Highway Stream Crossings

The Meandering Path to Fish-friendly Culverts

Doug Kirk, PE, CFM
West Virginia Division of Highways
Hydraulic & Drainage Unit

November 8 & 9, 2018

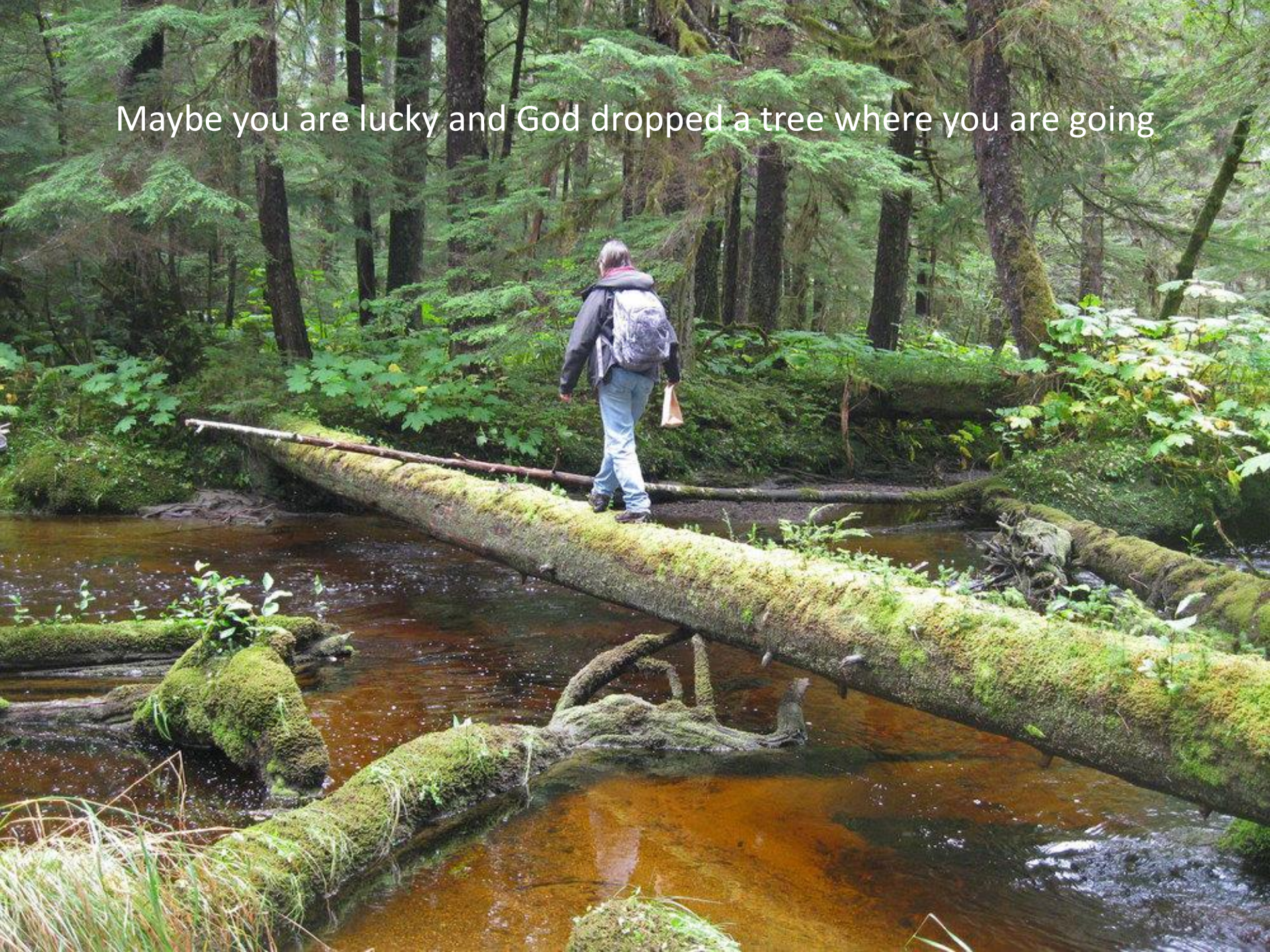
Chesapeake Bay Program
Science. Restoration. Partnership.

