U.S. Army Corps of Engineers
Detroit District

ST. JOSEPH RIVER SEDIMENT TRANSPORT MODELING STUDY

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1.0 INTRODUCTION

1.1 Purpose of Study

The U.S. Army Corps of Engineers is directed to develop sediment transport models for tributaries to the Great Lakes that discharge to federal navigation channels or Areas of Concern (AOCs). These models are being developed to assist state and local resource agencies in evaluating alternatives for soil conservation and non-point source (NPS) pollution prevention in the tributary watersheds. The ultimate goal is to support state and local measures that will reduce the loading of sediments to navigation channels and AOCs, and thereby reduce the costs for navigation maintenance and sediment remediation. This report includes a description of the St. Joseph River Watershed and the modeling tools that were developed and tested during the course of this study.

1.2 Watershed Description

The St. Joseph River Basin is a part of the Lake Michigan Basin, comprising 1.6 percent of its contribution. Its headwaters begin at Baw Beese Lake, near Hillsdale, Michigan. The River flows south and enters Indiana north of Bristol, Indiana. It flows through Elkhart and St. Joseph counties, leaving Indiana northwest of South Bend. The St. Joseph River eventually discharges into Lake Michigan at St. Joseph, Michigan (Figure 1.1). Major tributaries discharging to the St. Joseph River (from east to west) include:

- Prairie River
- Coldwater River
- Fawn River
- Pigeon River
- Little Elkhart River
- Elkhart River
- Dowagiac River
- Paw Paw River

The St. Joseph River main channel is 210 miles long and has over 1,641 miles of significant tributaries. The watershed covers 4,685 square miles: 3,000 in Michigan and 1,685 square miles in Indiana. The river has a fall of over 600 feet from the source to its discharge into Lake Michigan.
Figure 1.1: Location of the St. Joseph Watershed
1.3 St. Joseph River Watershed Modeling System

To assess the problems outlined above, a set of computational tools were used to evaluate watershed hydrology, net erosion, sediment delivery, river channel hydrodynamics and sediment transport. These models were developed to gain a general understanding of the hydrologic and geomorphic behavior of the watershed and to predict the effects of changing land use and the effectiveness of different best management practice (BMP) strategies on subwatershed scale erosion and sediment delivery. Models were calibrated against river flow and sediment transport records, reservoir sedimentation surveys and harbor dredging records. A summary of the models contained in the St. Joseph River Watershed Modeling System (SJWMS) is presented in Table 1.1. A flow chart outlining the functionality of the SJWMS is shown in Figure 1.2. The range of applicability of each model, the types of management issues each model addresses and the scale and complexity of the processes they represent are summarized in Figure 1.3.

Table 1.1: Summary of Models in the St. Joseph River Watershed Modeling System

<table>
<thead>
<tr>
<th>Acronym</th>
<th>Model Name</th>
<th>Agency</th>
<th>Processes</th>
</tr>
</thead>
<tbody>
<tr>
<td>SWAT</td>
<td>Soil Water Assessment Tool</td>
<td>USDA / EPA</td>
<td>Hydrology</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td>Soil Erosion</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td>Sediment Delivery</td>
</tr>
<tr>
<td>GSSHA</td>
<td>Gridded Surface-Subsurface</td>
<td>USACE</td>
<td>Hydrology</td>
</tr>
<tr>
<td></td>
<td>Hydrologic Analysis</td>
<td></td>
<td>(1-D River Hydrodynamics)</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td>Sediment Transport</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td>Sediment Yield</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td>Sediment Delivery</td>
</tr>
<tr>
<td>RMA2-</td>
<td>RMA2-SED2D</td>
<td>USACE-WES</td>
<td>2-D River Hydrodynamics;</td>
</tr>
<tr>
<td>SED2D</td>
<td></td>
<td></td>
<td>Sediment Erosion, Transport and Deposition</td>
</tr>
</tbody>
</table>
Figure 1.2: General Outline of the St. Joseph River Watershed Modeling System
Figure 1.3: Schematic of Applicability of the St. Joseph River Watershed Modeling System
1.3.1 Hydrologic Modeling

The hydrologic models (SWAT, GSSHA) in the SJWMS simulate overland flow generation, soil erosion and sediment delivery from the watershed. They use input data from the St. Joseph River Watershed GIS and use a variety of modeling approaches to represent watershed processes (Table 1.2). Each model has a different range of applicability and all three were necessary to characterize different aspects of watershed processes examined in this study.

