



# FHWA Eastern Hydraulic Activities

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Presented to  
**FHWA Western Hydraulic  
Conference**

By

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Federal Highway Administration

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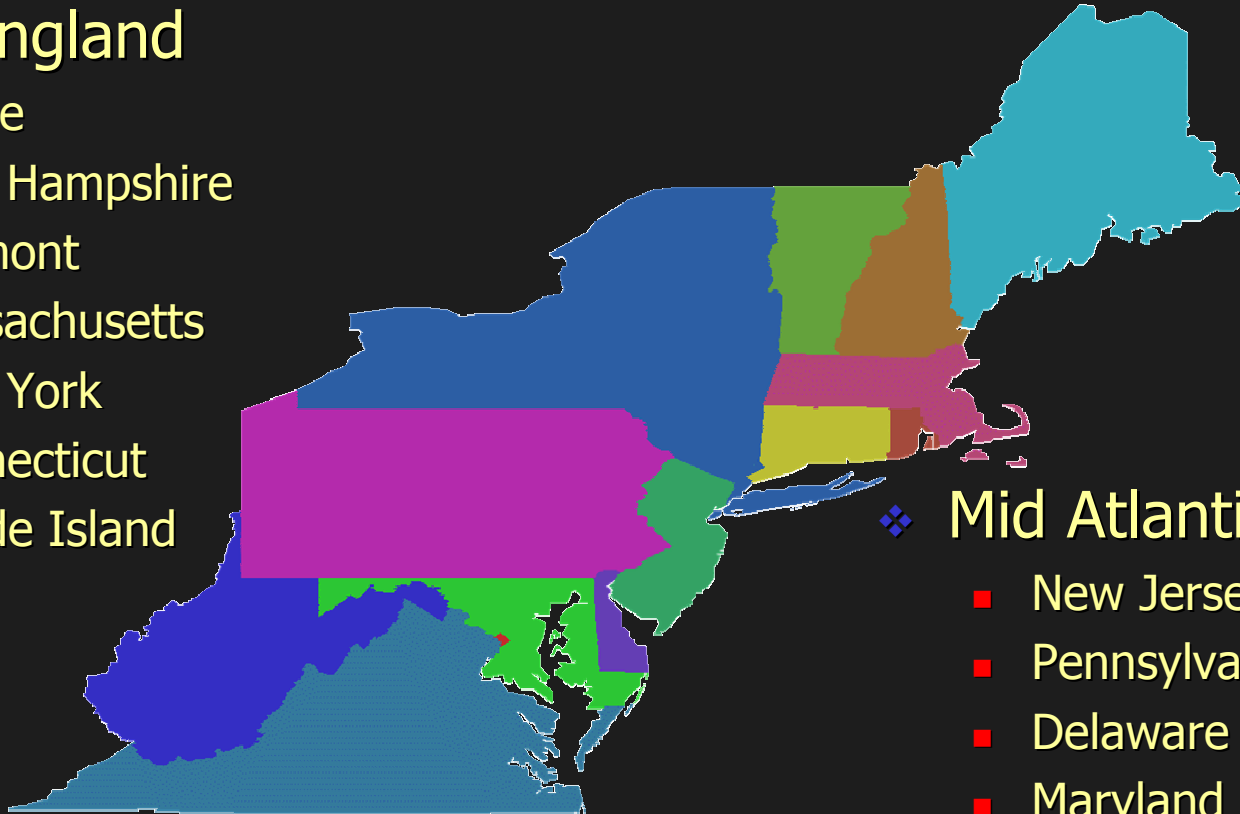


# Eastern States

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## ❖ New England

- Maine
- New Hampshire
- Vermont
- Massachusetts
- New York
- Connecticut
- Rhode Island



## ❖ Mid Atlantic

- New Jersey
- Pennsylvania
- Delaware
- Maryland
- District of Columbia
- West Virginia
- Virginia



# Issues & Activities

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- ❖ NPDES Permitting

- ❖ Tidal Waterways

- Storm Characterization
- Hydraulics

- ❖ Junction Loss

- Supercritical
- Surcharged

- ❖ Hydrology

- Ice debris
- Wetlands
- Subsurface
- WRC 17B

- ❖ Major Projects

- Woodrow Wilson Bridge
- Cameron Run Crossings
- Blennerhasset Island Bridge
- Great Egg Harbor Causeway
- Hampton Roads Tunnel

- ❖ Other activities

- Limestone scour
- Inlet applicability

# Caveats



*Eastern approaches still evolving ...*

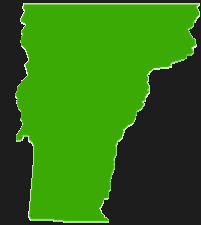


# NPDES Permits

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- ❖ Municipal Separate Storm Sewer System (MS4)
- ❖ Construction Activities
- ❖ Industrial Activities

***Vermont***



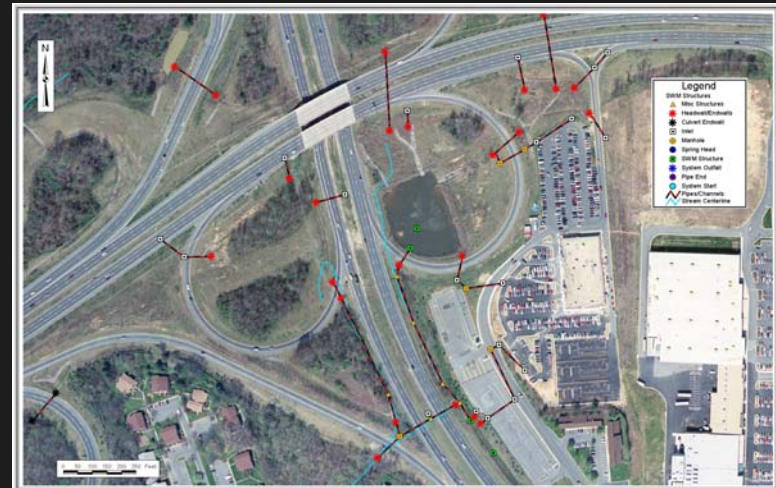
***Maryland***



# Maryland

- Hydraulics Unit
  - Lead group
  - Build on other programs
- Regulators
  - Early coordination
  - Proactive cooperation
- Support
  - Management
  - \$\$\$
  - Staff
- Other municipalities
  - Sharing data
  - Interactive

***Positive Experience!***





# Vermont

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- Hydraulics Unit
  - Lead group
  - Assigned program late in the regulatory process
  - Updating approaches
- Regulators
  - No proactive coordination
- Support
  - very little \$\$\$
  - “double duty” for staff
- Oh no!
  - Lawyers
  - Interest groups
  - ... more lawyers ...



