Appendix A:

Bioassessment Plan for the DuPage and Salt Creek Watersheds

Center for Applied Bioassessment and Biocriteria
Midwest Biodiversity Institute

West Branch DuPage River

Bioassessment Plan for the DuPage and Salt Creek Watersheds

DuPage and Cook Counties, Illinois

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Technical Report MBI/03-06-1

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DuPage and Cook Counties, Illinois

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DuPage-Salt Creek Work Group

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INTRODUCTION

The Midwest Biodiversity Institute (MBI) was contracted by the Conservation Foundation on behalf of the DuPage-Salt Creek watershed group to prepare a watershed-based biological assessment plan for the DuPage and Salt Creek subbasins within DuPage and Cook Counties, Illinois. This plan describes spatial and temporal sampling designs and the indicators and parameters that should be collected at each sampling site. It also describes the type of biological sampling methods for fish and macroinvertebrate assemblages and habitat assessment that should be employed. In addition, chemical and physical measures are also included to provide supporting data and information for the biological assessment. This plan will be used to develop a Request for Proposals for conducting the actual field work and the subsequent data analysis for a baseline bioassessment in the near future.

The sampling designs employ a combination of stratified-random and targeted-intensive surveys. These are employed to fulfill multiple management purposes and goals in addition to the determination of the existing status of the extant biological assemblages. As such, the principles of adequate monitoring (ITFM 1995; Yoder 1998) were used in anticipation that the resulting biological assessment will be used to support the development of cost-effective watershed management responses to existing and emerging issues. The following describes these principles in detail, which is followed by the recommended watershed-based bioassessment designs.

Strategic Role of Monitoring and Assessment

The generation of data and information via ambient environmental monitoring is inherently a strategic process, which requires an understanding of the broad goals and objectives about the use of such information in the management of water resources. During the late 1980s and early 1990s, renewed interest by federal and state agencies and research organizations resulted in a number of reviews and compendia about what constitutes an *adequate* and *credible* framework for the monitoring and assessment of the nation's waters. The most comprehensive of these was the Intergovernmental Task Force on Monitoring Water Quality (ITFM) which produced a national strategy for water monitoring (ITFM 1995) and the establishment of the National Water Quality Monitoring Council (NWQMC) in 1997. Other efforts included a revision of U.S. EPA's basic guidance on surface water monitoring programs, a description of the important concepts and elements of an *adequate* watershed monitoring and assessment approach by U.S. EPA and the Association of State and Interstate Water Pollution Control Administrators (ASIWPCA; Yoder 1998), the Consolidated Assessment and listing Methodology (CALM) guidance of U.S. EPA, and the National Research Council's review of science in the TMDL process (NRC 2001). Together, these provide strategic guidance and essential principles by which a surface water monitoring program should be developed and conducted, including those of local and regional scope.

MBI produced monitoring program plans and strategies based on these principles for two organizations, the Miami Conservancy District (Ohio) and the state of Rhode Island DEM (MBI 2003a, 2003b). These efforts reflect the implementation of these principles and concepts at regional and watershed scales of application. Most of what follows is a reflection of these products and experiences. In addition, the experience of Ohio EPA (1999) in developing and using a geometric monitoring site selection design is also used herein.

The Relationship between Monitoring and Watershed Management

A growing awareness and appreciation that our air, land, and water resources are subject to a variety of effects of human activities on local, regional, national, and global scales has resulted in a proliferation of efforts to manage water resources at the watershed scale by a diversity of governmental and non-governmental organizations. Most of these efforts are driven by an emphasis on the identification and implementation of management practices, frequently on the basis of prescription that is frequently lacking sufficient grounding in environmental criteria and data. An improved capability to more accurately measure the extent and severity of impairments and threats and understand the causes and sources associated with each is essential to formulating accurate, effective, and proportionate management responses. Adequate environmental monitoring and assessment is a key enterprise in enabling this process.

Environmental monitoring of surface waters has been defined as the systematic collection and evaluation of data about the chemical, physical, and biological attributes of the aquatic environment and how both natural and human-induced changes affect overall quality (Cooly 1976). Some estimates indicate that $500 billion to $1 trillion has been spent on water pollution abatement nationally since the early 1970s. Yet, with only a few notable exceptions, the effectiveness of these expenditures has been largely undocumented in true environmental terms (ITFM 1992). The reason lies in the fact that only 0.2% of the amount spent on water pollution abatement and water quality management between 1970 and 1990 was devoted to ambient monitoring (ITFM 1992). Our challenge then is to more accurately measure, characterize, and understand the significance of these efforts, which is crucial to the effective management and protection of water resources. Comprehensive and adequate monitoring and assessment is an indispensable component of achieving this goal (ITFM 1992).

Monitoring plays a key role in the management of surface water resources by driving the progression of events from initial problem identification and characterization through the making of management decisions in such areas as pollution abatement and water quality management programs to the enforcement of laws and regulations. The recent efforts to revitalize the role of monitoring and assessment in state and federal water quality management programs were intended to provide the essential data and information needed to answer questions about the status and trends of water quality nationwide and guide the development of water quality management activities. At the same time, the

ITFM process was intended to stimulate interest and activity at all levels of government, including local and regional entities. As such, there are four principal aspects of a complete and comprehensive monitoring strategy:

Context

Monitoring should be the foundation of water resource policy-making and management. This means that monitoring information should not only be available to managers and policy makers, but also be sufficiently comprehensible and conclusive. A critical aspect is not just generating data, but providing an understandable assessment of what the data means (i.e., the essential conversion of data to useable information). This includes a determination of whether or not criteria, standards, and other management objectives are being achieved and the degree (both quantitatively and qualitatively) to which any are being exceeded or abrogated. This process requires the use of multiple classes of indicators, each used within their most appropriate role and in their proper relationship to each other (Yoder and Rankin 1998).

Scope

Monitoring includes the following activities:

- articulating objectives;
- collecting, storing, and interpreting data;
- conversion of data to information;
- preparing assessments of the information (what does it mean?);
- communication of assessment results; and
- evaluation of management program performance.

This progression allows water quality management programs to become more appropriately focused on the resource at issue, as opposed to the care-taking of administrative systems and processes. It fosters an approach of "managing for environmental results" in which administrative processes function as tools to improve the environment, not as a final endpoint of success.

Scale

Monitoring should address the relevant scale(s) at which management is being applied. This can range from site-specific investigations to watershed scale assessments to regional and national summaries of condition. Monitoring programs need to be constructed so that the baseline data and information supports assessments at the *same scale at which management is being applied.* The specific designs, indicators, and assessment tools used must be tailored to the regional peculiarities in climate, soils, land use, geology, ecological resources (flora and fauna), socioeconomic influences, and geography. Thus, the indicators that are used need to be sufficiently developed and calibrated to reflect these influences and applied at the scales at which the management is being conducted.

Objectives
General monitoring objectives usually include:

- defining status and trends;
- identification of existing and emerging problems;
- support of water quality management policy and program development;
- evaluating management program effectiveness;
- responding to emergencies, and
- continued development and improvement of the understanding of the basic chemical, physical, and biological processes that affect environmental quality.

Effective monitoring and, by extension, water quality management programs require a supporting infrastructure in terms of personnel and logistical support to carry out monitoring from a "cost-of-doing-business" standpoint. This means that monitoring resources must be tailored to meet the management needs of the statewide, regional, or local scale through space and time.

An Adequate Watershed Monitoring Program

The question of what constitutes an adequate watershed monitoring and assessment program was articulated in general by the ITFM (1992, 1995) and more specifically by Yoder (1997). Adequate monitoring and assessment is key to resolving current deficiencies and inequities within and between programs and questions about the reliability 303(d) listings, nonpoint source management, and water quality standards. The document entitled *Important Concepts and Elements of an Adequate State Watershed Monitoring and Assessment Program* (Yoder 1997) outlined the important elements and concepts of adequate watershed monitoring and assessment. This document relied principally on the results of the ITFM process, EPA's environmental indicators initiatives of the late 1980s and early 1990s, and state agency experiences in operating systematic and adequately funded programs over a period of years.

Choosing Indicators and Parameters
Different types of measurements comprise an adequate watershed monitoring and assessment approach. These consist of core and supplemental indicators and parameters (Figure 1). The core parameters form the basis of all monitoring and assessment and are collected at all sites since they represent the baseline attributes of an aquatic ecosystem. Fundamental to this approach is the role of biological indicators as direct measures of ecosystem response supported by chemical and physical parameters as indicators of stress and exposure. These comprise the baseline of the adequate monitoring and assessment process and are directly linked to the data and information needs for answering fundamental assessment questions such as overall ecosystem status, water quality standards compliance, use attainability analyses, delineating associated causes/sources of threats and impairments, and basic reporting (305b report) and listing requirements (303d listings). Supplemental

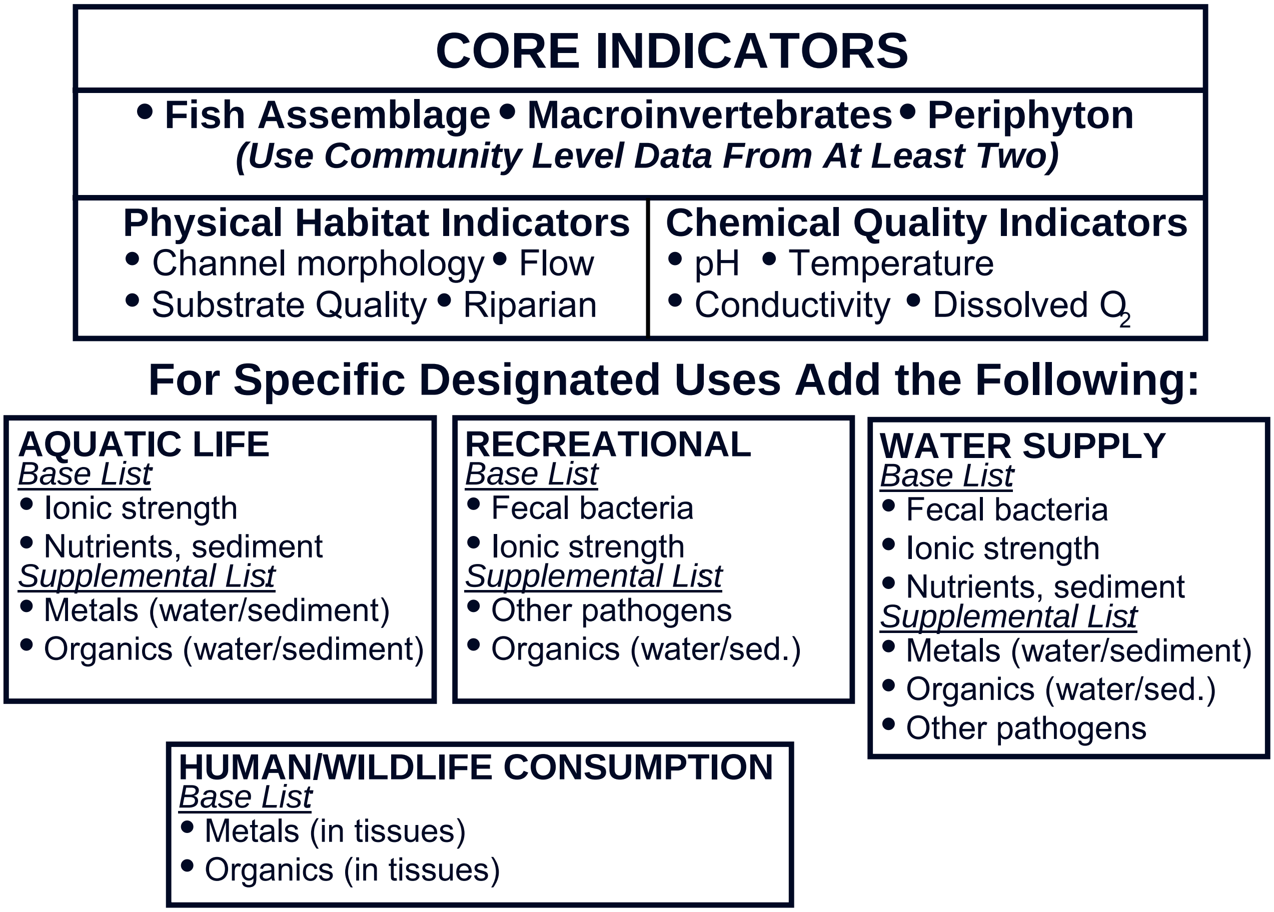

Figure 1. Core indicators and parameters and supplemental parameters organized by designated uses; these comprise an adequate watershed monitoring and assessment approach (after Yoder 1997).

parameters (Figure 1) consist largely of chemical, physical, and biologically-based indicators of stress and exposure and are added in accordance with the complexity of the setting and as the assessment needs (or questions) increase in diversity, quantity, and complexity. Table 1 shows the full suite of indicator categories (or levels) that are related to classes of possible management objectives. The data for some of these indicators may be accessed later in the analysis and reporting phases of the assessment process.

The approach emphasizes cost-effectiveness by carefully allocating sampling resources and by scaling the intensity and complexity of the monitoring in accordance with the complexity of the setting and the management questions and issues that need to be resolved. Such an approach also allows for more flexible management responses that are attenuated by the information revealed about the environmental complexity of the setting, the inherent quality of the aquatic resource, and the potential

Table 1. Summary matrix of recommended environmental indicators for meeting management objectives for status and trends of surface waters (a bold **X is** recommended as a primary indicator after ITFM 1993; other recommended indicators are designated by a √). The corresponding EPA indicator hierarchy level is listed for each suite of indicator groups.

Categories of Management Objectives

	Human Health		**Ecological Health**		**Economic Concerns**	
Indicator Groups	**Consump-tion of Fish/ Shellfish**	**Public Water Supply**	**Recreation (swimming, boating, fish Ing)**	**Aquatic & Semi-aquatic life**	**Industry/ Energy/ Transporta-tion**	**Agriculture/ Forestry**
Biological Response Indicators (Level 6)						
Macroinvertebrates		X	**X**	**X**		X
Fish	**X**	X	**X**	**X**		X
Semi-aquatic animals	X		**X**	**X**	X	
Pathogens	**X**	X	**X**		**X**	
Phytoplankton	**X**	**X**	X	**X**	**X**	
Periphyton				**X**		
Aquatic Plants		X	**X**	X	X	X
Zooplankton		X	X	X		X
Chemical Exposure Indicators (Levels 4&5)						
Water chemistry	X	**X**	**X**	**X**	X	**X**
Odor/Taste	**X**	**X**	**X**			X
Sediment Chemistry	**X**	**X**	**X**	**X**	**X**	**X**
Tissue Chemistry	**X**	X		X	X	
Biochemical Markers	√	√	√	√		√
Physical Habitat/Hydrological Indicators (Levels 3&4)						
Hydrological Measures	X	**X**	X	**X**	**X**	**X**
Temperature	X	X	**X**	**X**	**X**	
Geomorphology	X	X	**X**	**X**	**X**	**X**
Riparian/Shoreline	X	**X**	√	**X**	X	**X**
Habitat Quality	√	√	√	√	√	√
Watershed Scale Stressor Indicators (Levels 3,4,&5)						
Land Use Patterns	X	**X**	**X**	**X**	X	**X**
Human Alterations	X	**X**	**X**	**X**	X	√
Watershed Imperm.	√	√	√	√	√	√
Pollutant Loadings Indicators (Level 3)						
Point Source Loads	√	√	√	√	√	√
Nonpoint Loadings	√	√	√	√	√	√
Spills/Other Releases	√	√	√	√	√	√

pollution problems that might be encountered. Effective implementation of this process is enhanced through experience and knowledge gained by conducting monitoring and assessment for many years and over a wide geographical area.

Monitoring Networks and Design

Adequate monitoring employs a stepwise approach to the selection and use of the variety of chemical, physical, and biological indicators and measures that are currently available. The decision(s) about which indicators and parameters to use are based on the type of aquatic resource being assessed (*i.e.*, headwater stream, wadeable stream, non-wadeable large river, lake or reservoir, wetland, etc.), the environmental complexity of the setting (includes consideration of all potential stressors), and the water quality management objectives and purposes that are at issue. For example, in a small, headwater stream with only one or two potential stressors, a the two biological organism groups may be assessed using a relatively rapid bioassessment protocol accompanied by a *qualitative* habitat assessment, and comparatively limited chemical water quality sampling analyzing for field, demand, and nutrient series parameters. A relative few (e.g., 2-3) sampling sites would suffice and the field sampling would be completed in the matter of a few hours with one visit for biology and habitat and 1-3 samples for chemical/physical parameters. The resulting assessment could be turned around in a matter of a few days if necessary. In more complex watershed settings with multiple management issues, multiple and complex stressors, and the potential for the discovery of unknown and undocumented sources, the cumulative sampling requirements are more intensive, but may include many of the preceding example within a watershed. In addition, the bioassessment protocols are tailored to the resource that now includes mainstem rivers and streams. The accompanying habitat assessment remains much the same, but chemical water quality sampling includes more intensive and frequent sampling for heavy metals, other selected toxics, and organic scans of both the water column and bottom sediments. Continuous monitoring of temperature and D.O. would also be included in complex settings. The density and distribution of sampling sites would be in proportion to the size of the watershed and would also consider the location and entry of potential stressors into the aquatic ecosystem. A systematic sampling effort spans a summer-fall index period (mid-June through mid-October), requiring many sampling days and multiple field crews to complete. Data analysis and reporting culminate in the production of a comprehensive assessment months after the sampling is completed. This ensures that the careful analysis of multiple indicators and assignments of causes and sources is performed in accordance with sound indicator practice and procedures.

