

USGS Streamgauge and Indiana Water Quality Optimization

An Indiana Silver Jackets and Indiana Water Monitoring Council Assessment



Jeff Frey

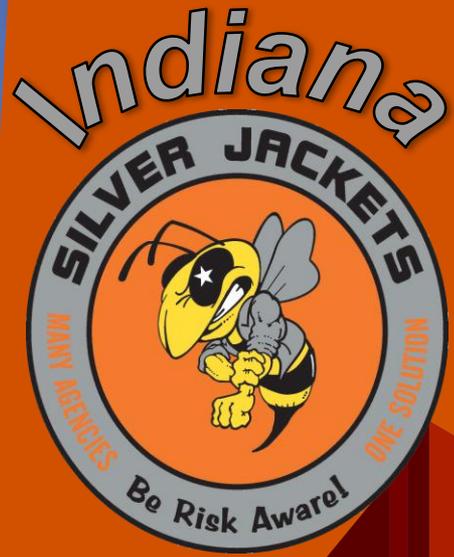
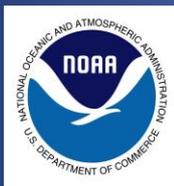
USGS Ohio-Kentucky-Indiana Water Science Center

Federal and National Partners

State, Local, & Educational Partners



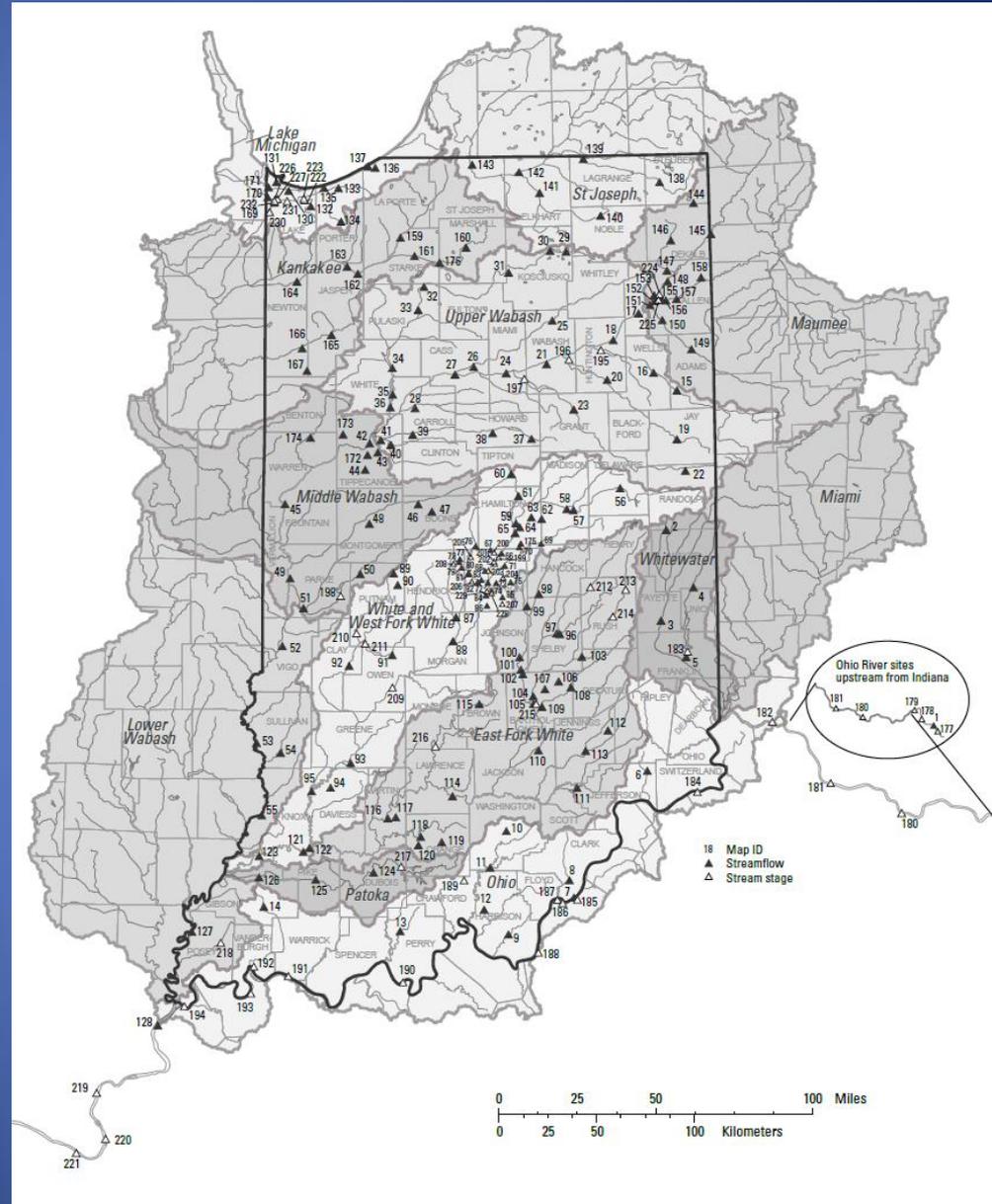
FEMA



Location of USGS Streamgages

STREAMGAGES

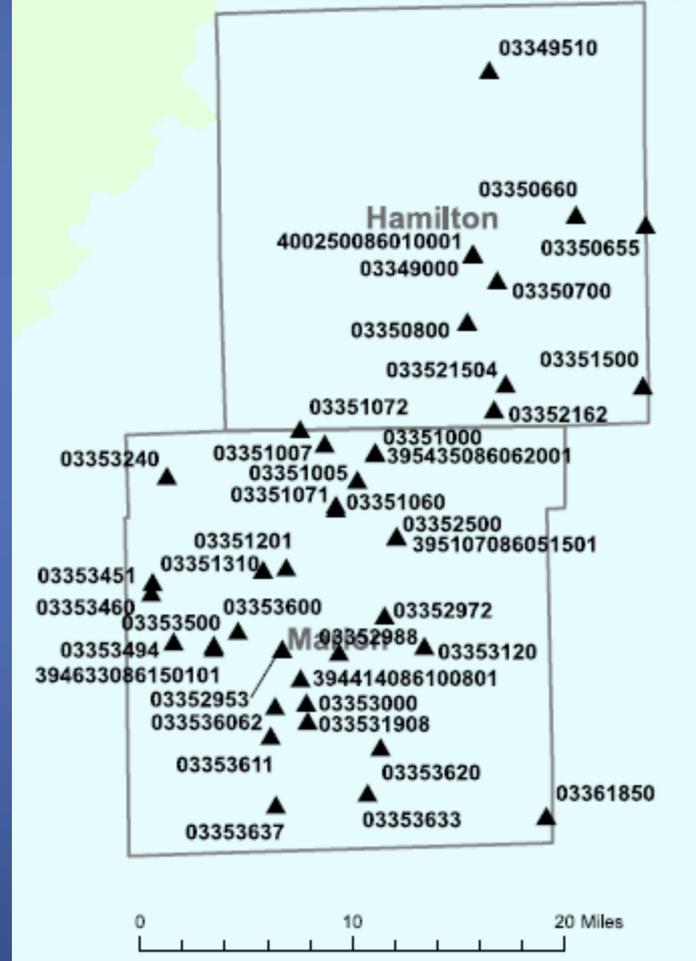
- 214 in Indiana
- 23 on the Ohio River
- Good spatial coverage
some potential holes
 - Tribs to Ohio River



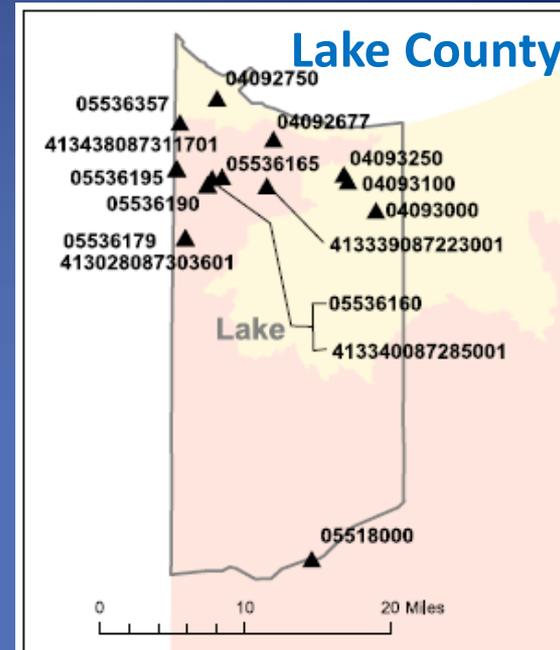
Location of USGS Streamgages

- Some areas have better coverage

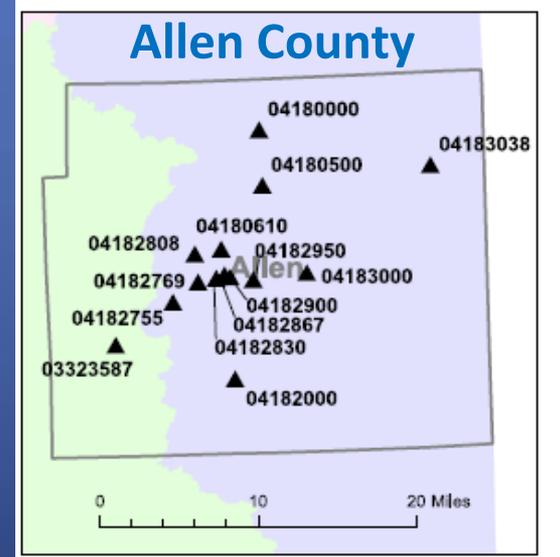
Marion and Hamilton Counties



Lake County



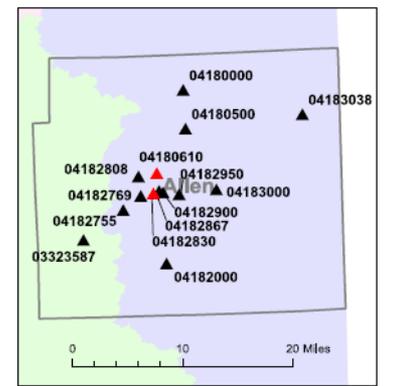
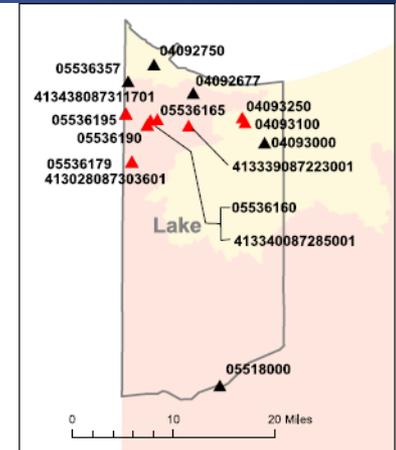
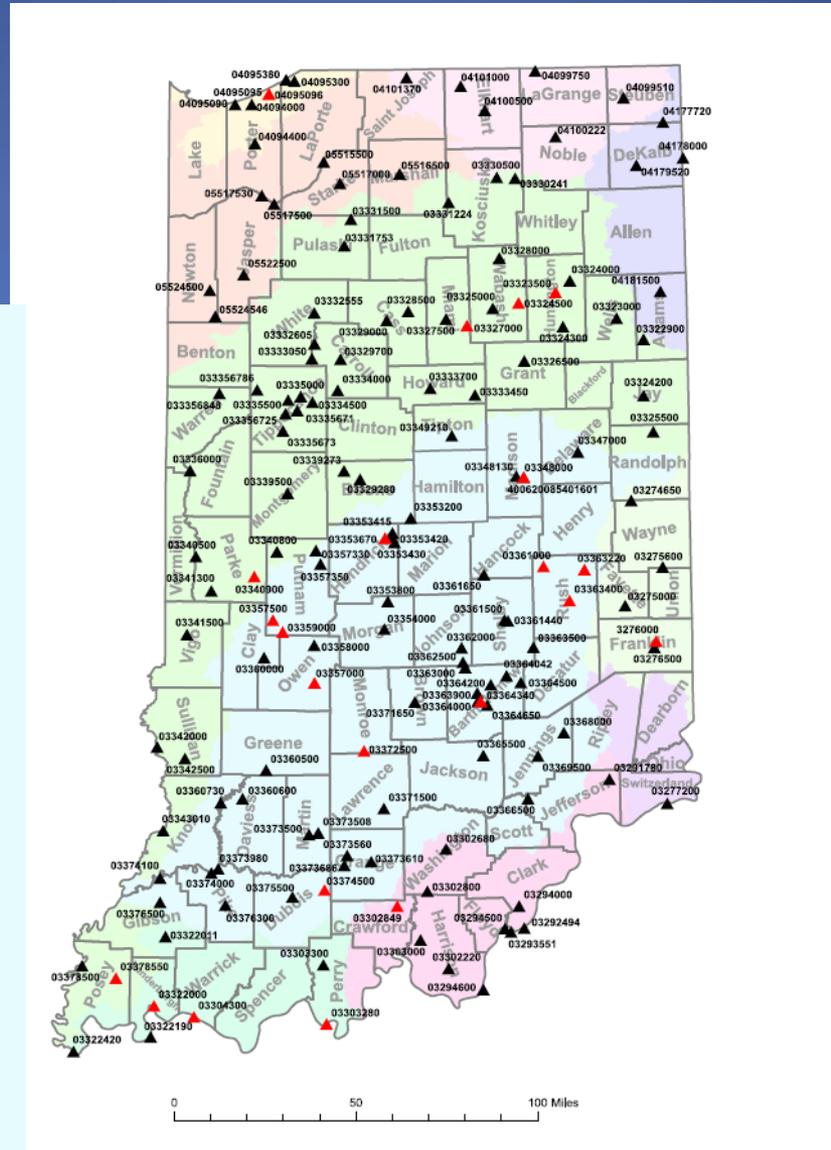
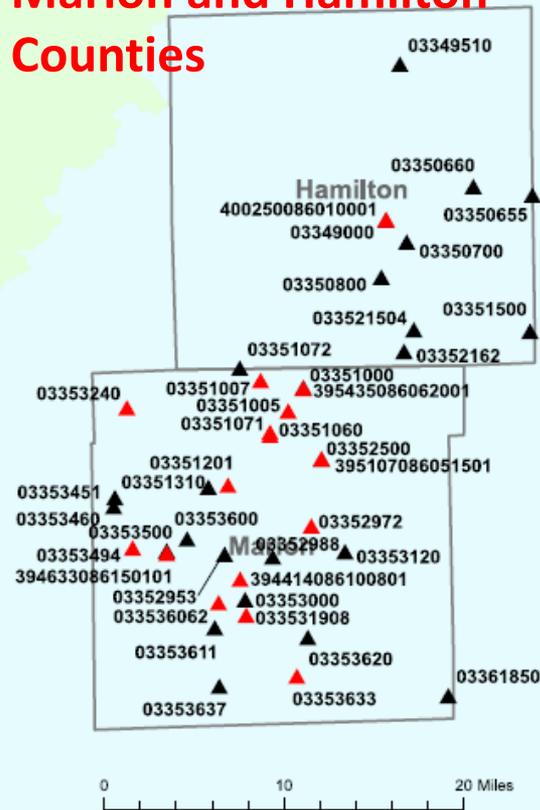
Allen County



