

Lessons Learned about Flood Resiliency Benefits of Stream Simulation Designs and Policy Direction



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Outline

- Background: Culverts, Aquatic Organism Passage and Flood Damage
- Tropical Storm Irene – Impacts and Lessons Learned
- Policy Guidance for Use of Stream Simulation Design Approach
- Restoration Categorical Exclusions

Typical Barriers to Aquatic Organism Passage on U.S. National Forest Lands



Undersized Culverts = Flood Damage





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How and Why Road-Stream Crossings Fail

How Structures Fail

- Hydraulic capacity exceeded
- Sediment “Slug”
- Debris flow (wood, etc.)

Why Structures Fail

- Undersized hydraulic capacity
- Abrupt transitions
- Poor vertical alignment with channel
- Poor stream to structure geometry
- Poor geomorphic location/design not account for diversion potential

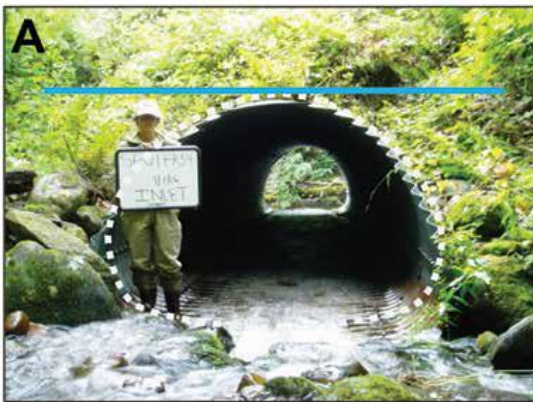


Stream Simulation Designs Proved Resilient

- 24 Forest Service System Roads (40 km)
- Estimates repair costs = \$6.4+ million
- 11 stream crossing failures
- No stream simulation design failures (3)