Assessment of Monitoring Results

Hierarchy of Environmental Indicators for Water

A carefully conceived ambient monitoring approach, using cost-effective indicators comprised of biological, chemical, and physical measures, can ensure that all relevant pollution sources are judged objectively on the basis of quantifiable environmental results. Such an approach simultaneously assures that indicators will be representative of the elements and processes of the five factors which determine water resource integrity (Figure 2; Karr et al. 1986). An indicators hierarchy first developed by U.S. EPA (1995a,b) provides a hierarchical framework within which the use of environmental indicators should take place (Figure 3). It offers a structured approach to assure that management programs are evaluated and, if necessary, adjusted based on sound environmental feedback. A comprehensive ambient monitoring effort that includes indicators representative of the key variables within the five factors that determine the integrity of a water resource (Figure 2) is essential to successfully implementing a true environmental indicators based approach.

A hierarchical approach is used in attempting to link the results of management actions as evaluated by the response of true environmental measures (Yoder and Rankin 1998). This integrated framework

The Five Major Factors Which Determine the Integrity of Aquatic Resources

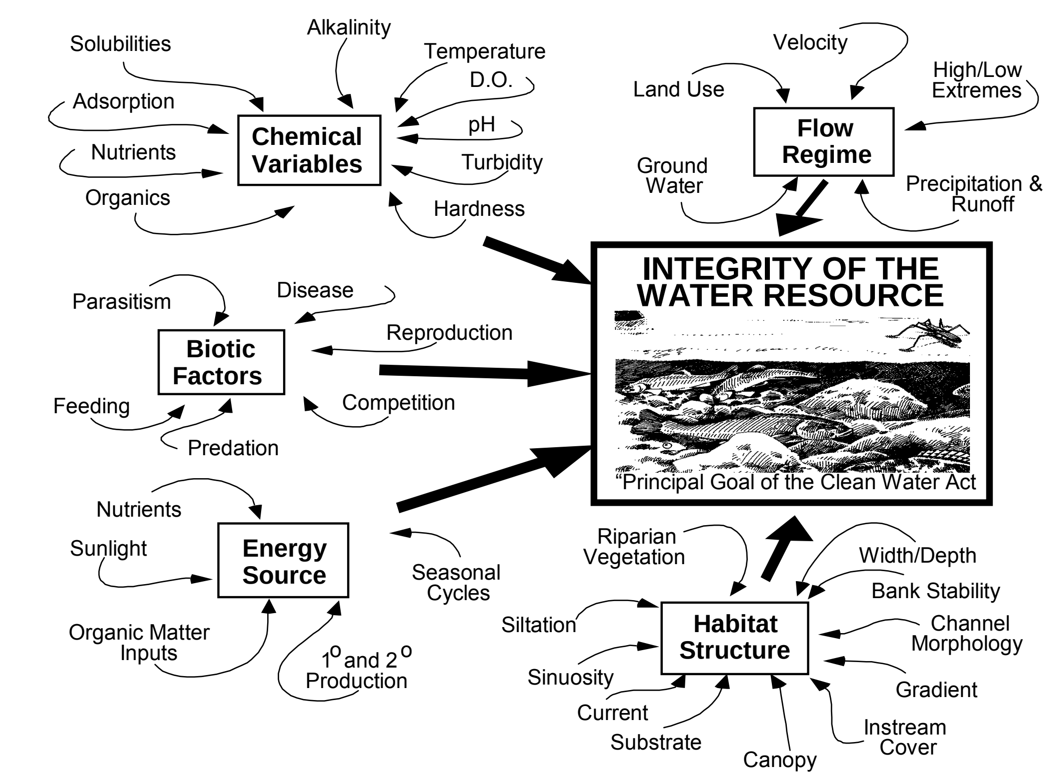

Figure 2. The five major factors which determine the integrity of water resources (modified from Karr et al. 1986).

uses the continuum of indicators within the discipline of stress, exposure, and response. The original framework developed by U.S. EPA (1995a) includes six "levels" of indicators as follows:

Level 1 - actions taken by regulatory agencies (*e.g.*, permitting, enforcement, grants);
Level 2 - responses by the regulated community (*e.g.*, construction of treatment works, pollution prevention);
Level 3 - changes in discharged quantities (*e.g.*, pollutant loadings);
Level 4 - changes in ambient conditions (*e.g.*, water quality, habitat);
Level 5 - changes in uptake and/or assimilation (*e.g.*, tissue contamination, biomarkers, assimilative capacity); and,
Level 6 - changes in health, ecology, or other effects (*e.g.*, ecological condition, pathogenicity).

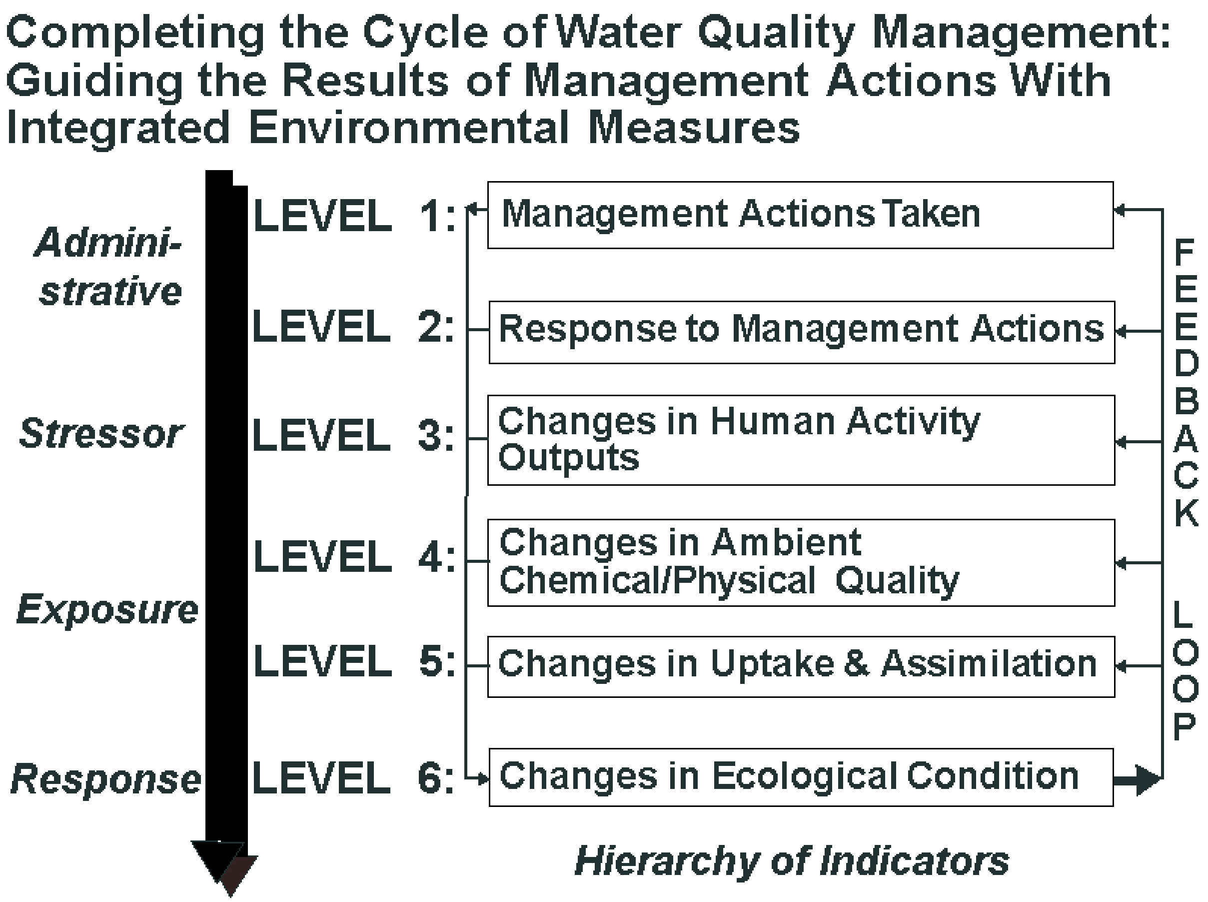

Figure 3. Hierarchy of indicators for determining the effectiveness of water quality management and maintaining appropriate relationships and feedback loops between different classes of indicators (modified from U.S. EPA 1995a by Karr and Yoder 2004).

In this process the results of administrative activities (levels 1 and 2) are followed by changes in pollutant loadings and ambient water quality (levels 3, 4, and 5), all of which leads to measurable environmental "results" (level 6). The process is multi-directional with the level 6 indicators providing direct feedback about the completeness, accuracy, and effectiveness of the management process through the preceding levels. While the U.S. EPA (1995a) hierarchy employs point source terminology, it has been shown to be adaptable to nonpoint sources (Karr and Yoder 2004) and environmental media other than surface waters. Superimposed on this hierarchy is the concept of stressor, exposure, and response indicators (Figure 3) similar to that developed by the U.S. EPA Environmental Monitoring and Assessment Program (EMAP; U.S. EPA 1991) and later described for water quality management by Yoder and Rankin (1998). *Stressor indicators* are the result of actions that have the potential to impair the aquatic environment; these include pollutant discharges, land use changes, and habitat modifications (level 3). *Exposure indicators* are those which measure the apparent effects of stressors and include chemical water quality criteria, whole effluent toxicity tests, tissue residues, bacterial levels, and biomarkers, each of which provides evidence of biological exposure to a stressor or bioaccumulative agent (levels 4 and 5). *Response indicators* include biologically-based measures of the cumulative effects of stress and exposure and include measures of biological community, assemblage, and population response (level 6). Other response indicators could include target assemblages (*e.g.,* rare, threatened, endangered, special status, and declining species). All of these indicators represent the essential technical elements for watershed-based monitoring and management approaches. The key is to use the different indicators within the roles that are most appropriate for each. Historically, this has not always been done and it represents a national issue - the inappropriate use of stressor and exposure indicators as substitutes for response. Response indicators are inherently better at evaluating attainment of designated uses which are the basis of State water quality standards. An example is relying on biological assemblage measures to evaluate designated aquatic life uses in lieu of elevating chemical data into this role.

Biological and Water Quality Surveys

A biological and water quality survey, or "biosurvey", is an interdisciplinary monitoring effort coordinated on a water body specific or watershed scale. Biological, chemical, and physical monitoring and assessment techniques are employed in biosurveys to meet three major objectives:

1) determine the extent to which use designations assigned in the state Water Quality Standards (WQS) or equivalent policies or procedures are either attained or not attained;

2) determine if use designations and/or goals set for or assigned to a given water body are appropriate and attainable; and,

3) determine if any changes in key ambient biological, chemical, or physical indicators have taken place over time, particularly before and after the implementation of point source pollution controls or best management practices.

The data gathered in a biosurvey is processed, evaluated, and synthesized in one of several assessment reports or outputs. This can range from a comprehensive, integrated watershed report to summaries compiled for the waterbody system (WBS) in support of 305(b) reporting and extended products (e.g., 303[d] list). Each assessment also addresses recommendations for revisions to WQS, future monitoring needs, problem discovery, or other actions which may be needed to resolve impairments of or threats to designated uses. While the principal focus of a biosurvey is on the status of aquatic life uses, the status of other uses such as recreation and water supply, as well as human health concerns may also be addressed.

Functional support provided by individual basin assessments for specific water quality management activities includes the 305(b) reporting process, TMDLs/303(d) listing, revising water quality standards (i.e., use designations, criteria refinements and modifications), and NPDES permit support. Support is also provided for other management issues including site-specific 404/401 reviews, 319 projects, and enforcement actions. A positive consequence of this type of sustained, routine, and standardized effort is a database and informational resource, which supports ongoing water quality management efforts in the aggregate. This includes the development of new and improved assessment tools, improved and refined criteria, indicators development and use, concepts, policies, and rules. The critical concept is that by doing the level of monitoring and assessment that is required by the rotating basin approach, the basic informational infrastructure needed to support the entirety of water quality management is in place when the need for such support is realized. This demonstrates how this type of sustained approach is inherently anticipatory. Anticipatory monitoring and assessment is essential to maintaining and improving the overall water quality management process.

Watershed Monitoring Design

A key issue within watershed assessment is the selection of spatial and temporal monitoring designs. It is now widely recognized that fixed station designs that were once the mainstay of State monitoring programs are simply insufficient to meet the previously stated program objectives. However, this is not to conclude that fixed stations do not have an appropriate role in a monitoring program. Simply stated, they are *alone* insufficient to support management decision-making at the local watershed scale. Selecting information-effective spatial monitoring designs is a critical step in the process of developing an adequate watershed monitoring program. A relatively new design that has recently been implemented in Ohio is termed the Geometric Site Selection process - it is used as part of the statewide five-year rotating basin approach (Ohio EAP 1999). This design is employed within watersheds that correspond to the 11-14 digit HUC scale in order to fulfill multiple water quality management objectives in addition to the conventional focus on status assessment. It is employed at a spatial scale that is representative of the scale at which watershed management is generally being conducted. In the Midwestern U.S., most HUC 11 watersheds drain approximately 150-300 mi^2. Sites within a watershed of this size are allocated based on a geometric progression of drainage areas starting with the area at the mouth of the mainstem river or stream and working "upwards" through the various tributaries to the primary headwaters (Figure 4). This approach allocates sampling sites in a semi-random fashion and according to the stratification of available stream and river sizes based on drainage area. It is then supplemented by a targeted selection of additional sampling sites that are used to focus on localized management issues such as point source discharges, habitat modifications, and other potential impacts within a watershed. This design also fosters data analysis that takes into consideration overlying natural and human caused influences within the streams of a watershed. The example in Figure 3 also demonstrates the multiple management issues that are supported including the proportionate assessment of the member streams and rivers, applying tiered designated uses for

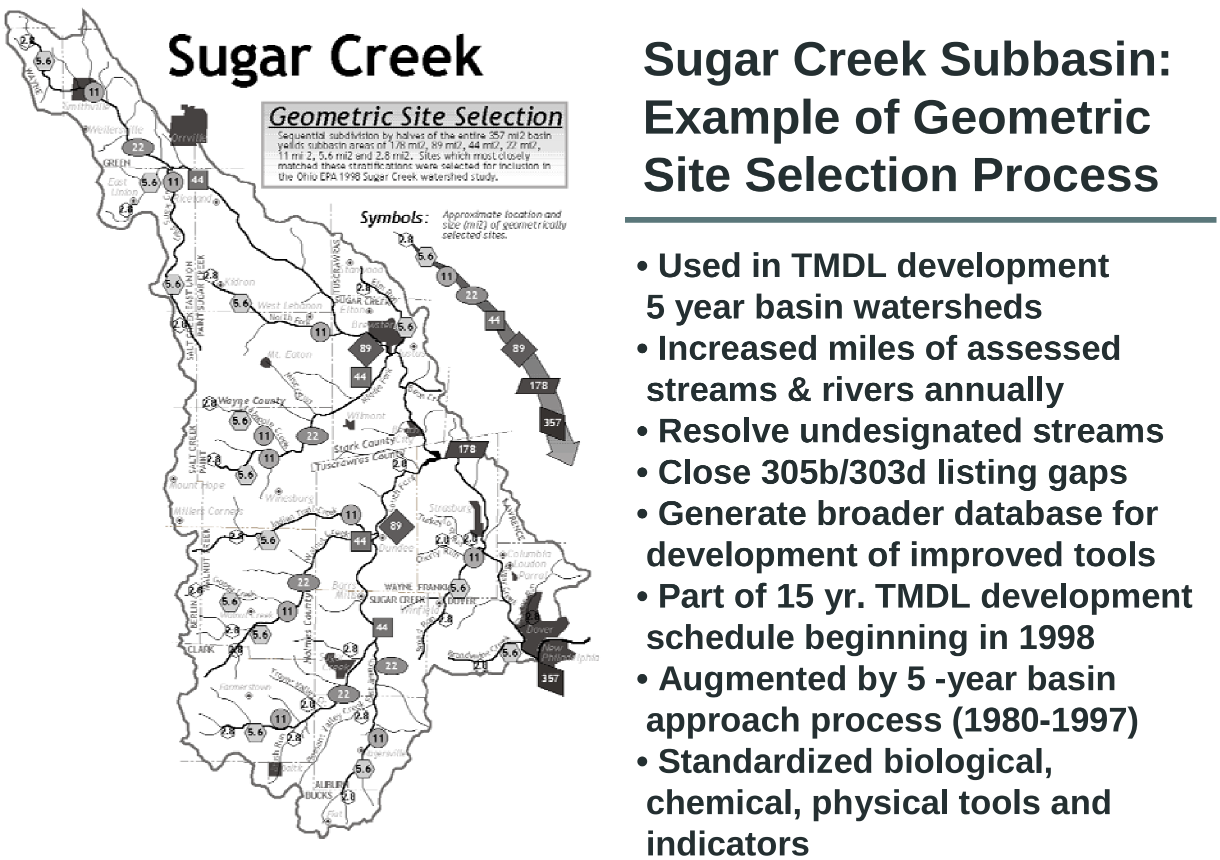

Figure 4. Geometric site selection design and outcomes used to assess small watersheds and assure equitable spatial coverage (Sugar Creek basin in northeast Ohio is shown here as an example).

aquatic life, the development of TMDLs that include the inter-relationships of both pollutant and non-pollutant stressors, and the development of a comprehensive spatially representative database through time. Other benefits of this design include the application of cost-effective sampling methods on a watershed scale, development of a stratified database, and the enhanced ability to capture previously unassessed streams. The design has been particularly useful for watersheds that are targeted for TMDL development in that unassessed waters and incomplete or outdated assessments can be addressed prior to TMDL development.

