



The USGS Flood Inundation Mapping Initiative

USGS Texas Water Science Center Technical Talk

Scott Morlock

USGS Indiana Water Science Center

U.S. Department of the Interior
U.S. Geological Survey

THE GREAT OVERFLOW INUNDATED DISTRICTS OF THE MISSISSIPPI VALEY

SCALE 25 MILES TO 1" INCH

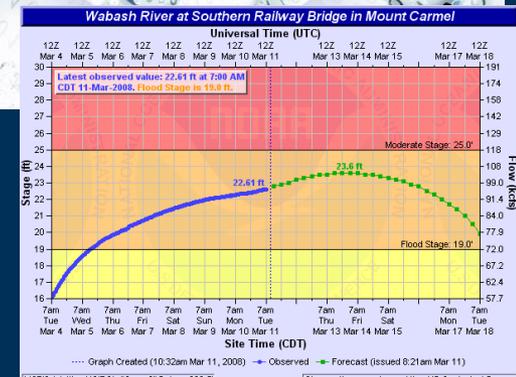
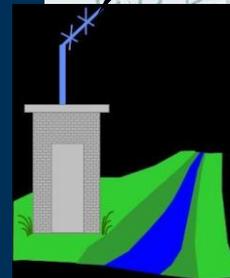
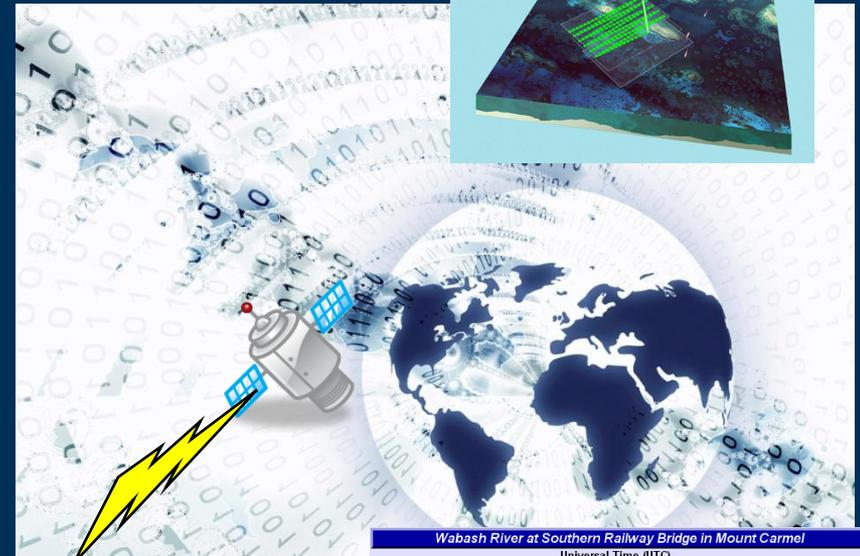
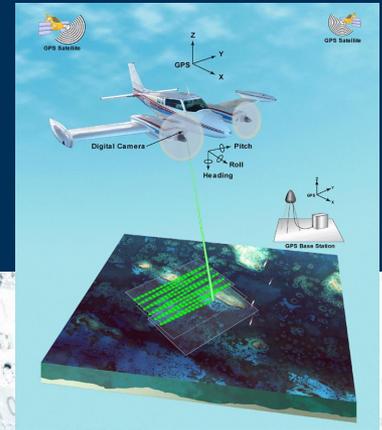


Courtesy of Louisiana Digital Map Library:
<http://www.usgwarchives.org/maps/louisiana/>

COMPILED
PRINTED
BY THE
NEW ORLEANS
PICAYUNE

Leveraging Evolving Technologies

- Real-time and forecast hydrologic data
- LiDAR- DEMs
- GIS
- Internet
- Interactive flood map viewers



Flood Inundation Mapping Initiative

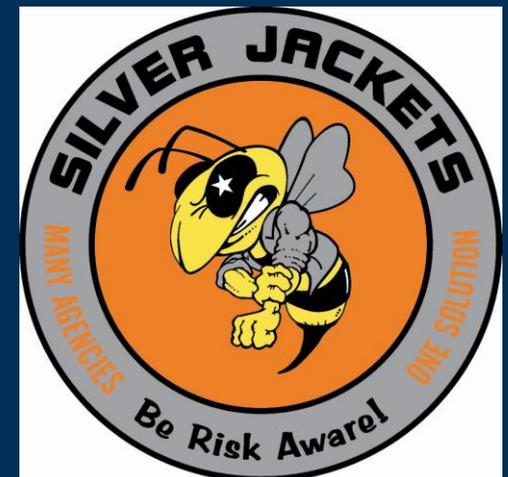
1. Consistent visual and electronic format for USGS inundation geospatial products.
2. Static flood inundation map libraries linked to gages/flood forecasts
3. State-of-the art dynamic, real-time flood inundation applications
4. A core of USGS and partner agencies
5. National USGS FIMI Web portal

Products

- Designed to have consistent “look and feel,” meet minimum USGS standards
- Designed for the broadest base of users
 - From “expert” to the general public
 - Fit multiple Fed, State, local missions
 - Served through multiple outlets

FIMI – partner oriented

- State/local level, to leverage resources for inundation
 - e.g. State Silver Jackets
- On a Federal level, getting the agencies to work together
 - USGS
 - NWS
 - USACE
 - FEMA
 - Integrated Water Resources Science and Services (IWRSS)



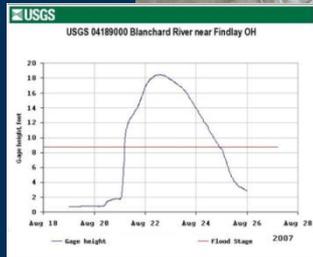
FIMI Partner Vision

- Long term vision is to get appropriated dollars for a National flood inundation program.
- In the short term, the USGS initiative is relying on cooperative projects with partners:
 - Other federal agencies – e.g. FEMA, DOD
 - State agencies – transportation, water resource/environmental, emergency mgmt
 - Regional/local agencies – counties, towns/cities, even an art museum!

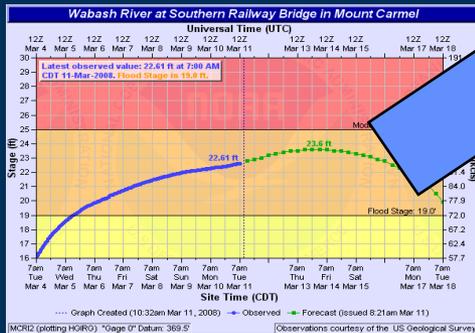
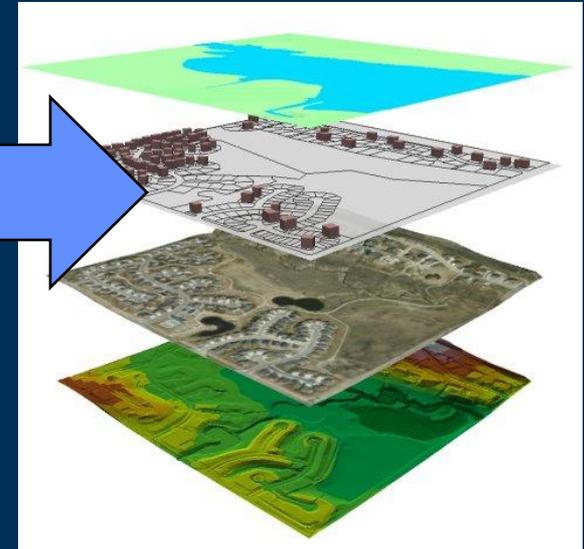
Flood info – from a point on the landscape to geospatial products



High-water marks



USGS Real-time streamgage data



http://las.depaul.edu/geography/images/Misc_Images/gis.jpg



National Weather Service flood forecasts

I.M. becomes a tool for flood.....

- Preparedness
 - “What-if” scenarios
- Response
 - Tied to gage & forecast data
- Recovery
 - Damage assessment – e.g. HAZUS-MH
- Mitigation & planning
 - Flood risk analyses



Blanchard River at Findlay, OH (FDYO1)

Data Type

- Inundation Levels
- Flood Categories
- Current/Forecast

Inundation Levels

NAVD88	Stage
772.2	18.4
771.8	18.0
770.3	17.0
770.3	16.5
769.8	16.0
769.3	15.5
768.8	15.0
767.8	14.0
766.8	13.0

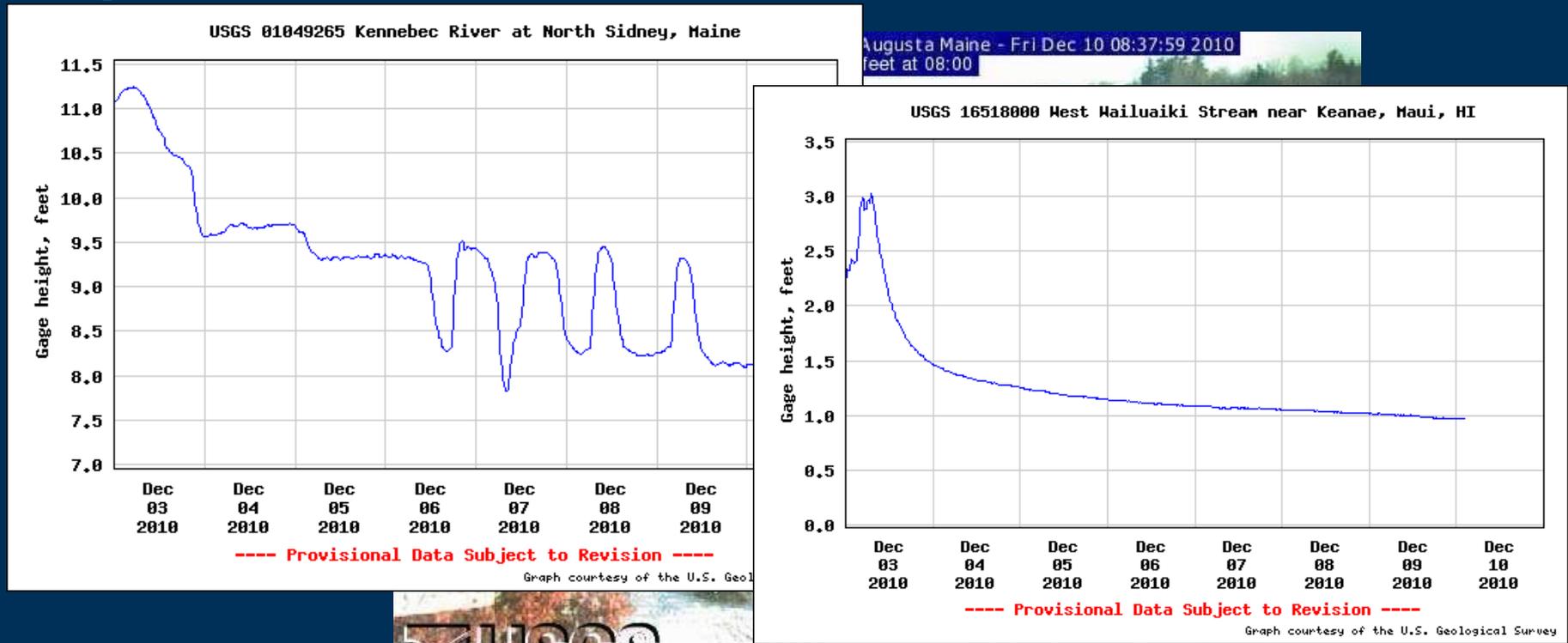


Flooded underpass, Beaumont, TX (photo courtesy of L. Roll/FEMA)