<table>
<thead>
<tr>
<th>Model</th>
<th>Developer</th>
<th>Hydrology</th>
<th>Soil Erosion</th>
<th>Sediment Delivery</th>
<th>Spatial Resolution</th>
<th>Applicability</th>
</tr>
</thead>
<tbody>
<tr>
<td>GSSHA</td>
<td>USACE</td>
<td>PDP / Multi-dimensions</td>
<td>USLE based</td>
<td>Yang (1973) method</td>
<td>Varies details / small watersheds</td>
<td>Event / detail plan / detail design</td>
</tr>
<tr>
<td>SWAT</td>
<td>USDA/EPA</td>
<td>ELP / PDP</td>
<td>MUSLE</td>
<td>Process / Channel Sediment Routing</td>
<td>Medium / large watershed</td>
<td>Continuous / overview / agriculture practices / climate change / land use</td>
</tr>
</tbody>
</table>

(ELP - Empirically based, lumped parameter models; PDP - Physically-based, distributed parameter models; USLE – Universal soil loss equation; MUSLE – Modified USLE)

The objective of SWAT is to predict the impact of management decisions on water and sediment yields in large complex watersheds. Variation in land use and management conditions over long periods of time can be represented. While the project scope did not include a whole-watershed model using SWAT, this was included instead of the 1D HEC-6 river modeling, which was originally scoped. SWAT is particularly good at modeling NPS-pollution loads from agricultural practices, and routines for urban sediment loads are currently being improved. The grid resolution for SWAT in this project was 30 m. SWAT also has a good interface with GIS software (ArcView), making it suitable for end-user applications. It is physically based and it needs basin-specific data on weather; soil properties; topography; vegetation and land management practices.

SWAT is a continuous time model - not ideally suited to simulate detailed (sub-daily), single-event flood routing. To achieve detailed single-event forecasts, the GSSHA model was set up for the Dowagiac River subbasin of the watershed. A more detailed description of the SWAT model is given in Section 4.2.

Gridded Surface Subsurface Hydrologic Analysis (GSSHA) is a finite difference two-dimensional hydrologic model. Features include 2D overland flow, 1D streamflow, 1D
infiltration, 2D groundwater, and full coupling between the groundwater, vadose zone, streams, and overland flow. GSSHA can run in both single event and long-term modes. The fully coupled groundwater to surface water interaction allows GSSHA to model both Hortonian (infiltration-excess) and Non-Hortonian (saturated) areas.

The GSSHA model is a physically based, distributed-parameter hydrologic model intended to identify runoff mechanisms and simulate surface water flows in watersheds. The GSSHA model is capable of simulating streamflow generated from Hortonian runoff, saturated source areas, exfiltration, and groundwater discharge to streams. The model employs mass-conserving approximate solutions of partial differential equations (PDEs) and closely links the hydrologic components to assure an overall mass balance and correct feedback.

1.3.2 Channel Hydrodynamic and Sediment Transport Modeling

A detailed hydrodynamic model (RMA2) and an associated sediment transport model (SED2D) were set up to evaluate sediment movement through the harbor and into the nearshore zone. The main objectives of this exercise were to provide estimates of sediment movement through the harbor over long time periods and to evaluate the impact of dredging the inner harbor on sediment discharges to the nearshore zone. RMA2 is a two-dimensional, depth-averaged, finite element hydrodynamic numerical model. It computes water surface elevations and horizontal velocity components for subcritical, free-surface flow in two-dimensional flow fields. Norton, King and Orlob (1973) developed the original RMA2 model for the US Army Corps of Engineers. Many subsequent enhancements have been made, culminating in the current version of the code. The program has been applied to calculate water levels and flow patterns in rivers, reservoirs, and estuaries. RMA2 has the following capabilities:

- Simulate wetting and drying events;
- Account for effects of the Earth’s rotation;
- Apply wind stress involving frontal (storm) passages;
- User selectable turbulent exchange coefficients, Manning’s n-values, etc;
- Model up to 5 different types of flow control structures;
- Provides for user defined computational guidelines;
- Accepts a wide variety of boundary conditions.

