

Impacts of Road Crossings on Streams



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Stream Crossing Perspectives



Culvert and Road Impacts



Water Quality: Sediment, Temperature
Channel Morphology
Aquatic Organisms
Woody Debris

Sediment Sources

Culvert and Road Impacts

- **Frequent Washouts**
- **Road Surface and Ditch Erosion**
- **Embankment Erosion**

Frequent Washouts

Sediment Sources



Major source

- Sediment volume
- Sediment delivery

Road Surface and Ditch Erosion

Sediment Sources



- **Surface material**
- **Drainage**
- **Slope length**
- **Slope steepness**
- **Low point**

Road Surface and Ditch Erosion

Sediment Sources



Road Surface and Ditch Erosion Sediment Sources



Road Surface and Ditch Erosion Sediment Sources



Road Surface Drainage

Sediment Sources



Road Surface Erosion

Sediment Sources



Embankment Erosion

Sediment Sources



Embankment Erosion Solutions

Sediment Sources



Stable side-slopes 2:1 or less, adequate riprap, properly sized culvert with $HW/D < 1$ for 100-yr flow. Beveled culverts can reduce maintenance.

Embankment Erosion Solutions

Sediment Sources



Headwalls for embankment protection and to shorten culverts.

Sediment Impacts



- **Pool Habitat**
- **Spawning Habitat**
- **Invertebrates**

Spawning Habitat

Sediment Impacts

- 
- Trout
 - Walleye
 - Sauger
 - Dace
 - Darters
 - C. shiner
 - Suckers
 - Redhorse
 - Lake sturgeon

Sediment Impacts

EPT (ephemeroptera, plecoptera, tricoptera
(mayfly, stonefly, caddisfly))



Channel Morphology

Culvert and Road Impacts

- **Downstream Sediment**
- **Upstream Ponding**
 - **Culvert Set Too High**
 - **Frequent Washouts**
- **Upstream Gravel Accumulation**
- **Channelization**
- **Downstream Scour**

Downstream Sediment

Channel Morphology Impacts



Downstream Sediment Channel Morphology Impacts

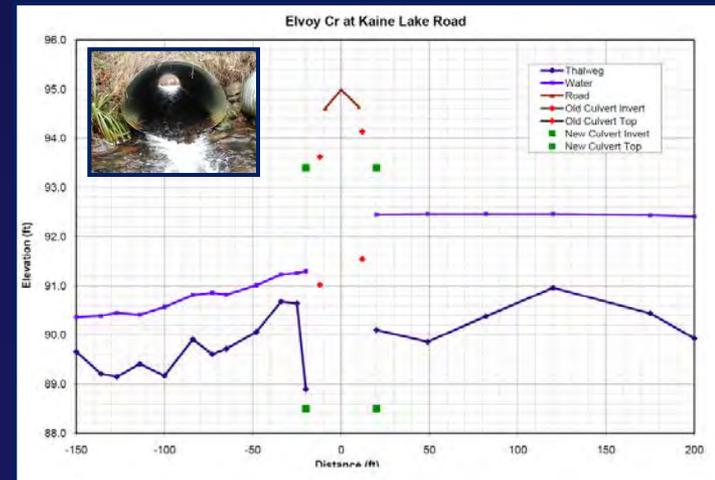
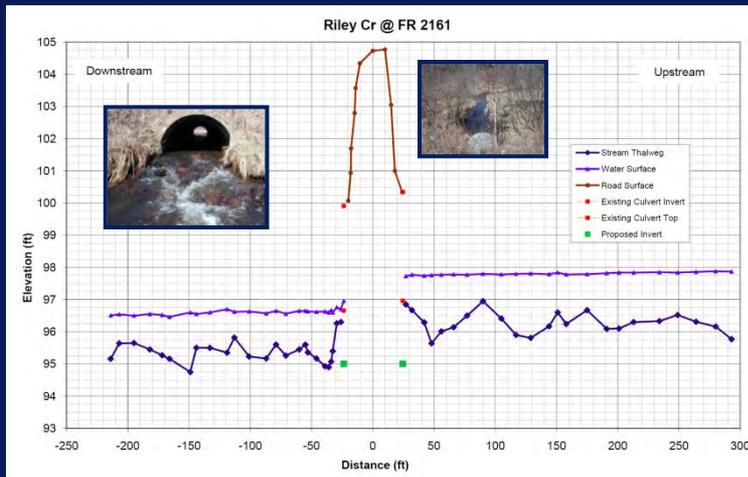