Quality assurance, standard metadata, and consistent presentation of products

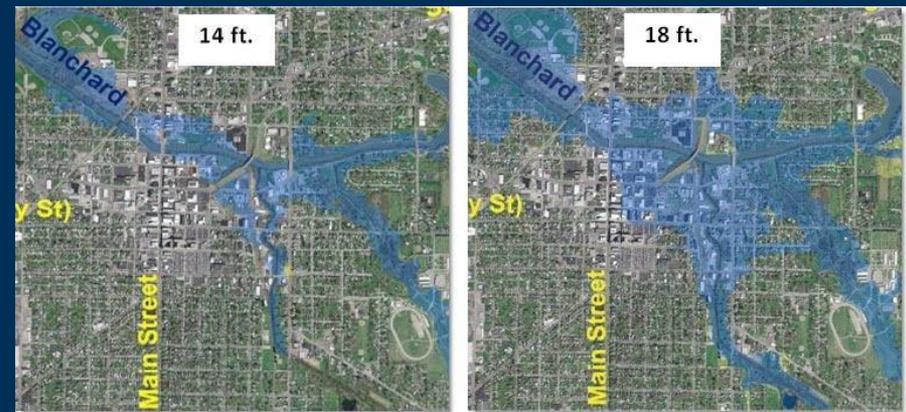
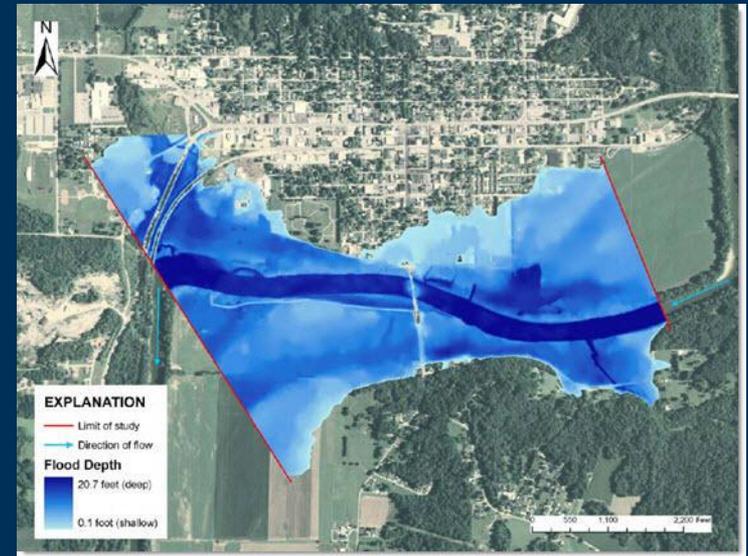
- Goal – consistent “look and feel” to products, like USGS network data



[AIR TEMP: 20.9°F] [HUMIDITY: 70.0%] [BAR: 1025.7] [INTERNAL TEMP: +57.0°F]

USGS FIMI Focus Areas

- Major flood documentation: high-water marks
- Static inundation map libraries at gages/flood forecast points
- Real-time, dynamic applications for the future



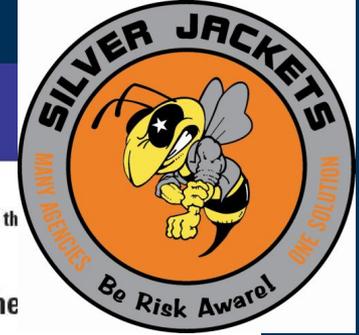
Major Flood Documentation

- In Cooperation with FEMA
- Many partners
- USGS report
- Flood causes, magnitudes, & impacts
- Peak profiles and inundation maps



In Cooperation with the Federal Emergency Management Agency and the Indiana Department of Natural Resources, Division of Water

Flood of June 7–9, 2008, in Central and Southe



In Cooperation With the Federal Emergency Management Agency and the Indiana Department of Natural Resources, Division of Water

Flood of September 2008 in Northwestern Indiana



Open-File

U.S. Department of the Interior
U.S. Geological Survey



Open-File Report 2010–1098

U.S. Department of the Interior
U.S. Geological Survey

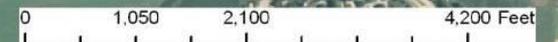


EXPLANATION

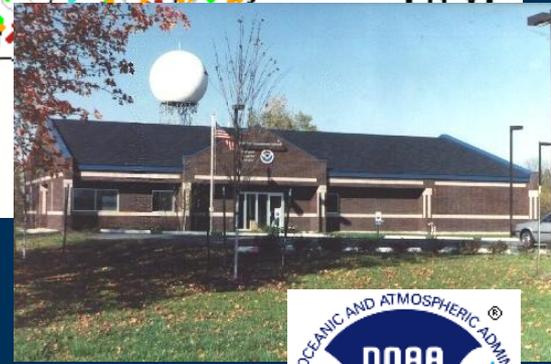
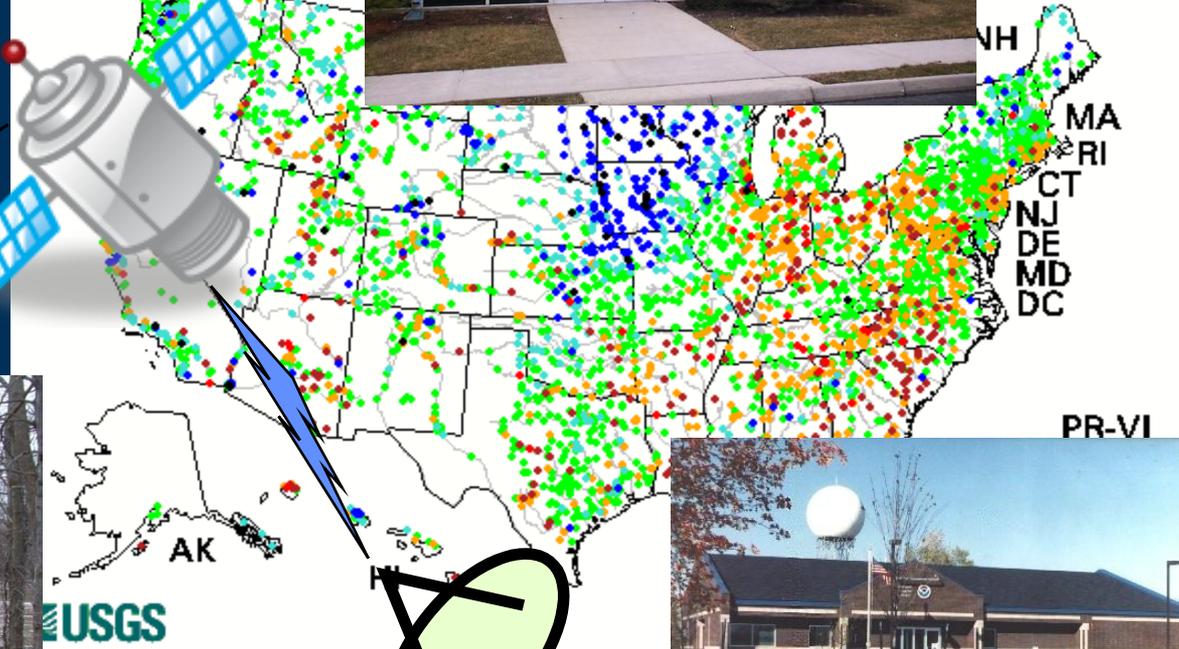
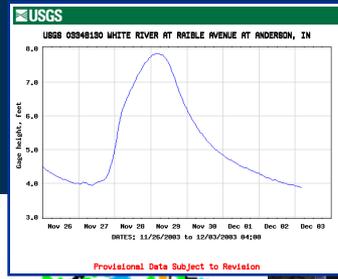
-  Limit of study
-  Direction of flow

Flood Depth

-  22.4 feet (deep)
-  0.1 foot (shallow)



Static Inundation Map Libraries



USGS streamgages: 8000 points

NWS AHPS: Advanced Hydrologic Prediction Service

- Forecast stage at flood forecast points
- Most collocated at USGS gages

<http://www.weather.gov/ahps/>

Flood Safety Awareness Week: March 17-22

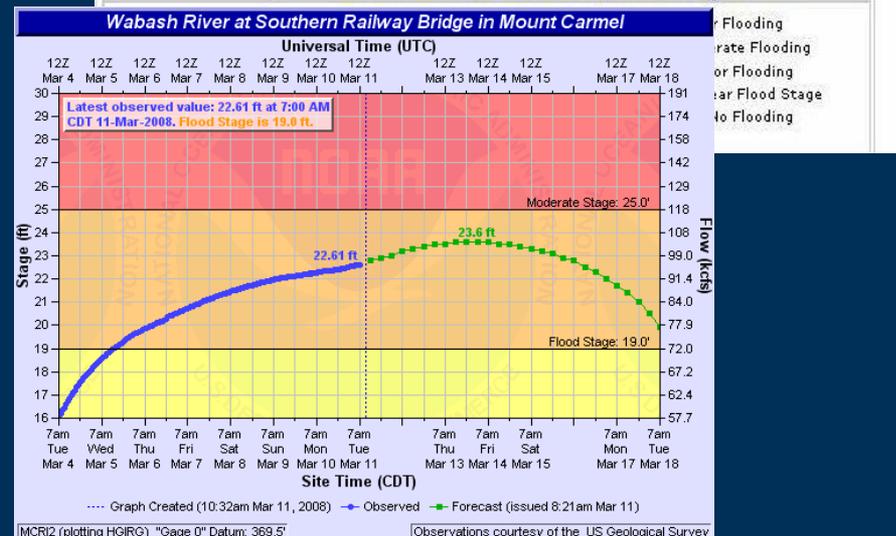
Society continues to build homes and businesses in floodplains which are vulnerable to flooding. This increases the need for more accurate and timely hydrologic information including flood and flash flood watches and warnings. See what the National Weather Service is doing to protect lives and property. Details... <http://www.weather.gov/floodsafety/>

[Warnings & Forecasts](#)
[Graphical Forecasts](#)
[National Maps](#)
[Radar](#)
[Water](#)
[Air Quality](#)
[Satellite](#)
[Climate](#)

[River Observations](#)
[River Forecasts](#)
[Precipitation](#)
[River Download](#)
[Other Information](#)

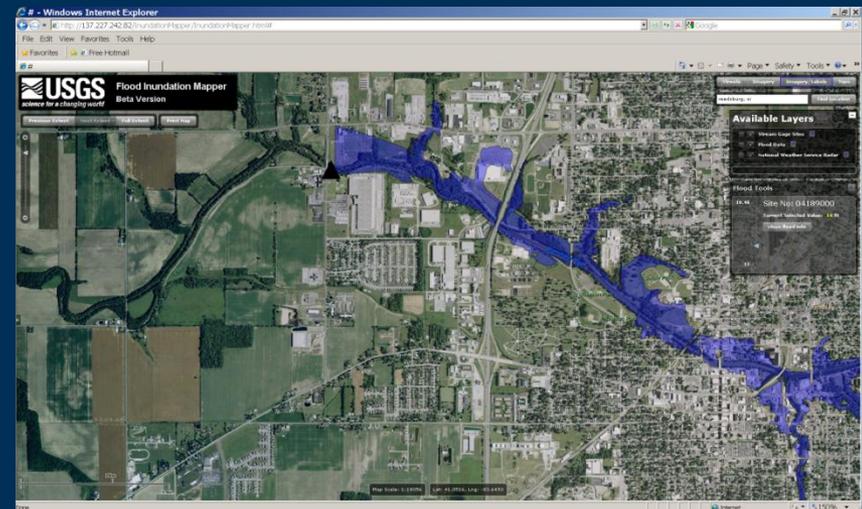
All Locations [Click The Map To Zoom In.](#)

