Hydrologic Calibration for Unsteady Flow Models

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Plan Design Enable

Calibrate

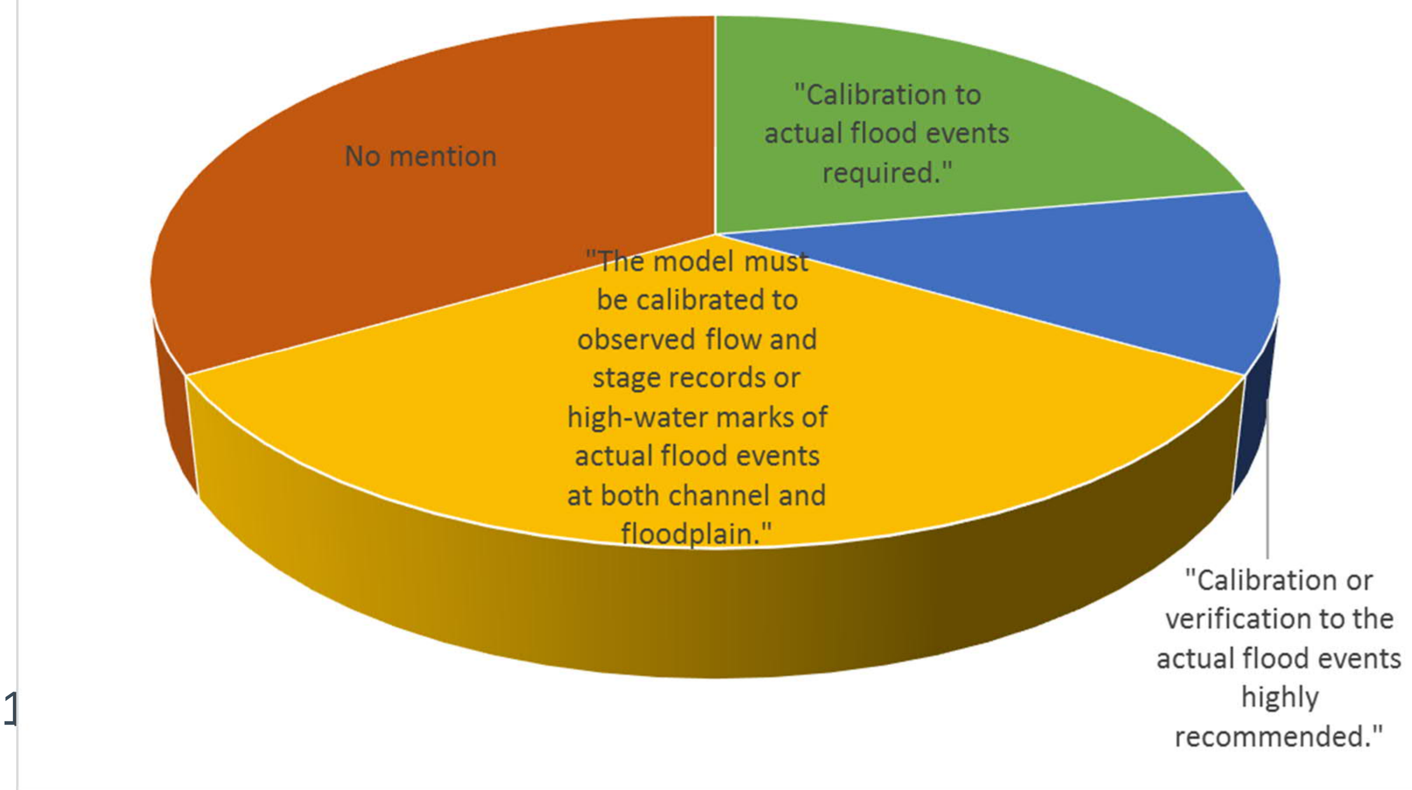
To determine, check or rectify the graduation of any instrument giving quantitative measurements

Webster's Dictionary, 1996

Flood study requirements

Hydraulic Numerical Models Meeting the Minimum Requirement of National Flood Insurance Program

This page provides a list of nationally and locally accepted hydraulic models that meet National Flood Insurance Program (NFIP) requirements for flood hazard mapping activities. This page is intended for Engineers, surveyors, floodplain managers and FEMA mapping partners.



FEMA, 2017

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Calibrating peak flow for design storm events

National Streamflow Statistics Program

- Home
- Publications
- Software Version History
- Summary of NSS
- Download Software
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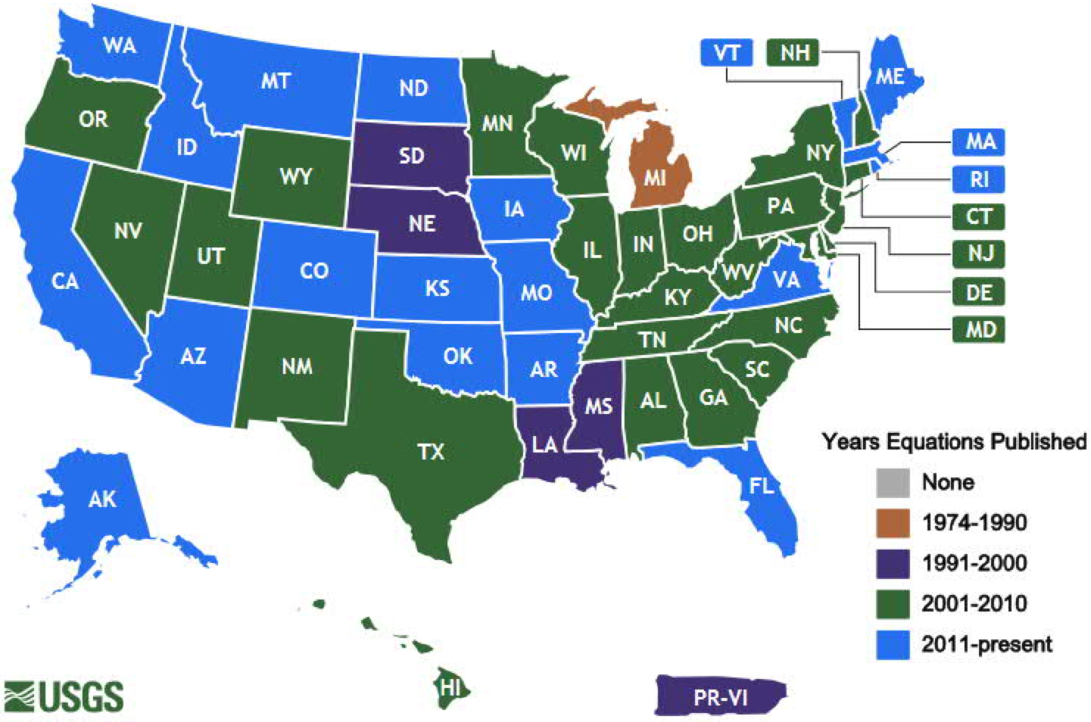
Regional Regression Equation Publications by State

USGS Rural Peak-Flow Regression Equations



(Note: Regional regression equations may not be representative of the entire state.)