The sediment transport model, SED2D is coupled with the RMA2 model. SED2D is a sediment transport numerical model developed by the U.S. Army Corps of Engineers Waterways Experiment Station. It has the ability to compute sediment loadings and bed elevation changes when supplied with a hydrodynamic solution computed by RMA2. SED2D can be used to model sand bed types or clay bed types with up to 10 clay layers. It is possible to model both steady state and transient flow types, just as with RMA2.
1.4 Report Outline

The subsequent sections in this report aim to provide an overview of the major activities and findings of the St. Joseph Watershed Sediment Modeling Study. While this report is intended to be a stand-alone document, the GIS and model data DVD-ROMs and the User Manual accompanying this report provide additional project information and should be referred to where appropriate.

Section Two of this report describes the data used in this study, including a summary of a Stakeholders’ Meeting at the start of the project, previous studies and data sources for precipitation, discharge and sediment data, GIS data and information collected in the field.

Section Three presents preliminary analyses of watershed characteristics, including land use history, land use broken down by subbasin, and riparian buffer analysis. It also discusses spatial and temporal alteration to the hydrologic characteristics of the watershed, and presents an overview of sediment delivery in the watershed.

Section Four describes the SWAT model used to evaluate watershed hydrology, sediment yield and sediment delivery. This section outlines model development, calibration and validation, and then presents a summary of sediment delivery analysis using SWAT. The influence of land use change and dam construction on sediment delivery were evaluated using the SWAT model and the findings of this exercise are discussed.

Hydrology and sediment delivery on the Dowagiac River subwatershed were evaluated using the GSSHA 2-D hydrologic and sediment transport model. The model description, setup, calibration and preliminary results at the event timescale are discussed in Section Five.

Section Six discusses use of the SWAT and GSSHA models to evaluate Best Management Practices (BMPs). Consideration is given to the effects of lot sizes, construction runoff and riparian buffers on hillslope hydrology and sediment transport. Results from use of the SWAT model to evaluate tillage practices; crop rotation and filter strip scenarios are presented and discussed.

Detailed instream hydrodynamic and sediment transport modeling was undertaken on the St. Joseph Harbor area using RMA2 and SED2D. The model setup, results and implications of this for sediment dynamics in the harbor, along with detailed analysis of gage data and sediment rating curves are discussed in Section Seven.

Section Eight provides a summary of the study and provides recommendations for potential future evaluation of management activities using the models provided.
2.0 DATA COLLECTION

2.1 Introduction

Primary data collection was not a mandate of this study, but several datasets from a variety of sources were used throughout the investigation. These sources included consultation with local stakeholders, review of previous studies, and collation of digital data from diverse origins.

2.2 Summary of Stakeholders’ Meeting

A number of issues related to the watershed hydrology, sediment dynamics, water quality, biological habitat and geomorphologic conditions of the St. Joseph River were discussed at the St. Joseph Watershed Conference on 10th-11th June, 2002. These included:

- **The Friends of the St. Joseph River Association, Inc.** This organization is very active and sponsors on-the-river activities such as routine cleanups, and promotes awareness of the issues pertaining to the overall quality of the river.

- **Significant groundwater contribution to basin hydrologic response.** A large portion of the basin contains highly permeable soils that provide a significant contribution to the base flow of the river due to interflow, as well as the presence of excellent habitat for cool-water species.

- **Significant basin contribution to the contaminants entering Lake Michigan.** The role of this basin and its contribution of PCBs, nutrients, suspended solids, trans-nonachlor and mercury has been studied by the EPA.

- **St. Joseph Watershed is one of the most significant contributors of Atrazine to the Great Lakes.** BMPs to control the delivery and transport of this pesticide from the farm fields to Lake Michigan would be beneficial. The significance of this contaminant to this study is that it adsorbs to clay particles, which may then be eroded and transported through the system. BMPs that reduce sediment delivery to the river would also reduce the delivery of Atrazine.

- **The basin is largely agricultural, and this affects watershed hydrology and sediment dynamics.** Agricultural practices of interest to this study include tile drainage, drainage ditches, and irrigation. The implementation of tile drainage and drainage ditches significantly alters the hydrologic response of subbasins, both in terms of quantity and in timing, as compared to the response with undisturbed land. Irrigation can have the same effect, depending on the frequency and duration of abstraction and application of water. These practices can provide
a positive economic return, but may produce undesirable effects on the water quality of the system.

