



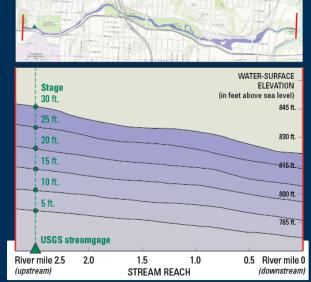


# U.S. Geological Survey Streamflow- and Precipitation-based Flood Warning and Mapping With Integrated USGS tools

#### USGS Central Midwest Water Science Center

Illinois Association for Floodplain and Stormwater Management Annual 2020 Conference

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



# USGS WaterWatch

**Annual Summaries** 

About WaterWatch

Data Services

#### https://waterwatch.usgs.gov/

Streamgage-based maps, graphs, and tables describing realtime, recent, and past streamflow conditions for the United States

#### WaterWatch

#### Home

Special Features

Current Streamflow

Flood

Drought

Past Flow/Runoff

Animation

Toolkit

Toolkit (internal)

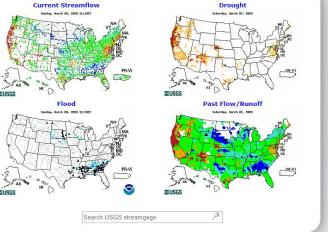
**Annual Summaries** 

**Data Services** 

Additional Information

About WaterWatch





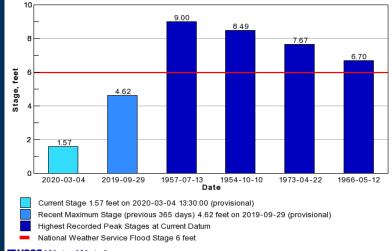
# Midlothian Creek at Oak Forest, IL

#### WaterWatch : Flood Tracker

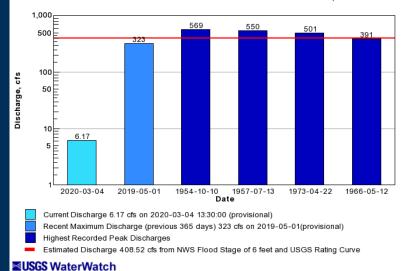


#### **≥USGS**

USGS 05536340 MIDLOTHIAN CREEK AT OAK FOREST, IL



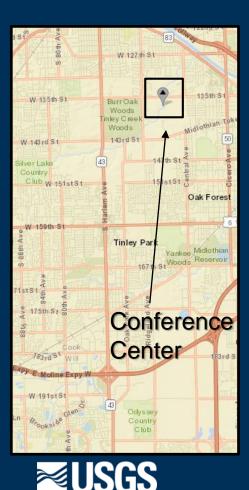
#### USGS WaterWatch

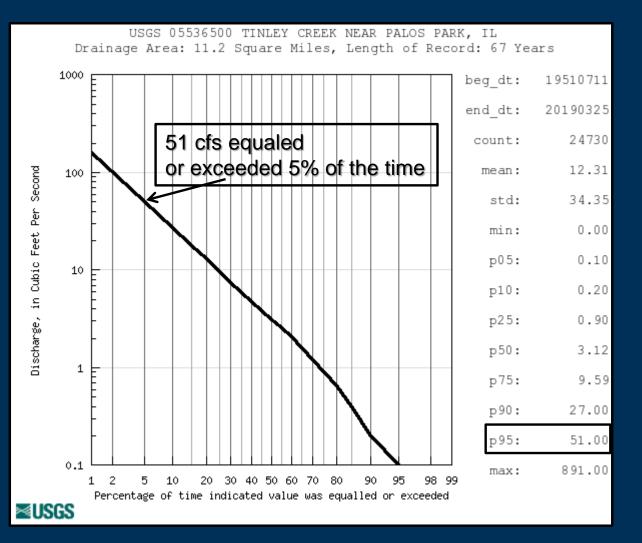


#### USGS 05536340 MIDLOTHIAN CREEK AT OAK FOREST, IL

# **Tinley Creek near Palos Park, IL**

Waterwatch : Streamgage Stats
Daily Flow Equal or Exceeded Percentages





# Waternow http://water.usgs.gov/waternow

Text or email station number to <u>WaterNow@usgs.gov</u> to receive current conditions

USGS Current Water Conditions D Inbox x

USGS WaterNow

to me 🔻

Blue River at Blue Ridge Blvd Ext in KC, MO 04/01/2019 15:00 CDT Gage height, feet = 25.83 Discharge, cubic feet per second = 136 See: <u>https://waterdata.usgs.gov/nwis/uv/?site\_no=06893150</u>

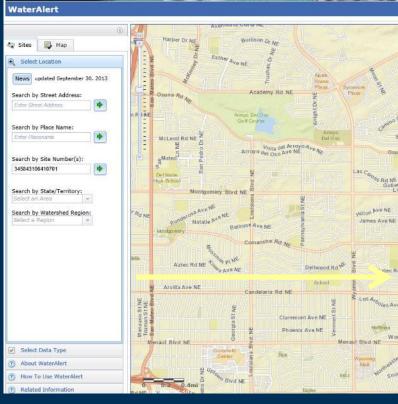


Text Me



# Wateralert http://water.usgs.gov/wateralert

### Sign up to receive alert messages by text or email



#### Subscription Form

The U.S. Geological Survey WaterAlert service sends e-mail or text (SMS) messages when <u>certain parameters</u>, as measured by a USGS real-time data-collection station, exceed user-definable thresholds. The development and maintenance of the WaterAlert system is supported by the USGS and its partners, including numerous federal, state, and local agencies.

Real-time data from USGS gages are transmitted via satellite or other telemetry to USGS offices at various intervals; in most cases, 1 to 4 times per hour. Emergency transmissions, such as during floods, may be more frequent. *Notifications will be based on the data received at these site-dependent intervals*.