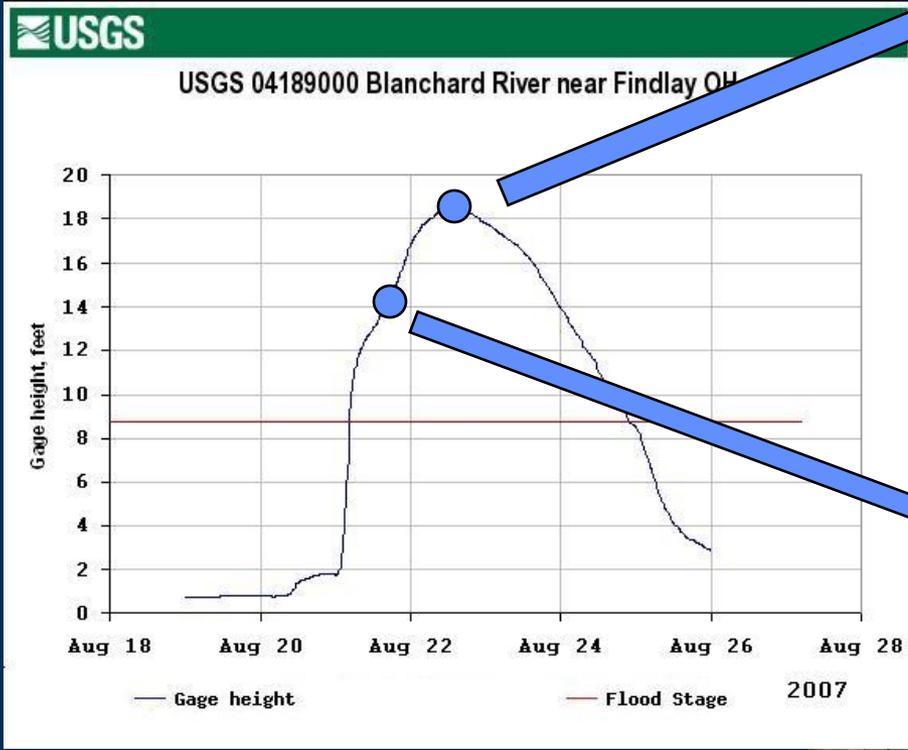
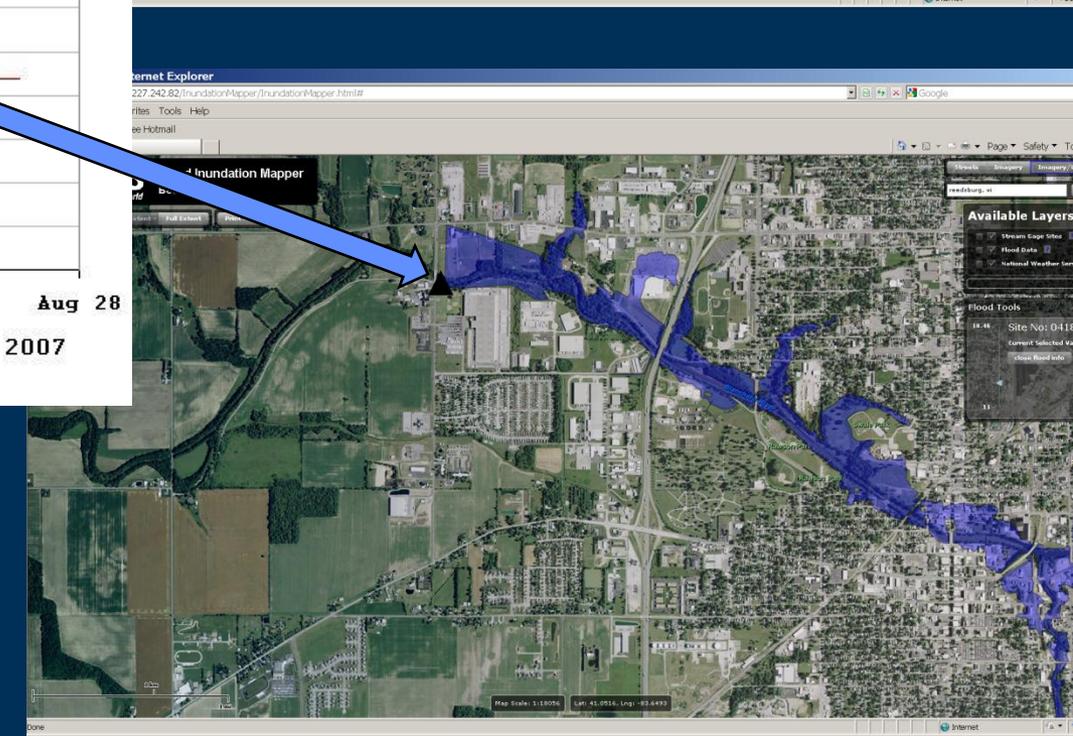
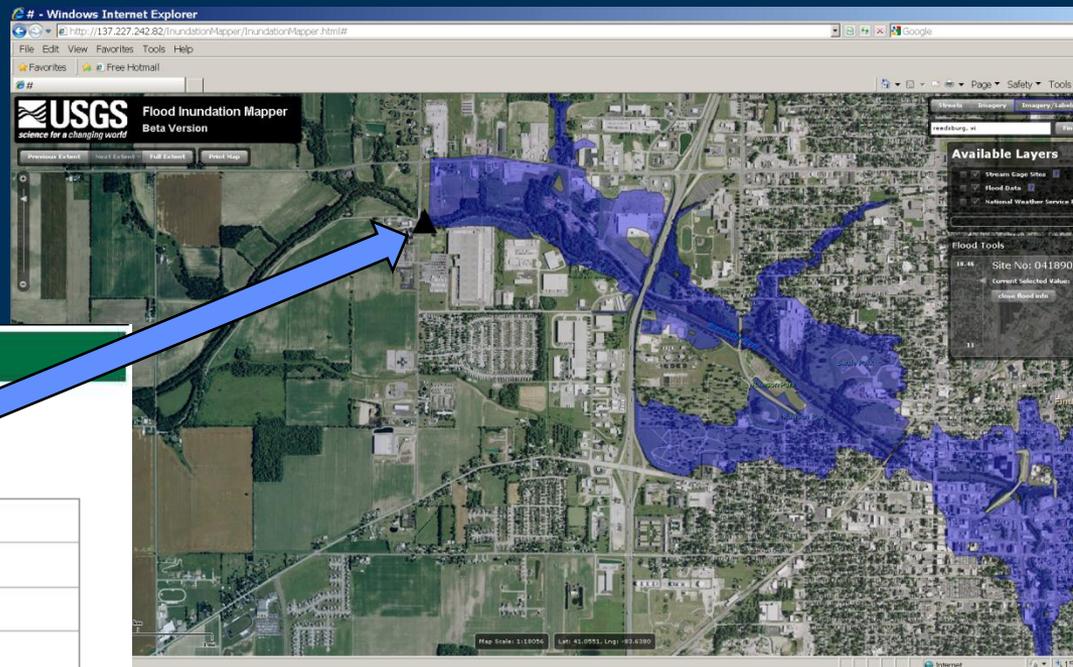
American Samoa · Guam · Puerto Rico/Virgin Islands



Inundation-map Libraries

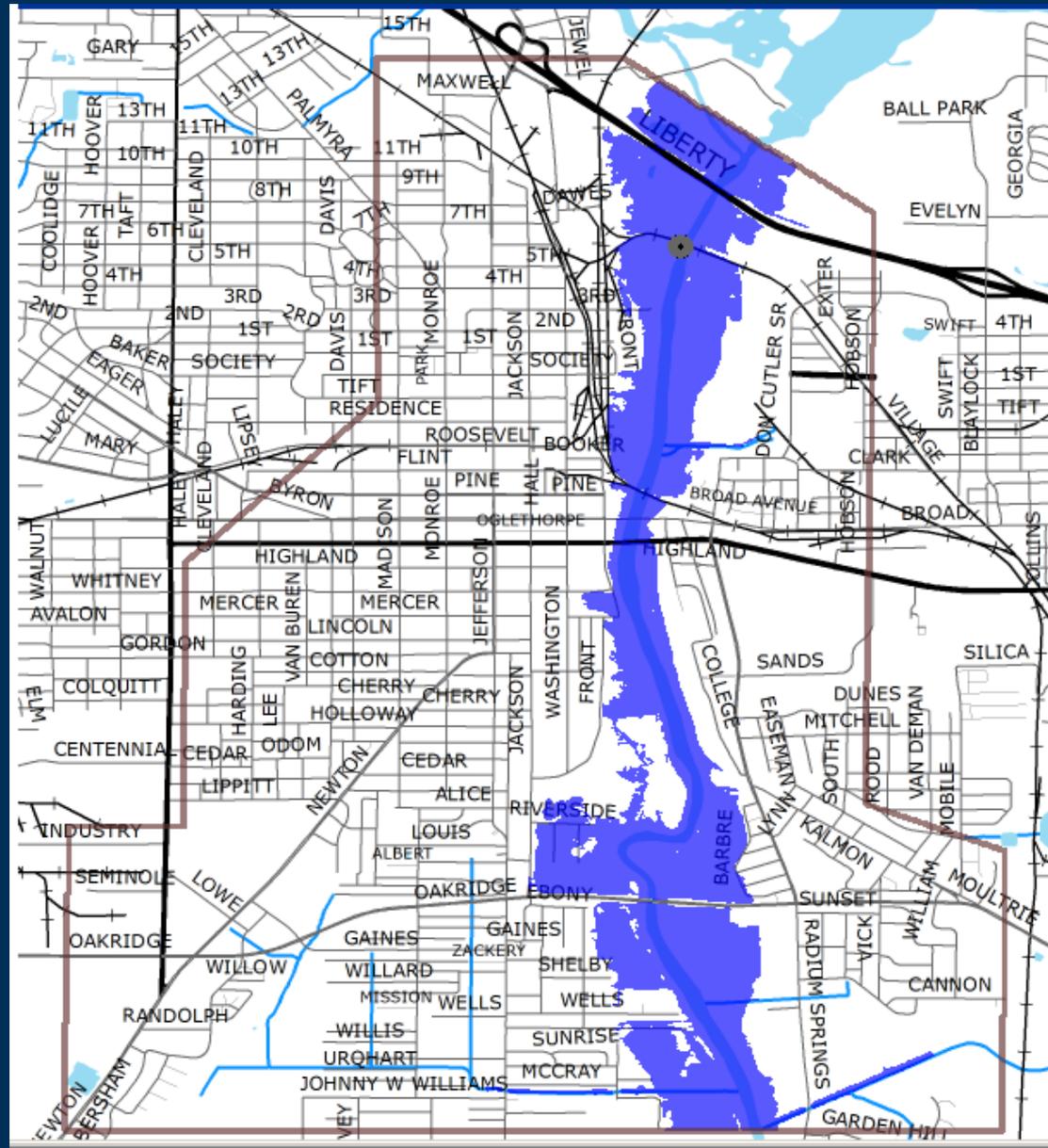
- DEMs + hydraulic model
- Gage/HWMK calibration data
- GIS generated maps
 - bankfull-record stage
 - Predefined map interval
- Linked to USGS real-time gage and NWS flood forecast





