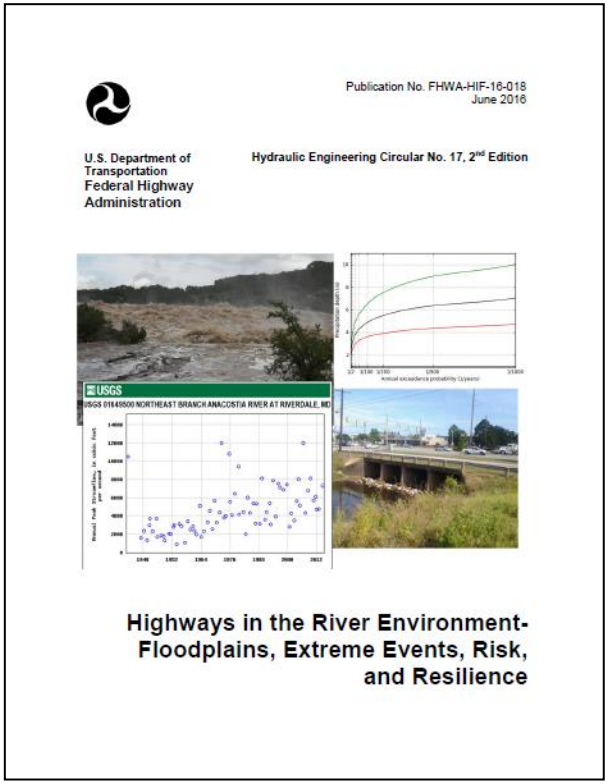
HEC 17:

Highways in the River Environment

::

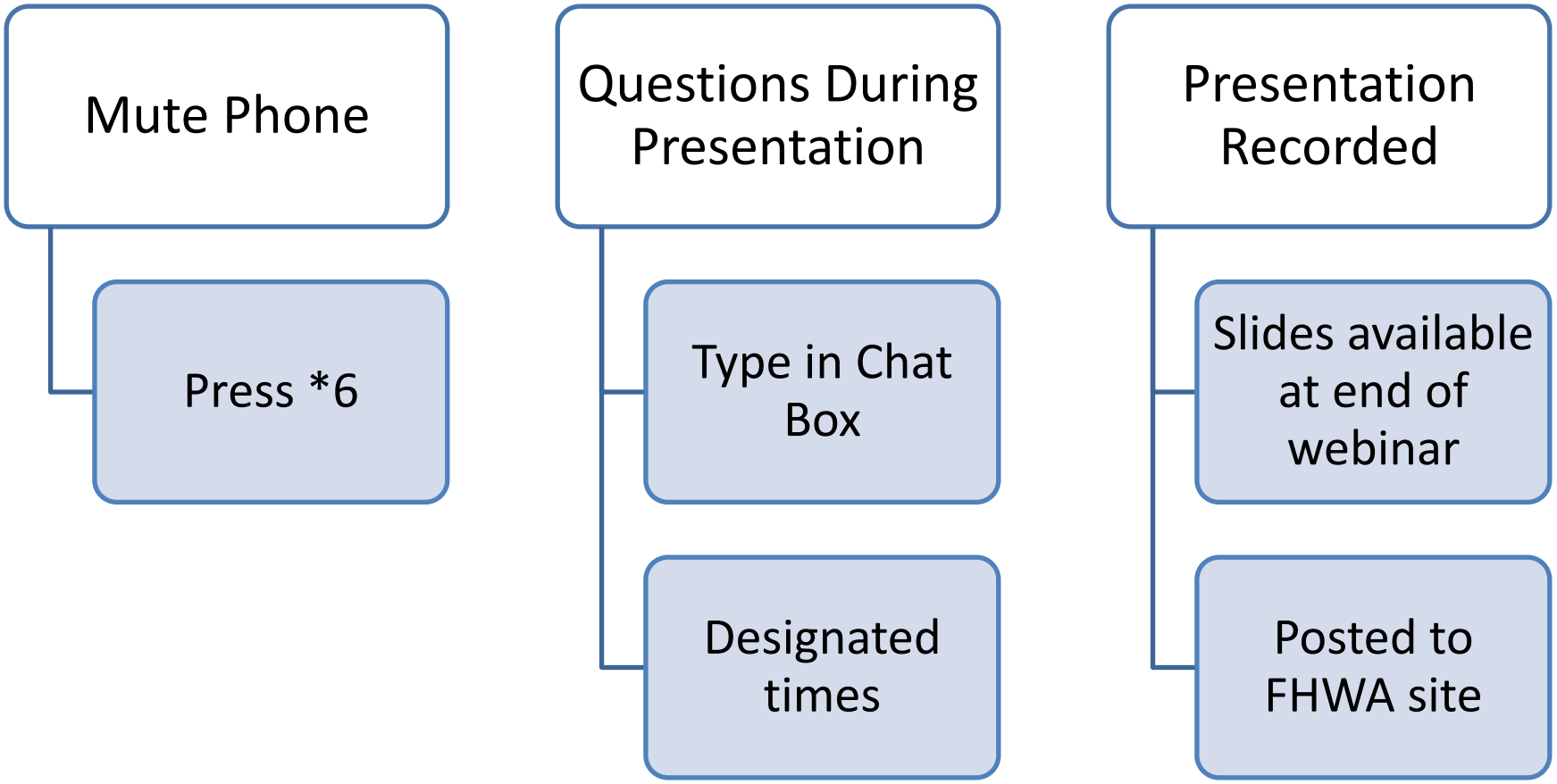
Floodplains, Extreme Events, Risk and Resilience



Webinar A: Chapters 1 through 4

Presenters: Joe Krolak and Cynthia Nurmi

Webinar Logistics



Webinar Schedules

Webinar A: Introduction, Floodplains, Riverine Flood Events, Non-Stationarity (Chapters 1-4)

January 25, 2017, 10 am to 12 pm (Eastern Std Time)

https://connectdot.connectsolutions.com/hec17rollouta/

Webinar B: Climate Modeling and Risk and Resilience (Chapters 5 & 6)

February 8, 2017, 10 am to 12 pm (Eastern Std Time)

https://connectdot.connectsolutions.com/hec17rolloutb/

Webinar C: Analysis Framework and Case Studies (Chapters 7 & 8)

February 22, 2017, 10 am to 12 pm (Eastern Std Time)

https://connectdot.connectsolutions.com/hec17rolloutc/

People Presenting

Joe Krolak
FHWA HQ
Principal Hydraulic Engineer

Cynthia Nurmi
FHWA Resource Center
Hydraulic Engineer

Rob Kafalenos
FHWA HQ :: Environmental Protection Specialist

Rob Hyman
FHWA HQ :: Environmental Protection Specialist

Brian Beucler
FHWA HQ
Senior Hydraulic Engineer

Authors to Acknowledge

- **Roger T. Kilgore**
  - ***Kilgore Consulting & Management***
- **George (Rudy) Herrmann**
  - ***Desert Sky Engineering and Hydrology***
- **Wil Thomas**
  - ***Michael Baker International***
- **David B. Thompson**
  - ***Thompson Hydrologics***

Chapter

1

Introduction

HEC-17 – Why's, What's, How's, & Who's

Caveats to Consider

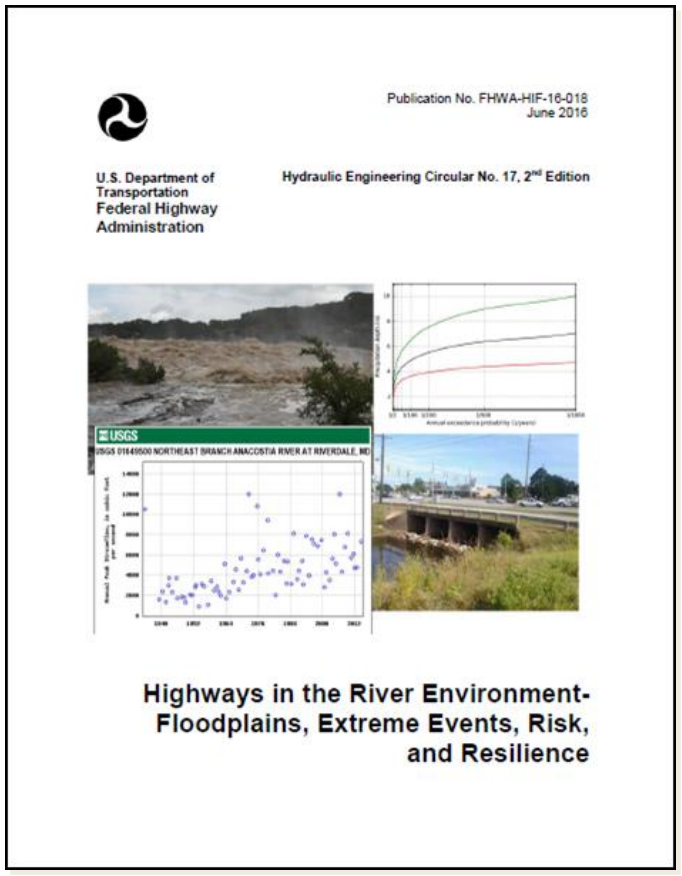
Bismarck was totally correct about Sausages and Laws …

Knowledge to Know

- What the Heck is a HEC?
- HEC = Hydraulic Engineering Circular
  - *Published by Bureau Public Roads / FHWA*
  - *Began to publish HECs in 1960*

- HDS = Hydraulic Design Series

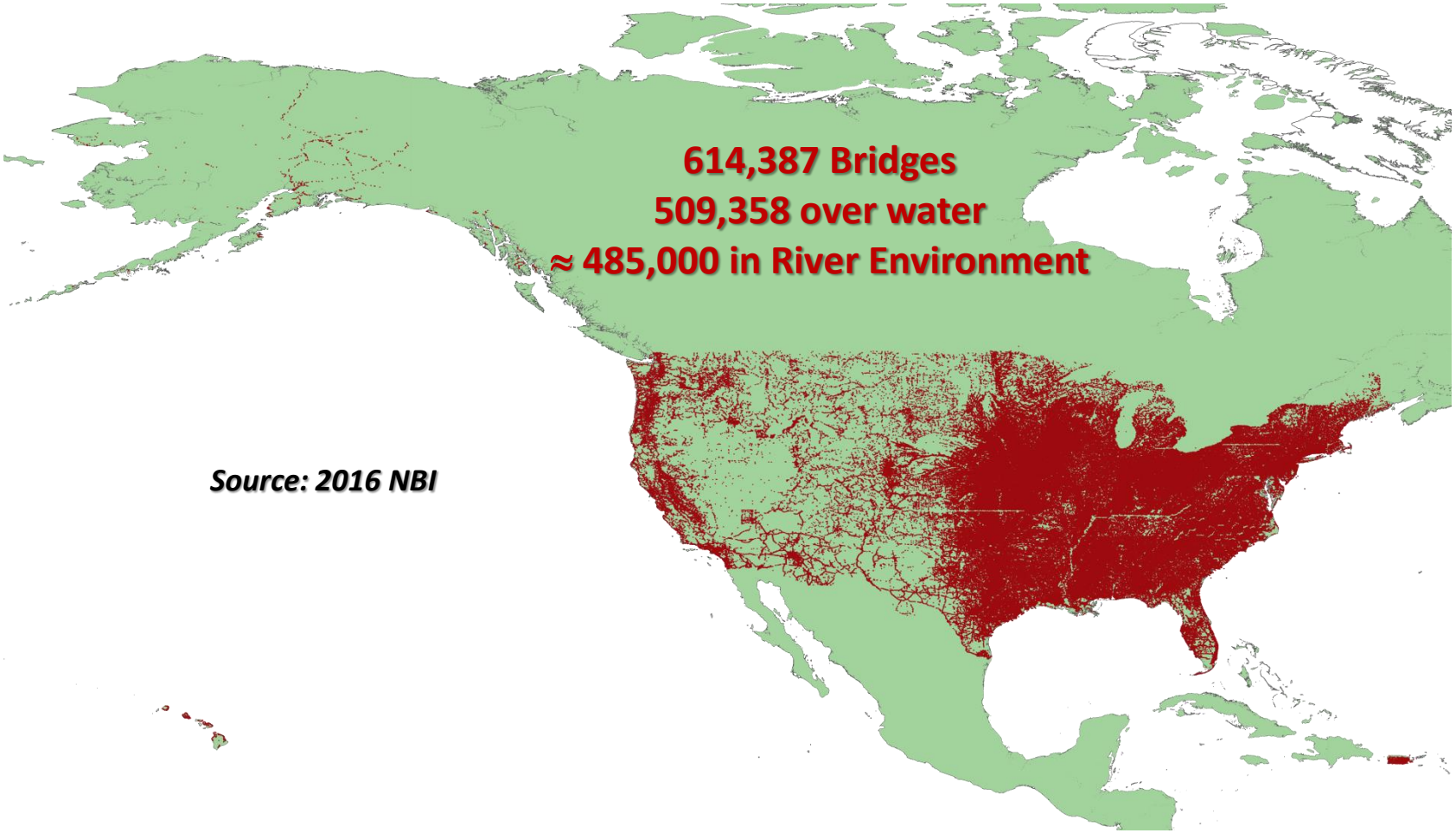
Why HEC-17?



Intent

- ***Provide***
  - Best currently available science, technology and information
  - National consistency and relevance to our highway programs
- ***Focus Areas***
  - Floodplains
  - Extreme Events
  - Risk
  - Resilience
- ***Assist***
  - Our transportation partners
  - FHWA
  - Other agencies

Why the River Environment?



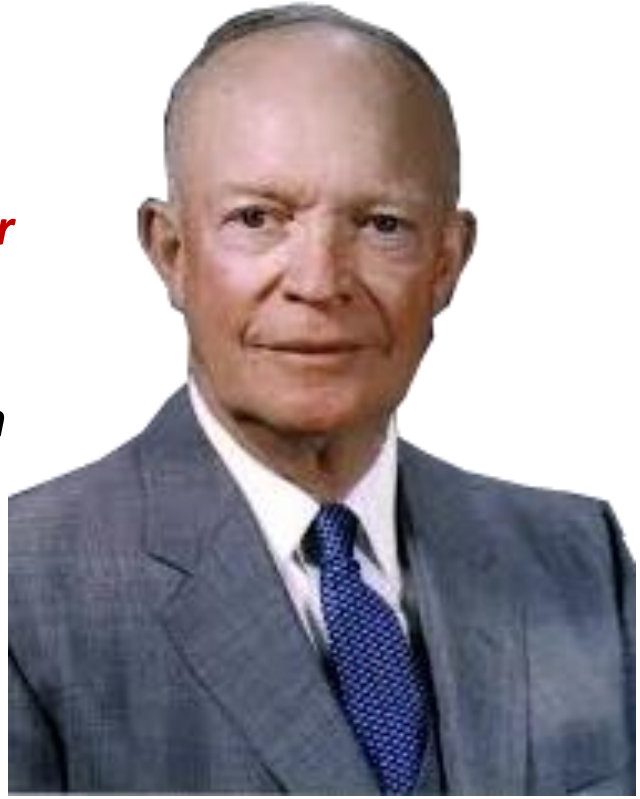
Missing: nationally applicable riverine information on focus areas

Why Change?