	Site Info:	
	Number:	350726106314230
	Name:	MITCHELL ELEMENTARY
0	Agency:	USGS
		fG3gv
	Send Notification To:	about this
au r	⊖My mobile phone	
	⊖ My email address	
e er al	Notification Frequency:	about this
	Hourly	0
2	Daily	•
9	Precipitation Parameter(s):	about this
2	1 hour	$\odot$
	2 hours	0
Re	4 hours	0
1	5 hours	0
ve	12 hours	0
	24 hours	0
00	Alert Threshold Condition:	about this
	Oreater than (>)	
(ef	🔿 Less than (<)	Deal viscously, increasing the second second
00	○ Outside a range (< or >)	Real-time value isgreater than: undefined
1	○ Inside a range (> and <)	

□ I have read and acknowledge the <u>Provisional Data Statement</u> and <u>Disclaimer</u>.

#### **Preempted Decision Support** Consequence-based flood scenarios

# Step 1



Calibration &

Prediction

Stage Streamflow Precipitation

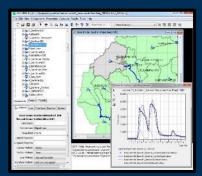
#### Precipitation

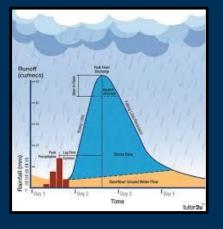


## Step 2

HEC-HMS / PRMS

Rainfall-Runoff





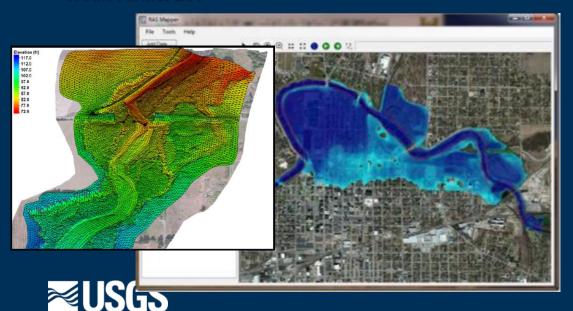


# **Preempted** Decision Support

Consequence-based flood scenarios

#### Step 3 HEC-RAS / SRH2D Mapper

 Hydraulics and Inundation



# Step 4

# Consequence-based product dissemination

- Scenarios defined
- Gage / Radar observed conditions correlated to flood inundation mapping



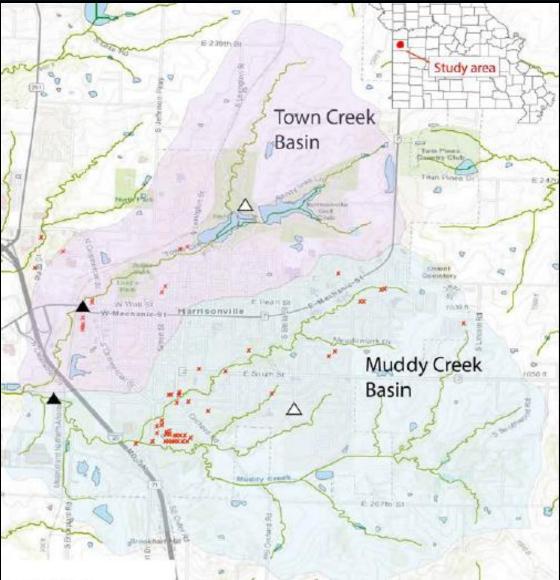
Flood Inundation Mapper

# City of Harrisonville, Missouri Proposed

#### Explanation

**≥USGS** 

- X Location of property damage from 2017 flooding
- Potential location of USGS streamgage
   Potential location of USGS rain gage



# Muddy Creek Data Collection City of Harrisonville, Missouri

- Drainage Area~ 5 sq. mil
- Partial-record gage
- Precipitation gage

Partial Record Gage Location





# Flood Warning Support Systems Precipitation-based gaging/mapping

Duration (hr.)		Incremental Magnitude (in)										
1	1.5	2.0	2.5	3.0	3.5							
2	2.0	2.5	3.0	3.5	4.0	4.5						
4	2.0	2.5	3.0	3.5	4.0	4.5	5.0					
6	2.5	3.0	3.5	4.0	4.5	5.0	5.5	6.0				

## **USGS** Water Alert !

#### Subscription Form

The U.S. Geological Survey WaterAlert service sends e-mail or text (SMS) messages when <u>certain parameters</u>, as measured by a USGS real-time data-collection station, exceed user-definable thresholds. The development and maintenance of the WaterAlert system is supported by the USGS and its partners, including numerous federal, state, and local agencies.

Real-time data from USGS gages are transmitted via satellite or other telemetry to USGS offices at various intervals; in most cases, 1 to 4 times per hour. Emergency transmissions, such as during floods, may be more frequent. *Notifications will be based on the data received at these site-dependent intervals*.

Site Info:							
Number:		350726106314230					
Name:		MITCHELL ELEMENTARY					
Agency:		USGS					
Transactio		fG3gv					
Send Not	ification To:	about this					
⊖ My mo	bile phone						
⊖ My em	ail address						
Notificati	on Frequency:	about this					
Hourly		0					
Daily		۲					
Precipita	tion Parameter(s):	about this					
1 hour		۲					
2 hours		0					
4 hours		0					
6 hours		0					
12 hours		0					
24 hours		0					
Alert Threshold Condition:		about this					
Greate	r than (>)						
🔾 Less th	nan (<)						
Outside	e a range (< or >)	Real-time value isgreater than: undefined					
◯Inside	○ Inside a range (> and <)						



**≥USGS** 

□ I have read and acknowledge the <u>Provisional Data Statement</u> and <u>Disclaimer</u>.