Sparks Brook Stream Simulation Design



Original Q25 Hydraulic Design



Stream Simulation Design with
>Q100 Design

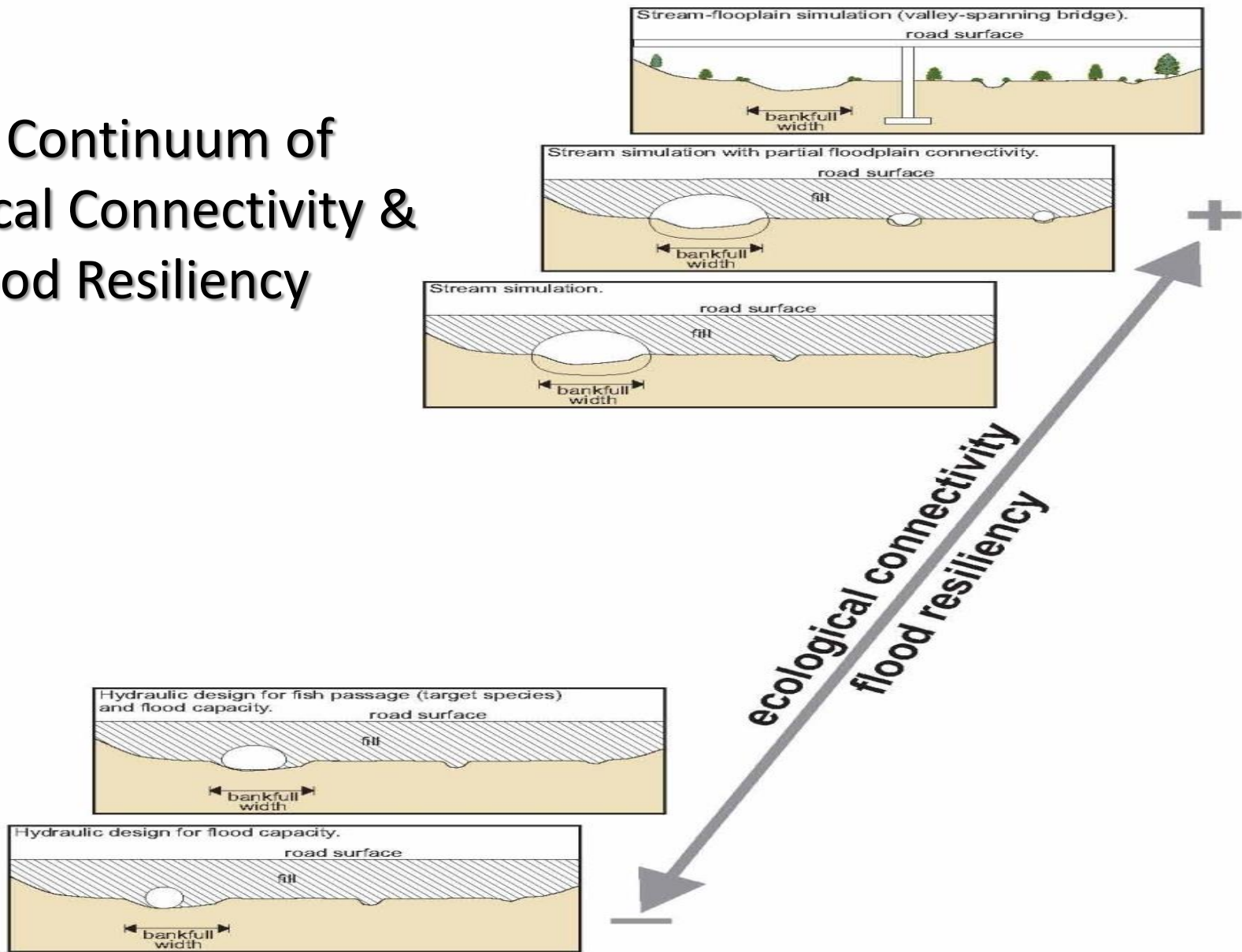


Height of Tropical Storm Irene
Flood Level

The Link between Aquatic Organism Passage (AOP) and Flood Resiliency

- Of 43 Road-Stream Crossings identified by Vermont FWD as barriers to fish movement in Upper White River Watershed, 15 failed. Average bankfull width/culvert width ratio of 0.54.
 - VT FWD inventoried 43 culverts >2.3 m bankfull width for fish passage in watershed, 15 failed.
 - These 15 failed culverts provided reduced or no aquatic passage.
 - Of the failed culverts, ratio of culvert width to bankfull width averaged 0.54, ranging from 0.27 to 0.90.

The Continuum of Ecological Connectivity & Flood Resiliency



Other Examples of Flood Resiliency of Stream Simulation Designs

- **Tongass National Forest in Alaska**: Of 93 crossings installed for AOP since 1998, 98% provide fish passage to State Standards, NO failures with floods estimated in 25 to 50 year recurrence interval
- **Siuslaw National Forest in Oregon**: 8 crossings installed for AOP since 2003 have survived 25 year recurrence interval floods with no damage.

In the Context of Climate Change- How to Best Evaluate the Avoidance of Catastrophic Failure?



Cost Comparison

- Green Mountain National Forest examples demonstrate real costs for upgrading to Stream Simulation Design Standards ranged from 9-22% above conventional hydraulic design
- Similar data suggest that a 50% increase in structure width results in 20% to 33% increase in total project cost (Gubernick 2011) from across U.S. Forest Service Lands
- Most cost comparisons are made at Year 0, not extended out to the 50-75 year time frame.