WVDOT
DIVISION OF HIGHWAYS

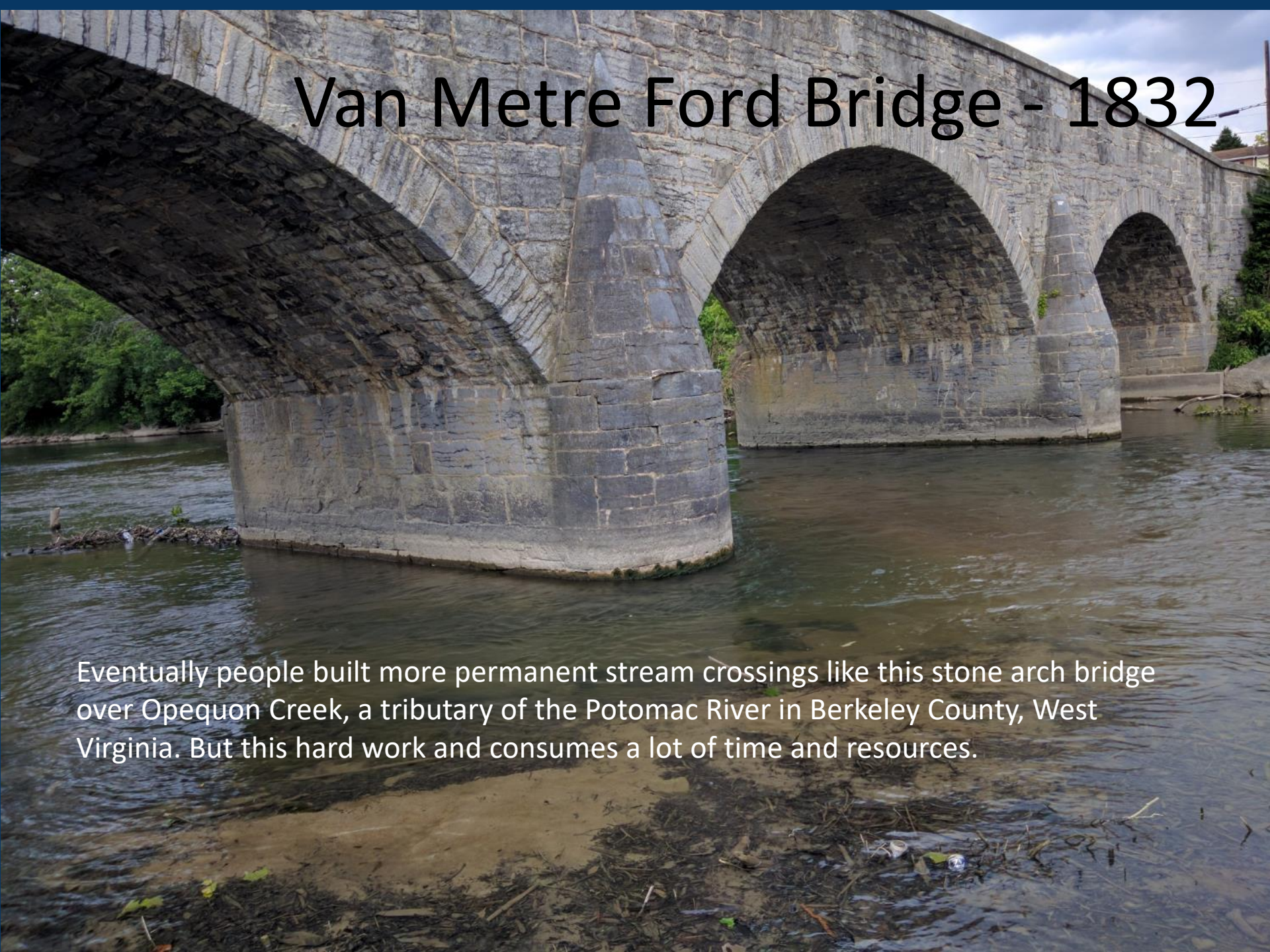
Thank you Chesapeake Bay Program for being good stewards of the Bay


It’s never been easy to cross the river, even with the help of friends!