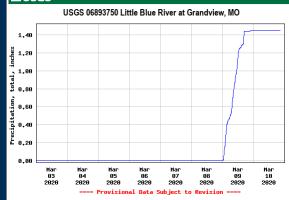
# Flood Warning Support Systems Precipitation-based gaging/mapping

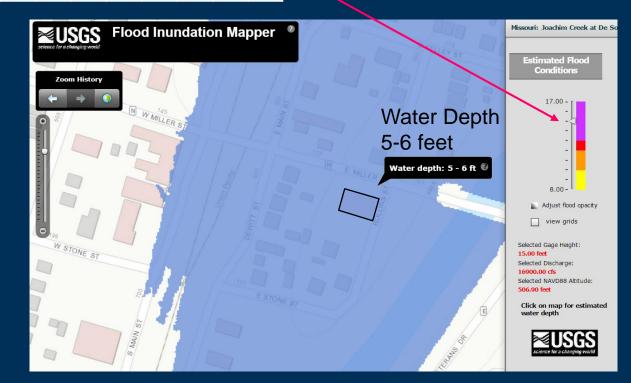


Recent Installation for – Flood Warning at the <u>City of Grandview</u>



Duration hr.)			Incr	emer	ntal M	agnit	ude (	in)	
1	1.5	2.0	2.5	3.0	3.5				
2	2.0	2.5	3.0	3.5	4.0	4.5			
4	2.0	2.5	3.0	3.5	4.0	4.5	5.0		
6	2.5	3.0	3.5	4.0	4.5	5.0	5.5	6.0	

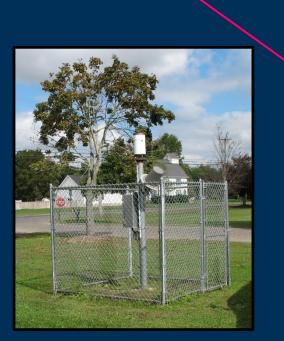




# Flood Warning Support Systems Precipitation-based gaging/mapping

Duration (hr.)		Incremental Magnitude (i								
1	1.5	2.0	2.5	3.0	3.5					
2	2.0	2.5	3.0	3.5	4.0	4.5				
4	2.0	2.5	3.0	3.5	4.0	4.5	5.0			
6	2.5	3.0	3.5	4.0	4.5	5.0	5.5	6.0		





	Precipitation Parameter(s):	about this				
	1 hour	۲	$\mathbf{A}$			
	2 hours	0	$\mathbf{A}$			
	4 hours	0				
	6 hours	•				
	12 hours	0	$\mathbf{A}$			
	24 hours	0				
	Alert Threshold Condition:	about this				
	Greater than (>)					
	O Less than (<)					
	○ Outside a range (< or >)	Real-time value isgreater than: 6.0				
	○ Inside a range (> and <)					

### USGS Water Alert !

# Flash Flooding – First Line of Defense National Weather Service - Notifications

Notifications – "What do they mean?"



- 1. Flood Watch: Preparation, issued when conditions are favorable for a hazardous weather event to occur. Flooding possible.
- 2. Flood Advisory: Weather event that is forecast to occur may become a nuisance. Issued when flooding is not expected to be bad enough to issue a warning. However, it may cause significant inconvenience, and if caution is not exercised, it could lead to situations that may threaten life and/or property



Flash Flooding – Second Line of Defense USGS / National Weather Service - Notifications

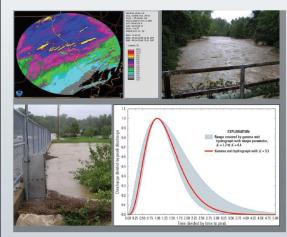
Notifications – Implementation and Definition

 Flood Warning: USGS Precipitation-Based Mapping/Warning System.
 Rain to Peak Estimate ~ 2+ hours

**≊USGS** 

Prepared in cooperation with the Metropolitan Sewer District of St. Louis

An Initial Abstraction and Constant Loss Model, and Methods for Estimating Unit Hydrographs, Peak Streamflows, and Flood Volumes for Urban Basins in Missouri



Scientific Investigations Report 2014–5193

associated 5-minute time interval, the basin-depth peak streamflow  $(q_p)$ , and the basin shape parameter (K) for 39 s urban areas in and adjacent to Missouri.—Continued

Table 3. Listing and symmary statistics of the basin-specific and regressed values of the unit hydrograph time to

[no., number; in/hr, basin inches per hour; dim., dimensionless; cell shading is to help identify different urban areas and roughly corresp colors in figs. 11, 12]

		Basin-specific (	(mean) valu		Regressed values		
	T <sub>p</sub> (hours)	5-minute time interval	q <sub>p</sub> (in/hr)	Computed K <sup>a</sup> (dim.)	T <sub>p</sub> (hours)	5-minute time interval	$q_p$ (in/h
Minimum	0.333	4.00	0.137	1.67	0.417	5.00	0.13
First quartile	0.875	10.50	0.297	2.76	0.875	10.50	0.32
Mean	1.810	21.72	0.614	3.52	1.793	21.51	0.58
Median	1.500	18.00	0.469	3.18	1.417	17.00	0.40
Third quartile	2.583	31.00	0.841	3.93	2.250	27.00	0.78
Maximum	5.000	60.00	2.116	7.00	5.333	64.00	1.9

<sup>a</sup>Shape parameter K is computed from  $T_p$  and  $q_p$  using equation 4 with V = 1, using a numerical root solver (appendix 1).

Flash Flooding – Second Line of Defense USGS / National Weather Service - Notifications Notifications – Implementation and Definition



4. Flood Warning: Flash flooding is imminent or occurring.
 \*Less than 1 hour

5. CodeRed Weather Alert: Advanced warning of sever weather as a bulletin is issued by the National Weather Service.

- Two-Way Messaging
- Social Media Capabilities
- S Code RED
- Real-Time Reporting



https://www.weather.gov/safety/flood-watch-warning

# Flood Warning Support Systems

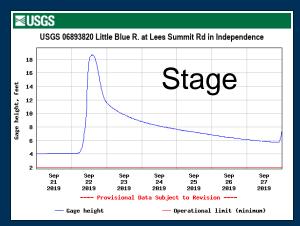
Streamflow-based validation

Also serves to monitor best management practices in terms of development







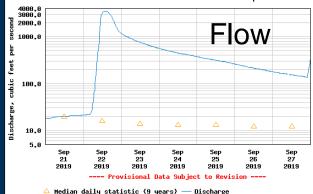






#### **≊USGS**

USGS 06893820 Little Blue R. at Lees Summit Rd in Independence



Flood Warning Support Systems Streamflow-based validation

Are there more economical alternatives in streamflow gaging for warning systems?