Downstream Sediment Channel Morphology Impacts



Upstream Ponding

Culvert Too High on Flat Streams, Channel Morphology Impacts



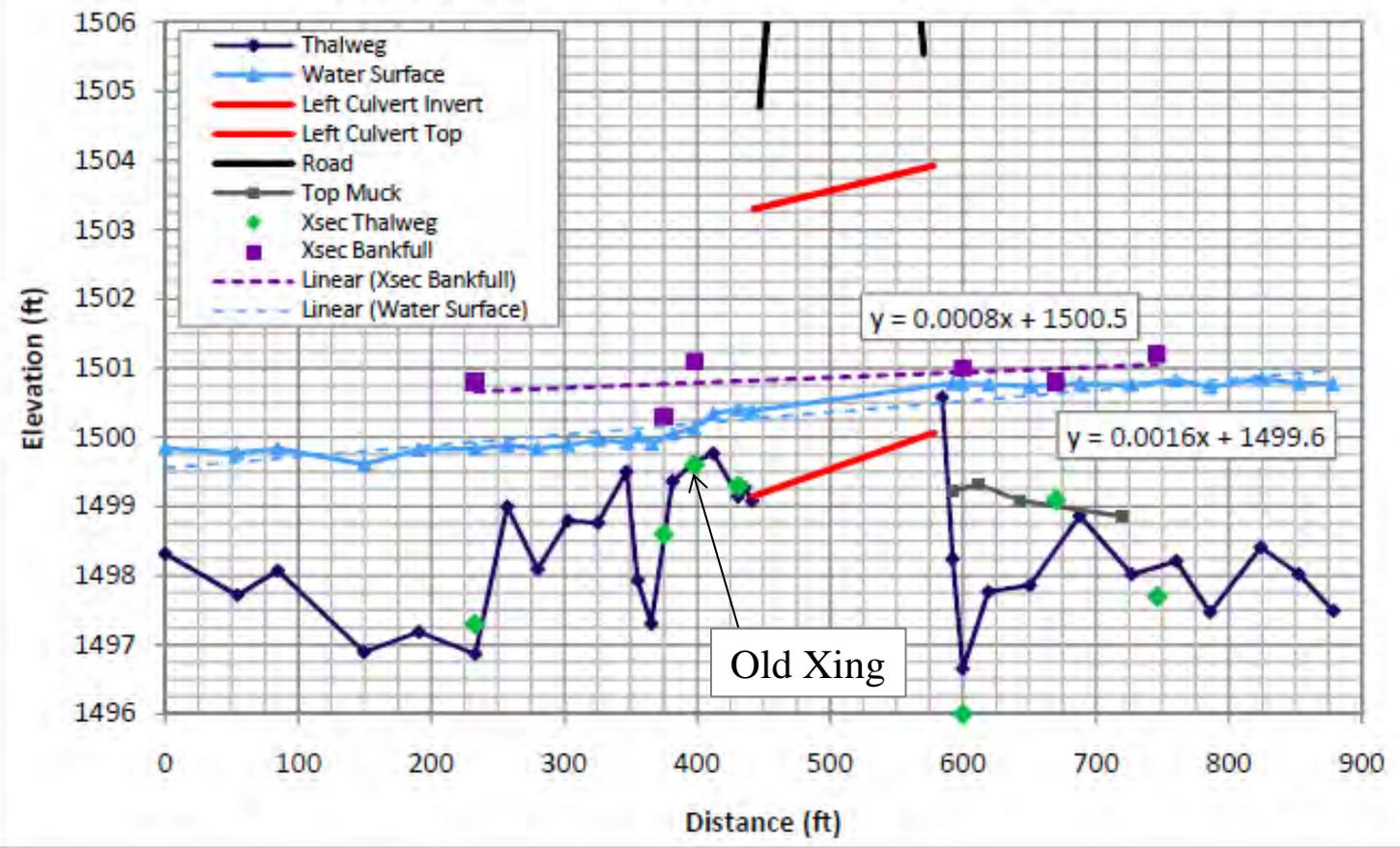


Upstream Ponding

Culvert Too High on Flat Streams
Channel Morphology Impacts