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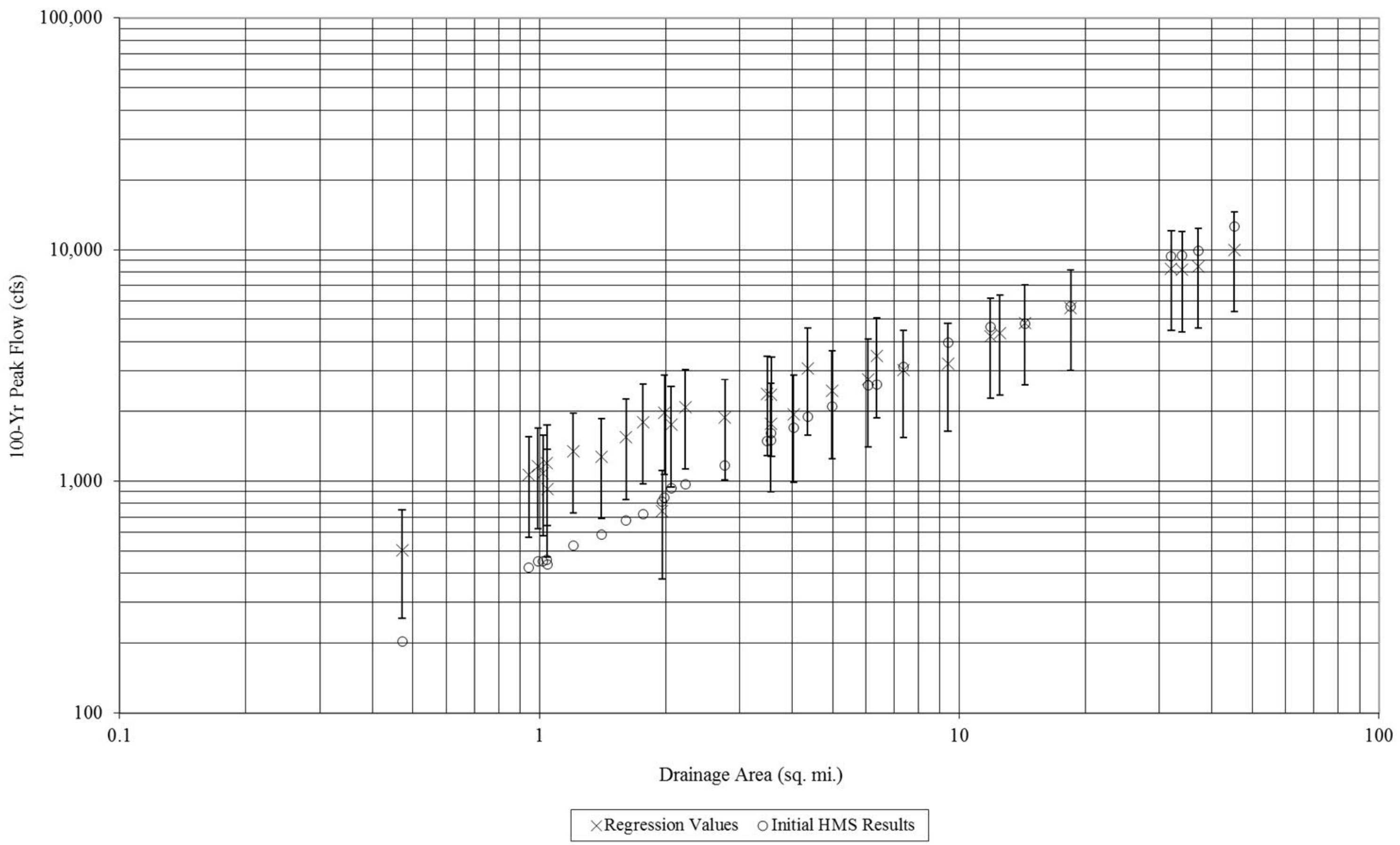
Calibrating peak flow for design storm events

Attachment 10. Initial HMS vs. regression results



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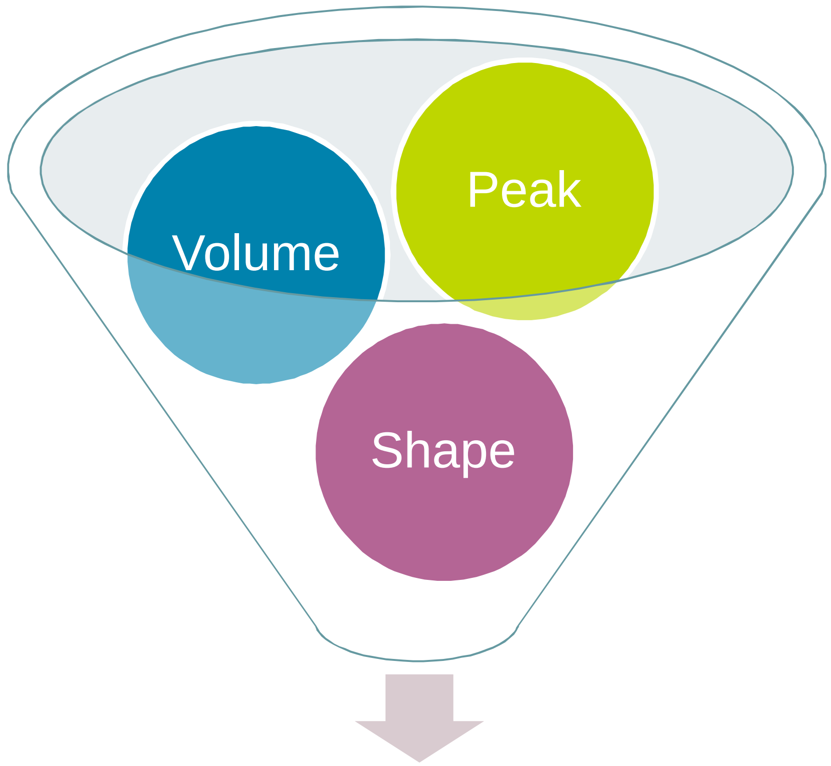
It’s not just the peak flow…



Final flow depth

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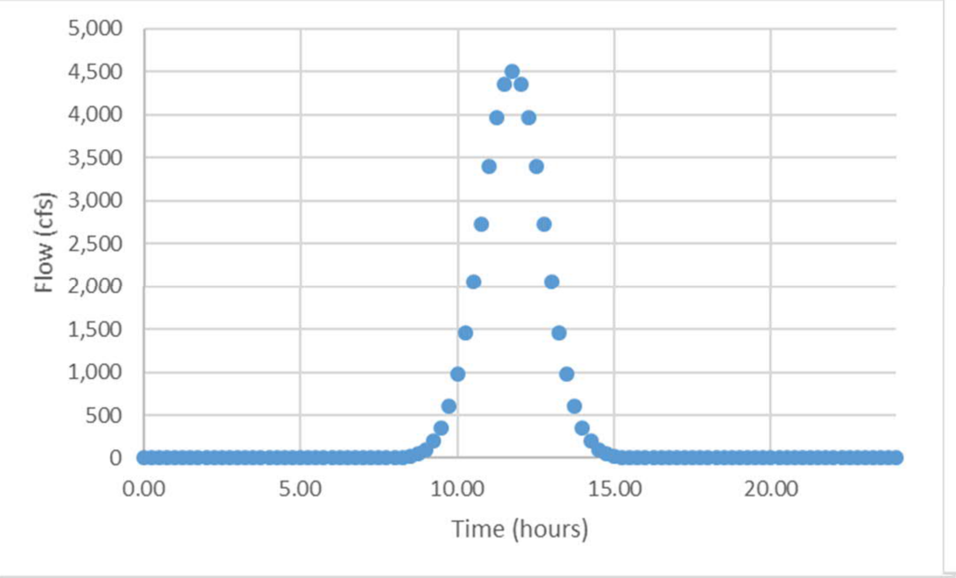
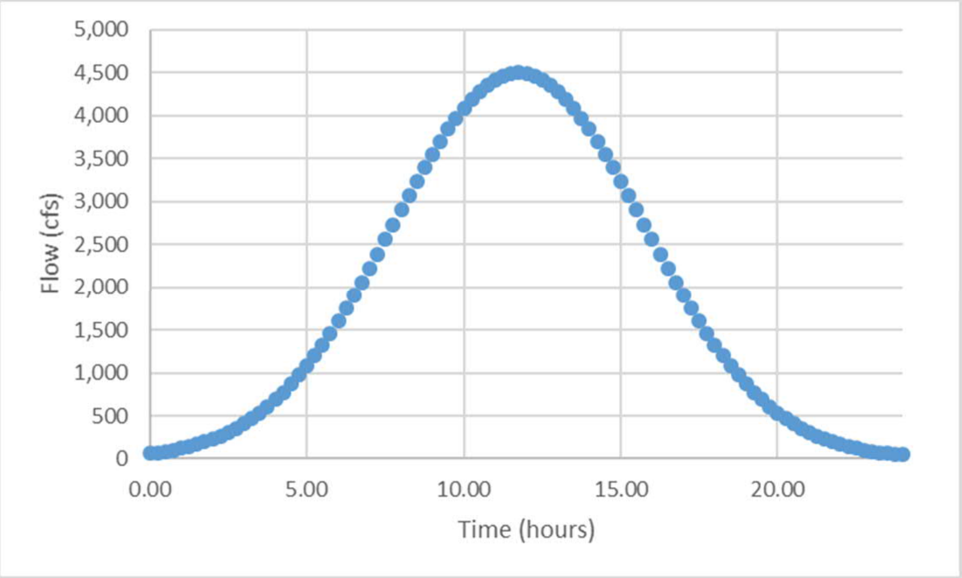
Same peak, 3X the volume