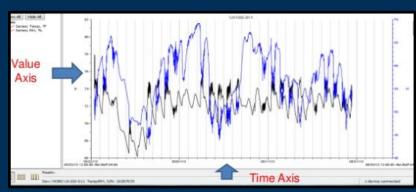
Consideration → Hybrid Crest Stage Gage



Submersible sensors



#### Graphical output example

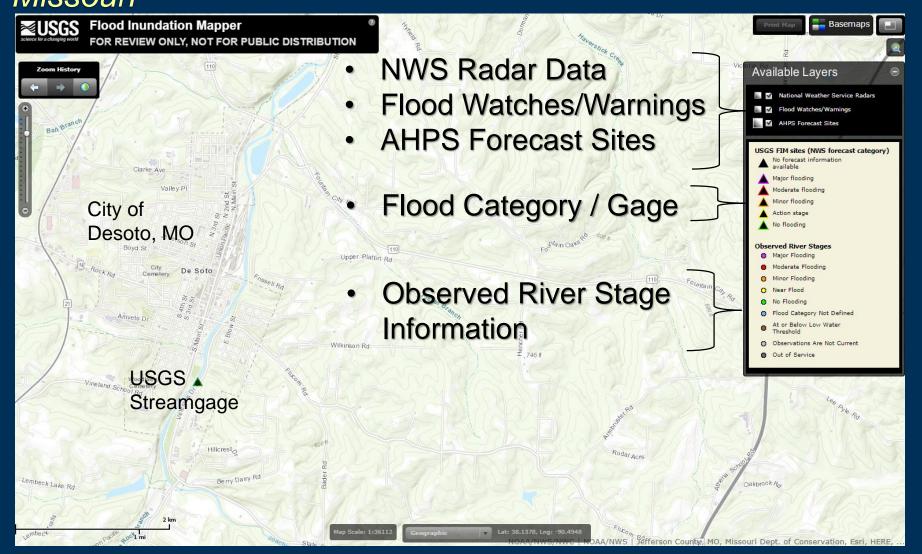






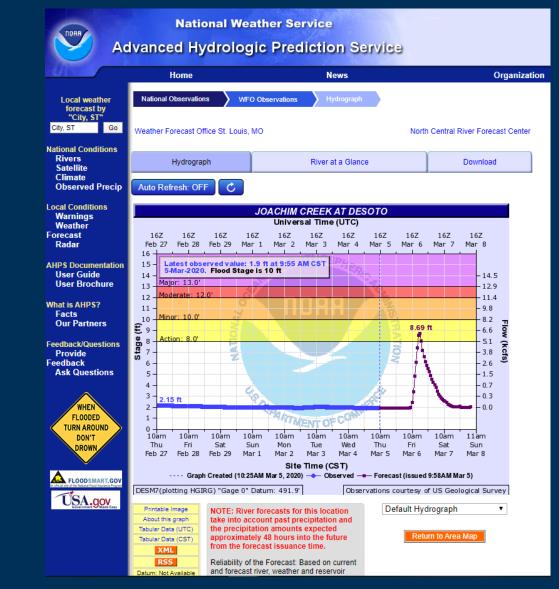
\*Would <u>not</u> be broadcast / telemetered \*Only high flow measurements made