Not all USGS Streamgages are the same

- Gage height only
- Easy upgrade

Marion and Hamilton Counties

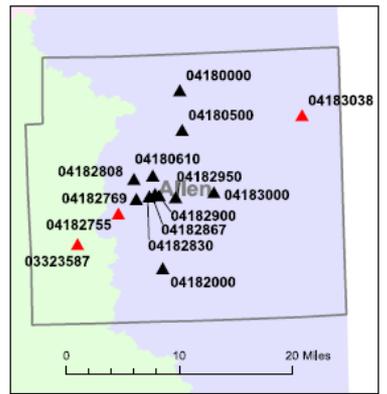
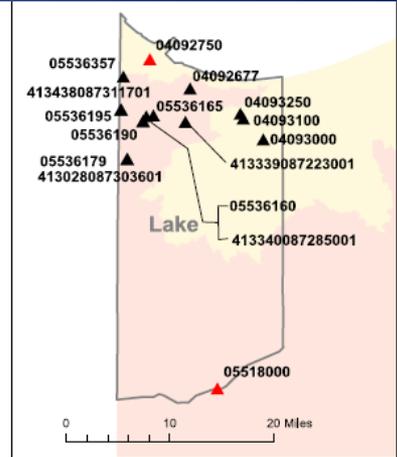
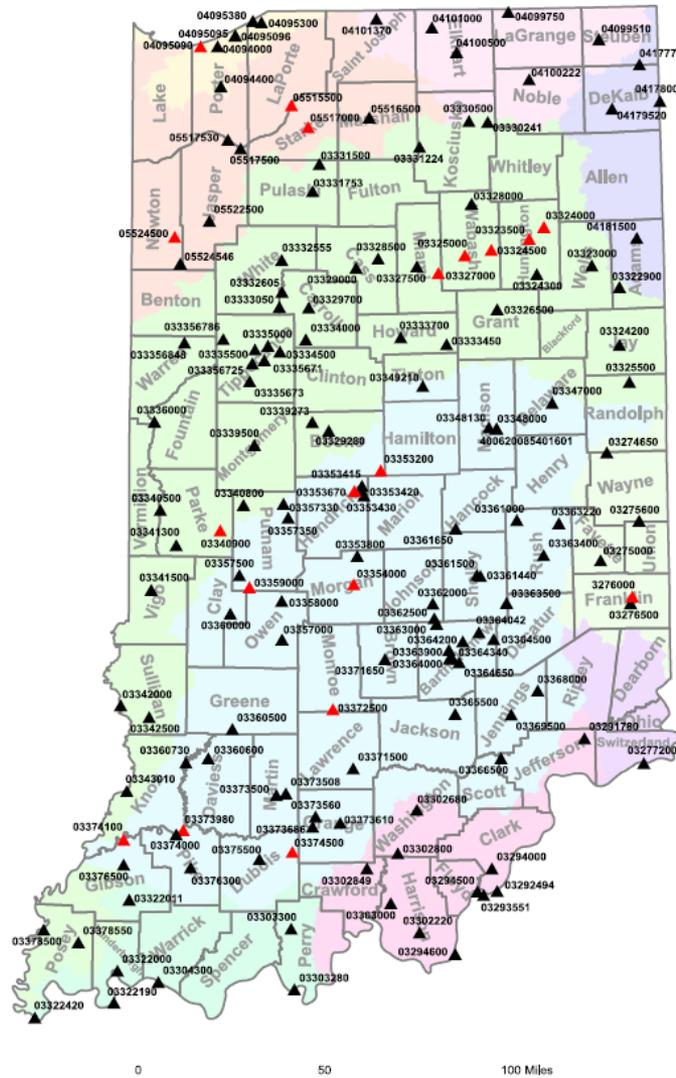
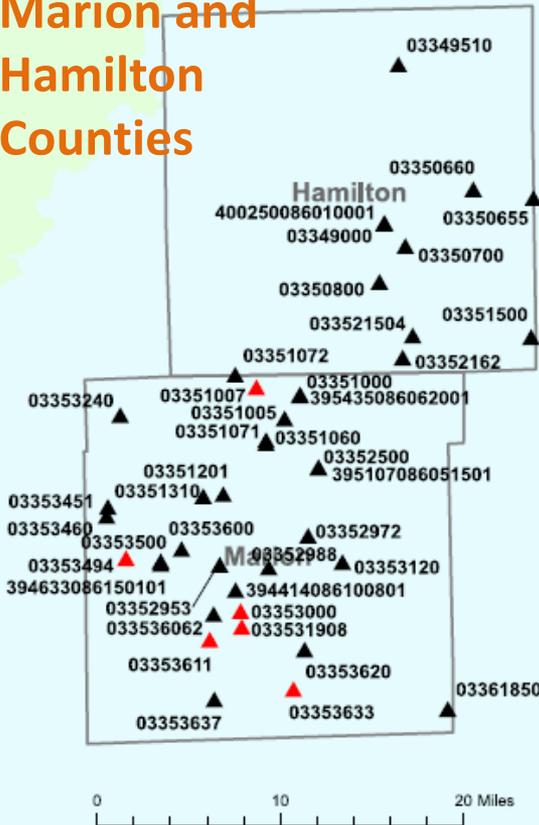


GAGES THAT ARE GAGE-HEIGHT ONLY ARE HIGHLIGHTED IN RED

Not all USGS Streamgages are the same

- Temperature
- Not research grade

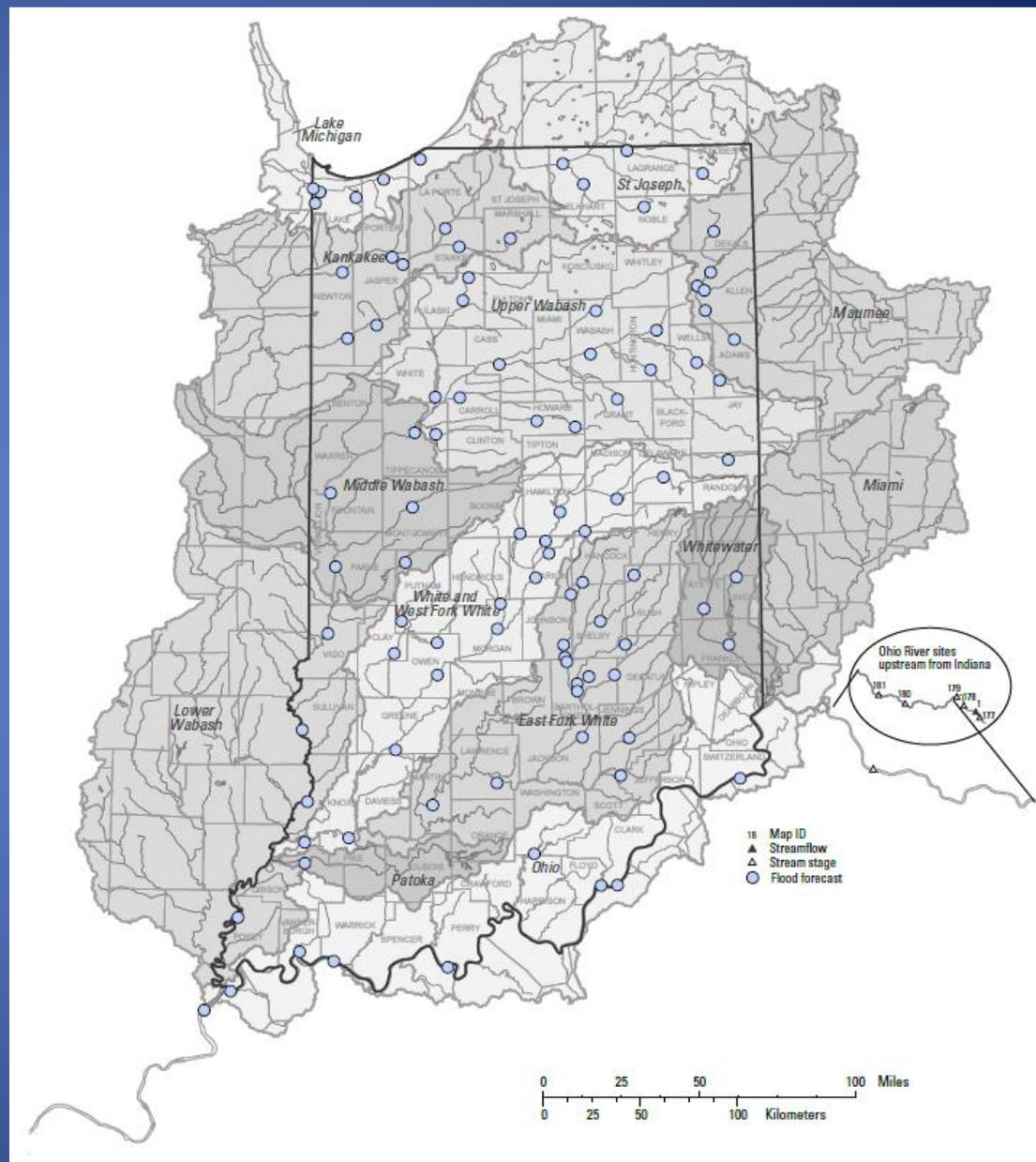
Marion and Hamilton Counties



WATER TEMPERATURE GAGES ARE HIGHLIGHTED IN RED

Hazards: Flood Forecasting Gages

- Asked NOAA and NWS contacts for input
 - 101 of 214 sites used for flood forecasting
 - What additional sites would be helpful



Hazards: Emergency Manager Needs

- Questionnaire:
 - Where does it flood?
 - Which gages do you use for flooding?
 - Which are critical?
 - Are you missing key gages?

- Results to date

- 89 of 92 counties
- Remaining: Hancock, Knox, Marion

Google Forms

Having trouble viewing or submitting this form?

[FILL OUT IN GOOGLE FORMS](#)

I've invited you to fill out a form:

Survey of County Emergency Managers to optimize USGS Streamgages
Streamgage optimization from Emergency Managers

For which County are you Emergency Manager?

Which areas in your County are most prone to flooding (please list)?

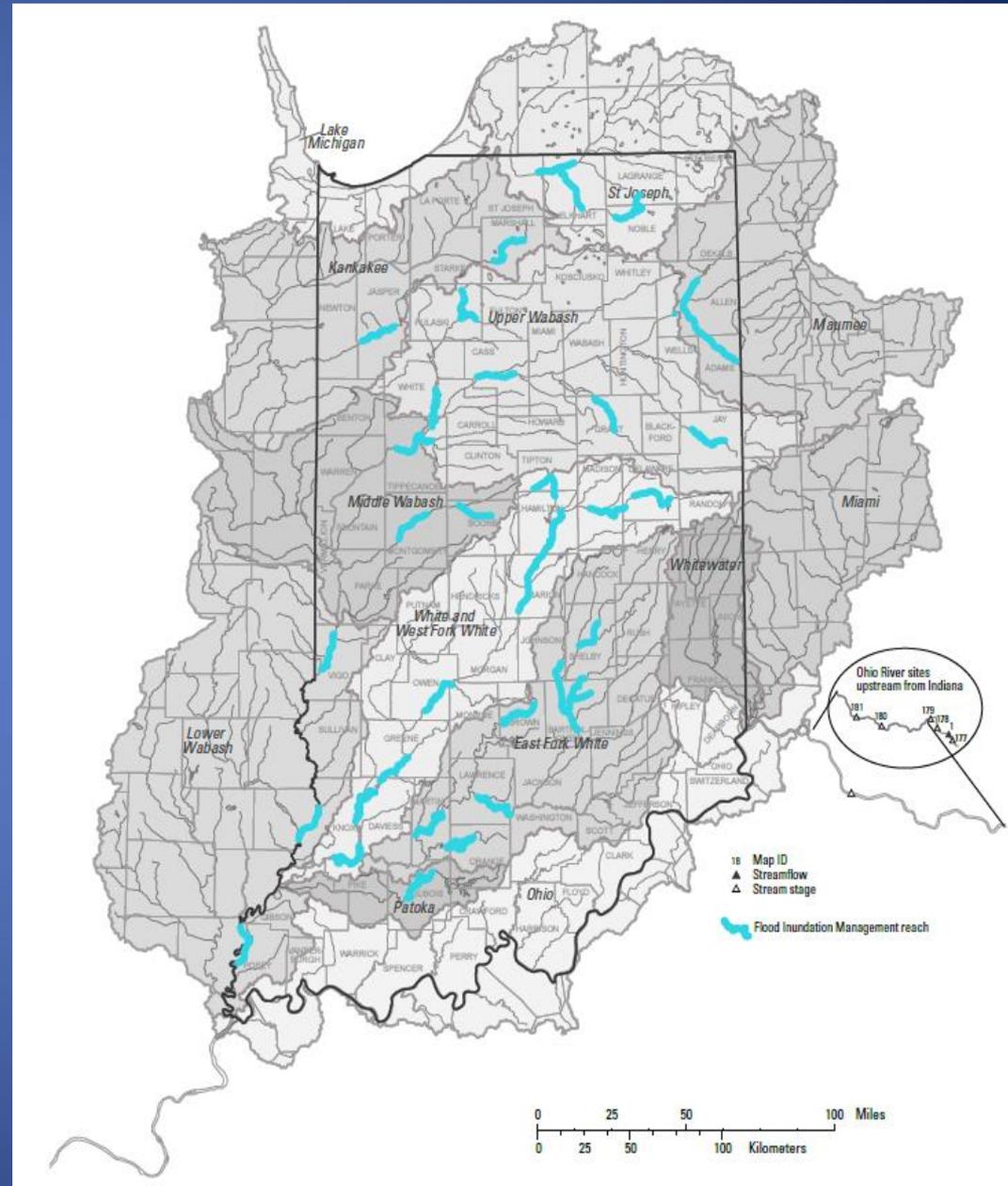
What USGS streamgage(s) do you use for flooding and other emergency situations (gage information can be found <http://waterdata.usgs.gov/in/nwis/current/?type=flow>)?