Analysis of Biological Assessment Options

Selection of the appropriate biological assessment method is primarily driven by defining appropriate data quality objectives (DQOs), which are determined by the cumulative array of management goals and objectives, and standards set by state or federal agencies. For the DuPage-Salt Creek watershed these are defined by the applicable protocols published by the Illinois EPA (1997, 2005) and Illinois DNR (2005). Secondly, the management issues, which occur in the study area are varied and complex.

Data Quality Objectives Approach
A data quality objectives (DQO) process is recommended for the selection of the appropriate biological assessment method and protocol for a given situations. Table 2 illustrates a hierarchy of bioassessment methods from very simple, comparatively low resolution protocols to increasingly rigorous and reliable techniques practicable for most bioassessment programs. The level of the bioassessment is comparably defined by the skill or expertise level required by the operator, the standard methodology associated with each (appropriate QA/QC procedures included), the relative accuracy of the method in terms of making an accurate assessment, the discriminatory power (i.e., the ability to detect real changes in biological condition), and how this should influence policy decisions made with the resulting data and information. This type of matrix allows program managers to evaluate the need for comparative rigor in environmental decision making with the level of effort required for a given bioassessment technique. This can be both a programmatic and individual study decision in that a monitoring and assessment program needs to have available the appropriate suite of tiered methods (calibrated and verified) available before deciding which ones to apply to a particular management issue. Table 3 illustrates these same concepts in a different manner by showing the relative capabilities of commonly available bioassessment methods to fulfill and/or satisfy various management needs. Designations of excellent, good, fair, and poor indicate the relative accuracy and power of the bioassessment method to provide an adequate, cost-effective, and sufficiently comprehensive assessment for each of several common management needs. The appropriate level of assessment and data collection that is needed to support a given situation can be evaluated using these criteria.

Quality Assurance/Quality Control Issues
Biological data collected via this process will need to be validated in accordance with approved QA/QC procedures. Biological data will be collected, stored, and analyzed in accordance with the Quality Assurance Program Plan (QAPP) that accompanies a detailed study plan.

Table 2. Hierarchy of ambient bioassessment approaches defined by Yoder (1995) that use information about indigenous aquatic biological communities (NOTE: this applies to aquatic life use attainment only - it does not apply to bioaccumulation concerns, wildlife uses, human health, or recreation uses).

BIOASSESSMENT TYPE/LEVEL	SKILL REQUIRED[1]	ORGANISM GROUPS[2]	TECHNICAL COMPONENTS[3]	ECOLOGICAL COMPLEXITY[4]	ENVIRONMENTAL ACCURACY[5]	DISCRIMINATORY POWER[6]	POLICY RESTRICTIONS[7]
1. Stream Walk (Visual Observations)	Non-biologist	None	Handbook[8]	Simple	Low	Low	Many
2. Volunteer Monitoring	Non-biologist to Technician	Invertebrates	Handbook[9], Simple equipment	Low	Low to Moderate	Low	Many
3. Professional Opinion (e.g., RBP Protocol V)	Biologist w/ experience	None or Fish/Inverts.	Historical records	Low to Moderate	Low to Moderate	Low	Many
4. RBP Protocol I&II	Biologist w/ training	Invertebrates	Tech. Manual,[10] Simple equip.	Low to Moderate	Low to Moderate	Low to Moderate	Many
5. Narrative Evaluations	Aquatic Biologist w/training & experience	Fish &/or Inverts.	Std. Methods, Detailed taxonomy Specialized equip.	Moderate	Moderate	Moderate	Moderate
6. Single Dimension Indices	(same)	(same)	(same)	Moderate	Moderate	Moderate	Moderate
7. Biotic Indices (HBI, BCI, etc.)	(same)	Invertebrates	(same)	Moderate to High	Moderate to High	Moderate	Moderate to Few
8. RBP Protocols III&V	(same)	Fish & Inverts.	Tech. Manual,[10] Detailed taxonomy, Specialized equip., dual organism groups	High	Moderate to High	Moderate to High	Few
9. Regional Reference Site Approach	(same)	Fish & Inverts.	Same plus baseline calibration of multimetric indices & dual organism groups	High	High	High	Few
10. Comprehensive Bioassessment	(same)	All Organism Groups	Same except all organism groups are sampled	Highest	High	High	Few

[1] Level of training and experience needed to accurately implement and use the bioassessment type.
[2] Organism groups that are directly used and/or sampled; fish and macroinvertebrates are most commonly employed in the midwest states.
[3] Handbooks, technical manuals, taxonomic keys, and data requirements for each bioassessment type.
[4] Refers to ecological dimensions inherent in the basic data that is routinely generated by the bioassessment type.
[5] Refers to the ability of the ecological end-points or indicators to differentiate conditions along a gradient of environmental conditions.
[6] The relative power of the data and information derived to discriminate between different and increasingly subtle impacts.
[7] Refers to the relationship of biosurveys to chemical-specific, toxicological (i.e. bioassays), physical, and other assessments and criteria that serve as surrogate indicators of aquatic life use attainment/non-attainment.
[8] Water Quality Indicators Guide: Surface Waters (Terrell and Perfetti 1989)
[9] Ohio Scenic River Stream Quality Monitoring (Kopec and Lewis 1983).
[10] U.S. EPA Rapid Bioassessment Protocol (Plafkin et al. 1989).

Table 7. The relative capabilities of different levels of bioassessment to fulfill and/or satisfy various needs within of major surface water program areas at Ohio EPA. Designations of EXCELLENT, GOOD, FAIR, POOR, etc. indicate the relative capability and power of the bioassessment method to provide an adequate, cost-effective, and sufficiently comprehensive assessment for each program need.

	MAJOR PROGRAM AREAS														
	Basic --Reporting--		WQS -Program-		----Watersheds/Nonpoint Sources----					------NPDES Permitting------					
Level of Bioassessment	5 Yr. Basin Surveys	305b Report	Use Desig.	Chem. Criteria	General Screen	Education Involvement	NPS Assess.	Habitat	Problem Discovery	Permit Terms	Priority Setting	CSOs Storm.	Toxic Impact	Mixing Zones
A- Full Scale: (Fish, Macroinvertebrates based on mulimetric indices)	EXCELL.	EXCELL.	EXC.	EXC.	EXCELL.	FAIR[1]	EXC.	EXC.	EXCELL.	EXC.	EXC.	EXC.	EXC.	EXC.
B- Partial Bio-assess ments (Fish **o**r Macro-invertebrates)	GOOD	GOOD	GOOD[2]	FAIR	GOOD[2]	FAIR[1]	GOOD[2]	GOOD[2]	GOOD[2]	GOOD	GOOD	GOOD	GOOD	GOOD
C- Qualitative Bioassment (Macroinvertebrates based on narrative criteria)	FAIR[3]	GOOD	POOR[4]	POOR[4]	GOOD	FAIR[1]	FAIR[4]	POOR[4]	GOOD[2]	FAIR	POOR[4]	GOOD[2]	FAIR	GOOD
D- EPA Rapid Bioassessment Protocol II (Macroinvertebrates, family level of taxonomy)	FAIR[3]	FAIR[5]	POOR[4]	POOR[4]	GOOD	GOOD[1]	FAIR[4]	FAIR[4]	GOOD	FAIR	POOR[4]	FAIR[5]	FAIR[5]	FAIR[5]
E- "Volunteer" Methods (Macroinvertebrates based on SQM procedure)	POOR[6]	FAIR[7]	POOR[6]	POOR[6]	FAIR[7]	EXCELL.[8]	FAIR[7]	POOR[6]	FAIR[7]	POOR[6]	POOR[6]	FAIR[7]	POOR[6]	POOR

Table 3. (continued)

FOOTNOTES:

[1] - Fair because complexity of data makes interpretation by untrained persons difficult; good because lower level of taxonomy is easier to attain.
[2] - Good only if macrohabitat is not a major limiting factor or if the Exceptional Warmwater Habitat or Modified Warmwater Habitat use designations are not an issue.
[3] - Fair if this is the only level included; level is strengthened if A level of assessment is available.
[4] - Poor because quantitative indices are lacking; can be strengthened with addition of Qualitative Habitat Evaluation Index results (not normally part of this level).
[5] - Fair because family level of taxonomy limits interpretation power and utility of the resulting assessment.
[6] - Poor because the inherent methodology lacks sufficient resolution or reproducibility even with fine tuning and training.
[7] - Fair only if the assessment parameters have been sufficiently calibrated against the A-D levels of bioassessment; otherwise the rating is poor.
[8] - Excellent rating because the method can be used and understood by unskilled volunteers.

DuPAGE-SALT CREEK WATERSHED BIOASSESSMENT

The DuPage-Salt Creek study area consists of three subbasins; the West Branch DuPage River, the East Branch DuPage River, and Salt Creek. The West Branch DuPage River drains 125 $mi.^2$, Salt Creek drains 150 $mi.^2$, and the East Branch DuPage River drains 82 $mi.^2$ (Table 4). The watersheds are impacted by a variety of activities including municipal and industrial point source discharges of wastewater, habitat modifications in the form of run-of-river low head dams, riparian encroachment, and channelization, and differing degrees of urbanization. The urban impact gradient is strongest in Salt Creek lessening somewhat from east to west through the East Branch and into the West Branch subbasins. There are 112 NPDES permitted entities listed in Table 5 of which 29 are municipal wastewater treatment plants and 33 are combined sewer overflows. They are well distributed throughout each of the 3 subbasins (Figure 5). The remainder is a mix of non-contact cooling water, ground water pumpage, storm water, and small industrial wastewater discharges. There are 21 dams of varying heights, but all qualify as run-of-river low head dams and most pose significant barriers to fish passage (Table 6; Figure 6). Each basin is urbanized being heaviest in Salt Creek followed by the East and West Branches of the DuPage River (Figure 5). Numerous reserves and wetlands occur mostly in the East and West Branches.

Combined Geometric and Targeted Design Sites

The delineation of recommended sampling locations for the watershed bioassessment was performed using various GIS coverages created and manipulated in Arc View. Overlays of stream traces, watershed and subwatershed boundaries, major highways and streets, lakes and wetlands,

Table 4. Watershed areas and length of mainstems and tributaries in the DuPage-Salt Creek study area.

Subbasin	Drainage area in square miles		Portion in Cook Co. percent
	Total	DuPage Co. portion	
East Branch	82.0	--	--
West Branch	125.0	8.0	6.4
Salt Creek	150.0	86.3	57.5
Total area	357.0	94.3	26.4

Watershed	Length of streams in miles		Length in Cook Co. percent
	Total	DuPage Co. portion	
East Branch	34.9	--	--
West Branch	64.2	5.3	8.3
Salt Creek	85.6	49.8	58.2
Total length	184.7	55.1	29.8

Watershed and stream	Length of stream in miles	Cook Co. portion
East Branch DuPage R.		
East Branch	25.0	--
Prentiss Creek	0.4	--
Rott Creek	0.6	--
St. Joseph Creek	8.9	--
Lacey Creek	0.0	--
Armitage Creek	0.0	--
West Branch DuPage R.		
West Branch	35.4	5.3
Ferry Creek	5.1	--
Spring Brook	5.0	--
Kress Creek	8.2	--
Winfield Creek	4.4	--
Klein Creek	6.1	--
Salt Creek		
Salt Creek	45.9	26.3
Addison Creek	12.5	8.5
Addison Creek Tributary	0.0	--
Ginger Creek	0.9	--
Sugar Creek	1.4	--
Salt Creek Tributary	0.2	--
Spring Brook	8.5	--
Meacham Creek	1.2	--
West Branch Salt Creek	9.0	9.0
Arlington Heights Branch	6.0	6.0

References: 1. IEPA TMDL Reports dated October 2004. 2. River Mileages and Drainage Areas for Illinois Streams, Volume 2, Illinois River Basin, USGS Water Resources Investigations Report 79-111, 1979.

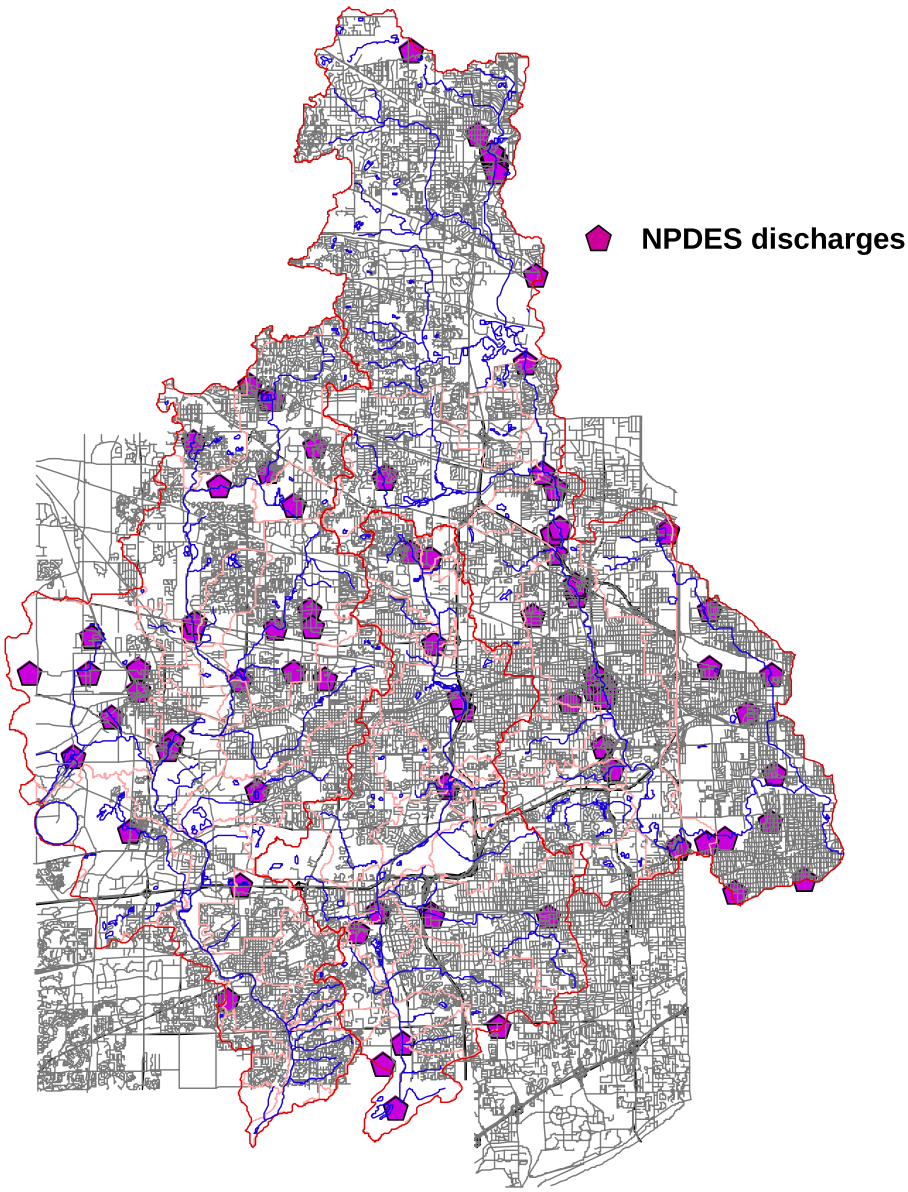

Figure 5. NPDES discharges in the DuPage-Salt Creek study area showing the density of urban development as roads and streets.

