U. S. Army Corps of Engineers
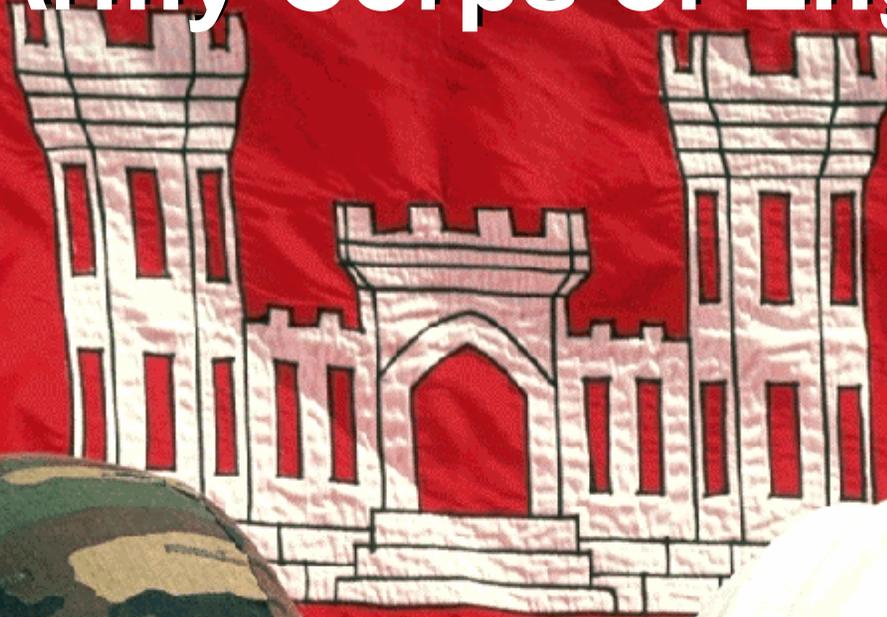
In Support of the Army and the Nation

Civil Works Support to the Nation

- 75 Hydropower Dams
- 627 Shallow Draft Harbors
- 11.7 Million Acres Public Lands
- 383 Major Lakes & Reservoirs 376 M Visitors/yr
- 299 Deep Draft Harbors
- 11,000 miles Inland Waterways
- Emergency Operations
- 400 miles Coastal Structures
- 276 Locks
- $500M Annual Dredging Costs
- 4340 Recreation Areas
- 8500 Miles of Levees
- Environmental Stewardship/ Regulatory

- US Ports & Waterways convey > 2B Tons Commerce
- Foreign Trade alone Creates > $160B Tax Revenues
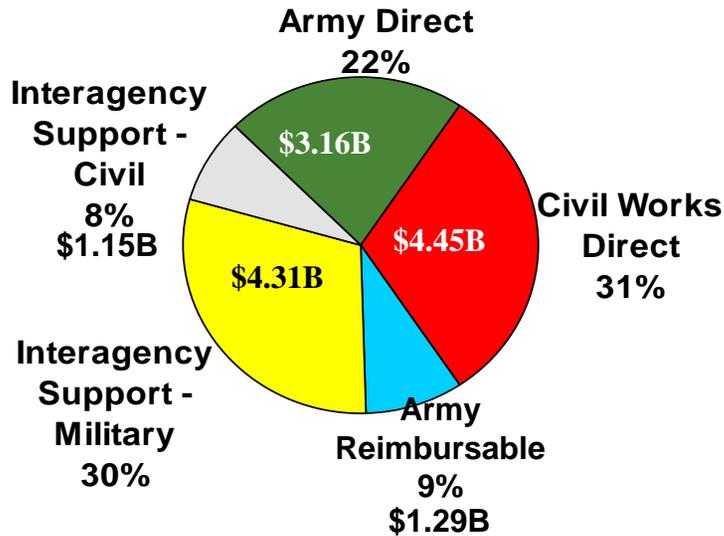- Cumulative Flood Damage Prevention >$419B

Great Lakes and Ohio River Division

Northwestern Division

South Pacific Division

Southwestern Division

North Atlantic Division

South Atlantic Division

Mississippi Valley Division

MILCON Only

Pacific Ocean Division

MILCON Only

MILCON Only

RHQ

HQ

HQ Division Headquarters

RHQ Regional Headquarters

⭐ Corps Headquarters

Other Commands

USACE -- The Army's Engineer

Army Direct
22%
$3.16B

Interagency Support - Civil
8%
$1.15B

Civil Works Direct
$4.45B
31%

$4.31B

Interagency Support - Military
30%

Army Reimbursable
9%
$1.29B

---

8 Divisions

41 Districts

2 Centers

7 World Class Labs

1 Engineer Battalion

Personnel

Military Programs

Uniformed = 557

Civil Works

10K

25K
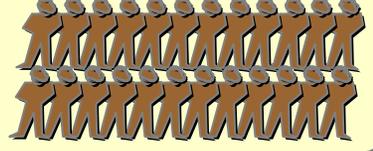
Engineer Research and Development Center

- ⊠ **2014 Employees**
- ⊠ **1029 Scientists & Engineers**
  - ⊠ **533 Master's Degrees**
  - ⊠ **266 Doctorate Degrees**
- ⊠ **$1.2 Billion in Research Facilities & Equipment**
- ⊠ **$568 Million Annual Program**

Cold Regions Research Engineering Laboratory

Hanover, NH

Construction Engineering Research Laboratory

Champaign, IL

Topographic Engineering Center

Alexandria, VA

Coastal and Hydraulics Laboratory
Environmental Laboratory
Geotechnical and Structures Laboratory
Information Technology Laboratory

Vicksburg, MS

Research Funding

- **Two Approaches:**

  - Direct funding from HQ/Congress

  - Mission Support

Institute for Water Resources
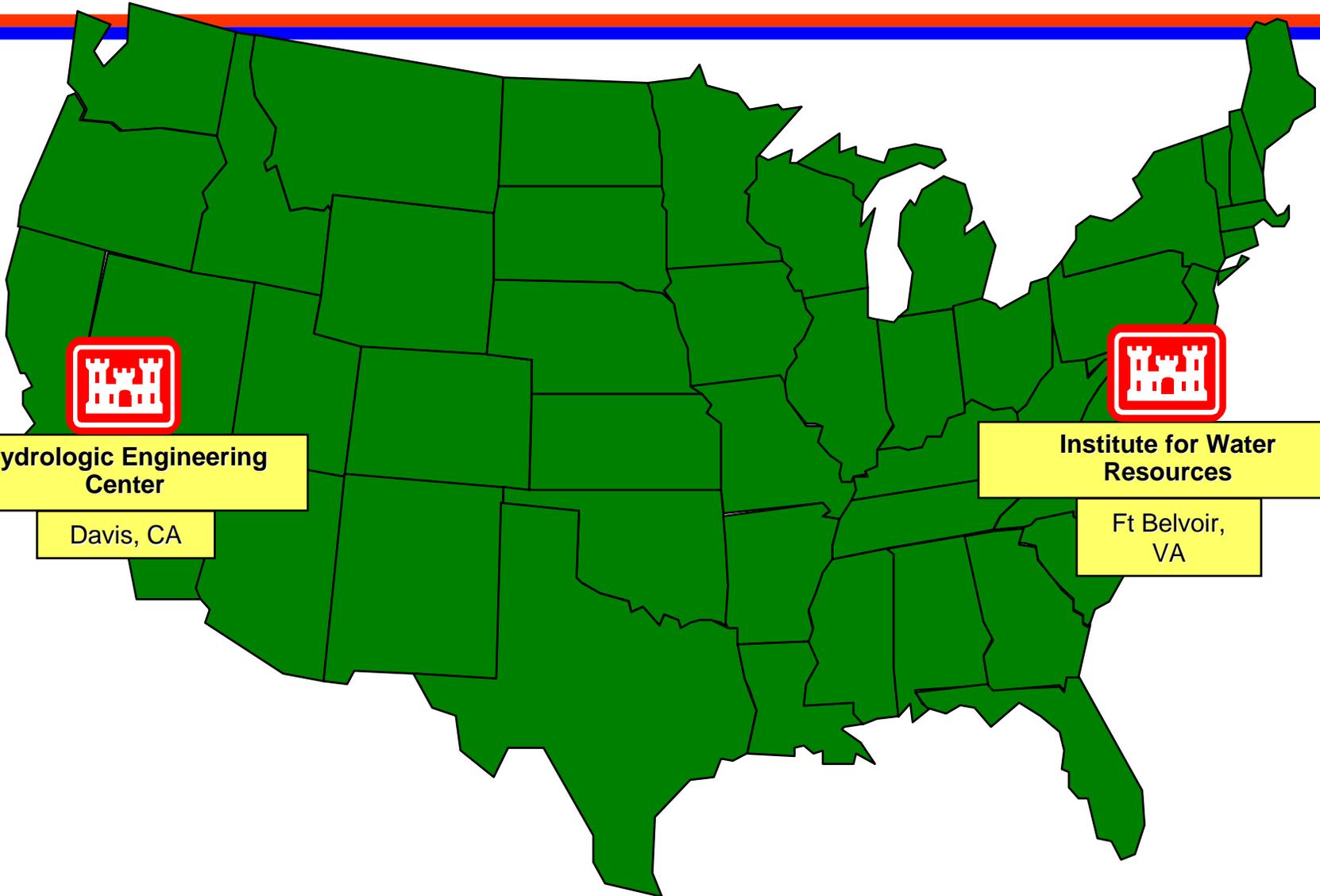
Hydrologic Engineering Center

Davis, CA

Institute for Water Resources

Ft Belvoir, VA

Hydrologic Engineering Center

- 35 professionals; civil/hydraulic engineers, a few computer specialists, most MS, few Ph.Ds.

- Products: H&H and planning analysis methods; software; guidance; technical assistance; training, research; special studies and projects.

- Primarily support Corps, some other U.S. Federal, occasional International assistance and training.

- Funding: R&D; reimbursable technical assistance; software maintenance subscriptions; special projects; training.

Hydrologic Engineering Center

Direct Allotted Research

- **General Investigations Research Programs**
  - Navigation Research Program
  - Environment Research Program
  - Flood & Coastal Storm Damage Reduction Research Program
    - Focus Area: Hydraulics & Hydrology
  - System-wide Water Resources Research Program
    - Focus Area: Watershed Hydrology Simulation
    - Focus Area: Water Processes & Assessment
    - Focus Area: River & Estuarine Simulation
    - Focus Area: Coastal Simulation

OUTLINE

- **Highlight Common Areas of work**
  - HEC's work in water control & forecasting
    - Hydraulic & Hydrologic Models & support tools
    - Corps Water Management System
  - ERDC's work with
    - Distributed Modeling
    - Graphical User Interfaces
    - Parameter Estimation
    - Data Tools & Requirements

# Hydrologic Engineering Center
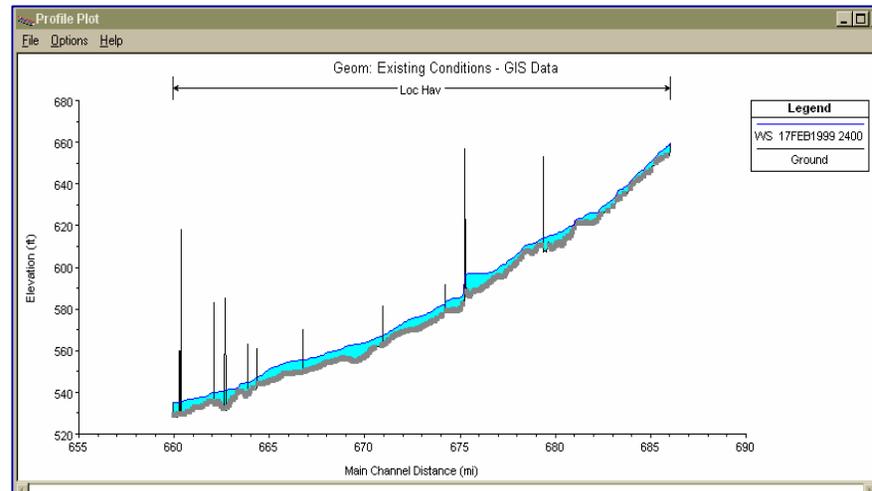
HEC-RAS
River Analysis System

- Steady, unsteady flow, bridges, culverts, network/ quasi-2D, animation, pumps, dam/levee break, navigation locks & dams operation. Sediment transport underway.

