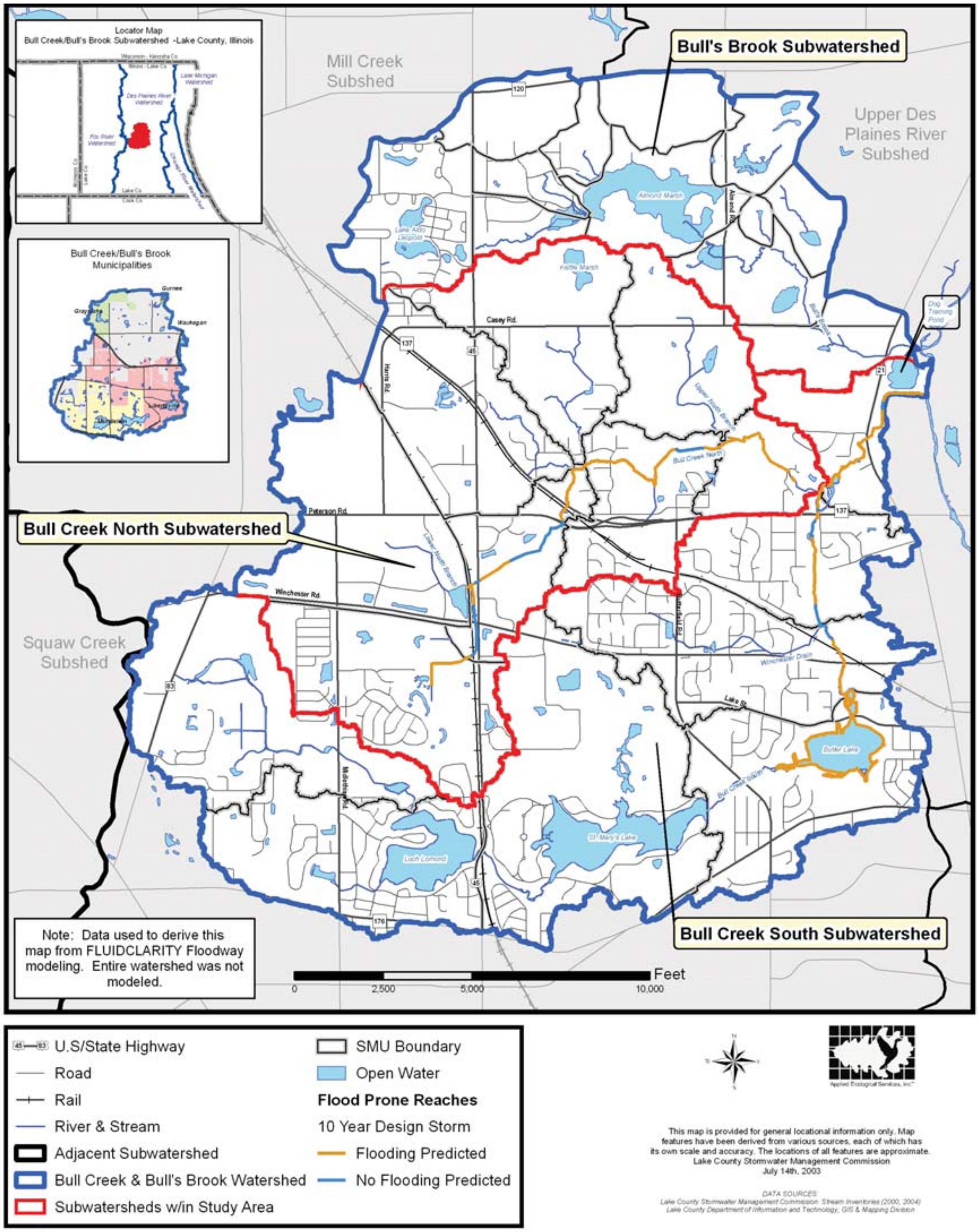


Figure 70: Stream Reaches Where Flooding is Predicted for 100-Year Design Storm

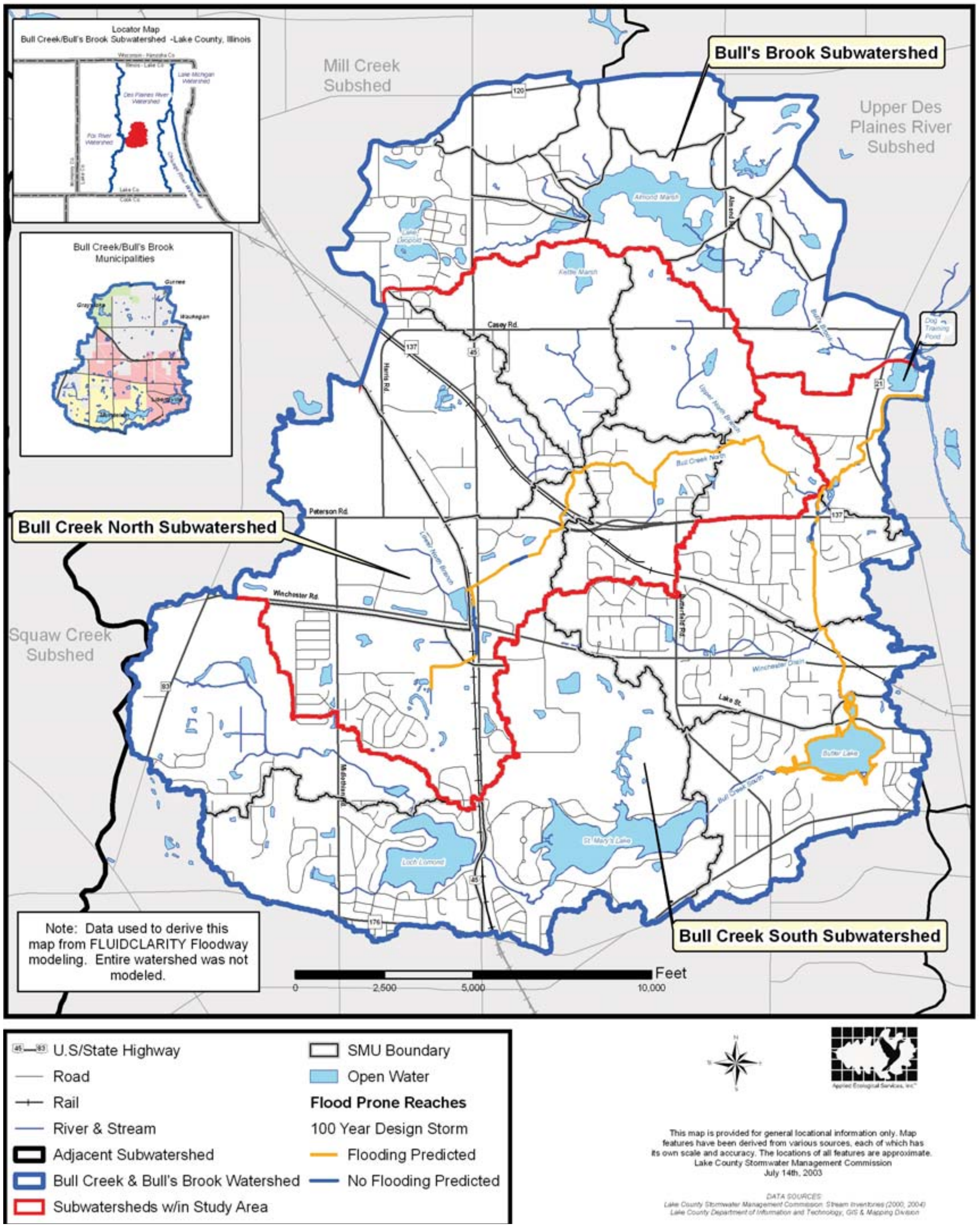
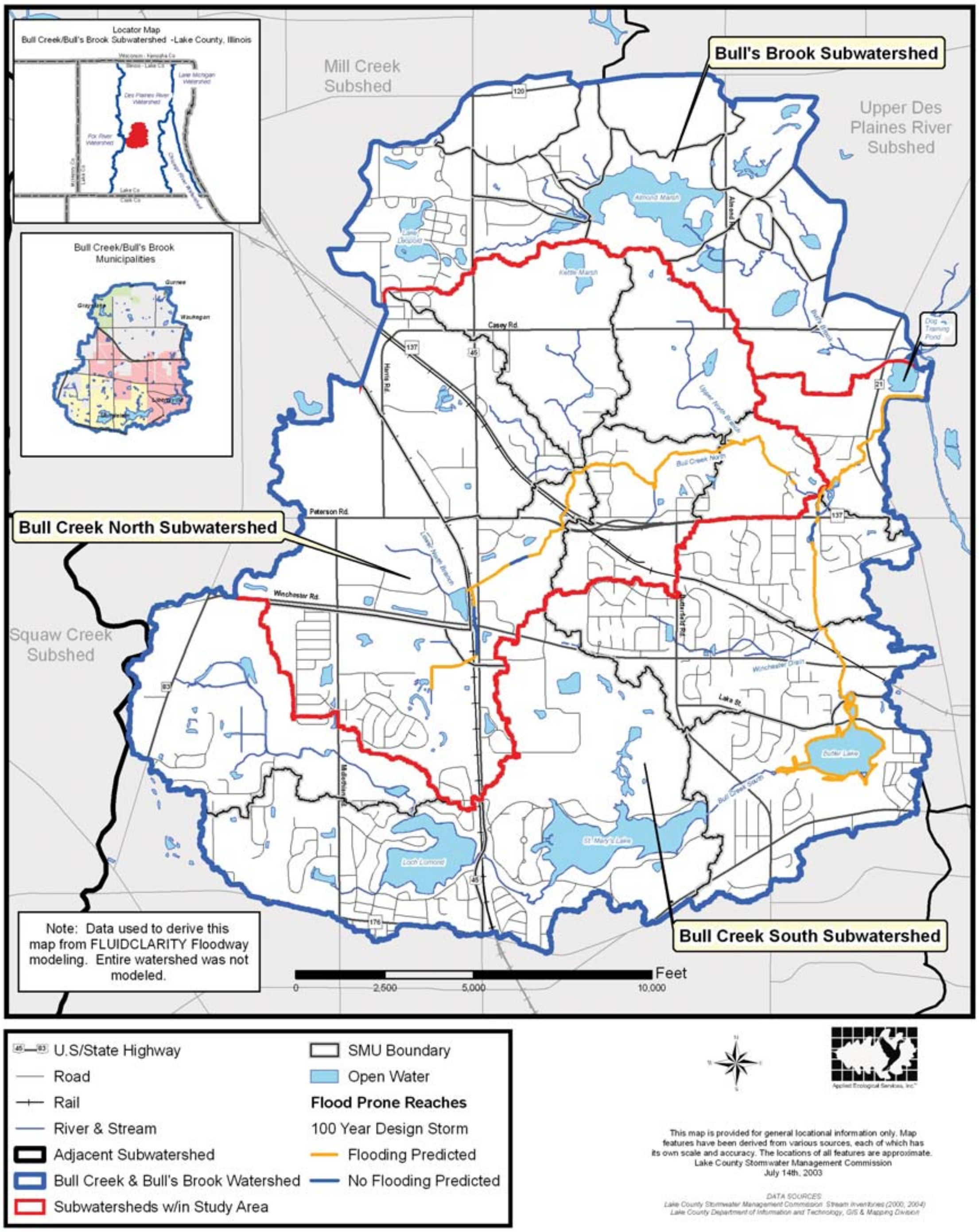


Figure 71: Stream Reaches Where Flow Velocity is Predicted to Exceed 4 fps for 2-Year Design Storm



4.5 Watershed Jurisdictional Coordination

THE PROBLEM: Watershed protection in Lake County is a shared responsibility of both public and private interests. Development within incorporated areas is regulated by municipal administration of the Lake County Watershed Development Ordinance (WDO) and local municipal ordinances (which may vary). In unincorporated areas, the Lake County Planning, Building and Development Department assumes this role through enforcement of the Unified Development Ordinance (UDO). Requirements for, and application of, best management practices vary.

An example of good of public and private coordination is occurring in the Liberty Prairie Reserve. However, no coordination programs exist for watershed stream maintenance and other best management practices (BMPs).

PRIMARY CAUSE: With multiple jurisdictions in the watershed, coordination is a limiting factor in completing BMP projects. The following section includes a detailed look at watershed jurisdiction coordination roles/responsibilities, policy, regulation, planning/zoning, and in-ground projects.

Watershed protection and regulation provided by jurisdictional entities comes in several forms: policy/regulation, planning/zoning, and in-the-ground BMP projects, including government coordination and partnerships with private entities for planning and in-the-ground projects. Protection and regulation is handled by multiple levels of government from municipalities and townships to the county, state, and the federal government. This section describes watershed management and discusses ways to improve jurisdictional coordination among the responsible parties.

WATERSHED ROLES AND RESPONSIBILITIES

Watershed management in Lake County is a shared responsibility of both public and private interests. Municipal government plays a significant role in influencing and overseeing development impacts to the watershed through land use planning, policies and regulatory oversight. Township government oversees road projects that may impact watershed resources. Municipal and county government is by far the most responsible for watershed protection in Lake County. Development affecting water resources (rivers, streams, lakes, isolated wetlands, and floodplains) is regulated by the Lake County Watershed Development Ordinance (WDO) and ultimately enforced by the Lake County Stormwater Management Commission (LCSMC) and under local ordinances and land use plans. Certified municipalities, which include all six municipalities in the Bull Creek/Bull's Brook watershed (Grayslake, Gurnee, Waukegan, Libertyville, Round Lake, and Mundelein), administer and enforce the standard development provisions of the WDO, but LCSMC administers the Isolated Wetlands Program for each of the municipalities.

Water resources on unincorporated parcels are regulated by the Unified Development Ordinance (UDO) and enforced by the Lake County Planning, Building and Development Office (LCPBD). Unincorporated areas are located in Avon, Warren, Fremont, and Libertyville Townships. Development affecting water resources in these townships must be reviewed by LCPBD, or in the case of publicly funded projects, by LCSMC. Lake County Planning Building and Development (LCPBD) reviews often involve coordination with LCSMC on issues such as base flood elevation determinations.

Water resource protection even at the county and municipal level still involves close coordination with state agencies and the federal government. Cultural resources, threatened and endangered species, rare habitats, and navigable, scenic waterways, or federal jurisdiction wetlands are all regulated by state or federal agencies.

Other governments and private entities with watershed jurisdictional or technical advisory roles include the Lake County Forest Preserve District, park districts (Grayslake, Mundelein, Libertyville), County Board Districts, and the Lake County Soil and Water Conservation District. The forest preserve district and municipal park districts play a critical role in natural resource protection, particularly for rare or high quality habitat and threatened and endangered species. They protect and manage land that often contains wetlands, lakes, ponds, streams, and detention facilities. The County Board oversees decisions made by county government and therefore has the power to override or alter policies and regulations for unincorporated Lake County (42% of watershed). The Lake County Soil and Water Conservation District provides technical resource assistance to the public and other regulatory agencies. Although the district has no regulatory authority, it influences watershed protection through soil and sediment control and pre-development site inspections.

POLICY & REGULATION

Policy and regulation are the foundation of watershed protection. The WDO sets the minimum standards for development as a consistent standard throughout Lake County. Therefore, changes in development policy and regulation fall in the hands of LCSMC and local enforcement officers for the WDO. Additional avenues for policy & regulatory change are the responsibility of the County and local municipalities in their land use plans, local subdivision ordinances, etc. It is up to these enforcing bodies to communicate effectively and discuss problems with WDO language interpretation and amendment needs that may help clarify regulations.

General and watershed-specific regulatory changes are addressed in Sections 4.1. Of utmost importance for Bull Creek/Bull's Brook watershed is coordination that would require mitigation for unavoidable wetland loss to occur within the same watershed as the impact.

PLANNING POLICY/ZONING REGULATION

Planning and zoning guidance provides the next level of watershed protection. Most planning and zoning regulation is in the form of local comprehensive land use plans and floodplain, zoning, and other development related ordinances that regulate onsite land use practices to ensure adequate floodplain, wetland, stream, lake, pond, soil conservancy, and other natural resource protection. Zoning ordinances and overlay districts in particular define what type of development is allowed and where it can be located relative to natural resources. Other examples of planning/zoning forms of resource protection include riparian and wetland buffers, impervious area reduction, open space/greenway dedication, and conservation development. Most of these preventative and remedial land use practices are discussed further in the Best Management Practices Toolbox (Appendix B). Conservation development is discussed further below.

To improve the impact of planning/zoning on water resource protection, there needs to be improved coordination and communication between county and local government. Watershed development regulations should be made very clear to local enforcement officers; local planners and zoning boards should consider revisions to local ordinances that address watershed, subwatershed, and/or site-specific natural resource issues.

CONSERVATION AND LOW IMPACT DEVELOPMENT

County and local governments need to work together to develop incentives for conservation and low impact development. Conservation development is the ideal compromise between economic development and water resource protection. Some ways to incorporate conservation development into developing communities and provide incentives for developers include:

- Allow conservation development "by-right" (does not require variances)
- Establish a joint county/community application process that reduces review time for conservation development;
- Reduce fees for conservation development application review;
- County and municipalities work together to locate appropriate parcels for future conservation development, and then zone those parcels as conservation development;
- Require all developments to have a certain percentage of preserved open space;
- Develop native landscaping ordinances;
- Reduce setback requirements between lots and encourage multi-level and clustered residential development to reduce land consumption;
- Provide credit for combining natural buffers with recreational opportunities;
- Require native plantings in all detention basins;

Conservation development zoning should be applied to re-zoning changes in rural areas. Conservation development zoning should outline the intent, design guidelines, density bonus, and in specific areas can be permitted where conservation development zoning changes would be permitted. The areas that may be re-zoned to a conservation development might include areas that are adjacent to areas zoned for existing conservation zones, rural residential districts, or less productive agricultural areas. Areas that are defined as rural residential could provide a transition from higher density residential to rural.

Design guidelines for conservation developments should include low impact development practices, a detailed outline of the process used to define the environmentally sensitive areas on the site, and identify areas on the site that are developable. Because each site will have different developable areas and sizes, design guidelines should be flexible and should consider different development characteristics, such as roadway length, width, and lot size. Density bonus may be written into the zoning code and could include bonuses for the following: use of native vegetation throughout the development, including individual lots, reduction in pavement or impervious surface, use of permeable pavements, increased percentages of open space, trail or sidewalk connections to other developments or regional trails, additional expanded buffering of natural areas and adjacent spaces and creation of wildlife habitat.

IN-THE-GROUND PROJECTS

In-the-ground projects are possible through county-wide adoption of a watershed management plan by local units of government followed by close coordination and development of funding mechanisms, timelines, and shared responsibilities for the projects prioritized by watershed planning efforts. Of particular importance for implementing projects identified in watershed plans is the development of partnerships – stakeholder groups (Homeowners associations, businesses, etc), schools, watershed council, community agencies and the like – to coordinate, fundraise, secure grants, and ultimately oversee project implementation. The experience and success that partnerships often gain from working together on a watershed project can influence regulatory changes and further cooperation among policy-makers.

Watershed plans, such as those recently developed for Lake County watersheds, often identify lead and support roles for multiple units of government to assist private landowners and watershed groups. Specific types of aid that governments can provide to private landowners can include BMP project funding or technical assistance especially for studies/plans. Private entities in turn can provide cost share for design, consulting, and construction work for projects, and/or in-kind BMP services such as seeding, planting, restoration work, trail construction, and interpretive education.

Nearly all watershed projects, including those developed through coordinated planning efforts, benefit from partnerships that share design, permitting, material, and labor costs. In Lake County, partnerships involving one or more municipalities, townships, drainage districts, homeowner associations, developers, county agencies, lakes management groups, landowners, and local, state and federal agencies are possible. Teams of public and private entities are becoming more and more critical for securing state or federal funding for in-the-ground projects. Projects with shared costs and benefits often result in more successful projects because of relationship building among partners who share a vested interest in how well their projects perform, and how soon they can build future projects together.

CHAPTER 5.0

Green Infrastructure Plan

5.1 The Green Infrastructure System

A primary objective of this plan is to examine ***green infrastructure*** (*open* and *partially open parcels*) in the Bull Creek/Bull's Brook watershed, and determine how open land would best be utilized as part of the green infrastructure system to meet major watershed goals including:

— flood prevention and reduction

— natural resource protection and enhancement

— water quality improvement

Prioritizing open space parcels for the green infrastructure system began with first identifying all open and partially open parcels in the watershed (see Section 3.8: Green Infrastructure Inventory). Once the inventory was complete, a meeting was conducted with the Bull Creek/Bull's Brook Watershed Planning Committee (BCPC) to identify an appropriate set of prioritization criteria that address each of the four watershed goals. GIS was used to analyze the information; if a parcel met a criterion it received a "Yes" or one point. If the parcel did not meet that criterion, it received a "No" or zero points. This process was repeated for each parcel for all criteria. The total points received for each parcel were summed to determine parcel priority for the green infrastructure system. Parcels with the highest number of points were ranked highest in the context of the system. Figure 70 depicts the parcel prioritization process. The selected criteria included in the total parcel prioritization are listed below and again in Table 52. The 15 selected criteria are as follows:

- Parcels that intersect with the 100-year floodplain
- Parcels within 0.5-mile of the headwaters
- Parcels that intersect with a wetland
- Parcels that are adjacent to or include at least 2.5 acres of drained hydric soils (potential wetland restoration sites)
- Parcels in an Subwatershed Management Unit where less than 10% of the Subwatershed Management Unit is existing wetland
- Parcels within 0.5-mile radius of Lake County Stormwater Management Commission flood problem area
- Parcels that are within 100 feet of a watercourse or lake

Headwaters: *Upper reaches of tributaries in a drainage basin.*

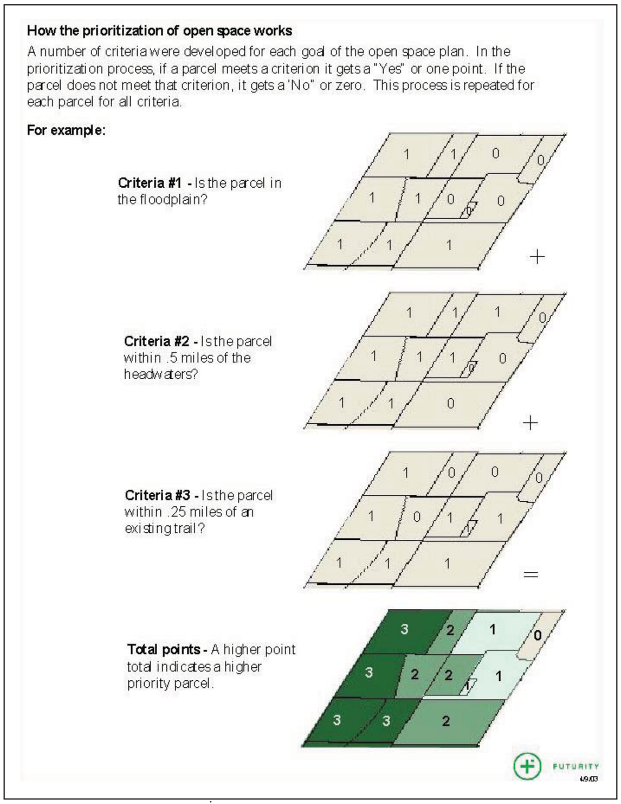


Figure 72. How the open space parcel prioritization works.

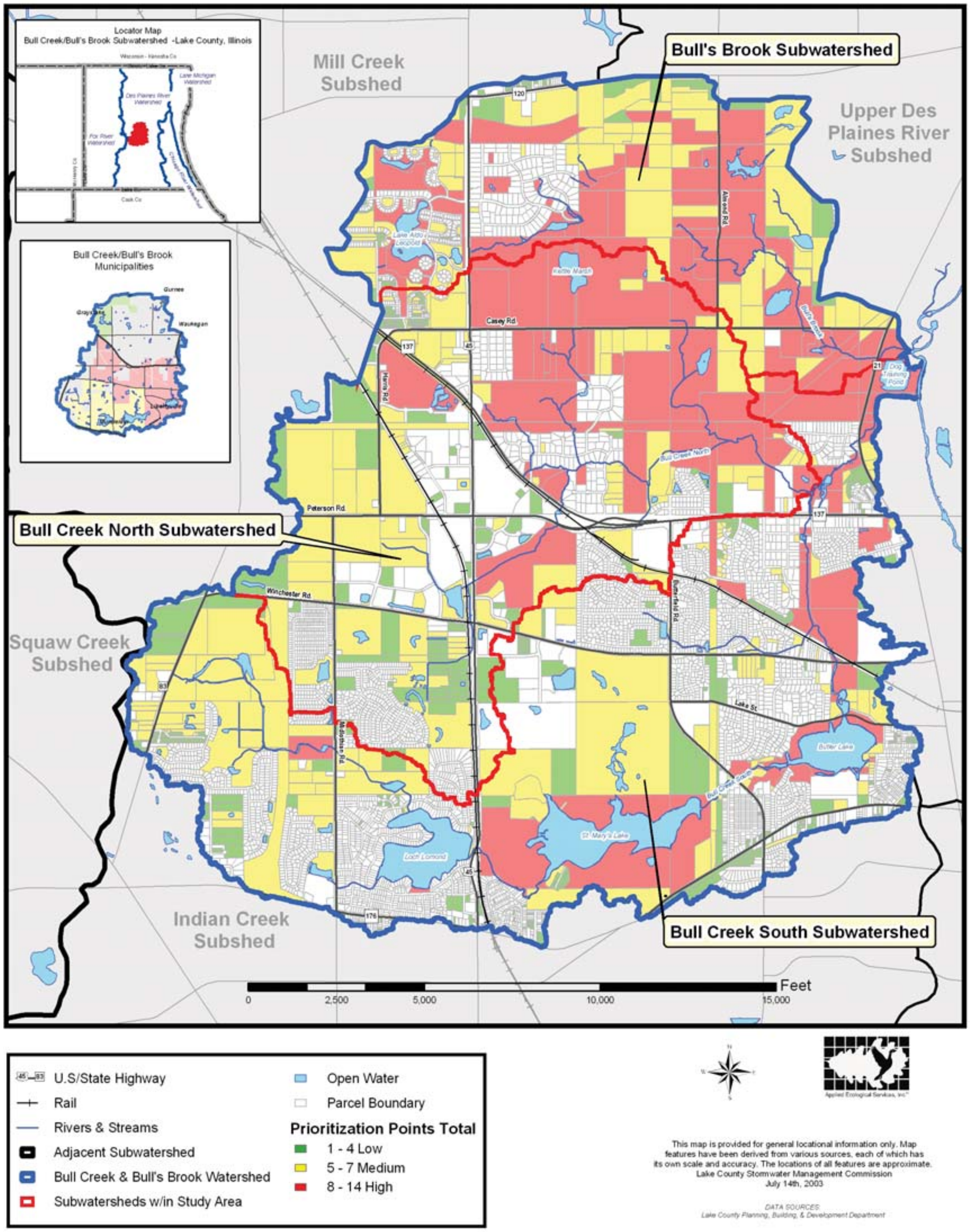
Source: North Branch of the Chicago River Open Space Management Plan (Futurity Inc, Christy S.F. 2004)

- Parcels that intersect with developed but undetained areas
- Parcels intersecting with non-point source pollutant hotspot Subwatershed Management Unit
- Parcels adjacent to or including forest preserves, land trusts, township, and privately and publicly protected open space
- Parcels adjacent to or including high quality wetlands (ADID)
- Parcels adjacent to or including Illinois Natural Areas Inventory sites, nature preserves and high quality natural areas
- Parcels adjacent to or including Threatened & Endangered (T&E) sites
- Parcels intersecting with or adjacent to a National Pollution Discharge Elimination System permitted point source or high priority site from Environmental Data Resources search
- Parcels with highly erodible soils

The highest total value received by a parcel in the weighting process was 14 (having met 14 of the 15 criteria). After completion of the prioritization, parcels were categorized as 'high', 'medium' or 'low' priority based on natural breaks (in statistical histogram data) in the GIS data *(Figure 71)*. Parcels meeting 8-14 of the criteria are designated high priority for meeting project goals while parcels meeting 5-7 criteria are designated medium priority. Parcels with a combined value of 1-4 are categorized as low priority.

A general examination of Figure 73 reveals the results of the parcel prioritization conducted for all 15 criteria. Much of the open space in the northern half of the watershed is ranked high priority for meeting project goals. This area contains many protected parcels that are associated with stream/lake corridors, wetlands, and high quality natural areas. There are more medium priority open parcels in the southern portion of the watershed. Much of this area is built out with fewer parcels having high quality natural areas, although the combined parcels along and surrounding the waterways are important as buffer and riparian corridor. Figure 81 (located in Section 8: Prioritized Action Plan) uses the results of the parcel prioritization for all criteria (Figure 73) to specifically map high and medium priority parcels that are recommended for potential greenway connections in the watershed.

Figure 73: Green Infrastructure Prioritization Results for all Criteria



5.2 Parcel Prioritization Results by Project Goal

The 15 criteria developed under the total parcel prioritization were grouped according to individual project goals *(Table 52)* to evaluate their applicability toward meeting each goal.

Table 52. Criteria used to prioritize parcels for each of the three project goals

Criteria	Flood Prevention & Reduction	Natural Resources Protection & Enhancement	Water Quality Improvement
1. Parcels that intersect 100-year floodplain	X		
2. Parcels within 0.5-miles of the headwaters	X	X	X
3. Parcels that intersect with a wetland	X	X	X
4. Parcels that are adjacent to or include at least 2.5 acres of drained hydric soils	X	X	X
5. Parcels in an Subwatershed Management Unit where less than 10% of the SMU is existing wetland	X		X
6. Parcels within 0.5-mile radius of Lake County Stormwater Management Committee flood problem area	X		
7. Parcels that are within 100 feet of a watercourse or lake	X	X	X
8. Parcels that intersect with developed but undetained areas	X		
9. Parcels intersecting with non-point source pollutant hotspot SMU (see Section 4.2: Water Quality Problems)			X
10. Parcels adjacent to or including forest preserves, land trusts, township, and privately and publicly protected open space		X	
11. Parcels adjacent to or including high quality wetlands (ADID)		X	X
12. Parcels adjacent to or including Illinois Natural Areas Inventory sites, nature preserves and high quality natural areas		X	
13. Parcels adjacent to or including Threatened & Endangered species sites		X	
14. Parcels intersecting with or adjacent to a National Pollution Discharge Elimination System permitted point source or high priority site from Environmental Data Resources search			X
15. Parcels with highly erodible soils			X

FLOOD PREVENTION AND REDUCTION

Table 52 outlines the eight criteria selected to prioritize parcels for flood prevention and reduction. Figure 74 reveals the location of high, medium, and low priority parcels where appropriate BMPs for reducing flood damage could be implemented with the best results. The highest total value received by a parcel is 7 points. Parcels meeting 5-7 of the criteria are designated high priority for meeting the goal while parcels meeting 3-4 criteria are designated medium priority. Parcels with a combined value of 0-2 are categorized low priority. A large number of high priority parcels are found along stream reaches and their associated 100-year floodplain.

NATURAL RESOURCE PROTECTION AND ENHANCEMENT

Table 52 outlines the eight criteria selected to prioritize parcels for natural resource protection and enhancement. Figure 75 reveals the location of high, medium, and low priority parcels. The highest total value received by a parcel for this goal is 8. The GIS distribution of prioritization scores is as follows: 5-8 (high priority), 3-4 (medium priority), and 1-2 (low priority). Many of the parcels selected as high priority are located in existing high quality natural resource areas, associated with wetlands, or are protected open space owned by the forest preserve, park districts and townships.

WATER QUALITY IMPROVEMENT

Table 52 lists the nine criteria selected to prioritize parcels for water quality improvement. Figure 76 reveals the location of high, medium, and low priority parcels where BMPs for protecting and improving water quality would prove most beneficial. The highest total value received by a parcel for this goal is 8. Parcels receiving 5-8 points are designated high priority; parcels with 3-4 points are medium priority; parcels with and 0-2 are low priority. Results of the analysis are somewhat similar to those derived under natural resource protection and enhancement. Most high priority parcels are associated with existing open space located on or adjacent to streams, lakes, and wetlands.

Figure 74: Open Space Parcel Prioritization Results for Flood Prevention and Reduction

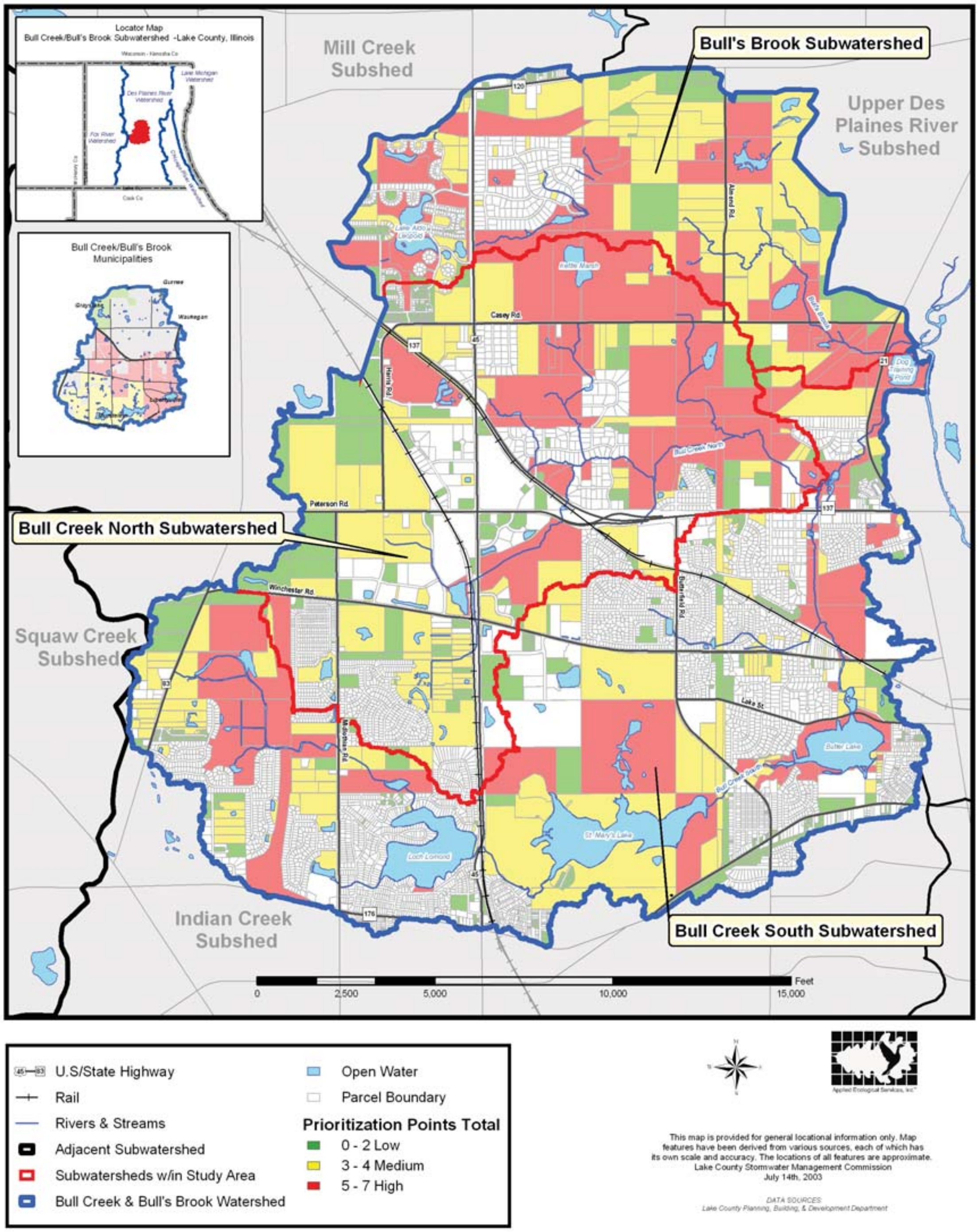


Figure 75: Open Space Parcel Prioritization Results for Natural Resources Protection and Enhancement

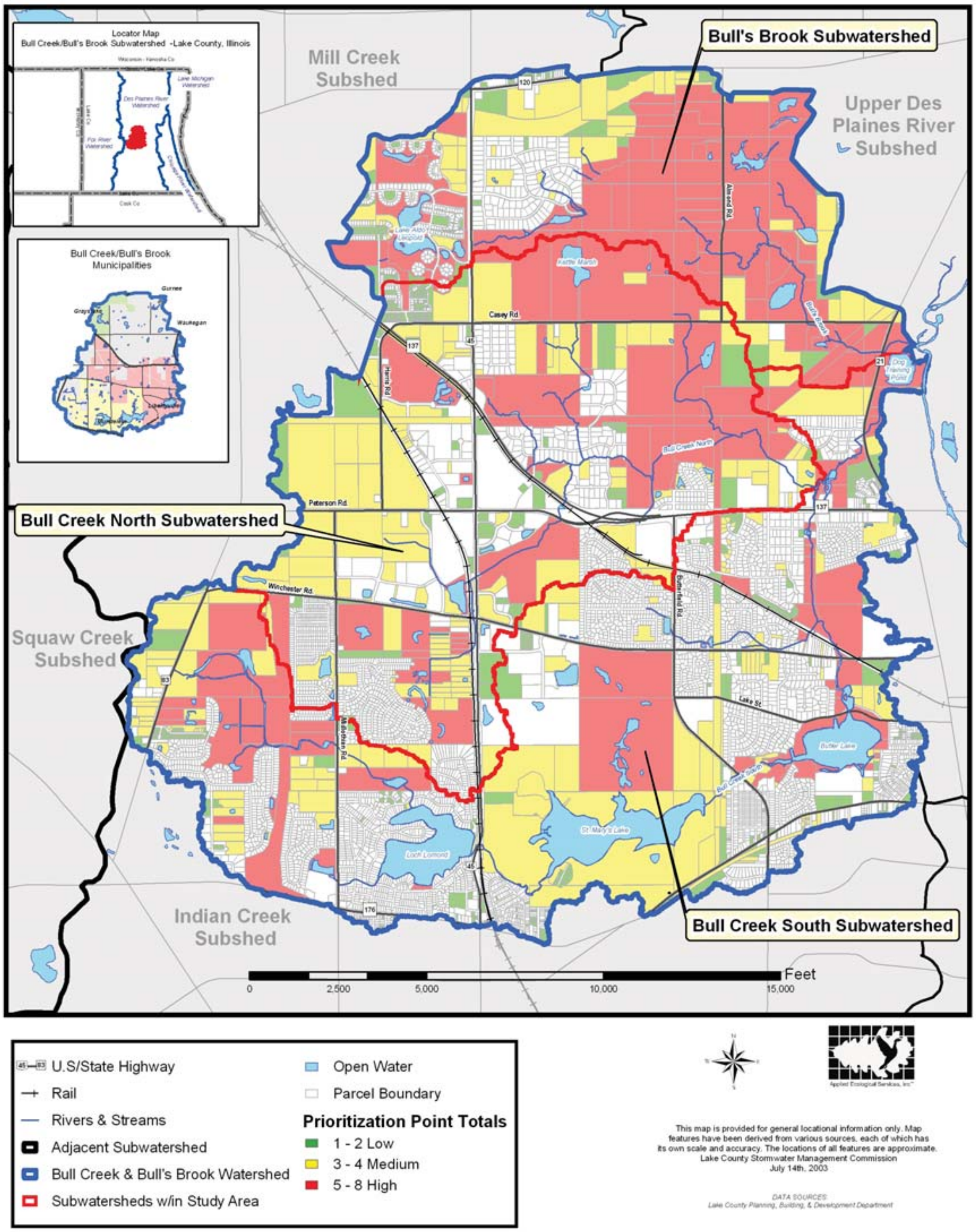
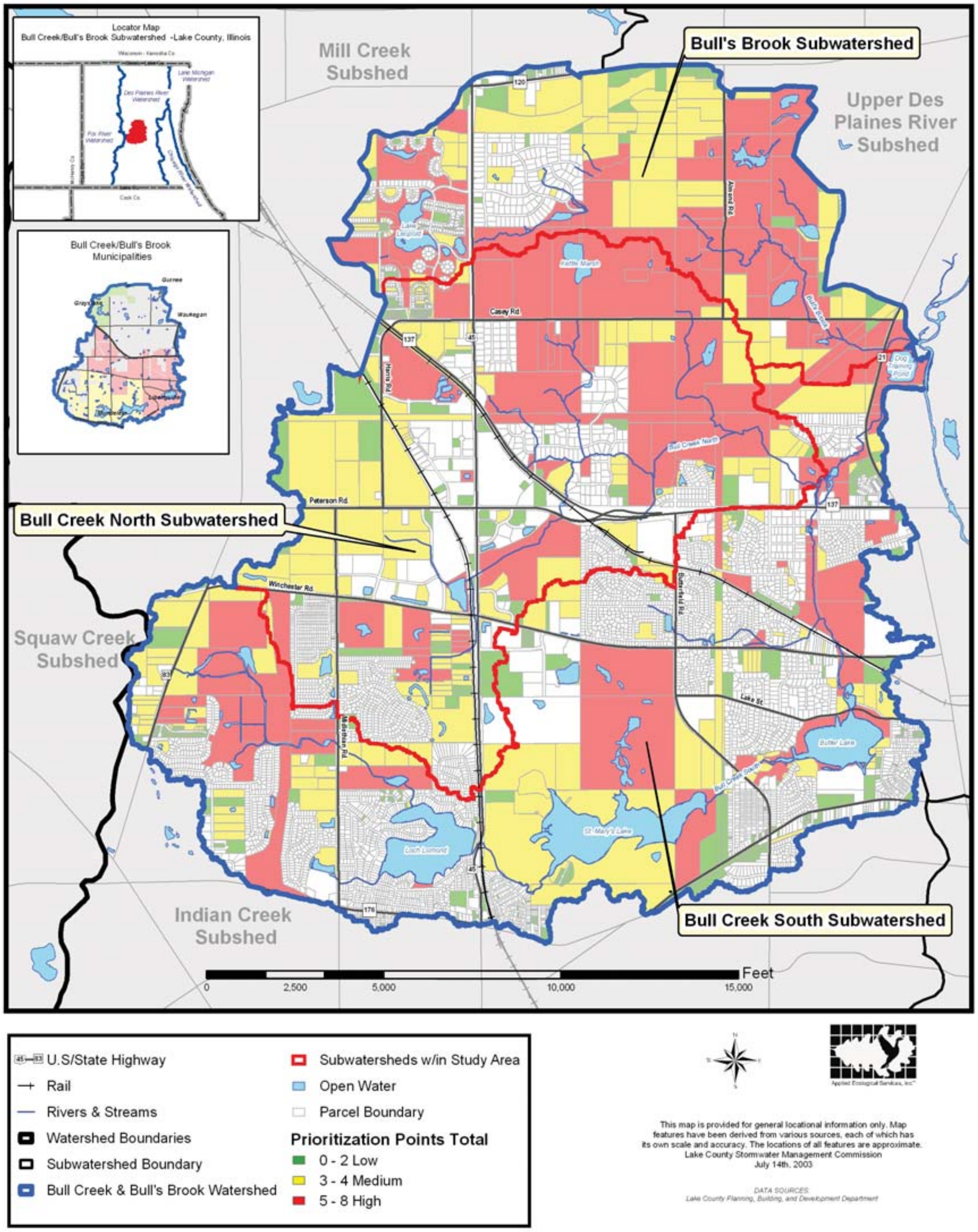


Figure 76: Open Space Parcel Prioritization Results for Goal #3: Water Quality Improvement



CHAPTER 6.0

Watershed Information/ Education Programs

Watershed Information/Education (I/E) Programs are a vital component to any watershed planning effort because they inform the general public on how to become more aware of the effects of human actions on the quality of a watershed, and how to help make a positive change. An effective I/E Program leads to changes in social behavior and public cooperation. It provides the knowledge, skills, and motivation needed to take action to meet water quality and other watershed based goals and objectives.

Flood reduction, water quality improvement, and natural resource protection/enhancement are among the watershed goals addressed by this plan. The cumulative actions of thousands of individuals in the watershed can either improve flooding, water quality, and natural resources or degrade them. Addressing these issues requires the efforts of individuals and communities watershed-wide. When people begin to understand the issues related to flood reduction, water quality, and natural resource protection/enhancement they slowly begin to change their behaviors and activities thereby improving the overall health of the watershed.

A successful I/E Program first makes stakeholders aware of issues/problems followed by education then supplies actions that stakeholders can take to address the issues/problems. An effective I/E Program usually includes the following components:

1) Define I/E goals and objectives.
2) Identify and analyze the target audiences and barriers to success.
3) Create the messages and vehicles for each audience.
4) Package the message and vehicles to various audiences.
5) Distribute the message and implement the vehicles.
6) Evaluate the I/E program.

6.1 Watershed Information/Education Needs

Before an I/E Program can be developed, it is important to understand the needs for information and education in the watershed. A questionnaire was distributed to various stakeholders in order to gather data about the needs in the Bull Creek/Bull's Brook watershed. A blank version of the survey is included in Appendix L. The purpose of this survey was to gather relevant information that is not easily available from reports or maps. Data gathered from the survey was used to identify sources of information that will contribute to an accurate description of the existing watershed I/E Programs. It is necessary to have an understanding of existing watershed management procedures, watershed problems, unmet needs, enhancement and restoration opportunities, and stakeholders' goals in order to make changes and recommend new programs.

The survey was distributed to 30 stakeholders throughout various organizations and included several questions about the current I/E Programs presently in place for the Bull Creek/Bull's Brook watershed. Further information on the survey included comments and additional programs that stakeholders would like to see implemented. Only two completed surveys were returned.

The first completed survey stated that the individual was not aware of any existing I/E Programs in the watershed but that Goal B (protect/restore natural resources) Goal E (ecologically friendly new development), Goal F (green infrastructure plan), and Goal G (watershed education) currently lack sufficient I/E Program support. Other comments and interests related to assisting in developing an outreach program for the watershed included: targeting homeowner associations, schools, and PTO meetings.

The second completed survey indicated the stakeholder was aware of only a few existing programs currently being implemented. The individual felt the existing programs were fair to good at addressing project goals. The following goals were listed as currently lacking sufficient I/E Program support efforts: Goal B (protect/restore natural resources), Goal E (ecologically friendly new development), Goal I (coordination between government agencies). Programs listed to potentially implement in the future include more educational materials to homeowners that share boundaries with the wetlands, and more requirements for developers regarding retention/detention ponds.

There are several educational programs that are currently being implemented in the Bull Creek/Bull's Brook watershed. The Liberty Prairie Conservancy (LPC) provides an education program. The LPC program includes a speaker's bureau for community groups, volunteer restoration workdays, family nature programs, Prairie Pedal: a bike ride with educational stops, Secret Gems: educational hikes on private property, and controlled burn and invasive species control training programs. The Upper Des Plaines Ecosystem Partnership coordinates a watershed tour and several other workshops every year and provides information on grant funding and reviews grant proposals for watershed projects.

The various municipalities, townships and SMC also provide pollution prevention and non-point source BMP information and workshops as a component of the National Pollution Discharge Elimination System (NPDES) program.

6.2 Recommended Information/Education Programs

Development of an I/E program begins by defining I/E goals and objectives. The Bull Creek/Bull's Brook Planning Committee (BCPC) specifically addressed watershed information and education issues by developing an I/E program goal. The education goal for this plan is stated as follows:

GOAL G: Provide watershed stakeholders with the knowledge, skills and motivation needed to take action on implementing the watershed plan.

The BCPC reviewed the draft action plan (Section 8) and determined which actions would require more education and outreach in order to be successfully implemented, and target audiences were identified for each education need. The target audience is a group of people selected to be reached with a particular message. The general audience of the watershed can include people of all demographics, locations, occupations, watershed roles, and ages. The target audiences selected to meet watershed goals and objectives include riparian and other landowners, residents, local government (i.e. municipalities and townships), homeowner's associations, developers, businesses, lake property owners, high schools, and farmland owners. Each audience has specific needs and requirements, and can impact the watershed on different levels.