Big animals and wheels make it a little easier, and dryer


Maybe you are lucky and God dropped a tree where you are going

Van Metre Ford Bridge - 1832



Eventually people built more permanent stream crossings like this stone arch bridge over Opequon Creek, a tributary of the Potomac River in Berkeley County, West Virginia. But this hard work and consumes a lot of time and resources.

INDUSTRIAL SOLUTION

The need for fast, cheap and easy lead to corrugated metal pipe

1820 through 20th century


Now we have so many pipes carrying streams under roads, we don’t know how many, or where they are located. So we send out college students with GPS devices to find them.

Manufacturing, shipping and installing costs $$$, so good stewardship demands economical design

- Initial cost, not life-cycle cost
- Collateral damage ignored

- Smaller pipe is cheaper, so we developed criteria that seemed to meet our needs, without regard to what might happen beyond the right-of-way

General Design Policy

Culverts shall be…

- hydraulically designed
- located to minimize hazard
- structurally stable and hydraulically efficient
- Designed to consider construction **and** maintenance costs,
- Designed based on risk of failure and property damage, traffic safety and environmental considerations
- Compliant with NFIP regulations when located in FEMA mapped floodplains

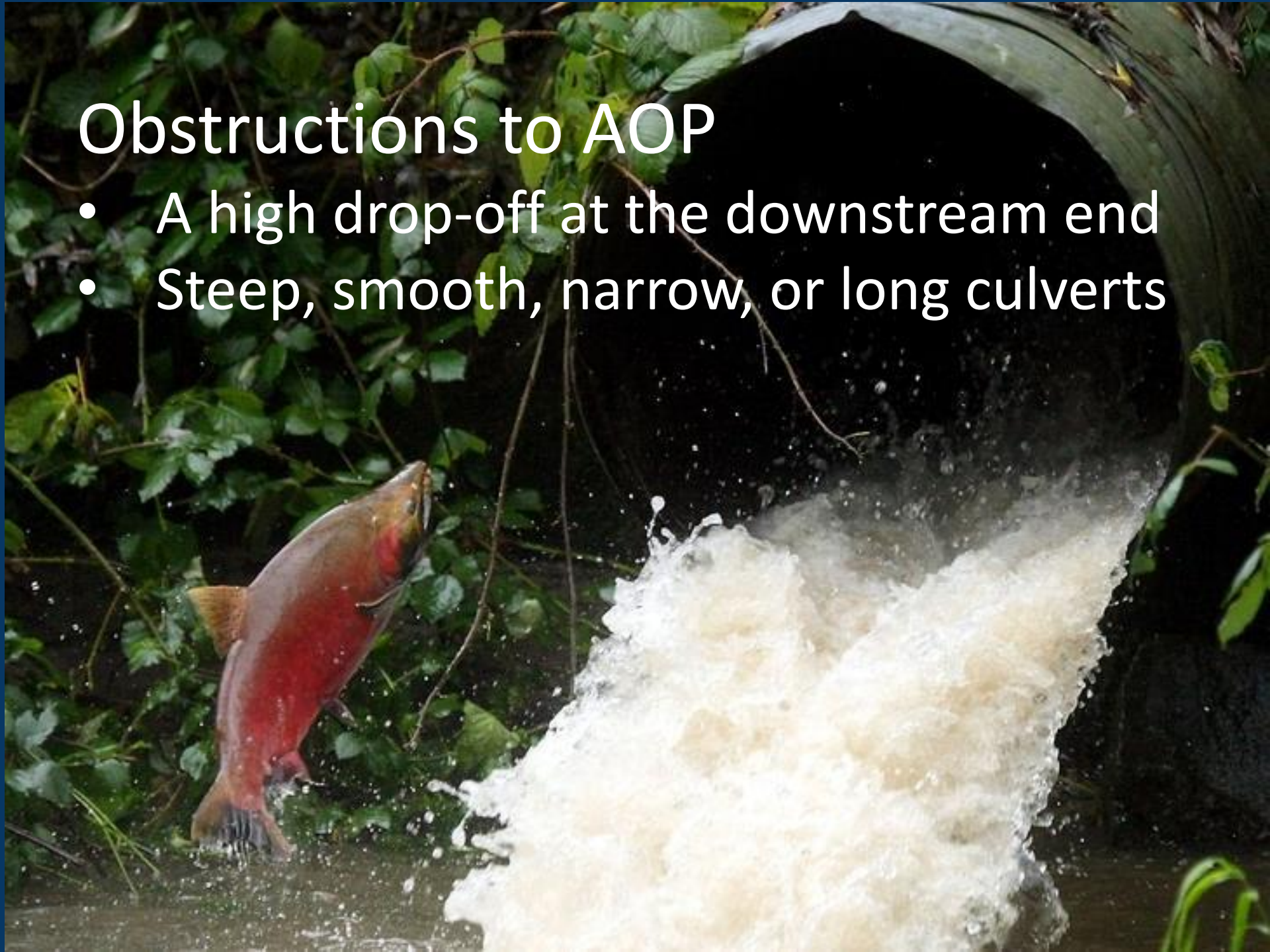
Maximum Allowable Headwater

Allowable headwater is the depth of water that can be ponded at the upstream end of the culvert during the design storm event. It will be based on the following requirements:

- Non-damaging to upstream property
- Below the roadway subgrade
- HW/D no greater than 1.5
- Equal to the elevation where flow diverts around the culvert
- For replacement culverts, no greater than the existing condition
- In compliance with FEMA and local floodplain regulations


Avoid Multi-Barrel Culverts
Structures with piers located within the bankfull channel width trap debris and sediment


Pipes that are smaller that the bankfull channel width will send storm flows out with such force that a big scour hole is created at the downstream end