- GIS utility for geometry, inundation mapping, other parameters. ArcGIS version underway.
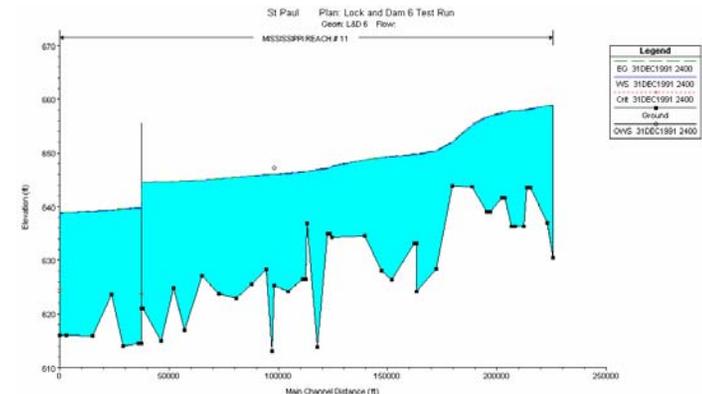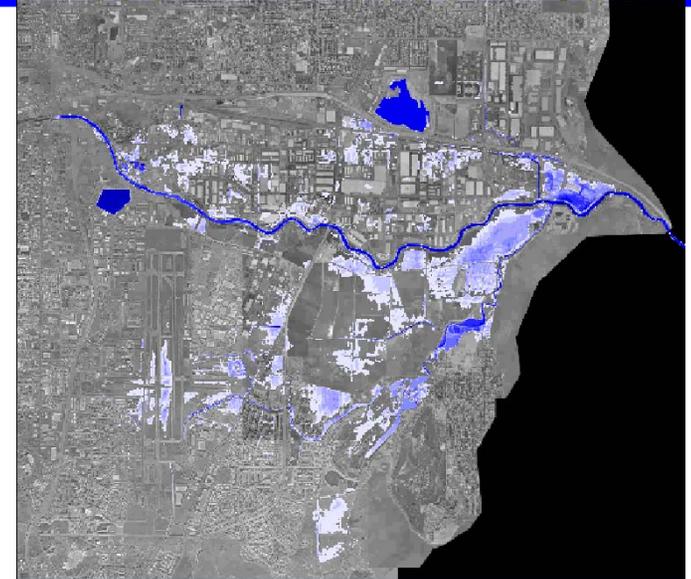
HEC-HMS
Hydrologic Modeling System

- Event and continuous simulation, multiple routing/ runoff methods, grid precipitation, losses & runoff, coefficient estimation, dam break, powerful GUI. Snowmelt in next version.

- GeoHMS GIS utility for watersheds/sub-watersheds, runoff parameters. ArcGIS 8.X version underway.
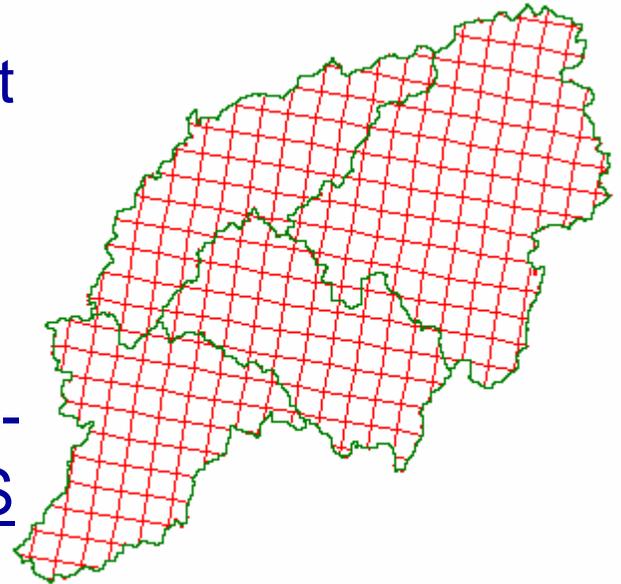
HEC-ResSim Reservoir Analysis

- Rule-based multi-purpose system simulation, local hydropower, multiple outlets, network structure, integral to CWMS. <u>System power underway, more routing methods, controls</u>.

- Newest HEC model: latest GUI, code, graphics, etc. Optimization models also.
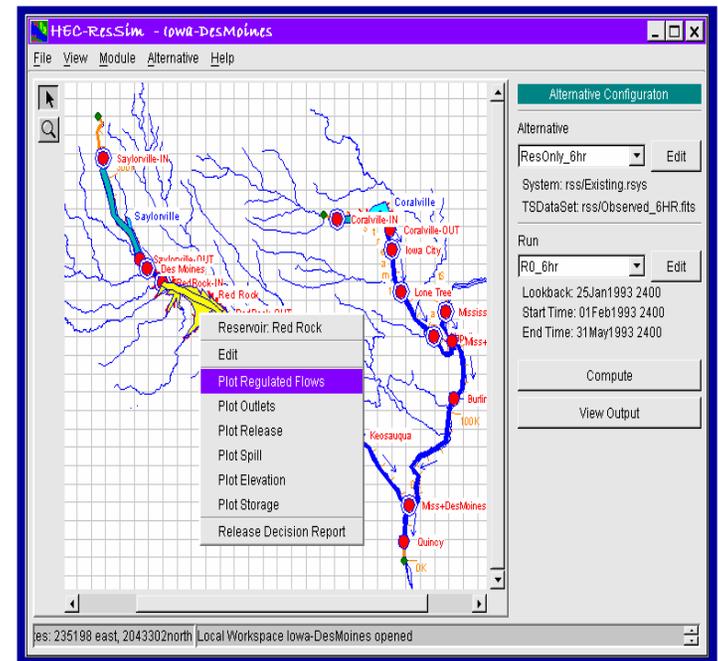
CWMS
Corps Water Management System

- Corps corporate AIS for water control management. Real-time 24/7 dedicated system. Network-based client-server system. Suite of decision-support models.

- System development '97 – '01, deployment '01 – 02'. Version 1.3 improvements underway.

- Operational in all USACE district and division offices.

CWMS Components

- Data Collection
- Data Base
- Modeling
- Data Visualization
- Information dissemination
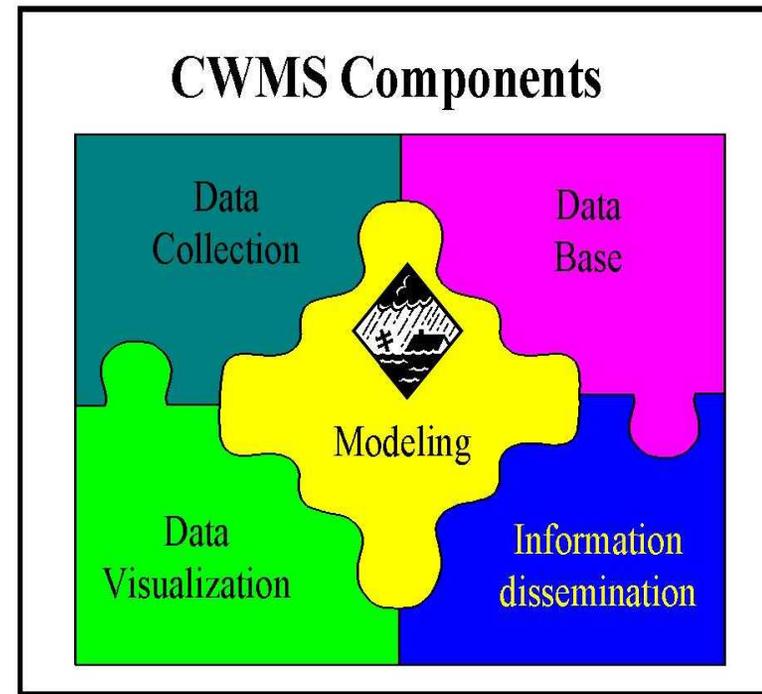
CWMS Decision-support Modeling

Model Working Files

MFP   **HFP**

Unsteady flow river hydraulic routing

Inundation mapping and GIS viewing

HMS   **ResSim**   **RAS**   **FIA**   **GIS**

Runoff Forecasting via grid/ spatial modeling

Rule-based reservoir system simulation

Flow-impact analysis of flood damage and response.

ArcInfo/ ArcView
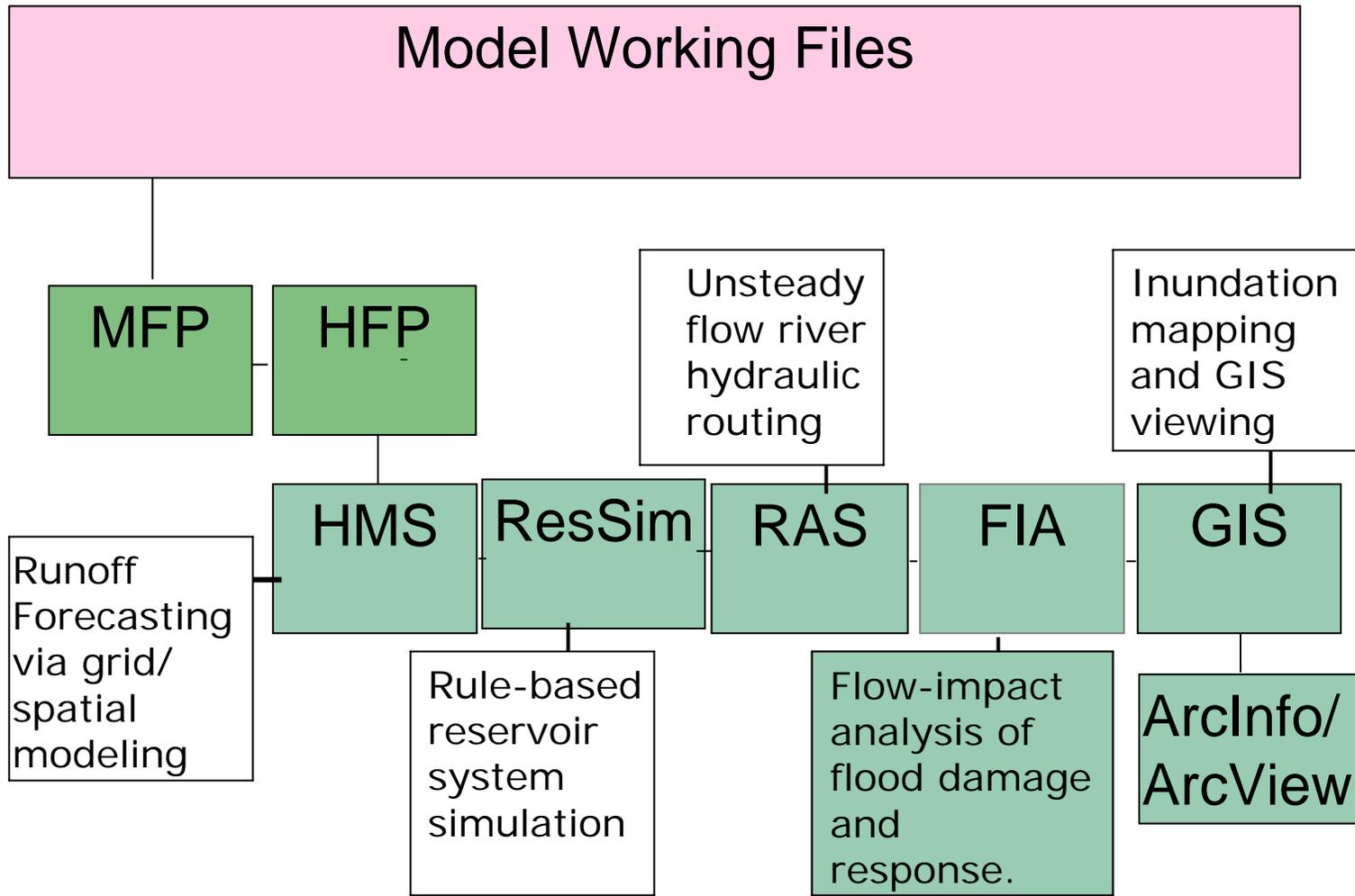
HEC Products and Contact

◆HEC software and reports are available over the Web. Other material via order from HEC office.

