Chapter 9. Summary

Indications of water quality problems have led to a designation of the Fox River in Illinois and some of its tributaries on the Illinois Environmental Protection Agency Agency's list of impaired waters (IEPA, 2003, 303(d) list). Concerns about water quality led to the formation of the Fox River Study Group, Inc. (FRSG), a diverse coalition of watershed stakeholders who organized with the common interest of fostering sustainable growth in the Fox River watershed. Initially, the FRSG initiated a water quality sampling program in 2001 to augment water quality data collection in the watershed. The FRSG recognized a unique opportunity to collaborate on developing a comprehensive plan of study for the watershed with the objective of developing tools to provide watershed management guidance. The Illinois State Water Survey (ISWS) proposed a multi-phase plan, the Fox River Watershed Investigation, to develop tools for watershed planning and management. The Fox River Watershed Investigation is the basis for the FRSG work plan, and the Illinois Environmental Protection Agency (IEPA) funded phase I of the Fox River Watershed Investigation.

The goal of the Fox River Watershed Investigation is to develop objective, scientific tools that provide information to guide watershed planning and management. Effective planning and management decisions require information on links between causes and effects. Water quality models link pollution sources to effects by simulating the pollution processes and their impacts on water quality of the receiving waters. The Fox River Watershed Investigation was designed to proceed in a stepwise, logical manner to develop models and design a monitoring network that will serve as tools for watershed management well into the future. Collaboration with stakeholders and information dissemination are integral to the project.

Objectives of phase I were: 1) to compile available data, 2) to identify water quality issues, 3) to analyze water quality data for temporal and spatial trends, and data gaps, 4) to develop recommendations for watershed modeling on the basis of the information and analysis, and 5) to provide ready access to the information collected. This report is one of the products of phase I. The Fox River Watershed Investigation Web site (http://ilrdss.sws.uiuc.edu/fox), the information hub for the project, is hosted as part of the Illinois Rivers Decision Support System. The Web site includes: a searchable publication database; a Web mapping application for viewing geospatial data and printing maps of the Fox River watershed; links to GIS datasets; the Fox River database (FoxDB) a Microsoft Access database of water quality data compiled for the project, and the Data Loader & Viewer, a program designed for entering new data. The FoxDB and the Data Loader & Viewer may be downloaded from the Web site.

9.1. Review of Water Quality Studies

A variety of studies of water quality in the Fox River watershed have been conducted and reflect different interests and objectives. A thorough literature review was performed to provide a comprehensive assessment of water quality issues identified and to identify data sources. A brief statement of the findings of previous studies follows and a complete discussion and summary may be found in Chapter 3.

Pollution sources in the Fox River watershed include those regulated under the National Pollution Discharge Elimination System (NPDES) program and nonpoint sources such as surface runoff, groundwater seepage, and atmospheric deposition. Municipal and industrial wastewater treatment discharges may constitute a significant portion of the river's base flow and dominate in-stream water quality at low-flow conditions. Impacts of nonpoint sources are largely governed by rainfall, land uses, and land management practices. Designated uses of the Fox River are impaired due to nutrients, organic enrichment/low dissolved oxygen (DO), pathogens, suspended solids, flow alteration, and habitat alteration. Ecosystem monitoring found that the Fox River and Des Plaines River watersheds (assessed as watershed units) generally scored below the statewide average for most biological indicators. This deteriorated biological integrity correlated with urbanization and in-stream dam structures.

On a regional scale, chemical forms and spatial distributions of nutrients are governed by land uses in the watershed. The Fox River watershed has a lower ammonia level than the Des Plaines River watershed and lower nitrate concentrations than the Kankakee River watershed. Phosphorus levels are comparable with the Kankakee River watershed and lower than the Des Plaines River watershed. Most recent studies indicated nutrient-enriched conditions, with high algal biomass in the Fox River during summer and fall seasons.