Torpee Cr at Hwy 32 Stream Profile



Upstream Ponding

Frequent Washouts on Flat Streams

Channel Morphology Impacts



Upstream Ponding

Frequent Washouts on Flat Streams

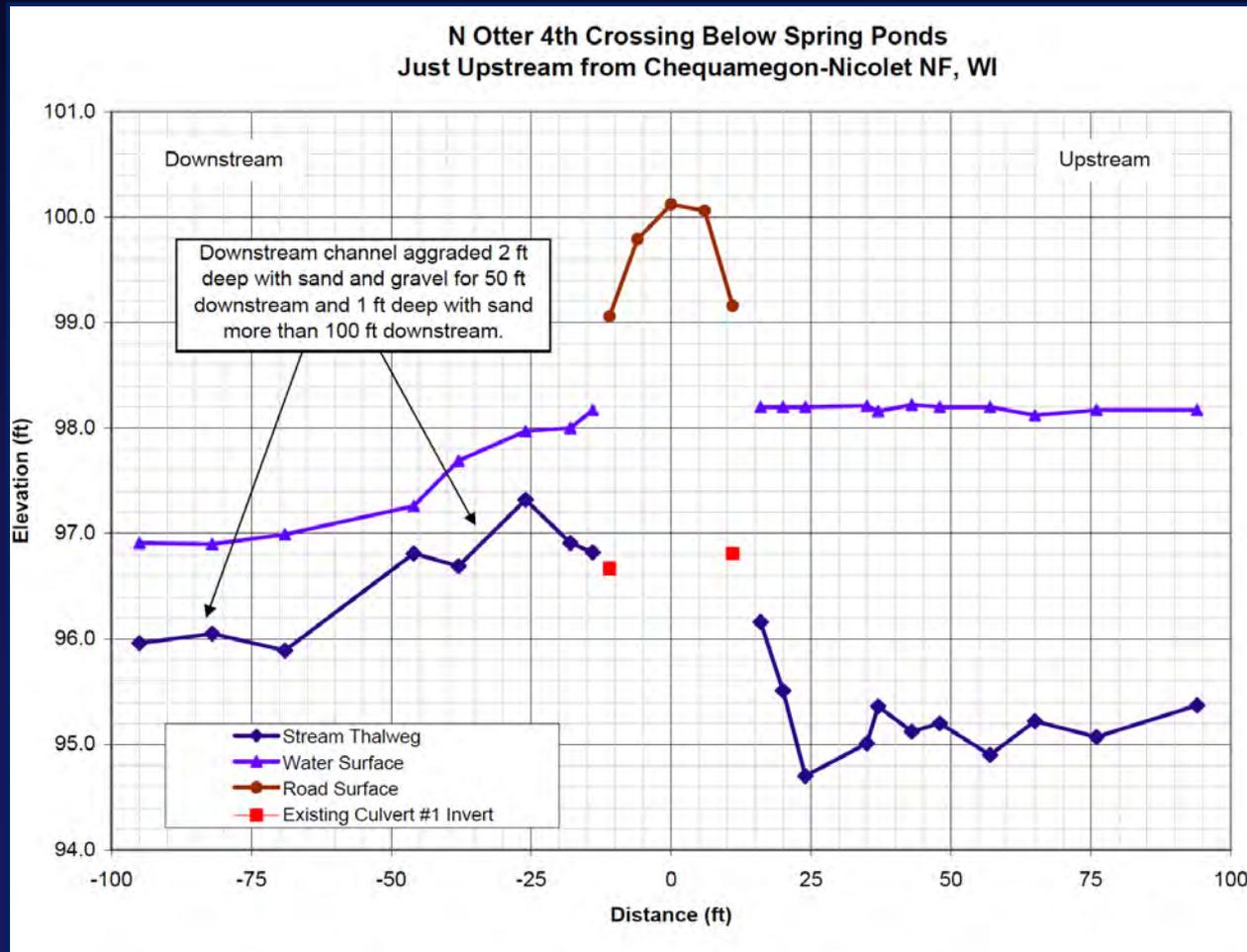
Channel Morphology Impacts



Upstream Ponding