***Umm ... glad Maryland has a positive experience!***



# Tidal Hydraulics

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## ❖ Tides

- Ranges
- Types
- Period

## ❖ Storms

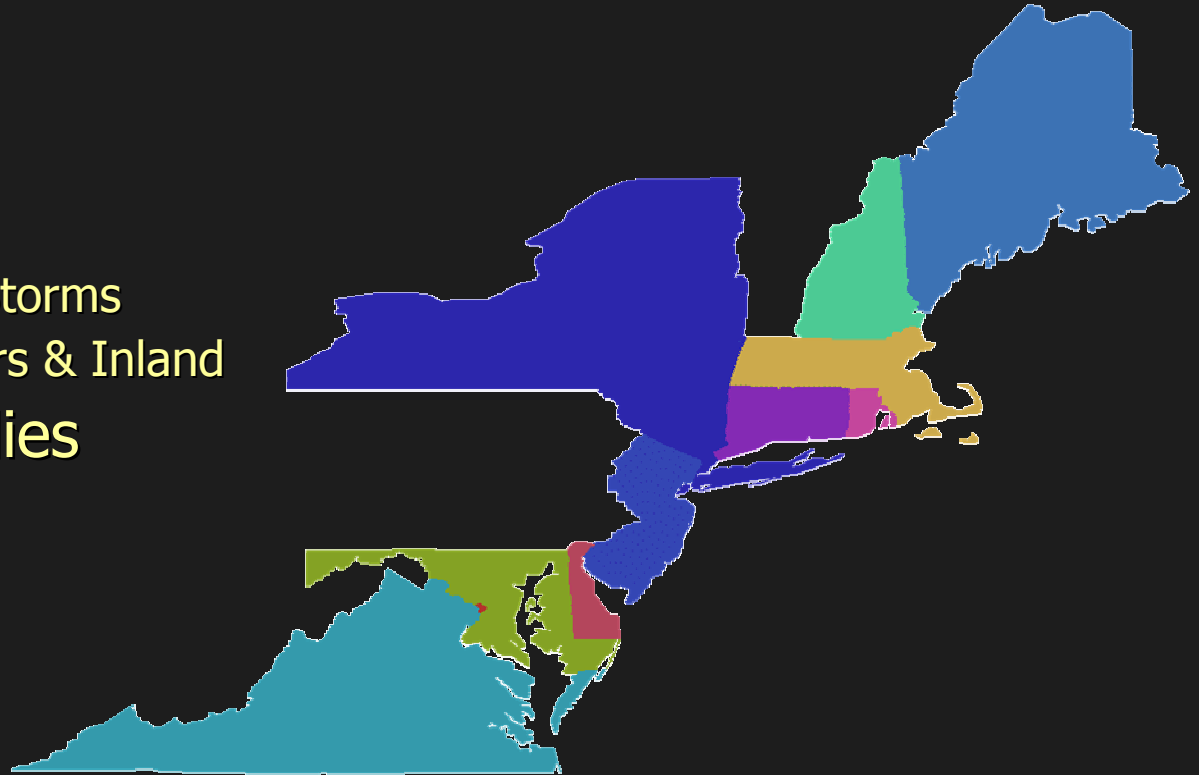
- Tropical Storms
- Nor'easters & Inland