The Fox River watershed exhibited the largest variability in suspended solids concentrations compared to the neighboring watersheds in the upper Illinois River basin. Elements that exceeded U.S. Environmental Protection Agency (USEPA) freshwater chronic and acute criteria based on sampling during 1978–1986 include total cadmium, chromium, copper, iron, lead, mercury, silver, and zinc. Fecal coliform counts varied widely with several orders of magnitude difference, suggesting pathogen-related parameters are greatly affected by nonpoint sources such as surface runoff related to rain events. Concentrations of pesticide and synthetic organics compounds in the Fox River watershed were lower than those in the Chicago River and Des Plaines River watersheds.

Emerging water quality issues related to chemicals used in household products, pharmaceuticals, and other consumables, as well as hormones, have been getting more attention in recent years. These chemicals are of concern because they are developed for the express purpose of causing biological effects. Potential concerns include increased toxic effects, development of more resistant bacteria, and endocrine disruption in humans and animals. The impact of these constituents are not yet defined. While not identified as problematic in the Fox watershed, stakeholders should be cognizant of the potential and this may be an area of consideration in the future.

9.2. Water Quality Database

A variety of monitoring activities have been pursued in the Fox River watershed over the years. Some monitoring efforts are designed to collect long-term datasets to monitor ambient water quality conditions, some for short-term projects, some for compliance or permit monitoring, and others are by volunteer citizen groups. These monitoring activities are described in Chapter 4. A database, FoxDB, was created to provide a central repository for the data, which is stored in a consistent format for retrieval and comparison. As part of the present study, the

structure and attributes of the original datasets were reviewed and translated to a common format in the FoxDB. The quality of the data, collection protocol, and laboratory analyses were reviewed to assign a consistent grade to the datasets for comparability and reliability. Storing the data in the FoxDB provides consistent and efficient data access. Data from different sources also can be easily compared, combined, or separated, as desired.

The FoxDB serves several functions. In order to perform a comprehensive statistical assessment of all available chemical water quality data, it was necessary to compile the data into a consistent format. These data will be needed for the initial calibration of water quality models. The FoxDB serves as a central repository for data collected by a variety of groups for ready comparison. It is a resource for study and information about the watershed for interested persons and can be updated to provide an information resource for watershed study into the future.

9.3. Water Quality Data Analysis

The analysis of the water quality data compiled in the FoxDB is a central aspect of the phase I study. The data analysis was performed to provide an updated assessment of water quality issues, identify data trends for consideration in model choices, and to identify data gaps. Water quality data collected in the Fox River watershed during 1998–2002 by various agencies were analyzed, and results are presented in Chapter 5. The evaluation focused on the following parameters: nutrients (nitrogen and phosphorus), DO, pH, suspended solids, fecal coliform, algae and biomass, and selected priority pollutants (copper, lead, nickel, iron, and zinc).

Water quality data in the Fox DB were analyzed primarily for model selection. Spatial, temporal, and seasonal trends were explored. Compliance with water quality standards was evaluated for those parameters for which standards were available. Potential water quality problems were identified either by presence of values exceeding the standards or by probabilistic evaluation. The purpose of comparing the data to water quality standards was to use the standards as guidance for selecting water constituents of concern for future modeling activities.

Data collected from the mainstem of the Fox River were evaluated, as well as water quality data from tributaries. Low DO concentrations were observed at most stations along the mainstem of the Fox River from Johnsburg to Oswego. Ammonia nitrogen may be problematic near Algonquin in McHenry County, and also near the mouth of the Fox River at Ottawa. Samples with high phosphorus concentrations were observed at Algonquin, South Elgin, and Yorkville. Fecal coliform concentrations have exceeded standards at most stations from Algonquin to Ottawa. Water quality data for tributaries were less complete than along the mainstem. Low DO was observed in Buck Creek. Ammonia nitrogen levels may have exceeded standards on Poplar, Blackberry, Somonauk, and Nippersink Creeks. Levels of total cadmium, copper, and nickel exceeded standards in samples collected from Poplar, Blackberry, Nippersink, and Little Indian Creeks.