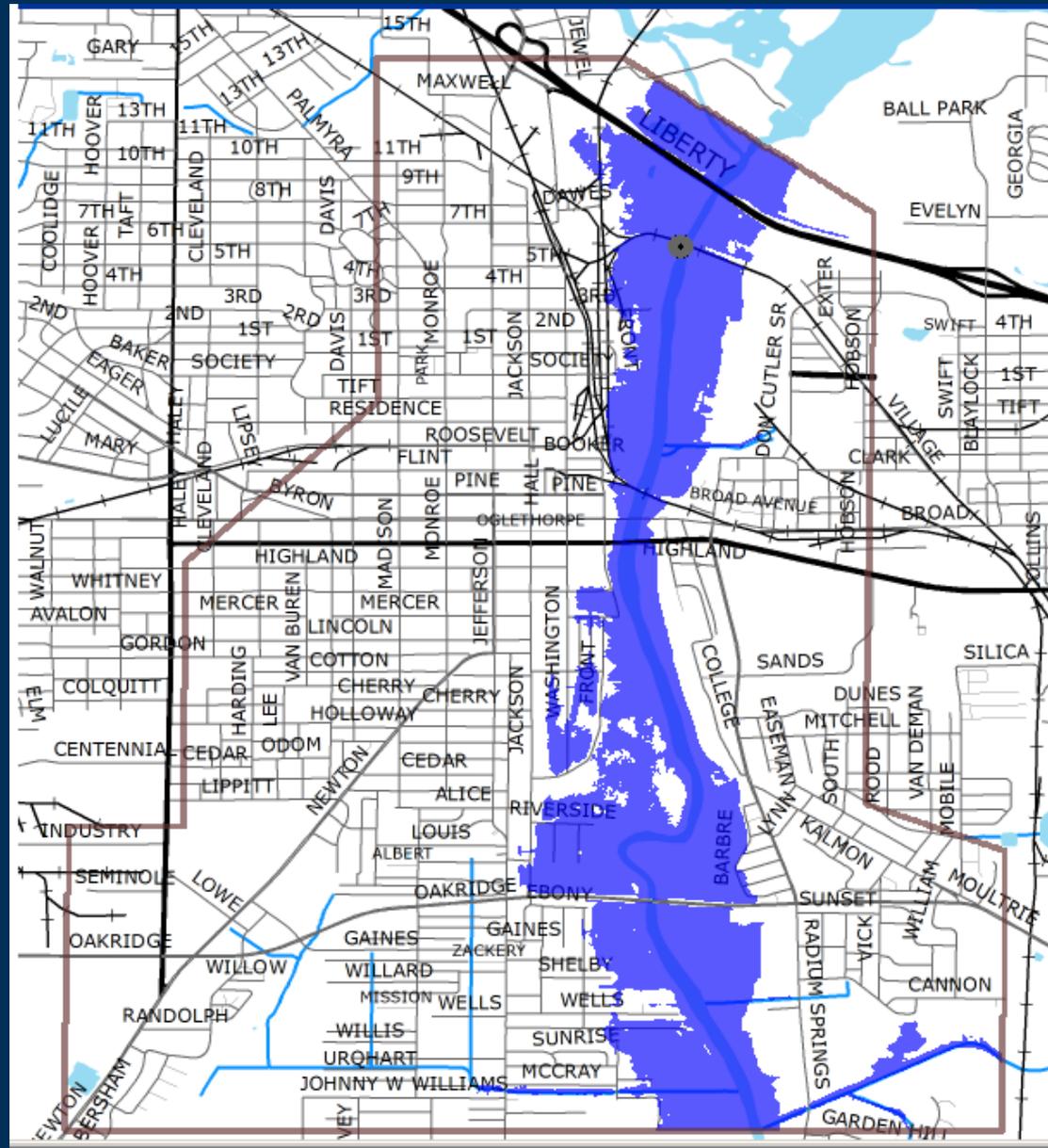
Static Libraries

12 feet



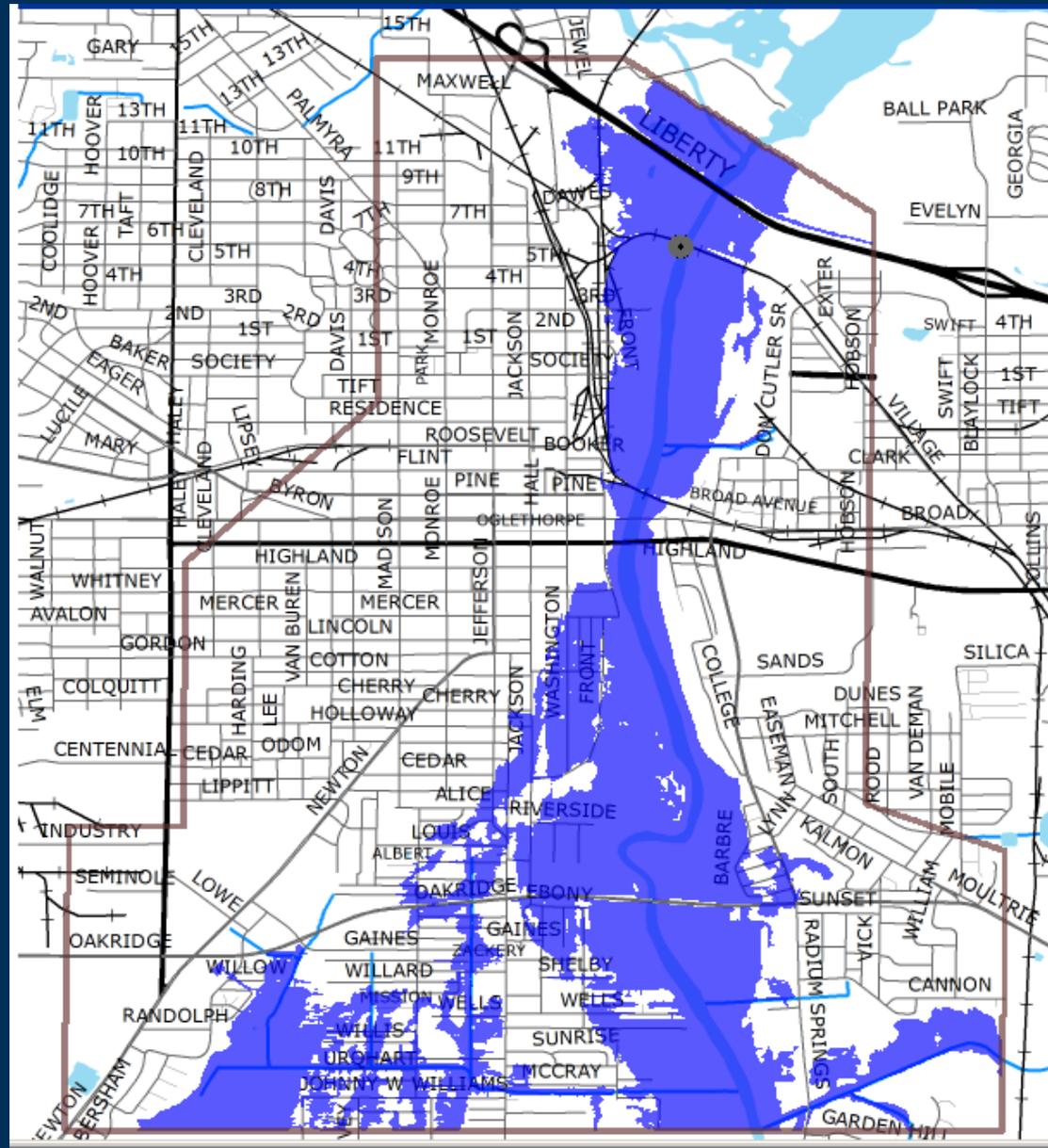
Static Libraries

14 feet



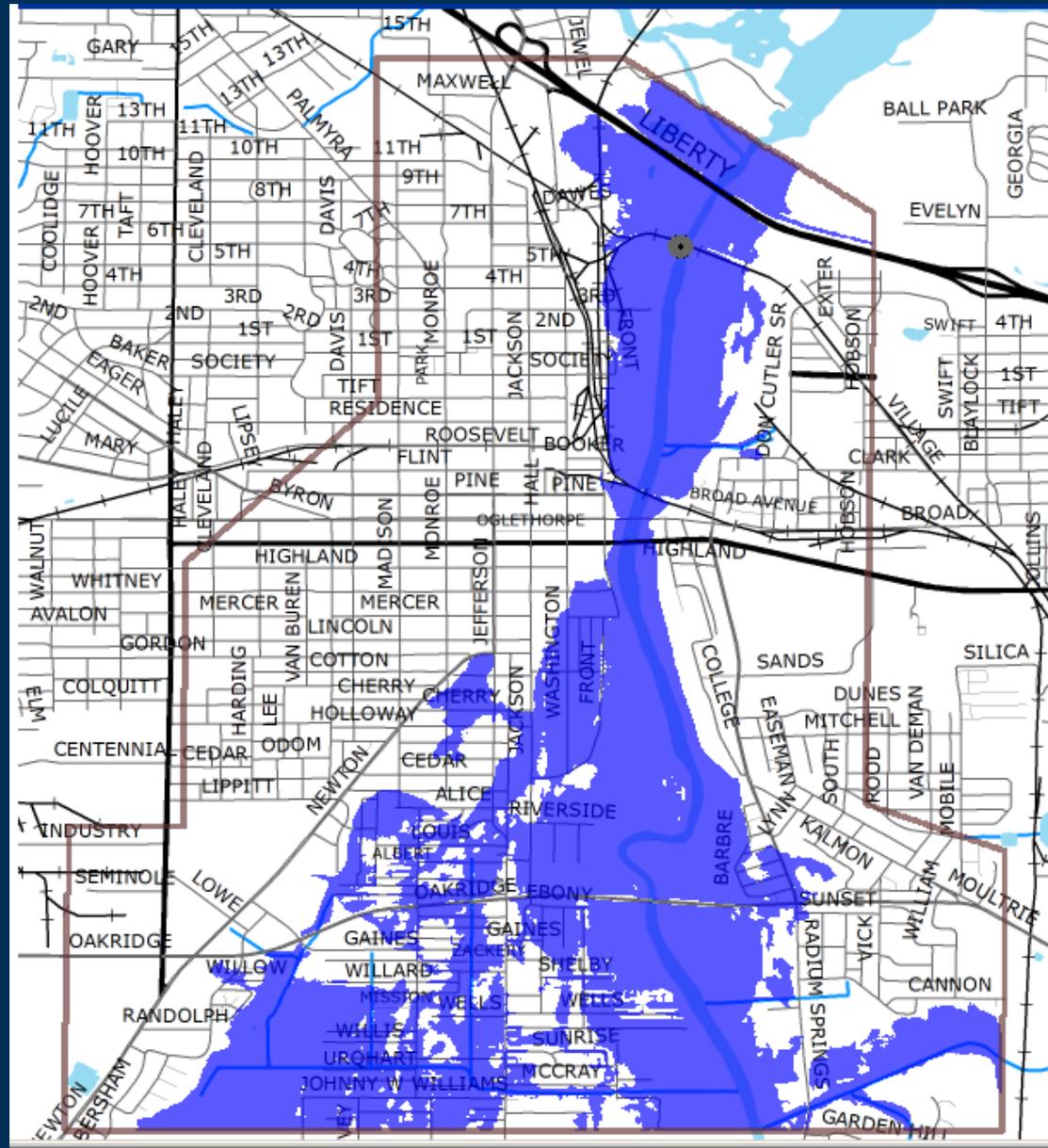
Static Libraries

16 feet



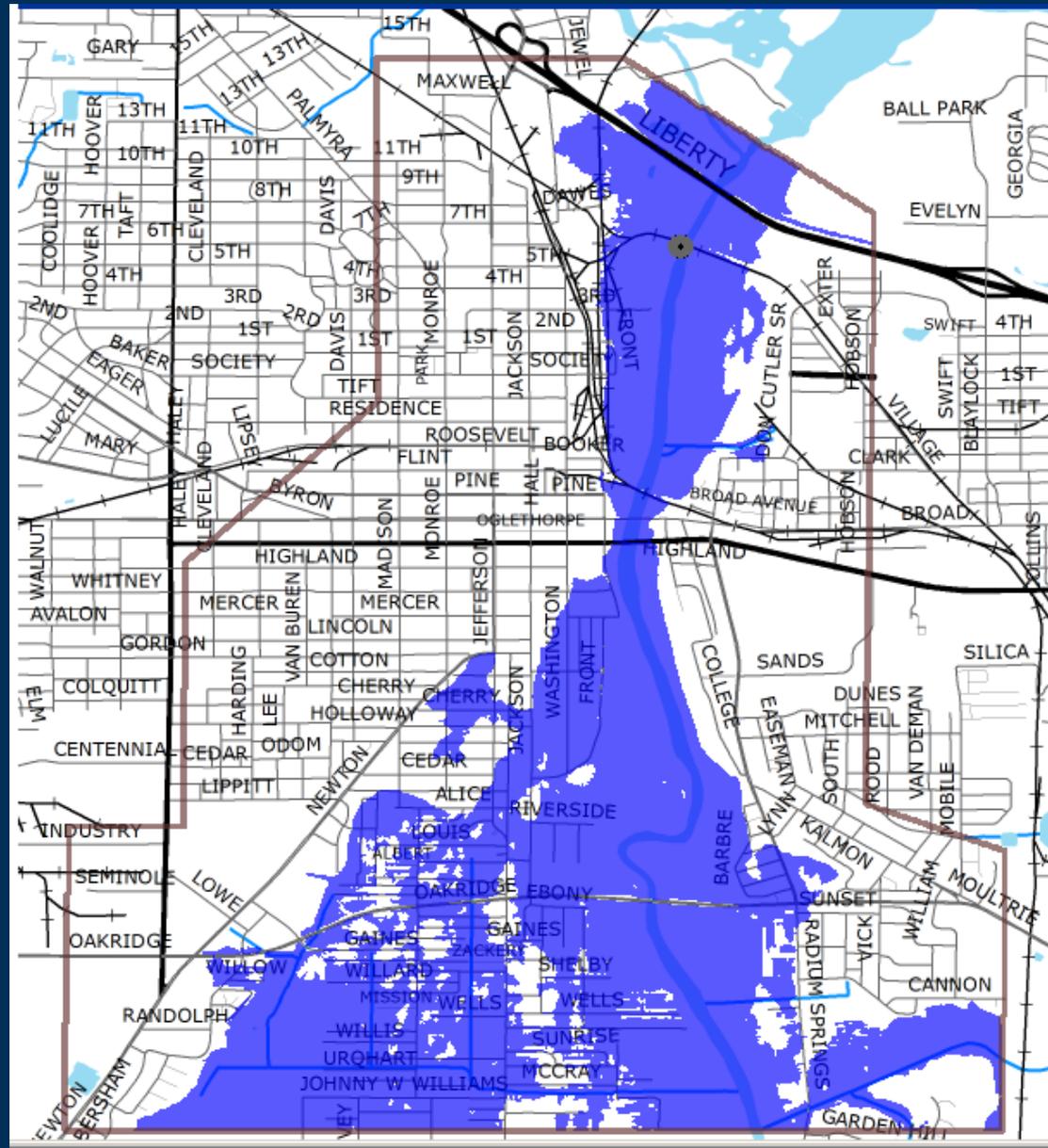
Static Libraries

17 feet



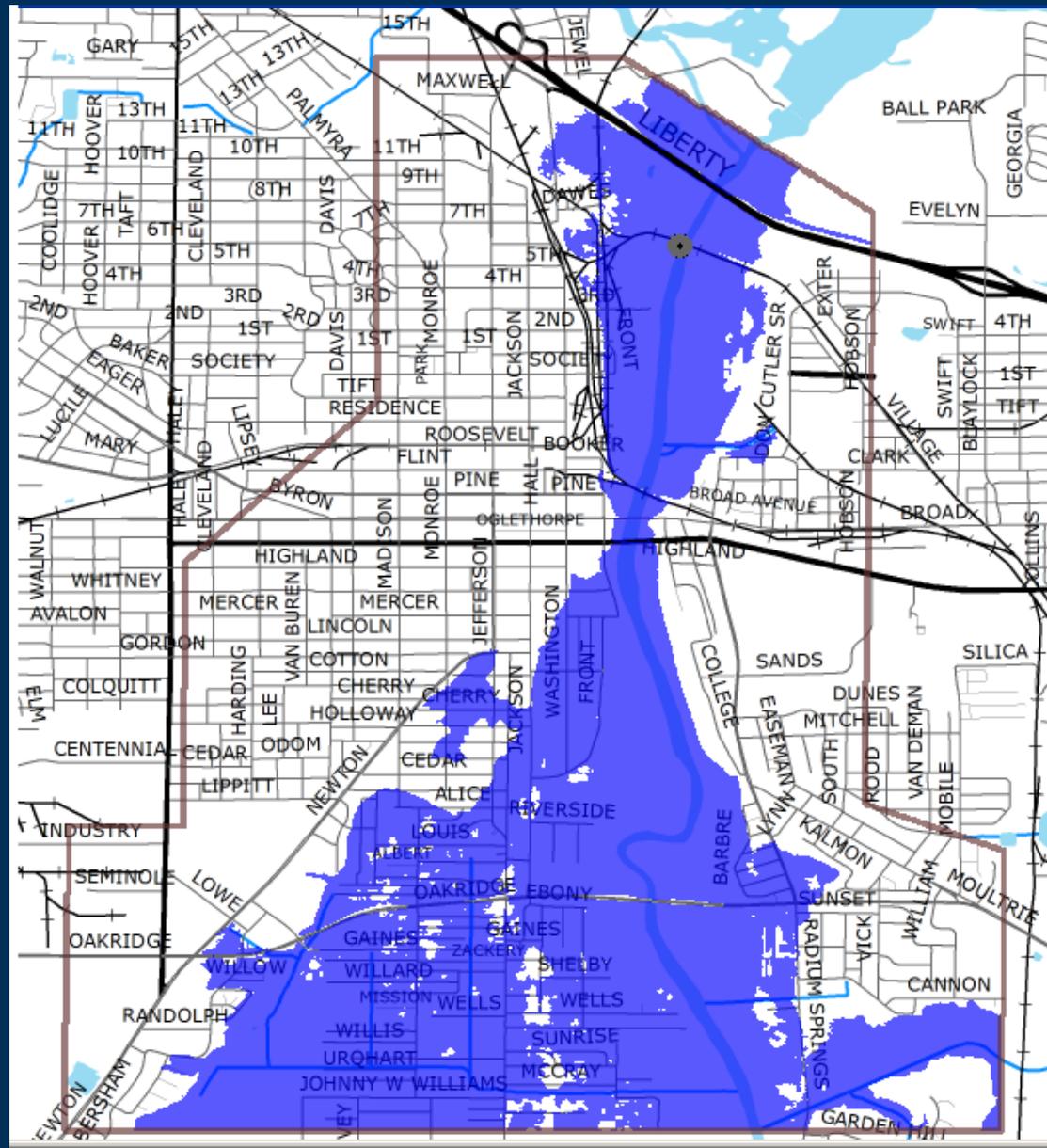
Static Libraries

18 feet