#### **USGS Flood Inundation Mapping** Available Layers – Example: Joachim Creek at Desoto, Missouri

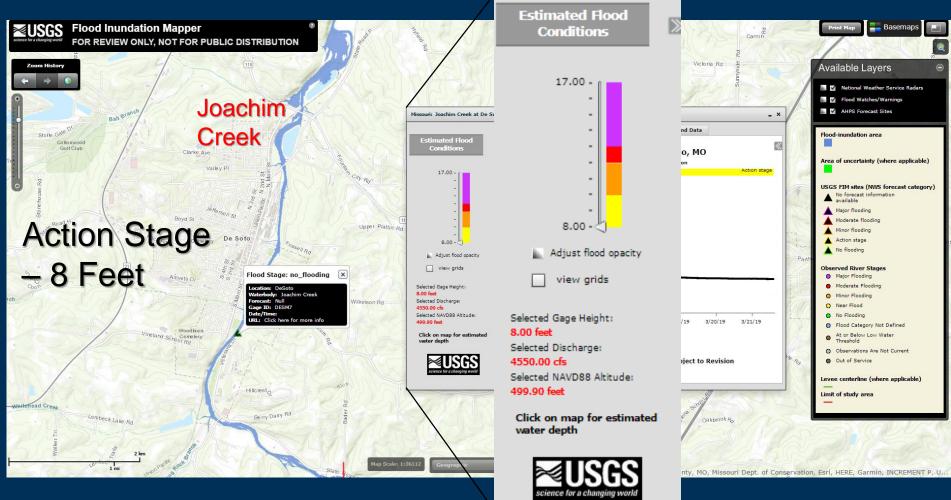


# USGS Flood Inundation Mapping Forecasting – Example: Joachim Creek at Desoto, Missouri



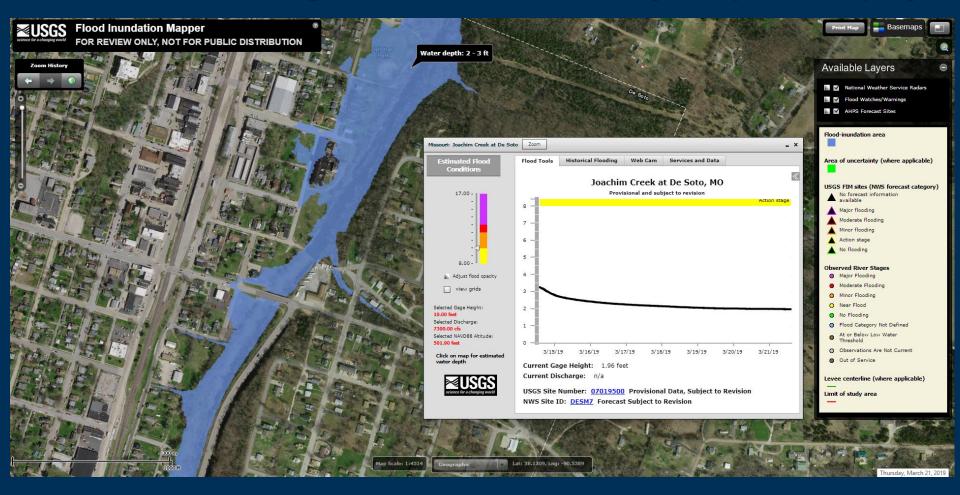


# USGS Flood Inundation Mapping Inundation Mapping Tied to Flood Categories – Action Stage



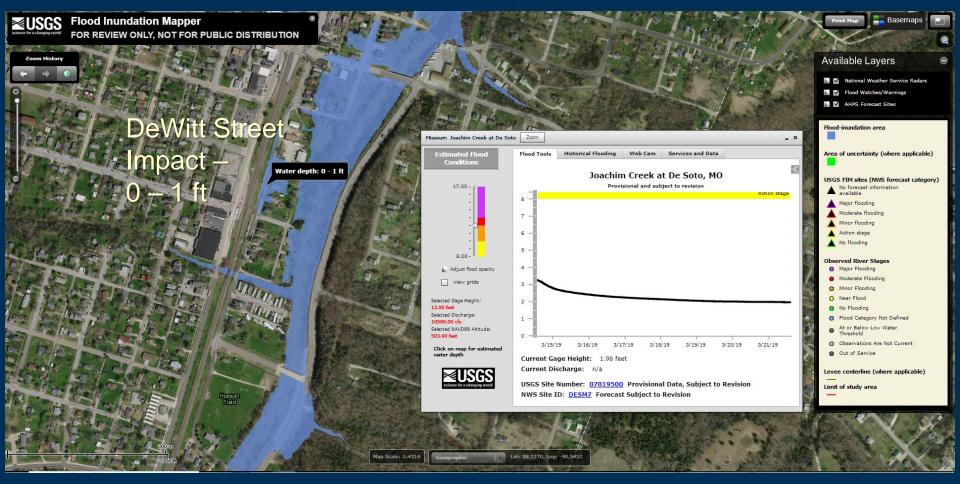


# **USGS Flood Inundation Mapping** *Minor or Flood Stage – 10 Feet – Base Layer Option Display*



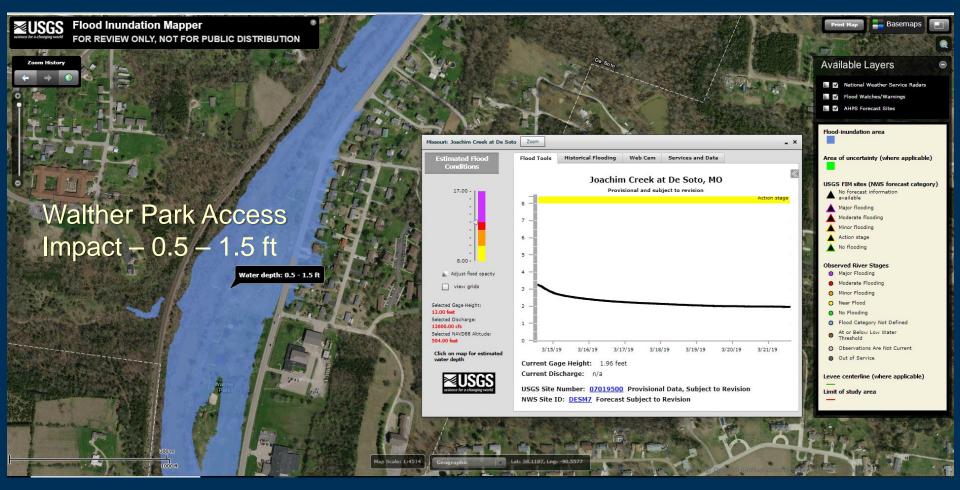
**≥USGS** 

# USGS Flood Inundation Mapping Moderate Stage – 12 Feet



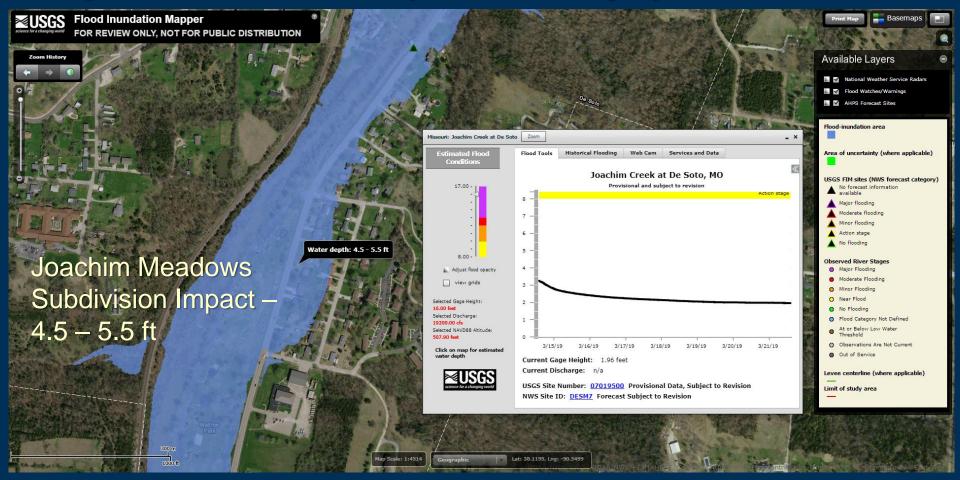


# USGS Flood Inundation Mapping Major Stage – 13 Feet





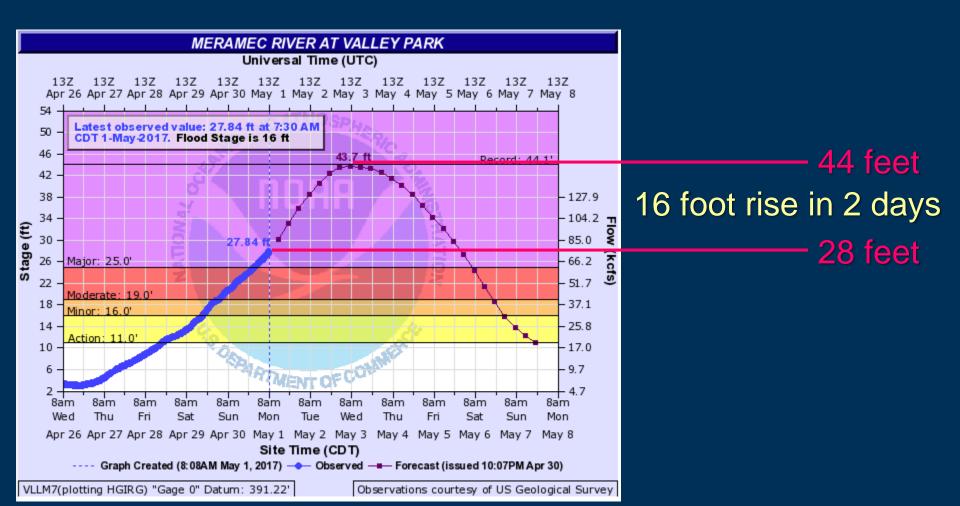
# **USGS Flood Inundation Mapping** Stage of 16 feet in the Major flood category





