BURNS DITCH / WATERWAY
SEDIMENT TRANSPORT MODELING PHASE I

PREPARED FOR:

U.S. ARMY CORPS OF ENGINEERS
CHICAGO DISTRICT

CONSOER TOWNSEND ENVIRODYNE ENGINEERS, INC.
303 East Wacker Drive / Suite 600
Chicago, IL 60601-5276

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- PHASE I -

INTRODUCTION

This report summarizes work completed in Phase I for the Burns Ditch / Waterway Sediment Transport Modeling task order by Consoer Townsend Envirodyne Engineers, Inc. (CTE) including the following major tasks:

- Assess existing sediment delivery / sediment transport.
- Identify major stakeholder concerns / key issues.
- Identify & review data sources provided by the Corps and stakeholders.
- Assess sediment transport models.
- Develop a preliminary field data plan.

CTE has participated in a two-day stakeholder conference and field visit, reviewed all data provided and the stakeholder concerns, performed limited investigations of other available data sources and has investigated potential models.

A. THE MAJOR WATERSHEDS IN THE STUDY AREA

The study area is formed by the following major watersheds shown schematically in Figure 1:

1. **EAST BRANCH OF LITTLE CALUMET** flows from Westville to Burns Ditch and is approximately 24 miles in length (Porter County, IN). Two major tributaries are part of the East Branch of Little Calumet River Watershed: Coffee Creek and Salt Creek[1]. The major land uses in the watershed are: 48% agriculture, 19% forested, 18% residential, 14% urban and 1% waterbodies or other natural features. The highest average monthly discharge for East Branch of Little Calumet River is about 120-130 cfs in May-June, and the lowest values are about 40-50 cfs in July-August-September. The average discharge is 80 cfs. USGS gaging stations are located in Porter (on Little Calumet River) and in Portage (on Burns Ditch)[2]. The average monthly precipitation in the watershed area varies around 4 inches from April to July. The average maximum value for a "wet" year is about 5.5", and the average maximum value for a "dry" year is 2.5-2.75". The 24 hr rainfall with various frequencies has the following values:

Frequency	1-yr	5-yr	25-yr	100-yr
Rainfall Amount	2.4"	3.5"	6.5"	7.8"

[1] "*Water Resources of Porter County, Indiana*" by Jane R. Frankerberger and Natalie Carroll, Department of Agricultural and Biological Engineering, 1996

[2] Current Stream Flow Conditions in Indiana @ http://www.thetent.com/arcadia/in

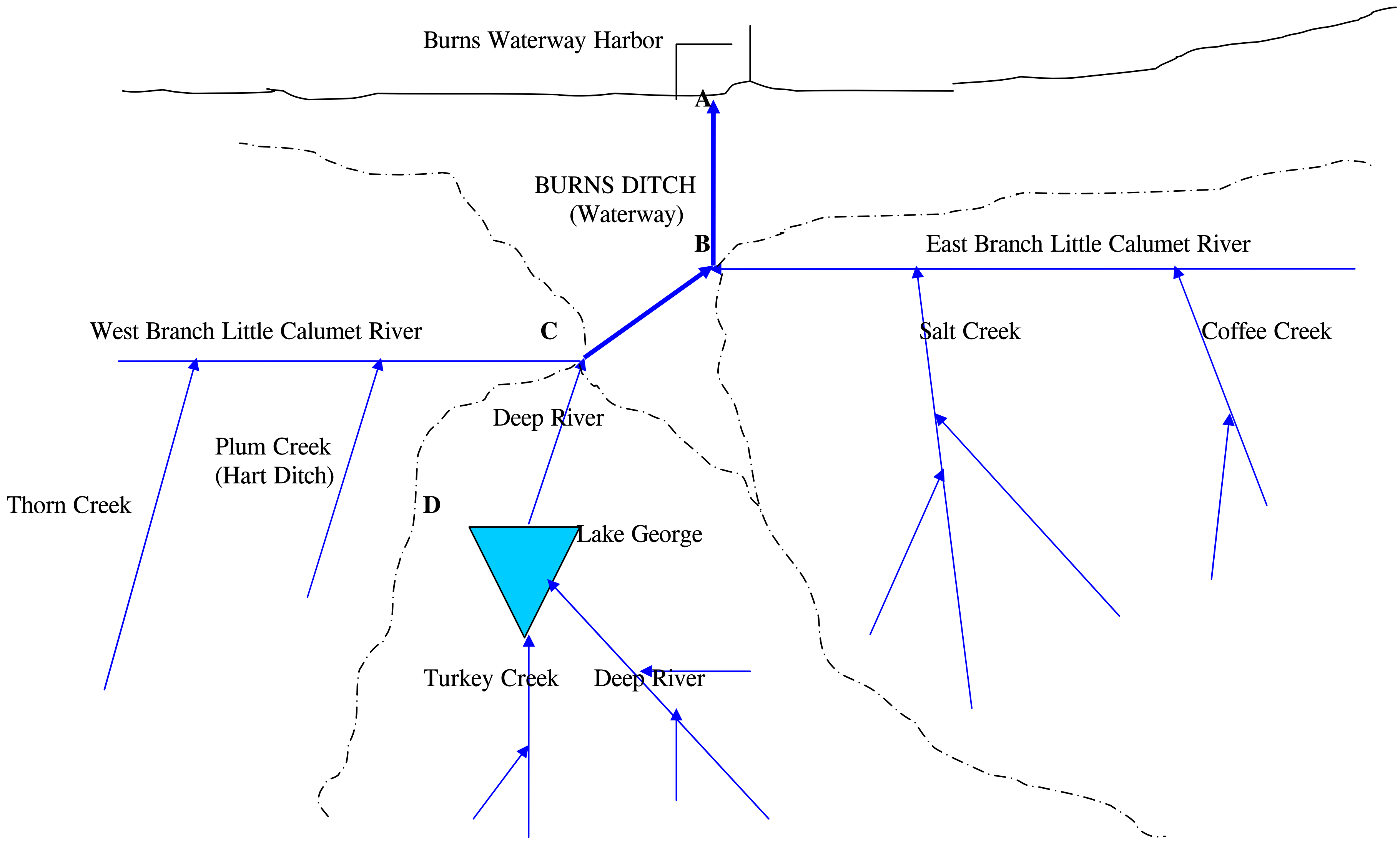

Burns Waterway Harbor
A
BURNS DITCH
(Waterway)
B
East Branch Little Calumet River
West Branch Little Calumet River
C
Salt Creek
Coffee Creek
Deep River
Plum Creek
(Hart Ditch)
Thorn Creek
D
Lake George
Turkey Creek
Deep River

FIGURE 1

The minimum daily mean flow for Little Calumet River in Porter, IN is 21 cfs and the maximum daily mean flow is 250 cfs (Figure 2), with an average daily value of 61 cfs (based on 57 years of records).

Point Source Pollution is mainly due to the large plants (Bethlehem Steel Corporation and National Steel) and municipal sewage treatment plants (Valparaiso, Portage).

Non-point Pollution Sources are due to agricultural activities (nutrients, pesticides) from the approx. 132,000 acres of agricultural land in Porter County, and from the approximately 30% of the 47,000 households in Porter County that use septic systems for waste disposal.

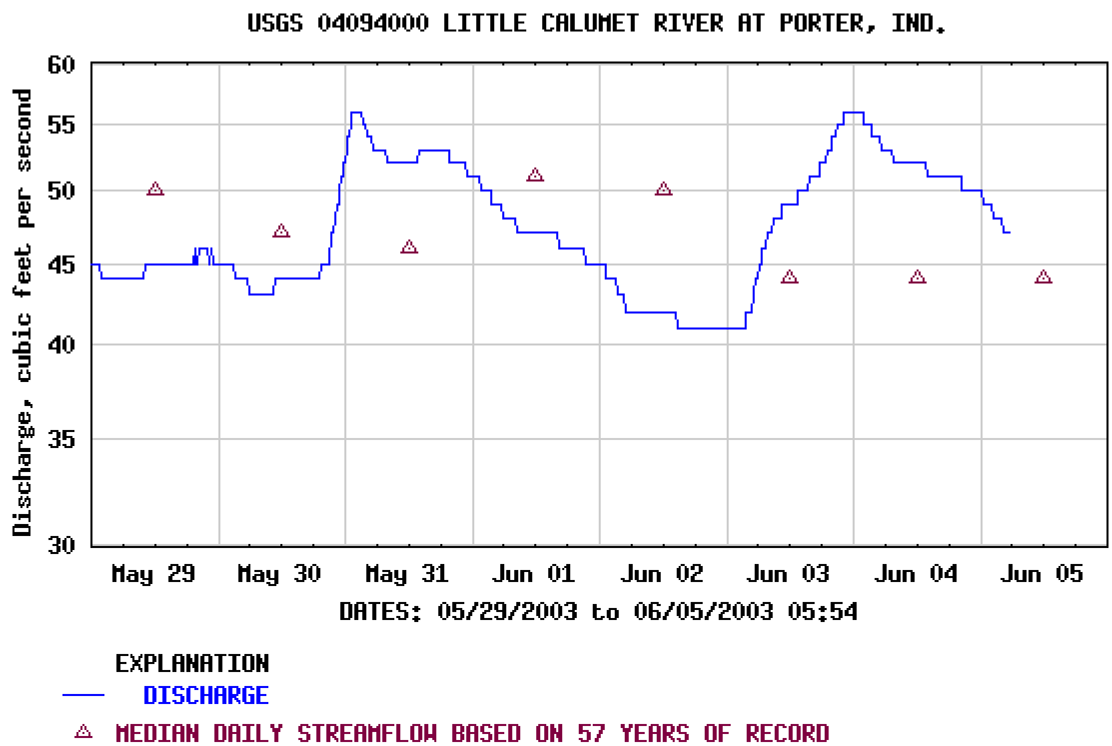


Figure 2

Due to the mainly agricultural land use and the position of the confluence with Burns Ditch (i.e. closer to the mouth at Lake Michigan), East Branch of Little Calumet River is probably one of the main sources of sediment that would eventually ends into Burns Waterway Harbor area.

Dredging is still conducted along the East Branch of Little Calumet River from the junction with Burns Ditch (Point B in Figure 5) and the confluence with Salt Creek. Contaminants in the dredged spoil pose serious environmental concerns (E.coli and cyanide). East Branch of Little Calumet River is included on the IDEM 303 (d) list of the impaired waterbodies in Indiana[3].

2. **DEEP RIVER/TURKEY CREEK,** the second major hydrologic unit in the study area, has a drainage area of about 124 square miles (Deep River has 79.4 sq.mi. and Turkey Creek has 38.3 sq.mi.).

[3]**Indiana Department of Environmental Management (IDEM)**: Indiana's **303(d)** Listing Methodology for Impaired Waterbodies

Both rivers and their tributaries flow into Lake George (12,879 acres), a manmade lake created about 1840 in the City of Hobart. The minimum daily mean flow for Deep River at Lake George outlet is 12 cfs while the maximum daily value could reach 1080 cfs, with a daily mean value of 102 cfs. From the previously mentioned data, it could be pointed out the big difference between the maximum and the minimum values of the daily flows downstream of Lake George. In addition, as shown on Figure 3, the operation of Lake George gates could generate flow fluctuations in a matter of few hours, from 30 cfs to 400 cfs.

These daily flow fluctuations could have important effects on the river reach located downstream of Lake George Dam, as is clearly illustrated in Figure 4 that shows a sudden increase of more than 1.5 feet on Burns Ditch at Porter, IN, produced on May 31.

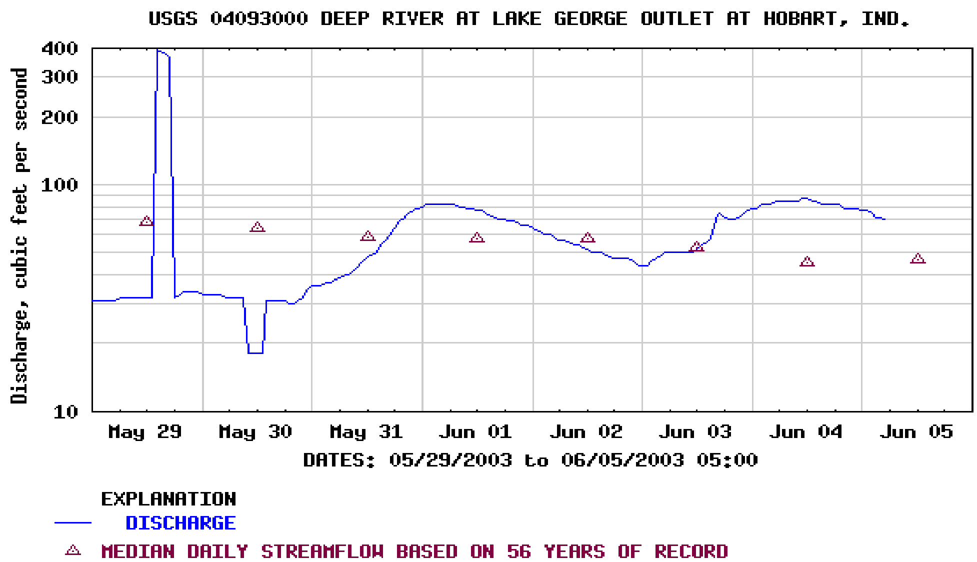


Figure 3

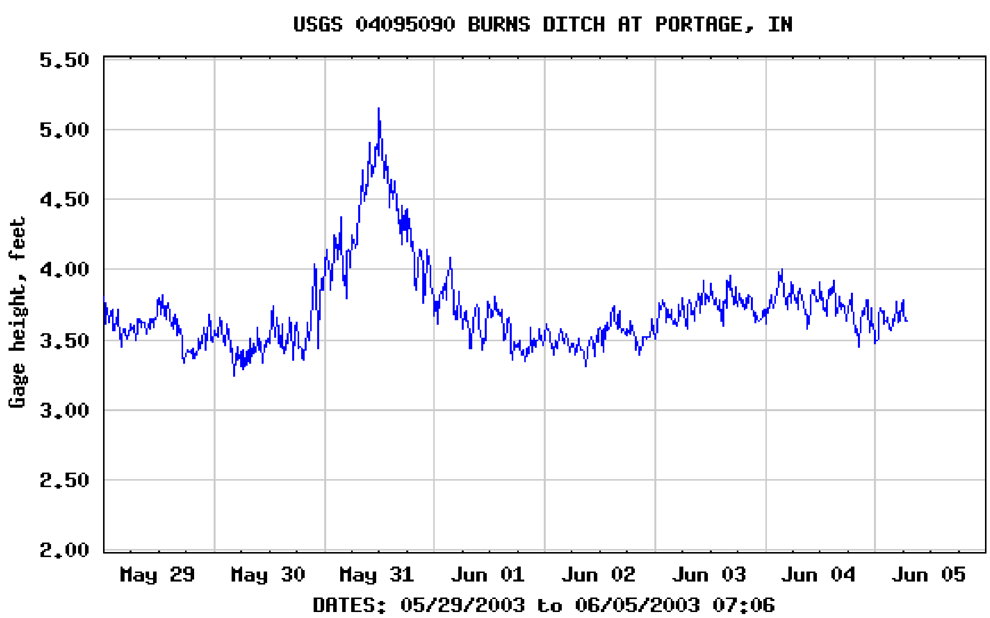


Figure 4

In these flow conditions, it appears that the channel erosion on the river reach downstream of Lake George could be also an important source of sediment that ultimately settles at the Burns Ditch mouth at Lake Michigan (Burns Waterway Harbor).

One of main issue of concerns for Lake George is the sedimentation in the lake. Currently, the lake is filled with sediment that reduced the average depth of water from approximately 6-8 ft to 1-3 ft[4]. In 1993 the COE-Chicago District initiated an extensive evaluation of Lake George and its tributary regarding the technical and economical feasibility for dredging the lake[5].

The sediment in lake is mostly from intensive agricultural activities and development construction in the upstream watershed. The sediment on the Lake bottom is formed by fine silt and clay (90 to 98%) in the majority part of the lake[6]. This percentage diminishes to 33% to 68% in the upper part of the lake. In 2000, the City of Hobart proceeded to a limited dredging of the lake, by removing more than 590,000 cu.yds. of sediment (costs of operation was more than $2 mil.). A project for Deep River/Turkey Creek Watershed management[7] was prepared by Goode & Associates, Inc. and J. F. New & Associates Inc. for City of Hobart in June 2002 that has the following main objectives:

- Minimize of sediments entering into the lake
- Improve water quality in the watersheds upstream of Lake George
- Eliminate illegal discharges from the septic systems
- Develop partnership relations with neighboring communities, business, agricultural producers and interested stakeholders.

Another important factor that influences the sediment entering into the surface water system is the *soil erodibility*. While the *soil erodibility factor* (T) for the portion of the watershed located upstream of Lake George varies from 0.344-0.38 to 0.273-0.309, the same factor is only 0.167-0.202 for the area located downstream of Lake George. This situation is due to the fact that the area downstream of Lake George is mostly urban, with mild natural slopes of the land, as compared to the upper part of the watershed that has steeper land slopes and large agricultural areas. However, due to the fact that the majority of the upstream eroded sediment is settled in the lake, as previously mentioned, it appears that the sediment in the river reach located downstream of Lake George is from channel erosion rather than from land erosion.

3. **BURNS DITCH (Portage Burns Waterway)** was completed in 1926 by changing the course of the Little Calumet River in the proximity of Lake Michigan and combining the Little Calumet River and Deep River, downstream of Conrail Railroad in Gary, to flow into a common channel (Burns Ditch) on an eight mile reach to Lake Michigan (Burns Waterway).

   Due to its location, the hydraulic and sediment transport characteristics are the result of the interaction between the characteristics of its upstream tributaries (i.e. East Branch of Little Calumet River and Deep River/Turkey Creek), Lake George and Lake Michigan (Figure 1).

[4] "*Lake George Working Files*", USDA-Soil Conservation Service and US Army-COE , 1973 - 1991
[5] "*Lake George, Hobart, IN - Planning/Engineering Report* (draft)", US Army-COE Chicago District, May 1995
[6] "*Collection and Analysis of Sediment Samples from Lake George, Hobart, IN"* by Midwest Division of Coast-to-Coast Analytical Services Inc., Valparaiso, IN, December 1992 and K&S Testing and Engineering, Inc. Highland, Indiana, 1992.
[7] "*Deep River/Turkey Creek Watershed Plan*", City of Hobart, IN, Final Draft, June 2002

Stage and flow data for Burns Ditch are available at the gauging station No. 5552 / 04095090, Portage, IN[8] (Figure 5).

