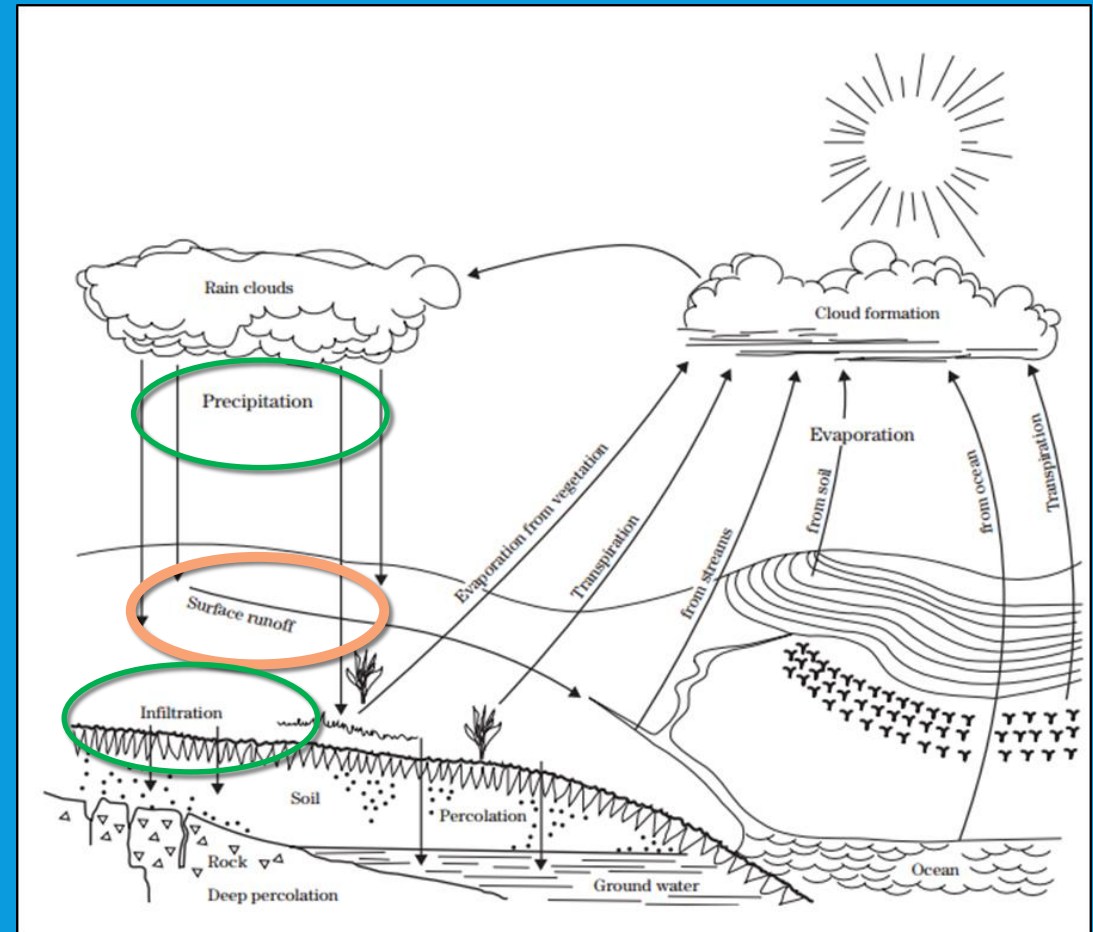


# NWS RIVER FORECAST SERVICES

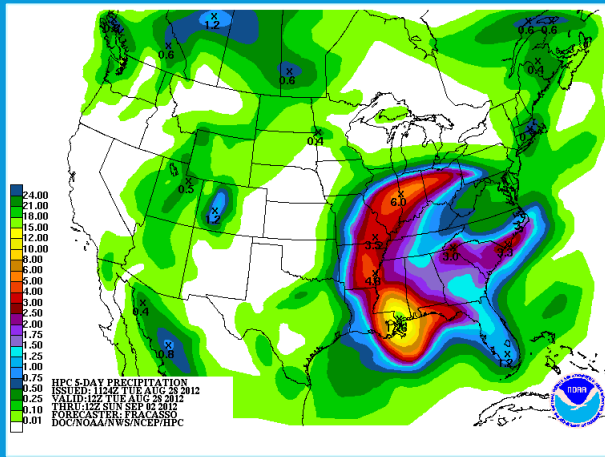
# MAKING RIVER FORECASTS

- Hydrologists focus on water at the earth's surface
- Hydrologists at the National Weather Service use computer models to help determine **runoff**, the amount of rain water which heads directly to streams.
- Based upon expected river levels and impacts, the NWS issues watches, warnings, or advisories.



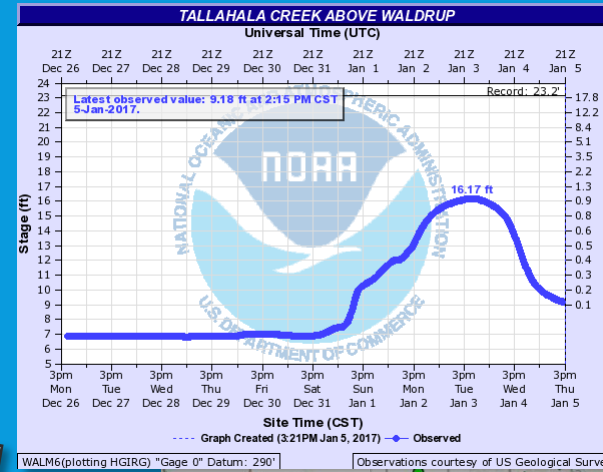
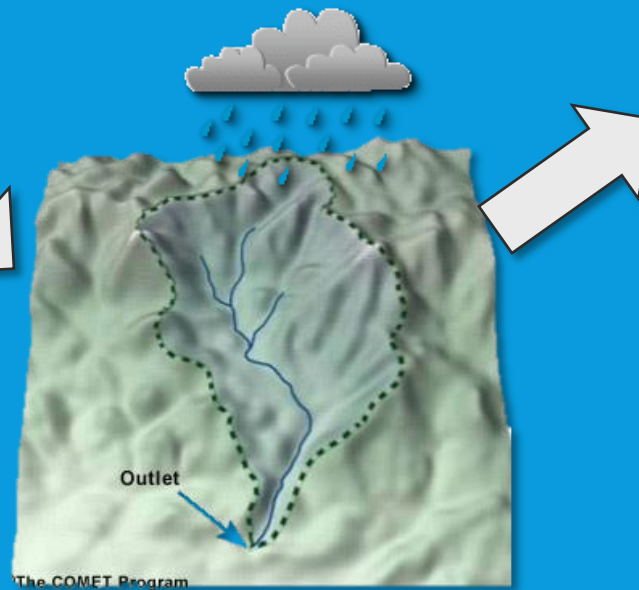
*Conflicting attributions*

# MAKING RIVER FORECASTS

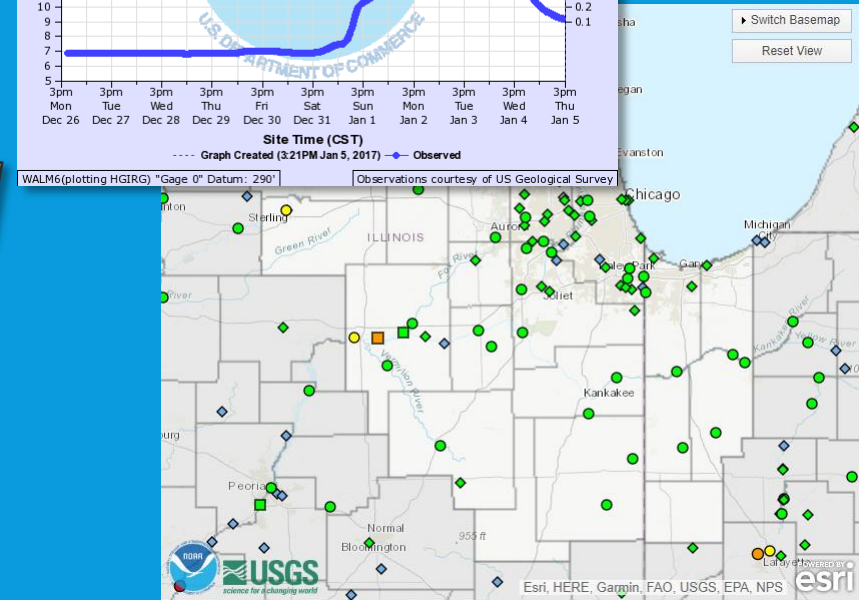


How much precipitation has fallen + will fall?

Where is it going to fall?



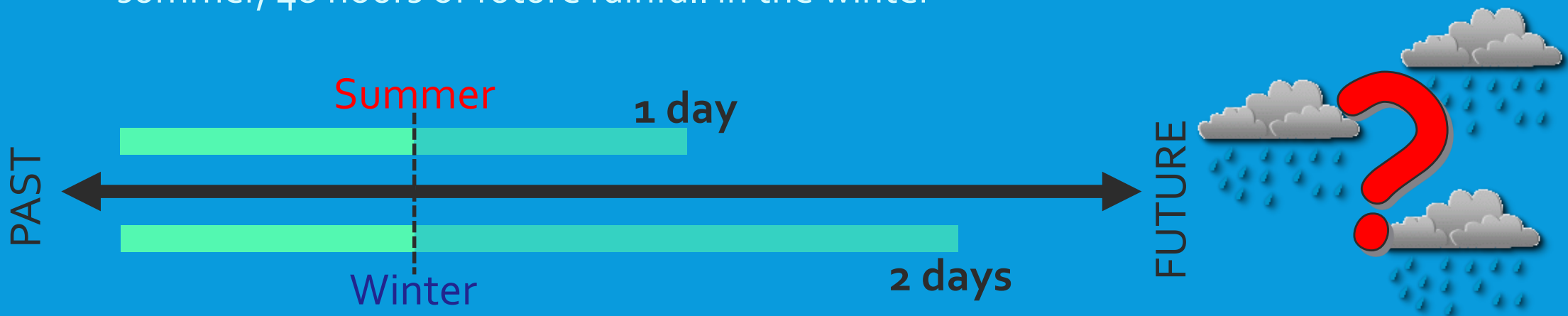
How quickly will runoff reach the rivers?



# MAKING RIVER FORECASTS

River forecasts are based upon another forecast...

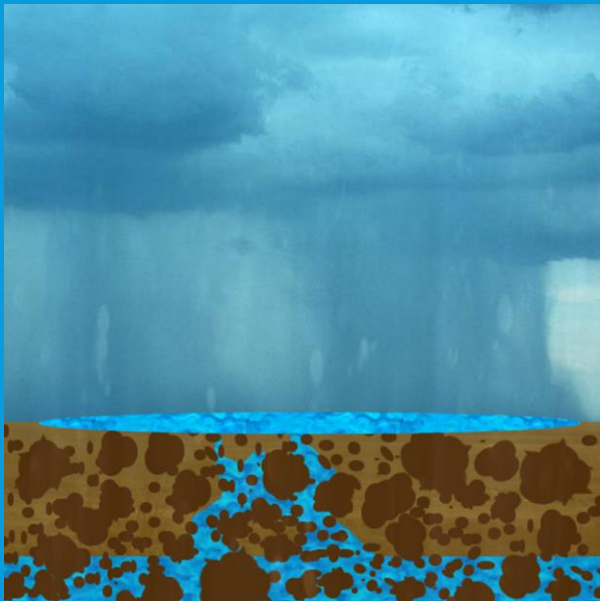
- River forecasts highly dependent on weather forecasts
- Small shifts in rainfall can move water into a different river basin entirely
- River forecasts use 24 hours of future rainfall in the summer, 48 hours of future rainfall in the winter



# MAKING RIVER FORECASTS

*River forecasts are complicated...*

How saturated is the soil?



Will any precipitation be blocked or evaporated by vegetation?

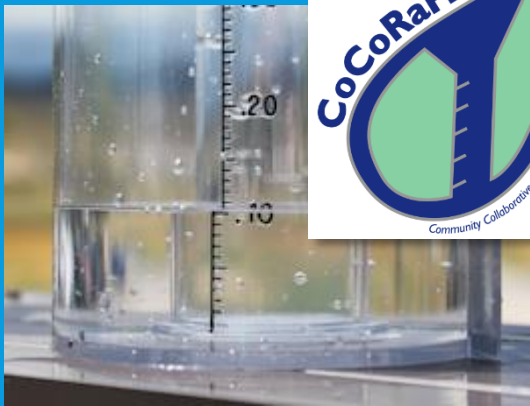
Is there snow cover?



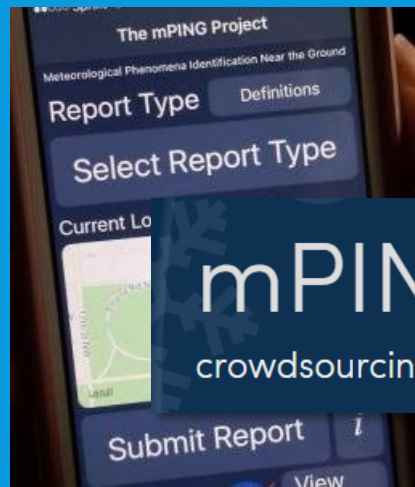


# MAKING RIVER FORECASTS

*How can I help  
improve river forecasts?*



Become a volunteer  
precipitation observer  
[cocorahs.org](http://cocorahs.org)



**mPING**  
crowdsourcing weather reports

Report severe weather  
via mPING app  
[mping.nssl.noaa.gov](http://mping.nssl.noaa.gov)



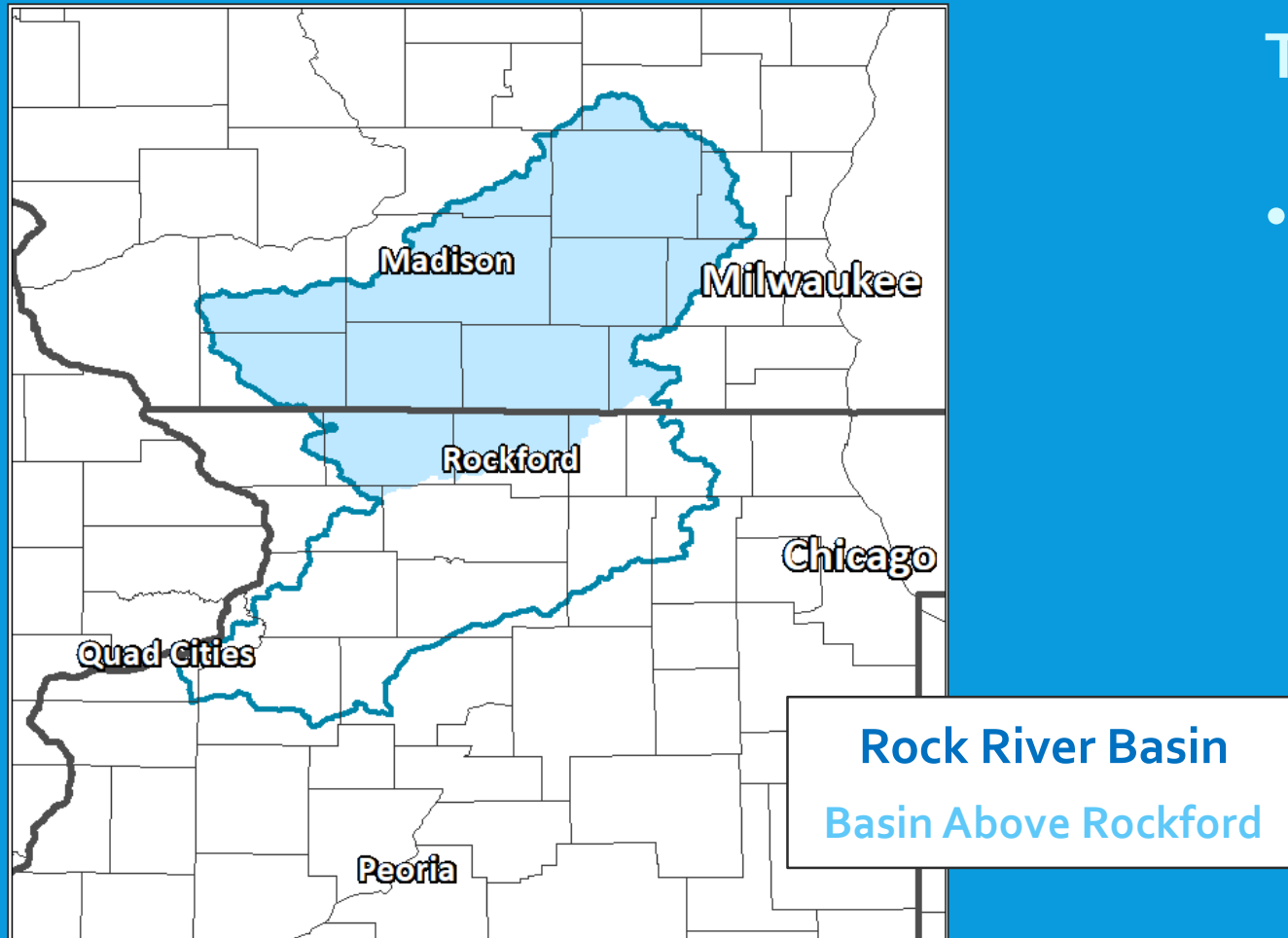
*Kevin Lally, Lee County*

Report ice jams  
*Contact our NWS office*

# ABOUT THE ROCK RIVER BASIN

-

# THE ROCK RIVER BASIN



## The Rock River Basin

- Most water that reaches Rock River in Rockford area comes from south central Wisconsin

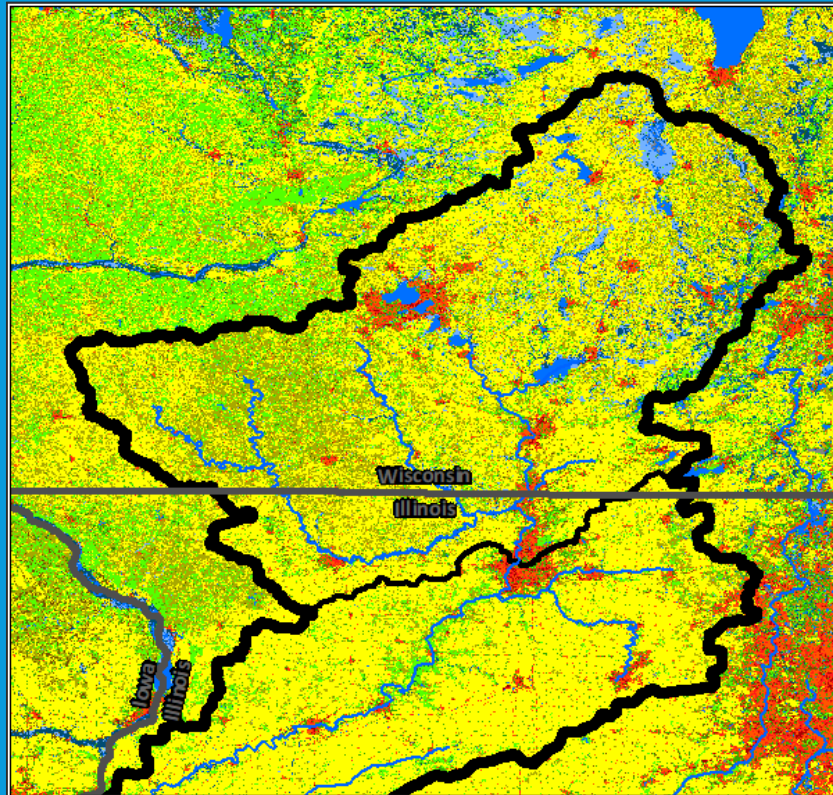


# THE ROCK RIVER BASIN

Pre-Settlement

1992

2011



8%	1%	71%	6%
Forest	Prairie	Agriculture	Developed

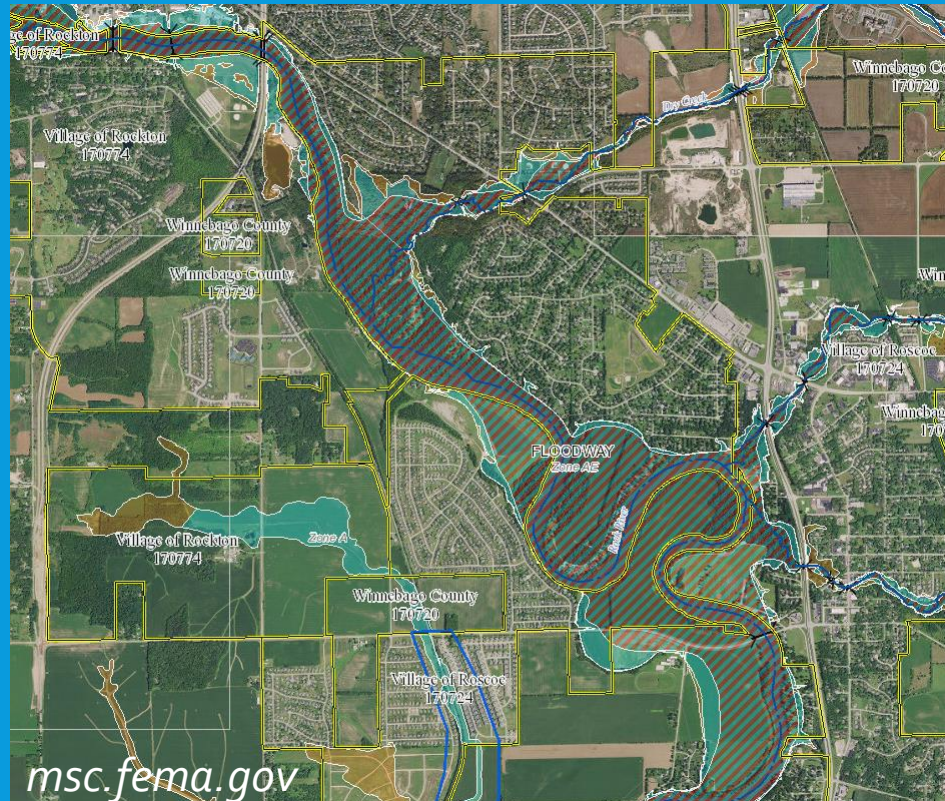
## Rock River Basin Land Cover

- Land cover prior to humans was a mix of prairie and forest
- By the 1990s, most of the basin was agriculture
- By the 2010s, a minor expansion of developed areas and agriculture.