Table 5. List of NPDES permitted entities in the DuPage-Salt Creek study area.

NPDES ID	Name of Discharge	Description	Type
IL0001945	MATERIAL SERVICE	GW SEEPAGE, SW, PIT PUMPAGE	GW
IL0001945	MATERIAL SERVICE	GW SEEPAGE, SW, PIT PUMPAGE	
IL0002127	UNION PACIFIC	STORMWATER RUNOFF	SW
IL0002402	LAGROU DISTRIBUTION	NON-CONTACT COOLING WATER	NC
IL0004189	INDEPENDENCE MATERIALS	CONTROLLED ACID MINE DRAINAGE	IND
IL0020061	WOOD DALE NORTH STP	INFLUENT MONITORING	
IL0020061	WOOD DALE NORTH STP	EXCESS FLOW (OVER 3.93 MGD)	
IL0020061	WOOD DALE NORTH STP	STP OUTFALL	WWTP
IL0021130	BLOOMINGDALE-REEVES	EXCESS FLOW OUTFALL (001A)	CSO
IL0021130	BLOOMINGDALE-REEVES	INFLUENT MONITORING	
IL0021130	BLOOMINGDALE-REEVES	STP OUTFALL	WWTP
IL0021547	GLENBARD WW	INFLUENT MONITORING	
IL0021547	GLENBARD WW	STP OUTFALL	WWTP
IL0021849	BENSENVILLE SOUTH STP	INFLUENT MONITORING	
IL0021849	BENSENVILLE SOUTH STP	MAIN STP OUTFALL	WWTP
IL0021849	BENSENVILLE SOUTH STP	EXCESS FLOW (FLOW > 10 MGD)	
IL0022471	GLENBARD WW	COMBINED SEWAGE TRTMNT OUTFALL	CSO
IL0022471	GLENBARD WW	CSO-OLD LAGOON OUTFALL	CSO
IL0022471	GLENBARD WW	CSO-90" CSO TRTMNT PLT BYPASS	CSO
IL0023469	WEST CHICAGO STP	EXCESS FLOW (001A)	CSO
IL0023469	WEST CHICAGO STP	INFLUENT MONITORING	
IL0023469	WEST CHICAGO STP	STP OUTFALL	WWTP
IL0026123	FERMILAB-BATAVIA	NCCW AND STORMWATER	NC
IL0026123	FERMILAB-BATAVIA	NCCW AND STORMWATER	NC
IL0026280	ITASCA STP	INFLUENT MONITORING	
IL0026280	ITASCA STP	STP OUTFALL	WWTP
IL0026352	CAROL STREAM WRC	EXCESS FLOW (FORMERLY 001A)	CSO
IL0026352	CAROL STREAM WRC	INFLUENT MONITORING	
IL0026352	CAROL STREAM WRC	STP OUTFALL	WWTP
IL0027367	ADDISON SOUTH-A.J.	TREATED CSO (FORMERLY 001A)	CSO
IL0027367	ADDISON SOUTH-A.J.	INFLUENT MONITORING	
IL0027367	ADDISON SOUTH-A.J.	STP OUTFALL	WWTP
IL0027367	ADDISON SOUTH-A.J.	CSO DIVERSEY/VILLA AVE. LFT ST	CSO
IL0027618	BARTLETT WWTP	INFLUENT MONITORING	
IL0027618	BARTLETT WWTP	EXCESS FLOW (OVER 5.151 MGD)	CSO
IL0027618	BARTLETT WWTP	STP OUTFALL	WWTP
IL0027618	BARTLETT WWTP	EXCESS FLOW - DEVON AVENUE	
IL0028380	DOWNERS GROVE SD WTC	MAIN DIS MX CHMBR(>22 MGD)001A	WWTP
IL0028380	DOWNERS GROVE SD WTC	EXCESS FLW E BR DUPGE RVR-001B	CSO
IL0028380	DOWNERS GROVE SD WTC	INFLUENT MONITORING	
IL0028380	DOWNERS GROVE SD WTC	MIXING CHMBR E. BR. DUPAGE RVR	WWTP
IL0028380	DOWNERS GROVE SD WTC	GR THAN 22MGD & EX FLOW OPT.	CSO
IL0028380	DOWNERS GROVE SD WTC	MIXING CHMB-ST JOSEPHS CREEK	CSO
IL0028380	DOWNERS GROVE SD WTC	EXCESS FLOW TO ST. JOSEPH CRK	CSO
IL0028398	DUPAGE COUNTY-NORDIC	INFLUENT MONITORING	
IL0028398	DUPAGE COUNTY-NORDIC	STP OUTFALL	WWTP
IL0028428	DUPAGE COUNTY-CASCADE	INFLUENT MONITORING	
IL0028428	DUPAGE COUNTY-CASCADE	STP OUTFALL	WWTP

Table 5. continued

NPDES ID	Name of Discharge	Description	Type
IL0028746	ELMHURST WWTP	INFLUENT MONITORING	
IL0028746	ELMHURST WWTP	EXCESS FLOW (OVER 1.0 MGD)	CSO
IL0028746	ELMHURST WWTP	STP OUTFALL	WWTP
IL0028746	ELMHURST WWTP	EHB-SEWAGE TREATMENT PLANT	
IL0028746	ELMHURST WWTP	EHB-EUCLID AND HARRISON	
IL0028746	ELMHURST WWTP	EHB-SAYLOR AND JACKSON	
IL0028746	ELMHURST WWTP	EHB-BERKLEY AND ADAMS	
IL0028746	ELMHURST WWTP	EHB-EUCLID AND MADISON	
IL0028746	ELMHURST WWTP	EHB-MCKINLEY AND SUNNYSIDE	
IL0028746	ELMHURST WWTP	EHB-RANDOLPH AND WEST	
IL0028746	ELMHURST WWTP	EHB-WEST AND UTLEY	
IL0028746	ELMHURST WWTP	EHB-THIRD AND MAPLE	
IL0028746	ELMHURST WWTP	EHB-NORTH AVENUE	
IL0028746	ELMHURST WWTP	EHB-NORTH ELMHURST	
IL0028746	ELMHURST WWTP	EHB-INDUSTRIAL	
IL0028967	GLENDALE HEIGHTS STP	EXCESS FLOW TREATMENT (001A)	CSO
IL0028967	GLENDALE HEIGHTS STP	INFLUENT MONITORING	
IL0028967	GLENDALE HEIGHTS STP	STP OUTFALL	WWTP
IL0030813	ROSELLE-J.L. DEVLIN WWTP	EXCESS FLOW (FORMERLY 001A)	CSO
IL0030813	ROSELLE-J.L. DEVLIN WWTP	INFLUENT MONITORING	
IL0030813	ROSELLE-J.L. DEVLIN WWTP	STP OUTFALL	WWTP
IL0030953	SALT CREEK SANITARY	INFLUENT MONITORING 001	
IL0030953	SALT CREEK SANITARY	MAIN OUTFALL	WWTP
IL0030953	SALT CREEK SANITARY	FILTER BYPASS	CSO
IL0031739	WHEATON S.D.	INFLUENT MONITORING	
IL0031739	WHEATON S.D.	STORAGE POND OVERFLOW	CSO
IL0031739	WHEATON S.D.	MAIN OUTFALL	WWTP
IL0031739	WHEATON S.D.	EXCESS FLOW	CSO
IL0031844	DUPAGE	INFLUENT MONITORING	
IL0031844	DUPAGE	STP OUTFALL	WWTP
IL0031844	DUPAGE	EXCESS FLOW-STORMWATER BASIN	CSO
IL0031844	DUPAGE	EXCESS FLOW-CLARIFIER OUTFALL	CSO
IL0032689	BOLINGBROOK STP #1	STP OUTFALL	WWTP
IL0033618	VILLA PARK WET WEATHER	CSO-HIGHLAND AVENUE	CSO
IL0033618	VILLA PARK WET WEATHER	CSO-KENILWORTH AVENUE	CSO
IL0033618	VILLA PARK WET WEATHER	CSO-ST. CHARLES ROAD	CSO
IL0033618	VILLA PARK WET WEATHER	CSO-PARK BOULEVARD	CSO
IL0033618	VILLA PARK WET WEATHER	EXCESS FLOW SSOS(OVR 7.55 MGD)	
IL0033618	VILLA PARK WET WEATHER	EXCESS FLOW FOR COMB. SEWERS	CSO
IL0033812	ADDISON NORTH STP	EXCESS FLOW (FORMERLY 001A)	CSO
IL0033812	ADDISON NORTH STP	INFLUENT MONITORING	
IL0033812	ADDISON NORTH STP	MAIN PLANT OUTFALL	WWTP
IL0034274	WOOD DALE SOUTH STP	INFLUENT MONITORING	
IL0034274	WOOD DALE SOUTH STP	EXCESS FLOW (OVER 2.33 MGD)	CSO
IL0034274	WOOD DALE SOUTH STP	MAIN PLANT OUTFALL	WWTP
IL0034479	HANOVER PARK STP #1	EXCESS FLOW (FORMERLY 001A)	CSO
IL0034479	HANOVER PARK STP #1	INFLUENT MONITORING	
IL0034479	HANOVER PARK STP #1	STP OUTFALL	WWTP

Table 5. continued

NPDES ID	Name of Discharge	Description	Type
IL0035831	CONGRESS DEV HILSIDE	UNCONTAMINATED SW & GROUNDWTR	GW
IL0036137	MWRDGC HANOVER PARK	INFLUENT MONITORING-0070	
IL0036137	MWRDGC HANOVER PARK	BIOMONITORING	
IL0036137	MWRDGC HANOVER PARK	WRP SOUTH OUTFALL	WWTP
IL0036340	MWRDGC EGAN WRP	INFLUENT MONITORING	
IL0036340	MWRDGC EGAN WRP	WRP OUTFALL	WWTP
IL0036340	MWRDGC EGAN WRP	EMERGENCY HIGH LEVEL BYPASS	CSO
IL0036340	MWRDGC EGAN WRP	EXCESS FLOW	CSO
IL0037028	PLEASANT RIDGE MHP	INFLUENT REPORTING	
IL0037028	PLEASANT RIDGE MHP	STP OUTFALL	WWTP
IL0045039	WESTERN SPRINGS CSOS	CSO-GROVE AVENUE	CSO
IL0045039	WESTERN SPRINGS CSOS	CSO-49TH STREET	CSO
IL0045241	BP NAPERVILLE COMPLEX	NON-CONTACT COOLING WATER	NC
IL0046540	NORTHWESTERN FLAVORS,	NON-CONTACT COOLING WATER	NC
IL0048542	CAMP REINBERG STP	INFLUENT REPORTING	
IL0048542	CAMP REINBERG STP	STP OUTFALL	WWTP
IL0048721	ROSELLE-J. BOTTERMAN	INFLUENT MONITORING	
IL0048721	ROSELLE-J. BOTTERMAN	MAIN OUTFALL	WWTP
IL0052817	STONEWALL UTILITY CO STP	INFLUENT MONITORING	
IL0052817	STONEWALL UTILITY CO STP	STP OUTFALL	WWTP
IL0053155	ELMHURST CHICAGO	PIT PUMPAGE AND STORMWATER	GW
IL0054712	BALL HORTICULTURAL	BBD, PLT IRRIGATION & WATERING	SW
IL0063487	ARLINGTON INTERNATL	A-21	SW
IL0063487	ARLINGTON INTERNATL	PC-12	SW
IL0063487	ARLINGTON INTERNATL	B-24	SW
IL0063487	ARLINGTON INTERNATL	C-24	
IL0063487	ARLINGTON INTERNATL	D	
IL0063487	ARLINGTON INTERNATL	E	
IL0063487	ARLINGTON INTERNATL	G-15	
IL0063487	ARLINGTON INTERNATL	F-30	
IL0063487	ARLINGTON INTERNATL	H	
IL0063487	ARLINGTON INTERNATL	I	
IL0063487	ARLINGTON INTERNATL	J-12	
IL0063487	ARLINGTON INTERNATL	K	
IL0063487	ARLINGTON INTERNATL	PW	
IL0063495	KERR-MCGEE-WEST	TR GROUND,SURFACE,& MISC WATER	GW
IL0063975	PIERCE & STEVENS	NCCW AND STORMWATER	NC
IL0063975	PIERCE & STEVENS	STORMWATER	SW
IL0064866	ACCURATE CAST PRODUCTS	RINSE WATER	IND
IL0064866	ACCURATE CAST PRODUCTS	RINSE WATER	
IL0065021	BLACKHAWK MOLDING	SEMI-ANNUAL REPORTING AT 001	
IL0065021	BLACKHAWK MOLDING	NON-CONTACT COOLING WATER	NC
IL0066427	PRAIRIE MATERIAL SALES,	TREATED RECYCLE WATER	NC
IL0067458	BLACHFORD, INC.-WEST	NONCONTACT COOLING WATER; SW	NC
IL0068381	OFFICE PARK OF HINSDALE	NC COOLING WATER AND STORMWATR	NC
IL0068381	OFFICE PARK OF HINSDALE	NON-CONTACT COOLING WTR AND SW	
IL0068381	OFFICE PARK OF HINSDALE	NON-CONTACT COOLING WTR AND SW	
IL0069124	VANEE FOODS	NON-CONTACT COOLING WATER; SW	NC

Table 5. continued

NPDES ID	Name of Discharge	Description	Type
IL0069531	GARDEN MARKET SHOPPING	MLOC 1=STP;MLOC J=INTERNAL WW	SW
IL0069671	REED KEPPLER FAMILY	SWIMMING POOL DRAINAGE	Other
IL0070416	A.G. COMMUNICATIONS	TR GROUNDWATER;VAPRO EXTRACTN	GW
IL0070947	AMOCO PIPELINE-STATEWIDE	CHICAGO PIPELINE	SW
IL0070947	AMOCO PIPELINE-STATEWIDE	O'HARE PIPELINE	
IL0070947	AMOCO PIPELINE-STATEWIDE	WEST SHORE PIPELINE	
IL0070947	AMOCO PIPELINE-STATEWIDE	MANHATTAN PIPELINE STATION	
IL0070947	AMOCO PIPELINE-STATEWIDE	WOOD RIVER TERMINAL	
IL0070947	AMOCO PIPELINE-STATEWIDE	APL CONSTRUCTION SITE	
IL0070947	AMOCO PIPELINE-STATEWIDE	FLANAGAN STATION	
IL0072460	GAS RECOVERY	DUAL MEDIA FILTER BACKWASH	IND
IL0072460	GAS RECOVERY	DISCHARGE FROM A010; SW	IND
IL0073253	NAPERVILLE PARK	SHOOTING AREAS	SW
IL0074420	PILLSBURY	COOLING TOWER BLOWDOWN	NC
IL0074446	MAPEI CORPORATION-WEST	NON-CONTACT COOLING WATER	NC
IL0074918	TRAFFIC CONTROL	TREATED CONTAMINATED GW	GW
IL0075426	PEPPERIDGE FARM-DOWNERS	NCCW & COOLING TOWER SPILLAGE	NC
IL0076171	MEIJER-PADDOCK SHOPPING	TREATED CONTAMINATED GROUNDWTR	GW
IL0076376	BELL FUELS, INC	TREATED CONTAMINATED GROUNWTR	GW
ILG840029	MATERIAL SERV CORP-YARD	NON-COAL OUTFALL	SW
ILG910121	BADGER PIPE LINE COMPANY	TREATED GROUNDWATER	GW

Summary:

Waste Water Treatment Plants (WWTP) - 29
Combined Sewer Overflows (CSO) - 33
Ground water pumpage (GW) - 9
Storm Water (SW) - 12
Non-contact Cooling Water (NC) - 23
Industrial Wastewater (IW) - 5
Other - 1
Total Permitted - 112

Table 6. Names and locations of dams in the DuPage-Salt Creel study area.