- **Dam removal near Watervliet, Michigan.** There is reported to be a significant quantity of sediment in the impoundment that accumulated while the dam was functioning. It was suggested at the meeting that if this sediment were to be remobilized, it would pose a risk to the downstream water quality and aquatic habitat.

- **Placement of dredged material from Benton Harbor.**

- **Sedimentation of impoundments in the basin.** There are several cases of impoundments in the basin that have filled with sediment. An impoundment in Three Rivers was dredged approximately 10 years ago (60,000 cubic yards) and had refilled only 4 years later. There are other cases of dams in the basin with sedimentation issues.

### 2.3 Previous Studies

The following is a synopsis of several studies on the St. Joseph River. In general, the project reports and websites devoted to these studies provided background information for this study.

#### 2.3.1 St. Joseph River Assessment

This report is a river assessment prepared by the Fisheries Division of the Michigan Department of Natural Resources (MDNR, 1999) that describes the characteristics of the St. Joseph River and its biological communities. The document consists of four parts: an introduction, a river assessment, management options, and public comments and response. The river assessment is the nucleus of the report. The characteristics of the St. Joseph River and its watershed are described in twelve sections:

- Geography;
- History;
- Geology and hydrology;
- Channel morphology;
- Dams and barriers;
- Soils and land-use patterns;
- Water quality;
- Special jurisdictions;
- Biological communities;
- Fishery management;
- Recreational use; and
- Citizen involvement.
This report is a comprehensive analysis of the overall health of the watershed, especially in terms of its ability to sustain aquatic life. It contains a substantial amount of qualitative information and parametric analyses of the watershed.

2.3.2 Dowagiac AGNPS Modeling

There have been several research projects involving AGNPS modeling of the Dowagiac River. AGNPS is a distributed model of hydrologic processes and sheet and rill erosion that was developed by USDA/NRCS. These modeling efforts include researchers from Michigan State University and Western Michigan University (He, C., et al, 1988).

2.3.3 Dowagiac River Watershed Project

This project (Southwestern Michigan Commission, 1998) was a planning study on the impacts of growth and development in the Dowagiac subwatershed. The project was funded by a grant from the Michigan Department of Environmental Quality in accordance with its Non-point Source Program with fund matching from the Southwestern Michigan Commission.

The goal of this study was to work with landowners and local governmental units to implement mechanisms for guiding land use decisions that would preserve and protect the natural resources of the watershed. The project included four study components:

- Economic and Agricultural Trends;
- Building Construction Trends;
- Land Division Act;
- Proposal A – Tax Reform.

The Dowagiac River Watershed is located in Southwestern Michigan and encompasses a total area of 287 square miles, which is about 6% of the total St. Joseph Basin. The basin land use is predominantly agricultural (66%), followed by forested areas (20%).

2.3.4 Indiana Department of Environmental Management (IDEM) Section 205J St. Joseph River Watershed Initiative

The City of Elkhart will establish a watershed protection initiative between the three largest Indiana communities on the St. Joseph River: Elkhart, Mishawaka and South Bend. Surface water quality monitoring will be performed in the St. Joseph River and its major tributaries, and a watershed water quality model will be developed to characterize point and nonpoint sources of E. coli impacting the St. Joseph River. GIS maps will be
produced relating land use, land use intensity, and wet and dry weather events to water quality in the subwatersheds of the major tributaries. Three public meetings will be conducted, and educational materials summarizing the project results will be widely distributed.

### 2.3.5 Section #319 Clean Water Grant Proposal Funded for MACOG Activities

On July 1, 2001, the Michiana Area Council of Governments (MACOG) began activities related to the reduction of nonpoint source pollution from two major sources—onsite wastewater disposal systems, and developing construction sites. Using matching funds from the St. Joseph River Basin Commission, and pass-through funds from the Indiana Department of Environmental Management, the MACOG will complete a number of projects with the goal of reducing the impact on water quality of failed septic systems and soil erosion from construction sites (MACOG, 2005).