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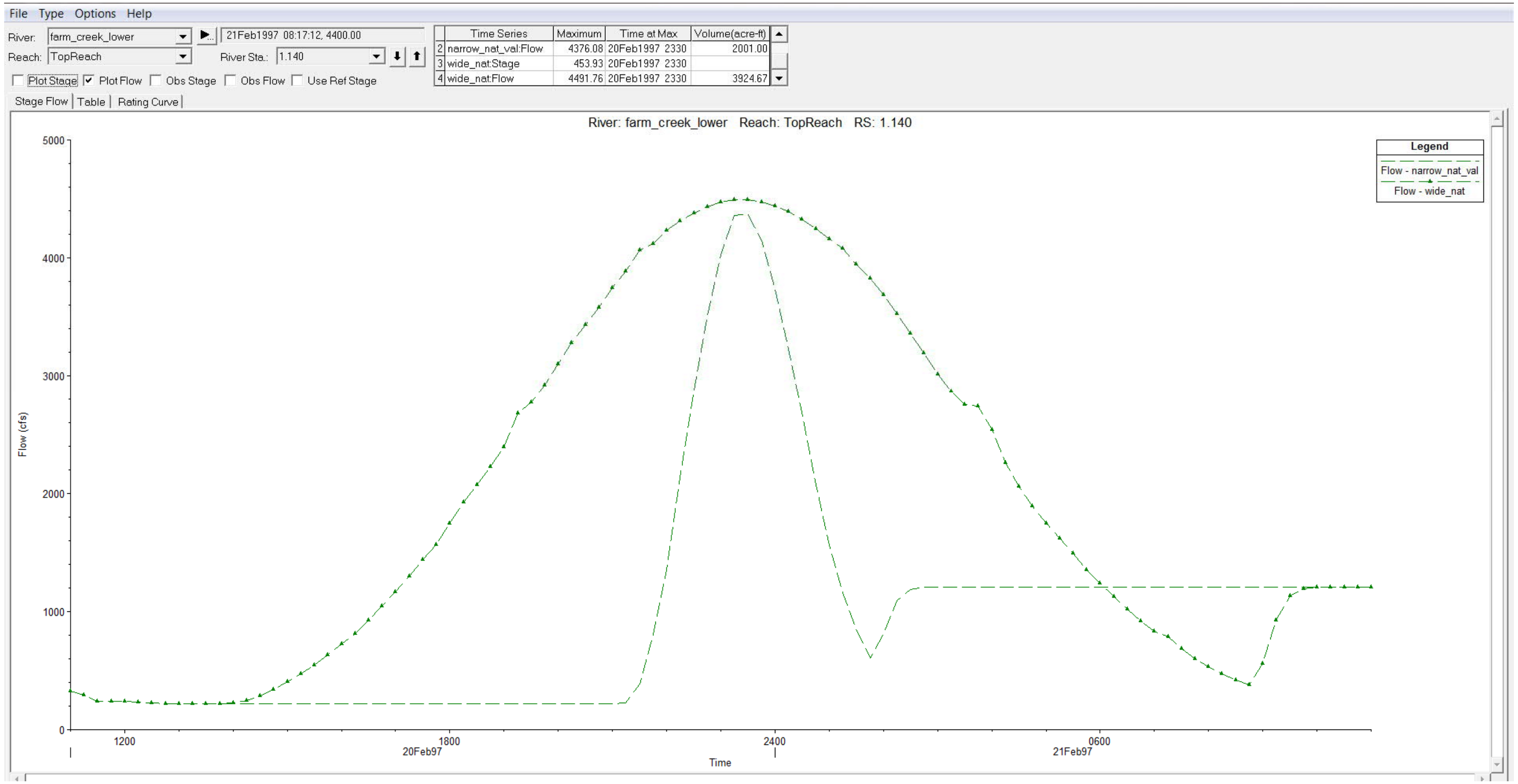
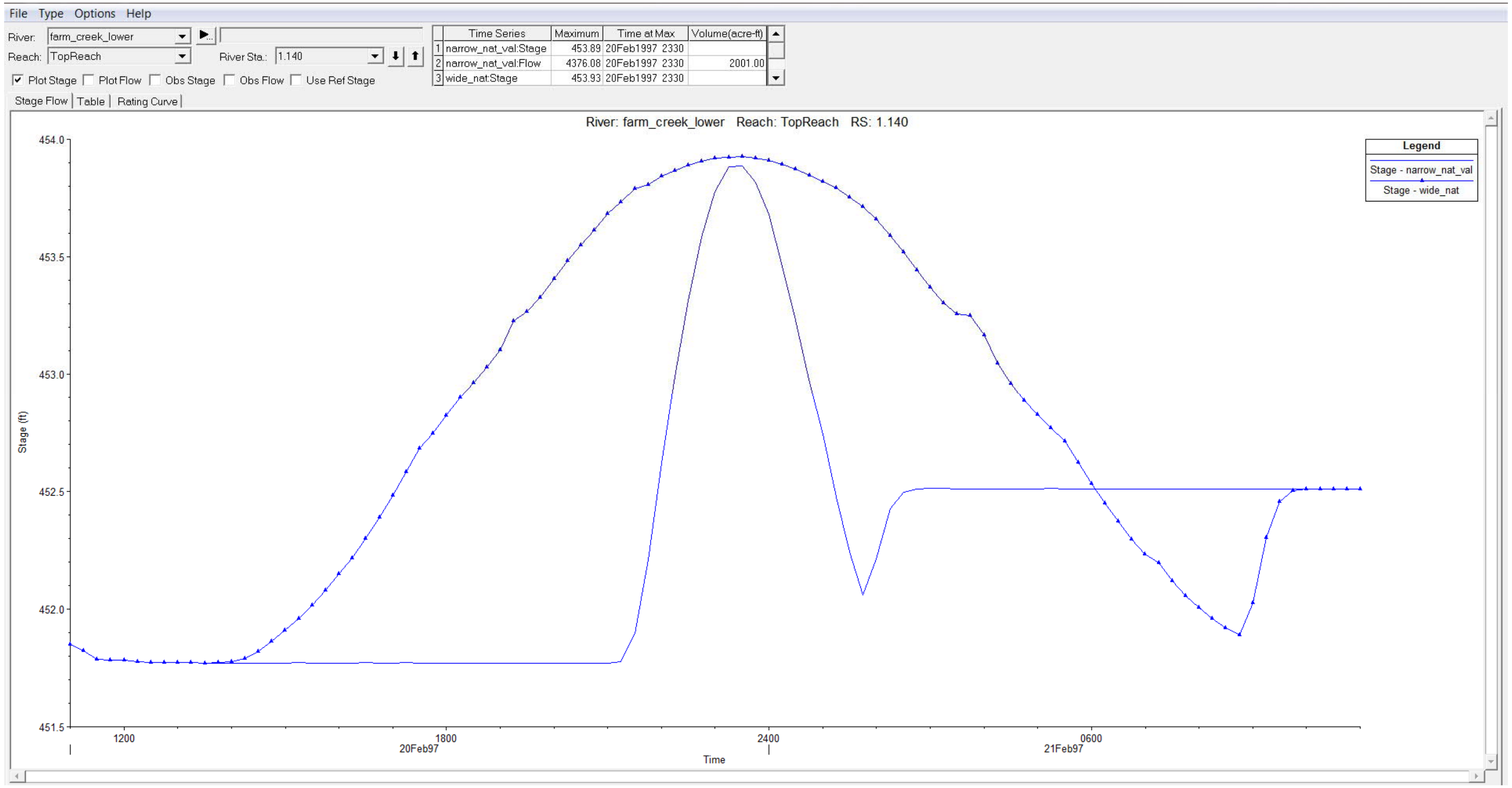
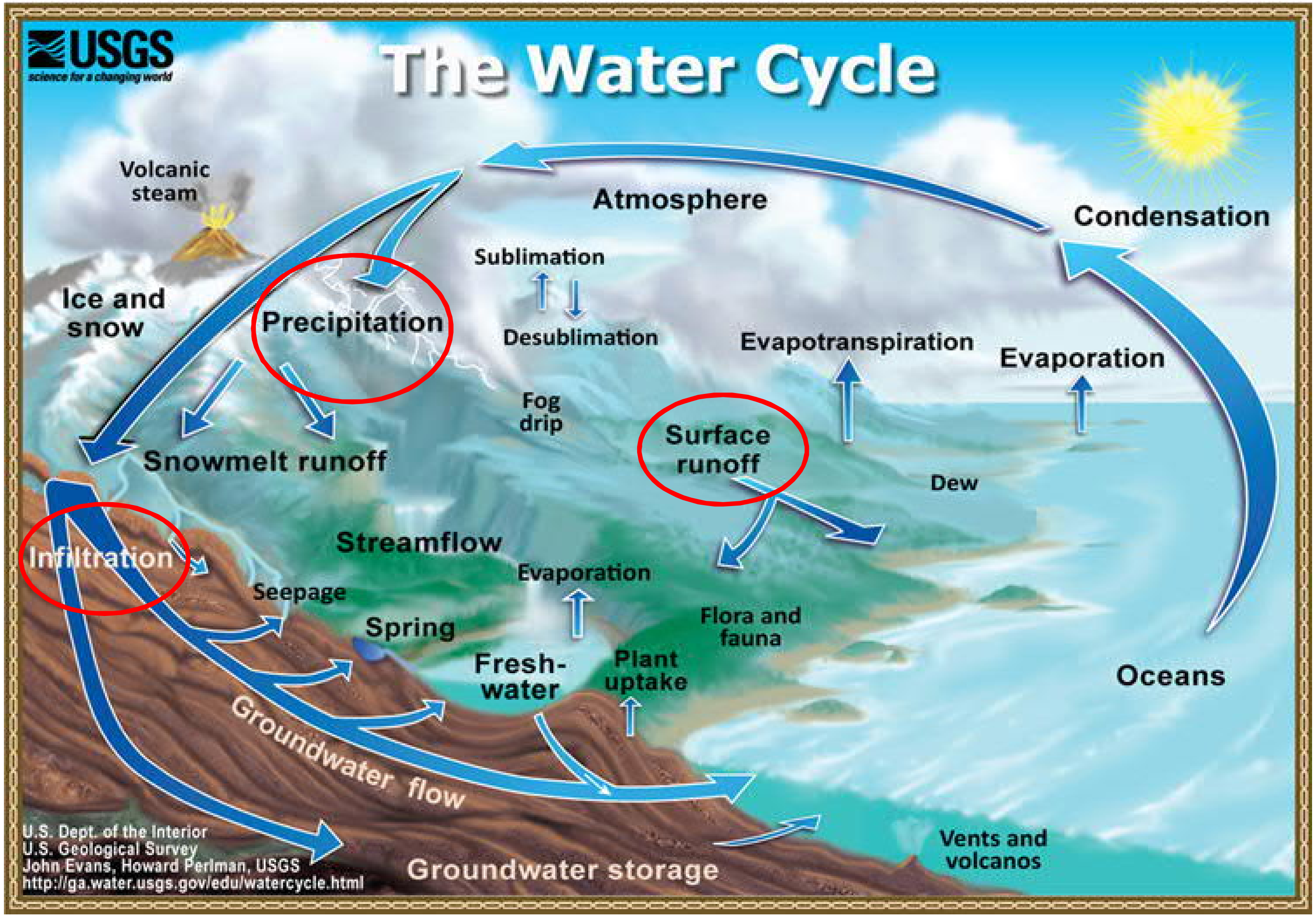
Attenuation of flow hydrograph