Frequent Washouts on Flat Streams

Channel Morphology Impacts

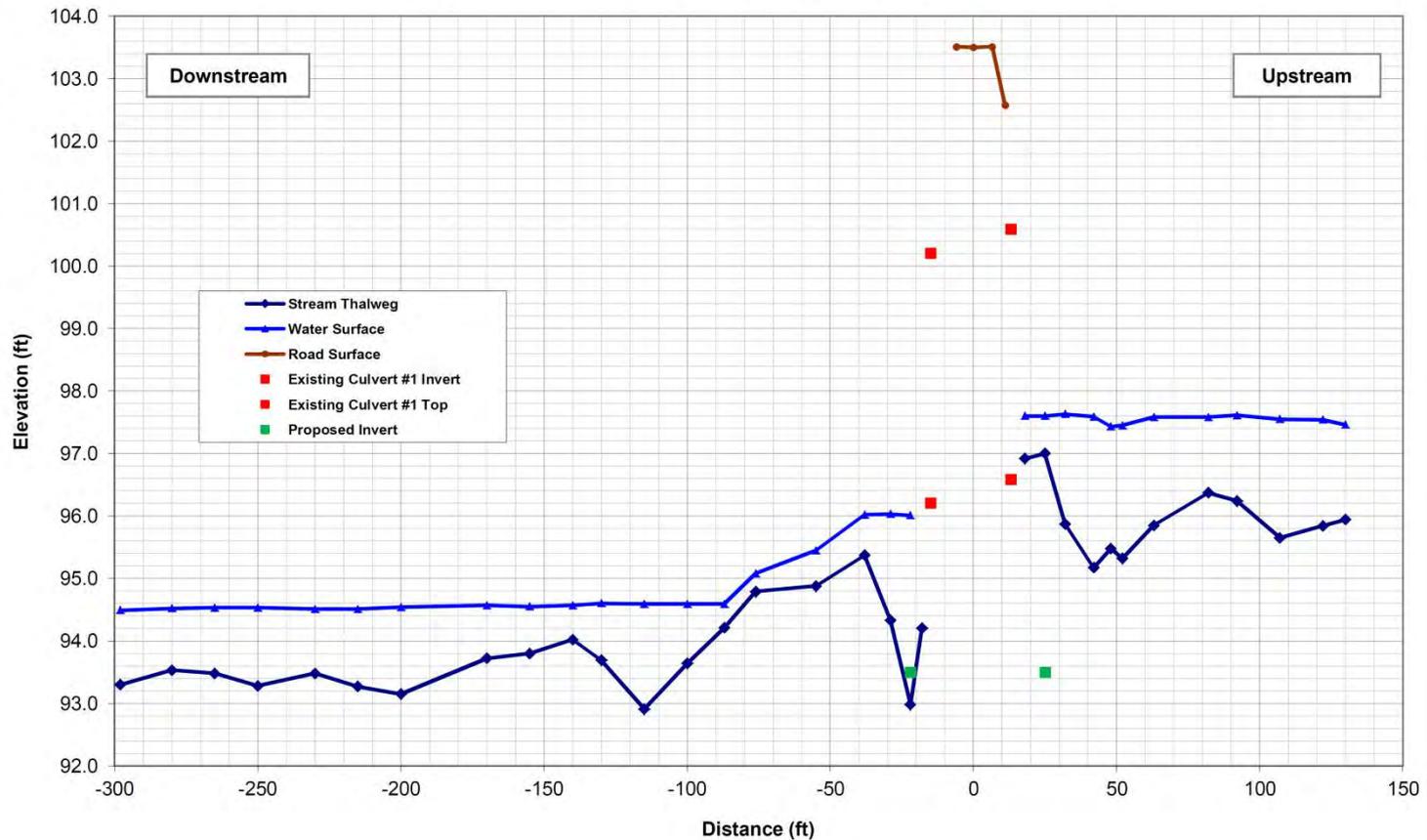




Upstream Ponding Water Temperature (and other) Impacts

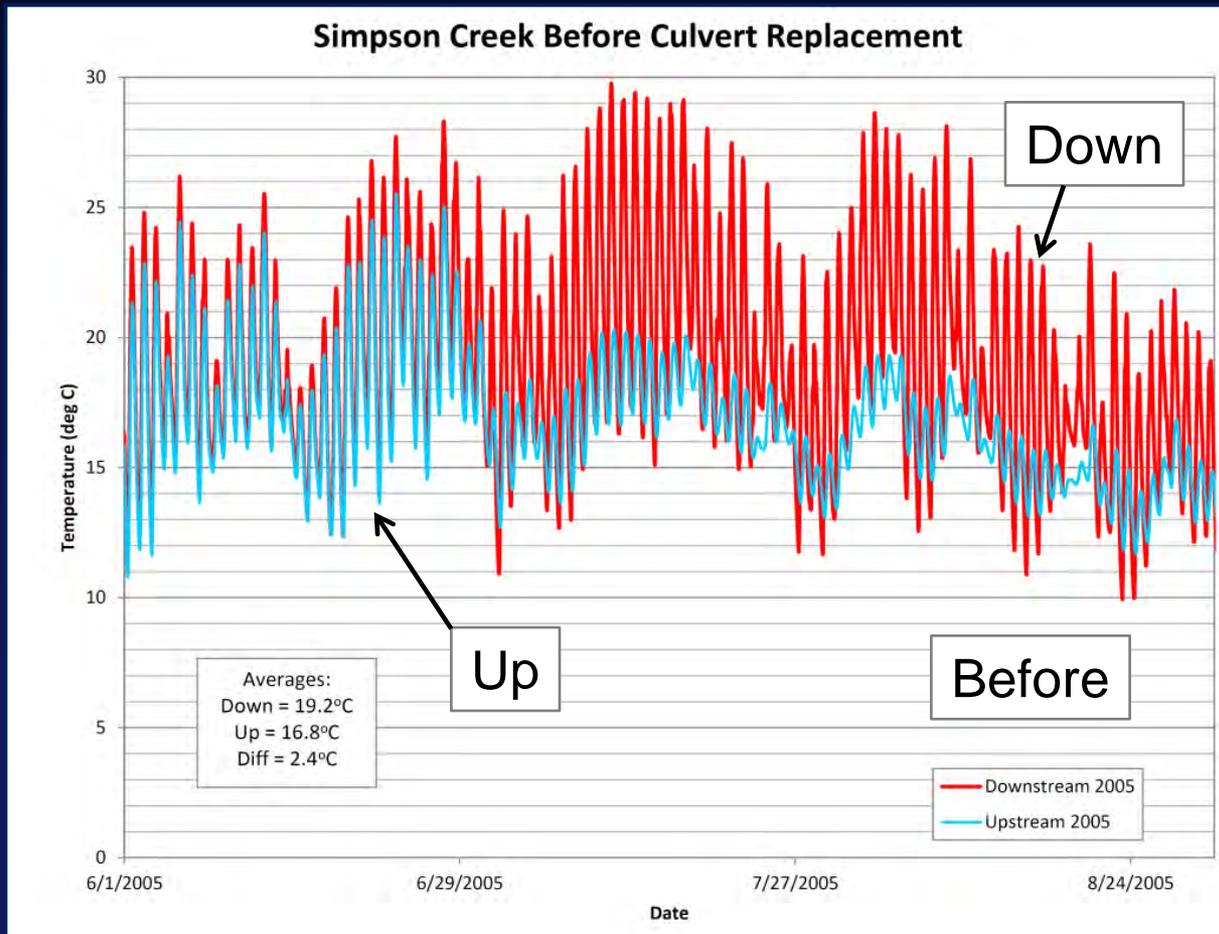


Simpson Creek at Forest Road 2386 (Site 62303)