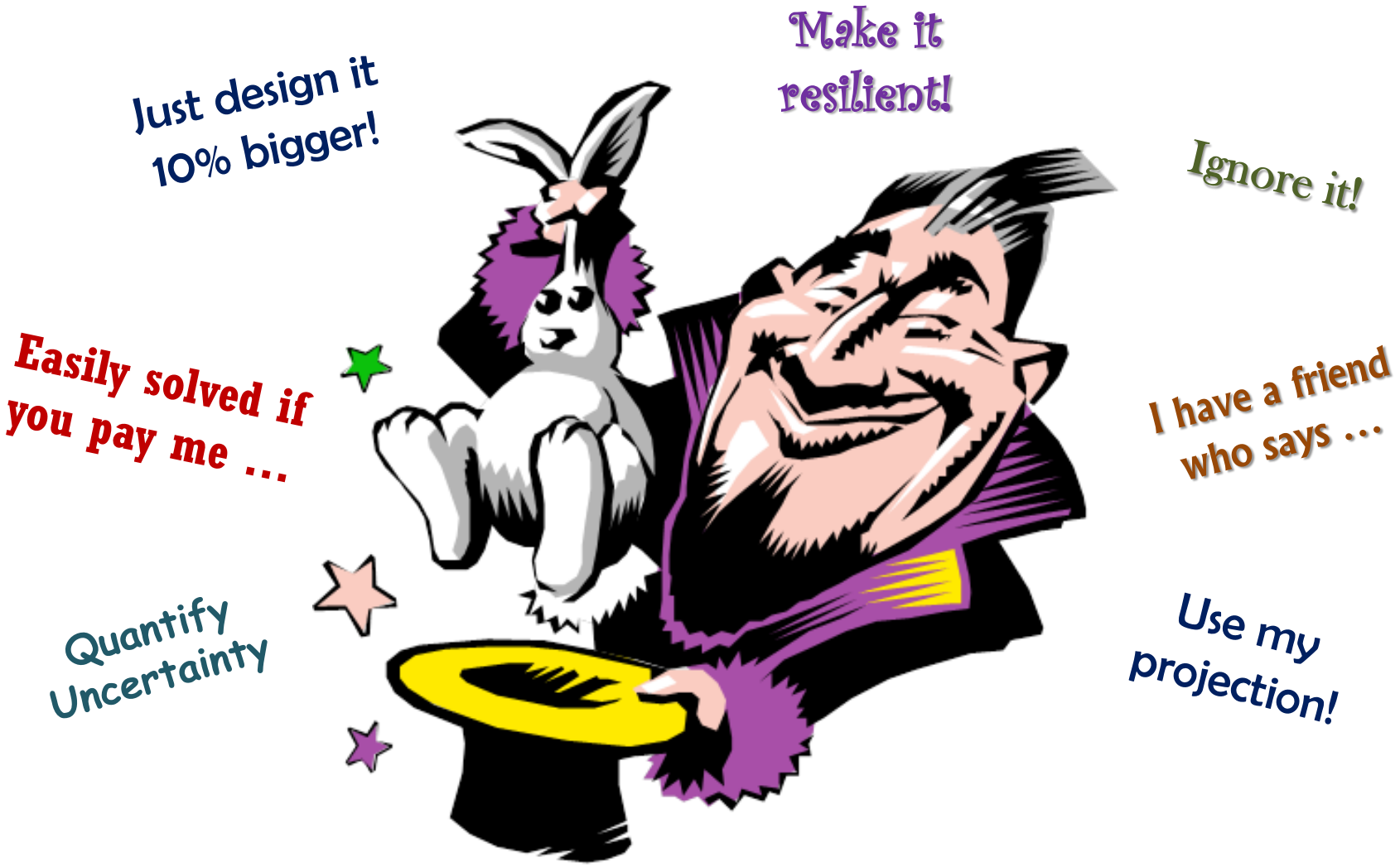
A Federal Design Standard

Designs for all [Interstate] culverts and bridges over streams shall … accommodate floods at least as great as that for a 50-year frequency or the greatest flood of record, whichever is the greater, with the runoff based on the land development expected in the watershed 20 years hence ….”

Policy and Procedure Memorandum 20-4
Bureau of Public Roads
August 10,1956



What's Change?



What Do We Know?

What Don't We Know?

What's Covered?

Webinar A

- Chapter 1: Introduction
- Chapter 2: Floodplains and Federal Policies for Development
- Chapter 3: Riverine Flood Events
- Chapter 4: Nonstationarity and Climate Change

Webinar B

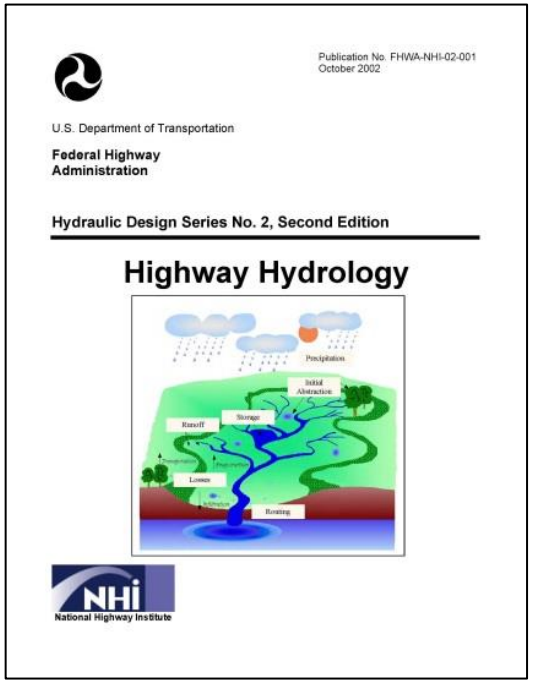
- Chapter 5: Climate Modeling
- Chapter 6: Risk and Resilience

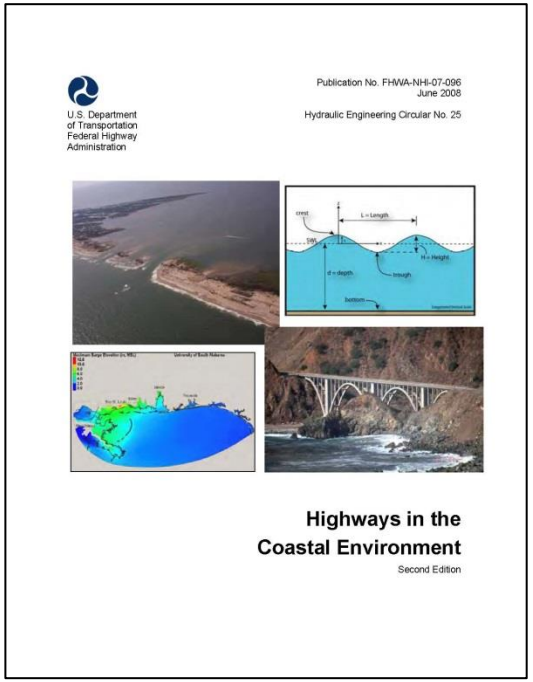
Webinar C

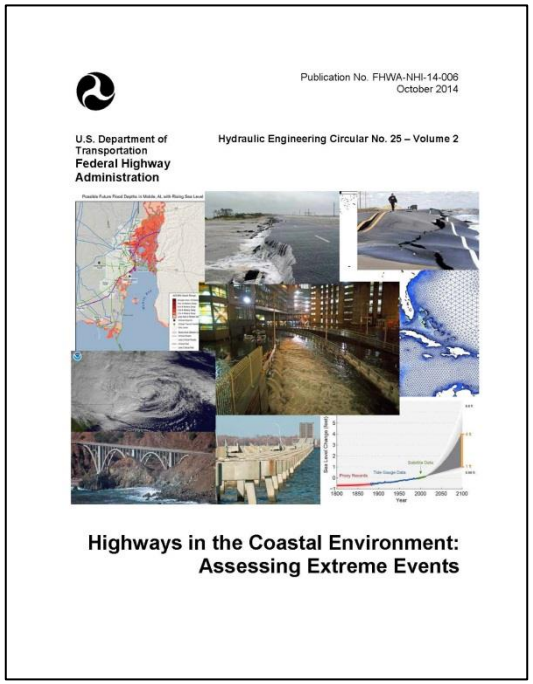
- Chapter 7: Analysis Framework
- Chapter 8: Case Studies

Who's Involved?

What other Resources?







www.fhwa.dot.gov/engineering/hydraulics

www.fhwa.dot.gov/environment/sustainability

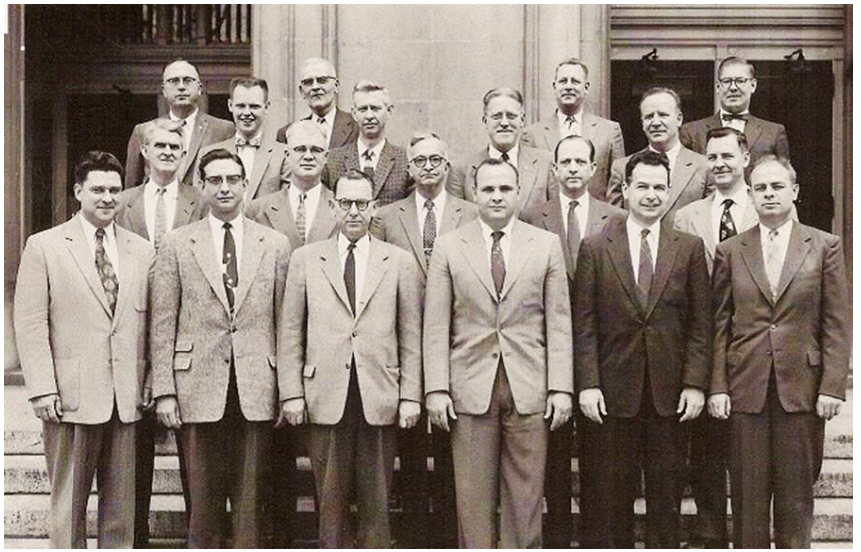
Questions?

Chapter

Floodplains & Federal Policies for Development

Historical :: Floods & Highways

- U.S. highways affected by floods & flood risks even before the 1915 creation of the Bureau of Public Roads.
- From 1900 to 1937 floods caused roughly 9,000 highway bridges failures
- Floods occurring between December 1935 and April 1936 resulted in loss of 911 highway bridges.
- No Private Flood Insurance
- Government Paid For Repairs



1966 :: Beginning of Federal Action

A Unified National Program for Managing Flood Losses

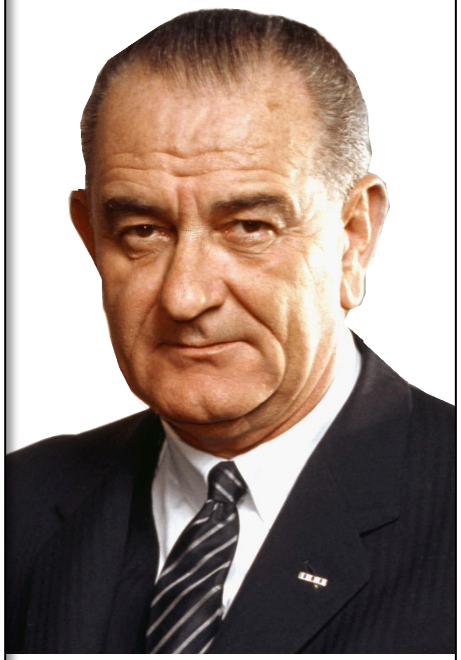
89th Congress, 2d Session - - - - - House Document No. 465

A UNIFIED NATIONAL PROGRAM
FOR MANAGING FLOOD LOSSES

COMMUNICATION
FROM
THE PRESIDENT OF THE UNITED STATES
TRANSMITTING
A REPORT BY THE TASK FORCE ON FEDERAL FLOOD CONTROL POLICY

AUGUST 10, 1966.—Referred to the Committee on Public Works, and ordered to be printed with illustrations

U.S. GOVERNMENT PRINTING OFFICE
67-221 WASHINGTON : 1966



Executive Order 11296

Presidential Documents

Title 3—THE PRESIDENT

Executive Order 11296

EVALUATION OF FLOOD HAZARD IN LOCATING FEDERALLY OWNED OR FINANCED BUILDINGS, ROADS, AND OTHER FACILITIES, AND IN DISPOSING OF FEDERAL LANDS AND PROPERTIES

WHEREAS uneconomic uses of the Nation's flood plains are occurring and potential flood losses are increasing despite substantial efforts to control floods; and

WHEREAS national and regional studies of areas and property subject to flooding indicate a further increase in flood damage potential and flood losses, even with continuing investment in flood protection structures; and

WHEREAS the Federal Government has extensive and continuing programs for the construction of buildings, roads, and other facilities and annually disposes of thousands of acres of Federal lands in flood hazard areas, all of which activities significantly influence patterns of commercial, residential, and industrial development; and

WHEREAS the availability of Federal loans and mortgage insurance and land use planning programs are determining factors in the utilization of lands:

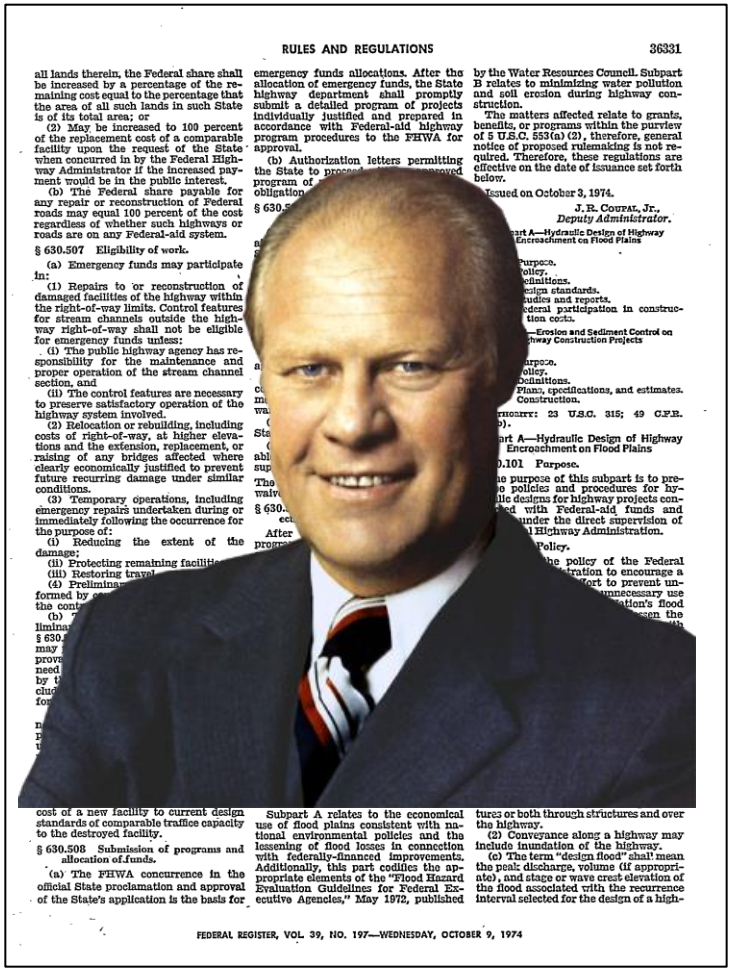
NOW, THEREFORE, by virtue of the authority vested in me as President of the United States, it is hereby ordered as follows:

SECTION 1. The heads of the executive agencies shall provide leadership in encouraging a broad and unified effort to prevent uneconomic uses and development of the Nation's flood plains and, in particular, to lessen the risk of flood losses in connection with Federal lands and installations and federally financed or supported improvements. Specifically:

(1) All executive agencies directly responsible for the construction of Federal buildings, structures, roads, or other facilities shall evaluate flood hazards when planning the location of new facilities and, as far as practicable, shall preclude the uneconomic, hazardous, or unnecessary use of flood plains in connection with such facilities. With respect to existing Federally owned properties which have suffered flood damage or which may be subject thereto, the responsible agency head shall require conspicuous delineation of past and probable flood heights so as to assist in creating public awareness of and knowledge about flood hazards. Whenever practical and economically feasible, flood proofing measures shall be applied to existing facilities in order to reduce flood damage potential.

(2) All executive agencies responsible for the administration of Federal grant, loan, or mortgage insurance programs involving the construction of buildings, structures, roads, or other facilities shall evaluate flood hazards in connection with such facilities and, in order to minimize the exposure of facilities to potential flood damage and the need for future Federal expenditures for flood protection and flood disaster relief, shall, as far as practicable, preclude the uneconomic, hazardous, or unnecessary use of flood plains in such connection.

1974 :: FHWA Floodplain Regulation



RULES AND REGULATIONS 36331

all lands therein, the Federal share shall be increased by a percentage of the remaining cost equal to the percentage that the area of all such lands in such State is of its total area; or

(2) May be increased to 100 percent of the replacement cost of a comparable facility upon the request of the State when concurred in by the Federal Highway Administrator if the increased payment would be in the public interest.

(b) The Federal share payable for any repair or reconstruction of Federal roads may equal 100 percent of the cost regardless of whether such highways or roads are on any Federal-aid system.

§ 630.507 Eligibility of work.

(a) Emergency funds may participate in:

(1) Repairs to or reconstruction of damaged facilities of the highway within the right-of-way limits. Control features for stream channels outside the highway right-of-way shall not be eligible for emergency funds unless:

(i) The public highway agency has responsibility for the maintenance and proper operation of the stream channel section, and

(ii) The control features are necessary to preserve satisfactory operation of the highway system involved.

(2) Relocation or rebuilding, including costs of right-of-way, at higher elevations and the extension, replacement, or raising of any bridges affected where clearly economically justified to prevent future recurring damage under similar conditions.

(3) Temporary operations, including emergency repairs undertaken during or immediately following the occurrence for the purpose of:

(i) Reducing the extent of the damage;

(ii) Protecting remaining facili

(iii) Restoring travel

(4) Preliminar

formed by

the cont

(b)

liminar

§ 630.

may

provi

need

by t

clu

for

emergency funds allocations. After the allocation of emergency funds, the State highway department shall promptly submit a detailed program of projects individually justified and prepared in accordance with Federal-aid highway program procedures to the FHWA for approval.

(b) Authorization letters permitting the State to proc

program of

obligation

§ 630.5

a

S

a

c

m

wa

(

Sta

(

abl

sup

The

waiv

§ 630.

ec

After

progra

by the Water Resources Council. Subpart B relates to minimizing water pollution and soil erosion during highway construction.

The matters affected relate to grants, benefits, or programs within the purview of 5 U.S.C. 553(a)(2), therefore, general notice of proposed rulemaking is not required. Therefore, these regulations are effective on the date of issuance set forth below.

Issued on October 3, 1974.