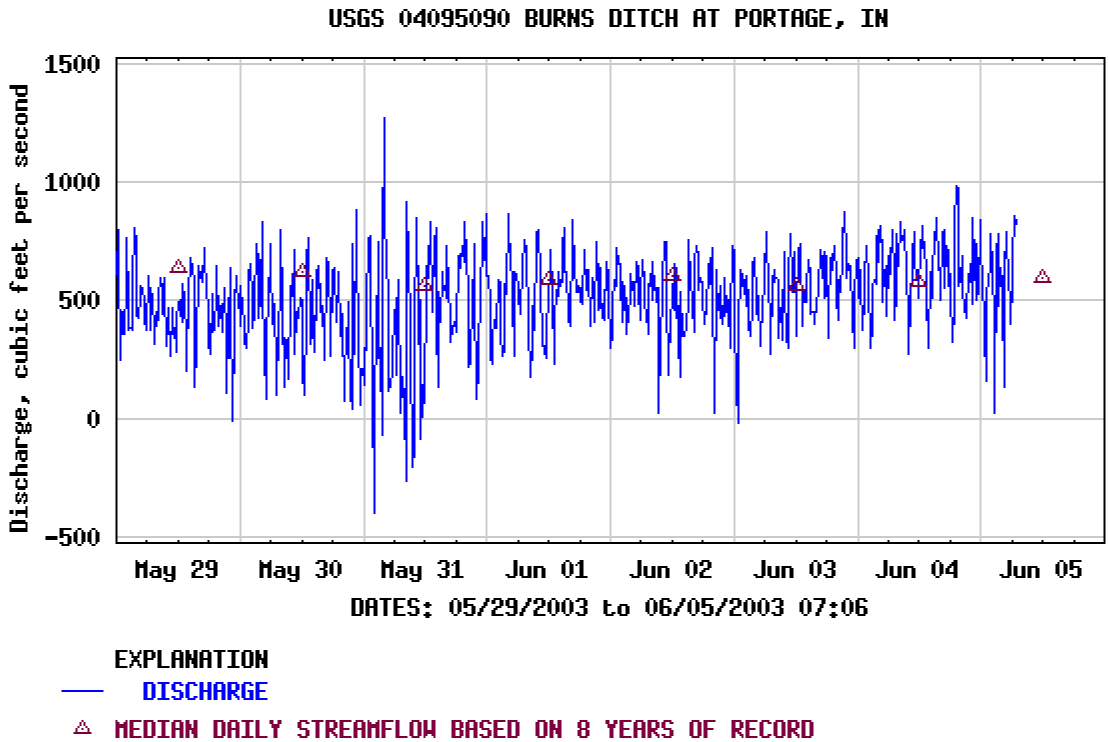


Figure 5

Based on eight years of record, the minimum, mean and maximum daily flows (cfs) are as shown below:

Minimum	Mean	Maximum
234	934	3450

Sediment sampling in the area located on reach **A - B** (see Figure 1) were performed by Lakeshore Engineering Services, Inc in May 2001[9]. The channel on reach **A-B-C** was included in the Hydrologic and Hydraulic Analysis performed by the COE-Chicago District in February 1994 [10].

The Little Calumet River hydrology and hydraulics was initially developed using HEC-1/HEC-2 computer programs. However, due to the flow reversal at the mouth of Hart Ditch and Deep River, later it was considered that an unsteady flow model (i.e. UNET) should be more appropriate for the hydraulic analysis of Little Calumet River[10]. Two very large flood events (i.e. May 1989 and

[8] www.americanwhitewater.org/gauges/id/5552 or http://waterdata.usgs.gov/in/nwis/uv?04095090

[9] "*Burns Waterway Harbor Sediment Sampling-Field Report*", LES, June 2001
[10] "*Little Calumet River – Local Flood Protection and Recreation*" – Design Memorandum 5 – West Reach Levee System – Appendix A "*Hydrologic and Hydraulic Analyses*", COE-Chicago District, February 1994.

November 1990) were used for calibration of the UNET model. The eastern limit of the modeled area in the UNET model was at the mouth of Burns Ditch, at the Lake Michigan. The previously-mentioned study did not include any sediment transport analysis for the Burns Ditch channel.

Relatively recent cross-sections were performed by US Army-COE-Chicago District[11] in March and April 2001 for a small channel reach of Burns Ditch, located in the area of Burns Small Boat Harbor, Indiana (Figures 6 and 7). In June 2001, Lakeshore Engineering Services, Inc. performed a sediment sampling for Burns Waterway Harbor [8]. However, the report does not contain any data regarding the sediment size which is one of the key elements for sediment transport modeling. According to the information contained in the "*Data Report for Little Calumet and Burns Ditch TMDL*"[12] [1], some information regarding sediment sampling sites, as well as the GIS data could be finding at IDEM and Indiana Geological Survey (IGS). However, the subsequent investigations on the above mentioned sources did not reveal any important data for sediment transport modeling.

One important set of data regarding the sediment transport modeling is the relationship between the suspended sediment concentration for a range of flows including the sediment type and gradation. Based on the consulted documentation, it appears that such data are not available for the Burns Ditch and the upstream tributaries.

B. IDENTIFICATION OF MAJOR STAKEHOLDER CONCERNS AND KEY ISSUES

The primary stakeholders that will be potential end-users of the future sediment model for Burns Ditch are regional and state planning agencies (i.e. NIRPC and IDEM). Based on the discussions with the stakeholders and representatives of major local agencies at the Sediment Transport Modeling Workshop for Burns Ditch/Waterway Watershed, held on May 7-8, 2003 in Portage, IN, the 44 questions raised by the participants[13] could be summarized into five major categories that the proposed sediment transport model for Burns Ditch should try to provide answers:

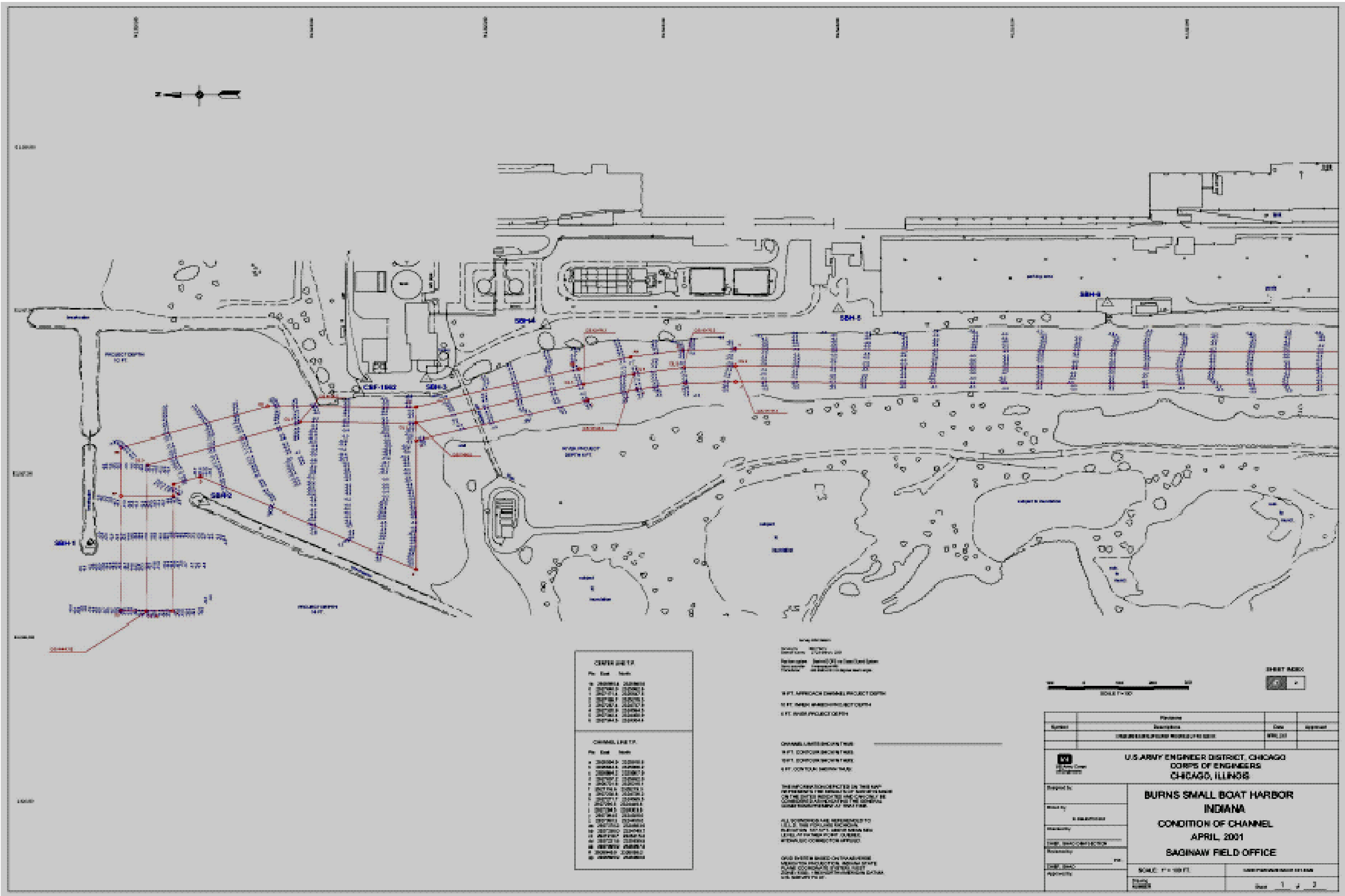
- Identification of problem areas and sediment budget (erosion-transport-sedimentation)
- Prediction of the land use impact on sediment transport and water quality
- Effects of various BMP in the agricultural and construction practices used in watershed on sediment transport and water quality.
- Prioritization of the various management measures in order to obtain an optimum effect on sediment transport and water quality.
- The model/models should be used as a planning/predicting tolls in operational activity

As resulted from the above list, it appears that the stakeholder concerns tended to be of general aspects regarding especially the impact of development and various stormwater management practices and erosion control measures on the sediment and erosion processes. In addition, no specific sites or channel reaches were identified as critical, that would impose a detailed sediment transport modeling.

[11] www.lrc.usace.army.mil/co-o/Survey.htm

[12] "*Data Report for Little Calumet and Burns Ditch TMDL*", prepared by "E" for Indiana Department of Environmental Management (IDEM) in October 2002

[13] "*A Sediment Transport Modeling Workshop for the Burns Ditch/Waterway Basin*", Northwest Indiana Regional Planning Commission", Portage, IN, may 7-8, 2003



U.S. ARMY ENGINEER DISTRICT, CHICAGO
CORPS OF ENGINEERS
CHICAGO, ILLINOIS
BURNS SMALL BOAT HARBOR
INDIANA
CONDITION OF CHANNEL
APRIL, 2001
SAGINAW FIELD OFFICE

FIGURE 6

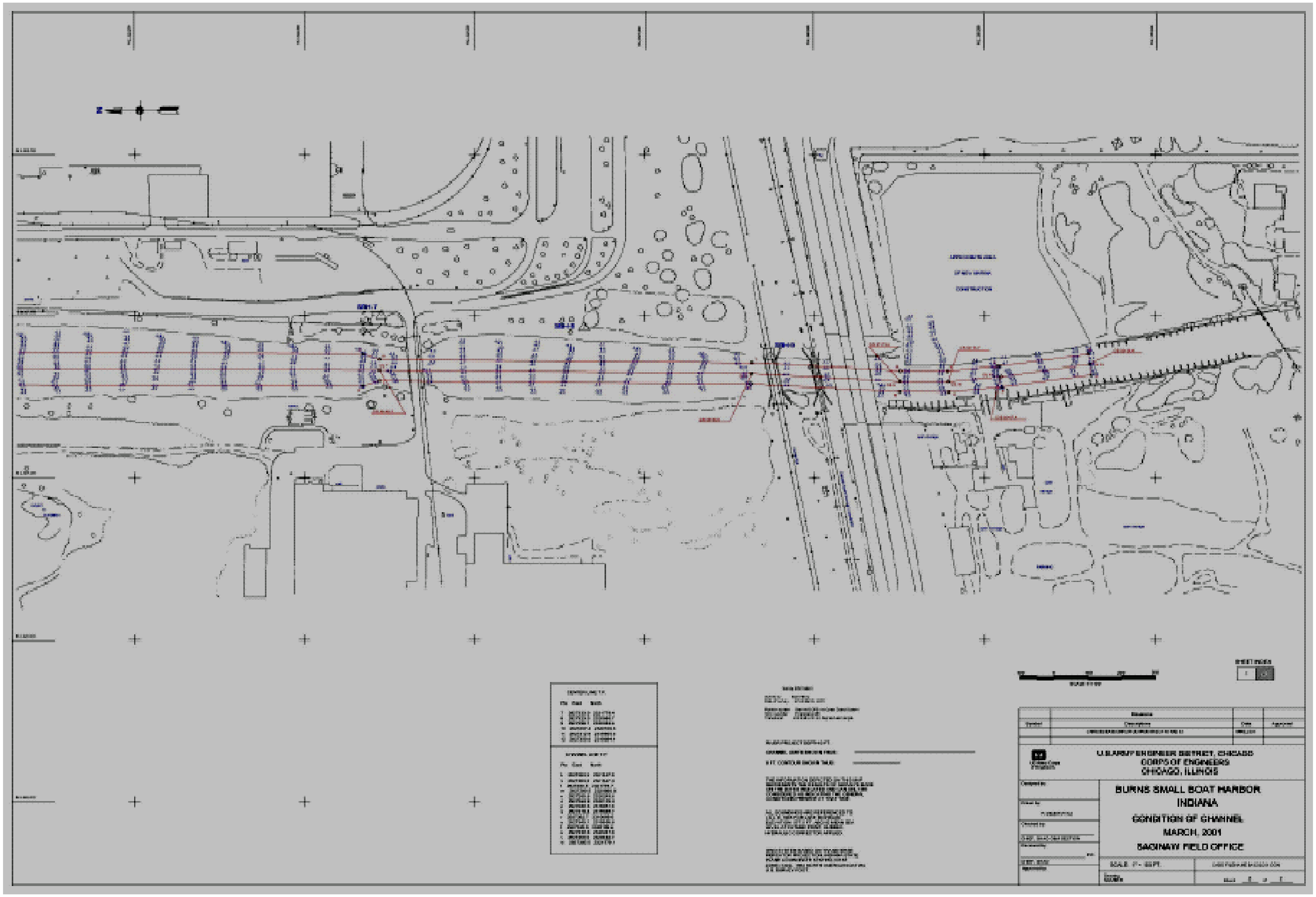

CORPS OF ENGINEERS
CHICAGO, ILLINOIS
BURNS SMALL BOAT HARBOR
INDIANA
CONDITION OF CHANNEL
MARCH, 2001
SAGINAW FIELD OFFICE

FIGURE 7

However, the above-mentioned goals impose the following major elements that must be considered in the model preparation:

1. Delineation of the system components and configuration (tributaries, watersheds, land use, etc).
2. System operation/functions and the level of detail for the output parameters.
3. Sediment sources and interaction between them.
4. Sediment transport pattern.
5. Interaction effects of various management practices in the watershed.
6. Land erosion reduction versus increase of stream channel erosion.
7. The boundary conditions (upstream and downstream).
8. Location of monitoring points in watershed.
9. Who will use/operate the model and what capabilities are available.
10. A general/global model for entire watershed used primarily as a "planning tool" and one or several local-area models (i.e. "operational tools") for specific sediment concerns, identified by local agencies.

An important aspect that could decide the type of model that would be prepared for the study case is what type of information are expected to be obtained based on such model:

- Sediment transport?
- Water quality?
- Economic benefits from the management measures taken in the watershed?
- Qualitative or quantitative results?

Each of the above-mentioned categories would require a specialized model that could get answers to specific problems. In addition, the available data could be an important factor in deciding the type of model that can be developed for the study area, as well as the capability of the user/users in operating a certain type of model. Based on the existing field data collected in the watershed, several computer models could be developed that would simulate open channel and floodplain flows, as well as the sediment transport. The results of these models could be used to develop an overall stormwater management program for prioritizing system improvement alternatives.

A possible approach for a "*macro-scale model*" should be using the advantages offered by the GIS techniques. The GIS techniques could be applied to delineate the drainage boundaries using digital topographic contours and to incorporate land use within the component watersheds, in order to estimate the watershed characteristic parameters necessary for the hydrologic and hydraulic models. The GIS applications that are of particular importance for the study case are: **m**apping, **m**onitoring, **m**odeling, and **m**aintenance. These four "**m**" define the four most important activities in effectively managing watershed systems. The GIS technique integrates all kinds of information and applications with a geographic component into one manageable model that could offer integrated solutions for planning, engineering, operation and maintenance.

Integrated GIS system for evaluating stormwater BMPs could be developed using the ArcView software that incorporates hydrologic, water quality input data, and BMP models. This could be used to analyze the effectiveness of different BMPs.

C. REVIEW OF AVAILABLE DATA FOR BURNS DICH/WATERWAY

1. AVAILABLE GIS DATA FOR BURNS DITCH/WATERWAY WATERSHED

The interactive maps and geospatial data available for the study area could be obtained from the Indiana Geological Survey – Center for Geospatial Data Analysis[14]. A list of available GIS projects in the study area is included in Attachment D.

2. AVAILABLE SEDIMENT DATA

Based on the review of existing documentation consulted up to this phase of the study, practically no information is available regarding the sediment size distribution in various channel locations in the Burns Ditch watershed (including all upstream tributaries). In addition, for a sediment transport model, a key element is the relation between the suspended sediment and the water discharge, and its distribution for various seasons represented by the following relationships:

- *Total Sediment Load* (tons/day) *versus Water Discharge* (cfs) as shown on Figure 5 in Attachment E.
- *Sediment Discharge* (tons/day) versus *Water Discharge* (cfs) *for various sediment types and sizes (fine, medium and coarse sand, etc)* as shown on Figure 6 (Attachment E).
- *Variation of sediment transport with the grain size*, as shown on Figure 7(Attachment E).

None of the above-mentioned data was found in the consulted documentation. Very limited data regarding the suspended sediment at Burns Ditch are listed in the following table[15]:

Julian Day	Year	Time	SpC (ms/cm)	Temp (deg C)	Turbidity (NTU)	TSS(grab) (mg/l)	TSS(auto) (mg/l)
126	1999	2100	0.65375	18.4825	471.05	48.4	
127	1999	0	0.66975	17.9475	698.675	14.4	28.4
127	1999	300	0.674	17.46	1049.225	34	31.2
127	1999	600	0.66225	17.125	1231.3	14.8	50.4
127	1999	900	0.6705	17.085	751.775	34.4	30.8
127	1999	1200	0.6705	17.6625	466.025	28.4	30
127	1999	1500	0.64675	18.05	648.3	19.2	28.4
127	1999	1800	0.634	18.09	1053.025	14.8	33.2
127	1999	21	0.64025	17.635	709.6	18.8	32.8
141	1999	2230	0.6505	21.7475	18.3	9.6	
142	1999	130	0.634	21.065	20.875	18	14.8
142	1999	430	0.627	20.845	19.55	14.8	13.6
142	1999	730	0.61375	20.525	20.1	10.8	17.6
142	1999	1030	0.65575	19.46	30.75		20
142	1999	1330	0.69925	20.18	23.675		23.2
142	1999	1630	0.653	21.1175	25.475	20	14.4
142	1999	1930	0.6405	21.095	16.7	13.6	11.2
142	1999	2230	0.62075	20.335	17.275	18	14.4
162	1999	1700	0.496	24.3575	18.8	21.2	
162	1999	2000	0.47625	23.5775	20.575	30.8	19.6
162	1999	2300	0.49225	23.5625	20.175	18.4	20.4
163	1999	200	0.522	23.9925	25.725	26	20
163	1999	500	0.536	23.795	22.375	35.6	28
163	1999	800	0.546	23.6	25.575	27.2	28.8
163	1999	1100	0.484	23.1425	21.35	25.2	25.6
163	1999	1400	0.5195	24.03	18.3	26.4	23.6
163	1999	1700	0.49425	23.5125	23.075	19.6	21.6

In order to develop a useful sediment transport model, additional sediment data will be needed for calibration.