Creating and distributing a message for each audience is done through development of actions to address the I/E Program needs related to the watershed goals and objectives. The Programmatic Action Plan (Section 8.1) includes general action recommendations to stakeholders for addressing the goals and objectives. The actions identified as needing more stakeholder education prior to implementation directed the education actions. Generally speaking, the plan recommends an action that an owner, municipality, or other agency should address, it is included in the education action list found in the Bull Creek/Bull's Brook Watershed Education Plan Matrix *(Table 53)*. The matrix was developed to help implement the I/E Program. The matrix includes columns for education/outreach themes, target audiences, messages, potential vehicles for the action messages, desired outcomes, priorities, a recommended schedule, and lead agencies or entities.

As with any program, the I/E Program should be evaluated to provide feedback regarding the outreach effort. Evaluation conducted early on in the effort will help determine which programs are working and which ones are not. Based on this information, money and time can be saved by focusing on the programs that work and doing away with those that do not. Section 9.0 (Evaluating Plan Performance) contains a "Report Card" with milestones related to watershed education that can be used to assess the I/E efforts.

Table 53. Information/Education Plan Matrix

Goal: Provide watershed stakeholders with the knowledge, skills, and motivation needed to take action on implementing the watershed plan.

OBJECTIVES:

Education Outreach Theme	Target Audience	Message(s) to convey
Watershed ecological health	All stakeholders Watershed committee or council Local units of government	• A vision for protecting, restoring and enhancing the ecological systems of the watershed. • Report on current watershed health status.
Floodplain (Risk) Awareness	Floodplain property owners	• How to protect yourself from flood losses. • Who to call for flood response assistance.
Floodproofing	Property owners in known flood problem areas	How to protect your property from flood damage.
Flood Prevention: No Adverse Impact	Municipalities (staff, plan commission, trustees) County (staff, RPC, ZBA, plan committee, board)	• How to protect your property from flood damage. • Why & how to prevent flood damage from worsening and protect natural floodplain benefits.
Developing or Retrofitting with Infiltration Practices	Municipalities (staff, plan commission, trustees) County (staff, RPC, ZBA, plan committee, board)	Infiltrating runoff reduces pollution and flooding.
	Homeowners associations Master gardeners Garden clubs	Rain gardens absorb runoff (keeping water clean) and are great for birds and butterflies.
	Developers	Infiltrating runoff mitigates impervious surface.
Pollution Prevention RE Landscape Maintenance Chemicals/Practices	Homeowners Master Gardeners Garden Clubs Landscape companies Lake/riparian property owners	• Do your part to keep waters clean. • Only feed your lawn in the fall. • Use landscaping that does not require heavy chemicals, water and mowing. • Use phosphorus free fertilizer.
	Golf courses/ Driving ranges Institutions Corporations Government facilities staff	• You can reduce pollution and maintenance costs while increasing profitability.

Vehicle(s)	Outcome	Priority[1]	Schedule[2]	Lead[3]
• Promote the vision through branding all correspondence, print materials, website, advertisements etc. with a vision statement. • Develop a watershed information-sharing website. • Report on the status of land use changes and progress made to protect greenways and open space to the watershed council biannually. • Compile periodic watershed report cards* and disseminate results through the web and media including community newsletters.	Watershed residents will know what watershed they live in and what its ecological health is. Key decision makers will get an update on land use changes, impervious surface status, water quality and progress made to protect greenways and open space on a regular basis.	H	S-L**	SMC
Print information to all properties in floodplain or flood problem areas	All floodplain property owners have flood insurance.	H	S-L	SMC PB&D
Workshop	Property owners floodproof structures at risk of flood damage.	H	S	SMC PB&D
• Meeting presentation(s) w/supporting • No Adverse Impact print materials. • Model ordinance.	Community adopts "no adverse impact" standard for floodplain development and identifies an incentive/easement program to protect floodplain as open space into perpetuity.	H	M	SMC
• Low impact development workshop/tour. • Meeting presentation(s) w/supporting print materials. • Model ordinance language.	Communities require infiltration practices for new development/redevelopment and promote infiltration practices as retrofits.	H	S	BCPC WRI UDPREP
• Workshops w/homeowner associations & garden clubs. • Print media (incl. community newsletters). • Team up with garden centers & garden clubs to organize a rain garden tour. • Distribute copies of rain garden "how to" guides to landscape companies and interested homeowners.	Rain gardens installed in yards and along streets.	L†	S	BCPC SMC LCAS
• Develop a demonstration project using low impact development and other green building practices. • Low impact development workshop/tour.	Developers learn to utilize the natural drainage features of the land, preserve open space with native plants and use low impact development practices that reduce runoff and pollution.	H	S	SMC PB&D WRI
• Print media (incl. community/ Home Owners Association newsletters) and Advertisements. • Public service announcement. • Door knockers. • Team with landscape companies, garden centers & clubs to distribute information on environmentally friendly maintenance. • Yard/lake signage.	Reduced number of homeowners using lawn chemicals. Better water quality in lakes and creeks.	H	S	LCHD SMC
• Audubon Sanctuary promotional materials to golf course managers. • Host a workshop/tour. • Interpretive signage on water feature buffers. • Demonstration site. • Print media. • Promotional materials. • Signage program	Golf courses meet the Audubon Sanctuary program certification requirements. Reduced number of campus owners using lawn chemicals. Better water quality in lakes and creeks.	H M	S M	BCPC PD OP

** The report card will serve as a vehicle to share information on goals, and will measure and document progress and accomplishments.*

*** Report Card completed in Years 3,7,10*

† Ohers already working on this

Table 53. (cont.)

Education Outreach Theme	Target Audience	Message(s) to convey
Pollution Prevention RE Ag Practices	Farmers	• Use suitable crops and farming practices if you are farming erodible soils. • You can reduce farming inputs and pollution while increasing profitability. • Organic farming has many benefits and is profitable.
Illicit Inflow & Infiltration	Homeowners Businesses	Make sure you are not advertently polluting our lakes and streams with cross-connections between sanitary sewers and storm drains.
Lake/Stream Stewardship	Schools Lake associations Homeowner associations/ riparian land owners Businesses	Make a difference in your watershed.
Detention Pond & Drainage Swale Maintenance/Retrofit	Homeowner associations Corporations Municipalities Churches Schools	Your detention basin can clean pollutants from stormwater as well as reduce flooding.
Impact of Road Salt Use on WQ	Government facilities staff Businesses Township Hwy Lake County Dept. of Transportation Illinois Dept. of Transportation	Road salt pollutes our waters. Less is best - use only as needed and apply in ways that optimize its effectiveness.
Riparian Zone/Buffer Management Stream Maintenance	Riparian land owners Landscape companies	Be a good steward of our water. Maintain a stream/lake plant buffer, do not place any yard waste or apply lawn chemicals in the buffer. Remove excessive debris that collects in the stream channel.
Stream Erosion/Restoration	Municipalities Riparian land owners Township County annual budget.	• Use bioengineering practices to stabilize eroding streambanks where appropriate. • Include stream stabilization/restoration in your

Vehicle(s)	Outcome	Priority[1]	Schedule[2]	Lead[3]
• Team up with Natural Resource Conservation Service, Soil & Water Conservation District, Farm Bureau and Extension Service to work with farmers one-on-one to develop conservation plans. • Farm Bureau, Soil & Water Conservation District and Extension newsletter articles. • Direct mail information on Conservation Reserve Program.	Reduce nutrient inputs to waters from farm fields. Eliminate Atrazine and other farm chemicals in waters. Better water quality in lakes and creeks.	L	S	NRCS FB SWCD
• Support NPDES II community efforts to understand & identify illicit discharges and disconnect illicit illicit hookups by including information in publications and on the web site. • Encourage residents to report suspicious discharges and provide a "who to call" list.	Greater awareness of pollution threat and how to remedy it. Better water quality in lakes and creeks.	H	L	MUNI PB&D LCHD
• Establish student/volunteer water quality monitoring program with training workshops and follow-up data summaries reported via email and newsletters. • Sponsor lake/stream cleanup/ restoration days. • Use signage to recognize contributing organizations/ persons.	A new generation of conservation-literate citizens who are motivated and equipped to act. More comprehensive water quality data is available and disseminated for the watershed.	H	S-L	Schools UDPREP LPC
• Develop demonstration project. • Workshop/tour. • Direct mailing w/ before and after case study examples. • Provide how to guide for interested stakeholders.	Retrofitted & maintained detention basins and drainage swales that function to improve water quality, reduce flooding, provide habitat and are a community amenity rather than an eyesore.	H/M	M	MUNI PB&D
Team up with American Public Works Association, Lake County Health Department and Municipal Advisory Committee to present periodic workshops and forward best practices and alternative products information to applicators.	Decrease amount of road salt applied to roads. Better water quality in lakes and streams.	L†	S	APWA LCHD MAC
• Mail riparian landowners guide to all riparian landowners. • Hold a riparian landowner training workshop. • Provide NIPC Restoring & Managing Stream Greenways "how to" guide for interested stakeholders. • Periodic articles in community newsletters. • Provide a "who to call" list for landowner questions/assistance.	A healthy riparian buffer of deep-rooted native plants. Better water quality in streams and lakes.	H	S	SMC
• Provide information on stream reach condition to respective responsible parties. • Develop demonstration project. • Workshop/tour. • Directed mailing with before and after case study examples. Provide information on sources of technical and funding assistance.	Maintain stream energy and sediment transport equilibrium Move all watershed streams and lakes to a "B" or good water quality/aquatic habitat ranking. Stem erosion before it becomes destructive to property.	M/L	L	SWCD

† *Ohers already working on this*

Table 53. (cont.)

OBJECTIVES:

Education Outreach Theme	Target Audience	Message(s) to convey
Beneficial Use of Native Plants Natural Area Buffers	Property owners adjacent to natural areas Homeowners Corporations Institutions Local government units Realtors Landscape companies	Native plants can help restore watershed hydrology and health. They are: • low maintenance. • better able to infiltrate precipitation into the ground. • useful as habitat for fish & wildlife. • the best stream and lake buffers.
Controlling Invasive Plants	Property owners adjacent to natural areas Local government units Farmers Landscape companies Garden centers Homeowner associations	Invasive plants are weeds that over run and crowd out native plant communities. The result: habitat is lost and biodiversity is threatened.
Neighborhood Wildlife Habitat	Homeowners Homeowner associations Local government units	As more land is developed in the watershed it is important to provide wildlife habitat in yards and neighborhood parks. Your yard is important to birds, butterflies and other wildlife.
Value/Importance of Open Space/Green Infrastructure	Municipalities Developers Homeowner associations Residents Elected Officials	• Green infrastructure increases property values and decreases the cost of gray infrastructure and public services. • Green infrastructure preserves the current watershed hydrology and sustains natural ecological processes providing quality habitat for wildlife and people. • Include green infrastructure protection/enhancement in community and HOA capital and operating budgets.

• Demonstration projects/sites. Team up with Forest Preserve District and Soil & Water Conservation District to host a workshop targeting the owners of large landscapes. • Advertisements. Public service announcement. • Provide easily accessible sources for native plants. • Promotional materials for golf course managers. • Signage.	50% of watershed open space is native plant communities. Homeowners, businesses, institutions and local government properties landscape with native plants.	H	S	SWCD SMC
• Host a plant invaders workshop. • Send a letter and print materials to garden centers and landscape companies requesting that they not sell, propagate or transport invasive plants.* • Host "how to identify" & "best practices to control" workshop for large landscape owners. • Sponsor weed walk for homeowners.	Watershed residents learn to identify invasive species and their negative impacts and initiate control methods on their properties.	M	S	LCFPD
• Establish and promote a neighborhood yard and park certification program—include signage. • Identify neighborhood champions and "experts". • Team up with Audubon to provide "how to" information via the web and print materials. • Work with landscapers to promote native plant habitats.	Homeowners realize that they can play an important role in maintaining or enhancing local wildlife and biodiversity.	M	L	LCAS
• Model conservation ordinance. • Conservation design development standards. • Meeting presentation(s) w/supporting print materials. • Land protection tools workshop. • Trails/greenways workshop. Widely distribute a greenway/infrastructure map/ brochure for the watershed. • Designated community open space coordinator.	At least 50% of the watershed will be protected open space preventing flood damage, maintaining water quality, protecting natural resources and wildlife while protecting and enhancing property values, the local economy and quality of life for future generations.	H	S	CMAP LCFPD

**Distribute Midwest Invasive Plant Network brochures and publicize their website & information centers*

1. H: high; **M**: medium; **L**: low

2. S: short term 1–3 years; **M**: medium term 4–7 years; **L**: long term 8–10 years

3. Abbreviation	**Stakeholder**
APWA	American Public Works Association
BCPC	Bull Creek/Brook Plan Committee
CMAP	Chicago Metropolitan Agency for Planning
FB	Farm Bureau
HOAs	Home Owners Associations
LCAS	Lake County Audubon Society
LCFPD	Lake County Forest Preserve District
LCHD	Lake County Health Department
MAC	Municipal Advisory Committee (to SMC)
MUNI	Municipalities
PB&D	Lake County Planning Building and Development Department
PD	Park Districts/Departments
SMC	Lake County Stormwater Management Commission
SWCD	Lake County Soil & Water Conservation District
UDPREP	Upper Des Plaines Ecosystem Partnership
WRI	Wetlands Research Inc.

CHAPTER 7.0

Plan Implementation

7.1 Plan Implementation Roles and Coordination/Responsibilities

Key ***stakeholders*** with the potential to form ***watershed partnerships*** for watershed improvement projects were identified. The key stakeholders *(Table 54)* include organizations encouraged to perform one or more of the following functions: acquire funding, implement education programs, organize or participate in data collection, provide regulatory or technical guidance, issue permits, protect and restore land, oversee or implement restoration projects, and monitor long-term success of watershed improvement projects. A description of each stakeholder/partner is included in Appendix M. Plan implementation will ultimately depend on developing an ongoing watershed council for plan implementation.

Stakeholders: *Individuals, organizations, or enterprises that have an interest or a share in a project. (see also Watershed Stakeholders).*

Watershed partner(s): *Watershed stakeholders who take an active role in the watershed management planning process and implementing the watershed plan.*

Table 54. Bull Creek/Bull's Brook Watershed Stakeholders/Partners

Watershed Partner	Abbreviation
Bull Creek/Bull's Brook Planning Committee	BCPC
Corporate Landowners	Corp
Corporation for OpenLands	CorLands
Farm Bureau	FB
Federal Emergency Management Agency	FEMA
Golf Courses	Golf
Homeowner Associations	HOA
Illinois Department of Natural Resources	IDNR
Illinois Department of Natural Resources—Office of Water Resources	IDNR-OWR
Illinois Department of Transportation	IDOT
Illinois Emergency Management Agency	IEMA
Illinois Environmental Protection Agency	IEPA
Lake County Audubon Society	LCAS
LC Board	CB
LC Planning, Building & Development Department	PB&D
LC Department of Transportation	LCDOT
LC Health Department	LCHD
LC Health Department Lakes Management Unit	LMU
LC Health Department Individual Sewage Disposal Program	ISD
LC Public Works Department	PWD
LC Forest Preserve District	LCFPD
LC Soil & Water Conservation District	SWCD
LC Stormwater Management Commission	LCSMC
Liberty Prairie Conservancy	LPC
Municipalities	Munic
Chicago Metropolitan Agency for Planning (formerly NIPC)	CMAP
OpenLands Project	OP
Park Districts	PD
Residents or Owner	Residents/ Owner
Townships	TWP
Upper Des Plaines River Ecosystem Partnership	UDPREP
US Army Corps of Engineers	USACE
US Fish & Wildlife Service	USFWS
USDA Natural Resources Conservation Service	NRCS

7.2 Implementation Schedule

The development of a ***Best Management Practice (BMP)*** implementation schedule is important in the watershed planning process because it provides a timeline for when each BMP should be implemented in relation to others. Higher priority or less expensive BMPs are often scheduled for implementation before expensive or highly technical projects. A schedule also helps organize project implementation evenly over a given time period, allowing reasonable time availability for developing funding sources and opportunities.

For this plan, each site specific BMP implementation recommendation located in the Site Specific Action Plan tables *(see Section 8.2)* contains a column with a recommended implementation schedule based on short term (1-5 years), medium term (5-10 years) and long term (10+ years) objectives and generally relates to the implementation priority (i.e. high priority = 1-5 years, medium priority = 5-10 years, etc.). However, some projects that are high priority could be recommended for long term implementation based on selected practices, available funds, technical assistance needs, and time frame. Although a schedule is recommended in the Action Plan, circumstances related to project need and funding availability may dictate a different timeframe for a project. For example, if a parking lot or road needs to be reconstructed, it would be an ideal time to include biofilters or vegetated swales as a BMP.

Best Management Practice (BMP):
BMPs are non-structural practices such as site planning and design aimed to reduce stormwater runoff and avoid adverse development impacts—or structural practices that are designed to store or treat stormwater runoff to mitigate flood damage and reduce pollution. Some BMPs used in urban areas may include stormwater detention ponds, restored wetlands, vegetative filter strips, porous pavement, silt fences and biotechnical streambank stabilization.

7.3 Funding Sources

One of the best ways to secure funds for restoration projects is for watershed stakeholders to establish a sustainable "watershed council" that will meet at least quarterly to discuss watershed funding and progress toward implementing BMPs. The council should also discuss the results of monitoring, assess each milestone "report card" *(see Section 9.0: Plan Implementation)* using grade classifications, and review/update the watershed management plan accordingly.

Opportunities to secure funds for restoration projects in the Bull Creek/Bull's Brook watershed are widespread due to the scope of BMPs and diversity of actions available to meet the project goals and objectives. Public and private organizations that administer various conservation and environmental programs are often eager to form partnerships and leverage funds for land preservation, restoration, and environmental education. In this way, funds invested by partners in the Bull Creek/Bull's Brook watershed can be doubled or tripled, although actual dollar amounts are difficult to measure. A list of potential funding programs and opportunities is included in Appendix N. The list was developed from Applied Ecological Services, Inc. (AES) involvement in recent watershed and biodiversity studies (Conservation Fund et al., 2001; O'Leary et al., 2001; Applied Ecological Services, Inc., 2003a & 2003b). Additional information on federal monies available for watershed projects can be found on the EPA's Office of Water website: www.epa.gov/owow/watershed/funding.html.

Funds generally fall into two relatively distinct categories (Conservation Fund et al., 2001). The first includes existing grant programs, funded by a public agency or by other sources. These funds are granted following an application process. The Division of Wildlife Resources Special Funds program is an example: an applicant will submit a grant application to the program, and, if the proposed project meets the required criteria and if the funds appropriated have not been exhausted, a grant will be awarded.

A challenge with developing funds from several state and federal grant programs is the lag time between application and award of the grant. A granting system similar to that being used in the North Branch Chicago River Watershed where a "pot" of funding is applied for and allocated to the watershed over a 2-year period to implement projects recommended by the watershed plan should be developed for the Bull Creek/Brook watershed. Projects are proposed, reviewed and recommended to IEPA by a local watershed group several times a year. This process takes a matter of a few months rather than the typical year for projects submitted through the regular annual Section 319 grant program.

The second category, one that can provide greater leverage, might be called "money to be found." The key to this money is to recognize that any given project may have multiple benefits. A specific project to preserve and restore wetlands in the Bull Creek/Bull's Brook watershed may be recognized by a partner organization as an opportunity to provide benefits such as water quality improvement or threatened and endangered species protection in addition to flood prevention. It is important to note and explore all of the potential project benefits from the perspective of potential partners and to then engage those partners. Partners may wish to become involved because they believe the project will achieve their objectives, even if they have little interest in the specific objectives of the watershed plan.

It is not uncommon for an exciting and innovative project to attract funds that can be allocated at the discretion of project partners. When representatives of interested organizations gather to talk about a proposed project, they are often willing to commit discretionary funds simply because the proposed project is attractive, is a priority for the agency or organization, is a networking opportunity, or will help the organization achieve its mission. In this way, a new partnership is assembled.

LEVERAGING AND PARTNERSHIPS

It is critically important to recognize that no one program has been identified that will simply match the overall investment of the Bull Creek/Bull's Brook watershed partners in implementing the watershed plan. Rather, partnerships are most likely to be developed in the context of individual BMPs and specific land preservation, restoration, or education projects that are recommended in the Plan. Partners attracted to one project or land acquisition may not have an interest in another located elsewhere for jurisdictional, programmatic, or fiscal reasons.

Almost any land or water conservation project ultimately requires the support of those who live nearby if it is to be successful over the long run. Local neighborhood associations, homeowner associations, and similar groups interested in protecting water resources, open space, preventing sprawl or protecting wildlife habitat and scenic vistas, make the best partners for specific projects. Those organizations ought to be contacted in the context of specific individual projects.

It is equally important to note that the development of partnerships that will leverage funding or goodwill can be, and typically is, a time-consuming process. In many cases, it takes more time and effort to develop partnerships that will leverage support for a project than it does to negotiate with the landowners for use or acquisition of the property. Each protection or restoration project will be different; each will raise different ecological, political and financial issues, and each will in all likelihood attract different partners. It is also likely that the process will not be fully replicable. That is, each jurisdiction or partner will have a different process and different requirements.

In short, a key task in leveraging additional funds is to assign responsibility to specific staff for developing relationships with individual agencies and organizations, recognizing that the funding opportunities might not be readily apparent. With some exceptions, it will not be adequate simply to write a proposal or submit an application; more often, funding will follow a concerted effort to seek out and engage specific partners for specific projects, fitting those projects to the interests of the agencies and organizations. Successful partnerships are almost always the result of one or two enthusiastic individuals who believe that engagement in this process is in the interests of their organization. There is an old adage in private fundraising: people give to other people, not to causes. The same thing is true with partnerships using public funds.

Partnerships are also possible, and probably necessary, to leverage assets other than money. By entering into partnerships with some agencies, organizations, or even neighborhood groups, a stakeholder will leverage valuable goodwill, and relationships that have the potential to lead to funds and other support, including political support, from secondary sources (Conservation Fund et al., 2001).

The programs described in Appendix N do not include all possible partners and/or available funds. Rather, they are programs deemed most promising for restoration projects that will likely result from the watershed plan. It is highly likely that as the watershed plan is developed, publicized, and implemented, many additional partners and programs will be identified. Many of the partners are expected to perform regulatory roles in implementation of the watershed plan, and as such, are excellent starting points for securing funds.

CHAPTER 8.0

Prioritized Action Plan

This section presents a Prioritized Action Plan developed to provide stakeholders with action items for watershed-wide improvements and direct stakeholders towards specific sites in the watershed where implementation of best management practices and programs would result in watershed benefits.

The Prioritized Action Plan is divided into a Programmatic Action Plan and a Site Specific Action Plan. The Programmatic Action Plan recommends program and project actions that are applicable throughout the watershed. Actions are based on goals and objectives developed by the Bull Creek Planning Committee (BCPC) *(see Section 2.0)*. The Site Specific Action Plan identifies specific sites where flooding, water quality, or natural resource/green infrastructure opportunities or issues have been identified in the Watershed Characteristics and Problems Assessment sections of this report. The list serves only as a starting point for watershed improvement projects and should be adjusted as projects are completed and additional sites are targeted. Lead agencies are encouraged to organize partnerships with key stakeholders and develop various funding arrangements to help delegate and implement the recommended actions. Key stakeholders and funding opportunities are discussed in Section 7.0: Plan Implementation.

A priority ranking was assigned to both programmatic and site-specific action recommendations. Assigning priority to watershed improvement projects is largely dependent upon need and feasibility, which is determined by size of the project, location, land use, ownership, funding, scope of work, and other factors such as level of interest and support by potential partners.

8.1 Programmatic Action Plan

The Programmatic Action Plan *(Tables 55–63)* includes recommended watershed improvement actions that are applicable throughout the watershed to meet specific goals and objectives developed, refined, and categorized by the BCPC. The nine goals that were developed by the BCPC include:

GOAL A: **Protect and restore the natural components of the watershed's natural drainage system, including:**

- bodies of water such as wetlands, lakes, ponds and streams;
- highly erodible and hydric soils; and
- natural prairies, wetland, savanna and woodland landscapes.

These components also benefit native plant and animal communities and provide important habitats for threatened and endangered species.

GOAL B: **Improve overall water quality in the lakes, ponds, streams and wetlands of the watershed.**

GOAL C: **Reduce flood damage in the Bull Creek/Brook Watershed and prevent flooding from worsening in the watershed and along the Des Plaines River downstream.**

GOAL D: **Protect, restore, and enhance stream health and stream channel function and conveyance.**

GOAL E: **Guide new development and redevelopment to benefit rather than impair watershed goals to reduce flood damage, improve water quality and protect natural resources.**

GOAL F: **Implement a "Green Infrastructure" plan to guide preservation, restoration, and management activities in the watershed.**

GOAL G: **Provide watershed stakeholders with the knowledge, skills and motivation needed to take action on implementing the watershed plan.**

GOAL H: **Identify and capitalize on potential funding sources for watershed improvement projects.**

GOAL I: **Improve coordination between**

- municipalities, townships, special districts (i.e. parks, schools, forest preserves, etc.),
- county agencies and other local government units,
- federal, state, regional agencies, and
- private business, non-profits, citizen stakeholders, and the general public in watershed plan implementation, monitoring, enhancement, and protection.

The Programmatic Action Plan *(Tables 55–63)* lists actions to meet each of the above goals and associated objectives *(see Section 2.0)*, and in addition, provides information needed to facilitate implementation of specific actions. This information includes the priority, cost (where applicable), designated lead public or private landowner, agency, or other stakeholder with the greatest potential for implementation, and the designated support parties that would be responsible for issuing appropriate permits or providing coordination, technical, regulatory, or funding assistance.

Cost estimates are provided only for those watershed improvement actions that involve remedial projects, such as planting native vegetation, retrofitting detention basins, etc. Cost estimates are not provided for preventative measures such as education and regulatory action. Cost estimates should not be considered actual costs, but used as a way to compare the relative costs of proposed treatments. Furthermore, BMP implementation projects vary drastically by specific technique employed, size of area, access to location, property values, and other factors.

Priority was assigned to each action item and classified as H (high), M (medium), or L (low) based on several factors including urgency, ownership types, cost, technical and financial needs, and potential shortcomings. High priority recommendations deserve immediate attention and are generally expected to be addressed in the short term whereas medium and low priority recommendations are not as urgent and should be addressed in the long term. Medium and low priority recommendations should not be written off as less important projects. In many cases, funding availability, technical assistance, or other shortcomings may be responsible for a project being designated as medium or low priority.

Goal A

Protect and restore the natural resource components of the watershed's natural drainage system, including:

- Bodies of water, such as wetlands, lakes, ponds and streams;
- Highly erodible and hydric soils; and
- Natural prairie, wetland, savanna and woodland landscapes.

These components also benefit native plant and animal communities and provide important habitats for threatened and endangered species.

Objectives

A.1 Channel new development into the least sensitive areas—those parcels identified as low and medium priority for open space protection.

A.2 Identify and protect important natural communities.

A.3 Restore degraded natural communities, both terrestrial and aquatic (lakes, wetlands and streams), to ecological health with natural practices and native plants to improve habitat.

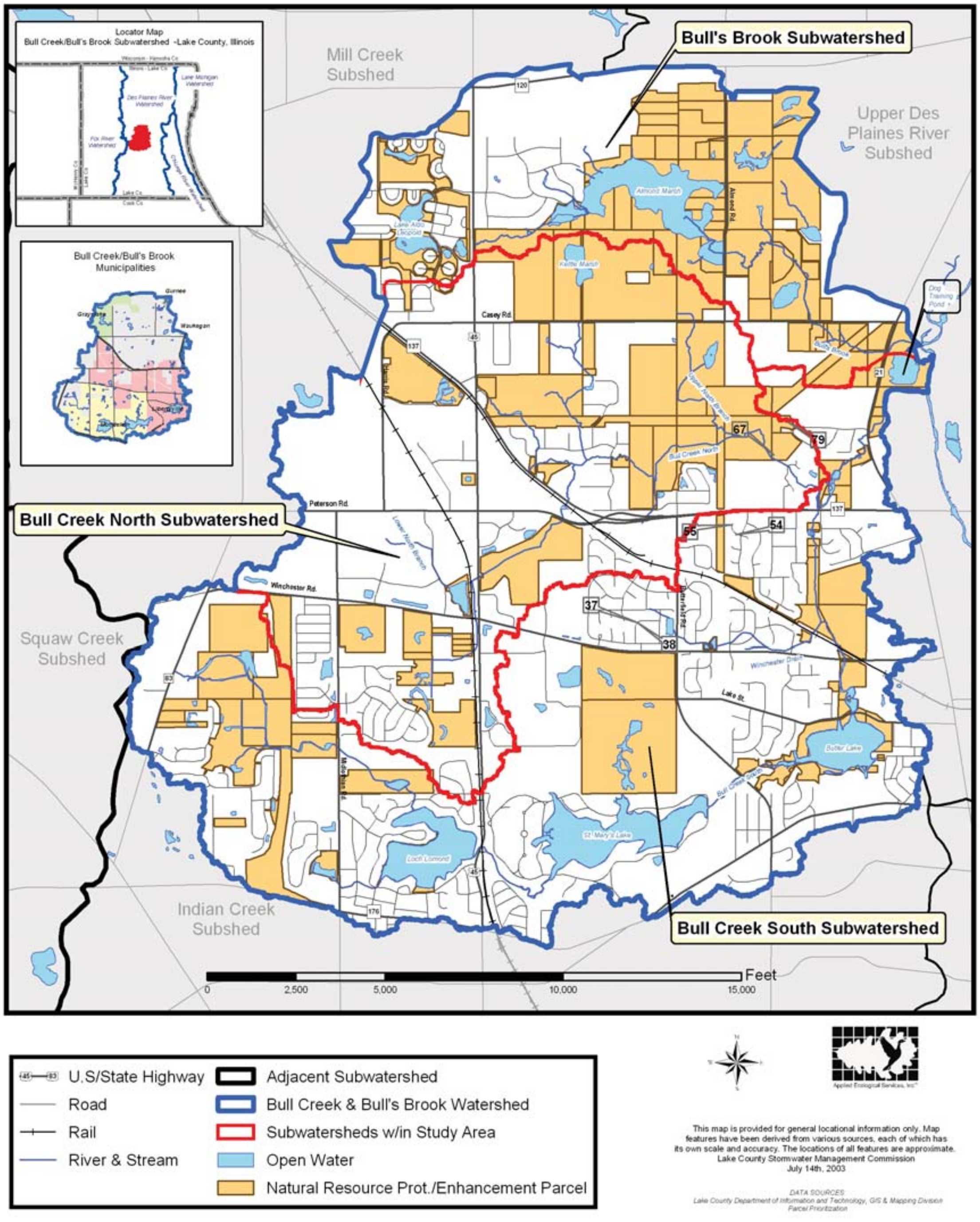
A.4 Provide adequate native plant buffers between developed areas and natural communities.

Table 55. Programmatic Actions for Goal A

Action	Primary Objective	Secondary Goal/ Objective	Priority	Cost	Lead Agency	Supporting Agency
1. Include all high priority open space parcels identified in the watershed plan in all community comprehensive land use and green infrastructure plans and maps. See Figure 77 for a map of high priority parcels recommended for natural resource protection and enhancement.	A.1, E.3	E.3, E.6	H	n/a	Munic, TWP, PB&D	PD
2. Identify and flag all high priority open space parcels identified in the watershed plan on all appropriate development review maps and databases. See Figure 77 for a map of high priority parcels recommended for natural resource protection and enhancement.	A.1	E.3, E.6	H	n/a	Munic, PB&D	Health Department
3. Develop resource conservation and management plans for ADID wetlands and Threatened & Endangered species sites.	A.2	E.3	M	$5,000 per site	LCFPD: IDNR: TWP: USACE	USFWS; LPC LCSMC
4. Identify and provide incentives for private/public protection strategies using conservation easements, annexation agreements, and other techniques.	A.2	n/a	H	n/a	BCPC	Munic; IDNR; LCSMC; USFWS
5. Identify high priority parcels for restoration of native vegetation if appropriate. See Figure 77 for a map of high priority parcels recommended for natural resource protection and enhancement.	A.2,A.3	D.5	M	n/a	SWCD;BCPC	IDNR; LPC NRCS
6. Private property owners assess whether native vegetation can be planted on their property.	A.2,A.3	D.5	M	$0	Owner	NRCS; IDNR; LCSMC
7. Restore identified potential wetland restoration sites.	A.3	B.1, B.4, B.5, B.6, C.2, D.5	M	$20K per acre	BCPC; LCSMC	USACE; USFWS; IDNR; CorLands; LCFPD; TWP
8. Review and evaluate existing wetland buffer requirements.	A.2,A.4	B.2,B.6	L	n/a	LCSMC; USACE	CB; Munic
9. Identify/compile and adopt habitat buffer guidelines between developments and high quality terrestrial or aquatic natural communities.	A.4	D.5	M	n/a	LCFPD; USFWS; IDNR	USACE; Munic County UDPREP; PD
10. Prevent the spread of non-native species and control existing populations of invasive plants.	A.3	n/a	H	n/a	BCPC; Owner	IDNR; NRCS; LCFPD; TWP; PD

lf = linear feet; **ea** = each; **var** = varies; **sqyd** = square yard; **n/a** = not applicable

Figure 77: High Priority Open and Partially Open Parcels Recommended for Natural Resource Protection and Enhancement



Goal B

Improve overall water quality in the lakes, ponds, streams and wetlands.

Objectives

B.1 Lakes and streams shall at minimum attain state water quality standards to "fully support designated uses".

B.2 Reduce sediment accumulation in surface waters by reducing streambank, shoreline and construction–related erosion throughout the watershed.

B.3 Reduce point source pollutant loadings.

B.4 Implement stormwater management practices that minimize runoff volumes, velocities and pollutants to the creek.

B.5 Promote infiltration of rainwater on-site using best stormwater management and landscaping practices such as rain gardens, bioretention and open swales to minimize runoff volumes, velocities and pollutants.

B.6 Improve agricultural practices to reduce, sediment, chemical and nutrient transport to Bull Creek/Brook.

B.7 Retrofit existing stormwater management structures such as detention ponds to provide or enhance water quality improvement.

B.8 Tie National Pollutant Discharge Elimination System (NPDESII) minimum control measures into watershed plan objectives.

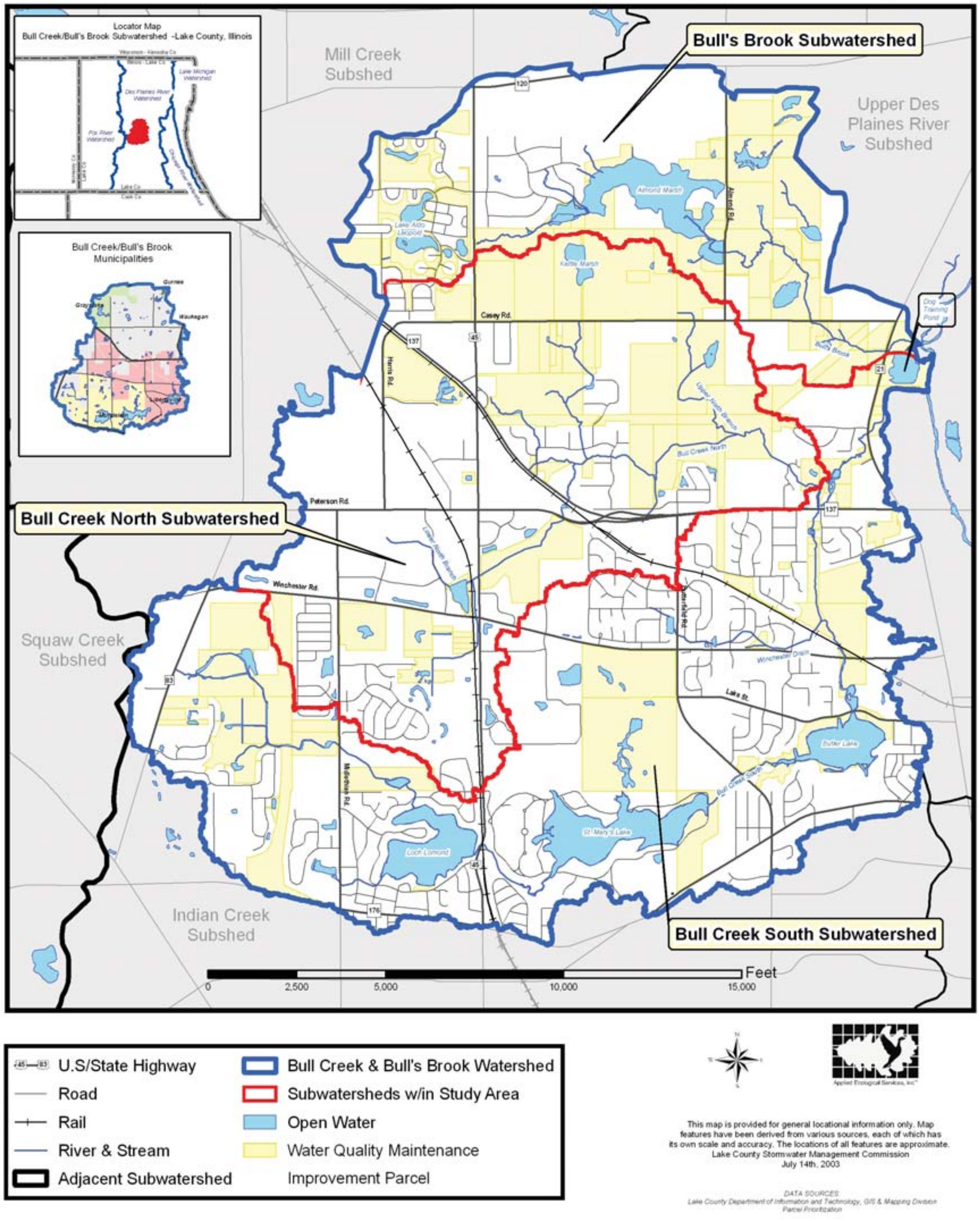
B.9 Examine the impacts of road salt usage on water quality and aquatic life and develop recommendations for education related to road salt alternatives and application best management practices (BMPs).

Table 56. Programmatic Actions for Goal B

Action	Primary Objective	Secondary Goal/ Objective	Priority	Cost	Lead Agency	Supporting Agency
1. Create detailed nutrient budgets for Loch Lomond, St. Mary's, and Butler Lakes.	R.1	n/a	M	n/a	IEPA; LMU,	IDNR
2. Conduct Intensive Basin Surveys on five year rotational basis for Bull's Brook.	B.1	n/a	M	n/a	IEPA; IDNR	LCSMC; LMU
3. Apply nutrient inactivation techniques to lakes.	B.1	n/a	M	n/a	IEPA; LCHD	IDNR
4. Employ charcoal packets or other appropriate technique to track organics from agricultural fields.	B.6	n/a	L	n/a	NRCS; owner	SWCD; IEPA
5. Implement a watershed wide water quality monitoring program to assess whether state water quality standards are being met to fully support designated uses.	B.1, B.6	n/a	M	n/a	IEPA; LCHD	IDNR; LCSMC BCPC; High schools
6. Continue Lake County Health Department and IEPA's Volunteer Lake Monitoring programs	B.1	n/a	M	n/a	LMU; IEPA	High schools
7. Identify, repair, or disconnect all illegal discharges (illicit storm drain and/or sump pump hookups) and improve local regulatory oversight.	B.1, B.8	n/a	H	$500 each	Munic (Ms-4's); TWP;Owner; County	LCSMC
8. Work with IEPA to evaluate wastewater treatment systems for overall water quality impacts, upgrade plants to accommodate phosphorus control, and develop more stringent NPDES permit limits for problem discharges if any are identified.	B.1, B.8	n/a	M	n/a	BCPC	Munic; St. Mary's LMU; IEPA
9 .Review and refine requirements for soil erosion enforcement provisions in applicable ordinances and NPDES requirements.	B.1,B.2, B.8	n/a	L	n/a	LCSMC; SWCD; USACE	CB; Munic
10. Develop recommendations for education related to road salt alternatives and application best management practices (BMPs).	B.1, B.9	n/a	H	n/a	LMU;IEPA Munic (MS-4"s); TWP	LCSMC; BCPC IDNR
11. Develop watershed-specific buffer recommendations for streams and lakes. Also consider adopting a formula for calculating buffer widths based on wetland quality, adjacent land uses, topography, and habitat quality,	B.1, B.2 B.4	D.5	L	n/a	LCSMC	CB; Munic
12. Encourage limitations in impervious surface coverage at the subwatershed scale (i.e. less than than 25%).	B.1, B.4	C.5,C.6,E.2	H	n/a	Munic;PB&D BCPC	LCSMC
13. Retrofit existing dry-bottom detention basins to wet bottom basins to improve water quality.	B.1, B.4, B.5, B.7	C.1,C.2	H	$2,500 each	Owner; Munic	LCSMC
14. Identify opportunities for wetland protection and enhancement on high priority parcels identified to maintain or improve water quality as part of the green infrastructure system. See Figure 78 for a map of high priority parcels recommended for maintaining or improving water quality.	B.1, B.3 B.4, B.5 B.6	C.1,C.2,C.3	H	var.	Munic;Twp	LCSMC PD
15. Review and update landscaping stormwater requirements for water quality BMPs in ordinances to insure that current ordinance codes do not preclude use of native vegetation in water quality BMPs.	B.1-5,B.7	n/a	L	n/a	Munic;LCSMC PB&D	CB;CMAP
16. Increase the use of agricultural BMPs by developing Resource Management Service plans for agricultural landowners. BMPs can include no-till or hay production for highly erodible fields, conservation tillage, stream buffers, grassed waterways, reduced chemical input, etc.	B.1,B.6	n/a	M	n/a	NRCS;owner	SWCD TWP
17. Conduct further investigation of high priority Environmental Data Resource (EDR) sites by monitoring for the chemical constituents in these releases to resolve questions of hazard waste contamination.	B.3	n/a	M	n/a	Owner	IEPA; LMU
18. Individual communities consider adopting buffer requirements especially between developments and high quality terrestrial or aquatic natural resources.	B.1,B.2, B.4	D.5	L	n/a	Munic; TWP	CB;LCPB&D; LCSMC

lf = linear feet; **ea** = each; **var** = varies; **sqyd** = square yard; **n/a** = not applicable

Figure 78: High Priority Open and Partially Open Parcels Recommended for Maintaining and Improving Water Quality



Goal C

Reduce existing flood damage in the Bull Creek/Brook Watershed and prevent flooding from worsening in the watershed and along the Des Plaines River downstream.

Objectives

C.1 Protect and maximize use of the natural drainage system and establish regular maintenance programs for retention and conveyance.

C.2 Identify and restore wetlands where feasible to provide additional storage in the watershed.

C.3 Identify and provide regional scale multi-objective floodwater storage sites for new development that may be funded by fees assessed to permit applicants in lieu of constructing on-site stormwater storage ("fee-in-lieu").

C.4 Identify the properties that flood and the source of flooding for flood damage sites that repetitively flood and mitigate existing flood damage.

C.5 Reduce the rate and volume of stormwater runoff from areas that are already developed.

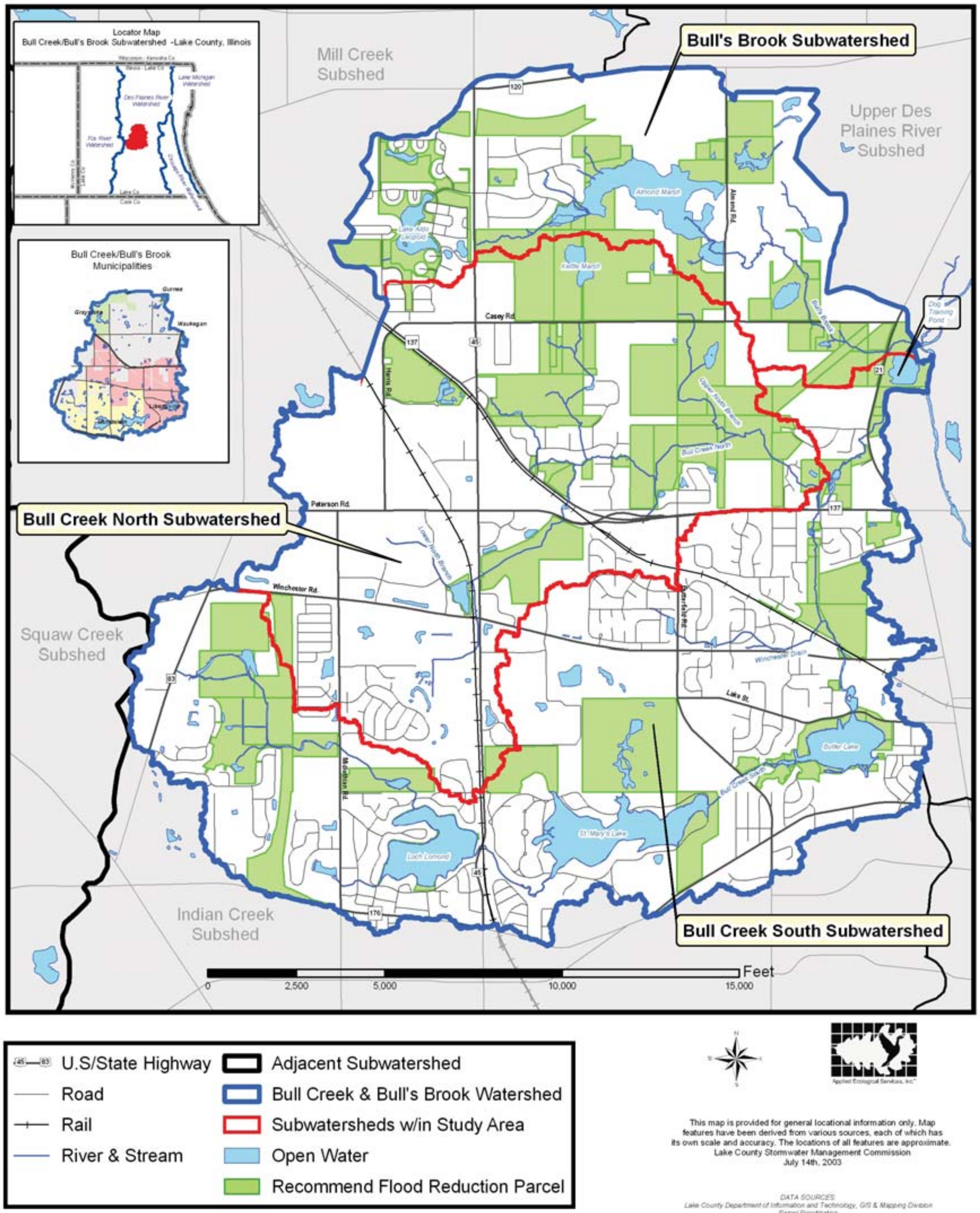
C.6 Reduce the rates and volume of runoff from new development—maintain pre-development hydrology.