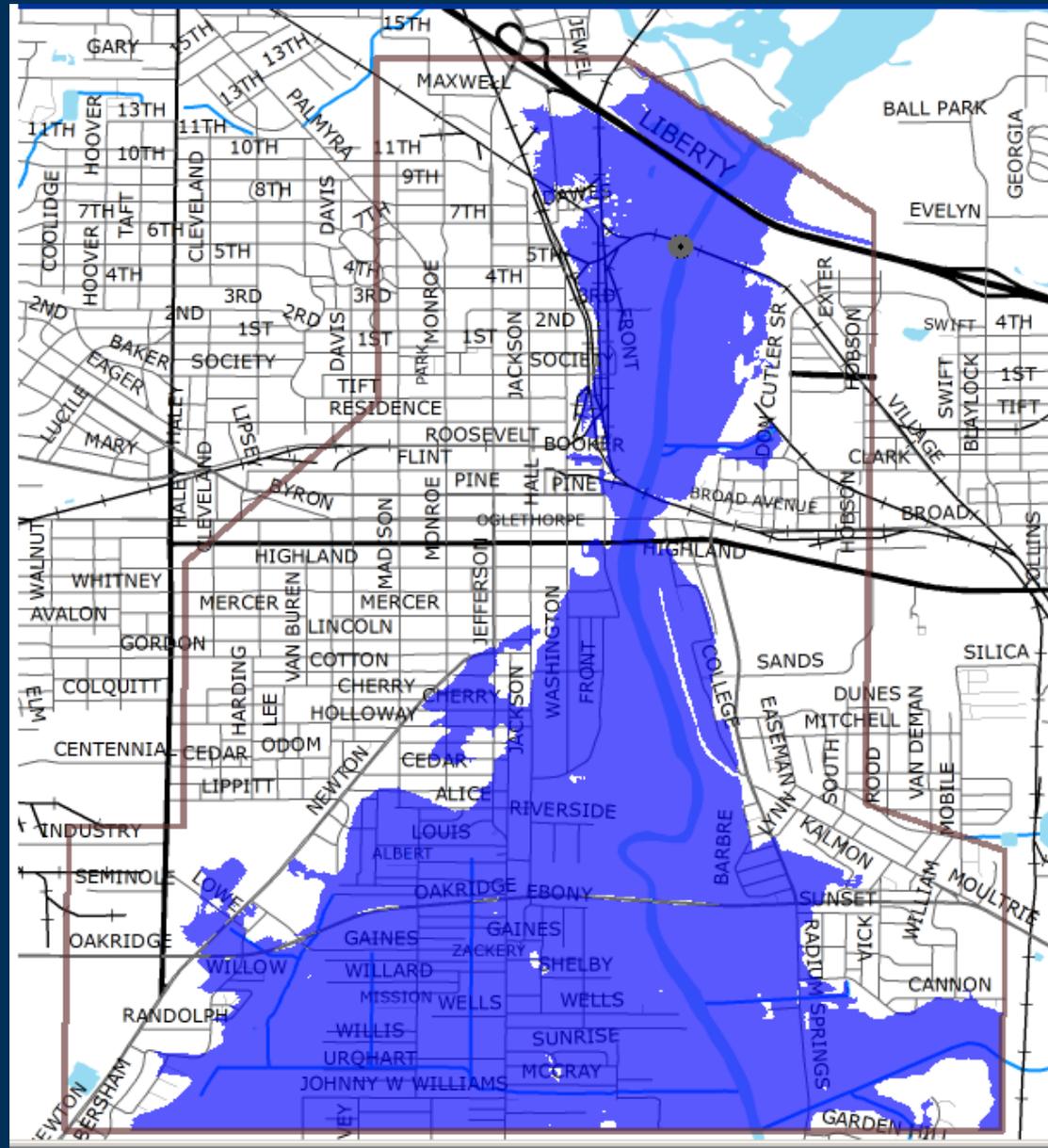
Static Libraries

19 feet



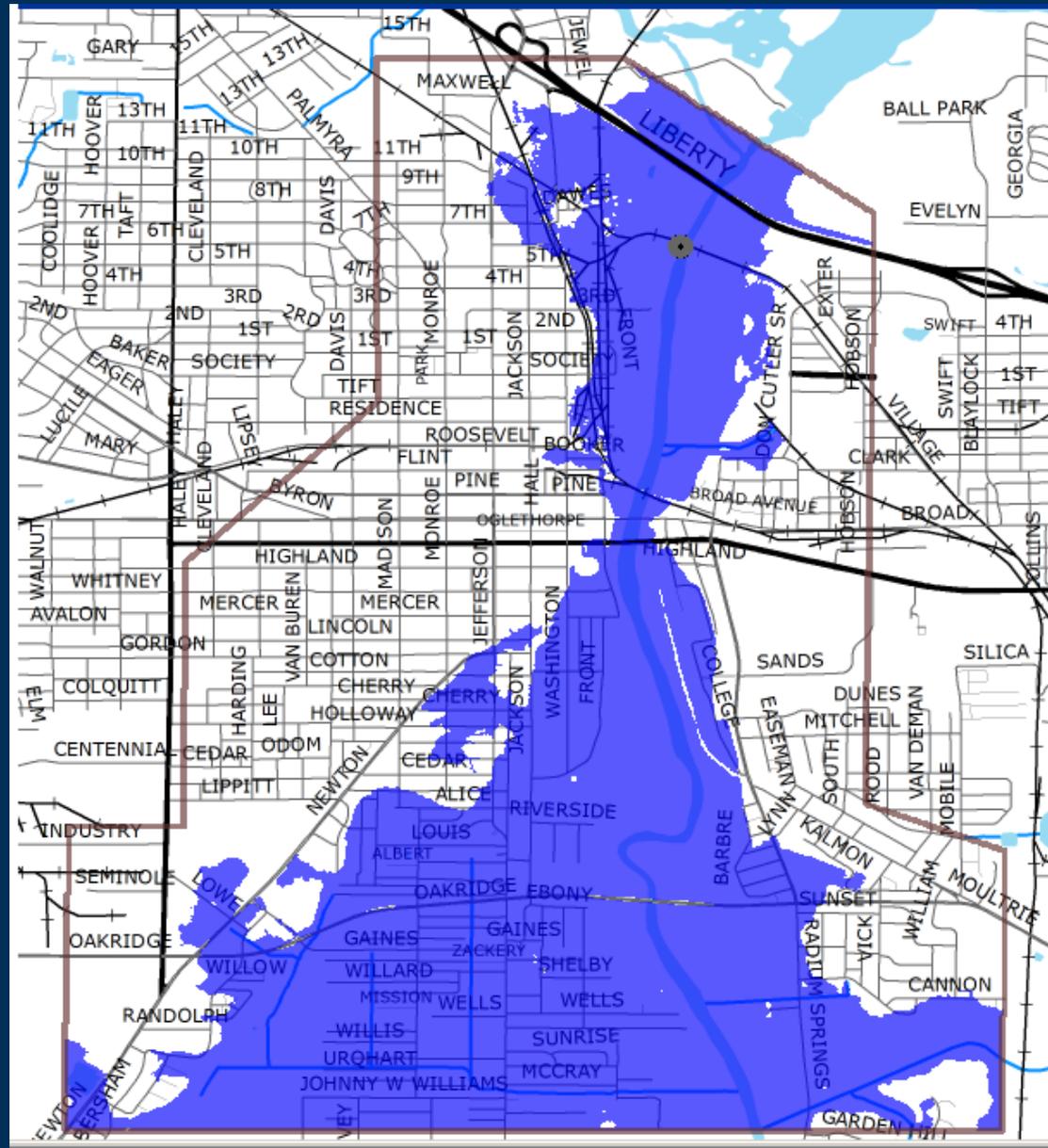
Static Libraries

21 feet



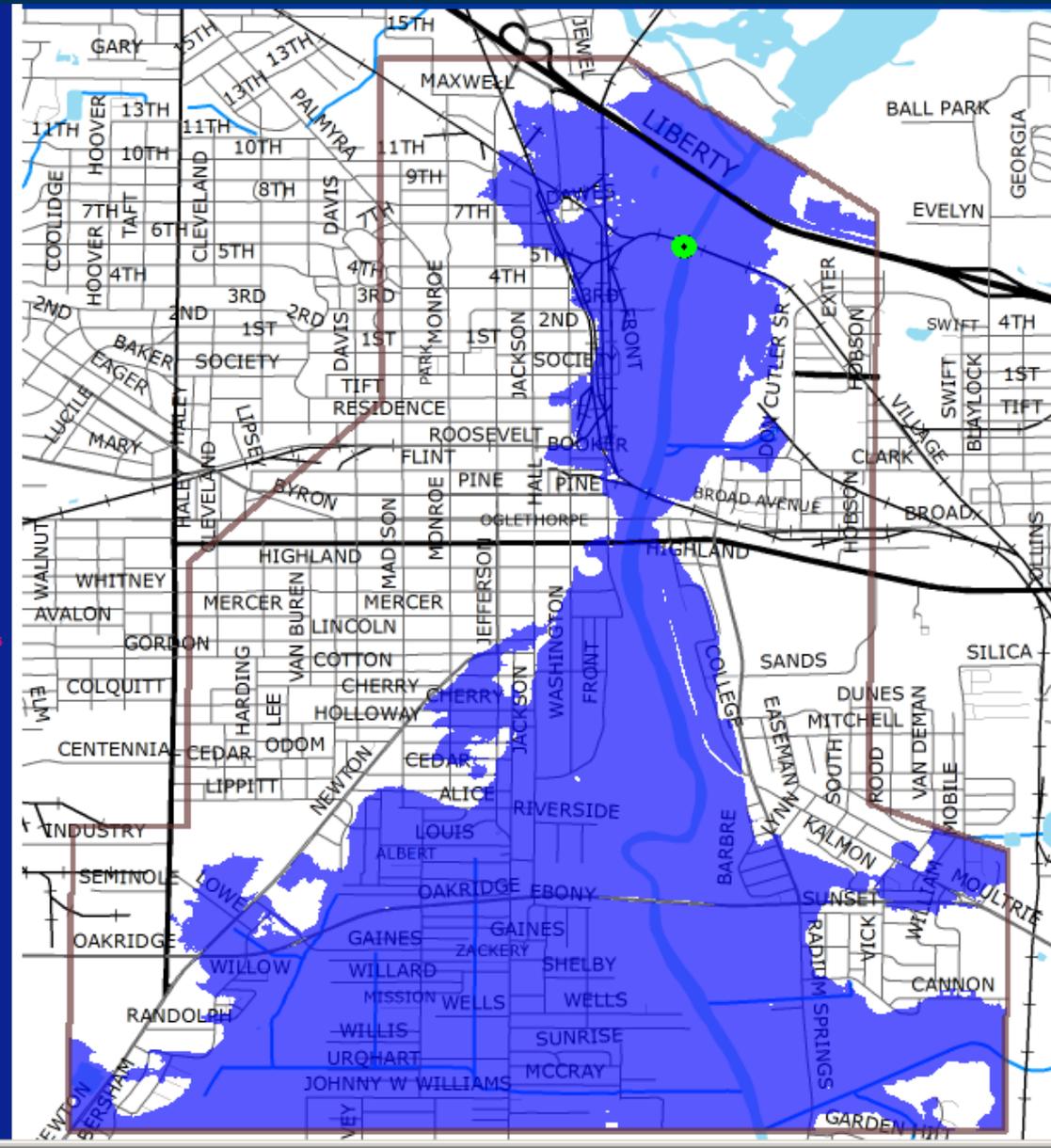
Static Libraries

22 feet



Static Libraries

Forecast Peak



FIMI File Formats

- GIS
 - Federal Geographical Data Committee (FGDC) compliant metadata