Affect on stage hydrograph



Hydrograph volume



USGS, 2017

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Curve Numbers

- **Developed from plots of rainfall versus runoff for studies of 24 watersheds**
- **Never peer reviewed, underlying data is no longer available**
- **However, method seems to work well in many cases**

NRCS, 2016

Table 2-2a Runoff curve numbers for urban areas [1]

Cover description: Cover type and hydrologic condition	Average percent impervious area [2]	Curve numbers for hydrologic soil group: A	B	C	D
Fully developed urban areas (vegetation established)					
Open space (lawns, parks, golf courses, cemeteries, etc.) [3]:					
Poor condition (grass cover < 50%)		68	79	86	89
Fair condition (grass cover 50% to 75%)		49	69	79	84
Good condition (grass cover > 75%)		39	61	74	80
Impervious areas:					
Paved parking lots, roofs, driveways, etc. (excluding right-of-way)		98	98	98	98
Streets and roads:					
Paved; curbs and storm sewers (excluding right-of-way)		98	98	98	98
Paved; open ditches (including right-of-way)		83	89	92	93
Gravel (including right-of-way)		76	85	89	91
Dirt (including right-of-way)		72	82	87	89
Western desert urban areas:					
Natural desert landscaping (pervious areas only) [4]		63	77	85	88
Artificial desert landscaping (impervious weed barrier, desert shrub with 1- to 2-inch sand or gravel mulch and basin borders)		96	96	96	96
Urban districts:					
Commercial and business	85	89	92	94	95
Industrial	72	81	88	91	93
Residential districts by average lot size:					
1/8 acre or less (town houses)	65	77	85	90	92
1/4 acre	38	61	75	83	87
1/3 acre	30	57	72	81	86
1/2 acre	25	54	70	80	85
1 acre	20	51	68	79	84
2 acres	12	46	65	77	82
Developing urban areas					
Newly graded areas (pervious areas only, no vegetation) [5]	77	86	91	94	
Idle lands (CN's are determined using cover types similar to those in table 2-2c).					

1 Average runoff condition, and $I_a = 0.2S$.
2 The average percent impervious area shown was used to develop the composite CN's. Other assumptions are as follows: impervious areas are directly connected to the drainage system, impervious areas have a CN of 98, and pervious areas are considered equivalent to open space in good hydrologic condition. CN's for other combinations of conditions may be computed using figure 2-3 or 2-4.
3 CN's shown are equivalent to those of pasture. Composite CN's may be computed for other combinations of open space cover type.
4 Composite CN's for natural desert landscaping should be computed using figures 2-3 or 2-4 based on the impervious area percentage (CN = 98) and the pervious area CN. The pervious area CN's are assumed equivalent to desert shrub in poor hydrologic condition.
5 Composite CN's to use for the design of temporary measures during grading and construction should be computed using figure 2-3 or 2-4 based on the degree of development (impervious area percentage) and the CN's for the newly graded pervious areas.

(210-VI-TR-55, Second Ed., June 1986) 2–5

USDA, 1986

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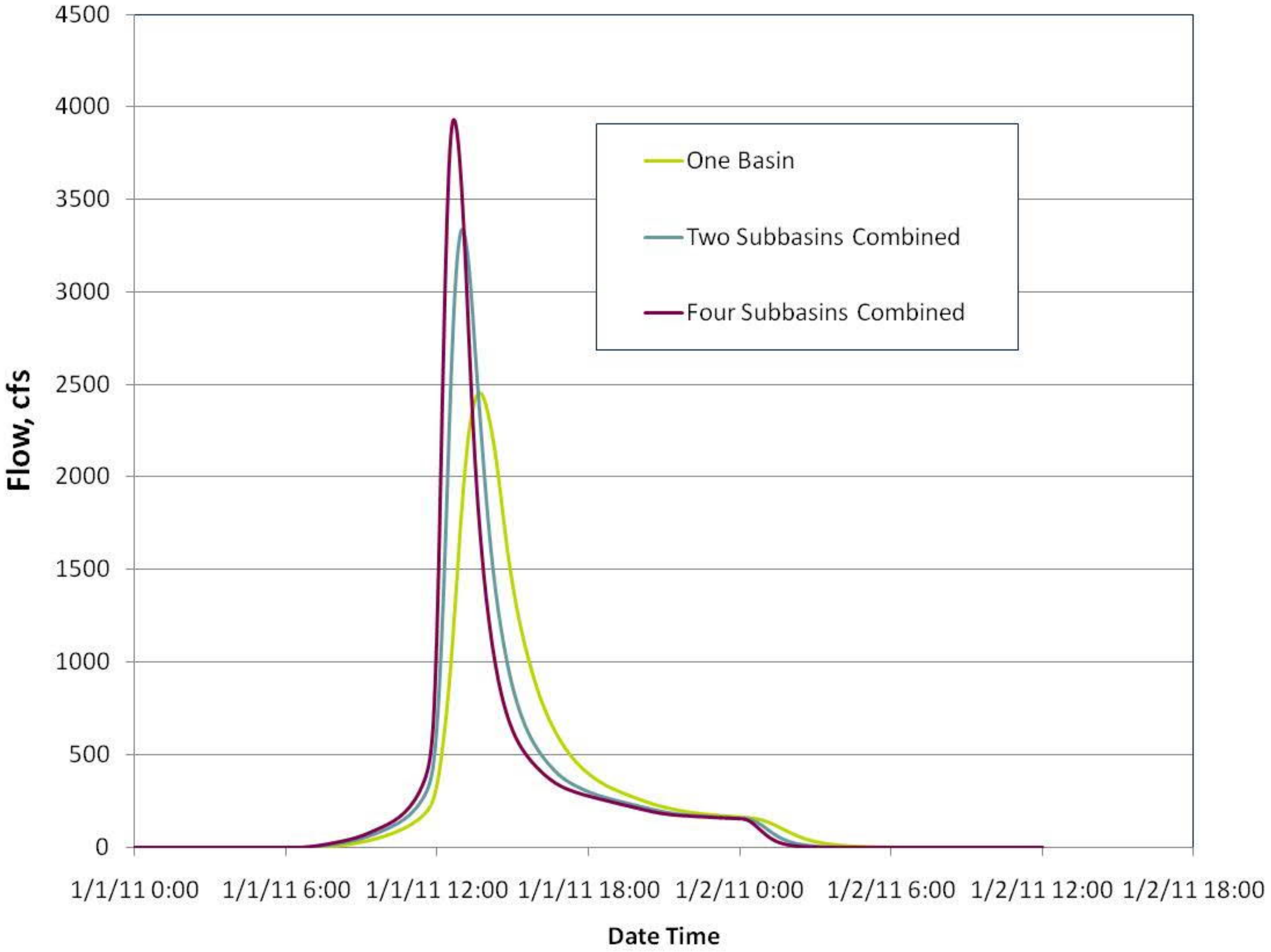
Horton Infiltration

“Horton's model is empirical and is perhaps the best known of the infiltration equations. Many hydrologists have a "feel" for the best values of its three parameters despite the lack of published information.”