NAME	RIVER/STREAM	CITY	LOCATION
Graue Mill Dam	Salt Creek	Oak Brook	SE Edge of Fullersburg FP; 300 ft US of York Rd
Butler Nature Center Dam	Salt Creek	Oak Brook	NW edge of Fullersburg FP; 1.4 mi. DS 31st Street
Lake Kadijah	Spring Brook	Itasca	1/2 mi. US of Rohlwing Rd / Rt 53
Itasca Golf Coure Dam	Spring Brook	Itasca	Itasca Golf Course; 50 ft US of Prospect Ave.
Churchill Lake Dam	East Branch DuPage River	Lombard	50 ft US of Crescent Blvd
Seven Bridges Dam	East Branch DuPage River	Woodridge	0.75 mi. US of Hobson Rd NW of Rt 53 Intersection
Possum Hollow Woods Dam	Salt Creek	Westchester	0.5 mi. E of Wolf Rd; 1/4 mi. N of 31st St
Elmhurst Co. FP Dam	Salt Creek	Villa Park	0.25mi. E of Rt 83; 0.25 mi. S of Madison St.
Salt Creek Trib. WWTP Dam	Addison Creek	Addison	500 ft E. of Addison Rd; 200 ft SW of I-290
Oak Meadows Golf Course Dam	Salt Creek	Wood Dale	300 ft N. of I-290; 1000 ft E. of Addison Rd.
Busse Woods South Dam	Salt Creek	Elk Grove Village	1/2 mi. N of Arlington Hts Rd & Elk Grove Hig School
Hidden Lake FP Dam?	East Branch DuPage River	Lombard	1/2 mi. S of Rt 56; 500 ft E of Rt 53
Gabion Weir	East Branch DuPage River	Glen Ellyn	Adjacent Mary Knoll Circle; 1/4 mi. S. Rt 38; 200 ft W. of I-355
Possible Dam	East Branch DuPage River	Glendale Heights	Near Fullerton Ave; 1/2 mi. W. of I-355
Possible Dam @ RR Culvert	East Branch DuPage River	Glendale Heights	East Br. Reservoir FP; US of RR Culvert
West Lake Dam	East Branch DuPage River	Bloomingdale	West Lake Park; 1/2 mi. N of Army Trail Rd; 500 ft W. Glen Ellyn Rd.
Mt. Emblem Cemetary Pond	Addison Creek	Bensenville	Mt Emblem Cemetary; SW Corner Grand Ave & County Line Rd.
George Street Reservoir	Addison Creek	Bensenville	1/2 mi. E of York Road; N of George Street
Warrenville Dam	West Branch DuPage River	Warrenville	
McDowell Grove Dam	West Branch Dupage River	UNINC	
Fawell Dam	West Branch Dupage River	UNINC	

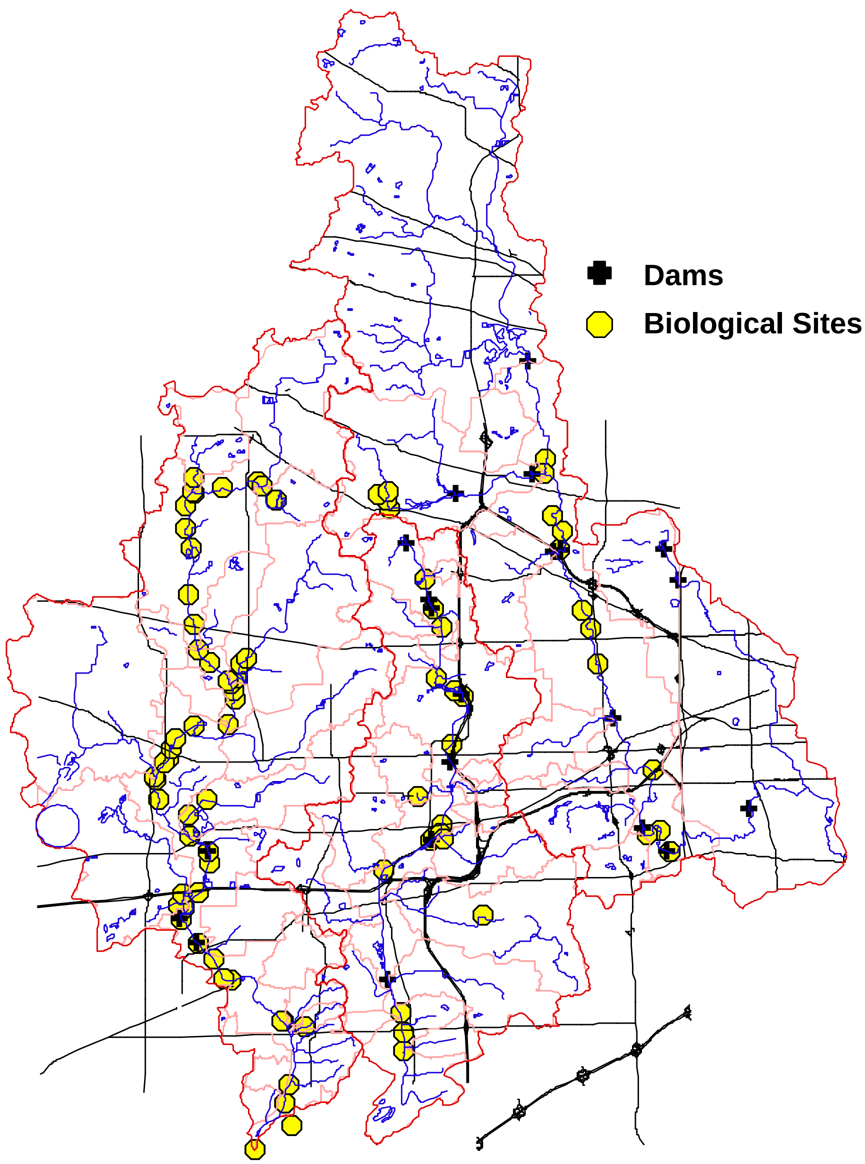

Figure 6. Dams in the DuPage-Salt Creek study area showing locations relative to existing biological sampling sites.

reserve areas (parks, forests, prairies), NPDES discharges, dams, and historical biological sampling locations for each subbasin was performed beginning with the watershed area of the largest subbasin, Salt Creek. Using the 150 $mi.^2$ drainage area at the mouth, this becomes the level 1 category, 75 $mi.^2$ is level 2, 38 $mi.^2$ is level 3, 19 $mi.^2$ is level 4, 9 $mi.^2$ is level 5, 5 $mi.^2$ is level 6, and 2 $mi.^2$ is level 7. In Salt Creek this yielded 33 sites, in the East Branch it yielded 25 sites, and in the West Branch it yielded 28 sites (Tables 7-9). Targeted sites were then added by visual inspection of the GIS overlays of dams and NPDES discharges to position sites upstream and downstream from major discharges and dams and to provide a "pollution profile" of each major mainstem stream or river. The result is an initial allocation of 135 potential sampling locations (Figure 7). Of these, 65 are level 6 and 7 sites, i.e., they drain 5 and 2 $mi.^2$ respectively.

Indicators and Parameters

The allocation of indicators and parameters was done following the principles outlined previously for the adequate monitoring framework (see Figure 2 and Table 1). The biological, chemical, and physical indicators listed in tables 7-9 are grouped by category in keeping with the concept of core and supplemental parameters. Fish and macroinvertebrate assemblages are recommended as the two biological indicator groups that comprise the core biological indicators. These are accompanied by a qualitative habitat assessment tool and field measured chemical/physical parameters at all sites. Demand and nutrient parameters are to be collected at all sites, but at varying frequencies based on the inherent risk of variation due to stream size and local area complexity. Common heavy metals are to be collected at the mainstem and tributary sites (level 1-4 sites) and upstream and downstream of significant discharges and other impacts in the level 5-7 sites. Organic scans are recommended for 1 water column sample at selected sites listed in Tables 7-9. Sediment chemical analysis for heavy metals and an organic scan are recommended for mainstem sites, larger tributaries, and upstream and downstream from significant discharges and other potential stressors. As such the recommended indicator, parameter, and frequency coverage is risk based, i.e., analytical costs are incurred when there is a reasonable risk of measuring effects.

Biological Methods

Biological sampling for fish and macroinvertebrate assemblage data should follow established protocols of the Illinois DNR (2001) and Illinois EPA (1997, 2005) *or* be capable of producing comparable data and assessments. An important assumption of this plan is that an economy of effort will be achieved in the level 5, 6, and 7 sites due to their small size. We estimate that at least 4-6 of these sites need to be sampled each field day with the proposed methods. Tables 7-9 indicate what we estimate are the appropriate sampling protocols or the two best candidates, i.e., non-wadeable vs. wadeable, generator-powered vs. back-pack electrofishing methods, qualitative vs. semi-quantitative macroinvertebrate methods, etc. The specifications for the different equipment and methods are described in Tables 10 and 11. The contractor will need to demonstrate a grasp

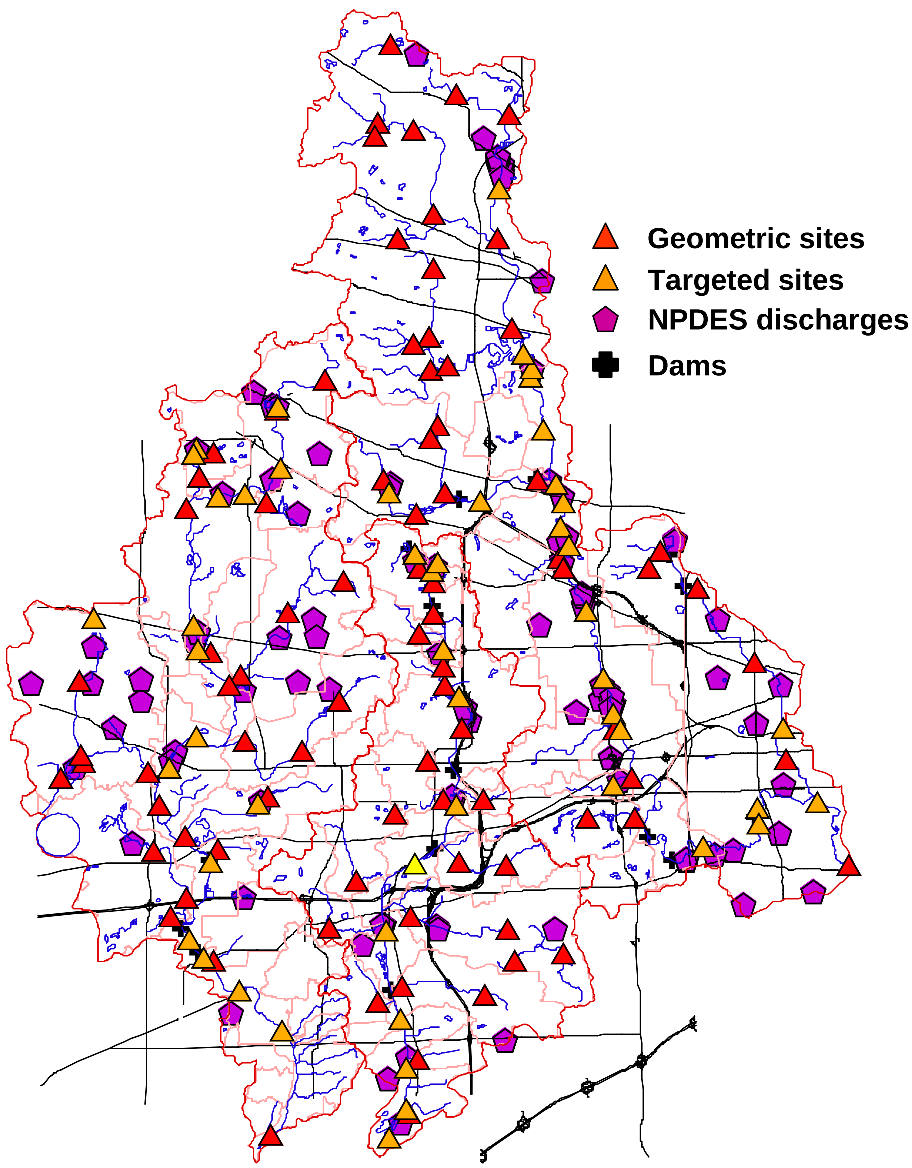

Figure 7. Results of combined geometric and targeted site selection for the DuPage-Salt Creek study area with NPDES discharges and dams shown in the overlay.

Table 7. Recommended allocation of biological, habitat, and chemical/physical sampling sites in the W. Branch DuPage River subbasin based on a combined geometric and targeted intensive survey design. Indicators, methods, and parameters are indicated for each site (G = geometric draw; T = targeted site).

