

# Overview and Update on the Watershed Modeling System

## **WMS 7.0**

Mid-Western Hydraulics Engineers  
Conference

East Lansing, Michigan

August 26-28, 2003

# FHWA Licensing and Usage

- Developed at the Environmental Modeling Research Lab (EMRL) at BYU
- Distributed by EMS-I
- FHWA has licensed for all state DOTs
- Significant usage in the following states
  - ▶ Utah, California, Minnesota, Nevada, Arizona, New Mexico, New York, South Carolina, Pennsylvania, Delaware, Maine, Connecticut, Kentucky, Maryland
- NHI Course 135080

# What is WMS?

- A Geographic Information System (GIS) for Hydrologic Design and Analysis
  - ▶ Not an extension of GIS
- Delineate Watersheds from Digital Elevation Models (DEMs)
- Uses other digital files for Land Use and Soil Type properties
- Graphical Interface to Hydrologic Programs

# Model Interfaces

- Regional Regression Equations (NFF)
  - ▶ Updated to latest USGS database
- HEC-1 (HMS)
- HEC-RAS (new in 7.0)
- Storm Drain (new in 7.0)
- TR-55, TR-20
- Rational Method
- Other culvert, stream channel, and detention basin design and analysis calculators

# Steps

- 1) Obtain digital elevation data
- 2) Obtain other digital data
  - Aerial photographs, land use, soil types, etc.
- 3) Delineate watershed boundaries
- 4) Determine hydrologic modeling parameters from digital data sets
- 5) Perform/Review analysis

# Demonstration



# Data Acquisition Website

- Elevation
- Image
- Land cover
- Soil
- Other

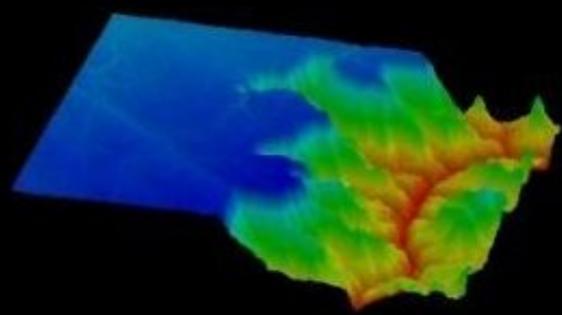
<http://emrl.byu.edu/gsda>

# gsda geoSPATIAL DATA ACQUISITION

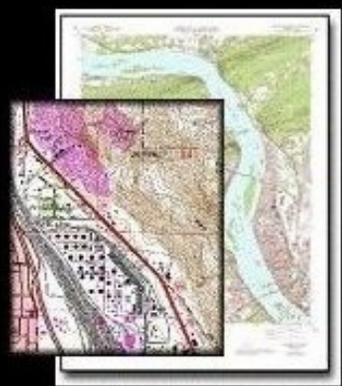


## New Additions to this Site

WMS is designed after the GIS standard for spatial data. Data of primary importance to WMS include DEMs, images, soil type and land use. Other data types such as TINs, hydrography, precipitation and stream stage can also be essential to a hydrologic model.



**DEM**



**IMAGES**

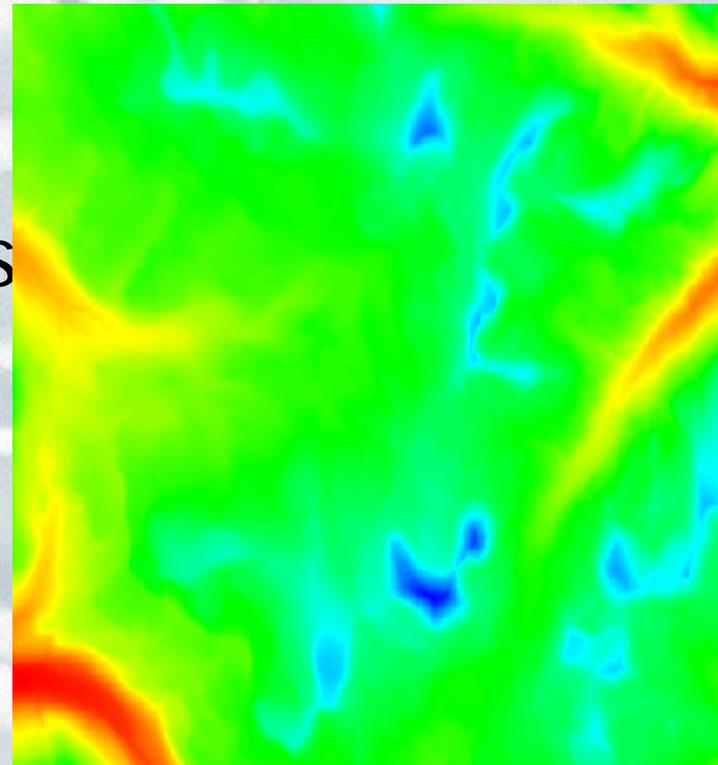


**SOIL TYPE**



# Elevation Data

- Slopes
- Cross-sections
- Basin boundaries
- Flow paths



# National Elevation Dataset

- 30 m / 10 m resolution
- Seamless
- Can download quickly
- Geographic coordinates (NAD '83)

Seamless Data Distribution System – Enhanced

<http://seamless.usgs.gov>

# Obtaining DEM Data



The USGS offers the following DEM data:

- **30 meter (and some 10 meter) data from the National Elevation Database**

This NED data is accessed via the USGS Seamless Data Distribution System-Enhanced. The site offers NED data in the Gridfloat, BIL, ArcGRID, and TIFF formats.

Advantages of the NED data are that you define a custom area to download, the DEM data is seamless, and the interface allows you to display various GIS layers to aid in the selection process.

COST: None

- **1:250,000 scale (~90 meter) data**

This DEM data is provided in the native \*.dem format.

COST: None

[CLICK HERE](#)

to obtain DEM data from the National Elevation Database

[CLICK HERE](#)

to obtain 1:250K (~90m) DEM data from the USGS

[Need additional help obtaining a 30 meter NED DEM from the Seamless Data Distribution Center-Enhanced?](#)

[Need additional help obtaining a 1:250K DEM from the USGS?](#)



The Seamless Data Distribution System provides custom-generated digital products based on user specified geographic extents and [user specified datasets](#). Seamless digital data is available to users in several [optional formats](#) for delivery via web downloads or CD media. ([Web Requirements](#))

The Seamless Data Distribution System will provide data at the exact boundaries that you specify resulting in a more efficient delivery system and a more manageable dataset.