J. R. COUPAL, Jr.,
Deputy Administrator.

art A—Hydraulic Design of Highway Encroachment on Flood Plains

urpose.

olicy.

efinitions.

esign standards.

tudies and reports.

ederal participation in construction costs.

—Erosion and Sediment Control on ighway Construction Projects

urpose.

olicy.

efinitions.

Plans, specifications, and estimates.

Construction.

THORITY: 23 U.S.C. 315; 49 C.F.R. 5).

art A—Hydraulic Design of Highway Encroachment on Flood Plains

.101 Purpose.

he purpose of this subpart is to pre- o policies and procedures for hy- lic designs for highway projects con- ed with Federal-aid funds and under the direct supervision of l Highway Administration.

Policy.

he policy of the Federal ration to encourage a ort to prevent unnecessary use nation's flood tween the

cost of a new facility to current design standards of comparable traffice capacity to the destroyed facility.

§ 630.508 Submission of programs and allocation of funds.

(a) The FHWA concurrence in the official State proclamation and approval of the State's application is the basis for

Subpart A relates to the economical use of flood plains consistent with national environmental policies and the lessening of flood losses in connection with federally-financed improvements. Additionally, this part codifies the appropriate elements of the "Flood Hazard Evaluation Guidelines for Federal Executive Agencies," May 1972, published

tures or both through structures and over the highway.

(2) Conveyance along a highway may include inundation of the highway.

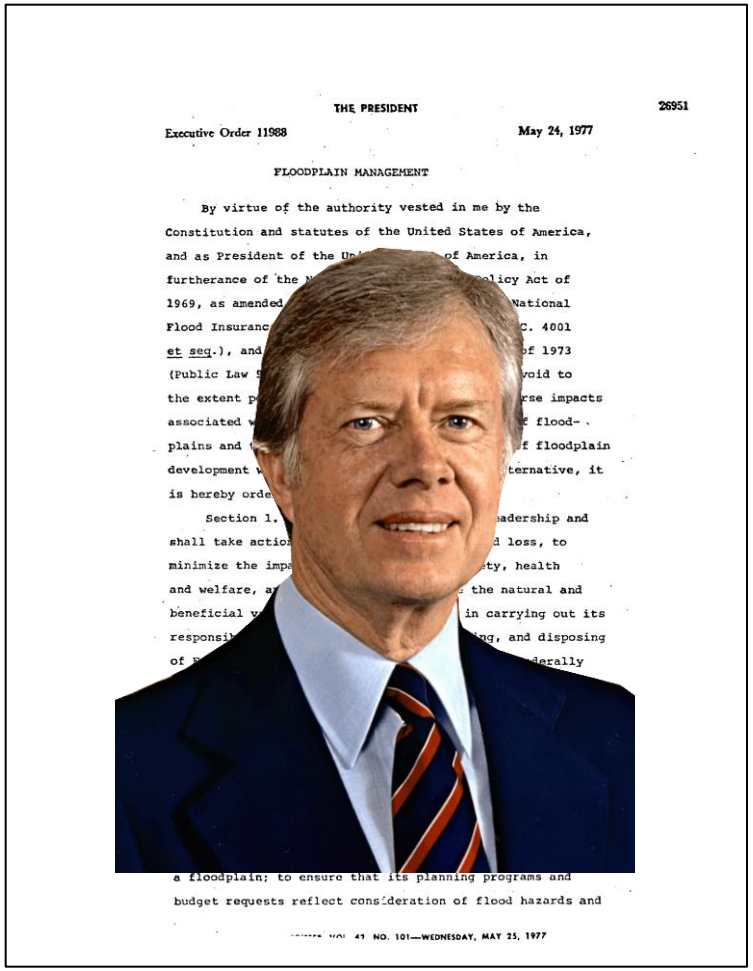
(c) The term "design flood" shall mean the peak discharge, volume (if appropriate), and stage or wave crest elevation of the flood associated with the recurrence interval selected for the design of a high-

FEDERAL REGISTER, VOL. 39, NO. 197—WEDNESDAY, OCTOBER 9, 1974

- **23 CFR 650 A**
  - *"Hydraulic Design of Highway Encroachments on Flood Plains"*
  - *October 9, 1974*
- **Elements**
  - *100-year event as base flood*
  - *Set design standards*
  - *Required hydrologic & hydraulic computations & data*
  - *Instituted consideration of RISK*
  - *No NEPA elements!*

1977 :: Executive Order 11988

- **Federal Agencies must develop floodplain management policies to:**
  - ***Reduce Flooding***
  - ***Minimize Impact of Flooding***
  - ***Restore or Preserve Floodplain Values***
- **Elements**
  - ***NEPA***
  - ***FIA (pre-FEMA)***
  - ***Avoidance***



THE PRESIDENT 26951

Executive Order 11988 May 24, 1977

FLOODPLAIN MANAGEMENT

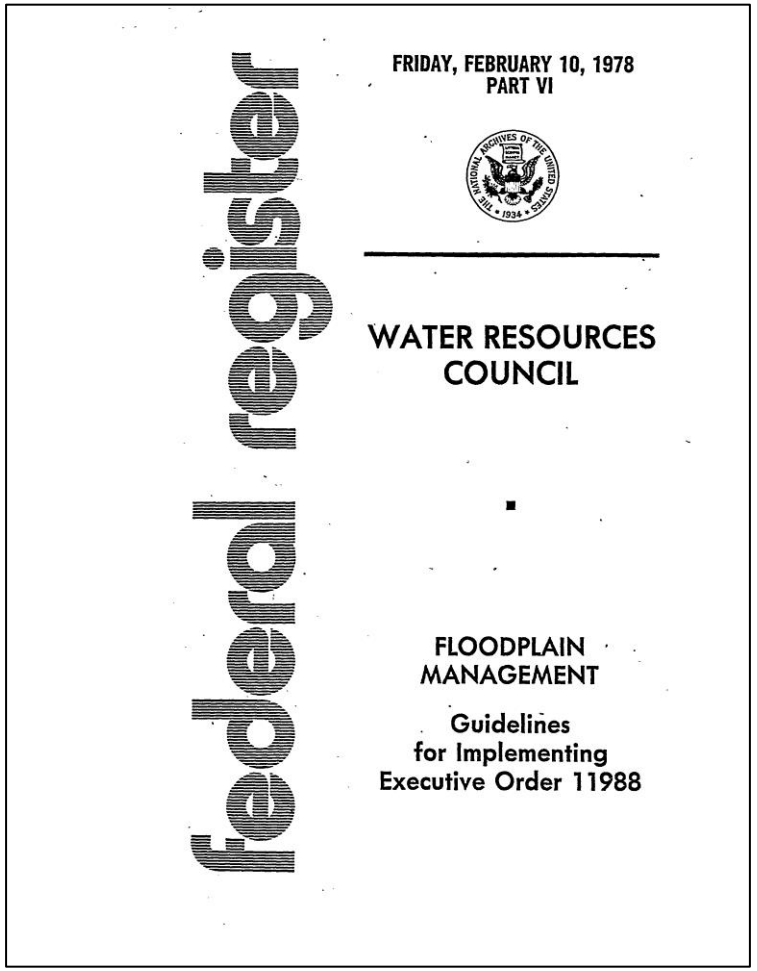
By virtue of the authority vested in me by the Constitution and statutes of the United States of America, and as President of the Un... of America, in furtherance of the N... olicy Act of 1969, as amended ... National Flood Insuranc... C. 4001 et seq.), and ... of 1973 (Public Law ... void to the extent p... rse impacts associated w... f flood- plains and ... f floodplain development w... ternative, it is hereby orde...

Section 1. ... adership and shall take actio... d loss, to minimize the imp... ty, health and welfare, a... the natural and beneficial v... in carrying out its responsi... ng, and disposing of ... derally

a floodplain; to ensure that its planning programs and budget requests reflect consideration of flood hazards and

... VOL. 42, NO. 101—WEDNESDAY, MAY 25, 1977

1978 :: WRC issues “Guidelines”


federal register

FRIDAY, FEBRUARY 10, 1978
PART VI

WATER RESOURCES COUNCIL

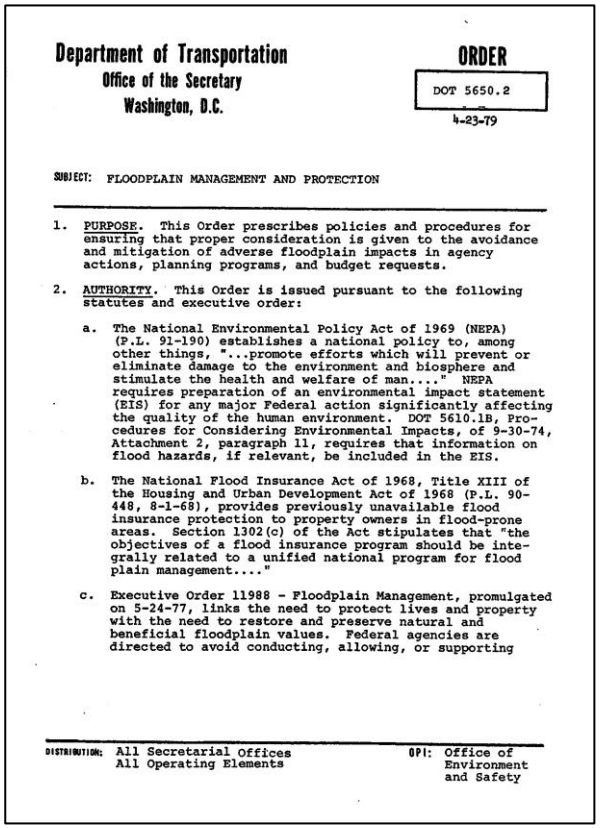
FLOODPLAIN MANAGEMENT

Guidelines for Implementing Executive Order 11988

- Floodplain Management Guidelines for Implementing E.O. 11988
- Specifically cited in E.O.
- Eight Step Process
- Federal agencies required to BASE their Floodplain process using these Guidelines

1979 :: USDOT & FHWA compliance

- **DOT Order 5650.2**
  - ***All USDOT modes***
- **23 CFR 650 A**
  - ***Updated Regulation***



Department of Transportation
Office of the Secretary
Washington, D.C.

ORDER
DOT 5650.2
4-23-79

SUBJECT: FLOODPLAIN MANAGEMENT AND PROTECTION

1. PURPOSE. This Order prescribes policies and procedures for ensuring that proper consideration is given to the avoidance and mitigation of adverse floodplain impacts in agency actions, planning programs, and budget requests.

2. AUTHORITY. This Order is issued pursuant to the following statutes and executive order:

   a. The National Environmental Policy Act of 1969 (NEPA) (P.L. 91-190) establishes a national policy to, among other things, "...promote efforts which will prevent or eliminate damage to the environment and biosphere and stimulate the health and welfare of man...." NEPA requires preparation of an environmental impact statement (EIS) for any major Federal action significantly affecting the quality of the human environment. DOT 5610.1B, Procedures for Considering Environmental Impacts, of 9-30-74, Attachment 2, paragraph 11, requires that information on flood hazards, if relevant, be included in the EIS.

   b. The National Flood Insurance Act of 1968, Title XIII of the Housing and Urban Development Act of 1968 (P.L. 90-448, 8-1-68), provides previously unavailable flood insurance protection to property owners in flood-prone areas. Section 1302(c) of the Act stipulates that "the objectives of a flood insurance program should be integrally related to a unified national program for flood plain management...."

   c. Executive Order 11988 - Floodplain Management, promulgated on 5-24-77, links the need to protect lives and property with the need to restore and preserve natural and beneficial floodplain values. Federal agencies are directed to avoid conducting, allowing, or supporting

DISTRIBUTION: All Secretarial Offices
All Operating Elements

OPI: Office of Environment and Safety

67578 Federal Register / Vol. 44, No. 228 / Monday, November 26, 1979 / Rules and Regulations

DEPARTMENT OF TRANSPORTATION
Federal Highway Administration
23 CFR Part 650

Location and Hydraulic Design of Encroachments on Flood Plains

AGENCY: Federal Highway Administration (FHWA), DOT.
ACTION: Final rule.

SUMMARY: The FHWA is revising its existing flood plain regulation. The revisions include criteria for flood-plain actions taken under programs administered by the FHWA and implement provisions of Executive Order 11988 of May 24, 1977, and DOT Order 5650.2 of April 26, 1979.

EFFECTIVE DATES: This rule is effective November 15, 1979. However, highway sections may be processed without the formal coordination and studies required by §§ 650.109 through 650.113, where the draft environmental impact statement (EIS) has been filed with the Environmental Protection Agency (EPA) prior to October 26, 1979, and the final EIS for this draft EIS is filed with EPA prior to April 26, 1980.

FOR FURTHER INFORMATION CONTACT: Mr. Frank L. Johnson or Mr. Philip L. Thompson, 202-472-7690, Office of Engineering, (HNG-31); Mr. Irwin L. Schroeder, 202-426-0800, Office of the Chief Counsel, (HCC-40), Federal Highway Administration, 400 Seventh Street, SW., Washington, D.C. 20590. Office hours are from 7:45 a.m. to 4:15 p.m. ET, Monday through Friday.

SUPPLEMENTARY INFORMATION: The FHWA is revising its existing flood plains regulation to include provisions required by Executive Order (E.O.) 11988—Floodplain Management, which are not addressed in other FHWA regulations. The existing regulation (23 CFR Part 650, Subpart A) was originally published at 39 FR 36331 on October 9, 1974. This revision will codify the policies and procedures contained in Volume 6, Chapter 7, Section 3, Subsection 2, of the Federal-Aid Highway Program Manual.[1]

Pursuant to Executive Order 11988, the Department of Transportation (DOT) published at 44 FR 24678 on April 26, 1979, its policies and procedures on protection and management of flood plains (DOT Order 5650.2). This revision is consistent with those policies and procedures.

[1]This document is available for inspection and copying as prescribed in 49 CFR Part 7, Appendix D.

Since provisions of this regulation will be implemented by State highway agencies which receive Federal-aid highway funds, the provisions are in the form of general policy and requirements. Specific procedures to satisfy this regulation will be established by highway agencies within the framework of their environmental action plans (23 CFR Part 795, Process Guidelines for the Development of Environmental Action Plans) and design policy. Review for compliance with this regulation will be accomplished by FHWA division offices located in each State.

In preparing this regulation, the FHWA consulted with the U.S. Water Resources Council (WRC), the U.S. Council on Environmental Quality (CEQ), and the Federal Insurance Administration (FIA), now in the Federal Emergency Management Agency (FEMA).

Advisory material in the WRC Floodplain Management Guidelines for Implementing E.O. 11988 (43 FR 6030) was considered in drafting this regulation. The decisionmaking process set forth in the Guidelines, as an explanation of the Executive Order's provisions, is not the same as procedures normally applicable to programs administered by the FHWA. The Guidelines assume that the decisionmaking process involves a single large flood plain and a proposed action at a location on that large flood plain. With this premise, the following WRC decisionmaking process steps appear workable: (1) Determine if proposed action is in the base flood plain, (2) provide early public review, (3) identify and evaluate alternatives to locating in the base flood plain, (4) identify impacts of proposed action, (5) minimize impacts, restore and preserve flood plain values, (6) reevaluate alternatives, and (7) make findings and provide public explanation.

This WRC decisionmaking process is inappropriate for general application in making highway location and design decisions. Highway actions are processed and reviewed as sections or projects between logical termini and, as such, cross numerous flood plains of varying size and importance. Since flood plains can only be entirely avoided for those rare projects located on a watershed boundary, the "no-build" alternative is the only alternative to an encroachment of even minimal impact. If a specific flood plain or series of flood plains are avoided, encroachment at other locations or other flood plains by necessity become involved. Therefore, the avoidance of all base flood plains is not feasible for most highway actions.

Except for locations on a watershed boundary and the "no-build" solution, alternative locations under consideration will involve flood plains.

For proposed highway actions on flood plains, the decision process involves comparing various highway alternatives and their related significant impacts, choosing an alternative, minimizing the impacts of the chosen alternative, and restoring and preserving the impacted flood-plain values. This process includes the alternative of avoiding any action by withdrawing the proposed project. The decision generally is not whether the highway should be located in or out of the base flood plain, but rather which series of flood plains to impact if the "no-build" alternative is not a viable alternative. To support the resulting decision, § 650.111 of the revised regulation requires that base flood plain impacts be identified for all alternatives. If this identification reveals that an "action on the base flood plain" (encroachment) will cause unusually adverse impacts, the action will be termed a "significant encroachment" and require special attention. This includes a requirement in § 650.113 that such actions will not be approved unless the FHWA finds that the proposed significant encroachment is the "only practicable alternative."

A significant encroachment, as defined in this proposed regulation, contemplates construction- or flood-related impacts which involve significant risk, flood-plain environmental impact, or potential interruption or termination of a vital transportation facility. The application of this definition in highway location and design will avoid the significant adverse effects due to occupancy and alteration of flood plains and will allow for the thorough consideration of all relevant highway actions.