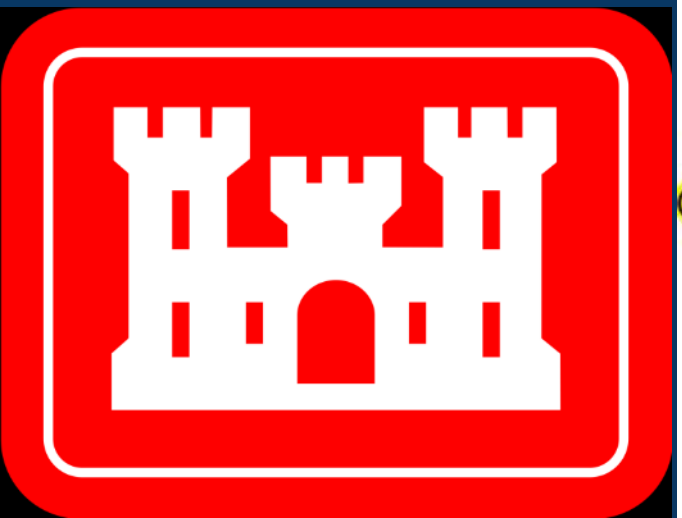


Obstructions to AOP

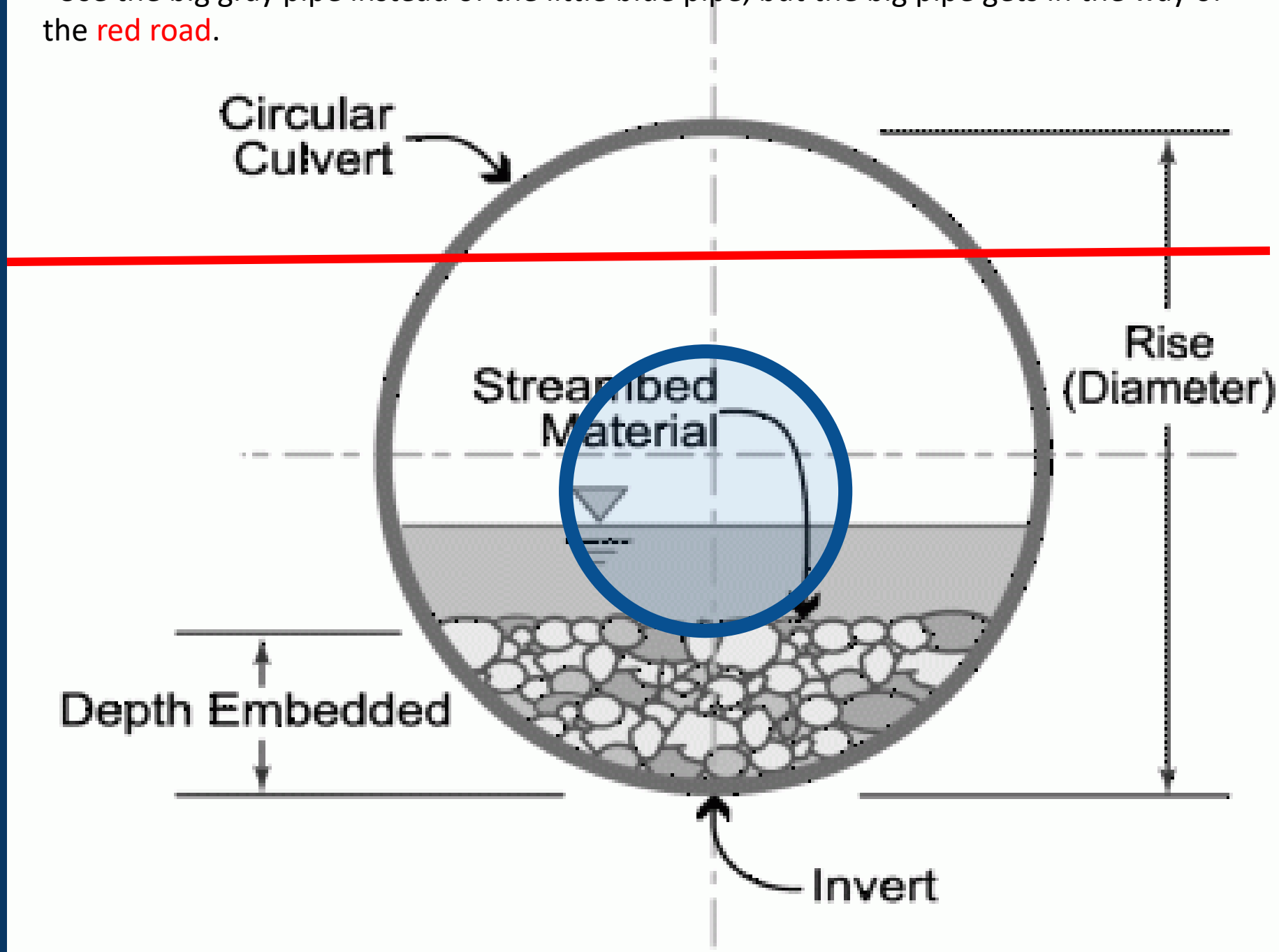
- A high drop-off at the downstream end
- Steep, smooth, narrow, or long culverts

Salmon don't swim in WV, so we were going on as usual

About 2002 our friends began trying to get us to make improvements



“Use the big gray pipe instead of the little blue pipe, but the big pipe gets in the way of the red road.