Site I.D.	River/Stream	Site Location - proxomity to major features	Subbasin	Type	Drainage Area	Geometric Level	Fish[1]	Macroinverts.[2]	Habitat[3]	Field Chem.[4]	Demand[5]	Nutrients[6]	Metals[7]	Organic[8]	Supplemental[9]	Sed. Metals[10]	Sed. Organics[11]	Reference[12]
11	W. Branch DuPage River	Mainstem upstream from mouth (need distance reference)	West Branch	G	150	1	EF (B)	MH	X	X	Weekly	Weekly	Bi-weekly	1X	TBD	X	X	TBD
124	W. Branch DuPage River	Adjacent to Washington Street; at Abrahamson Court	West Branch	T	150	1	EF (B)	MH	X	X	Weekly	Weekly	Bi-weekly			X	X	
125	W. Branch DuPage River	Adjacent to intersection of Raymond Drive and Redfield Rd.	West Branch	T	150	1	EF (B)	MH	X	X	Weekly	Weekly	Bi-weekly			X	X	
126	W. Branch DuPage River	1200' upstream from Jackson Ave.	West Branch	T	150	1	EF (B)	MH	X	X	Weekly	Weekly	Bi-weekly	1X		X	X	
15	W. Branch DuPage River	Upstream from Mack Rd. - adjacent to River Savana North	West Branch	G	75	2	EF (W or B)	MH	X	X	Weekly	Weekly	Bi-weekly	1X		X	X	
130	W. Branch DuPage River	Immediately upstream from Main Street; downstream from Warrensville Dam	West Branch	T	75	2	EF (W or B)	MH	X	X	Weekly	Weekly	Bi-weekly			X	X	
131	W. Branch DuPage River	Upstream from Ogden Ave.; downstream from Fawell Dam	West Branch	T	75	2	EF (W or B)	MH	X	X	Weekly	Weekly	Bi-weekly			X	X	
20	W. Branch DuPage River	1600' upstream from Geneva Rd. within Prarie Path Meadows	West Branch	G	38	3	EF (W)	MH	X	X	Bi-weekly	Bi-weekly	4X			X	X	
115	W. Branch DuPage River	Immediately upstream from Great Western Trail; downstream from DuPage Co.- Nordi	West Branch	T	38	3	EF (W)	MH	X	X	Bi-weekly	Bi-weekly	4X	1X		X	X	
116	W. Branch DuPage River	At Windsor Court; downstream from Kerr-McGee discharge (IL0063495)	West Branch	T	38	3	EF (W)	MH	X	X	Bi-weekly	Bi-weekly	4X	1X		X	X	
127	W. Branch DuPage River	At Morningside Drive; upstream from West Chicago WWTP	West Branch	T	38	3	EF (W)	MH	X	X	Bi-weekly	Bi-weekly	4X	1X		X	X	
128	W. Branch DuPage River	Immediately upstream from St. Charles Rd.; upstream from DuPage Co.- Cascade WWT	West Branch	T	38	3	EF (W)	MH	X	X	Bi-weekly	Bi-weekly	4X	1X		X	X	
24	W. Branch DuPage River	Adjacetnt to Bartlett Rd./Kelm Trail interstection; 1900" upstream from CC&P RR;	West Branch	G	19	4	EF (W)	MH	X	X	Bi-weekly	Bi-weekly	4X			X	X	
91	W. Branch DuPage River	Immediately downstream from County Farm Rd.; 3200' upstream from NPDES (IL002761	West Branch	T	9	5	LL/BP	MH or QL	X	X	4X	4X	3X	1X		X	X	
92	W. Branch DuPage River	700' downstream from NPDES (IL002761)	West Branch	T	9	5	LL/BP	MH or QL	X	X	4X	4X	3X	1X		X	X	
28	W. Branch DuPage River	Downstream MWRDGC Hanover Park WWTP (IL0036137); between Westchester and Sycamor	West Branch	G	5	6	LL/BP	MH or QL	X	X	4X	4X	3X	1X		X	X	
95	W. Branch DuPage River	Upstream from MWRDGC Hanover Park WWTP (IL0036137)	West Branch	T	5	6	LL/BP	MH or QL	X	X	4X	4X	3X	1X		X	X	
112	W. Branch DuPage River	Downstream from Lake Street	West Branch	T	5	6	LL/BP	MH or QL	X	X	4X	4X						
29	W. Branch DuPage River	Upstream from Braintree Drive; downstream Cambridge Drive	West Branch	G	2	7	LL/BP	QL	X	X	2-3X	2-3X						
5	Kress Creek	Upstream intersection of Joliet Street and Wilson Street	West Branch	G	19	4	EF (W)	MH	X	X	Bi-weekly	Bi-weekly	4X			X	X	
2	Kress Creek	1200' downstream from Burlington Northern RR	West Branch	G	9	5	LL (W)	MH or QL	X	X	4X	4X	2-3X	1X		X	X	
4	Kress Creek	Adjacent Illinois Prarie Path; 700' E. of Kress Rd.	West Branch	G	5	6	LL/BP	MH or QL	X	X	4X	4X	-					
89	Kress Creek	Downstream from North Ave.	West Branch	T	2	7	LL/BP	QL	X	X	2-3X	2-3X						
1	W. Br. Kress Creek	Adjacent Road A - Winfield; dst. unnamed lake/wetland	West Branch	G	5	6	LL/BP	MH or QL	X	X	4X	4X	-					
88	W. Br. Kress Creek	Upstream from Wilson Rd.	West Branch	G	2	7	LL/BP	QL	X	X	2-3X	2-3X						
9	Ferry Creek	Immediately upstream from Ferry Rd.	West Branch	G	9	5	LL (W)	MH or QL	X	X	4X	4X	2-3X					
6	Ferry Creek	Immediately dst. St. Rt. 59	West Branch	G	5	6	LL/BP	MH or QL	X	X	4X	4X	-					
8	Ferry Creek	Adjacent Diehl Rd. - 1200" upstream Raymond Meadow	West Branch	G	2	7	LL/BP	QL	X	X	2-3X	2-3X						
13	Spring Brook	Immediately downstream from Morris Ct.	West Branch	G	9	5	LL (W)	MH or QL	X	X	4X	4X	2-3X					
90	Spring Brook	Adjacent to Shaffner Rd. - immediately dst. Wheaton SD CSO (IL0031739)	West Branch	T	5	6	LL/BP	MH or QL	X	X	4X	4X	3X	1X		X	X	
14	Spring Brook	Adjacent to Creekside Drive - upstream Wheaton SD CSO - IL0031739	West Branch	G	2	7	LL/BP	QL	X	X	2-3X	2-3X	3X	1X		X	X	
16	Winfield Creek	Adjacent to Liberty Street - 900' downsytream from Church Street	West Branch	G	9	5	LL (W)	MH or QL	X	X	4X	4X	2-3X					
17	Winfield Creek	Immediately upstream from Liberty Drive	West Branch	G	5	6	LL/BP	MH or QL	X	X	4X	4X	-					
18	Winfield Creek	Immediately upstream from Cole Ave.; adjacent to Brookside Circle	West Branch	G	2	7	LL/BP	QL	X	X	2-3X	2-3X						
19	Klein Creek	Upstream from impoundment in Klein Savanna; 1400' above Illinois Prarie Path - E	West Branch	G	9	5	LL (W)	MH or QL	X	X	4X	4X	2-3X					
22	Klein Creek	Adjacent to Hiawatha Drive; 1200' downstream from Illini Drive	West Branch	G	5	6	LL/BP	MH or QL	X	X	4X	4X	-					
23	Klein Creek	Immediately upstream from Schmale Rd.	West Branch	G	2	7	LL/BP	QL	X	X	2-3X	2-3X						
10	Cress Creek	Immediately downstream from 5th Ave.	West Branch	G	2	7	LL/BP	QL	X	X	2-3X	2-3X						
25	Trib. to W. Branch	Immediately upstream from Stearns Rd.	West Branch	G	5	6	LL/BP	MH or QL	X	X	4X	4X	-					
94	Trib. to W. Branch	Upstream from Wilcox Drive; downstream from Bartlett WWTP	West Branch	T	5	6	LL/BP	MH or QL	X	X	4X	4X	3X	1X		X	X	
12	Trib. to W. Branch	Immediately upstream from Winfield Rd. - South Fields	West Branch	G	2	7	LL/BP	QL	X	X	2-3X	2-3X						
21	Trib. to W. Branch	Immediately upstream from Great Western Trail; Ancient Oaks Prarie	West Branch	G	2	7	LL/BP	QL	X	X	2-3X	2-3X						
26	Trib. to W. Branch	Immediately upstream from Coral Ave.	West Branch	G	2	7	LL/BP	QL	X	X	2-3X	2-3X						
27	Trib. to W. Branch	Smook Meadow	West Branch	G	2	7	LL/BP	QL	X	X	2-3X	2-3X						
93	Trib. to W. Branch	Immediately upstream from Bartlett WWTP (IL0027618)	West Branch	T	2	7	LL/BP	QL	X	X	2-3X	2-3X	3X	1X		X	X	

Footnotes:

1 - EF (B) = boat mounted electrofishing; EF (W) = electrofishing, wading method using towboat or similar apparatus; LL (W) = bank set generator electrofishing using long line; BP = backpack electrofishing only in lieu of long line and where conditions are acceptable.

2 - MH = Illinois EPA multihabitat method; QL = qualitative multihabitat method in lieu of MH only where conditions are acceptable.

3 - Habitat assessment using a visual, qualitative method in connection to the biological sampling (e.g. - the Qualitative Habitat Evaluation Index [QHEI] or equivalent).

4 - Field parameters to include (at a minimum) temperature, dissolved oxygen, and conductivity; may also include pH.

5 - Demand parameters include total suspended solids, total dissolved solids, pH (lab), specific conductance, BOD (5-day), chloride, sulfate, and associated parameters depending on labortaory capabilities.

6 - Nutrients include the nitrogen series (Total Kjeldahl N, nitrate + nitrite-N, ammonia-N) and total phospohorus; may include subforms of P as needed.

7 - Includes common heavy metals - copper, cadmium, lead, iron, and zinc; includes magnesium and calcium for hardness determination; may include chromium and nickel when necessary.

8 - Organics inlcudes a scan for pesticides, VOCs, PAHs, and PCBs; laboratory capabilities may dictate exact parameters.

9 - Supplemental list includes source specific parameters not included above; to be determined as part of detailed plan of study.

10 - Sediment metals to include all common and supplemental parameters; collection during October.

11 - Sediment organics to include scan for pesticides, VOCs, PAHs, PCBs, and other identified compounds.

12 - Reference sites are intended to reflect least impacted conditions, but may also relfect subsets of alterations that are likely to be irretrievable or unrestorable; these sites are sampled for all parameters to establish baseline expectations.

Sites Summary:

Level 1 (150 mi^2): 4
Level 2 (75 mi^2): 3
Level 3 (38 mi^2): 5
Level 4 (19 mi^2): 2
Level 5 (9 mi^2): 7
Level 6 (5 mi^2): 11
Level 7 (2 mi^2): 13
Total Sites: 45

Table 8. Recommended allocation of biological, habitat, and chemical/physical sampling sites in the E. Branch DuPage subbasin based on a combined geometric and targeted intensive survey design. Indicators, methods, and parameters are indicated for each site (G = geometric draw; T = targeted site).

Site I.D.	River/Stream	Site Location - proxomity to major features	Subbasin	Type	Drainage Area	Geometric Level	Fish[1]	Macroinverts.[2]	Habitat[3]	Field Chem.[4]	Demand[5]	Nutrients[6]	Metals[7]	Organic[8]	Supplemental[9]	Sed. Metals[10]	Sed. Organics[11]	Reference[12]
121	E. Branch DuPage River	At Hobson Rd.	East Branch	T	75	2	EF (W or B)	MH	X	X	Weekly	Weekly	Bi-weekly	1X	TBD	X	X	TBD
122	E. Branch DuPage River	1500' W. of St. Rt. 53; downstream from DuPage Co.- Woodrisge WWTP (IL0031844)	East Branch	T	75	2	EF (W or B)	MH	X	X	Weekly	Weekly	Bi-weekly	1X		X	X	
123	E. Branch DuPage River	Downstream from Bollingbrook WWTP (IL0032689)	East Branch	T	75	2	EF (W or B)	MH	X	X	Weekly	Weekly	Bi-weekly	1X		X	X	
129	E. Branch DuPage River	Upstream from Bollingbrook WWTP (IL0032689); downstream from unnamed tributary	East Branch	T	75	2	EF (W or B)	MH	X	X	Weekly	Weekly	Bi-weekly	1X		X	X	
74	E. Branch DuPage River	Adjacent to and downstream from St. Rt. 53	East Branch	G	38	3	EF (W)	MH	X	X	Bi-weekly	Bi-weekly	Bi-weekly	-		X	X	
119	E. Branch DuPage River	400' W. of Valley Rd.; downstream from Glenbard WWTP	East Branch	T	38	3	EF (W)	MH	X	X	Bi-weekly	Bi-weekly	Bi-weekly	1X		X	X	
120	E. Branch DuPage River	At Short Street; downstream from Downers Grove WTC (IL00228380)	East Branch	T	38	3	EF (W)	MH	X	X	Bi-weekly	Bi-weekly	Bi-weekly	1X		X	X	
81	E. Branch DuPage River	Downstream Glenbard CSOs - 2 (IL0022471); at end of Shady Lane; adjacent to I-35	East Branch	G	19	4	EF (W)	MH	X	X	Bi-weekly	Bi-weekly	Bi-weekly	1X		X	X	
107	E. Branch DuPage River	Upstream North Ave.; upstream from Glendale WWTP (IL0028967)	East Branch	T	19	4	EF (W)	MH	X	X	Bi-weekly	Bi-weekly	Bi-weekly	-		X	X	
132	E. Branch DuPage River	Upstream Churchill Lkae dam; Churchill Lake	East Branch	T	19	4	EF (W)	MH	X	X	Bi-weekly	Bi-weekly	Bi-weekly	-		X	X	
83	E. Branch DuPage River	Downstream Glendale Heights WWTP (IL0028967); 1500' upstream from Great Western	East Branch	G	9	5	LL (W)	MH or QL	X	X	Bi-weekly	Bi-weekly	4X	1X		X	X	
85	E. Branch DuPage River	At corner on Fullerton Ave.; 1000' downstream from CC&P RR	East Branch	G	9	5	LL (W)	MH or QL	X	X	Bi-weekly	Bi-weekly	4X	-		X	X	
87	E. Branch DuPage River	At Brookdale Drive; downstream from Bloomingdale-Reeves WRF CSO (IL0021130)	East Branch	G	5	6	LL (W)	MH or QL	X	X	4X	4X	2-3X	1X		X	X	
110	E. Branch DuPage River	At Glen Ellyn Rd.; immediately upstream from Bloomingdale-Reeves WRF CSO (IL0021	East Branch	T	2	7	LL/BP	QL	X	X	2-3X	2-3X						
79	E. Branch DuPage River	Downstream from Finley Rd.; ust. I-355	East Branch	G	2	7	LL/BP	QL	X	X	2-3X	2-3X	-	-				
69	St. Joseph Creek	Immediately upstream BNSF RR	East Branch	G	9	5	LL (W)	MH or QL	X	X	Bi-weekly	Bi-weekly	4X	-		X	X	
70	St. Joseph Creek	Upstream and adjacent to Curtiss Street	East Branch	G	5	6	LL (W)	MH or QL	X	X	4X	4X	2-3X	-				
72	St. Joseph Creek	At King Arthur's Court	East Branch	G	2	7	LL/BP	QL	X	X	2-3X	2-3X	-	-				
71	Trib. to St. Joseph Creek	At Carpenter Street	East Branch	G	5	6	LL (W)	MH or QL	X	X	4X	4X	2-3X	-				
65	Prentiss Creek	Immediately downstream from St. Rt. 53	East Branch	G	5	6	LL (W)	MH or QL	X	X	4X	4X	2-3X	-				
66	Prentiss Creek	Between Palmer Street and Barclay Court	East Branch	G	2	7	LL/BP	QL	X	X	2-3X	2-3X	-	-				
75	Lacey Creek	At edge of King's Grove reserve; 3500' upstream from Finley Rd.	East Branch	G	5	6	LL (W)	MH or QL	X	X	4X	4X	2-3X	-				
76	Lacey Creek	At Saratoga Ave.	East Branch	G	2	7	LL/BP	QL	X	X	2-3X	2-3X	-	-				
77	Glencrest Creek	At intersection of Glen Crest Drive and Danby Drive	East Branch	G	5	6	LL (W)	MH or QL	X	X	4X	4X	2-3X	-				
78	Glencrest Creek	1700' S. of 22nd Street (stream may be under ground - did not show on map)	East Branch	G	2	7	LL/BP	QL	X	X	2-3X	2-3X	-	-				
80	Glencrest Creek	Immediately upstream from Nicoll Ave. (stream may be under ground - does not sho	East Branch	G	2	7	LL/BP	QL	X	X	2-3X	2-3X	-	-				
64	Crabtree Creek	Immediately upstream St. Rt. 53	East Branch	G	2	7	LL/BP	QL	X	X	2-3X	2-3X	-	-				
68	Rott Creek	At Wellington Ave.	East Branch	G	2	7	LL/BP	QL	X	X	2-3X	2-3X	-	-				
73	Willoway Brook	Immediately upstream from Leask Lane	East Branch	G	2	7	LL/BP	QL	X	X	2-3X	2-3X	-	-				
84	Armitage Creek	At Armitage Ave.	East Branch	G	2	7	LL/BP	QL	X	X	2-3X	2-3X	-	-				
86	Army Trail Creek	Downstream from Valley View Rd.; upstream from North Marsh reserve	East Branch	G	2	7	LL/BP	QL	X	X	2-3X	2-3X	-					
63	Trib. to E. Branch	Confluence just upstream from Bollingbrook WWTP (IL0032689)	East Branch	G	2	7	LL/BP	QL	X	X	2-3X	2-3X	3X	-				
67	Trib. to E. Branch	Upstream Green Trails Drive	East Branch	G	2	7	LL/BP	QL	X	X	2-3X	2-3X	-	-				
82	Trib. to E. Branch	At Swift Rd.; in Churchill Prarie reserve	East Branch	G	2	7	LL/BP	QL	X	X	2-3X	2-3X	-	-				
108	Trib. to E. Branch	Upstream Army Trail Rd.; downstream from Bloomingdale-Reeves WWTP (IL0021130)	East Branch	T	2	7	LL/BP	QL	X	X	2-3X	2-3X	3X	1X		X	X	
109	Trib. to E. Branch	Immediately upstream from Bloomingdale-Reeves WWTP (IL0021130); South Field rese	East Branch	T	2	7	LL/BP	QL	X	X	2-3X	2-3X	3X	1X		X	X	

Footnotes:

[1] - EF (W) = electrofishing, wading method using towboat or similar apparatus; LL (W) = bank set generator electrofishing using long line; BP = backpack electrofishing only in lieu of long line and where conditions are acceptable.

[2] - MH = Illinois EPA multihabitat method; QL = qualitative multihabitat method in lieu of MH only where conditions are acceptable.

[3] - Habitat assessment using a visual, qualitative method in connection to the biological sampling (e.g. - the Qualitative Habitat Evaluation Index [QHEI] or equivalent).

[4] - Field parameters to include (at a minimum) temperature, dissolved oxygen, and conductivity; may also include pH.

[5] - Demand parameters include total suspended solids, total dissolved solids, pH (lab), specific conductance, BOD (5-day), chloride, sulfate, and associated parameters depending on labortaory capabilities.

[6] - Nutrients include the nitrogen series (Total Kjeldahl N, nitrate + nitrite-N, ammonia-N) and total phospohorus; may include subforms of P as needed.

[7] - Includes common heavy metals - copper, cadmium, lead, iron, and zinc; includes magnesium and calcium for hardness determination; may include chromium and nickel when necessary.

[8] - Organics inlcudes a scan for pesticides, VOCs, PAHs, and PCBs; laboratory capabilities may dictate exact parameters.

[9] - Supplemental list includes source specific parameters not included above; to be determined as part of detailed plan of study.

[10] - Sediment metals to include all common and supplemental parameters; collection during October.

[11] - Sediment organics to include scan for pesticides, VOCs, PAHs, PCBs, and other identified compounds.

[12] - Reference sites are intended to reflect least impacted conditions, but may also relfect subsets of alterations that are likely to be irretrievable or unrestorable; these sites are sampled for all parameters to establish baseline expectations.

Sites Summary:

Level 1 (150 mi^2): 0
Level 2 (75 mi^2): 4
Level 3 (38 mi^2): 3
Level 4 (19 mi^2): 3
Level 5 (9 mi^2): 3
Level 6 (5 mi^2): 6
Level 7 (2 mi^2): 17
Total Sites: 36

Table 8. Recommended allocation of biological, habitat, and chemical/physical sampling sites in the Salt Creek subbasin based on a combined geometric and targeted intensive survey design. Indicators, methods, and parameters are indicated for each site (G = geometric draw; T = targeted site).