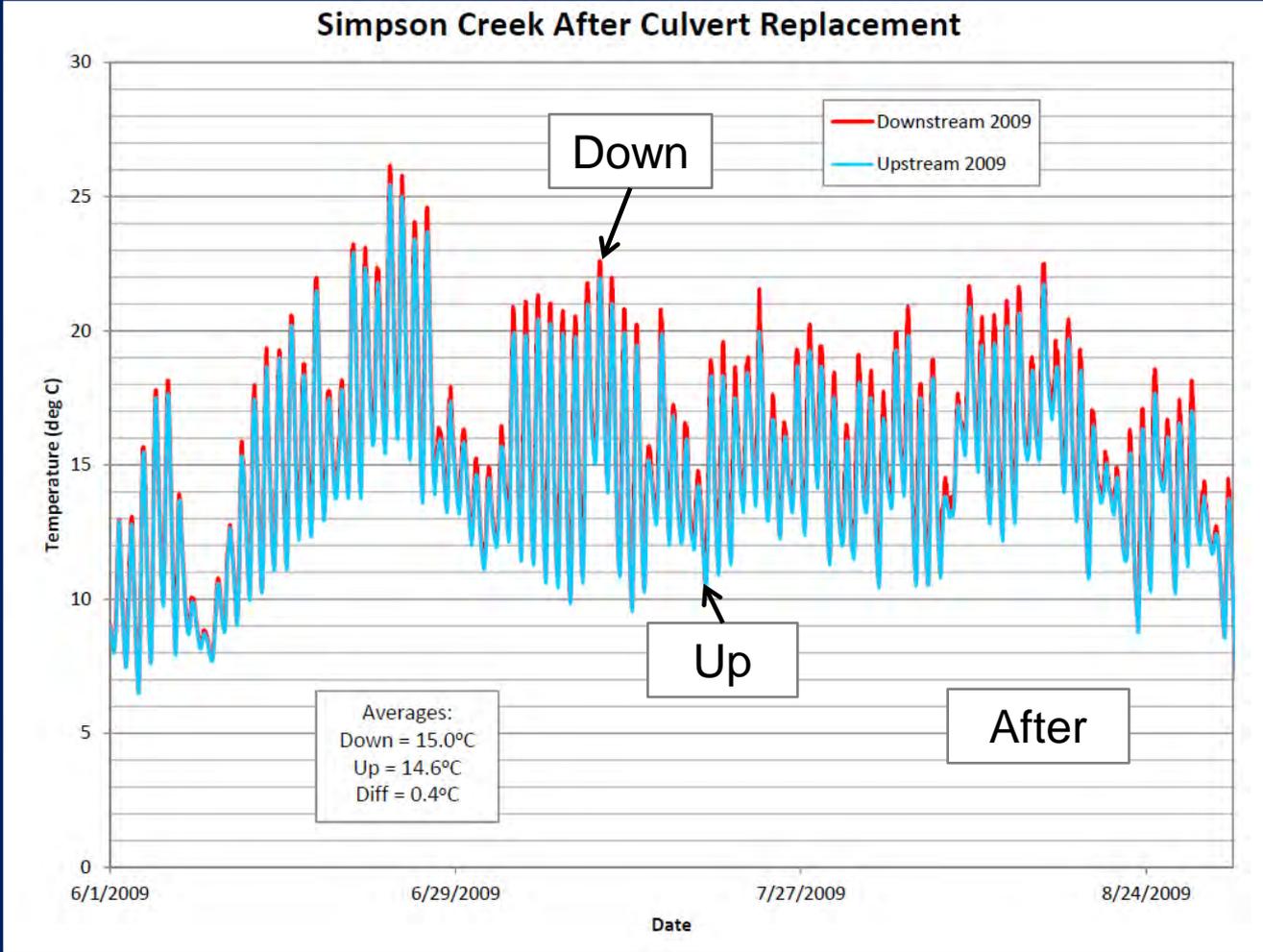


Upstream Ponding Water Temperatures Impacts





Upstream Ponding Water Temperatures Impacts



Upstream Ponding

Water Temperature (and other) Impacts



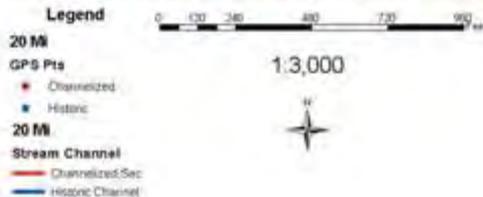
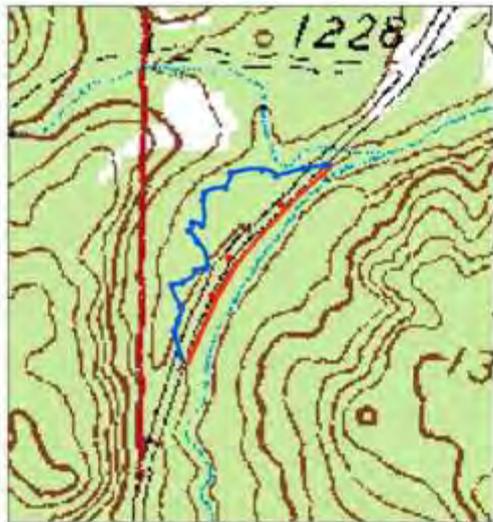
Gravel Bed Accumulation on Steep Streams