◆HEC Web site: http://www.hec.usace.army.mil

◆Contact for publications, software:

Hydrologic Engineering Center
609 Second Street
Davis, CA 95616
Ph 530/756-1104
E-mail: darryl.w.davis@usace.army.mil

GSSHA
Gridded Surface/Subsurface Hydrologic Analysis
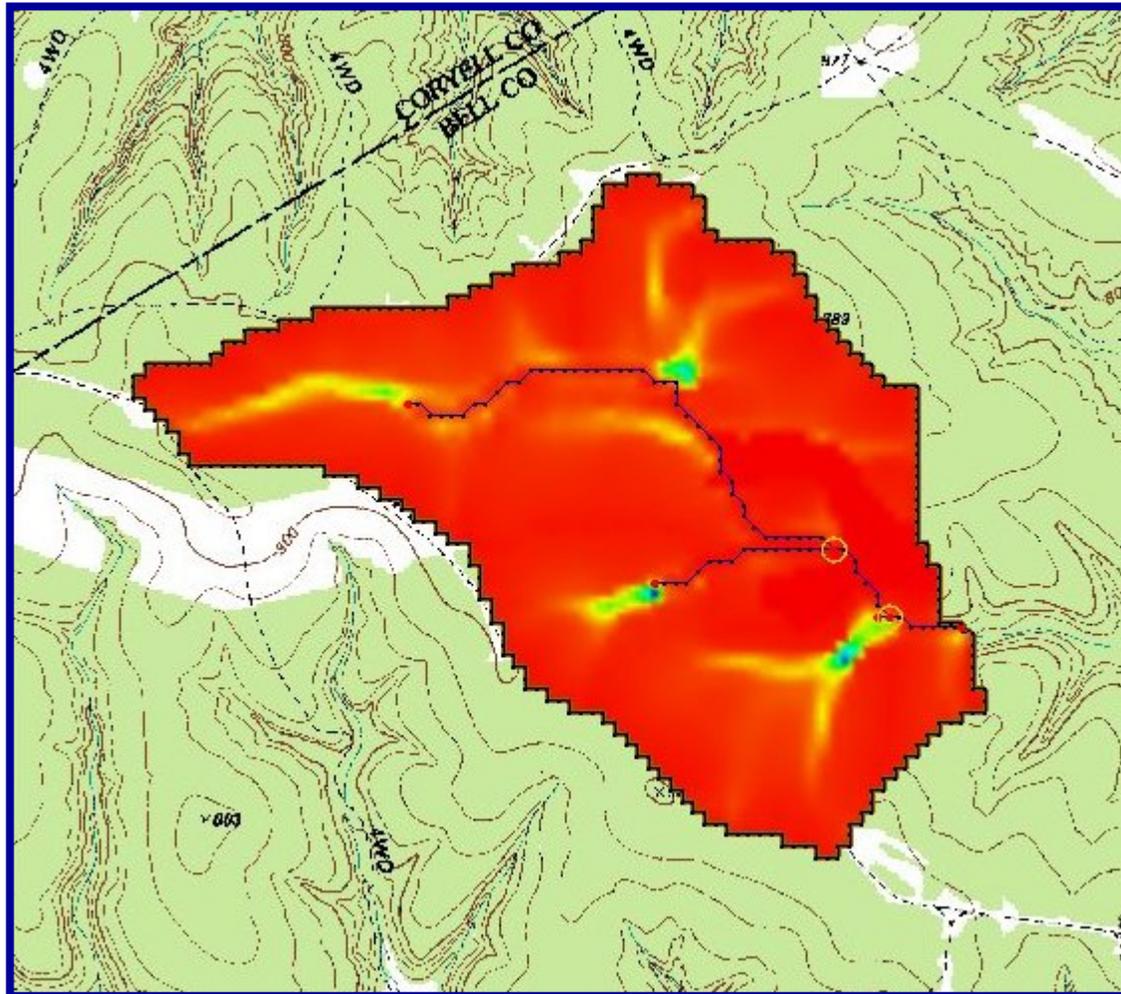
GSSHA
Distributed Hydrologic Modeling

- Hydrologic Model
- Spatially Distributed
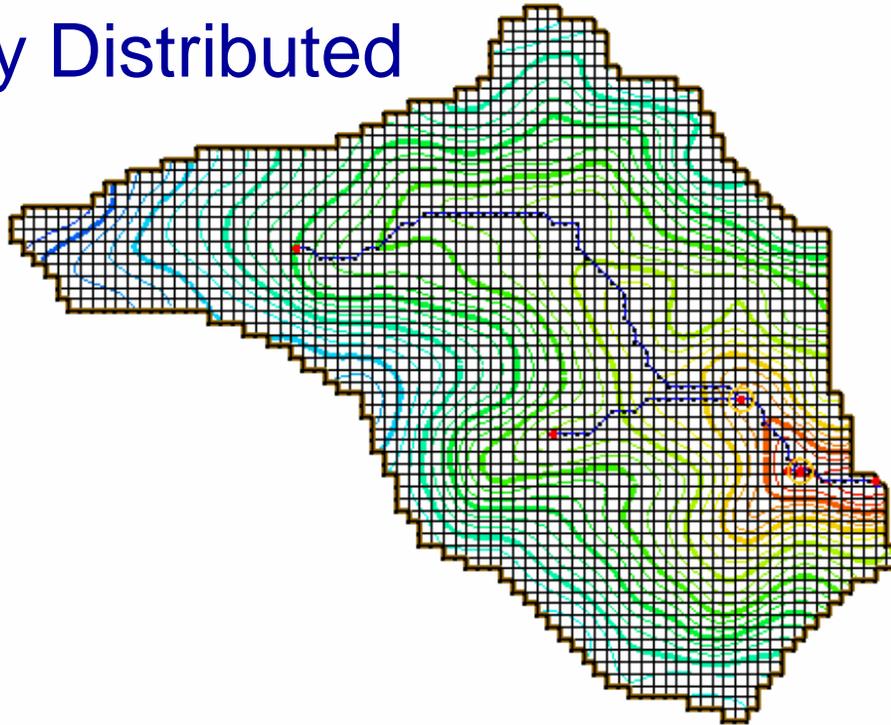
GSSHA

- Uses Land Use, Soil Type Information

Land Use Classifications

- Residential
- Commercial & Services
- Transportation, Utilities
- Mixed Urban, built up
- Other Urban, built up
- Cropland & Pastures
- Herbaceous Rangeland
- Evergreen Forest Land
- Reservoirs
- Strip Mines, Quarries, & Gravel Pits
- Transitional Areas
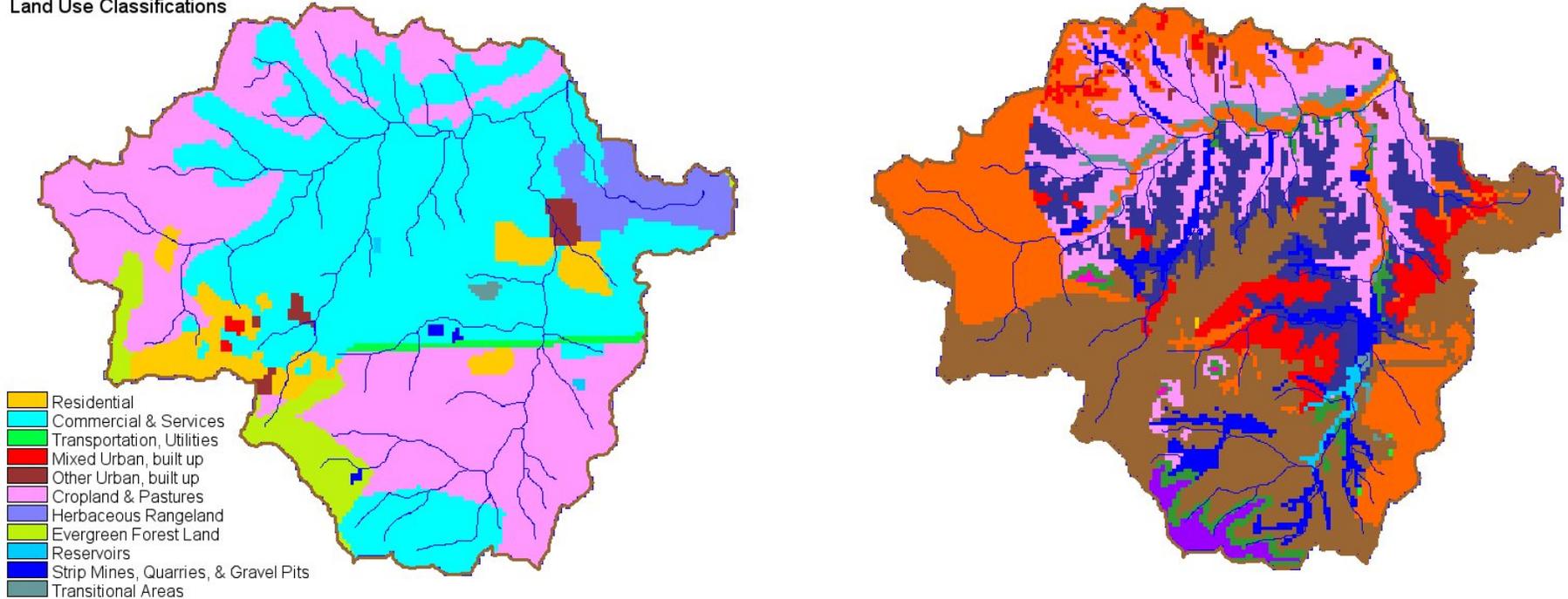
GSSHA