[14] Indiana University – IGS @ http://igs.indiana.edu/sutvey/staff/cgda/projects.cfm

[15] E-mail from Sally Letsinger, Indiana Geological Survey, data from J.C. Thomas Ph.D. Thesis "Monitoring and Statistical Modeling of Bacterially Contaminated Streamflow at the Outlet of Burns Ditch", Indiana University (2001).

4. AVAILABLE TOPOGRAPHIC DATA FOR STREAM CHANNELS

The topographic data for the channel on various streams that are part of the Burns Ditch/Waterway watershed are another key element that are necessary for a sediment transport model formulation. No other information regarding channel cross-section data, in addition of those mentioned at page 6 (see footnote [10]), was found at this stage of the study. This is another important issue that must be clarified in the future study phases, as function of the specific type of model that will be developed.

3. AVAILABLE LAND USE / SOIL DATA

Based on the information provided at the previously-mentioned Sediment Transport Modeling Workshop, Lake and La Porte Counties do have soil and land use maps, but Porter County does not have such information. The existing interactive maps for Indiana[13] are show in Attachment F.

. POSSIBLE TYPES OF COMPUTATION MODELS FOR THE STUDY AREA

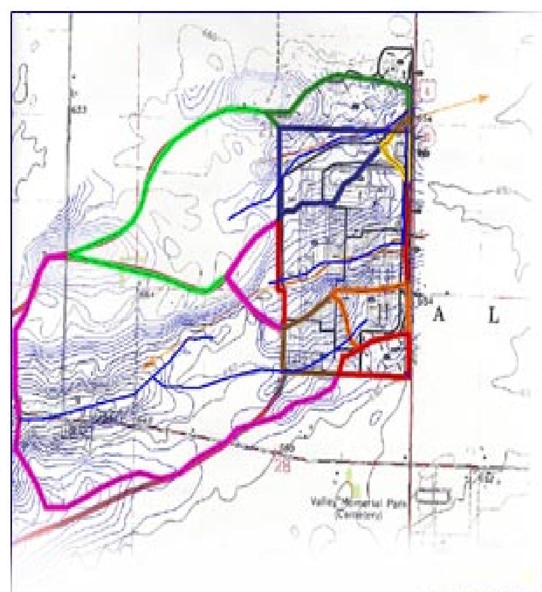
1. HYDROLOGIC MODELS

1.a. WMS-7.0: Watershed Modeling System incorporates several well-known computation models, as for example HEC-1 and HEC-2 (US Army-COE), TR-20 (US-SCS), National Flood Frequency Mode - NFF (USGS / FHWA) and HSPH (EPA). It provides user-friendly interface with graphics and visualization in 3-D.

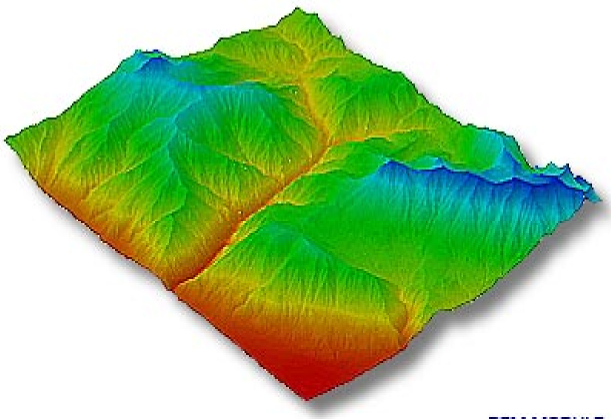
The CAD/GIS standard functions allow using digital terrain and GIS data for watershed delineation and computation of the model input parameters.

USGS-Quad maps could also be used for watershed input parameters computation.

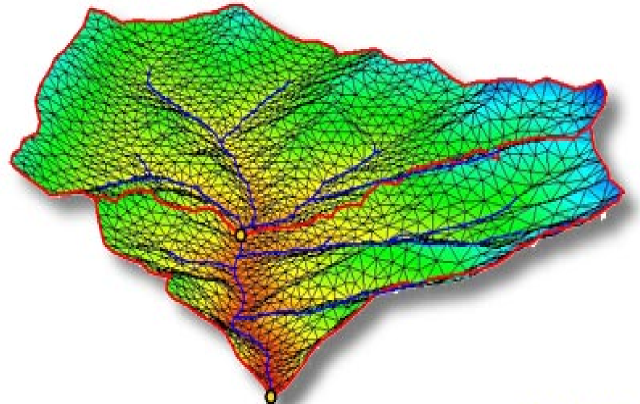
DEM (Digital Elevation Model) and TIN (Triangulated Irregular Network) modules allows an automatic delineation of stream network, watershed boundaries and drainage areas.



MAP MODULE



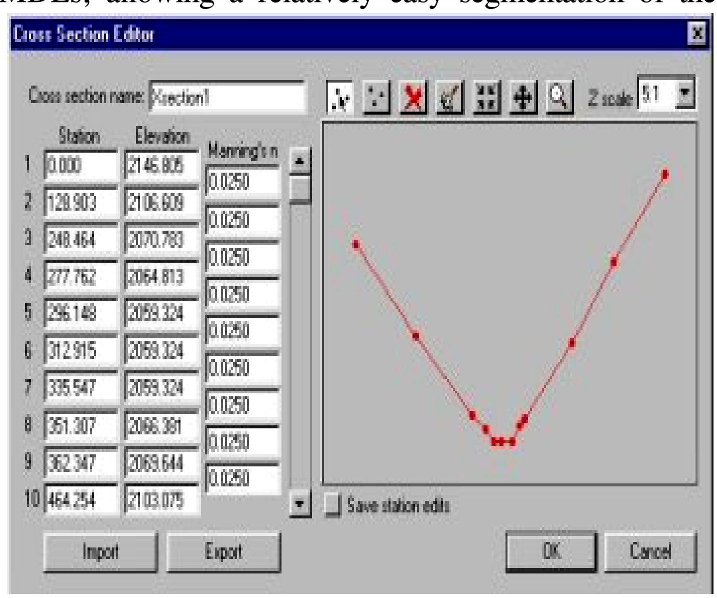
DEM MODULE



TIN MODULE

The Scatter Point Module (SPM) is a useful tool for interpolation from scatter data, especially for floodplain delineation.

The 2-D Grid Module is used for discretization the watershed into a number of grid cells for which the hydrologic parameters (i.e. rainfall intensity, infiltration rates) or the channel properties can be defined.



In the versions higher than 6.0, the WMS model has an interface with the HSPF model, which is used by the EPA for development of TMDLs, allowing a relatively easy segmentation of the watershed using the land use or soil type information for the study area. In addition, WMS-6.0 and up has a module that allows cutting cross-sections from the DEM and TIN modules (maps). However, the accuracy of these cross-sections is determined by the contour line interval of the base maps. Obviously, the stream channels are obtained with a very limited accuracy which, generally, is not accepted for sediment transport models. In WMS-7.0 it is included an extension to the ArcView GIS software called WMSHydro that can be used to prepare land use, soil or elevation data for the studied watershed. It also can be used to view the computation results. By incorporating several hydrologic models, WMS has the advantage of comparing the results obtained using several computations methods (i.e. HEC-1 or TR-20).

1.b. **<u>GSSHA</u>:** <u>**G**ridded **S**urface-**S**ubsurface **H**ydrologic **A**nalysis</u> is a hydrologic model that has the capability to take into consideration and the groundwater component of the modeled watershed, as well as the sediment delivery from the land to the river. This model is an alternative to HEC-HMS (Hydrologic Modeling System).

GSSHA computation model was developed at the COE-Coastal and Hydraulics Laboratory of the Engineering Research and Development Center. It is a reformulation and enhancement of the

CASC2D model, based on finite-difference/finite-volume methods. The major capabilities of this model are as follows:

- It has a modular structure and a process-based formulation (each component process having its own time-step and internal-time-step limitation for increasing computation stability)
- It has an improved overland flow and channel routing algorithms that allows a larger time-step for simulation of backwater effects.
- It allows stream – groundwater interaction and base flow calculations.
- It takes into consideration the overland - groundwater interaction and groundwater recharge.
- The tile drains can be modeled as a small rough channel network.
- It allows including GIS data input (available from DEM), and the specific characteristics of the soil and land use in the watershed.

It must be pointed out that the channel modeling is very approximate, using some "average" cross-sections of trapezoidal shape. No sediment transport analysis can be performed with the above-mentioned model.

1.c. HEC-HMS: **H**ydrologic **M**odeling **S**ystem is designed to simulate the precipitation-runoff processes of dendritic watershed systems. It is designed to be applicable in a wide range of geographic areas for solving the widest possible range of problems. This includes large river basin water supply and flood hydrology, and small urban or natural watershed runoff. Hydrographs produced by the program are used directly or in conjunction with other software for studies of water availability, urban drainage, flow forecasting, future urbanization impact, reservoir spillway design, flood damage reduction, floodplain regulation, and systems operation. It has the following main capabilities:

- Integrated watershed environment
- Analysis of meteorological data
- Rainfall-Runoff Simulation
- Infiltration Losses
- Open-Channel Routing

No sediment transport analysis can be performed with the above-mentioned model.

2. COMPREHENSIVE STORMWATER MANAGEMENT MODELS

2.1. BASINS, an acronym for **B**etter **A**ssessment **S**cience **I**ntegrating Point and **N**onpoint **S**ources, is a software package originally developed by EPA[16] in 1996 that incorporates several advanced capabilities, as for example:

- Geographic Information System (GIS) data for watershed topographic information and land use data (Figure 8).
- Digital Elevation Model (DEM) module
- ArcView environment

[16] http://www.epa.gov/OST/BASINS

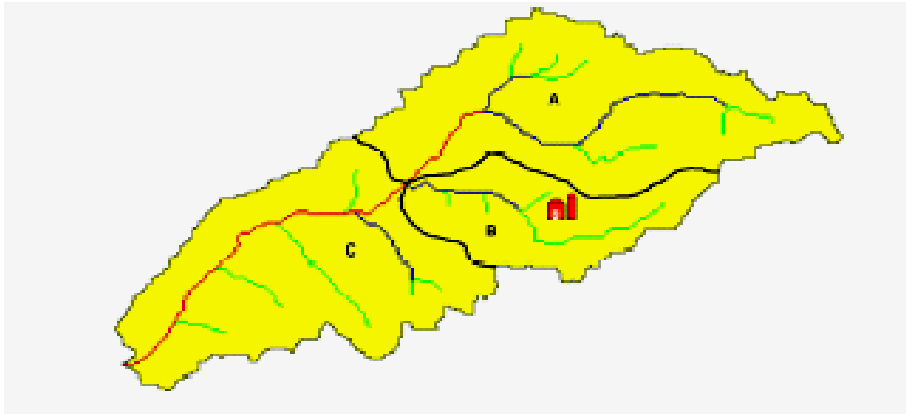


Figure 8

The current version is **BASINS 3.0,** which includes additional functional capabilities as well as updated and expanded set of databases and assessment tools that are directly integrated within an ArcView GIS environment. By using GIS, a user can fully visualize, and modify a watershed characteristics according to various management plans. The simulation models run in a Windows environment, using data input files generated in ArcView. A Basins 3.0 system overview is shown in Figure 9.

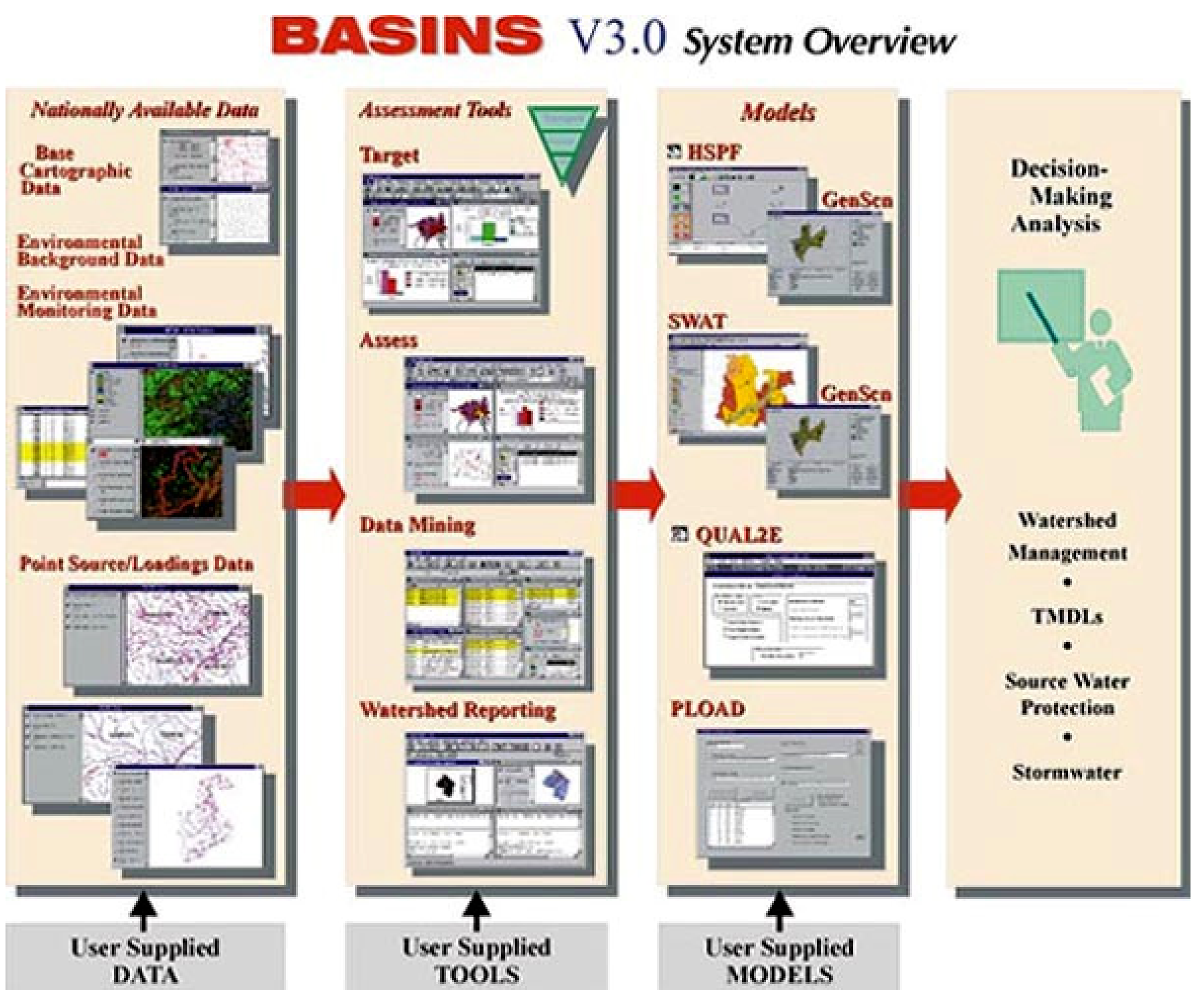


Figure 10

Some of the new features are:

- An automatic delineation tool for watershed delineation based on DEM (Digital Elevation Model) grid formatted data.
- QUAL2E, an instream water quality model
- PLOAD, a GIS based nonpoint-source watershed loading model
- HSPF (with a new Windows interface) and SWAT (Soil Water Assessment Tool) that are watershed assessment modules developed by USDA
- WDMUtil which is a toll for manipulating the watershed data management files
- A postprocessor module to visualize and analyze results

A "*BASINS User's Manual*", system files, documentation, tutorial, and data for a watershed practical application are available on the previously mentioned web-page.

2.2. BasinSoft, developed by PixSell[17] is a proprietary GIS software tool developed as an alternative to BASINS. As presented by the developer, **BasinSoft** is a user-friendly GIS application program designed for hydrology watershed analysis. It computes more than 30 parameters of a watershed for use as inputs to a wide range of regional flood frequency, low-flow, and surface-water runoff regression equations and open-channel flow and water-quality models that require data regarding the drainage basin morphology as input parameters.

An interactive version of **BasinSoft** was also developed by USGS - Iowa District. Information regarding this software can be found at the Iowa Internet Home Page[18], by sending e-mail to basinsoft@maildiaiwc.cr.usgs.gov or by contacting the U.S. Geological Survey, Federal Building / Room 269, 400 South Clinton Street, Iowa City, IA 52244 (phone: 319 – 337 – 4191)

BasinSoft can be used for spatial analytical problems in several areas, including:

- Agriculture: Modeling agricultural land for the purpose of computing area-weighted statistics for erosion susceptibility, defining marginal land usage, and identifying best area for sustainable agriculture practices.
- City Planning & Community Development: Resolving transportation issues, such as best location for transportation lines and identifying areas of urban sprawl.
- Environmental Impact: Conducting environmental studies, such as remediation, and environmental impact analysis.
- Civil and Structural Engineering: Conducting risk analysis studies, creating flood inundation and land erosion models for decision support systems.

BasinSoft can be easy applied by inexperienced GIS users, and can save time for experienced GIS professionals. It requires a full installation of ESRI's ArcINFO 7.2 or later. While the spatial computations carried out by the application are complex, the user is guided through the requisite preprocessing steps and model initiation by a set of intuitive graphical user interfaces (GUIs), similar to what a user might experience with a Windows platform. The advanced analyses are presented in an easy-to-use way so an inexperienced user can intuitively conduct complicated spatial analyses.

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[17] http:// www.pixsel.com

PixSell Inc. is an information technology company specializing in the management and application of geo-spatial data, and has offices at the NASA Stennis Space Center in Mississippi, and in McLean, Virginia.

[18] http://dg00diaiwc.cr.usgs.gov/index.html

BasinSoft has been used by U.S. federal agencies, such as the United States Geological Survey, United States Department of Agriculture Forest Service, and the Environmental Protection Agency for several years. The US Geological Survey reports a 74% reduction in processing time when using **BasinSoft**, compared to traditional methods. (USGS Water Resources Investigations Report 95-4287). To date, more than 16,000 drainage basins of all sizes have been processed in more than 15 states.

Taking into account the above mentioned advantages, **BasinSoft** could be a better alternative for a "*macro-scale*" model of Burns Ditch Watershed.

2.3 **SWMM** (**S**torm **W**ater **M**anagement **M**odel) was the first comprehensive model for stormwater management at a watershed scale[19]. Version 4.3 (May 1994) contains a new Transport Flow Divider, revised hydraulic calculations for natural channels in EXTRAN and TRANSPORT (to agree with the HEC-2 method) modules, multiple land use options in RUNOFF module, additional infiltration options, improved manipulation of long-term rainfall data (especially 15-min data), a linkage to WASP4 from TRANSPORT module, additional statistical output from RUNOFF module and many other enhancements to various program options. **SWMM-Version 4.4h** contains many more improvements, options and modifications including ArcView capabilities for GIS data. An updated *Beta Test Version (B)* of **SWMM-5** is available for evaluation at EPA site[20] that contains also some details regarding the new features included into this version. This update version fixes all of the problems identified from the "*Beta A*" release, as listed on the "*Problem Status Report*" page. It also includes a few useful additions to the user interface, in order to make it easier for third parties to add graphical user interfaces and other enhancements onto the SWMM engine. The schematics of conceptualization of a drainage area in SWMM are shown in Figure 9 and the new graphical interface for SWMM-5 is shown in Figure 10.