- KML/KMZ – **K**eyhole **M**arkup **L**anguage (**Z**ip)
- PDF/JPG
- Available through FIMI Web Portal

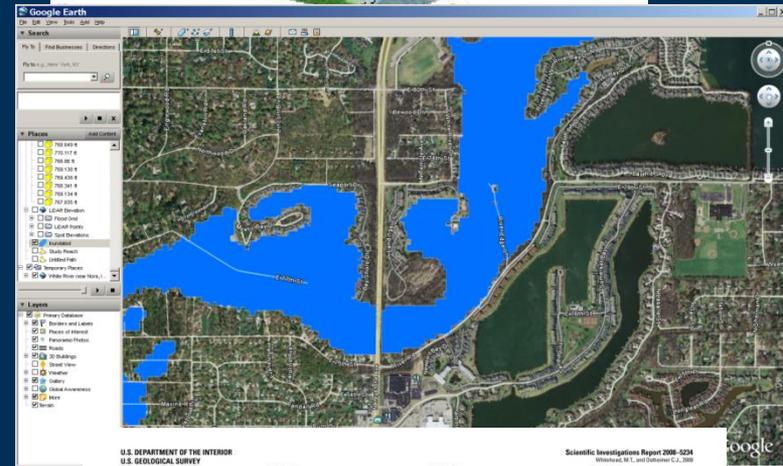
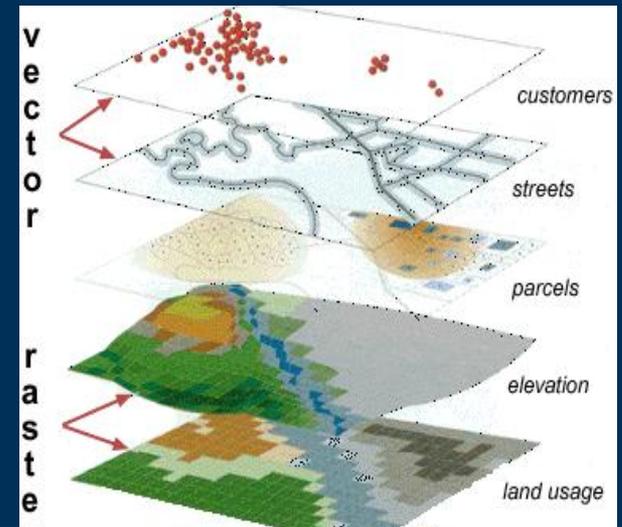
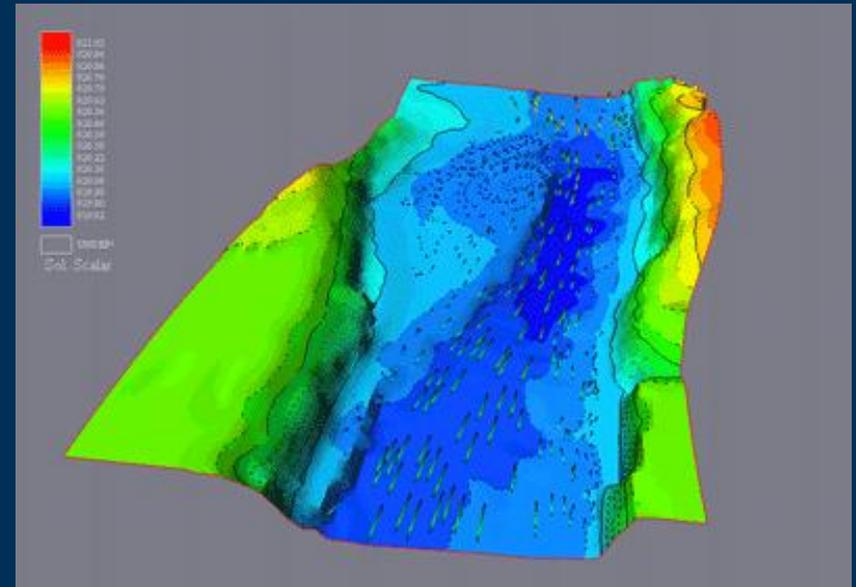


FIG. 3. Flood-inundation areas for Blanchard River near Findlay, Ohio (station 04180000), for type-A and type-B flow distributions, stage of 17.06 feet.



