Fox River Watershed Investigation, Stratton Dam to the Illinois River
Summary Report of Phase II Work, Parts 1 – 5, November 2003 – January 2005

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The objective of the Fox River Watershed Investigation, a multi-phase project, is to provide technical support for the Fox River Study Group (FRSG), focusing on building a suite of water quality models of the Fox River watershed below Stratton Dam. Phase I, which is complete, involved data assimilation and model planning. The final report for Phase I is on the Fox River Watershed Investigation Web site hosted on the Illinois Rivers Decision Support System Web site (http://ilrdss.sws.uiuc.edu/fox/) maintained by the Illinois State Water Survey (ISWS). Phase II focuses on model development and calibration using existing information and on design of a monitoring network to collect data necessary to refine the calibrated models. Upon completion of the Phase I study, it was determined in consultation with the FRSG to use the Hydrological Simulation Program - FORTRAN (HSPF) model to simulate watershed loading. An HSPF model will be prepared for each major tributary to the Fox River and the inter-basin areas; ultimately, the HSPF models for the entire study area will be assembled. Along the mainstem of the Fox River, a model will be developed to simulate water quality during steady, low flow (QUAL2). The HSPF and the QUAL2 models are part of the US Environmental Protection Agency (USEPA) Better Assessment Science Integrating Point and Nonpoint Sources (BASINS) model framework.

The goal of Phase II is to develop the structure of watershed loading and in-stream water quality models for the study area and to calibrate those models using available data. The plan is to establish a model structure that retains options for more refined calibration as additional monitoring data become available. Models developed in Phase II may be used as tools to help design the monitoring network planned for Phase III of the project. The Blackberry and Poplar Creek watersheds were chosen for detailed review as these two watersheds have the most abundant discharge and water quality datasets of the major tributaries and represent contrasting land uses. Blackberry Creek is a primarily rural watershed, and Poplar Creek is a primarily urban watershed. Parameter values determined from the calibration of the HSPF models for these two tributaries may be used for other similar (ungaged) tributary watersheds in the preparation of the HSPF models for the entire study area.

Due to funding considerations, tasks to conduct Phase II were segmented into parts. Part 1 began in November 2003, with the task of determining a model scheme for the mainstem Fox River from Stratton Dam to the confluence with the Illinois River, including identification of the major tributary watersheds for which HSPF models will be developed. Part 2 included development of input data files of channel characteristics for the Fox River mainstem and formatting available climate data files for input to the HSPF model. Part 3 included calibration and validation of the hydrologic components for the Blackberry Creek watershed of the HSPF model and preparation of model components for the Poplar Creek watershed HSPF model. Part 4 included continuing work on the Poplar Creek watershed HSPF model, compiling information on point and nonpoint pollution discharges in the Blackberry and Poplar Creek watersheds, as well

as compiling data for modeling and general support of the FRSG efforts. Part 5 included calibration and validation of the hydrologic components for the Poplar Creek watershed of the HSPF model. A summary of the tasks completed in each part is provided below. Draft reports for Parts 1–5 are posted on the Fox River Watershed Investigation Web site, but access is limited to the FRSG Board and is password protected. When complete, final reports will be posted for public access.

Phase II, Part 6 began February 1, 2005 and will continue through February 2006.

Part 1: Model Reach Design for the Mainstem of the Fox River below Stratton Dam

(Draft Report posted on January 22, 2004)

The Part 1 report provides a plan for the model reach segmentation of the mainstem of the Fox River for modeling purposes. Specification of physical geometry for each reach is fundamental to any watershed or water quality model and defines relationships between flow, depth, time of travel, and volume of water in a reach. Water depth, travel time, and other parameters play an important role in reactions/transformations of modeled water quality constituents. This report presents a reach segment scheme of the mainstem of the Fox River from Stratton Dam to the confluence with the Illinois River. Tributary inflows, National Pollution Discharge Elimination (NPDES) discharge locations, public water-supply withdrawal sites, and channel geometry were evaluated to design the reach segmentation scheme for the river. After preliminary analyses of data, this strategy for segmenting the river and recommended scale (level of detail) were presented to the FRSG and discussed (24 November, 2003; and 5 December, 2003).

Part 2: Watershed Hydrology Model Input File Preparation

(Draft Report posted on May 5, 2004)

The Part 2 report provides documentation of data sources and procedures used to compile climate and hydraulic data. Climate data were converted to a desired format for input to the HSPF Model. Time-series climate data are necessary for the HSPF model to simulate the continuous hydrologic and water quality response of the watershed. Appropriate representation of the precipitation, temperature, wind speed, potential evapotranspiration, potential surface evaporation, solar radiation, dewpoint temperature, and cloud cover are required to develop a valid model. Time-series climate datasets from various stations were compiled for the period of interest and stored in a binary format in the Watershed Data Management (WDM) file format.