Table 57. Programmatic Actions for Goal C

Action	Primary Objective	Secondary Goal/ Objective	Priority	Cost	Lead Agency	Supporting Agency
Existing Flood Damage Reduction						
1. Prevent changes to drainage characteristics of existing storage areas.	C.1	n/a	H	var	Munic; TWP; Owner; PB&D	LCSMC
2. Restore or create multiobjective floodplain storage.	C.1	B.1, B.4, B.5	H	var	LCSMC; Owner TWP	IDNR-OWR; USACE
3. Retrofit existing dry-bottom detention basins to wet bottom and install post 1992 release rate outlets where possible on pre 1992 basins to capture additional stormwater.	C.1-3	B.1	H	$2,500 each	Munic; TWP Owner;HOA	LCSMC; USACE; SWCD; PB&D
4. Require in-watershed mitigation for any wetlands lost within the same watershed or subwatershed.	C.2,C.6	E.2	M	n/a	LCSMC; USACE	Munic; PB&D
5. Modify streets, parking lots, yards (I.E. rain gardens, swales etc.), parks, athletic fields, golf courses and other open space for storm storage and infiltration.	C.3,C.5	n/a	M	var	Munic; Owner	LCSMC;PD, TWP
6. Identify open areas in undetained developed parcels for creating additional storage.	C.3,C.5	n/a	M	n/a	LCSMC	Munic; PD; TWP
7. Reduce existing flood damage potential by floodproofing structures prone to flooding in the 100-year floodplain.	C.4	n/a	M	n/a	Owner	FEMA; IEMA LCSMC
8. Create rain gardens to capture runoff from impervious surfaces.	C.5,C.6	B	M	$1,500 each	Residents/ Owners; BCPC	LCDOT; HOA Munic; LCSMC
9. Evaluate potential for additional storage in large online lakes and wetlands.	C.5,C.6	n/a	M	var	LCSMC	TWP; Munic LMU
10. Restore historical floodplain function by removing spoil piles along channelized stream reaches.	C.6,C.4	D.3, D.4	M	var	Owner	LCSMC; Munic; SWCD; TWP
Flood Prevention						
11. Develop and adopt a maintenance schedule for all drainageways.	C.1	D.4, D.2	H	var	Munic; Owner TWP; LCSMC	IDNR; LCSMC; LCFPD; BCPC; HOA
12. Protect all high and medium priority undeveloped floodplain parcels as open space through drainage or conservation easements. See Figure 79 for a map of high priority parcels recommended for preventing or reducing flood damage.	C.1	A.2, B.1, D.5	H	var	Munic;TWP Owner	LCSMC, FEMA, IEMA
13. Identify opportunities for wetland protection on high priority parcels identified to prevent or reduce flooding as part of the green infrastructure system. See Figure 79 for a map of high priority parcels recommended for preventing or reducing flood damage.	C.1-3	B.1	H	n/a	LCSMC; LCFPD; Munic	PD; PB&D; FEMA; TWP
14. Prepare floodplain mapping based on future landuse conditions.	C.6, C.4	n/a	M	$5–8K	LCSMC	CMAP
15. Recommend communities adopt and implement "no adverse impact" floodplain management standards.	C.5, C.6	n/a	H	var	Munic; TWP; PB&D	LCSMC; FEMA; Owner
16. Assess each development site for proper implementation of stormwater management practices that best minimize runoff volumes and velocities.	C.5, C.6	B.1, B.4	H	n/a	LCSMC; Munic PB&D	CB

lf = linear feet; **ea** = each; **var** = varies; **sqyd** = square yard; **n/a** = not applicable

Figure 79: High Priority Open and Partially Open Parcels Recommended for Reducing or Preventing Flood Damage



Goal D

Protect, restore, and enhance stream health and channel function and conveyance.

Objectives

D.1 Develop a planning, funding and implementation mechanism to provide stream maintenance on public and private property and across multiple political jurisdictions.

D.2 Remove excessive debris loads in channels following American Fisheries Society standards.

D.3 Stabilize streambanks along stream reaches identified as having moderate to high streambank erosion.

D.4 Increase in-stream aquatic habitat.

D.5 Maintain and expand high quality native riparian buffers and restore native riparian buffers along those stream reaches identified as having a high or medium level of need for improvement in the stream inventory.

D.6 Identify locations where beaver are impacting the stream channel and specify the best practices for controlling beaver damage where control is needed.

Table 58. Programmatic Actions for Goal D

Action	Primary Objective	Secondary Goal/ Objective	Priority	Cost	Lead Agency	Supporting Agency
1. Develop routine short and long term stream maintenance guidelines and standards for public and private properties within municipalities and unincorporated Lake County.	D.1	n/a	M	n/a	LCSMC	Munic; PB&D
2. Develop and adopt stream restoration guidelines and standards related to stabilization, buffer vegetation, and other bio-engineering techniques.	D.1,D.5	A.4,B.2	M	n/a	LCSMC; SWCD	NRCS;IDNR USFWS; LCFPD;CMAP BCPC
3. Conduct a field assessment of degraded streams to develop a plan for restoring the proper profile for the stream.	D.3	n/a	H	$3,000 per site	LCSMC; Owner; Munic; TWP	USACE IDNR-OWR
4. Where possible, re-meander channelized stream reaches, including headwater reaches.	D.3-5	n/a	M	$300 per lf	LCSMC; Owner; Munic; TWP	USACE; IDNR-OWR; NRCS
5. Use grade controls in severely entrenched stream channels to reconnect to floodplain.	D.3	B.2	M	var	LCSMC; Owner; Munic; TWP	IDNR-OWR; USACE
6. Replace failing seawalls with bioengineering stabilization measures.	D.3,D.4	n/a	M	$200 per lf	Owner	LCSMC; SWCD
7. Install or restore pool/riffle complexes, habitat for fish and macroinvertebrates, and bioengineering bank stabilization practices in degraded stream reaches to improve stream habitat and increase dissolved oxygen.	D.3,D.4	A.3	H	$3,000 each	LCSMC; Owner Munic;TWP	IDNR-OWR; USFWS; PD; SWCD; USACE
8. Maximize in-stream habitat in conjunction with installation of structures (bridges, culverts, etc.) to minimize negative impacts to streams.	D.4	n/a	H	$5-10K per site	LCDOT; TWP; IDOT; Munic	NRCS; SWCD; LCSMC
9. Replace non-native plants with native plants in riparian buffers and filter strips.	D.5	A.3	H	$3,000 per acre	Owner;TWP; PD; LCFPD	Munic; USACE; LPC; HOA
10. Identify where beaver are negatively impacting stream reaches and manage appropriately.	D.6	n/a	M	n/a	Owner	TWP; Munic PB&D
11. Reduce release relates for the 100-year storm event in stormwater storage facilities to reduce stress on stream channels that are currently degraded or high risk streams.	D.3	B.4,C	M	n/a	Munic; TWP; Owner; HOA	LCSMC; USACE;; SWCD; PB&D

lf = linear feet; **ea** = each; **var** = varies; **sqyd** = square yard; **n/a** = not applicable

Goal E

Guide new development and redevelopment to benefit rather than impair watershed goals to reduce flood damage, improve water quality and protect natural resources.

Objectives

E.1 Incorporate maintenance of the pre-development hydrology in stormwater plans for new development.

E.2 Increase infiltration and absorption in order to decrease runoff from developed areas.

E.3 Identify and protect sensitive resources during future development.

E.4 Watershed jurisdictions will evaluate their regulatory requirements to determine if they are adequate to protect the watershed and will make changes where needed.

E.5 Monitor the percent of impervious cover and evaluate the impact impervious areas are having on the watershed on a regular basis to insure that additional impervious cover does not degrade Subwatershed Management Units (SMUs) to the "Non-Supporting" category.

E.6 Implement conservation design developments that cluster development to protect open space.

Table 59. Programmatic Actions for Goal E

Action	Primary Objective	Secondary Goal/ Objective	Priority	Cost	Lead Agency	Supporting Agency
1. Identify and incorporate natural drainage patterns and natural drainage depressions into new site development plans.	E.1,E.2	n/a	H	var	Owner; Munic: PB&D	LCSMC
2. Encourage at least 50% of open space to be planted with native vegetation.	E.1,E.2	F.1, A.3	H	$3,000 per acre	Owner; Munic; PB&D	SWCD; LCSMC
3. Use Stormwater Treatment Train concepts wherever possible to infiltrate and clean stormwater runoff.	E.1,E.2	B.5	H	n/a	Munic; PB&D Owner	LCSMC
4. Require new and re-developments to implement stormwater management practices that minimize runoff, such as reduction in impervious surface, preservation of 50% open space, etc.	E.1,E.2 E.4,E.6	A, C.5,C.6, F.1	H	n/a	Munic; PB&D	LCSMC
5. Review options to reduce runoff from car habitat, possibly including parking ratios, multi-level parking, permeable surface parking, street widths, and infiltration BMPs.	E.1,E.2 E.4	C.5,C.6	M	var	Munic: Owner, PB&D	LCSMC; TWP; CB
6. Work with developers to restore streams as part of the development process, such as streambank stabilization, re-meandering, pool and riffle structures, etc.	E.1,E.3	D.2, D.3, D.4, D.5	H	$300 per lf	Munic; PB&D	INDR; SWCD LCSMC
7. Adopt standards for conservation development to be applied on high priority open space.	E.2, E.4 E.6	C.6, F	H	n/a	PB&D; Munic	CMAP; LCSMC
8 . Identify opportunities for agencies to provide economic incentives that encourage the preservation of natural resources and the use of BMPs in new development.	E.3, E.4	n/a	M	n/a	BCPC	LCSMC; PB&D; Munic
9. Develop standardized 5-year and long term maintenance and monitoring plan for natural areas within new developments, and require developers to identify a funding and implementation mechanism.	E.3, E.4	A.2	H	$2,500 Lump Sum	Munic; PB&D	IDNR; SWCD; LCSMC
10. Encourage municipalities and the County to require developers to maximize open space through conservation easements and dedications.	E.3	A.2	L	var	BCPC	LPC; Munic; County; Owner
11. Conduct Natural Resource Inventories on all sites prior to development to identify any sensitive/ high quality natural resources.	E.3	A.2	H	$5,000 per site	SWCD; Owner	Munic; PB&D; LCSMC
12. Establish conservation development standards for high priority open space parcels and distribute to municipalities.	E.3	A.2	M	$5,000 Lump	BCPC	USACE; LCSMC; NRCS; CMAP; IDNR
13. Identify and build at least one wetland mitigation bank within the Bull Creek/Bull's Brook watershed to mitigate for wetlands lost to development.	E.4	A.3, B.1, B.4 B.5, C.2&6	H	$8-12K per acre	LCSMC; Owner	USACE; TWP
14. Review impervious cover changes by SMU every 5 years and convey to stakeholders.	E.5	n/a	M	$3,000 per assessment	County	LCSMC; BCPC
15. Provide incentives or priority review status for developers to conserve natural resources and utilize existing water resource features as additional site stormwater BMPs. Incentives might include reduced fees for reduced impervious surface, reduced detention requirements for using permeable paving, preservation of existing natural communities that filter stormwater, or reduced landscape requirements when using native plantings.	E.1-6	A, B, C, D	H	n/a	LCSMC; PB&D; Munic	USACE; INDR
16. Consider mitigation for all wetland losses in the same Subwatershed Management Unit (SMU) as the impact occurred.	E.4	A.1, B.1, B.4, B.5 C.2&6	L	$8-12K per acre	LCSMC;	USACE; TWP
17. All certified community staff assist developers by assessing each new development site for proper BMP site selection and implementation of stormwater management practices that best minimize runoff volumes and velocities.	E.1-6	C	M	n/a	Owner; Munic; PB&D	LCSMC;

lf = linear feet; **ea** = each; **var** = varies; **sqyd** = square yard; **n/a** = not applicable

Goal F

Implement a "Green Infrastructure" plan to guide preservation, restoration, and management activities in the watershed.

Objectives

F.1 Protect greater than 50% of the watershed as pervious open land by preserving open and partial open space.

F.2 Identify areas critical for a greenway of open land in each Subwatershed Management Unit (SMU) as green infrastructure to mitigate the negative impacts of impervious cover and allow for flood damage reduction, water quality improvement, natural resource protection, and wetland restoration.

F.3 Identify and preserve open land with permeable soils, depressional storage, floodplain, wetlands, hydric soils, important natural communities, or significant cultural features within the watershed greenway.

F.4 Preserve open space that provides important trail or habitat corridor connections and provide passive recreational opportunities such as hiking, fishing, biking, riding, canoeing, and environmental interpretation/education as part of the greenway.

F.5 Preserve farmland as green infrastructure.

Table 60. Programmatic Actions for Goal F

Action	Primary Objective	Secondary Goal/ Objective	Priority	Cost	Lead Agency	Supporting Agency
1. Use recommendations from green infrastructure plan to prioritize and protect 50% of open space in watershed.	F.1	n/a	H	$5-15K per acre	Owner; TWP Munic; PB&D	PD; LCSMC
2. Investigate potential for improving all high priority parcels related to recreational opportunities. See Figure 80 for map of high priority parcels related to recreation opportunities.	F.4	n/a	H	n/a	BCPC; PD LCDOT	LCFPD; SWCD; OP; Corlands; IDNR; Munic
3. Use open space inventory and parcel prioritization to locate high and medium priority parcels for determining feasibility for greenway connections in each community. See Figure 81 for map of high and medium priority open space related to greenways (natural resources, water quality, flooding, and recreation).	F.2, F.4	A.2	H	n/a	Munic; TWP BCPC; PB&D LCFPD	IDNR
4. Work with municipalities, townships, conservation agencies/organizations, and Lake County to include high quality stream reaches in green infrastructure plan for conservation and protection.	F.2-4	A.2	H	n/a	TWP; LCFPD LPC, PD; LCSMC; BCPC	IDNR, PB&D; Munic
5. Form a multi-jurisdictional partnership to develop funding packages and grant proposals to implement greenway protection/connection strategies	F.1–5	n/a	M	var	BCPC	LCFPD; PD; SWCD; OP; Corlands; IDNR; PB&D
6. Identify and designate a lead person from each municipality, township, park district, county, forest preserve district, and conservation organization to serve as the watershed green infrastructure plan "coordinator".	F.4	n/a	H	n/a	BCPC	Munic; PD LCFPD; PB&D; TWP LPC
7. Convene a meeting of watershed municipalities, park district, forest preserve, and other agencies to identify opportunities and strategies to protect and connect greenway corridors.	F.4	n/a	H	n/a	Munic; TWP BCPC; PB&D	LCSMC; LPR; LCFPD; PD
8. Identify green infrastructure needs based on projected 2030 population in the watershed and assess land protection needs to meet the desired level of service for 2030.	F.4	n/a	M	n/a	BCPC; PD; LCFPD	Munic; PB&D; IDOT LCDOT; CMAP
9. Identify open space adjacent to schools for potential education and recreation opportunities.	F.4	n/a	L	n/a	Schools; PD BCPC	TWP
10. Identify high priority farmland parcels in the watershed and recommend for farmland protection program to County agencies.	F5	n/a	H	$5–15K per acre	PB&D; TWP LPC	IDNR; NRCS CP; FB

lf = linear feet; ea = each; var = varies; sqyd = square yard; n/a = not applicable

Figure 80: High Priority Open and Partially Open Parcels Recommended for Recreation Connections

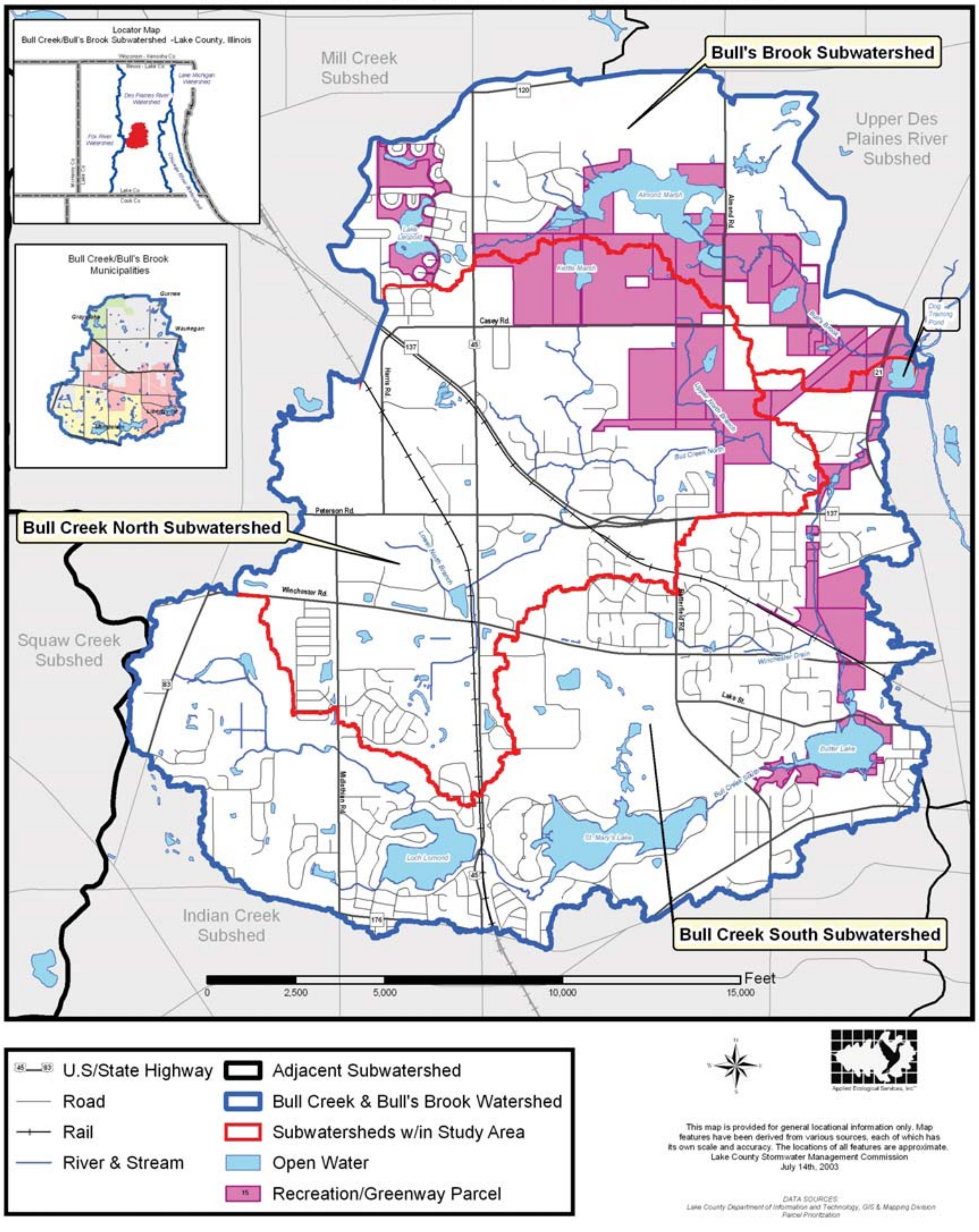
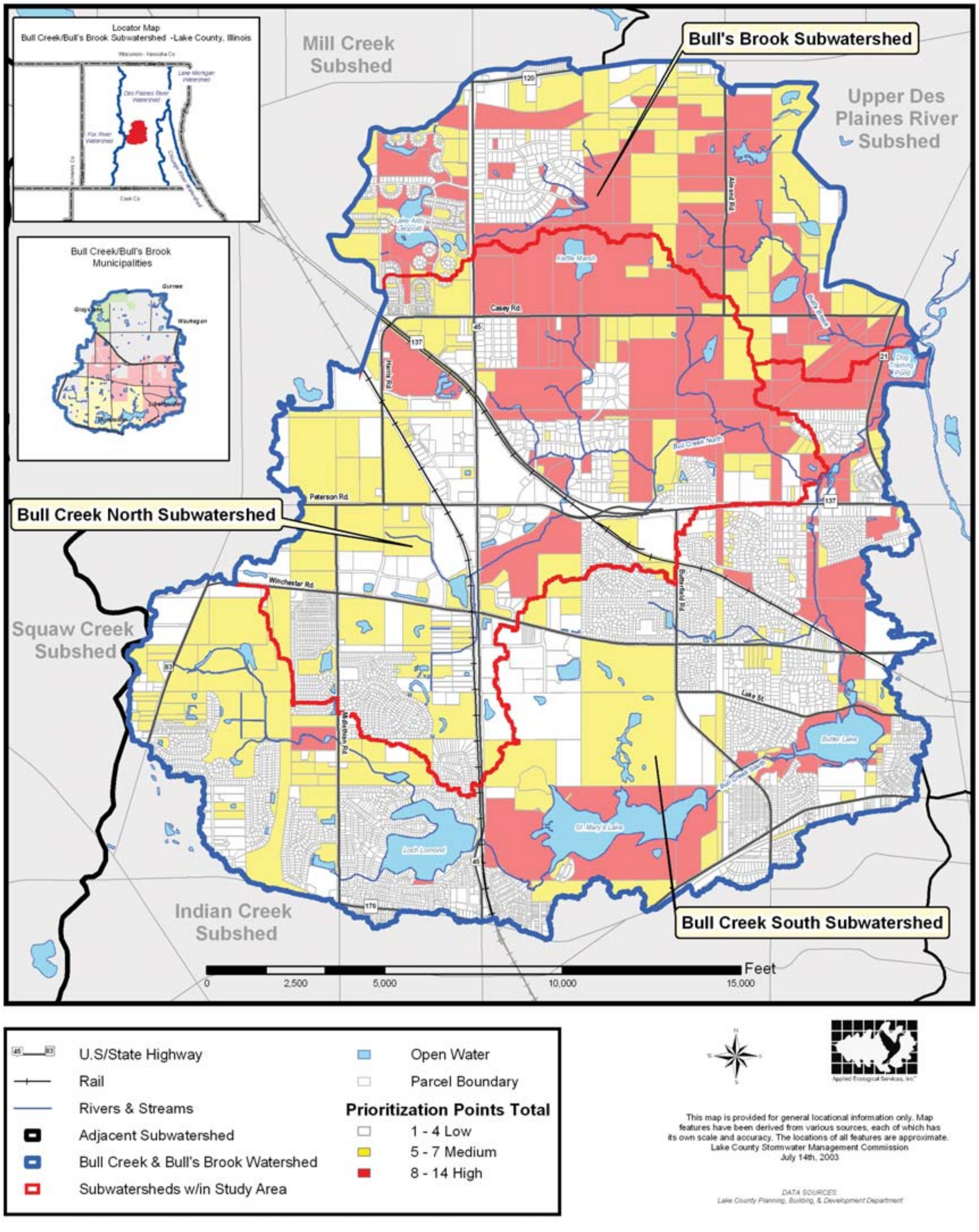


Figure 81: Green Infrastructure Network Consisting of High and Medium Open and Partially Open Parcels



Provide watershed stakeholders with the knowledge, skills and motivation needed to take action on implementing the watershed plan.

Goal G

Table 61. Programmatic Actions for Goal G

Action	Primary Objective	Secondary Goal/ Objective	Priority	Cost	Lead Agency	Supporting Agency
1. Educate municipalities in "no adverse impact" for new developments in floodplain.	E.1-6	C.1,5,6	M	n/a	LCSMC	IDNR-OWR; PB&D; IEMA; FEMA
2. Educate homeowners in flood prone areas on how to floodproof structures to prevent flood damage.	C.4	n/a	M	n/a	LCSMC; Munic PB&D	IDNR; PB&D; IEMA FEMA; TWP
3. Educate homeowners and municipalities concerning water quality problems associated with sump pump and illicit storm drain hookups.	B.1, B.3 H.2	n/a	M	n/a	LCSMC; LMU PB&D	IEPA; Munic; TWP
4. Educate riparian landowners and local governments on how to use environmentally-friendly lawn maintenance practices related to fertilizers and pesticide use, protection/restoration of buffers, and persistent removal of debris jams.	B.1, D.5 C.1, H.1	A	H	n/a	BCPC; LMU	LCSMC; IEPA; PB&D; SWCD
5. Establish a neighborhood certification program for wildlife habitat and educate private residents about the beneficial uses of native plants and whether they can be planted on their property.	A.3, A.4	n/a	M	n/a	BCPC	Owner, IDNR NRCS; HOA; LPC; SWCD
6. Provide education to farmland owners on how to develop and implement resource management plans designed to improve agricultural practices to reduce erosion and limit fertilizer/pesticide use.	B.1, B.6	n/a	H	n/a	NRCS; FB, Owner	SWCD; TWP; LPC
7. Educate/coordinate high school environmental program teachers, riparian landowners, and lake associations about implementing water quality monitoring programs for lakes and streams to assess state water quality standards.	B.1	n/a	M	n/a	BCPC; LMU; IEPA	LCSMC, Owner, high schools; HOA
8. Educate residents about how to prevent the spread of non-native species and control existing populations of invasive plants.	A.3	n/a	H	n/a	BCPC	IDNR; SWCD; HOA; LCFPD
9. Educate developers, municipalities, and residents about the negative impact that untreated or unmitigated impervious surface coverage has on water resources.	E.5	B.4, C.5, C.6	H	n/a	BCPC	LCSMC; LMU
10. Educate municipalities, businesses and homeowner associations on how to maintain detention ponds for water quality and flood reduction.	B.1, 4,5,7; C.1	C.2, C.3	H	n/a	BCPC; LCSMC	Residents; HOA; LMU
11. Educate riparian and lake property owners on how to prevent bank erosion by removing failing seawalls and installing bioengineering techniques.	D.3, A.3	A.4	H	n/a	BCPC; SWCD HOA	LMU; Owner LCSMC
12. Encourage homeowner association participation in watershed implementation projects by educating them about project funding opportunities.	H.1	n/a	M	n/a	BCPC	LCSMC
13. Establish a watershed information sharing website.	relates to all goals	n/a	H	$1,000-$2,000 lump sum	BCPC	Munic; LCSMC; LCFPD; SWCD; TWP

lf = linear feet; **ea** = each; **var** = varies; **sqyd** = square yard; **n/a** = not applicable

Table 61. Programmatic Actions for Goal G (cont.)

Action	Primary Objective	Secondary Goal/ Objective	Priority	Cost	Lead Agency	Supporting Agency
14. Sponsor a native landscaping/restoration workshop targeting the owners of large landscapes.	G.2	A,B	M	n/a	LCFPD; BCPC	LCSMC; Munic; LMU
15. Educate local government, businesses, and residents about the negative impacts of salt usage on water quality.	B.9	B.1	H	n/a	LMU; Munic	LCSMC; BCPC; IEPA; TWP
16. Educate residents and businesses about the benefits of constructing rain gardens to capture and clean rain/stormwater.	C.5, B.5	A.3	M	n/a	UDPREP; SWCD; LCSMC	HOA; PB&D
17. Eductate Homeowners's Associations about the importance of maintaining open space in developments and allocating monies to this purpose.	H.1	E.3, A.3	M	n/a	BCPC	HOA; PB&D
18. Educate local government about potential projects for cost-share ideas.	I.1	n/a	M	n/a	BCPC	Munic LCSMC; IEPA
19. Educate watershed council biannually regarding land use decisions and report on progress made to protect green infrastructure.	1.2	n/a	H	n/a	BCPC	Munic; PB&D; LCSMC; LCFPD; TWP

lf = linear feet; ea = each; var = varies; sqyd = square yard; n/a = not applicable

Identify, develop and capitalize on potential funding sources for implementing watershed projects and programs recommended in the action plan.

Goal H

Objectives

H.1 Identify and disseminate information to stakeholders on funding sources and mechanisms for implementing watershed projects.

H.2 Add watershed improvement functions to ongoing activities and gray infrastructure projects (i.e. streets, the manmade drainage system etc.).

Table 62. Programmatic Actions for Goal H

Action	Primary Objective	Secondary Goal/ Objective	Priority	Cost	Lead Agency	Supporting Agency
1. Identify cost-share opportunities to protect green infrastructure and create greenways for recreation and wildlife habitat protection.	H.1	F.4	M	n/a	BCPC	IDNR: USFWS; LCFPD; PD
2. Initiate private/public partnerships and funding to complete wetland or stream restoration projects recommended in plan.	H.1	A.3, C.2, D.3	H	n/a	BCPC	LCSMC; IDNR
3. Recommend Homeowner's Association dues for maintenance of open space in developments.	H.1	E.3	M	var	Residents (HOA)	BCPC
4. Encourage riparian buffer strip cost-share and incentive and easement programs available to landowners.	H.1	B	M	n/a	Munic; Owner PB&D	LCSMC; IDNR
5. Identify funding for potential implementation of regional storage areas.	H.1	C.3	M	n/a	LCSMC	LCFPD; USACE; IDNR; Munic; TWP
6. Identify potential financial incentives for flood-proofing programs.	H.2	C	M	var	LCSMC	USACE; IEMA: FEMA
7. Develop a granting system where a "pot" of funding is applied for and allocated to the watershed over 2-year time periods.	H.1	All	H	n/a	BCPC	LCSMC

lf = linear feet; **ea** = each; **var** = varies; **sqyd** = square yard; **n/a** = not applicable

Goal I

Improve coordination between municipalities, townships, county agencies and special districts (parks, schools etc.) in watershed planning and protection.

Objectives

I.1 Facilitate cost-sharing arrangements among jurisdictions for projects that benefit more than one jurisdiction.

I.2 Establish a sustainable watershed council that will meet regularly, promote and guide watershed plan implementation within respective jurisdictions, and initiate and coordinate inter-jurisdictional activities and projects.

I.3 Jurisdictions will consider watershed recommendations when making land use change decisions.

Table 63. Programmatic Actions for Goal I

Action	Primary Objective	Secondary Goal/ Objective	Priority	Cost	Lead Agency	Supporting Agency
1. Develop a model or template for an intergovernmental agreement for participation in cooperative watershed projects.	I.1	n/a	M	n/a	BCPC; UDPREP	Munic; LCSMC; LCFPD; PB&D: TWP
2. Identify and present case studies of successful watershed projects for cost-sharing ideas.	I.1	n/a	M	n/a	BCPC; UDPREP LCSMC	Munic; LCFPD
3. Form a multijurisdictional partnership to develop funding packages and grant proposals to implement recommendations in the watershed plan.	I.1	H.1	H	n/a	BCPC; UDPREP	Munic; LCSMC LCFPD; PB&D
4. Develop a non-profit organization to specifically coordinate long-term protection of watershed projects that overlap multiple jurisdictions.	I.1	H.1	H	n/a	BCPC; UDPREP	Munic; LCSMC; LCFPD; Residents
5. Hire a Watershed Implementation Manager to coordinate the watershed council and follow through on implementation recommendations.	I.2	A, B, C, D	H	n/a	BCPC; LCSMC	Munic; TWP PB&D
6. Solicit representatives from each municipality, township, county agency, and special district to form a sustainable watershed council.	I.2	n/a	H	n/a	BCPC	Munic; LCSMC; LCFPD; SWCD; NRCS; LCHD; PB&D
7. Invite planners making land use decisions to lead workshops and/or make biannual presentations to watershed council regarding land use decisions and progress made to protect green infrastructure at the community and county levels.	I.2	n/a	M	n/a	BCPC	Munic; PB&D; LCSMC; LCFPD
8. Incorporate watershed plan recommendations or green infrastructure protection into community and county comprehensive land use plans.	I.3	F	H	n/a	Munic; PB&D	LCSMC; LCFPD
9. Flag high priority open space parcels/areas and flood problem areas on all development review maps/databases.	I.3	n/a	M	n/a	LCSMC; PB&D; Munic	
10. Develop and adopt a process for incorporating watershed recommendations into the development review process.	I.3	E.4	M	n/a	LCSMC; PB&D; Munic	
11. Municipalities and County review development standards and policies such as native vegetation, and adopt changes as needed to impement the watershed plan and preserve and protect healthy aquatic life and good water quality.	I.3	n/a	H	n/a	Munic; PB&D	LCSMC
12. Greenway coordinators designated by each municipality, township, relevant county and state agency, and private conservation/land trust organization will meet 2 times/year to evaluate and coordinate green infrastructure preservation.	I.3	F.4	M	n/a	BCPC	LCSMC; PB&D; LCDOT; Munic; TWP; LPC

lf = linear feet; **ea** = each; **var** = varies; **sqyd** = square yard; **n/a** = not applicable

8.2 Site Specific Action Plan

Best Management Practice (BMP): *BMPs are non-structural practices such as site planning and design aimed to reduce stormwater runoff and avoid adverse development impacts—or structural practices that are designed to store or treat stormwater runoff to mitigate flood damage and reduce pollution. Some BMPs used in urban areas may include stormwater detention ponds, restored wetlands, vegetative filter strips, porous pavement, silt fences and biotechnical streambank stabilization.*

This section lists specific sites in the Bull Creek/Bull's Brook watershed where flood damage prevention and reduction, water quality improvement, and natural resources and green infrastructure protection and enhancement projects would produce watershed benefits. Methods used to identify specific sites vary by ***Best Management Practice (BMP)*** category. Most sites were identified using a combination of existing inventory data, map analysis, and assessment analyses described in earlier sections of the report. Existing inventories included the detention basin inventory, stream inventory, and flood problem areas inventory conducted by the Lake County Stormwater Management Commission (LCSMC), and the lake summary reports provided by the Lake County Health Department (LCHD)-Lakes Management Unit. New data and analyses included the green infrastructure inventory *(Section 3.8)*, vulnerability analysis *(Section 4.1)*, pollutant loading analysis *(Section 4.2)*, hydrology and hydraulic analysis *(Section 4.4)*, flooding analysis *(Section 4.4)*, and green infrastructure parcel prioritization *(Section 5.0)*. The following BMP categories are included in the Site Specific Action Plan:

- Detention Basin Retrofits
- Regionally Significant Storage Locations
- Stream Maintenance
- Flood Mitigation
- Potential Wetland Restoration Sites
- Stream Restoration
- Lake Shoreline Restoration
- Preventing Soil Erosion
- Potential Trail Connections
- Parcel Protection Adjacent to Protected Ecologically Significant Areas and T&E Species Locations

The action recommendations are listed alphabetically by governing body and by BMP category in Tables 64-69. When using the action plan, the user should first find their respective governing body then identify the appropriate BMP category. A figure is associated with each BMP category *(Figures 82-93)* to help the user identify the location of each site-specific action recommendation. For many of the individual action items in Tables 64-69, the BMP ID# is preceded by a subwatershed identifier *(Figures 82-93 show subwatershed boundaries)*:

BB = Bull's Brook subwatershed;

BCN = Bull Creek North subwatershed; and

BCS = Bull Creek South.

Each recommended site specific action in Tables 64-69 includes a BMP ID#, size (acres) of area or parcel, public status, protected status, action recommendation, priority, lead agency/owner, primary sources of technical assistance, cost estimate, potential funding mechanisms, and implementation schedule. For most sites, the lead agency/owner is the property owner. In addition, primary and secondary goals addressed as well as technical and financial assistance needs are described in a row below each BMP category description. General goals addressed include flood damage prevention and reduction, water quality improvement, and natural resources, recreation, and greenway protection and improvement.

Urgency, technical and financial assistance needs as well as cost, feasibility, and ownership type was considered when prioritizing the individual site specific BMPs and developing the implementation schedule. Priority was assigned to each action item in the same way it was assigned to programmatic action items. H (high), M (medium), or L (low) was assigned to each action item based on the factors listed above. The implementation schedule is based on short term (1-5 years), medium term (5-10 years) and long term (10+ years) objectives and generally relates to the implementation priority (i.e High priority = 1-5 years, Medium priority = 5-10 years, Low priority = 10+ years).

DETENTION BASIN RETROFITS

The LCSMC conducted a detention basin inventory of the Bull Creek/Bull's Brook watershed in the summer of 2004. 108 basins were identified and inventoried. The results of the detention basin inventory can be found in Appendix F. The detention basin inventory also noted estimated storage volume for each of the inventoried basins if applicable *(Appendix F)*. The total storage volume is approximately 17,944 cubic feet. Retrofit recommendations for preventing/reducing flooding, and improving water quality are included under detention basin retrofits.

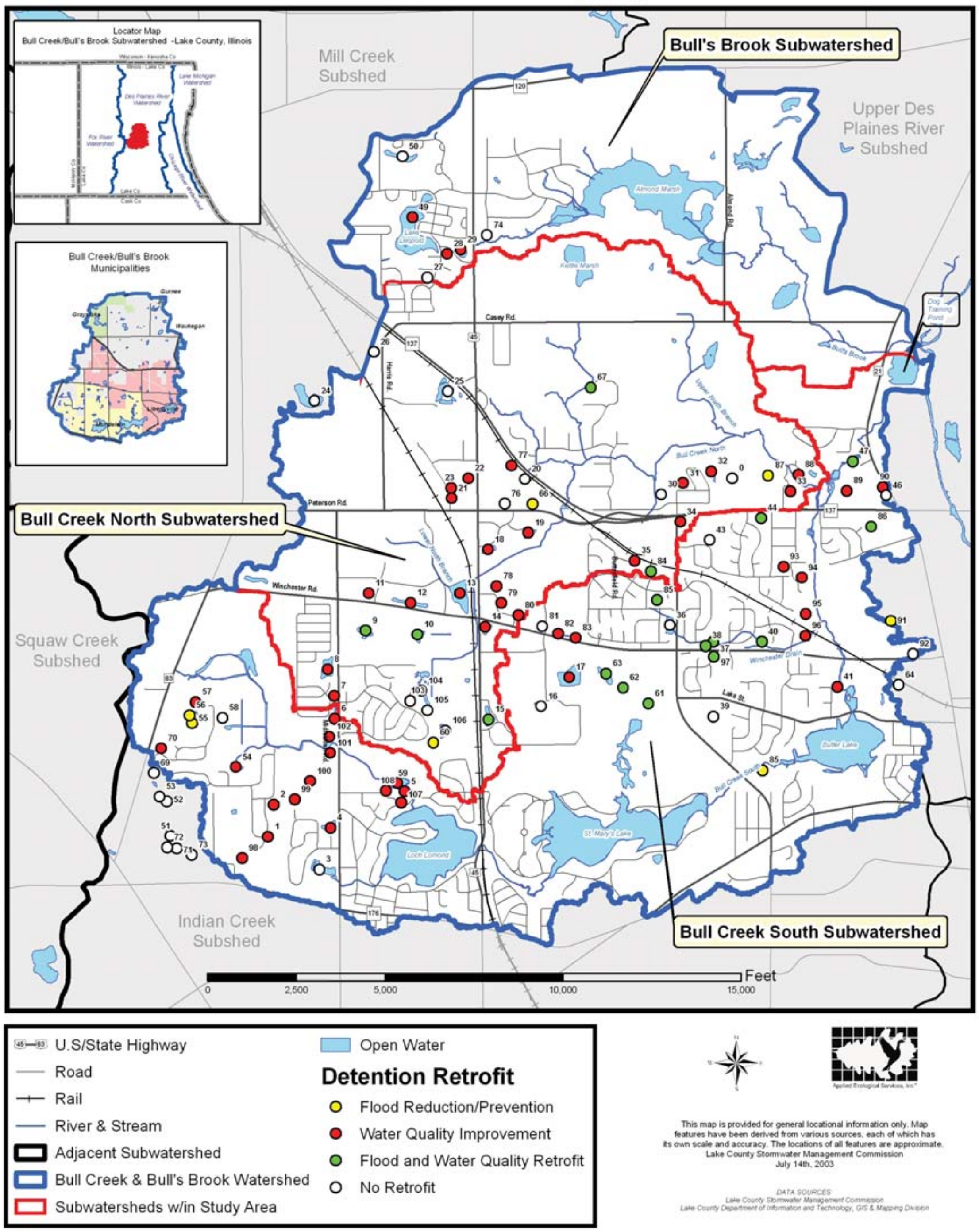
In 1992, Lake County adopted the Watershed Development Ordinance (WDO) governing the entire County, which restricted stormwater release rates for all new development within the County. The ordinance limited release rates from the 2-year recurrence interval design storm to 0.04 cfs/acre of development area and limited release rates from the 100-year recurrence interval design storm to 0.15 cfs per development acre. Detention basins constructed prior to 1992 did not have regulated release rates. Retrofits to reduce flooding include determining the feasibility to convert pre-1992 constructed basins with post-1992 outfall restrictors.

The detention basin inventory conducted by the LCSMC provides information related to potential water quality improvements. These notes were used to develop basin-specific recommendations related to improving water quality by filtering and retention processes. The detention inventory noted the following potential retrofit options related to water quality improvement:

- convert 25 dry basins to wet or wetland basins;
- remove concrete and other low flow channels to allow flow to spread out and be filtered;
- replace turf grass, excessive woody vegetation, or rip-rap with native vegetation around 52 basins for improved buffer filtration, habitat, and shoreline stabilization;
- treat algae problems in 10 basins;
- repair inlets/outlets;

All detention basins recommended for flood improvement and water quality retrofits are located by BMP ID# on Figure 82 and listed in Tables 64-69 by governing body. In some cases, basins are recommended for both flood and water quality improvements. Most publicly owned basins with problems and those with major problems or a combination of flood and water quality problems are assigned high priority for retrofits because funding and implementation are usually easier on public land and major problems generally require immediate attention. Medium and low priority is generally assigned to private basins and those exhibiting few problems. If a basin requires only a post 1992 restrictor, it was assigned medium priority for implementation.

Figure 82: Detention Basins Recommended for Flood Reduction/Prevention & Water Quality Improvement Retrofits

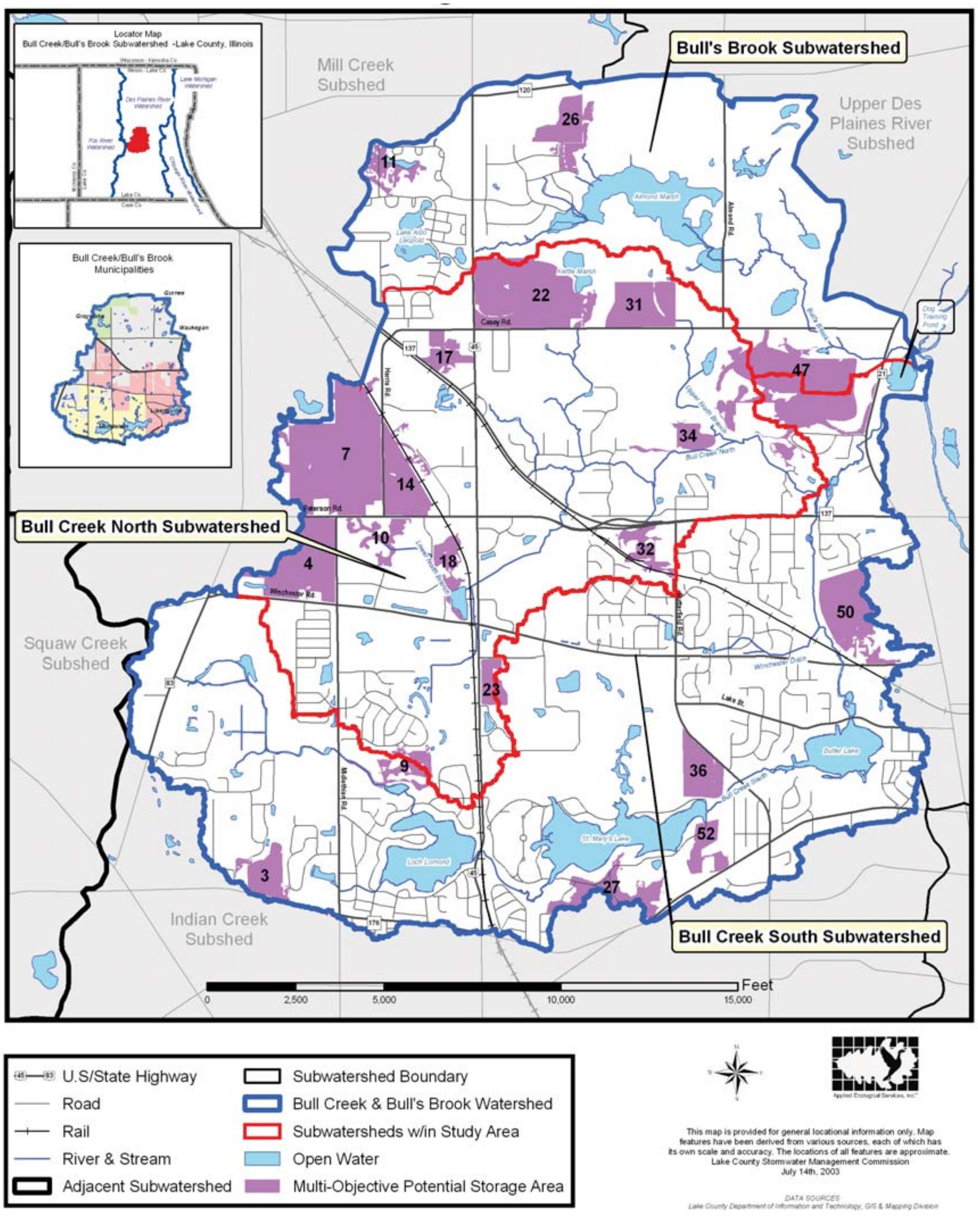


REGIONALLY SIGNIFICANT STORAGE LOCATIONS

Regional storage areas are existing or created depressional areas that presently or potentially could store stormwater runoff to decrease flooding in the watershed. Potential storage is typically created by building small berms in existing low areas to allow them to hold more water thereby reducing the amount of water that is released downstream in the watershed.,

Fifty-three (53) potential regionally significant storage location sites were identified in the watershed *(see Section 3.14)*. Those sites recommended for implementation can be located and identified by BMP ID# on Figure 83 and are listed in Tables 64–69 by governing body. Those potential sites that are between 29 and 40 acres are generally designated medium or low priority for implementation. Potential sites that are between 40 and 179 acres are generally high priority. However, some sites are prioritized based on need for storage in a particular subwatershed. Smaller sites are not included in the action plan but information about them can be found in Section 3.14. These smaller sites are all considered low priority because they would provide little potential storage compared to other sites and would not significantly benefit the watershed.

Figure 83: Potential Storage Locations for Flood Damage Reduction



STREAM MAINTENANCE

LCSMC's stream inventory *(Appendix C)* identifies stream reaches and specific locations where stream maintenance is required. Stream maintenance includes the removal of excess in-stream and overbank debris loads as well as areas where heavy sediment deposition needs to be removed. It also includes repairing problematic discharge points and removing problematic hydraulic structures from the stream channel.

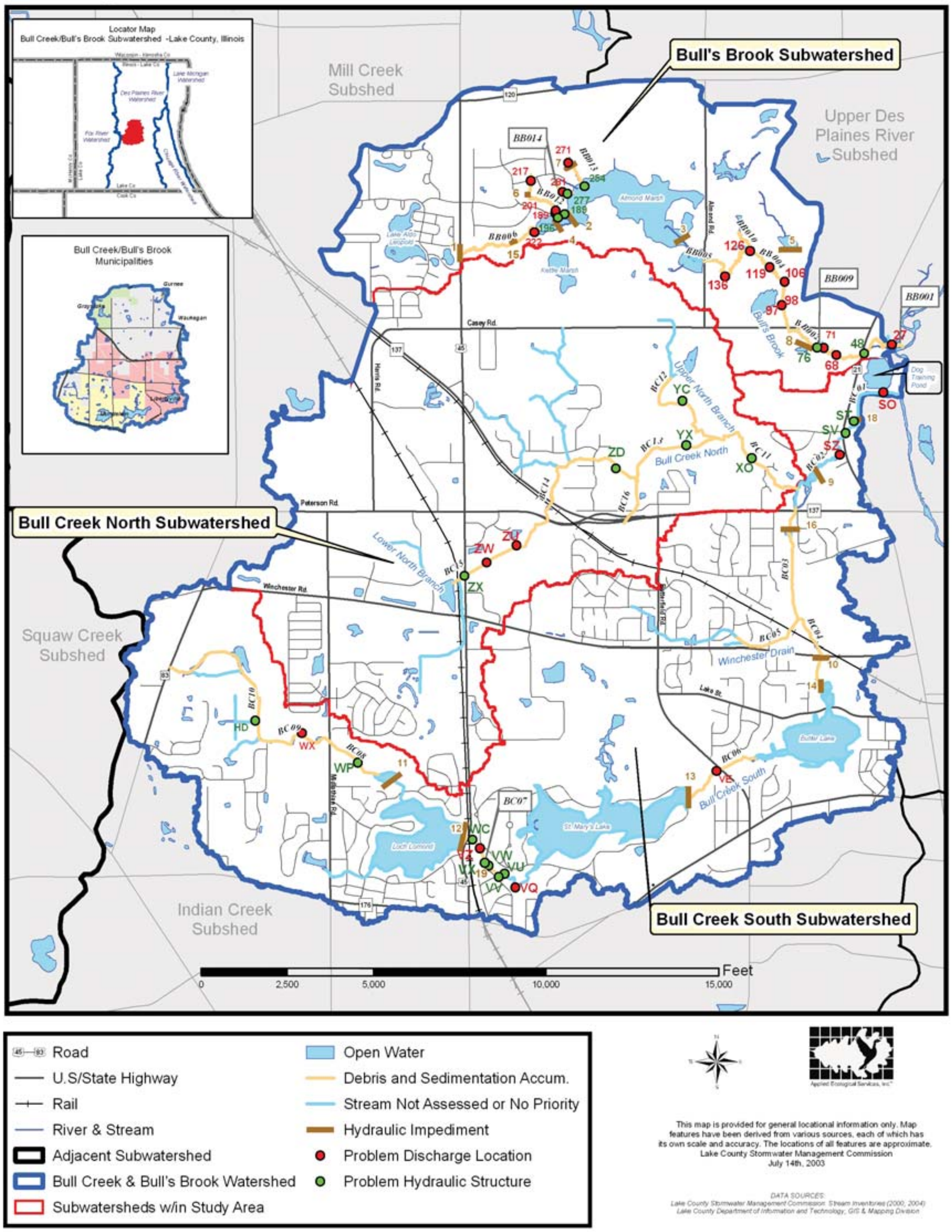
Excess debris loads can alter the natural flow regime in streams and contribute to streambank erosion and sediment accumulation. Sedimentation negatively impacts streams because fine silty particles settle out of the water column and smother the natural gravel or cobble substrates thereby reducing habitat quality for fish and macroinvertebrates. Removing the silt or flushing it downstream re-exposes the natural stream bottom but should be done with caution because it can impact downstream conditions. Section 3.10 (Streams) includes a summary and map depicting the stream reaches and amount of sediment and debris loading.