The temporal patterns of the various water quality constituents were investigated, and the parameters can be categorized into two groups: problems associated with summer and low-flow periods, or with high flows (usually spring runoff events). Steady-state water quality models are

appropriate to describe fairly constant low-flow conditions in summer. Pollutants associated with runoff events should be modeled using dynamic models.

The FoxDB includes water quality data collected at 190 different sites in the Fox watershed: 88 sites located directly on the Fox River and 102 sites on the tributaries. However, only 60 sites were sampled at least once during 1998–2002: 38 sites on the Fox River and 22 sites on its tributaries. The central part of the watershed (Kane County) has been monitored extensively, while there is sporadic coverage of the watershed's lower part. The central part of the watershed has been a focus of several water quality studies due to its urbanization level and numerous impoundments in this region. The dams and associated impoundments introduce discontinuity in the flow so that samples do not necessarily reflect water quality above and below the monitoring site. Water quality as well as chemical and biological processes differ between free-flowing and impounded reaches.

Generally, recent water quality data (1998–2002) are very limited for the lower part of the watershed and for tributaries. Most monitoring programs include DO as a primary indicator of enrichment by organic matter. Most stations with recent DO data are located in the central part of the watershed. Most tributaries have either no DO data or limited data available. Sites with available nutrient data (ammonia, nitrate, and phosphorus) and associated parameters (suspended solids) are evenly located along the mainstem with a cluster of sites around Elgin: other sites have no data or limited data. Fecal coliform was sampled at several sites along the mainstem, again with a cluster of sites around Elgin. Limited trace metal data are available for some tributaries and for the Fox River.

Three tributaries represent a top priority for filling the data gaps: Crystal Creek has no current data while there are several point sources in its watershed, including Lake in the Hills Sanitary Treatment Plant and Crystal Lake Sanitary Treatment Plant. Recent data for both Tyler Creek and Ferson Creek are insufficient because these locations were just sampled once or twice. However, these creeks represent significant tributaries in the area of interest. Sampling data also are lacking for major tributaries in the lower portion of the watershed.

9.4. Sediment Chemistry

The geographic coverage of the sediment chemistry data within the FoxDB is good, especially along the mainstem. However, the temporal coverage is poor. With the available data, several general conclusions can be drawn. Sediment quality of tributaries is generally better than that along the mainstem. This trend is more distinct for potential metal contaminants (e.g., mercury and copper), and less distinct for total nutrient concentrations (total phosphorus and total Kjeldahl nitrogen). A similar trend probably holds for many potential organic contaminants, although only the USEPA dataset contains organic contaminant data for tributaries. Most analyses indicate concentrations near or below method detection limits. Most constituents in above dam pools tend to have higher concentrations, but are present at concentrations below available sediment quality guidelines in most samples. Total mercury concentrations appear to be an exception to this trend, with elevated mercury concentrations predominating in six above dam pools. Sediment oxygen demand, particularly in pooled areas along the Fox River should be included in water quality modeling, and additional field data will need to be collected for model calibration.

9.5. Modeling Issues

It is recommended that a flexible, modular framework be established for the Fox River watershed model. The framework initially should consist of watershed loading models for major tributaries to the Fox River and a receiving stream model of the Fox River mainstem. The modular framework should be such that various components (e.g., tributary watershed models) can be refined as data become available. The BASINS model framework is recommended, particularly the HSPF model for watershed loading in urbanizing watersheds. Initially, a QUAL2E or similar model is suggested for the mainstem to simulate low-flow DO cycle, but an unsteady flow model, such as HSPF, will also be needed for unsteady flow considerations along the mainstem of the Fox River.

The data assembled in the FoxDB and various GIS datasets identified in Chapter 2 provide a foundation for the model framework. It is suggested that the model framework be developed and the models calibrated to the extent possible using these data. Customized models then may be used to evaluate additional data needs and design an intensive monitoring program for model calibration. Datasets should be collected to validate the models, and an uncertainty analysis should be performed for parameters of major significance.