[View and Order Data Sets](#)

Data Set Information can be found at:

- [National Elevation Dataset \(NED\)](#)
- [National Land Cover Dataset \(NLCD\) 1992](#)
- [Shuttle Radar Topography Mission \(SRTM\)](#)

**IMPORTANT NEWS**

**Announcements**  
**(updated 06 Jan 2003)**

**Down Time**  
03/10/2003 7:30AM CDT -  
03/10/2003 12:30PM CDT, Server  
Maintenance (No products will be  
processed)



# The National Map Seamless Data Distribution System Viewer

Help

### Move



### Zoom



### Select



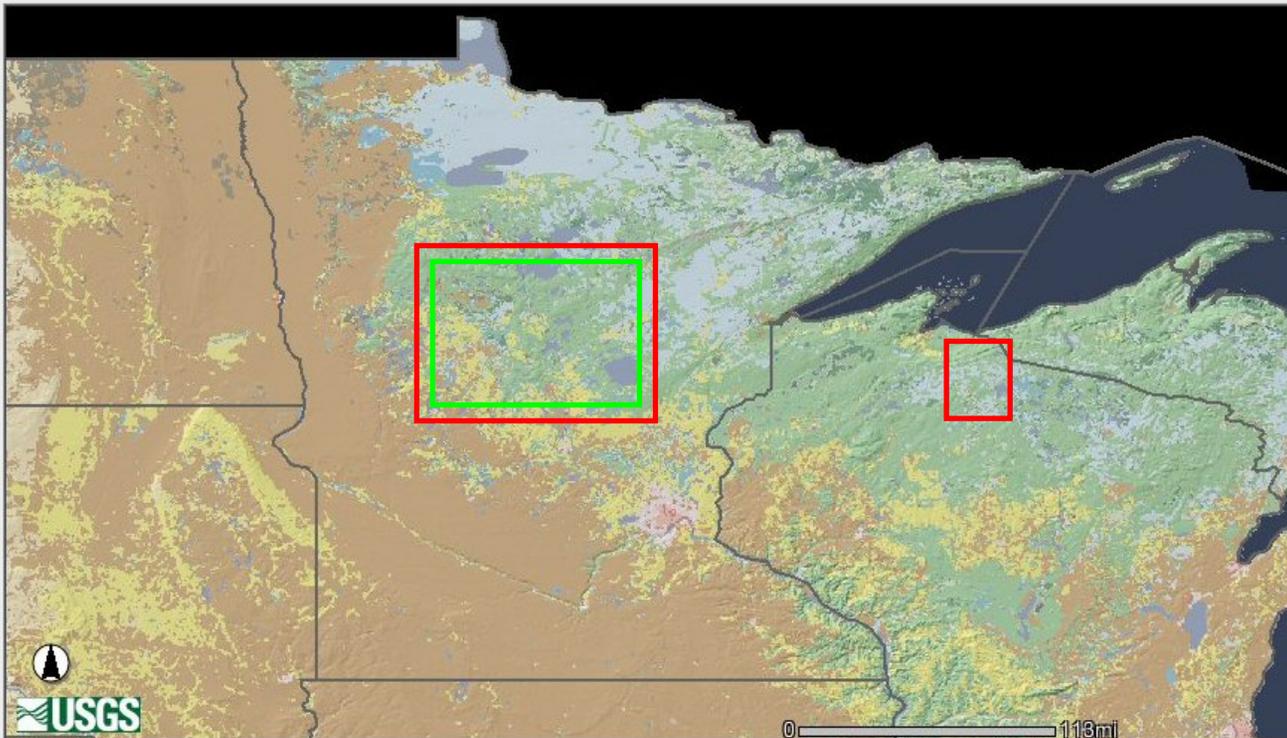
### Misc



### Download



Define Area By Coordinates



Welcome to the SDDS Raster Extraction Website

Tool selected = Zoom In

U.S. Department of the Interior || U.S. Geological Survey || EROS Data Center

URL: <http://seamless.usgs.gov/index.htm> || Maintainer: [webmapping@usgs.gov](mailto:webmapping@usgs.gov) || Last Modified: Fri 02 May 2003

**Current Active Layer**  
GNIS Names (text)

**Download Layers**

**Raster**

- NED
- 1/3" NED
- NLCD
- SRTM 30m
- SRTM 90m

**Display Legend/Layers**

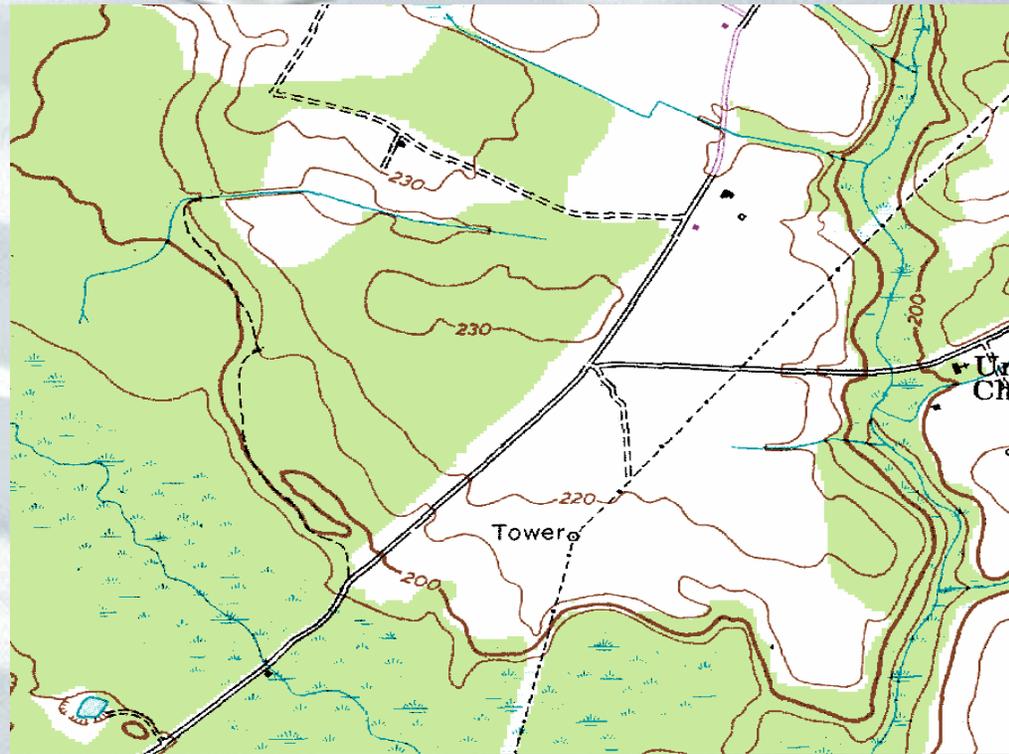
**Layer**

Visible

- Hi-Res Ortho Index
- NLCD Index
- 1/3" NED Index
- NED Index
- NED Update Index
- SRTM 30m Index
- SRTM 90m Index
- Counties 2M
- State Labels
- States 7.5M
- World Bndy
- Utility Lines 100K
- Interstate Labels

# Images

- Physical features
- Elevation contours
- Presentation



# MSN TerraServer

- File size is small = JPEG
- Can save a World File
- UTM Coordinates (NAD '83)



<http://terraserver.homeadvisor.msn.com>

# Obtaining DRG Image Data



**CLICK HERE**

**to obtain a DRG from MSN's Terraserver.**

Terraserver offers USGS Topos in several different resolutions.

[Need additional help obtaining an image from Terraserver?](#)

## **PUBLIC SITES**

**CLICK HERE**

**to obtain a DRG from other public sites.**

Sometimes, the best way to locate GIS data from a public source, such as a state or county agency, is to consult an internet search engine. Go to a search engine website, such as [www.google.com](http://www.google.com) and enter the search criteria, such as "DRG Georgia."

**GIS DATA DEPOT**



Search TerraServer



- ▶ Navigate
- ▶ Advanced Find
- ▶ Famous Places
- ▶ Web Services
- ▶ About

## TerraServer

Click the green areas to zoom-in on the map.