Slow progress

2006 – WV Division of Highways Engineers attend the FHWA Fish Passage Summit

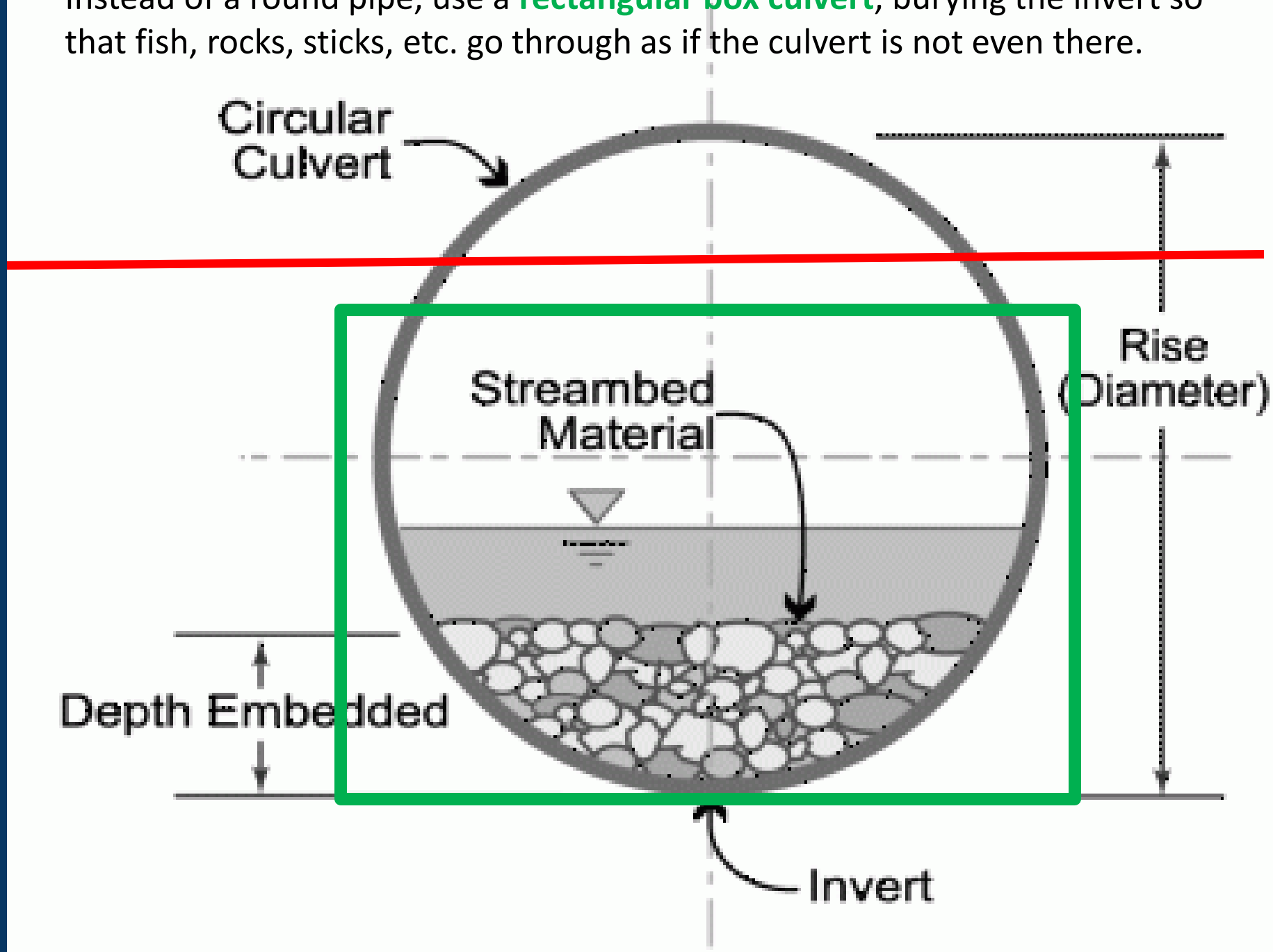
2007 - WVDOH publishes culvert design process for aquatic organism passage in new Drainage Manual

Sizing culverts based on “Bankfull width” becomes *somewhat* common practice

“Hydraulic design” still the norm


Instead of just saying “NO”, maybe we can figure out a way to cross the stream without messing it up.