Disposition of Major Comments

A notice of proposed rulemaking for this regulation was published for comment in the **Federal Register** at 43 FR 60298 on December 27, 1978, and a docket was established with a closing date of February 26, 1979. Thirty-six parties submitted comments: 22 from State highway agencies, 4 from county agencies, 3 from State environmental agencies, 2 from other Federal agencies, 2 from consultants, 1 from a Senator, and 1 from the Federal agencies (WRC, CEQ and FIA) which were identified in E.O. 11988 for consultation with other Federal agencies in issuing or amending regulations to implement E.O. 11988.

Numerous commenters expressed concern that the regulation would increase redtape, project costs, and

26 November 1979 :: 23 CFR 650 A

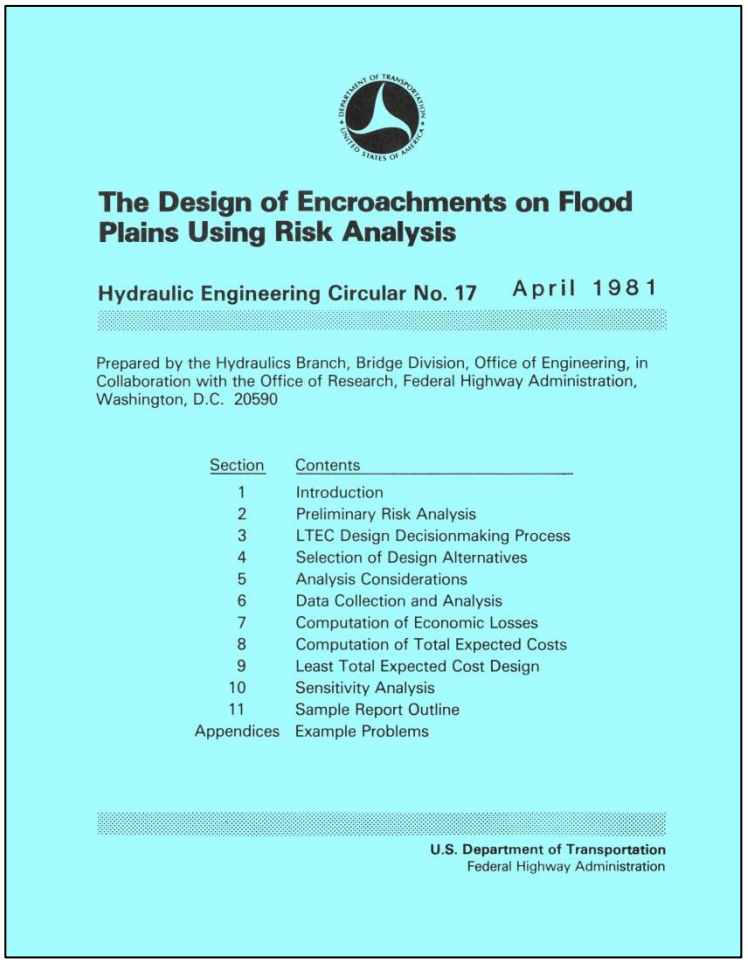
Location & Hydraulic Design of Encroachments on Flood Plains

- covers all aspects of project delivery -

- **Planning & NEPA**
  - ***Public Involvement***
  - ***Environmental documents***
  - ***Location hydraulics studies***
  - ***Significant encroachments***
  - ***Preliminary Engineering***
  - ***Right of Way***
  - ***NEPA Findings***
- **Design & Construction**
  - ***Design Standards***
  - ***Risk analysis / assessments***
  - ***Consistency with NFIP***
  - ***Shall contain H&H data and design computations***
  - ***Floodplain permits***
  - ***ER exemptions***

1981 :: Risk Analyses?

- **HEC-17, 1st edition**
  - ***The Design of Encroachments on Flood Plain Using Risk Analysis***
  - ***April 1981***
  - ***Economic & Risk focus***
  - ***Applicable for design portion of 23 CFR 650 A***



The Design of Encroachments on Flood Plains Using Risk Analysis

Hydraulic Engineering Circular No. 17 April 1981

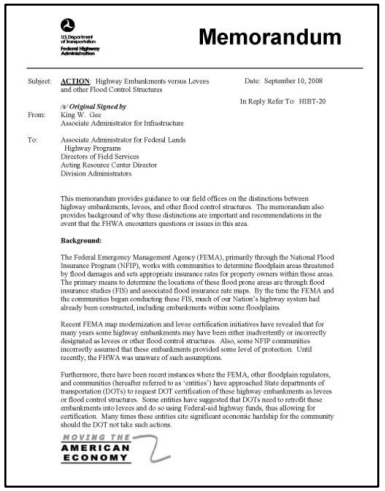
Prepared by the Hydraulics Branch, Bridge Division, Office of Engineering, in Collaboration with the Office of Research, Federal Highway Administration, Washington, D.C. 20590

Section	Contents
1	Introduction
2	Preliminary Risk Analysis
3	LTEC Design Decisionmaking Process
4	Selection of Design Alternatives
5	Analysis Considerations
6	Data Collection and Analysis
7	Computation of Economic Losses
8	Computation of Total Expected Costs
9	Least Total Expected Cost Design
10	Sensitivity Analysis
11	Sample Report Outline
Appendices	Example Problems

U.S. Department of Transportation
Federal Highway Administration

1981 to Present :: Status Quo

- **FHWA Floodplain Program**
  - ***Part of Planning Process***
  - ***Alignment with NEPA on projects***
  - ***200,000 Bridges built using Regulation***
  - ***Informs Construction, Maintenance, and ER activities***
  - ***Integrated in State DOT & AASHTO approaches***



Memorandum

Subject: ACTION: Highway Embankments versus Levees and other Flood Control Structures

Date: September 10, 2008

In Reply Refer To: HIBT-20

From: /s/ Original Signed by
King W. Gee
Associate Administrator for Infrastructure

To: Associate Administrator for Federal Lands
Highway Programs
Directors of Field Services
Acting Resource Center Director
Division Administrators

This memorandum provides guidance to our field offices on the distinctions between highway embankments, levees, and other flood control structures. The memorandum also provides background of why these distinctions are important and recommendations in the event that the FHWA encounters questions or issues in this area.

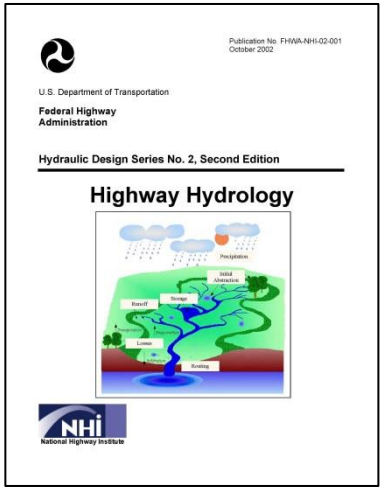
Background:

The Federal Emergency Management Agency (FEMA), primarily through the National Flood Insurance Program (NFIP), works with communities to determine floodplain areas threatened by flood damages and sets appropriate insurance rates for property owners within those areas. The primary means to determine the locations of these flood prone areas are through flood insurance studies (FIS) and associated flood insurance rate maps. By the time the FEMA and the communities began conducting these FIS, much of our Nation's highway system had already been constructed, including embankments within some floodplains.

Recent FEMA map modernization and levee certification initiatives have revealed that for many years some highway embankments may have been either inadvertently or incorrectly designated as levees or other flood control structures. Also, some NFIP communities incorrectly assumed that these embankments provided some level of protection. Until recently, the FHWA was unaware of such assumptions.

Furthermore, there have been recent instances where the FEMA, other floodplain regulators, and communities (hereafter referred to as 'entities') have approached State departments of transportation (DOTs) to request DOT certification of these highway embankments as levees or flood control structures. Some entities have suggested that DOTs need to retrofit these embankments into levees and do so using Federal-aid highway funds, thus allowing for certification. Many times these entities cite significant economic hardship for the community should the DOT not take such actions.

MOVING THE AMERICAN ECONOMY



Publication No. FHWA-NHI-02-001
October 2002

U.S. Department of Transportation

Federal Highway Administration

Hydraulic Design Series No. 2, Second Edition

Highway Hydrology

2005 :: Coastal Storm Events

Outcome: Use 650 A's Design Standard

2007 :: I-35W - Mississippi River

Outcome: Risk Based, Data Driven approaches

2011 :: Riverine Flood Events

Outcome: Use 650 A's Design Standard?

2012 :: MAP-21

H. R. 4348

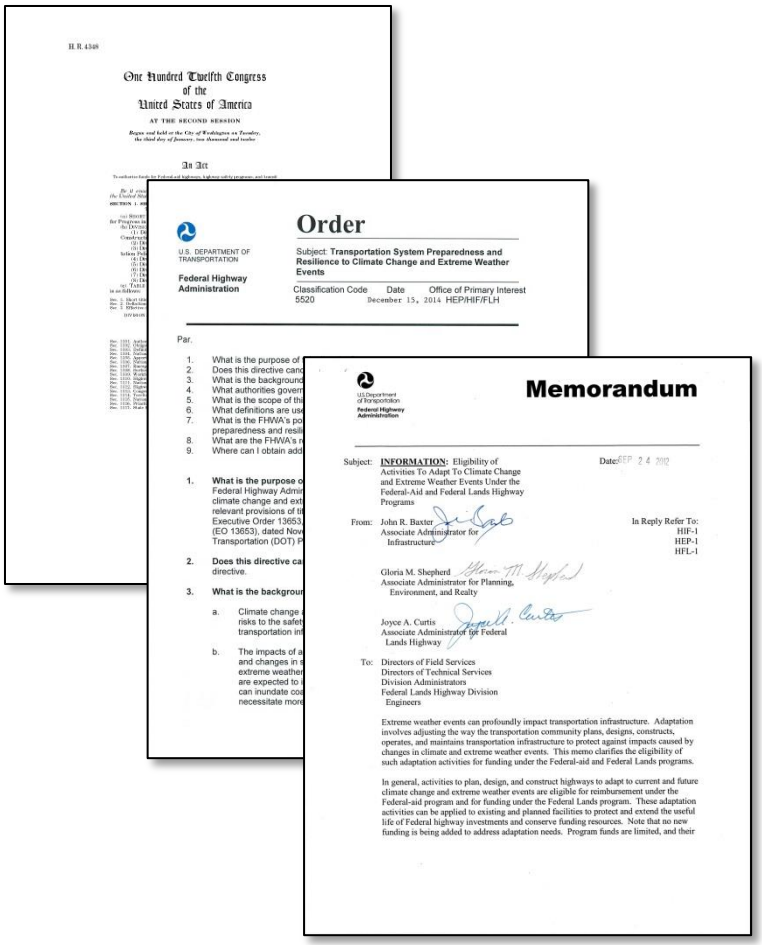
One Hundred Twelfth Congress
of the
United States of America

AT THE SECOND SESSION

An Act

- July 2012
- Codified Data Driven, Risk Based approaches
- Required Asset Management approaches & regulation
- Allowed Projects to Consider “Extreme Events”

FHWA Approaches



One Hundred Twelfth Congress
of the
United States of America
AT THE SECOND SESSION

An Act

Order

U.S. DEPARTMENT OF TRANSPORTATION
Federal Highway Administration

Subject: Transportation System Preparedness and Resilience to Climate Change and Extreme Weather Events

Classification Code 5520 | Date December 15, 2014 | Office of Primary Interest HEP/HIF/FLH

Par.

1. What is the purpose of
2. Does this directive canc
3. What is the backgroun
4. What authorities govern
5. What is the scope of thi
6. What definitions are us
7. What is the FHWA's po preparedness and resili
8. What are the FHWA's r
9. Where can I obtain add

1. **What is the purpose o** Federal Highway Admir climate change and ext relevant provisions of th Executive Order 13653, (EO 13653), dated Nov Transportation (DOT) P

2. **Does this directive ca** directive.

3. **What is the backgrou**

a. Climate change risks to the safet transportation int

b. The impacts of a and changes in extreme weather are expected to can inundate cos necessitate more

Memorandum

U.S. Department of Transportation
Federal Highway Administration

Subject: **INFORMATION:** Eligibility of Activities To Adapt To Climate Change and Extreme Weather Events Under the Federal-Aid and Federal Lands Highway Programs

Date: SEP 24 2010

From: John R. Baxter, Associate Administrator for Infrastructure

In Reply Refer To: HIF-1, HEP-1, HFL-1

Gloria M. Shepherd, Associate Administrator for Planning, Environment, and Realty

Joyce A. Curtis, Associate Administrator for Federal Lands Highway

To: Directors of Field Services
Directors of Technical Services
Division Administrators
Federal Lands Highway Division Engineers

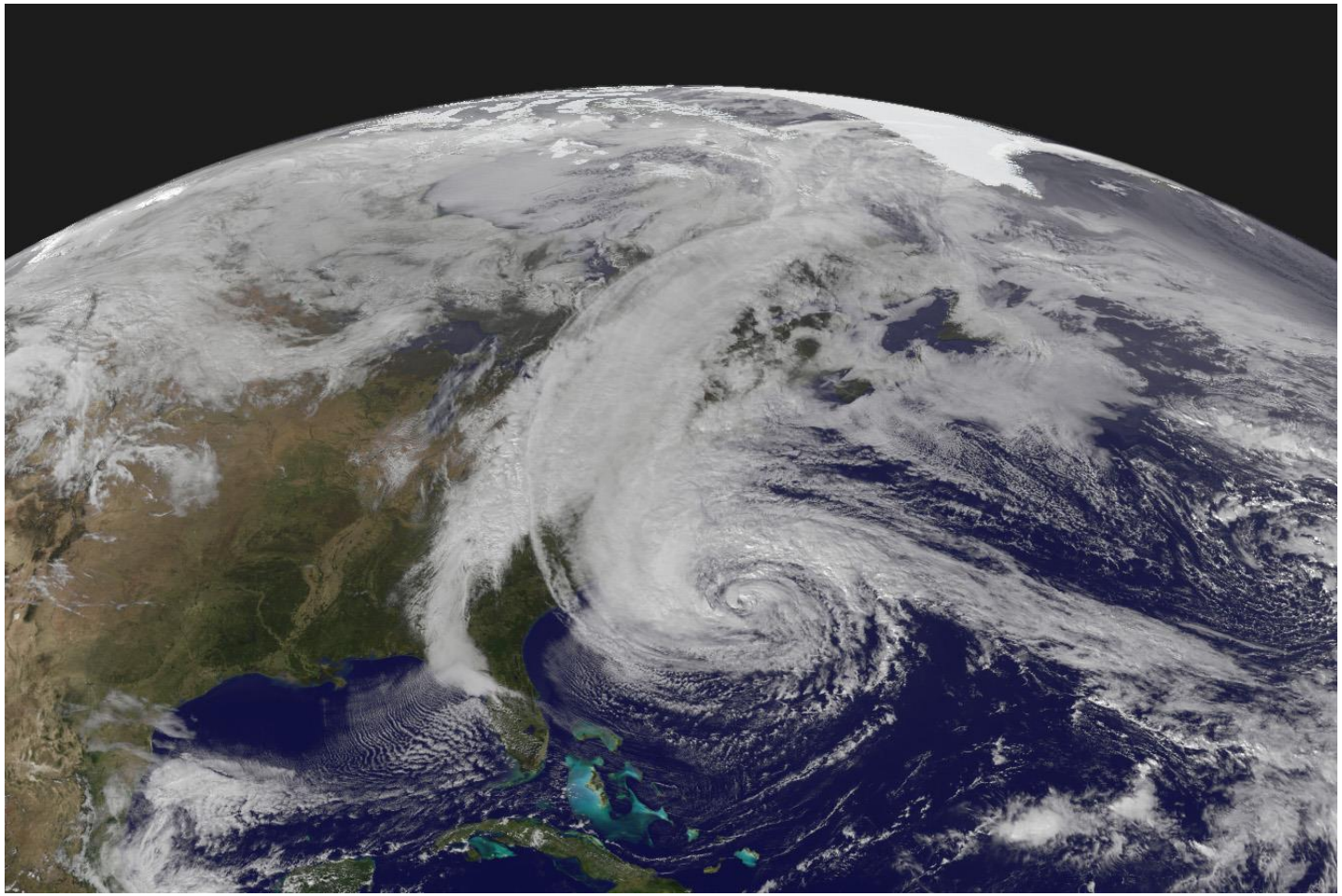
Extreme weather events can profoundly impact transportation infrastructure. Adaptation involves adjusting the way the transportation community plans, designs, constructs, operates, and maintains transportation infrastructure to protect against impacts caused by changes in climate and extreme weather events. This memo clarifies the eligibility of such adaptation activities for funding under the Federal-aid and Federal Lands programs.