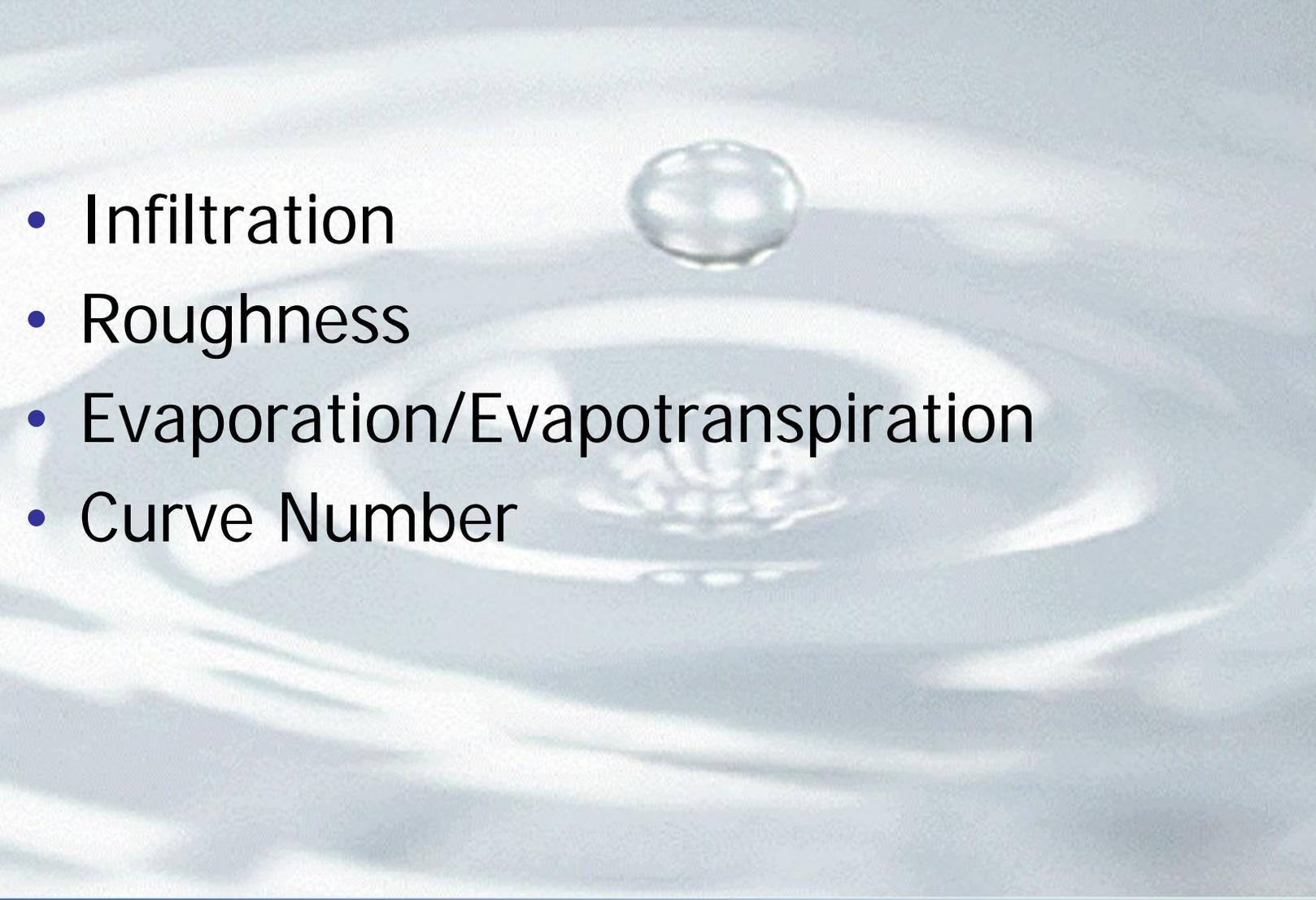


TerraServer contains 3.3 tera-bytes of high resolution **USGS aerial imagery** and **USGS topographic maps**. You can locate imagery by clicking on the map above, **entering a city or town name** in the "Search TerraServer" form at the top of the page, or **entering a U.S. street address**. Click on **Advanced Find** to see other methods for searching our imagery database.

Below are sample thumb-nail images of famous places contained in the TerraServer database. Click on a thumb-nail image to see a famous place or click on **more famous places** to see a complete the complete list images of famous sites.

				<a href="#">More Famous Places</a>
Iowa Class Battleship	Niagara Falls	Lambeau Field	St. Louis Gateway	

# Land Use / Vegetation

- Infiltration
  - Roughness
  - Evaporation/Evapotranspiration
  - Curve Number
- 
- A close-up photograph of a single water droplet suspended in mid-air just above a pool of water. The droplet is perfectly spherical and highly reflective. Below it, the water surface is disturbed, creating concentric ripples that spread outwards. The background is a soft, out-of-focus light blue.

# EPA Basins

- Shapefile format
- Good U.S. coverage
- Contains both land use and soil data



# Obtaining Soil Type Data

**EPA**

ENVIRONMENTAL PROTECTION AGENCY

The EPA has divided the United States into hydrologic units and assigned each one a HUC (hydrologic unit code). In order to download land use data for an area, you first need to know its HUC.

**CLICK HERE****to obtain the HUC number for your watershed.**

The EPA provides the "Locate Your Watershed" site to help users determine their region's HUC.

**CLICK HERE****to obtain the land use data from the EPA HUC index.**

The EPA offers land use shapefiles.

[Need additional help obtaining soil type data from the EPA?](#)

[Click here to go to the BASINS Metadata website.](#)

**CLICK HERE****to obtain soil type data from the NRCS (STATSGO format).**

The NRCS offers soil type ARC/INFO coverages by state.

**CLICK HERE****to obtain soil type data from the NRCS (SSURGO format).**



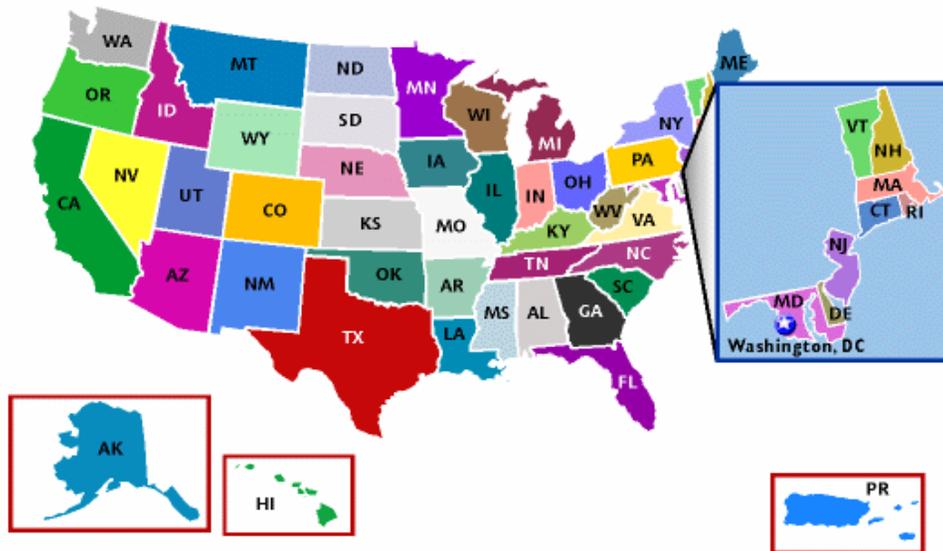
## U.S. Environmental Protection Agency

# Surf Your Watershed

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[EPA Home](#) > [Surf Your Watershed](#) > [Locate Your Watershed](#) > U.S. Map

- About
- Help
- Locate Your Watershed
- Add Information
- Search Information
- Watershed Atlas



[Alabama](#) | [Alaska](#) | [Arkansas](#) | [Arizona](#) | [California](#) | [Colorado](#) | [Connecticut](#) | [Delaware](#) | [District of](#)



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## Surf Your Watershed

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[EPA Home](#) > [Surf Your Watershed](#) > [Locate Your Watershed](#) > Michigan

### Michigan

Use the state map or Places Involving this State watershed links below to zoom in to find more information about your watershed.