GSSHA: Kishwaukee Basin
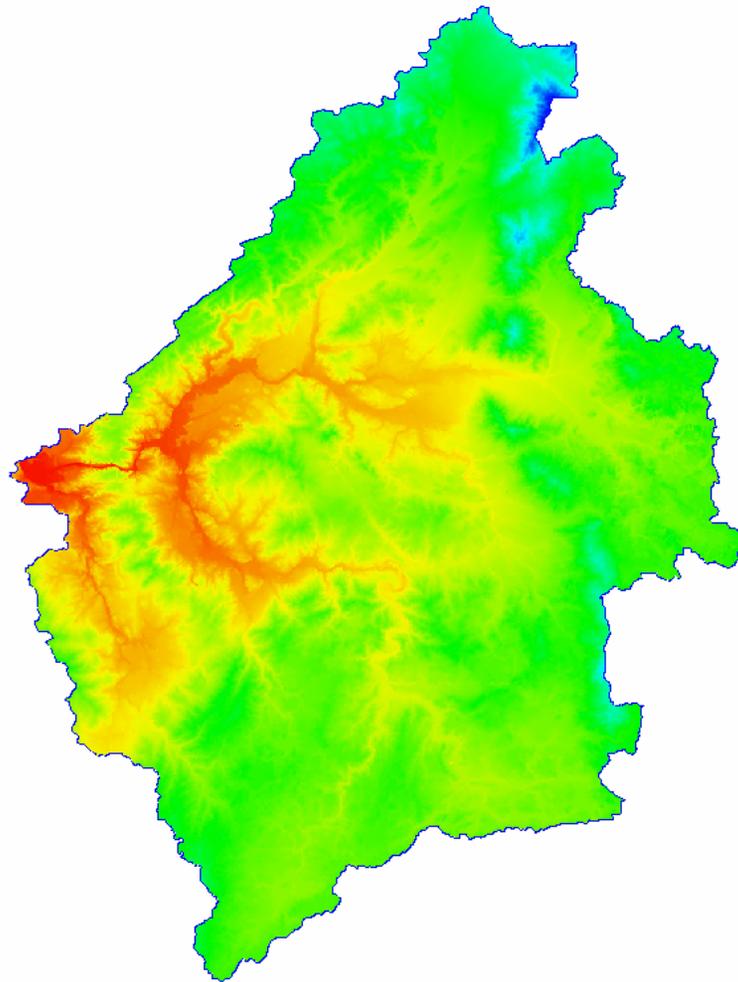
GSSHA: Kishwaukee Basin
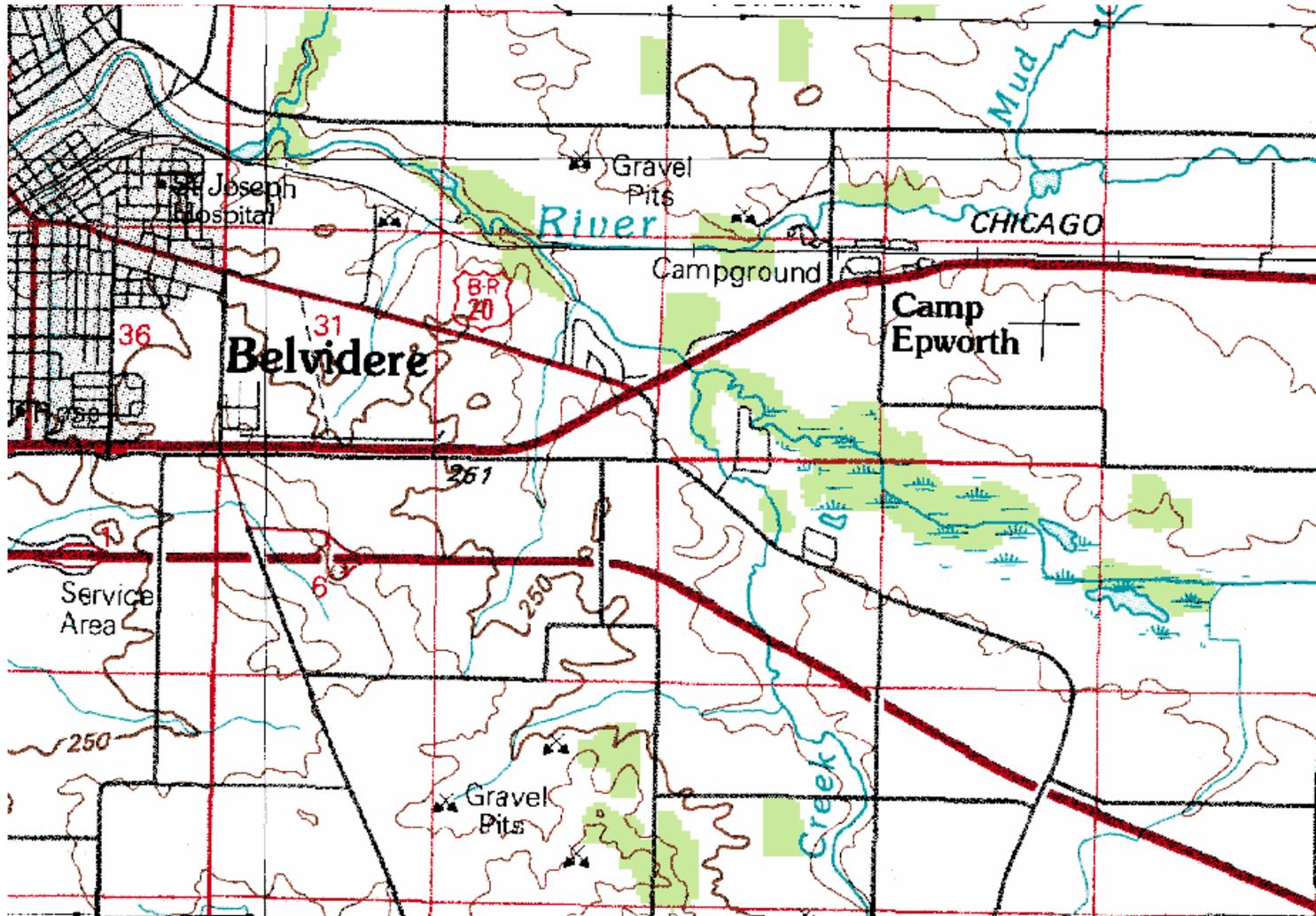
GSSHA: Kishwaukee Basin
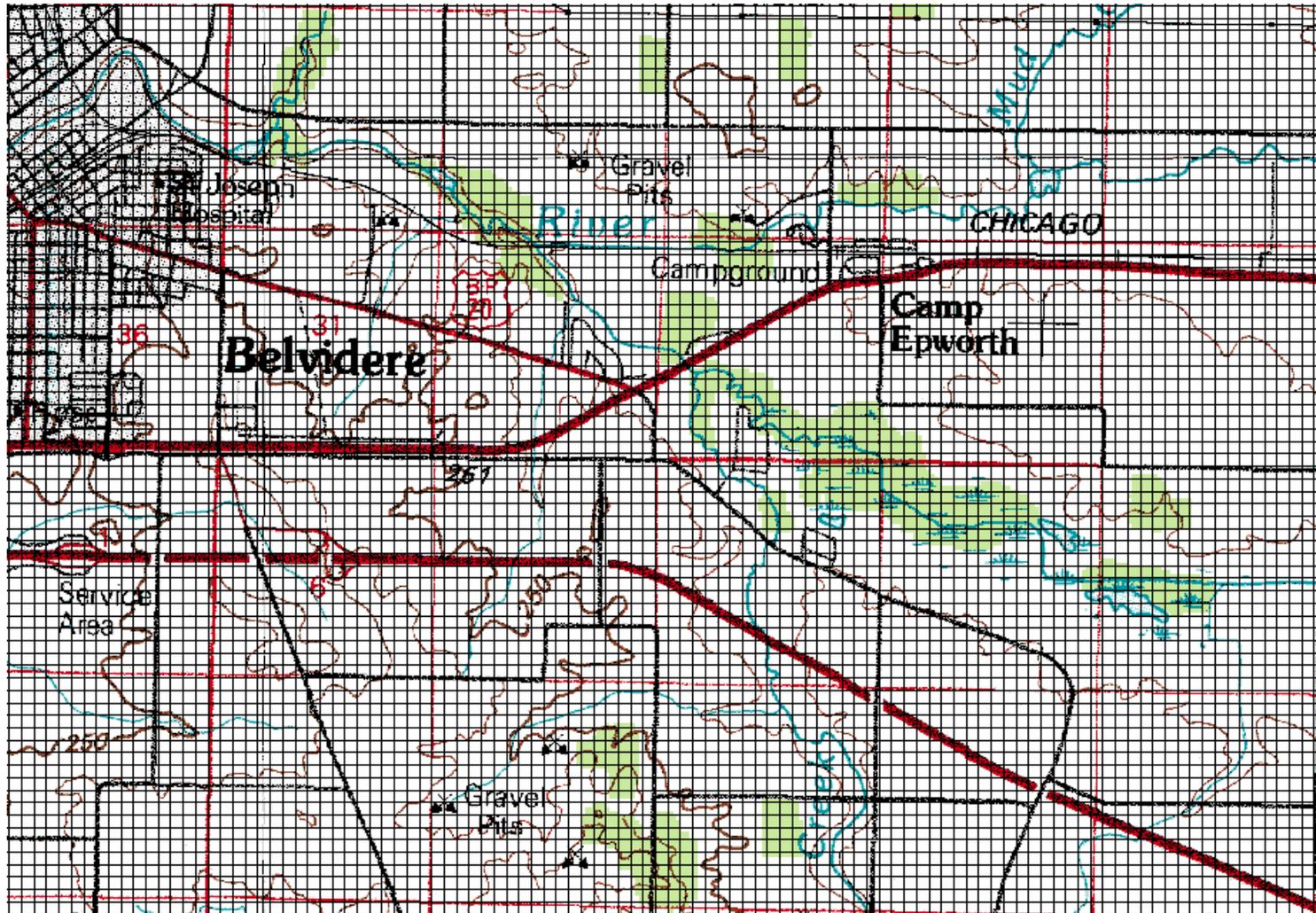
Kishwaukee Simplified Soils

- 8 Soil Types
- 3 Subsurface Layers
- Simplified by similar surface, subsurface characteristics
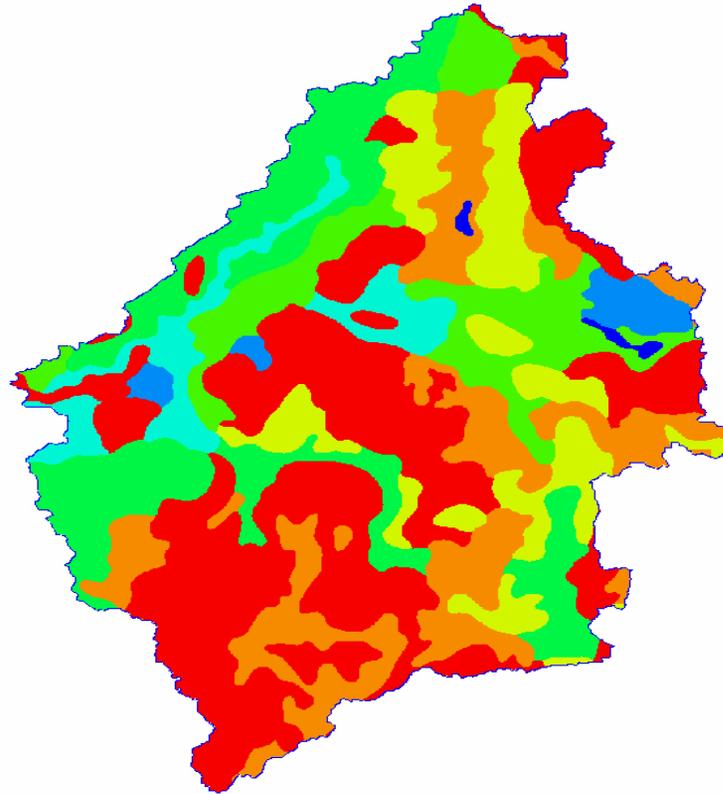
Kishwaukee Land Use