The stream inventory identifies all discharge pipes (greater than 4 inches in diameter) and ditches or swale drainage to the main stream channel within the various inventoried stream reaches that comprise the watershed. The survey found 161 discharge points, 23 of which were considered problematic. A more detailed discussion of problem discharge points is included in Section 3.10 (Streams). Problematic discharges include erosion at a pipe outfall, erosion of an open channel, polluted or suspicious discharges, and failing outfall structures. Priority for retrofits/repairs was assessed based on severity of the problem. Severity is based on notes made during the stream inventory and by examining photographs of the problem.

Hydraulic structures such as bridges, culverts, dams, or weirs were identified in the stream inventory. Additional dam locations were obtained from Integrated Lakes Management (ILM 2003). 131 structures were located in the stream inventory, 20 of which are considered problematic. ILM identified 18 dams in the watershed but the impacts of most of these dams is not known. A more detailed discussion of these dams is included in Section 3.10. These structures should be studied in more detail to assess the potential positive and negative affects of removal. Bridges, culverts, dams, or weirs that negatively impact aquatic fauna and contribute to streambank erosion are considered problematic. Problem hydraulic structures were assessed based on severity of the problem. Severity is based on notes made during the stream inventory and by examining photographs of the problem.

All stream maintenance recommendations are made by stream reach. The stream reach codes are listed under the BMP ID# column in Tables 64-69 and are depicted on Figure 84. The Location column in Tables 64-69 identifies all problem discharge points, hydraulic structures, and dams within the reach using specific codes (numbers or letters) that relate back to the stream inventory table found in Appendix C. Problem discharge points and hydraulic structures, and dam location codes are preceded with identifiers so the user can properly locate the individual problems within each reach (PD=Problem Discharge; HS=Problem Hydraulic Structure; D=Dam). The identifiers do not show up on Figure 84, but are color coded per the Legend. Prioritization for each reach was based on the cumulative negative impacts identified. For example, if a stream reach contained debris loads, sedimentation, and problem discharge points and hydraulic structures, it was assigned high priority for maintenance. On the other hand, if a stream reach only exhibits hydraulic structure problems, it is assigned low priority for maintenance. It is recommended that after initial recommendations are achieved, each governing body establish a long term maintenance plan for each reach. An example of a maintenance and monitoring plan is included in Section 4.3.

Figure 84: Stream Reaches Recommended for Maintenance



FLOOD MITIGATION

Reducing Flooding at Flood Problem Area (FPA) Sites and Nuisance Flooding Sites

In 1996, the LCSMC conducted a Flood Problem Areas Inventory (FPAI) of the Bull Creek/Bull's Brook watershed for the Flood Hazard Mitigation Plan. A Flood Problem Area (FPA) is composed of one or more structures that are damaged by flooding. Structures include transportation and utility infrastructure as well as buildings. Flood damage can be caused by overbank flooding, local drainage problems, flooding in depressional areas, or by sanitary sewer backup. The FPAI noted two Flood Problem Areas in the Bull Creek/Brook watershed. In addition to the LCSMC's study, AES conducted field reconnaissance during the May 2004 flood event to identify nuisance flooding sites. Nuisance flooding usually occurs on yards or open space and does not cause damage to structures. Ten nuisance flooding sites were recorded. Section 4.4 discusses in more detail the results of the flooding analysis. Figure 85 includes the location of each FPA and nuisance flooding site as well as recommendation notes regarding potential flood mitigation at each site. These recommendations are also included in Tables 64–69 under the representative governing body. FPA sites were given high priority for flood mitigation while nuisance flooding sites were prioritized as medium or low priority.

Preventing Flooding of Structures in the 100-year Floodplain

Flood risk areas include structures that have been identified as being at risk for flood damage because of their location in the 100-year floodplain. 104 structures were identified in the 100-year floodplain. These were identified in Section 4.4 of the report. Figure 86 identifies the general location of each structure while Tables 64–69 include general flood proofing recommendations. All structures are listed by governing body and are assigned high priority for floodproofing.

Figure 85: Flood Problem Area and Nuisance Flooding Mitigation Recommendations

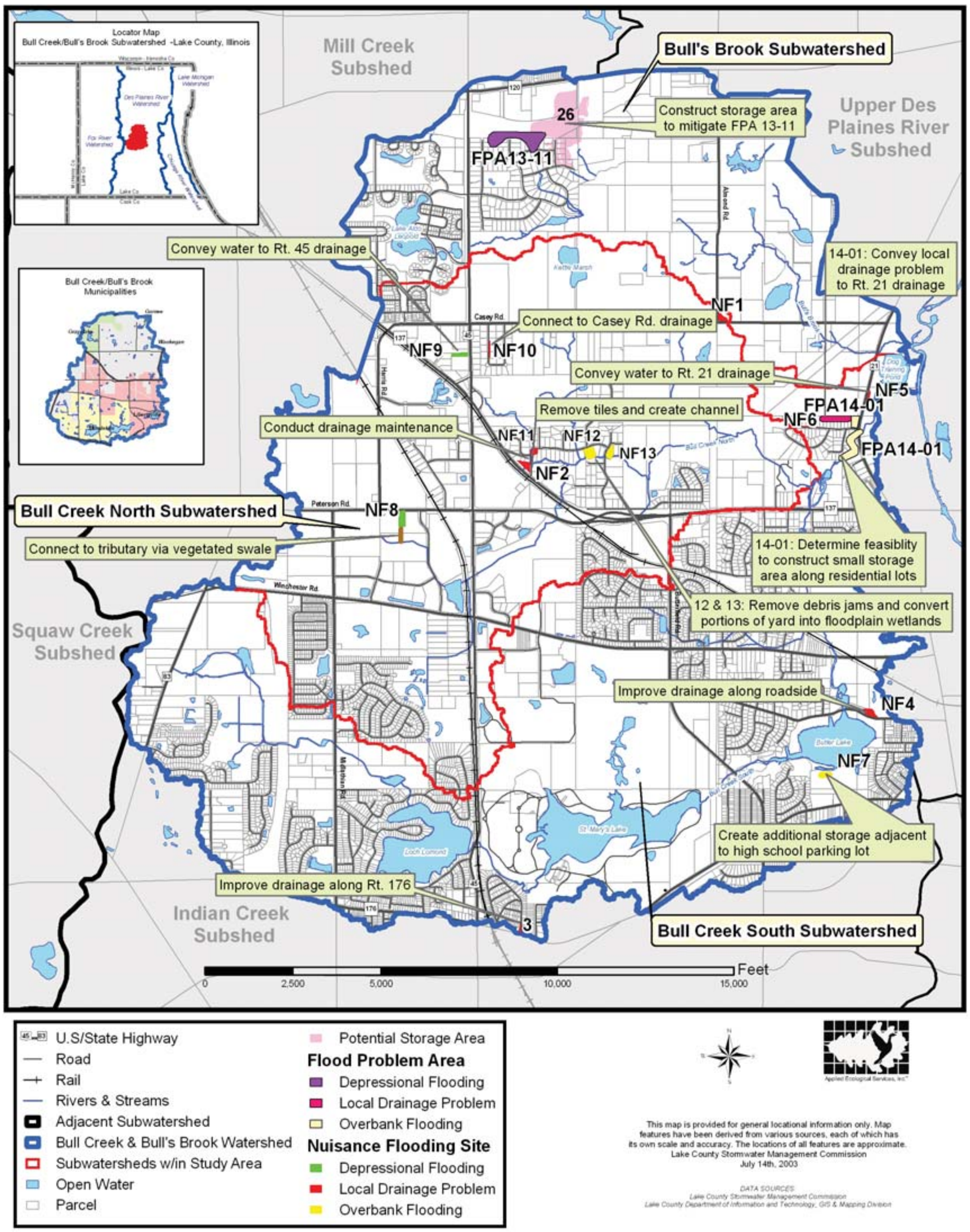
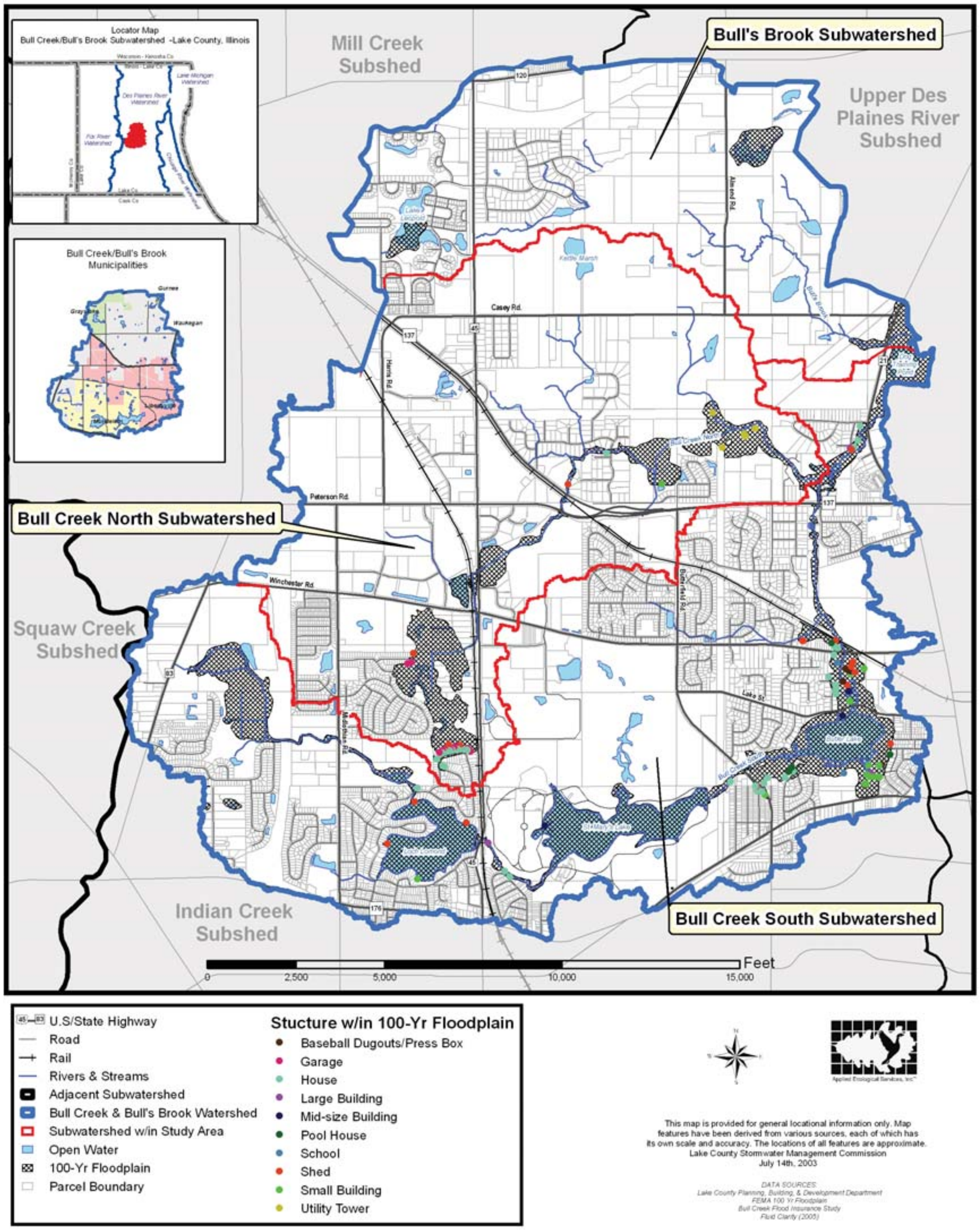


Figure 86: Structures in the 100-Year Floodplain in Need of Floodproofing Review

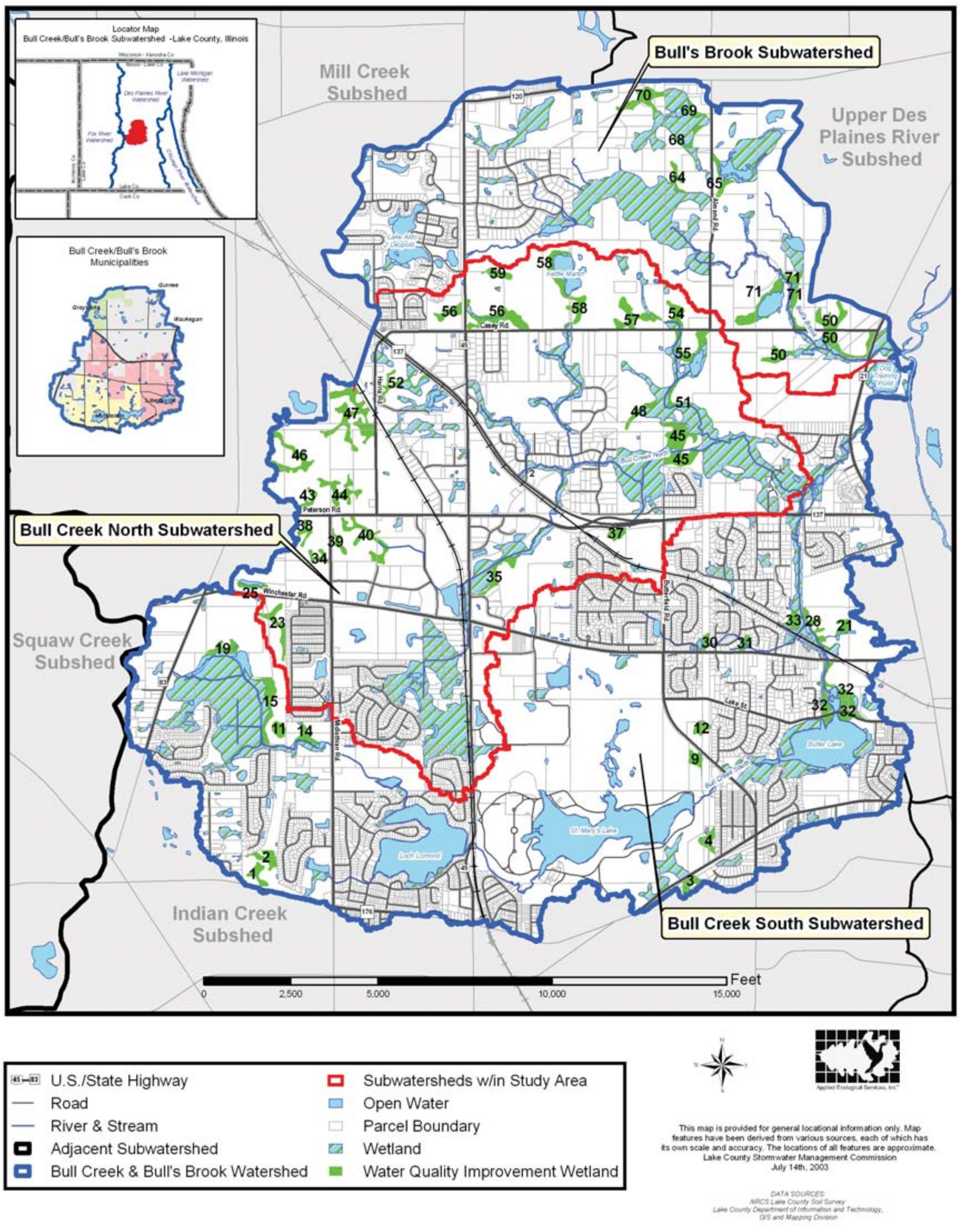


POTENTIAL WETLAND RESTORATION SITES

Wetland restoration is a term used to describe the rehabilitation or creation of prior existing wetlands that have been drained, usually by drain tiles or ditches. Wetland restoration not only improves water quality by filtrating polluted water through the sponge-like nature of a wetland but also increases flood storage by holding water. A wetland is also excellent habitat for many plant and animal species.

Potential wetland restoration sites were identified using GIS data and specific criteria determined to be essential for restoration of a functional and beneficial wetland *(see Section 3.13)*. The analysis resulted in 71 potentially feasible wetland restoration sites. Twelve (12) of these sites coincide with wetland restoration sites identified in the Des Plaines River Wetland Restoration Study (DPRWRS 2001). Figure 87 shows the location of all potentially feasible wetland restoration sites while Tables 64–69 include action related information for each that is sorted by governing body. Larger sites, sites on public land, large agricultural fields, and sites identified in the Des Plaines River Wetland Restoration Study are assigned high priority for implementation. Smaller sites and those on private land are assigned medium or low priority. A feasibility study should be completed prior to the restoration of any wetland.

Figure 87: Potential Wetland Restoration Sites



STREAM RESTORATION

Stream restoration usually includes addressing three components; 1) improving buffers; 2) restoring streambanks; and 3) improving in-stream habitat. All three components were assessed during LCSMC's stream inventory of the watershed. Section 3.10 (Streams) contains detailed summaries of each.

The inventory includes notes regarding the condition of the riparian buffer such as width and types of plants comprising the buffer. These notes were used to make recommendations regarding riparian buffer improvement opportunities. Buffer improvements usually include removing invasive or non-native plants and replacing with native vegetation. High, medium, and low priority was assigned to buffers surrounding each stream reach based on the severity of the problem. Severity is based on notes made during the inventory. Narrow or weedy/non-native buffers are typically high priority for improvement.

Streambank erosion is a major contributor to water quality degradation in any watershed because streams transport sediment originating from eroded streambanks. Bare streambanks, or streambanks with shallow-rooted non-native vegetation such as turf grass are more likely to erode than those planted with deep-rooted native plants. Streambank restoration BMPs may include remeandering, slope regrading, and native vegetation plantings on the streambanks. This approach helps stabilize eroding soils by reintroducing native plants that have deep and dense root systems that bind the soil. These techniques are referred to as ***bioengineering***. LCSMC's stream inventory identifies stream reaches where low, moderate, or high streambank erosion and channelization is present. All stream reaches identified as having moderate to highly eroded banks and channelization in Section 3.10 (Streams) are assigned high or medium priority for implementing BMPs based on severity of the problem. Severity of the problem is assessed based on notes made during the stream inventory.

Bioengineering (or Soil Bioengineering): *Techniques for stabilizing eroding or slumping stream banks that rely on the use of plants and plant materials such as live willow posts, brush layering, coconut logs and other "greener" or "softer" techniques. This is in contrast to techniques that rely on creating "hard" edges with riprap, concrete and sheet piling (metal and plastic).*

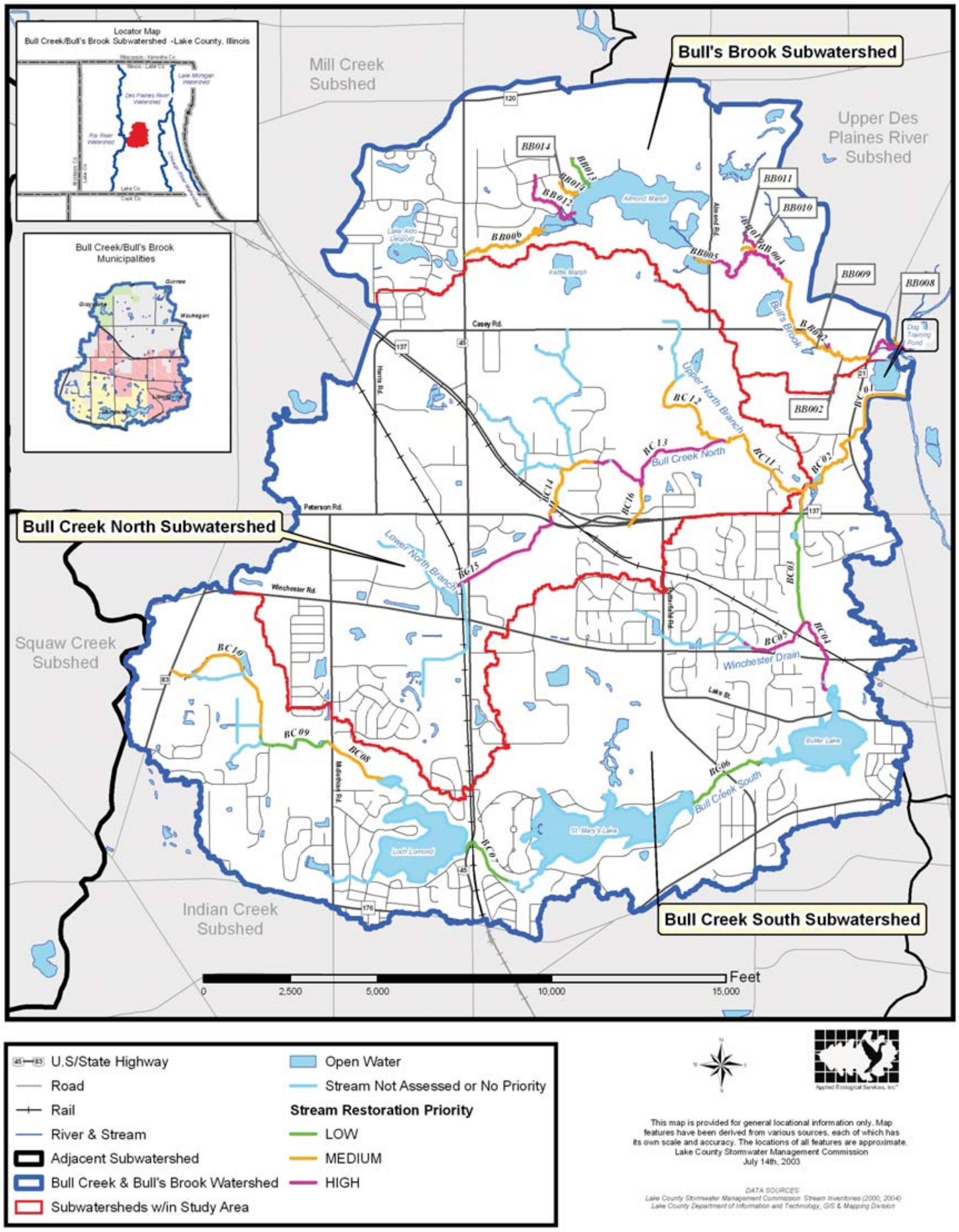
LCSMC's stream inventory also notes the presence or absence of eight in-stream habitat types in each stream reach inventoried during the study. Habitat types include:

- undercut banks
- overhanging vegetation
- pools
- rootwads
- macrophytes
- boulders
- logs
- backwaters

Stream reaches exhibiting between 0 and 2 habitat types are assigned high priority for enhancement in Section 3.10. Reaches with between 3 and 5 habitat types are medium priority. Reaches with at least 6 habitat types were considered to have adequate habitat and were not mapped in Section 3.10.

The cumulative stream reach data for buffers, streambanks, and in-stream habitat was used to make recommendations related to stream restoration priority. Each stream reach exhibiting a buffer, streambank, or in-stream habitat needing improvement is included in the action plan and can be found on Figure 88 and listed in Tables 64-69 by governing body. All recommendations are located or listed by stream reach in the BMP ID# column. In general, those stream reaches needing more than one type of improvement, with severe problems, and those on public land are assigned higher priority for restoration.

Figure 88: Stream Restoration Opportunities



LAKE SHORELINE RESTORATION

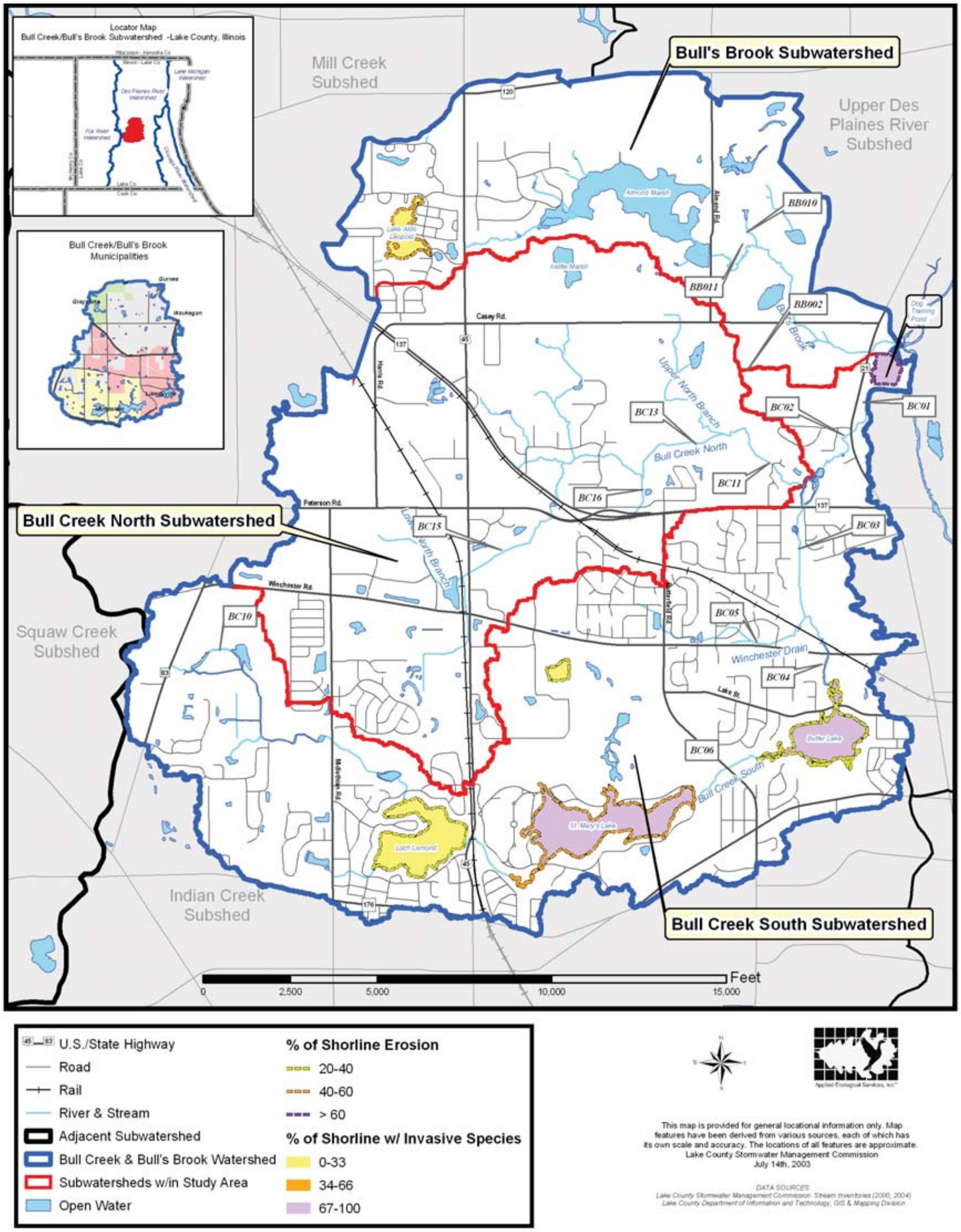
Lake shoreline restoration generally includes the removal of invasive species followed by replacement with native vegetation and erosion stabilization if applicable. The Lake County Health Department (LCHD)-Lakes Management Unit recently collected data on estimated percent of invasive species and amount of shoreline erosion for all the major lakes in the watershed except Leopold Lake in Prairie Crossing. Information for Lake Leopold was obtained from Integrated Lakes Management (ILM).

Lake shoreline erosion is a major contributor to water quality degradation in lakes and can result in negative overall water quality by contributing nutrients, sediment, and pollutants into the water. Lake shores with shallow-rooted non-native vegetation such as turf grass are more likely to erode than those planted with deep-rooted native plants. Lake shoreline restoration may include removal of non-native or invasive species, minor regrading, and planting native vegetation. This approach helps stabilize eroding soils by introducing native vegetation that has deep and dense root systems that bind the soil. Restoration using these types of techniques is referred to as bioengineering.

A detailed summary of invasive species and shoreline erosion conditions around major lakes can be found in Section 3.11 of this report. All lake shorelines exhibiting high (67–100%), medium (34–66%), and low (0–33%) invasive species abundance are recommended for some degree of invasive species removal because replacement with natives greatly improves natural resources and water quality. All lakes exhibiting low (20–40%), moderate (40–60%), or high (>60%) lake shoreline erosion are also discussed in Section 3.11 and are recommended for stabilization.

Data for invasive species abundance and lake shoreline erosion were used to make recommendations related to lake shoreline restoration priorities. Each major lake exhibiting at least some invasive species and erosion are included in the action plan and can be found on Figure 89 and listed in Tables 64-69 by governing body. In general, those lakes needing more than 34% invasive species removal and/or have at least 40% bank erosion are listed in the action plan as medium or high priority for restoration.

Figure 89: Lake Shoreline Restoration Opportunities



PREVENTING SOIL EROSION IN POLLUTANT LOADING "HOTSPOT" SMUS

Existing Agricultural Parcels within Pollutant Loading "Hotspot" SMUs

Highly erodible soils can have significant impacts on water quality because when they become detached (erode) they not only make water turbid but also carry with them attached pollutants such as phosphorus and pesticides. A detailed summary of highly erodible soils in the watershed is located in Section 3.2. Stabilizing soils in agricultural areas within pollutant loading "hotspot" SMUs will ultimately improve water quality. A summary of pollutant loading hotspots is included in Section 4.2. Agricultural BMPs designed to stabilize soils are numerous (see Toolbox of BMPs; Appendix B). No-till cropping is a practice by which the farmer manages the amount of plant residues left on the ground thereby reducing rill erosion. Filter strips and contour buffer strips can be implemented in highly eroded areas to prevent soil erosion and improve water quality.

The location of all highly erodible soils in relation to existing agricultural parcels and high category pollutant loading "hotspot" SMUs is shown on Figure 90. Tables 64-69 lists by governing body those parcels that are recommended for implementing agricultural BMPs and reduction in fertilizer to improve water quality. Priority for implementation is based on the size of the parcel and the amount of highly erodible soils. Those parcels with extensive highly erodible soils are considered high priority. Smaller parcels or parcels with small areas of highly erodible soils are considered medium priority.

Projected Future Developments within Pollutant Loading "Hotspot" SMUs

Land disturbance associated with development greatly increases the risk of soil erosion. Strict erosion control inspections and implementation in "high category" pollutant loading "hotspot" SMUs during future development is critical to the overall water quality in the watershed. Stabilizing soils, especially during grading activities, will keep soils from eroding from highly erodible areas and other areas throughout the site. Currently, NPDES II requires erosion control implementation and inspections for all construction sites over 1 acre. The Watershed Development Ordinance (WDO) also has provisions related to erosion control; a Designated Erosion Control Inspector, hired or employed by the applicant, is required for all development that exceeds 10 acres of hydrologic disturbance or exceeds 1 acre of hydrologic disturbance and has a ***Regulatory Floodplain***, ***Isolated Waters of Lake County*** or ***Waters of the United States*** on-site or on adjoining property.

The location of all highly erodible soils in relation to projected future development greater than 10 acres and also located within "high category" pollutant loading "hotspot" SMUs is shown on Figure 91. Summaries of high erodible soils and pollutant loading "hotspots" can be found in Sections 3.2 and 4.2 respectively. Tables 64-69 list by governing body those parcels/developments that should require strict erosion control implementation and inspections. High priority was assigned to all parcels because all developments should be responsible for implementing erosion control measures and inspections.

Watershed Development Definitions:

Regulatory floodplain: *Regulatory Floodplains may be either riverine or non-riverine depressional areas. Projecting the base flood elevation onto the best available topography delineates floodplain boundaries. A floodprone area is Regulatory Floodplain if it meets any of the following descriptions:*

Any riverine area inundated by the base flood where there is at least 640 acres of tributary drainage area.

Any non-riverine area with a storage volume of 0.75 acre-foot or more when inundated by the base flood.

Any area indicated as a Special Flood Hazard Area on the FEMA Flood Insurance Rate Map expected to be inundated by the base flood located using best available topography.

Isolated waters of Lake County (Isolated wetland): *All waters such as lakes, ponds, streams (including intermittent streams), farmed wetlands, and wetlands that are not under U. S. Army Corps of Engineers jurisdiction:*

The limits of the Isolated Waters of Lake County extend to the ordinary high water mark or the delineated wetland boundary.

Isolated Waters of Lake County exclude permitted excavations created for such purposes as: stormwater conveyance, detention/retention areas constructed as part of a stormwater management system, recreation, stock watering, irrigation, settling basins or wastewater treatment systems and roadside ditches. Also excluded are areas created by incidental construction grading that are exempt per Article IV Section A.2. of this ordinance.

Compensatory wetland mitigation created to meet the requirements of this Ordinance or Section 404 of the Clean Water Act is not excluded.

Waters of the United States (WOUS): *For the purpose of this Ordinance the term Waters of the United States refers to those water bodies and wetland areas that are under the U. S. Army Corps of Engineers jurisdiction.*

Figure 90: Preventing Soil Erosion of Existing Agricultural Parcels w/in Pollutant Loading Hotspot SMUs

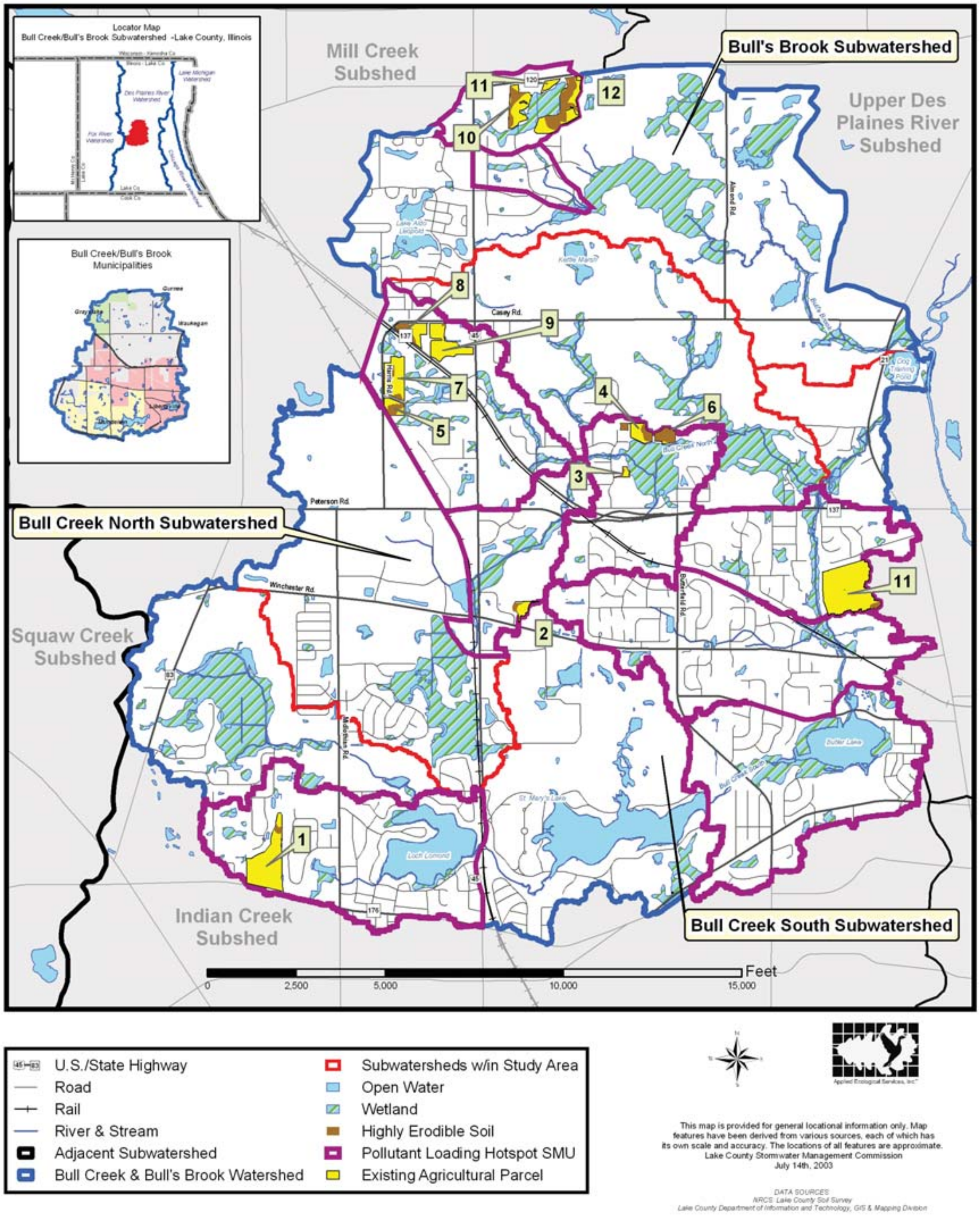
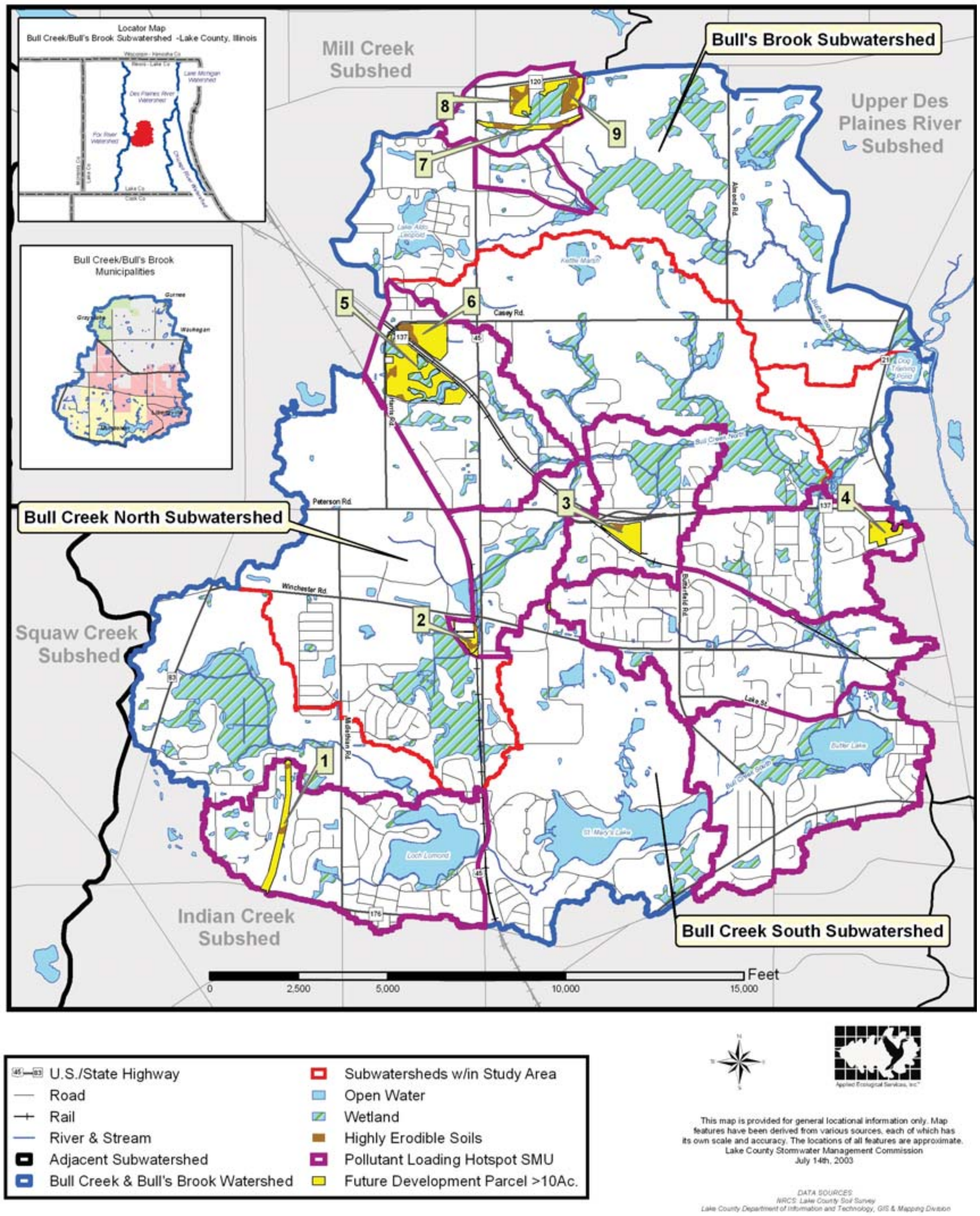


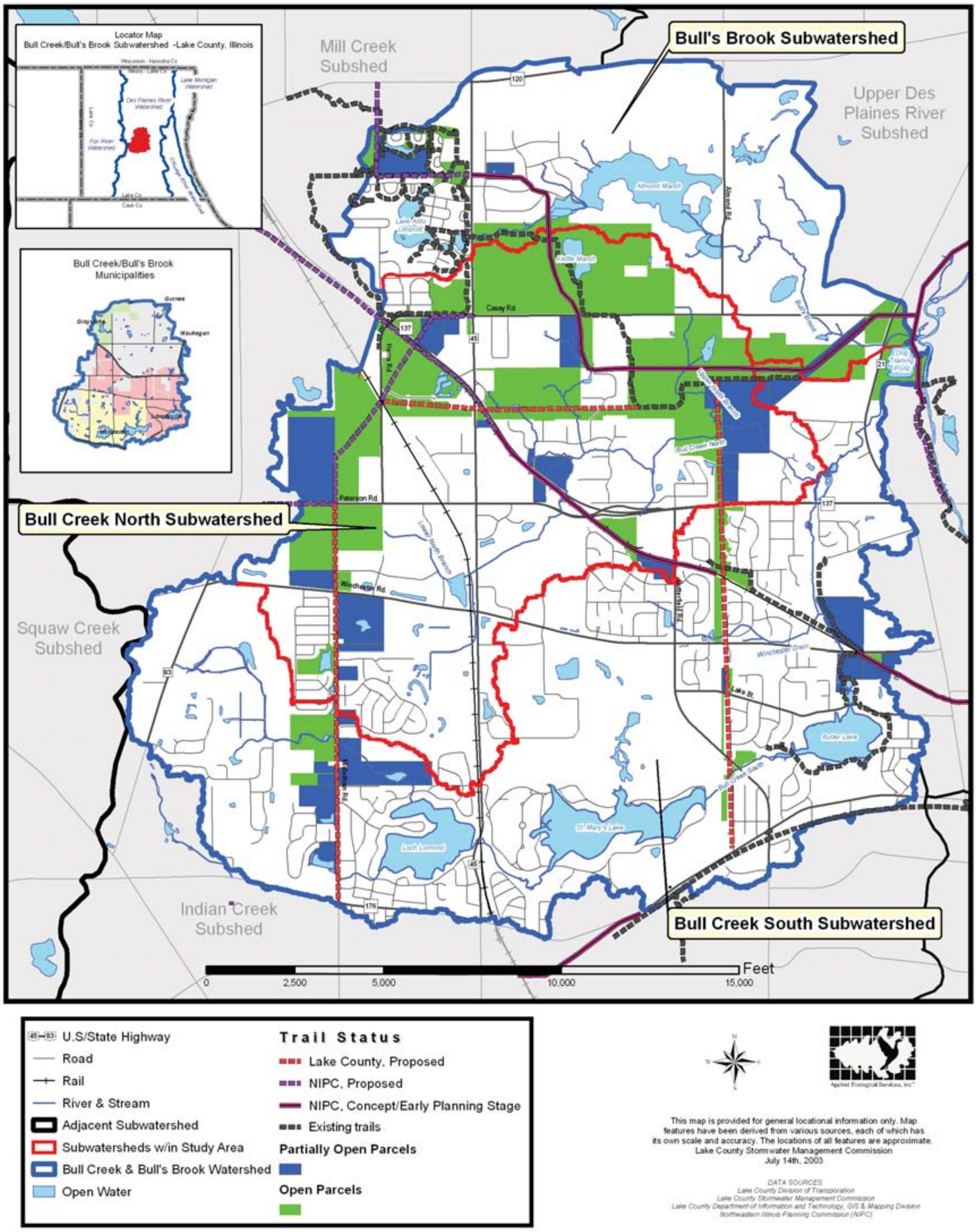
Figure 91: Preventing Soil Erosion on Projected Future Developments w/in Pollutant Loading Hotspot SMUs



POTENTIAL TRAIL CONNECTIONS

Open and partially open parcels (green infrastructure) related to trail networks is discussed in Section 3.8 of this report. The results of this analysis were used to investigate the potential to expand proposed or conceptual/early planning stage trails throughout the watershed. The location of all open or partially open parcels within 100 feet of proposed or unknown status trails is depicted on Figure 92. All of these parcels were assigned high priority for determining the feasibility to expand or create new trails. Information for each parcel is listed by municipality in Tables 64–69.

Figure 92: Open and Partially Open Parcels within 100 Feet of Proposed Trails or Trails in Conceptual/Early Planning Stage



PARCEL PROTECTION AND ENHANCEMENT ADJACENT TO PROTECTED ECOLOGICALLY SIGNIFICANT AREAS AND/OR T&E SPECIES LOCATIONS

Several Ecologically Significant Areas and Threatened and Endangered Species (T&E) records were identified in the Bull Creek/Bull's Brook watershed *(see Section 3.7)*. Ecologically Significant Areas include Illinois Natural Area Inventory sites, Natural Areas, and high function (ADID) wetlands. Protecting and enhancing currently unprotected parcels adjacent to important natural areas is important because they provide buffers and expand already existing important natural areas. All unprotected open and partially open parcels adjacent to or intersecting ecologically significant areas and/or T&E locations were assigned high priority for protection by using conservation easements or other types of protection on the land. The location of each of these parcels is shown in relation to already protected parcels and ecologically significant areas/T&E locations on Figure 93. Recommendations related to each parcel are listed by governing body in Tables 64–69.