### State Profile

*Find general information integrated for this specific state*

### Assessments of Watershed Health

- [Unified Watershed Assessment \(UWA\)](#) (provided by MI and Tribes)
- [State Water Quality](#) (2000 305(b) Report to Congress).
- [State Impaired Waters \(TMDL\) Program](#)



- About
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## Surf Your Watershed

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[EPA Home](#) > [Surf Your Watershed](#) > [Locate Your Watershed](#) > Muskegon Watershed -- 04060102

### Muskegon

#### Watershed Profile

Watershed Name: Muskegon  
USGS Cataloging Unit: 04060102

[Environmental Websites Involving this Watershed](#)

Visit the [Envirofacts Warehouse](#) to retrieve environmental information from EPA databases on [Air](#), [Community Water Sources](#), [Water Dischargers](#), [Toxic Releases](#), [Hazardous Waste](#), and [Superfund Sites](#). Geographic searches include zip code, city, EPA Region, or county.

[Citizen-based Groups at work in this watershed](#) (Provided by [Adopt your Watershed](#))

[River Corridors and Wetlands Restoration Efforts](#)

[National Watershed Network](#) (provided by [Conservation Technology Information Center](#)) [EXIT disclaimer >](#)

#### Assessments of Watershed Health

- [Index of Watershed Indicators](#) (provided by EPA)
- 1998 Impaired Water for:
  - [Michigan](#)  
(provided by EPA / State partnership)



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File Edit View Favorites Tools Help

Back Forward Stop Home Search Favorites History Print Copy Paste Mail News RSS Feeds User

Address [http://www.epa.gov/ost/ftp/basins/gis\\_data/huc/17080002/](http://www.epa.gov/ost/ftp/basins/gis_data/huc/17080002/)Links [Customize Links](#) [Free Hotmail](#) [Windows Media](#) [Windows](#) [RealOne Player](#)

## Index of /ost/ftp/basins/gis\_data/huc/17080002/

Name	Last modified	Size	Description
------	---------------	------	-------------

[Parent Directory](#)[17080002\\_DEMG.exe](#)

15-Aug-2001 15:27 652K

[17080002\\_core.exe](#)

29-Jul-1998 15:03 8M

[17080002\\_dem.exe](#)

27-Jul-1998 18:20 1M

[17080002\\_pcs3.exe](#)

19-Oct-2001 13:19 32K

# Demonstration



# New Features Highlights

- Reorganization of TIN/DEM modules
  - ▶ Increased editing of TINs/DEMs for hydrologic and hydraulic modeling
- Data Tree data management
- GIS Module
  - ▶ Integration with or without ArcView GIS
- Update for NFF
- Storm Drain (HYDRA) interface
- HEC-RAS interface
- Uncertainty Analysis in modeling

# New Features Highlights

- DEM Editing
  - ▶ Allows embankment with elevation to be superimposed on DEM
  - ▶ Volume behind embankment

X: 294.7 Y: 363.1 Z: 0.0

- New Simulation
- Save Simulation
- Run Simulation
- Read Solution
- Job Control...
- Link Nodes...
- Assign Pipe Elevations
- Assign Gutter Elevations
- Map Hydrographs

Units... XY Units: Feet Z Units: Feet

Navigation and tool icons including pan, zoom, and drawing tools.



- Map Data
  - default coverage
  - provostormdrain.jpg
  - Storm Drain**

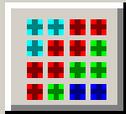
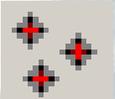
Time Steps:

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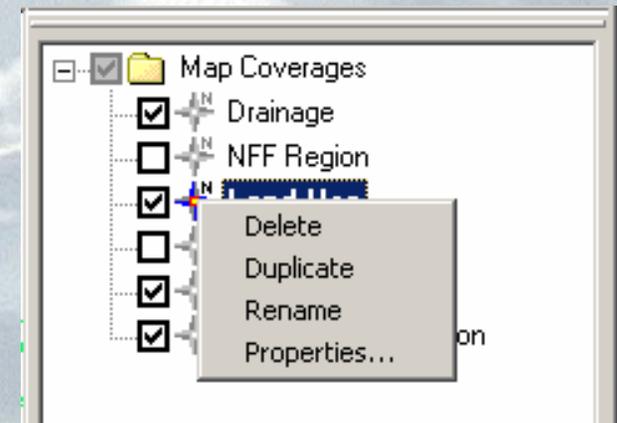
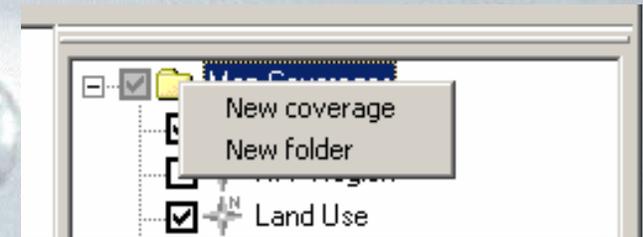
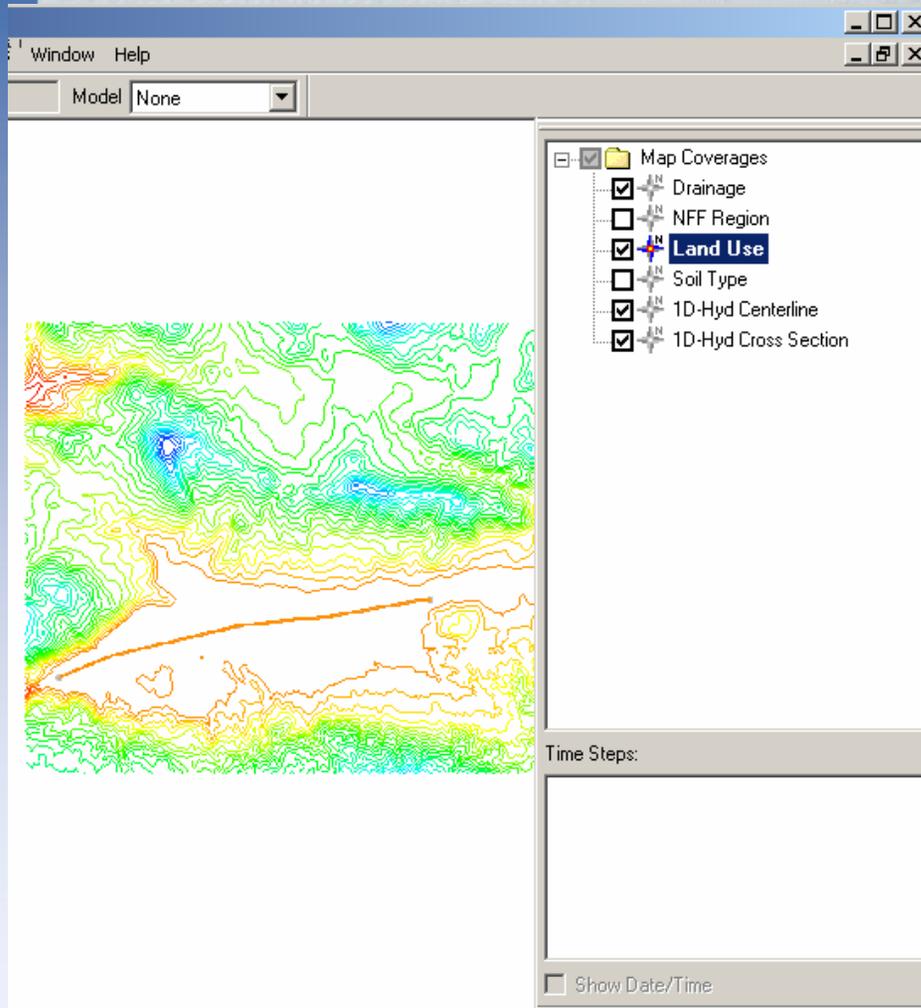
Show Date/Time