In general, activities to plan, design, and construct highways to adapt to current and future climate change and extreme weather events are eligible for reimbursement under the Federal-aid program and for funding under the Federal Lands program. These adaptation activities can be applied to existing and planned facilities to protect and extend the useful life of Federal highway investments and conserve funding resources. Note that no new funding is being added to address adaptation needs. Program funds are limited, and their

- **MAP-21 & FAST Act**
  - ***"Extreme Events"***
- **FHWA Order 5520**

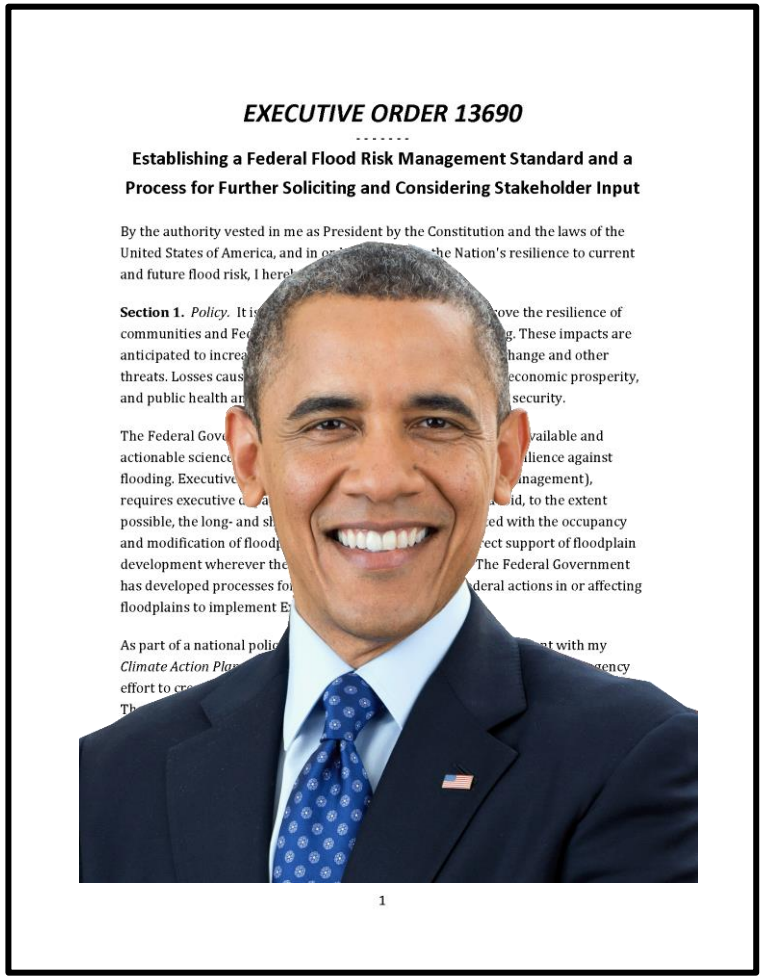
  Transportation System Preparedness and Resilience to Climate Change and Extreme Weather Events
  - ***Defines & places context of "Extreme Events"***
  - ***FHWA decides what are appropriate scientific approaches***
- **FHWA "Eligibility Memo"**

2012 :: End of Status Quo?



2015 :: Future Floods & Floodplains

- **EO 13690**
  - ***"Establishing a Federal Flood Risk Management Standard and a Process for Further Soliciting and Considering Stakeholder Input"***
- **Standard**
  - ***Federal Flood Risk Management Standard***
- **Guidelines**
  - ***Guidelines for Implementing Executive Order 11988, Floodplain Management, as Revised***
- **Implementation Plan**



EXECUTIVE ORDER 13690

Establishing a Federal Flood Risk Management Standard and a Process for Further Soliciting and Considering Stakeholder Input

By the authority vested in me as President by the Constitution and the laws of the United States of America, and in or... the Nation's resilience to current and future flood risk, I hereb...

Section 1. *Policy.* It i... prove the resilience of communities and Fe... g. These impacts are anticipated to increa... change and other threats. Losses caus... economic prosperity, and public health ar... security.

The Federal Gove... vailable and actionable scienc... ilience against flooding. Executiv... nagement), requires executive d... id, to the extent possible, the long- and sh... ed with the occupancy and modification of floodp... rect support of floodplain development wherever the... The Federal Government has developed processes fo... deral actions in or affecting floodplains to implement E...

As part of a national polic... t with my *Climate Action Plan*... gency effort to cre...

1

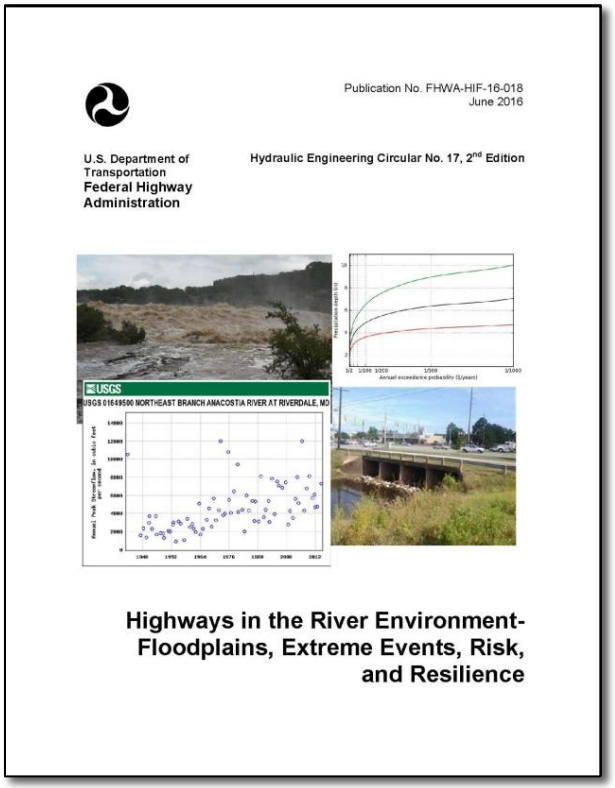
These next few slides go "beyond" HEC-17 …

FFRMS :: (aka) Standard

- Issued January 30, 2015
- Introduces “FFRMS Floodplain”
- Describes 3 approaches to achieve “Future Flood” standards:
  - *Climate-Informed Science Approach*
  - *Freeboard Value Approach*
  - *Use 500-year floodplain elevation and extent.*
- Gives each Federal agency choice on approach(es)
- Provides for Exceptions & Exemptions
  - *National Security*
  - *Emergency Actions*
  - *Demonstrably Inappropriate*
  - *Mission Critical*

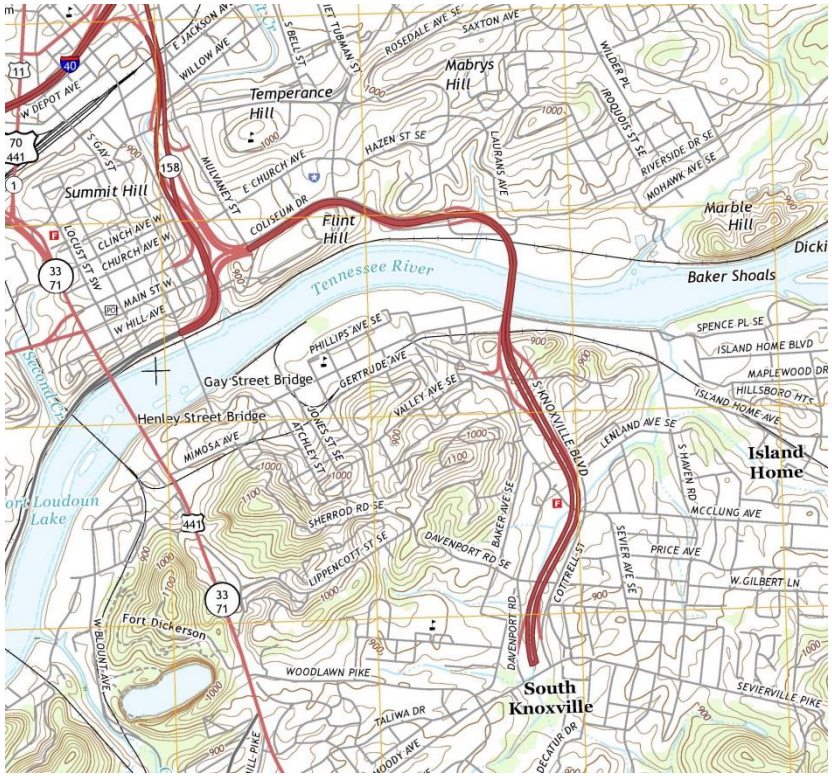
Standard :: Climate Informed Science

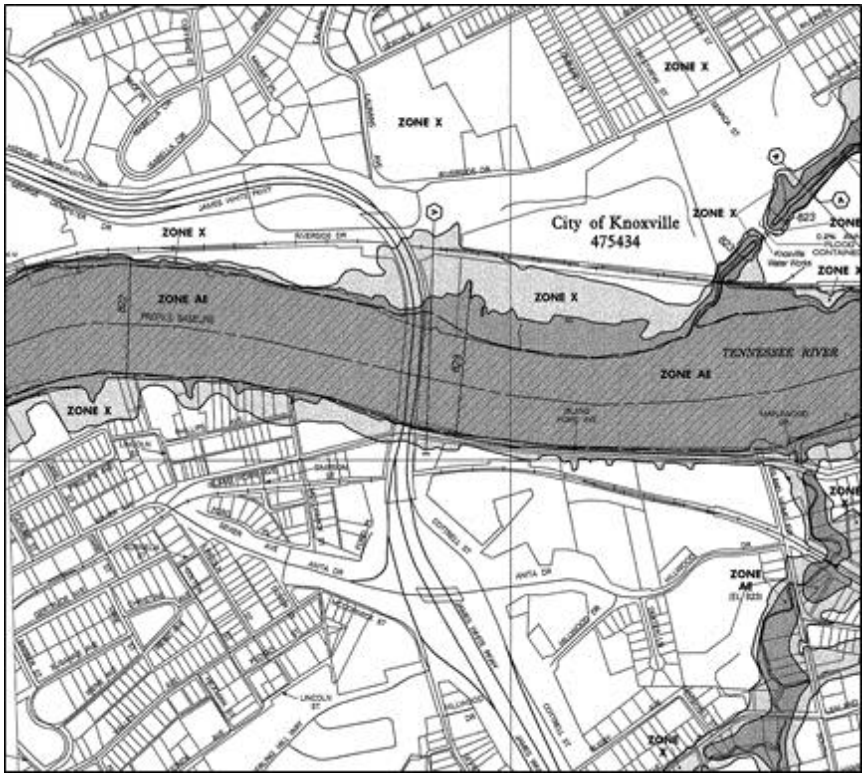
- **Coastal :: HEC-25 V2**
  - ***Sea level with Sea Level Rise***
  - ***Include waves, surge, tide data***
- **Riverine :: HEC-17**
  - ***Changes in riverine conditions resulting from climate changes***
  - ***Science still emerging***
- **Both**
  - ***Apply state-of-the-art science in a manner appropriate to policies, practices, criticality, risks & consequences***



Standard :: Freeboard

- **Base Flood (100-year floodplain) + 2 feet**

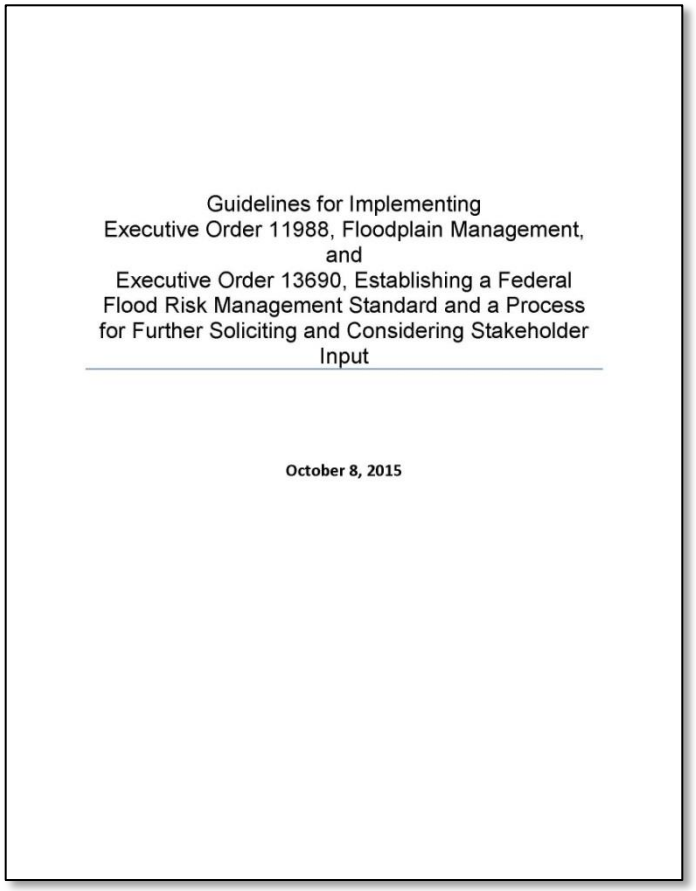




Standard :: 500-Year

- Use 500-year floodplain

Guidelines



Guidelines for Implementing
Executive Order 11988, Floodplain Management,
and
Executive Order 13690, Establishing a Federal
Flood Risk Management Standard and a Process
for Further Soliciting and Considering Stakeholder
Input

October 8, 2015

- **Issued October 8, 2015**
- **Result of**
  - ***2300+ Public Comments***
  - ***500 Different Parties***
- **Describes and Interprets**
  - ***Requirements and information of the EO 13690 and Standard***
- **Replaces**
  - ***1979 EO 11988 Implementing Guidelines***
- **Informs, but does not require agency approach**

Implementation Plans

- **White House required Implementing Plan**
  - ***30 days AFTER end of Implementing Guidelines public comment period***
- **Contains Milestones and Deadlines**
- **White House reviews and approvals**

Implementation Plan :: USDOT

- **USDOT's plan**
  - ***Assess FFRMS & EO 13690***
  - ***Update DOT Order 5620.2***
  - ***Obtain White House approval***
  - ***Stakeholder Outreach***
  - ***Seek Public comments***
  - ***Resolve comments as appropriate***
  - ***Issue Final Order***
    - **Allow each Modal Agency to Implement**

Status: on hold!

Implementation Plan :: FHWA

- **FHWA**
  - ***Until DOT Order issued***
    - **Collect current FHWA program areas involving floodplains**
      - **Determine FFRMS impacts**
      - **Account & resolve impacts**
      - **Implement resolutions**
    - **Develop technical guidance**
  - ***Update Regulation***
    - **Same Rulemaking Process as DOT Order**

Status: ???

Implementation Plan :: Others

- HUD
- FEMA
  - *Draft Rule in FR*
  - *Reviewing comments*
  - *Final Rule???*
- Corps
  - *Draft EC in FR*
  - *Comments due 30 January*

FHWA unaware of any other federal agency Regulations placed on hold

Future of Federal Floodplain Policies?

Photo Source: WhiteHouse.gov

New administration will provide leadership, direction and focus!

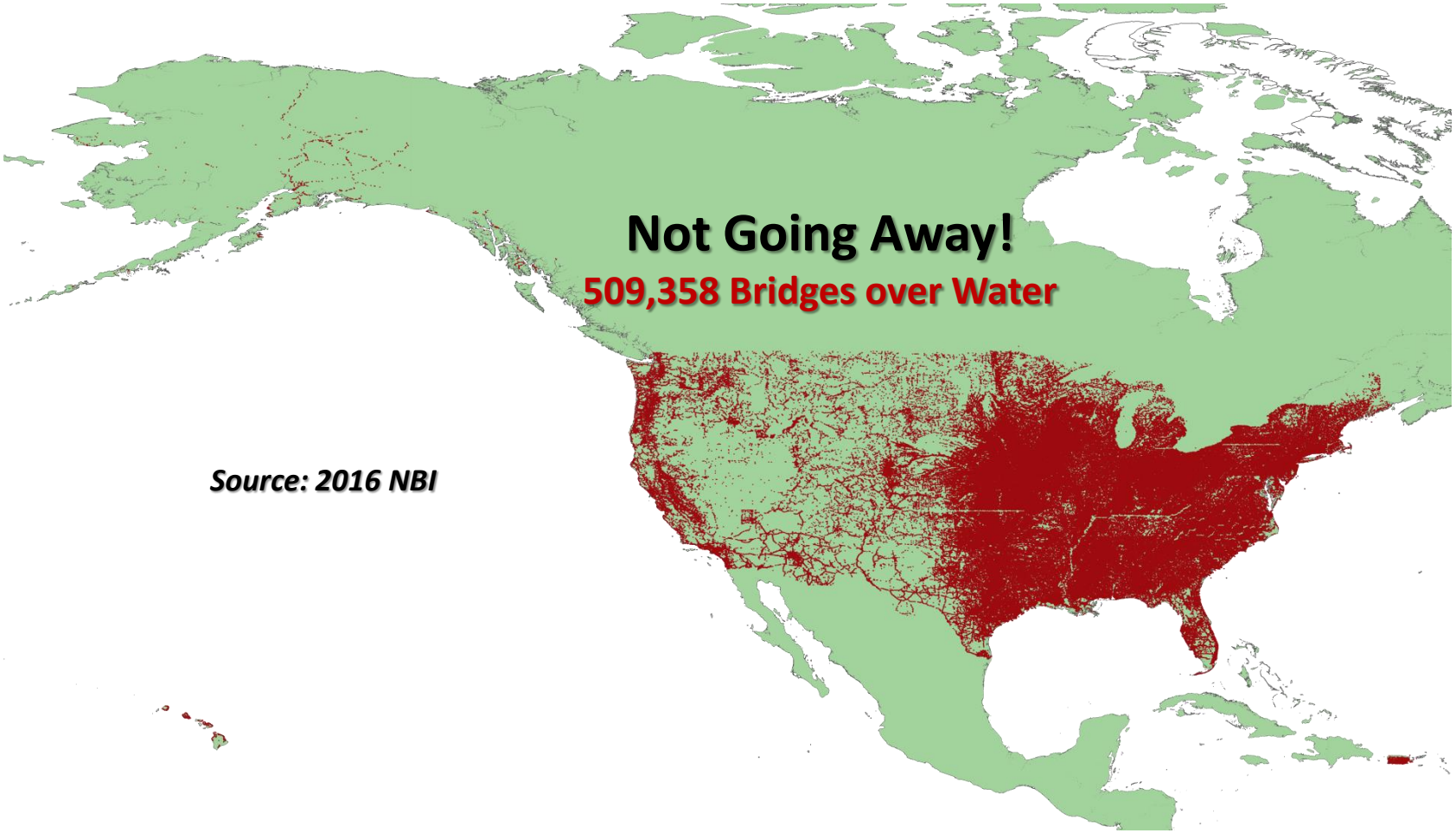
Takeaways!