Figure 93: Parcel Protection and Enhancement Adjacent to Protected Ecologically Significant Areas and/or T & E Species Locations

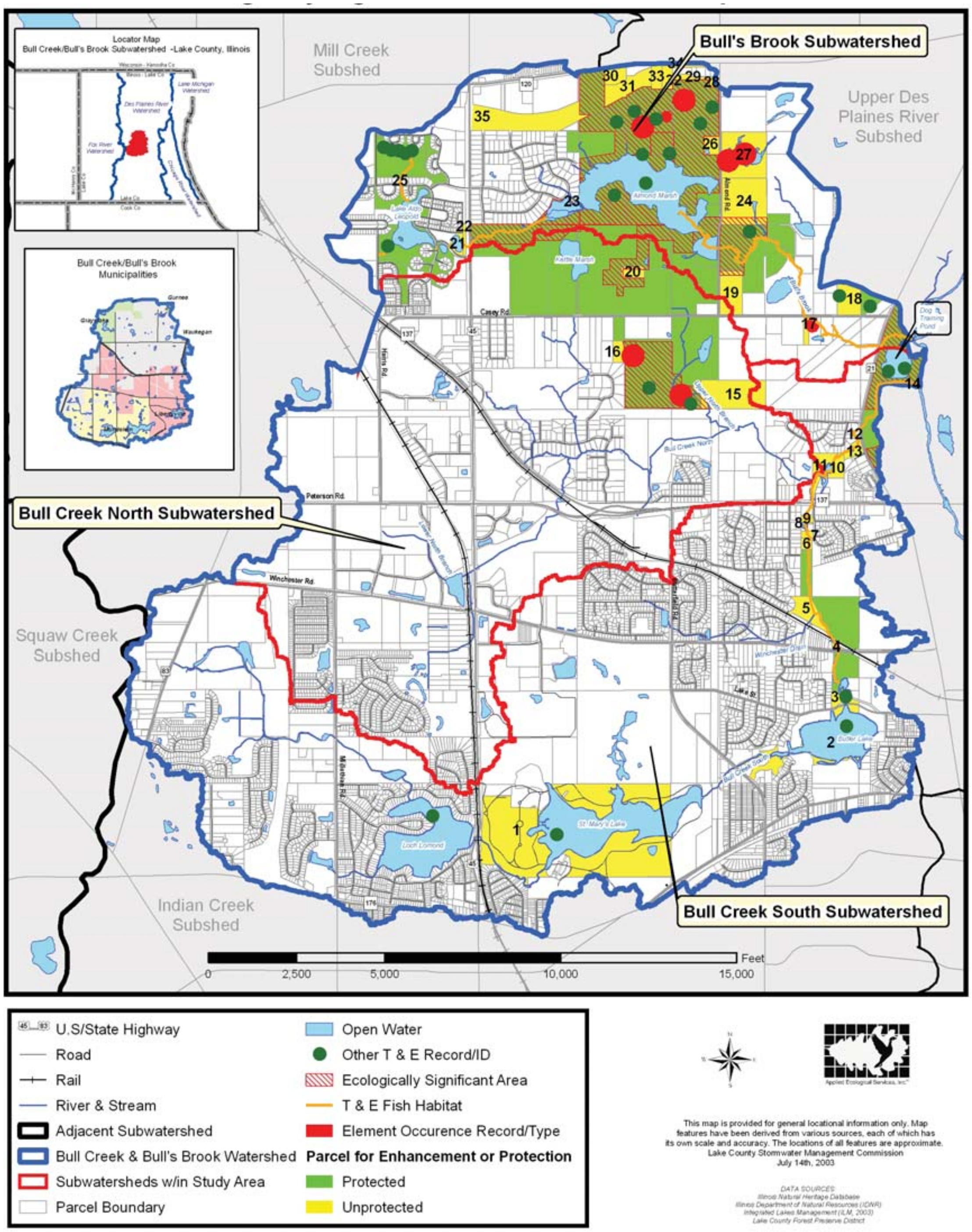


Table 64. Site Specific Action Plan Recommendations for Fremont Township

FREMONT TOWNSHIP

BMP ID#	Location	Acres/ Linear Feet	Public	Protected	Action Recommendation	Priority	Lead Agency/Owner	Sources of Technical Assistance	Cost Estimate	Funding Mechanism	Schedule (Short, Medium, Long Term)
DETENTION BASIN RETROFITS Detention basin retrofit recommendations included in this plan primarily address reducing flooding and improving water quality but also improve natural resources as a secondary function.											
Technical and Financial Assistance Needs: Technical assistance needed to implement the recommendations is generally low to medium while financial assistance is generally moderate. Installing post 1992 outfall retrofits require less technical assistance than installing a native plant buffer. Private landowners will require the greatest assistance.											
BCS 55, 56	Long Meadow Estates	n/a	No	No	Determine feasibility to convert to post 92 release rates.	M	Private	LCSMC	$2–4K	LCSMC Watershed Board; County Drainage Fund	5–10 years
REGIONALLY SIGNIFICANT STORAGE LOCATIONS Implementation of potential Regionally Significant Storage Locations primarily prevents and reduces flooding downstream but also improves water quality and natural resources if planted with native vegetation.											
Technical and Financial Assistance Needs: Technical and financial assistance needed to implement storage locations is generally high because of land protection, design, permitting, and construction costs.											
BCN 7, 14, 4, 10	Varies (see Fig 83)	178.6	No	No	Determine feasibility to construct multiobjective storage area on existing agricultural land projected to become commercial by 2030.	H	Private	LCSMC; USACE	$20–30K/ acre	LCSMC Watershed Board; USACE	1–5 years
REDUCING FLOODING AT FLOOD PROBLEM AREA (FPA) SITES AND NUISANCE FLOODING SITES The primary objective of implementing flood mitigation projects is to reduce existing flood damage. Secondary benefits include water quality and natural resource improvement depending on the nature of the project.											
Technical and Financial Assistance Needs: Technical and financial assistance needed to implement flood reduction projects varies. Correcting local drainage problems generally requires low to moderate technical support and funding.											
NF-8	Private lot off Peterson Rd.	n/a	No	No	Connect depressional nuisance flooding at NF-8 to headwater tributary just south of site via a vegetated swale through surrounding open parcels.	M	Private	SWCD; LCSMC; Township	$3–5K	LCSMC Watershed Board; County Drainage Fund; USACE	5–10 years
NF-9	Private lot off 45	n/a	No	No	Connect depressional nuisance flooding at NF-9 to ditch along Route 45.	M	Private	LCSMC; Township	$1–2K	LCSMC Watershed Board; County Drainage Fund; USACE	5–10 years
PREVENTING FLOODING AT STRUCTURES IN 100-YEAR FLOODPLAIN The primary objective of preparing floodproofing plans for structures in the 100-year floodplain is to prevent future flood damage. Few secondary objectives address improving water quality and natural resources.											
Technical and Financial Assistance Needs: Technical assistance needed to prepare floodproofing plans is low while financial assistance is generally moderate and will require consultation with LCSMC and Lake County.											
See Fig 85	Varies (see Fig 86)	Var.	Var.	Var.	Prepare floodproofing plans and implement for two identified structures in the 100-year floodplain.	H	LCSMC; County	Owner	$2–3K each	LCSMC; Lake County; FEMA Flood Mitigation Assistance Program	1–5 years
POTENTIAL WETLAND RESTORATION SITES Wetland restoration projects are implemented primarily to improve water quality but also have excellent secondary benefits for reducing flooding and improving natural resources.											
Technical and Financial Assistance Needs: Wetland restoration projects are typically complex and require high technical and financial assistance needs to protect land, design, construct, monitor, and maintain the restoration.											
BCS 14, 15, 19	Varies (See Fig 87)	3.5, 8.5, 4.6	No	No	Assess feasibility for wetland restoration project on existing private agricultural land.	L	Private	NRCS; LCSMC; USACE	$20K/acre	EPA; Township: Lake County SMC	10+ years
BCN 23, 25, 34, 38, 43	Varies (See Fig 87)	6.8, 3.1, 2.9, 2.7, 2.6	No	No	Determine feasibility for wetland restoration project on drained hydric soils on existing private agricultural land.	M	Private	NRCS; LCSMC; USACE	$20K/acre	EPA; Township: Lake County SMC	5–10 years

Table 64. (Cont.)

FREMONT TOWNSHIP

BMP ID#	Location	Acres/ Linear Feet	Public	Protected	Action Recommendation	Priority	Lead Agency/Owner	Sources of Technical Assistance	Cost Estimate	Funding Mechanism	Schedule (Short, Medium, Long Term)
STREAM RESTORATION Streambank restoration projects are implemented primarily to improve water quality but also have excellent secondary benefits for reducing flooding and improving natural resources. They improve water quality by stabilizing eroded banks, improve flooding by reconnecting channelized streams to the historic floodplain, and improve natural resources by improving habitat.											
Technical and Financial Assistance Needs: Stream restorations are often complex and require high technical and financial assistance needs to protect land, design, construct, monitor, and maintain the restoration. The project becomes more complex when constructed on reaches that flow through several governing bodies or private owners.											
BC09	Kettering Rd. to Midlothian Rd.	2500 lf	No	No	1) Remeander moderately channelized stream and/or restore streambanks and install in-stream BMPs; 2) Control invasive species and replace with native vegetation along agricultural land.	L	Private	USACE; IDNR-OWR; LCSMC; NRCS; SWCD; IDNR	$100–300/lf	EPA; TWP; LCSMC; NFWF—Native Plant Initiative	10+ years
BC10	Route 83 to Kettering Rd.	2800 lf	No	No	1) Remeander moderately channelized stream and/or restore streambanks; 2) Control invasive species and replace with native vegetation along agricultural land' 3) Construct artificial pools and riffles as well as structures such as rootwads and crosslogs to increase in-stream habitat.	M	Private	USACE; IDNR-OWR; LCSMC; NRCS; SWCD; IDNR	$100–300/lf	EPA; TWP: LCSMC; NFWF—Native Plant Initiative; NRCS	5–10 years
PREVENTING SOIL EROSION ON PROJECTED FUTURE DEVELOPMENTS WITHIN POLLUTANT LOADING "HOTSPOT" SMUs The primary function of implementing strict erosion control inspection and implementation on future developments is to control erosion from development sites thereby maintaining or improving water quality originating from the site.											
Technical and Financial Assistance Needs: Implementing erosion control inspection and implementation practices usually comes at very little financial expense to a developer and is currently required by NPDES II and the WDO. Technical assistance involved with implementing the practice is moderate and usually involves the governing body, LCSMC, IEPA, and SWCD as primary parties involved.											
BCN: 2	Existing Vacant Forest & Grassland	n/a	No	No	Existing vacant forest and grassland parcel is projected to become residential and institutional by 2030. Implement strict soil erosion inspection and implementation per the WDO or NPDES II when/if developed.	H	Applicant	Munic.; SWCD; LCSMC; IEPA	Var.	Developer	During construction, especially mass grading
POTENTIAL TRAIL CONNECTIONS The primary function of identifying potential trail connections is to expand greenways and recreational opportunities for the community.											
Technical and Financial Assistance Needs: The technical and financial assistance needed to implement trail projects is usually high because it involves coordination between multiple agencies across multiple jurisdictions.											
	Varies (see Fig 92)	Var.	No	No	Determine feasibility to extend proposed or status unknown trails through Privately owned utility corridor parcels.	H	Private (utility)	IDNR; IDOT; BCPC; PB&D; MUNIC; LCDOT; NRCS	Var.	FHA-Rec/Trails Program; LWCF; US Dept. of Housing & Urban Development	1–5 years
	Varies (see Fig 92)	Var.	No	No	Determine feasibility to extend proposed or status unknown trails through Privately owned corridor parcels.	H	Private	IDNR; IDOT; BCPC; PB&D; MUNIC; LCDOT; NRCS	Var.	FHA-Rec/Trails Program; LWCF; US Dept. of Housing & Urban Development	1–5 years

Table 65. Site Specific Action Plan Recommendations for Grayslake

GRAYSLAKE

BMP ID#	Location	Acres/ Linear Feet	Public	Protected	Action Recommendation	Priority	Lead Agency/Owner	Sources of Technical Assistance	Cost Estimate	Funding Mechanism	Schedule (Short, Medium, Long Term)
DETENTION BASIN RETROFITS Detention basin retrofit recommendations included in this plan primarily address reducing flooding and improving water quality but also improve natural resources as a secondary function.											
Technical and Financial Assistance Needs: Technical assistance needed to implement the recommendations is generally low to medium while financial assistance is generally moderate. Installing post 1992 outfall retrofits require less technical assistance than installing a native plant buffer. Private landowners will require the greatest assistance.											
BB 28	Prairie Crossing	n/a	No	Yes	Increase buffer width to at least 30 feet from water edge with native vegetation.	L	Private	LCSMC; Grayslake	$3K/acre	EPA 319; DNR C2000; HOA fees	10+ years
BB 29	Prairie Crossing	n/a	No	No	Remove minor clog at inlet.	L	Private	LCSMC; Grayslake	$100	EPA 319; DNR C2000; HOA fees	ASAP
BB 49	Prairie Crossing	n/a	No	Yes	Reduce geese by planting additional native plants on east side of basin.	L	Private	LCSMC; Grayslake	$3K/acre	EPA 319; DNR C2000; HOA fees	10+ years
REGIONALLY SIGNIFICANT STORAGE LOCATIONS Implementation of potential Regionally Significant Storage Locations primarily prevents and reduces flooding downstream but also improves water quality and natural resources if planted with native vegetation.											
Technical and Financial Assistance Needs: Technical and financial assistance needed to implement storage locations is generally high because of land protection, design, permitting, and construction costs.											
BB 26	North of Arbor Vista	40.9	Partial	No	Determine feasibility to construct multiobjective storage area adjacent to FPA 13-11.	H	State and Private	LCSMC; USACE	$20–30K/ acre	LCSMC Watershed Board; USACE	1–5 years
BB 11	Prairie Crossing	22.7	No	Yes	Determine feasibility to construct multiobjective storage area on existing agricultural land/open space.	L	Private	LCSMC; USACE	$20–30K/ acre	LCSMC Watershed Board; USACE	10+ years
BCN 17	Southeast corner of Casey and 137	20.1	No	No	Determine feasibility to construct multiobjective storage area on existing agricultural land.	M	Private	LCSMC; USACE	$20–30K/ acre	LCSMC Watershed Board; USACE	5–10 years
STREAM MAINTENANCE Most stream maintenance is conducted to keep the stream channel clear of debris that may cause flooding issues. Water quality also benefits when problem pipes or hydraulic structures are repaired.											
Technical and Financial Assistance Needs: Technical and financial assistance associated with stream maintenance is generally low for minor tasks such as removing debris jams and repairing problematic hydraulic structures and discharge points. Feasibility studies for dam and bridge repairs and removals require much more technical and financial support.											
BB013	Windschandt kennels to Almond Marsh (PD #271; HS #254; D #7)*	2000 lf	Partial	Partial	1) Remove debris jams and install structures that increase flow velocity and transport sediments; 2) Armor three outlet pipes with rock (PD #271); 3) Remove chain link fence from channel (HS #254); 4) Determine feasibility to remove dam (D #7).	H	Private	IDNR-OWR; LCFPD/ LCSMC; USACE; NRCS	$200-500 (ea. debris jam); $1–2K (ea. structure); $1–2K (stabilize pipes); $200 (chain lin fence); var. (remove dam)	Township; DNR C2000; USACE; EPA 319; LCPBD Watershed Board	1–5 years
REDUCING FLOODING AT FLOOD PROBLEM AREA (FPA) SITES AND NUISANCE FLOODING SITES The primary objective of implementing flood mitigatation projects is to reduce existing flood damage. Secondary benefits include water quality and natural resource improvement depending on the nature of the project.											
Technical and Financial Assistance Needs: Technical and financial assistance needed to implement flood reduction projects varies. Creating depressional storage for example involves high technical and financial assistance needs. Correcting local drainage problems involves much less support and money.											
FPA 13-11	North of Arbor Vista	11.6	Partial	No	Determine feasibility to construct potential storage (26) adjacent to depressional flooding at FPA 13-11.	H	State and Private	LCSMC; USACE	$20–30K/ acre	LCSMC Watershed Board; USACE	1–5 years

* PD = problem discharge; HS = hydraulic structure; D = dam as identified in stream inventory; DP = discharge point

Table 65. (Cont.)

GRAYSLAKE

BMP ID#	Location	Acres/ Linear Feet	Public	Protected	Action Recommendation	Priority	Lead Agency/Owner	Sources of Technical Assistance	Cost Estimate	Funding Mechanism	Schedule (Short, Medium, Long Term)
STREAM RESTORATION Streambank restoration projects are implemented primarily to improve water quality but also have excellent secondary benefits for reducing flooding and improving natural resources. They improve water quality by stabilizing eroded banks, improve flooding by reconnecting channelized streams to the historic floodplain, and improve natural resources by improving habitat.											
Technical and Financial Assistance Needs: Stream restorations are often complex and require high technical and financial assistance needs to protect land, design, construct, monitor, and maintain the restoration. The project becomes more complex when constructed on reaches that flow through several governing bodies or private owners.											
BB013	Windschandt kennels to Almond Marsh	2000 lf	Partial	Yes	1) Specifically remove buckthorn along buffer and replace with native vegetation; 2) Construct artificial pools and riffles as well as structures such as rootwads and crosslogs to increase in-stream habitat.	L	Private LCFPD	LCSMC; NRCS, IDNR; IDNR-OWR; USACE	$100–300/lf	LCSMC; NFWF—Native Plant Initiative; NRCS	10+ years
LAKE SHORELINE RESTORATION Lake shoreline restoration projects are implemented primarily to buffer the waterbody and have equal benefits for improving water quality and improving natural resources by introducing native plants that are beneficial to wildlife.											
Technical and Financial Assistance Needs: Lake shoreline restoration is not as complex as restoring stream reaches but still requires a moderate amount of technical and financial assistance to complete the project. The cost for implementing this kind of project increases depending on the amount of invasives that need to be removed and any grading work involved.											
Lake Leopold	Lake Leopold (see Fig 89)	n/a	No	Yes	1) Reduce moderate (40–60%) shoreline erosion by implementing erosion control bioengineering BMPs. 2) Remove/maintain low abundance (0–33%) of exotic or invasive species. Supplement with native vegetation as needed.	M	Home-owners Assoc.	USACE; IDNR-OWR; LCSMC; NRCS; SWCD	$100–300/lf	EPA; Township: LCSMC; Lake Association; LC-Health Department; USDA	1–5 years
PREVENTING SOIL EROSION ON EXISTING AGRICULTURAL PARCELS WITHIN POLLUTANT LOADING "HOTSPOT" SMUs The primary function of implementing agricultural BMPs is to improve the quality of water originating from agricultural fields. They usually have small secondary benefits for improving natural resources and decreasing flooding.											
Technical and Financial Assistance Needs: Agricultural BMP implementation is a relatively straight forward process with low to moderate technical assistance needs and medium financial assistance needs. Support increases as BMPs become more complex. For example, till cropping requires little effort for the farmer, but installing large filter strips can be quite complex.											
BCN: 8	Ag field in western portion of watershed	8.3	No	No	Implement erosion control agricultural BMPs such as filter strips and no till cropping along highly erodible soils on western portion of agricultural parcel. Also reduce fertilizer usage on entire parcel.	H	Private	NRCS; SWCD	Var.	NRCS	1–5 year
BCN: 9	Ag field in western portion of watershed	14.6	No	No	Implement erosion control agricultural BMPs such as filter strips and no till cropping along small erodible soils area on northwest portion of agricultural parcel. Also reduce fertilizer usage on entire parcel.	H	Private	NRCS; SWCD	Var.	NRCS	1–5 years
BCN: 10, 11, 12	Ag fields in northern portion of watershed	n/a	Partial	No	Implement erosion control agricultural BMPs such as filter strips and no till cropping in highly erodible soil areas. Also reduce fertilizer usage on entire parcel.	H	Private and State	NRCS; SWCD	Var.	NRCS	1–5 years
PREVENTING SOIL EROSION ON PROJECTED FUTURE DEVELOPMENTS WITHIN POLLUTANT LOADING "HOTSPOT" SMUs The primary function of implementing strict erosion control inspection and implementation on future developments is to control erosion from development sites thereby maintaining or improving water quality originating from the site.											
Technical and Financial Assistance Needs: Implementing erosion control inspection and implementation practices usually comes at very little financial expense to a developer and is currently required by NPDES II and the WDO. Technical assistance involved with implementing the practice is moderate and usually involves the governing body, LCSMC, IEPA, and SWCD as primary parties involved.											
BCN: 6, 7, 8, 9	Existing Agriculture fields	n/a	Partial	No	Existing agricultural area is projected to become commercial and residential with new roads by 2030. Implement strict soil erosion inspection and implementation per the WDO or NPDES II when/if developed.	H	Applicant	Munic.; SWCD; LCSMC; IEPA	Var.	Developer	During construction, especially mass grading

Table 65. (Cont.)

GRAYSLAKE

BMP ID#	Location	Acres/ Linear Feet	Public	Protected	Action Recommendation	Priority	Lead Agency/Owner	Sources of Technical Assistance	Cost Estimate	Funding Mechanism	Schedule (Short, Medium, Long Term)
POTENTIAL TRAIL CONNECTIONS The primary function of identifying potential trail connections is to expand greenways and recreational opportunities for the community.											
Technical and Financial Assistance Needs: The technical and financial assistance needed to implement trail projects is usually high because it involves coordination between multiple agencies across multiple jurisdictions.											
	Varies (see Fig 92)	Var.	No	No	Determine feasibility to extend proposed or status unknown trails through privately owned parcels.	H	Private	IDNR; IDOT; BCPC; PB&D; MUNIC; LCDOT; NRCS	Var.	FHA-Rec/Trails Program; LWCF; US Dept. of Housing & Urban Development	1–5 years
	Varies (see Fig 92)	Var.	Yes	No	Determine feasibility to extend proposed or status unknown trails through Prairie Crossing parcels.	H	Private	IDNR; IDOT; BCPC; PB&D; MUNIC; LCDOT; NRCS	Var.	FHA-Rec/Trails Program; LWCF; US Dept. of Housing & Urban Development	1–5 years
OPEN SPACE PARCEL PROTECTION AND ENHANCEMENT ADJACENT TO PROTECTED ECOLOGICALLY SIGNIFICANT AREAS AND/OR T&E SPECIES LOCATIONS The primary function for protecting and enhancing unprotected open parcels adjacent to already protected high quality parcels or parcels with known T&E species is to provide permanent buffer protection and/or add to their size and function.											
Technical and Financial Assistance Needs: Protecting and enhancing parcels is not always an easy process and involves close technical coordination with the owner and agency that will protect the parcel in perpetuity. Cost to protect open space can be substantial if the transaction involves acquisition, but is much less expensive if deed or conservation easements are used instead.											
BB 35	North of Arbor Vista	41.1	No	No	Protect and enhance unprotected State owned parcels adjacent to ecologically significant area using conservation easements or other similar techniques.	H	State	IDNR; IDOT; BCPC; PB&D; MUNIC; LCDOT; NRCS	Var.	FHA-Rec/Trails Program; LWCF; US Dept. of Housing & Urban Development	1–5 years
BB 21, 22, 25	North of Almond Marsh Forest Preserve	4.2, 1.7, 0.1	No	No	Protect and enhance unprotected privately owned parcel adjacent to ecologically significant area using conservation easements or other similar techniques.	H	Private	IDNR; IDOT; BCPC; PB&D; MUNIC; LCDOT; NRCS	Var.	FHA-Rec/Trails Program; LWCF; US Dept. of Housing & Urban Development	1–5 years
BB 30	North of Almond Marsh Forest Preserve	5.8	No	No	Protect and enhance unprotected privately owned parcel adjacent to ecologically significant area using conservation easements or other similar techniques.	H	Private	IDNR; IDOT; BCPC; PB&D; MUNIC; LCDOT; NRCS	Var.	FHA-Rec/Trails Program; LWCF; US Dept. of Housing & Urban Development	1–5 years

Table 66. Site Specific Action Plan Recommendations for Libertyville

LIBERTYVILLE

BMP ID#	Location	Acres/ Linear Feet	Public	Protected	Action Recommendation	Priority	Lead Agency/Owner	Sources of Technical Assistance	Cost Estimate	Funding Mechanism	Schedule (Short, Medium, Long Term)
DETENTION BASIN RETROFITS Detention basin retrofit recommendations included in this plan primarily address reducing flooding and improving water quality but also improve natural resources as a secondary function.											
Technical and Financial Assistance Needs: Technical assistance needed to implement the recommendations is generally low to medium while financial assistance is generally moderate. Installing post 1992 outfall retrofits require less technical assistance than installing a native plant buffer. Private landowners will require the greatest assistance.											
BCN 34	Butterfield Square	n/a	No	No	Plant native vegetation and determine feasibility of converting to wet bottom.	H	Private	LCSMC; Libertyville	$3K/acre (planting); wet bottom conversion varies	EPA 319; DNR C2000; HOA fees	1–5 years
BCN 14	Candlewood Suites	n/a	No	No	Unclog outlets and plant natives to reduce goose problem.	M	Private	LCSMC; Libertyville	$3K/acre	EPA 319; DNR C2000; HOA fees	5–10 years
BCS 37, 38, 40	Interlaken Ridge	n/a	No	Yes	Determine feasibility to convert to post 92 detention release rates. Plant native vegetation on slopes and bottom; unclog outlets; determine feasibility to convert to wet bottom.	H	Private	LCSMC; Libertyville	$2–4K (92 release); 3K/acre (planting); wet bottom conversion varies	LCSMC Watershed Board; EPA 319; DNR C2000; HOA fees	1–5 years
BCN 35	Interlaken Ridge	n/a	No	No	Plant native vegetation and determine feasibility to convert to wet bottom.	H	Private	LCSMC; Libertyville	$3K/acre (planting); wet bottom conversion varies	EPA 319; DNR C2000; HOA fees	1–5 years
BCN 21, 22, 23	Industrial Dr.	n/a	Partial	Partial	Plant native vegetation along banks and determine feasibility to convert basins 21 and 23 to wet bottom.	H	Private	LCSMC; Libertyville	Var.	EPA 319; DNR C2000; HOA fees	1–5 years
BCN 15	Motorola	n/a	No	Yes	Determine feasibility to convert to post 92 release rates.	M	Private	LCSMC	$2–4K	LCSMC Watershed Board	5–10 years
BCN 18, 19	Northwind Blvd.	n/a	No	No	Plant native vegetation along slopes.	M	Private	LCSMC; Libertyville	$3K/acre	EPA 319; DNR C2000; HOA fees	5–10 years
BCS 17 (IMC Lake)	Technology Way	n/a	No	No	Inhibit geese usage by planting natives and remove major clog at outlets.	H	Private	LCSMC; Libertyville	$3K/acre (planting); $100 (remove clogs)	EPA 319; DNR C2000; HOA fees	1–5 years
BCS 90; BCN 87	Liberty Grove; Libertyville Manor	n/a	No	No	Plant native vegetation along slopes.	M	Private	LCSMC; Libertyville	$3K/acre	EPA 319; DNR C2000; HOA fees	5–10 years
BCN 31, 32	Libertyville (Timber Creek)	n/a	No	No	Unclog outlets and plant native vegetation along banks.	M	Private	LCSMC; Libertyville	$100 (unclog outlets); $3K/ acre (planting)	EPA 319; DNR C2000; HOA fees	5–10 years
BCN 11, 12, 13	Winchester Business Park	n/a	No	No	Remove clogged outlets and treat algae.	H	Private	LCSMC; Libertyville	$100 (unclog outlets); $1-2K (algae treatment)	EPA 319; DNR C2000; HOA fees	1–5 years
BCS 39	Bufferfield School	n/a	Yes	No	Plant native vegetation along banks and treat algae.	H	Libertyville	LCSMC; Libertyville	$100 (unclog outlets); $3K/ acre (planting)	EPA 319; DNR C2000; HOA fees	1–5 years
BCN 77	Libertyville Sports Complex	n/a	Yes	No	Enhance pond by planting additional plants around basin and in basin bottom; also treat algae.	L	Libertyville	LCSMC; Libertyville	$3K/acre (planting)	EPA 319; DNR C2000	10+ years
BCN 78, 79	Unnamed	n/a	No	No	Plant native vegetation along banks and determine feasibility to convert to wet bottom basin.	H	Private	LCSMC; Libertyville	Var.	EPA 319; DNR C2000	1–5 years
BCN 88	Unnamed; Forest Creek	n/a	No	No	Plant native vegetation along banks and determine feasibility to convert to wet bottom basin.	H	Private	LCSMC; Libertyville	Var.	EPA 319; DNR C2000	1–5 years
BCN 80	Hawthorne Community Church	n/a	No	No	Plant native plant buffer along side slopes.	M	Private	LCSMC Libertyville	$3K/acre (planting)	EPA 319; DNR C2000	5–10 years

Table 66. (Cont.)

LIBERTYVILLE

BMP ID#	Location	Acres/ Linear Feet	Public	Protected	Action Recommendation	Priority	Lead Agency/Owner	Sources of Technical Assistance	Cost Estimate	Funding Mechanism	Schedule (Short, Medium, Long Term)
BCS 82, 83, 89	Winchester Court; Saddle Shop	n/a	No	No	Plant native plant buffer along side slopes and emergent areas.	H	Private	LCSMC; Libertyville	$3K/acre (planting)	EPA 319; DNR C2000	1–5 years
BCN 84; BCS 85, 97	Interlaken Meadows;	n/a	No	Yes	Determine feasibility to convert to post 92 detention release rates. Determine feasibility to convert to wet bottom basin planted with native vegetation.	H	Private	LCSMC; Libertyville	$2–4K (92 release); 3K/acre (planting); wet bottom conversion varies	LCSMC County Drainage Fund; EPA 319; DNR C2000; HOA fees	1–5 years
BCS 86	Virginia Park	n/a	No	No	Determine feasibility to convert to post 92 detention release rates. Plant native plant buffer along side slopes and emergent areas.	M	Private	LCSMC; Libertyville	$2–4K (92 release); 3K/acre (planting); wet bottom conversion varies	LCSMC County Drainage Fund; EPA 319; DNR C2000; HOA fees	5–10 years
BCS 90	Ace Hardware	n/a	No	No	Control trees, shrubs, and cattails.	L	Private	Libertyville	Maintenance (1–2K/acre)	LCSMC County Drainage Fund; EPA 319; DNR C2000	10+ Years
BCS 93, 95, 94, 96	Wineberry; Unnamed	n/a	No	No	Plant native vegetation along banks and determine feasibility to convert to wet bottom basin.	H	Private	LCSMC; Libertyville	Var.	EPA 319; DNR C2000	1–5 years
BCS 44	Elderberry Dr.	n/a	Yes	Yes	Plant native vegetation on slopes and bottom; unclogged outlets; determine feasibility to convert to wet bottom.	H	Libertyville	LCSMC Libertyville	$100 (unclog outlets); $3K/acre (planting); conversion to wet bottom varies	EPA 319; DNR C2000; HOA fees	1–5 years
BCS 41	Stonegate Rd.	n/a	Yes	No	Plant native vegetation on slopes and bottom; determine feasibility to convert to wet bottom.	H	Libertyville	LCSMC; Libertyville	$3K/acre (planting); conversion to wet bottom varies	EPA 319; DNR C2000; HOA fees	1–5 years
REGIONALLY SIGNIFICANT STORAGE LOCATIONS Implementation of potential Regionally Significant Storage Locations primarily prevents and reduces flooding downstream but also improves water quality and natural resources if planted with native vegetation.											
Technical and Financial Assistance Needs: Technical and financial assistance needed to implement storage locations is generally high because of land protection, design, permitting, and construction costs.											
BCN 23	See Fig 83	17.3	No	No	Determine feasibility to construct multiobjective storage area on existing open space.	M	Private	LCSMC; USACE	$20–30K/acre	LCSMC Watershed Board; USACE	5–10 years
BCN 18	Northwest corner of Winchester and 45	20.9	No	No	Determine feasibility to construct multiobjective storage area.	L	Private	LCSMC; USACE	$20–30K/acre	LCSMC Watershed Board; USACE	10+ years
BCN 32	See Figure 83	20.2	No	Yes	Determine feasibility to construct multiobjective storage area on existing commercial/open space.	M	Private	LCSMC; USACE	$20–30K/acre	LCSMC Watershed Board; USACE	5–10 years
BCS 50	County Ag land north of Winchester	67.1	Yes	Yes	Determine feasibility to construct multiobjective storage area on existing agricultural land (currently being used for spoils and dewatering from Butler Lake project).	L	Lake County	LCSMC; USACE	$20–30K/acre	LCSMC Watershed Board; USACE	10+ years
BCS 52	Southeast side of St. Mary's Lake	20.9	No	No	Determine feasibility to construct multiobjective storage area on existing open space along St. Mary's Lake.	M	St. Mary's	LCSMC; USACE	$20–30K/acre	LCSMC Watershed Board; USACE	5–10 years
BCS 36	Northeast side of St. Mary's Lake	35.7	No	No	Determine feasibility to construct multiobjective storage area on existing open space/agricultural land.	M	St. Mary's	LCSMC; USACE	$20–30K/acre	LCSMC Watershed Board; USACE	5–10 years

Table 66. (Cont.)

LIBERTYVILLE

BMP ID#	Location	Acres/ Linear Feet	Public	Protected	Action Recommendation	Priority	Lead Agency/Owner	Sources of Technical Assistance	Cost Estimate	Funding Mechanism	Schedule (Short, Medium, Long Term)
STREAM MAINTENANCE Most stream maintenance is conducted to keep the stream channel clear of debris that may cause flooding issues. Water quality also benefits when problem pipes or hydraulic structures are repaired.											
Technical and Financial Assistance Needs: Technical and financial assistance associated with stream maintenance is generally low for minor tasks such as removing debris jams and repairing problematic hydraulic structures and discharge points. Feasibility studies for dam and bridge repairs and removals require much more technical and financial support.											
BC02	Rt. 137 to Rt. 21 (DP # SZ; D #9)	3200 lf	No	No	1) Cut plastic pipe flush with bank and stabilize with rip-rap and erosion control blanket; 2) Investigate source of white substance coming from pipe (DP #SZ); 3) Determine feasibility to remove dam to allow fish passage (D #9).	H	IEPA; Township; Owner	USACE; LCSMC; NRCS; SWCD; IEPA	$1-3K (stabilize pipe); dam analysis varies	EPA 319; LCSMC Watershed Board; Township; Municipality	1–5 years
BC04	Butler Lake Park to Bike Path Bridge (D #10, 14)	2500 lf	Yes	Partial	1) Install grade control structures that increase flow velocity and transport sediments; 2) Determine feasibility to remove dam to allow fish passage (D #10, 14).	H	Libertyville Private	IDNR-OWR; USACE; LCSMC, SWCD	$1-2K each (structures); dam analysis varies	Township; DNR C2000; USACE; EPA 319; Municipality	1–5 years
BC05	Winchester Rd. to confluence	3500 lf	Partial	Partial	Install grade control structures that increase flow velocity and transport sediments.	M	Libertyville Private	IDNR-OWR; USACE; LCSMC	$1-2K each	Township; DNR C2000; USACE	5–10 years
BC06	St. Mary's Lake to Butler Lake (PD #VE; D#13)	2500 lf	Partial	No	1) Remove debris jams throughout reach; 2) Cut plastic pipe flush with bank and stabilize (PD #VE); 3) Determine feasibility to create more friendly fish passage (D #13).	H	Libertyville Private	IDNR-OWR; USACE; LCSMC; NRCS	$200–500 each (debris jams); $1–3K (stabilize pipe); fish passage analysis varies	Township; DNR C2000; USACE; EPA 319; LCSMC Watershed Board	1–5 years
REDUCING FLOODING AT FLOOD PROBLEM AREA (FPA) SITES AND NUISANCE FLOODING SITES The primary objective of implementing flood mitigatation projects is to reduce existing flood damage. Secondary benefits include water quality and natural resource improvement depending on the nature of the project.											
Technical and Financial Assistance Needs: Technical and financial assistance needed to implement flood reduction projects varies. Creating depressional storage generally involves high technical support and funding.											
NF-4	Buter Lake Park	n/a	Yes	No	Improve local drainage problem at Butler Lake Park/street by creating additional roadside swales or stormsewer inlets.	M	Libertyville	LCSMC	LCSMC Watershed $1–2K each	Board; USACE	5–10 years
NF-7	Libertyville High school	n/a	Yes	Yes	Create additional wetland storage area within adjacent open space along the Libertyville High school parking lot to capture overbank flooding from Butler Lake .	L	Libertyville High School	NRCS; USACE; LCSMC	$20–30K/acre	LCSMC Watershed Board; USACE	10+ years
PREVENTING FLOODING AT STRUCTURES IN 100-YEAR FLOODPLAIN The primary objective of preparing floodproofing plans for structures in the 100-year floodplain is to prevent future flood damage. Few secondary objectives address improving water quality and natural resources.											
Technical and Financial Assistance Needs: Technical assistance needed to prepare floodproofing plans is low while financial assistance is generally moderate and will require consultation with LCSMC and Lake County.											
See Fig 86	See Fig 86	Var.	Var.	Var.	Prepare and implement floodproofing plans for 57 identified structures in the 100-year floodplain.	H	LCSMC; County	Owner	$2–3K each	LCSMC; Lake County; FEMA Flood Mitigation Assistance Program	1–5 years
POTENTIAL WETLAND RESTORATION SITES Wetland restoration projects are implemented primarily to improve water quality but also have excellent secondary benefits for reducing flooding and improving natural resources.											
Technical and Financial Assistance Needs: Wetland restoration projects are typically complex and require high technical and financial assistance needs to protect land, design, construct, monitor, and maintain the restoration.											
BCN 37	See Fig 87	3.7	No	No	Assess feasibility for wetland restoration project on private open space between Peterson road and Metra rail line.	L	Private	LCSMC; USACE	$20K/acre	EPA; Township: Lake County SMC	10+ years
BCS 3, 4	See Fig 87	3.5, 4.3	No	No	Assess feasibility for wetland restoration project on privately owned land.	L	Private	IDOT; LCSMC; USACE	20K/acre	EPA; Township: Lake County SMC	10+ years

Table 66. (Cont.)

LIBERTYVILLE

BMP ID#	Location	Acres/ Linear Feet	Public	Protected	Action Recommendation	Priority	Lead Agency/Owner	Sources of Technical Assistance	Cost Estimate	Funding Mechanism	Schedule (Short, Medium, Long Term)
BCS 9	See Fig 87	3.4	No	No	Assess feasibility for wetland restoration project on existing private parcel owned by St. Mary's Seminar.	L	St. Mary's Seminary	NRCS; LCSMC; USACE	$20K/acre	EPA; Township: Lake County SMC	10+ years
BCS 30	See Fig 87	3.3	Yes	No	Assess feasibility for wetland restoration project within ComEd utility corridor	H	Utility (ComEd)	LCSMC; USACE	$20K/acre	EPA; Township: Lake County SMC	1–5 years
BCS 12	See Fig 87	3.3	Partial	No	Assess feasibility for wetland restoration project on utility corridor and school (District 20) property.	H	Utility (ComEd); District 20	LCSMC; USACE	$20K/acre	EPA; Township: Lake County SMC	1–5 years
BCS 21, 28, 31, 33	See Fig 87	2.7, 4.8, 2.8, 3.7	Yes	No	Assess feasibility for wetland restoration project on publicly owned land.	H	Liberty-ville; County	LCSMC; USACE	$20K/acre	EPA; Township: Lake County SMC	1–5 years
BCS 32	See Fig 87	16.7	Yes	No	Assess feasibility for wetland restoration project in Butler Lake Park and adjacent to west side of stream.	M	Libertyville	LCSMC; USACE	$20K/acre	EPA; Township: Lake County SMC	5–10 years
BCN 39	See Fig 87	2.7	No	No	Assess feasibility for wetland restoration project on existing private agricultural land.	L	Private	NRCS; LCSMC; USACE	$20K/acre	EPA; Township: Lake County SMC	10+ years
BCN 52	See Fig 87	5.2	No	No	Assess feasibility for wetland restoration project on existing private agricultural land.	L	Private	NRCS; LCSMC; USACE	$20K/acre	EPA; Township: Lake County SMC	10+ years

STREAM RESTORATION
Streambank restoration projects are implemented primarily to improve water quality but also have excellent secondary benefits for reducing flooding and improving natural resources. They improve water quality by stabilizing eroded banks, improve flooding by reconnecting channelized streams to the historic floodplain, and improve natural resources by improving habitat.

Technical and Financial Assistance Needs: Stream restorations are often complex and require high technical and financial assistance needs to protect land, design, construct, monitor, and maintain the restoration. The project becomes more complex when constructed on reaches that flow through several governing bodies or private owners.

BMP ID#	Location	Acres/ Linear Feet	Public	Protected	Action Recommendation	Priority	Lead Agency/Owner	Sources of Technical Assistance	Cost Estimate	Funding Mechanism	Schedule (Short, Medium, Long Term)
BC02	Rt. 137 to Rt. 21	3200 lf	No	Partial	Restore streambanks; 2) Remove invasive shrub and tree species and replace with native vegetation; 3) Construct artificial pools and riffles as well as structures such as rootwads and crosslogs to increase in-stream habitat.	M	Liberty-ville Private	USACE; IDNR-OWR; LCSMC; NRCS; SWCD; IDNR; USACE	$100–300/lf	EPA; Township: LCSMC; NFWF- Native Plant Initiative; NRCS	5–10 years
BC04	Butler Lake Park to Bike Path Bridge	2500 lf	Yes	Partial	1) Remeander highly channelized stream and/or restore streambanks; 2) Increase buffer width to at least 30 feet on left bank and remove invasive trees and plant native vegetation; 3) Construct artificial pools and riffles as well as structures such as rootwads and crosslogs to increase in-stream habitat.	H	Liberty-ville Private	USACE; IDNR-OWR; LCSMC; NRCS; SWCD: IDNR	$100–300/lf	EPA; Township: LCSMC; NFWF- Native Plant Initiative; NRCS	1–5 years
BC05	Winchester Rd. to confluence	3500 lf	Partial	Partial	1) Remeander highly channelized stream and/or restore streambanks; 2) Increase buffer width to at least 30 feet on right bank and remove invasive trees and replace with native vegetation; 3) Construct artificial pools and riffles as well as structures such as rootwads and crosslogs to increase in-stream habitat.	H	Liberty-ville Private	USACE; IDNR-OWR; LCSMC; NRCS; SWCD: IDNR; USACE	$100–300/lf	EPA; Township: LCSMC; NFWF- Native Plant Initiative; NRCS	1–5 years
BC06	St. Mary's Lake to Butler Lake	2500 lf	Partial	Partial	1) Remeander moderately channelized stream and/or restore streambanks; 2) Remove invasive shrub and tree species and plant native vegetation.	L	Liberty-ville Private	USACE; IDNR-OWR; LCSMC; NRCS; SWCD: IDNR	$100–300/lf	EPA; Township: LCSMC; NFWF- Native Plant Initiative	10+ years
BC11	Confluence of BCN to Upper Branch BCN	4500 lf	No	No	1) Remeander moderately channelized stream and/or restore streambanks; 2) Increase buffer width to at least 30 feet in residential areas by removing turf grass and planting native species.	M	Private	IDNR-OWR, USACE; NRCS; SWCD; LCSMC; IDNR	$100–300/lf	EPA; Township: LCSMC; NFWF- Native Plant Initiative	5–10 years

Table 64. (Cont.)

LIBERTYVILLE

BMP ID#	Location	Acres/ Linear Feet	Public	Protected	Action Recommendation	Priority	Lead Agency/Owner	Sources of Technical Assistance	Cost Estimate	Funding Mechanism	Schedule (Short, Medium, Long Term)
LAKE SHORELINE RESTORATION Lake shoreline restoration projects are implemented primarily to buffer the waterbody and have equal benefits for improving water quality and improving natural resources by introducing native plants that are beneficial to wildlife.											
Technical and Financial Assistance Needs: Lake shoreline restoration is not as complex as restoring stream reaches but still requires a moderate amount of technical and financial assistance to complete the project. The cost for implementing this kind of project increases depending on the amount of invasives that need to be removed and any grading work involved.											
Butler Lake	Libertyville	n/a	Yes	Yes	1) Stabilize minor/moderate erosion around north shoreline of Butler Lake and Butler Lake Park using bioengineering techniques; 2) Remove or control low abundance (0-33%) of exotic or invasive species (reed canary grass, buckthorn, honeysuckle) around entire lake and replace with native vegetation.	L	Libertyville	- USACE; IDNR OWR; LCSMC; NRCS; SWCD	$100–300/lf	EPA; Township: LCSMC; Lake Association; LC-Health Department; USDA	10+ years
St. Mary's Lake	Mundelein/ Libertyville	n/a	No	No	1) Stabilize moderate (34-66%) erosion mostly along north and south shorelines using bioengineering techniques; 2) Remove moderate (40-60%) exotic or invasive species (purple loosestrife, buckthorn) and replace with native vegetation.	M	St. Mary's Seminar	USACE; IDNR-OWR; LCSMC; NRCS; SWCD	$100–300/lf	EPA; Township: LCSMC; Lake Association; LC-Health Department; USDA	5–10 years
IMC Lake	Libertyville	6.7	No	No	1) Stabilize moderate (34-66%) erosion mostly along southern shoreline using bioengineering techniques.	M	Private	USACE; IDNR-OWR; LCSMC; NRCS; SWCD	$100–300/lf	EPA; LCSMC; LC-Health Department; USDA	5–10 years
PREVENTING SOIL EROSION ON EXISTING AGRICULTURAL PARCELS WITHIN POLLUTANT LOADING "HOTSPOT" SMUs The primary function of implementing agricultural BMPs is to improve the quality of water originating from agricultural fields. They usually have small secondary benefits for improving natural resources and decreasing flooding.											
Technical and Financial Assistance Needs: Agricultural BMP implementation is a relatively straight forward process with low to moderate technical assistance needs and medium financial assistance needs. Support increases as BMPs become more complex. For example, no till cropping requires little effort for the farmer, but installing large filter strips can be quite complex.											
BCN: 2	Ag field in central portion of watershed	n/a	No	No	Implement erosion control agricultural BMPs such as filter strips and no till cropping along highly erodible soils on agricultural parcel. Also reduce fertilizer usage on entire parcel.	H	Private	NRCS; SWCD	Var.	NRCS	1–5 years
BCN: 5	Ag field in western portion tof watershed	5.1	No	No	Implement erosion control agricultural BMPs such as filter strips and no till cropping along highly erodible soils on southern portion of agricultural parcel. Also reduce fertilizer usage on entire parcel.	H	Private	NRCS; SWCD	Var.	NRCS	1–5 years
BCN: 7	Ag field in western portion of watershed	14.2	No	No	Implement erosion control agricultural BMPs such as filter strips and no till cropping along small erodible soils area on western portion of agricultural parcel. Also reduce fertilizer usage on entire parcel.	M	Private	NRCS; SWCD	Var.	NRCS	5–10 years
BCS: 11	County Ag field in eastern portion of watershed	50.2	Yes	No	Implement erosion control agricultural BMPs such as filter strips and no till cropping along small erodible soils area on southwest portion of agricultural parcel. Also reduce fertilizer usage on entire parcel.	M	Lake County	NRCS; SWCD	Var.	NRCS	5–10 years
PREVENTING SOIL EROSION ON PROJECTED FUTURE DEVELOPMENTS WITHIN POLLUTANT LOADING "HOTSPOT" SMUs The primary function of implementing strict erosion control inspection and implementation on future developments is to control erosion from development sites thereby maintaining or improving water quality originating from the site.											
Technical and Financial Assistance Needs: Implementing erosion control inspection and implementation practices usually comes at very little financial expense to a developer and is currently required by NPDES II and the WDO. Technical assistance involved with implementing the practice is moderate and usually involves the governing body, LCSMC, IEPA, and SWCD as primary parties involved.											
BCN: 3	Existing Forest & Grassland	n/a	No	No	Existing forest and grassland parcel is projected to become industrial by 2030. Implement strict soil erosion inspection and implementation per the WDO or NPDES II when/if developed.	H	Applicant	Munic.; SWCD; LCSMC; IEPA	Var.	Developer	During construction, especially mass grading
BCN: 5	Existing Ag field	n/a	No	No	Existing agricultural parcel is projected to become industrial by 2030. Implement strict soil erosion inspection and implementation per the WDO or NPDES II when/if developed.	H	Applicant	Munic.; SWCD; LCSMC; IEPA	Var.	Developer	During construction, especially mass grading

Table 66. (Cont.)