(-5.9, 86.8)

# Terrain Data Module

- In previous versions we had TIN  and DEM  Modules
- In 7.0 we have Terrain Data  and Watershed Delineation  Modules

# Data Tree Data Management



# GIS Module - ArcObjects

The screenshot shows the ArcGIS WMS 7.0 interface. The 'Layer Properties' dialog box is open, and the 'Fields' tab is selected. The 'Attributes' table displays the following data:

	FID	Shape	AREA	PERIMETER	PID	NAME	SUB_NAME	BA
1	0	Polygon	3380956.49273	7419.41561	1000011003	White Tanks A	White Tanks/Agua Fria	10
2	1	Polygon	12617558.00577	16580.49901	1000021003	White Tanks A	White Tanks/Agua Fria	10
3	2	Polygon	8619613.03106	17023.71794	1000031003	White Tanks A	White Tanks/Agua Fria	10
4	3	Polygon	3928052.16239	10549.77893	1000041003	White Tanks A	White Tanks/Agua Fria	10
5	4	Polygon	10108054.9776	14941.02804	1000051003	White Tanks A	White Tanks/Agua Fria	10
6	5	Polygon	4159512.73535	9588.48756	1000061003	White Tanks A	White Tanks/Agua Fria	10
7	6	Polygon	21119664.29617	18552.25983	1000071003	White Tanks A	White Tanks/Agua Fria	10
8	7	Polygon	16194505.92576	18656.04293	1000081003	White Tanks A	White Tanks/Agua Fria	10
9	8	Polygon	22253547.94328	20947.91169	1000091003	White Tanks A	White Tanks/Agua Fria	10
10	9	Polygon	23437246.28804	19303.21123	1000101003	White Tanks A	White Tanks/Agua Fria	10
11	10	Polygon	26544735.5273	20950.68475	8001358000	Lower New River	New River	50
12	11	Polygon	5182481.46542	9690.66271	1000111003	White Tanks A	White Tanks/Agua Fria	10
13	12	Polygon	8547341.79568	12982.74934	1000121003	White Tanks A	White Tanks/Agua Fria	11

At the bottom of the dialog box, it indicates '596 records.' and 'Help' and 'OK' buttons are visible.

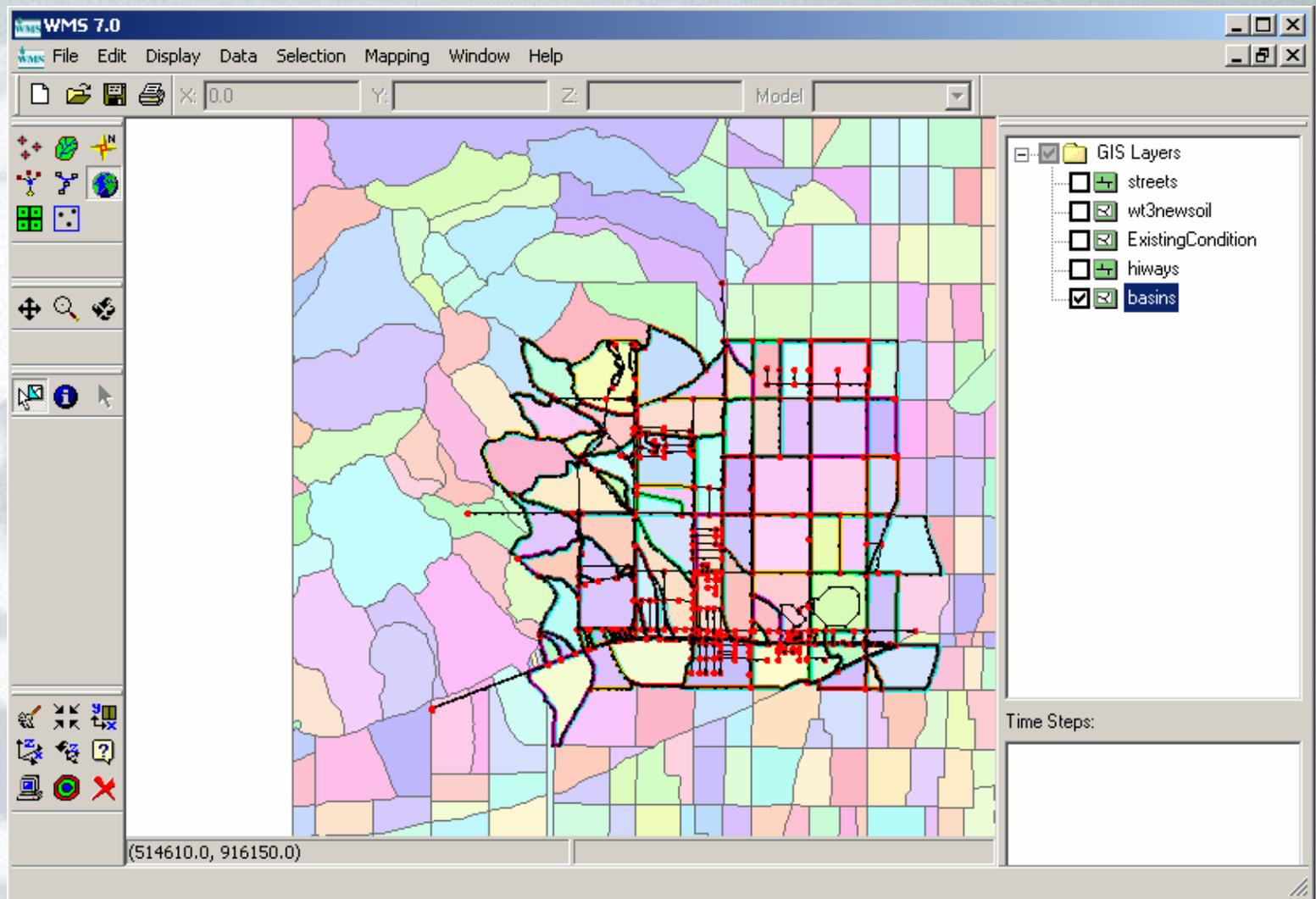
# GIS Module – Shapefile data

The screenshot displays a GIS application window with a central 'Attributes' dialog box. The dialog box contains a table with 13 rows and 4 columns: AREA, PERIMETER, MUID, and HYDGRP. The data is as follows:

	AREA	PERIMETER	MUID	HYDGRP
1	0.001	0.122	WA222	C
2	0.005	0.791	WA215	C
3	0.027	1.435	WA236	C
4	0.018	1.172	WA239	B
5	0.009	0.907	WA226	B
6	0.018	0.668	WA235	C
7	0.019	1.003	WA233	B
8	0.000	0.022	WAW	B
9	0.004	0.379	WA235	C
10	0.053	2.770	WA239	B
11	0.000	0.198	WAW	B
12	0.000	0.022	WAW	B
13	0.005	0.470	WA220	B

Below the table, the dialog box shows '51 records.' and buttons for 'Help' and 'OK'. On the right side of the main window, the 'GIS Layers' panel is visible, with a context menu open over it. The menu options are: Delete, Rename, Open Attribute Table, and Join Table To Layer. The 'Join Table To Layer' option is highlighted by the mouse cursor. The main window also shows a toolbar on the left and a status bar at the bottom with coordinates (-120.122, 46.97).