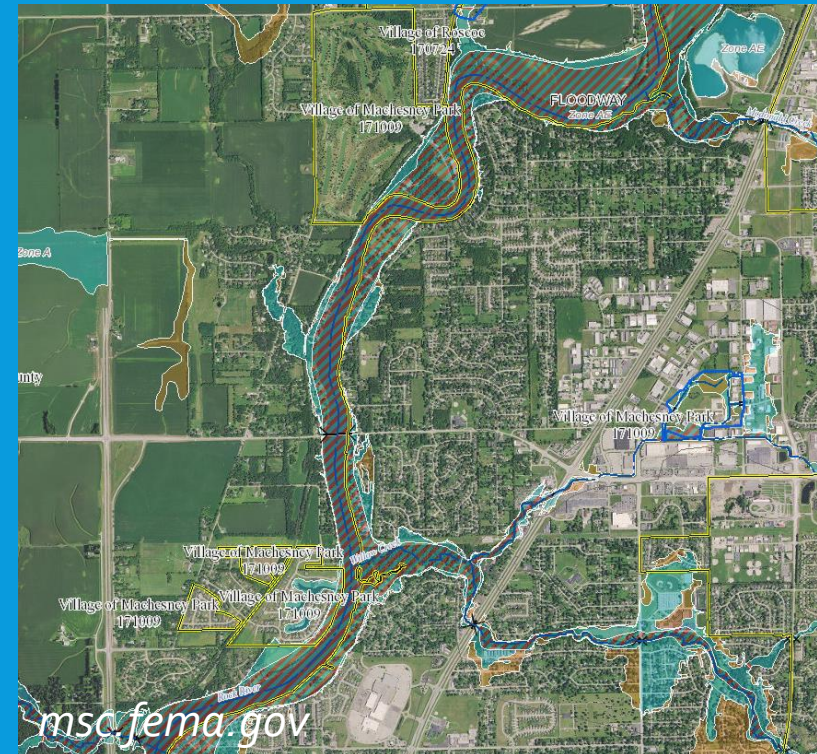


# THE ROCK RIVER FLOODPLAIN

## Rockton to Roscoe



## Roscoe to Machesney Park

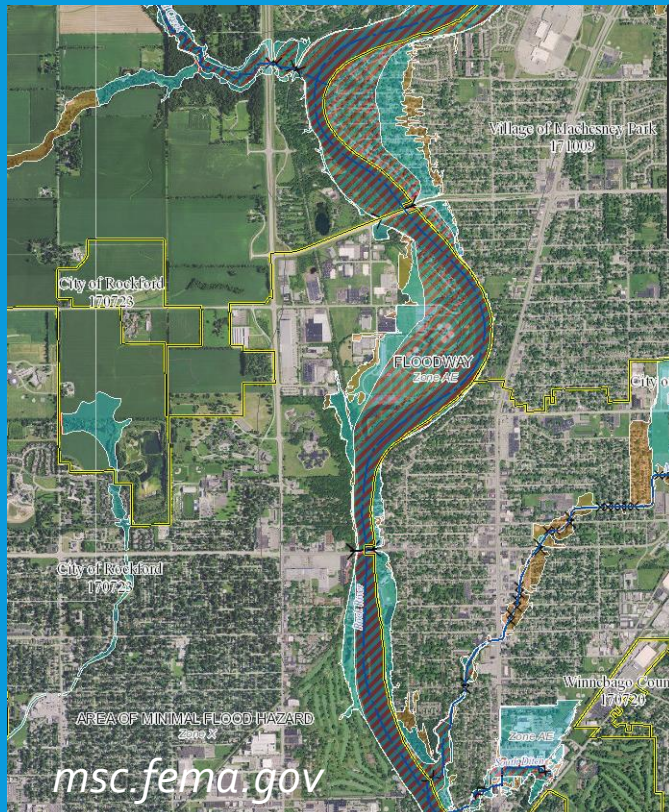


**Annual Risk**  
**1% chance**  
**0.2% chance**



# THE ROCK RIVER FLOODPLAIN

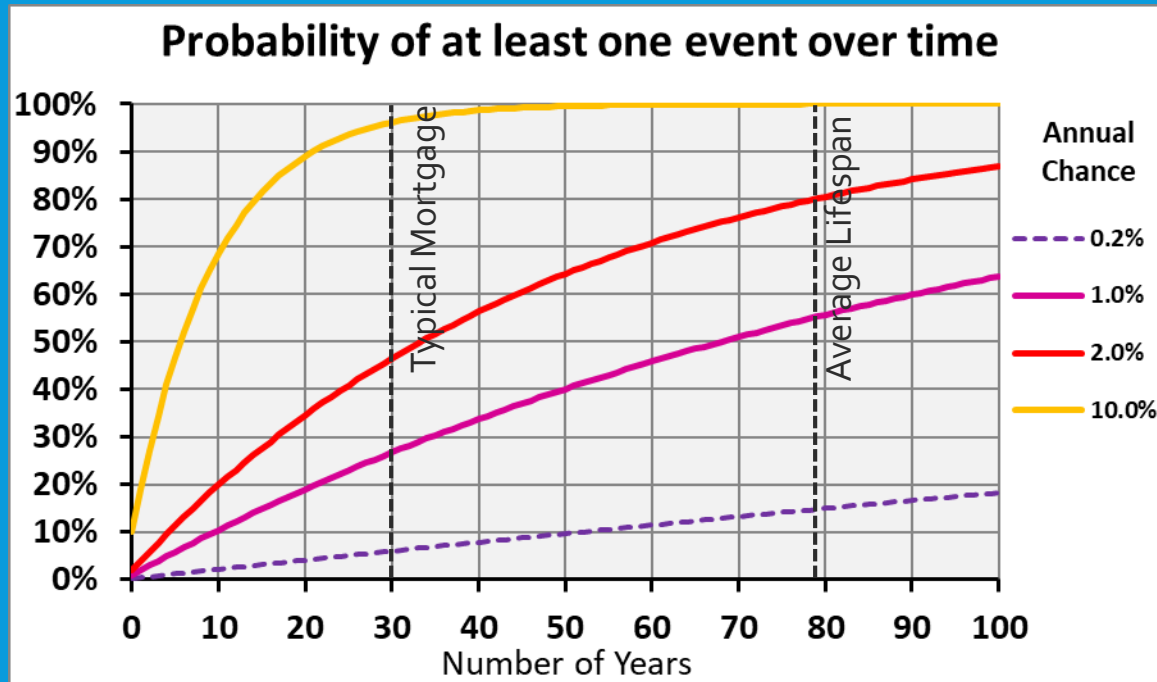
## Machesney Park to Loves Park



**Annual Risk**  
**1% chance**  
**0.2% chance**

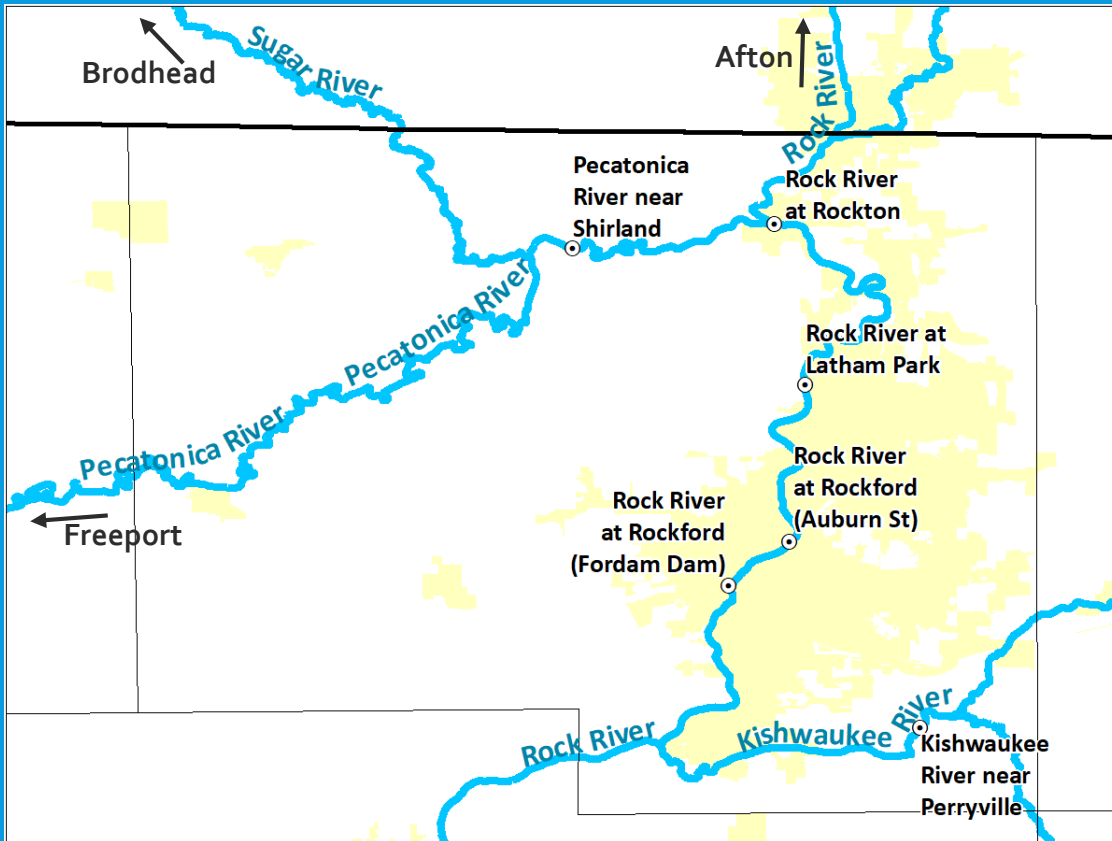
- Some areas have narrow floodplain, others have a wider floodplain. **This is natural.**
- Risk varies location to location - It's important to **know your risk.**
- FEMA Floodplain Maps: [msc.fema.gov](https://msc.fema.gov)

# THE ROCK RIVER FLOODPLAIN



- Over the span of a typical mortgage, there is a near 30% chance of experiencing the 1-in-100 chance flood
- Floods can happen spread out, or in clusters. Chance of flooding is basically the same each year\*

# ROCK RIVER GAUGES



## Gauges we watch

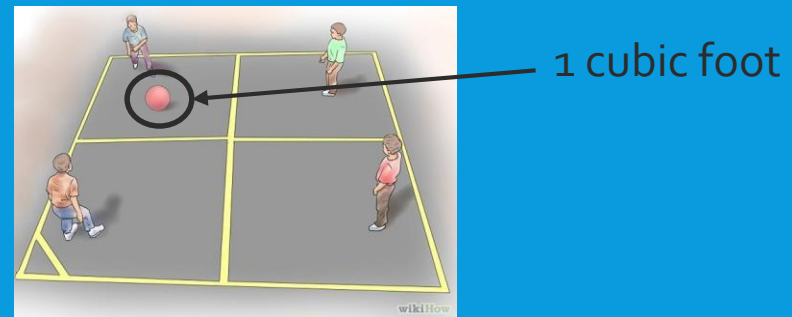
- Rock River at Afton (Rock County, WI)
- Pecatonica River at Freeport (Stephenson County)
- Pecatonica River at Shirland
- Rock River at Rockton
- Rock River at Latham Park
- Rock River at Rockford (Auburn Street)
- Rock River at Rockford (Fordam Dam)

# ROCK RIVER GAUGES



## How do we measure river levels?

- Stage  
Height of water above a reference elevation at a location.
- Discharge  
Rate of water moving past a location.  
Cubic feet per second = 1 very large playground ball.



# ROCK RIVER GAUGES

Each gauge represents a section of river

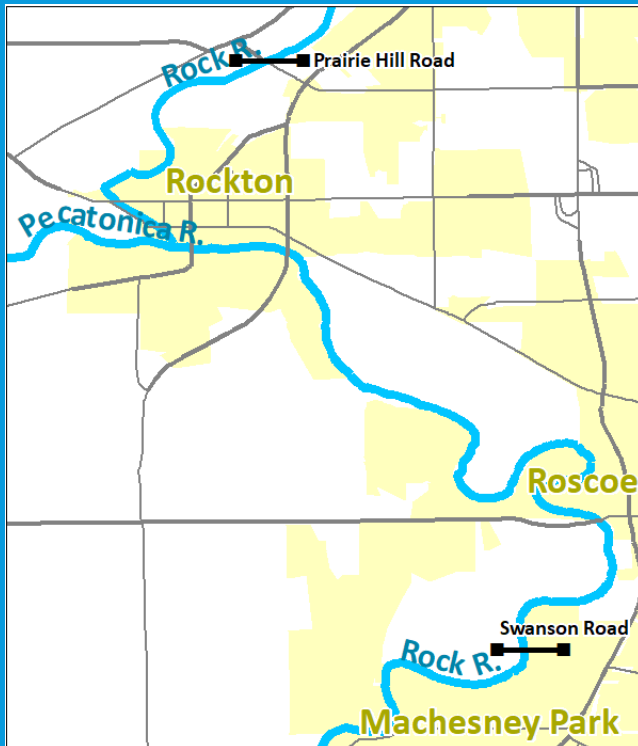
- Each river gauge is tied to a section of river called a “reach”
- River flood impacts along each section of river are tied to a stage on the river gauge



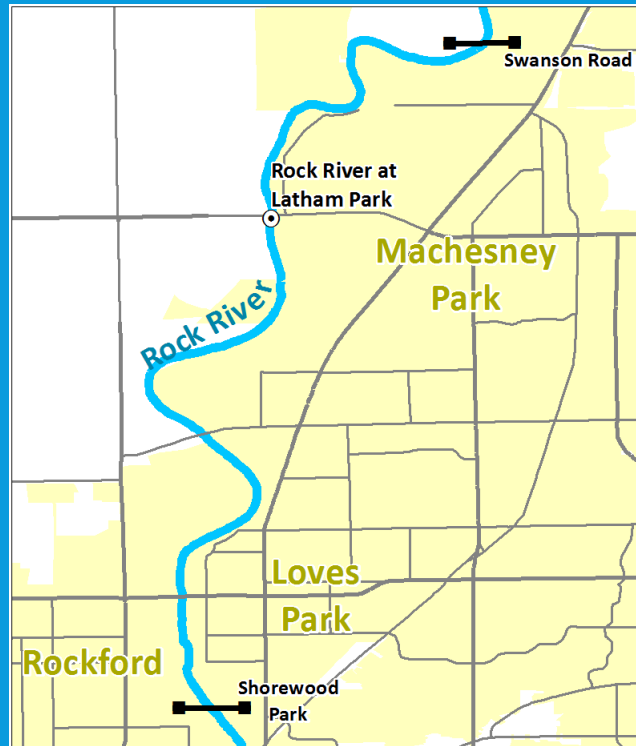


# ROCK RIVER GAUGES

## Rockton



## Latham Park



## Rockford (Auburn St)



# RELEVANT TERMS USED BY THE NWS TO DESCRIBE FLOODING

# NWS FLOODING TERMS: IMPACT CATEGORIES

## Action Stage

An established gage height where action is taken in preparation for possible significant hydrologic activity.

## Forecast Issuance Stage

The stage where the National Weather Service begins issuing forecasts. By default, this stage is set the same as action stage.

## Minor Flood Stage

Minimal property damage, but possibly some public threat. This may include inundation of roads.

## Moderate Flood Stage

Some inundation of structures and roads. Evacuations of people and/or transfer of property to higher elevations.

## Major Flood Stage

Extensive inundation of structures and roads. Significant evacuations of people and/or transfer of property to higher elevations.

# EFFECT OF A POSSIBLE SAND BAR ON ROCK RIVER FLOODING

Action  
Stage

Minor  
Flood  
Stage

Forecast  
Issuance  
Stage

Moderate  
Flood  
Stage

Major  
Flood  
Stage

## Flood Impact Categories and Other Thresholds

- Are set based upon actual impacts due to river flooding
- Are set based upon the entire stretch of river covered by a gauge
- Are **NOT** meant to apply to any specific person or neighborhood

# NWS FLOODING TERMS: IMPACT CATEGORIES

## Action Stage

An established gage height where action is taken in preparation for possible significant hydrologic activity.

### Action Stage is:

- Set with the impacted community, based upon actions taken by the community
- Often near the bankfull level

### Action Stage IS NOT:

- A level meant to force a community or a structure to do anything

**Flood Advisories** are issued by the NWS when water levels are expected to reach this level.

- increased river monitoring by a community
- river restrictions
- moving property away from the river
- staffing of emergency operations centers

# NWS FLOODING TERMS: IMPACT CATEGORIES

## Minor Flood Stage

Minimal property damage, but possibly some public threat. This may include inundation of roads.

Some flooding may already be occurring **BELOW** this level, but would generally be confined to areas away from people and property that can be damaged by water. Examples include forest land, low-lying sections of parks away from maintained trails.

**Flood Warnings** are issued by the NWS when water levels are expected to reach this level.

- Roads impacted
- Heavily-used trails impacted
- Athletic fields impacted
- Water covering property near structures
- Utility sheds, boathouses impacted

# NWS FLOODING TERMS: IMPACT CATEGORIES

## **Moderate Flood Stage**

Some inundation of structures and roads. Evacuations of people and/or transfer of property to higher elevations.

- Major roads impacted
- Residences with water inundation at ground level (not basements)
- Major park structures impacted
- Commercial facilities near water impacted



# NWS FLOODING TERMS: IMPACT CATEGORIES

## Major Flood Stage

Extensive inundation of structures and roads. Significant evacuations of people and/or transfer of property to higher elevations.

- Expressways or interstates impacted
- Numerous residences impacted
- Hospitals, police, fire, or utilities impacted

# NWS FLOODING TERMS: IMPACT CATEGORIES

- Are **NOT** meant to apply to any specific person or neighborhood. Think big, like comparing river to river, or region to region.
- Local community action plans may use similar language and terms, but they have different purposes.
- Don't base your actions on a flood impact category – know the elevation and river stage where you see flood impacts!