The grant ended in June 2003. The products of the grant activities include:

- A video that addresses the care and maintenance of on-site wastewater disposal systems and the distribution of that video to libraries, health departments and title companies throughout the Basin in Indiana and Marshall County.

- Development of a CD and paper format tool for contractors to assess nonpoint source pollution potential for construction or landuse change projects. The tool will include a self-assessment survey along with best management practices that can improve the overall "pollution score" for the project.

### 2.3.6 Miscellaneous Michigan Department of Environmental Water Quality 319(h) Projects

Michigan DEQ (MDEQ, 2005a) has several planned, ongoing or completed 319(h) water quality studies. These include projects on the Dowagiac River, Hog Creek (watershed planning project), Nottawa Creek (water quality planning study), Homer Lake (stormwater retention to prevent sedimentation), Sprong Lake Inlet (streambank erosion, reduced sediment delivery to lake), Rocky River Watershed (planning, inventory), and the St. Joseph River Planning Project for the Friends of the St. Joseph River.

### 2.3.7 Hog Creek Watershed Hydrologic Study

In this study, a hydrologic model of the Hog Creek watershed (HEC-HMS) was developed by the Hydrologic Studies Unit (HSU) of the Michigan Department of Environmental Quality (MDEQ, 2005b). The hydrologic model was developed to help stakeholders better understand the watershed's hydrologic characteristics and the impact
of hydrologic changes in the Hog Creek Watershed. This watershed, which is located among the headwaters of the St. Joseph River basin, is undergoing urbanization, and may be susceptible to increased sedimentation issues due to the flashier hydrologic response. This study was conducted in support of a federal Section 319 watershed-planning grant.

### 2.3.8 St. Joseph River Watershed Management Plan

This report, produced by the Friends of the St. Joe River Association (DeGraves, 2005), with funding from the USEPA, offers information relating to management practices in the St. Joseph Watershed. This information includes pollutants, impaired uses, and goals and objectives for management, and critical areas for preservation in the watershed.

### 2.3.9 www.stjoeriver.net

This website, part of the St. Joseph River Watershed Management Planning Project, being undertaken by Keiser & Associates, provides a wealth of information on the St. Joseph Watershed. This includes bibliographic information, drainage basin characterization, identification of concerns, and background to the development of the watershed management plan.

### 2.4 Data Sources

Several data sources were identified at the stakeholder meeting which included the following types:

- GIS data (land use, soils, topography, digital orthophotos, hydrography);
- Hydrologic data (precipitation, river stage or flow data, historic flood levels);
- Water quality data (suspended sediment) and sediment data;
- Anecdotal flood data (photos, location of debris jams);
- Additional topographic and geologic data (stream cross-sections, soils).

The sources of data included several organizations/agencies:

- Michigan Department of Environmental Quality – total suspended solids (TSS) data;
- Indiana Department of Environmental Management – TSS data;
- Lake Michigan College – TSS and other physical/chemical parameters;
- City of South Bend, Indiana - TSS and other physical/chemical parameters;
- City of Elkhart, Indiana - TSS and other physical/chemical parameters;
- Michigan DNR – possible source of bedload data;
- Michiana Area Council of Governments (MACOG) – has planning information;
- United States Geological Survey (USGS) – sedimentation study and data for watershed, river flow data from gages;
- Detroit District, USACE – flood study with accompanying data for Three Rivers, Michigan. The data include cross-sections for St. Joseph, Rocky and Portage Rivers;
- EPA has water-quality data available through their STORET database, which includes 33 National Sediment Inventory sites;
- The USDA – NRCS has soils data contained in their STATSGO and SSURGO databases.

### 2.4.1 Precipitation Data

Precipitation data for this study were obtained from the National Oceanic and Atmospheric Administration / National Weather Service (NOAA/NWS). The NOAA/NWS gage network includes 9 gages within the watershed, including daily and hourly gage values (Figure 2.1). The website for the NOAA/NWS data is [http://dipper.nws.noaa.gov/hdsb/data/archived/legacy/stainv.html](http://dipper.nws.noaa.gov/hdsb/data/archived/legacy/stainv.html). Rainfall distribution across the watershed calculated from these records is shown in Figure 2.2.