LIBERTYVILLE

BMP ID#	Location	Acres/ Linear Feet	Public	Protected	Action Recommendation	Priority	Lead Agency/Owner	Sources of Technical Assistance	Cost Estimate	Funding Mechanism	Schedule (Short, Medium, Long Term)
BCS: 41	Existing Ag field	12.4	No	No	Existing open space parcel is projected to become commercial by 2030. Implement strict soil erosion inspection and implementation per the WDO or NPDES II when/if developed.	H	Applicant	Munic.; SWCD; LCSMC; IEPA	Var.	Developer	During construction, especially mass grading
POTENTIAL TRAIL CONNECTIONS The primary function of identifying potential trail connections is to expand greenways and recreational opportunities for the community.											
Technical and Financial Assistance Needs: The technical and financial assistance needed to implement trail projects is usually high because it involves coordination between multiple agencies across multiple jurisdictions.											
	See Fig 92	33.1	Yes	Yes	Determine feasibility to extend proposed or status unknown trails through School District owned parcel.	H	School District	IDNR; IDOT; BCPC; PB&D; MUNIC; LCDOT; NRCS	Var.	FHA-Rec/Trails Program; LWCF; US Dept. of Housing & Urban Development	1–5 years
	Varies (see Fig 92)	Var.	No	No	Determine feasibility to extend proposed or status unknown trails through privately owned utility corridor parcels.	H	Private (utility)	IDNR; IDOT; BCPC; PB&D; MUNIC; LCDOT; NRCS	Var.	FHA-Rec/Trails Program; LWCF; US Dept. of Housing & Urban Development	1–5 years
	Varies (see Fig 92)	Var.	No	No	Determine feasibility to extend proposed or status unknown trails through privately owned parcels.	H	Private	IDNR; IDOT; BCPC; PB&D; MUNIC; LCDOT; NRCS	Var.	FHA-Rec/Trails Program; LWCF; US Dept. of Housing & Urban Development	1–5 years
	Varies (see Fig 92)	Var.	Yes	No	Determine feasibility to extend proposed or status unknown trails through Libertyville owned parcel.	H	Libertyville	IDNR; IDOT; BCPC; PB&D; MUNIC; LCDOT; NRCS	Var.	FHA-Rec/Trails Program; LWCF; US Dept. of Housing & Urban Development	1–5 years
	Varies (see Fig 92)	Var.	Yes	Yes	Determine feasibility to extend proposed or status unknown trails through privately owned parcels.	H	Private	IDNR; IDOT; BCPC; PB&D; MUNIC; LCDOT; NRCS	Var.	FHA-Rec/Trails Program; LWCF; US Dept. of Housing & Urban Development	1–5 years
	Varies (see Fig 92)	1.6, 7.9	Yes	No	Determine feasibility to extend proposed or status unknown trails through Libertyville owned parcel.	H	Libertyville	IDNR; IDOT; BCPC; PB&D; MUNIC; LCDOT; NRCS	Var.	FHA-Rec/Trails Program; LWCF; US Dept. of Housing & Urban Development	1–5 years
OPEN SPACE PARCEL PROTECTION AND ENHANCEMENT ADJACENT TO PROTECTED ECOLOGICALLY SIGNIFICANT AREAS AND/OR T&E SPECIES LOCATIONS The primary function for protecting and enhancing unprotected open parcels adjacent to already protected high quality parcels or parcels with known T&E species is to provide permanent buffer protection and/or add to their size and function.											
Technical and Financial Assistance Needs: Protecting and enhancing parcels is not always an easy process and involves close technical coordination with the owner and agency that will protect the parcel in perpetuity. Cost to protect open space can be substantial if the transaction involves acquisition, but is much less expensive if deed or conservation easements are used instead.											
BCS: 2, 3, 4, 5, 7, 8, 9	Along Bull Creek South	59.3, 4.4, 6.8, 9.5, 1.6, .4, 1.6	Yes	No	Protect and enhance unprotected publicly owned parcels adjacent to Bull Creek South using conservation easements or other similar techniques.	H	Liberty-ville County	IDNR; IDOT; BCPC; PB&D; MUNIC; LCDOT; NRCS	Var.	FHA-Rec/Trails Program; LWCF; US Dept. of Housing & Urban Development	1–5 years
BCS: 10, 11	Along Bull Creek South	1.0, 12.1	No	No	Protect and enhance unprotected privately owned parcels adjacent to Bull Creek South using conservation easements or other similar techniques.	H	Private	IDNR; IDOT; BCPC; PB&D; MUNIC; LCDOT; NRCS	Var.	FHA-Rec/Trails Program; LWCF; US Dept. of Housing & Urban Development	1–5 years

Table 67. Site Specific Action Plan Recommendations for Libertyville Township

LIBERTYVILLE TOWNSHIP

BMP ID#	Location	Acres/ Linear Feet	Public	Protected	Action Recommendation	Priority	Lead Agency/Owner	Sources of Technical Assistance	Cost Estimate	Funding Mechanism	Schedule (Short, Medium, Long Term)
DETENTION BASIN RETROFITS Detention basin retrofit recommendations included in this plan primarily address reducing flooding and improving water quality but also improve natural resources as a secondary function.											
Technical and Financial Assistance Needs: Technical assistance needed to implement the recommendations is generally low to medium while financial assistance is generally moderate. Installing post 1992 outfall retrofits require less technical assistance than installing a native plant buffer. Private landowners will require the greatest assistance.											
BCN 66	Peterson Rd.	n/a	No	No	Determine feasibility to convert to post 92 release rates. Basin is located just upstream from nuisance flooding areas 11 and 2.	H	Private	LCSMC	$2–4K	LCSMC Watershed Board; County Drainage Fund	1–5 years
BCN 67	Bob-O-Link Ln.	n/a	No	Yes	Determine feasibility to convert to post 92 release rates. Remove rip-rap and plant native vegetation along slopes.	M	Private	LCSMC, County	$5K/acre (remove rip-rap and plant)	LCSMC Watershed Board; County Drainage Fund; EPA 319; DNR C2000; HOA fees	5–10 years
BCS 47	Janus Ct.	n/a	No	Yes	Determine feasibility to convert to post 92 detention release rates. Basin is located adjacent to FPA 14-01. Plant native vegetation along slopes and determine feasibility to convert to wet bottom.	H	Private	LCSMC	$2–4K (92 release); 3K/acre (Planting); wet bottom convert. varies	LCSMC Watershed Board; County Drainage Fund; EPA 319; DNR C2000; HOA fees	1–5 years
REGIONALLY SIGNIFICANT STORAGE LOCATIONS Implementation of potential Regionally Significant Storage Locations primarily prevents and reduces flooding downstream but also improves water quality and natural resources if planted with native vegetation.											
Technical and Financial Assistance Needs: Technical and financial assistance needed to implement storage locations is generally high because of land protection, design, permitting, and construction costs.											
BCN 17	Southeast corner of Casey and 137	20.1	No	No	Determine feasibility to construct multiobjective storage area.	M	Private	LCSMC; USACE	$20–30K/acre	LCSMC Watershed Board; USACE	5–10 years
BCN 22	Northeast corner of Casey and 45	128.9	Yes	Yes	Determine feasibility to construct multiobjective storage area.	H	Libertyville Township	LCSMC; USACE	$20–30K/acre	LCSMC Watershed Board; USACE	1–5 years
BCN 31	Ag land north of Casey	52.4	Yes	Yes	Determine feasibility to construct multiobjective storage area.	H	Libertyville Township	LCSMC; USACE	$20–30K/acre	LCSMC Watershed Board; USACE	1–5 years
BCN 34	See Figure 83	17.4	Yes	Yes	Determine feasibility to construct multiobjective storage area.	H	Libertyville Township	LCSMC; USACE	$20–30K/acre	LCSMC Watershed Board; USACE	1–5 years
BCS 47	See Figure 83	157.6	No	Yes	Determine feasibility to construct multiobjective storage area adjacent to FPA 14-01.	H	State and Private	LCSMC; USACE	$20–30K/acre	LCSMC Watershed Board; USACE	1–5 years
STREAM MAINTENANCE Most stream maintenance is conducted to keep the stream channel clear of debris that may cause flooding issues. Water quality also benefits when problem pipes or hydraulic structures are repaired.											
Technical and Financial Assistance Needs: Technical and financial assistance associated with stream maintenance is generally low for minor tasks such as removing debris jams and repairing problematic hydraulic structures and discharge points. Feasibility studies for dam and bridge repairs and removals require much more technical and financial support.											
BB001	Rt. 21 to Des Plaines River (PD #27; HS #48)	2000 lf	Yes	Yes	1) Install grade control structures that increase flow velocity and transport sediments; 2) Remove debris jam that is creating new eroded channel (PD #27); 3) Remove chain link fence from channel (HS #48).	H	LCFPD	IDNR-OWR; USACE; LCSMC; NRCS	$1–2K (structures); $100– 500 (debris jam removal); $200 (chainlink fence)	Township; DNR C2000; USACE; EPA 319; LCSMC Watershed Board	1–5 years

Table 67. (Cont.)

LIBERTYVILLE TOWNSHIP

BMP ID#	Location	Acres/ Linear Feet	Public	Protected	Action Recommendation	Priority	Lead Agency/Owner	Sources of Technical Assistance	Cost Estimate	Funding Mechanism	Schedule (Short, Medium, Long Term)
BB002	Casey Rd. to Rt. 21 PD #68, 71; HS #76; D #8	3500 lf	Partial	Partial	1) Remove debris jams and install grade control structures that increase flow velocity and transport sediments.; 2) Stabilize eroded swale (PD #68, 71); 3) Remove chain link fence from channel (HS #76); 4) Determine feasibility to remove dam (D #8).	H	Libertyville Township/ Private	IDNR-OWR; USACE; LCSMC; NRCS; SWCD	$200–500 (debris jams); $1–3K (stabilize swale); $200 (chain link fence); Dam removal varies each	Township; DNR C2000; USACE; EPA 319; LCSMC Watershed Board	1–5 years
BB003	Forest edge to Casey Rd. (PD #97, 98, 106)	2000 lf	No	Yes	1) Install grade control structures that increase flow velocity and transport sediments throughout reach; 2) Remove silt blocking outflow (PD #97); 3) Stabilize 7-foot swale at pipe outfall (PD #98); 4) Cut plastic corrugated pipe flush with bank and stabilize (PD #106).	M	Private	IDNR-OWR; USACE; LCSMC; NRCS	1–3K each (all PDs); $1–2K (structures);	Township; DNR C2000; USACE; EPA 319; LCSMC Watershed Board	5–10 years
BB004	Almond Rd. to Forest edge (PD #119, 126, 136)	5500 lf	No	Yes	1) Remove debris jams and install structures that increase flow velocity and transport sediments throughout reach; 2) Stabilize swale possibly with rock check dams (PD #119); 6) Stabilize small tributary and remove adjacent woody vegetation to allow light to canopy floor (PD #126); 7) Stabilize swale and remove tree and roots causing erosion (PD #136).	M	Private	IDNR-OWR; USACE; LCSMC; NRCS	1-3K each (all PDs); $200–500 (debris jams); $1–2K (struc-tures)	Township; DNR C2000; USACE; EPA 319; LCSMC Watershed Board	5–10 years
BB005	Almond Marsh to Almond Rd. (D #3)	700 lf	No	Yes	Determine feasibility to remove dam or create more friendly fish passage.	M	Private	USACE; LCSMC; NRCS; SWCD	Var.	EPA 319; Township; Municipality	5–10 years
BB006	Rt. 45 to Almond Marsh (PD #222; D #1, 15)	3000 lf	Yes	Yes	1) Remove debris jams throughout reach and install structures that increase flow velocity and transport sediment downstream ; 2) Cut plastic corrugated pipe flush with banks and stabilize (PD#222); 3) Determine feasibility to construct more fish passage friendly structure (D#1, 15).	H	Libertyville Township	IDNR-OWR; USACE; LCSMC; SWCD	$200–500 each (debris jams); $1–3K (stabilize (pipe/ bank); dams analysis varies	Township; DNR C2000; USACE; EPA 319; LCSMC Watershed Board	1–5 years
BB010	Wetlands to confluence with Bull's Brook	1000 lf	No	Partial	Remove debris jams throughout reach.	H	Private	IDNR-OWR; USACE; LCSMC	$200–500 each	Township; DNR C2000; USACE	1–5 years
BB: D #5 (no stream reach ID)	n/a	n/a	No	No	Determine feasibility to remove dam (D # 5).	L	Private	USACE; LCSMC; NRCS; SWCD	Var.	EPA 319; Township; Municipality	10+ years
BC01	Rt. 21 to Des Plaines River (DP #SO; HS #SV, ST/D #18)	2500 lf	Yes	Yes	Cut corrugated drainage pipe flush with bank and stabilize (PD #SO); 2) Remove chain link fence from stream channel (HS #SV); 3) Investigate feasibility to remove boulder dam (HS #ST/D #18).	L	LCFPD	USACE; LCSMC; NRCS; SWCD	$1–3K (stabilize pipe);$200 (fence); $5–10K (dam removal)	EPA 319; Township; Municipality	10+ years
BC02	Rt. 137 to Rt. 21 (DP #SZ; D #9)	3200 lf	No	No	1) Cut plastic pipe flush with bank and stabilize with rip-rap and erosion control blanket; 2) Investigate source of white sub--stance coming from pipe (DP #SZ); 3) Determine feasibility to remove dam to allow fish passage (D #9).	H	IEPA; Township; Owner	USACE; LCSMC; NRCS; SWCD; IEPA	$1–3K (stabilize pipe); dam analysis varies	EPA 319; LCSMC Watershed Board; Township; Municipality	1–5 years
BC03	Bike Path Bridge to Rt. 137 (D #16)	5200 lf	Partial	Partial	1) Remove debris jams throughout reach and install structures that increase flow velocity and transport sediments; 2) Deter-mine feasibility to remove dam to allow fish passage (D #16).	H	Libertyville Township	IDNR-OWR; USACE; LCSMC; SWCD	$200–500 each (debris jams); $1–2K each (structures); dam analysis varies	Township; DNR C2000; USACE; EPA 319; Municipality	1–5 years
BC08	Midlothian Rd. to Loch Lomond (HS# WP; D #11)	2800 lf	Yes	Yes	1) Remove debris jams throughout reach; 2) Remove silt from culvert (HS #WP); 3) Determine feasibility to create more friendly fish passage (D #11).	H	Park District	IDNR-OWR; USACE; LCSMC; NRCS; SWCD	$200–500 each (debris jams); $200 (remove silt) dam analysis varies	Township; DNR C2000; USACE; EPA 319; Municipality	1–5 years

Table 67. (Cont.)

LIBERTYVILLE TOWNSHIP

BMP ID#	Location	Acres/ Linear Feet	Public	Protected	Action Recommendation	Priority	Lead Agency/Owner	Sources of Technical Assistance	Cost Estimate	Funding Mechanism	Schedule (Short, Medium, Long Term)
BC09	Kettering Rd. to Midlothian Rd. (PD #WX)	2500 lf	No	No	1) Remove debris jams; 2) Stabilize agricultural drainage pipe (PD #WX).	H	Private	IDNR-OWR; USACE; LCSMC	$200–500 each (debris jams); $1–3K (stabilize pipe)	Township; DNR C2000; USACE; EPA 319; LCSMC Watershed Board	1–5 years
BC11	Confluence of BCN Upper Branch to BCN (HS #XO)	4500 lf	No	No	1) Remove debris jams throughout reach; 2) Remove chain link fence from stream channel (HS#XO).	H	Private	IDNR-OWR; USACE; LCSMC	$200–400 each (debris jams); $200 (fence)	Township; DNR C2000; USACE; EPA 319; Municipality	1–5 years
BC12	Ag field edge to confluence of BCN and Upper Branch	4500 lf	Yes	Yes	1) Remove debris jams throughout reach and install structures that increase flow velocity and transport sediment; 2) Stabilize soils around metal corrugated pipe using bioengineering techniques (HS #YC) .	H	Libertyville Township	IDNR-OWR; USACE; LCSMC; SWCD	$200–400 each (debris jams); $1–2K each (structures); $1–3K (pipe stabilization)	Township; DNR C2000; USACE; EPA 319; Municipality	1–5 years
BC13	Countryside Dr. to confluence of BCN and Upper Branch (HS #YX, ZD)	4000 lf	Yes	Yes	1) Monitor beaver dam on Townsip properly Remove debris jams throughout reach may consider installing structures that increase flow velocity and transport sediment; 2) Stabilize soils around metal corrugated pipe using bioengineering techniques (HS #ZD) .	M	Private Libertyville Township	IDNR-OWR; USACE; LCSMC; SWCD	$200–400 each (debris jams); $1–2K (structures); $5K (remove bridge); $5-8K (rebuilt culvert)	Township; DNR C2000; USACE; EPA 319; Municipality	5–10 years
BC14	Rt. 137 to Countryside Dr.	2000 lf	No	No	Remove debris jams throughout reach.	H	Private	IDNR-OWR; USACE; LCSMC	$200–400 each	Township; DNR C2000; USACE	1–5 years
BC15	Wisconsin Central Railroad to Rt. 137 (PD #ZU, ZW; HS #ZX)	4000 lf	Yes	Yes	1) Install grade control structures that increase flow velocity and transport sediments; 2) Stabilize clay pipe outlet with rip-rap and erosion control blanket to reduce severe erosion (PD #ZU); 3) Investigate source of petrochemical-like material coming from pipe (PD #ZW); 4) Remove 2 feet of silt from culvert under Route 45 (HS #ZX).	H	Township; County	IDNR-OWR; USACE; LCSMC; NRCS; IDOT, IDOT	$1–2K each (structures); $1–3K each (stabilize pipe); $500 (investigate) $1-2K (remove silt)	Township; DNR C2000; USACE; EPA 319; LCSMC Watershed Board	1–5 years
BC16	Rt. 137 to confluence of BCN and Lower Branch	2200 lf	Yes	Partial	Remove debris jams throughout reach.	H	Libertyville Township	IDNR-OWR; USACE; LCSMC	$200–400 each	Township; DNR C2000; USACE	1–5 years
REDUCING FLOODING AT FLOOD PROBLEM AREA (FPA) SITES AND NUISANCE FLOODING SITES The primary objective of implementing flood mitigation projects is to reduce existing flood damage. Secondary benefits include water quality and natural resource improvement depending on the nature of the project.											
Technical and Financial Assistance Needs: Technical and financial assistance needed to implement flood reduction projects varies. Creating depressional storage for example involves high technical and financial assistance needs. Correcting local drainage problems involves much less technical support and funding.											
NF-2	Bull Creek Dr.	n/a	No	No	Remove old tiles at local nuisance flooding at NF-2 and create overland channel with native plant buffer.	H	Private	NRCS; LCSMC; Township	$5–10K	LCSMC Watershed Board; County Drainage Fund; USACE	1–5 years
NF-11	Bull Creek Dr.	n/a	No	No	Conduct drainage maintenance at undersized culverts at Bull Creek Dr. (NF-11). Replace if necessary.	H	Private	LCDOT; LCSMC; Township	$5–10K (replacement)	LCSMC Watershed Board; County Drainage Fund; USACE	1–5 years
NF-1	Northeast corner of Casey and Almond	n/a	No	No	Connect local drainage nuisance flooding area at northeast corner of Almond and Casey Roads to wetland complex south of Casey Road via a pipe under Casey Road into a vegetated swale.	M	Libertyville Township/ Private	SWCD; LCSMC	$5–10K	LCSMC Watershed Board; County Drainage Fund; USACE; LCDOT	5–10 years
NF-6	Brookhill Subdivision	n/a	No	No	Improve local drainage along roadside swales in Brookhill subdivision to roadside drainage along Route 21.	M	Township/ County	County; LCSMC	$1–2K	LCSMC Watershed Board; County Drainage Fund; USACE	5–10 years

Table 67. (Cont.)

LIBERTYVILLE TOWNSHIP

BMP ID#	Location	Acres/ Linear Feet	Public	Protected	Action Recommendation	Priority	Lead Agency/Owner	Sources of Technical Assistance	Cost Estimate	Funding Mechanism	Schedule (Short, Medium, Long Term)
NF-5	Along Rt. 21	n/a	Yes	Yes	Improve local drainage problem along Route 21 to better convey water and reduce flooding in residential yards.	M	Forest Preserve District	LCSMC; Township	$1–2K	LCSMC Watershed Board; County Drainage Fund; USACE	5–10 years
NF-12, 13	Bull Creek Dr.	n/a	No	No	Remove any debris jams from channel then consider converting portions of yard that are frequently flooded into floodplain wetlands.	L	Private	IDNR-OWR; USACE; NRCS; LCSMC; Township	$15–20K per lot	LCSMC Watershed Board; County Drainage Fund; USACE	10+ years
FPA 14-01	Brookhill Subdivision	n/a	No	No	Determine feasibility to construct small storage area along residential lots adjacent to FPA 14-01 (overbank flooding).	H	Private	LCSMC; Township	Var.	LCSMC Watershed Board; County Drainage Fund; USACE	1–5 years
FPA 14-01	Brookhill Subdivision	n/a	No	No	Improve local drainage problem at FPA 14-01 (local drainage problem) by connecting to Route 21 drainage.	H	Private	LCSMC; Township	$1–3K	LCSMC Watershed Board; County Drainage Fund; USACE	1–5 years
PREVENTING FLOODING AT STRUCTURES IN 100-YEAR FLOODPLAIN The primary objective of preparing floodproofing plans for structures in the 100-year floodplain is to prevent future flood damage. Few secondary objectives address improving water quality and natural resources.											
Technical and Financial Assistance Needs: Technical assistance needed to prepare floodproofing plans is low while financial assistance is generally moderate and will require consultation with LCSMC and Lake County.											
See Fig 86	See Fig 86	Var.	Var.	Var.	Prepare and implement floodproofing plans for 12 identified structures in the 100-year floodplain.	H	LCSMC; County	Owner	$2–3K each	LCSMC; Lake County; FEMA Flood Mitigation Assistance Program	1–5 years
POTENTIAL WETLAND RESTORATION SITES Wetland restoration projects are implemented primarily to improve water quality but also have excellent secondary benefits for reducing flooding and improving natural resources.											
Technical and Financial Assistance Needs: Wetland restoration projects are typically complex and require high technical and financial assistance needs to protect land, design, construct, monitor, and maintain the restoration.											
BB 50	See Fig 87	19.0	Yes	Yes	Assess feasibility for wetland restoration project on Libertyville Township and private land.	H	Township Private	LCSMC; USACE	$20K/acre	EPA; Township: Lake County SMC	1–5 years
BB 71	See Fig 87	21.5	Yes	Yes	Assess feasibility for wetland restoration on protected parcels in Liberty Prairie Reserve.	H	LPC Private	LCSMC; USACE	$20K/acre	EPA; Township: Lake County SMC	1–5 years
BCN 54, 59, 56, 57	See Fig 87	4.3, 3.5, 15.6, 9.1	Yes	Yes	Assess feasibility for wetland restoration project on existing drained hydric soils on agricultural land in Liberty Prairie Reserve.	H	Private Township	LPC; NRCS; LCSMC; USACE	$20K/acre	EPA; Township: Lake County SMC	1–5 years
BCN 35, 45	See Fig 87	4.6, 16.8	Yes	Yes	Assess feasibility for wetland restoration project on Libertyville Township open space adjacent to ADID wetland #94.	H	Township	LCSMC; USACE	$20K/acre	EPA; Township: Lake County SMC	1–5 years
BCN 51, 55, 58	See Fig 87	3.6, 2.5, 6.1, 10.6	Yes	Yes	Assess feasibility for wetland restoration project on Libertyville Township open space adjacent to ADID wetland #94.	H	Township	LCSMC; USACE	$20K/acre	EPA; Township: Lake County SMC	1–5 years
BCN 40, 44, 46, 47	See Fig 87	10.1, 9.9, 9.5, 20.6	No	No	Assess feasibility for wetland restoration project on drained hydric soils on existing agricultural land.	H	Private	NRCS; LCSMC; USACE	$20K/acre	EPA; Township: Lake County SMC	1–5 years

Table 67. (Cont.)

LIBERTYVILLE TOWNSHIP

BMP ID#	Location	Acres/ Linear Feet	Public	Protected	Action Recommendation	Priority	Lead Agency/Owner	Sources of Technical Assistance	Cost Estimate	Funding Mechanism	Schedule (Short, Medium, Long Term)
STREAM RESTORATION Streambank restoration projects are implemented primarily to improve water quality but also have excellent secondary benefits for reducing flooding and improving natural resources. They improve water quality by stabilized eroded banks, improve flooding by reconnecting channelized streams to the historic floodplain, and improve natural resources by improving habitat.											
Technical and Financial Assistance Needs: Stream restorations are often complex and require high technical and financial assistance needs to protect land, design, construct, monitor, and maintain the restoration. The project becomes more complex when constructed on reaches that flow through several governing bodies or private owners.											
BB001	Rt. 21 to Des Plaines River	2000 lf	Yes	Yes	1) Implement streambank and in-stream BMPs to reduce severe erosion; 2) Remove invasive trees and shrubs to help establish herbaceous ground cover.	H	LCFPD	USACE; IDNR -OWR; LCSMC; NRCS; SWCD; IDNR	$100–300/lf	EPA; Township: LCSMC; NFWF- Native Plant Initiative	1–5 years
BB002	Casey Rd. to Rt. 21	3500 lf	Partial	Partial	1) Implement streambank and in-stream BMPs to reduce moderate erosion; 2) Remove invasive trees and shrubs to help establish herbaceous ground cover.	M	Private & Township	LCSMC; NRCS, IDNR; USACE; SWCD	$100–300/lf	LCSMC; NFWF- Native Plant Initiative; EPA; Township, Lake County	5–10 years
BB003	Forest edge to Casey Rd.	2000 lf	No	Yes	1) Remeander moderately channelized stream and/or restore streambanks; 2) Remove portion of turf grass lawn on right bank and replace with at least 30 feet of native vegetation.	M	Private	USACE; IDNR-OWR; LCSMC; NRCS; SWCD; IDNR	$100–300/lf	EPA; Township: LCSMC; NFWF—Native Plant Initiative	5–10 years
BB004	Almond Rd. to Forest edge	5500 lf	No	Yes	1) Implement streambank and in-stream BMPs to reduce severe erosion; 2) Remove invasive trees and shrubs from buffer to help establish herbaceous ground cover.	H	Private	USACE; IDNR-OWR; LCSMC; NRCS; SWCD; IDNR	$100–300/lf	EPA; Township: LCSMC; NFWF—Native Plant Initiative	1–5 years
BB005	Almond Marsh to Almond Rd. (D #3)	700 lf	No	Yes	Construct artificial pools and riffles as well as structures such as rootwads and crosslogs to increase in-stream habitat.	M	Private	LCSMC; NRCS; IDNR-OWR; USACE	$500–1500 each	NRCS	2–5 years
BB006	Rt. 45 to Almond Marsh	3000 lf	Yes	Yes	1) Implement streambank and in-stream BMPs to reduce moderate erosion; 2) Construct artificial pools and riffles as well as structures such as rootwads and crosslogs to increase in-stream habitat.	M	Libertyville Township	LCSMC; NRCS; IDNR-OWR; USACE; SWCD	$100–300/lf	NRCS; EPA; Township: LCSMC	5–10 years
BB008	Wetland east of Rt. 21 to Independence Grove (Dog Park)	500 lf	Yes	Yes	1) Specifically remove buckthorn along buffer and replace with native vegetation; 2) Construct artificial pools and riffles as well as structures such as rootwads and crosslogs to increase in-stream habitat.	M	LCFPD	LCSMC; NRCS, IDNR; IDNR-OWR; USACE	$4–8K/acre (Buckthorn); $500–1,500 each (Habitat)	LCSMC; NFWF—Native Plant Initiative; NRCS	5–10 years
BB009	Natural spring to ComEd Utilty	200 lf	Yes	Yes	Specifically remove box elder trees along buffer and replace with native vegetation.	H	Township	LCSMC; NRCS, IDNR	$4–8K/acre	LCSMC; NFWF—Native Plant Initiative	1–5 years
BB010	Wetlands to confluence with Bull's Brook	1000 lf	No	Partial	1) Implement streambank and in-stream BMPs to reduce severe erosion; 2) Specifically remove buckthorn along buffer and replace with native vegetation; 3) Construct artificial pools and riffles as well as structures such as rootwads and crosslogs to increase in-stream habitat.	H	Private	USACE; IDNR-OWR; LCSMC; NRCS; SWCD; IDNR	$100–300/lf	EPA; Township: LCSMC; NRCS; NFWF—Native Plant Initiative	1–5 years
BB011	Forest edge to confluence with tributary	1000 lf	No	Yes	1) Implement streambank and in-stream BMPs to reduce moderate erosion; 2) Selectively remove young native trees (i.e. maples) along buffer to increase sunlight to herbaceous layer; 3) Construct artificial pools and riffles as well as structures such as rootwads and crosslogs to increase in-stream habitat.	M	Private	LCSMC; NRCS, IDNR; IDNR-OWR; USACE; SWCD	$100–300/lf	LCSMC; NFWF- Native Plant Initiative; NRCS; EPA; Township	2–5 years
BC01	Rt. 21 to Des Plaines River	2500 lf	Yes	Yes	1) Remeander moderately channelized stream and/or restore streambanks; 2) Remove invasive shrub and tree species and replace with native vegetation; 3) Construct afrificial pools and riffles as well as structures such as rootwads adn crosslogs to increase in-stream habitat.	M	LCFPD	USACE; IDNR-OWR; LCSMC; NRCS; SWCD; IDNR	$100–300/lf	EPA; Township: LCSMC; NFWF—Native Plant Initiative; NRCS	2-10 years
BC02	Rt. 137 to Rt. 21	3200 lf	No	Partial	1) Remeander moderately channelized stream and/or restore streambanks; 2) Remove invasive shrub and tree species and replace with native vegetation;	M	Private	USACE; IDNR-OWR; LCSMC; NRCS; SWCD; IDNR; USACE	$100–300/lf	EPA; Township: LCSMC; NFWF—Native Plant Initiative; NRCS	5–10 years

Table 67. (Cont.)

LIBERTYVILLE TOWNSHIP

BMP ID#	Location	Acres/ Linear Feet	Public	Protected	Action Recommendation	Priority	Lead Agency/Owner	Sources of Technical Assistance	Cost Estimate	Funding Mechanism	Schedule (Short, Medium, Long Term)
BC03	Bike Path Bridge to Rt. 137	5200 lf	Partial	Partial	1) Remeander moderately channelized stream 2) Remove invasive shrub and tree species and plant native vegetation.	L	Libertyville; Private	USACE; IDNR-OWR; LCSMC; NRCS; SWCD; IDNR	$100–300/lf	EPA; Township: LCSMC; NFWF—Native Plant Initiative	10+ years
BC11	Confluence of BCN Upper Branch to BCN	4500 lf	No	No	1) Remeander moderately channelized stream and/or restore streambanks; 2) Increase buffer width to at least 30 feet in residential areas by removing turf grass and planting native species.	M	Private	IDNR-OWR, USACE; NRCS; SWCD; LCSMC; IDNR	$100–300/lf	EPA; Township: LCSMC; NFWF—Native Plant Initiative	5–10 years
BC12	Ag field edge to confluence of BCN and Upper Branch	4500 lf	Partial	Partial	1) Remeander moderately channelized stream and/or restore streambanks; 1) Control invasive species and replace with native vegetation along agricultural land.	M	Township; Private	LCSMC; NRCS, IDNR; IDNR-OWR; USACE; SWCD	$100–300/lf	LCSMC; NFWF—Native Plant Initiative	5–10 years
BC13	Countryside Dr. to confluence of BCN and Upper Branch	4000 lf	Yes	Yes	1) Remeander highly channelized stream and/or restore streambanks; 2) Remove invasive shrub and tree species and plant native vegetation.	H	Township	IDNR-OWR, USACE; NRCS; SWCD; LCSMC; IDNR	$100–300/lf	EPA; Township; LCSMC; NFWF—Native Plant Initiative	1–5 years
BC14	Rt. 137 to Countryside Dr.	2000 lf	No	No	1) Restore streambanks; 2) Increase buffer width to at least 30 feet in residential areas by removing turf grass and planting native vegetation.	M	Private	IDNR-OWR, USACE; NRCS; SWCD; LCSMC; IDNR	$100–300/lf	EPA; Township; LCSMC; NFWF—Native Plant Initiative	5–10 years
BC15	Central Railroad to Rt. 137	4000 lf	Yes	Yes	1) Remeander highly channelized stream and/or restore streambanks; 2) Remove invasive shrub and tree species and plant native vegetation.	H	Township; County	IDNR-OWR, USACE; NRCS; SWCD; LCSMC; IDNR	$100–300/lf	EPA; Township; LCSMC; NFWF—Native Plant Initiative	1–5 years
BC16	Rt. 137 to confluence of BCN and Lower Branch	2200 lf	Yes	Yes	1) Remeander moderately channelized stream and/or restore streambanks; 2) Remove invasive shrub and tree species and plant native vegetation; 3) Construct artificial pools and riffles as well as structures such as rootwads and crosslogs to increase in-stream habitat.	M	Township; County	IDNR-OWR, USACE; NRCS; SWCD; LCSMC; IDNR	$100–300/lf	EPA; Township; LCSMC; NFWF—Native Plant Initiative; NRCS	5–10 years

LAKE SHORELINE RESTORATION
Lake shoreline restoration projects are implemented primarily to buffer the waterbody and have equal benefits for improving water quality and improving natural resources by introducing native plants that are beneficial to wildlife.

Technical and Financial Assistance Needs: Lake shoreline restoration is not as complex as restoring stream reaches but still requires a moderate amount of technical and financial assistance to complete the project.The cost for implementing this kind of project increases depending on the amount of invasives that need to be removed and any grading work involved.

BMP ID#	Location	Acres/ Linear Feet	Public	Protected	Action Recommendation	Priority	Lead Agency/Owner	Sources of Technical Assistance	Cost Estimate	Funding Mechanism	Schedule (Short, Medium, Long Term)
Dog Training Pond	Dog Training Pond (see Fig 89)	n/a	Yes	Yes	1) Reduce severe erosion along southern shoreline and low to moderate erosion around remainder lake by using bio-engineering techniques; 2) Remove high (> 60%) exotic or invasive species (buckthorn, reed canary grass, purple loosestrife, honeysuckle) and replace with native vegetation; 3) Create dog access areas to lake.	H	LCFPD	USACE; IDNR-OWR; LCSMC; NRCS; SWCD	$100–300/lf	EPA; Township: LCSMC; Lake Association; LC-Health Department; USDA	1–5 years

PREVENTING SOIL EROSION ON EXISTING AGRICULTURAL PARCELS WITHIN POLLUTANT LOADING "HOTSPOT" SMUs
The primary function of implementing agricultural BMPs is to improve the quality of water originating from agricultural fields. They usually have small secondary benefits for improving natural resources and decreasing flooding.

Technical and Financial Assistance Needs: Agricultural BMP implementation is a relatively straight forward process with low to moderate technical assistance needs and medium financial assistance needs. Support increases as BMPs become more complex. For example, no till cropping requires little effort for the farmer, but installing large filter strips can be quite complex.

BMP ID#	Location	Acres/ Linear Feet	Public	Protected	Action Recommendation	Priority	Lead Agency/Owner	Sources of Technical Assistance	Cost Estimate	Funding Mechanism	Schedule (Short, Medium, Long Term)
BCN: 3, 4, 6	Ag fields in central portion of watershed	n/a	No	No	Implement erosion control agricultural BMPs such as filter strips and no till cropping along highly erodible soils on agricultural parcels. Also reduce fertilizer usage on entire parcel	H	Township Private	NRCS; SWCD	Var.	NRCS	1–5 years

Table 67. (Cont.)

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BMP ID#	Location	Acres/ Linear Feet	Public	Protected	Action Recommendation	Priority	Lead Agency/Owner	Sources of Technical Assistance	Cost Estimate	Funding Mechanism	Schedule (Short, Medium, Long Term)
POTENTIAL TRAIL CONNECTIONS The primary function of identifying potential trail connections is to expand greenways and recreational opportunities for the community.											
Technical and Financial Assistance Needs: The technical and financial assistance needed to implement trail projects is usually high because it involves coordination between multiple agencies across multiple jurisdictions.											
	See Fig 92	22.7	Yes	Yes	Determine feasibility to extend proposed or status unknown trails through Township owned parcels.	H	LPC Township	IDNR; IDOT; BCPC; PB&D; MUNIC; LCDOT; NRCS	Var.	FHA-Rec/Trails Program; LWCF; US Dept. of Housing & Urban Development	1–5 years
	Varies (see Fig 92)	Var.	No	No	Determine feasibility to extend proposed or status unknown trails through Privately owned utility corridor parcels.	H	LPC Private (utility)	IDNR; IDOT; BCPC; PB&D; MUNIC; LCDOT; NRCS	Var.	FHA-Rec/Trails Program; LWCF; US Dept. of Housing & Urban Development	1–5 years
	Varies (see Fig 92)	Var.	No	No	Determine feasibility to extend proposed or status unknown trails through privately owned parcels.	H	Private	IDNR; IDOT; BCPC; PB&D; MUNIC; LCDOT; NRCS	Var.	FHA-Rec/Trails Program; LWCF; US Dept. of Housing & Urban Development	1–5 years
	See Fig 92	38.2	Yes	Yes	Determine feasibility to extend proposed or status unknown trails through LCFPD owned parcels.	H	LCFPD	IDNR; IDOT; BCPC; PB&D; MUNIC; LCDOT; NRCS	Var.	FHA-Rec/Trails Program; LWCF; US Dept. of Housing & Urban Development	1–5 years
OPEN SPACE PARCEL PROTECTION AND ENHANCEMENT ADJACENT TO PROTECTED ECOLOGICALLY SIGNIFICANT AREAS AND/OR T&E SPECIES LOCATIONS The primary function for protecting and enhancing unprotected open parcels adjacent to already protected high quality parcels or parcels with known T&E species is to provide permanent buffer protection and/or add to their size and function.											
Technical and Financial Assistance Needs: Protecting and enhancing parcels is not always an easy process and involves close technical coordination with the owner and agency that will protect the parcel in perpetuity. Cost to protect open space can be substantial if the transaction involves acquisition, but is much less expensive if deed or conservation easements are used instead.											
13, 15, 16, 17, 18, 19, 20, 6	Along Bull Creek and Nature Preserves	0.6, 3.4, 34.8, 4.6, 4.8, 13.7, 18, 4.8	No	No	Protect and enhance unprotected privately owned parcel adjacent to ecologically significant areas using conservation easements or other similar techniques.	H	LPC Private	IDNR; IDOT; BCPC; PB&D; MUNIC; LCDOT; NRCS	Var.	FHA-Rec/Trails Program; LWCF; US Dept. of Housing & Urban Development	1–5 years

Table 68. Site Specific Action Plan Recommendations for Mundelein

MUNDELEIN

BMP ID#	Location	Acres/ Linear Feet	Public	Protected	Action Recommendation	Priority	Lead Agency/Owner	Sources of Technical Assistance	Cost Estimate	Funding Mechanism	Schedule (Short, Medium, Long Term)
DETENTION BASIN RETROFITS Detention basin retrofit recommendations included in this plan primarily address reducing flooding and improving water quality but also improve natural resources as a secondary function.											
Technical and Financial Assistance Needs: Technical assistance needed to implement the recommendations is generally low to medium while financial assistance is generally moderate. Installing post 1992 outfall retrofits require less technical assistance than installing a native plant buffer. Private landowners will require the greatest assistance.											
BCS 6	Cambridge North	n/a	No	No	Remove litter, plant natives along slopes.	M	Private	LCSMC; Mundelein	$3K/acre (planting)	EPA 319; DNR C2000; HOA fees	5–10 years
BCS 1	Fieldcrest	n/a	No	No	Treat algae, increase buffer width to at least 30 feet with native vegetation, unclog outlet.	M	Private	LCSMC; Mundelein	$1–2K (algae treatment); $3K/acre (planting); $100 (unclog outlets)	EPA 319; DNR C2000; HOA fees	5–10 years
BCS 2	Fieldcrest	n/a	No	No	Improve buffer area to at least 30 feet with native vegetation and treat algae.	M	Private	LCSMC; Mundelein	$3K/acre (planting); $1–2K (algae treatment)	EPA 319; DNR C2000; HOA fees	5–10 years
BCS 4	Fremont Public Library	n/a	No	No	Treat algae, increase buffer area to at least 30 feet.	M	Mundelein	LCSMC; Mundelein	$3K/acre (planting); $1–2K (algae treatment)	EPA 319; DNR C2000; HOA fees	5–10 years
BCS 54	Long Meadow Estates	n/a	No	No	Discourage geese usage by planting native vegetation (30 feet) and remove excess woody vegetation.	M	Private	None	$3K/acre (planting); $1–2K (woody removal)	EPA 319; DNR C2000; HOA fees	5–10 years
BCS 70	Long Meadow Estates	n/a	No	No	Remove excess litter and woody debris.	M	Private	None	$1–2K (woody removal)	EPA 319; DNR C2000; HOA fees	5–10 years
BCS 57	Long Meadow Estates	n/a	No	No	Treat algae.	L	Private	None	$1–2K/treatment	EPA 319; DNR C2000; HOA fees	10+ years
BCS 5	Mundelein Park	n/a	Yes	Yes	Improve buffer area with native vegetation; determine feasibility to convert to wet bottom.	M	Mundelein Park District	LCSMC	$3K/acre (planting); wet bottom conversion varies	EPA 319; DNR C2000; HOA fees	5–10 years
BCN 9, 10	Village Green Country Club	n/a	Yes	No	Determine feasibility to convert to post 92 release rates. Plant` native vegetation along side slopes to reduce erosion.	H	Mundelein	LCSMC	$2–4K (92 release) $3K/acre (planting)	LCSMC Watershed Board, EPA 319; DNR C2000; HOA fees	1–5 years
BCS 59	Community Park	n/a	Yes	Yes	Plant native vegetation along banks, remove trash, treat algae.	H	Mundelein Park District	LCSMC; Mundelein	$3K/acre; $1–2K (algae treatment)	EPA 319; DNR C2000; HOA fees	1–5 years
BCN 60	Ambria Dr.	n/a	Yes	Yes	Determine feasibility to convert to post 92 release rates.	M	Mundelein	LCSMC	$2–4K	LCSMC Watershed Board	5–10 years
BCS 61, 62, 63	Pine Meadow Golf Course	n/a	No	No	Determine feasibility to convert to post 92 release rates. Plant native vegetation along banks and use environmentally friendly dye in water.	M	Private	Mundelein LCSMC; Libertyville	$2–4K (92 release) $3K/acre (planting)	LCSMC Watershed Board, EPA 319; DNR C2000, HOA fees	5–10 years
BCS 98	The Woodlands	n/a	No	No	Improve buffer area with native vegetation; determine feasibility to convert to wet bottom.	M	Private	LCSMC	$3K/acre (planting); wet bottom conversion varies	EPA 319; DNR C2000; HOA fees	5–10 years
BCS 99	The Woodlands	n/a	No	No	Improve buffer area with native vegetation; determine feasibility to convert to wet bottom.	M	Private	LCSMC	$3K/acre (planting); wet bottom conversion varies	EPA 319; DNR C2000; HOA fees	5–10 years

Table 68. (Cont.)

MUNDELEIN

BMP ID#	Location	Acres/ Linear Feet	Public	Protected	Action Recommendation	Priority	Lead Agency/Owner	Sources of Technical Assistance	Cost Estimate	Funding Mechanism	Schedule (Short, Medium, Long Term)
BCS 100, 101, 102	Unnamed	n/a	No	No	Install settling basin.	M	Private	LCSMC	basin creation varies	EPA 319; DNR C2000; HOA fees	5–10 years
BCS 107, 108	Unnamed	n/a	No	No	Install settling basin and plant side slopes to native vegetation	M	Private	LCSMC	$3K/acre (planting); basin creation varies	EPA 319; DNR C2000; HOA fees	5–10 years
REGIONALLY SIGNIFICANT STORAGE LOCATIONS Implementation of potential Regionally Significant Storage Locations primarily prevents and reduces flooding downstream but also improves water quality and natural resources if planted with native vegetation.											
Technical and Financial Assistance Needs: Technical and financial assistance needed to implement storage locations is generally high because of land protection, design, permitting, and construction costs.											
BCS 3	See Fig 83	29.6	No	No	Determine feasibility to construct multiobjective storage area on existing agricultural land.	M	State	LCSMC; USACE	$20–30K/acre	LCSMC Watershed Board; USACE	5–10 years
BCS 9	See Fig 83	24.3	Yes	Yes	Determine feasibility to construct multiobjective storage area on existing open space.	M	Mundelein	LCSMC; USACE	$20–30K/acre	LCSMC Watershed Board; USACE	5–10 years
STREAM MAINTENANCE Most stream maintenance is conducted to keep the stream channel clear of debris that may cause flooding issues. Water quality also benefits when problem pipes or hydraulic structures are repaired.											
Technical and Financial Assistance Needs: Technical and financial assistance associated with stream maintenance is generally low for minor tasks such as removing debris jams and repairing problematic hydraulic structures and discharge points. Feasibility studies for dam and bridge repairs and removals require much more technical and financial support.											
BC07	Loch Lomond to St. Mary's Lake (PD #VQ, VZ; HS #VV, VW, VU, VX, WC; D #12, 19)	2500 lf	No	No	1) Remove debris jams throughout reach and install grade control structures that increase flow velocity and transport sediment; 2) Stabilize severely eroded area around steel pipe outlet (PD #VQ); 3) Stabilize 5 outlet pipes originating from St. Mary's Seminary (PD #VZ); 4) Remove chain link fence from stream channel (HS #VV, VW, VU, VX, WC); 5) Determine feasibility to create more friendly fish passage (D #12, 19).	H	Private (St. Mary's Seminary)	IDNR-OWR; USACE; LCSMC; NRCS	$200–500 each (debris jams); $1–2K (structures); $1–3K each (pipes); $200/each (fence); fish passage analysis varies	Township; DNR C2000; USACE; EPA 319; LCSMC Watershed Board; Municipality	1–5 years
BC10	Rt. 83 to Kettering Rd. (HS #HD)	2800 lf	No	No	1) Install grade control structures that increase flow velocity and transport sediments; 2) Remove silt from corrugated metal culvert (HS #HD).	L	State/ Private Owner	IDNR-OWR; USACE; LCSMC	$1–2K each (structures); $1K (remove silt)	Township; DNR C2000; USACE; EPA 319; Municipality	10+ years
REDUCING FLOODING AT FLOOD PROBLEM AREA (FPA) SITES AND NUISANCE FLOODING SITES The primary objective of implementing flood mitigatation projects is to reduce existing flood damage. Secondary benefits include water quality and natural resource improvement depending on the nature of the project.											
Technical and Financial Assistance Needs: Technical and financial assistance needed to implement flood reduction projects varies. Correcting local drainage problems generally requires low to moderate technical support and funding.											
NF-3	Along 176	n/a	No	No	Improve local drainage problem at residential lot by connecting to drainage swales or stormsewers along Route 176.	M	Liberty-ville	LCSMC	$1–2K each	LCSMC Watershed Board; USACE	5–10 years
NF-10	Subdivision at southeast corner of Casey and 45	n/a	No	No	Connect local drainage problem in subdivision to roadside ditch along Casey Road.	M	LCDOT Private	LCSMC; Township	$1–2K	LCSMC Watershed Board; County Drainage Fund; USACE	5–10 years

Table 68. (Cont.)

MUNDELEIN

BMP ID#	Location	Acres/ Linear Feet	Public	Protected	Action Recommendation	Priority	Lead Agency/Owner	Sources of Technical Assistance	Cost Estimate	Funding Mechanism	Schedule (Short, Medium, Long Term)
PREVENTING FLOODING AT STRUCTURES IN 100-YEAR FLOODPLAIN The primary objective of preparing floodproofing plans for structures in the 100-year floodplain is to prevent future flood damage. Few secondary objectives address improving water quality and natural resources.											
Technical and Financial Assistance Needs: Technical assistance needed to prepare floodproofing plans is low while financial assistance is generally moderate and will require consultation with LCSMC and Lake County.											
See Fig 86	See Fig 86	Var.	Var.	Var.	Prepare and implement floodproofing plans for 32 identified structures in the 100-year floodplain.	H	LCSMC; County	Owner	$2–3K each	LCSMC; Lake County; FEMA Flood Mitigation Assistance Program	1–5 years
POTENTIAL WETLAND RESTORATION SITES Wetland restoration projects are implemented primarily to improve water quality but also have excellent secondary benefits for reducing flooding and improving natural resources.											
Technical and Financial Assistance Needs: Wetland restoration projects are typically complex and require high technical and financial assistance needs to protect land, design, construct, monitor, and maintain the restoration.											
BCS 1, 2	See Fig 87	3.8, 5.0	No	Yes	Assess feasibility for wetland restoration project on state owned Route 53 corridor if it does not proceed.	M	State,	IDOT; LCSMC; USACE	$20K/acre	EPA; Township: Lake County SMC	5–10 years
BCS 11	See Fig 87	3.4	No	No	Assess feasibility for wetland restoration project on existing private agricultural land.	L	Private	NRCS; LCSMC; USACE	$20K/acre	EPA; Township: Lake County SMC	10+ years
STREAM RESTORATION Streambank restoration projects are implemented primarily to improve water quality but also have excellent secondary benefits for reducing flooding and improving natural resources. They improve water quality by stabilized eroded banks, improve flooding by reconnecting channelized streams to the historic floodplain, and improve natural resources by improving habitat.											
Technical and Financial Assistance Needs: Stream restorations are often complex and require high technical and financial assistance needs to protect land, design, construct, monitor, and maintain the restoration. The project becomes more complex when constructed on reaches that flow through several governing bodies or private owners.											
BC07	Loch Lomond to St. Mary's Lake	2500 lf	No	No	1) Remeander moderately channelized stream and/or restore streambanks and install in-stream BMPs; 2) Remove invasive shrub and tree species and plant native vegetation.	L	Private	USACE; IDNR-OWR; LCSMC; NRCS; SWCD; IDNR	$100–300/lf	EPA; Township: LCSMC; NFWF—Native Plant Initiative	10+ years
BC08	Midlothian Rd. to Loch Lomond	2800 lf	Yes	Yes	1) Remeander moderately channelized stream and/or restore streambanks and install in-stream BMPs; 2) Increase buffer width in residential areas by removing turf grass and planting native vegetation.	M	Mundelein Park District	USACE; IDNR-OWR; LCSMC; NRCS; SWCD	$100–300/lf	EPA; Township; LCSMC; NFWF—Native Plant Initiative	5–10 years
BC09	Kettering Rd. to Midlothian Rd.	2500 lf	Partial	Partial	1) Remeander moderately channelized stream and/or restore streambanks and install in-stream BMPs; 2) Control invasive species and replace with native vegetation along agricultural land.	L	Private	USACE; IDNR-OWR; LCSMC; NRCS; SWCD; IDNR	$100–300/lf	EPA; Township; LCSMC; NFWF—Native Plant Initiative; HOA	10+ years
BC10	Rt. 83 to Kettering Rd.	2800 lf	No	No	1) Remeander moderately channelized stream and/or restore streambanks; 2) Control invasive species and replace with native vegetation along agricultural land' 3) Construct artificial pools and riffles as well as structures such as rootwads and crosslogs to increase in-stream habitat.	M	Private	USACE; IDNR-OWR; LCSMC; NRCS; SWCD; IDNR	$100–300/lf	EPA; Township: LCSMC; NFWF—Native Plant Initiative; NRCS	5–10 years
LAKE SHORELINE RESTORATION AND FOLLOW UP MONITORING Lake shoreline restoration projects are implemented primarily to buffer the waterbody and have equal benefits for improving water quality and improving natural resources by introducing native plants that are beneficial to wildlife.											
Technical and Financial Assistance Needs: Lake shoreline restoration is not as complex as restoring stream reaches but still requires a moderate amount of technical and financial assistance to complete the project. The cost for implementing this kind of project increases depending on the amount of invasives that need to be removed and any grading work involved.											
St. Mary's Lake	St. Mary's Lake (see Fig 89)	n/a	No	No	1) Stabilize moderate and severe (34-66%) erosion mostly along north and south shorelines using bioengineering techniques; 2) Remove moderate (40-60%) exotic or invasive species (purple loosestrife, buckthorn) and replace with native vegetation.	M	St. Mary's Seminary	USACE; IDNR-OWR; LCSMC; NRCS; SWCD	$100–300/lf	EPA; Township: LCSMC; Lake Association; LC-Health Department; USDA	5–10 years

Table 68. (Cont.)