# Mapping GIS Layers



# Updated NFF

- USGS developed new database and Windows application with updated state equations
- WMS now links directly to the same database as NFF
  - ▶ Will be easier to maintain future updates
- Same basic interface
  - ▶ A new NFF region coverage can be added

# Updated NFF

**National Flood Frequency Regression Method**

Basin information

Basin Name:  Total Basin Area:  [mi<sup>2</sup>]

State:  Max Flood Region:

Regional regression equations

Available Equations:

- Region 1
- Region 2
- Region 3
- Region 4
- Region 6

Select ->

<- Remove

Selected Equations:

- Region 5

Compute Overlapping Areas...

Variable values

Variable Name	Abbreviation	Value	Units	Minimum	Maximum
Drainage Area	AREA	19.3...	mi2	0.38	638.0

Restore Computed Geometric Values

Results

Weighting Options... Compute Results Max Flood Envelope:  [CFS]

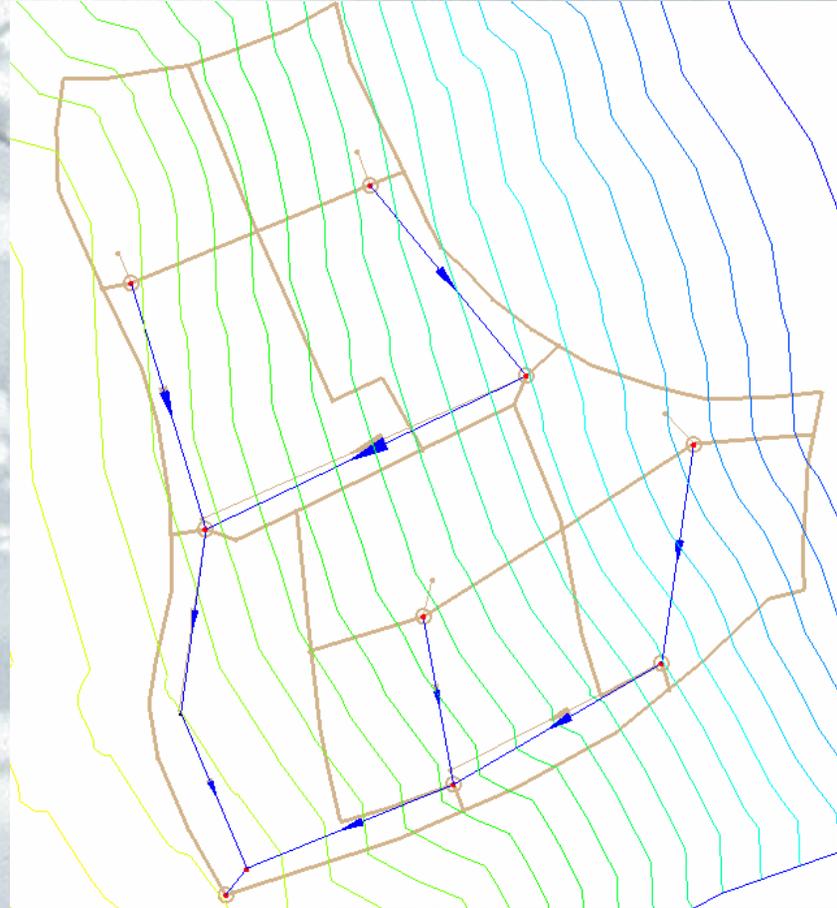
Type	Peak [cfs]	Recurrence [years]	Equivalent Years	Error [%]
------	------------	--------------------	------------------	-----------

Compute Hydrograph... Export...

Help Done Cancel

# Storm Drain

- Based on HYDRA
- Storm drain inlets
  - ▶ Drainage coverage
- Manholes
  - ▶ Storm drain coverage
- Supports rational and hydrographic analysis



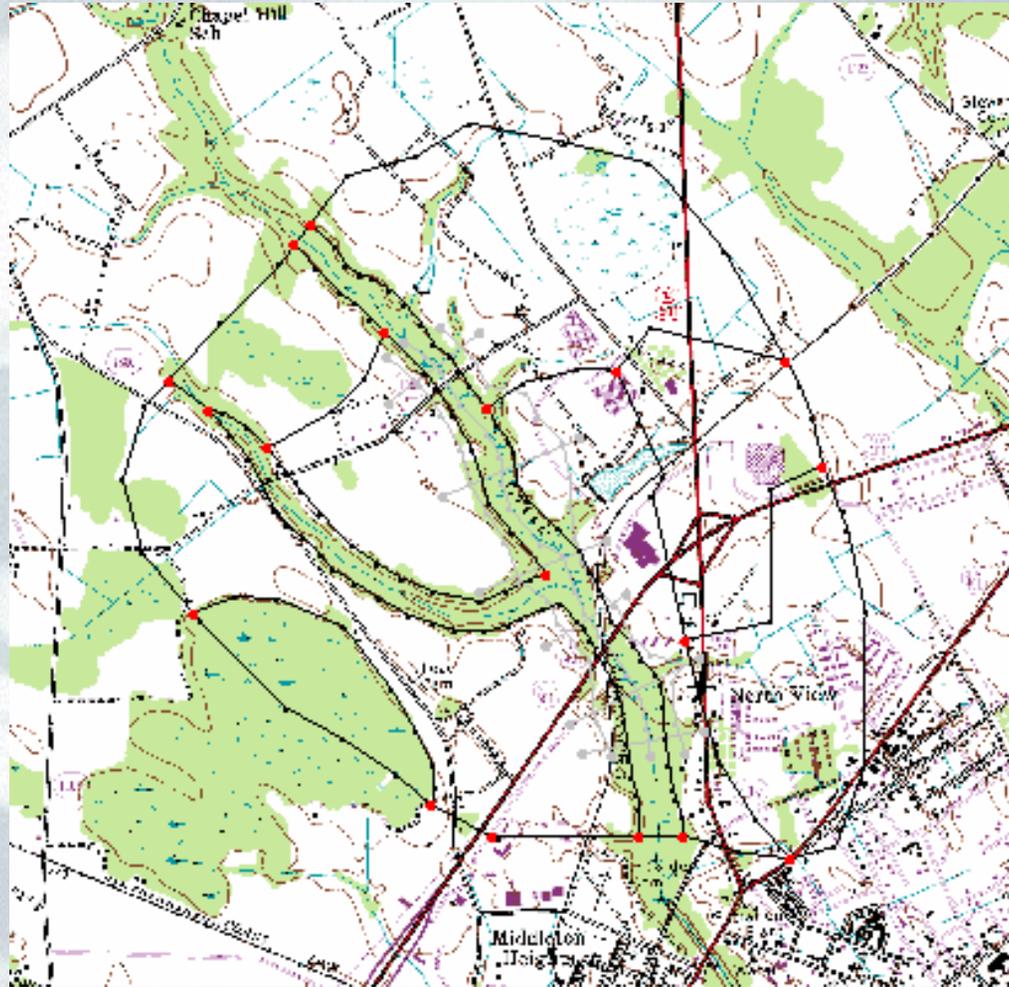
# HEC-RAS Model Support



# HEC-RAS Model Support

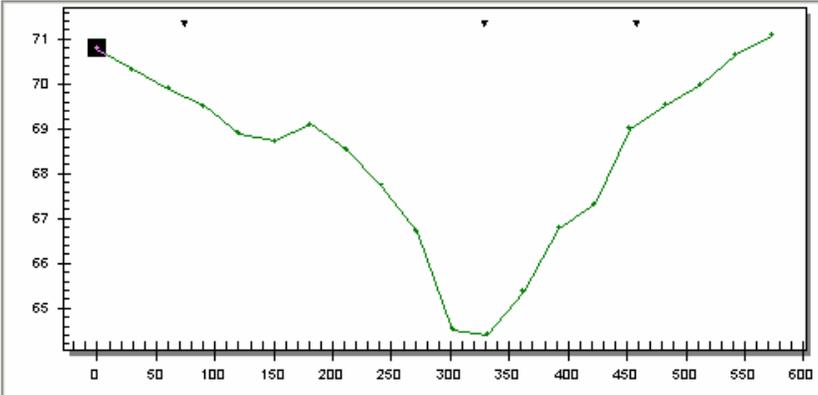


# Material Boundaries



# Cross Section Editor

Cross-Section Attributes



The graph displays a cross-section profile with elevation on the y-axis (ranging from 65 to 71) and stationing on the x-axis (ranging from 0 to 600). A green line represents the profile, showing a central depression (thalweg) and rising banks on either side. A black square marker is located at station 0 and elevation 71.