In order for the flow in the channel to be adequately routed downstream, input files must specify the hydraulic characteristics (or volume-discharge relationships) of all reaches in the model network. Hydraulic characteristics are stored in F-TABLEs in the HSPF input sequence. Each F-TABLE describes a river reach or reservoir segment by defining the functional relationship between water depth, surface area, water volume, and outflow in the segment. These F-TABLEs, can be derived automatically by the BASINS model using simplified assumptions on

river geometry; however, this method does not consider effects of impoundments. Instead, the F-TABLEs were created using cross-section data from various Flood Insurance Study models.

Part 3: Hydrology Model for Blackberry and Poplar Creek Watersheds

(Draft Report posted on October 20, 2004)

The Part 3 report describes calibration of the hydrologic components of the HSPF model for the Blackberry Creek watershed and preparation of the model structure for the Poplar Creek watershed. The process includes delineation of sub-watershed boundaries, characterization of sub-watersheds into Hydrologic Response Units (HRUs), calibration and validation of the hydrologic model, and sensitivity analysis. Streamflow data from U.S. Geological Survey (USGS) streamflow gages at Yorkville, IL (USGS 05551700) and at Montgomery, IL (USGS 05551675) were used for model calibration and validation. Climate data were available only from one station (Aurora, IL).

The model was calibrated for the period October 1992–September 2000. Values of several model parameters were adjusted within reasonable limits to improve fit between observed and simulated data on long-term, annual, monthly and daily basis. The calibrated model was validated for the period October 1999–September 2003 at both the Yorkville and the Montgomery gages. Additional validation was accomplished by comparing simulations for the period October 1990–September 1990 to data collected at the Yorkville gage during that time period. Sensitivity analysis of the calibrated model parameters also was performed.

General agreement between observed and simulated flow-duration curves indicates adequate calibration over the range of the flow conditions estimated. The calibrated model simulated the range of daily streamflows reasonably but underestimated some high daily streamflows in the exceedence range of 1–10 percent and low daily streamflows in the exceedence range of 90 percent and above. Discrepancies between model-estimated and observed streamflow values could be due to lack of availability of spatially representative precipitation data for the Blackberry Creek watershed.

Part 4: Supporting Tasks for Modeling, Revised Deliverables

(Submitted on November 9, 2004)

Part 4 focused on obtaining supporting data for the model. The water quality database, FoxDB, developed in Phase I, was updated with new data available from the Illinois Environmental Protection Agency (IEPA), Fox River Study Group (FRSG), and Metropolitan Water Reclamation District of Greater Chicago (MMWRD). Additional database updates included recoding some parameters based on new information provided to the ISWS, adding some USGS- specific parameter codes, and initiating general maintenance procedures to ensure internal integrity. The public has access to the updated FoxDB on the Fox River Watershed Investigation Web site. The FRSG and the IEPA data for the same period were compared at four sites sampled by both agencies during 2002–2003. After two years of monitoring, the results from both agencies are very consistent for most constituents.

Effluent data were gathered for NPDES facilities identified in the pilot watershed during Phase I. The USEPA database EnviroFacts includes monthly average discharges and concentrations as required for reporting by individual permit owners. Agricultural information compiled for the Fox River watershed included data on corn and soybean production, livestock population, chemical fertilizer application data, and populations of wild birds and other animals. Additional climate data for the study area were requested from the FRSG and various other agencies. Data received were processed, reformatted, and included in the WDM file for use in the study.

Resolution of elevation data plays an important part in accuracy of automatic delineation procedures, especially in generally flat areas. High-resolution elevation data were secured for the Poplar Creek watershed from Cook County. The LIDAR (LIght Detection And Ranging) technology data for the Poplar Creek watershed area were finalized in mid–October, 2004. Point data were processed by the ISWS into continuous raster coverage with 10-meter horizontal resolution and 0.01-foot vertical resolution. Municipalities in the Poplar Creek watershed were contacted and asked to provide digital or paper copies depicting their storm sewer systems to improve the accuracy of evaluating subwatershed boundaries. The municipalities also were asked about areas under their jurisdiction served by septic systems.

A meeting of the Poplar Creek Watershed Partners was arranged by Jeff Wickenkamp (Northeastern Illinois Planning Commission), who has been working with the group since 2003. The meeting took place in the Village of Streamwood on 29 October 2004. The ISWS prepared a three-part presentation: (i) general overview and goals of the Fox River Watershed Investigation, (ii) approach to creating a tributary model and preliminary results for Blackberry Creek hydrology, and (iii) available data, additional anticipated needs, and problematic areas specific to creating the Poplar Creek watershed model. In addition, the group was asked for suggestions on internal subdivision and location of calculation points (model outlets).