Are there USGS streamgages that are critical for your work (please list)?

Are there streams in your county that need a streamgage that would help your work (please list)?

Hazards: Flood Inundation Maps

- 31 FIM Maps



Indiana Water Monitoring Council

- National Water Quality Monitoring Council
- Began in 2008
 - Collaboration
 - Coordination
 - Communication
- Board of Directors
 - State
 - Local
 - Federal
 - Universities
 - Consultants

Indiana Water Monitoring Council

Maximizing resources through improved communication, coordination, data sharing, and collaboration



InWMC – Welcome

The Indiana Water Monitoring Council (InWMC) serves as a broad-based, state-wide body to enhance the communication, collaboration and coordination of professionals, organizations, and individuals involved in water monitoring within Indiana. Founded in 2008, the InWMC:

- Provides a forum for communication among groups that are monitoring
- Promotes sharing monitoring [information](#) including data, and effective procedures and protocols for sample collection
- Facilitates the development of collaborative monitoring strategies

The InWMC addresses the full range of water resources, including ground and surface waters, physical, chemical and biological components, and associated wetland resources within Indiana.

Council activities include 1) coordinating water monitoring field days where water-monitoring methods such as flow measurement and water quality sampling are taught, and 2) hosting symposia where talks on specific water resources issues are presented.

Current projects include an effort to compile technical resources and outreach materials related to water monitoring in Indiana and developing a task force aimed at optimizing the existing water quality monitoring sites in Indiana.

[InWMC Newsletter, Volume 3, Issue 1](#)

Follow us on  

© Indiana Water Monitoring Council

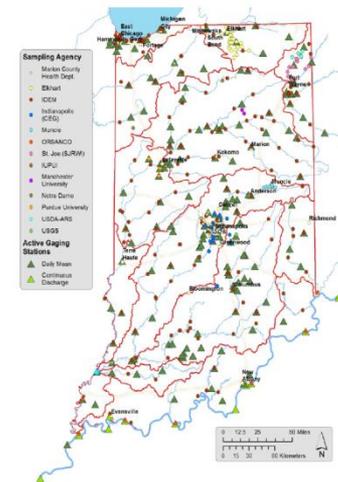
<http://www.inwmc.org/>

Integrated Water Monitoring Network Optimization

Indiana Water Monitoring Council Council White Paper

- Which agencies are actively monitoring?
- Where are the monitoring gaps?
- Which sampling sites are co-located at a gage so that loads can be calculated?
- Where is continuous monitoring going on?
- Which sites are being sampled by 2 or more agencies

Indiana Water Monitoring Council Integrated Water Monitoring Network Optimization Taskforce White Paper



This paper was compiled by the following authors:

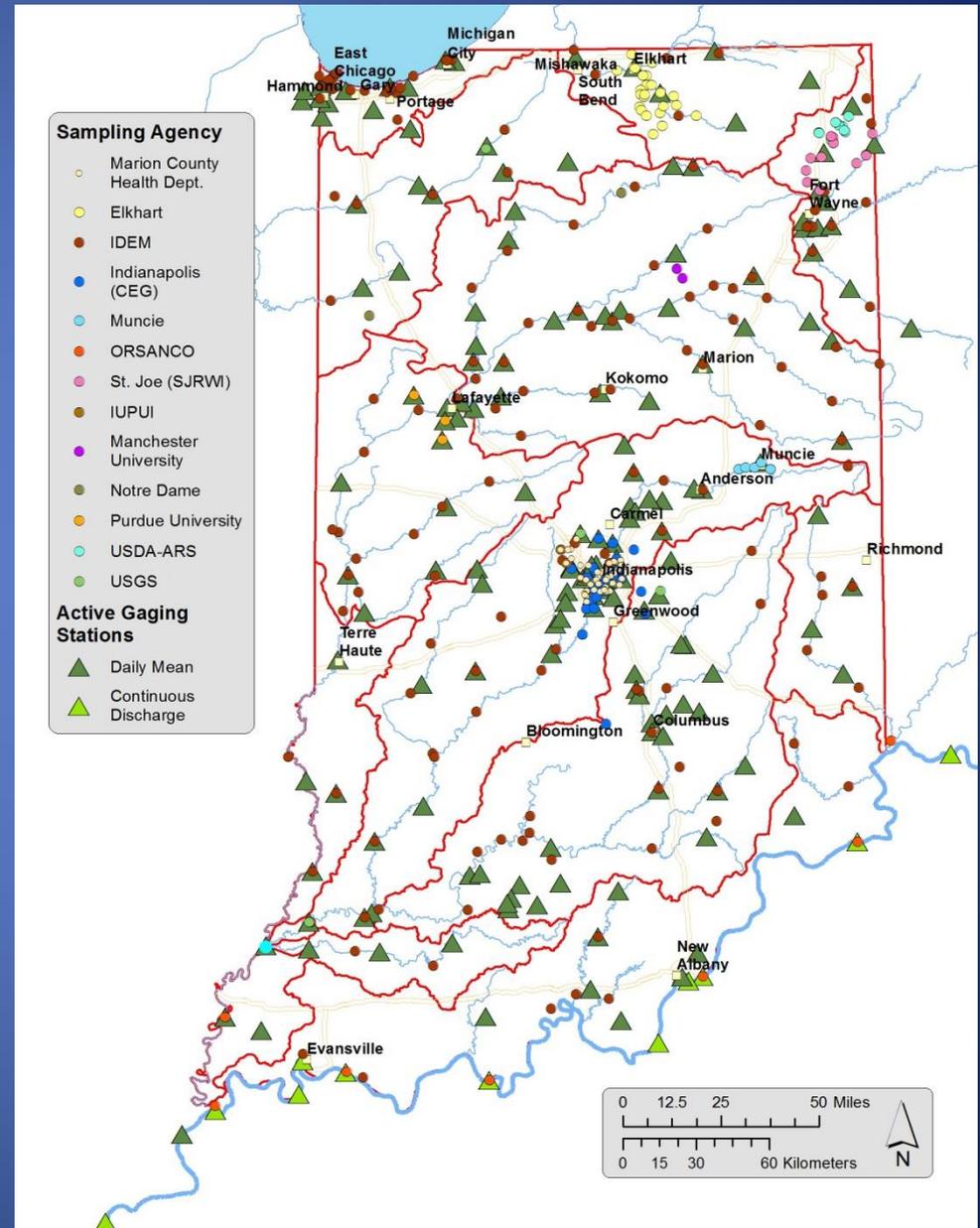
Steve Braun, ORSANCO
Aubrey Bunch, USGS
Heather Buck, Christopher Burke Engineering
Joe Foy, City of Elkhart
Jeff Frey, USGS - Chair
Bob Gillespie, Indiana University- Fort Wayne
Jason Heath, ORSANCO
Chi-Hua Huang, ARS
Bert Mbongo, USGS Volunteer
Gretchen Quirk, Marion County Public Health Department
Mary Lou Renshaw, IDEM
Stacy Sobat, IDEM
Ben Sperl, USGS
Jeff Thomas, ORSANCO
Jeremy Webber, CEES

1
InWMC White Paper

Water-Quality Monitoring in Indiana

Discrete sampling

- At least bimonthly sampling
- All sites sampled for N and P
- 13 agencies/groups
- 311 sampling sites

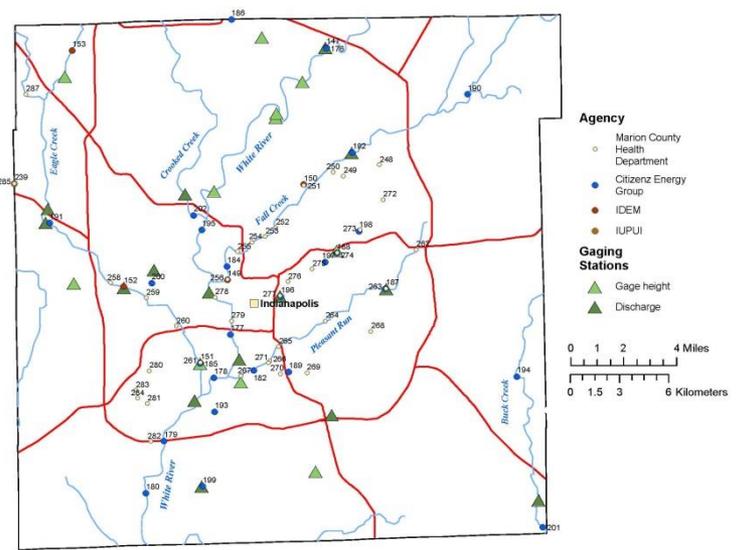


IDEM Major River Basins were used to

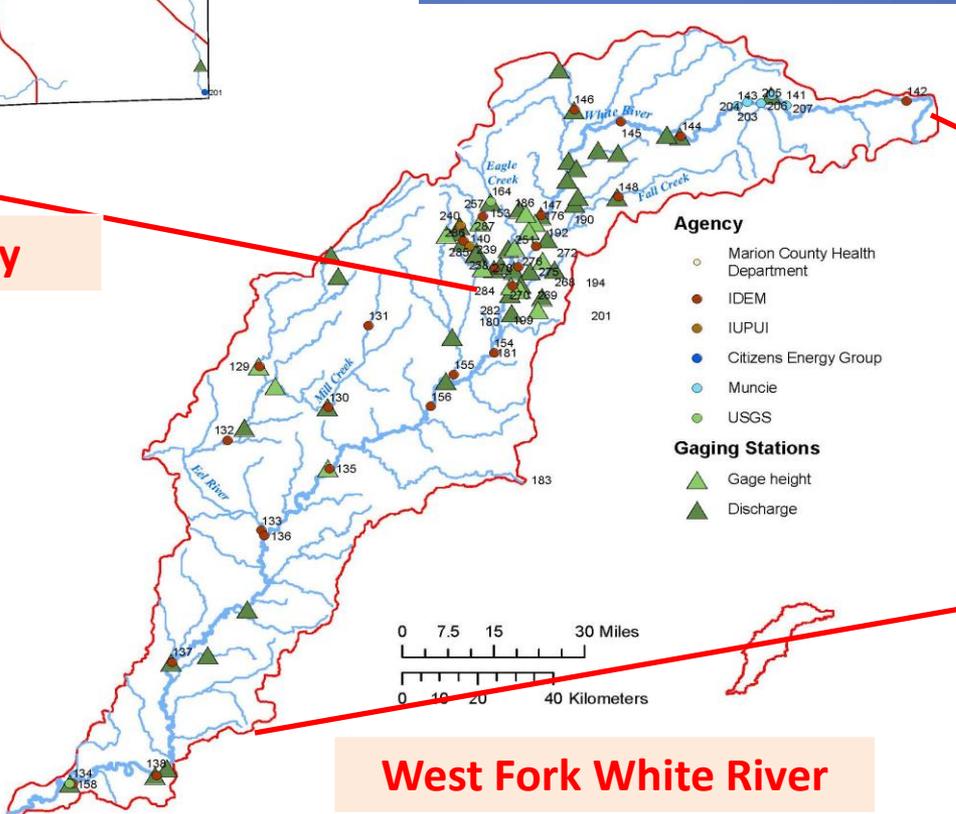
identify missing sites

Major River Basins

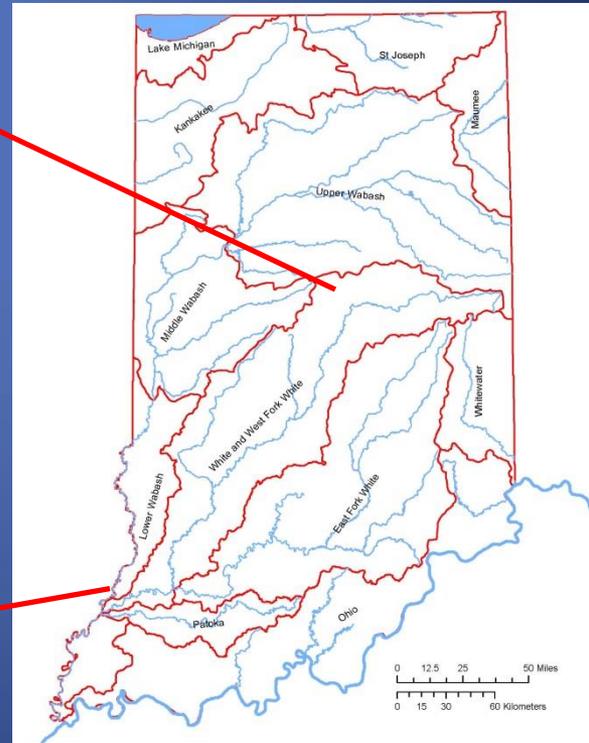
- Spatial coverage
- Important pour points