### 2.4.2 Discharge Data

Discharge data for this study were obtained from the USGS through their streamflow data portal at [http://nwis.waterdata.usgs.gov/mi/nwis/discharge](http://nwis.waterdata.usgs.gov/mi/nwis/discharge). A summary of the stream gage location is shown in Figures 2.3 and 2.4, and Table 2.1 summarizes available gage data.

### 2.4.3 Suspended Sediment Data

The time-series of total suspended solids (TSS) data consists of two types: the USGS data series, and municipal TSS data used for National Pollutant Discharge Elimination System (NPDES) compliance. NPDES is an EPA program that has regulatory requirements for stormwater runoff from parking lots, factories, and other impermeable urban areas. The USGS (USGS, 2005b) dataset comprised of data from the 1970s for the upper reaches of the St. Joseph, and from the 1980s on the Paw Paw River. The location of these gage sites is shown in Figure 2.5. The data from these periods are adequate for the modeling purposes of this study (see Section 6), however the extrapolation of this dataset data for use in the entire watershed is questionable. The TSS data from municipal sources are mostly in the form of weekly data points, so it is generally not helpful in a modeling sense.
Figure 2.1: Location of Precipitation Gages
Figure 2.2: Annual Precipitation Depths in the St. Joseph Watershed
Figure 2.3: USGS Streamflow Gages – 1980s
Figure 2.4: USGS Streamflow Gages – 1990s
<table>
<thead>
<tr>
<th>Gage #</th>
<th>Site Name</th>
<th>Area Km²</th>
<th>From</th>
<th>To</th>
</tr>
</thead>
<tbody>
<tr>
<td>4096325</td>
<td>MI*</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>4096340</td>
<td>ST JOSEPH RIVER AT CLARENDON, MI*</td>
<td>373</td>
<td>7/1/1974</td>
<td>9/18/1978</td>
</tr>
<tr>
<td>4096400</td>
<td>ST. JOSEPH RIVER NEAR BURLINGTON, MI</td>
<td>520</td>
<td>10/1/1962</td>
<td>9/30/1991</td>
</tr>
<tr>
<td>4096405</td>
<td>ST. JOSEPH RIVER AT BURLINGTON, MI</td>
<td>533</td>
<td>10/1/1962</td>
<td>9/30/2000</td>
</tr>
<tr>
<td>4096500</td>
<td>SAUK R AT JAY ST AT COLDWATER, MI</td>
<td>10/1/1937</td>
<td>9/30/1962</td>
<td></td>
</tr>
<tr>
<td>4096515</td>
<td>SOUTH BRANCH HOG CREEK NEAR ALLEN, MI</td>
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<td>10/1/1966</td>
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<td>4097170</td>
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<td>4098000</td>
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<td>229</td>
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<td>2/28/1947</td>
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<td>ST. JOSEPH RIVER AT MOTTVILLE, MI</td>
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<td>9/30/2000</td>
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<td>4099750</td>
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<td>9/30/1956</td>
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<td>4102533</td>
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<td>12090</td>
<td>4/1/1994</td>
<td>10/31/1995</td>
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</tbody>
</table>

*Indicates Temporary USGS Sediment Sampling Site
Figure 2.5: Sediment Gaging Stations in the St. Joseph Watershed
2.5 GIS Data

GIS data layers from numerous sources were used for basemap analysis as well as for input into watershed numerical models. One main source of base GIS data for the St Joseph River Watershed was the BASINS dataset developed by the EPA. A complete list of the websites used during this study can be found in the User Manual accompanying this document. The EPA BASINS dataset is freely available for download from the BASINS website: [http://www.epa.gov/docs/ostwater/BASINS/](http://www.epa.gov/docs/ostwater/BASINS/). The GIS layers included in this dataset are:

**Spatially Distributed Data**

- Land use/land cover;
- Urbanized areas;
- Populated place locations;
- Reach File Version 1 (RF1);
- Soils (STATSGO);
- Elevation (DEM);
- National Elevation Dataset (NED);
- Major roads;
- USGS hydrologic unit boundaries (accounting unit, cataloging unit);
- Dam sites;
- EPA regional boundaries;
- State boundaries;
- County boundaries;
- Federal and Indian Lands;
- Ecoregions.