# CHANGES TO ROCK RIVER FORECAST SERVICES

Effective April 1

# COLLECTED FLOOD IMPACTS ALONG THE ROCK RIVER

## Timeline of Changes to Rock River Forecast Services

- **September 2018**  
Discussions with Winnebago County and City of Rockford about need to collect additional flood impacts and evaluate current flood impact categories for potential change.
- **October 2018**  
Emails and phone calls began to NWS Chicago/Rockford asking for a lower Action Stage and Minor Flood Stage
- **October 2018 – February 2019**  
Dozens of hours of research, modeling, and analysis conducted by NWS. Numerous discussions and meetings with Winnebago County, Machesney Park, Rockford officials about potential changes.
- ~~April 1<sup>st</sup>, 2019~~ **March 12th**  
Changes will take effect.

# COLLECTED FLOOD IMPACTS ALONG THE ROCK RIVER

Latham Park Gauge  
Swanson Rd downstream to Shorewood Park



water.weather.gov

- Few impacts documented previously
- Documented flood impacts are already updated
- Based upon these flood impacts, potential changes were discussed with community leaders

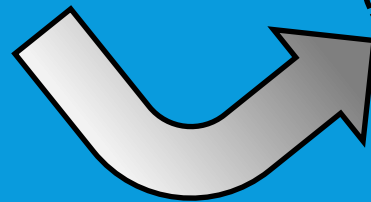
# CHANGES TO FLOOD IMPACT CATEGORIES AND THRESHOLDS

## Old Flood Impact Categories

9.0 ft	Forecast Issuance Stage
9.0 ft	Action Stage
10.0 ft	Minor Flood Stage
11.0 ft	Moderate Flood Stage
14.0 ft	Major Flood Stage

## New Flood Impact Categories

7.0 ft	Forecast Issuance Stage
8.0 ft	Action Stage
9.0 ft	Minor Flood Stage
11.0 ft	Moderate Flood Stage
13.5 ft	Major Flood Stage



**Latham Park  
Gauge**

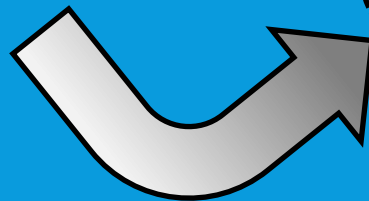
# CHANGES TO FLOOD IMPACT CATEGORIES AND THRESHOLDS

## Old Flood Impact Categories

8.0 ft	Forecast Issuance Stage
8.0 ft	Action Stage
9.0 ft	Minor Flood Stage
10.0 ft	Moderate Flood Stage
11.0 ft	Major Flood Stage

## New Flood Impact Categories

5.0 ft	Forecast Issuance Stage
5.5 ft	Action Stage
6.0 ft	Minor Flood Stage
8.5 ft	Moderate Flood Stage
10.0 ft	Major Flood Stage



**Auburn Street  
Gauge**



# CONSEQUENCES OF PROPOSED CHANGES

Lowering Action Stage and Minor Flood Stage will increase the amount of time that the river is under a **Flood Advisory** or **Flood Warning**.

## Latham Park

- Flood Advisory: 5% → 9% of the time
- Flood Warning: 3% → 5% of the time

## Auburn Street

- Flood Advisory: 0% → 1% of the time
- Flood Warning: 0% → <1% of the time

## Latham Park

How much time  
above a certain  
stage?

5.0	55%
5.5	40%
6.0	29%
6.5	23%
7.0	18%
7.5	13%
8.0	9%
8.5	7%
9.0	5%
9.5	4%
10.0	3%
10.5	2%
11.0	2%

# COLLECTED FLOOD IMPACTS ALONG THE ROCK RIVER

- Changes originally scheduled for April 1<sup>st</sup>
- Due to the threat of flooding in the end of March into early April, special permission was granted to make changes effective immediately (March 12)

# ABOUT FORDAM DAM

# ABOUT FORDAM DAM

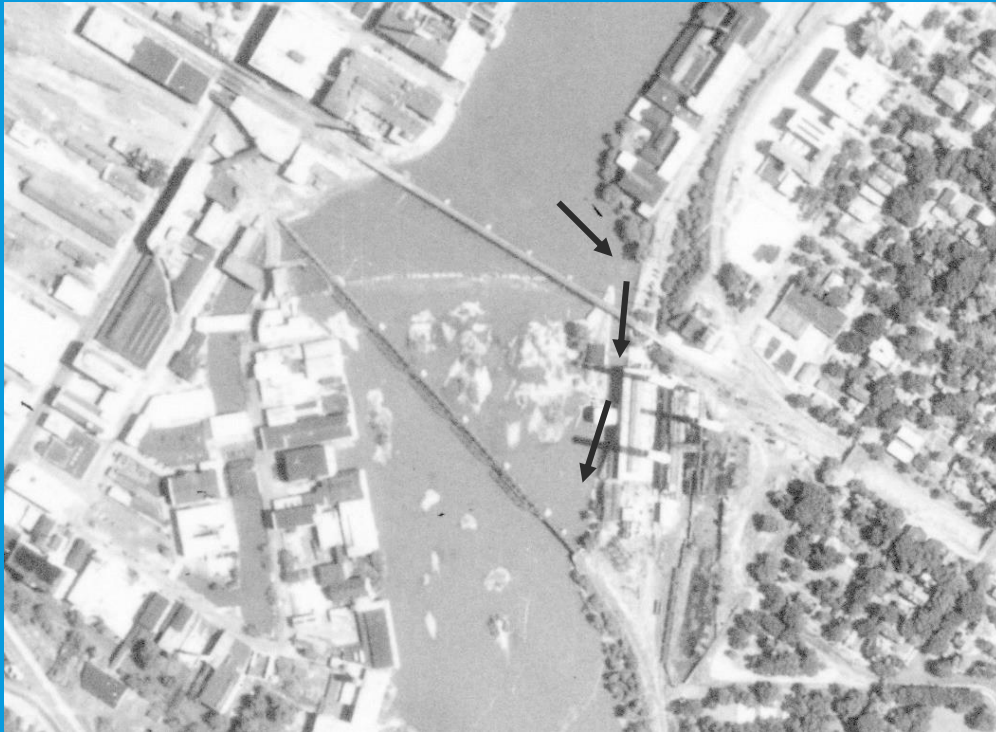
- Built in mid-1800s and originally used for hydro power
- Artificially raises water level in downtown Rockford ~3-12ft
- Not a storage reservoir
- Not a flood control structure
- Impact of the dam gets smaller as amount of water in the river increases

2018  
Google



# ABOUT FORDAM DAM

1930s  
Illinois State Geological Survey

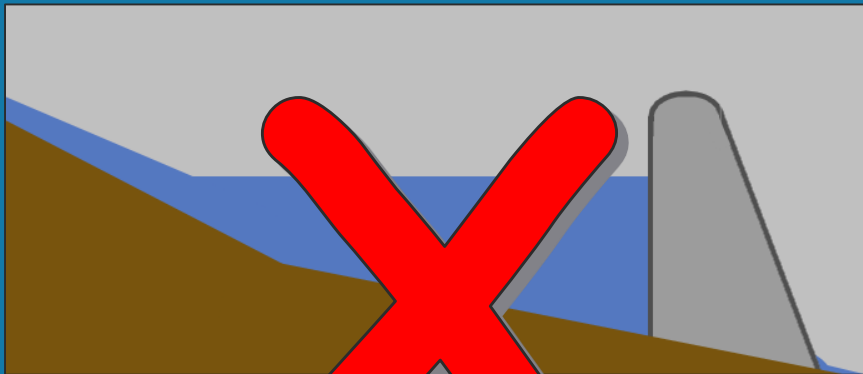


2018  
Google



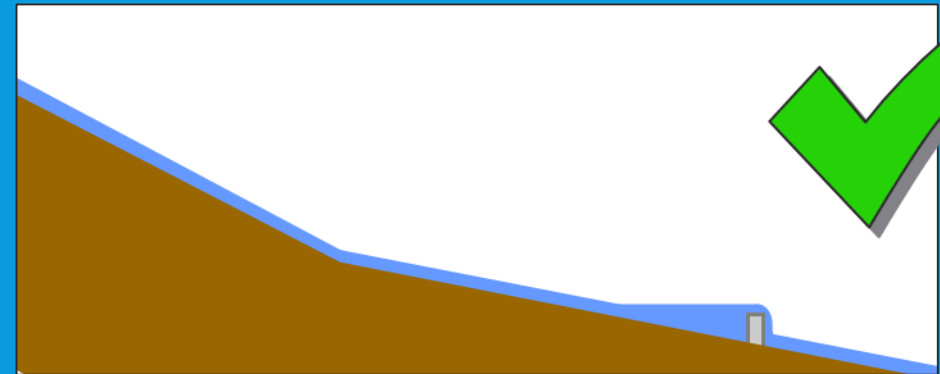
# WHAT KIND OF HYDRO POWER DAM IS FORDAM DAM?

## Perception: Storage Reservoir Dam



- Store water during wet periods, release water during dry periods
- Large storage of water behind dam
- Timing of gate openings can have big impact on flood crest upstream and downstream

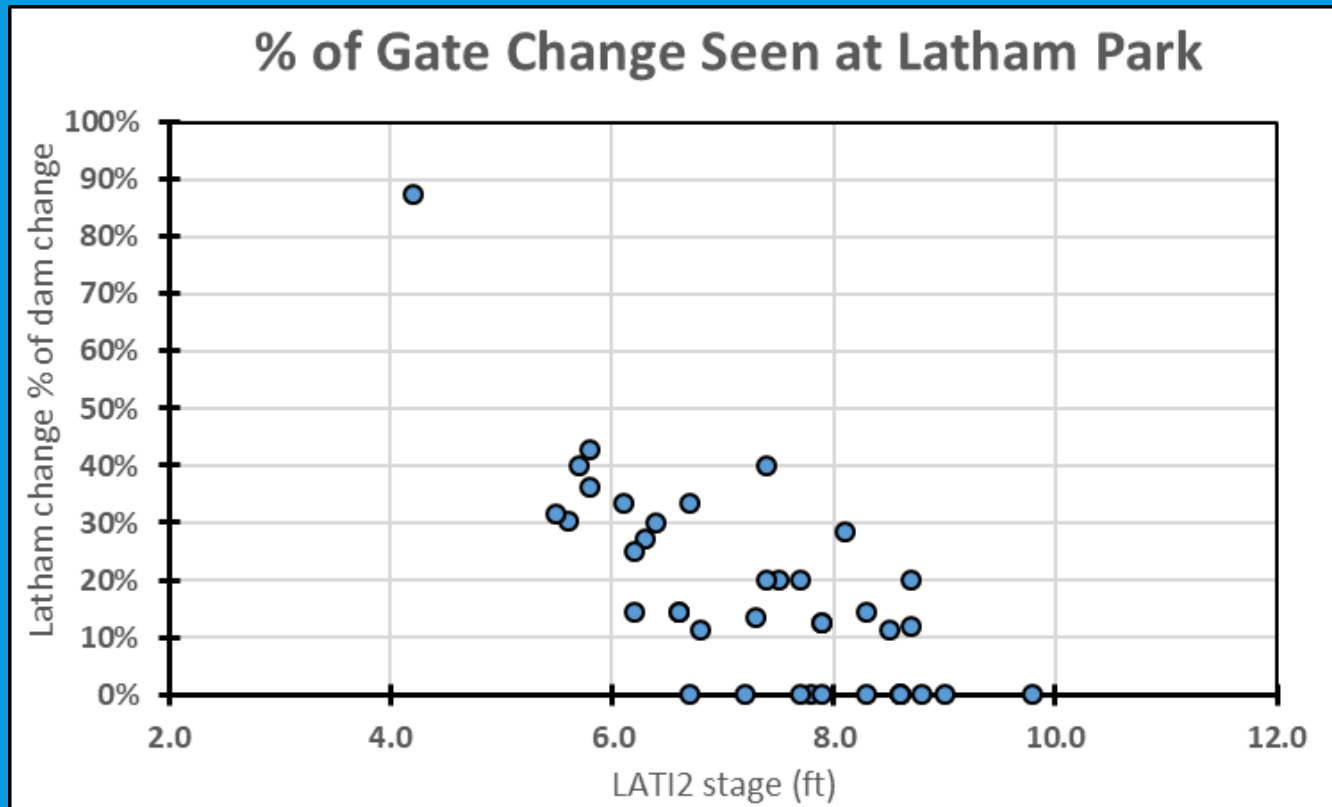
## Reality: "Run-of-the-river" Dam



- Little or no storage capacity
- Small artificial rise in water, **mostly near dam**
- Timing of gate openings has little or no impact on flood crests



# FORDAM DAM GATE ADJUSTMENTS

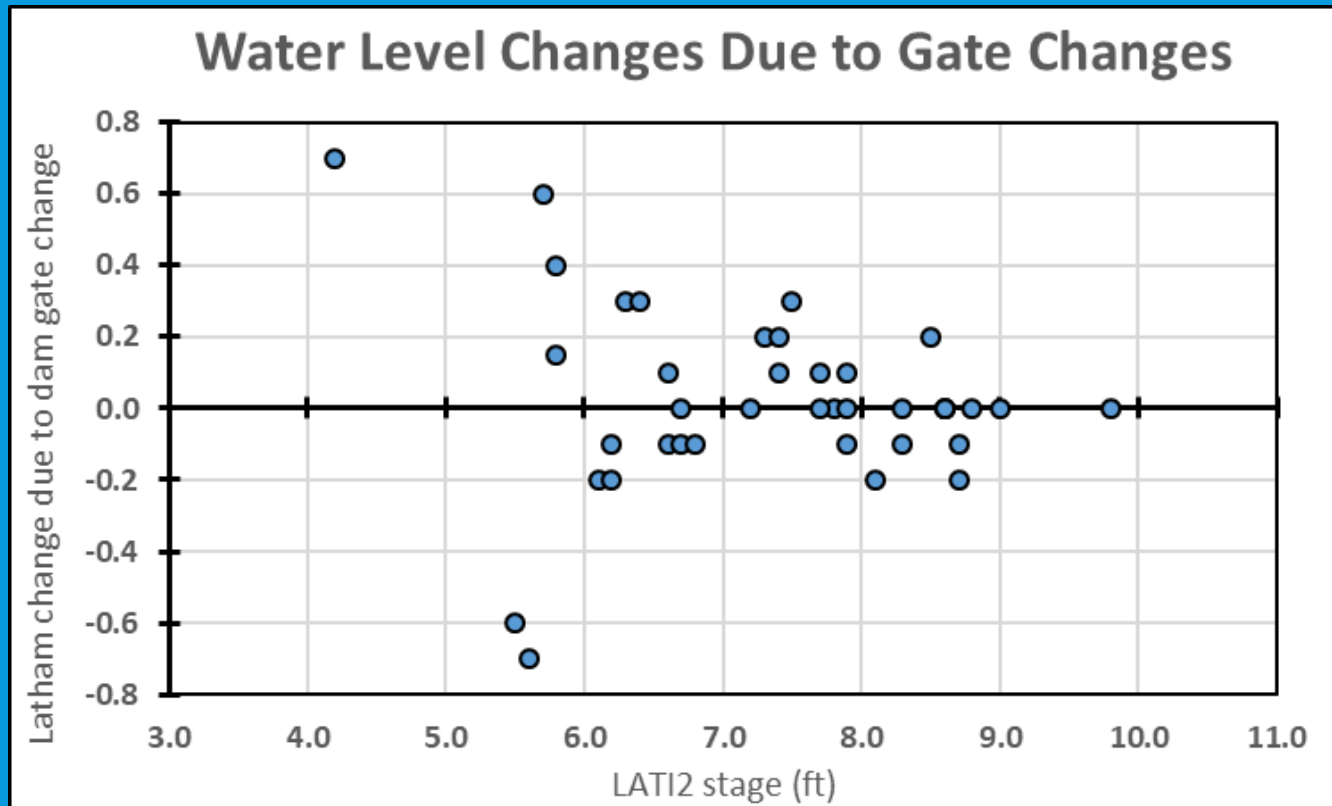


Fordam Dam gate changes (Jun 2016-Jan 2019)

## Fordam Dam Influence

- Reviewed observations, documented every gate adjustment back to 2016
- Some influence from Fordam Dam at Latham Park, but effect almost non-existent above 8.0-8.5 ft stage

# FORDAM DAM GATE ADJUSTMENTS



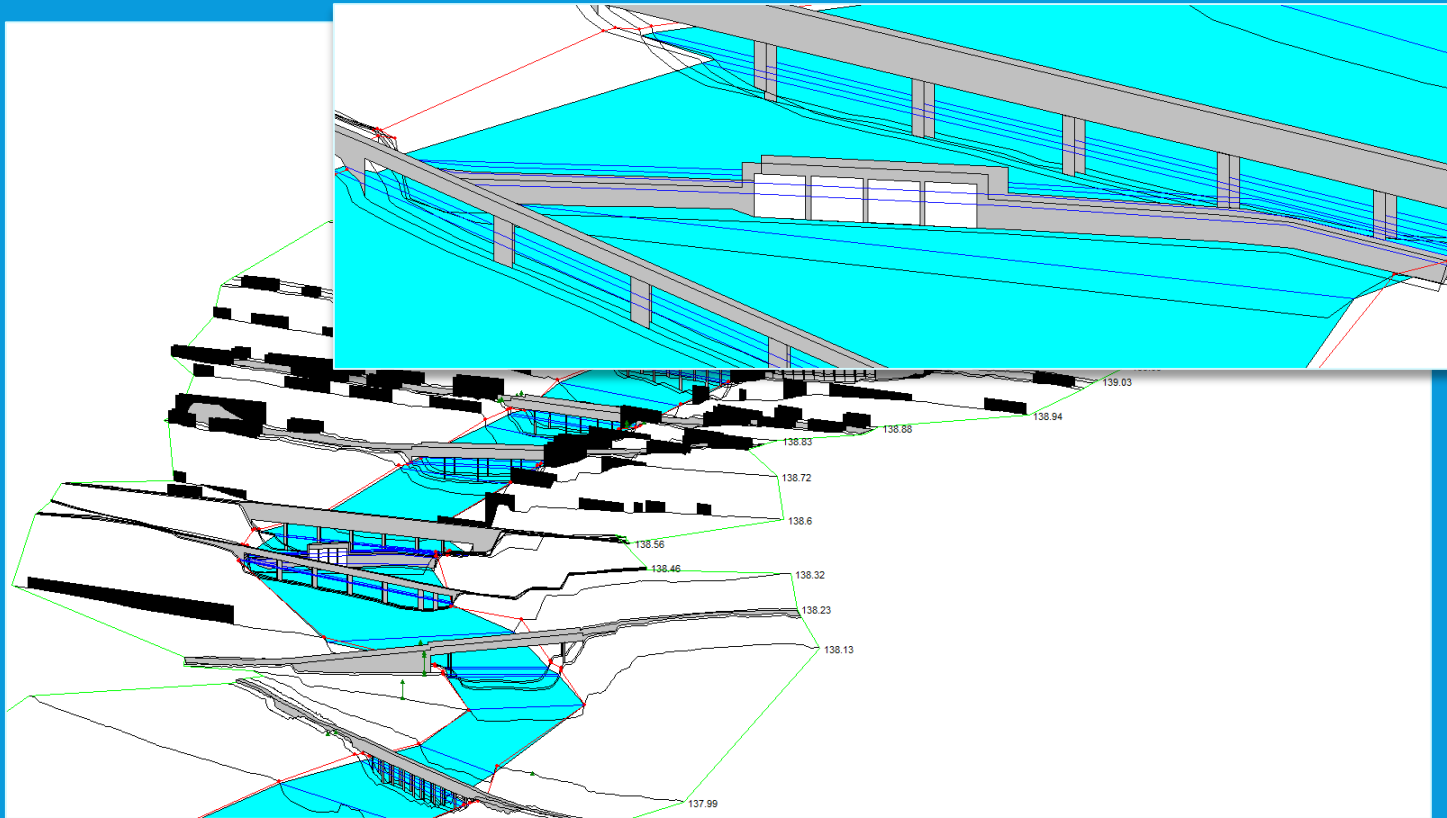
Fordam Dam gate changes (Jun 2016-Jan 2019)

