Hydraulics and Hydrology Update

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TEAM Conference

March 7, 2018

Hydrology or Hydraulics?

- Hydrology
  - Determination of the design flow of surface water.

- Hydraulics
  - Characteristics of the conveyance of flow in a drainage system (bridges, culverts, pipes, etc.)

Pavement Drainage

- Performed by District Design Squads
- Typically a 10-year rainfall event
- Guidance in Article 640.1 of the EPG

Drainage Areas < 1,000 acres

- Performed by District Design Squads
- Typically a 25-year rainfall event for most roadways
- 50-year rainfall event for Interstates
- Guidance in Article 748.2.2 of the EPG

Drainage Areas > 1,000 acres

- Performed by Central Office Bridge Division
- Typically a 50-year frequency for bridges and culverts
- 100-year frequency for Interstates
- Guidance in Article 748.2.2 of the EPG

Floodplain Regulations

- National Flood Insurance Program (NFIP).
- Run by FEMA through SEMA.
- If no map, no regulation.
- If map, you need to do hydraulics and get a permit.
- If map indicates a Floodplain, then you must limit backwater to 1 foot over existing conditions.
- If map indicates a Floodway, then you will need a “No Rise” certificate (no backwater).

Floodplain Guidance

- Even if there are no regulations, there is still guidance.
- EPG 748.4.2 provides guidance on freeboard.

Bridge Hydraulics

- Two Common Ways to Calculate
  - Use regression equations for the region.
  - Use data from a gage near the bridge (Stream Gage Analysis).

Regression Equations

- Used when we don’t have a gage near the bridge.
- This is the case about 85% of the time.
- The state is broken into 3 regions based on topography.
- They are updated about every 20 years (1974, 1995, 2014).
- Updates are done by USGS and cost about $600,000.

Stream Gage Analysis

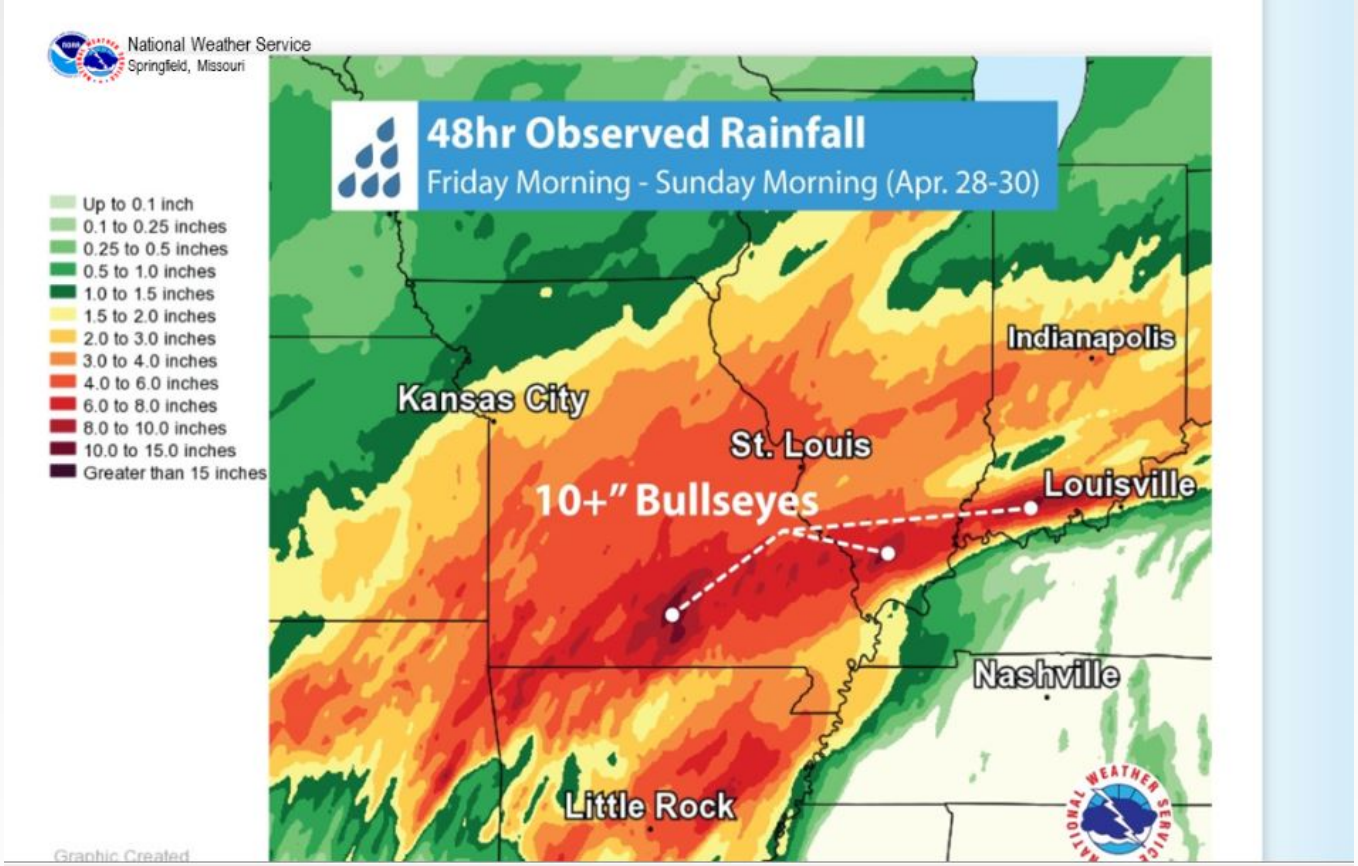
- Used when we have a gage on the same stream as the bridge.