- XP-SWMM manual

Hydrograph shape



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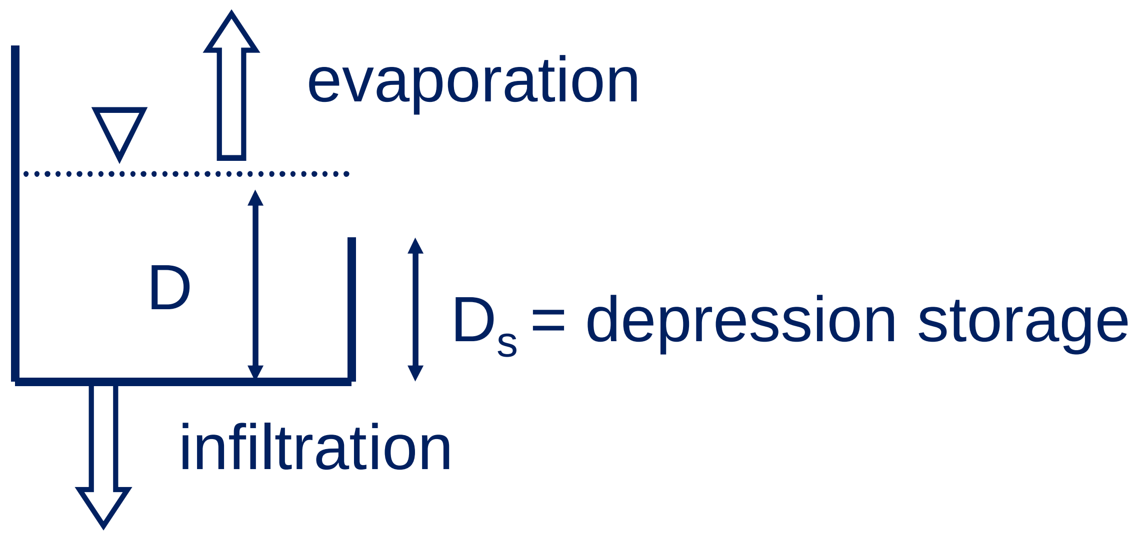
XP-SWMM RUNOFF

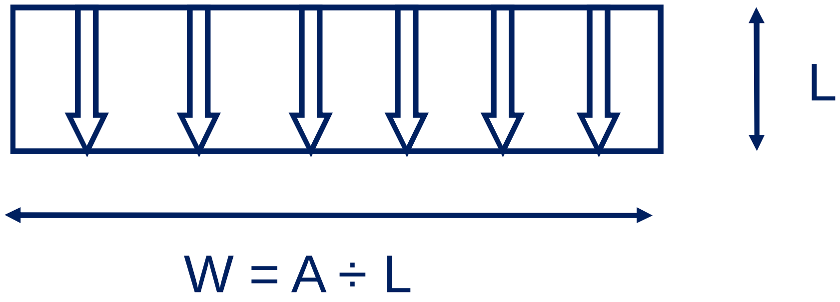
Manning's equation:

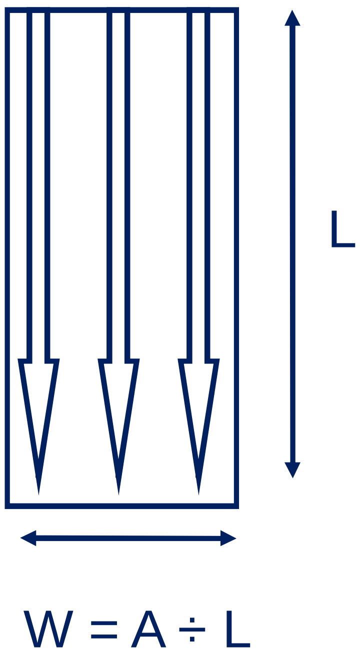
$Q = (1.49/n) \times A \times R^{2/3} \times S^{1/2}$

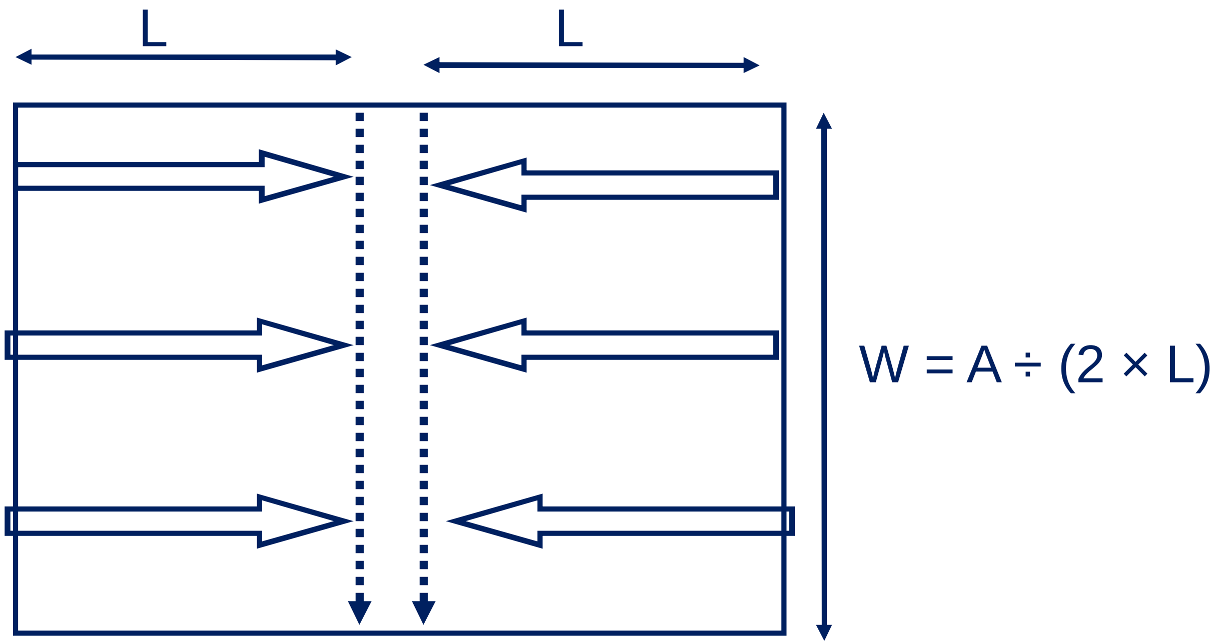
$Q = (1.49/n) \times W \times (D - D_s)^{5/3} \times S^{1/2}$



XP-SWMM RUNOFF







Routing -Manning's n

TABLE 5.4

MANNING'S COEFFICIENT EXPERIMENT FORM

The purpose of this experiment is to estimate the Manning's n-values of the stream locations shown in the slides. The estimates should coincide with a 1-percent chance event. The estimates may be based on available materials. However, you are asked not to discuss them with others participating in the exercise.

Statistical results of the n-value estimates will be used to evaluate the effects of the reliability of n-values on computed water surface profile accuracy. No names will be used in this exercise.

SLIDE NO.	DESCRIPTION OF STREAM	N-VALUE ESTIMATE
1	A 60 square mile basin near Houston, Texas. The channel surface is a combination of concrete (lower flows) and grass (higher) flows). The concrete section is designed for a 10-percent chance event.	______
2	Upper Gila River, New Mexico. A 30 square mile basin, channel 10 yards across.	______
3	A 90 square mile Pennsylvania stream, channel 25 yards across.	______
4	700 square mile southern Illinois stream, channel 30 yards across.	______
5	20,000 square mile Ohio River, channel 250 yards across.	______