Marion County



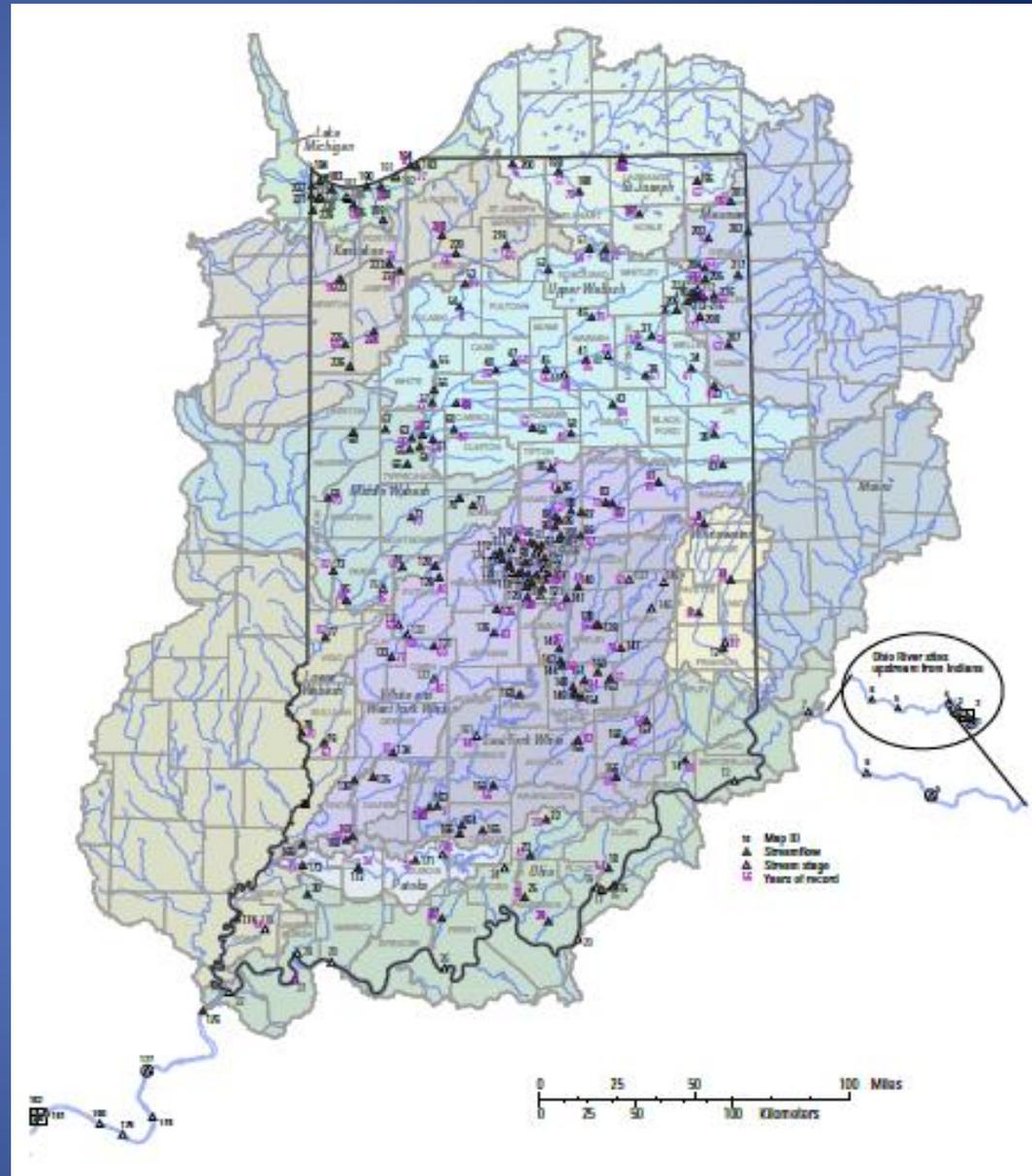
West Fork White River



Major River Basins

Water Quality: Long running gages

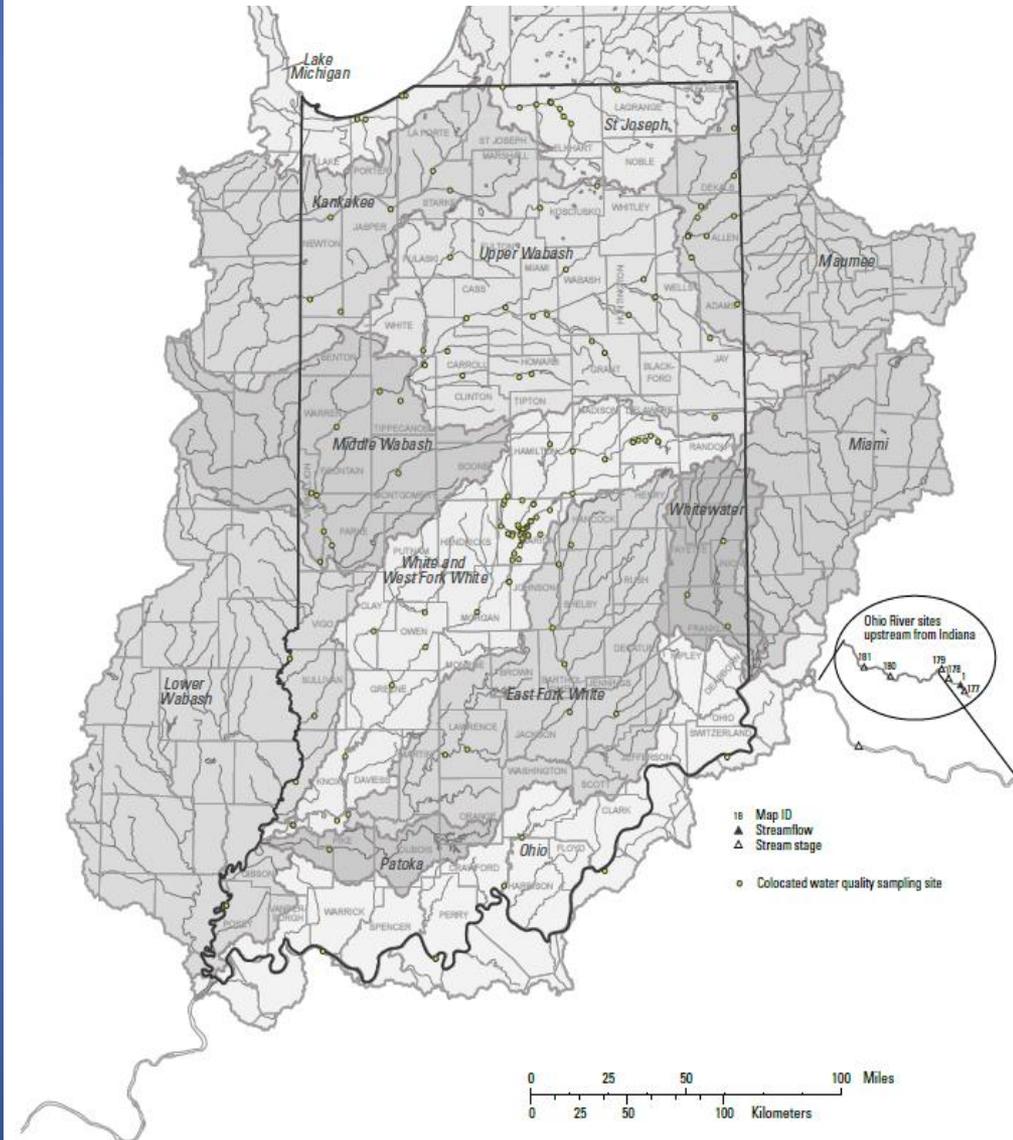
- Water quality sampling sites
- Important for trends



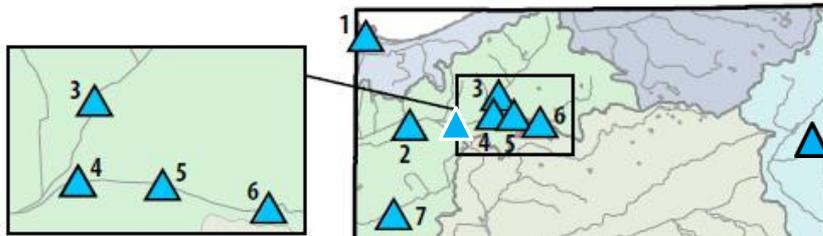
Water Quality: Co-located gages

- Water quality sampling sites
 - Documents 154 streamgages within 10% of basin area
 - Loads and yields can be calculated
 - Are we missing key gages?

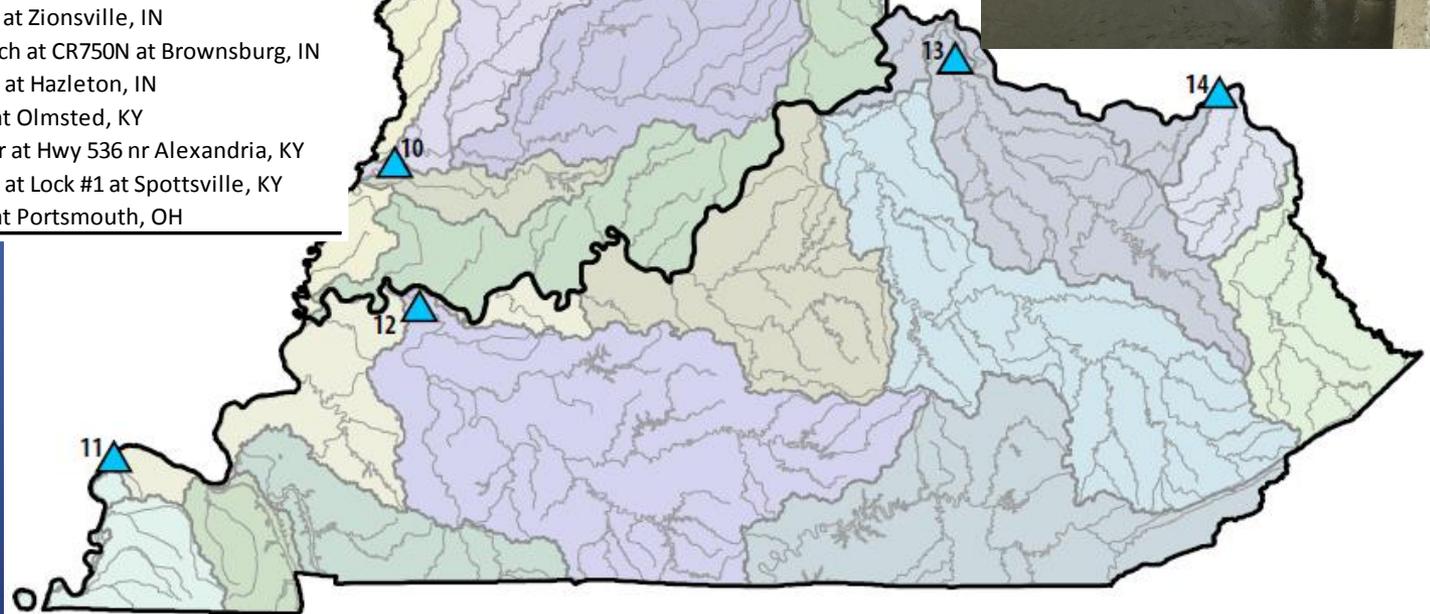
InWMC White Paper: Optimizing water quality monitoring in IN



Water Quality: Supergages



Map ID Number	Sation ID	Site Name
1	04092750	Indiana Harbor Canal at East Chicago, IN
2	05518000	Kankakee River at Shelby, IN
3	05515500	Kankakee River at Davis, IN
4	05517010	Yellow River nr Brems, IN
5	05517000	Yellow River at Knox, IN
6	05516665	Yellow River nr Oak Grove, IN
7	05524500	Iroquois River nr Foresman, IN
8	03353200	Eagle Creek at Zionsville, IN
9	03353420	School Branch at CR750N at Brownsburg, IN
10	03374100	White River at Hazleton, IN
11	03612600	Ohio River at Olmsted, KY
12	03254520	Licking River at Hwy 536 nr Alexandria, KY
13	03321500	Green River at Lock #1 at Spottsville, KY
14	03217200	Ohio River at Portsmouth, OH



Streamgauge Scorecard

Metrics used for comparison

- **Streamflow**
 - Discharge
 - Gage height only
 - Long-term streamgages (*trends, climate change*)
- **Hazards**
 - Flood forecasting site
 - Emergency Manager site
 - FIM Library
- **Water quality**
 - Co-located with QW sampling site
 - Continuous parameters
 - Supergage
 - 303d site

Potential other optimization parameters

Water Quality

Needed WQ sites

Threatened and endangered species

Water quantity/water users issues

DS of a reservoir

Drinking water source

Hazards

DS of a reservoir

Streamgauge Scorecard

- Which streamgages have the highest scores

				Optimization Scorecard									
Site number	Station name	Cooperator	Active since	Discharge site	Temp	Precip	Has QW parameter	Super gage	Used to calculate loads	NOAA Forecast site	Used by County EM	FIM Library	Total score
05518000	KANKAKEE RIVER AT SHELBY, IN	USACE/USGS NSIP	1922	10	5	5	10	10	10	10	30		90
03331500	TIPPECANOE RIVER NEAR ORA, IN	INDNR/USGS NSIP	1943	10	5					10	50		75
03331753	TIPPECANOE RIVER AT WINAMAC, IN	USGS NSIP/NIPSCO		10					5	10	30	20	75
05515500	KANKAKEE RIVER AT DAVIS, IN	IDEM	1924	10	5	5	10	10	10	10	10		70
05517500	KANKAKEE RIVER AT DUNNS BRIDGE, IN	KRBC/USGS NSIP	1948	10			10	10	10	10	20		70
03322900	WABASH RIVER AT LINN GROVE, IN	USACE/USGS NSIP	1964	10	5				10	10	30		65
03364000	EAST FORK WHITE RIVER AT COLUMBUS, IN	INDNR/USGS NSIP	1947	10	5				10	10	20	10	65
03303280	OHIO RIVER AT CANNELTON DAM AT CANNELTON, IN	USGS NSIP/USACE		10	5				10	10	30		65
03335500	WABASH RIVER AT LAFAYETTE, IN	INDNR/USGS NSIP/USACE	1923	10					10	10	20	10	60
03347000	WHITE RIVER AT MUNCIE, IN	INDNR	1930	10					10	10	20	10	60
03353200	EAGLE CREEK AT ZIONSVILLE, IN	INDNR/Zionsville/NSIP	1957	10	5	5	10	10	10	10			60
03374100	WHITE RIVER AT HAZLETON, IN	USGS NSIP		10	5	5	10	10	10	10			60
05524500	IROQUOIS RIVER NEAR FORESMAN, IN	INDOT	1948	10	5	5	10	10		10	10		60
03333050	TIPPECANOE RIVER NEAR DELPHI, IN	INDOT/NIPSCO/USACE	1939	10	5				10	10	10	10	55
03373500	EAST FORK WHITE RIVER AT SHOALS, IN	USGS NSIP/USACE	1923	10	5				10	10	10	10	55
05517000	YELLOW RIVER AT KNOX, IN	INDOT	1943	10		5		10	10	10	10		55

Thank you

- **Summary**

- We need to optimize our streamgage network to meet all cooperators needs and minimize costs
- By understanding who has streamgage needs can we work together to find the necessary funding
 - Maumee River at Antwerp
 - Wabash River at New Harmony
- By considering streamflow, flooding, hazards, and water quality needs at each site we can identify the most important sites in the state.