# **Meramec River Flooding**

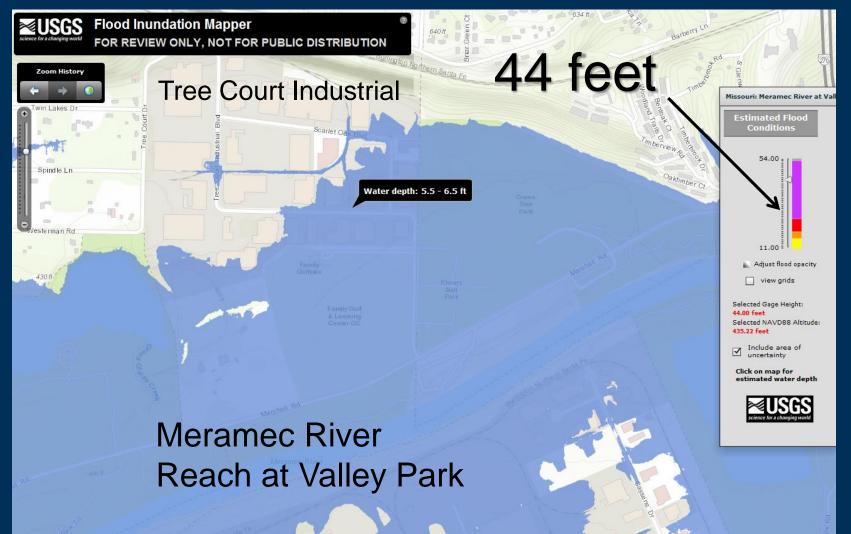
#### Flood Inundation Mapping Effort – Valley Park / Keyes Summit 2017 Flood In Practice



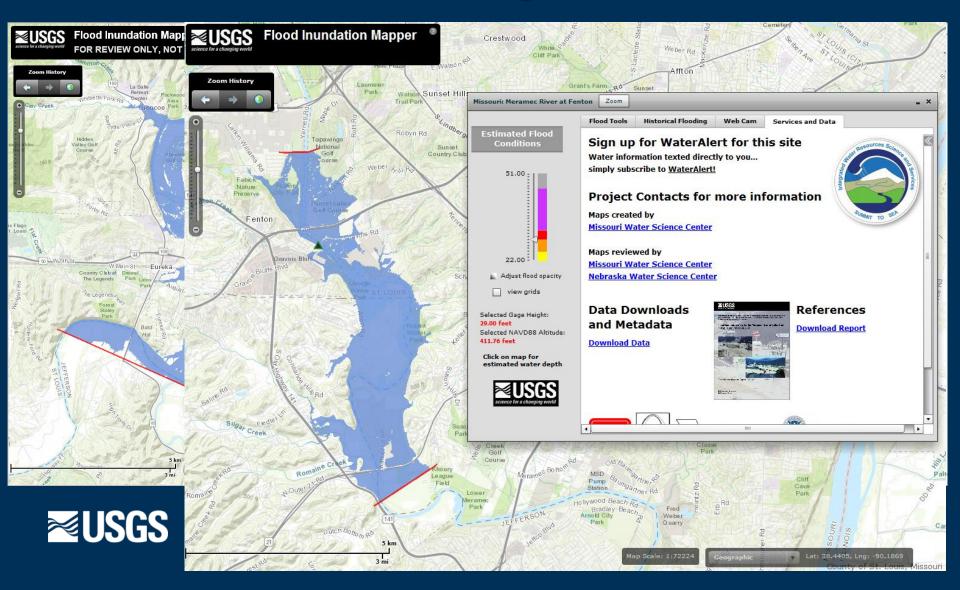
## Meramec River Flooding Flood Inundation Mapping Effort – Keyes Summit 2017 Flood In Practice