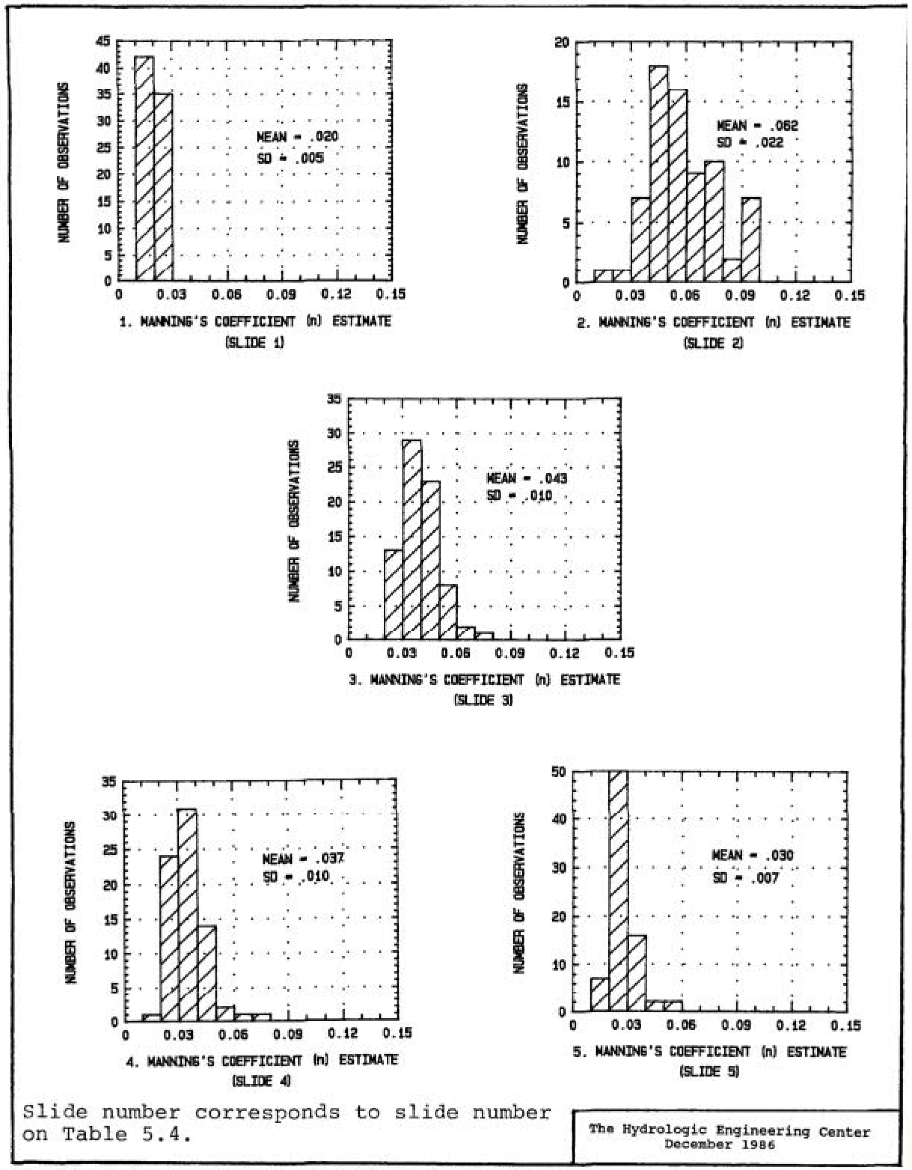


FIGURE 5.5 Manning's Coefficient Estimates

From USACE RD-26, "Accuracy of Computed Water Surface Profiles", 1986

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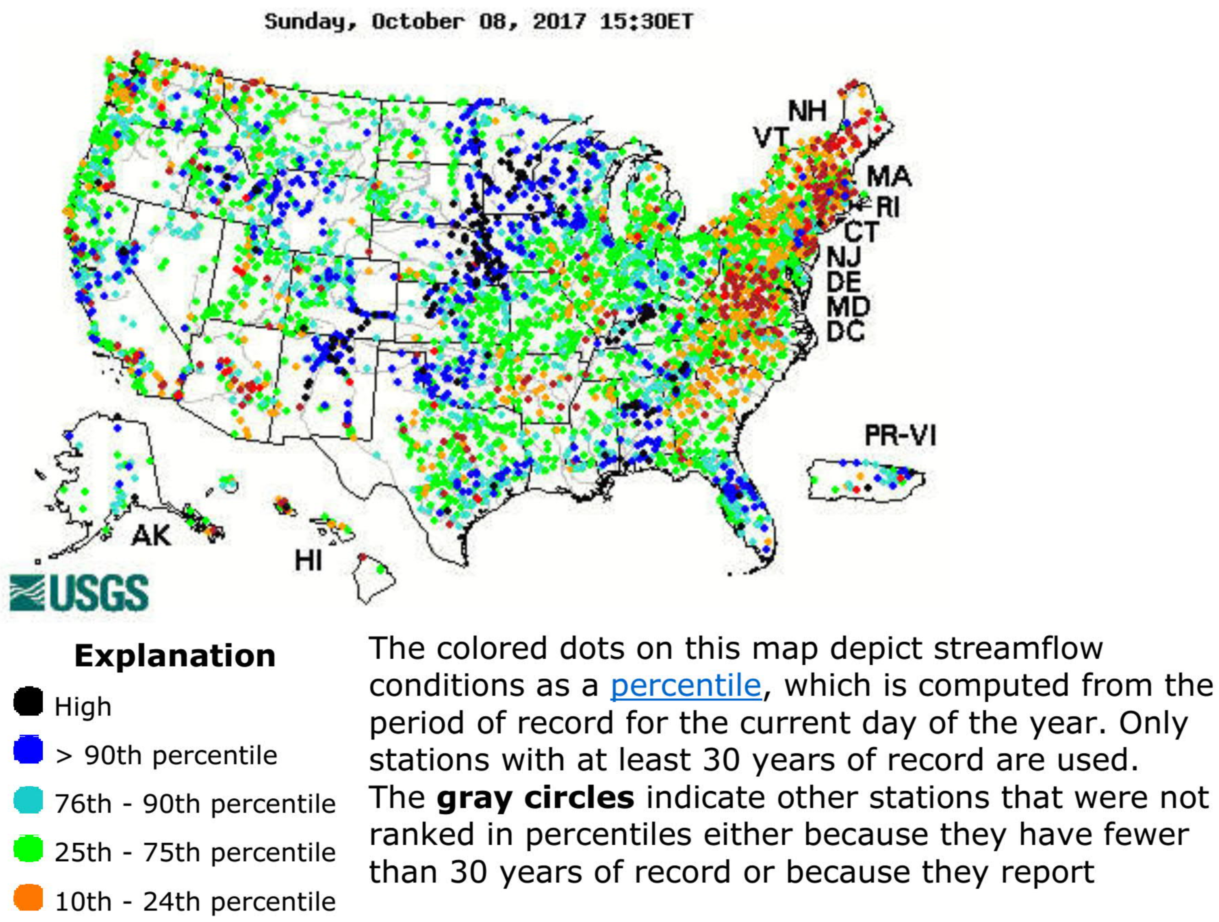
Methods

Calibration/Verification/Comparison

Recording gage



19,924 gage sites have current conditions data

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USGS, 2017a

Crest stage gages or high water marks

Table 6. Crest stage data from the IDNR

Location	May 2004 event peak stage, ft	May 2006 event peak stage, ft
DS side of Hartman Lane on South Pier	No reading (below 513.59)	No reading (below 513.59)
DS wingwall of IL 161	492.74	No reading (below 492.72)
DS Wingwall of C Street	480.65	479.81
DS wingwall of Centreville Road	474.90	473.41
DS wingwall of IL 159	No reading (below 465.20)	No reading (below 465.20)

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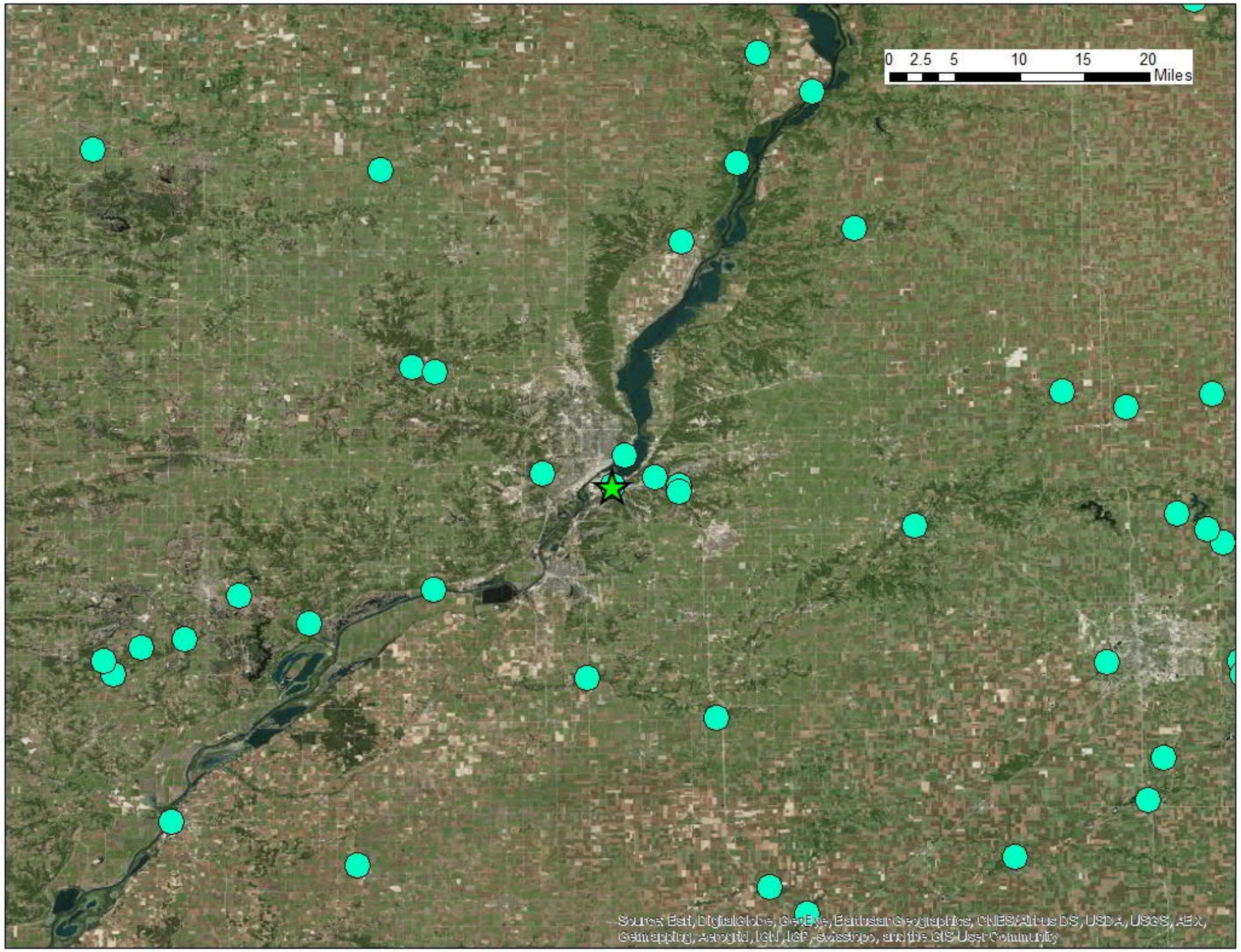
Finding a similar gaged area