- This is the case about 15% of the time.

- All available data for that gage is used.

2017 Flooding

- 48 hour rainfall totals of 3 to 15 inches were observed over most of the state.



2017 Roadway Closures

Total Closures

- 384 Closures - Noon Sunday
- 285 Closures – Flood 2015

A2550 – Rte. 42 – Maries County

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W0498 – Rte. NN – Pulaski County

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It is very helpful if Districts record high water marks.

N0670 – Rte. PP – Ozark County

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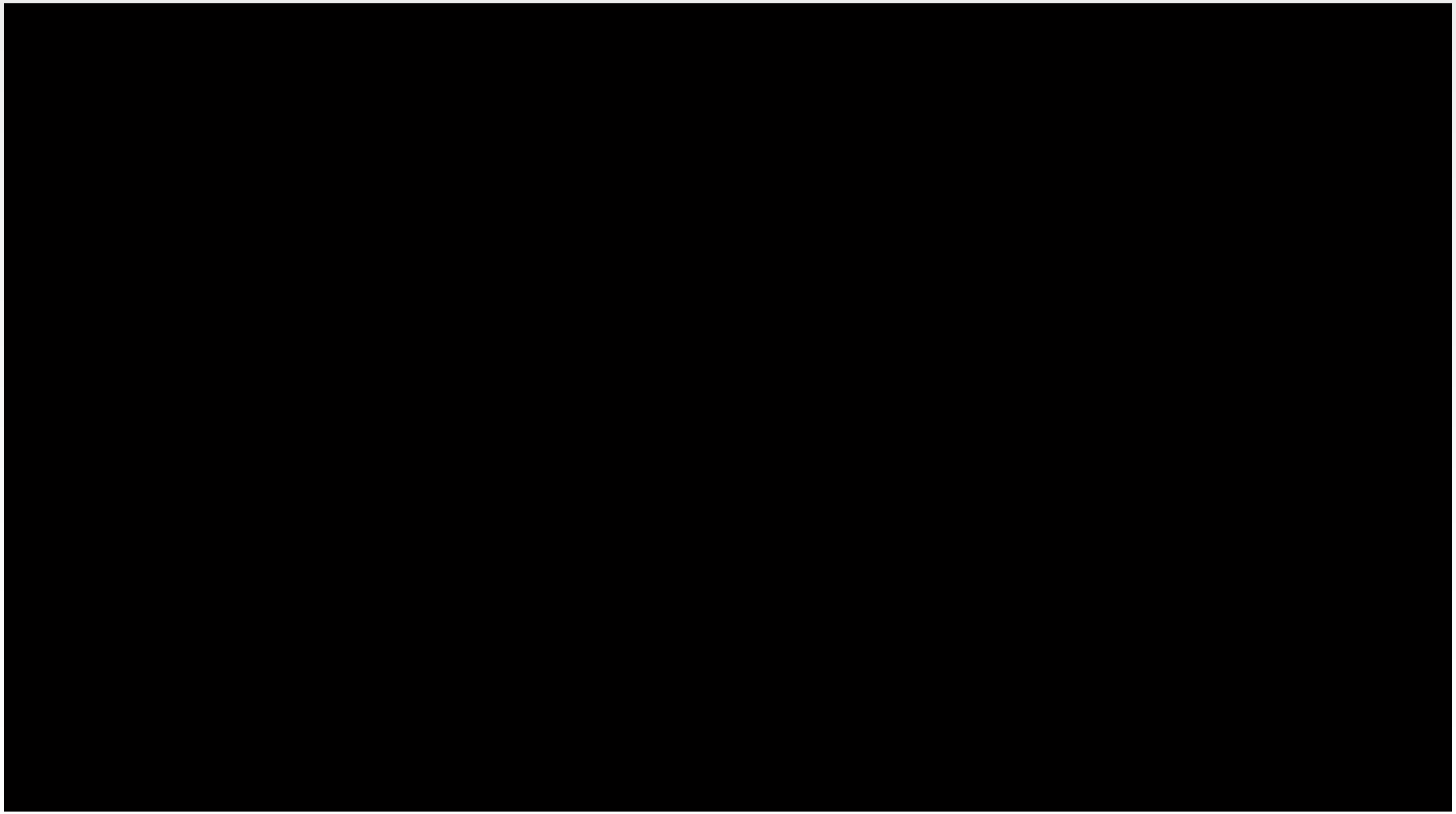

N0670 – Rte. PP – Ozark County

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A3647 – Rte. CC – Ozark County

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Route CC Ozark County

- North Fork of the White River.
- The April/May 2017 event was a 200-year flood.
- Had this same flood happened in 1990, it would have been classified as a 500-year flood.
- The change is due to the number of floods since 1990.

I-44 at Jerome

I-44 at Jerome

Table 6: Summary of Recent Flood Events on Gasconade River

Flood Event	Rank	Year	Stage	Peak Flow	Frequency
Flood of Record	1st	2017	35.06 ft	197,000 cfs	150-year
2015 Flood	2nd	2015	31.92 ft	140,000 cfs	50-year