Channel Morphology Impacts



Encroachment and Channelization

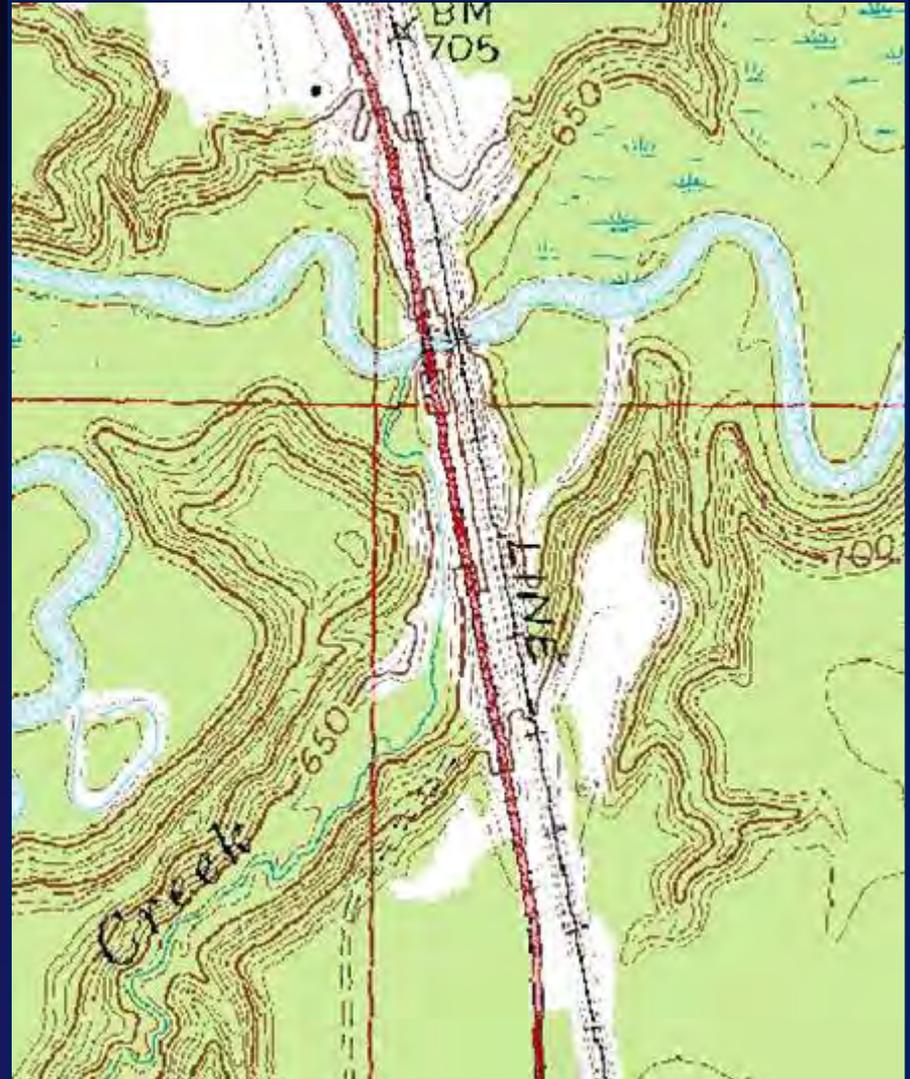
Channel Morphology



20 Mile Creek and Forest Road 378



Floodplain Encroachment by Roads



Downstream Scour

Channel Morphology Impacts



Upstream

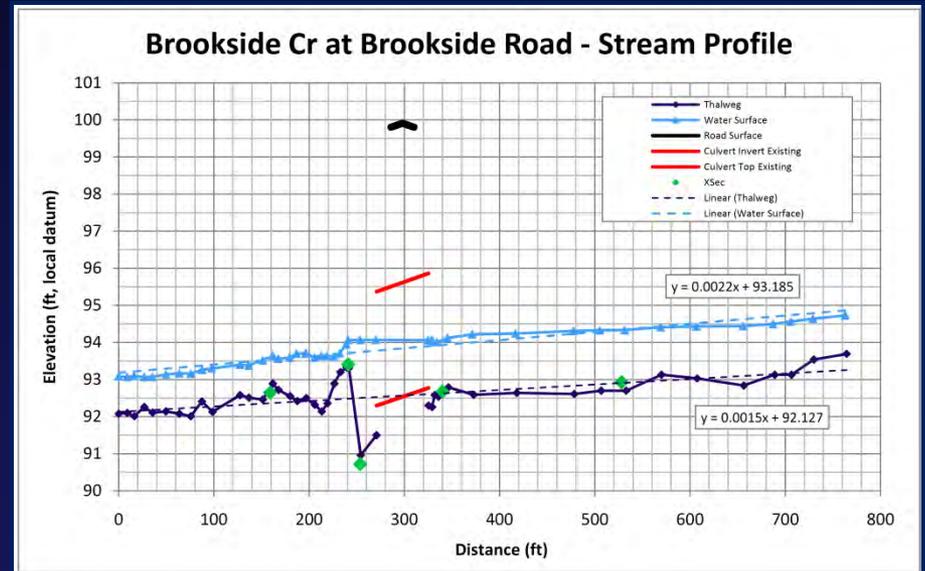
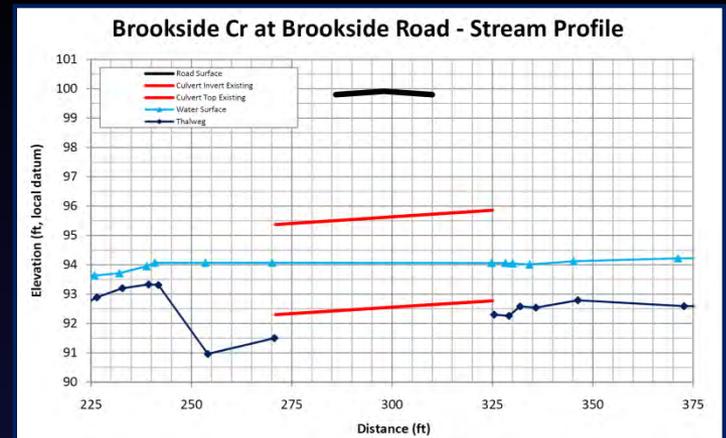


Downstream

Downstream Scour

Plunge Pool

Channel Morphology Impacts



Culverts that constrict the channel to much can elevate the headwater and cause extreme velocities at high flows. This scours a large plunge pool with an elevated tailwater control that ponds water upstream. The lower upstream velocities can cause the channel to aggrade and allow vegetation to encroach.