MUNDELEIN

BMP ID#	Location	Acres/ Linear Feet	Public	Protected	Action Recommendation	Priority	Lead Agency/Owner	Sources of Technical Assistance	Cost Estimate	Funding Mechanism	Schedule (Short, Medium, Long Term)
Loch Lomond Lake	Loch Lomond (see Fig 89)	n/a	No	No	1) Stabilize minor (20-40%) erosion around majority of lake using bioengineering techniques; 2) Remove low density (0-33%) exotic or invasive species and replace with native vegetation. 3) Monitoring entities include sampling for toxic blue green algae. Also see lake specific Watershed-Based Plan in Appendix R.	L	Home-owners Assoc.	USACE; IDNR-OWR; LCSMC; NRCS; SWCD	$100–300/lf	EPA; Township: LCSMC; Lake Association; LC-Health Department; USDA	10+ years
PREVENTING SOIL EROSION ON EXISTING AGRICULTURAL PARCELS WITHIN POLLUTANT LOADING "HOTSPOT" SMUs The primary function of implementing agricultural BMPs is to improve the quality of water originating from agricultural fields. They usually have small secondary benefits for improving natural resources and decreasing flooding.											
Technical and Financial Assistance Needs: Agricultural BMP implementation is a relatively straight forward process with low to moderate technical assistance needs and medium financial assistance needs. Support increases as BMPs become more complex. For example, no till cropping requires little effort for the farmer, but installing large filter strips can be quite complex.											
BCS: 1	Ag field in southwestern portion of watershed	28.1	No	No	Implement erosion control agricultural BMPs such as filter strips and no till cropping along small erodible soils area on northern portion of agricultural parcel. Also reduce fertilizer usage on entire parcel.	M	IDOT	NRCS; SWCD	Var.	NRCS	5–10 years
PREVENTING SOIL EROSION ON PROJECTED FUTURE DEVELOPMENTS WITHIN POLLUTANT LOADING "HOTSPOT" SMUs The primary function of implementing strict erosion control inspection and implementation on future develoments is to control erosion from development sites thereby maintaining or improving water quality originating from the site.											
Technical and Financial Assistance Needs: Implementing erosion control inspection and implementation practices usually comes at very little financial expense to a developer and is currently required by NPDES II and the WDO. Technical assistance involved with implementing the practice is moderate and usually involves the governing body, IEPA, LCSMC, and SWCD as primary parties involved.											
1	Exisiting Ag/ forest grassland area	35.2	No	No	Existing state owned agricultural and vacant forest/grassland parcels are projected to become part of the Route 53 corridor expansion by 2030. Implement strict soil erosion inspection and implementation per the WDO or NPDES II when being developed.	H	IDOT	Munic.; SWCD; LCSMC	Var.	IDOT	During construc-tion, esp. grading
POTENTIAL TRAIL CONNECTIONS The primary function of identifying potential trail connections is to expand greenways and recreational opportunities for the community.											
Technical and Financial Assistance Needs: The technical and financial assistance needed to implement trail projects is usually high because it involves coordination between multiple agencies across multiple jurisdictions.											
	See Fig 92	15, 1.2	Yes	Yes	Determine feasibility to extend proposed or status unknown trails through Mundelein Park District owned parcel.	H	Park District	IDNR; IDOT; BCPC; PB&D; MUNIC; LCDOT; NRCS	Var.	FHA-Rec/Trails Program; LWCF; US Dept. of Housing & Urban Development	1–5 years
	Varies (see Fig 92)	Var.	No	No	Determine feasibility to extend proposed or status unknown trails through privately owned parcels.	H	Private	IDNR; IDOT; BCPC; PB&D; MUNIC; LCDOT; NRCS	Var.	FHA-Rec/Trails Program; LWCF; US Dept. of Housing & Urban Development	1–5 years
	Varies (see Fig 92)	Var.	Yes	Yes	Determine feasibility to extend proposed or status unknown trails through Mundelein owned parcel.	H	Mundelein	IDNR; IDOT; BCPC; PB&D; MUNIC; LCDOT; NRCS	Var.	FHA-Rec/Trails Program; LWCF; US Dept. of Housing & Urban Development	1–5 years
OPEN SPACE PARCEL PROTECTION AND ENHANCEMENT ADJACENT TO PROTECTED ECOLOGICALLY SIGNIFICANT AREAS AND/OR T&E SPECIES LOCATIONS The primary function for protecting and enhancing unprotected open parcels adjacent to already protected high quality parcels or parcels with known T&E species is to provide permanent buffer protection and/or add to their size and function.											
Technical and Financial Assistance Needs: Protecting and enhancing parcels is not always an easy process and involves close technical coordination with the owner and agency that will protect the parcel in perpetuity. Cost to protect open space can be substantial if the transaction involves acquisition, but is much less expensive if deed or conservation easements are used instead.											
BCS: 1	Adjacent to St. Mary's Lake	290.1	No	No	Protect and enhance unprotected St. Mary's Seminary owned parcels or use conservation easements or other similar techniques.	H	Private	IDNR; IDOT; BCPC; PB&D; MUNIC; LCDOT; NRCS	Var.	FHA-Rec/Trails Program; LWCF; US Dept. of Housing & Urban Development	1–5 year

Table 69. Site Specific Action Plan Recommendations for Warren Township

WARREN TOWNSHIP

BMP ID#	Location	Acres/ Linear Feet	Public	Protected	Action Recommendation	Priority	Lead Agency/Owner	Sources of Technical Assistance	Cost Estimate	Funding Mechanism	Schedule (Short, Medium, Long Term)
DETENTION BASIN RETROFITS Detention basin retrofit recommendations included in this plan primarily address reducing flooding and improving water quality but also improve natural resources as a secondary function.											
Technical and Financial Assistance Needs: Technical assistance needed to implement the recommendations is generally low to medium while financial assistance is generally moderate. Installing post 1992 outfall retrofits require less technical assistance than installing a native plant buffer. Private landowners will require the greatest assistance.											
BB 74	Arbor Vista	n/a	Yes	Yes	Determine feasibility to convert to post 92 release rates.	M	Warren TWP	LCSMC	$2–4K	LCSMC County Drainage Fund	5–10 years
STREAM MAINTENANCE Most stream maintenance is conducted to keep the stream channel clear of debris that may cause flooding issues. Water quality also benefits when problem pipes or hydraulic structures are repaired.											
Technical and Financial Assistance Needs: Technical and financial assistance associated with stream maintenance is generally low for minor tasks such as removing debris jams and repairing problematic hydraulic structures and discharge points. Feasibility studies for dam and bridge repairs and removals require much more technical and financial support.											
BB006	Rt. 45 to Almond Marsh (PD #222; D #1, 15)	3000 lf	Yes	Yes	1) Remove debris jams throughout reach and install grade control structures that increase flow velocity and transport sediment downstream ; 2) Cut plastic corrugated pipe flush with banks and stabilize (PD#222); 3) Determine feasibility to construct more fish passage friendly structure (D#1, 15).	H	Libertyville Township	IDNR-OWR; USACE; LCSMC; SWCD	$200–500 each (debris jams); $1–3K (stabilize pipe/bank); Dams analysis varies	Township; DNR C2000; USACE; EPA 319; LCSMC Watershed Board	1–5 years
BB012	Arbor Vista to Almond Marsh (PD #189, 199, 201, 217; HS #189, 196; D#6)	3000 lf	Partial	Partial	1) Remove debris jams throughout reach and install structures that increase flow velocity and transport sediments downstream; 2) Remove rubber hose that drains hot tub from adjacent house (may contribute polluted water to stream) (PD #189); 3) Remove sump pump drain from stream channel (PD #199); 4) Cut plastic corrugated pipes flush with bank and stabilize (PD #201, 217); 5) Determine feasibility to remove dam.	H	LCFPD Private	IDNR-OWR; USACE; LCSMC; NRCS	$200–500 each (debris jams); $500–1000 each (structures); $1–3K (stabilize pipe); dam analysis varies	Township; DNR C2000; USACE; EPA 319; LCSMC Watershed Board	1–5 years
BB014	Arbor Vista to Almond Marsh (PD #281; HS #277)	1500 lf	Partial	Partial	1) Install grade control structures that increase flow velocity and transport sediments; 2) Cut plastic corrugated pipe flush with bank and stabilize (PD #281); 3) Remove foot bridge and stabilize eroded banks with bioengineering techniques (HS #277).	M	LCFPD Private	IDNR-OWR; USACE; LCSMC; SWCD	$1–2K each (structures); $1–3K (stabilize pipe); $200 (fence); $1–3K (remove bridge)	Township; DNR C2000; USACE; EPA 319; Township; Municipality	5–10 years
BB: D #2, 4 (no stream reach ID)	Warren Township	n/a	Yes	Yes	Determine feasibility to remove dam to allow fish passage (D #2, 4).	M	LCFPD	USACE; LCSMC; NRCS; SWCD	Var.	EPA 319; Township; Municipality	5–10 years
REDUCING FLOODING AT FLOOD PROBLEM AREA (FPA) SITES AND NUISANCE FLOODING SITES The primary objective of implementing flood mitigate projects is to reduce existing flood damage. Secondary benefits include water quality and natural resource improvement depending on the nature of the project.											
Technical and Financial Assistance Needs: Technical and financial assistance needed to implement flood reduction projects projects varies. Creating depressional storage for example involves high technical and financial assistance needs. Connecting local drainage problems generally involves much less technical support and funding.											
FPA 13-11	North of Arbor Vista	11.6	Partial	No	Determine feasibility to construct potential storage (26) adjacent to depressional flooding at FPA 13-11.	H	State and Private	LCSMC; USACE	$20–30K/acre	LCSMC Watershed Board; County Drainage Fund; USACE	1–5 years

Table 69. (Cont.)

WARREN TOWNSHIP

BMP ID#	Location	Acres/ Linear Feet	Public	Protected	Action Recommendation	Priority	Lead Agency/Owner	Sources of Technical Assistance (Short, Medium, Long Term)	Cost Estimate	Funding Mechanism	Schedule
POTENTIAL WETLAND RESTORATION SITES Wetland restoration projects are implemented primarily to improve water quality but also have excellent secondary benefits for reducing flooding and improving natural resources.											
Technical and Financial Assistance Needs: Wetland restoration projects are typically complex and require high technical and financial assistance needs to protect land, design, construct, monitor, and maintain the restoration.											
BB 64, 68, 69	See Fig 87	3.8, 2.8, 2.5	Yes	Yes	Assess feasibility for wetland restoration on Lake County Forest Preserve Land.	H	LCFPD	LCSMC; USACE	$20K/acre	EPA; Township: Lake County SMC	1–5 years
BB 65	See Fig 87	3.5	No	No	Assess feasibility for wetland restoration on privately owned land.	L	Private	LCSMC; USACE	$20K/acre	EPA; Township: Lake County SMC	10+ years
BB 70	See Fig 87	8.7	No	No	Assess feasibility for wetland restoration on state owned land proposed to be developed into Route 120 bypass if not located here.	H	State	LCSMC; USACE	$20K/acre	EPA; Township: Lake County SMC	1–5 years
STREAM RESTORATION Streambank restoration projects are implemented primarily to improve water quality but also have excellent secondary benefits for reducing flooding and improving natural resources. They improve water quality by stabilized eroded banks, improve flooding by reconnecting channelized streams to the historic floodplain, and improve natural resources by improving habitat.											
Technical and Financial Assistance Needs: Stream restorations are often complex and require high technical and financial assistance needs to protect land, design, construct, monitor, and maintain the restoration. The project becomes more complex when constructed on reaches that flow through several governing bodies or private owners.											
BB006	Rt. 45 to Almond Marsh	3000 lf	Yes	Yes	1) Implement streambank and in-stream BMPs to reduce moderate erosion; 2) Construct artificial pools and riffles as well as structures such as rootwads and crosslogs to increase in-stream habitat.	M	LPC Libertyville Township	LCSMC; NRCS; IDNR-OWR; USACE; SWCD	$100–300/lf	NRCS; EPA; Township: LCSMC	5–10 years
BB012	Arbor Vista to Almond Marsh	3000 lf		Yes	1) Implement streambank and in-stream BMPs to reduce severe erosion; 2) Remove invasive trees and shrubs along buffer and replant with native vegetation to help establish herbaceous ground cover.	H	Home-owners Assoc.; LCFPD	USACE; IDNR-OWR; LCSMC; NRCS; SWCD, IDNR	$100–300/lf	EPA; Township: LCSMC; NFWF—Native Plant Initiative	1–5 years
BB014	Arbor Vista to Almond Marsh	1500 lf			1) Implement streambank and in-stream BMPs to reduce moderate erosion; 2) Increase buffer width to at least 30 feet on left bank and remove box elder and buckthorn and replace with native vegetation; 3) Construct artificial pools and riffles as well as structures such as rootwads and crosslogs to increase in-stream habitat.	M	LCFPD; Private	USACE; IDNR-OWR; LCSMC; NRCS; SWCD; IDNR	$100–300/lf	EPA; Township: LCSMC; NFWF—Native Plant Initiative; NRCS	5–10 years
POTENTIAL TRAIL CONNECTIONS The primary function of identifying potential trail connections is to expand greenways and recreational opportunities for the community.											
Technical and Financial Assistance Needs: The technical and financial assistance needed to implement trail projects is usually high because it involves coordination between multiple agencies across multiple jurisdictions.											
	See Fig 92	9.5	Yes	Yes	Determine feasibility to extend proposed or status unknown trails through LCFPD owned parcel.	H	LPC LCFPD	IDNR; IDOT; BCPC; PB&D; MUNIC; LCDOT; NRCS	Var.	FHA-Rec/Trails Program; LWCF; US Dept. of Housing & Urban Development	1–5 years
	Varies (see Fig 92)	Var.	Yes	Yes	Determine feasibility to extend proposed or status unknown trails through Township owned parcels.	H	LPC Township	IDNR; IDOT; BCPC; PB&D; MUNIC; LCDOT; NRCS	Var.	FHA-Rec/Trails Program; LWCF; US Dept. of Housing & Urban Development	1–5 years

Table 69. (Cont.)

WARREN TOWNSHIP

BMP ID#	Location	Acres/ Linear Feet	Public	Protected	Action Recommendation	Priority	Lead Agency/Owner	Sources of Technical Assistance	Cost Estimate	Funding Mechanism	Schedule (Short, Medium, Long Term)
OPEN SPACE PARCEL PROTECTION AND ENHANCEMENT ADJACENT TO PROTECTED ECOLOGICALLY SIGNIFICANT AREAS AND/OR T&E SPECIES LOCATIONS The primary function for protecting and enhancing unprotected open parcels adjacent to already protected high quality parcels or parcels with known T&E species is to provide permanent buffer protection and/or add to their size and function.											
Technical and Financial Assistance Needs: Protecting and enhancing parcels is not always an easy process and involves close technical coordination with the owner and agency that will protect the parcel in perpetuity. Cost to protect open space can be substantial if the transaction involves acquisition, but is much less expensive if deed or conservation easements are used instead.											
BB 23, 31, 32, 33, 34	Adjacent to Nature Preserve	2.3, 15.4, 4.9, 4.9	No	No	Protect and enhance unprotected State owned parcels adjacent to ecologically significant area using conservation easements or other similar techniques.	H	State	IDNR; IDOT; BCPC; PB&D; MUNIC; LCDOT; NRCS	Var.	FHA-Rec/Trails Program; LWCF; US Dept. of Housing & Urban Development	1–5 years
BB 24, 26, 27, 28	Adjacent to Nature Preserve	38.6, 5.3, 38.6, 1.2	No	No	Protect and enhance unprotected privately owned parcels adjacent to ecologically significant area using conservation easements or other similar techniques.	H	LPC Private	IDNR; IDOT; BCPC; PB&D; MUNIC; LCDOT; NRCS	Var.	FHA-Rec/Trails Program; LWCF; US Dept. of Housing & Urban Development	1–5 years

CHAPTER 9.0

Evaluating Plan Performance

9.1 Interim Milestones and Progress Evaluation

Interim measurable milestones are directly tied to the watershed plan schedule *(Section 7)*. Milestones are essential when determining if management measures are being implemented and how effective they are at achieving plan goals and objectives over given time periods. This allows for periodic plan updates and changes that can be made if milestones are not being met.

Watersheds are often complex systems with varying degrees of interaction and interconnection between physical, chemical, biological, hydrological, habitat, and social characteristics. "Indicators" that reflect these characteristics may be used as a measure of watershed health. Goals and objectives in the watershed plan determine which indicators should be monitored to assess the success of the watershed plan. Many measurable indicators are included under the factors listed above. For example, physical indicators could include amount of sediment deposited in a stream reach or water temperature, whereas chemical and biological indicators could include phosphorus loads or fish health respectively. Social indicators can be measured using demographic data or for example the number of stream cleanup miles.

A successful watershed plan must involve stakeholder participation to get projects completed, and must include a feedback mechanism to measure or assess progress toward meeting goals. Watershed "Report Cards" provide this sort of information. Report cards are intended to provide brief descriptions of current conditions, suggest performance indicators that should be evaluated and monitored, milestones to be met, and remedial actions if milestones are not being met.

Bull Creek/Brook watershed report cards were developed for each of the 9 plan goals and are located at the end of this section. The milestones are based on short term (1–3 years), medium term (4–7 years) and long term (8+ years) objectives. Terms were used to help evaluate progress toward meeting goals and objectives. The milestones and "Report Cards" will be used to identify and track plan implementation to ensure that progress is being made towards achieving the plan goals and to make corrections as necessary.

In the early stages of the plan implementation process, watershed stakeholders should establish a sustainable watershed council that will meet at least quarterly to discuss watershed progress. During the monitoring process, the council should discuss the results of monitoring, assess each milestone "report card" using grade classifications, and adapt the watershed management plan accordingly. For example, the council could meet in 3 years to specifically reassess water quality goals and objectives in the watershed. The council would use the water quality goal "Report Card" to assess milestones for years 1–3. If any of the milestones are not met, the council would reference the remedial actions and notes/lessons learned sections on the report card then develop a strategy to either change the milestone or implement projects or actions to achieve the milestone.

When intended results are not being achieved, watershed stakeholders should ask and answer questions related to their efforts such as:

- Are BMPs being implemented in the correct areas and on schedule?
- Can BMPs be adjusted to be more effective in improving watershed health?
- Have water quality objectives and healthy biotic communities been attained?
- Has flood damage been reduced or prevented?
- Are the natural resources of the watershed improving?
- Is new development negatively impacting the environment?
- Have the designated uses of the water resources in the watershed been attained?
- Has the pubic become more informed about and involved in watershed issues?
- What funding sources have been utilized in improving the watershed?
- Has coordination between municipalities, townships, and other agencies improved?

Goal A

Protect and restore the natural resource components of the watershed's natural drainage system including:

- Bodies of water such as wetlands, lakes, ponds and streams;
- Highly erodible and hydric soils; and
- Natural prairie, wetland, savanna, and woodland landscapes,

These components make up native plant and animal communities and provide important habitats for threatened and endangered species.

Watershed Findings:

HIGH QUALITY NATURAL RESOURCES TO PRESERVE:

- 31 documented state threatened or endangered (T&E) species occurrences,
- 2 Illinois Natural Area Inventory sites & 3 dedicated Nature Preserves,
- 2 Forest Preserves,
- 11 ADID (high quality) wetlands,
- T&E fish nursery in Sanctuary Pond at Prairie Crossing.

Impacted Natural Resources:

- Aquatic habitat in lakes, streams and wetlands is impaired due to invasive plants, hydrology changes, erosion, and high sediment and nutrient loads. Wetland, riparian and shoreline buffers, stabilizing hydrology and reducing pollutant loads will improve aquatic habitat.
- 44% of pre-settlement hydric soils have been filled or drained and are no longer wetland. Wetlands are homes for an estimated 40% of the state's T&E species. Drained wetlands result in increased flows in streams. Wetland restoration and requiring wetland mitigation within the watershed will recover some of the wetland loss.
- Woodlands and savanna dominated by invasive plant species such as buckthorn, honeysuckle etc.

Threats to Natural Resources:

- Invasive plants are displacing native plant communities in lakes, wetlands and uplands.
  Recommended: Recognizing and managing invasive plants while addressing the root causes of their proliferation.
- 25% of the soils in the watershed are considered highly erodible. Erosion from agriculture and future development in these areas increases the likelihood of sediment and nutrient loading to waterbodies.
  Recommended: Require proper soil erosion sediment control measures for highly erodible soils.

- Direct & indirect impacts from adjacent and future land development. *Recommended:* Requiring native plant buffers and maintaining natural hydrology post-development can reduce these negative impacts. Open space protected as part of a green infrastructure plan will protect natural resources.
- Major road construction and improvement projects may degrade high quality resources particularly in the northern part of the watershed if not designed and constructed to reduce impacts.
  Recommended: Watershed council participation with transportation agencies in proper location of roadways and use of low impact development practices in design & construction.

Indicators to Meet Objectives:

- Number of and acreage of unprotected parcels that are high priority for natural resource protection/enhancement that are protected
- Number of wetland restoration projects
- Percent of developments that include buffers to protect natural communities
- Number of general natural resource restoration projects

Milestones:	Grade
1–3 YEARS: 1. Establish program and funding to complete Natural Resource Inventories (NRI) for high priority unprotected green infrastructure parcels. 2. Develop conservation and management plans for at least 50% of the protected open space areas that are high priority for natural resource protection/enhancement that do not currently have plans. 3. Each municipality and the County will have adopted native plant buffer requirements for developments adjacent to natural communities. 4. Identify 5 feasible wetland restoration projects. 5. Identify 10 potential general natural resource restoration projects.	
4–7 YEARS: 1. Complete Natural Resource Inventories (NRI) of high priority unprotected green infrastructure parcels recommended for natural resource protection and enhancement (see Site Specific Action Plan). 2. Protect 20% of the acreage of high priority unprotected green infrastructure identified in #1 above that has been determined to have high natural resource value based on NRIs. 3. Implement all conservation and management plans developed in #2 above.	

	Grade
4. All new developments will include native plant buffers adjacent to natural communities. **5.** Complete two wetland restoration projects. **6.** Complete 5 general natural resource restoration projects.	
8–10 YEARS: **1.** Protect 50% of the acreage of high priority unprotected green infrastructure parcels identified in # 1 above that have been determined to have high natural resource value based on NRIs. **2.** Develop and implement conservation and management plans for all green infrastructure areas protected during plan implementation. **3.** Complete 3 wetland restoration projects. **4.** Complete 5 natural resource restoration projects.	

Monitoring Needs/Efforts:

- Track NRIs conducted on unprotected high priority parcels and number of existing conservation and management plans on existing protected green infrastructure areas.
- Track number of high priority parcels and acres that are protected during each of the milestone time periods. Determine the % of these parcels that have conservation or management plans.
- Track percent of developments that implement native plant buffers adjacent to natural communities.

Remedial Actions:

- Assess county, township, or municipal budgets for green infrastructure protection efforts.
- Apply for additional grant money to conduct Natural Resource Inventories and create and implement conservation or management plans.
- Conduct follow-up inspections of native plant buffers implemented in new and older developments.

Grade Evaluation: A = Met or exceeded milestone(s); B = Milestone(s) 75% achieved; C = Milestone(s) 50% achieved; D = Milestone(s) 25% achieved; F = Milestone(s) not achieved

Goal B

Improve overall water quality in the lakes, ponds, streams and wetlands of the watershed.

Watershed Findings:

There has been a general decline in water quality for watershed lakes based on trend data. Problems include: excess nutrients, high chloride concentrations and a decrease in water clarity.

Current Conditions/Water Quality Impacts:

LAKES/PONDS IN BULL'S BROOK SUBWATERSHED

- Lake Leopold has average water quality and high biological productivity, but is plagued with high chloride levels from road salt and has a moderately eroded shoreline.
- Dog Training Pond exhibits excellent chemical water quality but has severely eroded banks with a high percent of invasive plants and low biological quality.

LAKES/PONDS IN BULL'S BROOK SOUTH SUBWATERSHED ARE IMPAIRED BY HIGH PHOSPHORUS AND SALT CONCENTRATIONS.

- Loch Lomond is hypereutrophic, has high phosphorus levels, and high turbidity/low water clarity.
- St. Mary's Lake has high phosphorus, high turbidity/low water clarity, high conductivity (high chloride — road salt), and a high percent of invasive plants along a moderately eroded shoreline. St. Mary's Lake has a wastewater treatment plant discharge directly to the lake.
- Butler Lake has experienced low dissolved oxygen levels, high conductivity (high chloride — road salt). Shoreline restoration work is currently underway along a large section of the shoreline
- IMC Lake has high phosphorus and the highest conductivity (chloride—road salt) in the county.

STREAMS

Water quality in streams is overall average based on cumulative chemical, physical, and biological indicators.

- Bulls Brook, Bull Creek North, and Bull Creek South exhibit high nitrate, phosphorus, and suspended solids.
- Atrazine was detected in Bull Creek North and Bull's Brook.
- Salt concentrations have been high.
- Bull Creek is overall a poor fishery although several T& E listed species have been found. Fish sampling indicates moderate to restricted biotic stream resources.
- Macroinvertebrate sampling indicates good water quality/habitat at sample sites, except for a site downstream of St. Mary's Lake, which was poor.

Threats to water quality:

- The application of road salt (sodium chloride) as a de-icer.
  Recommended: Education of both public and private road and facility managers is needed.
- High nutrient loads from fertilizer applications.
  Recommended: Use of phosphorus-free fertilizer along with proper application of fertilizer.
- Nonpoint source pollutant loads and erosion from proposed future development.
  Recommended: New development should strive to emulate pre-development hydrology that reduces pollutant loads and filters runoff on-site.
- Agricultural applications of fertilizer, pesticides and erosion of farm fields.
  Recommended: Resource management plans be applied to all farms.

Indicators to Meet Objectives:

- Chemical water quality parameters (metals, nitrogen, phosphorus, E. coli) meet IEPA standards.
- All physical water quality parameters (temp, clarity pH, DO, TSS, turbidity) meet IEPA standards.
- Index of Biotic Integrity (IBI) scores for appropriate stream sizes are greater than 40.
- Macroinvertebrate Biotic Index (MBI) score for appropriate size streams are less than 6.0
- Trophic State Index (TSI) scores that are eutrophic (50–69) or mesotrophic (40–49) remain in these categories. TSI scores that are hypereutrophic (> 71) improve to eutrophic category.
- Linear feet of lake shoreline restoration (includes improved bank stability, habitat, native plant buffers)

Milestones:	Grade
1–3 YEARS:	
1. Develop funding support for a water quality monitoring program.	
2. Complete lake shoreline restoration concept plans for all shorelines exhibiting moderate to severe erosion and/or poor buffer quality.	
3. Require fertilizer to be phosphorus free.	
4. Municipalities, townships, county & state will reduce the amount of sodium chloride used on roads and parking lots to a level that is not harmful to aquatic resources.	
5. Develop conceptual plans and budgets for a minimum of 5 water quality BMP projects.	

Grade Evaluation: A = Met or exceeded milestone(s); B = Milestone(s) 75% achieved; C = Milestone(s) 50% achieved; D = Milestone(s) 25% achieved; F = Milestone(s) not achieved

	Grade
4–7 YEARS: **1.** Implement water quality monitoring program that involves schools, residents, HOAs, IDNR, IEPA, and LCHD; All IBI scores will be greater than 40. MBI scores will be less than 6. **2.** Implement at least two lake shoreline (> 250 linear feet) restoration, bank stabilization, and buffer improvement projects in the watershed. **3.** Municipalities, townships, county & state will use alternative(s) rather than sodium chloride for de-icing. **4.** Private road and facility managers will reduce the amount of sodium chloride used on roads and parking lots to a level that is not harmful to aquatic resources. **5.** Complete a minimum of 2 water quality BMP projects.	
8–10 YEARS: **1.** Implement at least two lake shoreline (>250 linear feet) restoration, bank stabilization, and buffer improvement projects in the watershed. **2.** All state water quality standards that are not currently met will meet all IEPA physical and chemical standards. **3.** Private road and facility managers will use alternative(s) rather than sodium chloride for de-icing. **4.** Complete a minimum of 3 water quality BMP projects.	

Monitoring Needs/Efforts:

- Regular monitoring of physical, chemical, and biotic water quality parameters will need to continue indefinitely on an annual cycle to track changes in water quality. A monitoring component is included in Section 4.2.
- Visit lake shoreline restoration sites annually to assess success and failures.
- Check local garden suppliers annually to see if phosphorus-free fertilizer is readily available and prominently displayed.
- Check public and private de-icing managers in years 3, 7 and 10 to determine what products are being used and in what amounts.

Remedial Actions:

- Assess number of projects that have been implemented versus water quality changes to determine if projects are effectively removing pollutants. If not, conduct assessment to find causes of pollution and address.
- If targeted chemical pollutants and physical parameters (see indicators above) are not improved after 4-7 years, implement only projects that are specifically designed to remove a particular pollutant and continue monitoring cycle.

Reduce flood damage in the Bull Creek/Brook Watershed and prevent flooding from worsening in the watershed and along the Des Plaines River downstream.

Goal C

Watershed Findings

Flood damage is a minor problem in the watershed where there are two areas that experience flood damage to structures. Several nuisance flooding sites were identified during the watershed assessment process.

Flood risk was also assessed with an updated floodplain study. There are over 100 structures located within the 100-year floodplain boundary.

Current Condition and Problems:

FLOOD DAMAGE—FLOOD PROBLEM AREAS

- Brookhill Subdivision — several homes located along Bull Creek North in unincorporated Libertyville Township have had basement flooding. Septic fields and wells have also been flooded.
- Approximately 5 homes on the north side of Arbor Vista Subdivision in unincorporated Warren Township in the Bull's Brook subwatershed have experienced damage from depressional flooding in the past.
- 13 nuisance flooding areas have been identified in the watershed. Most of this flooding is caused by local drainage problems, but overbank and depressional flooding are occurring at 5 of these locations.

FLOOD RISK

- 104 structures are located within the 100-year floodplain and are considered to be at risk of flooding (includes 2 schools, 38 homes, 3 large, 4 mid-size and 14 small buildings and various accessory structures).
- H&H modeling indicates that the water level in Bull Creek South downstream of Butler Lake is likely to exceed the channel depth for the 10 and 100-year storm events.

Flooding Threats:

- The increased volume of runoff from impervious surfaces from new development using traditional stormwater systems may exacerbate nuisance flooding sites and result in flood damage.
  Recommended: Communities require low impact development practices in all new developments.
- Aging and inadequately maintained drainage system components may result in more local drainage problems.
  Recommended: Communities and homeowner associations regularly monitor and maintain drainage systems. Communities consider establishing Special Ser-

Grade Evaluation: A = Met or exceeded milestone(s); B = Milestone(s) 75% achieved; C = Milestone(s) 50% achieved; D = Milestone(s) 25% achieved; F = Milestone(s) not achieved

vice Areas for funding maintenance of private systems where needed. Retrofit drainage systems to incorporate infiltration and filtration of stormwater where feasible.

- Lack of stream maintenance and poor riparian landowner stream and lawn management practices will likely cause more overbank flooding problems. *Recommended:* Establish stream monitoring and maintenance program. Riparian landowner education.

Indicators to Meet Objectives:

- Number of flood damage reports/claims
- Volume of stream flow
- Number of structures in 100-year floodplain
- Number of restored wetlands or created storage areas (increased storage volume in the watershed)
- Number of new development projects incorporating infiltration in site design.
- Number of debris jams removed
- Number of existing developed areas that are retrofitted to prevent flooding.

Milestones:	Grade
1–3 YEARS:	
1. All property owners at risk of flooding have been notified of their risk and encouraged to purchase flood insurance.	
2. Floodproof or reduce number of structures in floodplain by 5% (5 structures).	
3. Investigate feasibility of mitigating the two flood problem areas and 13 nuisance flooding sites using recommendations from the Site Specific Action Plan section.	
4. Remove all high priority problem debris jams from stream channels.	
5. Develop funding for a stream flow-monitoring program.	
6. Retrofit at least two pre-WDO areas to reduce flooding (i.e. detention/infiltration).	
4–7 YEARS:	
1. Floodproof or reduce number of structures in floodplain by 15% (16 Structures).	
2. Implement mitigation plans for two Flood Problem Areas.	
3. Implement stream flow monitoring program.	
4. Retrofit at least two pre-WDO developments to reduce flooding (i.e. detention basin retrofits).	

	Grade
8–10 YEARS: 1. Floodproof or reduce number of structures in floodplain by 30% (31 Structures). 2. Design and implement at least one wetland restoration (wetland bank) or multi-objective storage area in the watershed. 3. Retrofit at least two pre-WDO developments to reduce flooding (i.e. detention basin retrofits).	

Monitoring Needs/Efforts:

- Track number of mitigated Flood Problem Areas and nuisance flooding areas.
- Track number and progression of wetland restoration or created storage areas.
- Track number of structures floodproofed or removed from 100-year floodplain.
- Track number of retrofitted pre-WDO development sites that implement flood reduction BMPs.
- Track number of debris jams that are removed.

Remedial Actions:

- Conduct follow-up visits to Flood Problem Area sites during flood events to determine if additional remedial work is needed.
- Conduct inventory of older developments to determine feasibility for potential retrofits.

Grade Evaluation: A = Met or exceeded milestone(s); B = Milestone(s) 75% achieved; C = Milestone(s) 50% achieved; D = Milestone(s) 25% achieved; F = Milestone(s) not achieved

Goal E

Guide new development and redevelopment to benefit rather than impair watershed goals to reduce flood damage, improve water quality and protect natural resources.

Watershed Findings

Historically developed areas of the watershed have been designed to collect and convey stormwater runoff to a receiving lake or stream as quickly as possible through storm sewers or ditches with little consideration given to downstream receiving water impacts. In addition, past development did not fully recognize the value of green infrastructure and utilize it to improve watershed conditions, and often did not protect a sensitive resource if it was located on the development site. More recently, conservation/low impact development practices that incorporate green infrastructure have been incorporated into several watershed developments including most notably Prairie Crossing in Grayslake and Hampton Reserve in Mundelein.

Current Condition and Problems:

IMPERVIOUS COVER ESTIMATES FOR THE WATERSHED INDICATE:

- Bull's Brook subwatershed is 10% impervious (classified as sensitive);
- Bull Creek North subwatershed is 25% impervious (classified as impacted);
- Bull Creek South subwatershed is 26% impervious (classified as non-supporting).

In addition to impacting stream form and water quality, unmitigated impervious surfaces also impact flooding and natural resources.

- Wet bottom detention basins with outflow restrictors (and to a lesser extent stormwater treatment train systems and other green infrastructure filtering systems) are being constructed to increase infiltration and improve water quality before it is released from the site.
- In general, site design and development practices are improving because of the Watershed Development Ordinance and EPA-NPDES Phase II stormwater regulations.

THREATS TO NEW DEVELOPMENT ADDRESSING WATERSHED GOALS:

- Estimates for more impervious cover with projected future development indicate:
- Bull's Brook subwatershed will be 12% impervious (classified as impacted) ;
- Bull Creek North subwatershed will be 37% impervious (classified as non-supporting);
- Bull Creek South subwatershed will be 31% impervious (classified as non-supporting).

These estimates are based on traditional development patterns.
Recommendation: Reduce impervious cover associated with new development by using conservation development. Mitigate the negative impacts of impervious cover with low impact development (distributed on-site infiltration practices that utilize deep-rooted native plant species).

- Outdated community development standards can result in development that impairs rather than supports watershed goals.
  Recommendation: Allow low impact development by right rather than by exception. Revise development standards to include conservation development requirements for all categories of new development regardless of land use.
- Mass grading, and poor erosion control during development compacts soils reducing infiltration rates and contributes sediment and pollutants to water resources.
  Recommendation: Communities and other permitting agencies adopt incentives and standards to minimize site grading and aggressively monitor and enforce soil erosion sediment control requirements.

Indicators to Meet Objectives:

- Percent of approved developments greater than 1 acre that are designed to not change pre-development hydrology
- Percent of NRI recommendations incorporated into approved site designs.
- Number of new developments using conservation development techniques (>50% open space, use of alternative stormwater designs, cluster housing).
- Number of open space (natural areas) management plans in place on new and old development.

Milestones:	Grade
1–3 YEARS:	
1. Watershed communities require developments greater than 1 acre do not change pre-development hydrology as a development standard.	
2. All governing bodies in watershed adopt policy that requires NRI's be conducted prior to future development and that sensitive resources are preserved/restored.	
3. 20 new developments will implement conservation development techniques that preserve at least 50% open space, infiltrate and treat runoff from lawns and impervious surfaces.	
4. All governing bodies in the watershed adopt policy that requires short and long term green infrastructure management plans for all new development.	
5. All new developments incorporate infiltration BMPs in design.	

Grade Evaluation: A = Met or exceeded milestone(s); B = Milestone(s) 75% achieved; C = Milestone(s) 50% achieved; D = Milestone(s) 25% achieved; F = Milestone(s) not achieved

	Grade
4–7 YEARS: 1. 75% of all new developments will implement conservation development techniques that preserve at least 50% open space, infiltrate and treat runoff from lawns and impervious surfaces.	
8–10 YEARS: 1. 100% of all new developments will implement conservation development techniques that preserve at least 50% open space, infiltrate and treat runoff from lawns and impervious surfaces.	

Monitoring Needs/Efforts:

- Local land use jurisdiction track % of developments that do not change predevelopment hydrology.
- Local land use jurisdiction track % of new developments that implement conservation development techniques.
- Track % of developments where NRI is conducted and recommendations implemented in the site design.

Remedial Actions:

- If impervious cover analysis of the individual development sites or watershed indicates change to Non-Supporting, evaluate how open space is being utilized and if BMPs such as bioretention or permeable pavers are in place to mitigate for impervious cover.

Goal F

Implement a "Green Infrastructure" plan to guide preservation, restoration, and management activities in the watershed.

Watershed Findings

There is still a relative abundance of open space in the watershed available to develop a green infrastructure network, but approximately 60% of the open space is privately-owned and unprotected green infrastructure. A large amount of open land is protected in the watershed as part of the Liberty Prairie Reserve. The Liberty Prairie Reserve, located in the northern part of the watershed, is the result of collaboration between private landowners, Libertyville Township and the Forest Preserve District to preserve open land in this ecologically sensitive area.

- More than 50% of the Reserve is protected open land. Libertyville Township and the Lake County Forest Preserve District own about 800 and 500 acres respectively in the watershed portion of the Reserve, while approximately 1,000 acres of privately-owned open land is protected by conservation easement. The entirety of Bull's Brook is located in protected open land functioning as green infrastructure in the Reserve.

- In the southern part of the watershed, the largest area of open land is found at St. Mary of the Lake University and its surrounds. A green infrastructure corridor exists along most of Bull Creek South with the exception of Loch Lomond, which is developed up to the lake edge with private homes. St. Mary's University and the Village of Libertyville own most of the land in the green infrastructure corridor from Loch Lomond north to Route 137. A few private landowners own the corridor between Route 137 and Route 21, and the Forest Preserve District owns the green infrastructure that includes the creek corridor east of Route 21.
- Bull Creek North has a greenway corridor along much of its length that is predominately in private ownership. Libertyville Township owns portions of the green infrastructure corridor that includes the creek in the southern end of the Liberty Prairie Reserve and within the Libertyville soccer complex. The Bull Creek North subwatershed is at the greatest risk for green infrastructure loss due to industrial development occurring and projected in its western reaches.

Current Condition and Problems:

- Currently, 42% of the watershed is open space and 22.5% is partially open space. Most of this open space is under private ownership.
- Approximately 23.5% of the open and partially open parcels (2,110 acres) are protected. Nearly all ecologically significant areas and T&E species are located on protected parcels but many unprotected parcels are located adjacent to them.
- Proposed trail corridors are within or in close proximity to open and partially open parcels.
- Many open and partially open parcels are located within the 100-year floodplain and intersect drained hydric soils and existing wetlands.

Threats to Green Infrastructure

- Much of the existing 1,438 acres of open space in the Bull Creek North subwatershed is being converted to industrial development.
  Recommendation: Protect the greenway along the creek. Use conservation and low impact development techniques to protect green infrastructure corridors through industrial areas and minimize hydrologic impacts to the creek as land is developed.
- Although open space is abundant in the watershed, watershed communities do not have adopted greenway/green infrastructure plans in place to prioritize and preserve green infrastructure.
  Recommendation: Each community needs to adopt a green infrastructure system as part of their comprehensive land use plan.

Grade Evaluation: A = Met or exceeded milestone(s); B = Milestone(s) 75% achieved; C = Milestone(s) 50% achieved; D = Milestone(s) 25% achieved; F = Milestone(s) not achieved

- Watershed communities lack a dedicated capital budget for green infrastructure preservation.
  Recommendation: Build funding for preserving green infrastructure into community capital budgets. Funds can be used to purchase conservation or drainage easements and to use as match for state and federal grant funds for open space protection.

Indicators to Meet Objectives:

- Percent and acres of protected green infrastructure in the watershed
- Number of acres of protected high and medium priority green infrastructure in each SMU
- Percent of mapped green infrastructure that is protected open space

Milestones:	Grade
1–3 YEARS:	
1. Develop green infrastructure preservation and connection strategy for all high and medium priority parcels outlined in the Programmatic Action Plan.	
2. All jurisdictions establish green infrastructure preservation fund in capital budget to protect high priority parcels.	
4–7 YEARS:	
1. Protect additional 20% (1,800 acres) of watershed as open space.	
2. Protect 4 high priority unprotected parcels identified in the Parcel Prioritization for greenways.	
3. Implement at least one trail connection.	
10+ YEARS:	
1. 50% of the watershed (4,485 acres) is protected open space.	
2. Purchase or protect 8+ high priority unprotected parcels.	
3. Implement at least 2 trail connections.	

Monitoring Needs/Efforts:

- Track open space in green infrastructure network by SMU for each time period.
- Track number of high priority parcels that are protected.
- Track number and miles of implemented trail/greenway connections.

Remedial Actions:

- Reassess county, township, or municipal budgets for land protection efforts.
- If more than 50% of watershed becomes developed, insure that new development uses sound conservation BMPs techniques.

Goal F

Provide watershed stakeholders with the knowledge, skills, and motivation needed to take action on implementing the watershed plan.

Watershed Findings

While there are a number of education opportunities in the watershed area, there has not been a coordinated effort to reach the general public about Bull Creek-Brook watershed issues.

Current Education Programs:

- The Liberty Prairie Conservancy (LPC) has an education program that is heavily focused on natural resources and green infrastructure (open space) protection primarily in the Liberty Prairie Reserve.
- The Upper Des Plaines River Ecosystem Partnership (UDPREP) has been conducting watershed tours and additional education events since 2003 for the entire upper Des Plaines River watershed. UDPREP programs focus on water quality and natural resource protection and restoration.
- Although not specific to the Bull Creek-Brook watershed, SMC and other public works associations sponsor water quality programs and workshops that target local government stormwater managers for the National Pollution Discharge Elimination System (NPDES) Phase II program. SMC and individual permitted communities also provide educational materials and information via their websites and newsletters to residents as part of this program.
- The Liberty Prairie Area Homeowners Assn. and the Loch Lomond Property Owner Assn. provide educational materials, events and communications related to water resources to their memberships.

Education/Motivation Needs:

Education needs for the watershed primarily target property owners (businesses, institutions, farmers, developers, residents and HOAs), local elected officials and administrators, and area high school teachers & students.

SPECIFIC EDUCATION TOPICS INCLUDE:

- environmentally friendly lawn, grounds, and street maintenance;
- maintaining protecting, and restoring the natural and constructed drainage system of streams, wetlands, floodplain, detention basins and swales that make up the green infrastructure system,
- riparian corridor maintenance and buffers;
- infiltrating stormwater runoff;
- managing/reducing the use of sodium chloride as a de-icer;
- “No adverse impact” floodplain management;
- flood insurance & floodproofing;

Grade Evaluation: A = Met or exceeded milestone(s); B = Milestone(s) 75% achieved; C = Milestone(s) 50% achieved; D = Milestone(s) 25% achieved; F = Milestone(s) not achieved

- agricultural best management practices; and
- stream & lake monitoring.

  Recommendation: The watershed council forms an education subcommittee or task group that chooses an annual education theme (or themes); develops a strategy for identifying and engaging participants; a schedule for education events; and reports on the education program outcomes to the watershed council each year.

Indicators to Meet Objectives:

- Number of publicized projects in news media, Farm Bureau publications, agency newsletters, etc
- Number of seminars or workshops related to watershed issues
- Number of HOA, Lake Association, and school programs related to protecting the watershed
- Attendance at/in watershed education events
- Number of trained water quality monitoring volunteers
- Number of healthy watershed certifications e.g. water quality, etc.
- Number of landowners implementing watershed improvement projects e.g. rain gardens, riparian buffer enhancements, streambank stabilization etc.

Milestones:	Grade
1–3 YEARS: **1.** Develop a watershed information sharing website (that includes watershed related issues, dates of important events such as seminars, workshops, monitor training etc.). **2.** Conduct at least one seminar or workshop in or near the watershed each year (flooding, water quality, and natural resource/greenway protection and enhancement) and track attendance and survey attendees at events. **3.** Identify at least one HOA, Lake Association, or school program interested in initiating environmental monitoring programs and train at least 2 environmental monitoring volunteers. **4.** Establish program for healthy watershed certification. **5.** At least 2 landowners implement watershed improvement projects (rain gardens, buffers, etc.).	

	Grade
4–7 YEARS: 1. Conduct at least one seminar or workshop in or near the watershed each year (flooding, water quality, and natural resource/greenway protection and enhancement) and track attendance and survey attendees at events. 2. Implement at least one HOA, Lake Association, and school environmental monitoring program. 3. IEPA trains at least 4 environmental quality monitoring volunteers. 4. At least 4 landowners implement healthy watershed certifications. 5. At least 4 landowners implement watershed improvement projects (rain gardens, buffers, etc.).	
8–10 YEARS: 1. Conduct at least one seminar or workshop in or near the watershed each year (flooding, water quality, and natural resource/greenway protection and enhancement) and track attendance and survey attendees at events. 2. Implement at least one HOA, Lake Association, and school environmental monitoring program. 3. IEPA trains at least 4 environmental quality monitoring volunteers. 4. At least 4 landowners implement healthy watershed certifications. 5. At least 4 landowners implement watershed improvement projects (rain gardens, buffers, etc.).	