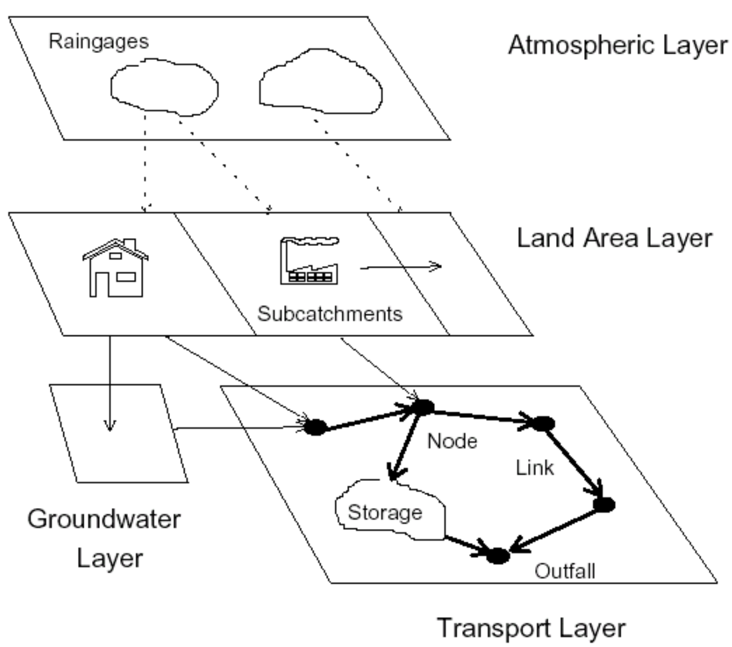

Figure 9

[19] http://www.ccee.orst.edu/swmm
[20] http://www.epa.gov/ednnrmrl/swmm/beta_test.html

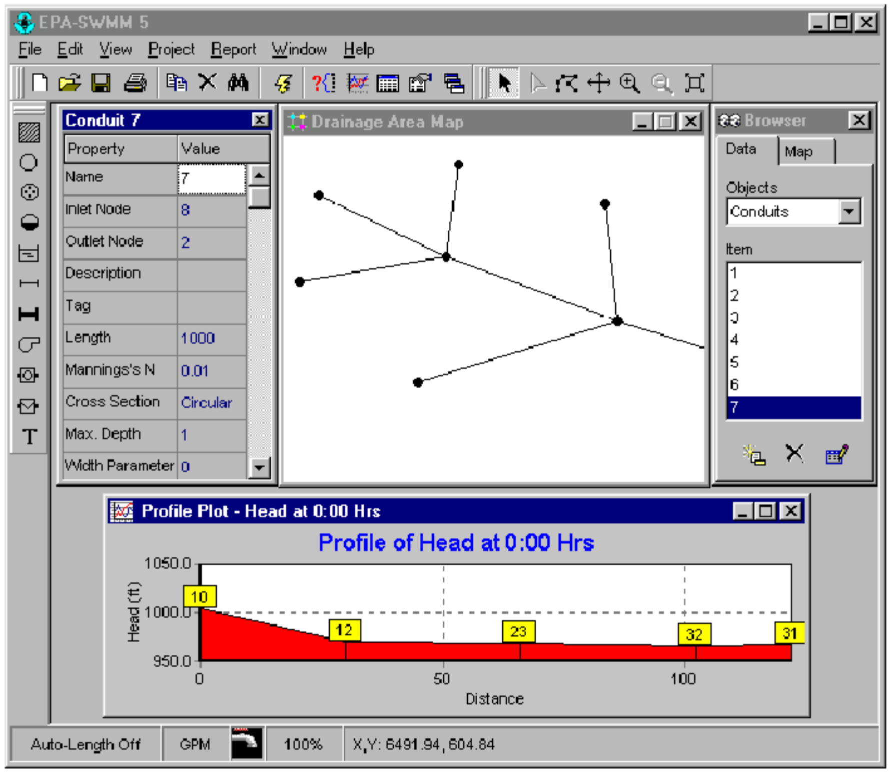

Figure 10

In present, work continues on adding in the remaining functions to **SWMM-5**, such as *"Treatment"*, *"Groundwater"*, *"Snowmelt"*, and *"RDII"*, during the beta test period. The official version of SWMM-5, scheduled for release in October 2003, will include the final QA/QC report and complete documentation in the form of a Users Manual, a Tutorial Help file, a Reference Manual, and a Programmers Manual.

The future versions of SWMM will include new features as for example:

- SCS curve number for infiltration
- Soil moisture accounting model for groundwater
- Implicit balance model flow routing
- Bed/suspended load sediment transport model
- Interactive real-time control of sewer flow routing

As can be seen in above list, <u>the current versions of SWMM do not have capabilities for sediment transport calculations.</u>

3. SEDIMENT TRANSPORT MODELS

3.a. HEC-6 / Version 6-4.1 is a one-dimensional movable boundary open channel flow numerical model that can simulate and predict changes in river profiles resulting from scour/deposition of the river bed. The main components of HEC-6 model are as follows:

HEC-6 Features

HEC-6 is a one-dimensional sediment transport model designed to calculate water surface and sediment bed surface profiles by computing the interaction between sediment material in the stream bed and the flowing water sediment mixture. Dredging can be simulated and reservoir deposition can also be analyzed with this model.

- **Water Surface Profile Simulation**
- **Sediment Deposition Modeling**
- **Sediment Transport Modeling**
- **River Geometry Simulation**
- **Assumptions and Limitations**

Water Surface Profile Simulation

HEC-6 is a one-dimensional movable boundary open channel flow numerical model designed to simulate and predict changes in river profiles resulting from scour and/or deposition over moderate time periods (typically years, although applications to single flood events are possible). A continuous flow record is partitioned into a series of steady flows of variable discharges and duration. For each flow a water surface profile is calculated thereby providing energy slope, velocity, depth, etc. at each cross section. Potential sediment transport rates are then computed at each section. These rates, combined with the duration of the flow, permit a volumetric accounting of sediment within each reach. The amount of scour or deposition at each section is then computed and the cross section adjusted accordingly. The computations then proceed to the next flow in the sequence and the cycle is repeated beginning with the updated geometry. The sediment calculations are performed by grain size fraction thereby allowing the simulation of hydraulic sorting and armoring.

Sediment Deposition Modeling

Separation of sediment deposition from the hydraulics of flow is valid in some circumstances; for example, deposition in deep reservoirs can usually be characterized as a progressive reduction in storage capacity if the material is rarely entrained once it is deposited. Prediction of sediment behavior in shallow reservoirs and most rivers, however, requires that the interactions between the flow hydraulics, sediment transport, channel roughness and related changes in boundary geometry be considered. HEC-6 is designed to incorporate these interactions into the simulation.

Sediment Transport Modeling

HEC-6 simulates the capability of a stream to transport sediment, given the yield from upstream sources. This computation of transport includes both bed and suspended load as described by Einstein's Bed-Load Function. A reach of river with a bed composed of the same type of sediment material as that moving in the stream is termed an 'alluvial' reach. Einstein recognized that an alluvial reach provides a record of the sediment that the stream has, and does, transport. That record is reflected in the materials that form the stream boundaries. Using the hydraulic properties of the flow and the characteristics of the sediment material (which can be determined by analyzing samples of the riverbed sediment particles), one can compute the rate of sediment transport. HEC-6 implements similar concepts to compute the movement of sediment materials for a temporal sequence of flows and, through volume conservation of bed material, changes in channel dimensions. The transport, deposition, and erosion of silts and clays may also be calculated. Effects of the creation and removal of an armor layer are also simulated.

River Geometry Simulation

A river system consisting of a main stem, tributaries and local inflow/outflow points can be simulated. Such a system in which tributary sediment transport is calculated is referred to in this document as a network model. Sediment transport is calculated by HEC-6 in primary rivers and tributaries. There will be upper limits on the number of network branches, number of cross sections, etc., due to computer memory limitations. As these may change among HEC-6 implementations on various computer systems, the user should check the header on the output file to determine the limits of the particular version being used.

Assumptions and Limitations

- HEC-6 is a one-dimensional continuous simulation model that uses a sequence of steady flows to represent discharge hydrographs. There is no provision for simulating the development of meanders or specifying a lateral distribution of sediment load across a cross section.

- The cross section is subdivided into two parts with input data; that part which has a movable bed, and that which does not. The movable bed is constrained within the limits of the wetted perimeter and other limitations that are explained later. The entire wetted part of the cross section is normally moved uniformly up or down; an option is available, however, which causes the bed elevation to be adjusted in horizontal layers when deposition occurs.

- Bed forms are not simulated; however, n values can be input as functions of discharge, which indirectly permits consideration of the effects of bed forms if the user can determine those effects from measured data.

- Density and secondary currents are not simulated.

- There are three restrictions on the description of a network system within which sediment transport can be calculated with HEC-6:

  - Sediment transport in distributaries is not possible.

  - Flow around islands; i.e., closed loops, cannot be directly accommodated.

  - Only one junction or local inflow point is allowed between any two cross sections.

HEC-6 is designed to analyze long-term scour and/or deposition. Single flood event analyses must be performed with caution. HEC-6 bed material transport algorithms assume that equilibrium conditions are reached within each time step; however, the prototype is often influenced by unsteady non-equilibrium conditions during flood events. Equilibrium may not occur under these conditions because of the continuously changing hydraulic and sediment dynamics. If such situations predominate, single event analyses should be performed only on a qualitative basis. For gradually changing sediment and hydraulic conditions, such as for large rivers with slow rising and failing hydrographs, single event analyses may be performed with confidence.

As can be seen from the above description, HEC-6 computation program allows the sediment transport analysis for channel as well as for the flood plain areas. Therefore, quite detailed topographic information is necessary in order to reproduce, as exactly as possible, the sediment transport characteristics on the river reach considered in the study. Therefore, this model could be used for specific areas that need detailed sediment transport analysis.

Using the continuity of sediment principle, the river bed changes are calculated with respect to time and distance along the study reach. The output is obtained as a total sediment load, volume and gradation of sediment that is scoured or deposited on each channel reach. Armoring of the channel bed and the modified cross-section elevations can be obtained numerically and graphically. In addition, sediment outflow at the downstream end of the study reach is calculated, and the amount of material that must be dredged can also be obtained, if necessary. For practical applications, upstream and downstream flow conditions must be defined.

The sediment load-water discharge relation for the upstream boundaries of the main stem, tributaries and local inflow points must be known as input data. For realistic computation of scour/deposition processes in the studied river reach, the gradation of the sediment material existing in the channel bed must be known. HEC-6 allows for various gradations at each cross-section.

Even if the HEC-6 is not an unsteady state model, through the above-mentioned procedure (i.e. discretization of the flow hydrograph as a series of time-step hydrograph of constant discharge) this model can handle quite well a series of annual hydrographs for a long time-range simulation.

3.2. CCHE-1D, is a one-dimensional unsteady flow computation model developed by the **N**ational **C**enter for **C**omputational **H**ydroscience and Engineering (NCCHE)[21] of the University of Mississippi for numerical simulation of flows in dendritic channel networks with sediment transport components. The sediment transport module can handle the following main issues:

- Non-equilibrium transport of non-uniform sediment mixtures, using four sediment transport capacity prediction formulas
- Channel bed erosion and deposition
- Hydraulic sorting of sediment and armoring of channel bed
- Bank toe erosion prediction and bank stability analysis
- Analysis of the necessary erosion control measures

CCHE-1D uses a semi-coupled numerical solution scheme, and has a graphical interface based on ArcView GIS 3.x that can extract the channel network and corresponding sub-watershed data directly from the ground elevation data. It can also digitizing on-screen the channel networks based on aerial photographs or scanned imagery. The necessary data for various module components are automatically transferred through the software.

The characteristics of the main module components of the CCHE-1D computation model are as follows:

Unsteady Flow Module

- One-dimensional unsteady flows in dendritic channel networks;
- Flow through in-stream hydraulic structures such as culverts, flumes, bridge crossings, and drop structures;
- Flow in ephemeral, steep slope channels;
- Arbitrary compound cross section shapes (main channel and floodplains);
- Dynamic Wave model, Diffusive Wave model, and their hybrid formulation;
- Efficient four-point, implicit finite-difference solver.

Sediment Transport and Channel Morphology Module

- Non-equilibrium transport of non-uniform sediment mixtures;
- Channel bed erosion and deposition;
- Hydraulic sorting and armoring of bed material;
- Bank toe erosion predictor and bank stability analysis module;
- Sediment yield prediction;
- Erosion control analysis;
- Four sediment transport capacity prediction formulas;
- Semi-coupled numerical solution scheme.

CCHE1D Graphical Interface and Control Module

- Graphical interface based on ArcView GIS 3.x;
- Extraction of the channel network and corresponding sub-watersheds from ground elevation data;

[21] NCCHE @ http://www.ncche.olemiss.edu

- On-screen digitizing of channel networks based on aerial photographs, scanned imagery, etc.;
- Generation of the computational mesh for the channel flow and sediment transport computations;
- Data management system for automatic transfer of data among modeling components;
- Relational database management technology for storing input and output data;
- Data interface to watershed modeling programs.

Limitations

- The CCHE1D model must be applied to dendritic channel networks with a single outlet only;
- Flow must be primarily subcritical in all reaches of the channel network. However, the model can handle local supercritical and transcritical flows without hydraulic jumps in isolated cross sections through the hybrid dynamic/diffusive wave model;
- The model has not been tested for tidal flow conditions;
- The model cannot be applied to dam-break type of flows.

NOTE: There are also available 2-D and 3-D versions of the CCHE computation model.

E. CONCLUSIONS AND RECOMMENDATIONS

Based on the information obtained at this development phase of the study, the following conclusions and recommendations are made:

4. Several types of models could be developed for Burns Ditch/Waterway watershed to help address the various types of interests/concerns. An important aspect that could decide the type of model that would be prepared for the study case is what type of information are expected to be obtained from the model:

    - Sediment transport?
    - Water quality?
    - Economic benefits from the management measures taken in the watershed?
    - Qualitative or quantitative results?

    Each of the above-mentioned categories would require a specialized model that could address the specific problems. In addition, the available data and the capability of the user/users operating the model are important factors in determining the type of model that should be developed for the study area.

1. **Stakeholder Concerns.** The main functions of the future sediment transport model for Burns Ditch/Waterway watershed were discussed at the meeting with the stakeholders[22] and during the site visit (May 7 and 8, 2003),. The stakeholders presented a broad list of diverse concerns and issues. However, the majority of these issues were not strictly related to the sediment transport issue. It appears that the stakeholder concerns tended to be of general aspects regarding especially the impact of development and various stormwater management practices and erosion control measures on the sediment and erosion processes. In addition, no specific sites or channel reaches were identified as critical, that would impose a detailed sediment transport modeling.

5. **Data Availability.** Based on the review of the existing data and documentation consulted as part of the first-phase of this study, very limited information is available regarding the channel cross-sections for Burns Ditch and its main upstream tributaries. In addition, practically no data is available regarding the sediment characteristics on various locations of Burns Ditch Watershed. These facts are serious limitations for developing a detailed sediment transport model for entire watershed.

6. **End User Capabilities.** The most likely end users of the model appear to be regional and State agencies (NIRPC and IDEM). These agencies appear to have relatively strong GIS capabilities but may not have experience in detailed local level sediment transport modeling.

2. **Model Recommendations.** Considering the stakeholder concerns, the available data and the capabilities of the end users, development of a general/global model (i.e. *macro-scale model*) for entire watershed to be used primarily as a planning tool is recommended. The best model choice is the EPA's **"BASIN"** software or "**BasinSoft**"[23] (which has the several advantages over the "classical" BASIN, as previously presented).

7. Once one or more site specific, localized problem areas are identified, one or more local-area models (i.e. "*operational tools*") should be developed for more quantitative analysis of specific sediment concerns. The **HEC-6** computation model is recommended for this purpose. Operation of this type of model will likely require additional technical assistance to ensure high quality results.

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[22] "*A Sediment Transport Modeling Workshop for the Burns Ditch/Waterway Basin*", Northwest Indiana Regional Planning Commission", Portage, IN, may 7-8, 2003
[23] The PixSell (proprietary) or USGS versions

8. ***The global watershed model*** (i.e. the "*macro-scale model*") could be developed using GIS techniques to delineate the drainage boundaries using digital topographic contours, incorporate land use within the component watersheds and estimate the watershed characteristic parameters necessary for the hydrologic and hydraulic components of the models. Integrated GIS system for evaluating stormwater BMPs could be developed using the ArcView software that incorporates hydrologic, water quality input data, and BMP models. This model could be used to analyze the effectiveness of different BMPs. Most, if not all of the basic data required for the development of this type of model appears to be available from public sources.

9. ***For the local sediment transport modeling***, several data are extremely important:

   - *Cross-sections of the channel* along the *main stem* and *main tributaries* (floodplain areas can be taken from the available maps).
   - The relation between the *sediment load* (tons/day) *versus water discharge* (cfs) for the upstream boundaries of the main stem, tributaries and at each main local inflow points, as shown on Figure 5 in Attachment E.
   - The relation between the *sediment discharge* (tons/day) *versus water discharge* (cfs) *for various sediment types and sizes* (i.e. fine, medium and coarse sand, etc) as shown on Figure 6 in Attachment E.
   - *Sieve analysis of sediments* that form the *channel bed* for the *main stem* and *tributaries*.
   - *Variation of sediment transport with the sediment grain size*, as shown on Figure 7 in Attachment E.

10. Since very limited data of these types are available in the documentation reviewed to date (see attachment A), additional field data collection would be necessary in Burns Ditch Watershed. A preliminary field data plan is attached at the end of this report. The locations where the field data would be collected should be determined by the end-users of the proposed models, as function of the major erosion and sediment related concerns that will be identified in the Burns Ditch Watershed.

3. Because no specific location was identified, up to the present, as an area of major concern regarding erosion or sediment related problems, it is suggested that a specific sediment transport model be developed for ***the lower part of Burns Ditch channel***, downstream of confluence with Deep River to Burns Waterway Harbor (reach **A-B-C** on Figure 1), which summarizes the effects of all actions in the upper watershed. In addition, the amount of field data collection for this reach would be significantly less than for any other area taking into account that, on this reach, there are already available some detailed topographic data (i.e. channel cross-sections on reach A-B, as shown on Figures 6 and 7), and a comprehensive monitoring and data collection program for the above-mentioned reach is already in progress as part of the Indiana Geological Survey (IGS) project "Monitoring and Forecasting Outfalls of Streamflow Contaminated by *E.coli* at Portage-Burns Waterway ("Burns Ditch"), Indiana"[24]. Even if this program does not contain collection of the specific parameters that are necessary for a detailed sediment transport model, it is suggested that the actual monitoring and data collection plan to be supplemented with the collection of additional data, as needed for a sediment model, through appropriate agreements between the involved agencies. The necessary additional data are mentioned in the attached Preliminary Data Collection Plan.

11. In the future, if other area(s) will be identified with sediment related problems of concern, specific sediment transport model(s) could be developed as needed. However, sediment, hydraulic and topographic characteristic parameters would need to be collected for these areas, before the sediment transport model will be developed.