## ❖ Water bodies

- Inlets
- Estuaries
- Bays

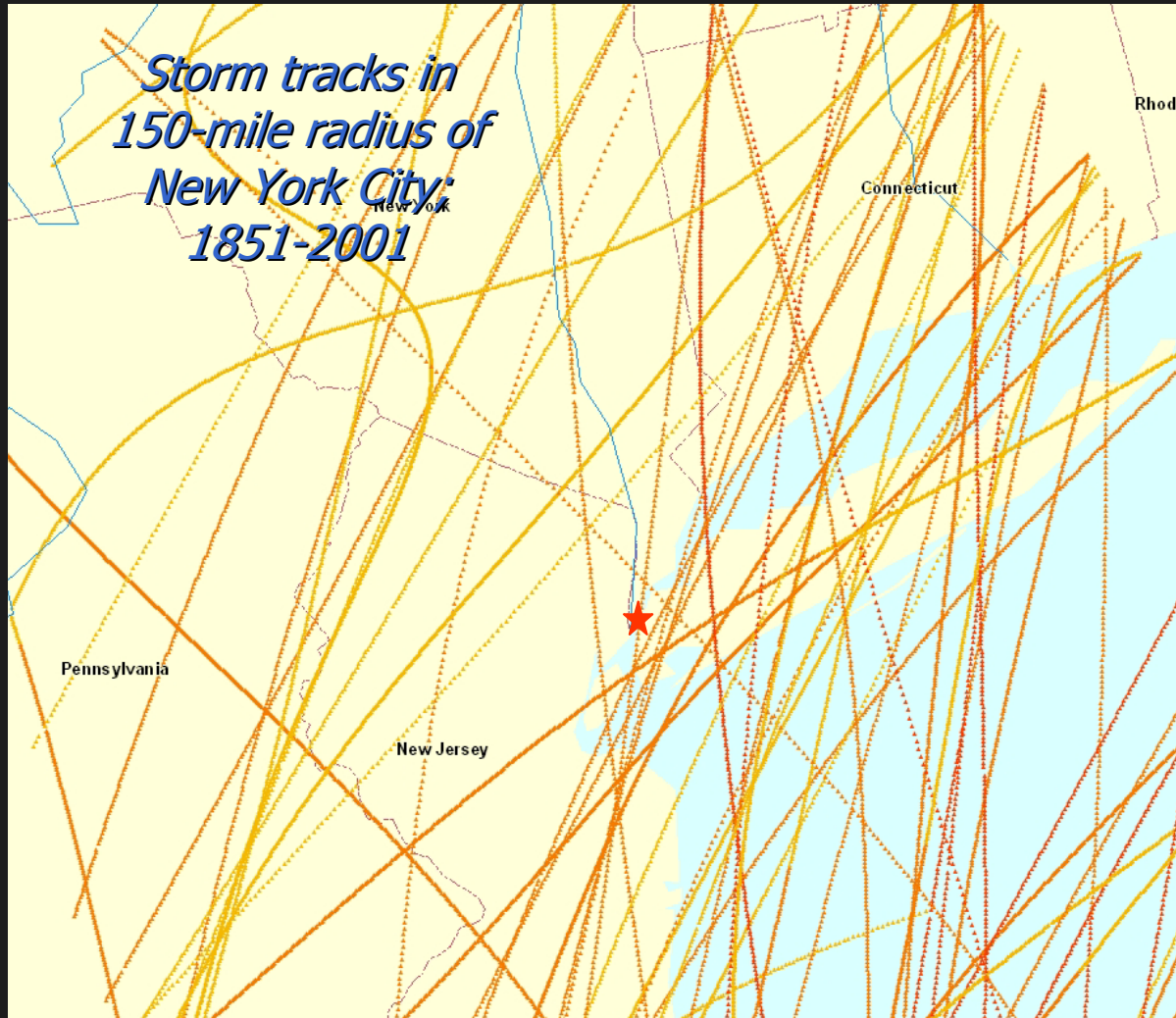
## ❖ Effects

- Flooding
- Scouring
- Environmental

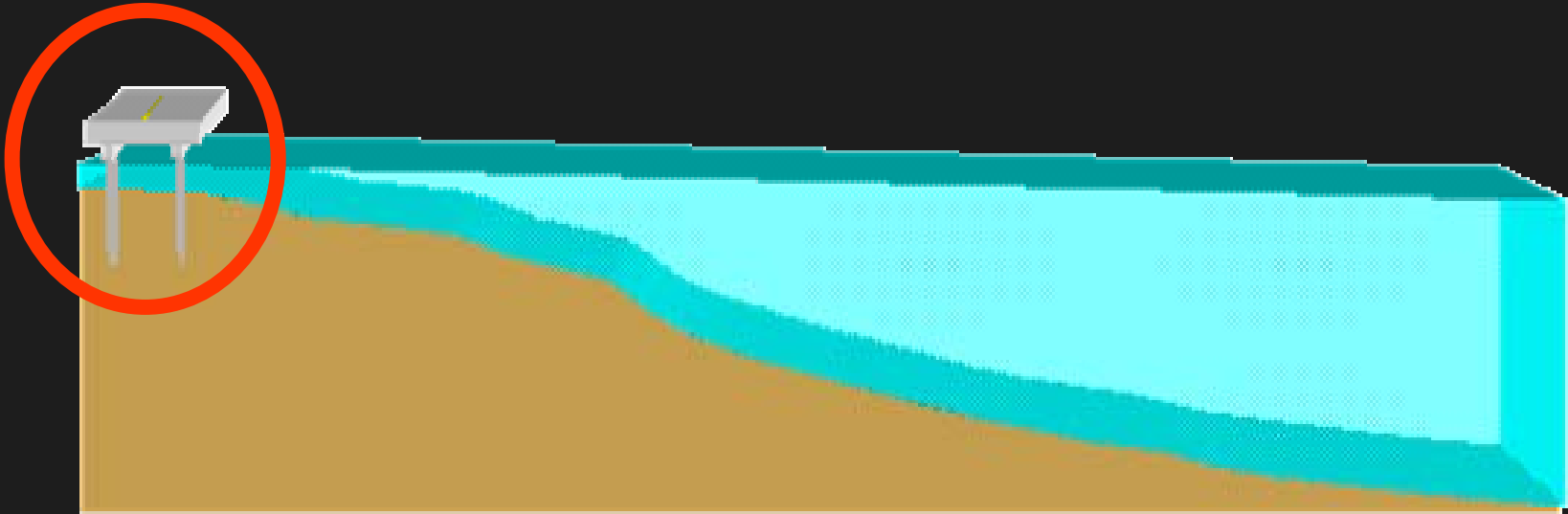




# Tropical Storm Events



# Tidal Flooding & Scour



## ❖ Floods

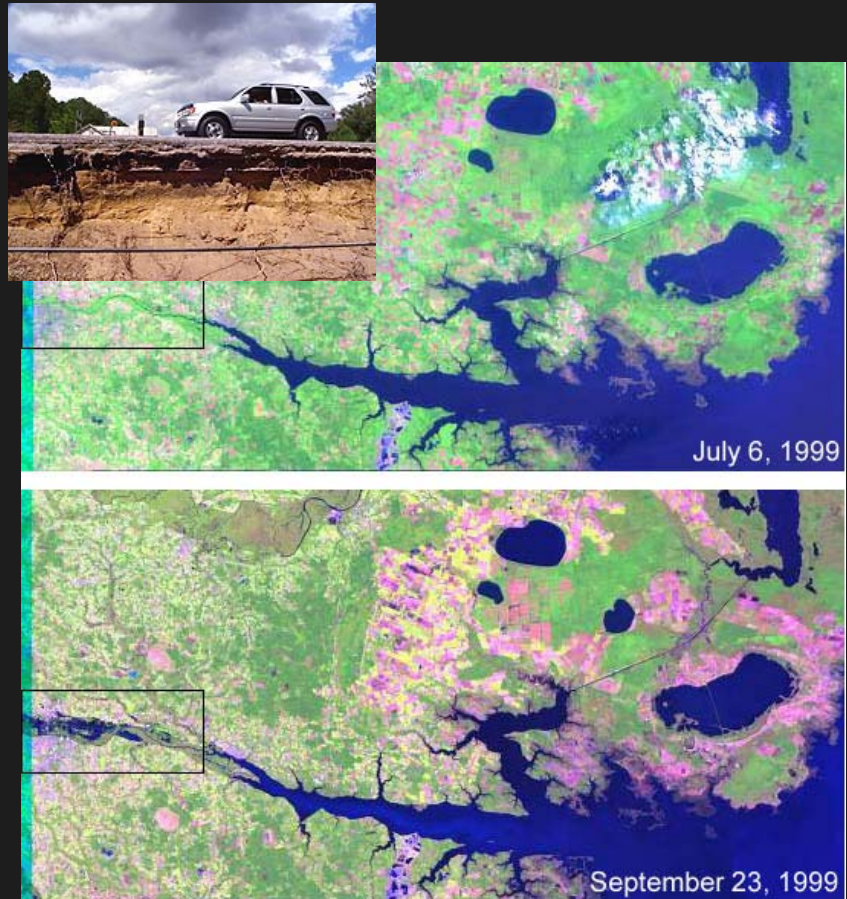
- Extent function of boundary conditions
  - Reducing downstream control ***reduces backwater***

## ❖ Scour

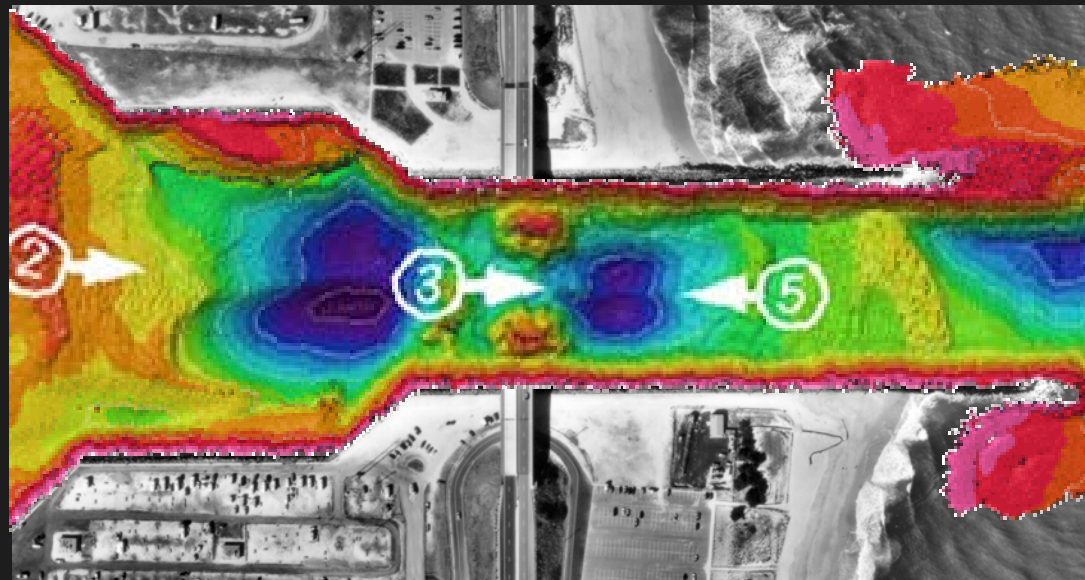
- Local scour highly dependent on velocity
  - Reducing downstream control ***increases velocity***

# Tar River

- ❖ Hurricane Floyd
  - Sept 14-17
  - Dennis (Sept 4-6)
- ❖ Surge & Rain
  - 10 year surge
  - 25 year rainfall
  - 500 Year Flooding!
  - \$70 million damages



# Indian River Inlet







# Junction Losses

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- ❖ Pennsylvania (and others)