Dynamic applications

- Real-time dynamic map applications run flood simulations and create maps "on the fly" during a flood
- Can provide flood extent, depth, & even arrival time and water speed
- State of the art, ultimate destination for FIMI





floodpath

Mapping a Flood... Before it Happens

- **Washington State – Snoqualmie River**
- **NWS flow forecasts fed to hydraulic model**
- **Model results GIS: flood timing, depth, etc.**
- **Maps to Web serving software**
- **Available soon after forecast issued**
- **Updated every 6 hours**

http://wa.water.usgs.gov/cgi/flood_snoqualmie.cgi



Snoqualmie Flood Path Viewer

Flood Information

Flood Timing & Velocity

Socioeconomic Impacts

Tools

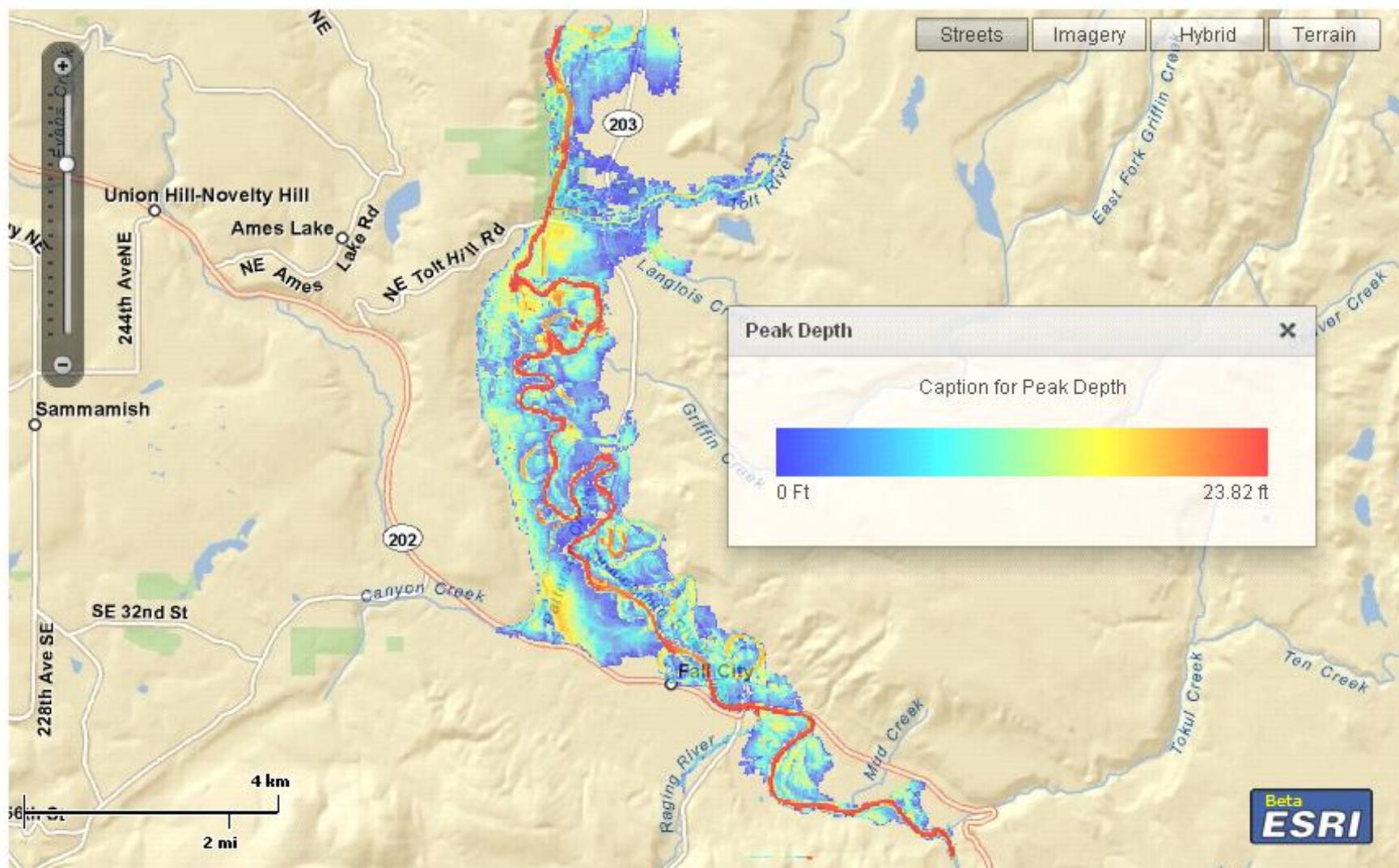
Flood Animation

Peak Depth

Select Information

Under Construction

Set Transparency



Snoqualmie Flood Path Viewer

Flood Information

Flood Timing & Velocity

Socioeconomic Impacts

Tools

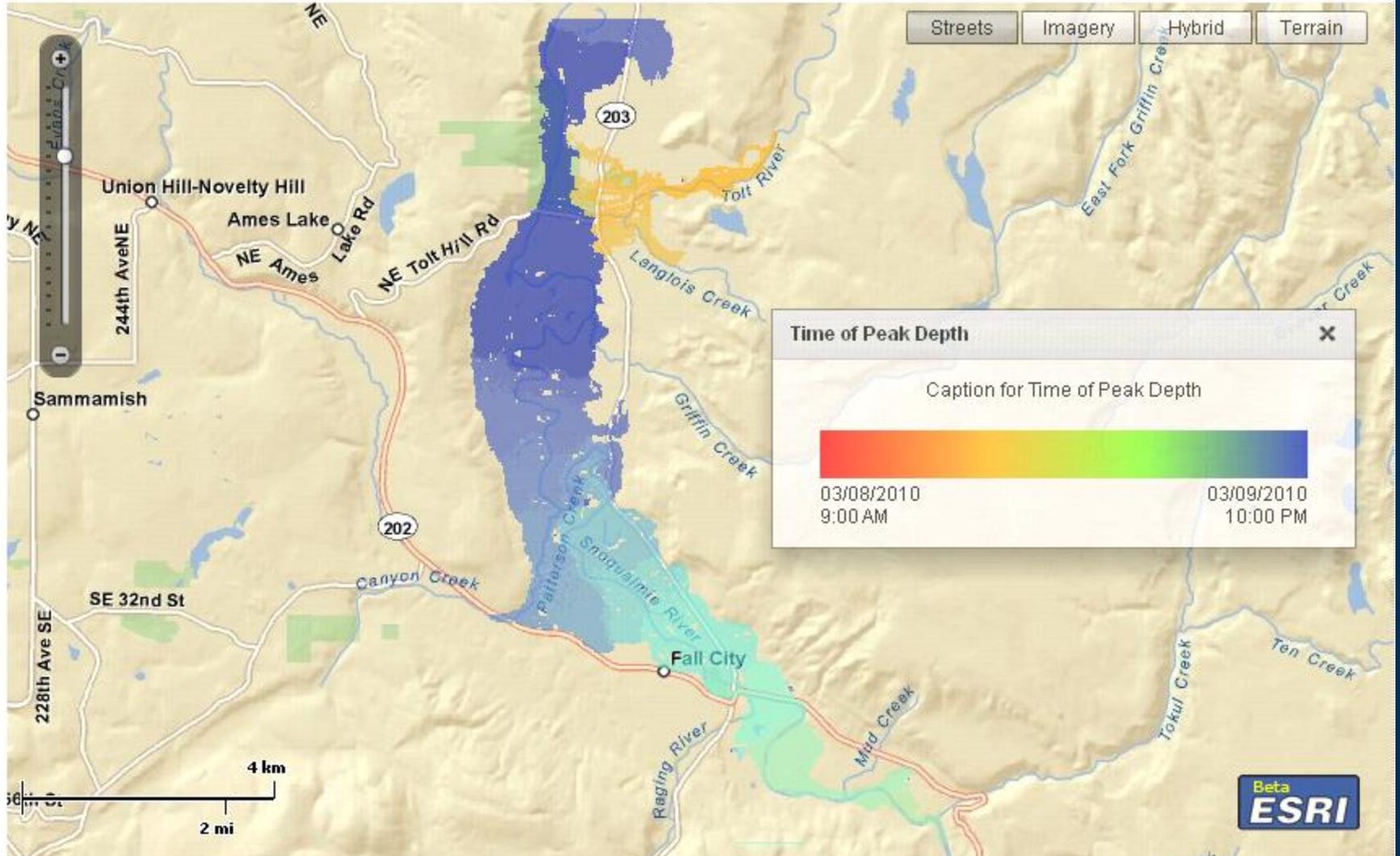
Flood Animation

Peak Depth

Time of Peak Depth

Under Construction

Set Transparency



Example of exposure analysis

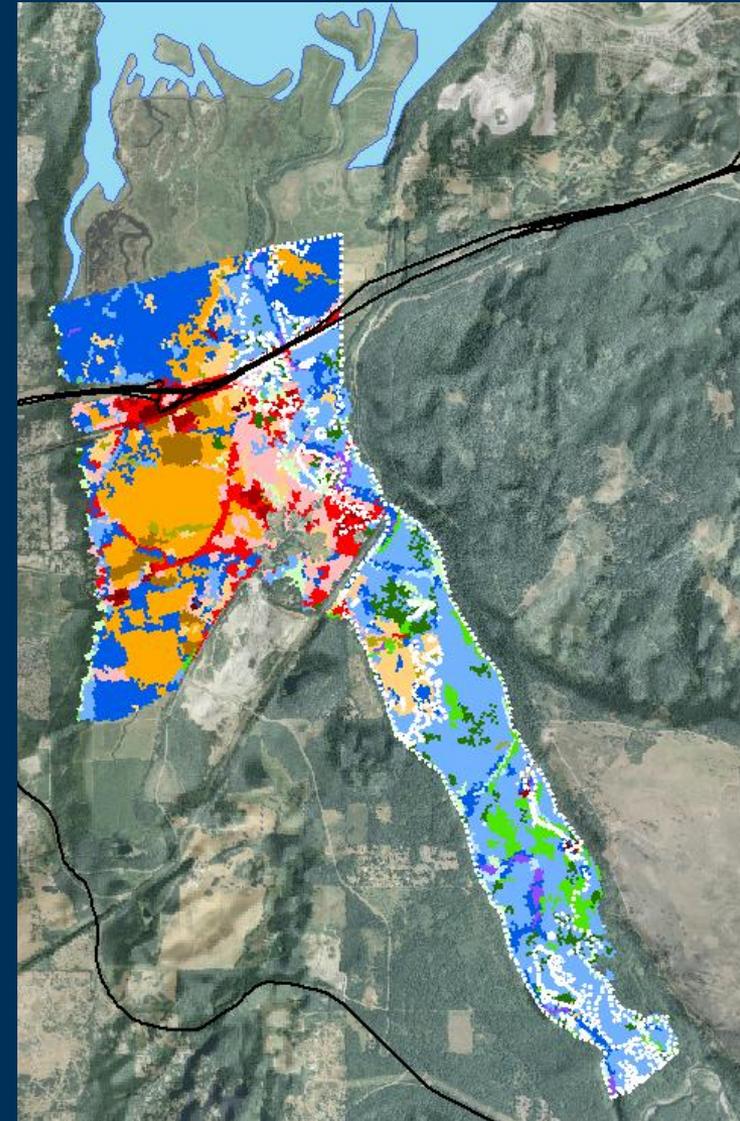
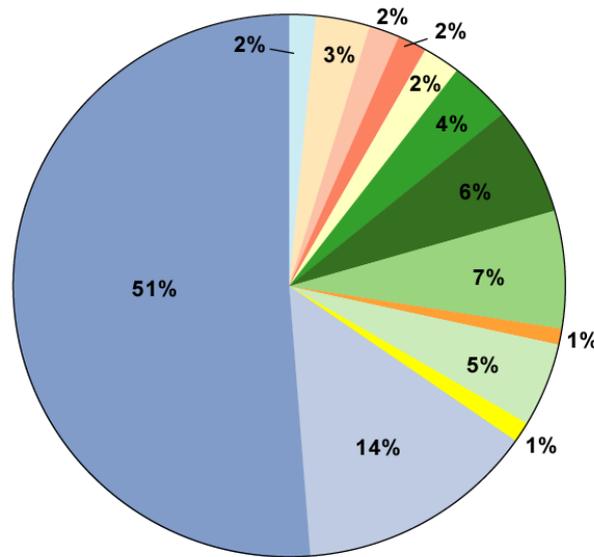
Exposure when forecast flood stage reaches 15 feet at Nisqually River at McKenna

- Residents – 262
- Businesses - 4
- Employees – 49
- Business types – school, campground, nonprofit organization, construction
- Land cover types:

Amount of land in flood hazard zone (sq. km)

Open Water	0.1
Developed, Open Space	0.2
Developed, Low Intensity	0.1
Developed, Medium Intensity	0.1
Developed, High Intensity	0.0
Barren Land (Rock/Sand/Clay)	0.2
Deciduous Forest	0.3
Evergreen Forest	0.4
Mixed Forest	0.5
Shrub/Scrub	0.1
Grasslands/Herbaceous	0.3
Pasture/Hay	0.1
Cultivated Crops	0.0
Emergent Herbaceous Wetlands	1.0
Woody Wetlands	3.6

Percentage of land, by type, in flood hazard zone



Dotted white line denotes 15-ft hazard zone

Web Portal



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USGS Flood Inundation Mapping Science

[home](#) [focus areas](#) [links](#) [contact](#) [internal](#)



FLOOD-INUNDATION PROJECTS

Georgia

- ◆ [Flint River at Albany](#)

Illinois

- ◆ [Du Page County](#)
- ◆ [Lake County](#)

Indiana

- ◆ [Flood of June 7-9, 2008](#)

Kansas

- ◆ [Cowskin Creek, Wichita](#)

Missouri

- ◆ [Upper Blue River, Indian Creek, and Dyke Branch](#)

North Carolina

- ◆ [LIDAR Applications, Tar River Basin](#)
- ◆ [Tar River Basin Mapping](#)
- ◆ [Tar River Basin Mapping \(NOAA/NWS/AHPS\)](#)

Ohio

- ◆ [Blanchard River, Findlay](#)
- ◆ [Blanchard River, Findlay \(NOAA/NWS/AHPS\)](#)

Washington

U.S. Geological Survey Flood Inundation Mapping Science

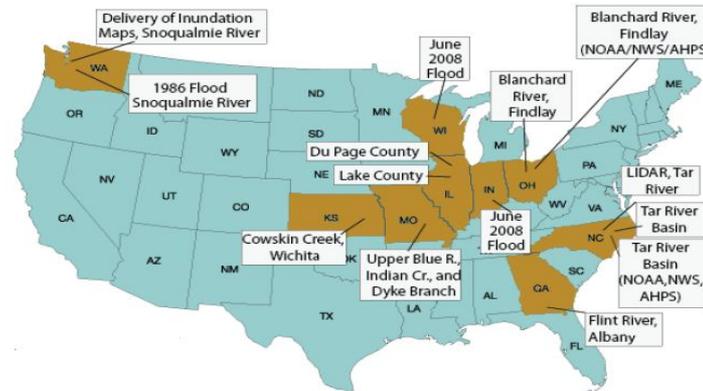
A powerful new tool for flood response and mitigation are digital geospatial flood-inundation maps that show flood water extent and depth on the land surface. Because floods are the leading cause of natural-disaster losses, the U.S. Geological Survey (USGS) is actively involved in the development of flood inundation mapping across the Nation pursuant to its major science strategy goal of reducing the vulnerability of the people and areas most at risk from natural hazards. Working with partners including the National Weather Service (NWS), U.S. Army Corps of Engineers (USACE), the Federal Emergency Management Agency (FEMA), state agencies, local agencies, and universities, the USGS is providing flood inundation mapping science resources to help build more resilient communities.

USGS Flood Inundation Mapping Science Focus Areas

The USGS is working in the following focus areas for flood inundation mapping science:

- ◆ [Flood documentation studies](#)
- ◆ [Static flood-inundation map libraries](#)