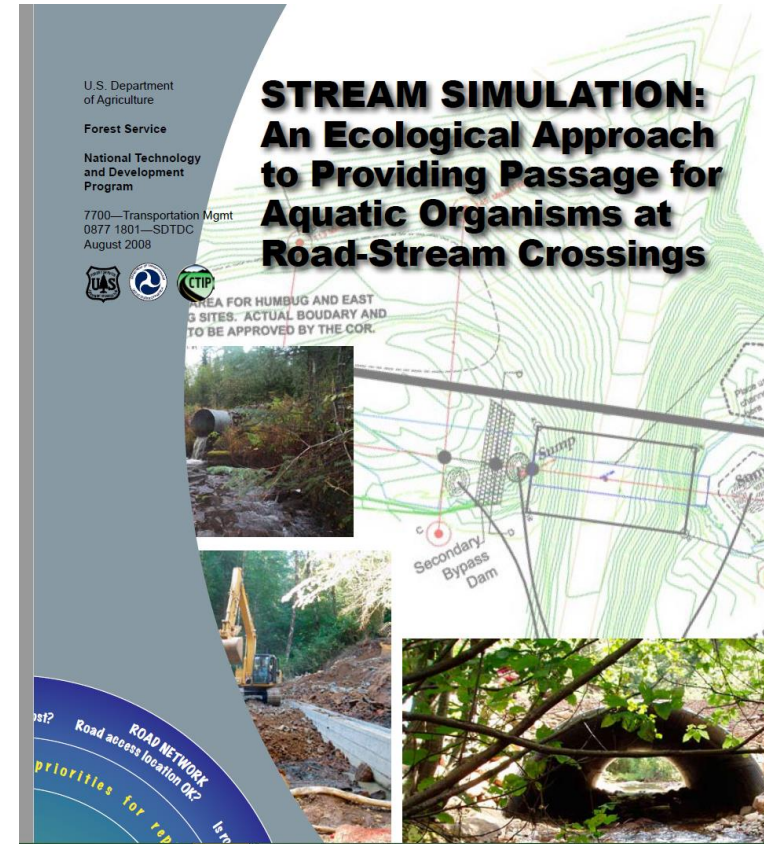
True Life Cycle Cost Analyses

- A culvert failure can result in significant costs to state/towns including replacement costs and other damaged infrastructure.
- Emergency replacement costs are generally higher than normal replacement costs*
- Temporary or long term loss of emergency services, business or recreational access need consideration*
- If a culvert remains undersized, these costs may be incurred multiple times during its life cycle*
- Maintenance costs over time to remove debris, repair erosion, protect headwall, etc. need consideration.

*Source: Perrin Jr., J and C. Jhaveri. "The Economic Costs of Culvert Failures." Jan 2004.

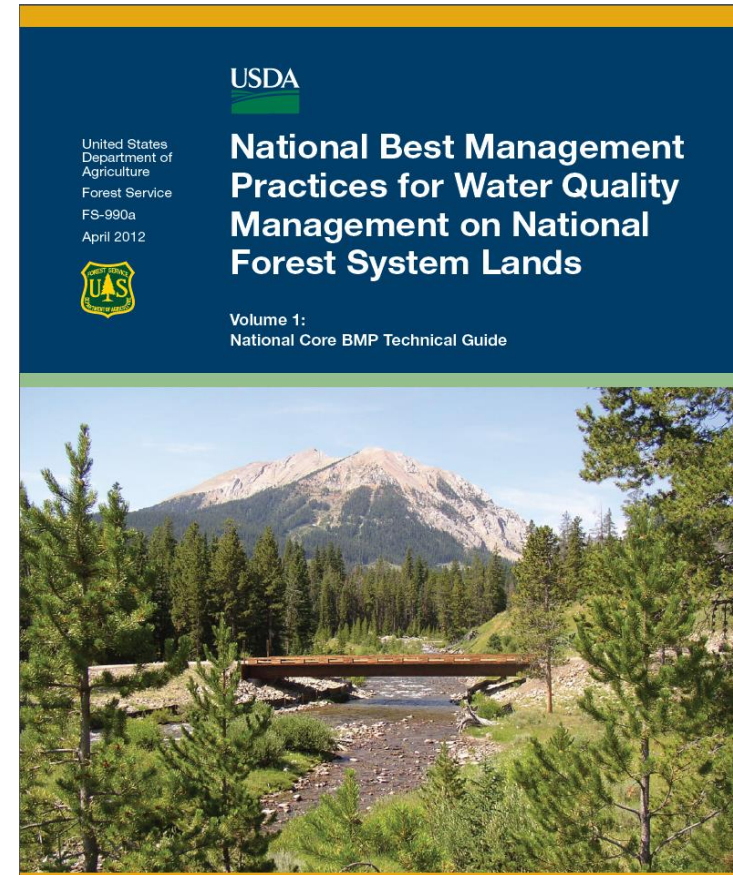
USFS Policy Guidance for Stream Simulation Design