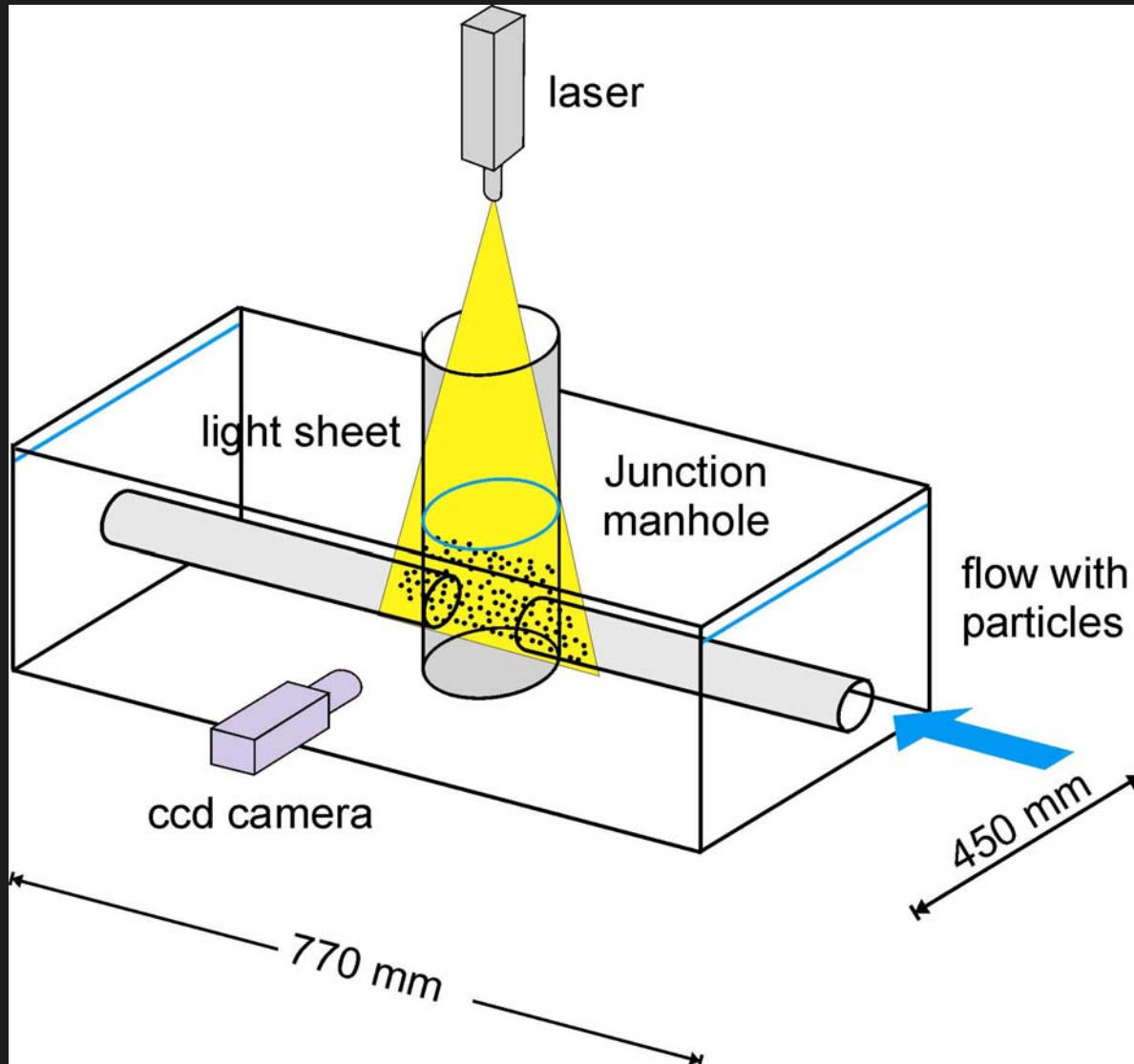
- ❖ Need

- Supercritical flow
  - Existing systems
  - New designs
- Surcharged junctions

- ❖ Approach

- Review existing FHWA data
- Conduct additional experiments
  - 1/3 scale physical models
  - Smaller scale using PIV and vertical light sheet

# PIV & Vertical Light Sheet





# Ice debris

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## ❖ States

- Maine
- Vermont
- Connecticut

## ❖ Issues

- Pressure scour
- Loading on structures
- Frequency of events



# Wetlands

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- ❖ Vermont (and others)

- ❖ Issues

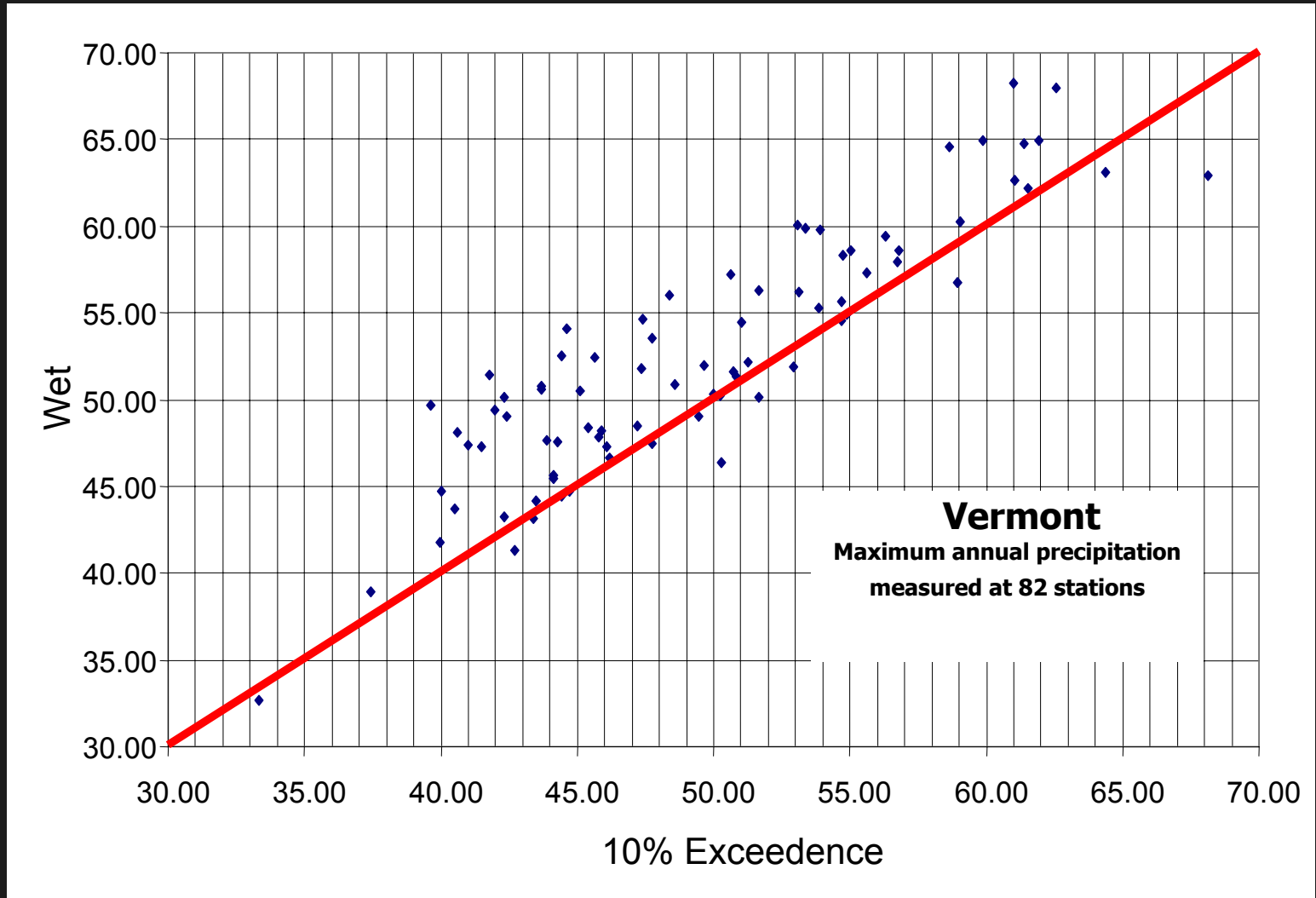
- Updating approaches for BMPs (new SMM)
- Limited growing season
- Inundation/saturation (hydroperiod)
  - Duration
  - Depth
  - Frequency (“dry” & “wet” years)
- Mitigation design