- Nearby location
- Similar land use
- Similar basin shape
- Similar level of development
- Instantaneous record for a significant flood

Nearby gages



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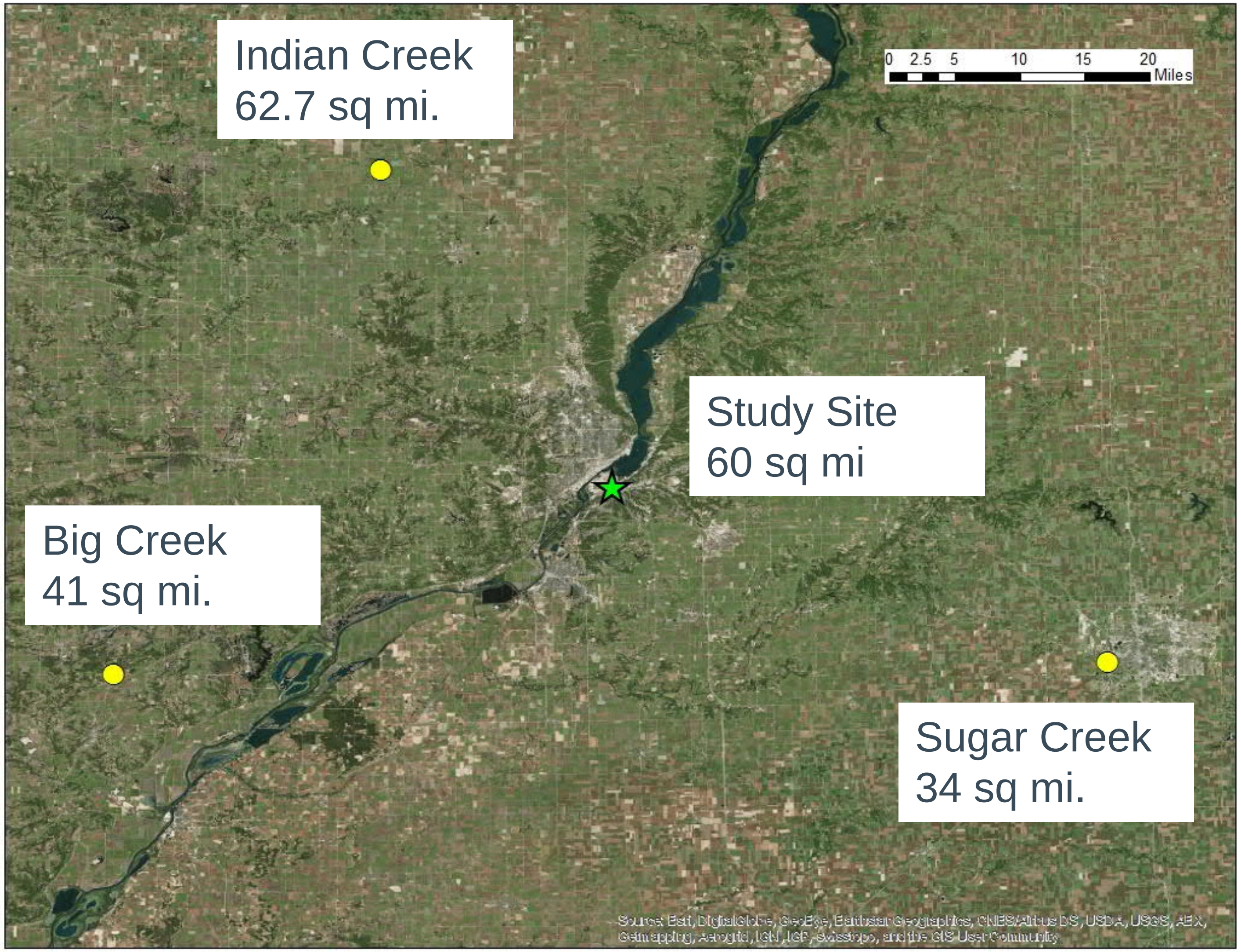
Quantitative factors



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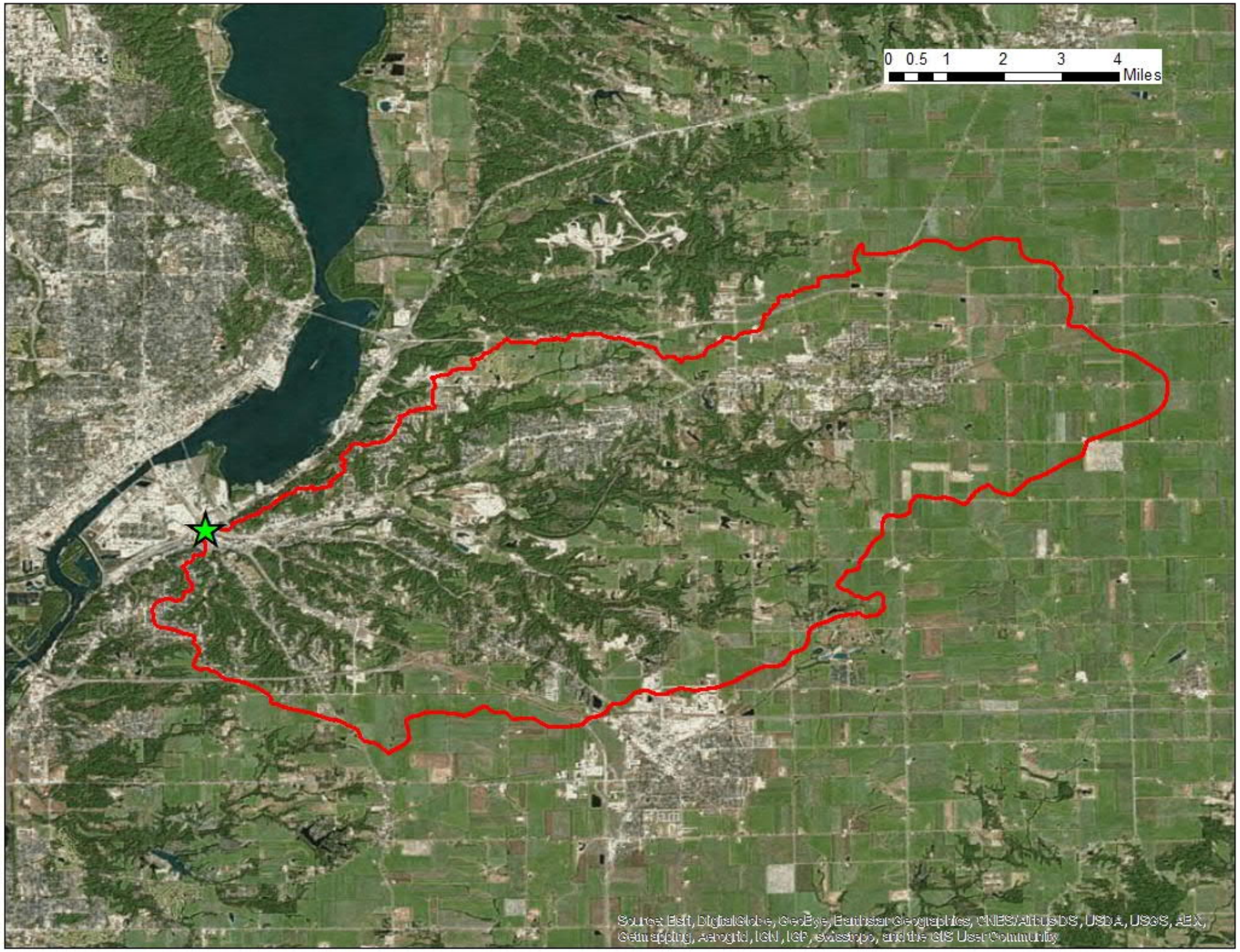
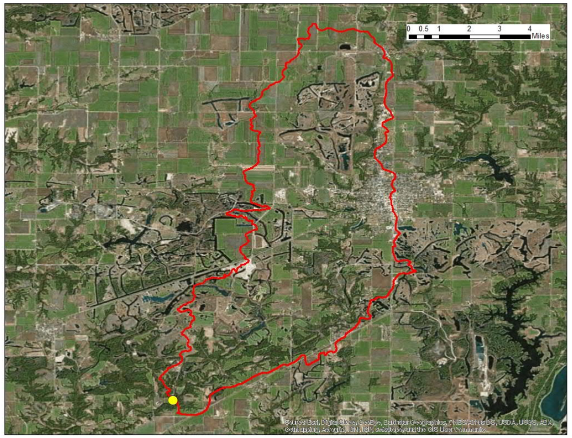
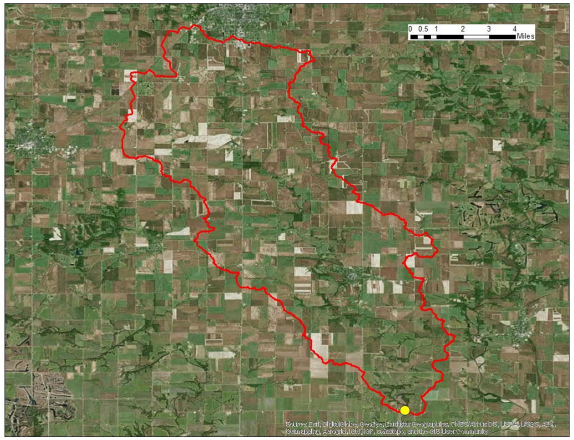
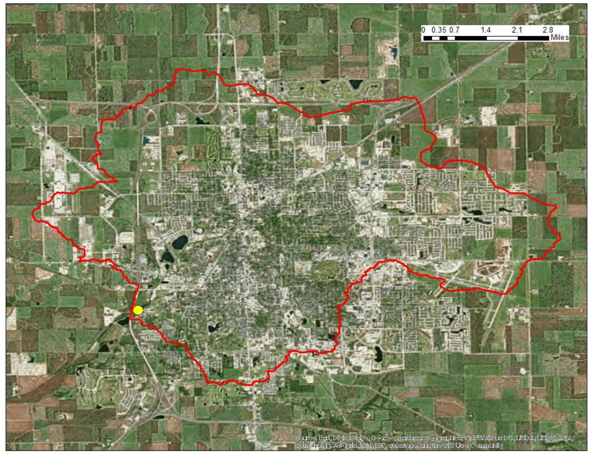
Qualitative factors