Monitoring Needs/Efforts:

- Track all watershed projects being implemented each year.
- Track number and topic of seminars and workshops each year.
- Track changes in attendance at seminars and workshops.
- Track programs implemented by HOAs, Lake Associations, and schools.
- Track number of trained volunteer water quality monitors.
- Track number of healthy watershed certifications and watershed improvement projects implemented.

Remedial Actions:

- Assign staff or find volunteer to keep website updated.
- Find volunteers to develop more interest in HOA, Lake Association, and school programs.
- If attendance at seminars or workshops is low, experiment with different types of events, timing, and publicity to see which draw the best attendance.
- Track number of healthy watershed certifications and watershed improvement projects on website.

Grade Evaluation: A = Met or exceeded milestone(s); B = Milestone(s) 75% achieved; C = Milestone(s) 50% achieved; D = Milestone(s) 25% achieved; F = Milestone(s) not achieved

Goal H

Identify and capitalize on potential funding sources for watershed improvement projects.

Watershed Findings

This watershed plan was largely completed with funding from the US Environmental Protection Agency (EPA) and IL EPA. Since the planning effort got underway, several watershed projects have secured matching funds through grant programs administered by the USEPA, the IL Department of Natural Resources (IDNR) and the Lake County Stormwater Management Commission (SMC).

This watershed plan is a guidance document that identifies for stakeholders the types of best management practices (BMPs) recommended for the watershed and where they are needed. Having a watershed-based plan will leverage additional funding through the IL EPA 319 and Conservation 2000 (C2000) grant programs to meet the major project goals, and will assist in securing natural resource enhancement and green infrastructure preservation funds from the state Open Space Land Acquisition and Development (OSLAD) and Natural Areas Acquisition Fund (NAAF) grant programs.

Current Condition and Problems:

- Liberty Prairie Conservancy & Libertyville Township have completed several studies and restoration projects in the Liberty Prairie Reserve including stream restoration of Bull's Brook and a sedge meadow and fen restoration at Liberty Prairie utilizing C2000, IL EPA and SMC funding.
- St Mary's University has a stream restoration project underway on Bull Creek South that is partially funded by US EPA grant funds.
- Design is underway for green site features including a green roof, bio and vegetated swales, rain gardens and wetland detention ponds for a new County permit facility in Libertyville. SMC has been awarded cost share funds from the US EPA and IL EPA for installation of these water quality practices.
- The Village of Libertyville Parks Department has a rain garden and bioswale project underway that will infiltrate and filter stormwater runoff from a parking lot at Butler Lake. Matching funds provided by SMC through the Watershed Management Board (WMB) grant program.
- Liberty Prairie Area Homeowners Assn & Libertyville Township received cost share funding from the C2000 program for developing a stream restoration plan for Bull Creek North.
- Loch Lomond Property Owners Assn., Mundelein Park District, and Liberty Prairie Area Homeowners Assn currently have grant proposals under consideration by the IL EPA.

- Although there has been recent funding development activity by several watershed partners, the number of watershed stakeholders that are currently pursuing grant funds to implement watershed improvement projects is limited.

Threats to Securing Grant Funding for Watershed Projects

- State sources of matching funds are at risk. C2000 funds were not awarded in 2008. The Governor's budget proposes to significantly cut funding for the OSLAD and NAAF grants in 2009.
- SMC Watershed Management Board grant proposals are more competitive every year and it is increasingly difficult to fund a number of the projects submitted for this grant program.
- IL EPA 319 funds are increasingly focused on watersheds with impaired streams that have Total Maximum Daily Load (TMDL) determinations. Bull Creek-Brook does not fall into this category.
  Recommendation: The Bull Creek-Brook watershed council establishes a technical grant committee to review grant proposals and provide feedback to the project sponsor on how the proposal could be strengthened to make it more competitive for the funding program. Local project sponsors will also work closely with the Upper Des Plaines Ecosystem Partnership grant proposal review team on strengthening IL EPA and C2000 grant proposals.
- Local communities and the County are receiving reduced tax revenues as a consequence of a declining economy. These reduced revenues limit local matching funds for watershed projects.
- Local communities lack a dedicated revenue source to use as matching funds for green infrastructure and watershed projects.
  Recommendation: Each community establishes a dedicated budget line item for green infrastructure and watershed projects (even if relatively small) to be used as local matching funds for grant dollars and for contributions to multi-jurisdictional cooperative projects.

Indicators to Meet Objectives:

- Amount of money both budgeted and obtained per year to implement recommendations in the Action Plan
- Number of grant applications submitted for watershed projects including green infrastructure preservation
- Number of grants received
- Number of in-kind hours provided by HOAs, schools, and other stakeholders in implementing watershed projects

Grade Evaluation: A = Met or exceeded milestone(s); B = Milestone(s) 75% achieved; C = Milestone(s) 50% achieved; D = Milestone(s) 25% achieved; F = Milestone(s) not achieved

Milestones:	Grade
1–3 YEARS: 1. Identify the appropriate funding sources to address watershed issues. 2. Obtain at least $500,000 in funds to implement watershed projects (grants, community funds and in-kind services).	
4–7 YEARS: 1. Provide/publicize funding source information to watershed stakeholders. 2. Obtain at least $1,000,000 in funds to implement watershed projects (grants, community funds, and in-kind services).	
8–10+ YEARS: 1. Obtain an additional $2,000,000+ in funds to implement watershed projects (grants, community funds, and in-kind services).	

Monitoring Needs/Efforts:

- Track amount of money obtained per year to implement watershed projects.
- Track number of watershed projects implemented using grant money.
- Survey workshop/seminar attendees on awareness of funding sources and opportunities.

Remedial Actions:

- If funding goal can not be achieved, reassess available county, township, municipal, and federal grant and funding budgets.
- Watershed council will track the number of grants applied for each year and increase if necessary.
- If survey results do not show increase in funding source awareness, explore new ways to bring information to stakeholders.

Improve coordination between

- municipalities, townships, special districts (i.e. parks, schools, forest preserves, etc.),
- county agencies and other local government units,
- federal, state, regional agencies, and
- private business, non-profits, citizen stakeholders, homeowner associations and the general public in watershed plan implementation, monitoring, enhancement, and protection.

Goal I

Watershed Findings

While there are several cooperative projects underway or completed in the watershed, these are few relative to the need for cooperation and coordination as specified in the watershed action plan. A number of watershed improvement practices and projects will require multi-jurisdictional and public-private coordination and participation.

Current Coordination Status and Opportunities:

- The private-public establishment and management of the Liberty Prairie Reserve, which spans the Bulls Brook and Bull Creek North subwatersheds is a good example of coordination/cooperation.
- The watershed planning process has brought together watershed stakeholders who did not have an opportunity to work collectively in the past to develop multi-jurisdictional projects. Partnerships for developing local funding sources, writing grant proposals, identifying cost sharing ideas, preserving green infrastructure, and adopting watershed plan recommendations are needed.
- A watershed planning group that represents a broad spectrum of watershed constituencies developed the watershed plan. They recommended that a sustainable watershed council be established to include multiple stakeholders to implement this plan. The successful establishment of this council will be a major step toward future watershed coordination and plan implementation.

Threats to Coordination & Cooperation in Watershed Plan Implementation

- Inability to secure commitments from major stakeholders to establish and participate in a sustainable watershed council.
- Lack of participation by some major stakeholders (including municipal jurisdictions) in preserving green infrastructure.
- Lack of initiative by some major stakeholders to implement the watershed plan recommendations.
  Recommendation: Target key local community "influentials" for one-on-one

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meetings with other watershed council members to discuss: watershed issues, the watershed plan, the importance of their community's participation in watershed plan implementation, and the benefits to their community and the watershed that will result from their participation. Each watershed jurisdiction will adopt the watershed plan by resolution.

- Difficulties with securing funding for a watershed implementation manager. *Recommendation:* Developing a position description and a sustainable source of funding for a watershed manager (will guide and support community efforts to develop cooperative watershed projects) will be a top priority for the watershed council.
- Jurisdictional disagreements related to responsibility. *Recommendation:* The watershed council with assistance from SMC will develop a model or template for an intergovernmental and a private/public partner agreement for participating in cooperative watershed projects. Involve community elected officials and staff in periodic events that focus on coordination including community updates and reports.
- Inconsistent development standards and practices between jurisdictions. *Recommendation:* Each community will review their development standards and policies to insure that they are consistent with watershed plan goals for protecting water quality, reducing flooding etc. High priority green infrastructure and watershed problem areas will be identified on community maps used for development review.

Indicators to Meet Objectives:

- Number of multijurisdictional partnerships and/or private-public cost sharing projects implemented during each of the milestone periods
- Number of watershed council meetings held each year
- Number of watershed improvement decisions made by jurisdictions based on watershed plan recommendations (may include conservation development standards, watershed-friendly operational changes/enhancements etc.)

Milestones:	Grade
1–3 YEARS: 1. Governing bodies in watershed adopt the Bull Creek/Bull's Brook Watershed Plan. 2. Multiple jurisdictions and/or public-private partnerships implement at least one cost sharing project. 3. Watershed stakeholders form an ongoing sustainable watershed council and meet quarterly to coordinate report on project work and semi-annually to track plan implementation progress.	

4–7 YEARS:	Grade
1. Multiple jurisdictions and/or public-private partnerships implement at least one cost sharing project. **2.** Watershed council meets quarterly to coordinate and report on project work and semi-annually to track progress and update plan implementation progress.	
8–10+ YEARS: **1.** Multiple jurisdictions and/or public-private partnerships implement at least one cost sharing project. **2.** Watershed council meets quarterly to coordinate and report on project work and semi-annually to track progress and update plan implementation progress.	

Monitoring Needs/Efforts:

- Track number of multiple jurisdiction and/or public-private partnership projects implemented during each milestone time period.
- Track number of watershed council meetings.
- Track number of projects implemented based on plan recommendations.

Remedial Actions:

- BCPC encourage government officials to adopt the watershed plan if it has not already been adopted.
- BCPC meet with government officials and other key partners regarding high priority projects that have not been implemented.

Grade Evaluation: A = Met or exceeded milestone(s); B = Milestone(s) 75% achieved; C = Milestone(s) 50% achieved; D = Milestone(s) 25% achieved; F = Milestone(s) not achieved

CHAPTER 10.0

Glossary of Terms

2 year- 3 year-10 year- 100 year flood: For each river, engineers assign statistical probabilities to different size floods to describe a common or ordinary flood for a particular river versus a less likely or a severe flood for the same river. A 100-year flood is a flood that has a 1-percent chance of being equaled or exceeded in any given year. The 100-year flood, also referred to as the "base flood", is the standard used by the National Flood Insurance Program (NFIP) for floodplain management and is used to determine the need for flood insurance. A structure located within the 100-year special flood hazard area shown on an NFIP map has a 26 percent chance of suffering flood damage during the term of a 30-year mortgage. A two-year flood event has a 50% probability of occurring in any year; 2-year rain events are important because they form the general shape of our stream systems and are the cause for much of the pollutant loading.

100-year floodplain: A flood inundates a floodplain. A 100-year flood is a flood that has a 1-percent chance of being equaled or exceeded in any given year. A 100-year flood may also be referred to as the base flood. The area inundated during the base flood is called the 100-year floodplain.

303(d): The Federal Clean Water Act requires states to submit a list of impaired waters to the USEPA for review and approval using water quality assessment data from the Section 305(b) Water Quality Report. States are then required to develop total maximum daily load analyses (TMDLs) for waterbodies on the 303(d) list.

305(b): The Illinois 305(b) report is a water quality assessment of the state's surface and groundwater resources that is compiled by the IEPA as a report to the USEPA as required under Section 305(b) of the Clean Water Act.

ADID wetlands: Wetlands that were identified through the Advanced Identification (ADID) process. Completed in 1992, the ADID process sought to identify wetlands that should be protected because of their high functional value. The three primary functions evaluated were:

1. Ecological value based on wildlife habitat quality and plant species diversity;
2. Hydrologic functions such as stormwater storage value and/or shoreline/bank stabilization value; and
3. Water quality values such as sediment/toxicant retention and/or nutrient removal/transformation function.

American Fisheries Society (AFS) Stream Obstruction Removal Guidelines: Document describing environmentally sound techniques to maintaining natural stream characteristics when dealing with channelization, clearing, snagging, or other severe stream modifications. Document can be found in Appendix D.

Applied Ecological Services Inc. (AES): A broad-based ecological consulting, contracting, and restoration firm that was founded in 1978. The company consists of consulting ecologists, engineers, landscape architects, planners, and contracting staff. The mission of AES is to bring wise ecological decisions to all land use activities.

Artificial wetland: A designed wetland, created for human use, such as wastewater or sewage treatment, as habitat to attract wildlife, or for land reclamation after mining or other disturbance.

Aquatic habitat: Structures such as stream substrate, woody debris, aquatic vegetation, and overhanging vegetation that is important to the survival of fish and macroinvertebrates.

Bankfull: The point at which water flow in a stream fills the channel to the top of its banks just to the point where water begins to overflow onto the adjacent floodplain. Bankfull stage flows transport the greatest quantity of soil and stone over time, because the bankfull stage occurs about once every year or two.

Base Flood Elevation (BFE): The elevation delineating the level of flooding resulting from the elevation of the 100-year flood. *(See also Floodplain.)*

Base flow: Stream discharge that is not directly attributable to direct runoff or melting snow. It is usually sustained by groundwater.

Bedrock: The solid rock that underlies loose material, such as soil, sand, clay, or gravel.

Benthic: Bottom dwelling (often referring to macroinvertebrates).

Best Management Practices (BMPs): BMPs are non-structural practices such as site planning and design aimed to reduce stormwater runoff and avoid adverse development impacts—or structural practices that are designed to store or treat stormwater runoff to mitigate flood damage and reduce pollution. Some BMPs used in urban areas may include stormwater detention ponds, restored wetlands, vegetative filter strips, porous pavement, silt fences and biotechnical streambank stabilization.

Biodiversity: The variety of organisms (plants, animals and other life forms) that includes the totality of genes, species and ecosystems in a region.

Bio-infiltration (rain gardens): Excavated depressional areas where stormwater runoff is directed and allowed to infiltrate back into groundwater rather than allowing to runoff. Infiltration areas are planted with appropriate vegetation.

Biological Oxygen Demand (BOD): The amount of dissolved oxygen that is required by microscopic organism (e.g. bacteria) to decompose organic matter in waterbodies.

Biological Stream Characterization (BSC): A multi-tiered stream quality classification based primarily on the attributes of lotic fish communities. The predominant stream quality indicator used in this process is the Index of Biotic Integrity (IBI), comprised of 12 metrics, which form a basis for describing the health or integrity of the fish community. When insufficient fishery data are available for calculating an IBI value, BSC criteria allow the use of sport fishing information or macroinvertebrate data to rate streams. BSC provides a uniform process of characterizing streams statewide and is used by a variety of sources for stream protection, restoration and planning efforts.

Bioengineering (or Soil Bioengineering): Techniques for stabilizing eroding or slumping stream banks that rely on the use of plants and plant materials such as live willow posts, brush layering, coconut logs and other "greener" or "softer" techniques. This is in contrast to techniques that rely on creating "hard" edges with riprap, concrete and sheet piling (metal and plastic).

Carrying capacity (streams): The maximum amount of water that a stream channel can support without overtopping its banks.

Center for Watershed Protection (CWP): Non-profit 501(c)3 corporation founded in 1992 that provides local governments, activists, and watershed organizations around the country with the technical tools for protecting some of the nation's most precious natural resources such as streams, lakes and rivers.

Certified Municipalities: A municipality that is certified by LCSMC to enforce the provisions of the Lake County Watershed Development Ordinance (WDO). The municipality's designated Enforcement Officer enforces the provisions in the Ordinance.

Channel modification: Alteration of a channel by changing the physical dimensions or materials of its bed or banks. Channel modification includes damming, riprapping or other armoring, widening, deepening, straightening, relocating and lining and significant removal of bottom or woody vegetation of the channel. Channel modification does not include the clearing of dead or dying vegetation, debris or trash from the channel; these actions are referred to as channel maintenance.

Channelized stream: A stream that has been artificially straightened, deepened, or widened to accommodate increased stormwater flows, to increase the amount of adjacent land that can be developed or used for urban development, agriculture or for navigation purposes. In addition to being unsightly, channelized streams have a uniform gradient, no riffle and pool development, no meanders (curves) and very steep banks. The vegetation is frequently removed and replaced with riprap, concrete or other hard surfaces. During low flow periods in the summer, many channelized streams have low dissolved oxygen levels, in part due to shallow, slow-moving water. Under these conditions, they provide poor habitat for fish or other stream organisms such as benthic macroinvertebrates.

Channel: Any river, stream, creek, brook, branch, natural or artificial depression, ponded area, lakes, flowage, slough, ditch, conduit, culvert, gully, ravine, swale, wash, or natural or man-made drainageway, in or into which surface or groundwater flows, either perennially or intermittently.

Chicago Metropolitan Agency for Planning (CMAP): The Chicago Metropolitan Agency for Planning (CMAP), www.chicagoareaplanning.org/default.asp, formerly known as the Northeastern Illinois Planning Commission (NIPC) has developed model ordinances on stormwater management, soil erosion and sediment control, streams and wetlands, and floodplains for local governments to use in developing regulatory programs. CMAP provides technical assistance and training opportunities to local governments to improve watershed management activities—including watershed planning and stormwater management. In addition, CMAP was one of the major partners in the development of the Northeastern Illinois Greenways Plan, which includes existing and proposed trails and greenway corridors for the Bull Creek/Bull's Brook watershed.

Conservation development: A development designed to protect open space and natural resources for people and wildlife while at the same time allowing building to continue. Conservation design developments designate half or more of the buildable land area as undivided permanent open space.

Conservation easement: The transfer of land use rights without the transfer of land ownership. Conservation easements can be attractive to property owners who do not want to sell their land now, but would support perpetual protection from further development. Conservation easements can be donated or purchased.

Converted Wetland: see Prior Converted Wetland.

Clean Water Act (CWA): The CWA is the basic framework for federal water pollution control and has been amended in subsequent years to focus on controlling toxics and improving water quality in areas where compliance with nationwide minimum discharge standards is insufficient to meet the CWA's water quality goals.

Debris load: Natural and man-made debris including leaves, logs, lumber, trash and sediment.

Depressional Storage/Area: Non-riverine depressions where stormwater collects.

Designated Use: EPA requirements that States and authorized Indian Tribes specify appropriate water uses to be achieved and protected. Appropriate uses are identified by taking into consideration the use and value of the water body for public water supply, for protection of fish, shellfish, and wildlife, and for recreational, agricultural, industrial, and navigational purposes. In designating uses for a water body, States and Tribes examine the suitability of a water body for the uses based on the physical, chemical, and biological characteristics of the water body, its geographical setting and scenic qualities, and economic considerations. Each water body does not necessarily require a unique set of uses. Instead, the characteristics necessary to support a use can be identified so that water bodies having those characteristics can be grouped together as supporting particular uses.

Detention basin/facility: A man-made structure for the temporary storage of stormwater runoff with controlled release during or immediately following a storm.

Discharge (streamflow): The volume of water passing through a channel during a given time, usually measured in cubic feet per second (cfs).

Digital Elevation Model (DEM): Regularly spaced grid of elevation points used to produce elevation maps.

Dissolved oxygen (DO): The amount of oxygen in water, usually measured in milligrams/liter (mg/L).

Downcutting: The action of a stream to deepen itself, often as a result from channelization.

Drainage basin: Land surface region drained by a length of stream channel; usually 1,000 to 10,000 square miles in size.

Dune complex: Sandy areas formed by the various stages of Lake Michigan. Dune complexes appear as beach ridges that parallel one another and contain lakes, marshes, and wetlands between them.

Ecosystem: An ecological community together with its environment, functioning as a unit.

Element Occurrence Records (EORs): Species, communities, or other biological features are referred to as "elements" Natural Heritage Programs and Conservation Data Centers. Each "element occurrence" represents a compendium of available information about the feature on the ground.

Erosion: Displacement of soil particles on the land surface due to water or wind action.

European settlement: A period in the early 1800's when European settlers moved across the United States in search of better lives. During this movement, much of the historical communities were altered for farming and other types of development.

Evaporation: The process of liquid water becoming water vapor, including vaporization from water surfaces, land surfaces, and snow fields, but not from leaf surfaces.

Evapotranspiration: The combined processes through which water is transferred to the atmosphere from open water and ice surfaces, bare soil and vegetation.

Eutrophic: A waterbody having a high level of biological productivity which is usually a result of high nutrient loads.

Farmed wetland: Wetlands that were manipulated and used to produce an agricultural commodity prior to December 23, 1985, but had not been completely converted prior to that date and therefore are not prior converted cropland. These areas still meet the wetland criteria and include areas that are seasonally ponded or flooded for an extended period of time.

Faunal: Animals of a particular region or period, considered as a group.

Federal Emergency Management Agency (FEMA): Government agency within the Department of Homeland Security that responds to, plans for, recovers from, and mitigates against disasters/emergencies, both natural and man-made.

Fee in lieu: Defined by the Corps and EPA as a payment "to a natural resource management entity for implementation of either specific or general wetland or other aquatic resource development projects" for projects that "do not typically provide compensatory mitigation in advance of project impacts."

Filamentous algae: Simple one-celled or multi-celled organisms (usually aquatic) capable of photosynthesis that are an indicator of high nutrient levels in the water column.

Filter strip: A long narrow portion of vegetation used to retard water flow and collect sediment for the protection of watercourses, reservoirs, sensitive areas, or adjacent properties.

Fish cover: Natural (trees, logs, boulders and undercut banks) and unnatural (tires and lunkers) structures in the stream that are available to fish for hiding, resting or egg laying.

Flashy hydrology/flooding: A quickly rising and falling overflow of water in stream channels that is usually the result of increased amounts of impervious surface in the watershed.

Flood Insurance Rate Map (FIRM): A map prepared by the Federal Emergency Management Agency that depicts the special flood hazard area (SFHA) within a community. The FIRM includes zones for the 100-year and 500-year floodplains and may or may not depict Regulatory Floodways.

Flood Insurance Study (FIS): Studies conducted by the Federal Emergency Agency (FEMA) to determine areas that have the highest probability for flooding.

Flood of record: The highest elevation recorded for the largest known flood event. Flood elevations are determined from the United States Geologic Survey Hydrologic Atlas.

Flood problem area (FPA): One or more buildings, roads or other infrastructure in one location that are repeatedly damaged by flooding.

Flood risk area: Special flood hazard areas where structures have been identified as being at risk for flood damage because of their location in the 100-year floodplain (see 100-year floodplain).

Floodproofing: Any combination of structural and non-structural additions, changes or adjustments to structures or property which reduce or eliminate flood damage to real estate or improved real property, water and sanitary facilities, structures and contents.

Floodplain (100-year): Land adjoining the channel of a river, stream, watercourse, lake or wetland that has been or may be inundated by floodwater during periods of high water that exceed normal bank-full elevations. The 100-year floodplain has a probability of 1% chance per year of being flooded.

Floodway: The floodway is the portion of the stream or river channel that includes the adjacent land areas that must be reserved to discharge the 100-year flood without increasing the water surface.

Flora: Collectively, the plants of a particular region, geological period, or environment.

Flow Regimes: The period during which a particular amount of water flows through a stream system.

General Use Water Quality Standards (State): The Illinois Pollution Control Board (IPCB), a sister Agency to the Illinois EPA, develops water quality standards in Illinois. These standards serve to protect aquatic life, human health or wildlife, although wildlife based criteria have not yet been derived.

Geographic Information System (GIS): A computer-based approach to interpreting maps and images and applying them to analysis of systems and problem-solving.

Glacial Drift: Earth and rocks which have been transported by moving ice or land ice.

Global Positioning System (GPS): Satellite mapping systems that enables locators and mapping to be created via satellite.

Grassland: An area such as a prairie or a meadow with grass or grass-like vegetation.

Gray infrastructure: A network of transportation, power, communication and other human constructed systems that are designed to connect across multiple jurisdictions and incorporate facilities that function at different scales.

Greenways: A protected linear open space area that is either landscaped or left in its natural condition. It may follow a natural feature of the landscape such as a river or stream, or it may occur along an unused railway line or some other right of way. Provides wildlife corridors and recreational trails.

Green infrastructure: Defined by the Lake County Stormwater Management Commission as: on the local scale, municipal or neighborhood, green infrastructure consists of site-specific best management practices (such as naturalized detention facilities, vegetated swales, porous pavements, rain gardens, and green roofs) that are designed to maintain natural hydrologic functions by absorbing and infiltrating precipitation where it falls. On the regional scale, green infrastructure consists of the interconnected network of open spaces and natural areas (such as forested areas, flooplains and wetlands, greenways, parks, and forest preserves) that mitigate stormwater runoff, naturally recharge aquifers, improve water quality while providing recreational opportunities and wildlife habitat.

Groundwater recharge: Primary mechanism for aquifer replenishment which ensures future sources of groundwater for commercial and residential use.

Headwaters: Upper reaches of tributaries in a drainage basin.

High Quality Aquatic Resources (HQAR): Waters of the United States or Isolated Waters of Lake County (unconnected waters) that are determined to be critical due to their uniqueness, scarcity, function or value.

Hydraulic and Hydrologic modeling: Engineering analysis that predicts expected flood flows and flood elevations based on land characteristics and rainfall events.

Hydraulic impediment: Structure of object that impedes free movement of water or aquatic organisms such as a dam or debris jam.

Hydraulic impoundments: Man-made reservoirs that provide flood protection. They are designed to store floodwater in excess of a bypass rate.

Hydraulic structures: Low head dams, culverts, weirs, bridges, levees, and any other structures along the course of the river.

Hydraulics: A branch of science that deals with practical applications of liquid in motion.

Hydrologic Simulation Program-Fortran (HSPF): Computer program that simulates for extended periods of time the hydrologic, and associated water quality, processes on pervious and impervious land surfaces and in streams.

Hydric inclusion soil: A soil unit (usually adjacent to hydric soils) that are not wet enough to form hydric properties but do have some hydric properties.

Hydric soil: Soil units that are wet frequently enough to periodically produce anaerobic conditions, thereby influencing the species composition or growth, or both, of plants on those soils.

Hydrograph: A way of measuring and graphing stream flow, or discharge, as it varies with time.

Hydrologic Soil Groups (HSG): Soils are classified by the Natural Resource Conservation Service into four Hydrologic Soil Groups based on the soil's runoff potential. The four Hydrologic Soils Groups are A, B, C and D. A's generally have the smallest runoff potential and D's the greatest.

Hydrology: The scientific study of the properties, distribution, and effects of water on the earth's surface, in the soil and underlying rocks, and in the atmosphere.

Hydrophytic vegetation: Plant life growing in water, soil or on a substrate that is at least periodically deficient in oxygen as a result of excessive water content; one of the indicators of a wetland.

Hypereutrophic: A waterbody having the highest level of biological productivity. They typically have very low water clarity, potential for many fish and other wildlife, and may have an abundance of aquatic plants.

Illicit connections & infiltration (I&I): Any discharge to a municipal separate stormsewer that is not composed entirely of stormwater.

Illinois Environmental Protection Agency (IEPA): Government agency established to safeguard environmental quality, consistent with the social and economic needs of the State, so as to protect health, welfare, property and the quality of life.

Illinois Department of Natural Resources (IDNR): A government agency established to manage, protect and sustain Illinois' natural and cultural resources; provide resource-compatible recreational opportunities and to promote natural resource-related issues for the public's safety and education.

Illinois Department of Transportation: The Illinois Department of Transportation focuses primarily on the state's policies, goals and objectives for Illinois' transportation system and provides an overview of the department's direction for the future.

Illinois Natural Areas Inventory (INAI): A survey conducted by the Illinois Department of Natural Resources to catalogue high quality natural areas, threatened and endangered species and unique plant, animal and geologic communities for the purpose of maintaining biodiversity.

Illinois Nature Preserves: State-protected areas that are provided the highest level of legal protection, and have management plans in place.

Illinois Pollution Control Board (IPCB): An independent agency created in 1970 by the Environmental Protection Act. The Board is responsible for adopting Illinois' environmental regulations and deciding contested environmental cases.

Impervious cover/surface: An area covered with solid material or that is compacted to the point where water can not infiltrate underlying soils (e.g. parking lots, roads, houses, patios, swimming pools, tennis courts, etc.). Stormwater runoff velocity and volume can increase in areas covered by impervious surfaces.

Impervious Cover Model: Simple urban stream classification model based on impervious cover and stream quality. The classification system contains three stream categories, based on the percentage of impervious cover that predicts the existing and future quality of streams based on the measurable change in impervious cover. The three categories include sensitive, impacted, and non-supporting.

Incised channel: A stream that has degraded and cut its bed into the valley bottom. Indicates accelerated and often destructive erosion.

Index of Biotic Integrity (IBI): The IBI is based on fish surveys with the rating dependent on the abundance and composition of the fish species in a stream. Fish communities are useful for assessing stream quality because fish represent the upper level of the aquatic food chain and therefore reflect conditions in the lower levels of the food chain. Fish population characteristics are dependent on the physical habitat, hydrologic and chemical conditions of the stream, and are considered good indicators of overall stream quality because they reflect stress from both chemical pollution and habitat perturbations. For example, the presence of fish species that are intolerant of pollution are an indicator that water quality is good. The IBI is calculated on a scale of 12 to 60, the higher the score the better the stream quality.

Infiltration: That portion of rainfall or surface runoff that moves downward into the subsurface soil.

Integrated Lakes Management (ILM): A midwest consulting agency offering a broad range of environmental services encompassing both aquatic and terrestrial environments. They specialize in environmental consulting, lake and pond management, and ecological restoration.

Invasive vegetation/plant: Plant species that are not native to an area and tend to out-compete native species and dominate an area (e.g. European buckthorn or garlic mustard).

Isolated waters of Lake County (Isolated wetland): All waters such as lakes, ponds, streams (including intermittent streams), farmed wetlands, and wetlands that are not under U. S. Army Corps of Engineers jurisdiction:

- The limits of the Isolated Waters of Lake County extend to the ordinary high water mark or the delineated wetland boundary.
- Isolated Waters of Lake County exclude permitted excavations created for such purposes as: stormwater conveyance, detention/retention areas constructed as part of a stormwater management system, recreation, stock watering, irrigation, settling basins or wastewater treatment systems and roadside ditches. Also excluded are areas created by incidental construction grading that are exempt per Article IV Section A.2. of this ordinance.
- Compensatory wetland mitigation created to meet the requirements of this Ordinance or Section 404 of the Clean Water Act is not excluded.

Knobby hill: Glacial formation by which melting ice deposits material forming irregular shapes.

Kettle hole: A depression in the surface of a ground moraine, caused by the melting of a block of subsurface ice after the moraine had formed.

Lake County Health Department—Lakes Management Unit (LCHD): Government agency initiated to monitor the quality of Lake County's surface water in order to maintain or improve water quality and alleviate nuisance conditions, promote healthy and safe lake conditions, and protect and improve ecological diversity.

Lake County Stormwater Management Commission (LCSMC): Government agency created to coordinate the stormwater activities of over 90 jurisdictions throughout Lake County. They provide technical assistance, local knowledge and problem-solving skills to coordinate flood damage reduction, flood hazard mitigation, water quality enhancements and natural resource protection projects and programs.

Lake County Watershed Development Ordinance (WDO): see Watershed Development Ordinance.

Lake County Wetland Inventory (LCWI): An inventory of wetlands in Lake County, Illinois that shows approximate wetland boundaries using the off-site delineation methodology in the 1989 "Federal Manual for Identifying and Delineating Jurisdictional Wetlands". The LCWI was completed by a group of federal, state and county agencies and published in March 1993.

Liberty Prairie Conservancy (LPC): A non-profit land conservation organization dedicated to protecting natural areas and working farmland throughout Lake County. The Conservancy was founded in 1995 to steward and advocate for the Liberty Prairie Reserve.

Liberty Prairie Reserve (LPR): 5,800-acre area in central Lake County that contains three Illinois Nature Preserves and nearly 3,200 acres of protected open space.

Limnology: The scientific study of bodies of fresh water for their biological, physical, and geological properties.

Loess: A fine-grained unstratified accumulation of clay and silt deposited by wind.

Macroinvertebrates: Invertebrates that can be seen by the unaided eye (macro). Most benthic invertebrates in flowing water are aquatic insects or the aquatic stage of insects, such as stonefly nymphs, mayfly nymphs, caddisfly larvae, dragonfly nymphs and midge larvae. They also include such things as clams and worms. The presence of benthic macroinvertebrates that are intolerant of pollutants is a good indicator of good water quality.

Macroinvertebrate Biotic Index (MBI): Method used to rate water quality using macroinvertebrate taxa tolerance to degree of and extent of organic pollution in streams. The method detects change in biological systems that result from the actions of human society. The MBI is very similar to the IBI except it is based on sampling macroinvertebrates (insects, worms etc.) that live in the stream rather than fish. The MBI scale is from 1 to 10, with 1 being the highest stream quality indicator and 10 being the worst. A MBI less than 6 indicates a good macroinvertebrate population. As with fish, the presence of pollution intolerant macroinvertebrate species is an indicator of good water quality. Since macroinvertebrates are less mobile than fish, the MBI is a good index to evaluate upstream/downstream impacts of point source discharges.

Marsh: An area of soft, wet, low-lying land, characterized by grassy vegetation and often forming a transition zone between water and land.

Meander (stream): A sinuous channel form in flatter river grades formed by the erosion on one side of the channel (pools) and deposition on the other (point bars).

Mesotrophic: A waterbody with moderate levels of biological productivity. These waterbody's commonly have clear water with beds of submerged aquatic plants and medium levels of nutrients.

Mitigation: Measures taken to eliminate or minimize damage from development activities, such as construction in wetlands or Regulatory Floodplain filling, by replacement of the resource.

Moraine: see Terminal Moraine.

National Flood Insurance Program (NFIP): Managed by the Mitigation Division within the Federal Emergency Management Agency (FEMA), participants in the NFIP adopt and enforce floodplain management ordinances to reduce future flood damage and in exchange are eligible to receive federally funded flood insurance.

National Wetland Inventory (NWI): U.S. Fish and Wildlife Service study that provides information on the characteristics, extent, and status of U.S. wetlands and deepwater habitats and other wildlife habitats.

Native vegetation/plants: Plant species that have historically been found in an area.

Natural community: an assemblage of plants and animals interacting with one another in a particular ecosystem

Natural divisions: Large land areas that are distinguished from each other by bedrock, glacial history, topography, soils, and distribution of plants and animals.

No-net-loss: A policy for wetland protection to stem the tide of continued wetland losses. The policy has generated requirements for wetland mitigation so that permitted losses due to filling and other alterations are replaced and the net quality wetland acreage remains the same.

Nonpoint source pollution (NPS or NPSP): Refers to pollutants that accumulate in waterbodies from a variety of sources including runoff from the land, impervious surfaces, the drainage system and deposition of air pollutants.

Northeastern Illinois Planning Commission (NIPC): Government agency created to conduct research required for regional growth management and comprehensive land-use planning for Cook, Lake, McHenry, DuPage, Kane, and Will counties.

National Pollutant Discharge Elimination System (NPDES Phase II): Clean Water Act law requiring smaller communities and public entities that own and operate an municipal separate stormwater system to apply and obtain an NPDES permit for stormwater discharges. Permittees at a minimum must develop, implement, and enforce a stormwater program designed to reduce the discharge of pollutants from the MS4 to the maximum extent practicable. The stormwater management program must include these six minimum control measures:

1. Public education and outreach on stormwater impacts
2. Public involvement/participation
3. Illicit discharge detection and elimination
4. Construction site stormwater runoff control
5. Post-construction stormwater management in new development and redevelopment
6. Pollution prevention/good housekeeping for municipal operations

Nutrients: Substances needed for the growth of aquatic plants and animals such as phosphorous and nitrogen. The addition of too many nutrients (such as from sewage dumping and over fertilization) will cause problems in the aquatic ecosystem through excess algae growth and other nuisance vegetation and may cause adverse impacts to aquatic species.

Oak woodland: A type of ecosystem characterized by open spacing between oak trees and intervening areas of grassland.

Oligotrophic: A waterbody with the lowest level of biological productivity. Oligotrophic waterbodies typically have clear water, few aquatic plants, and few fish.

Open space: Any land that is not developed and is often set aside for conservation or recreation purposes. It can be either protected or unprotected. Protected open space differs from unprotected in that it is permanently preserved by outright ownership by a body chartered to permanently save land, or by a permanent deed restriction such as a conservation easement. Open space is important to a watershed's hydrology, habitat, water quality, and biodiversity.

Organic matter: Decomposing vegetative litter and animal matter.

Outwash: Sand and gravel deposits removed or washed out from a glacier.

Partially open parcel: Parcels that have been developed to some extent, but still offer some opportunities for open space and Best Management Practice (BMP) implementation. They typically include private residences with acreage exceeding the surrounding minimum zoning, partly developed industrial sites, or institutions (churches, schools, etc.) with extensive grounds.

Point source pollution: Refers to discharges from a single source such as an outfall pipe conveying wastewater from an industrial plant or wastewater treatment facility.

Pollutant load: The amount of any pollutant deposited into waterbodies from point source discharges, combined sewer overflows, and/or stormwater runoff.

Pool: A location in an active stream channel usually located on the outside bends of meanders, where the water is deepest and has reduced current velocities.

Prairie: A type of grassland characterized by low annual moisture and rich black soil characteristics.

Preventative measures: Actions that reduce the likelihood that new watershed problems such as flooding or pollution will arise, or that those existing problems will worsen. Preventative techniques generally target new development in the watershed and are geared toward protecting existing resources and preventing degradation.

Prior converted wetland: Wetlands that were drained, dredged, filled, leveled, or otherwise manipulated, including the removal of woody vegetation to make production of an agricultural commodity possible, and that (1) do not meet specific hydrologic criteria, (2) have had an agricultural commodity planted or produced at least once prior to December 23, 1985, and (3) have not since been abandoned. Activities occurring in prior converted cropland are not regulated under Swampbuster or Section 404 of the CWA.

Radial Environmental Report: Report that identifies sites within subwatersheds that are listed on government-generated, environmental databases. The report contains information on sites that may pose environmental threats due to locations where hazardous materials have been released.

Regionally Significant Storage Locations (RSSL): Existing or created depressional areas on the landscape within a watershed.

Regulatory floodplain: Regulatory Floodplains may be either riverine or non-riverine depressional areas. Projecting the base flood elevation onto the best available topography delineates floodplain boundaries. A floodprone area is Regulatory Floodplain if it meets any of the following descriptions:

- Any riverine area inundated by the base flood where there is at least 640 acres of tributary drainage area.
- Any non-riverine area with a storage volume of 0.75 acre-foot or more when inundated by the base flood.

- Any area indicated as a Special Flood Hazard Area on the FEMA Flood Insurance Rate Map expected to be inundated by the base flood located using best available topography.

Regulatory floodway: The channel, including on-stream lakes, and that portion of the Regulatory Floodplain adjacent to a stream or channel as designated by the Illinois Department of Natural Resource—Office of Water Resources, which is needed to store and convey the existing and anticipated future 100-year frequency flood discharge with no more that a 0.1 foot increase in stage due to the loss of flood conveyance or storage, and no more than a 10% increase in velocities. Where interpretation is needed to determine the exact location of the Regulatory Floodway boundary, the IDNR-OWR should be contacted for the interpretation.

Remedial measures: Used to solve known watershed problems or to improve current watershed conditions. Remedial measures include retrofitting drainage system infrastructure such as detention basins and stormsewer outfalls to improve water quality, adjust release rates, or reduce erosion.

Remnant: a small fragmented portion of the former dominant vegetation or landscape which once covered the area before being cleared for human land use.

Recessional moraines: An end moraine formed during a temporary but significant halt in the final retreat of a glacier.

Retention facilities: A facility designed to completely retain a specified amount of stormwater runoff without release except by means of evaporation, infiltration or pumping.

Retrofit: Refers to modification to improve problems with existing stormwater control structures such as detention basins and conveyance systems such as ditches and stormsewers. These structures were originally designed to improve drainage and reduce flood risk, but they can also be retrofitted to improve water quality.

Ridge: A line connecting the highest points along a landscape and separating drainage basins or small-scale drainage systems from one another.

Riffle: Shallow rapids, usually located at the crossover in a meander of the active channel.

Riparian: Referring to the riverside or riverine environment next to the stream channel, e.g., riparian, or streamside, vegetation.

Runoff: The portion of rain or snow that does not percolate into the ground and is discharged into streams by flowing over the ground instead.

Runoff curve numbers: Numbers developed to classify the runoff potential of different soil types with different land cover. The curve numbers are a function of Hydrologic Soil Groups, land cover or usage, and antecedent soil moisture conditions. The curve number value can be a number from 0 to 100 although the typical range is between 25 through 98. A curve number value of 98 is considered to be an impervious land cover such as pavement or a building roof. A low curve number value would indicate conditions with a very low runoff potential.

Savanna: A type of woodland characterized by open spacing between its trees and by intervening grassland.

Section 319: see U.S. Environmental Protection Agency Section 319.

Sediment: Soil particles that have been transported from their natural location by wind or water action.

Sedimentation: The process that deposits soils, debris and other materials either on other ground surfaces or in bodies of water or watercourses.

Sensitive resource: Ecological features of the landscape that are determined to be critical due to their uniqueness, scarcity, function or value, and sensitivity to human impacts.

Silt: Fine mineral particles intermediate in size between clay and sand.

Source reduction: Changing everyday practices to reduce the quantity of pollutants that end up on the land and in the water.

Stakeholders: Individuals, organizations, or enterprises that have an interest or a share in a project. (see also Watershed Stakeholders).

Stormwater management: A set of actions taken to control stormwater runoff with the objectives of providing controlled surface drainage, flood control and pollutant reduction in runoff.

Stormsewershed: An area of land whose stormwater drains into a common storm sewer system

Stream corridor: The area of land that runs parallel to a stream.

Stream gage station: Point along a stream where the amount of water flowing in an open channel is measured. The USGS makes most streamflow measurements by current meter. A current meter is an instrument used to measure the velocity of flowing water. By placing a current meter at a point in a stream and counting the number of revolutions of the rotor during a measured interval of time, the velocity of water at that point is determined.

Stream order: A number from 1 to 6 or higher, designating the relative position of a stream or stream segment in a watershed. Ranking proceeds from the headwaters. First-order streams are without specific tributaries; the junction of two first-order streams produces a second-order stream; the junction of two second-order streams produces a third-order stream, and etc.

Stream reach: A stream segment having fairly homogenous hydraulic, geomorphic and riparian cover and land use characteristics (such as all ditched agriculture or all natural and wooded). Reaches generally should not exceed 2,000 feet in length.

Streambank stabilization: Techniques used for stabilizing eroding streambanks.

Stream monitoring: Chemical, biological and physical monitoring used to identify the causes and sources of pollution in the river and to determine the needs for reduction in pollutant loads, streambank stabilization, debris removal and habitat improvement.

Substrate (stream): The composition of the bottom of a stream such clay, silt or sand.

Subwatershed: A smaller basin within a larger drainage area that all drains to a central point of the larger watershed.

Subwatershed Management Unit (SMU): Small unit of a watershed or subwatershed that is delineated and used in watershed planning efforts because the effects of impervious cover are easily measured, there is less chance for confounding pollutant sources, boundaries have fewer political jurisdictions, and monitoring/mapping assessments can be done in a relatively short amount of time.

Swale: A vegetated channel, ditch or low-lying or depressional tract of land that is periodically inundated due to the conveyance of stormwater from one point to another. Swales are often used in natural drainage systems instead of stormsewers.

Threatened and Endangered Species (T&Es): An "endangered" species is one that is in danger of extinction throughout all or a significant portion of its range. A "threatened" species is one that is likely to become endangered in the foreseeable future.

Till: A hetergeneous mixture of clay, silt, sand, gravel, stones, and boulders deposited directly by and underneath a glacier without stratification.

Topography: The relative elevations of a landscape describing the configuration of its surface.

Total dissolved solids (TDS): A measure of the dissolved solids in water sample.

Total suspended solids (TSS): The organic and inorganic material suspended in the water column and greater than 0.45 micron in size.

Treatment Train: Several BMPs used together to improve water quality, infiltration and reduce sedimentation.

Total Maximum Daily Load (TMDL): A TMDL is the maximum amount of point and non-point source pollutants a stream can take in during a single day and still support its designated uses.

Trophic State Index (TSI): Trophic State is a measure of the degree of plant material in of a body of water. It is usually measured using one of several indices (TSI) of algal weight (biomass): water transparency (Secchi Depth), algal chlorophyll, and total phosphorus.

TR55 Document: A single event rainfall-runoff hydrologic model designed for small watersheds and developed by the USDA-NRCS and EPA.

Turbidity: Refers to the clarity of the water, which is a function of how much material including sediment is suspended in the water.

United States Environmental Protection Agency Section 319 (Section 319): Section 319 of the Clean Water Act encourages and funds nonpoint source pollution control projects (any indirect pollution, like runoff, stormwater discharge, road salt, sediment, etc.) or NPS reduction at the source.

United States Geological Survey (USGS): Government agency established in 1879 with the responsibility to serve the Nation by providing reliable scientific information to describe and understand the Earth; minimize loss of life and property from natural disasters; manage water, biological, energy, and mineral resources; and enhance and protect our quality of life.

United States Army Corps of Engineers (USACE): Federal group of civilian and military engineers and scientists that provide services to the nation including planning, designing, building and operating water resources and other Civil Works projects. These also include navigation, flood control, environmental protection, and disaster response.

Upper Des Plaines River Ecosystem Partnership (UDPREP): This Partnership was organized in 1996 between Wisconsin and Illinois through the Illinois Department of Natural Resources Ecosystems Program of Conservation 2000 and seeks to preserve and restore Illinois ecosystems. The Partnership is collaboration among the diverse organizations and private landowners who share an interest in improving the quality of life within the watershed. Their objectives include open space protection and restoration, floodplain and stormwater management, water quality improvement, reduction of soil erosion, enhancement of recreational opportunities, and demonstration of the feasibility of interstate and public/private partnerships.

Urban runoff: Water from rain or snow events that runs over surfaces such as streets, lawns, parking lots and directly into storm sewers before entering the river rather than infiltrating the land upon which it falls.

Vegetated buffer: An area of vegetated land to be left open adjacent to drainageways, wetlands, lakes, ponds or other such surface waters for the purpose of eliminating or minimizing adverse impacts to such areas from adjacent land areas.

Vegetated swale: An open channel drainageway used along residential streets and highways to convey stormwater and filter pollutants in lieu of conventional storm sewers.

Velocity (of water in a stream): The distance that water can travel in a given direction during a period of time expressed in feet per second.

Watershed: An area confined by topographic divides that drains to a given stream or river. The land area above a given point on a waterbody (river, stream, lake, wetland) that contributes runoff to that point is considered the watershed.

Watershed Development Ordinance (WDO): One part of the adopted Lake County Comprehensive Stormwater Management Plan. It sets forth the minimum requirements for the stormwater management aspects of development in Lake County.

Watershed stakeholder: A person who has a personal, professional, legal or economic interest in the watershed and the outcome of the watershed planning process.

Watershed partner(s): Watershed stakeholders who take an active role in the watershed management planning process and implementing the watershed plan.

Waters of the United States (WOUS): For the purpose of Watershed Development Ordinance the term Waters of the United States refers to those water bodies and wetland areas that are under the U. S. Army Corps of Engineers jurisdiction.

Watershed Vulnerability Analysis: Rapid planning tool for application to watersheds and subwatersheds that estimates future and impervious cover and provides guidance on factors that might alter the initial classification or diagnosis of a watershed or subwatershed.

Water yield: The total water that flows out from all or part of a drainage basin through either surface channels or subsurface aquifers within a given time frame, such as a year.

Wetland: A wetland is considered a subset of the definition of the Waters of the United States. Wetlands are land that is inundated or saturated by surface or ground water at a frequency and duration sufficient to support, under normal conditions, do support a prevalence of vegetation adapted for life in saturated soil conditions (known as hydrophytic vegetation). A wetland is identified based upon the three attributes: 1) hydrology, 2) hydric soils and 3) hydrophytic vegetation.

Wet meadow: A type of wetland away from stream or river influence with water made available by general drainage and consisting of non-woody vegetation growing in saturated or occasionally flooded soils.

CHAPTER 11.0

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