- 6 Classifications
  - Urban
  - Corn
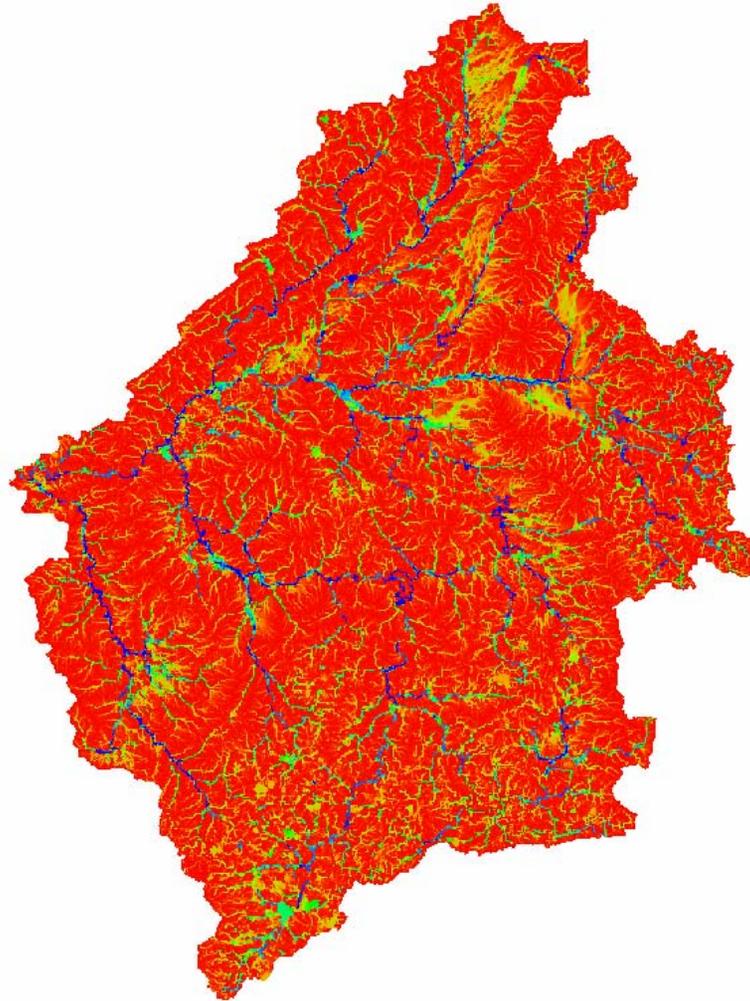 - Soybeans
  - Forest
  - Wetlands
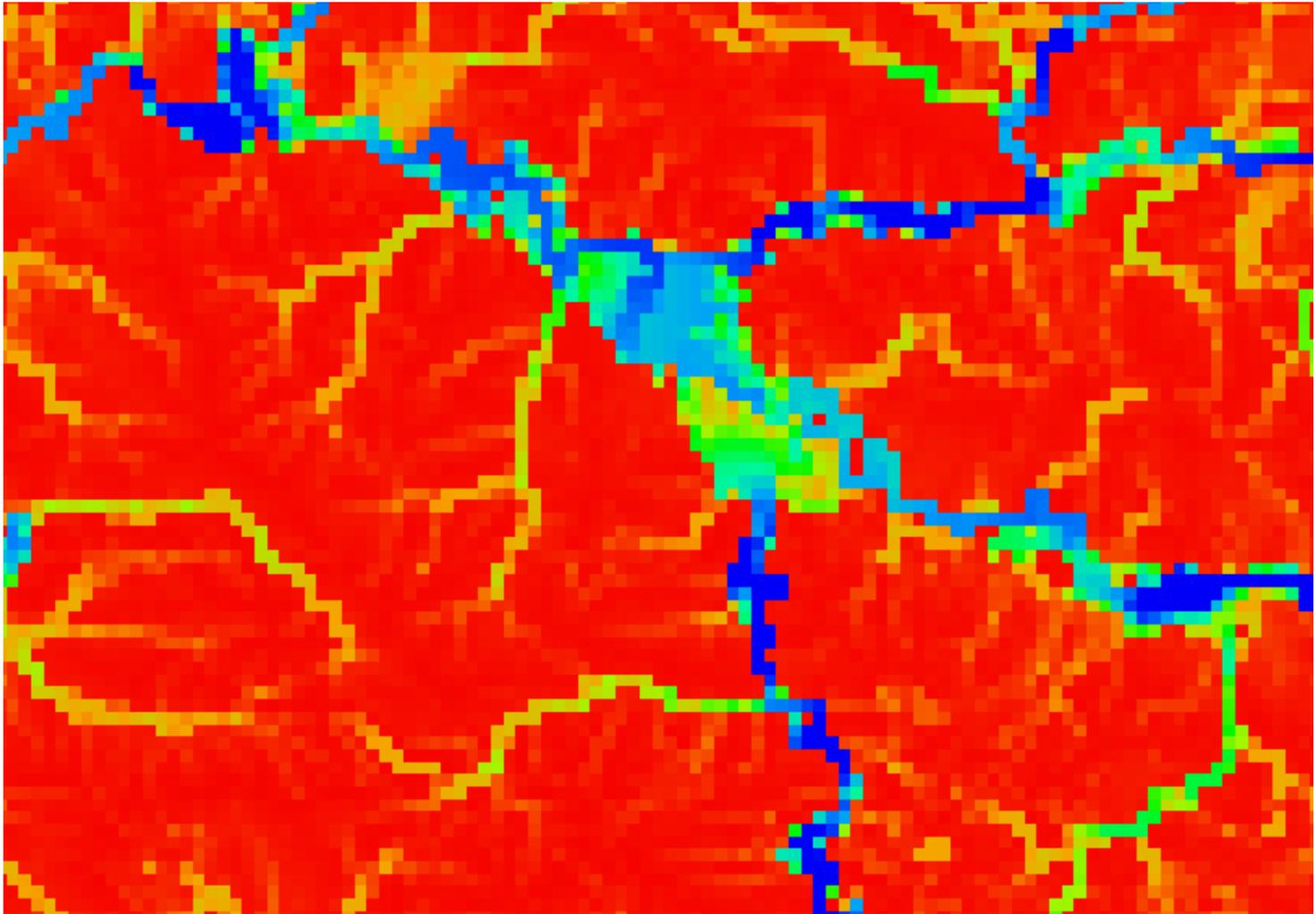 - Grassland
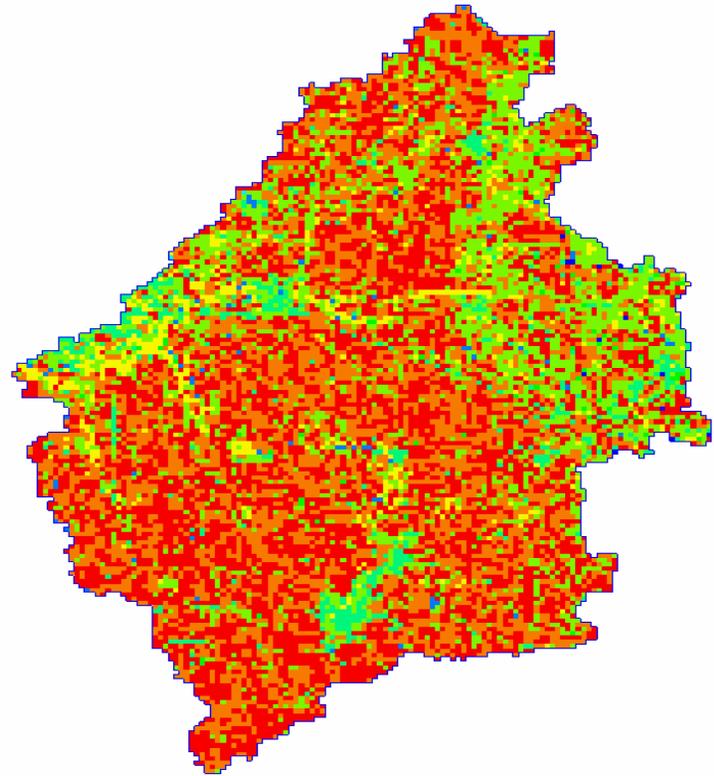
Precipitation: Rockford Airport

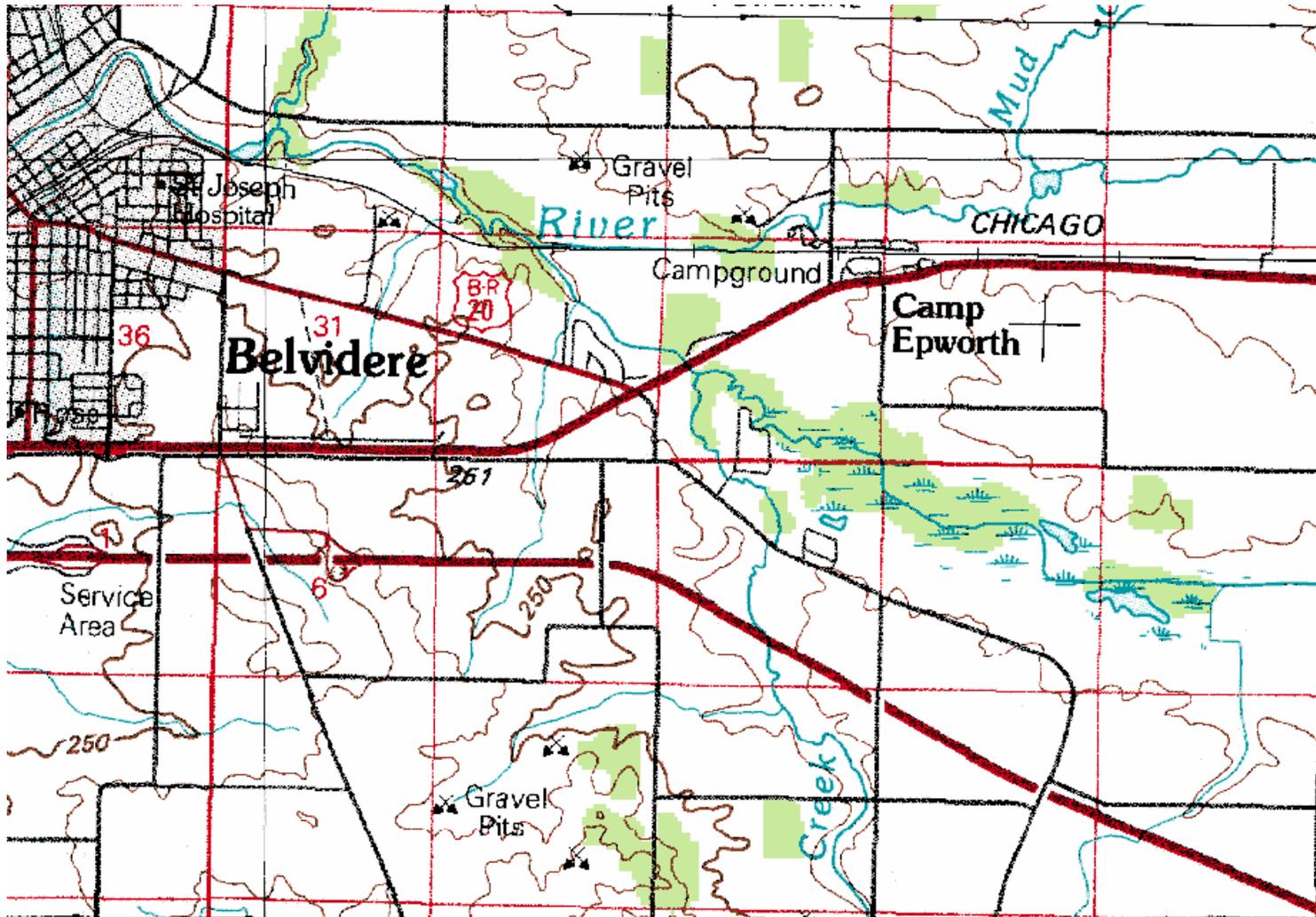Rockford, IL Precipitation
May to September 2002