- ❖ Appropriate water quality storage percentages in Vermont SMM

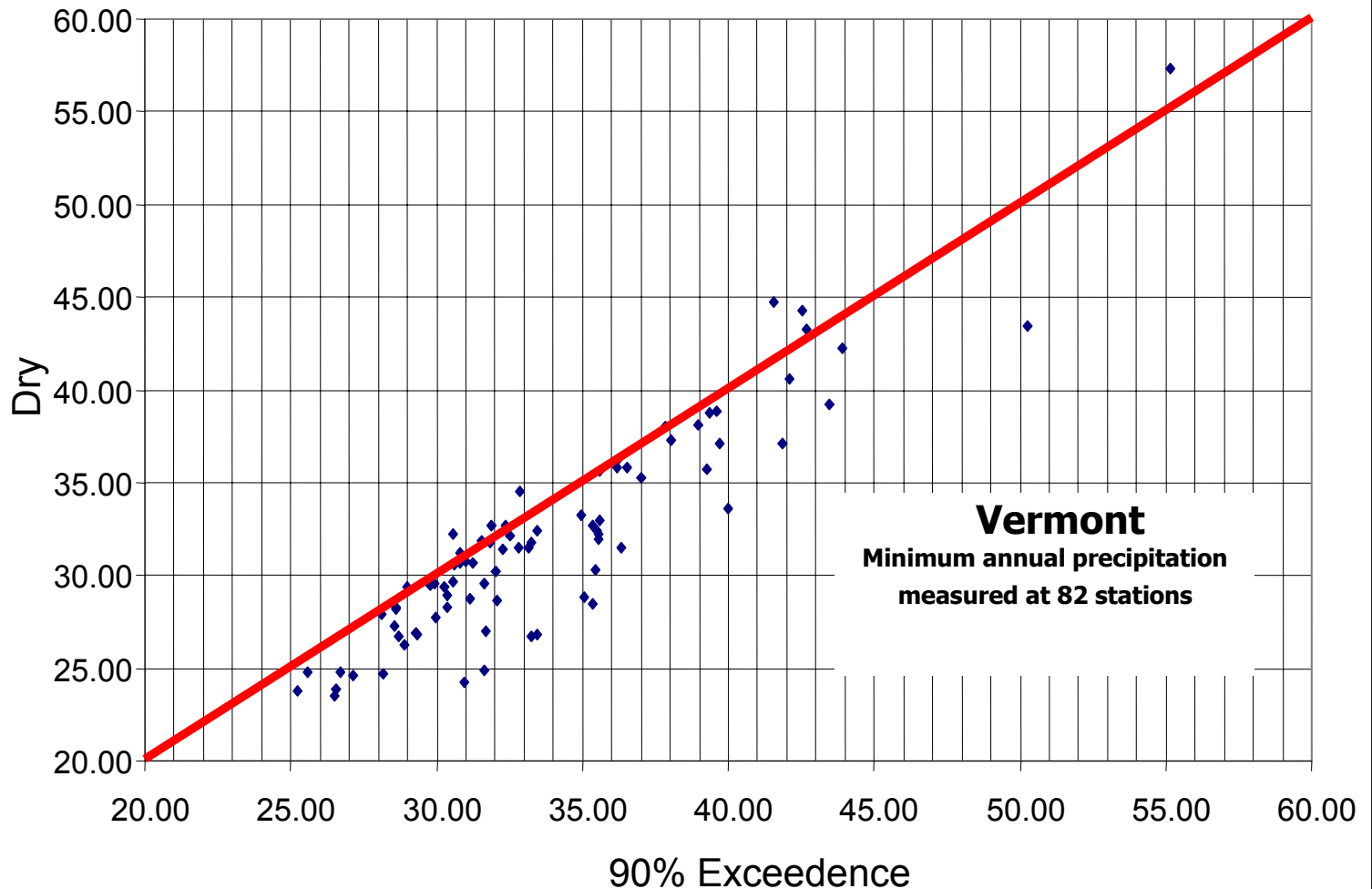
- Not necessarily “0.9 inches across Vermont”



# What is a Wet Year?



# What is a Dry Year?





# Subsurface Drainage

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- ❖ Virginia

- with TRB A2K06 Committee

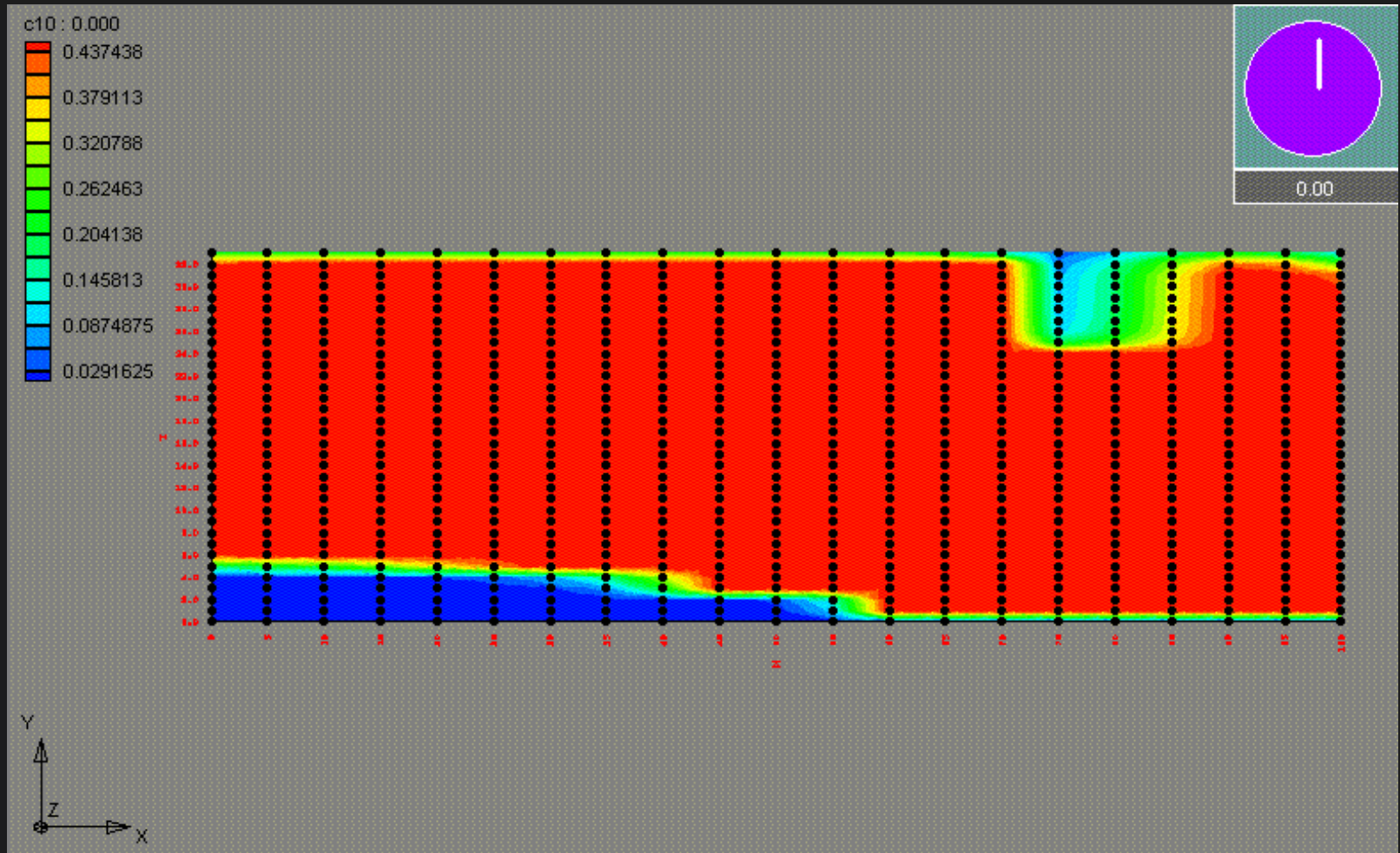
- ❖ Premature pavement failures

- Surface infiltration
- Water table and phreatic surface fluctuation
- Sources, seepage, and sinks
- Other groundwater hydrologic and hydraulic situations and effects

- ❖ Bottom line

***Water in the subgrade and subbase layers undermines the pavement structure and contributes to its eventual destabilization***

# Highway Model



... *really* high groundwater is tough ...





# “High” Frequency Events

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## ❖ States

- New York
- West Virginia

## ❖ Issues

- Stream restoration
- 1 to 2 year event validity?

Scientists ask:

“... why do hydraulic engineers call it ‘subcritical flow’ when the water depth is **clearly** above the critical depth!?!”