THE END

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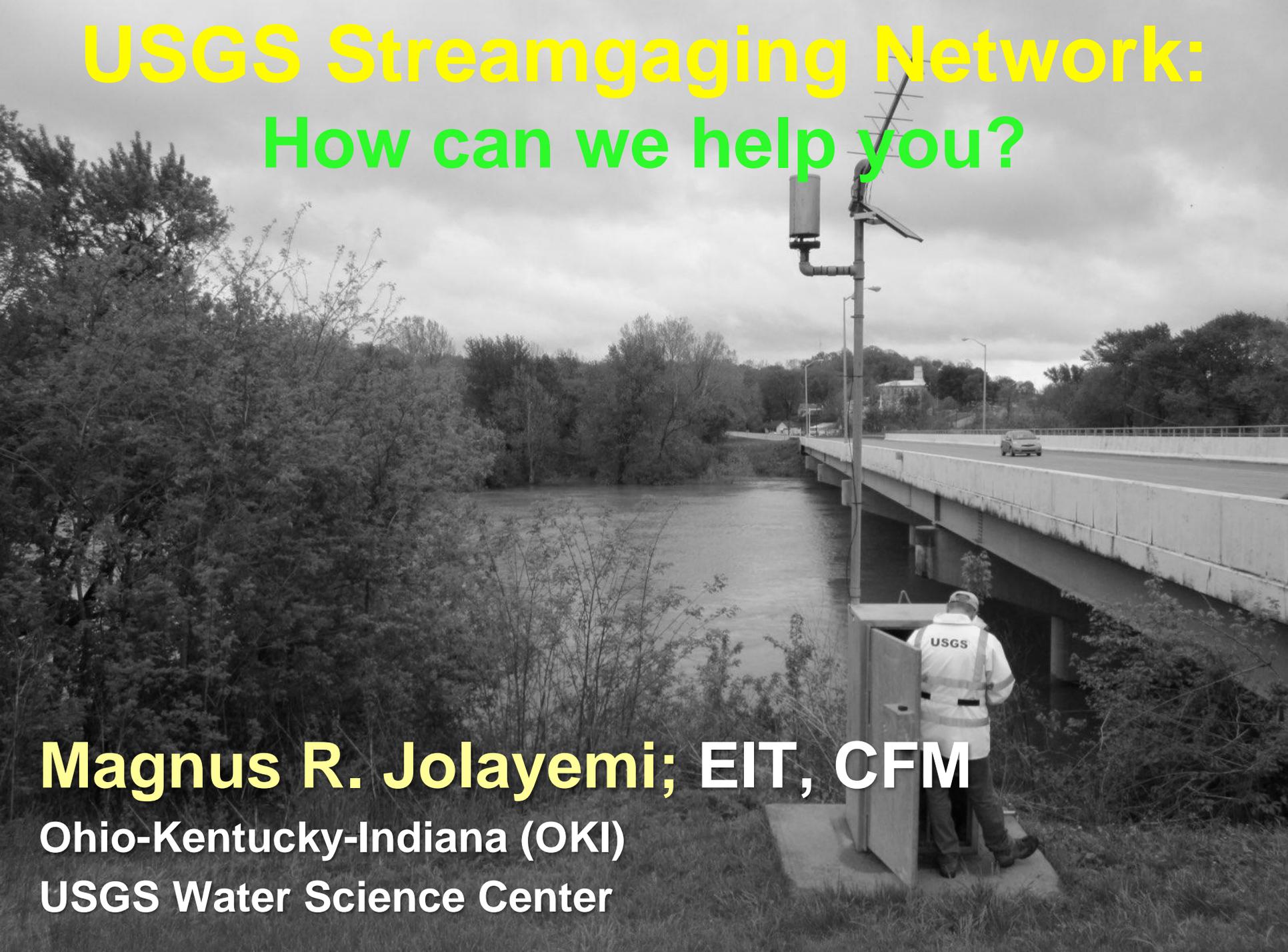
Indiana Water Monitoring Council

<http://www.inwmc.org/>

Indiana Silver Jackets

<https://silverjackets.nfrmp.us/State-Teams/Indiana>

USGS Streamgaging Network: How can we help you?



Magnus R. Jolayemi; EIT, CFM

Ohio-Kentucky-Indiana (OKI)

USGS Water Science Center

What is a Streamgage?

- A device that provides continuous data on water level, streamflow, and/or water quality (precipitation/temperature)



What is a streamflow (or discharge)?



- **Streamflow/discharge** is the volume of water that passes a specific point in a stream per unit of time

Over 9,000 Streamgages in the USGS Network



USGS Indiana Real-time Continuous Water Monitoring Network

River Water level sites

Discharge - 176

Index Velocity - 6

Stage only - 32

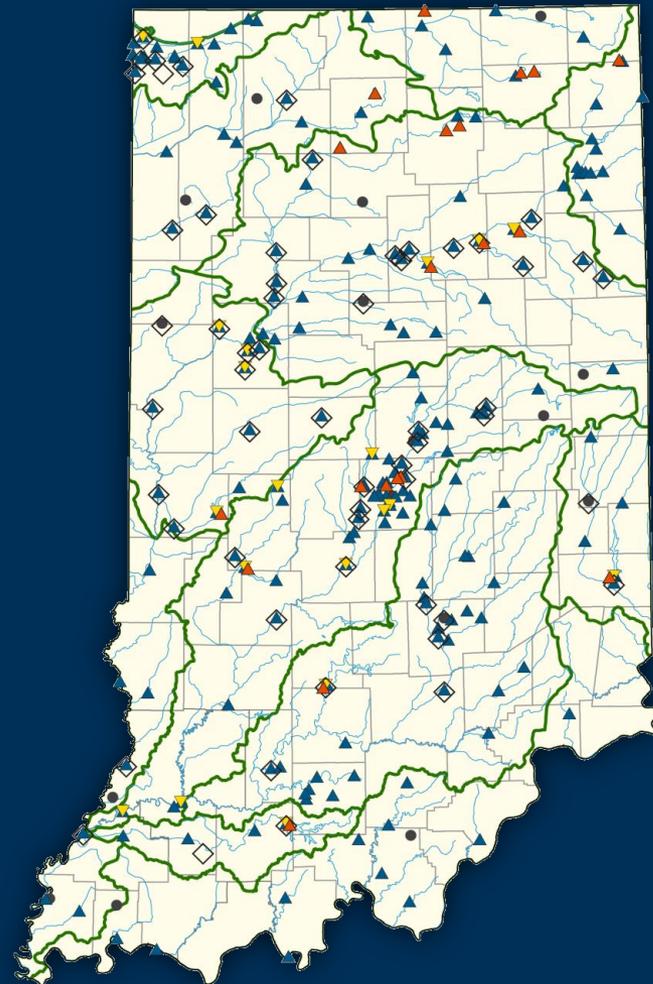
GW levels - 37 wells

Lake/Reservoir levels - 13

Rain Gages - 73

Water Quality - 22

Super Gages - 10



USGS Kentucky Real-time Continuous Water Monitoring Network

River Water level Sites

Discharge - 204

Index Velocity - 6

Stage only - 32

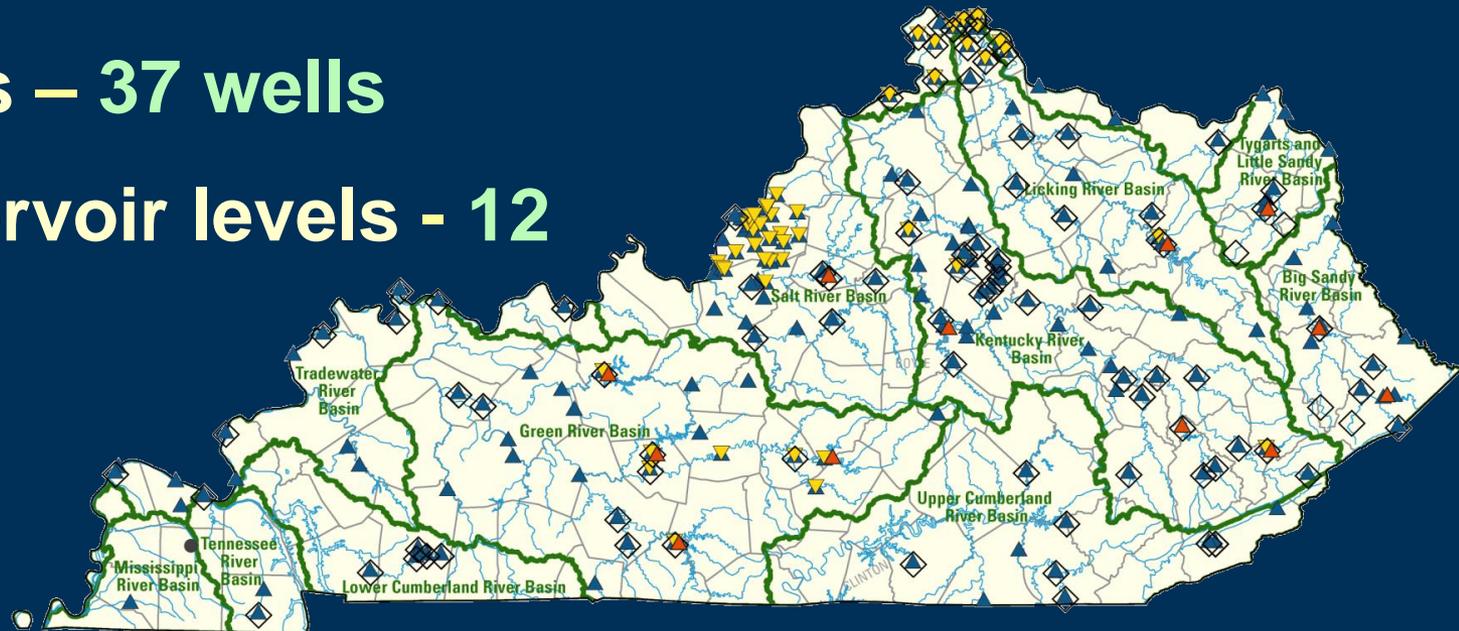
GW Levels – 37 wells

Lake/Reservoir levels - 12

Rain Gages – 95

Water Quality - 47

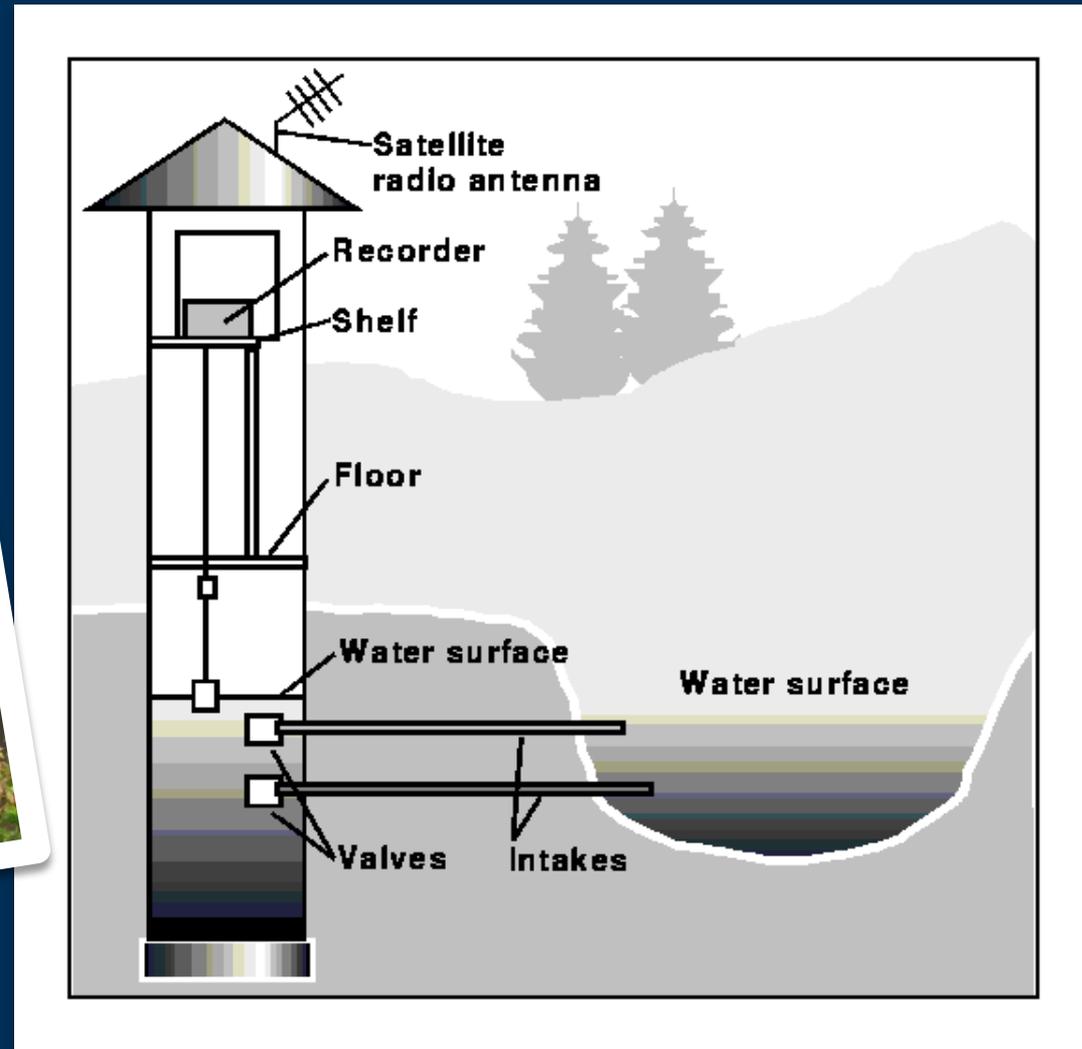
Super Gages - 2



Multiple types of equipment are used to measure streamflow

Water level sensor:

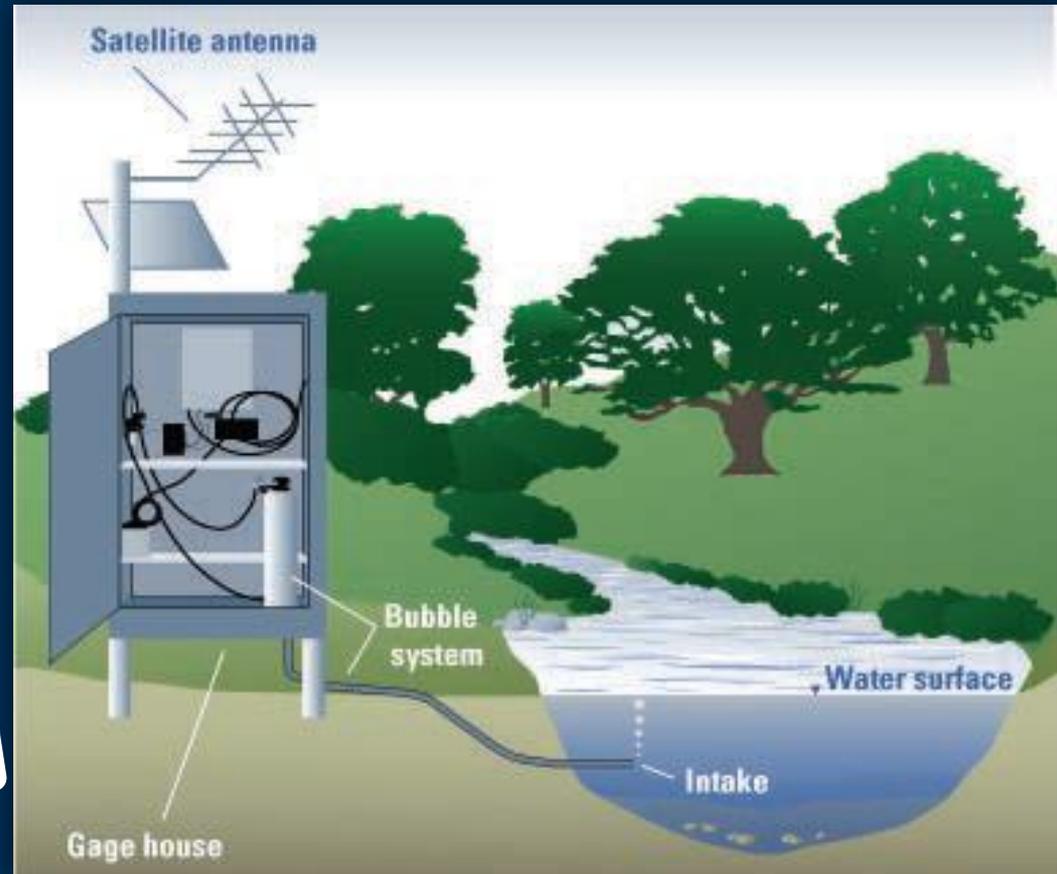
- **Stilling well**



Multiple types of equipment are used to measure streamflow (cont.)

Water level sensor:

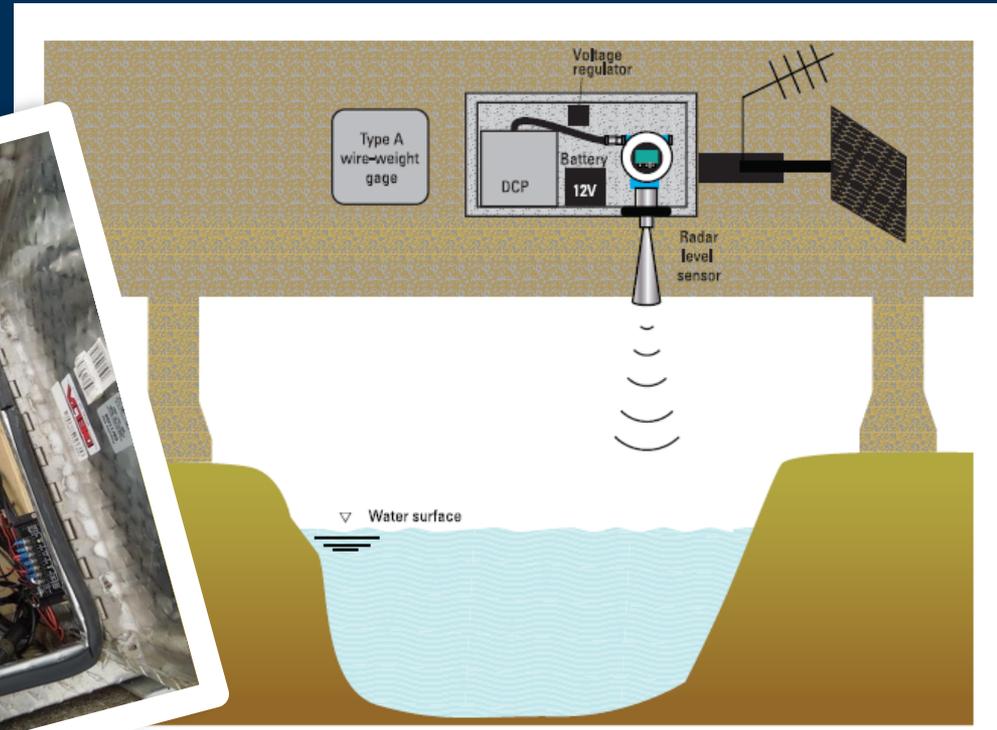
- **Bubbler system**



Multiple types of equipment are used to measure streamflow (cont.)

Water level sensor:

- Radar



Multiple types of equipment are used to measure streamflow (cont.)

Water level sensor:

- Index velocity



Side-looking doppler profiler

How do we assure continuous water level data is correct?

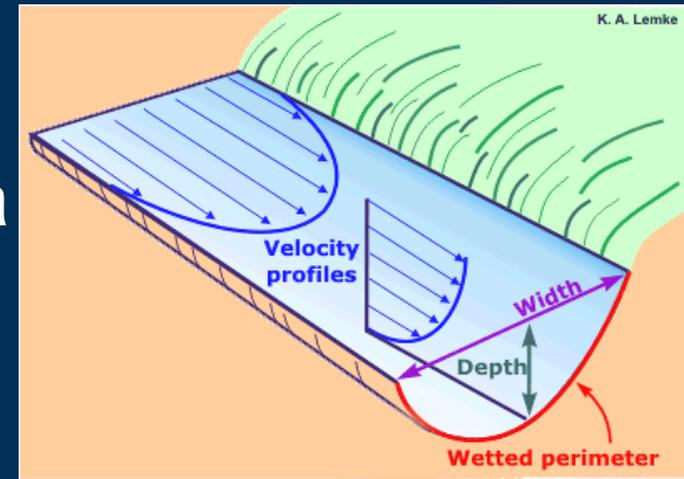
“Reference gages”

- Provides visual check of the elevation of the water surface
- Reading relies on the technician



How do we get from water level to discharge?

- Discharge is computed from the stage (water level) and area of the stream cross section



- **Discharge = Velocity * Area**

$$Q = V * A$$



What equipment is used to measure velocity?

Streams and low flow in rivers

- Wading
- Bridges



What equipment is used to measure velocity?

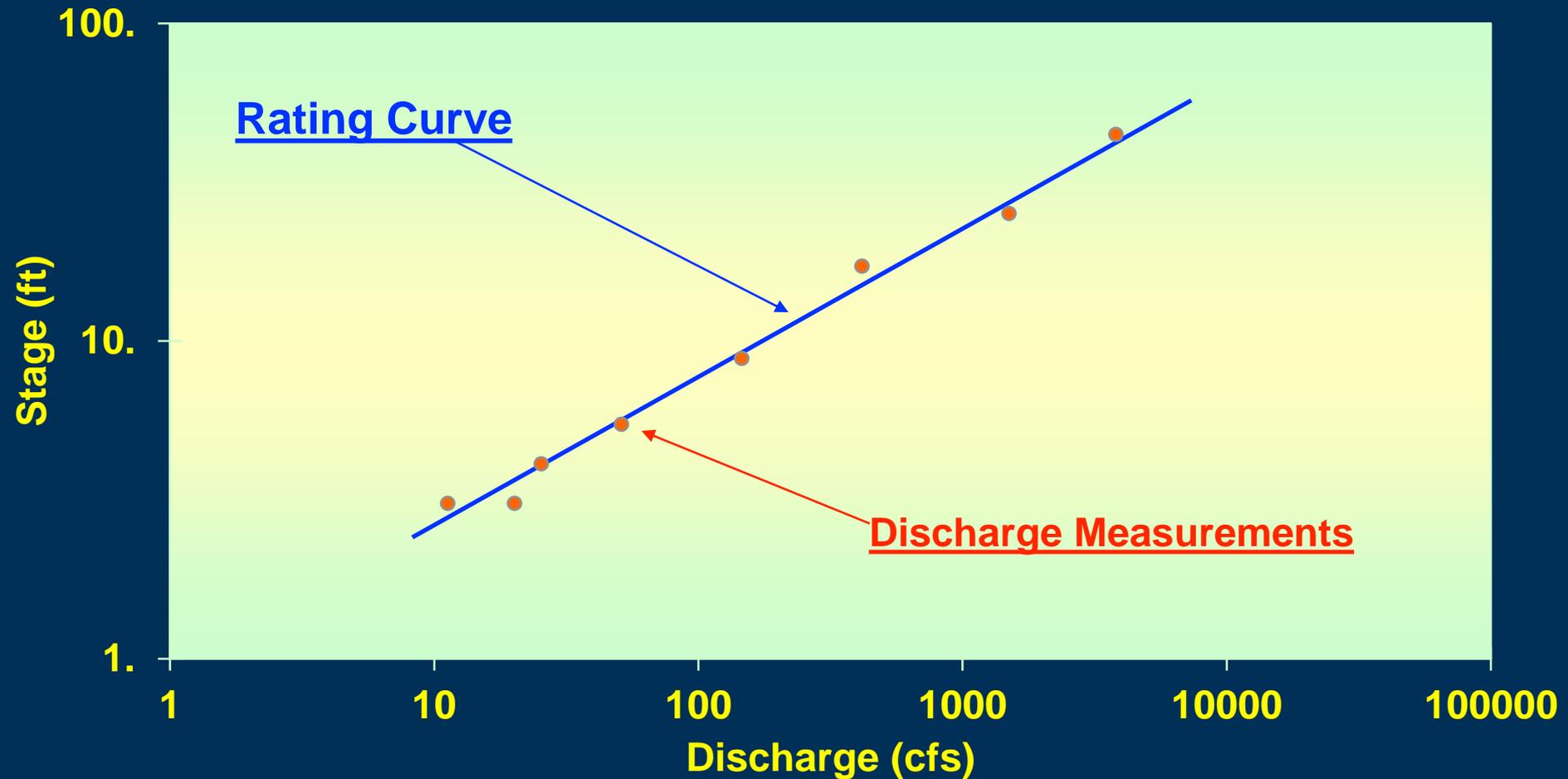
Big rivers and storms

- Boats
- Remote controlled

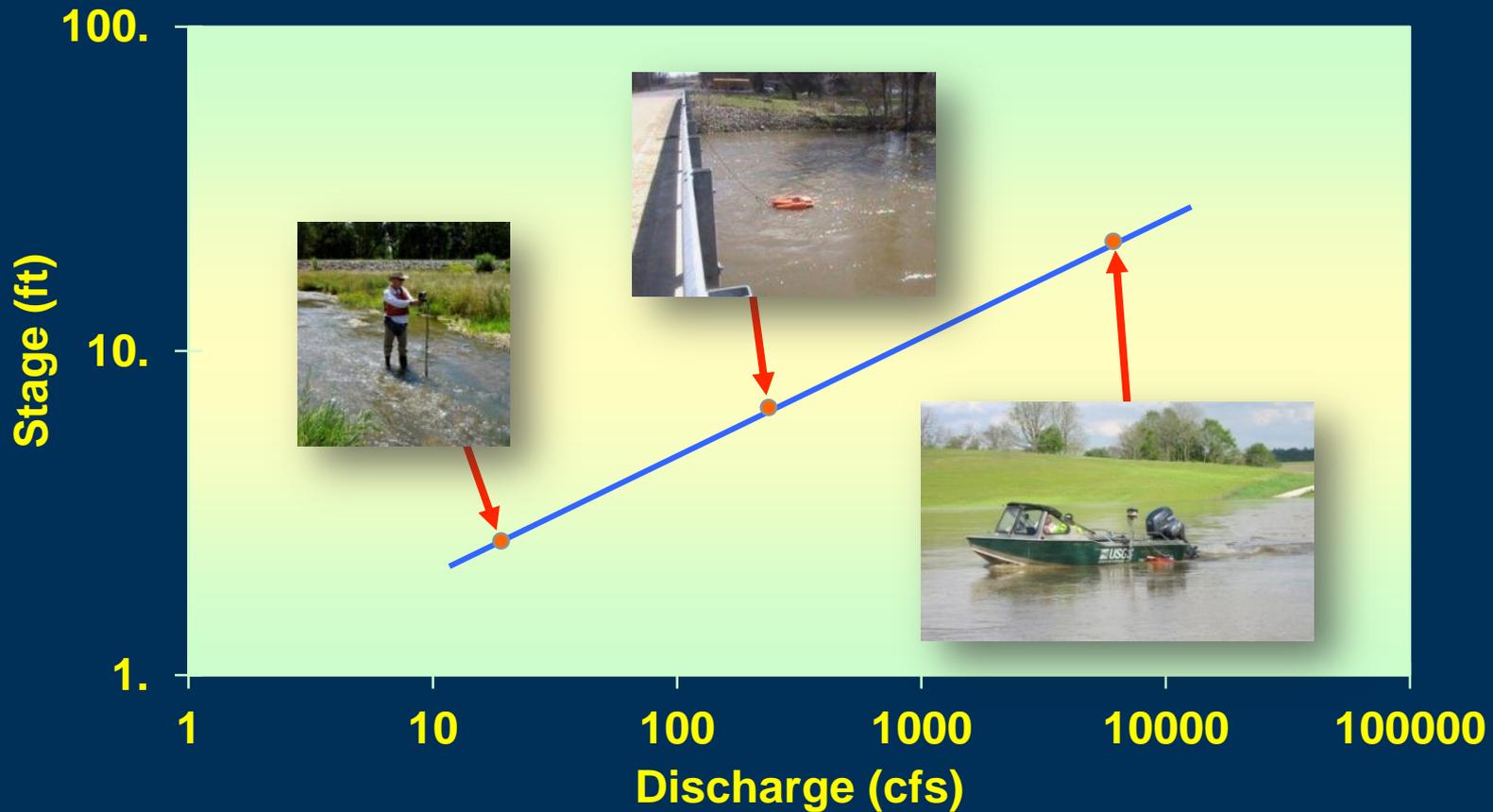


The goal: Discharge values at all water levels

How? Relation between stage and discharge



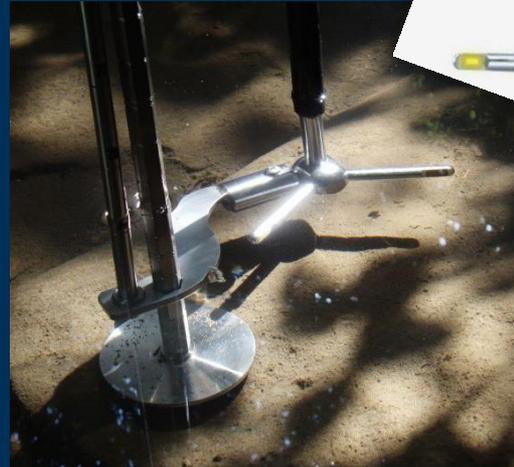
For accurate prediction discharge measurements must be collected at all flows



What equipment is used to measure velocity?