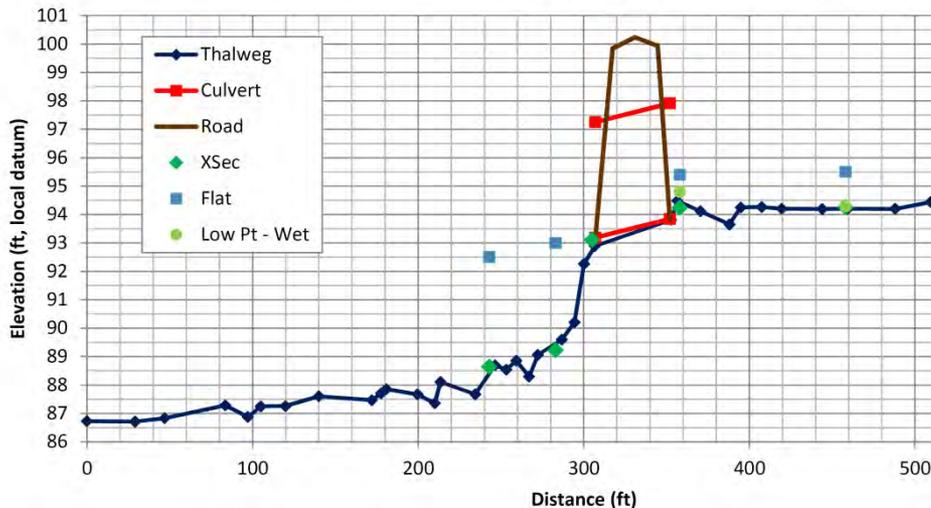
Headcuts and Culverts

Channel Morphology Impacts

In cases where a channel has degraded and a headcut has extended up to the culvert, grade controls may be necessary when replacing the culvert to ensure the headcut does not extend upstream.



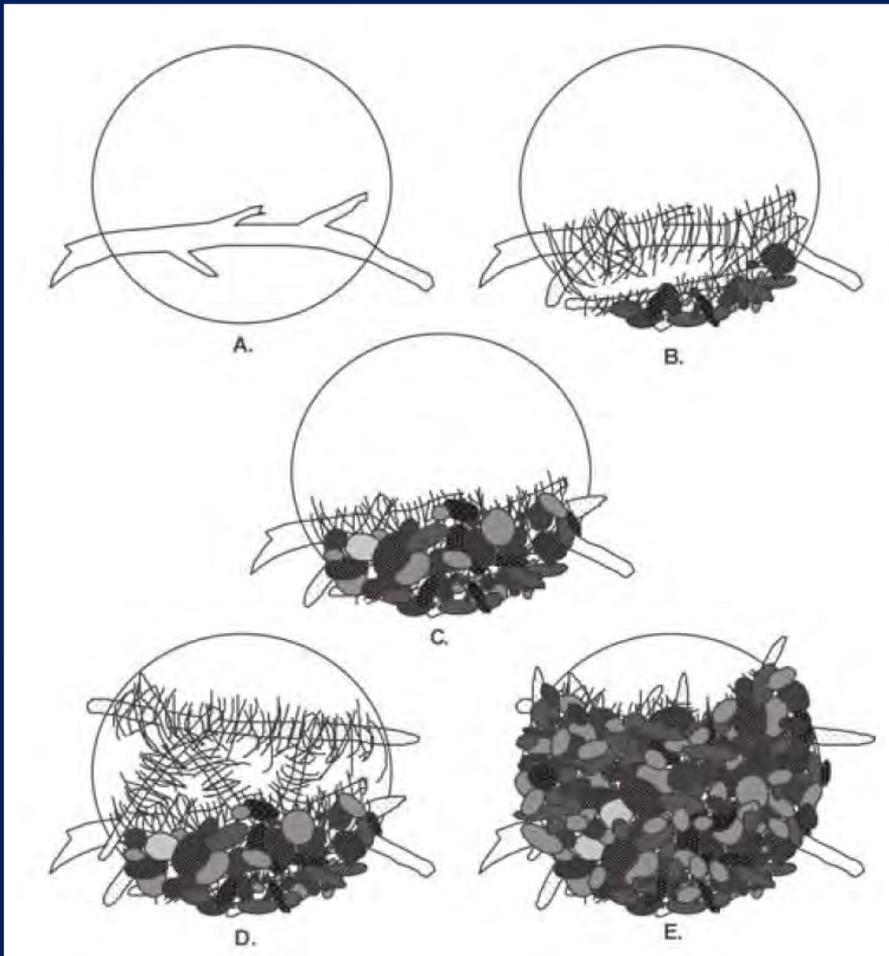
Trout Creek at Melanie Lane Profile



Woody Debris

Culvert Maintenance and Failure

Study of woody debris transport at road-stream crossings in NW California study, 1993-95