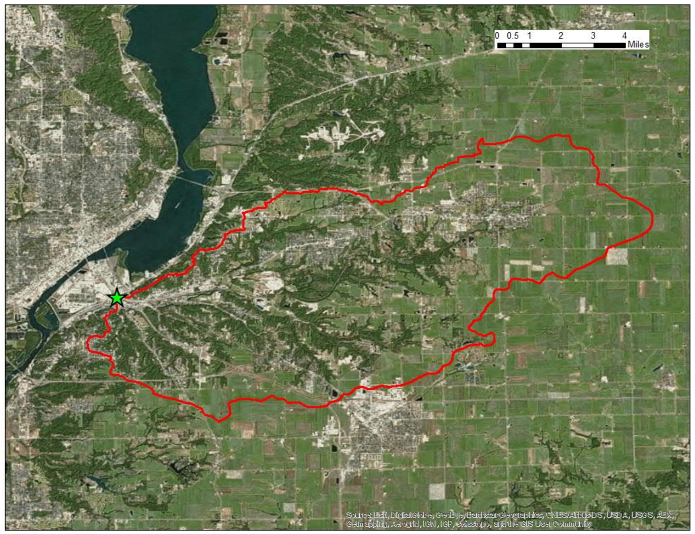


Qualitative Factors









Storm Event

- Full News

Peak Streamflow for the Nation

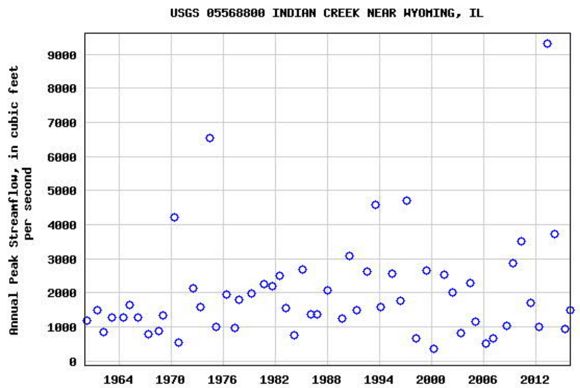
USGS 05568800 INDIAN CREEK NEAR WYOMING, IL

Available data for this site Surface-water: Peak streamflow GO

Stark County, Illinois
Hydrologic Unit Code 07130005
Latitude 41°01'08", Longitude 89°50'08" NAD83
Drainage area 62.7 square miles
Gage datum 606.78 feet above NGVD29

Output formats

Table
Graph
Tab-separated file
peakfq (watstore) format
Reselect output format



Download a presentation-quality graph

Questions about sites/data?
Feedback on this web site
Automated retrievals

Data Tips
Explanation of
Subscribe for

USGS, 2017a

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Regression Hydrographs

TECHNIQUE FOR SIMULATING PEAK-FLOW HYDROGRAPHS IN MARYLAND

U.S. GEOLOGICAL SURVEY
Water-Resources Investigations Report 97-4279

Prepared in cooperation with the
MARYLAND STATE HIGHWAY ADMINISTRATION

USGS, 1998

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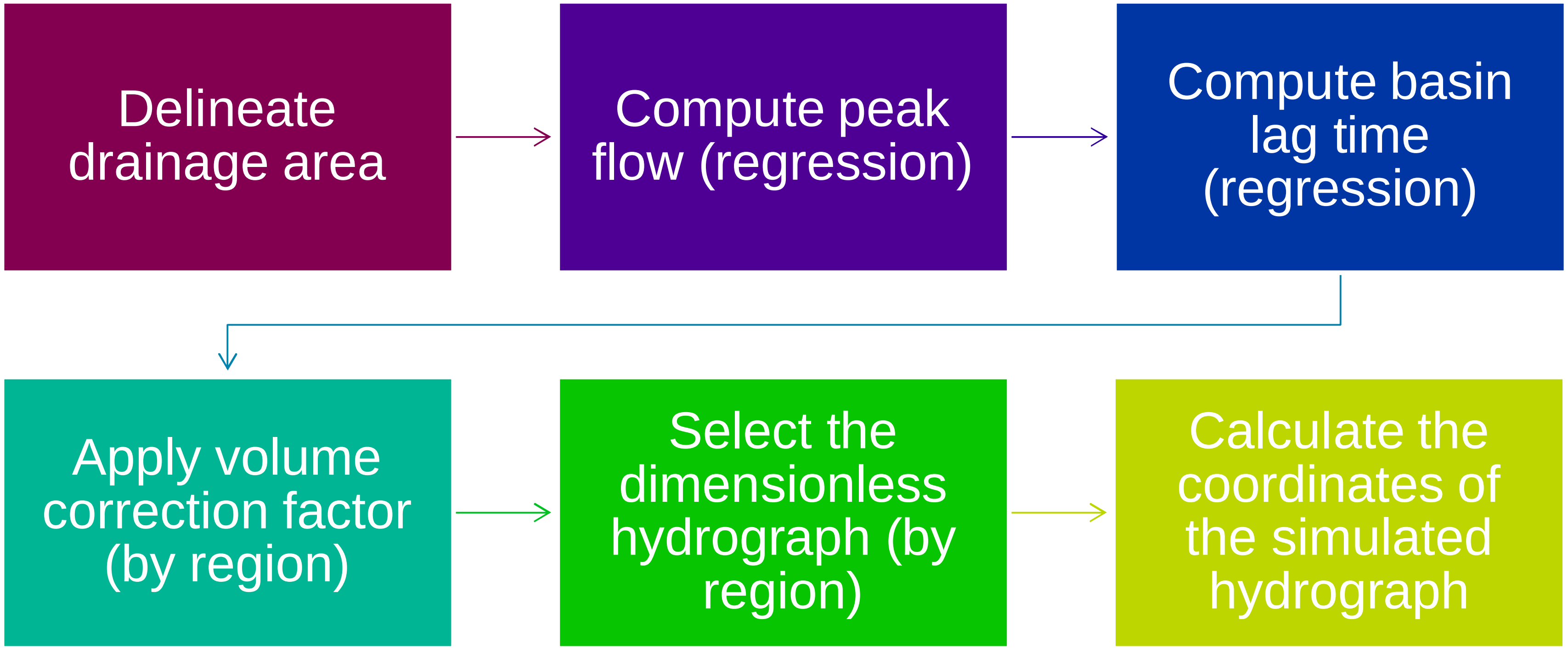
WRIR 97-4279 Process



Other studies

- Different models should not get drastically different results
- Consistent peak flow in terms of cfs/acre
- Consistent runoff volumes

Questions?

Contact:

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References

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Common ways infiltration is modeled

- Curve number
- Horton
- Green-Ampt

Green-Ampt infiltration

- Physically-based
- Measured properties of soils

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Similar gages

- Hydrograph shape – look for DA with similar basin shape (lag time) – pull Peoria example here
- Volume – similar rainfall characteristics, similar infiltration

Future needs?

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Summary