## Fordam Dam Influence

- No gate change at Fordam Dam has caused Latham Park water level to change more than 0.7 ft (around 8 inches)
- Most 0.2 ft (2 inches) or less



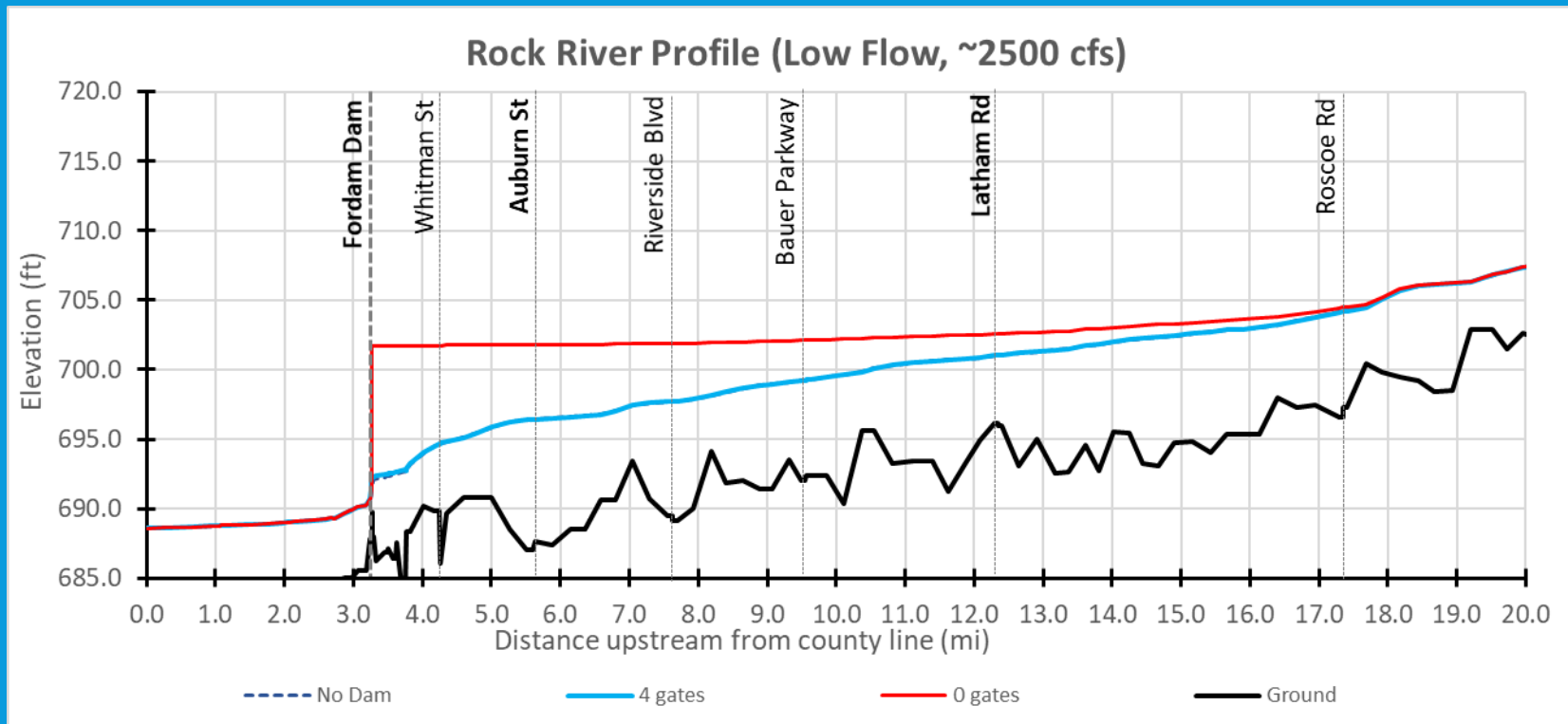
# FORDAM DAM'S IMPACT ON THE ROCK RIVER



## Rock River Model

- Modeling can be used to estimate the effect of Fordam Dam
- Model obtained from FEMA

# FORDAM DAM'S IMPACT ON THE ROCK RIVER

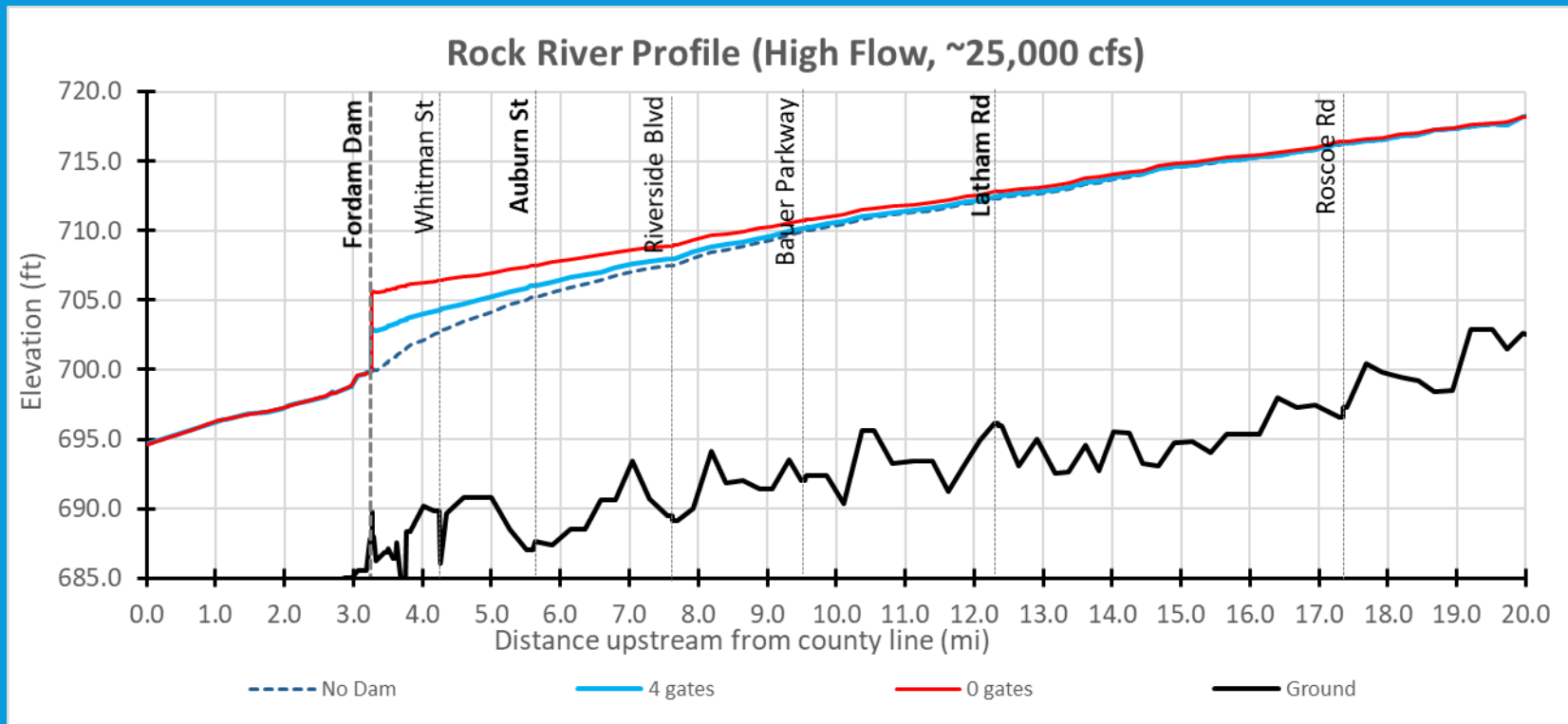


## Fordam Dam Backwater Effect

- During low flow, may reach Roscoe Road (<1 inch)

Low Flow: Latham Park 2.5 to 3.0 ft

# FORDAM DAM'S IMPACT ON THE ROCK RIVER

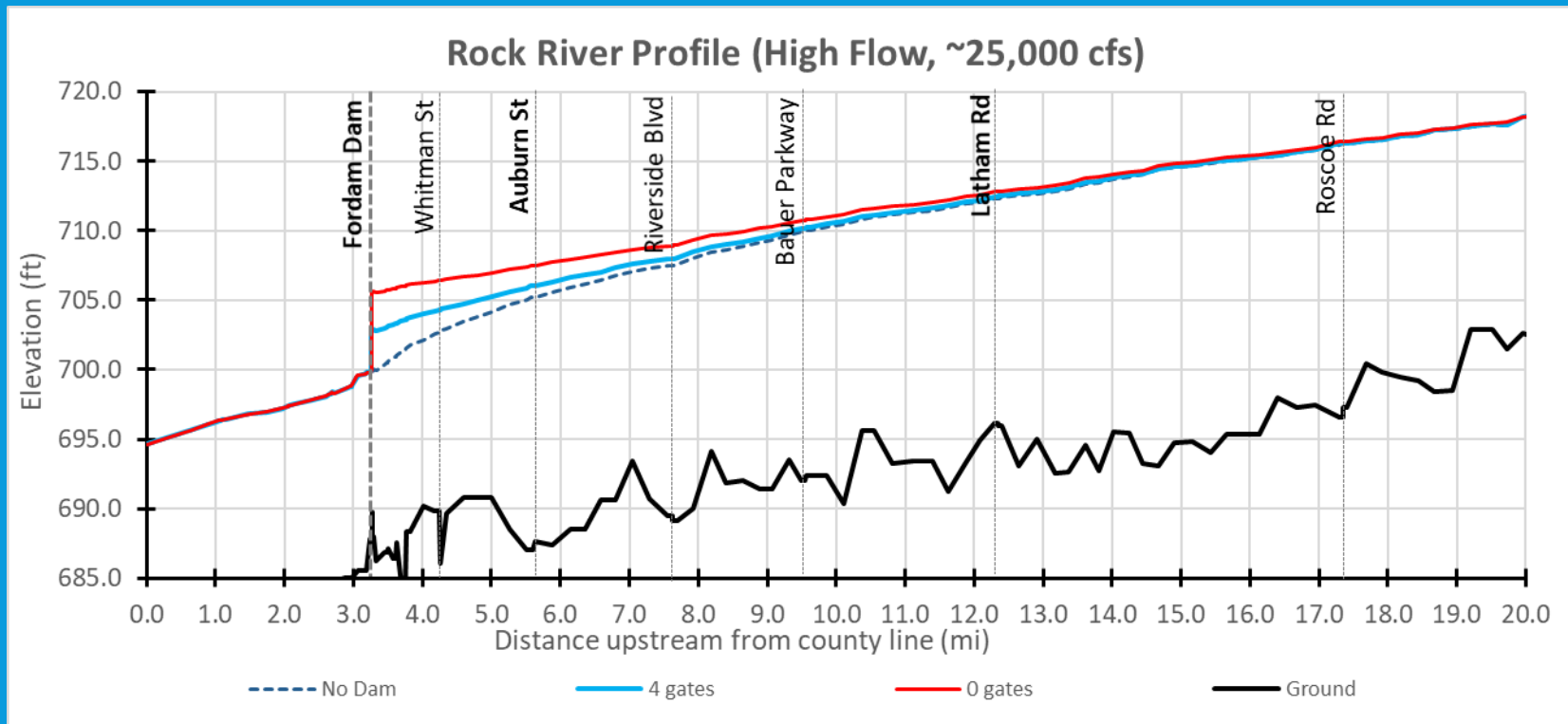


## Fordam Dam Backwater Effect

- During high flow (such as 2018), may reach Latham Road (2-3 inches)

Low Flow: Latham Park about 12.5 ft

# FORDAM DAM'S IMPACT ON THE ROCK RIVER



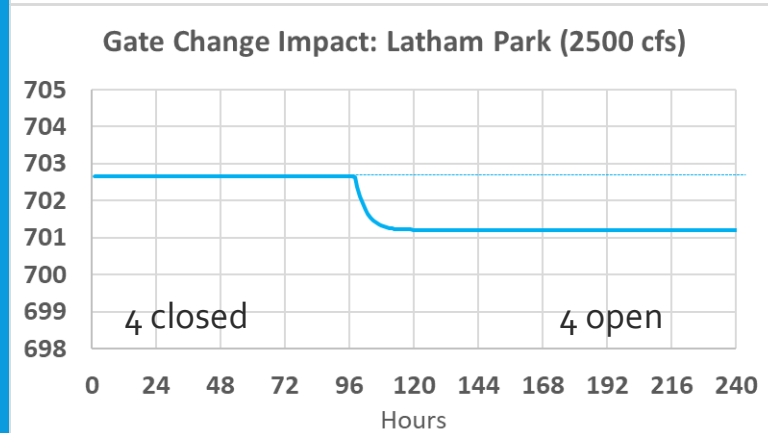
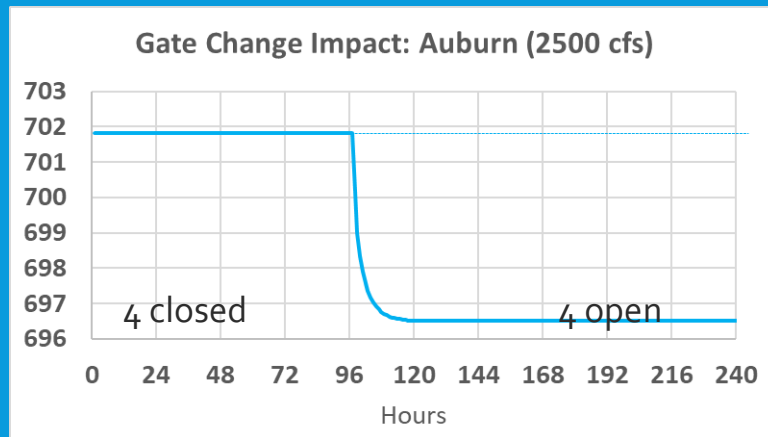
## Fordam Dam Backwater Effect

- During high flow (such as 2018), may reach Latham Road (2-3 inches)

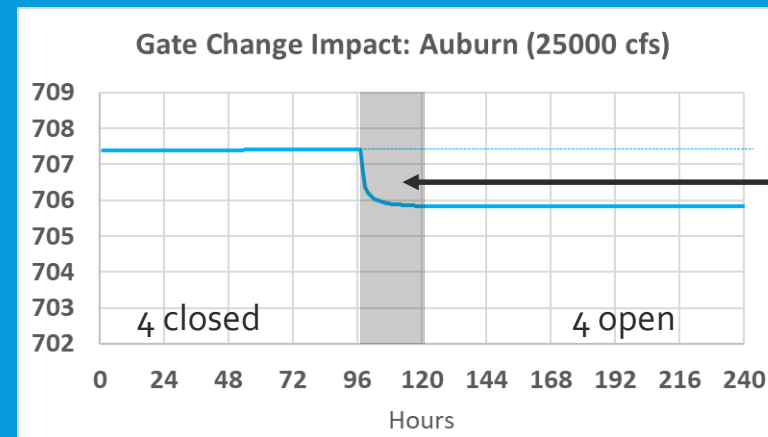
Low Flow: Latham Park about 12.5 ft

# FORDAM DAM'S IMPACT ON THE ROCK RIVER

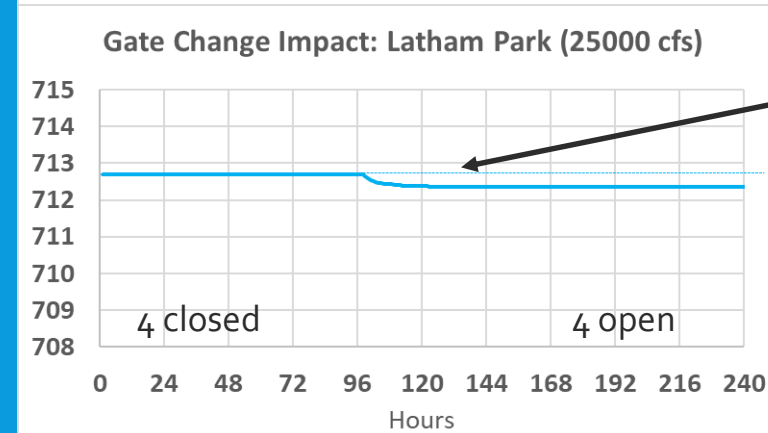
## Fully Open Gates: Low Flow



## Fully Open Gates: High Flow



Impact done in about 24hrs



3-4" total impact

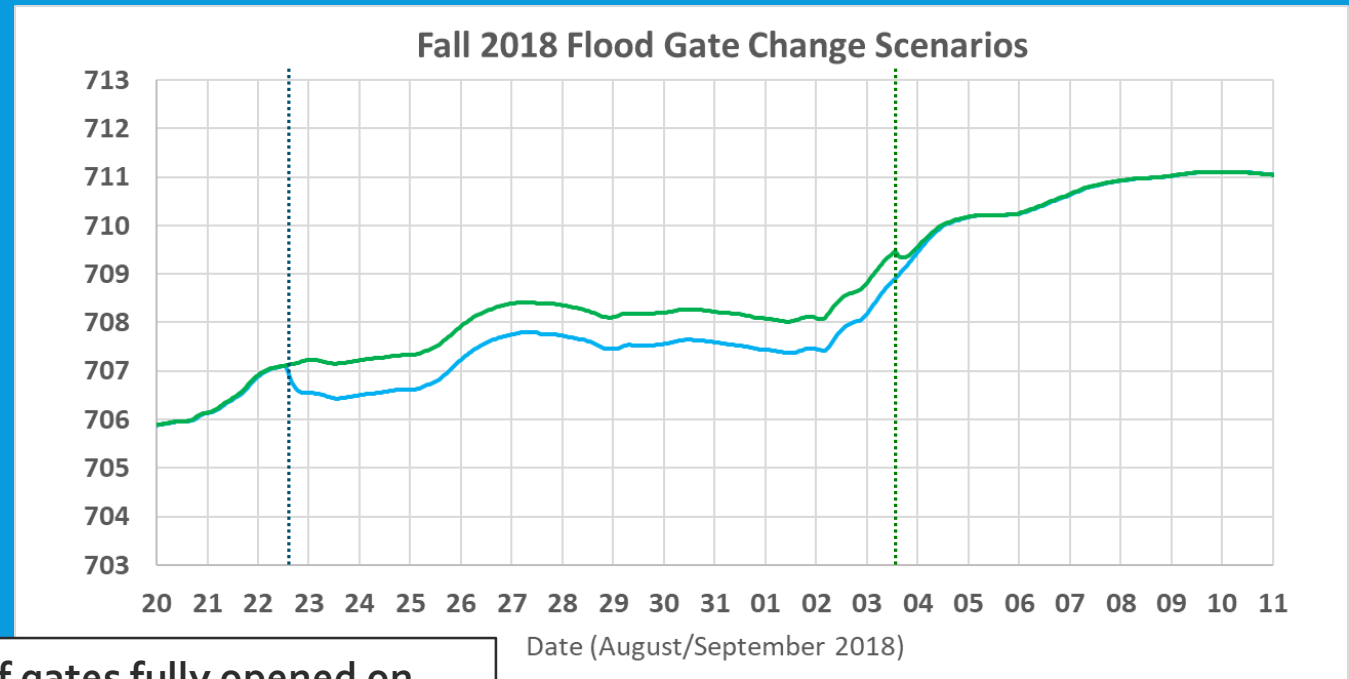
Auburn St

Latham Park

# FORDAM DAM'S IMPACT ON THE ROCK RIVER

## Fall 2018 Flood

- What if all 4 gates were opened on either August 22 or September 3?
- Opening gates 12 days earlier makes **no difference to the flood crest.**



What if gates fully opened on...