Price AA meter



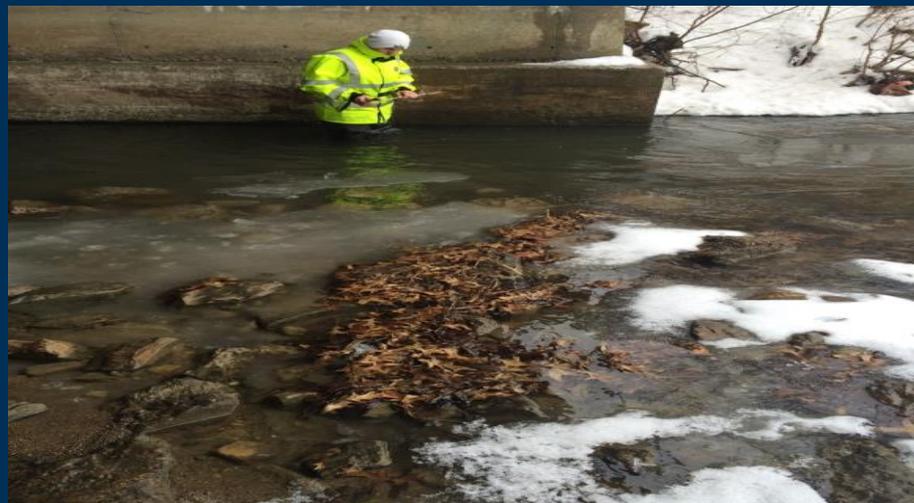
Acoustic Doppler Velocimeter (ADV)

What equipment is used to measure velocity (cont.)

- Acoustic Doppler Current Profiler (ADCP)



Discharge measurements are collected 8 times per year at different flows and conditions



Web Tools That Can Help Floodplain and Environmental Managers

- Water Watch
- Water Alert
- Flood Inundation Mapper



Web Tools: Water Watch

Real-time dashboard of flooding/drought conditions nationwide

The screenshot displays the USGS WaterWatch dashboard. At the top left is the USGS logo with the tagline "science for a changing world". At the top right are links for "USGS Home", "Contact USGS", and "Search USGS". Below the logo is the "WaterWatch" title and a search bar. A vertical navigation menu on the left includes links for Home, Current Streamflow, Flood, Drought, Past Flow/Runoff, Animation, Toolkit, Annual Summaries, Additional Information, and About WaterWatch. The main content area features four maps of the United States:

- Current Streamflow**: Thursday, March 07, 2013 11:30ET. Shows streamflow levels across the country with a color scale from green to red.
- Drought**: Wednesday, March 06, 2013. Shows drought conditions with a color scale from light orange to dark brown.
- Flood**: Thursday, March 07, 2013 11:30ET. Shows flood conditions with a color scale from light blue to dark blue.
- Past Flow/Runoff**: Wednesday, March 06, 2013. Shows past flow/runoff with a color scale from green to red.

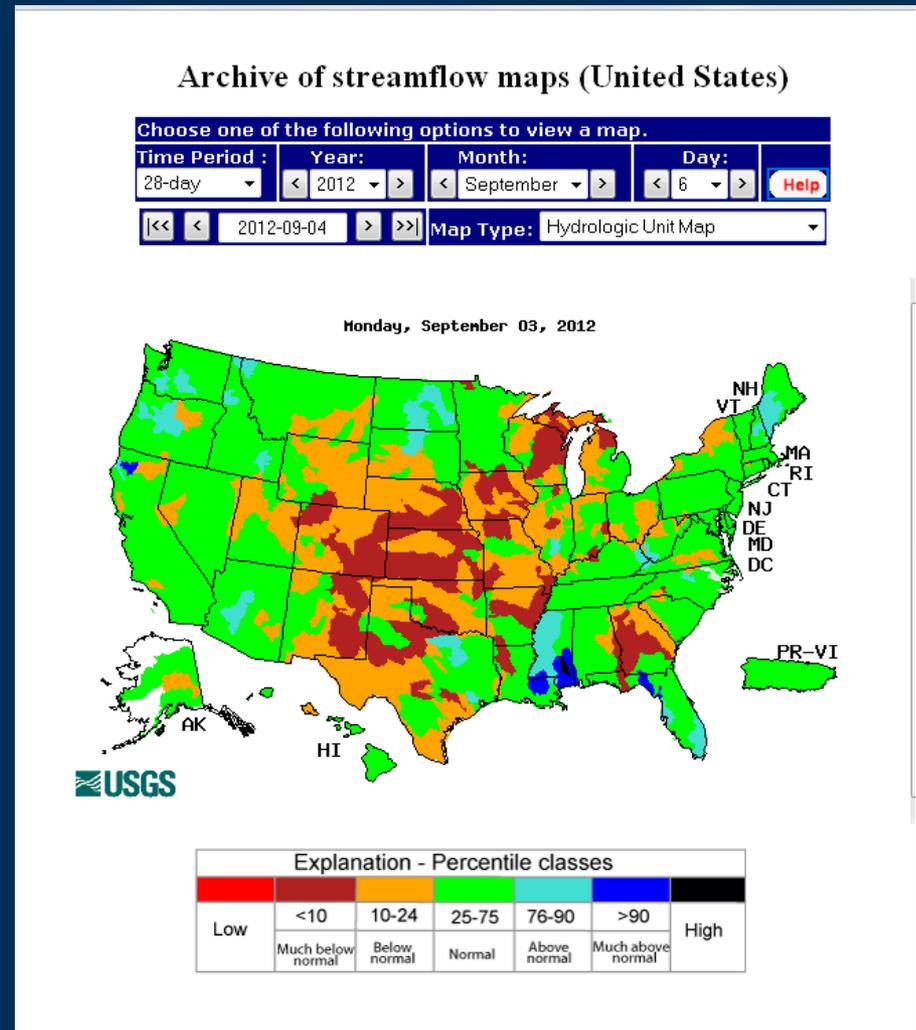
Each map includes the USGS logo and state abbreviations. The maps are arranged in a 2x2 grid.

Web Tools: Water Watch

Historical archive by hydrologic unit map

Other data available

- Streamflow measurements
- Shift information
- Discharge



Web Tools: Water Watch

Duration hydrograph builder

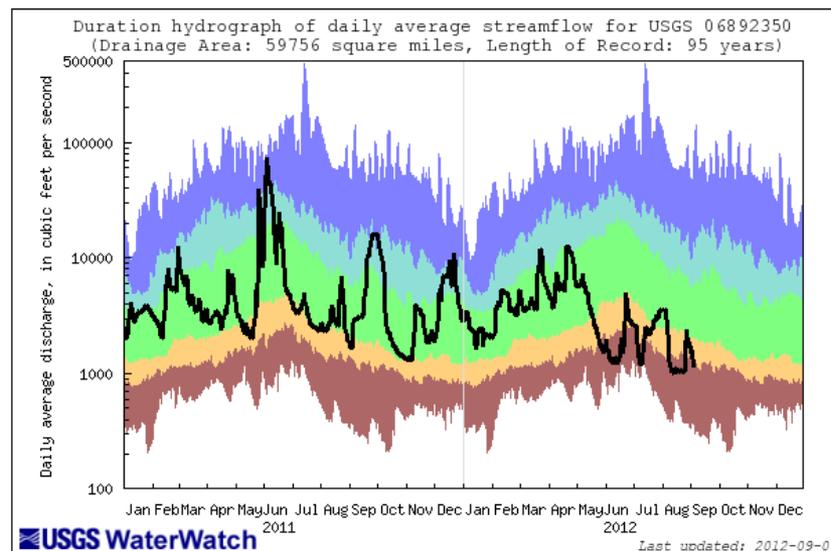
Other data available

- Daily
- 7 day
- 14 day
- 28 day

USGS Streamflow Duration Hydrograph Builder

Site Number: 06892350 Year: 2012 Flow type: Daily streamflow GO

For some streams, flow statistics may have been computed from mixed regulated and unregulated flows; this can lead to inaccurate depictions of flow conditions.



Explanation - Percentile classes				
lowest-10th percentile	10-24	25-75	76-90	90th percentile-highest
Much below normal	Below normal	Normal	Above normal	Much above normal
				Flow

Web Tools: Water Watch

Rank floods by period of record

Available for all sites

- Puts existing floods into context

Retrieve Summary of Recent Flood and High Flow Conditions
 (Warning: These Data are Provisional and Subject to Revision.)
 (Note: Begin Date cannot precede 2006-10-01)

Geographic area Indiana	Water Res. Region	SW: <input type="text"/>	Box Chooser	Refresh GO
		NE: <input type="text"/>		
Begin Date 2008-01-01	End Date 2008-04-01	Output Table	<input checked="" type="checkbox"/> Flooding sites only	Sort by: USGS station number Sort order: <input type="radio"/> ascend <input checked="" type="radio"/> descend

Summary of Recent Flood and High Flow Conditions
 (2008-01-01 - 2008-04-01)

["-", no data; "<", less than all historical peaks]

USGS station number	USGS station name	Drain. area [mi ²]	NWS flood stage [ft]	No. of days above flood stage	NWS flood class	Highest peak from 2008-01-01 to 2008-04-01				Historical Peaks	
						Date	Stage [ft]	Stream flow [ft ³ /s]	Rank	No. of years	Max. (year) [ft ³ /s]
03275000	WHITEWATER RIVER NEAR ALPINE, IN	522.00	17	7	▲	2008-02-07	18.17	16000	30	83	37100 (1937)
03302800	BLUE RIVER AT FREDERICKSBURG, IN	283	20	3	▲	2008-03-19	27.37	41700	1	43	41700 (2008)
03303280	OHIO RIVER AT CANNELTON DAM AT CANNELTON, IN	97000.0	42	6	▲	2008-03-21	45.23	--	--	--	--
03304300	OHIO RIVER AT NEWBURGH LOCK AND DAM, IN	100000.0	38	39	▲	2008-03-23	46.49	--	--	--	--
03322000	OHIO RIVER AT EVANSVILLE, IN	--	42	7	▲	2008-03-23	43.65	--	--	--	--
03322900	WABASH RIVER AT LINN GROVE, IN	453.00	11	12	▲	2008-02-07	13.52	9890	2	48	14500 (2003)
03322985	WABASH RIVER NEAR BLUFFTON, IN	508	12	12	▲	2008-02-07	16.43	10500	3	10	15300 (2003)
03324000	LITTLE RIVER NEAR HUNTINGTON, IN	263.00	15	3	▲	2008-02-07	18.91	5180	5	68	5990 (1950)
03324300	SALAMONIE RIVER NEAR WARREN, IN	425	12	4	▲	2008-02-06	14.86	10300	10	54	13500 (1998)
03325000	WABASH RIVER AT WABASH, IN	1768.00	14	2	▲	2008-02-06	16.37	14400	50	89	90000 (1913)
03325500	MISSISSINAWA RIVER NEAR RIDGEVILLE, IN	133.00	11	11	▲	2008-01-09	14.7	4560	23	65	13900 (1958)
03326500	MISSISSINAWA RIVER AT MARION, IN	682.00	12	3	▲	2008-02-07	13.8	16800	18	89	25000 (1927)
03328000	EEL RIVER AT NORTH MANCHESTER, IN	417.00	9	14	▲	2008-02-06	14.09	8230	4	90	8740 (1990)
03328500	EEL RIVER NEAR LOGANSPORT, IN	789.00	9	9	▲	2008-02-07	11.31	13500	6	69	17700 (1985)
03329700	DEER CREEK NEAR DELPHI, IN	274	11	1	▲	2008-02-06	11.41	7180	15	69	18700 (2003)
03330241	TIPPECANOE RIVER AT NORTH WEBSTER, IN	49.30	6	9	▲	2008-02-10	6.19	317	7	26	446 (2001)
03330500	TIPPECANOE RIVER AT OSWEGO, IN	113.00	7.5	23	▲	2008-02-10	8.54	661	8	63	1050 (1943)

Web Tools: Water Alert

Get notified when stream levels rise

Available for all sites

- Texts or email
- Daily updates or real-time
- No limit on # of alerts

• Available for:

- Surface water
- Groundwater
- Precipitation

The screenshot shows the USGS WaterAlert website. At the top, there is a banner image of a river with a dam. Below the banner is the USGS logo and the text "USGS WaterAlert". The navigation menu includes "Home", "Help", "Contact", and "USGS Water home". A search bar is present with the text "Search USGS Water Sites:" and a "Go" button. The main content area is divided into several sections: "WATER DATA FOR THE NATION" with a link to the National Water Information System (NWIS); "Data Discovery" with a link to explore data options; "Today's Water Conditions" with a link to view maps; "WATER SCIENCE SPECIALTIES" with a list of specialties including Surface Water, Groundwater, Water Quality, Water Use, and Research; and "WATER SCIENCE BY STATE" with a dropdown menu to select a state. On the right side, there is a "SITE SELECTION" section with a "State or Territory" dropdown menu and a "Data Type" section with radio buttons for Surface Water, Groundwater, Water Quality, and Precipitation. Below the site selection is a map of the United States with a grid overlay. The bottom of the page features "Related Services" including "USGS StreamMail" with a brief description.

Web Tools: Flood Inundation Mapping

How will the flooding affect me?