[24] http://igs.indiana.edu/survey/project/burns_web/index.cfm

F. PRELIMINARY DATA COLLECTION PLAN

For the Burns Ditch Channel Downstream of Confluence with Deep River (Reach A-B-C)

0. Topographic data (cross-sections) for the channel reach B-C (see Figure 1) with the same relative distance between the cross-sections as for the existing cross-section on reach A-B (see Figures 6 and 7).

0. Topographic maps (one to two foot contour intervals, if available) for the area downstream of confluence with Deep River (reach A-B-C) that will be used for flood plain modeling.

0. The existing FEMA (flood insurance maps) and USGS maps of the modeled area.

0. Construction data for the major structures existing of the considered channel reach (i.e. bridges, inlets, outfalls, bank protection works, pump stations, etc.).

0. Hydrologic and hydraulic data regarding the characteristic maximum discharges, characteristic discharge hydrographs (i.e. maximum, mean and minimum discharge hydrographs), existing vegetation in the flood plain and estimation of the roughness coefficients for reach A-B-C.

0. Identification of the main inflow locations into the Burns Ditch main channel (tributaries and man-made channels).

0. Characteristic discharges (as mentioned in item 5) on each major tributary at the confluence with Burns Ditch (i.e. East Branch of Little Calumet River, West Branch of Little Calumet River and Deep River - see Figure 1) or inflow/outflow points.

0. Field data collection for characterization of sediment transport on the modeled reach consisting in:

   . *Sediment sampling from the main channel bottom*, in 3 – 5 locations along each reach A-B and B-C (total 6 to 10 locations for entire reach A-B-C). For each sampling, a *complete grain size analysis* (i.e. *sieve analysis*) and the *bed material gradation* (i.e. "*percent finer*") need to be performed.

   . For each channel reach (i.e. A-B and B-C), in *at least two locations* (i.e. upstream and downstream ends of each reach) *minimum two suspended sediment samples* should be taken *each week for a whole year period*. These samples will be analyzed for:
   - Suspended sediment size.
   - Suspended sediment concentration related to the water discharge (mg/liter or lb/cfs).
   - Variation in time of sediment concentration for a 12 months period (monthly average sediment concentration – mg/l or lb/cfs per month).

   . Same data, as mentioned above, need to be collected on each major tributary (i.e. East Branch of Little Calumet River, West Branch of Little Calumet River and Deep River (see Figure 1), approximately 100 – 200 feet upstream of the confluence with Burns Ditch.

. The data mentioned above, in item **b** and **c,** would be also collected after each major rainfall/flood events.

. Based on the above field data the following input data for the sediment transport model would be prepared:

- *Variation of sediment transport with the sediment grain size*, as shown on Figure 7 in Attachment E.
- The relation between the *sediment load* (tons/day) *versus water discharge* (cfs) for the upstream boundaries of the main stem, tributaries and at each main local inflow points, as shown on Figure 5 in Attachment E.
- The relation between the *sediment discharge* (tons/day) *versus water discharge* (cfs) *for various sediment types and sizes* (i.e. fine, medium and coarse sand, etc) as shown on Figure 6 in Attachment E.

0. The above-mentioned data are absolute necessary for the development of a sediment transport model for Burns Ditch channel downstream of confluence with Deep River.

For Other Areas that Will be Identified with Sediment related Problems

The above-mentioned data would be needed to be collected, in advance, for any other area that will be identified with potential sediment related problems. The locations of the sediment field data are, generally, after any major tributary or inflow point confluence. Specific locations will be determined as function of each identified area and the problem involved (i.e. general erosion or sedimentation in the channel, bank erosion, channel meandering process, etc.). A minimum one year period length for field data collection would be necessary for each identified area.

ATTACHMENT A

EXISTING DOCUMENTATION
RELATED TO
BURNS DITCH WATERSHED

ATTACHMENT A

EXISTING DOCUMENTATION RELATED TO BURNS DITCH WATERSHED

1. Little Calumet and Burns Ditch TMDL for E.coli Bacteria, DO, Cyanide and Pesticide, Data Report, October 2002 / Revised December 2002 – Prepared by "E" for Indiana Dept. of Environment Management.
2. Little Calumet-Galien / Watershed Summary Information - Burns Ditch, Deep River Little Calumet River, Galien River, Salt Creek
3. Effective Sediment Management (Baird), The Military Engineer, No.623, May-June 2003
4. Land Use and Gross Soil Erosion for Lake George Watershed
5. Deep River Watershed Trip Report / USDA-Soil Cons. Service, Indiana - May 31, 1983 (Lake George Working Files)
6. Deep River/Turkey Creek Watershed Management Plan (June 2002)
7. St. Joseph River Sedimentation Modeling Scoping Study (March 2003)
8. Clinton River Watershed-Sediment Transport Modeling - Phase I – Scoping Study
9. Burns Waterway Harbor Sediment Sampling – Field Report – June 11, 2001
10. Final Report – Collection and Analysis of Sediment Samples from Lake George, Hobart, Indiana, Dec. 1992
11. Little Calumet River – Indiana – Hydrologic and Hydraulic Analyses – February 1994 (Chicago District of COE)
12. Lake George, Hobart, IN – Planning/Engineering Report (Draft) 1995/ COE-Chicago District
13. Indiana Lake Michigan – Coastal Program – Scoping Document 2001
14. Lake Michigan – Lakewide Management Plan 2000
15. Indiana Lake Michigan – Coastal Program (14a/14b)
16. Indiana Dunes – A Natural Wonder / Porter County, IN.
17. NIRPC – List of References provided by NIRPC (Laura Kaminski)
18. Modeling Tools for the Stormwater Manager (Basin Model) / Stormwater, March 2002
19. Summary of Technical Workshop – Great Lakes Sediment Management Program – Chicago, March 18-19, 1998.
20. a. Burns Ditch @ Portage, IN – Real-time Data (stage-discharge)
    b. Condition of Channel (April 2001) – Cross-Sections
    c. Deep River – Burns Ditch (Lake County) – DNR/Discharge Graph
21. Watershed Restoration Action Strategy for the Little Calumet-Galien Watershed (2002)
22. Lake Michigan Shoreline TMDL for E.Coli Bacteria / Data Report – December 2002
23. Parameters of Concern for Indiana (2002-303 list
24. Water Quality Assessment – EPA consolidated Methodology
25. 1998-303 (d) List of Impaired Waterbodies (Indiana)
26. Indiana Geological Survey – Projects (Maps)
27. Great Lakes Commission -The 2003 Great Lakes Program (To ensure Environmental and Economic Prosperity)
28. IDEM-Office of Water Quality – Total Maximum Daily Load (TDML) Program Strategy
29. Water Resources of Porter County, IN
30. IDEM – Indiana Surface Waters
31. Impact of TDML on Indiana Surface Water Quality Monitoring Program (April 2000)
32. Hydrologic History of the Lake Michigan in Indiana
33. Data Shortage Plagues Little Calumet Study (Chesterton Tribune – 12-13-2002)
34. Indiana – Geological Survey

35. Watersheds in the Great Lakes Region
36. Soil Erosion and Sedimentation in the Great Lakes Region
37. Lake Michigan Mass Balance
38. How Much Pollution can Lake Michigan Handle? (Chesterton Tribune 12-11-2002)
39. USGS Programs in Indiana
40. References for Burns Ditch Indiana (www.Google.com)
41. The Battle for the Indiana Dunes
42. Others' Experience: Notes on Watershed Management (Maryland DNR)
43. Memo from COE/VWIRPC for the "Sediment Transport Modeling Workshop" and the Stakeholders Meeting held in Portage Indiana on 05-07/08-2003.
44. Coffee Creek Watershed Management Plan and Appendices.
1. National Soil Erosion Research Laboratory: Water Erosion Prediction Project (WEPP)[25]
2. GeoWEPP – a program linked with ArcView 3.0GIS (beta version for evaluation only)[26]
3. NRCS maps with total wind and water erosion (1997)[27]
4. GIS for Lake, Porter and LaPorte Counties in Indiana (land use, USGS stream gages, etc)[28]
45. Description of BASINSOFT, a Computer Program to Quantify Drainage-Basin Characteristics, by Craig A. Davis and David A. Eash
5. ECOMSED, a hydrodynamic and sediment transport software developed by HydroQual, Inc.[29]
46. HEC-6: Section A2-Sediment Properties And Transport Functions
47. Documentation for the following software: WMS-7.0, GSSHA, HEC-HMS, BASINS, BasinSoft, SWMM, HEC-6-4.1, CCHE-1D.
48. HEC-2 Model for Hart Ditch from Munster gage to Little Calumet River (current 2003 conditions)
49. CD-Burns Ditch Data Search (COE-Chicago District)

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[25] http://topsoil.nserl.purdue.edu/nserlweb (for information, technical support and free download)
[26] http://www.geog.buffalo.edu/~rensch/geowepp/download.html
[27] http://www.nrcs.gov/technical/land/meta/m5112.html
[28] http://igs.indiana.edu/arcims/lrim/index.html
[29] www.hydroqual.com/ecomsed

ATTACHMENT B

NIRPIC
VARIOUS AGENCY DOCUMENTATION
FOR THE STUDY AREA

AGENCY STRATEGIES & ASSESSMENTS

Unified Watershed Assessment, IDEM-NRCS-IDNR-USGS-Purdue Univ.-ORSANCO-EPA..1998,1999, 2000, & 2001. *Information on the Clean Water Act.* (H)

Kankakee River Watershed Restoration Action Strategy, IDEM. 2001. *It gives a description of the watershed and recommendations.* (H)

Surface Water Quality Monitoring Strategy 2001-2005, IDEM. 2001. *This document focuses on a watershed approach for addressing water quality issues.* (H)

Strategic Plan for Water Resource Management, Northeastern Illinois Planning Commission. 2001. *This document describes the planning process, stormwater & Flooding, Water Quality, Water Supply, and Cross-Cutting Issues* (H)

Indiana Wetlands Conservation Plan, IDNR. 1996. *This plan includes a wetlands definition, goal, guiding principles, wetlands conservation priorities, and case studies of wetland conservation partnerships already started.* (H)

Surface Water Quality Monitoring Strategy, IDEM. 2001. *A strategy report on water quality monitoring* **Note:** Its is in the Water Quality file, in the IDEM folder (E)

Watershed Restoration Action Strategy for the Little Calumet-Galien Watershed. Indiana Department of Environmental Management, Office of Water Quality. 2002 (H) and (E)

Funding

Environmental Monitoring for Public Access and Community Tracking, EPA. *The goal of Environmental Monitoring for Public Access and Community Tracking (EMPACT) is to provide public access to clearly communicated, time-relevant (timely or real time), useful, and accurate environmental monitoring data in an ongoing and sustainable manner in 86 of the largest U.S. metropolitan areas.* (H)

Pollution Control Loans, SBA. *The Small Business Administration's (SBA) Pollution Control Loans are intended to provide loan guarantees to eligible small businesses fro the financing of the planning, design, or installation of pollution control facilities.* (H)

Clean Vessel Act Grant Program, U.S. Fish and Wildlife Service. *The program provides grants to coastal states for surveying and planning pumpout/dump stations for wastewater.* (H)

Chemical Emergency Preparedness and Prevention Technical Assistance Grants, EPA. *The Chemical Emergency Preparedness and Prevention (CEPP) program provides financial assistance to states, local agencies, and Indian tribes for (1) chemical accident prevention activities that relate to the Risk Management Program under Clean Air Act section 112(r), (2) chemical emergency planning, and (3) community right-to-know programs that are established to prevent or eliminate unreasonable risk to the health and environment of communities.* (H)

Pesticide Environmental Stewardship Grants, EPA. *The Pesticide Environmental Stewardship Program (PESP) forms voluntary partnerships with pesticide users to reduce the risks from pesticides in agricultural and non-agricultural settings, and implement pollution prevention measures.* (H)

Pollution Prevention Incentives for States, EPA. *This grant program provides project grants to states to implement pollution prevention projects.* (H)

Watershed Protection and Flood Prevention Program, USDA. *This program provides technical and financial assistance to address resource and related economic problems on a watershed basis.* (H)

Transportation Equity Act for the 21st Century-Funding Programs, DOT. *This program funds numerous transportation programs to improve the nation's transportation infrastructure, enhance economic growth, and protect the environment.* (H)

Land and Water Conservation Fund Grants to States, DOI. *This program uses offshore leasing revenues to support the creation of state and local park and recreation areas that guarantee perpetual public outdoor recreation opportunities.* (H)

Funding

State Nature Preserve Dedication, IDNR Division of Nature Preserves. *Acquisition and management of threatened habitat* (H)

Forestry Incentive Program, NRCS. *The Forestry Incentives Program (FIP) supports good forest management practices on privately owned, non-industrial forest lands nationwide. FIP is designed to benefit the environment while meeting future demands for wood products.* (H)

State of Indiana Total SRF Drinking Water Loans Closed, 1998-2000. *List of communities and amounts for SRF loans* (E)

Stat of Indiana Total SRF Clean Water (Wastewater) Loans Closed, 1991-2000. *List of communities and amounts for SRF loans* (E)

Grant Activity, *List of current grants with the organization, cycle, amounts, and project specification* ***Note**: This is in the database file under *Grant Activity* (E)

Guidance & Rules

Guidelines for Preparing Quality Assurance Projects Plans (QAPPs) For Section 319 Projects, IDEM. 2001. *This document is about procedures for QAPP* (H), (E)

Watershed Action Guide for Indiana-Straight Talk on Developing Watershed Plans, IDEM. 1999. *It provides guidelines for watershed plans* (H),(E)

National Planning Procedures Handbook, USDA. 1996. *It provides guidance for NRCS planning* (H)

Watershed Inventory Workbook for Indiana, NRCS & Purdue University. 2002. *This document describes what should go into a watershed report* (H)

Recreational Uses & the Natural Environment in the Area of Concern, Northwestern Indiana Planning Commission, 1992. *It's a report of municipal, county, state, and federal park lands* (H)

Low-Flow Characteristics of Indiana Streams, IDNR & USGS. 1996. *This document shows water flow characteristics* (H)

Executive Order 11988--Floodplain Management, National Archive and Records Administration Federal Register. Reprinted 2001. *It's a law concerning the impact of floods* (H)

Draft Rule #01-96(WPCB), Title 327 Water Pollution Control Board. 2002. *It's a document dealing with the new Phase II program* (H)

Water Resource Availability in the Kankakee River Basin, Indiana, IDNR. 1990. *This report describes the availability, distribution, quality and use of surface water and ground water in the Kankakee River Basin, Indiana.* (H)

Water Resource Availability in the Lake Michigan Region, Indiana, IDNR. 1994. *This report describes the availability, distribution, quality and use of surface water and ground water in the Lake Michigan region* (H)

Draft Rule #01-96(WPCB), Title 327 Water Pollution Control Board. 2002. *This is the completed document dealing with the Phase II program* (H)

Developing a Watershed Management Plan for Water Quality, Michigan State University & DEQ. 2000. *Things to do to manage a watershed* (H)

Protecting and Restoring America's Watersheds, EPA. 2001. *Info about addressing watershed problems* (H)

Guidance & Rules

Congressional Record House, 2000. *This is an act describing the best management practices for CSO's* **Note:** In the CSO LTCP Guidance file named *2001 wetweatherwqact* (E)

Combined Sewer Overflow (CSO) Long-Term Control Plan Use Attainability Analysis Guidance, IDEM. *It is a report on the guidance of CSO's* **Note:** In CSO LTCP Guidance file named *cso guidanceRev917* (E)

CSO Permit Update, *A list of the various communities and their status of CSO permits with various data* **Note:** In CSO LTCP Guidance file under the name *csotrad062002* (E)

Management Measure Program Framework and Objectives #1 to #12, EPA. *Runoff management program* **Note:** In the EPA Stormwater Manual file (E)

Urban Stream Restoration Practices: An Initial Assessment. October 2000. Center for Watershed Protection for USEPA Office of Wetlands, Oceans, and Watersheds. (H)

The Stream Protection Approach: Guidance for Developing Effective Local Nonpoint Source Control Programs in the Great Lakes Region. January 1994. Center for Watershed Protection for the Metropolitan Washington Council of Governments. (H)

Septic Systems 1-2-3 (Video). Produced by the Michiana Council of Governments (MACOG) 2002. (11:45 minutes)

Estimating Load Reductions for Agriculture and Urban BMPs (Online Worksheet) Indiana Department of Environmental Management (H)

Community Culture and the Environment: A Guide to Understanding a Sense of Place. U.S. Environmental Protection Agency. 2003 (H)

Watershed Restoration Toolkit: A Citizen's Guide to Improving Water Quality. Hoosier Environmental Council. 2002 (H)

Tools to Measure Source Control Program Effectiveness, Final Report. Water Environment Research Foundation. 2000 (H)

Opportunities for Water Resource Protection in Local Plans, Ordinances, and Programs: A Workbook for Local Government. Southeast Michigan Council of Governments. August 2002 (H)

Ordinances

Chapter 700 Stormwater Quality Guidance, Indianapolis, IN. 2001. *Best management practices for water quality* (H)

Subdivision Control Ordinance, Town of Burns Harbor, IN. *Ordinance of rules about obtaining land* (H)

Zoning Ordinance, Town of Burns Harbor, IN. *Ordinance gives procedures to follow when excavating or filling any sand, soil, earth, or any other material form or to the surface of any land* (H)

Development in Flood Hazard Areas, Portage,IN. *Document stating that all construction of buildings, subdivisions,etc. must be reviewed* (H), (E)

Ordinance Summary Board of Zoning Appeals Procedures, Town of Pines, IN. 1999. *Ordinance of regulations* (H)

Indiana Model Ordinance for Flood Hazard Areas, DNR. *Model ordinance to guide development in flood hazard areas* (H)

Portage Ordinance, City of Portage. 1992. *Technical guide for drainage* (H)

Lake County. March 2000. *Code of Ordinances* Volumes I & II. Local legislation current through Ord 1198D, passed 12-14-99; Burns Indiana Statutes current through Phamphlet No. 3, March 2000. (H)

Reports & Studies

Trail Creek Natural Resource Plan, NIRPC, LaPorte SWCD, and Trail Creek Improvement Plan Steering Committee. 1993. *Plans and general information on Trail Creek* (H)

Suspended Sediment in Trail Creek at Michigan City, Indiana, USGS and Army Corps of Engineers. 1992. *Suspended sediment information about Trail Creek* (H)

Kankakee River Basin Special Report Land Treatment Study Lake County, Indiana, Lake SWCD, USDA, Forest Service, Economic Research Service, Agricultural Stabilization and Conservation Service, State SWCD, IDNR, and Kankakee River Basin Commission. 1984. *Problems and concerns of soil erosion and sedimentation* (H)

Michigan City Harbor and Trail Creek Sampling and Analysis at Michigan City, IN, U.S Army Corps of Engineers. 1992. *Sample analysis of Michigan City Harbor and Trail Creek, Vol. 1 & 2* (H)

Environmental Assessment for Ongoing Repair of North and West Breakwaters at Burns Harbor, Porter County, IN, U.S Army Corps of Engineers. 2002. *Improvements to the harbor and possible consequences* (H)

Toxics Release Inventory-All of Indiana, Porter County, LaPorte County, and Lake County (Data), EPA.1997,1998,1999, and 2000. *The amounts of chemicals released by industry for all four years* (H),(E)