Part 5: Hydrologic Simulation Model of the Poplar Creek Watershed

(Submitted on March 15, 2005)

Part 5 of Phase II included calibration of the hydrologic components of the HSPF model for the Poplar Creek watershed. Values of several model parameters were adjusted within reasonable limits to improve fit between observed and simulated long-term, annual, monthly, and daily data. Sensitivity analysis of the calibrated model parameters also was performed. Streamflow data from the USGS streamflow gage at Elgin, IL (USGS 05550500) were used for model calibration and validation. Climate data from three daily precipitation stations and three hourly climate stations were used.

The model was calibrated for the period April 1991–September 1999. The calibrated model was validated by comparing simulation results and observations for the four-year period, October 1999–September 2003. The model did not show any seasonal bias or bias in over- or underestimating daily streamflows over the range of streamflows. Generally, the simulated hydrographs followed the trend of observed hydrographs reasonably well, but the model under- or overestimated some peak values particularly during large snowmelt events.

Overview of Deliverables for Parts 1-5:

- Reach segment scheme: figure and table showing beginning and endpoints for each segment, and main features displayed on the map.
- Stream geometry data for each reach segment (cross sections, including their location): electronic format.
- Location of main features (tributaries, gaging stations, and dams; withdrawals and discharges as available): GIS files.
- Part 1 brief technical report (summary of methods and results).
- Final list of major tributary watersheds that will be represented as individual watersheds in the HSPF model of the Fox River below Stratton Dam. The list has been submitted and was reviewed by the FRSG on 25 February 2004. Map 1 shows the approved list.
- Updated Fox River Watershed Investigation Web site (http://ilrdss.sws.uiuc.edu/fox/). The Web site has been available to the public since 15 April 2004.
- Climate data in WDM format.
- F-TABLEs for the mainstem of the Fox River.
- Part 2 brief technical report summarizing data sources and methods.
- HSPF model calibrated and validated with available data to simulate the watershed hydrology and daily flows for the Blackberry Creek watershed.
- HSPF model customized for the Poplar Creek watershed for hydrologic calibration.
- Draft report describing Blackberry Creek model setup and calibration, statistical and graphical summaries; and data files and model files posted on the Fox River Watershed Investigation Web site.
- Additional water quality data obtained from the IEPA, FRSG, and MWRD.
- The water quality database, FoxDB, updated with the new data.
- The IEPA and FRSG data compared for their coincident period of record.
- Effluent data secured for NPDES facilities in the Blackberry and Poplar Creek watersheds (October 1988 to present).
- Information on agriculture and wildlife obtained on county level for the Fox River watershed.
- Additional precipitation records obtained from various agencies.
- Sub-watersheds in the Poplar Creek watershed delineated based on the high-resolution elevation data from Cook County and the storm sewer plans obtained from communities.
- Organized a meeting with the Poplar Creek Watershed Partners.
- HSPF model calibrated and validated with available data to simulate the watershed hydrology and daily flows for the Poplar Creek watershed
- Draft report describing Poplar Creek model set up and calibration, statistical and graphical summaries, as well as data files and model files posted on the Fox Watershed Investigation Web Site

Map 1.
Major Tributary Watersheds for HSPF Model Fox River

Watershed number on map	*Miles above mouth at Ottawa*	*Stream name*	*Drainage area (sq. mi.)*
1	8.50	Buck Creek	40.9
2	9.40	Indian Creek	174.8
3		Little Indian Creek	88.4
4	13.00	Brumbach Creek	11.7
5	15.80	Mission Creek	15.2
6	20.10	Somonauk Creek	83.0
7	21.00	Roods Creek	15.9
8	25.20	Clear Creek	
9	29.50	Hollenback Creek	15.3
10		Little Rock Creek	74.3
11	31.00	Big Rock Creek	117.8
12	31.30	Rob Roy Creek	19.6
13	35.60	Blackberry Creek*	72.9
14	37.80	Morgan Creek	17.7
15	42.70	Waubansee Creek	29.4
16	49.00	Indian Creek	14.7
17	53.00	Mill Creek*	30.9
18	60.90	Ferson/Otter Creek*	54.1
19	62.40	Norton Creek	12.1
20	65.90	Brewster Creek*	15.5
21	68.80	Poplar Creek*	44.3
22	72.20	Tyler Creek*	40.0
23	74.60	Jelkes Creek	6.8
24	81.60	Crystal Creek	27.2
25	85.30	Spring Creek	25.8
26	89.40	Flint Creek*	36.8
27	89.45	Tower Lake outlet	
28	92.41	Silver Lake outlet	
29	94.30	Cotton (Mutton) Creek	12.4
30	96.90	Sleepy Hollow Creek	15.0

Notes:
* Continuous gaging station discharge data available