## Meramec River Flooding Flood Inundation Mapping Effort – Keyes Summit 2017 Flood In Practice



# **Flood Inundation Mapper** Meramec River Example Value Added – Historic Flooding and Documentation

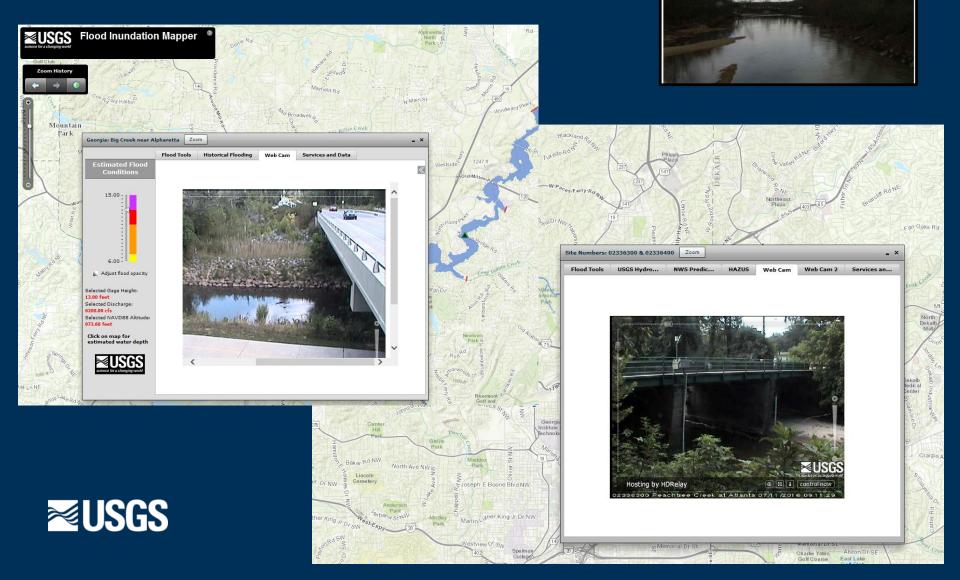


## Flood Inundation Mapper Value Added – Web Camera

#### Meramec River Example



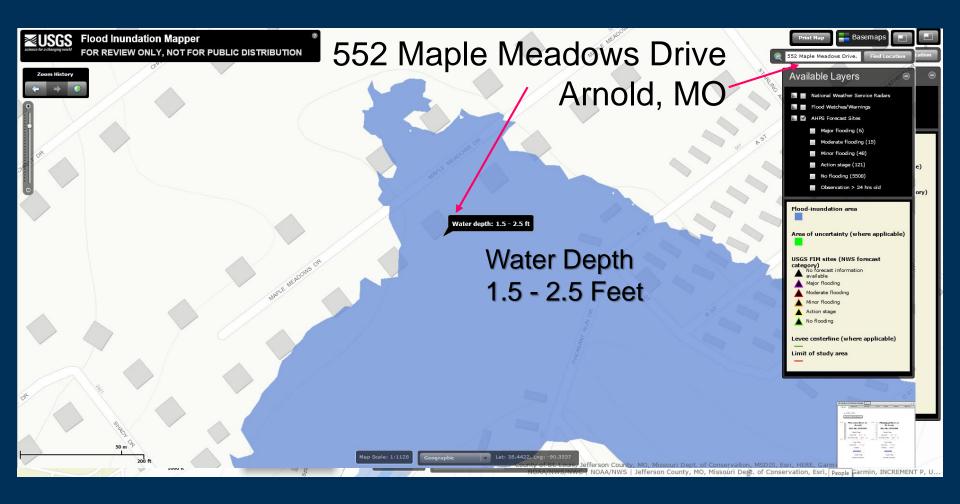
# Value Added Web Camera Examples



Ilinois River Floatcam

## Flood Inundation Mapper Value Added – Location Specific

#### Joachim Creek and Meramec River





# **USGS Water Alert**

#### The "where and why" for subscription

	WaterAlert		USGS Home Contact USGS Search USGS
WaterAlert		0	Help Info
<ul> <li>Sites Map</li> <li>Select Location</li> <li>News updated September 30, 2013</li> <li>Search by Street Address:</li> </ul>	Sites Map	City of Desoto, MO	
Enter Street Address	News updated September 30, 2013	Clarke Ave Valley Pl	
Search by Site Number(s): Enter Site Number(s) Search by State/Territory: Select an Area	Search by Street Address:	Foundar Clarks	PountainOnerad
Search by Watershed Region: Select a Region	Search by Place Name: Desoto, Missouri	Anvets D     Anvets D     Site Number: 07019500     Site Name: Joachim Creek at De Soto,     MO     Site Type: Stream	er Platun Rd
Select Data Type	Search by Site Number(s): Enter Site Number(s)	Agency: USGS Access Data	P P De Soto 110 P Partin
About WaterAlert     How To Use WaterAlert     Related Information	Search by State/Territory: Select an Area	Ake Ral	2 Micom Ag
	Search by Watershed Region:	https://mans.waterdata.usgs.gov/manper/u	vatoralort/