Site I.D.	River/Stream	Site Location - proximity to major features	Subbasin	Type	Drainage Area	Geometric Level	Fish[1]	Macroinverts.[2]	Habitat[3]	Field Chem.[4]	Demand[5]	Nutrients[6]	Metals[7]	Organic[8]	Supplemental[9]	Sed. Metals[10]	Sed. Organics[11]	Reference[12]
58	Salt Creek	Immediately upstream from St. Rt. 171	Salt Creek	150	G	1	EF (B)	MH	X	X	Weekly	Weekly	Bi-weekly	1X	TBD	X	X	TBD
137	Salt Creek	Immediately downstream from Maple Ave.	Salt Creek	150	T	1	EF (B)	MH	X	X	Weekly	Weekly	Bi-weekly			x	x	
96	Salt Creek	Upstream from Wood Dale South WWTP (IL0034274); upstream Elizabeth Drive	Salt Creek	75	T	2	EF (W or B)	MH	X	X	Weekly	Weekly	Bi-weekly	1X		X	X	
97	Salt Creek	Downstream fromWood Dale South WWTP (IL0034274); upstream from Oak Meadows GC da	Salt Creek	75	T	2	EF (W or B)	MH	X	X	Weekly	Weekly	Bi-weekly	1X		X	X	
99	Salt Creek	Downstream Villa Park CSOs (IL0033618)	Salt Creek	75	T	2	EF (W or B)	MH	X	X	Weekly	Weekly	Bi-weekly	1X		X	X	
100	Salt Creek	At Albert Street; upstream from Villa Park CSOs	Salt Creek	75	T	2	EF (W or B)	MH	X	X	Weekly	Weekly	Bi-weekly	1X		X	X	
101	Salt Creek	Downstream from Addison South - A.J. Larocca WWTP (IL00227367)	Salt Creek	75	T	2	EF (W or B)	MH	X	X	Weekly	Weekly	Bi-weekly	1X		X	X	
102	Salt Creek	Downstream from Wood Dale North WWTP (IL0020061)	Salt Creek	75	T	2	EF (W or B)	MH	X	X	Weekly	Weekly	Bi-weekly	1X		X	X	
103	Salt Creek	Downstream from Itasca WWTP (IL0026280)	Salt Creek	75	T	2	EF (W or B)	MH	X	X	Weekly	Weekly	Bi-weekly	1X		X	X	
118	Salt Creek	2000' upstream from I-294; downstream from Western Springs CSOs (IL0045039)	Salt Creek	75	T	2	EF (W or B)	MH	X	X	Weekly	Weekly	Bi-weekly	1X		X	X	
134	Salt Creek	Downstream Elmhurst Co. FP dam	Salt Creek	75	T	2	EF (W or B)	MH	X	X	Weekly	Weekly	Bi-weekly			X	X	
135	Salt Creek	Downstream Possum Hollow Woods dam	Salt Creek	75	T	2	EF (W or B)	MH	X	X	Weekly	Weekly	Bi-weekly			X	X	
136	Salt Creek	Downstream 31st Street; upstream Possum Hollow Woods dam	Salt Creek	75	T	2	EF (W or B	MH	X	X	Weekly	Weekly	Bi-weekly			X	X	
105	Salt Creek	Downstream from MWRDGC Egan WWTP; at Arlington Heights Rd.	Salt Creek	38	T	3	EF (W)	MH	X	X	Bi-weekly	Bi-weekly	4X	1X		X	X	
106	Salt Creek	Immediately upstream from MWRDGC Egan WWTP; downstream Busse Woods South dam	Salt Creek	38	T	3	EF (W)	MH	X	X	Bi-weekly	Bi-weekly	4X	1X		X	X	
133	Salt Creek	Upstream Busse Woods dam; Busse Woods Lake	Salt Creek	38	T	3	EF (W)	MH	X	X	Bi-weekly	Bi-weekly	4X			X	X	
44	Salt Creek	Immediately downstream from Higgins Rd.	Salt Creek	19	G	4	EF (W)	MH	X	X	Bi-weekly	Bi-weekly	4X			X	X	
104	Salt Creek	Downstream Devon Ave.; North Fields reserve	Salt Creek	19	T	4	EF (W)	MH	X	X	Bi-weekly	Bi-weekly	4X			X	X	
36	Salt Creek	At Old Plum Grove Rd.	Salt Creek	9	G	6	LL (W)	MH or QL	X	X	4X	4X	3X					
32	Salt Creek	Immediately upstream from Plymouth Drive	Salt Creek	2	G	7	LL/BP	QL	X	X	2-3X	2-3X						
33	Salt Creek	At Quentin Rd.	Salt Creek	5	G	6	LL (W)	MH or QL	X	X	4X	4X						
52	Westwood Creek	Downstream from Addison North WWTP	Salt Creek	75	G	2	EF (W or B)	MH	X	X	Weekly	Weekly	Bi-weekly	1X		X	X	
51	Westwood Creek	Upstream from Addison North WWTP; downstream from Salt Cr. trib. WWTP dam	Salt Creek	5	G	6	LL (W)	MH or QL	X	X	4X	4X		1X		X	X	
45	Spring Brook	Immediately upstream from Prospect Ave.	Salt Creek	19	G	4	EF (W)	MH	X	X	Bi-weekly	Bi-weekly	4X			X	X	
114	Spring Brook	Upstream I-290; access from Springlake Drive	Salt Creek	19	T	4	EF (W)	MH	X	X	Bi-weekly	Bi-weekly	4X	1X		X	X	
46	Spring Brook	3500' downstream from Irving Park Rd.	Salt Creek	5	G	6	LL (W)	MH or QL	X	X	4X	4X						
47	Spring Brook	Upstream from Spring Creek reserve; downstream from Lakeview Drive	Salt Creek	5	G	6	LL (W)	MH or QL	X	X	4X	4X						
49	Spring Brook	Downstream from Hawthorne Lane; upstream from reserve EMW01	Salt Creek	2	G	7	LL/BP	QL	X	X	2-3X	2-3X						
50	Spring Brook	Upstream from Roselle - J.L. Devlin WWTP (IL0030813); downstream from Walnut Str	Salt Creek	2	G	7	LL/BP	QL	X	X	2-3X	2-3X	3X	1X		X	X	
113	Spring Brook	At Spring Street; downstream from Roselle - J.L. Devlin WWTP (IL0030813)	Salt Creek	2	T	7	LL/BP	QL	X	X	2-3X	2-3X	3X	1X		X	X	
57	Addison Creek	At Gardner Rd.	Salt Creek	19	G	4	EF (W))	MH	X	X	Bi-weekly	Bi-weekly	4X			X	X	
117	Addison Creek	At VanBuren Street	Salt Creek	19	T	4	EF (W)	MH	X	X	Bi-weekly	Bi-weekly	4X			X	X	
56	Addison Creek	At U.S. Rt. 45	Salt Creek	9	G	5	LL (W)	MH or QL	X	X	4X	4X	3X					
55	Addison Creek	Downstream from Northwest Ave.	Salt Creek	5	G	6	LL (W)	MH or QL	X	X	4X	4X						
60	Addison Creek	Downstream from Jorie Blvd.	Salt Creek	5	G	6	LL (W)	MH or QL	X	X	4X	4X						
53	Addison Creek	Downstream from Red Oak Street	Salt Creek	2	G	7	LL/BP	QL	X	X	2-3X	2-3X						
54	Trib. to Addison Creek	At York Rd.	Salt Creek	2	G	7	LL/BP	QL	X	X	2-3X	2-3X						
37	Trib. to Salt Creek	At Central Rd.	Salt Creek	9	G	7	LL (W)	MH or QL	X	X	4X	4X						
111	Trib. to Salt Creek	Downstream from Euclid Ave.; downstream from Arlington Racecourse (IL0063487)	Salt Creek	9	T	7	LL (W)	MH or QL	X	X	4X	4X	3X	1X		X	X	
40	Trib. to Salt Creek	Immediately upstream from Schaumburg Rd.	Salt Creek	5	G	5	LL (W)	MH or QL	X	X	4X	4X						
43	Trib. to Salt Creek	Immediateltly downstream from Meacham Rd.	Salt Creek	9	G	5	LL (W)	MH or QL	X	X	4X	4X	3X					
62	Sugar Creek	Downstream from Riverside Drive	Salt Creek	5	G	6	LL (W)	MH or QL	X	X	4X	4X						
35	Trib. to Salt Creek	At Anderson Rd.	Salt Creek	2	G	4	LL/BP	QL	X	X	2-3X	2-3X						
30	Trib. to Salt Creek	6600' upstream from St. Rt. 14	Salt Creek	2	G	7	LL/BP	QL	X	X	2-3X	2-3X						
31	Trib. to Salt Creek	Adjacent Inverway Rd. between Palatine and Dewey Rds.	Salt Creek	2	G	7	LL/BP	QL	X	X	2-3X	2-3X						
34	Trib. to Salt Creek	At Benton Rd.	Salt Creek	2	G	7	LL/BP	QL	X	X	2-3X	2-3X						
38	Trib. to Salt Creek	Between Roselle and Hammond Dr.	Salt Creek	2	G	7	LL/BP	QL	X	X	2-3X	2-3X						
39	Trib. to Salt Creek	Between Tower and Remington Rd.	Salt Creek	2	G	7	LL/BP	QL	X	X	2-3X	2-3X						
41	Trib. to Salt Creek	1000' upstream from Plum Grove Rd.	Salt Creek	2	G	7	LL/BP	QL	X	X	2-3X	2-3X						
42	Trib. to Salt Creek	At end of University Lane	Salt Creek	2	G	7	LL/BP	QL	X	X	2-3X	2-3X						
48	Meacham Creek	Downstream from Arkansas Drive	Salt Creek	2	G	7	LL/BP	QL	X	X	2-3X	2-3X						
59	Trib. to Salt Creek	Immediately upstream from Midwest Rd.	Salt Creek	2	G	7	LL/BP	QL	X	X	2-3X	2-3X						
61	Ginger Creek	Immediately upstream from Spring Rd.; downstream from Badger Pipeline discharge	Salt Creek	2	G	7	LL/BP	QL	X	X	2-3X	2-3X						
98	Oak Brook	Upstream from St. Rt. 83	Salt Creek	2	T	7	LL/BP	QL	X	X	2-3X	2-3X						

Footnotes:

1 - EF (B) = boat mounted electrofishing; EF (W) = electrofishing, wading method using towboat or similar apparatus; LL (W) = bank set generator electrofishing using long line; BP = backpack electrofishing only in lieu of long line and where conditions are acceptable.
2 - MH = Illinois EPA multihabitat method; QL = qualitative multihabitat method in lieu of MH only where conditions are acceptable.
3 - Habitat assessment using a visual, qualitative method in connection to the biological sampling (e.g. - the Qualitative Habitat Evaluation Index [QHEI] or equivalent).
4 - Field parameters to include (at a minimum) temperature, dissolved oxygen, and conductivity; may also include pH.
5 - Demand parameters include total suspended solids, total dissolved solids, pH (lab), specific conductance, BOD (5-day), chloride, sulfate, and associated parameters depending on labortaory capabilities.
6 - Nutrients include the nitrogen series (Total Kjeldahl N, nitrate + nitrite-N, ammonia-N) and total phospohorus; may include subforms of P as needed.
7 - Includes common heavy metals - copper, cadmium, lead, iron, and zinc; includes magnesium and calcium for hardness determination; may include chromium and nickel when necessary.
8 - Organics inlcudes a scan for pesticides, VOCs, PAHs, and PCBs; laboratory capabilities may dictate exact parameters.
9 - Supplemental list includes source specific parameters not included above; to be determined as part of detailed plan of study.
10 - Sediment metals to include all common and supplemental parameters; collection during October.
11 - Sediment organics to include scan for pesticides, VOCs, PAHs, PCBs, and other identified compounds.
12 - Reference sites are intended to reflect least impacted conditions, but may also relfect subsets of alterations that are likely to be irretrievable or unrestorable; these sites are sampled for all parameters to establish baseline expectations.

Sites Summary:
Level 1 (150 mi^2): 2
Level 2 (75 mi^2): 12
Level 3 (38 mi^2): 3
Level 4 (19 mi^2): 6
Level 5 (9 mi^2): 5
Level 6 (5 mi^2): 8
Level 7 (2 mi^2): 18
Total Sites: 54

Table 10. Fish assemblage sampling method and gear specifications for the DuPage-Salt Creek biological assessment by geometric site level.

Parameter	Site Levels[1] Levels 6-7	Levels 2-6	Levels 1-2
Waterbody Size[2]	<1.0-5.0 mi^2	5.0-75 mi^2	75-150 mi^2
Channel Dimensions:[3]	<0.3-0.5m depth; 1-2m width	0.5-1.0m depth; 2-10m width	>1.0m depth; 10-100m width
Platform:	Backpack or Bank set/long line	Tow boat or Bank set/long line	12' boat
Power Source:[4]	12v battery or 300W alternator;[5] 1750 W alternator[6]	1750-2500W alternator	3500-5000 W alternator
Amperage Output:	1.5-2A; 2-4A	4-8A	8-20A
Volts D.C. Output:	100-200; 150-300	150-300; 300-1000	500-1000
Anode Location:	Net ring w/assist netters	Net ring w/assist netters	Boom w/droppers; bow netter
Sampling Direction:	Upstream	Upstream	Downstream
Distance Sampled:	0.10-0.15km	0.15-0.20km	0.5km
CPUE Basis:[7]	per 0.3km	per 0.3km	per 1.0km
Time Sampled	1800-3600 sec	1800-3600 sec	2500-3500 sec
Time of Sampling:	Daylight	Daylight	Daylight
Crew Size[8]	2-3	3	2

[1] Site levels described under Watershed Monitoring Design and described for each site in Tables 7-9.
[2] Watershed size upstream from the sampling site.
[3] Size dimensions are approximate and may vary by site – these should not be used as primary criteria.
[4] Wattage (W) is sustained output (not peak output).
[5] Back pack units can be either battery or generator powered.
[6] This is used with the long line sampling method.
[7] Basis for determining relative abundance parameters.
[8] Crew consists of a qualified crew leader and field technicians.

Table 11. Macroinvertebrate assemblage sampling method and gear specifications for the DuPage-Salt Creek biological assessment by geometric site level.

	Site Levels[1]		
Parameter	Levels 6-7	Levels 2-6	Levels 1-2
Waterbody Size[2]	<1.0-5.0 mi^2	5.0-75 mi^2	75-150 mi^2
Channel Dimensions:[3]	<0.3-0.5m depth; 1-2m width	0.5-1.0m depth; 2-10m width	>1.0m depth; 10-100m width
Protocol:	Qualitative Dip-Net, handpick	Multi-habitat IEPA Method	Multi-habitat or Artificial Substrate
Collection device:	D-frame dip net	D-frame dip net	D-frame dip net; Modified Hester-Dendy sampler
Effort:	30 minutes and >until no new taxa	20 sweeps; habitat defined	20 sweeps; 6 weeks H-D[4]
CPUE Basis:[5]	No. individuals per site	No. individuals per site	No. ind./site; No./m^2
Subsample:	Time based;	300 organisms	300 organisms; Proportioned
Taxonomic Resolution:	Lowest Practicable	Lowest practicable	Lowest practicable
Crew Size[6]	2	2	2

[1] Site levels described under Watershed Monitoring Design and described for each site in Tables 7-9.
[2] Watershed size upstream from the sampling site.
[3] Size dimensions are approximate and may vary by site – these should not be used as primary criteria.
[4] Artificial substrates used at non-wadeable sites that are deeper and wider; used where multi-habitat method is impractical as defined by IEPA 2005.
[5] Basis for determining relative abundance parameters.
[6] Crew consists of a qualified crew leader and one field technician.

of these concepts and prove the ability to make the correct equipment selection decisions in the field. Ultimately the methods will be documented in the Quality Assurance Project Plan (QAPP).

Fish Methods

Fish sampling methods should follow the specifications in Table 10 and defer to the most effective method given the important site characteristics. For example, one of the generator-pulsator methods is preferred in nearly every situation over a back-pack unit. Specifications restricting the use of back-pack units to situations where they will offer equal relative effectiveness will be written into the project QAPP. In this case we are recommending the use of pulsed D.C. generator powered methods in lieu of the electric seine method commonly employed by Illinois DNR. The principal reason for this recommendation is crew size which directly relates to sampling costs. The IDNR electric seine requires a crew size of 6 and the methods recommended here require a maximum crew of 3. Data comparing the two methods will be available from the 2004-5 National Wadeable Streams survey bioassessment methods comparability project in mid-2006.