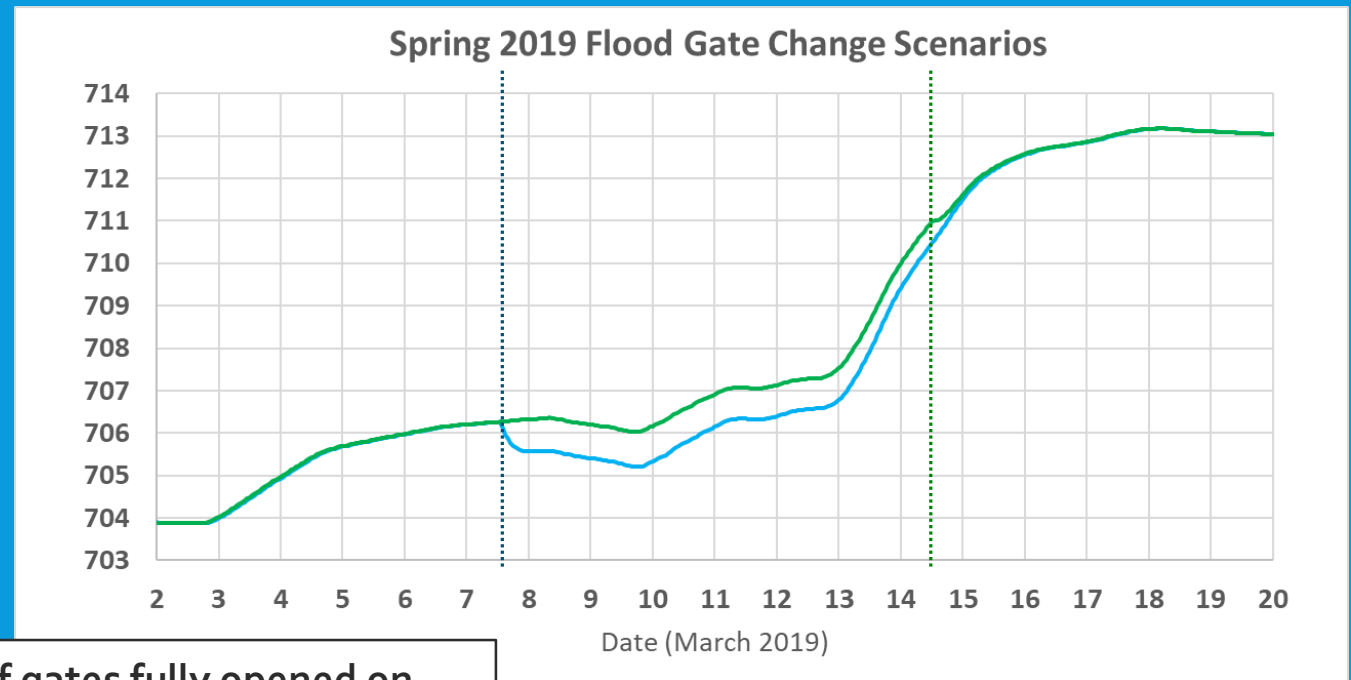
Aug 22nd

Sep 3rd

# FORDAM DAM'S IMPACT ON THE ROCK RIVER

## Spring 2019 Flood

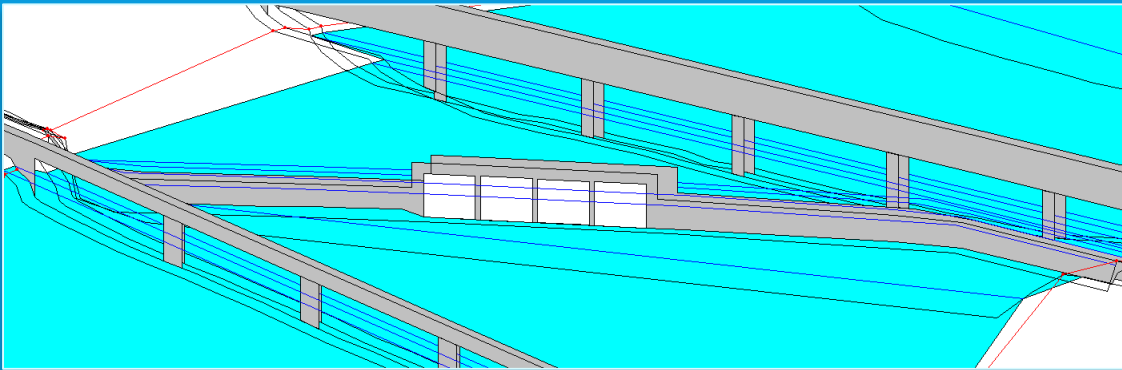
- What if all 4 gates were opened on either March 7 or Mar 14?
- Opening gates 7 days earlier makes **no difference to the flood crest.**



What if gates fully opened on...  
**Mar 7**      **Mar 14**



# FORDAM DAM'S IMPACT ON THE ROCK RIVER



- Fordam Dam **is not** a storage reservoir or a flood control structure
- Fordam Dam has a small impact on Rock River water level, but **only at low stages**
- Impact of the dam gets smaller as amount of water in the river increases
- Opening gates earlier has **no effect on level of flood crests**

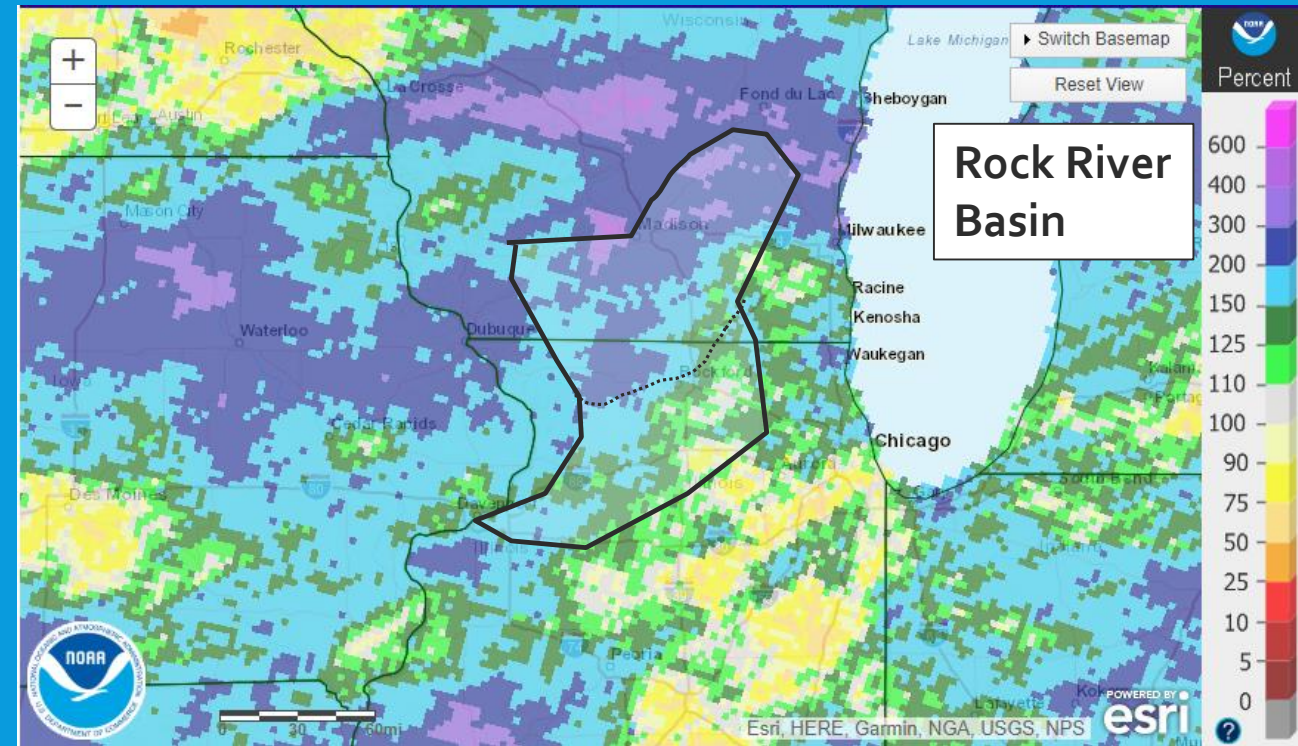
# 2018 AND 2019 ROCK RIVER FLOODING

The Meteorology and Hydrology Factors

# 2018 ROCK RIVER FLOODING

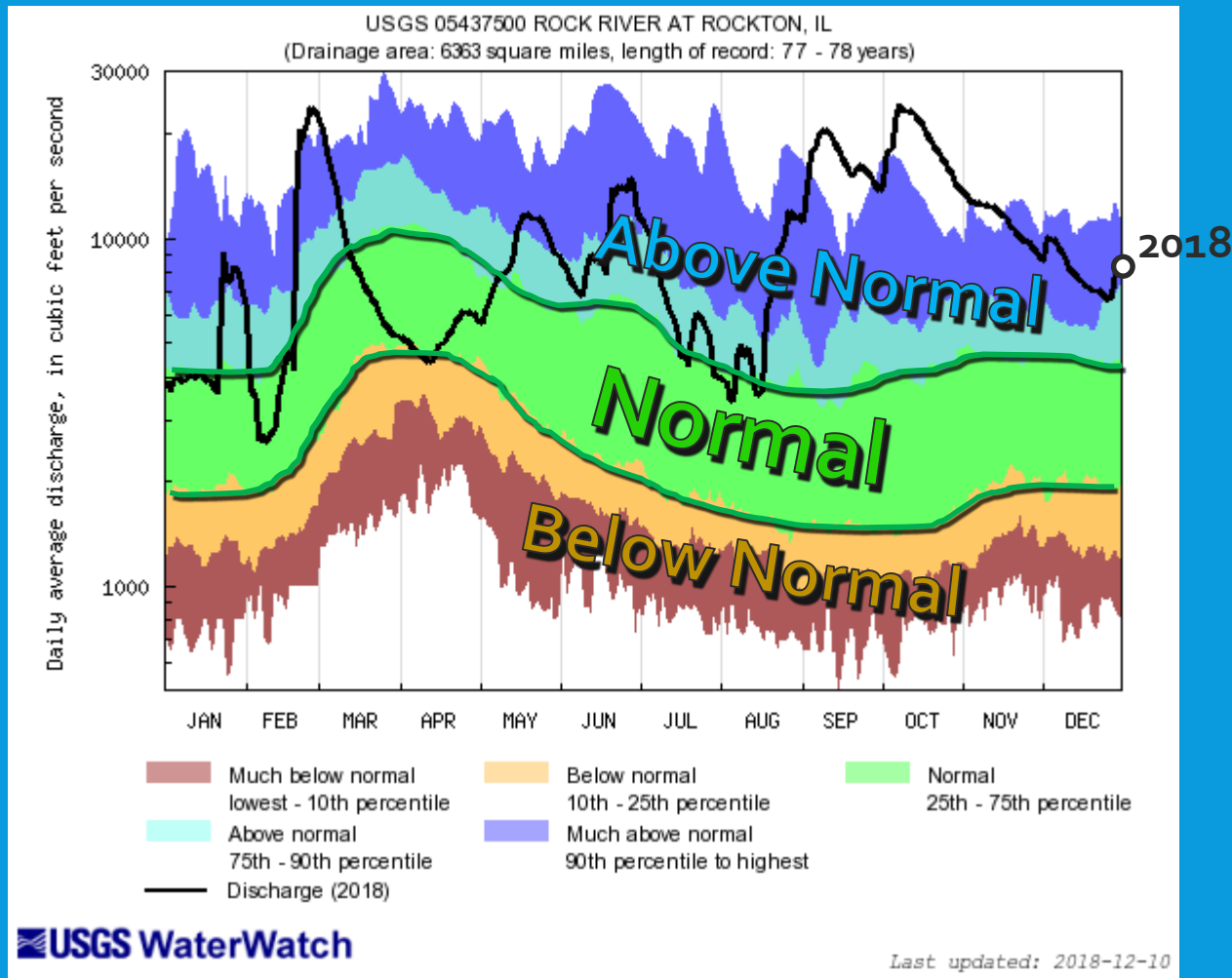
## Many Factors Contributed to High Water in Fall 2018

- River levels elevated as early as spring 2018.
- Frequent rainfall kept soil moisture very high into late summer.
- Another heavy rainfall month in August... 150-400% of average.



Graphic Credits: NOAA Climate Prediction Center, NOAA AHPS

# 2018 ROCK RIVER FLOODING



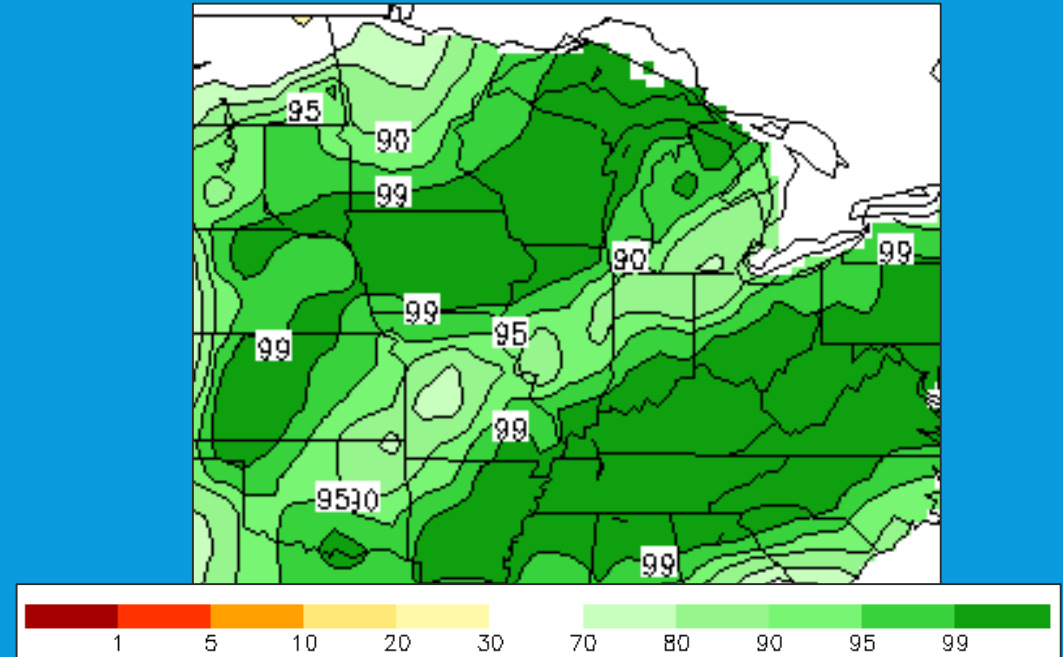
## What is “normal?”

- USGS defines “normal” as the middle 50% of past streamflow values
- Spring wet period  
5.0 to 7.5 feet at Latham Park
- Fall dry period  
2.5 to 4.0 feet at Latham Park

# 2019 ROCK RIVER FLOODING

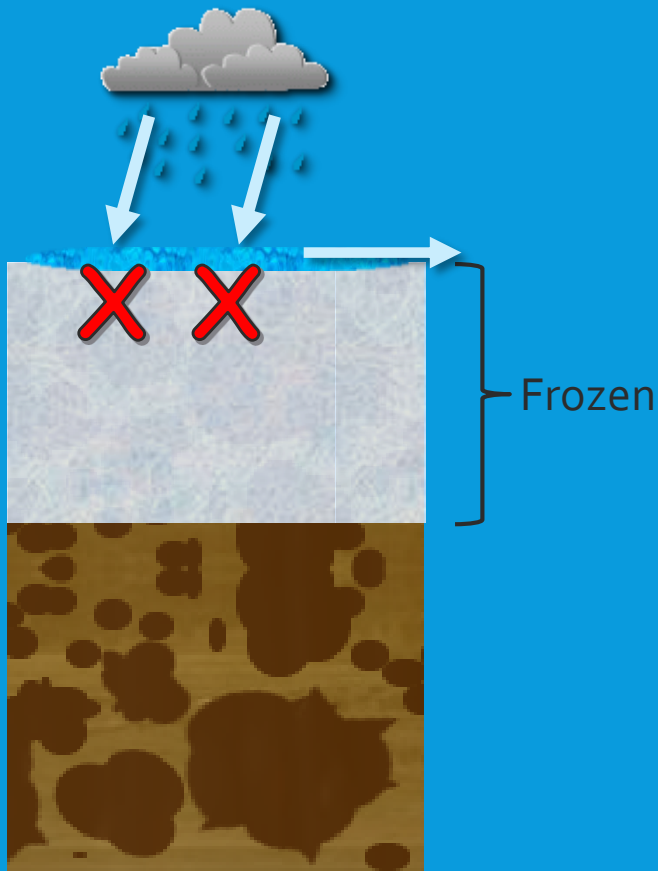
## High Soil Moisture worsens...

- Fall 2018 flood left elevated soil moisture and elevated river levels late into the year
- Very little evaporation or transpiration during winter. Soil moisture stayed high.
- Soil moisture **wetter than than 99%** of previous March values



Graphic Credit: NOAA CPC

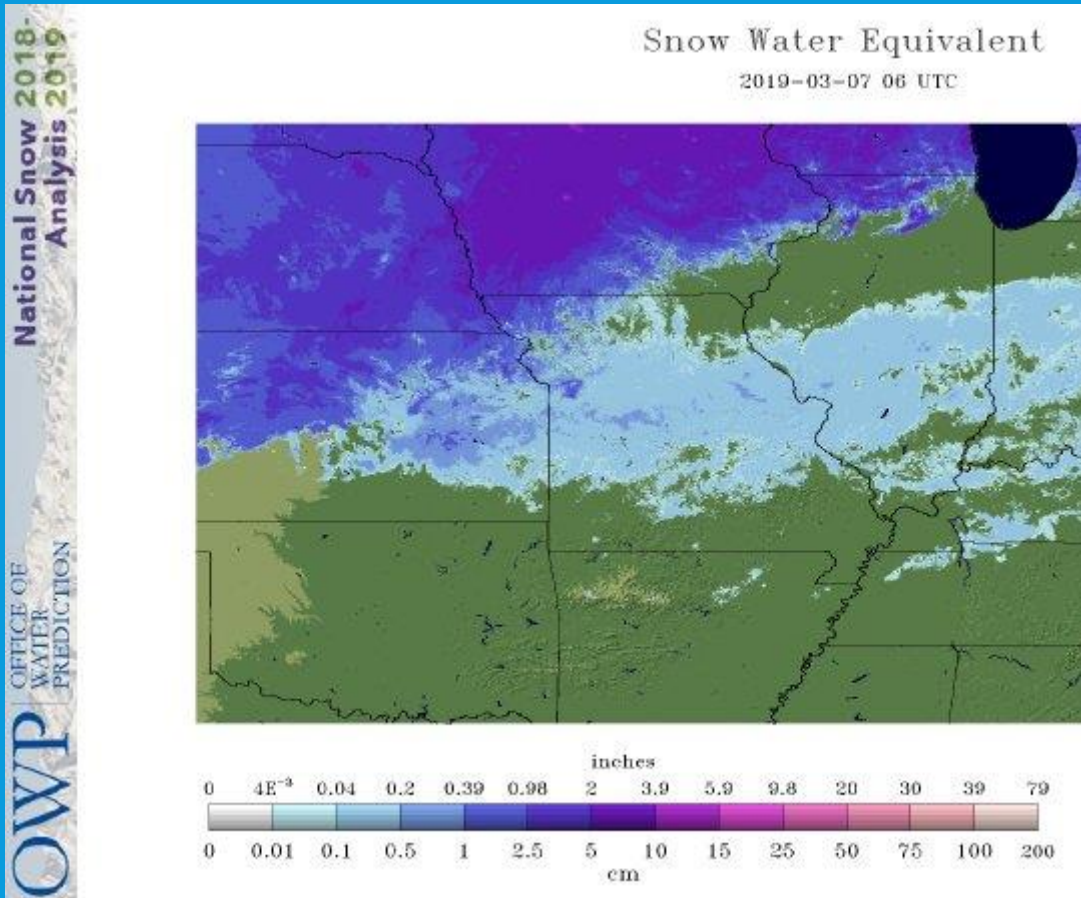
# 2019 ROCK RIVER FLOODING



## Significant Frozen Ground / Frost Depth

- Some locations frozen to a depth of 1-2 feet.
- Little water can penetrate frozen ground – instead goes straight to runoff