https://maps.waterdata.usgs.gov/mapper/wateralert/

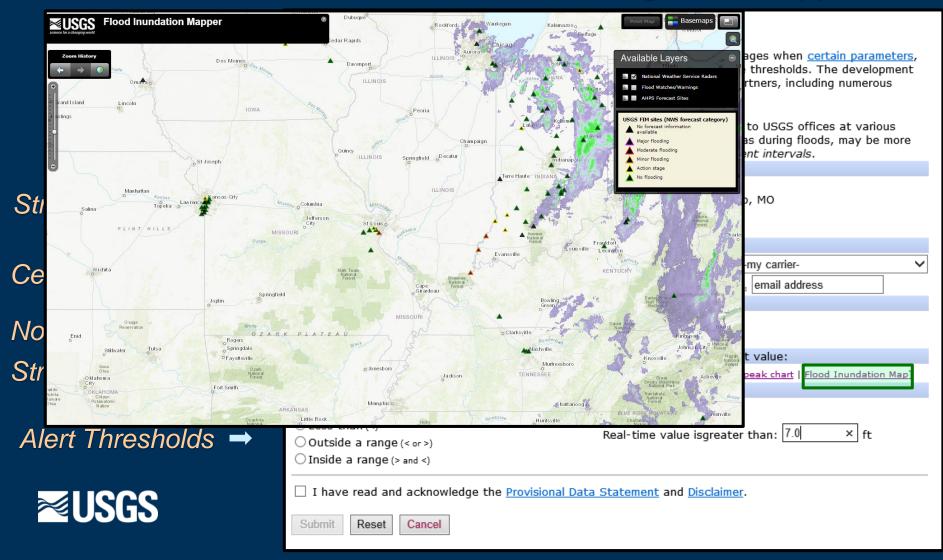
# **USGS Water Alert**

#### Joachim Creek at Desoto – Linked to Gage and Mapper

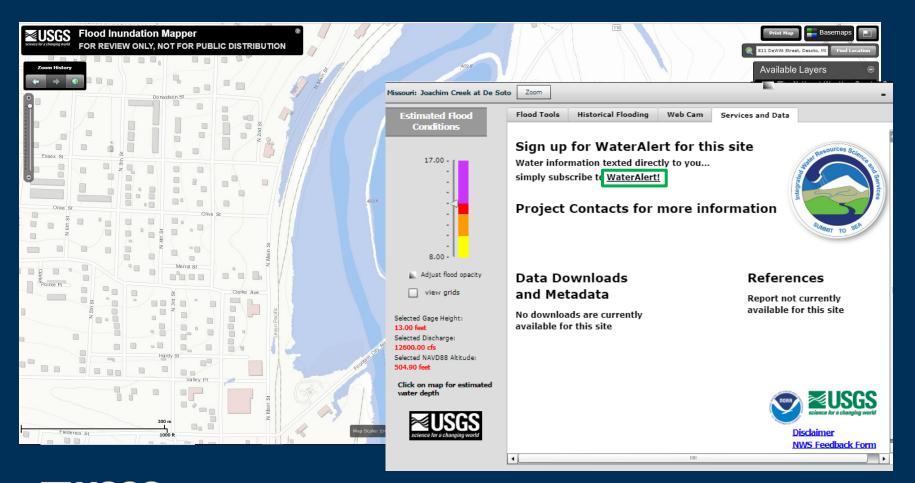
USGS 07019500 Joachim Creek at De Soto, MO 12 ervice sends e-mail or text (SMS) messages when certain parameters, collection station, exceed user-definable thresholds. The development 10 em is supported by the USGS and its partners, including numerous nsmitted via satellite or other telemetry to USGS offices at various Stage, feet r hour. Emergency transmissions, such as during floods, may be more the data received at these site-dependent intervals. 07019500 Joachim Creek at De Soto, MO USGS 1.85 2 b1MFP about this... 2020-03-10 Unavailable No Data Unavailable Unavailable Unavailable 10-digit phone number -my carrier-Date For a one-time confirmation only": email address Current Stage 1.85 feet on 2020-03-10 20:55:00 (provisional) Recent Maximum Stage Unavailable about this... Highest Recorded Peak Stages unavailable National Weather Service Flood Stage 10 feet  $\bigcirc$ **USGS** WaterWatch about this... Recent value: Stream Parameters Gage height, in ft  $\odot$ 1.96 [peak chart Flood Inundation Map] Alert Threshold Condition: about this... Oreater than (>) CLess than (<)</p> × ft Real-time value isgreater than: 7.0 Alert Thresholds Outside a range (< or >) Inside a range (> and <)</p> I have read and acknowledge the <u>Provisional Data Statement</u> and <u>Disclaimer</u>. Reset Cancel

# **USGS Water Alert**

#### Joachim Creek at Desoto – Linked to Gage and Mapper

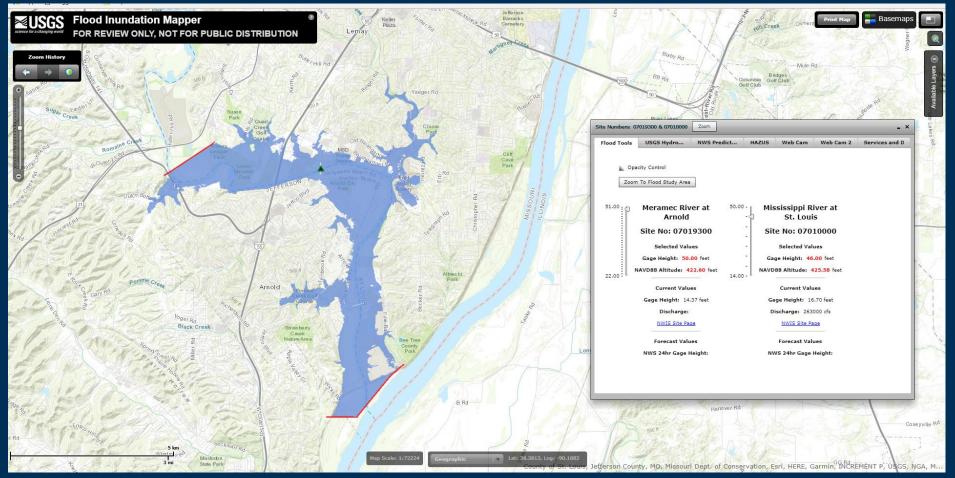


# USGS Water Alert / Flood Inundation Mapper – Services and Data



Source Alert Source Alert Source Alert Source Alert Source Alert

## **Flood Inundation Mapper** Meramec River Example Value Added – Multi-Layer Flood Tool

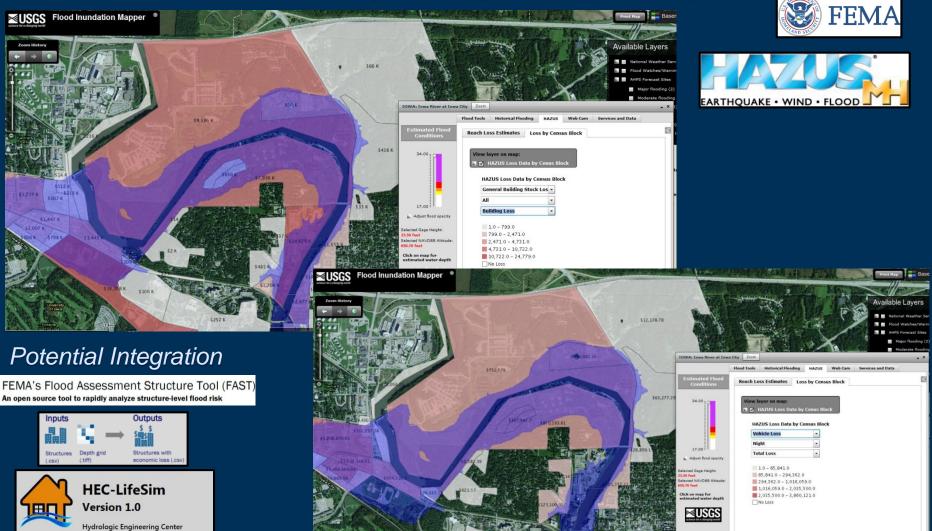




Application for Lower Meramec River and Mississippi River interaction

# **Flood Inundation Mapper**Lo **Value Added – HAZUS (**Building/Vehicle Loss)

#### Loss Estimation Application



U.S. Army Corps of Engineers 609 Second Street Davis, CA 95616 http://www.hec.usace.army.m

Institute for Water Resources

O cos\_not\_current • out\_of\_service

# **BENEFITS of Flood Inundation Mapping**

Local Agencies

≈USGS

- EMA director can focus warnings using automated technologies to get people/property out of harm's way
- Evacuation routes can be assessed quickly for flood access
- Police would know where to place barricades in advance of flood crest to block flooded roads and prevent accidents
- Officials would have answers quickly
- Public can be better educated to threat of floods



#### **National Flood Insurance Program** What is the value in USGS Flood Warning Gages and Mapping ?

# Community Rating System

*"Credit for measures that protect life and property during a flood, through flood warning and response programs."* 



#### 600 Series 610 – Flood Warning and Response