2000 Toxics Release Inventory-All States and All of Indiana, EPA. 2000. *Explanation of TRI and the amounts of releases in pounds of waste management material, chemicals, and waste material by facility name,city and county* H), (E)

Proposed Grand Kankakee Marsh National Wildlife Refuge-Draft Environmental Assessment, U.S. Fish & Wildlife Service. 1998. *A report showing the need for action to improve the Kankakee River Basin* (H)

Kankakee River Master Plan, Kankakee River Basin Commission. 1989. *Inventory and analysis of the Kankakee River* (H)

Great Lakes Strategy 2002, US Policy Committee for the Great Lakes. 2002. *Strategic plan for the ecosystem of the Great Lakes* (H), (E)

Indiana Fixed Station Statistical Analysis 1997, IDEM. 1998. *Report of surface water chemistry of IN* (H)

Kankakee River Basin Indiana, IDNR and USDA. 1976. *Physical data of the basin* (H)

Reports & Studies

Survey Sec Assessment Branch, IDEM. *This is a folder in the Water Quality file, and then the IDEM folder. It has spreadsheets of data on rivers, streams, and Lake Michigan dealing with water quality, general chemicals in the water, metals in the water, organics in the water, and pesticides in the water* (E)

CWP, *This folder is in the Water Quality file and contains various reports dealing with flood tolerance of woody species, housing density as indicators, better urban watersheds, indicators for streams, microbes and urban watersheds, performance of stromwater wetland in winter, rooftop runoff, stream and wetland buffers, suspended and deposited sediment, tools for watershed protection, urban pesticides in streams, and vegetation for salt impacted roads* (E)

Gary Sanitary District, *This folder in the Water Quality file contains stream reach characteristics and evaluation reports for the Little Cal River in the Gary, IN district. The report is taken in dry weather, wet weather, and CSO events.* (E)

Watershed Management Plan for Turtle Creek and Little Turtle Creek, Partnership for Turtle Creek. 2002. *Management plan for turtle creek* **Note:** Watershed Plans file (E)

An Assessment of Sediment Injury in the Grand Calumet River, Indiana Harbor Canal, Indiana Harbor, and the Nearshore Areas of Lake Michigan, USGS,MACDONDALD, INDUSTRIAL ECONOMICS INC. *Report on the investigation to determine sediments have been injured* (E), (CD)

Chemical, Physical, and Toxicological Characterization of Roxana Marsh, U.S Fish & Wildlife. 2002. *Laboratory and field data* (H), (E)

E.Coli Task Force Data, *Various reports on non-point source monitoring and CSO related rainfall events for Lake, Porter, and LaPorte counties* (H)

Geohydrology, Water Quality, and Simulation of Ground-Water Flow in the Vicinity of a Former Waste-Oil Refinery near Westville, Indiana, 1997-2000, USGS. 2002. *Report* (H)

Biodiversity at Sunset Hill Farm County Park: Present Status, Value and Prospects. Cortwright, S., O'Brien, S., Dancy, H. 2000 (H)

Geological Investigations of Sunset Hill Farm Park, Porter County, Indiana. Fisher, T.G., Brown, S.E., April 24, 2000. (H)

Priority Substances List Assessment Report – Road Salts. Environmental assessment of road salt and deicing application and practices. Environment Canada, Health Canada. 2001. (H)

Water

Upper Illinois River Basin Study Home Page, USGS. *Data on the Upper Illinois River Basin* (E)

Testing the Waters- A Guide to Water Quality at Vacation Beaches, NRDC. 2002. *Indicator organisms for pollution in water bodies* (H)

Water Withdrawal, DNR. *A list of who draws water and from were* (H)

Stormwater Strategies, NRDC. *This CD documents the most effective strategies to control urban runoff pollution* (CD)

Desdemona's Splash, CTIC. *This CD is a game to teach you what happens to water quality when it rains in areas like the city, neighborhood, or farm.* (CD)

The Practice of Watershed Protection, CWP. *This CD gives techniques for protecting our nation's streams, lakes, rivers and estuaries.* (CD)

River Bank, GREEN. *This is a stream and river monitoring database for monitoring data input and storage. It also has a field sheet set-up.* (CD)

Watershed Diagnostic Study of the Little Calumet-Galien River Watershed, NOAA and Lake Michigan Coastal Program. *It provides information on the Little Calumet-Galien watershed* (CD)

Indiana Lake Michigan Coastal Program Document & Draft Environmental Impact Statement, NOAA, INDNR, and Indiana Lake Michigan Coastal Program. *This is a draft environmental impact statement.* (CD)

Lake Michigan Coastal Coordination Program, Eppley Institute for Parks & Public Lands at Indiana University. *This is a coastal recreation study of the Lake Michigan Watershed.* (CD)

Hydro geologic Atlas of Aquifers of Indiana (Lake Michigan and Kankakee basins only), USGS. Water Resources Investigations Report 92-4142. *Provides geologic information for the basins.* (CD)

Water Management Basin Data, 1986 to 1997. *Water withdrawal rates for the Lake Michigan Basin, Kankakee River Basin, and other basins in IN* **Note:** In Water Quality file, under *Graphics folder* (E)

Agriculture

Registered Compost for Indiana, IDEM. 1998 to 2000. *All registered compost* (H), (E)

Agricultural Chemical Usage 2001 Field Crops Summary, Agriculture Statistics Board, NASS, and USDA. 2002. *In this packet is data on the amounts of herbicides and insecticides used on corn and soybeans in Indiana. It also has the amount of nitorgen, phosphate, and potash used on soybeans as fertilizer. Also is the percentage of IN corn fields receiving pest management practices and what those practices are. *Note: Use this information with the farm acreage(see Agriculture Inventory) to find out how much pesticide/fertilizer is used on each farm the Lake, LaPorte,and Porter counties.* (H)

Conservation Tillage and Water Quality, Purdue University Cooperative Extension Service. 1995. *It describes what tillage is, its impacts, and summaries of effects, and a general summary.* (H), (E)

Chemical Usage, Agricultural Statistics Board NASS, USDA. 2001. *It shows the amount pesticides used for each crop in IN* (H)

Agricultural Waste Management Field Handbook Part 651-Chapter 11 Waste Utilization, USDA. 1996. *This document gives information on animal waste consistency, land application, salinity, plant nutrients, nutrient management, and also tables and graphs describing this data.* (H)

Agricultural Waste Management Field Handbook Part 651-Chapter 3 Agricultural Wastes and Water, Air, and Animal Resources, USDA. 1996. *Affects of animal waste on various resources* (H)

Agricultural Waste Management Field Handbook Part 651-Chapter 6 Role of Plants in Waste Management, USDA. 1996. *The use of agricultural waste as a resource for plant growth* (H)

What Soil Erosion Means to Land Productivity, Purdue University Cooperative Extension Service. *It describes soil erosion and what it does* (H), (E)

Turkey, Seeding, and Farmland Information in LaPorte County, IN, DNR. *This is a fax of the estimated population of turkeys in LaPorte county, amounts of farmed fields and their crop, acreage refuge, amounts of seeding and acreage to attract turkeys, turkey harvest data and hunter data, and a rough map of the total area we are dealing with.* (H)

Maps

Lake County, *A map of what tributaries drain into the Little Calumet Watershed or the Kankakee Watershed* (H)

LaPorte County, *LaPorte County drainage map, and an assessment of each ditch/drain with it's SA Code, tax year, annual assessment, balance, sent to/date, and yearly collection.* (H)

All of Indiana, 1998. *303(d) map of impaired waters* (H)

Lake County, 1997 to 2001. *Lake County Drainage Board final budgets* (H)

Gary, IN, 2002. *This is a map of undeveloped and abandoned land in Gary, IN* (includes identification and descriptions of properties(H)

Lake County, *A list of all streams and their locations in Lake County* (H), (E)

Porter County, *A list of all streams and their locations in Porter County* (H), (E)

LaPorte County, *A list of all streams and their locations in LaPorte County* (H), (E)

ATTACHMENT C

MINUTES OF THE
SEDIMENT TRANSPORT MODELING
WORKSHOP

FOR

BURNS DITCH/WATERWAY BASIN

May 7-8, 2003 Portage, Indiana

A Sediment Transport Modeling Workshop for the Burns Ditch/Waterway Basin

Sponsored by: U.S. Army Corps of Engineers,
Great Lakes and Ohio River Division and Chicago District
Assisted by: Great Lakes Commission

Northwest Indiana Regional Planning Commission
Portage, Indiana
May 7-8, 2003

Workshop Participants (May 7, 2003):
A total of 26 participants attended the Sediment Transport Modeling Workshop for the Burns Ditch/Waterway Basin, including representatives from CTE Engineers, Inc., Great Lakes Commission (GLC), Indiana Department of Natural Resources (DNR), Indiana Dunes State Park, National Association of Conservation Districts (NACD), National Park Service Indiana Dunes National Lakeshore, Northwest Indiana Regional Planning Commission (NIRPC), Porter County, Purdue University Extension, Save the Dunes Council, Army Corps of Engineers (ACOE) Chicago District and Great Lakes and Ohio River Division, and U.S. Department of Agriculture Natural Resources Conservation Service (USDA - NRCS). See updated Participant List (Appendix A).

Workshop Summary (May 7, 2003):
Sarah Whitney (GLC) opened the workshop by welcoming the participants and outlining the goals for the day, which included developing a list of sedimentation problems and other issues related to the Burns Ditch/Waterway, identifying past and present watershed initiatives and potential data sources, developing model outcomes and objectives, brainstorming potential users of the model and their capabilities, and discussing potential organizations that might be interested in housing the model. See Agenda (Appendix B).

Jan Miller (ACOE) introduced Section 516(e) of the Water Resources Development Act (WRDA) of 1996, the legislation outlining the Tributary Modeling project. Section 516(e) directs the Corps to develop sediment transport models for all major Great Lakes tributaries contributing sediment to Federal navigation projects or Areas of Concern (AOCs). These models are to be used as tools by state and local agencies to evaluate options for soil conservation, non-point source pollution prevention, dredging and dredged material disposal needs, Remedial Action Plans (RAPs), and Lakewide Management Plans (LaMPs). Long term benefits of the modeling project include: applying a watershed approach to sediment management, supporting and enhancing measures that will reduce loadings of sediments and pollutants to tributaries, reducing the costs of navigation maintenance, and reducing the need for sediment remediation.

The tributaries where models will be developed were prioritized in cooperation with each state. Three of the approximately 100 tributaries to be modeled are located in Indiana. The ACOE works with the state/local stakeholders in the development of the models to determine what this model will be like and to be able to use it as a tool to support local watershed management efforts. Once the model is complete, the ACOE transfers the model to the state/local stakeholders.

Comment: Dredging waterways before implementing land treatment practices to reduce sedimentation may be fighting a losing battle.
Response: This program provides the tools to determine how to keep soils on the land.

Comment: Local communities need a model to help predict the effectiveness of conservation practices in a manner that the public can understand.

Q: Can the model show the effects of first flush – the concept that most soil comes off the land during the first ¼ inch of rainfall?
A: This could be a subcomponent of the model.

Q: Have past models been used to quantify the effectiveness of conservation practices?
A: Yes, the Ohio DNR is using a model to show the effects of buffer strips.

David Bucaro (ACOE) provided an introduction to the ACOE Burns Ditch/Waterway 516(e) effort by discussing the goals of the model, the basin characteristics, possible problem areas, sedimentation areas, and sedimentation sources, potential affected users of the model, and the next steps involved with the ACOE modeling effort.

Possible problem areas within the basin were listed as sedimentation from Lake George, the creation of new marina(s) at the mouth of the East Little Calumet, maintenance dredging of the Burns Waterway, the small Burns boat harbor at the mouth of the Burns Waterway, and sedimentation from the Burns Waterway into Lake Michigan.

Possible sedimentation sources that exist for the basin are Lake George during flooding events, agriculture fields in La Porte and Porter Counties, combined sewer overflows, erosion of watercourse banks, and sand movement from Lake Michigan. Additional sources identified by the participants are subdivisions and large construction projects in the area which remove the vegetation and increase erosion.

Potential affected users of the model include the ACOE for dredging Federal Navigation Channels and Harbors, the owners and users of inland marina(s) through the Burns Waterway, upstream municipalities relying on drainage, adjacent land owners, and restoration and preservation interest groups. Other groups that might be interested in the modeling effort are those required to perform TMDLs in the near future, those applying for Stage II stormwater permits, and future developers of areas near and around sedimentation problem areas.

The ACOE is currently gathering information on problems and sources of sedimentation and erosion within the basin, as well as identifying interested parties and their needs related to the modeling effort. Next steps for this process include determining a plan for the tool, creating a useful tool that will be used, and presenting, training, and turning over the tool to be used for positive change within the basin.

The meeting then progressed into a roundtable discussion involving the workshop participants for the remainder of the morning session and most of the afternoon session. The focus of the discussion was to respond to the goals for the day. During the morning session, the workshop participants listed the relevant programs represented by their organizations as well as other programs or parties that were not represented at the workshop. See Appendix C.

After a lunch break, Ken Dallmeyer (NIRPC, Director of Transportation Planning) provided a brief presentation on NIRPC's transportation projects and how they may relate to sedimentation issues in the basin.

The remainder of the afternoon session was dedicated to roundtable discussion by the workshop participants. Topics covered during the discussion included creating a wish-list of ideal questions for the model to answer (perfect black box scenario), categorizing the ideal questions into broader goals for the model, prioritizing the goals for the model, brainstorming who the potential users of the model might be, and listing relevant data that already exists within the basin. See Appendix C.

Based on the brainstorming efforts of goals for the model, workshop participants worked to narrow the focus of the model. The resulting priorities for the model included the prediction of land use impacts and BMP evaluation. These priorities will provide focus as the model is developed. However, during the discussion it was also noted that from a modeling perspective, certain objectives such as identifying a sediment budget must first be met by the model before other relationships can be analyzed. The group acknowledged that the actual process of creating the model may lead to new perspectives and, thus, the plans for building the model should remain flexible at this point.

Before adjourning for the day, Sue Davis (ACOE) and David Bucaro (ACOE) provided the group with a brief summary of the next steps for the modeling effort for the Burns Ditch/Waterway. The Great Lakes Commission will compile minutes for the meeting and post them to the project website. An email will be sent out to all workshop participants and other interested parties at that time, notifying them of the posting. The project website will be updated periodically with any new information or announcements related to the effort.

The ACOE and/or CTE Engineering, Inc. will be following up with workshop participants and other contacts to obtain and evaluate any available existing data. This may involve conference calls or smaller meetings to coordinate the effort among multiple parties and to ensure the most complete data is obtained.

It is predicted that Phase I of this effort will be completed by the end of September 2003, and will include several proposed models based on the available data gathered during this phase and a draft plan for the continuing effort. Once the draft plan is available, a second meeting will be held with local stakeholders and interested parties for questions and comments on the plan (possibly held later this summer or early fall).

Workshop Summary (May 8, 2003):
Participants met at NIRPC on the second day of the workshop for an informal driving tour of portions of the Burns Ditch/Waterway watershed, led by Jenny Kintzele (Indiana DNR). Stops on the tour included Portage Marina, Imagination Glen Park (Portage Park Department), and the Indiana Dunes National Lakeshore Heron Rookery. The tour also included views of the Burns Ditch, Little Calumet River, Willowcreek tributary, Salt Creek, agricultural fields, and the Ameriplex industrial development.

Appendix A

Sediment Transport Modeling Workshop for the Burns Ditch/Waterway Basin

Portage, Indiana
May 7-8, 2003

Participants

CTE Engineers, Inc.

Didi G. Duma
Senior Hydraulic Engineer
CTE Engineers, Inc.
303 East Wacker Drive, Suite 600
Chicago, IL 60606
Ph: (312) 861-4199 x.4394
Fax: (312) 938-1109
didi.duma@cte-eng.com

David Handwerk
Project Manager
CTE Engineers, Inc.
303 East Wacker Drive, Suite 600
Chicago, IL 60606
Ph: (312) 861-4199 x.4257
Fax: (312) 938-1109
david.handwerk@
cte-eng.com

Nick Textor
Vice President
CTE Engineers, Inc.
303 East Wacker Drive, Suite 600
Chicago, IL 60606
Ph: (312) 861-4036
Fax: (312) 938-1109
nick.textor@cte-eng.com

Great Lakes Commission

Laura Kaminski
Program Specialist
Great Lakes Commission
Eisenhower Corporate Park
2805 S. Industrial Hwy, Suite 100
Ann Arbor, MI 48104-6791
Ph: (734) 971-9135
Fax: (734) 971-9150
laurak@glc.org

Sarah Whitney
Project Manager
Great Lakes Commission
Eisenhower Corporate Park
2805 S. Industrial Hwy, Suite 100
Ann Arbor, MI 48104-6791
Ph: (734) 971-9135
Fax: (734) 971-9150
swhitney@glc.org

Indiana Department of Natural Resources

Randy Brindza
Indiana Dept. of Natural Resources
Lake Michigan Fisheries Investigation
100 W. Water Street
Michigan City, IN 46360
Ph: (219) 874-6824
Fax: (219) 879-2499
lkmichigan@dnr.state.in.us

Jenny Kintzele
Indiana Dept. of Natural Resources
Division of Soil Conservation
100 Legacy Plaza West
LaPorte, IN 46350
Ph: (219) 362-6633
jkintzele@dnr.state.in.us

Matt Lake
Indiana Dept. of Natural Resources
Division of Soil Conservation
928 S. Court Street, Suite C
Crown Point, IN 46307-4848
Ph: (219) 663-0588
mlake@dnr.state.in.us

Larry Osterholz
Indiana Dept. of Natural Resources
800 S. College Ave.
Rensselaer, IN 47978
Ph: (219) 866-8554 x.123
Fax: (219) 866-5507
losterholz@dnr.state.in.us

Janel Palla
Indiana Dept. of Natural Resources
Lake Michigan Fisheries Investigation
100 W. Water Street
Michigan City, IN 46360
Ph: (219) 874-6824
Fax: (219) 879-2499
lkmichigan@dnr.state.in.us

Indiana Dunes State Park

Caroline Jones
Interpretive Naturalist
Indiana Dunes State Park
1600 N. 25 East
Chesterton, IN 46304
Ph: (219) 926-1390
cjones@dnr.state.in.us

National Association of Conservation Districts

Christa Jones
National Association of Conservation Districts
550 E. Jefferson Street,
Suite 105
Franklin, IN 46131
Ph: (317) 738-3849
Fax: (317) 738-3859
christa-jones@nacdnet.org

National Park Service
Indiana Dunes National Lakeshore

Cheryl Burdett
Biological Science Technician
National Park Service
Indiana Dunes National Lakeshore
1100 N. Mineral Springs Road
Porter, IN 46304
Ph: (219) 926-7561 x.337
Fax: (219) 926-8516
Cheryl_Burdett@nps.gov

Susan Lehmann
National Park Service
Indiana Dunes National Lakeshore
1100 N. Mineral Springs Road
Porter, IN 46304
Ph: (219) 926-7561 x.505
Fax: (219) 926-8516
Susan_Lehmann@nps.gov

Northwest Indiana Regional Planning Commission

Jennifer Gadzala
Northwest Indiana Regional Planning Commission
6100 Southport Road
Portage, IN 46368
Ph: (219) 763-6060
jgadzala@nirpc.org