FHWA

- ***awaiting direction from the Administration***
- ***has a good history of involving and communicating with our transportation partners***
- ***will continue to do so with floodplains to the extent possible***
- ***will build upon Risk based, Data driven approaches***
- ***will align approaches with MAP-21 and FAST Act initiatives***

NO FHWA programs or project delivery should deviate from EXISTING requirements of 23 CFR 650 Subpart A until promulgation of any new/revised regulation, policies, and guidance.

Floodplains & FHWA



Questions?

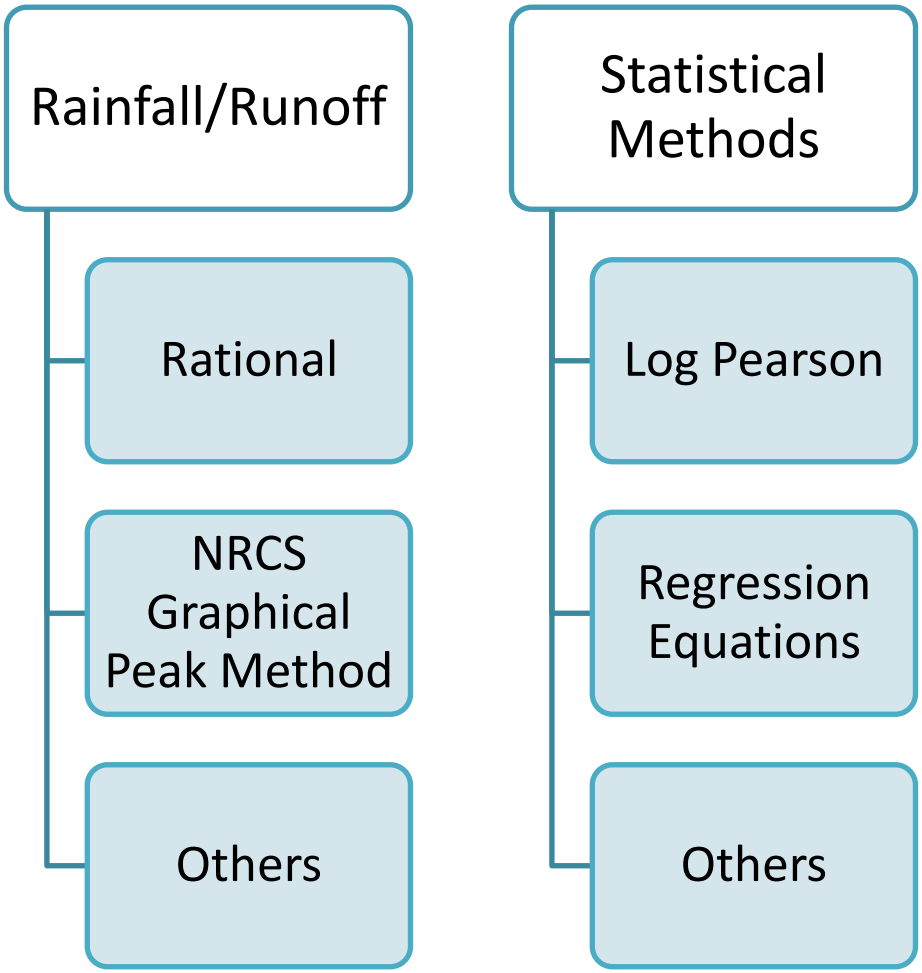
Chapter

Riverine Flood Events

Terminology

Base Flow	Bankfull Discharge	Runoff
Flood	Precipitation	Hydrograph
Hyetograph	Variable	Parameter

Methods for Estimating Discharge



Rainfall/Runoff Methods

Relate physical properties to discharge

Simplifying Assumptions

Smaller Structures

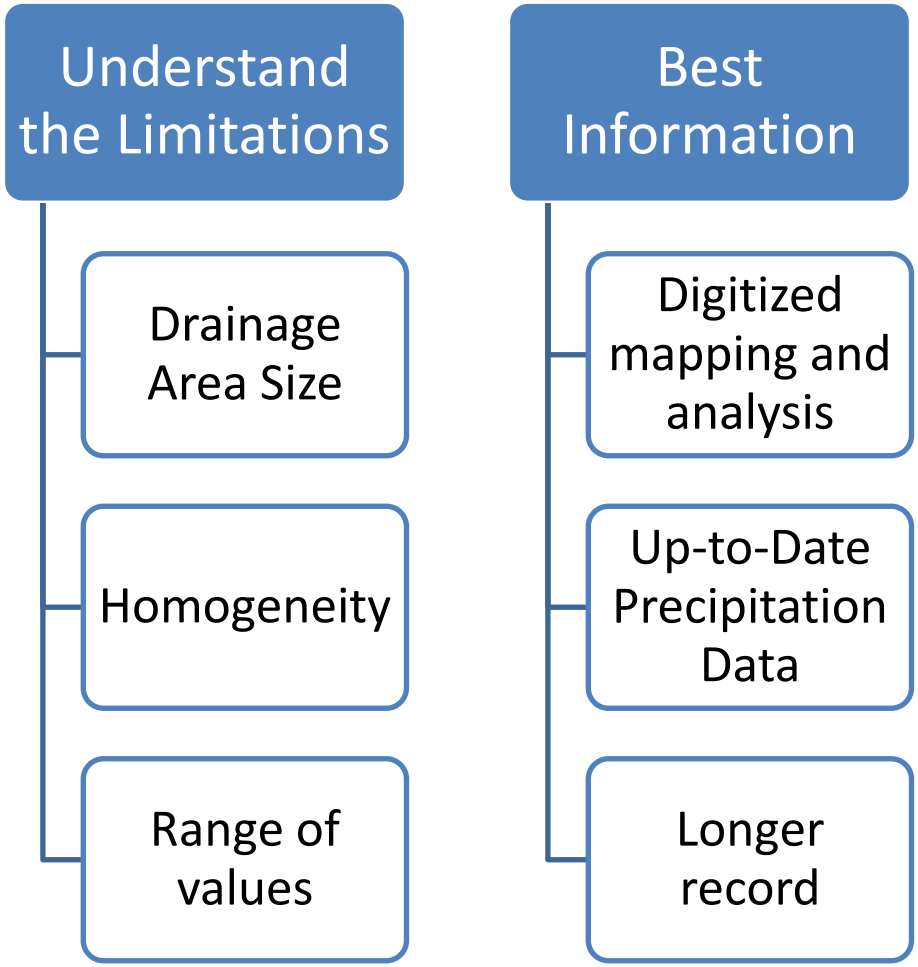
Statistical Methods

Historical gage data

Specific Gages or Regional

Larger Structures

Best Estimates

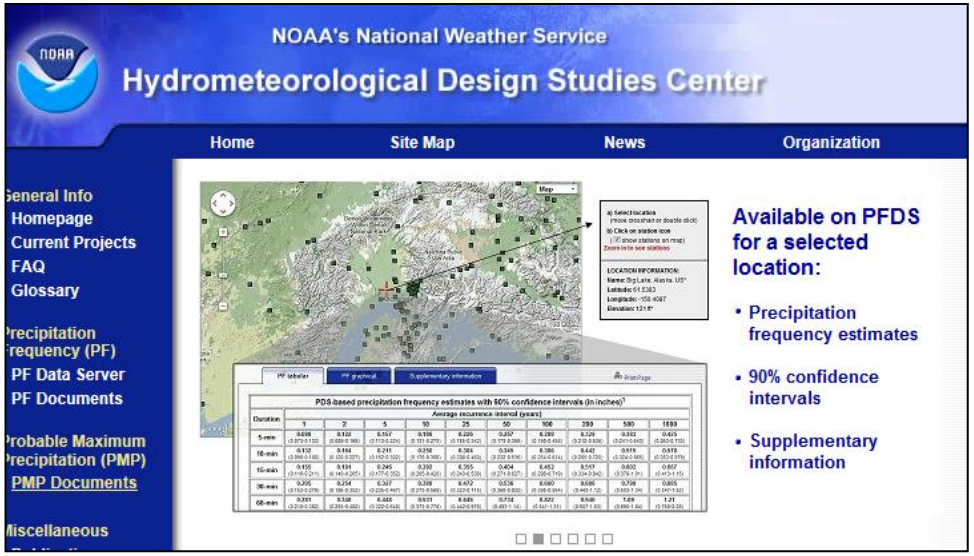


Best Actionable Precipitation Data

FHWA RECOMMENDS:

NOAA Atlas 14

http://www.nws.noaa.gov/oh/hdsc/index.html



Uncertainty of Estimate

Data Uncertainty

POINT PRECIPITATION FREQUENCY (PF) ESTIMATES

WITH 90% CONFIDENCE INTERVALS AND SUPPLEMENTARY INFORMATION

NOAA Atlas 14, Volume 9, Version 2

PF tabular | PF graphical | Supplementary information | Print page

AMS-based precipitation frequency estimates with 90% confidence intervals (in inches/hour)[1]

Duration	Annual exceedance probability (1/years)								
	1/2	1/5	1/10	1/25	1/50	1/100	1/200	1/500	1/1000
5-min	**5.28** (4.22–6.78)	**6.76** (5.39–8.70)	**7.99** (6.35–10.3)	**9.78** (7.61–13.0)	**11.2** (8.57–15.1)	**12.8** (9.48–17.4)	**14.4** (10.4–20.0)	**16.8** (11.6–23.7)	**18.7** (12.6–26.4)
10-min	**3.86** (3.09–4.97)	**4.95** (3.95–6.37)	**5.86** (4.65–7.55)	**7.16** (5.57–9.53)	**8.23** (6.27–11.0)	**9.37** (6.94–12.8)	**10.6** (7.58–14.7)	**12.3** (8.53–17.3)	**13.7** (9.24–19.3)
15-min	**3.14**	**4.02**	**4.76**	**5.82**	**6.69**	**7.62**	**8.60**	**9.99**	**11.1**

Method Uncertainty

Rainfall/Runoff Methods

- Uncertainty Unknown

Statistical Methods

- Confidence Interval
- Standard Error

Method Uncertainty

Confidence Interval

- Best Estimate = 27,000 cfs
- Range = 19,000 to 45,000 cfs

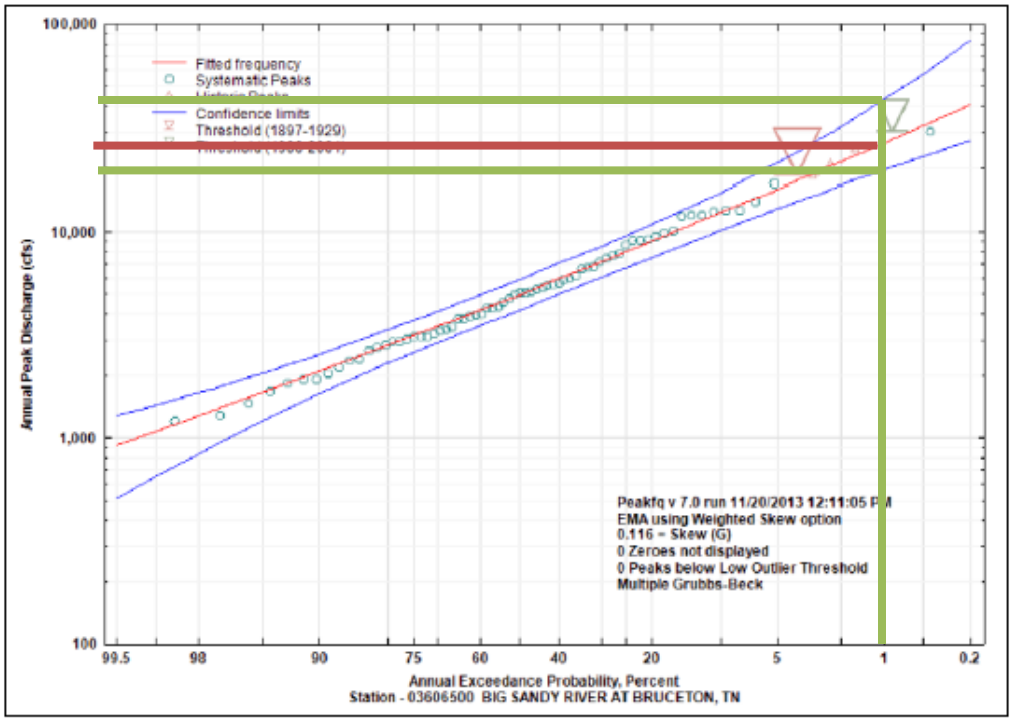
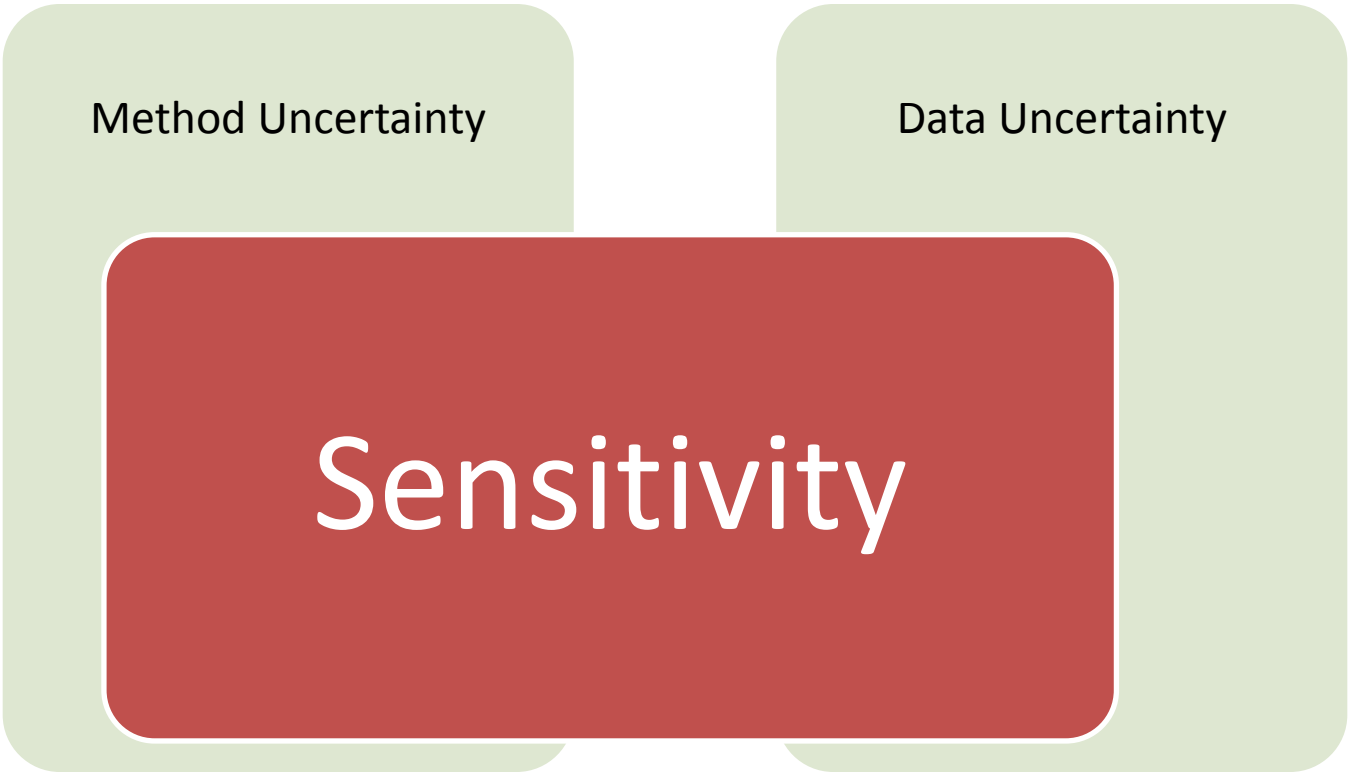


Figure 3.5. Example flood frequency curve with confidence intervals.