2013 Flood	3rd	2013	31.81 ft	138,000 cfs	50-year
2008 Flood	6th	2008	30.43 ft	118,000 cfs	30-year
2011 Flood	11th	2001	26.58 ft	85,100 cfs	10-year

- 5 of the 11 highest discharges are in the last 10 years!

Champ Clark Bridge at Louisiana

Champ Clark Bridge at Louisiana

- Mississippi River.

- From 1990 to 2007, US 54 was closed only 3 times for more than a week.

- From 2008 to 2016, US 54 was closed 6 times for more than a week.

- So twice the number of closures in half the time.

Observations

- If you have 100 years of gage data, about 7 out of the 10 highest discharges are in the last 25 years.

- We are seeing discharge increases of 30% - 50%.

Recommendations

- This is a national problem.

- We need better terminology to avoid “years”.

Recurrence intervals and probabilities of occurrences

Recurrence interval, in years	Probability of occurrence in any given year	Percent chance of occurrence in any given year
100	1 in 100	1
50	1 in 50	2
25	1 in 25	4
10	1 in 10	10
5	1 in 5	20
2	1 in 2	50

Recommendations

- Continue to use all available data when you have a gage.
- Continue to use regression equations from 2014.
- Consider increasing freeboard requirements.
- Consider “resiliency” options such as each county having one North/South and One East/West route designed to a higher standard.

Questions?