Geom Edit | Geo Ref | Line Props | Point Props | Merge | Filter

crosssects.idx

Cs Name

Reach

Station

Topo

# Points 20  
# Point Properties 3  
# Line Properties 3

Note

Auto Mark

	Measure	Type
1	328.600	Thalweg
2	457.975	Right Bank
3	73.818	Left Bank

Prop types

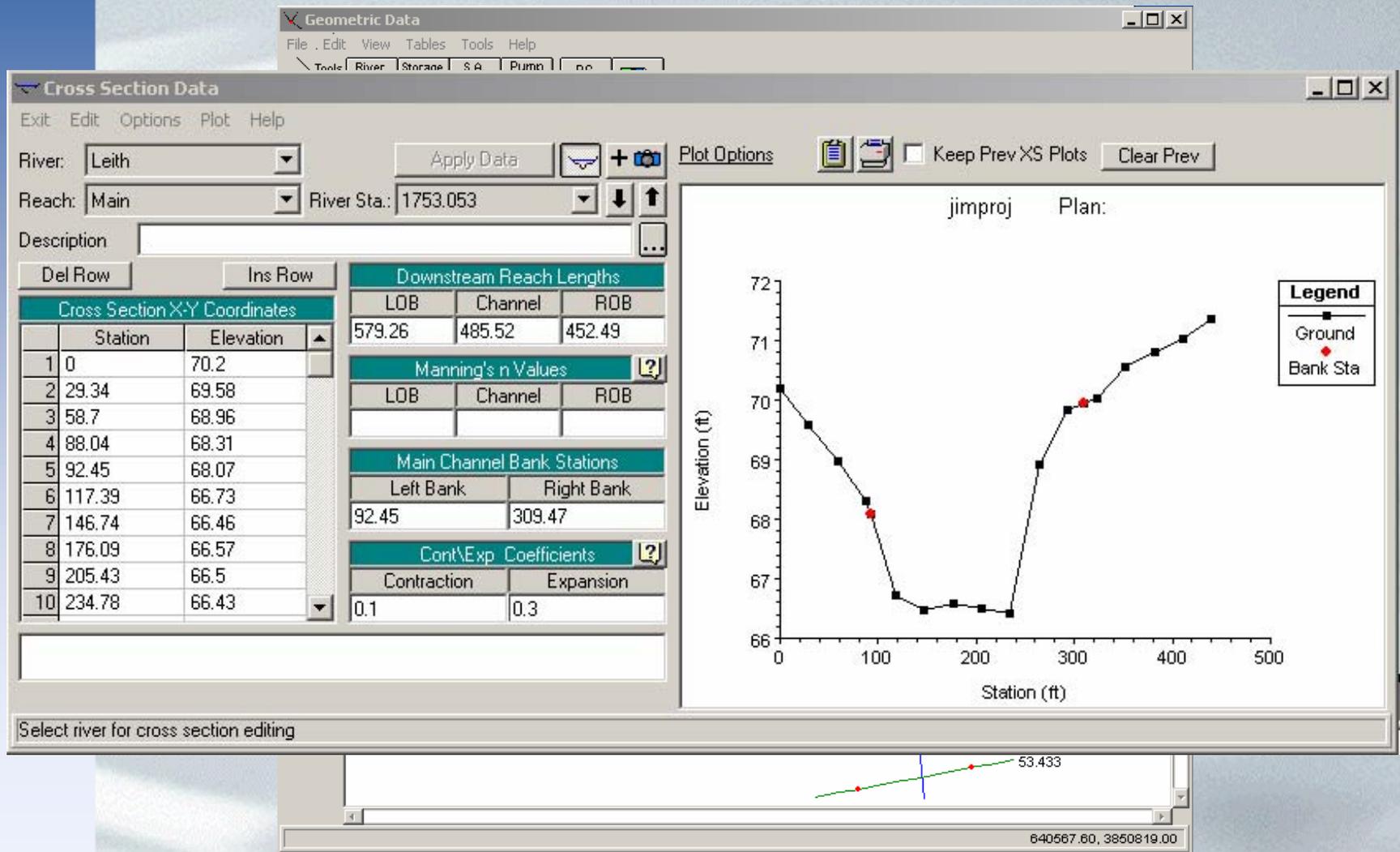
Add

Delete

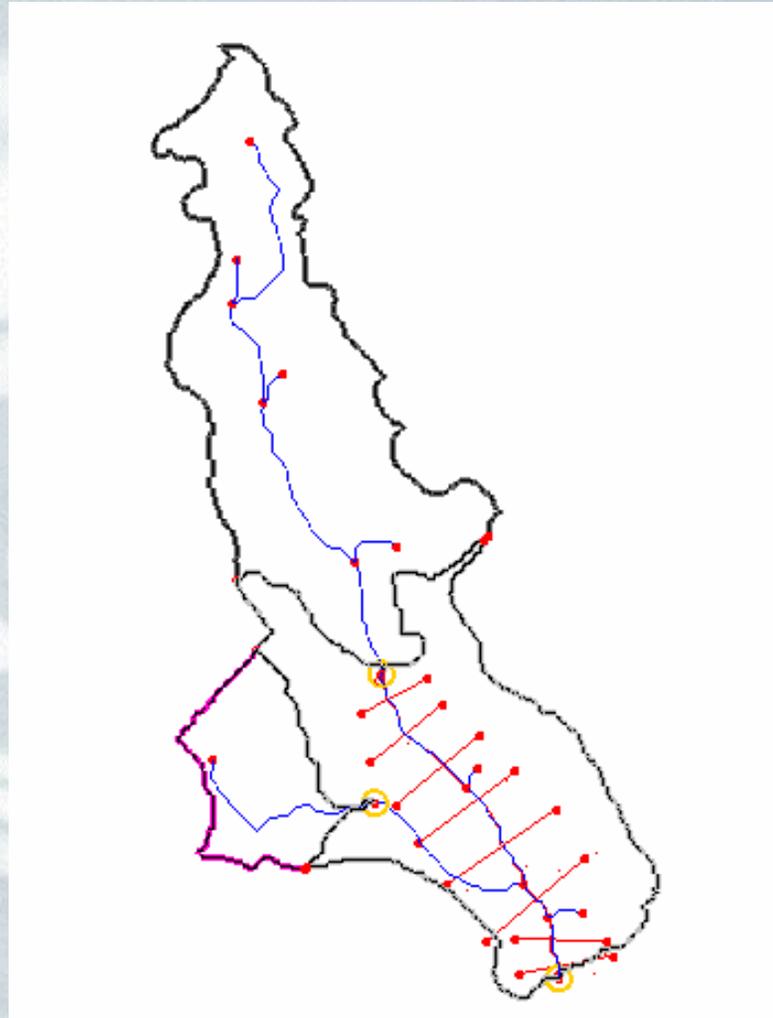
Sort

OK Cancel

# Export to HEC-RAS



# Model Linkage



# HEC-1 Model Uncertainty

**Stochastic Run Parameters**

Stochastic parameters

Simulation type

Monte carlo    Number of simulations: 10

Latin hypercube

Selected model

HEC-1

Define stochastic model

Filename parameters

Base filename: C:\WMS\wms\WESVISIT\chrisstuff\jimstoch\stochastic\hec1run

Input file: C:\WMS\wms\WESVISIT\chrisstuff\jimstoch\stochastic\hec1run.inp

Solution file: C:\WMS\wms\WESVISIT\chrisstuff\jimstoch\stochastic\hec1run\_\*.sol