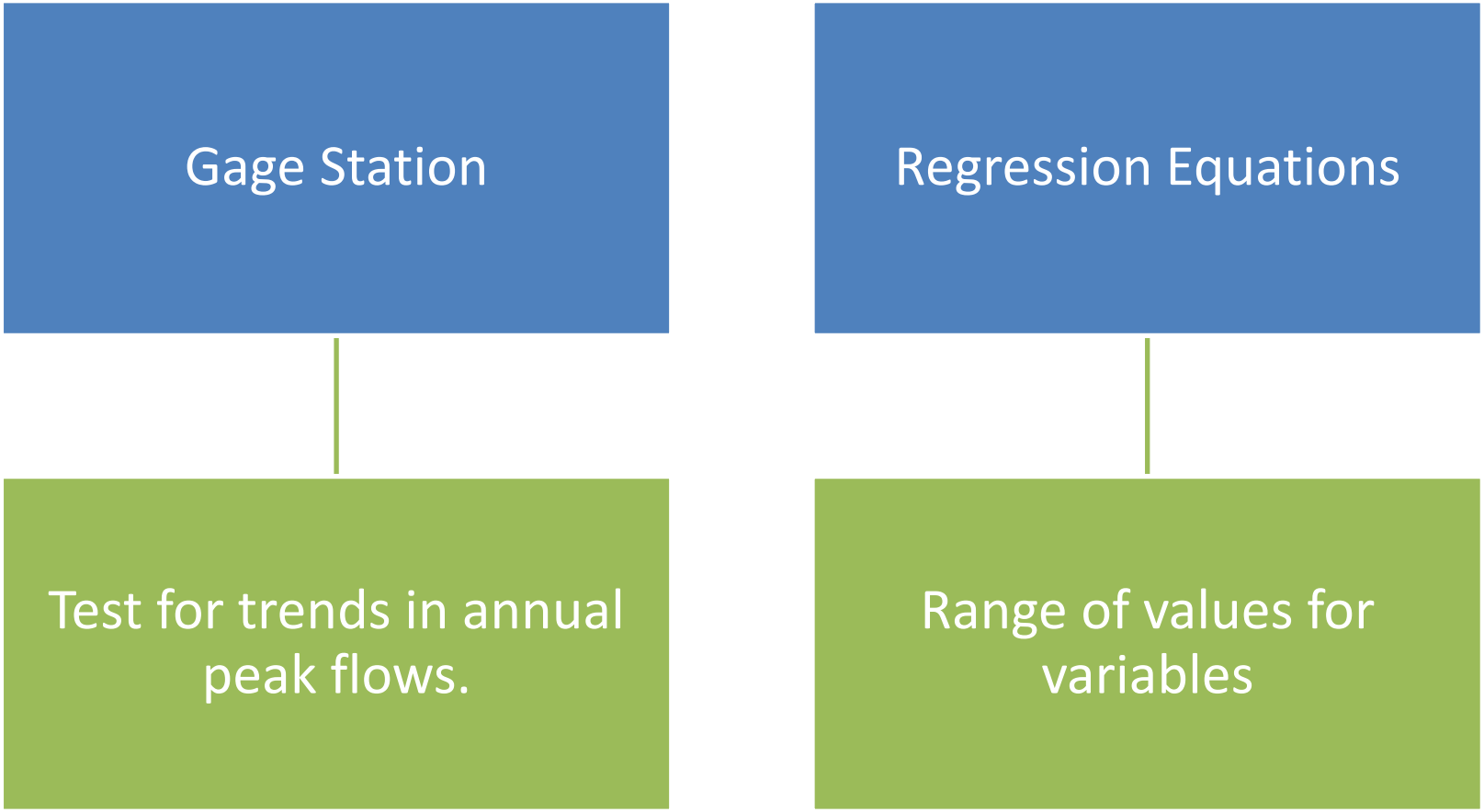
Uncertainty of Estimate



Change?

Land Use Change	• Curve Number
Intensity	• Confidence Limits

Change?


Gage Station
Regression Equations
Test for trends in annual peak flows.
Range of values for variables

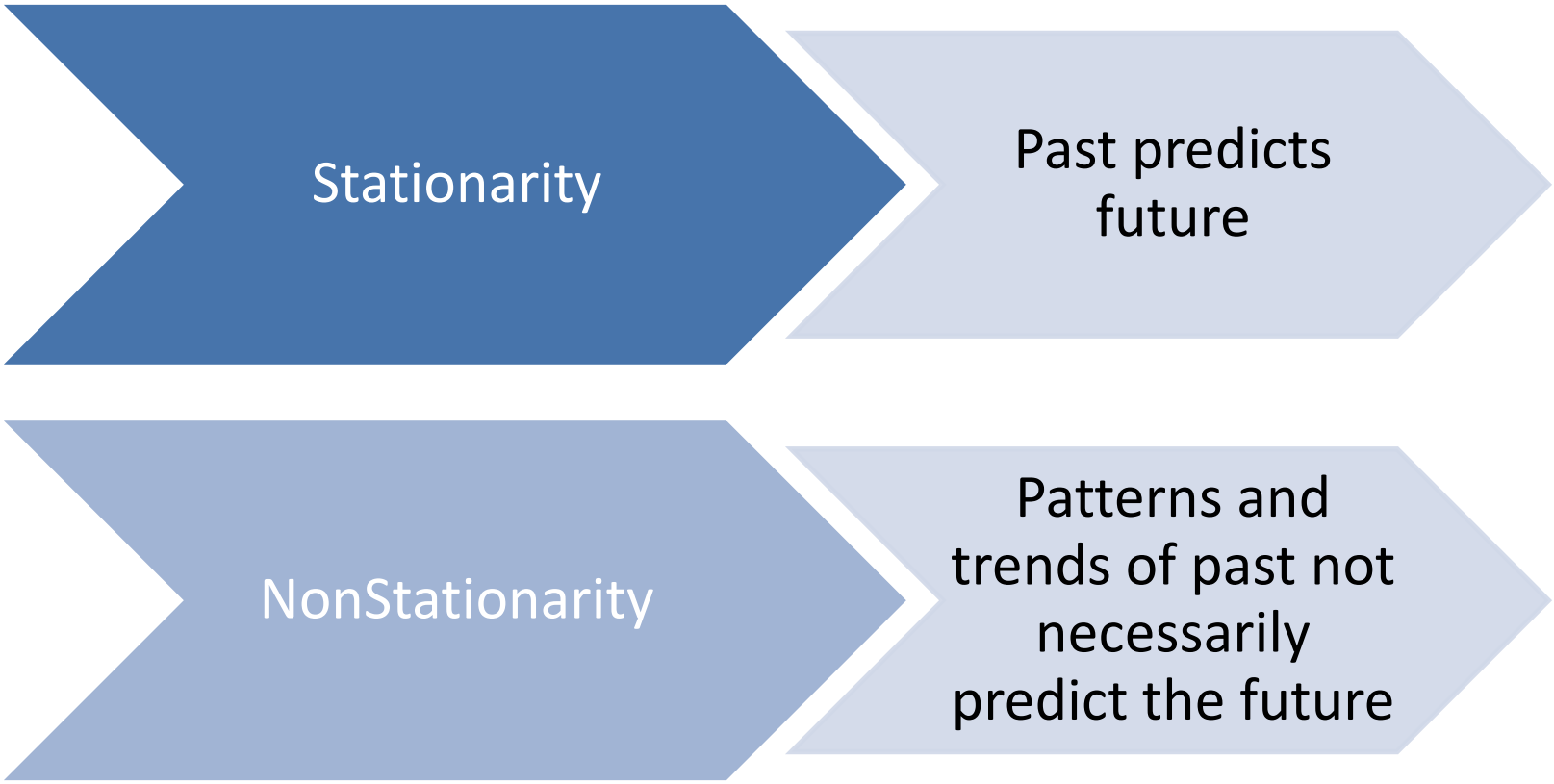
Questions?

Chapter

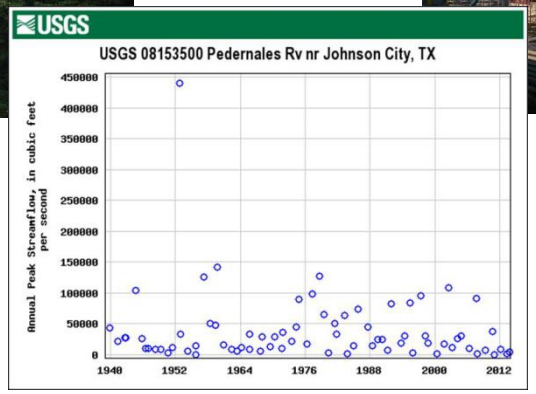
Nonstationarity or Change

Perspective

Past = Future?


Stationarity
Past predicts future
NonStationarity
Patterns and trends of past not necessarily predict the future

Nonstationarity



Which Precipitation?

Heavy	Daily or Annual?
Very Heavy	Annual or Partial Duration?
Extreme Event	6 hours or 24 hours?

Flood Trends

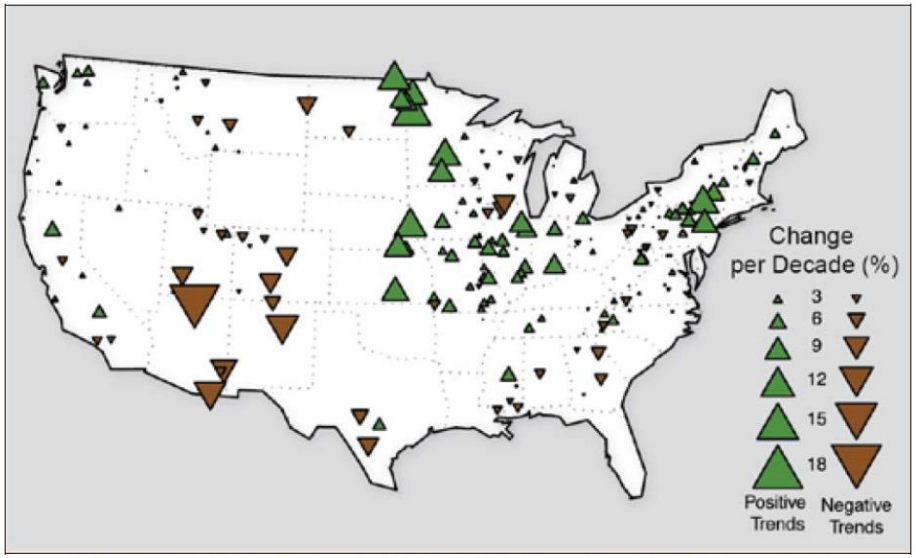


Figure 4.3. Trends in flood magnitude (from Hirsch 2011 and Petersen *et al*. 2013).

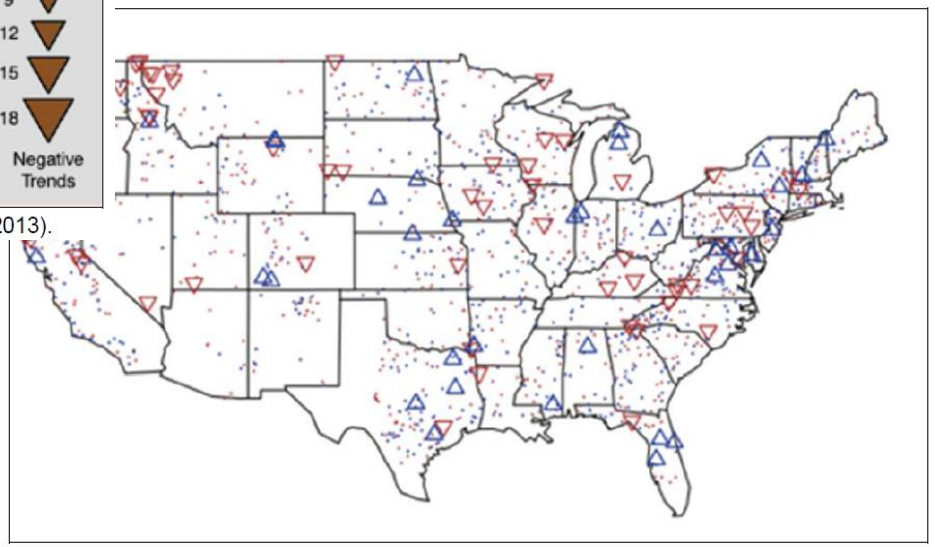


Figure 4.4. Trends in annual instantaneous peak streamflow (from Lins and Cohn, 2011).

Detecting Nonstationarity

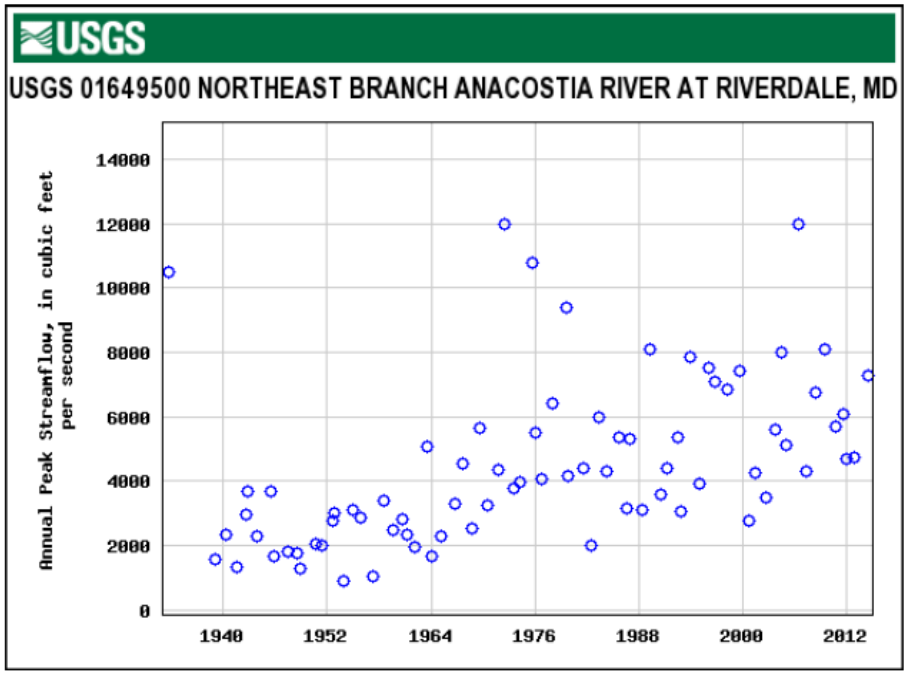


Figure 4.6. Annual peak discharges for the Northeast Branch Anacostia River at Riverdale, MD.

	TAU	P-VALUE	MEDIAN SLOPE	No. of PEAKS
SYSTEMATIC RECORD	0.492	0.000	62.683	76

Figure 4.7. PeakFQ output for the Northeast Branch Anacostia River at Riverdale, MD.