- September 16, 2008 Letter from the Chief
 - Consistent National Guidance for Aquatic Passage Designs
- FSM 7700-Transportation 0877 1801. SDTDC, 2008. Stream Simulation: An Ecological Approach to Providing Passage for Aquatic Organisms at Road-Stream Crossings.



USFS Policy Guidance for Stream Simulation Design continued

- National Best Management Practices for Water Quality Management on National Forest System Lands. Volume 1: National Core BMP Technical Guide. FS-990a. April 2012.
 - BMP Road 7 – Stream Crossings. pp.117-120, directs agency to use stream simulation techniques where applicable to aid in crossing design



USFS Policy Guidance for Stream Simulation Design continued

- Federal Endangered Species Act, 1973
 - The development of the Stream Simulation Design Approach originated in the Pacific Northwest in the 1990's to address numerous federally-listed salmon populations
- 2013 Washington State “Culvert Case” Case No. CV 70-9213
 - Upheld 2001 request from 21 federally-recognized American In Tribes that the State of Washington was compelled to restore fish passage at road-stream crossings to preserve reserved treaty rights . Stream Simulation Design was the only acceptable road-stream crossing design.

USFS Policy Guidance for Stream Simulation Design continued

- Federal Clean Water Act, 1972
 - Directs agency to restore and maintain the physical, chemical and biological integrity of the nation's waters.
- President's 2013 Executive Order: Preparing the United States for the Impacts of Climate Change
 - To improve the resilience of communities and federal assets to the impacts of flooding. "Where possible, an agency shall use natural systems, ecosystem processes, and nature-based approaches when developing alternatives for consideration."

Restoration Categorical Exclusion 18

- Published in the Federal Register on September 12, 2013.
- *18. Restoring wetlands, streams, and riparian areas by removing, replacing, or modifying water control structures such as, but not limited to, dams, levees, dikes, ditches, culverts, pipes, valves, gates, and fencing, to allow waters to flow into natural channels and floodplains and restore natural flow regimes to the extent practicable. Examples include but are not limited to:*
 - *(i) Removing, replacing, or repairing existing water control structures that are no longer functioning properly; only minimal dredging, excavation, or placement of fill is required and do not involve releasing hazardous substances;*
 - *(ii) Installing a newly designed culvert that replaces an existing inadequate culvert to improve aquatic organism passage or prevent resource or property damage where the road or trail maintenance level does not change; and*
 - *(iii) Removing a culvert and installing a bridge to improve aquatic and/or terrestrial organism passage or prevent resource or property damage where the road or trail maintenance level does not change.*

Restoration Categorical Exclusion 18 continued. . .

- Undersized road-stream crossings and culverts typically alter natural water and stream sediment flows, which often necessitates the physical restoration of the stream channel slope, geometry and substrate to some length upstream and downstream of the road-stream crossing.
- Restoring these stream channel dimensions and the correct stream substrate support the restoration of natural water and sediment flows and biological movement through the crossing.
- Restoring these stream channel dimensions and the correct stream substrate represent an important component of the stream simulation design process to help ensure that the road-crossing approach, abutments, footings and the crossing itself are protected from erosion and abrasion over time.



Questions?