# Advisory Committee on Water Information

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## ❖ Membership

Agricultural Research Service, American Forests, Association of State Floodplain Managers, Bureau of Land Management, Bureau of Reclamation, Defenders of Property Rights, Federal Emergency Management Agency, **Federal Highway Administration**, Federal Energy Regulatory Commission, National Hydrologic Warning Council, National Science Foundation, National Weather Service, Natural Resources Conservation Service, US Army Corps of Engineers, US Environmental Protection Agency, US Forest Service, US Geological Survey

# Advisory Committee on Water Information



**Guidelines  
For  
Determining**

## **Flood Flow Frequency**

Bulletin # 17B  
of the  
Hydrology Subcommittee

Revised September 1981  
Editorial Corrections March 1982

INTERAGENCY ADVISORY COMMITTEE  
ON WATER DATA



U.S. Department of the Interior  
Geological Survey  
Office of Water Data Coordination  
Reston, Virginia 22092

## ❖ Recent efforts

- FAQs on using 17B guidelines
- Most appropriate methodology for flood frequency analysis for ungaged watersheds
- Flood frequency analysis for regulated gaged streams



# Wilson Bridge



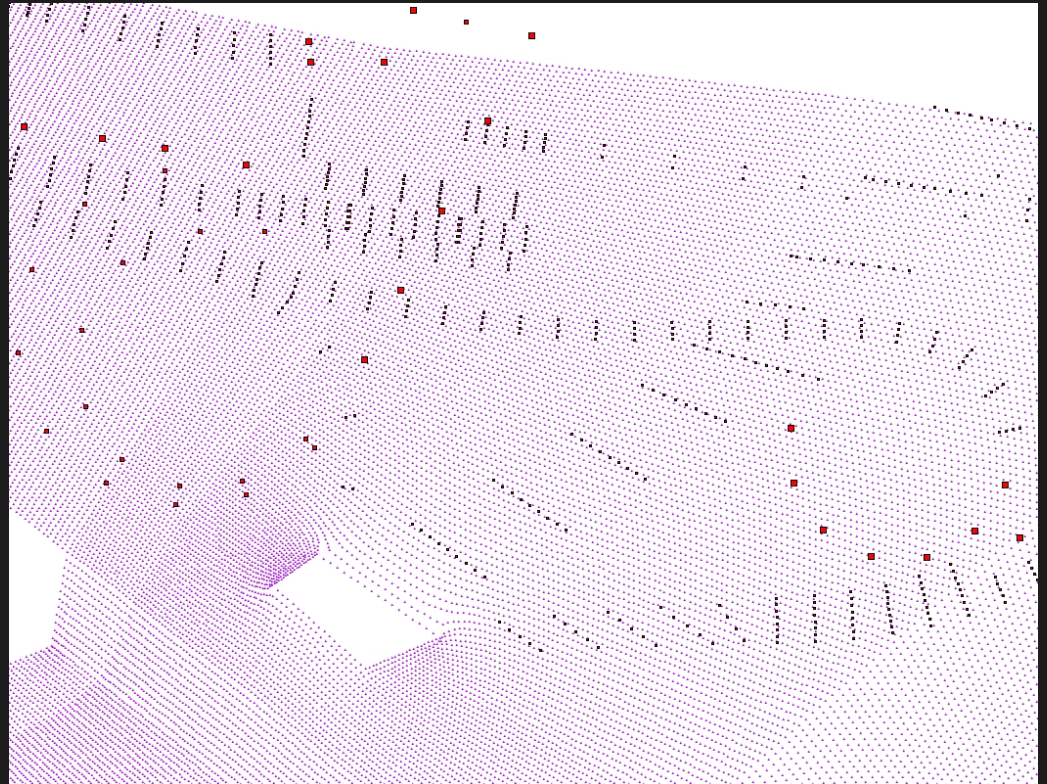
- ❖ Maryland –  
Virginia – DC
  - Potomac River
  - “\$2.2 billion” (Ha!)
- ❖ Deck Drainage
  - Scuppers
- ❖ Scour
  - Modeling



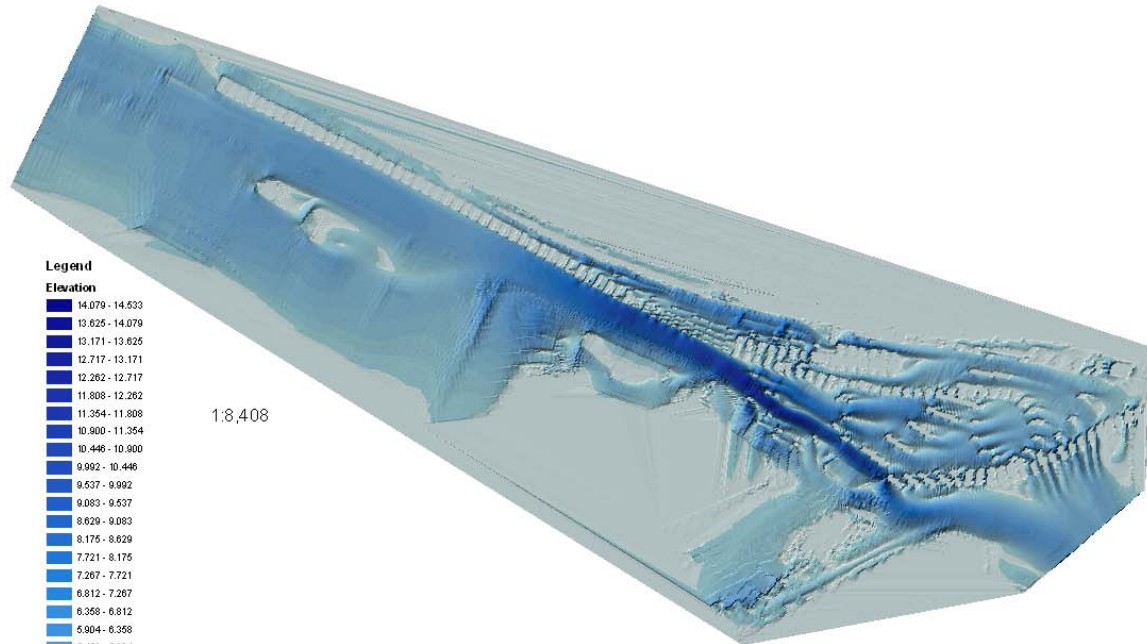
# Cameron Run

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- ❖ Virginia
- ❖ Complex Reach
  - $Q_{100} = 45,000$  cfs
  - 1,300 structures
  - HEC-RAS used
- ❖ FHWA review
  - CCHE2D model
    - 110,000 nodes
  - GIS model
    - Local scour