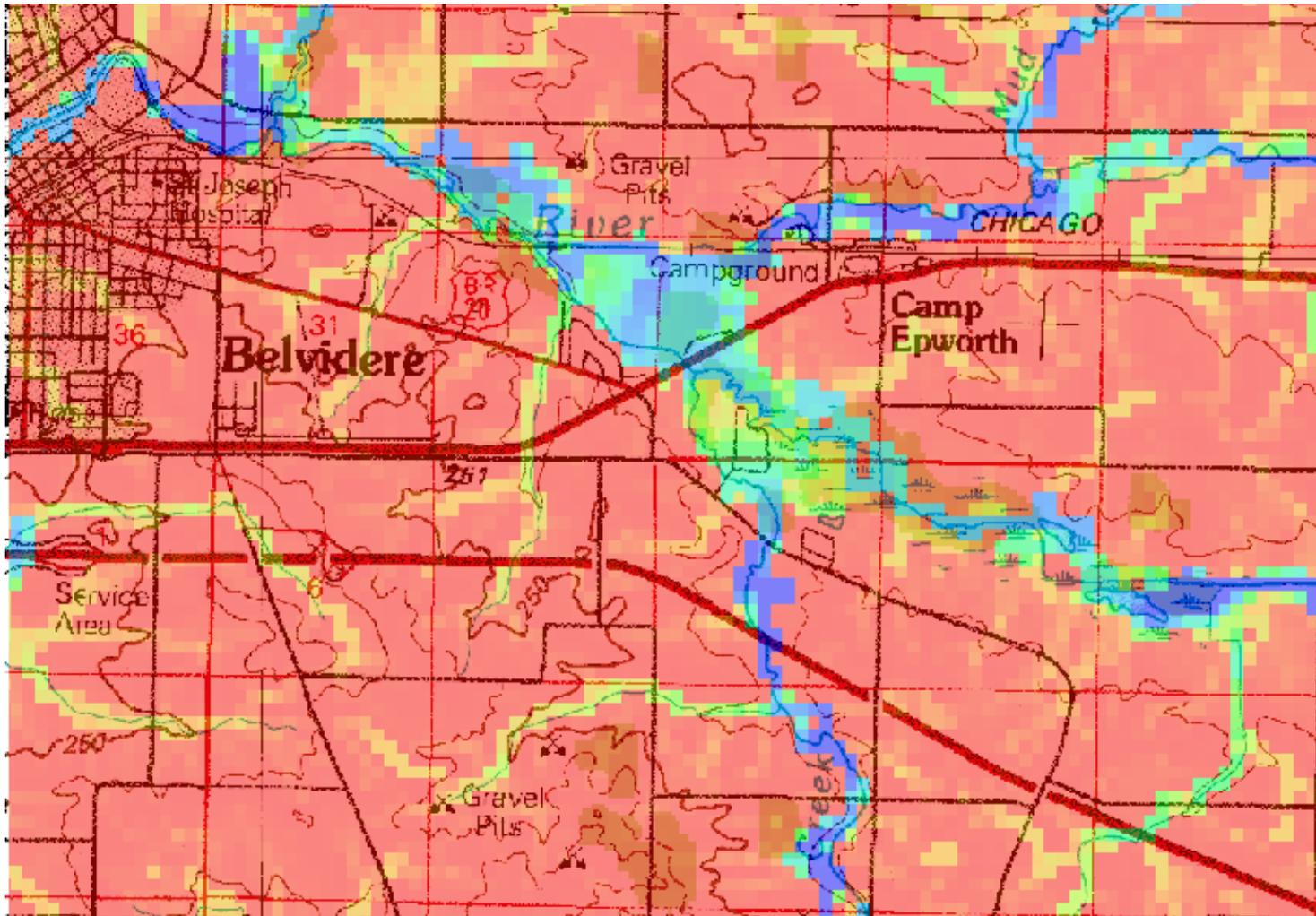June 3-5

Aug 22-23
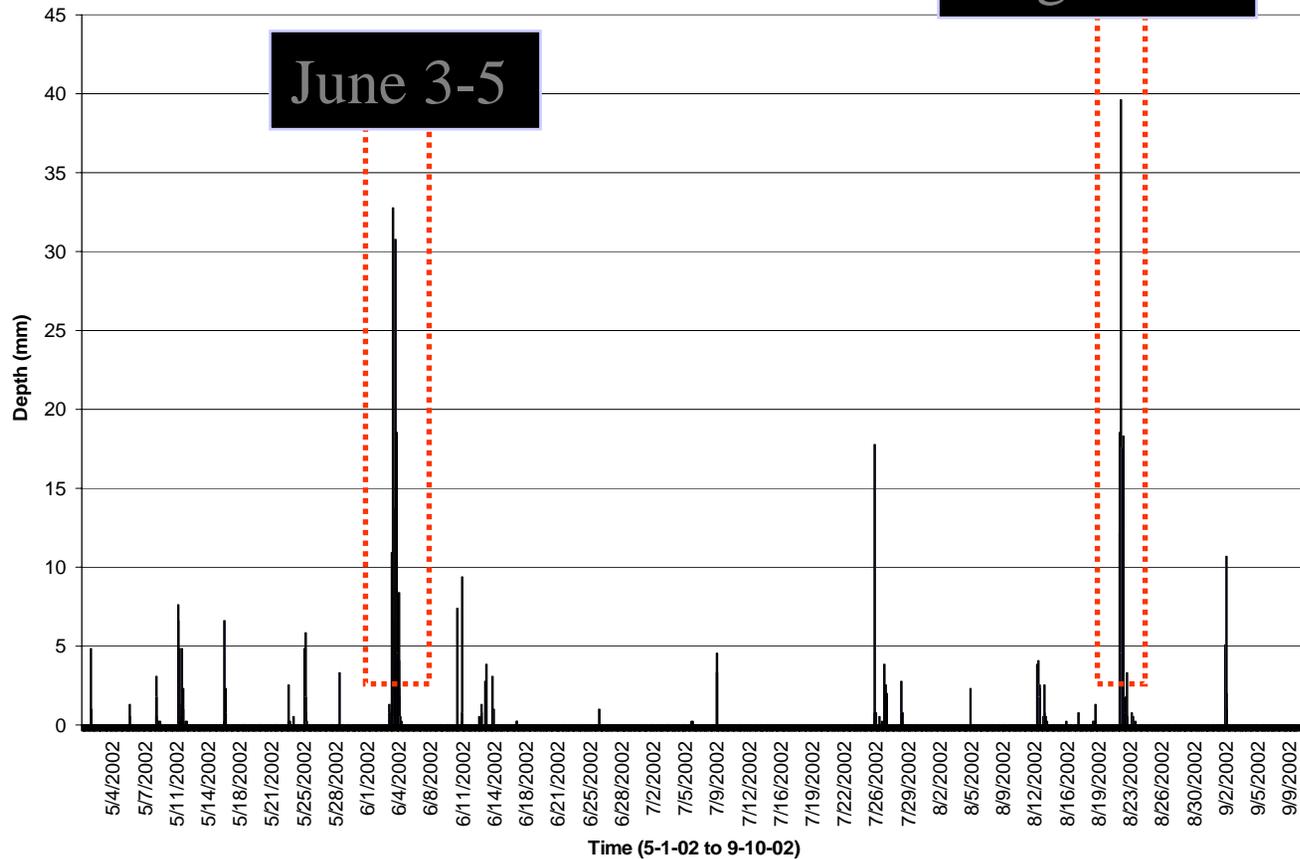
Preliminary Results

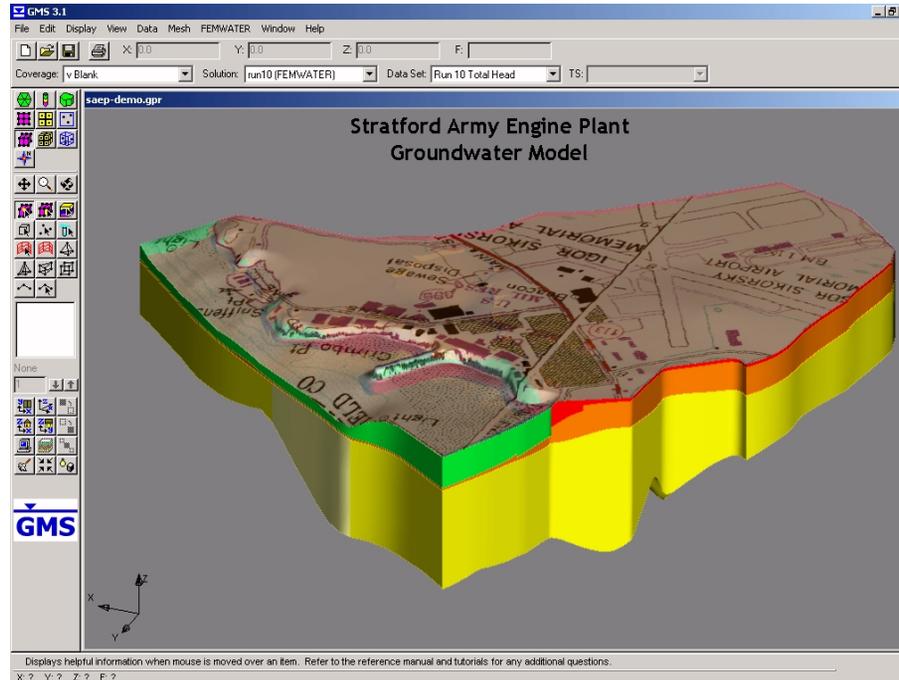# Preliminary Results

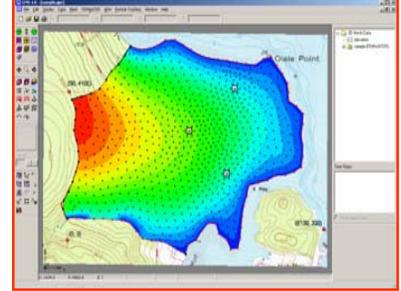# Preliminary Results

Preliminary Results

xMS:
The Corps' Multidimensional Hydroinformatic Toolbox

<u>x</u>MS

- **<u>x</u>MS is a series of GUIs designed by ERDC to improve modeling productivity**
  - **GMS – Groundwater Modeling System**
  - **SMS – Surface water Modeling System**
  - **WMS – Watershed Modeling System**
- **Consistent user interface and data structures**