- ◆ [Real-time dynamic flood inundation mapping](#)

USGS Flood Inundation Mapping Science Projects, by State



http://water.usgs.gov/osw/flood_inundation/

Flood-peak inundation areas for selected streams in Northwestern Indiana during the Flood of September 2008

Use the links below to download flood-inundation images and geospatial data. For each site, data is offered in three formats:

- JPG: Low resolution images (300 Kb)
- PDF: High resolution images (25-50 Mb)
- KMZ: Used by applications, as in Google Earth, to display geospatial data (8 Kb)

	JPG (low resolution)	PDF (high resolution)	KMZ *
Deep River near Hobart, Lake County		 (50 Mb)	
Little Calumet River (east) near Hammond, Lake County		 (45 Mb)	
Little Calumet River (west) near Hammond, Lake County		 (40 Mb)	
Turkey Creek near Schererville, Lake		 (25 Mb)	

 [GIS layers; ESRI raster and vector files, and associated metadata files](#) (19 Mb ZIP file)

Products

- Broad-based and universal
- Useable for many outlets and applications
 - USGS Web Mapping Application
 - AHPS
 - HAZUS
 - Google Map
 - SAGE
 - USGS Web Mapping Application
 - National Map
 - FLEX viewers
 - Mobile Apps

USGS Web Mapping Application

The screenshot displays the USGS Flood Inundation Mapper web application running in a Windows Internet Explorer browser. The browser's address bar shows the URL: <http://wim.usgs.gov/FIMI/FloodInundationMapper.html>. The application interface includes a top navigation bar with map style options: Streets, Imagery, Imagery/Labels, and Topo. A main map area shows a flood inundation model of the Kalamazoon River region, with a blue line indicating the river's path and a tooltip showing a water depth of 1.589722 ft. The map is overlaid on a topographic background and includes labels for various locations such as Springfield, Battle Creek, Ceresco, and Marshall. A scale bar at the bottom left indicates 5 km and 4 mi. The bottom right corner features the WIM logo and a small inset window. The browser's status bar at the very bottom shows an "Error on page" message and a "Local intranet" security indicator.

USGS Flood Inundation Mapper Beta Version
science for a changing world

Navigation: Previous Extent, Next Extent, Full Extent, Print Map

Map Style: Streets, Imagery, Imagery/Labels, Topo

Map Labels: Walnut Point, Brownlee Park, Springfield, W.K. Kellogg Airport, Battle Creek, Gogouac Lake, Beadle Lake, Ceresco, Marshall, Brooks Field, Wriets, Stanley Corners, Sonoma, Minnes Brook, Harper Creek, Barrum Creek, Wilder Creek, Rice C., Bear Creek, Orchard Park, Brownlee Park, Walnut Point

Water Depth: 1.589722 ft

Map Scale: 1:144448 | Lat: 42.2950, Lng: -85.1254

WIM

Error on page. Local intranet

WaterAlert

- WaterAlert allows you to receive text or email alerts
- Subscriber based
- You choose alert thresholds
- Works for any USGS real-time parameter
 - Stage
 - Streamflow
- Planning a FIMI tie in



<http://water.usgs.gov/wateralert/>

Food for thought

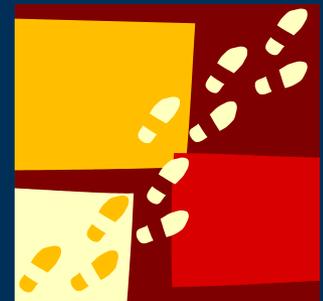
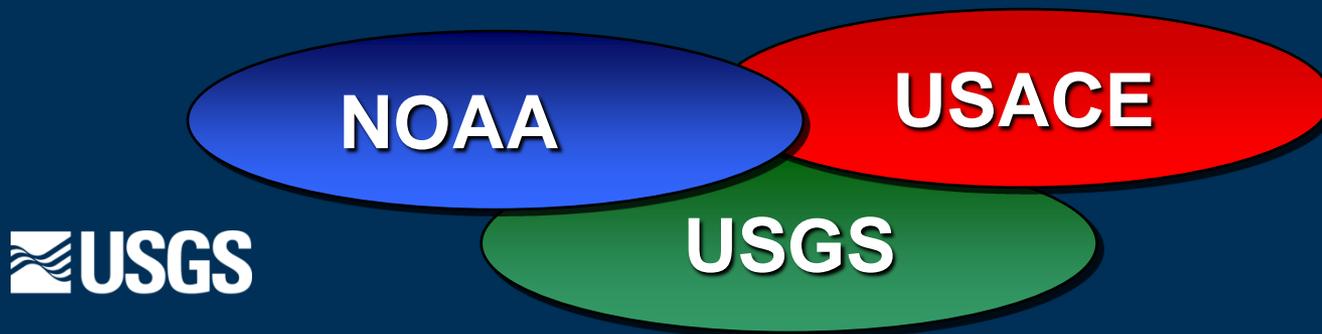
Flood maps – not just for urban flooding

- Agricultural applications
 - IN project with USDA to map 7-day inundation areas for Wetland Reserve Program
- Ecological applications
 - MI Kalamazoo River Oil Spill



Next Steps

- Map libraries - continue to add States and sites as resources allow (collaborative efforts)
- Continue partner building
 - Solidify Federal Tech Standards through IWRSS
 - Work with FEMA e.g. HAZUS and Risk MAP
- National Hydrologic Warning Council meeting, San Diego, May 9-12



Mid- to long-term issues

- Uncertainty
- Coastal inundation
- Breach analysis/inundation



THANK YOU!

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