Save solution only for each simulation

Stochastic variables

	Used	Name	Key	Type	Sta...	Min ...	Ma...	Stand...	Distribution	Log
1	<input checked="" type="checkbox"/>	HEC1_1	-1	Curve Nu...	75.0	60.0	90.0	10.0	Normal	<input type="checkbox"/>
2	<input checked="" type="checkbox"/>	HEC1_2	-2	Curve Nu...	75.0	60.0	90.0	10.0	Normal	<input type="checkbox"/>
3	<input checked="" type="checkbox"/>	HEC1_3	-3	Precipitat...	8.0	6.0	10.0	1.666...	Normal	<input type="checkbox"/>

Add variable    Delete variable

Help    OK    Cancel

# HEC-RAS Model Uncertainty

**Stochastic Run Parameters**

Stochastic parameters

Simulation type

Monte carlo    Number of simulations:

Latin hypercube

Selected model

HEC-RAS

Define stochastic model

Filename parameters

Base filename:  C:\WMS\wms\WESVISIT\chrisstuff\jimstoch\jim

Input file: C:\WMS\wms\WESVISIT\chrisstuff\jimstoch\jim.inp

Solution file: C:\WMS\wms\WESVISIT\chrisstuff\jimstoch\jim\_\*.sol

Save solution only for each simulation

Stochastic variables

	Used	Name	Key	Type	Sta...	Min ...	Ma...	Stand...	Distribution	Log
1	<input checked="" type="checkbox"/>	HECRAS_1	-1	Manning's N	0.02	0.01	0.03	0.006...	Normal	<input type="checkbox"/>

# Model Linkage

Stochastic HEC-1

Finished

	Converged
Run 1	
Run 2	
Run 3	
Run 4	
Run 5	
Run 6	

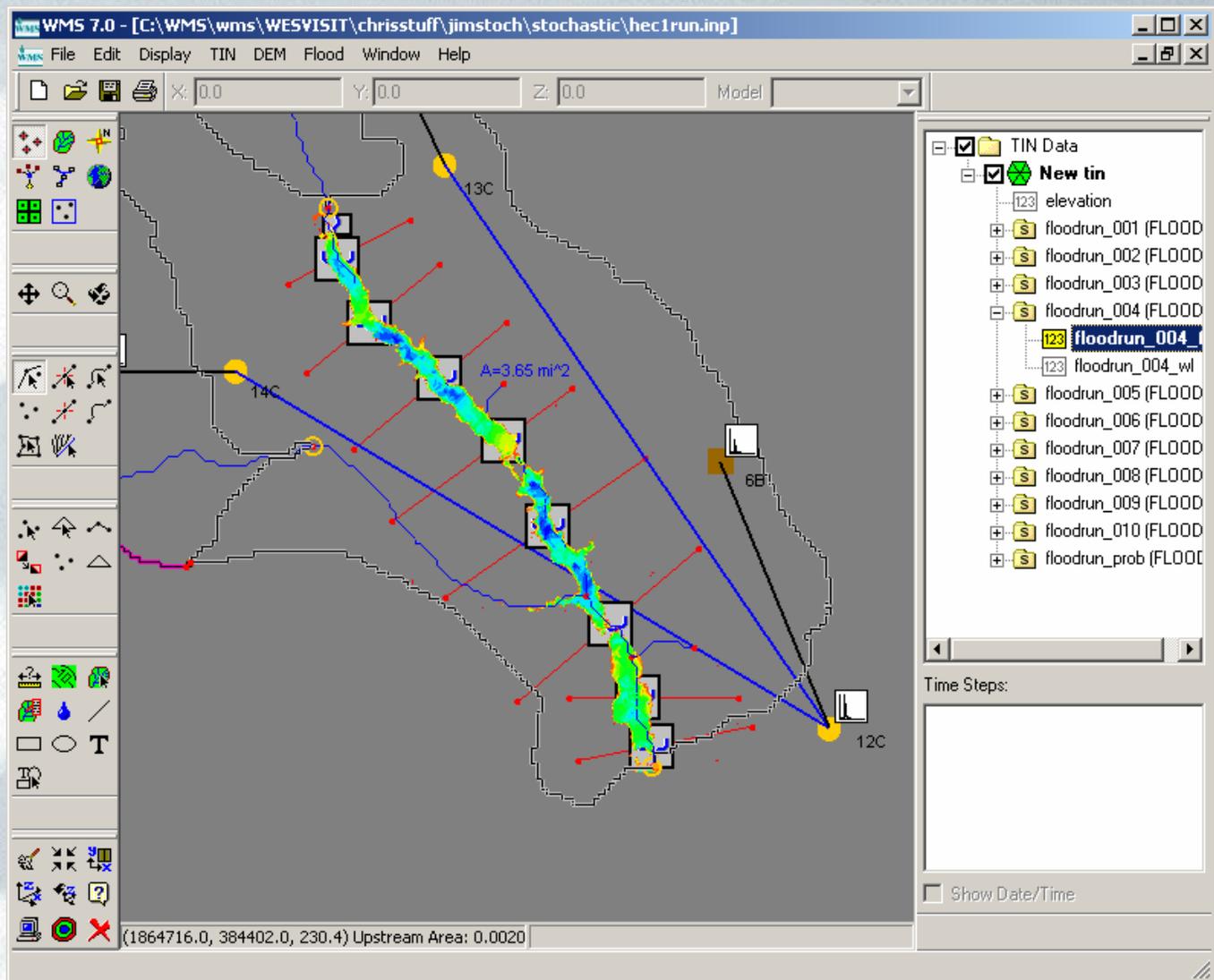
Elapsed Time: 0 hrs 0 min 52 sec

```
HEC-1 started
Writing HEC-RAS boundary conditions
Reading HEC-RAS solution
Floodplain delineation started
HEC-1 started
Writing HEC-RAS boundary conditions
Reading HEC-RAS solution
Floodplain delineation started
HEC-1 started
Writing HEC-RAS boundary conditions
Reading HEC-RAS solution
Floodplain delineation started
HEC-1 started
Writing HEC-RAS boundary conditions
Reading HEC-RAS solution
Floodplain delineation started
HEC-1 started
Writing HEC-RAS boundary conditions
Reading HEC-RAS solution
Floodplain delineation started
Stochastic runs finished.
```

Read solution on exit

Close

# Floodplain Delineation





# Distribution

- Demonstration Version Can Be Downloaded From:
  - ▶ <http://www.ems-i.com>
- Online Registration
  - ▶ Basic Contact Information
  - ▶ Select State
  - ▶ Submit

# Questions?