# 2019 ROCK RIVER FLOODING



## Significant Snow Cover

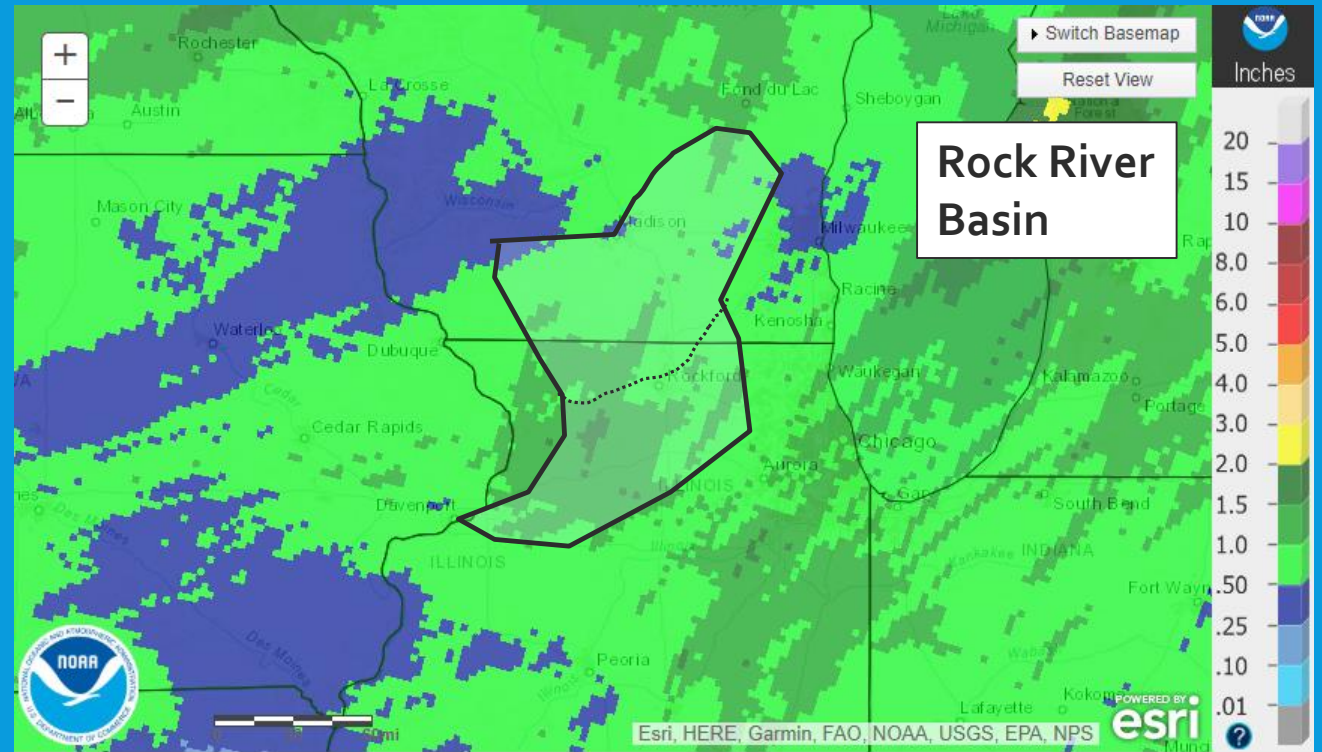
- Snow cover accumulated up to 8 inches depth in the Rock River Basin, with 2-4 inches of water equivalent



# 2019 ROCK RIVER FLOODING

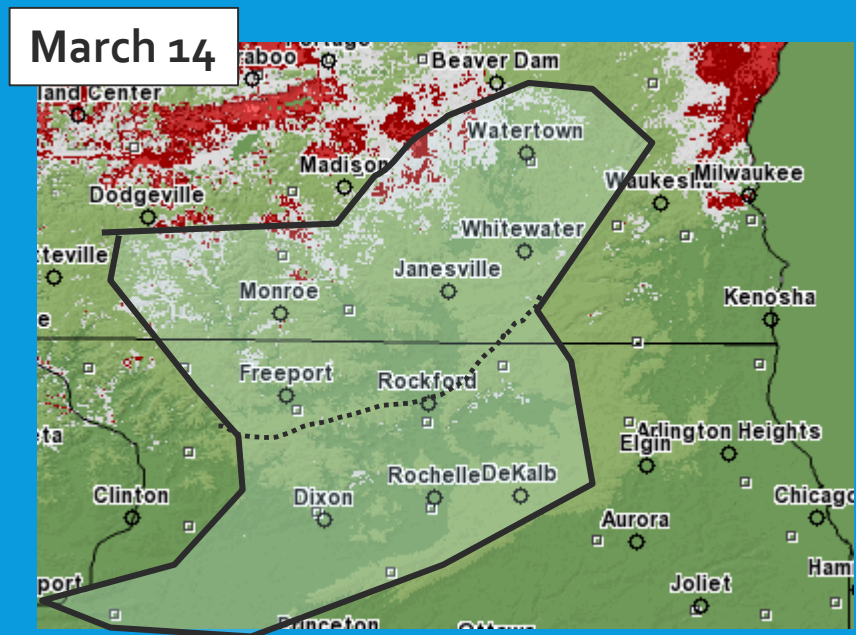
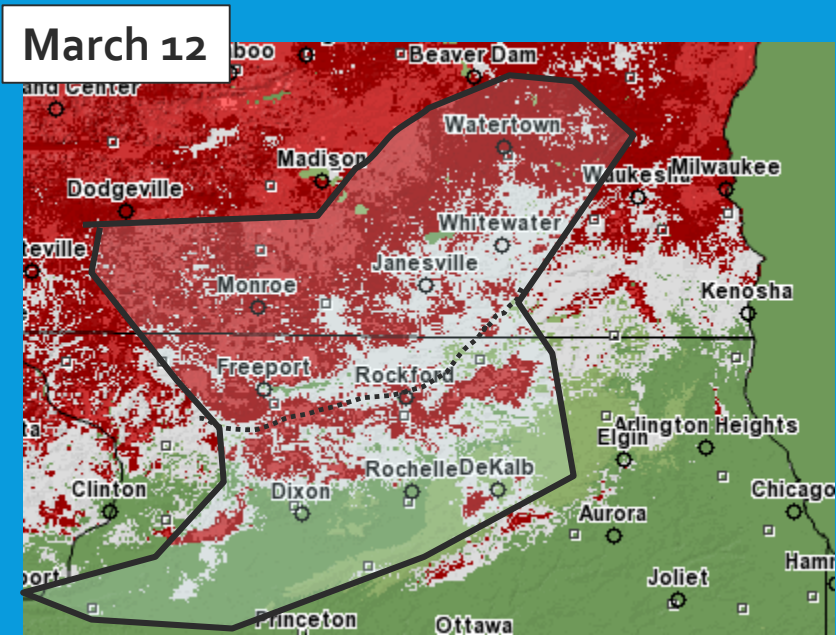
## Weather System Brings Rainfall

- 0.5 -1.5 inches of rainfall  
March 12-16 (most Mar 12-14)
- Upstream of Rockford 0.5-1.0 inches



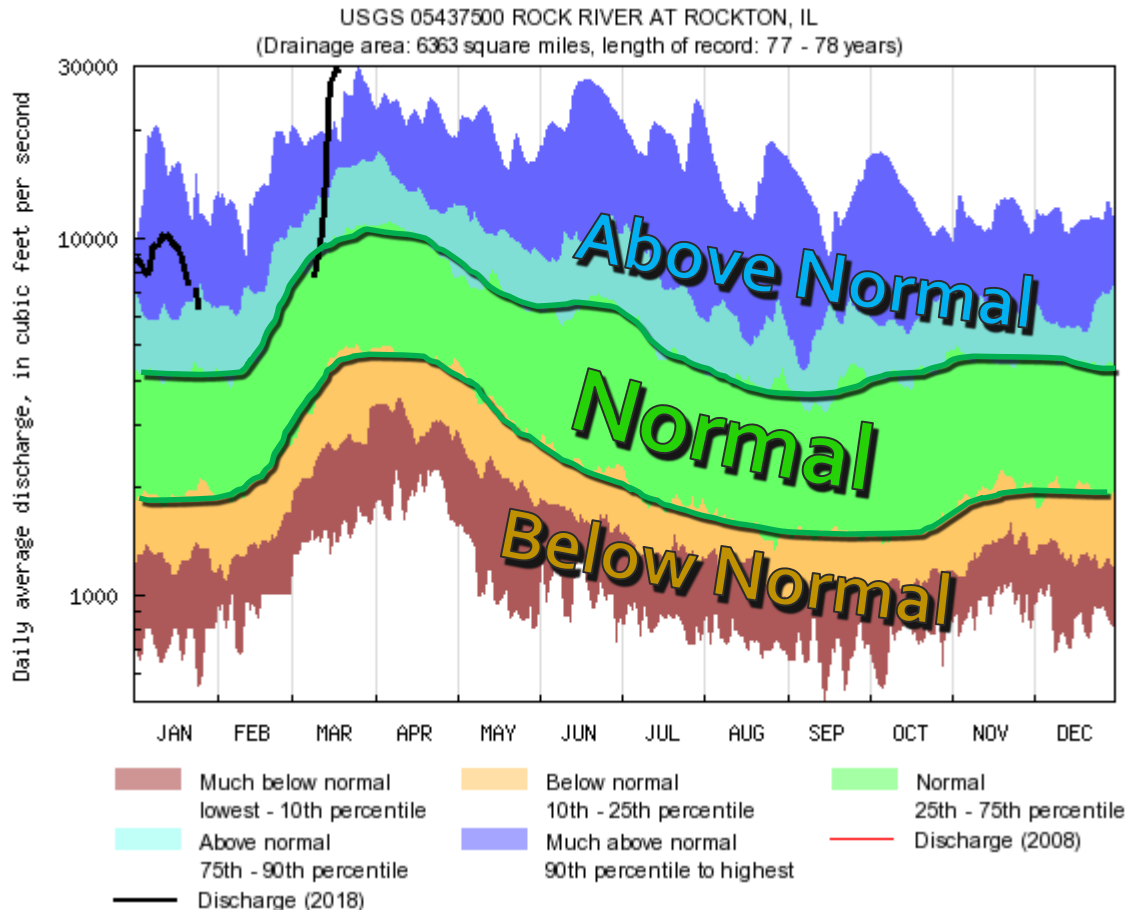
# 2019 ROCK RIVER FLOODING

...and Snow Melt



- Very warm temperatures melt almost all snow
- Like adding another 2-4 inches of rainfall over 2 days

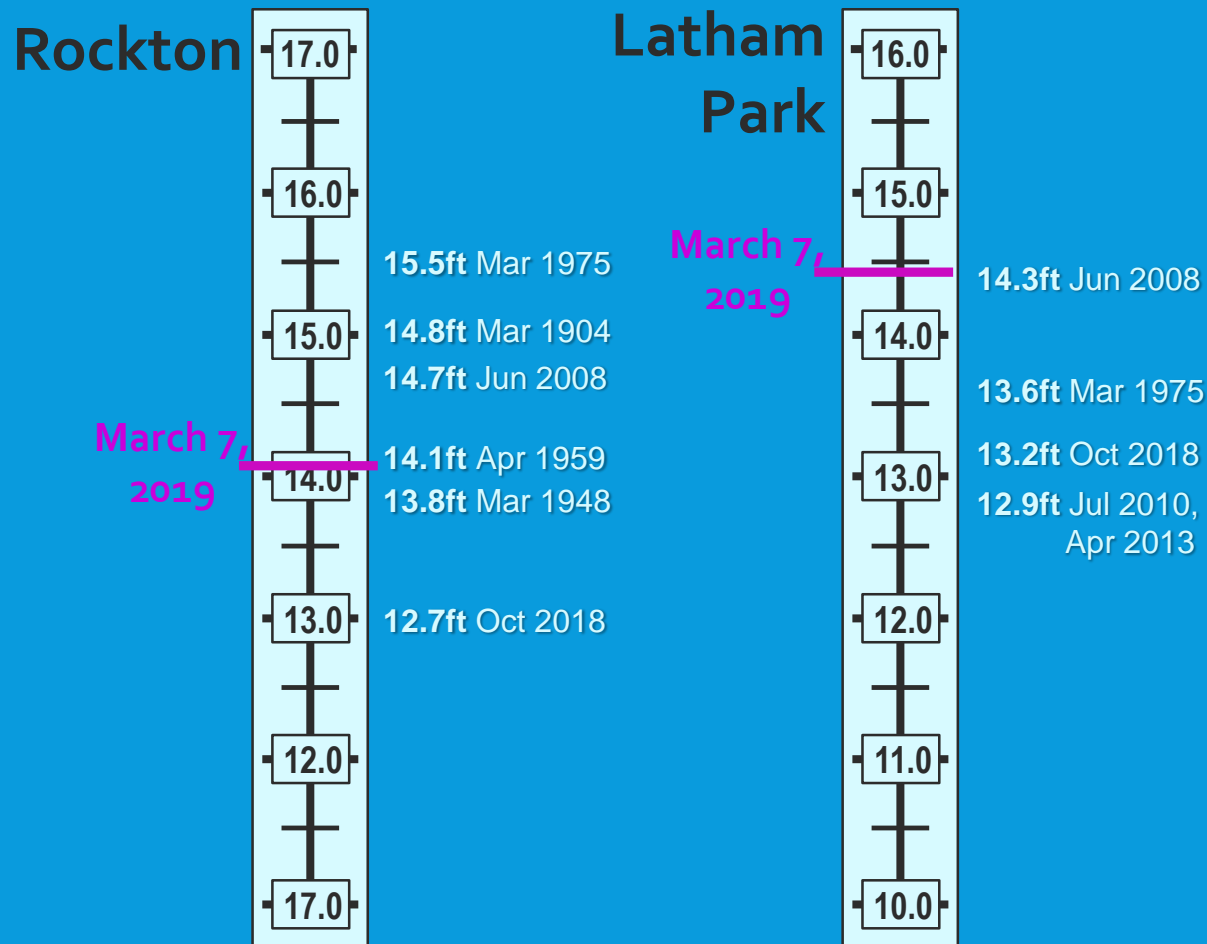
# 2019 ROCK RIVER FLOODING



How does 2019 so far compare to "typical?"

- Much above average water levels continue
- Elevated river conditions will increase the risk of additional floods

# 2019 ROCK RIVER FLOODING



## Spring 2019 Flood compared to other Rock River floods

- Among the highest crests recorded for Rockton and Rockford (Auburn).
- Record crest (preliminary) for Latham Park
- Flood with a 1-in-25 to 1-in-50 chance of occurring each year (FEMA)

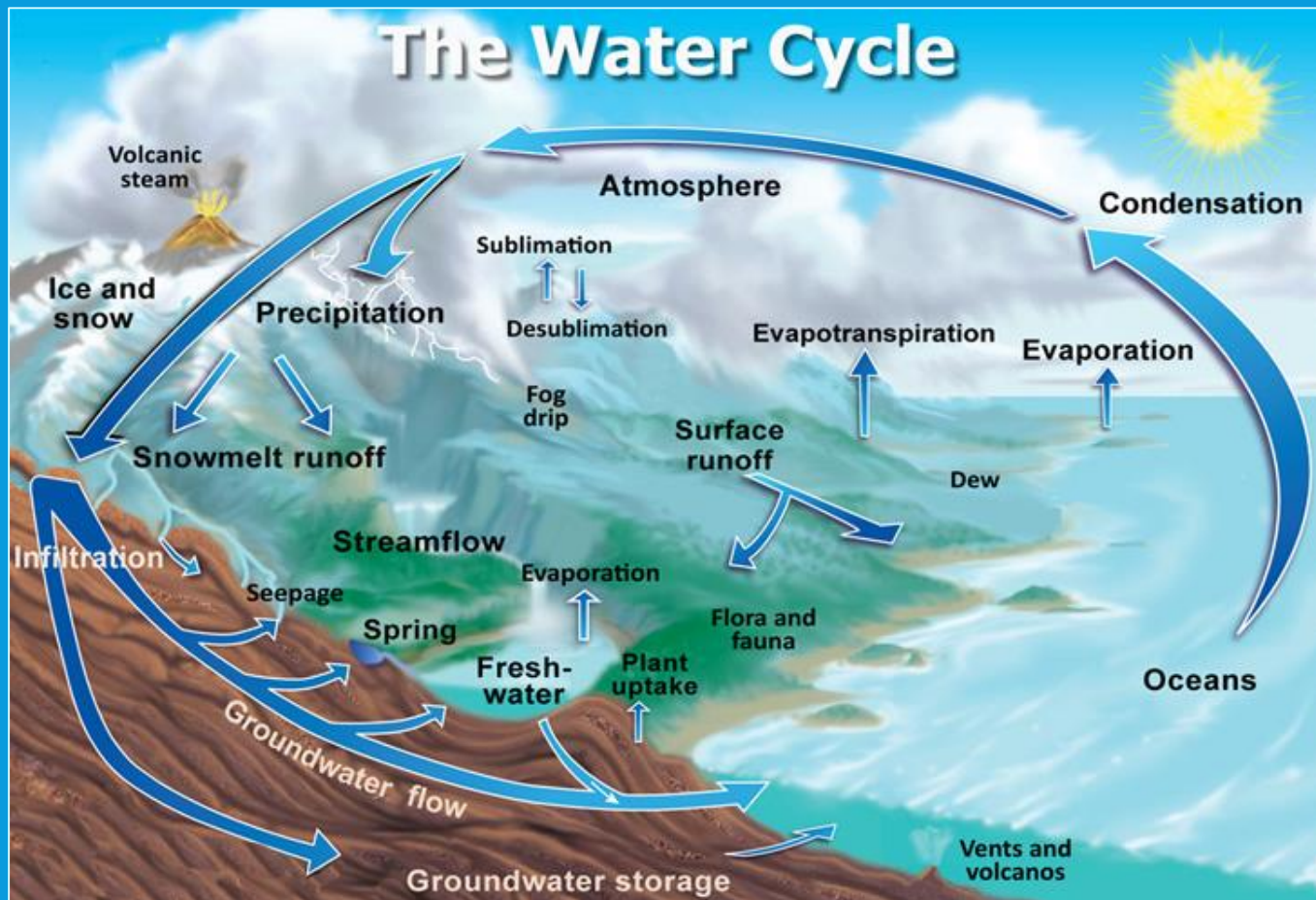


# WHY SO MUCH WATER IN THE ROCK RIVER BASIN?

**"There have been so many floods this year"**

**"I've lived here 40 years and it never flooded this much before"**

# WHY SO MUCH WATER IN THE ROCK RIVER BASIN?

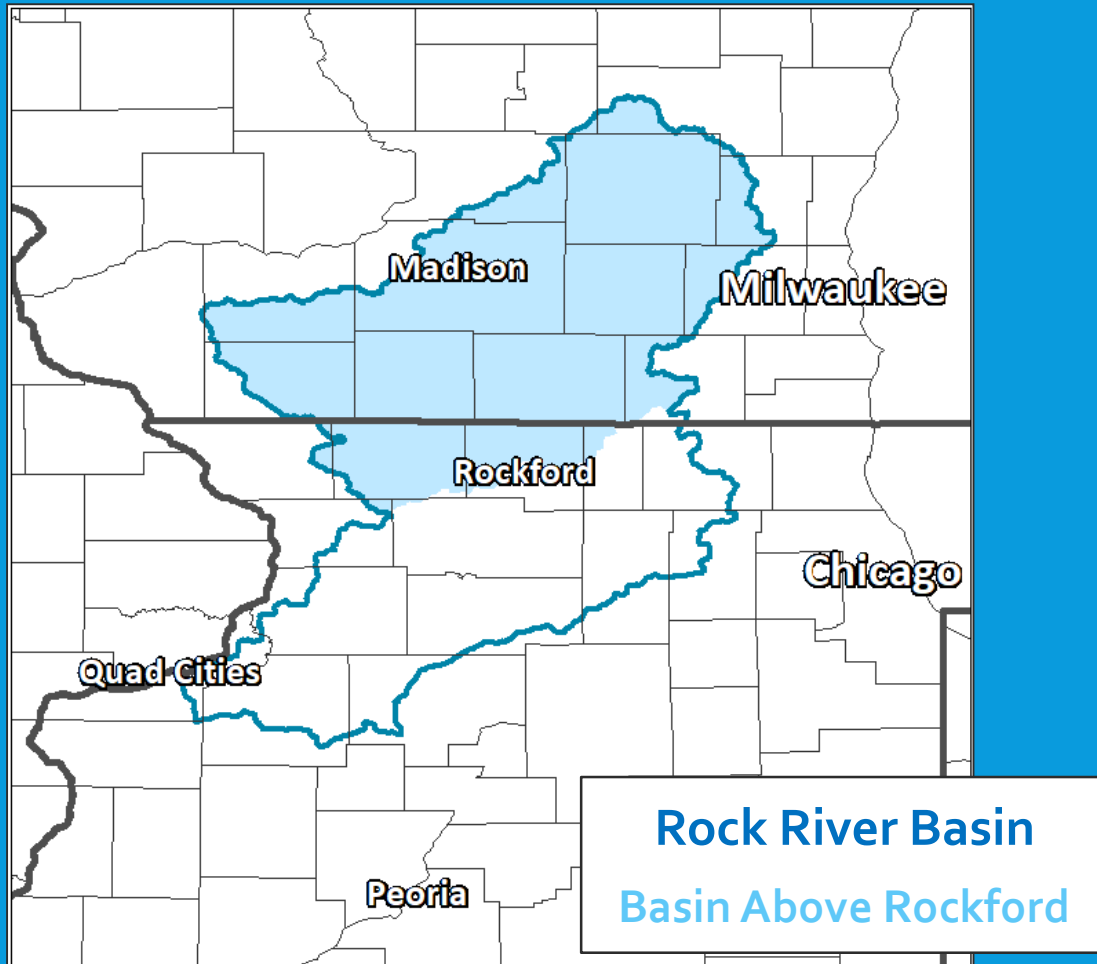


Graphic Credit: Wikipedia

## The Water Cycle

- Amount of water in the air and moving over the land is part of the “water cycle”
- The water cycle can change, causing more water in certain places