# Cameron Run - velocities



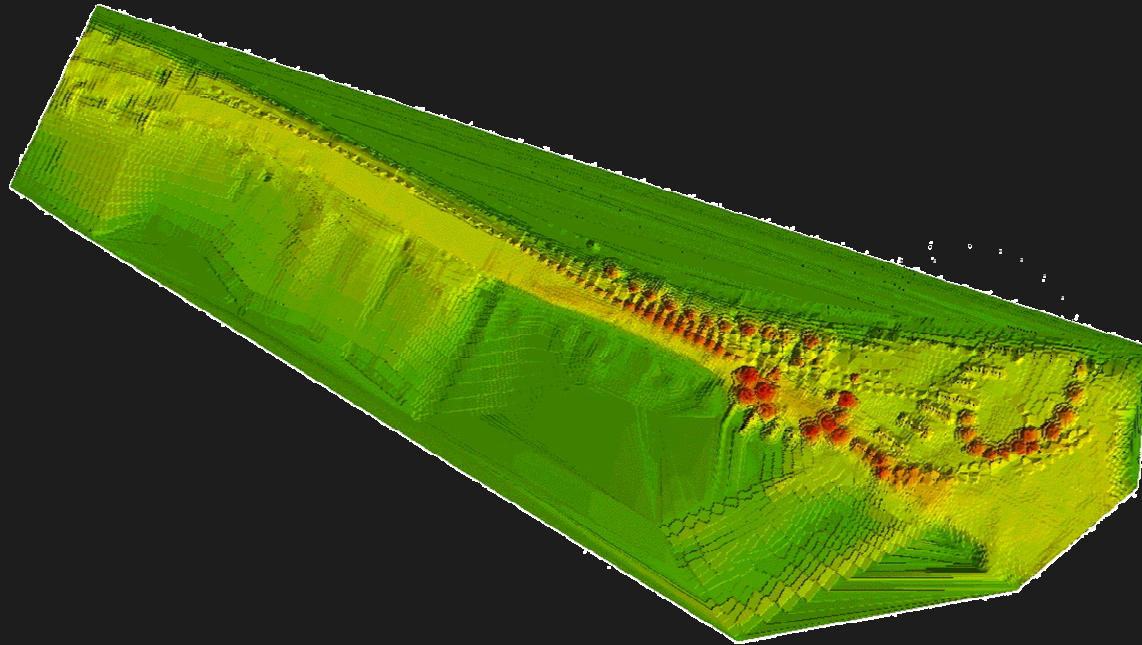
## Legend

### Elevation

14.079 - 14.533
13.625 - 14.079
13.171 - 13.625
12.717 - 13.171
12.262 - 12.717
11.808 - 12.262
11.354 - 11.808
10.900 - 11.354
10.446 - 10.900
9.992 - 10.446
9.537 - 9.992
9.083 - 9.537
8.629 - 9.083
8.175 - 8.629
7.721 - 8.175
7.267 - 7.721
6.812 - 7.267
6.358 - 6.812
5.904 - 6.358
5.450 - 5.904
4.996 - 5.450
4.542 - 4.996
4.087 - 4.542
3.633 - 4.087
3.179 - 3.633
2.725 - 3.179
2.271 - 2.725
1.817 - 2.271
1.362 - 1.817
0.908 - 1.362
0.454 - 0.908
0 - 0.454

# Cameron Run - scour

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# Blennerhassett Island



## ❖ West Virginia

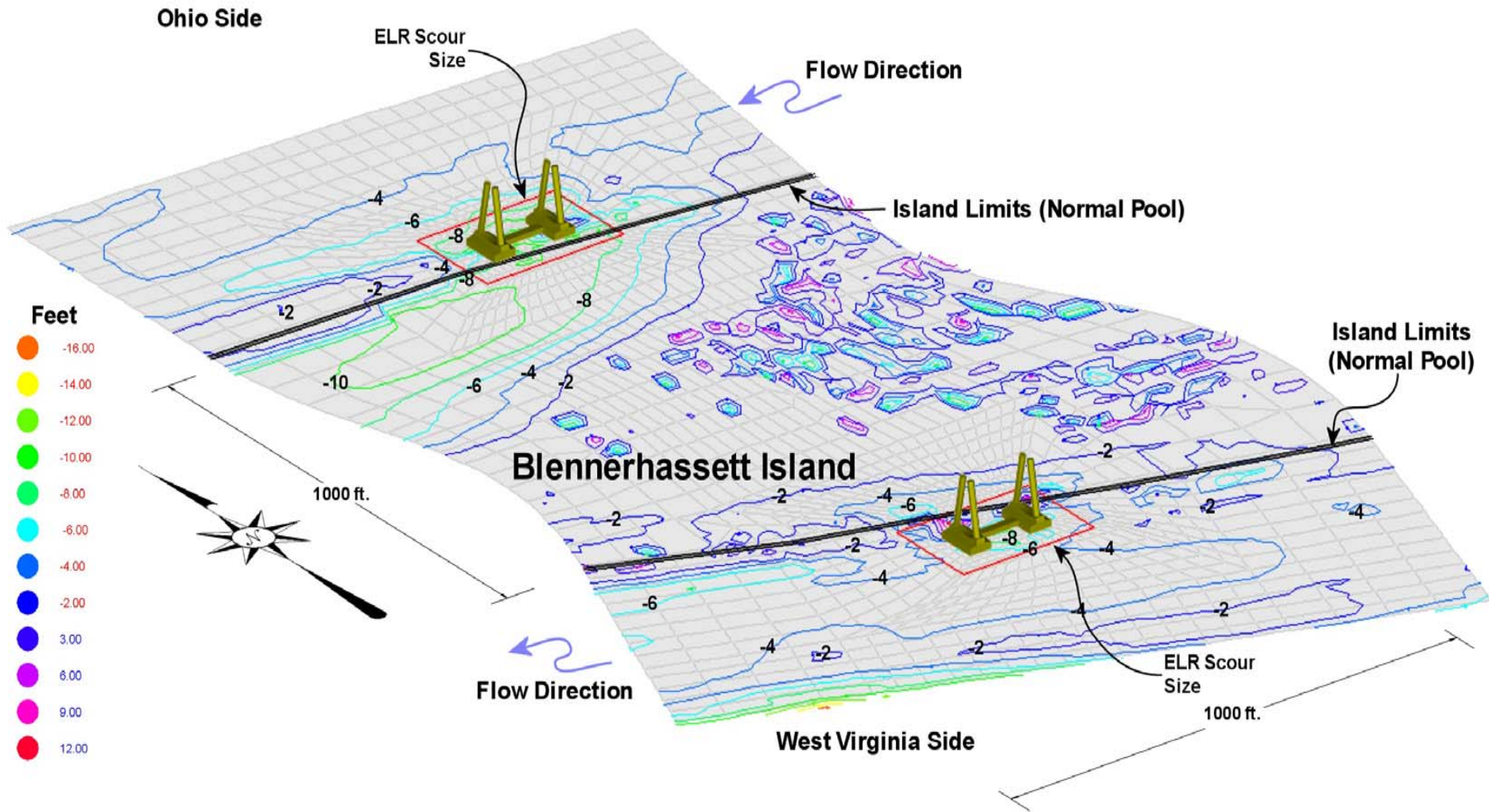
- Ohio River
- \$141 million span island

## ❖ Modeling

- HEC-RAS
  - Scour size of football field
- FESSWM
- 3-D by FHWA
  - Numerical (Dou)
  - Physical (Jones)