Dan Gardner
Deputy Director
Northwest Indiana Regional Planning Commission
6100 Southport Road
Portage, IN 46368
Ph: (219) 763-6060
Fax: (219) 762-1653
dgardner@nirpc.org

Porter County

Kevin Breitzke, P.E., L.S.
Porter County Surveyor
155 Indiana Avenue
Valparaiso, IN 46383-5543
Ph: (219) 465-3560
kbreit@porterco.org

Purdue University Extension

Gene Matzat
Conservation Program Specialist
Purdue University Extension
100 Legacy Plaza West
LaPorte, IN 46350
Ph: (219) 324-6303 x.106
ematzat@purdue.edu

Save the Dunes Council

Charlotte Reed
Save the Dunes Council
444 Barker Road
Michigan City, IN 46360
Ph: (219) 879-3937
char@savedunes.org

U.S. Army Corps of Engineers

David Bucaro
USACE – Chicago District
111 N. Canal
Chicago, IL 60606-7206
Ph: (312) 353-6400 x.3041
Fax: (312) 353-2169
David.F.Bucaro@usace.army.mil

Sue Davis
USACE – Chicago District
111 N. Canal
Chicago, IL 60606-7206
Ph: (312) 353-6400 x.3114
Fax: (312) 353-2169
Susanne.J.Davis@usace.army.mil

Jan Miller
USACE – Great Lakes and Ohio River Division
111 North Canal Street, 12th Floor
Chicago, IL 60606-7205
Ph: (312) 353-6354
Jan.A.Miller@usace.army.mil

U.S. Department of Agriculture

Bill Moran
USDA-NRCS
928 S. Court Street
Crown Point, IN 46307
Ph: (219) 663-0588 x.106
Fax: (219) 663-3274
bill.moran@in.usda.gov

Roger Nanney
Soil Conservationist
USDA-NRCS
3001 Leonard Drive, Suite 102
Valparaiso, IN 46383
Ph: (219) 462-7515 x.120
roger.nanney@in.usda.gov

Harvey Nix
USDA-NRCS
3001 Leonard Drive, Suite 104
Valparaiso, IN 46383
Ph: (219) 462-6541 x.109
Fax: (219) 464-3740
Harvey.Nix@in.usda.gov

Charles Walker
USDA-NRCS
3001 Leonard Drive, Suite 104
Valparaiso, IN 46383
Ph: (219) 462-6541 x.108
Fax: (219) 464-3740
chuck.walker@in.usda.gov

Appendix B

A Sediment Transport Modeling
Workshop for the Burns Ditch/Waterway Basin

Sponsored by: U.S. Army Corps of Engineers
Great Lakes and Ohio River Division and Chicago District
Assisted by: Great Lakes Commission

Northwest Indiana Regional Planning Commission
6100 Southport Road
Portage, Indiana 46368

Wednesday, May 7

10:00 a.m.	Welcome, Introductions and Workshop Objectives	Jan Miller, USACE Great Lakes and Ohio River Division, David Bucaro and Sue Davis, USACE Chicago District and Sarah Whitney, Great Lakes Commission
10:15 a.m.	Background and Methodology - Implementing Section 516(e), WRDA	Jan Miller
10:30 a.m.	An Introduction to Burns Ditch	David Bucaro and Sue Davis
11:15 a.m.	Break	
11:30 a.m.	Identification of Sedimentation Problems	All Participants
12:30 p.m.	Lunch	(A buffet style lunch will be served)
1:15 p.m.	Past and Present Watershed Initiatives and Potential Data Sources in the Burns Ditch Watershed	All Participants
2:15 p.m.	Developing Model Outcomes/Objectives	All Participants
2:30 p.m.	Break	
2:45 p.m.	Identification of Potential Users	All Participants
3:45 p.m.	Next Steps	Sue Davis, David Bucaro, and Jan Miller
4:00 p.m.	Adjourn	

Thursday, May 8

We will be gathering at the Northwest Indiana Regional Planning Commission for coffee and breakfast pastries at **8:00 a.m.**

A site tour of the Burns Ditch/Waterway Basin will follow, adjourning by **12:00 p.m.**

Appendix C

Programs Represented by the Workshop Participants (or other relevant programs):

DNR

- Environmental permitting, commenting on permitting
- Soil conservation
- Urban erosion control plans (Rule 5), site inspections for construction
- Education for communities on Municipal Separate Storm Sewer System (MS4) stormwater rules
- Land owner conservation planning, cost-share programs
- Technical assistance for developers in planning stages
- Trying to get to a point where Purchase of Development Rights (PDR) programs are possible
- Needs assessment programs (economics, smart growth, conservation)
- Coastal program
- Restoration projects to address non-point source pollution

Indiana Conservation Partnership – DNR, SWCD, USDA, Purdue Extension

- Tillage system report, crop residue levels, soil loss from agriculture fields
- Tillage transect developed for communities
- Looking at historic trends
- Developing management measures under the Coastal Zone Act Reauthorization Amendments (CZARA) Section 6217 to reduce non-point source pollution and erosion
- Writing management measures for 16 sections to reduce non-point source pollution

USDA

- Developing land owner conservation plans and identify funding sources for implementation (buffer strips, conservation tillage, riparian buffers, stream fencing)
- Public Law 566 – watershed analysis (flood control) – could use data generated by this model
- Resource Conservation and Development (RCD) – multi-county area
- Wetland Reservation Program (WRP)
- CRP
- Environmental Quality Incentive Program (EQIP)
- Farmers eligible for programs if they meet the required BMPs

NRCS

- Can determine changes in erosion after implementation of BMPs

NIRPC

- Plans for watershed; utilization of plans to address water quality and quantity for 3 counties
- Stormwater manual, model guidance, model ordinances for communities
- Stormwater education program for communities to obtain education under MS4
- Transportation – trail development, trail corridors
- Inventory of guidance, reports, comprehensive management plans for 3 counties

Save the Dunes Council

- Coffee Creek Conservancy – land and management plan
- Phase I plans

Programs/Parties Not Represented at the Workshop:

- U.S. Fish and Wildlife
- U.S. Forest Service
- DNR Lake Michigan Specialist
- City Officials (City of Hobart improvements)
- Other Local Entities (Coffee Creek, Chesterton)
- Stormwater Boards of Towns (Valparaiso, Stimson Creek project, Salt Creek)
- Lake County (Improvements to Cady Marsh)
- TMDL for Lake Michigan, Burns Ditch, Little Calumet underway
- La Porte County (TMDLs, Phase II)
- Other Counties (lack of funding)
- Dunes Creek (watershed development just beginning)
- Indiana Department of Environmental Management (IDEM)
- Stimson Drain (Coastal Zone Management project)
- Drainage Boards (each county)
- Public Works Department (Lake County)
- Little Calumet Commission (ACOE Little Calumet project)
- Farm Service Agency
- IN Geological Survey

Questions for the Model (44 total):

- Can it predict where erosion occurs?
- Can it help to create monitoring plans or track the effectiveness of monitoring activities?
- Can it predict the impacts of land use and development on water quality?
- Can it determine percent of soil erosion/pollution occurring from various pathways (agriculture, industry, urban development, wildlife)?
- What is the best BMP to apply to erosion sites?
- What is the effectiveness of applied BMPs?
- What is the effectiveness of previous money spent for BMPs/control practices?
- Can it predict areas that could potentially erode and areas of sedimentation?
- What are the impacts of Lake Michigan water levels on upstream sedimentation and erosion?
- What are the impacts of land use changes on flooding?
- Where can buffer strips be most effectively applied to filter sediments?
- Can it predict future dredging needs in harbor or marinas?
- Can it target critical areas for the use of available money?
- What are the impacts of preserving floodplains, wetlands, vulnerable areas, and/or impervious surfaces on sedimentation?
- Can it predict degradation of critical habitat areas and its impact on sedimentation?
- Can it be created in a manner simple enough for public understanding related to load reductions?
- What is the trapping efficiency of Lake George?

- What are the most effective BMPs to improve critical fish habitat?
- Can it determine a sediment budget (loading per drainage area) which would allow for "hot spot" predictions?
- Can it evaluate land use and soil type (erodability) and the impact on sedimentation?
- Can it measure/quantify first flush impacts?
- What are the costs and benefits of various soil erosion and conservation practices?
- Can it predict the psychological changes in attitudes of stakeholders in terms of BMPs and water quality?
- Can it utilize and/or support TMDL development?
- Can we use the model to generate support and funding for implementation?
- Can it rank areas slated for development by erosion potential?
- Can it determine sediment delivery ratios? (Is eroded soil reaching the waterway?)
- What is the effect of "technological fixes", non-traditional BMPs, and structural modifications?
- What is the impact of drainage and ditch maintenance on water quantity and erosion?
- Can it predict load reductions resulting from areas where water flow is slowed or decreased?
- What are possible barriers to implementation of BMPs?
- Who is best able to implement practices? (How to coordinate agencies and entities within the region?)
- How far into Lake Michigan does the first flush affect the water quality of the lake?
- Can it compare development practices?
- What is the cost effectiveness of structural versus vegetation BMPs?
- Can it provide justification for changes to existing ordinances?
- Can it show how many or what combinations of BMPs are needed to achieve reduced sedimentation? (And equate that to staffing/budget needs?)
- Can it predict taxpayer savings associated with sediment prevention measures?
- Can it help to sell itself and its usefulness to decision makers and planners?
- Can it identify quality of life issues?
- Can it encourage increased use or identify barriers to implementation of utilities to using erosion control practices?
- Can it identify best and worst case scenarios?
- Can it show the collective impact of small streams on Lake Michigan and associated wildlife?
- Can it show the impact of various industrial and commercial sites (impervious and pervious surfaces) on first flush? (There are lots of railways and interstates in the area.)

Broader Goals for the Model: The previous 44 questions consolidated into 5 categories.

- BMP Evaluation – cost, effectiveness, benefits
- Prediction of Land Use Impacts – on water quality/quantity, wildlife, habitat
- Problem Areas/Sediment Budget (transport and delivery)
- Prioritization/Optimization Tool
- Others

Observation: Questions of multiple scales were proposed for the model (macro vs. micro).

Prioritizing Goals: The 4 major goals for the model were prioritized by the participants. Each participant voted on their first and second priorities. According to the voting exercise, Prediction of Land Use Impacts and BMP Evaluation are the two most important objectives for the model.

1st priority
12 votes for Prediction of Land Use Impacts
5 votes for Problem Areas/Sediment Budget

2nd priority
8 votes for BMP Evaluation
7 votes for Problem Areas/Sedimentation Budget
2 votes for Prioritization/Optimization Tool

Observations Resulting from Prioritization of Goals:

- It is important to identify sedimentation issues first (where it comes from and where it goes) before the model can identify other relationships. The model is limited by the available data, geographic boundaries, and other constraints.
- Tomorrow's problem areas may not be the same as today's.
- We have no shortage of issues or problem areas to resolve.
- From a modeling perspective, we need to be able to meet the objective of identifying the Problem Areas/Sediment Budget before we can get to the Prediction of Land Use Impacts.
- We don't want to be close-minded with this effort. The process might lead to new perspectives and the plan to build the model should remain fluid.

Potential Housing Entity for the Model:

- Indiana Geological Survey – Currently houses other models.
- NIRPC – Organization dedicated to public awareness. Covers whole drainage area.
- Purdue Extension/Agricultural and Biological Engineering Dept. – Has engineering, GIS, water quality ties from an educational standpoint.
- Valparaiso University
- Partnerships between agencies/organizations
- Lake Michigan Coastal Zone Management Program for Indiana (NOAA/DNR)
- IN/IL Sea Grant Program

A potential housing entity was not decided during this discussion. However, it seems that NIRPC may be the best choice, depending on funding and other issues. Workshop participants wanted more information about what would be required by the housing entity.

Existing Data and Data Sources:

- Census Data
- ACOE dredging data
- IDEM – '98/'99 data reports published in fall '02
- IDEM, DNR, USGS – water quality data
- EPA – sediment data (Denny Clark, IDEM planning)
- USDA soil surveys – digital in Lake and La Porte Counties
- Porter County – land use data

- USFWS – '92/'93 land use gap analysis
- DNR, Coastal Management Division – slopes, HELs
- Lake RIM study
- ADID – wetlands – NIRPC, National Wetlands Inventory
- ACOE – DRD files
- Purdue Extension – soil tillage practices in watersheds
- National Soil Erosion Research Lab – predictive capability for soil erosion
- Watershed plans for Coffee Creek, Hobart (Goude & Associates)
- Agnips
- Natural Resources Inventory
- USFWS – IBI Data – Tom Simon, Bloomington (IDEM?)
- Lake George dredging activities
- River Watch – volunteer monitoring (Lynn Hartman, DNR)
- DNR, Division of Water – dredging permits, check on other dredging projects
- USDA-NRCS, erosion data, effects on sediments
- USDA programs – BMP info
- IDEM planning, CSO data
- Treatment plants
- Sediment trap data from gages – Indiana Geological Survey
- Stream gages – USGS
- E. Coli task force – rainfall data (Adriane Blaesing, IDEM Northwest Office)
- Improving Kids Environments (IKE) – CSO bypass inventory (Tom Nelter)
- Ameriplex's storm sewers
- K. Breitzke – wastewater data
- USDA photos back to 1938 – every 10 years
- Health departments – septic info, well info
- Sewer plans (public and private) – NPDES permits
- USDA website – BMPs costs
- City engineers/public works offices – storm and combined sewer maps, retention facilities
- DNR – habitat and fish surveys (IDEM too)
- FSA – annually flown aerial photo slides
- ACOE aerial photos (flies shoreline every 2 years)
- Surveyors office in each county – ditch profiles, construction
- IDEM – wastewater allocations

ATTACHMENT D

EXISTING GIS DATA

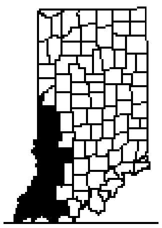
FOR

INDIANA

PROJECTS

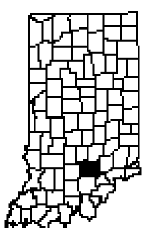
Current Projects

Statewide GIS Atlas Project. A geographic information system (GIS) atlas will be created for Indiana. The GIS will include those layers developed for the Southwestern Indiana GIS Project (see description below), as well as additional shape files, grids, and georeferenced images. Metadata will be generated that is compliant with standards of the Federal Geographic Data Committee (FGDC). An Internet Map Server (IMS) site will be created, and layers will be posted on the site as they become available. Indiana Department of Transportation (INDOT) and Bernardin, Lochmueller and Associates, Inc. (BLA). April 2002 to April 2004.

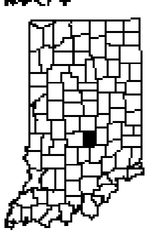


Mine Subsidence Mapping Project. Various geographic information system (GIS) layers, including historical aerial photos, low-altitude aerial photos, and commercially available satellite imagery, will be used to develop a methodology for mapping mine subsidence in the coal-mining region of southwestern Indiana. The relationship of subsidence-prone areas to hydrogeologic features will also be studied. Procedures for prioritizing future efforts at mapping and remediation will be developed. Indiana Department of Natural Resources, Division of Reclamation (IDOR). October 2001 to September 2002.

Source Water Assessment Project. Development and Dissemination of Source Water Assessments for Non-community, Non-transient Systems. Source Water Assessment Program (SWAP). Fact sheets will be developed for 650 individual, noncommunity, nontransient, public ground-water supplies throughout the state of Indiana. Susceptibility of source water to potential sources of contamination will be evaluated. The explanatory materials and individual fact sheets will be provided in both digital form and as paper pamphlets. Indiana Department of Environmental Management (IDEM). March 2001 to March 2003.



Jackson County Project Extension. Monitoring of ground-water chemistry and hydrology that was established during the Jackson County Project (see description below) will be continued. The information gained will provide guidance for establishment of best management practices in areas where nitrate problems occur in similar geological systems within the state, as well as in the study area. U.S. EPA and Indiana Department of Environmental Management (IDEM). July 2002 to June 2003.



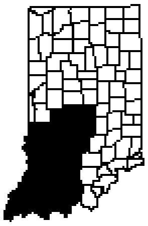
Evaluation of Riparian Buffer Zones. Development of a method of riparian buffer-zone evaluation using GIS and remote sensing to target areas with insufficient riparian protection. The results of the project should aid in targeting areas for restoration. The pilot study is being conducted in the Young's Creek watershed in Johnson County, Indiana. U.S. EPA and Indiana Department of Environmental Management (IDEM). July 2002 to June 2004.

Bedrock and Surficial Geologic Mapping, Monroe County, Indiana. Basic bedrock and surficial geology will be mapped in the Griffy Woods Research and Teaching Preserve recently established by Indiana University. The mapping will result in GIS layers to be used for research and teaching at the site. The site is located near the Indiana University campus in Bloomington, Indiana. American Association of State Geologists (AASG). August 2002 to December 2002.

Development of Watershed Modeling Tools. A streamflow model for routing flows through branching drainage networks will be developed for the Little Calumet and Trail Creek watersheds in northern Indiana. GIS layers will be developed and used in analyses to determine paths of contaminant flow. User-friendly interfaces will be constructed to allow the dynamic examination of relationships between land-use variables and process controls. Indiana Department of Environmental Management (IDEM). July

2001 to July 2002.

Past Projects



Southwestern Indiana GIS Atlas Project. A geographic information system (GIS) atlas was created for the 26 southwestern counties of Indiana. The GIS includes 173 shapefiles, grids, and georeferenced images derived from a variety of sources, including federal and state agencies, as well as IGS and BLA. Layers relate to planimetry, infrastructure, history, environment, biology, geology, resources, and hazards. Metadata were generated for all layers in a format prescribed by the Federal Geographic Data Committee (FGDC). An Internet Map Server (IMS) site was also created and will become available to the public in 2002. Indiana Department of Transportation (INDOT) and Bernardin, Lochmueller and Associates, Inc. (BLA). January 2000 to December 2001.

Jackson County Nitrate Project. Analysis of Nitrate in Groundwater in Jackson County, Indiana. Hydrologic, hydrochemical, and isotopic investigations were conducted to identify sources of nitrate contamination of ground water in an extensive shallow glacial outwash aquifer northwest of Seymour, Indiana. U.S. EPA and Indiana Department of Environmental Management (IDEM). October 1999 to December 2001.

Trail Creek Project. Development of a Three-Dimensional Aquifer Visualization and Ground Water Flow Model in the Upper Reaches of the Trail Creek and Little Calumet Watersheds, NW Indiana, and Creating a GIS for the Lake Michigan Drainage Basin in Indiana. Data at the Indiana Geological Survey (IGS), Indiana Department of Natural Resources (IDNR), and U.S. Geological Survey (USGS) were incorporated into a geographic information system (GIS). Three-dimensional images of the ground water aquifer system in northwestern Indiana were produced, and numerical models to simulate the flow system were developed. Indiana Department of Environmental Management (IDEM). April 1998 to December 2001.

Midwest Project Extension. Hydrologic and Hydrochemical Conditions at a Reclamation Site Containing Coal-Combustion Byproducts (CCB's). Hydrologic and hydrochemical investigations were conducted to determine recharge conditions in contaminant-producing materials and to evaluate the effects of the reclamation design on abatement of acidic mine drainage from the site. Three-dimensional visualizations were developed that show contaminant-producing materials and their relationship to underlying bedrock geology, buried coal-combustion byproducts, and capping materials that were utilized in the reclamation design. Indiana Department of Natural Resources, Division of Reclamation (IDOR). January 2000 to December 2001.