# WHY SO MUCH WATER IN THE ROCK RIVER BASIN?



## Simpler Water Cycle for Rock River Basin

- Amount of water leaving the basin is equal to water entering the basin

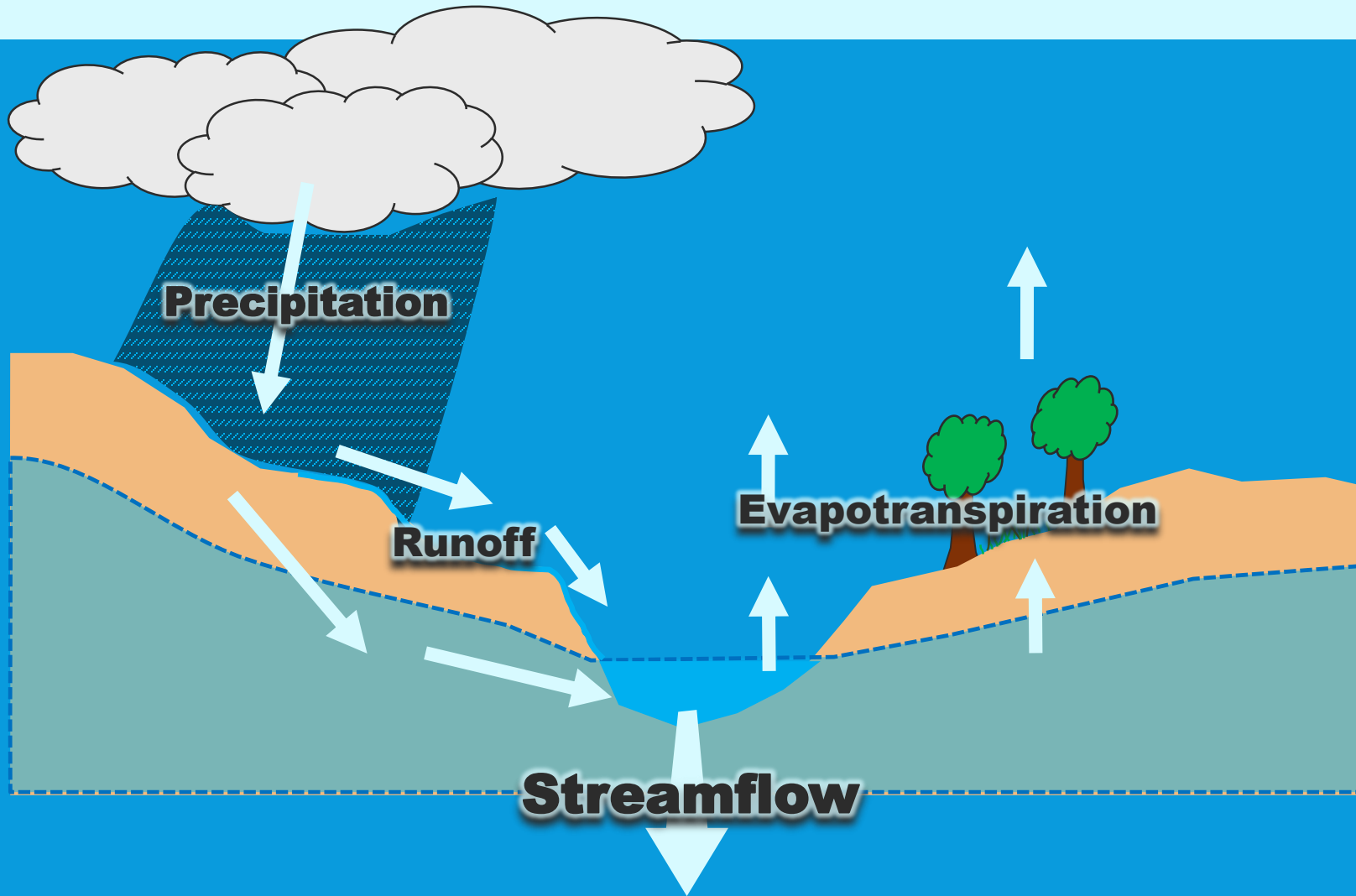
Precipitation (Rain/Snow) *Entering*

---

Evapotranspiration (Plants) *Leaving*  
Runoff (River Flow)



# WHY SO MUCH WATER IN THE ROCK RIVER BASIN?



## Simpler Water Cycle for Rock River Basin

- Water in river (streamflow) is precipitation minus evaporation and transpiration

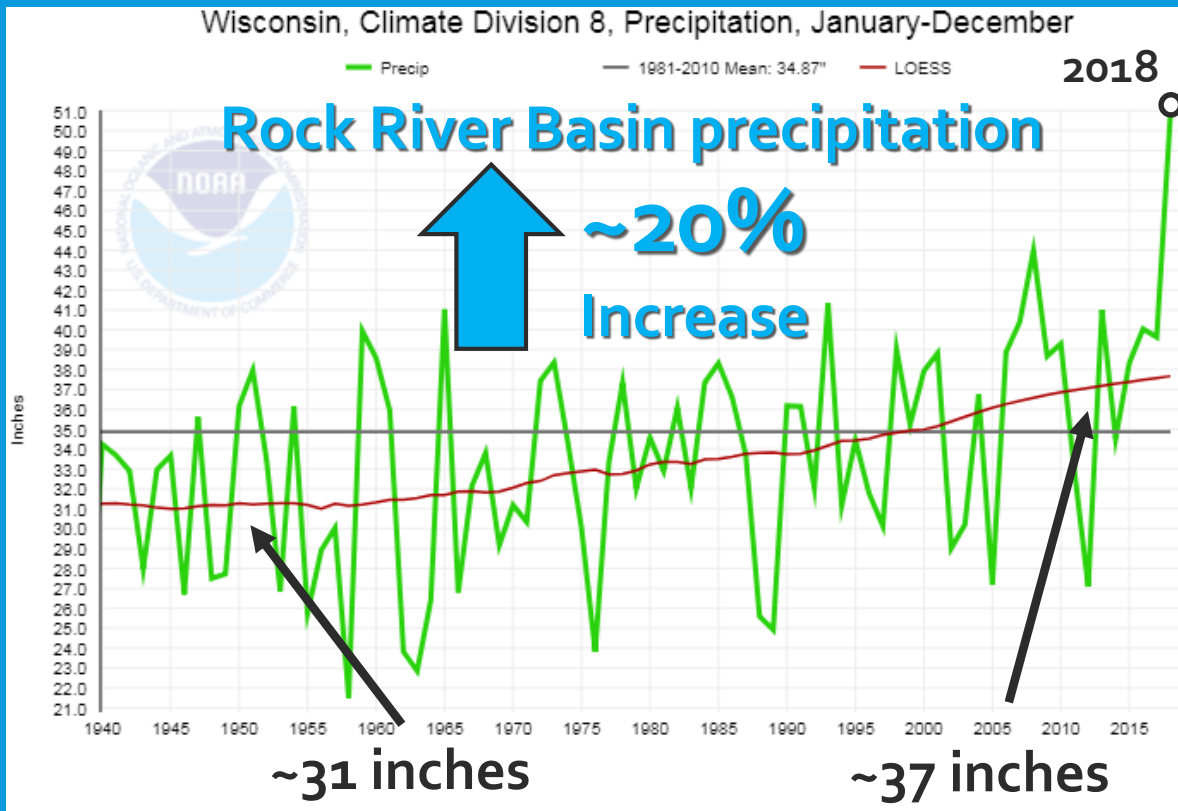
**[Precipitation]**

**- [Evapotranspiration]**

---

**[Runoff & Groundwater]**

# WHY SO MUCH WATER IN THE ROCK RIVER BASIN?

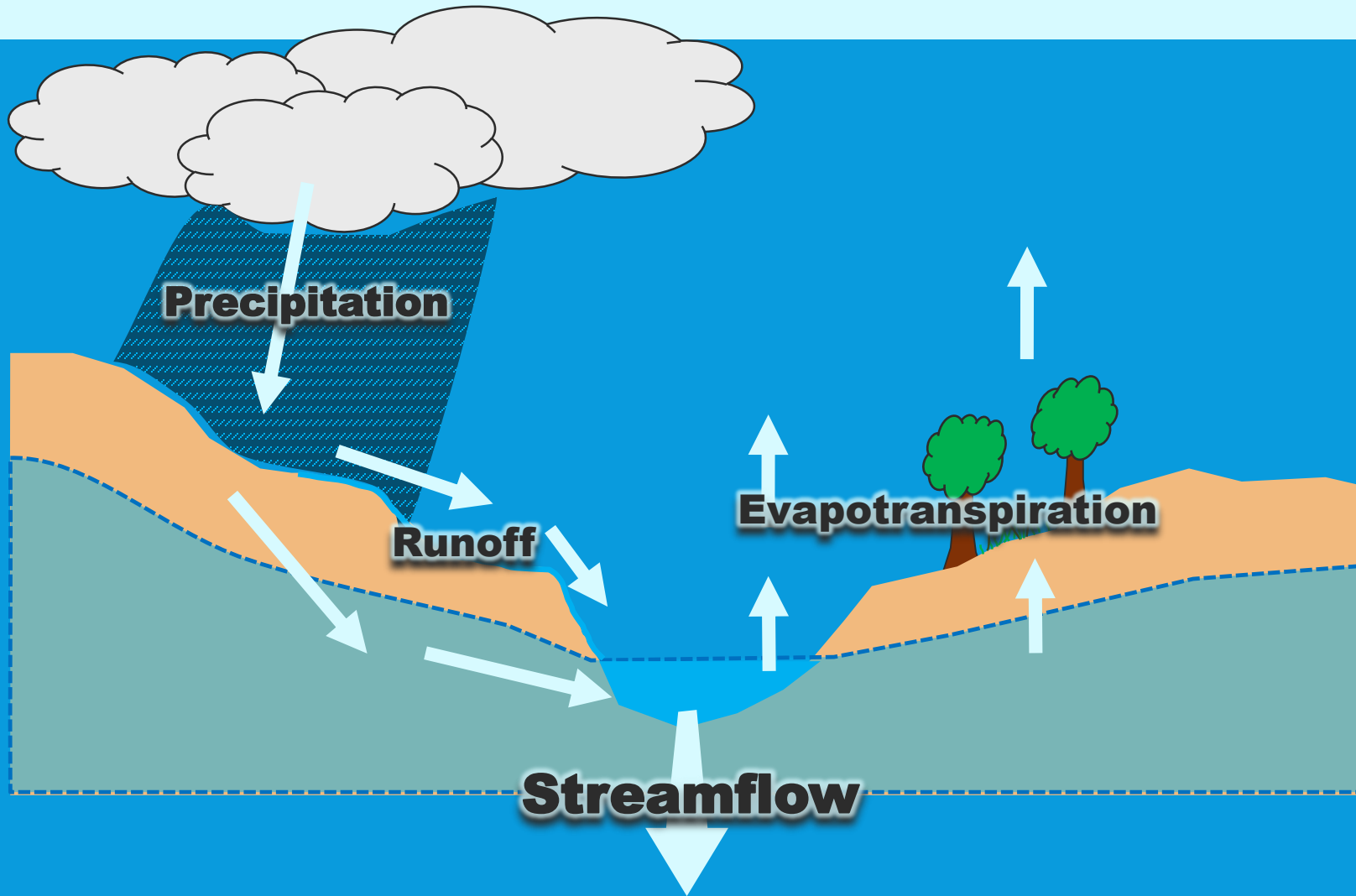


## Rock River Basin Precipitation

- 2018 was wettest year on record for the basin
- Precipitation (rain and snow) has been increasing since at least the 1960s
- Evapotranspiration has remained relatively stable at 23-24 inches per year

Graphic Credit: NOAA National Center for Environmental Information

# WHY SO MUCH WATER IN THE ROCK RIVER BASIN?



Rock River Basin: 1950s

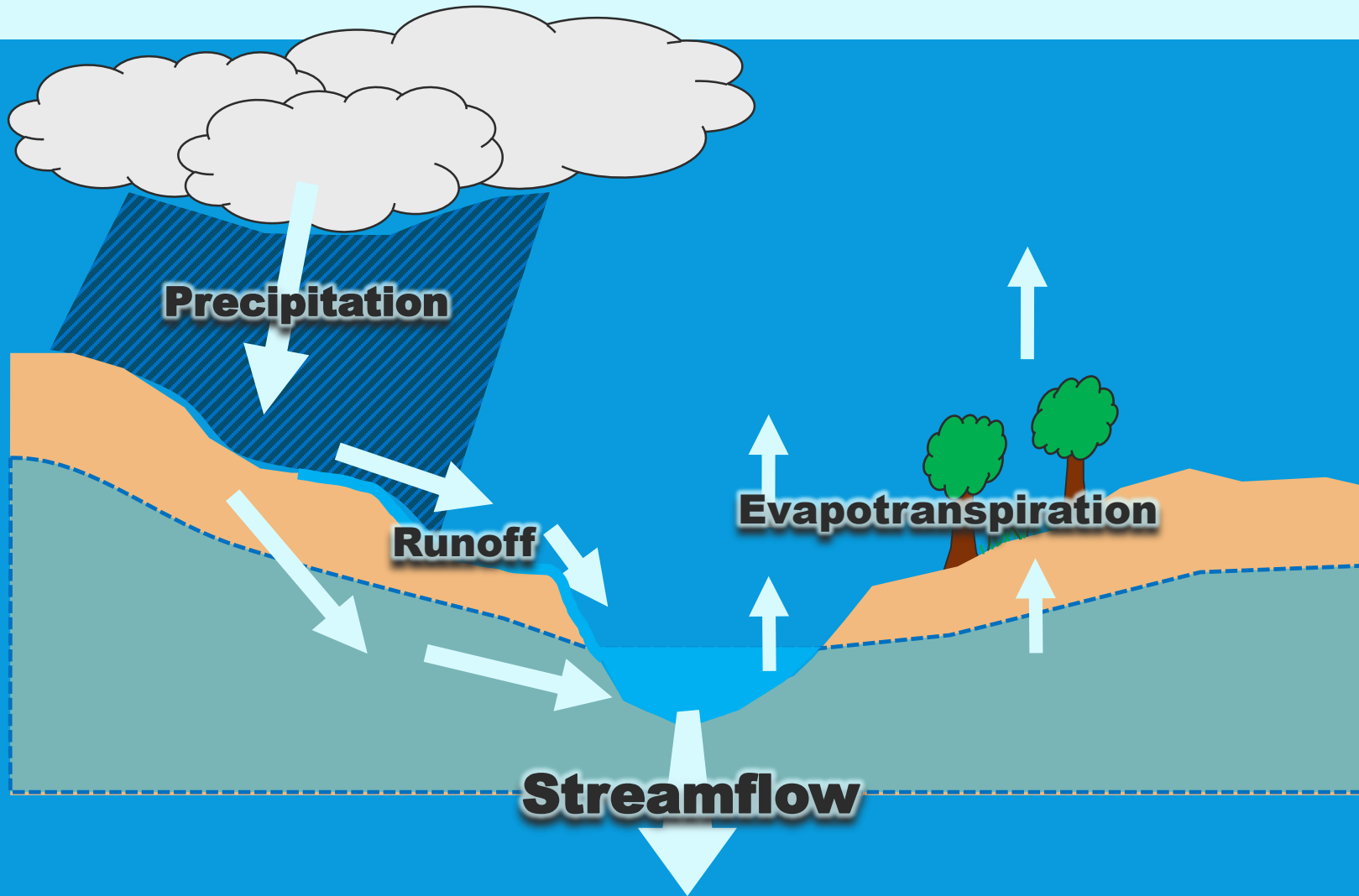
**31.2 inches Precip.**

**- 23.5 inches Evap.**

---

**7.7 inches Runoff/Gw.**

# WHY SO MUCH WATER IN THE ROCK RIVER BASIN?



Rock River Basin: 2010s

**37.3 inches Precip.**

**- 23.5 inches Evap.**

---

**13.8 inches Runoff/Gw.**

*Water headed for River*

**↑ ~75% Increase**

# WHY SO MUCH WATER IN THE ROCK RIVER BASIN?

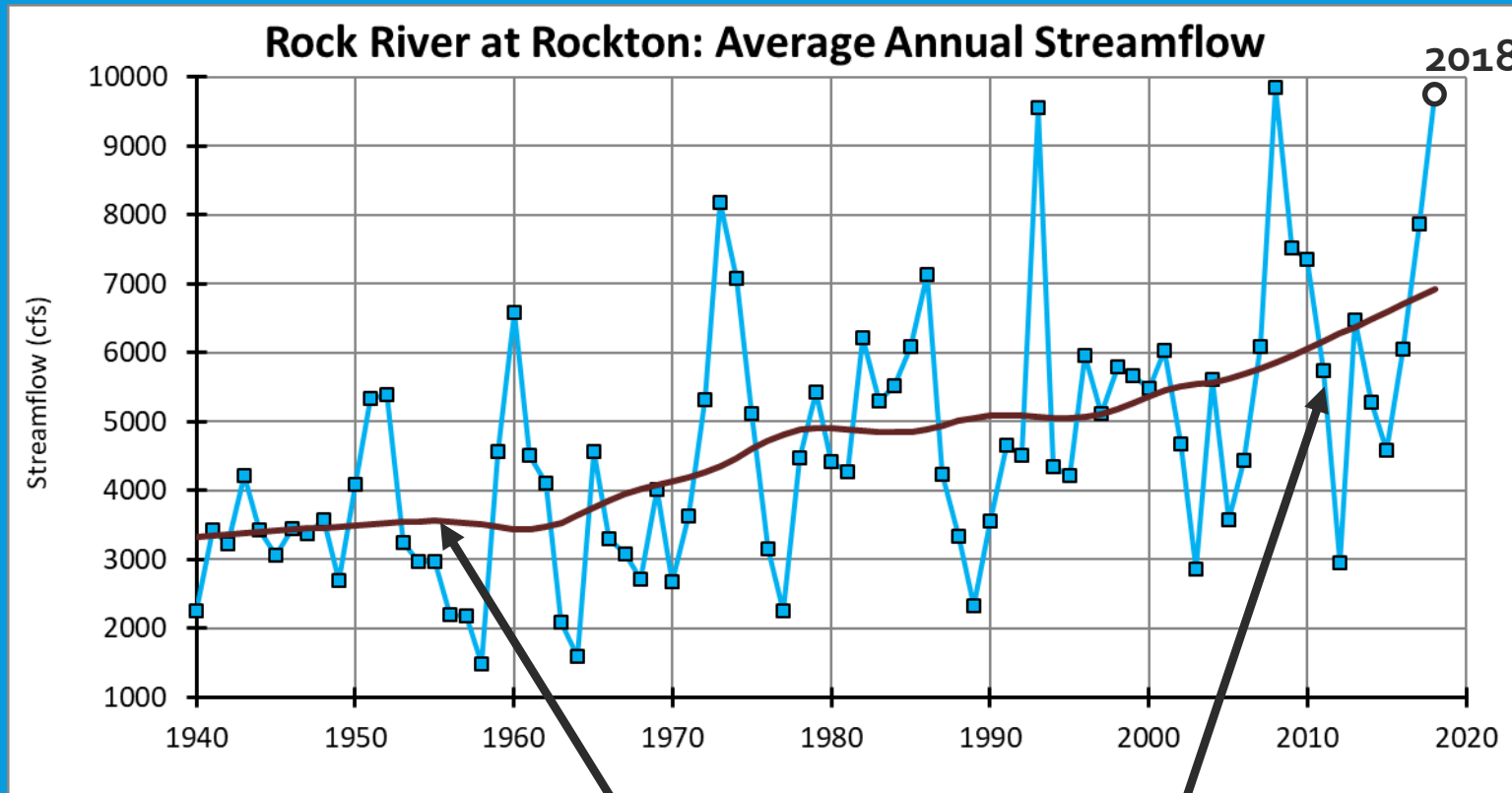


Photo Credit: USGS

## USGS Streamflow Measurements

- Are we actually seeing more water in the Rock River?  
We can confirm with measurements.
- USGS has streamflow information for Rockton since the 1940s