Detecting Nonstationarity

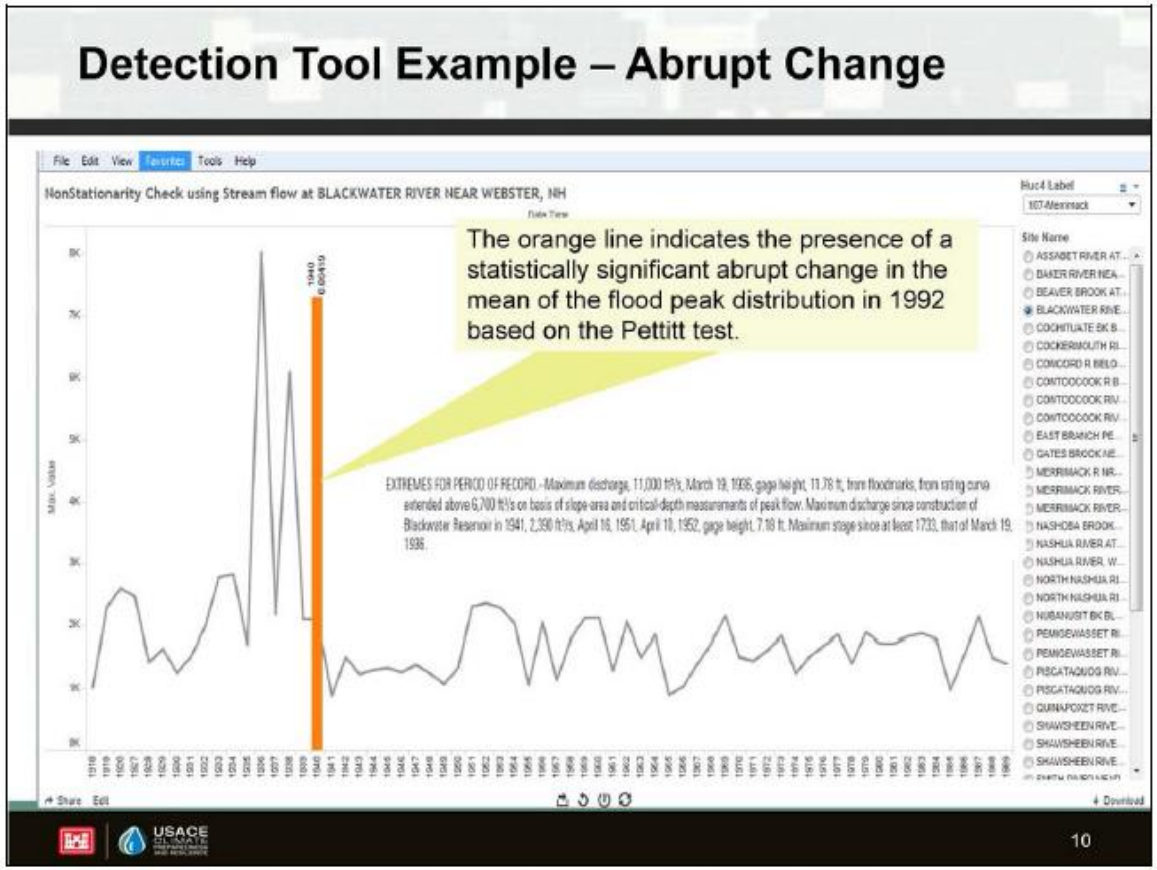
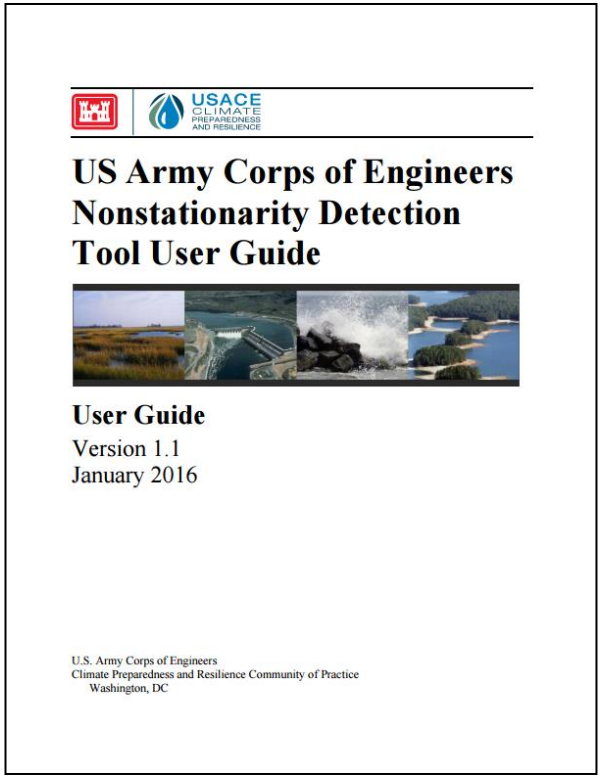


Figure 4.8. Example of the Pettitt test applied for the Blackwater River.

Detecting Nonstationarity



http://www.corpsclimate.us/ptcih.cfm

Adjusting for Nonstationarity

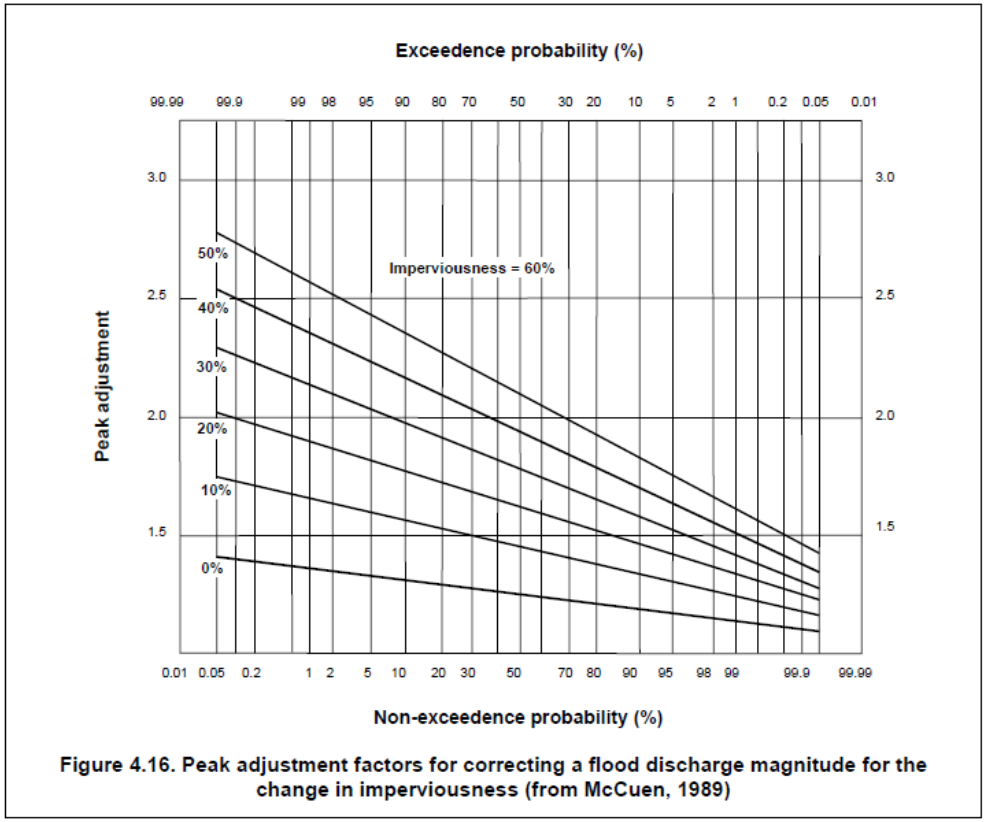
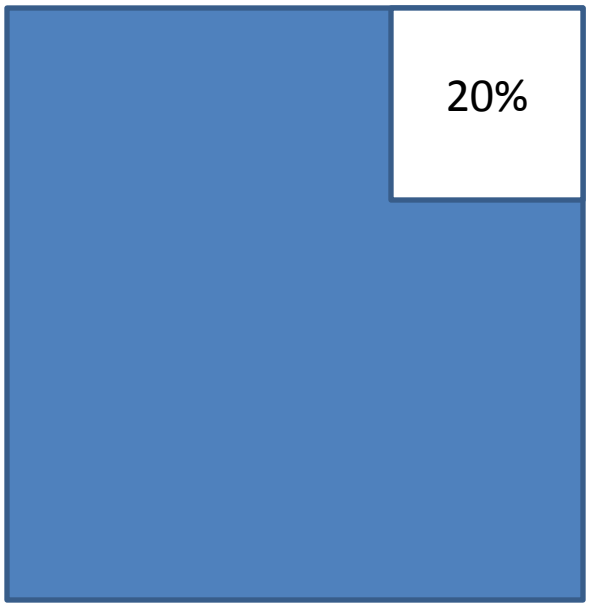


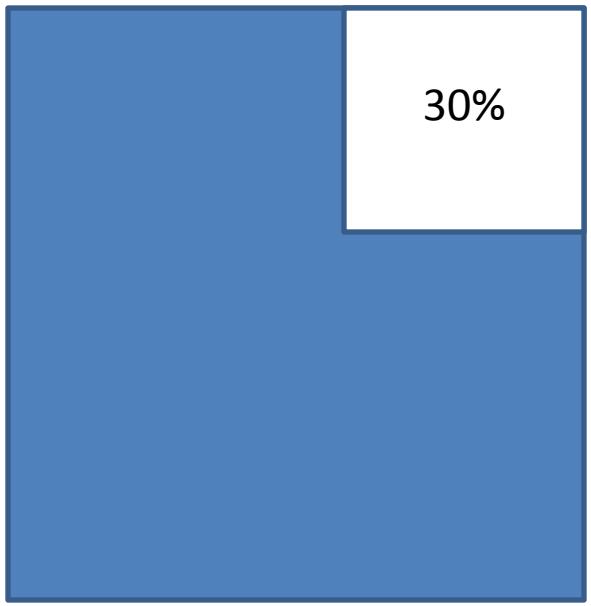
Figure 4.16. Peak adjustment factors for correcting a flood discharge magnitude for the change in imperviousness (from McCuen, 1989)

McCuen Index Adjustment Procedure

Adjusting for Nonstationarity



Beginning of Time Period



End of Time Period

Homogenous Subperiod of Record

Adjusting for Nonstationarity

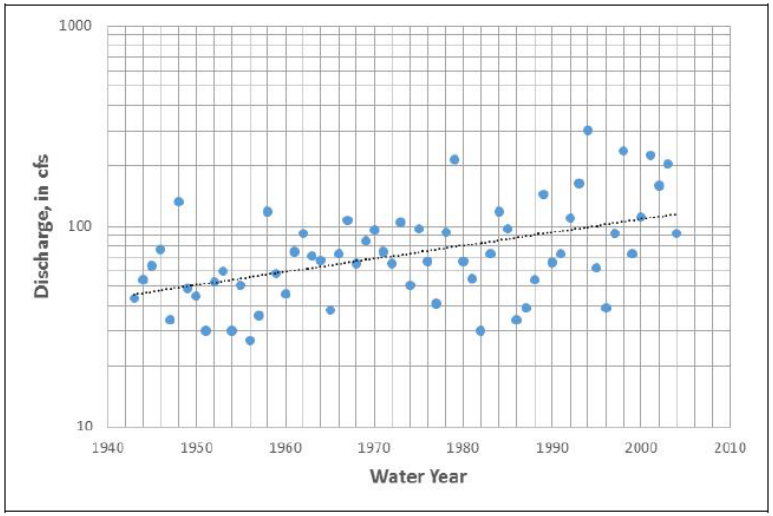


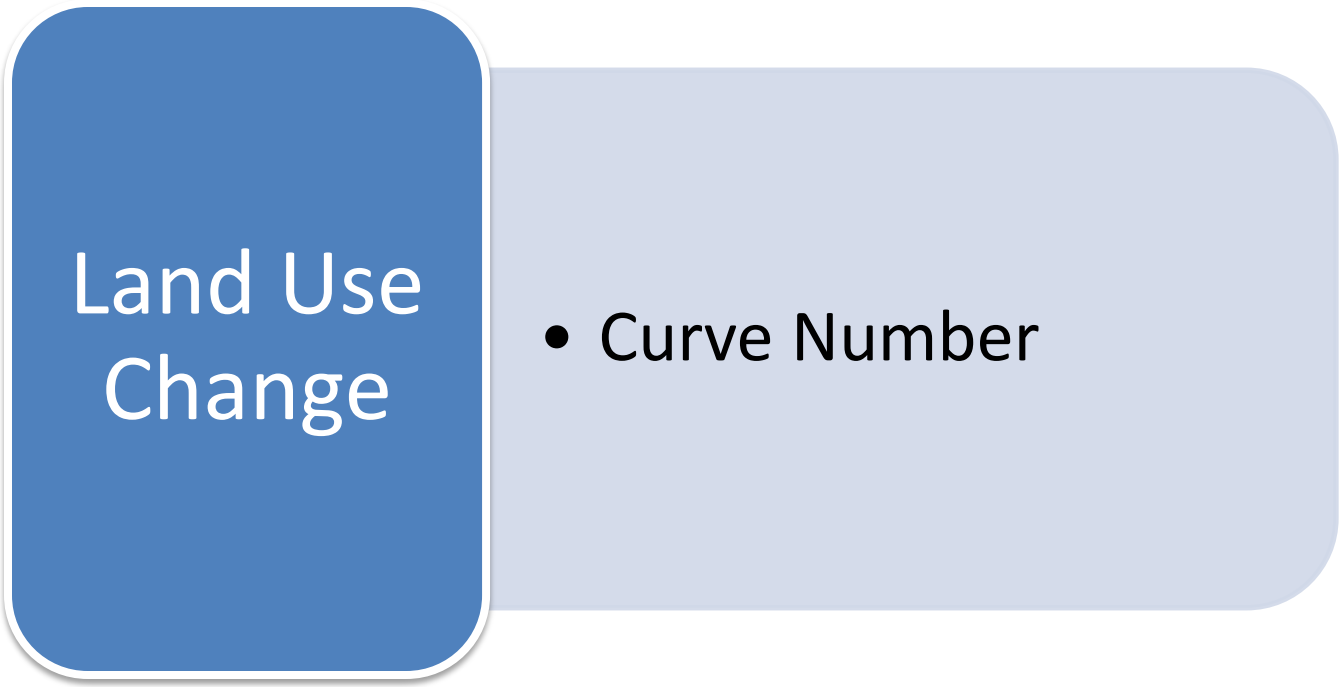
Figure 4.9. Annual peak discharges for Stockley Branch at Stockley, Delaware.

Table 4.1. Flood frequency estimates with and without adjusting for the mean.

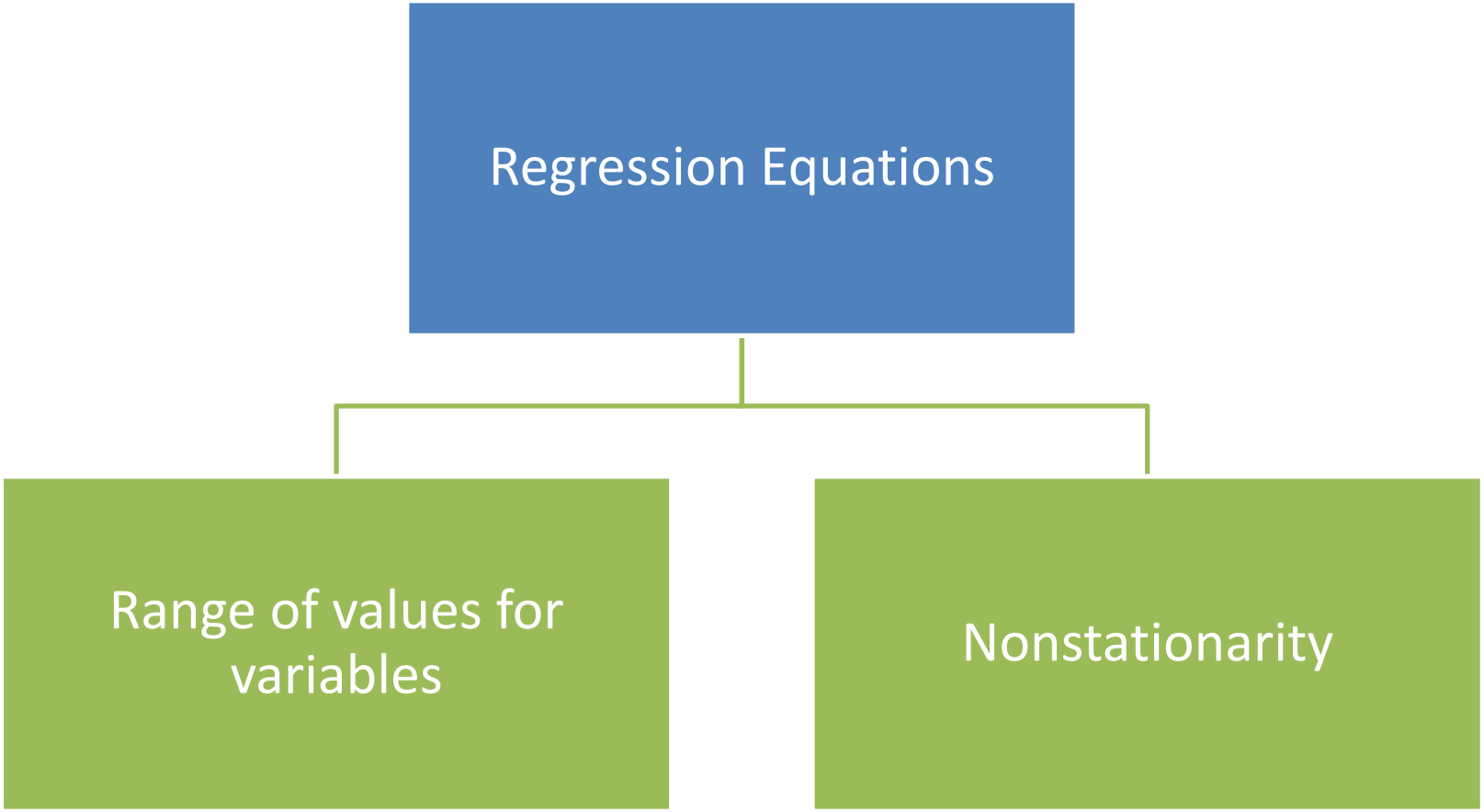
AEP	Estimate Without Adjusting for Nonstationarity (ft^3/s)	Estimate Adjusting for Nonstationarity (ft^3/s)
0.50	70	120
0.10	150	220
0.01	320	370

Frequency Analysis with Time Varying Mean

Projecting Flood Frequency



Projecting Flood Frequency



Questions?