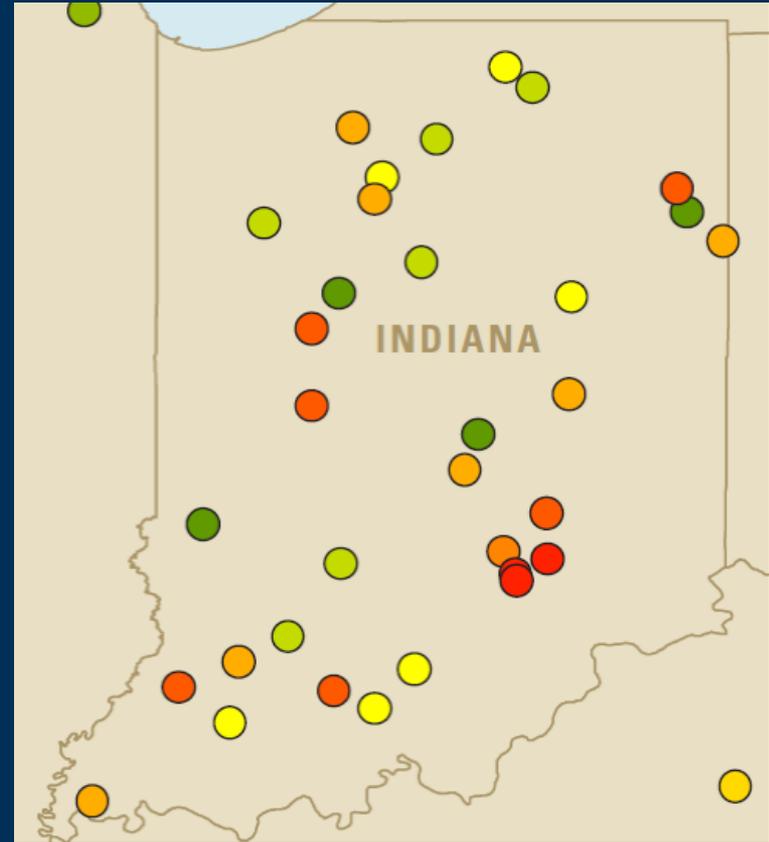
Collaboration with
Indiana Silver Jackets:
Hazard Mitigation Task
Force



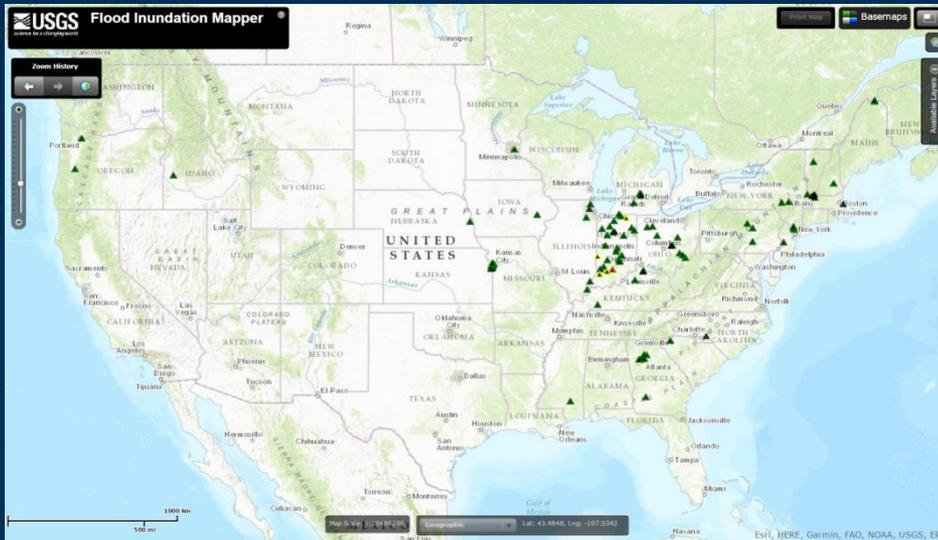
Web Tools: Flood Inundation Mapping

Where are these maps available?

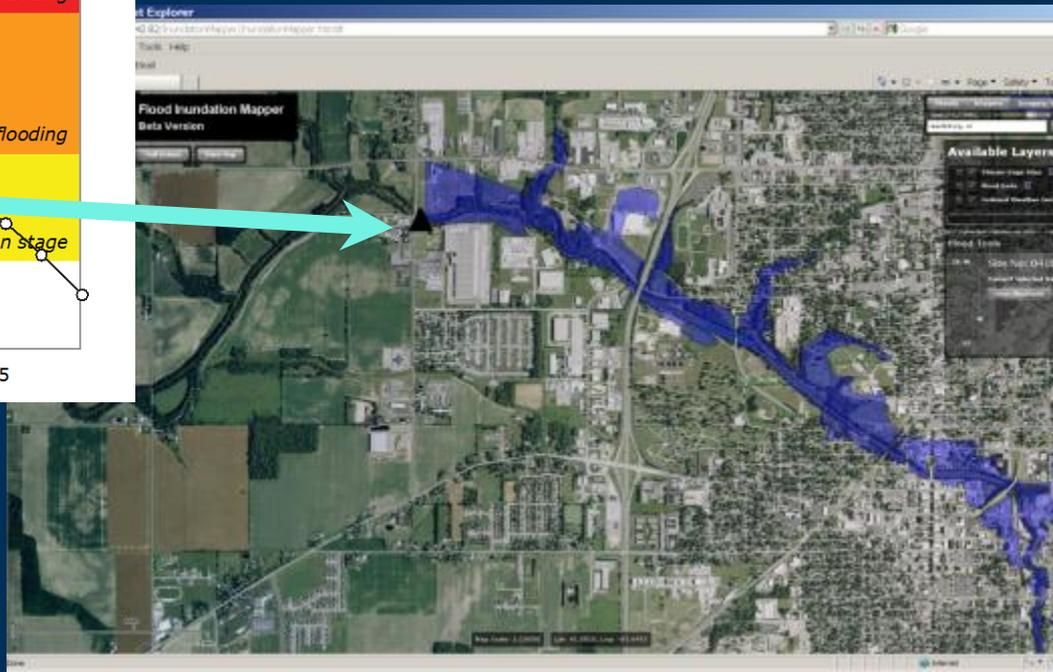
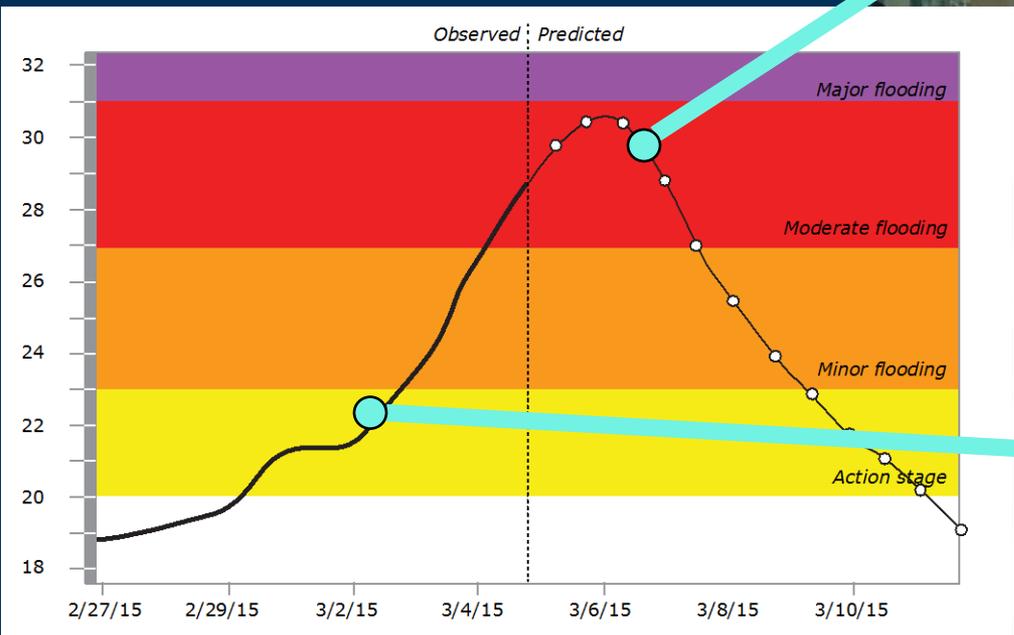
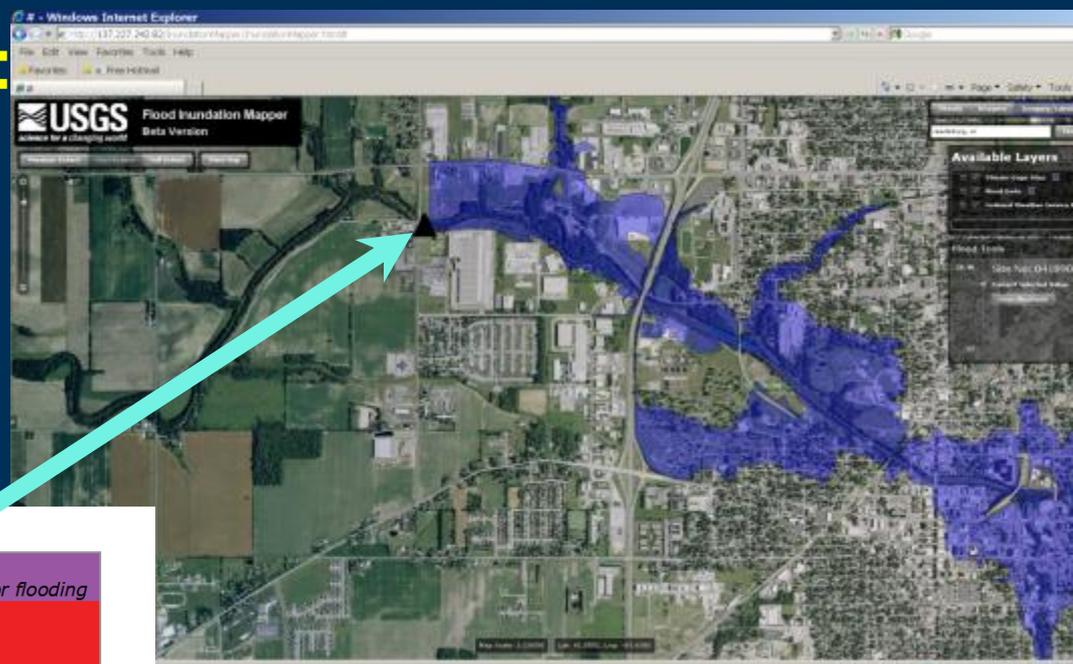
- In collaboration with:
 - IN office of Community and Rural Affairs (OCRA)
 - INDOT
 - Fort Wayne



**37 FIM libraries
online**



Flood Inundation Maps: translate a hydrograph into operational maps that communicate risk and consequences



For more information check out our webpages

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



Indiana Water Science Center
home projects publications drought flood Internal



Kentucky Water Science Center

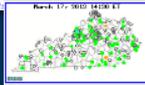
Kentucky Water Resources Program

Search the Index
Hydrologic Data Studies Sediment Lab Publications Science Center Information Links

DATA CENTER

- Real-time data
 - Streamflow
 - Ground water
 - Water quality
 - Precipitator
 - Lake/Reser.
- Historical data
 - Streamflow
 - Ground water
 - Water quality
 - Lake/Reser.
 - Annual Data
 - Instantaneous Archive (IDA)
- WaterWatchC
 - Floods | Drog
 - Current con
- Ground-water
 - Climate Res
- Water Alert
 - Get High/W

Current Water Conditions

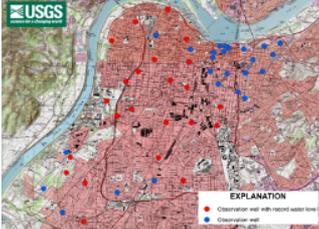


- WaterWatch
- Flood-Prone Area Assessments
- Drought Assessments
- Excess Rain Assessments
- Groundwater Watch

National Water Conditions

Science Highlights

Record Groundwater Levels in the Louisville Area



(Click image above for larger map) (PDF file - 134KB)

Record high groundwater levels have been measured recently for portions of the alluvial aquifer beneath Louisville, Kentucky. In March 2012, a team of scientists from the Kentucky Water Science Center of the U.S. Geological Survey (USGS) measured the depth to water in 48 groundwater observation wells to ascertain the current elevation of the water table in the alluvial deposits beneath Louisville. New high water levels were recorded for 23 of the 48 wells.

Recent above average annual precipitation amounts for the Louisville metro area have contributed to these record groundwater levels. But while some areas of the aquifer are at record levels, the water table in the downtown area remains near average elevation due in part to the pumping of ground water for the heating and cooling of some buildings. Should groundwater levels continue to rise or pumping in the downtown area decreases, inundation of man-made structures can cause significant structural settlement problems, damage to foundations and basements, and disruption of utility services such as gas, electric, water, sewer, and communications.

Water-level data have been collected in the alluvial aquifer at Louisville by the USGS since 1943. Interpretations of these data are published periodically to update the record and help manage this groundwater resource.

Featured Local Project

[Click River Alluvial Aquifer - Groundwater History](#)

Water-level data for the alluvial aquifer at Louisville, Kentucky, have been collected by the USGS in cooperation with various local and State Agencies since September 1943. Data are presently being collected in cooperation with the [Louisville Water Company](#). Special attention is given to the northeast portion of the alluvial aquifer where the [Louisville Water Company](#) is beginning to use riverbank filtration wells (refer to the photograph to the right) to draw water from the Ohio River through the aquifer at their B.E. Payne Water Treatment Plant near Prospect, Kentucky.



To monitor the groundwater levels, twenty-eight existing wells were incorporated into an observation well network. This network is measured quarterly. Twelve of the observation wells are equipped with continuously recording pressure transducers that measure water levels and water temperature. Hydrographs from the continuous recorder wells depict the trends in the groundwater levels.

A Louisville Water Company Riverbank Filtration Well.

Collaborative Projects

[Water Availability Tool for Environmental Resources](#)



The Water Availability Tool for Environmental Resources (WATER) was developed in cooperation with the [Louisville Water Company](#) to provide a consistent and defensible method of estimating streamflow, water availability, and other hydrologic information in ungauged basins.

WATER automatically incorporates and processes large amounts of basic and custom geospatial data to quantitatively describe topography, soil-water storage, climate, streamflow, and other parameters. WATER is also designed so that it can be expanded for other science and regulatory applications including, but not limited to, sediment and nutrient loads, evaluation of surface mining effects (Cumulative Hydrologic Impact Assessments), as well as flows that are necessary for ecological viability.

The concept of the Kentucky WATER application was born from the need to quantify water availability in areas of the Kentucky Commonwealth with limited long-term monitoring data. Kentucky's wealth of geospatial data was critical to the Kentucky WATER application and enabled USGS scientists to take hydrologic streamflow generation and

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