- **Access to tools, utilities, and data sources**
- **Separates site data from the models**
- **Facilitates comparisons of modeling approaches**
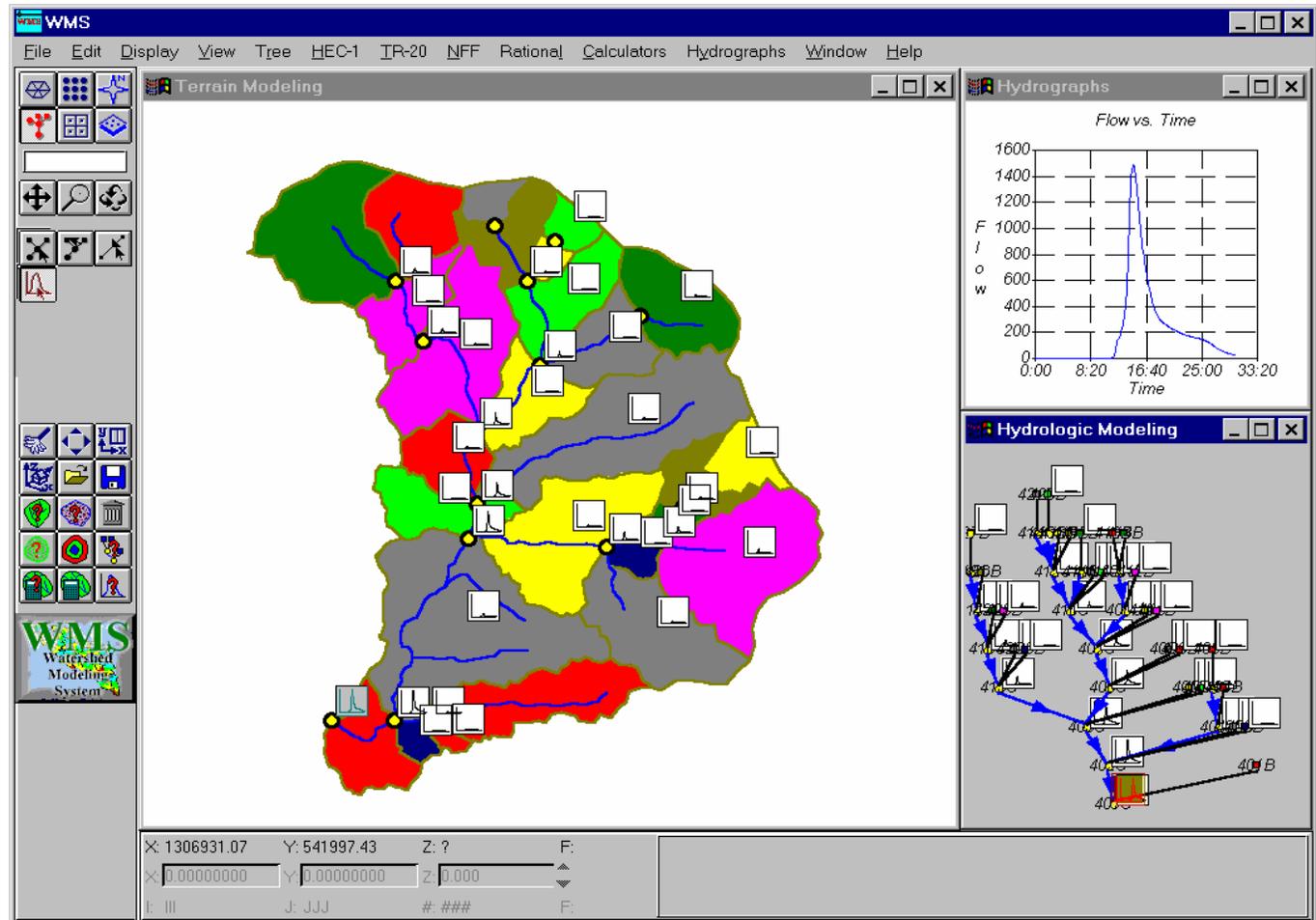
Watershed Modeling System (WMS)
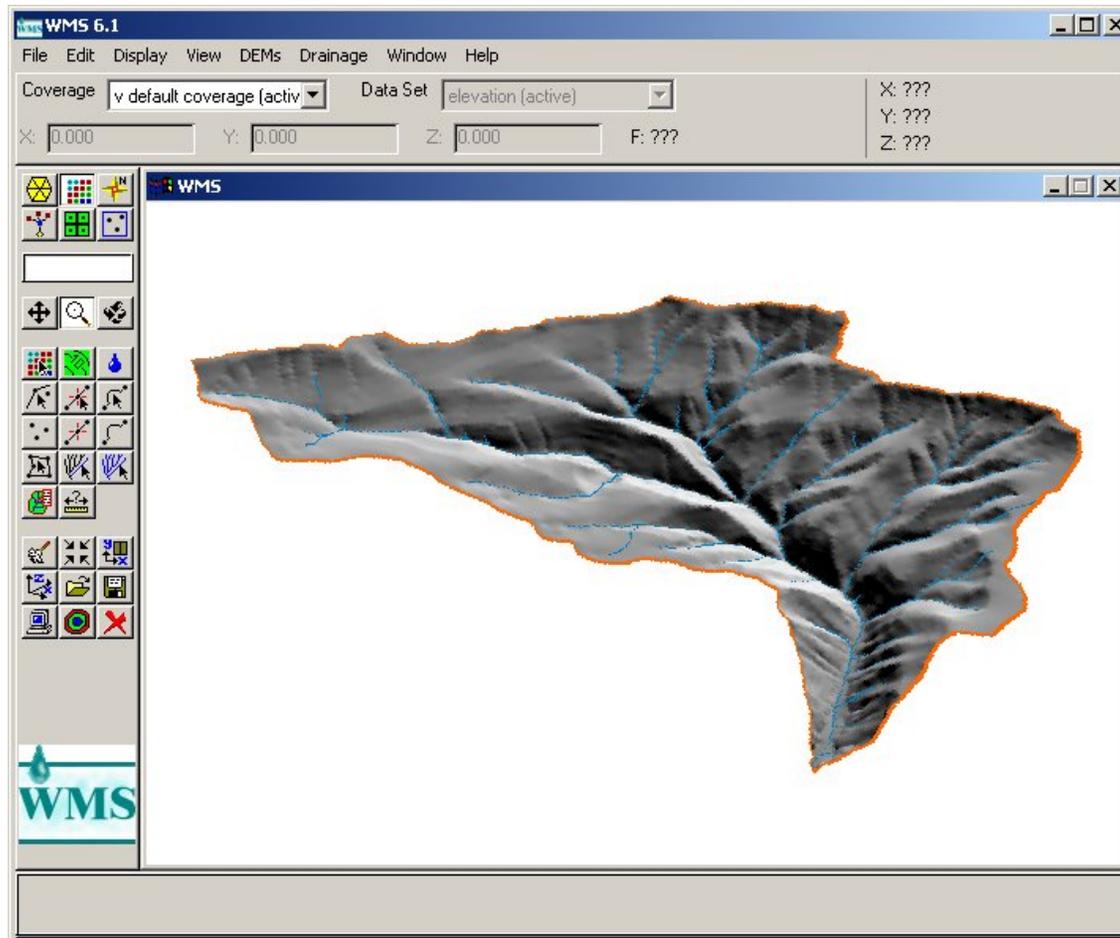
WMS Modeling Overview

- Multiple computational models supported
  - Empirically-based, lumped parameter models
  - Physically-based, distributed spatial parameter models
  - Single event models
  - Continuous models

- Integrates multiple data sources to automate model parameter definition
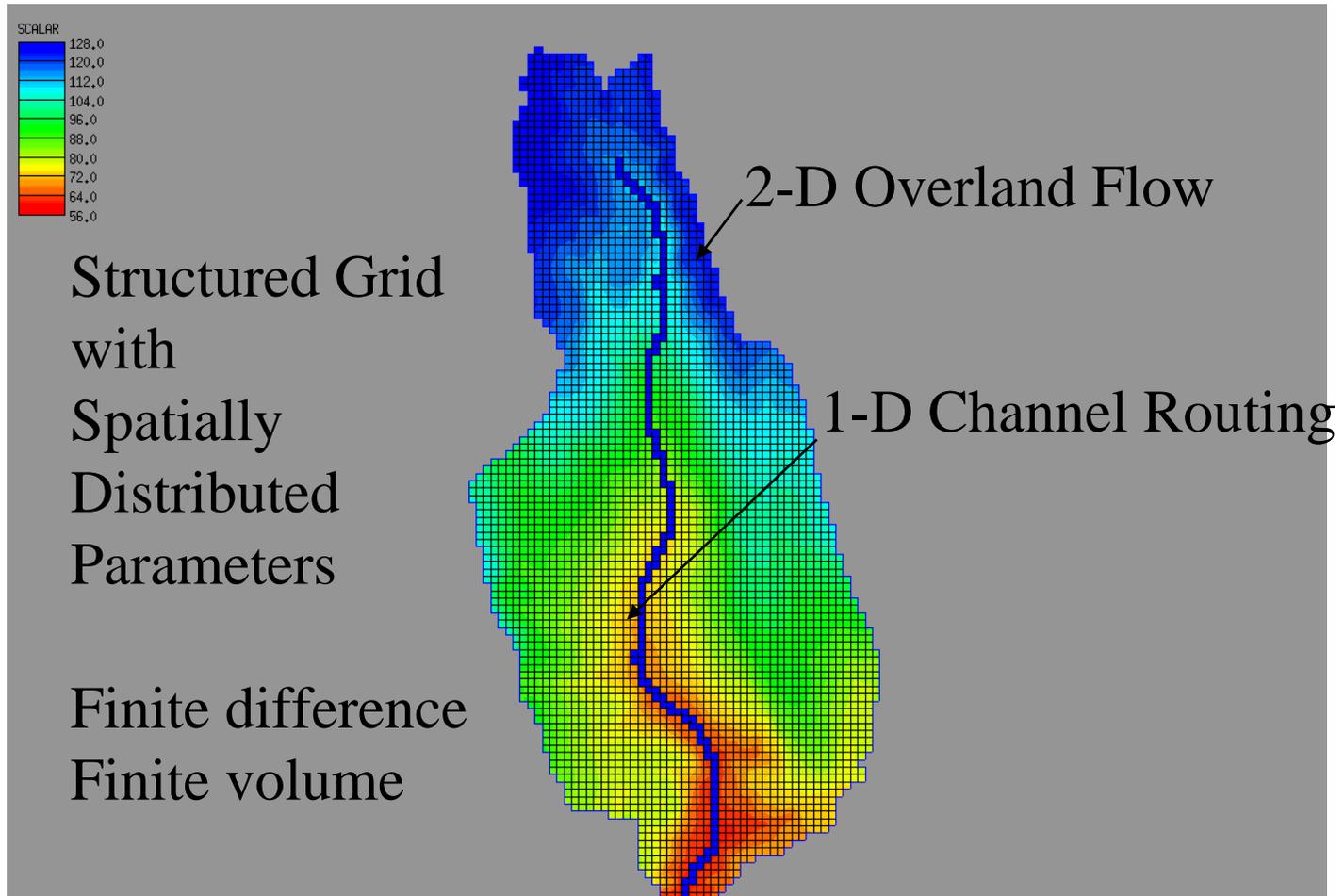
- Integrates directly with GIS through ArcObjects