Instead of a round pipe, use a **rectangular box culvert**, burying the invert so that fish, rocks, sticks, etc. go through as if the culvert is not even there.



Reduced future maintenance

- debris clogging
- abrasion on pipe
- Hydraulic pressure against embankment
- Plunge pool at outlet undermines road

Evidence of recent progress, and encouragement for the future

West Virginia Council of Trout Unlimited shared a post.
June 2, 2017 ·

West Virginia Department of Transportation

Like Page

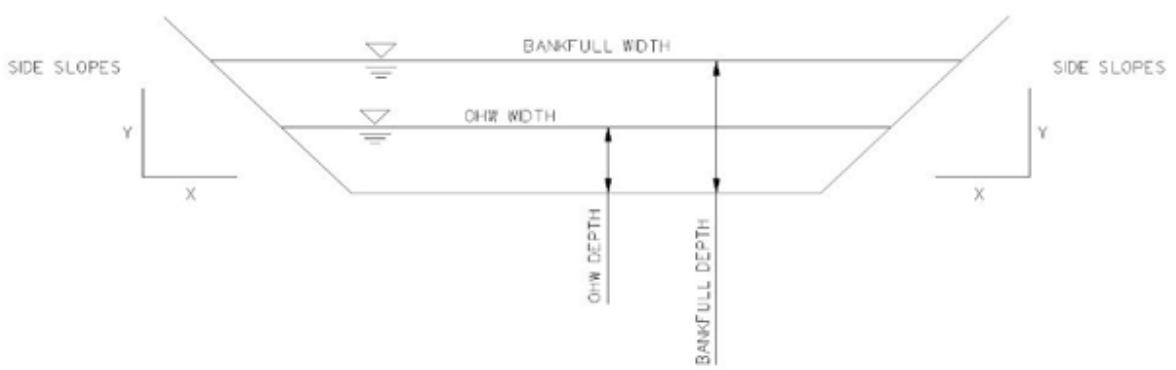
District 4 Form for Culvert Replacement

Site Visit Checklist

Structure Name:		Date:	
Structure No:			
Stream Name:			
Type of Structure:			
Coordinates:			

Hydrologic Information

Bankfull Width (ft-in):	
Bankfull Depth (ft-in):	
Manning n (Channel)	
Right Side Slope:	
Left Side Slope:	
OHW Width (ft-in):	
OHW Depth (ft-in):	



Pictures

Looking Downstream At Structure	
Looking Upstream At Structure	
Looking Downstream From Structure	
Looking Upstream From Structure	
Looking Forward At Structure	
Looking Backwards At Structure	

Structure Measurements

Depth From Road To Stream Bottom (ft):	
Width of Opening On Square (ft-in):	
Width of Opening On Skew (ft-in):	
Height of Opening (ft-in):	

Continuing Progress

- Greater emphasis on sustainable stream crossings
  - Drainage Manual Updates
  - Training for DOH staff and consultants

Field Trip: Roadway stream crossing that nearly spans the bankfull channel


Measuring the bankfull channel


bankfull channel about 15 feet


Nearby culvert on the same stream

- Four foot diameter pipe

Doug Kirk
WVDOH
douglas.w.kirk@wv.gov

Cynoscion nebulosus,
spotted seatrout,
also known as speckled trout
Murrels Inlet, South Carolina