**Environmental Monitoring Data**

- Water quality monitoring station summaries;
- Water quality observation data;
- Bacteria monitoring station summaries;
- Weather station sites;
- USGS gaging stations;
- Fish Consumption advisories;
- National sediment inventory (NSI);
- Shellfish classified areas;
- Clean Water Needs Survey.
Point Source Data

- Industrial Facilities Discharge (IFD) sites;
- BASINS 3 Permit Compliance System (PCS) sites and loadings;
- BASINS 2 Permit Compliance System (PCS) sites and loadings;
- Toxic Release Inventory (TRI) sites;
- CERCLIS-Superfund National Priority List (NPL) sites;
- Resource Conservation and Recovery Information System (RCRIS) sites;
- Mineral Industry Locations.

Figure 2.6 shows two of the BASINS datasets that were important for the numerical modeling portion of this project. The dam locations and their associated attribute data were used as input for the SWAT model and the USGS gage station locations were used for the SWAT model calibration.

Digital elevation data, hydrography and land use (Figures 2.7-2.9) were also used for the development of the numerical models. In addition, detailed crop-type data from the USDA-NASS for Indiana from 2001-2004 were used as input to the SWAT model. The 2003-2004 data layer is shown in Figure 2.10.

Soils data are also required for the hydrologic and sediment delivery models. The USDA-NRCS publishes soils data at two different scales. The STATSGO soils dataset has a mapping scale of 1:250,000 and the SSURGO soils dataset has a mapping scale of 1:12,000. The coarser scale STATSGO dataset was used for the SWAT model because the SSURGO dataset was not available for the entire watershed.

Additional GIS data used for mapping and modeling purposes include USGS HUC11 (Figure 2.11) and HUC14 (Figure 2.12) watershed boundaries. The St. Joseph SWAT model was delineated into subbasins equal to or less than the HUC11 subbasin areas (see Section 4).

Various digital imagery datasets are also available for the St. Joseph Watershed. Black and white digital orthophoto quads (DOQs) are available for all counties in the watershed for 1998. 2003 color DOQs are available for the Indiana portion of the watershed. These datasets were used in the buffer analysis portion of this project. In addition, digital quad maps and satellite imagery are available for most of the watershed.

GIS projects were set up as part of the numerical model development containing only those data sets necessary for model input. A separate GIS project was created in ArcView 9.x, which includes all the BASINS data as well as all additional GIS data collected as part of this project. A detailed listing of all GIS data layers can be found in the St. Joseph River Watershed Model Users Manual.
Figure 2.6: Dam and USGS Gage Locations for the St. Joseph Watershed From the BASINS Dataset
Figure 2.7: DEM from the National Elevation Dataset (NED) for the St. Joseph Watershed
Figure 2.8: Hydrography from the National Hydrography Dataset for the St. Joseph Watershed
Figure 2.9: 1992 National Land Cover Dataset (NLCD) for the St. Joseph Watershed
Figure 2.10: 2003-2004 Cropland Data Layer for Indiana (HUC8 Watershed)
Figure 2.11: USGS HUC11 Watershed Boundaries
Figure 2.12: USGS HUC14 Watershed Boundaries
2.6 Field Data Collection Summary

During the week of September 8, 2003, the study team performed field reconnaissance on the St. Joseph River and several tributaries. The purposes of the visit included the following:

- To obtain first-hand observations of the water quality throughout the basin;
- To summarize geomorphic conditions of the channels;
- Examine channel bottom to determine sediment source and sink reaches;
- To characterize riparian conditions;
- To estimate channel geometry;
- To visit “problem” areas mentioned in stakeholder meetings:
  1. Three Rivers – city park where sediment was dredged to form swimming area – later refilled by influx of sediment;
  2. Dowagiac – dam removal in the lower Dowagiac River could increase fish passage and renew habitat if sediment is removed from the area or flushed into the river downstream;
  3. Watervliet – dam removal;
- Develop photo database of major reaches of the river.

The field visit was performed by two crews, who investigated road crossings by vehicle, and performed a canoe-based inspection of channel features in the lower St. Joseph, Paw Paw and Dowagiac Rivers. The purpose of the field reconnaissance was not to provide a detailed inventory of all watershed channel and riparian features, but to familiarize the modeling team with the issues most pertinent to the study. The pictures and notes taken during the survey are available as layers in the GIS accompanying this report.