The methods in Table 10 are single gear approaches that do not require supplemental seining or other secondary methods. The determination of which sampling method and gear to use is ultimately a field decision made by an experienced crew leader. The ability to make these types of decisions will need to be demonstrated by the contractor. Deference should be given to the most powerful method in making these choices. For example, a small wadeable stream sampling site that is more than two times the depth or five times the width of the net ring (anode) should be sampled with the 1750 W generator powered long line method as opposed to using a back pack electrofishing unit. It may be easier to sample with the less powerful method, but ease of access is not a primary criterion. Access with this type of equipment should not be an issue in this study area.

The choice between wadeable and non-wadeable gear will necessarily be made in the field, but here also deference should be given to the more powerful boat-mounted method. Sites with extended pools greater than 1 meter average depth will likely require the boat platform. Where this type of approach has been employed, there is an area of overlap between methods where either can produce acceptable results. Navigability and accessibility issues may be a secondary determinant in this decision.

Most fish will be field processed in the field therefore the crew leader will need to be a skilled taxonomist with experience with the fish fauna of the region. The QAPP will outline specific field procedures for the retention of voucher specimens. In addition to the baseline relative abundance data (counts, biomass, and identifications) specified by the QAPP, the identification and enumeration of external anomalies will be required. These methods will be also specified in the QAPP.

Macroinvertebrate Methods
Macroinvertebrate sampling methods will follow the newly developed Illinois EPA (2005) multi-habitat method in the larger wadeable streams and tributaries (Table 11). A qualitative dip net/hand pick method that includes a determination of relative abundance will be employed in the smaller wadeable streams (i.e., level 6 and 7 sites). A modified Hester-Dendy artificial substrate method will be employed at all non-wadeable sites. This method employs a 6 week colonization period with a qualitative dip net/hand pick at the time of artificial substrate retrieval. The distinction between wadeable and non-wadeable will necessarily need to be made in the field.

Laboratory procedures will also follow Illinois EPA methods. For the newly developed multi-habitat method this requires the production of a 300 organism subsample with a scan and pre-pick of large and/or rare taxa from a gridded tray. For artificial substrates the laboratory processing includes the production of a sample by the disassembly and cleaning of the artificial substrates and subsampling procedures as followed by Illinois EPA. The qualitative dip net/hand pick samples should not require initial laboratory reduction. Taxonomic resolution will be at the lowest practicable resolution for the common macroinvertebrate assemblage groups such as mayflies, stoneflies, caddisflies, midges, and crustaceans and in keeping with the practices of Illinois EPA. A reference collection will also need to be maintained by the contractor.

Habitat Assessment
We recommend that the QHEI (Rankin 1989, 1995) be employed as it has been proven to be adequate for the stated purposes of this study. The protocol will need to be accomplished as part of the fish assemblage method in order to produce the data quantity required by the study design. The contractor should be required to complete the Ohio Credible Data training offered by Ohio EPA in June-July 2006.

Water Quality Assessment
We recommend that the majority of samples be collected as grabs during normal summer-fall flow conditions. Because chemical/physical data is being used in a supporting role, the statistical rigor needed to validate water quality criteria exceedences is reduced in a supporting role. The frequency and parameter requirements have been scaled to the risk or likelihood of detecting a substance or parameter. We have also reserved the ability to add other parameters not included in the core demand, nutrient, or heavy metal parameter groups in Tables 7-9.

Determination of Sampleability
In the small headwater streams, particularly the level 7 sites, the issue of sampleability will need to be addressed. Some of these streams will likely have intermittent or ephemeral flows during the summer-fall index period. The parameters to be followed for determining if a biological or chemical sample are simply based on the presence of sufficient water from which a sample can be collected. Sites with intermittent flows should be sampled provided there are pools of at least 20 cm depth. The established protocols should be followed for determining a sampling reach

regardless of intermittency. For example, the fish sampling protocol calls for site reach lengths of 100-150 meters. If flow at the site is intermittent, the dry areas between the intermittent pools should be included in the contiguous reach even though the dry areas would not be directly sampled. The same philosophy applies to the qualitative macroinvertebrate protocols as well.

Reference Sites
We recommend that least impacted reference sites be determined both within and outside of the DuPage-Salt Creek subbasins for biological, habitat, and chemical/physical data. This may require the addition of as many as 15-20 sites outside of the study area if insufficient analogs are available within the study area. The role of modified reference sites should also be recognized and incorporated for intractable impacts that may require resolution via use attainability analysis (UAA).

LONG-TERM MONITORING STRATEGY

The DuPage-Salt Creek also requested an outline for a long-term monitoring strategy. This also included a request for information about resources and costs for implementing an in-house approach. The following outlines a suggested process, schedule, and an estimate of the infrastructure that will be needed to support it.

Goals and Objectives for the DuPage-Salt Creek Watershed Assessment Program

The DuPage-Salt Creek working group has clearly expressed an interest in implementation a sustained watershed assessment approach. As such, the goals and objectives described previously are essentially the same. To meet that objective there will be a need to develop and maintain a capacity and infrastructure to generate data, manage information, and develop assessments that match the precision and accuracy of those produced by the 2006-7 assessment. This can be accomplished by matching the methods, protocols, and design of the QAPP which means acquiring personnel with appropriate skills, training, and capabilities to conduct the work.

A Rotating Basin Approach Planning Process
The DuPage-Salt Creek group will need to establish a systematic process by which each watershed is assessed. This could employ any number of sampling designs, but we recommend that it be done within the basic concept of a watershed assessment design. Furthermore, by basing the strategy on a watershed basis it is amenable to a rotating approach through time. For example, what could follow the initial baseline assessment of the three subwatersheds in 2006 (West Branch, East Branch, and Salt Creek) is a systematic rotation through each subwatershed in 2007, 2008, and 2009. Within each there is flexibility in terms of which parts of each subwatershed are the subject of what kind of sampling, i.e., problem areas or “hot spots” identified by the baseline

Table 12. Important timelines and milestones in the planning and execution of annual monitoring and assessment by the DuPage-Salt Creek watershed group.

Milestone	Description of Activity
November - January: (Months 1-3)	Screening of the major hydrologic areas takes place by soliciting input from the various program offices.
February - April: (Months 4 thru 6)	Final prioritization of issues and definition of study areas. Resource allocation takes place and study team assignments are made.
May - June: (Months 7 thru 8)	Study planning takes place and consists of detailed map reconnaissance, review of historical monitoring efforts, and initial sampling site selection by the study team. Final study plans are used to develop logistics for each field crew.
July - October: (Months 9 thru 12)	Field sampling takes place with field crews operating somewhat independently on a day-to-day basis, but coordinated by the study plan and team leader. Study team communication takes place as necessary, especially to resolve unexpected situations.
October - February: (Months 12 thru 16)	Laboratory sample analysis takes place for chemical and biological parameters. Raw data is entered into relational databases for reduction and analysis. The study team meets to review monitoring information and to coordinate the data analysis and reporting effort.
November - May: (Months 13 thru 17)	Information about indicator levels 3-6 is retrieved, compiled, and used to produce analyses which will support the evaluation of status and trends and causal associations within the study area. Integration of the information is initiated.
May - July: (Months 17 thru 19)	The assessment process is completed by producing working copies of the assessment for review by the study team and a final edit for internal review. Final assessment approved by work group for supporting 305b /303d, NPDES, water quality standards (*e.g.*, use designation revisions), and other programs.

assessment could be followed with specific types and designs of biological, chemical, and physical monitoring and assessment and other types of follow-up investigations.

The sequence of events within a given year from the initial screening of issues through the production of a final assessment are described in Table 12. This includes the major milestones and activities including the selection of specific subwatershed areas for monitoring, planning the monitoring activities, conducting the monitoring, data custody, data management, QA/QC, transformation of data into information, assessment and interpretation of the results, and the making of conclusions and recommendations. The major milestones are arranged sequentially and by major task. The process operates in a continuous cycle such that work will take place on as much as 2 or 3 different years monitoring at any given time, i.e., while year 1 reports are being completed, year 2 planning is well underway, etc. The process should be coordinated by the same person who develops the detailed plan of study and who also manages and oversees the reporting and analysis of the results. This person then reports to a watershed team that represents the key interests in each subwatershed. A written study plan, which delineates the study area boundaries, the scope and objectives, specific sampling locations, indicators, parameters, frequencies, and index sampling periods, is prepared for each year. This plan serves as the blueprint for the data collection phase. Individual program units involved in the sampling are each responsible for assuring data quality, integrity, and adherence to chain-of-custody procedures. Data collected via this process is validated in accordance with the approved QAPP. All data is validated by crew leaders and verified. Data entry is proofread by a data entry analyst and verified by the respective crew leader.

Resources and Logistics for a Sustained Bioassessment Program

Implementation of a bioassessment program by the DuPage-Salt Creek group will require the acquisition of qualified personnel, adequately equipped facilities, and the necessary equipment and supplies. Each of these areas is treated in detail as follows.

Personnel Qualifications

The execution of the biological program will require at least one and up to two full time staff biologists and 3-4 field technicians to assist with data collection during the field season, laboratory processing of samples, and data management tasks. The areas of specialty and expertise include the sampling and assessment of stream and river fish assemblages and macroinvertebrates. Each requires skill in taxonomy at the level of detail required by the QAPP, skill in using standardized sampling methods and procedures, sample processing, data recording, data custody procedures, data analysis, and reporting and communication. These staff should also be reasonably able to deal with administrative procedures and be responsible for the safety and well being of their respective field crews. Each should also be able to perform physical tasks associated with using the field sampling equipment, operating vehicles off-road, and traversing natural stream and river habitats on foot and in watercraft. Each should be certified in water safety procedures, first aid and CPR, and be able to swim. The technicians fulfill the role of providing labor and assistance with the field sampling and with laboratory and data management. Ideally, these will be year 3 and higher college students enrolled in a relevant degree curriculum. They should be capable of performing physical tasks and have a high degree of initiative for performing difficult work under normal field conditions. These attributes should be part of the job descriptions for each position.

One additional consideration will be the role of one on the biologists as a watershed assessment team leader. This will require additional experience and the added responsibility of completing watershed assessments in accordance with the project QAPP.

Training and Certification

Training and orientation of field staff is a general requirement of any QAPP. Training for a fish field crew leader at a minimum consists of having achieved a level of experience in order to operate independently and in accordance with the project QAPP. In addition the crew leader will need to be evaluated for competency in processing voucher specimens collected during the field season. This usually takes place immediately after the field season.

The macroinvertebrate crew leader will need to demonstrate the ability to execute field sampling procedures and for proficiency in performing laboratory identifications. The field training is similar to that described above, except that there will need to be training in the retrieval of artificial substrate samplers which takes place 6 weeks after they are set. Laboratory training essentially requires an apprenticeship of approximately 6 months to one year. This is accomplished by having the macroinvertebrate taxonomist closely supervised by a qualified taxonomist. This would be most easily performed in a central laboratory, which is an option that is recommended for this project. The other option is to maintain a laboratory operated by the group and contracting with an experienced biologist to provide direct oversight.

Facilities

Facilities in support of the biological field assessment consist of field warehousing and storage, a shop for constructing, maintaining, and repairing equipment, and sample receiving facilities that include sinks and a fume hood. Indoor storage of most sampling equipment is recommended to extend service life and operability. Boats can be stored outdoors, but there needs to be sufficient room indoors to easily accommodate a boat and vehicle. In addition, a fully equipped laboratory for processing and identifying macroinvertebrate samples is one of the options that may be considered. Thus cost estimates are presented in two parts, a field facility that meets the above stated specifications and the addition of a fully equipped laboratory (Table 13). The cost estimates are necessarily general, particularly for lease and build out costs, and assume a baseline of newly constructed facilities. Using an already existing facility would presumably reduce some costs, as would finding used bench and lab ware, etc. The initial cost estimates show that maintaining a full biological laboratory capability will double the up front costs in terms of equipment and

Table 13. General specifications and capital cost estimates for a biological field and laboratory facility and with annual operating costs.

Item – Description/Specification	Cost
I. Field Facility	
Annual Lease for 5,000 sq. ft. warehouse ($11/sq. ft.)	$5,550
Initial Build-out (Outdoor compound, indoor compartments, desk space)	$7,500
Lab ware with sink and fume hood (16' bench and sink)	$12,000
Plumbing and HVAC (fume hood)	$7,500
Misc./contingencies	$2,500
TOTAL	$35,000
Annual field facility operating costs	$8,000
II. Laboratory Facility	
Annual lease for 1,000 sq. ft. finished interior ($15/sq. ft.)	$1,500
Lab ware with sink and fume hood	$12,000
Bench ware, wall cabinets, lab tables, chairs	$14,000
Plumbing and HVAC (fume hood)	$5,000
Misc./contingencies	$2,500
TOTAL	$34,000
Annual laboratory operating costs	$4,000

construction costs, but will pay back their value the longer the program is maintained.

Equipment and Supplies

An initial list of major equipment and supply costs is included (Table 14). The majority of the costs in Tables 13 and 14 are essentially one-time, up front costs. We expect that annual costs will be 10-20% of these totals. Also, most equipment items should last at least 5-10 years or longer leaving replacement costs at no more than 10-20% of initial purchase costs. It is recommended that the personnel who will be using the equipment be involved in its purchase, which should take place in the winter and spring preceding the field season.

Other potential costs not included in Tables 13 and 14 include travel costs, which should not be a major factor since most field work will take place locally.

Table 14. Equipment and supply needs to outfit one fish and one macroinvertebrate field crew with estimated costs per item.

Item – Description	Quantity	Est. Cost
Fish Crew		
1. 5.0 GPP Electrofisher – Boat Mounted	1	$10,000
2. T&J 1736 DCV Electrofisher – Wading	1	$5,000
4. 12' John Boat - commercial grade, extra-wide w/trailer	1	$4,000
5. 15 hp. Outboard Motor	1	$2,500
6. Scales, field supplies & accessories	-	$5,000
7. 4 WD Pickup (Crewcab) w/winch	1	$28,000
Subtotal		$54,500
Macroinvertebrate Crew		
1. Current Meter	1	$3,500
2. Stereoscope	1	$2,000
3. Compound Microscope	1	$3,500
4. Artificial Substrates (annual cost)	100	$400
5. Field Supplies	-	$2,000
Subtotal		$11,400
General Needs		
1. PC desktops or laptops	1	$5,000
2. Cameras	2	$1,000
3. Shop Equipment (drills, tools ,etc.)	-	$1,500
4. Misc. Supplies	-	$5,000
Subtotal		$12,500
TOTAL		$78,400
Annual maintenance costs		$12,000

Summer-fall field work is most productive when accomplished in a four-day work week with a core work day of 10 hours. This allows maximum use of field equipment while not creating excessive crew fatigue. Greater than 40 hour work weeks are recommended as this increases sampling output in terms of samples and sites produced for the same fixed costs in terms of facilities, equipment, and supplies.

Options for a Long Term Monitoring Program

The development and maintenance of such a program at this scale is not unprecedented. In Indiana, the cities of Muncie and Elkhart each have operated ongoing biological assessment programs that include both fish and macroinvertebrates. These include geographic scales that are not dissimilar to the DuPage-Salt Creek watersheds and with many fewer individual jurisdictions that can lend support. Based on this model it is entirely feasible to execute such a program at this scale. There is also the potential for the contribution of in-kind services that would likely defray and reduce some of the start-up and maintenance costs outlined in Tables 13 and 14.

The baseline proposal allocated 139 total sampling sites across the 3 subwatersheds. We expect that at least 10% of these sites will not be sampled leaving approximately 125 total sites or approximately 35-45 sites per subwatershed. For fish this would include a mix of single pass, small wadeable stream sites and larger wadeable and non-wadeable sites sampled twice. The majority of the sites would be small stream sites (levels 6 and 7) that require comparatively less effort to sample. For similar reasons macroinvertebrates would consist of an approximate 50:50 ratio of qualitative dip-net samples to multi-habitat and artificial substrate samples. Added to this would be approximately 15-20 reference sites, some of which would necessarily be located outside of the immediate DuPage-Salt Creek watershed area, and special investigations that would likely focus on specific streams or stream segments. Thus a field crew would need to sample approximately 45-50 sites per year.

In practical terms, a single biological crew leader assisted by 2 or 3 technicians could accomplish all of the tasks outlined in the bioassessment plan. It would call for expertise in both fish and macroinvertebrate assemblages, which may present a challenge in terms of filling such a position. A more viable option would be to contract the macroinvertebrate laboratory processing which could add approximately $15-20,000 to the annualized program cost, but would obviate the need for some of the capital costs in Tables 13 and 14.

Some form of a rotating subwatershed approach seems most viable and could be accomplished on a 3-year rotation at a capacity of 50 sites per year. The latter is the common denominator for determining how much of each watershed is covered over a given period of time. It is also easier to adapt other monitoring designs such as localized intensive investigations or fixed stations to this core design.

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