Long Term Cost Benefit Considerations- Jon Simonsen—WDNR 2018

What is the Challenge?

- Time and money are stretched thin given the amount of roadwork needed.
- Difficult to justify cost of improvements based on unknown future events/ expenses.
- There is limited data about the total life cycle costs of culverts.

Total Cost of a Culvert Project

Initial structure & construction cost:

+ periodic maintenance

+ culvert lifespan

+ added cost of emergency repairs

If total life cycle costs are added up, municipalities can save time and $$$ over the long term by investing in culverts that span the stream.

How to reduce total culvert life cycle cost (time and money)?

- Maximize the culvert lifespan
  - Stream spanning culvert ~75 years vs. undersized culvert ~ 35 years
- Minimize periodic maintenance needs/ cost
- Avoid added costs during major flood events
  - Construction and supply costs during major floods are generally higher than planned replacements
  - Additional costs to restore streams and floodplains, remove debris, and repair property damage
  - Widespread road closures/ detours are also detrimental and costly to tourism, forestry, and other industries

Keys to a long-lived, low maintenance, and flood resilient culvert?

- ALWAYS compare a stream reference reach to the road crossing
  - Culverts that constrict the stream width have a much greater risk of problems over the long term.
  - DNR is a resource to help evaluate signs of geomorphic and hydraulic problems. Staff are also able to provide recommendations that will minimize stream impacts and avoid long term problems.
- Take steps now to plan and prioritize
  - Road crossing inventories are essential to finding and prioritizing the flood prone and ecologically important crossings. (This is also an important step to increase the chances of funding assistance.)
  - Making system wide improvements to deliver the broad public benefits is feasible! Inventories reduce surprises and identify the high priority sites.
- Document true total life cycle culvert costs

Culvert problems (& associated costs) are caused by the following stream factors:

Structure durability– ability of the crossing to safely carry loads

- Choose culvert material based on water chemistry, available cover, traffic weights, etc.
- Size structure to reduce abrasion. Avoid stream constriction to lower velocity of water and sediment (i.e. abrasive energy)
- Undersized structures often experience shoulder erosion, overtopping, piping, etc. that can reduce cover over the pipe, undermine culvert bedding at the inlet and outlet, weaken the integrity of the road core, etc.

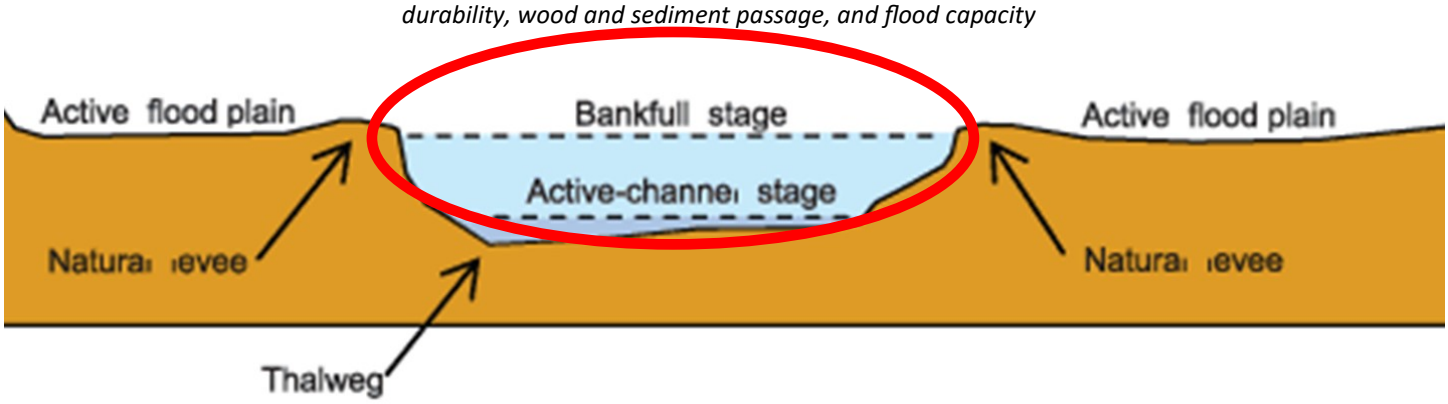
Geomorphic factors– ability of the crossing to convey stream sediment & wood

- **Often overlooked but a very important design factor.**
- Culverts that don't constrict the stream are more likely to pass sediment and woody debris.
  - ◊ In forest environments, the dominant culvert failure mechanism during major floods is wood and sediment blocking the inlet.
  - ◊ Passing sediment and wood is especially important at higher gradient/ valley watersheds with heavier soils and limited waterway/ wetland storage.
  - ◊ Most of the wood transported during floods is shorter than bankfull width.
- Undersized culverts can deliver significant amounts of road material downstream that can fill flood-plains & "plug" the channel. This will reduce the stream's ability to convey water, sediment and woody debris

Hydraulic factors– ability of the crossing to convey a wide range of stream flows

- Reduce the risk of storm damage and failure. Stream spanning culverts generally pass the 100 year flood event without overtopping or road damage. Culverts that significantly constrict bankfull width generally have difficulty passing the 50 or 100 year flood events.
- Consider 75+ year timespan, changing climate patterns, and changing watershed characteristics.

Spanning the stream greatly reduces the risk of problems caused by structure durability, wood and sediment passage, and flood capacity



"100 year flood" What are the chances???

- Terminology itself can be unintentionally misleading.
- Encourage thinking in terms of the annual exceedance probability or percent chance of occurrence.

Table 6.2. Probability of extreme event occurrence for various periods. From FHWA

Length of Service (years)	Frequency – Recurrence Interval				
	10-year	25-year	50-year	100-year	500-year
1	0.10	0.04	0.02	0.01	0.002
10	0.65	0.34	0.18	0.10	0.02
25	0.93	0.64	0.40	0.22	0.05
50	0.99	0.87	0.64	0.39	0.10
75	1.00	0.95	0.78	0.53	0.14
100	1.00	0.98	0.87	0.63	0.18

Lifespan of culvert (to minimize long term costs) has a 53% chance of experiencing a 100 year storm event.

Study finds Midwest flooding more frequent

Research covered more than 50 years of data in 14 states

The Chequamegon Bay of Lake Superior appears clear blue on Monday, July 30, 2018. Some business owners say flooding caused sediments and mud to cloud the bay, which impacted their business. *Danielle Kaeding/WPR*

Some Northern Wisconsin Businesses Feeling Impacts Of Summer Flooding

Some Say Storm Run Off And Washed Out Roads Have Hit Their Bottom Line

Thursday, August 9, 2018, 4:30pm
By Danielle Kaeding

naturalflow (CC-BY-SA)

Wisconsin Tourism Destinations Feel Impact Of Closed Highway 14

Taliesin, American Players Theatre Worry Road Closure Will Continue To Deter Visitors

Monday, August 27, 2018, 6:30am
By Hope Kirwan

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