"Lumped" Representation of Watershed
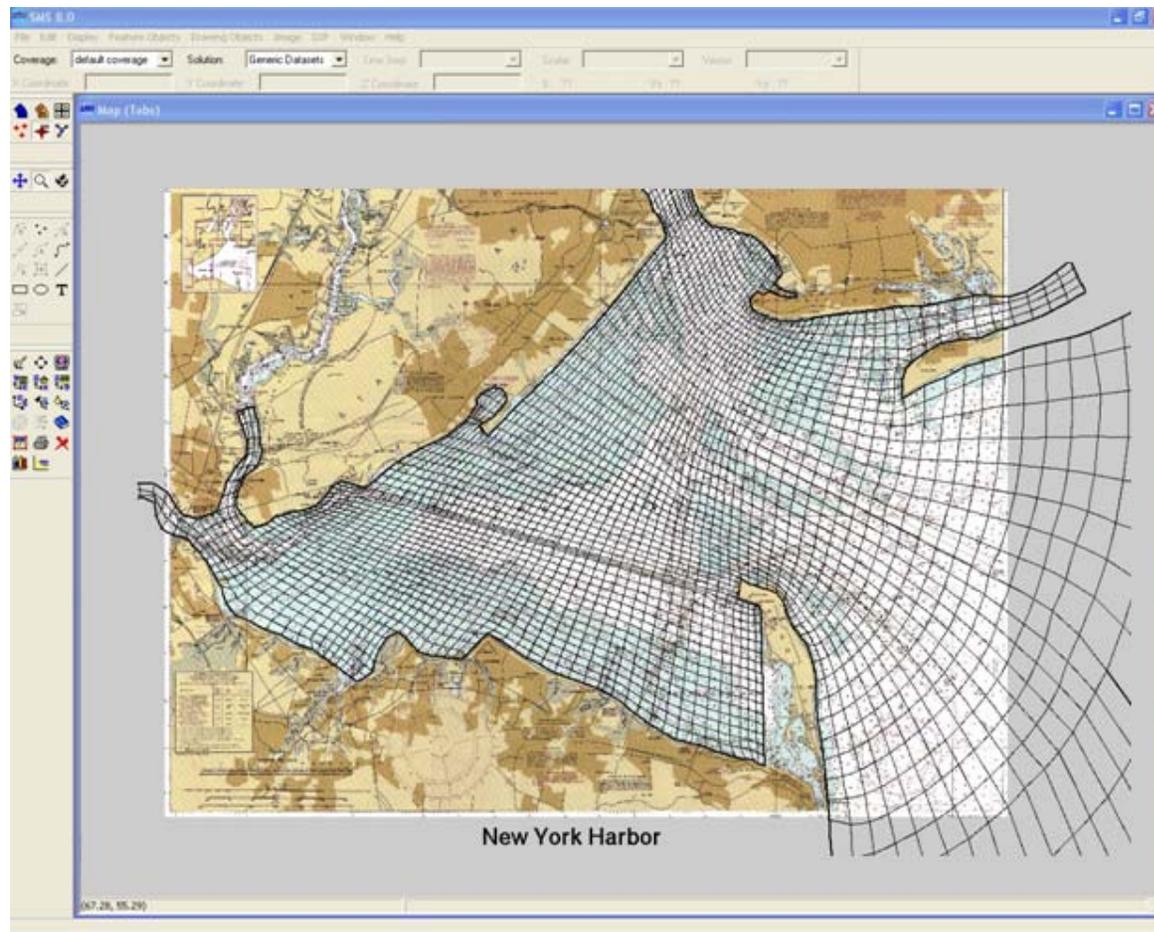
- HEC-1
- HEC-HMS
- TR-20
- HSPF

Distributed Model GSSHA
## Two-Dimensional, Physically Based, Hydrologic Model

Structured Grid with Spatially Distributed Parameters

Finite difference Finite volume

2-D Overland Flow

1-D Channel Routing

Surface Water Modeling System (SMS)

New York Harbor

SMS Components

- **Supports 1D/2D/3D coastal and riverine hydrodynamic analysis codes**

- **Steering module for automatic model calibration**

- Supported Models
  - TABS (RMA2, RMA4, SED2D)
  - FESWMS
  - HIVEL2D
  - ADCIRC
  - CGWAVE
  - STWAVE
  - CH3D
  - ICM
  - HEC-RAS (in development)
  - CASCADE (in development)

Groundwater Modeling System (GMS)
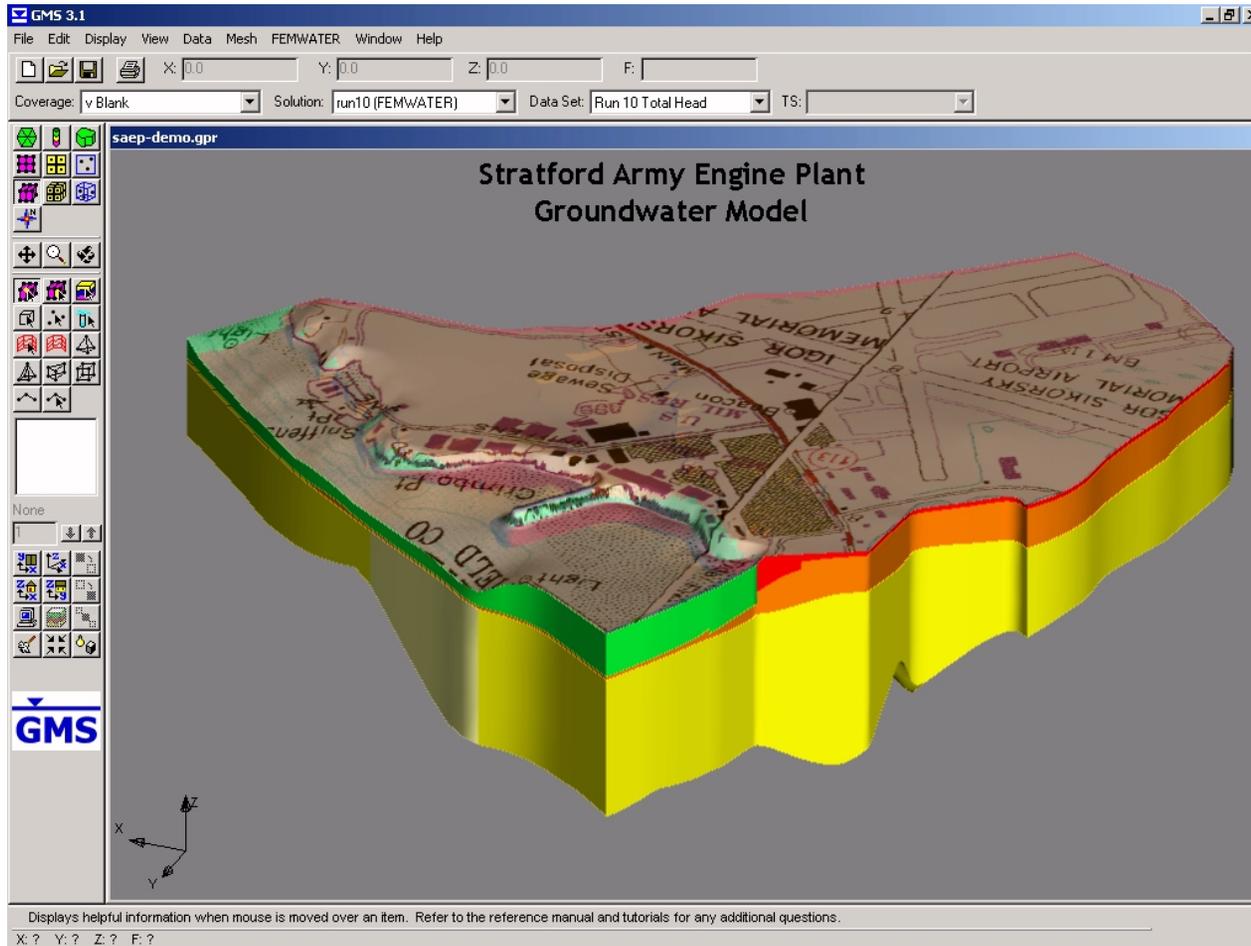
GMS Components

- Single database to house all site data
- Site characterization tools
- Predictive, numerical simulation models
  - Saturated soil models
    - MODFLOW/MODPATH
    - MT3DMS/RT3D
    - SEAM3D
  - Unsaturated/saturated soil models
    - SEEP2D
    - FEMWATER/WASH123
    - ADH
  - Immiscible Flow Model - UTCHEM
  - Groundwater/surface water interaction
    - WASH123
    - ADH
- Visualization tools to view results
- Optimization tools for remedial design
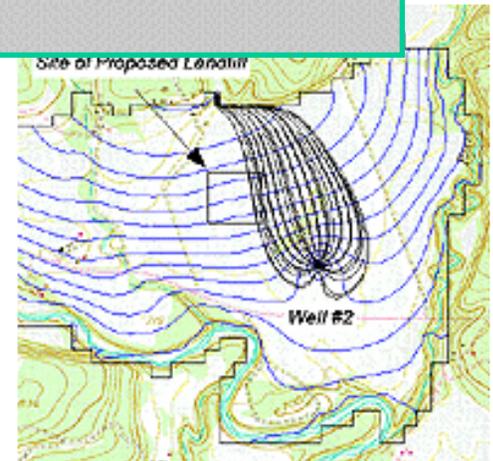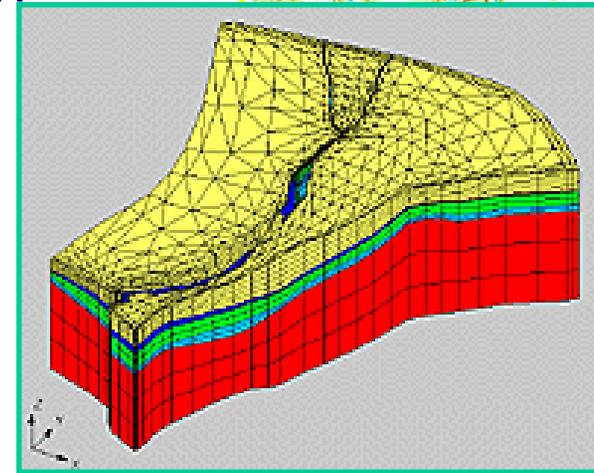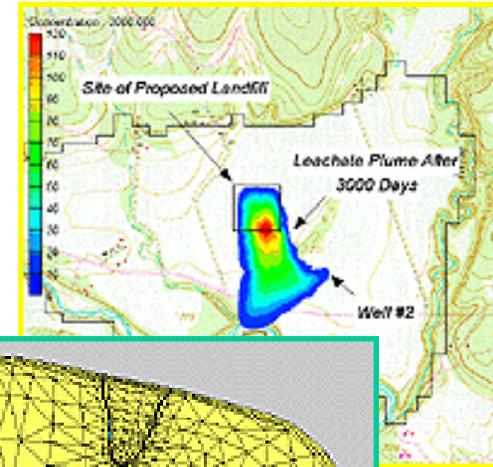
GMS User Base

- Over 1200 Federal Users/Groups at over 300 sites
  - Army, Navy, Air Force
  - EPA
  - DLA
  - DOE
  - NRC
  - NASA
- Over 3000 commercial users in 94 countries

Recent Applications of Numerical Models for Groundwater Flow and Transport

- DDMT Pump and Treat Remediation Design
- DDJC Sharpe Optimization of Plume Capture
- Longhorn Army Ammunition Plant
- Motsu Confined Disposal Facility
- Stratford Army Engine Plant
- Milan Army Ammunition Plant
- Tooele Army Depot
- Massachusetts Military Reservation
- Lakehurst Flow and Natural Attenuation
- EPA Region #3 Studies (six flow and transport)
- South Florida SW/GW Interaction Simulation
- Peele-Dixie Wellfield Contamination
- DOE – Paducah Gas Diffusion Plant
- Pueblo Chemical Depot
- Red River Army Depot

How to Obtain xMS Software

- Distributed from CHL web page located at: http://chl.erdc.usace.army.mil, select the product/services bar and then software from the menu.

- Download package includes executable files, tutorials, and manuals.

- Request password on registration form.

- Register software.

For More Information

- ## CONTACT:

  - ERDC Coastal & Hydraulics Laboraroty
    - Dr. Jack Davis jack.e.davis@us.army.mil

  - ERDC Cold Regions Research Engineering Laboratory
    - Dr. Robert "Bert" Davis robert.e.davis@erdc.usace.army.mil

  - Hydrologic Engineering Center
    - Mr. Darryl Davis darryl.w.davis@hec01.usace.army.mil