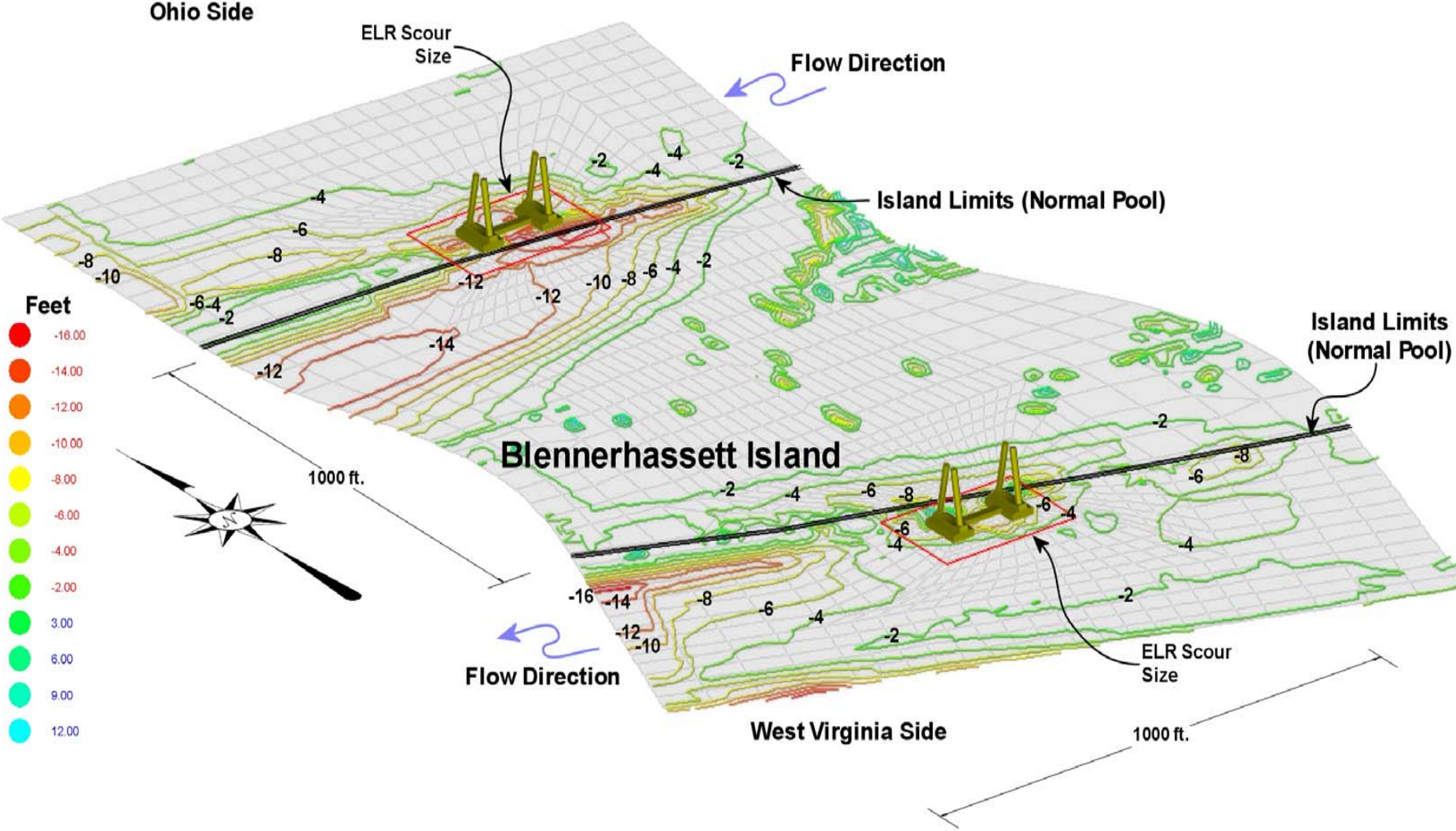


# Scour Depth after 78 hr. Sediment Transport Simulation (Clear Water)





# Scour Depth after 100 hr. Sediment Transport Simulation (Clear Water)



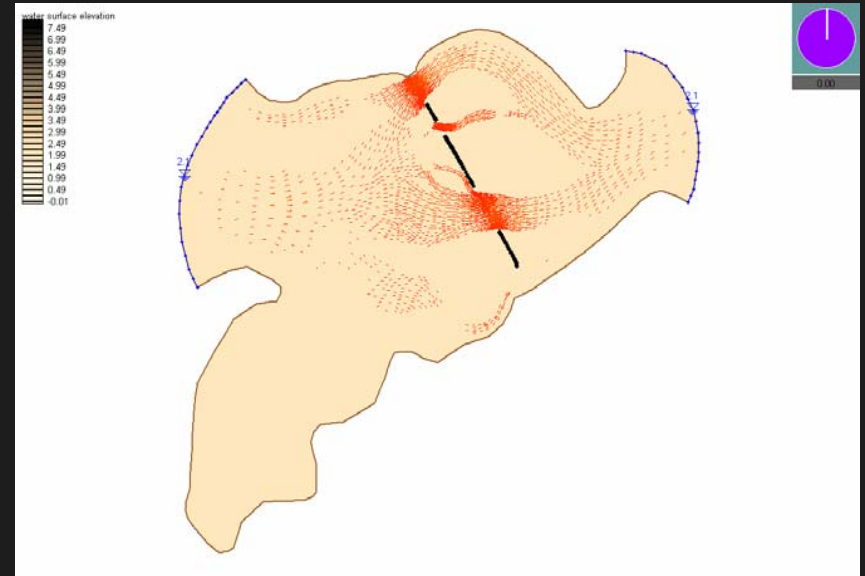
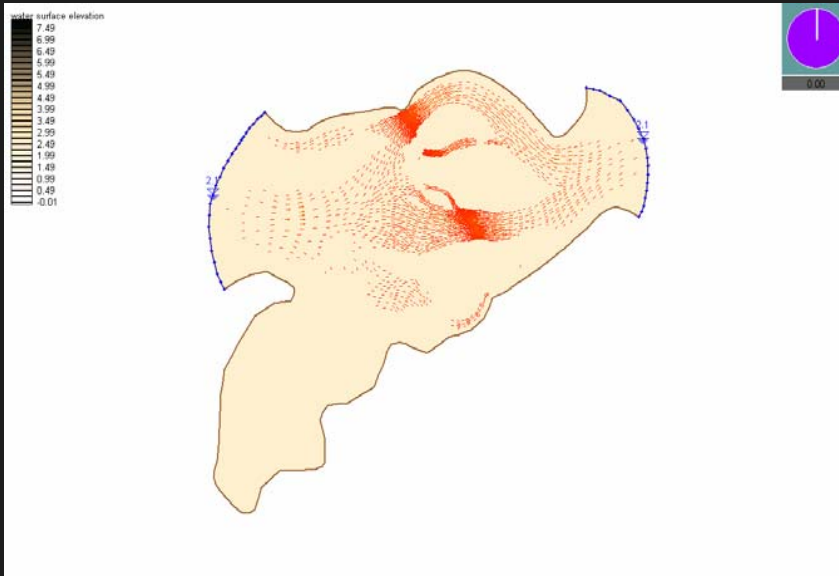
# Great Egg Harbor Causeway

## ❖ New Jersey

- Replacement bridge
- On-going review

## ❖ Scour issues

- Tidal hydraulics
- Inlet – Bay - Causeway
- Boundary conditions



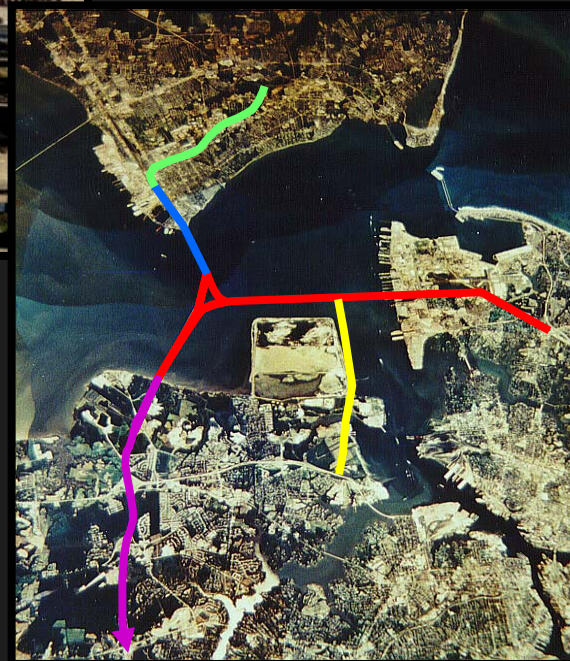


# Hampton Roads Tunnel



## ❖ Virginia

- \$4.4 Billion
- 14 years



# Limestone Scour

## ❖ States

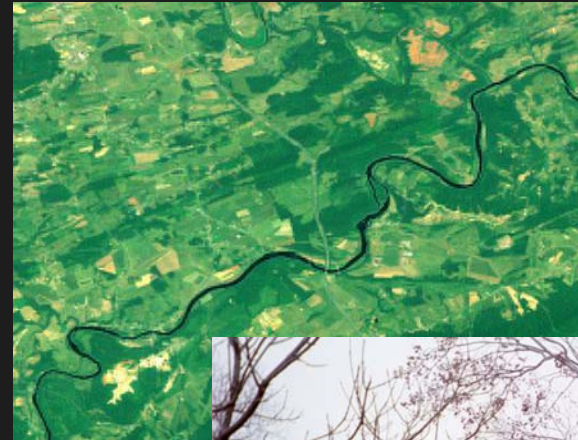
- Virginia
- West Virginia

## ❖ Sites

- New River
- Potomac River
- Shenandoah River

## ❖ Approach

- Multi-disciplinary
- Site-specific
- Non-dogmatic



# Inlet applicability



## ❖ New England State

- Inlet efficiency
  - Reticuline
  - Vanes
- Tradeoffs
  - Snow clogging
  - Hydraulic performance
  - Bicycle safety
  - Public service (?)



# Public service!?! ---

*Citizens find that  
these grates are  
excellent for ...*



*... Barbeques!*



# Questions?

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