# WHY SO MUCH WATER IN THE ROCK RIVER BASIN?



Rock River Basin: 1950s

~3600 cfs

Rock River Basin: 2010s

~6300 cfs

Water *in* the River

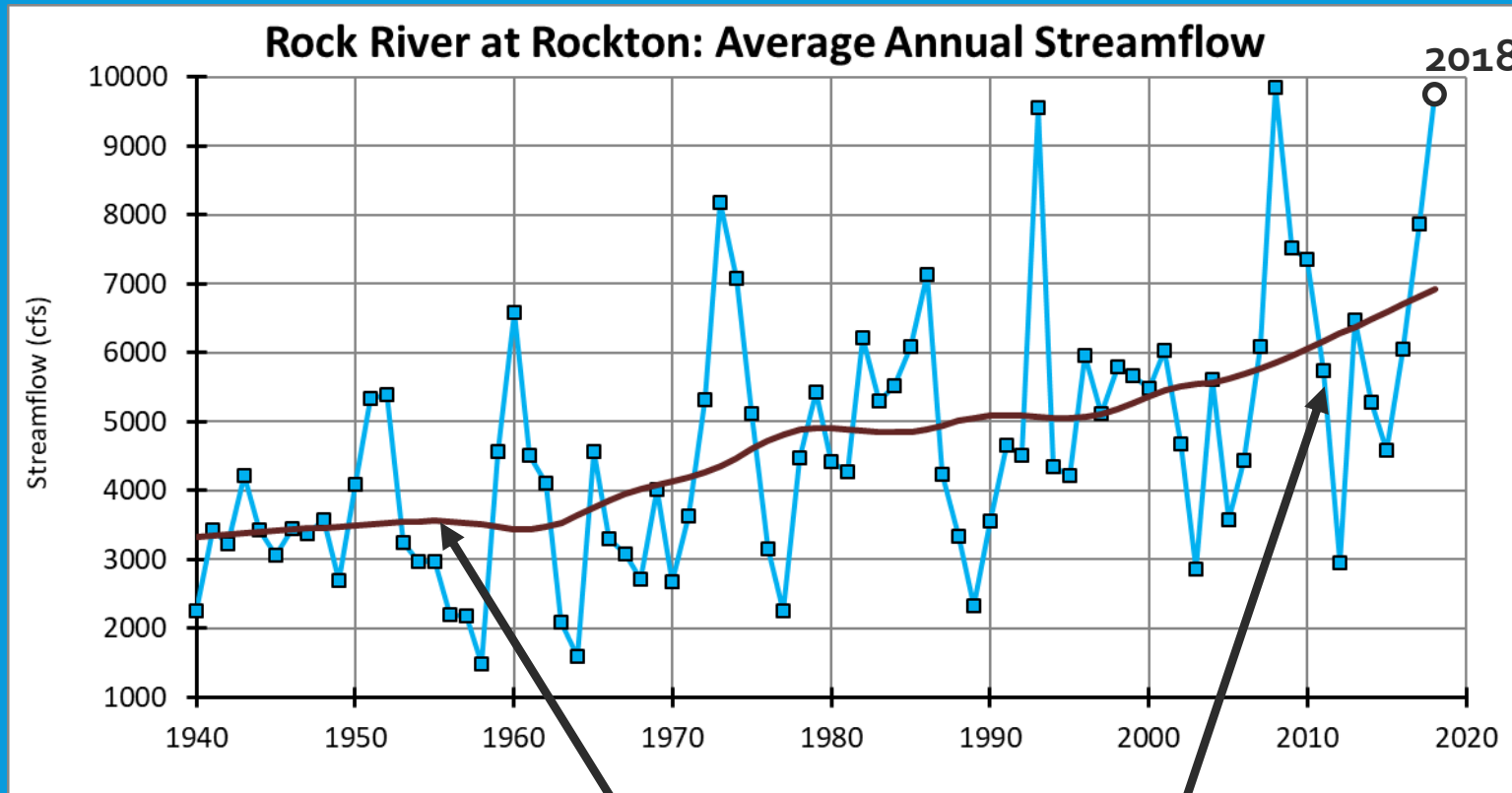
↑ ~75% Increase

Data Credit: USGS

~3600 cfs

~6300 cfs

# WHY SO MUCH WATER IN THE ROCK RIVER BASIN?



Data Credit: USGS

~3600 cfs

~6300 cfs

- Increase in streamflow large enough to increase water levels by noticeable amount
- 1-2 foot increase in annual low stage, annual high level, and annual average at Latham Park

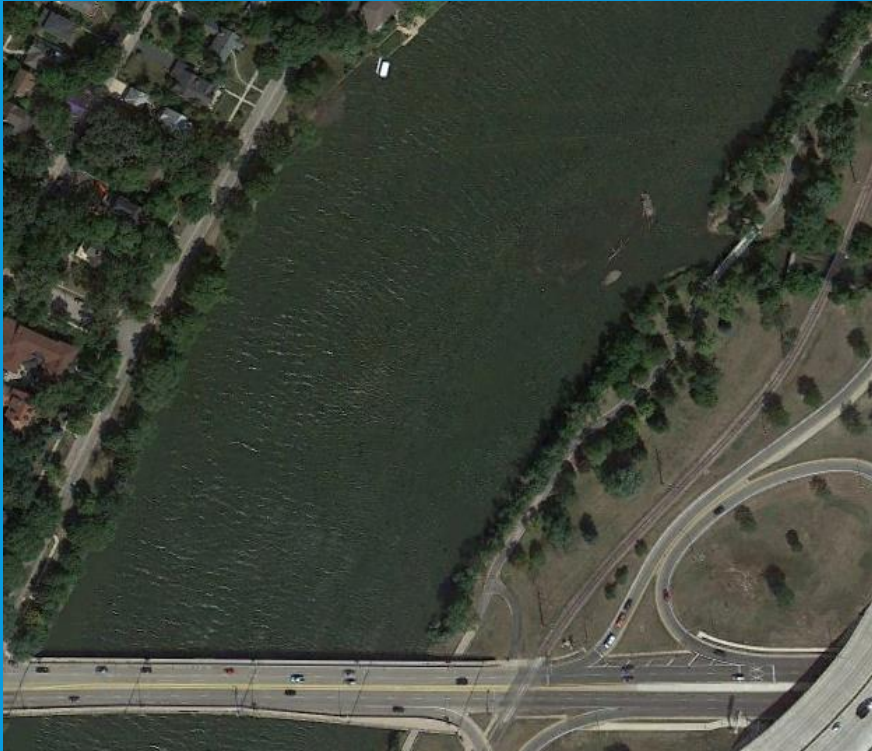
# 2018 ROCK RIVER FLOODING

What about large sand bars or other sediment?



# BUT WHAT ABOUT A BIG SAND BAR???

2013  
Google

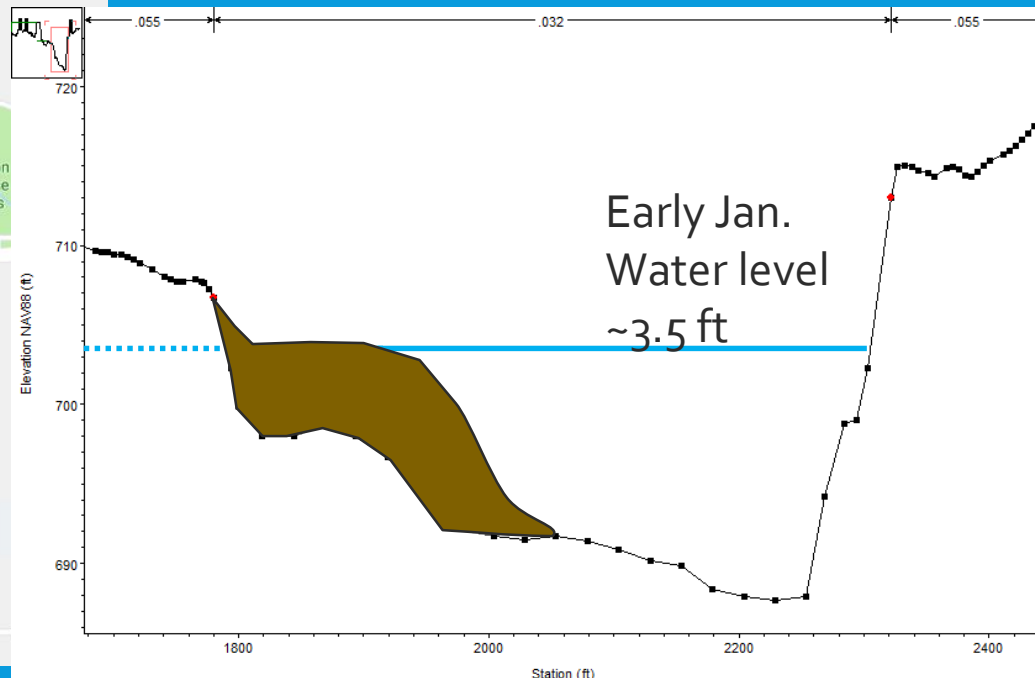
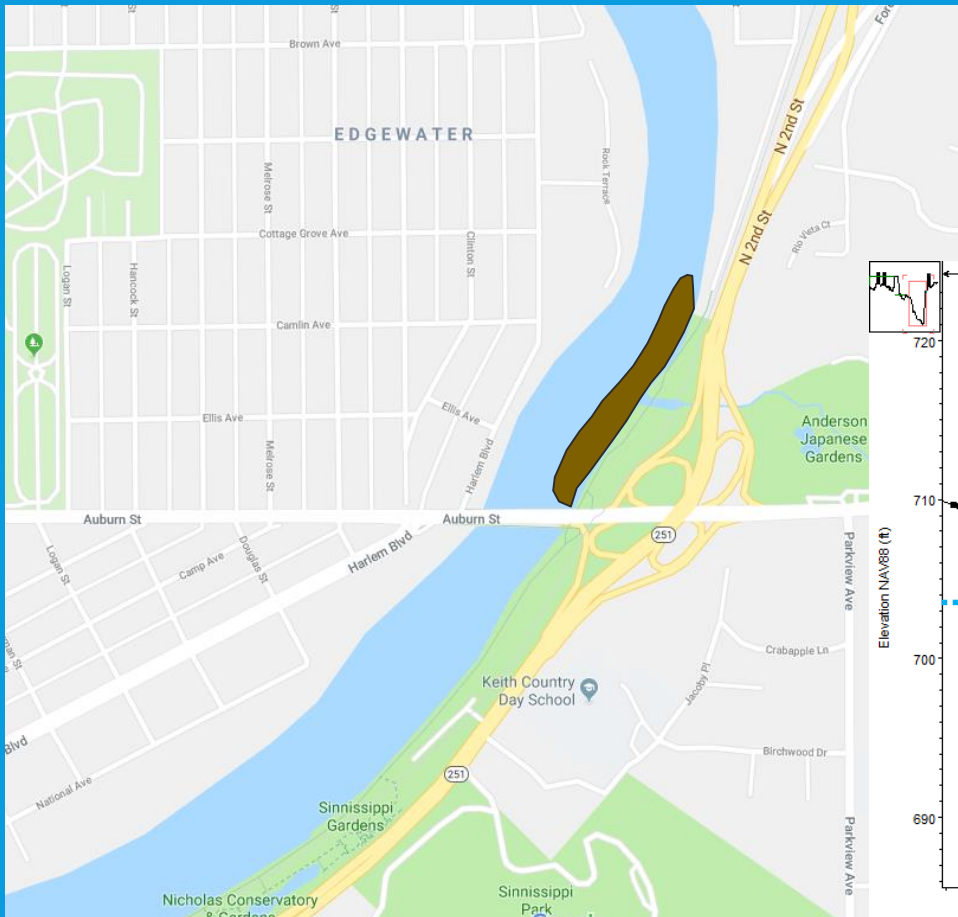


## Hypothetical Large Sand Bar Upstream of Auburn Street

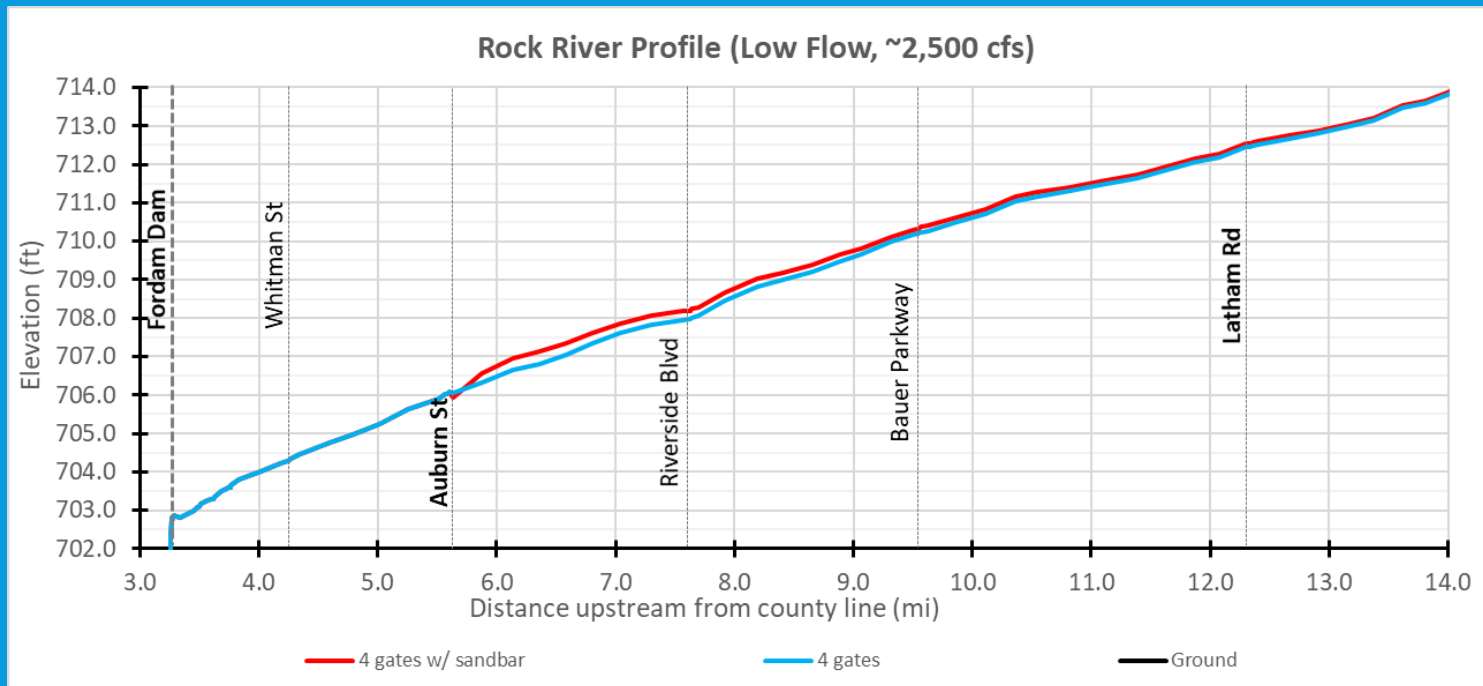
- Ran model scenarios with a hypothetical giant sand bar near Auburn Street

# EFFECT OF A POSSIBLE SAND BAR ON ROCK RIVER FLOODING

Raised river bottom in model near Auburn Street to see effect of a giant sand bar (far larger than what exists)



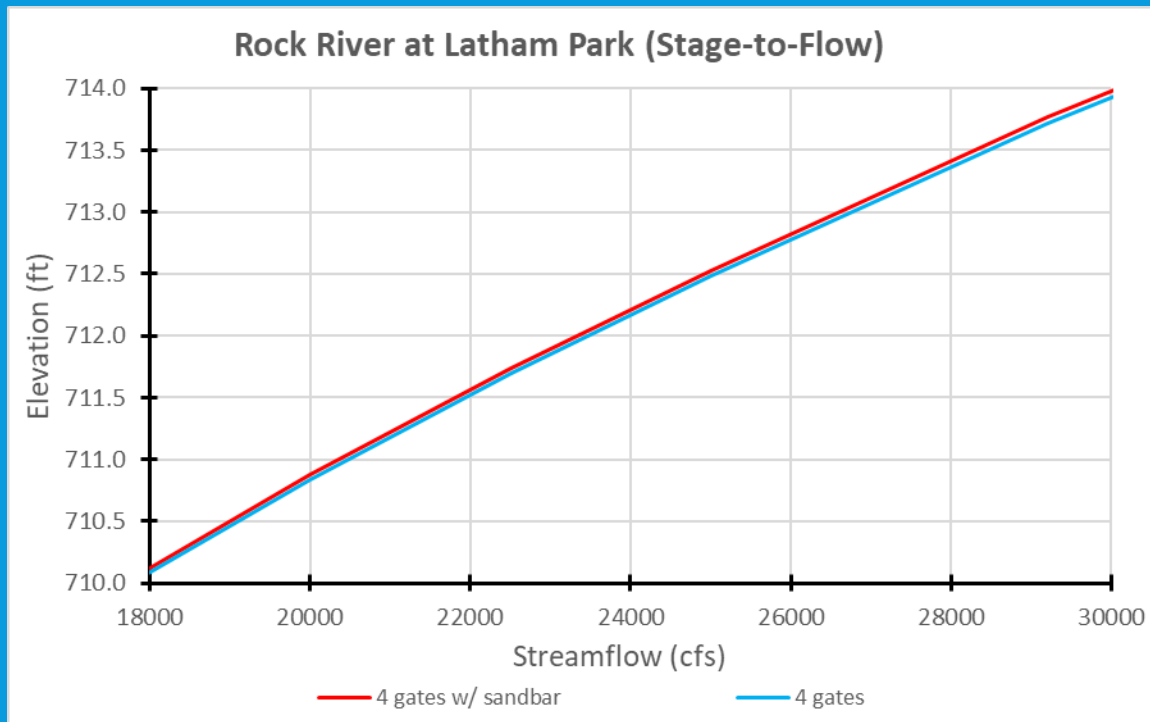
# EFFECT OF A POSSIBLE SAND BAR ON ROCK RIVER FLOODING



## “Auburn Street Sand Bar”

- Some impact (0.5ft or less) at low flow, but only near Auburn Street
- No noticeable impact at high flow. Water passes right over the top.

# EFFECT OF A POSSIBLE SAND BAR ON ROCK RIVER FLOODING



## “Auburn Street Sand Bar”

- Raises water level at Latham Park gauge 0.1 ft or less regardless of high flow or low flow

# EFFECT OF A POSSIBLE SAND BAR ON ROCK RIVER FLOODING

## Channel Sediment/Dredging

- Accumulation of sediment in the river channel impacts below-bankfull river rises the most, floods the *least*
- Dredging is often only temporary fix because it doesn't address the reason that sediment is accumulating – sediment often comes back
- Dredging can have other unintended consequences such as bank erosion
- Detailed study needed on case-by-case basis to determine the positive/negative consequences of dredging