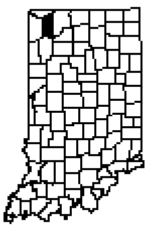
Pesticides Project. Development of a Statistically Valid Program for Monitoring Pesticides in Groundwater in the State of Indiana. Statistical software was written that can be interfaced with a database management system, in order to provide a statistically valid basis for evaluating data regarding pesticide concentrations in monitoring wells of the Indiana Baseline Monitoring Program (IBMP). Indiana Department of Environmental Management (IDEM) and Office of the Indiana State Chemist (OISC). 1995 to 1999, 2001.

Warrick County Project. Hydrologic Suitability of Mine Spoil as a Medium for Septic-tank Absorption Fields. Reconnaissance investigations and intensive monitoring of selected experimental plots were used to categorize deposits of mine spoil (which is the disrupted and displaced overburden created by surface coal mining), regarding their hydrologic suitability for the installation of septic-tank absorption fields. U.S. EPA and Indiana Department of Environmental Management (IDEM). April 1998 to December 2000.

Lake-Rim GIS Project Extension. Enhancement of the Lake Rim GIS Through a Program of Field Surveys and Data Conversion. Indiana Department of Natural Resources, Division of Water (IDOW). October 1999 to January 2000.

Lake-Rim GIS Project. Creating a GIS for the Lake Michigan Drainage Basin in Indiana. Indiana Department of Environmental Management (IDEM) and Indiana Department of Natural Resources, Division of Water (IDOW). May 1998 to May 2000.

Grand Calumet Project. Development of a Three-Dimensional, Shallow, Groundwater Flow Model for the Grand Calumet River/Indiana Harbor Canal Watershed, Northwest Indiana. Indiana Department of Environmental Management (IDEM). September 1998 to April 2000.



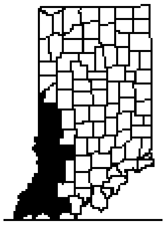
Burns Ditch Project. Monitoring and Forecasting Outfalls of E. coli Contaminated Streamflow at Burns Ditch, South Shore, Lake Michigan, Indiana. U.S. Environmental Protection Agency (EPA). October 1998 to June 2000.

Midwest Reclamation Project. Evaluation of the Hydrologic and Chemical Effects of Reclaiming a Coarse-refuse Deposit with Ash Fill and a Poz-o-tec Cap, Reclamation Site No. 1087 (Midwestern). Quantitative information was provided concerning the beneficial effects of reclamation involving the emplacement of a cap containing coal-combustion byproducts (CCB's) across a deposit of pyritic coarse-refuse that was generating contaminated drainage. Indiana Department of Natural Resources, Division of Reclamation (IDOR). March 1995 to February 1999.

Great Marsh Project Extension. Lake Michigan Tributary Monitoring Project (Derby Ditch). Great Lake Commission; U.S. Environmental Protection Agency (EPA), Region 5, Water Division. May 1999 to June 2000.

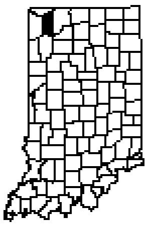
Great Marsh Project. Hydrologic Monitoring and Watershed Modeling Associated with the Great Marsh Restoration Project. A model, based on intensive field monitoring, was developed for the watershed hydrology of the Great Marsh in the Indiana Dunes National Lakeshore. The model can be used to predict outfalls of *E. coli* into Lake Michigan and to direct remediation efforts. U.S. Environmental Protection Agency (EPA) and Indiana Department of Environmental Management (IDEM). 1997 to 1999.

Great Marsh Pilot Project. Hydrologic Monitoring Associated with Pilot Restoration of Part of the Great Marsh, Indiana Dunes National Lakeshore. National Park Service (NPS). 1995 to 1996.

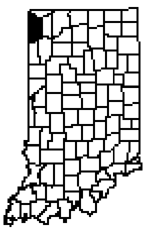


Coal Quality Database Project. Coal Quality Database of the Eastern Interior Basin in Indiana, Illinois, and Kentucky. U.S. Geological Survey (USGS). 1998 to 1999.

Coal Quality Assessment Project. Coal Quality Assessment in the Illinois Basin. Electric Power Research Institute (EPRI), PSI Energy, Inc., and U.S. Geological Survey (USGS). 1995 to 1997.



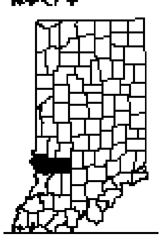
Porter County Water Well Project. Computerization of Water-well Records from Porter County, Indiana. Indiana Department of Environmental Management (IDEM). 1994 to 1995.



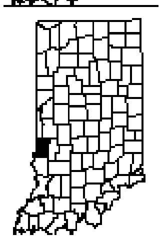
Lake County Water Well Project. Computerization of Water-well Records from Lake County, Indiana. Indiana Department of Environmental Management. 1993 to 1994.

Dunes Septic Project. Chemistry and Movement of Septic-tank Absorption-field Effluent in the Dunes Area, Lake and Porter Counties, Indiana. U.S. Environmental Protection Agency (EPA) Non-Point Source (NPS) Pollution Program. 1993 to 1995.

Cannelburg Subsidence Project. Hydrologic Conditions at a Subsidence-affected Area around Cannelburg, Indiana. Indiana Department of Natural Resources, Division of Reclamation (IDOR). 1990 to 1991.



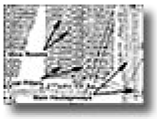
Friar Tuck Reclamation Project. Research and Reclamation Feasibility Studies at the Friar Tuck Site, Sullivan and Greene Counties, Indiana. Indiana Department of Natural Resources, Division of Reclamation (IDOR). 1987 to 1992.



Blackhawk Reclamation Project. Hydrologic Monitoring of the Blackhawk Site, Vigo County, Indiana. Indiana Department of Natural Resources, Division of Reclamation (IDOR). 1984 to 1987

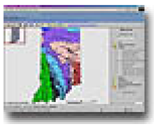
Interactive Maps and Geospatial Data Downloading

Indiana Coal Mine Information System



Create, view, and print maps showing locations of surface and underground coal mines and documented subsidence areas in Indiana, and obtain data about the mines.

A GIS Atlas for Indiana



This online atlas allows you to construct custom maps with layers showing information about coal, environment/biology, geology, hydrology, and infrastructure/demographics. New layers will be added each month through April 2004. The information available in two previously built online GIS atlases for specific regions of Indiana (see below) eventually will be incorporated into the statewide atlas.

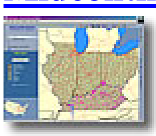
A GIS Atlas for Southwestern Indiana

The atlas features more than 170 layers of geographic and geologic information for 26 counties in southwestern Indiana. In addition to the online version, the atlas is also available on a set of 8 CD-ROMs as Open-File Study 01-23.

Lake Rim GIS

Create maps and view data pertaining to land-use and environmental conditions in Lake, Porter, and LaPorte Counties.

Midcontinent Interactive Digital Carbon Atlas and Relational Database



MIDCARB is a project that will build a digital spacial database for five states, including Indiana, to help characterize the amount of carbon dioxide available for sequestration, the geologic security and safety of a sequestration site, the long-term effects on a geologic reservoir, and the cost of compression and transport of carbon dioxide between source and sequestration site. The project includes an online interactive map that displays information about carbon dioxide sources and potential sequestration sites.

Download Indiana Public Land Survey System Data Set

Use this data set to apply state and county boundary lines, township and range lines, and more to your mapping projects. The data set is also available on CD-ROM through our Publication Sales office as Computer Database 3.

Download GPS Data

The IGS maintains a GPS base station for public use. The hours of operation are Monday through Saturday, 6:00 a.m. through 8:00 p.m. (Eastern Standard Time). These data are not searchable and the most recent entry is at the bottom of the file list.

Base Station Receiver Information

Download Indiana Spatial Data

Get Indiana spatial data, including digital map data, aerial photographs, and satellite images, from Indiana University's Massive Data Storage System.

ATTACHMENT E

NECESSARY SEDIMENT TRANSPORT DATA

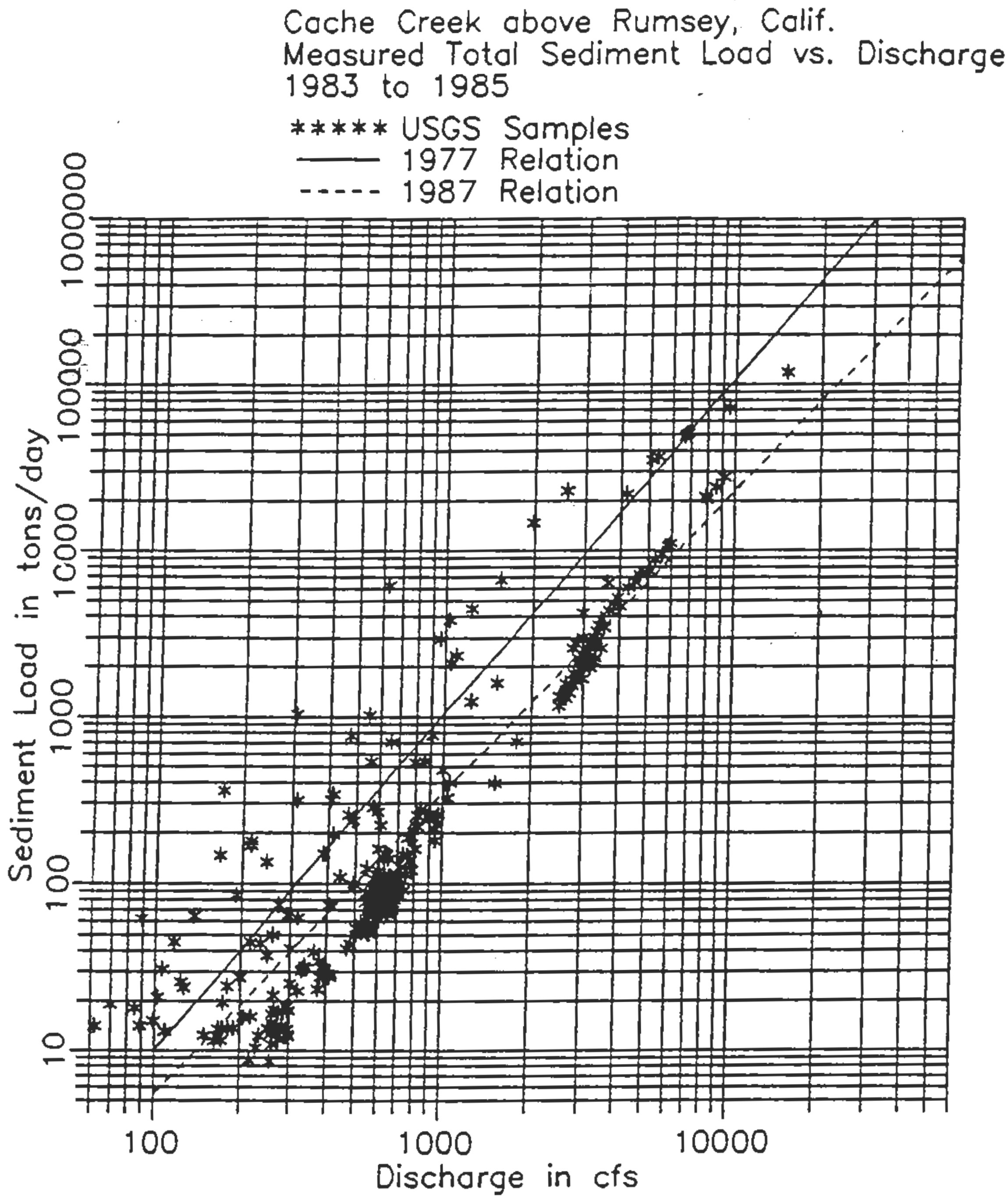


Figure 5.
Sediment-Discharge Rating Curve.

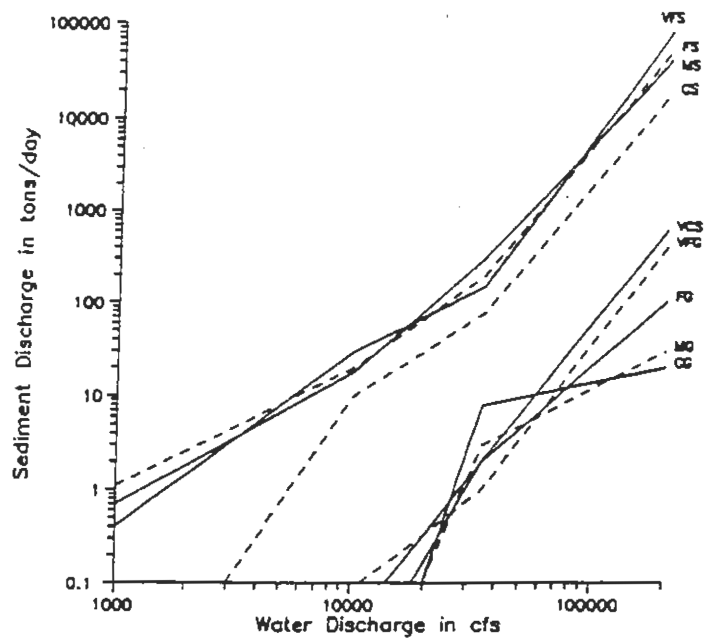


Figure 6.
Sediment Load Curves.

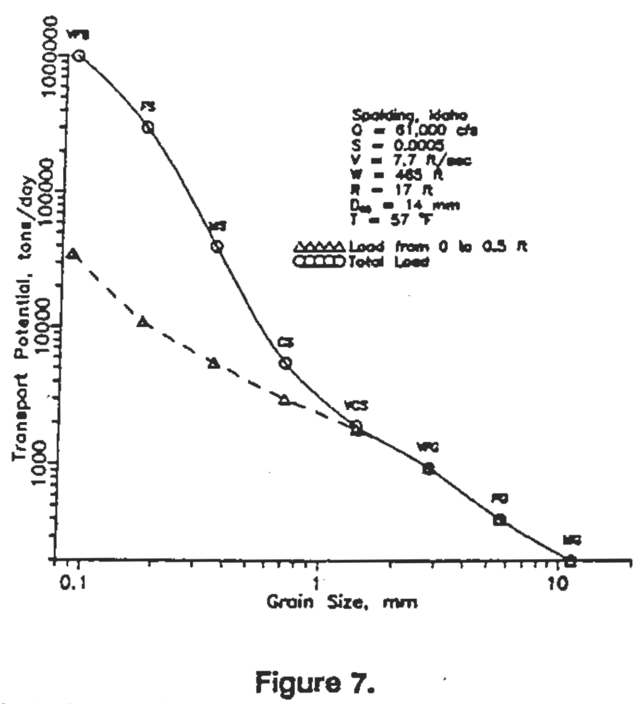


Figure 7.
Variation of Sediment Transport with Grain Size.

Table 1.

Distribution of Sediment Load by Grain Size Class

Water discharge: 35,000 cfs

Total Bed Load, tons/day. . . . . .130[a]
Total Susp. Load, tons/day. . . . . .1500[b]
Total Sediment Load. 1630

Grain Size Diameter mm	Classification	Percent Bed Load	Bed Load tons/day	Percent Suspended Load	Susp. Load tons/day	Total Load Col. (4) + (6) tons/day
(1)	(2)	(3)	(4)	(5)	(6)	(7)
< .0625	silt & clay	0.04	0.05	54	810	810
0.0625-.125	VFS	0.10	0.13	10	150	150
0.125-.250	FS	2.75	4.00	13	195	199
0.250-.500	MS	16.15	21.00	19	285	306
0.500-1	CS	13.28	17.00	4	60	77
1-2	VCS	1.19	2.00			2
2-4	VFG	1.00	1.00			1
4-8	FG	1.41	2.00			2
8-16	MG	2.34	3.00			3
16-32	CG	6.33	8.00			8
32-64	VCG	23.38	30.00			30
> 64	cobbles & larger	32.03	42.00			42
TOTAL		100.0	130.18	100.0	1500	1630

Notes:

a. The distribution of sizes in the bed load is usually computed using a bed load transport function and field samples of bed material gradation. The bed load rate is rarely measured and may have to be computed.

b. The suspended load and its gradation can be obtained from field measurements.

ATTACHMENT F

LAND USE AND SOIL MAPS

Indiana Land Use Consortium (ILUC)
Land Use Resources Catalog
Preface

November 2001

The Indiana Land Use Consortium (ILUC) developed the Land Use Resources Catalog to assist planners and decisionmakers across the state. Current information regarding land use is essential for effective state and local decisionmaking.

The data catalog is organized by topic. It includes sections about general resource organizations, as well as agricultural, demographic/social, environmental, geospatial, and natural resources data. An index of the included resources appears in Appendix C

If you have questions, comments, or suggestions concerning the catalog, please contact: Ron Lauster at 317-290-3200 extension 388 or email him at *ron.lauster@in.usda.gov*. A blank copy of the data sheet for other sources of information you would like to recommend to be added to the catalog is available in Appendix B.

The Indiana GIS Initiative also is working to develop a data catalog. The Consortium will share this land use information with the GIS Initiative for inclusion in their catalog.

If you have similar questions, comments, or concerns about the Indiana GIS Initiative and planning data information contact: Jill Saligoe-Simmel at 317-920-9150 or email her at *jsaligoe@iupui.edu*. The Indiana GIS Initiative's web site is at: *http://www.in.gov/ingisi/*.

We hope you find this information helpful!

Indiana Land Use Consortium (ILUC)- Land Use Resources Catalog

Indiana Land Use Consortium
(ILUC) Land Use Resources Catalog
Table of Contents

(COPY)

Brigid,

I spoke with Dr. Greg Olyphant from the IU Department of Geological Sciences, and he told me that some minimal sediment data had been collected in conjunction with the thesis research by Jude Thomas in 1999. The thesis related to this work is:

Thomas, J.C., 2001, Monitoring and statistical modeling of bacterially contaminated streamflow at the outlet of Burns Ditch, South Shore, Lake Michigan, Indiana: M.S. Thesis, Indiana University Department of Geological Sciences, 50 pgs.

The appendix in the back of her thesis records water-quality data from April 1999 through the end of May 2000. Turbidity is one of the constituents recorded (daily). However, she also sampled a number of storms with both grab samples and an Isco autosampler, and sampled for total suspended solids (TSS). I have attached a spreadsheet of these data. The samples were taken at Lefty's Landing on Burns Ditch, which is located near Highway 10 and Burns Ditch. The spreadsheet contains two different TSS measurements for each record. One is a grab sample that was taken manually as a check on the autosampler. The other, then, is the sample taken by the autosampler. I also left some of the other measured constituents in the file, if you need them for anything. Associated discharge can be found from USGS gage data at Burns Ditch.

Let me know if you need anything else.

Sally L. Letsinger, Ph.D., LPG

Research Hydrogeologist and Assistant Director
Center for Geospatial Data Analysis
Indiana Geological Survey
611 North Walnut Grove
Bloomington, IN 47405-2208
office: S301D
ph: 812-855-1356
fax: 812-855-2862
http://php.indiana.edu/~sletsing/
sletsing@indiana.edu