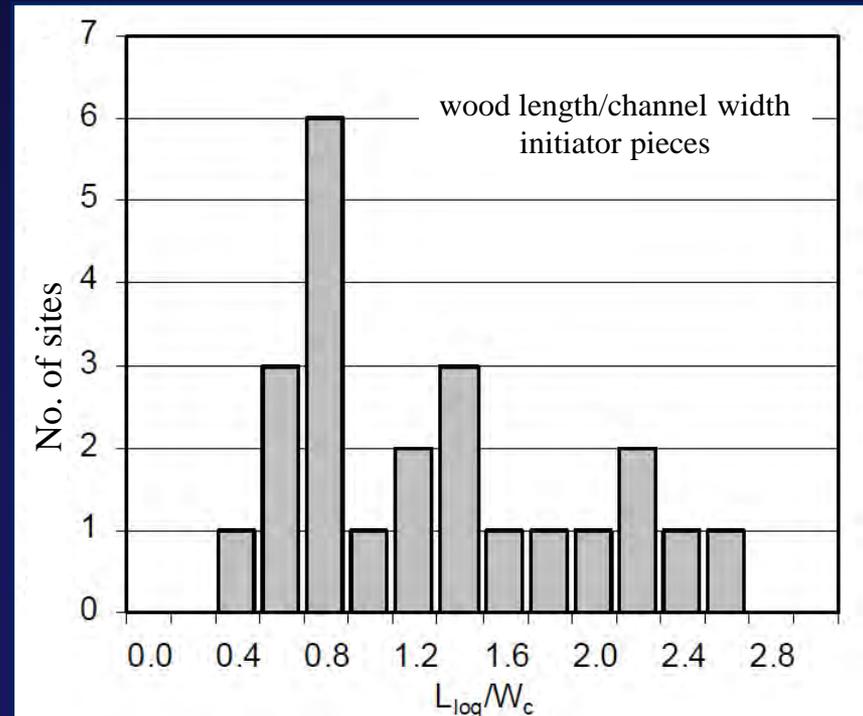
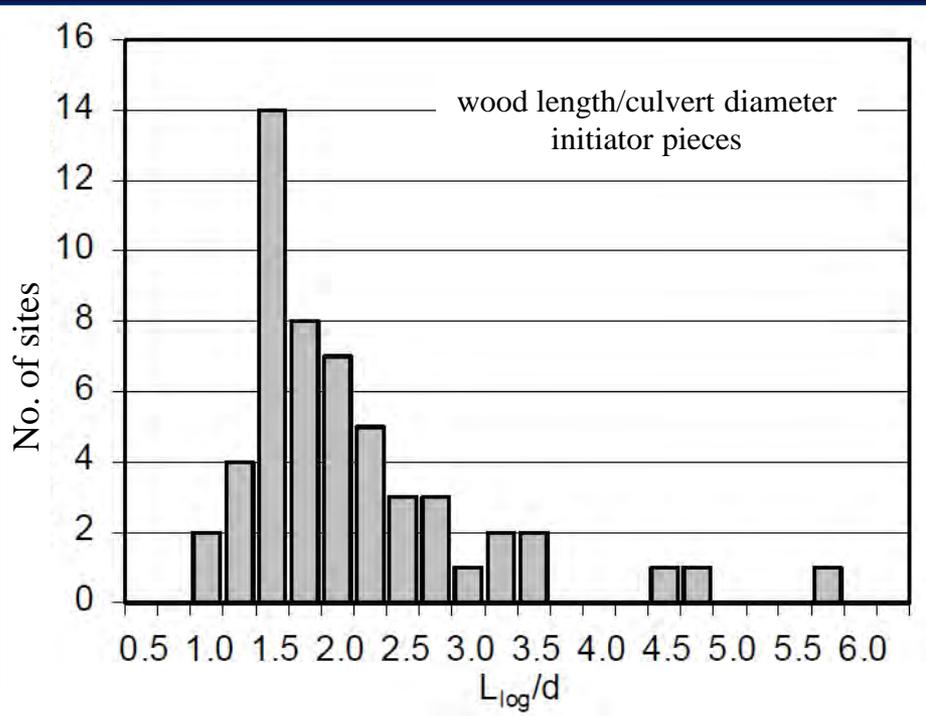
- A. Initiator piece
- B. Sediment and detritus accumulation
- C. Debris consolidates
- D. Second initiator piece
- E. Plug grows upward



Woody Debris

Culvert Maintenance and Failure

- Of 3,114 pieces of transported wood, 99% were shorter than channel width.
- The initiator pieces at 65% of 54 sites were 1-2 times the culvert diameter.
- The initiator pieces at 45% of 23 sites were less than channel width.

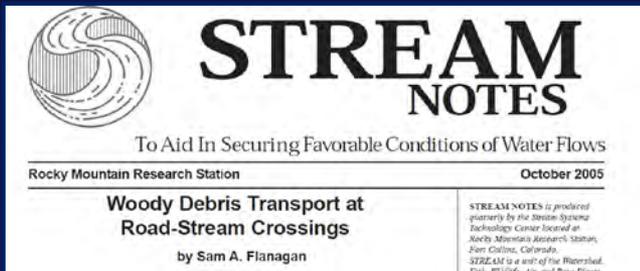


Woody Debris

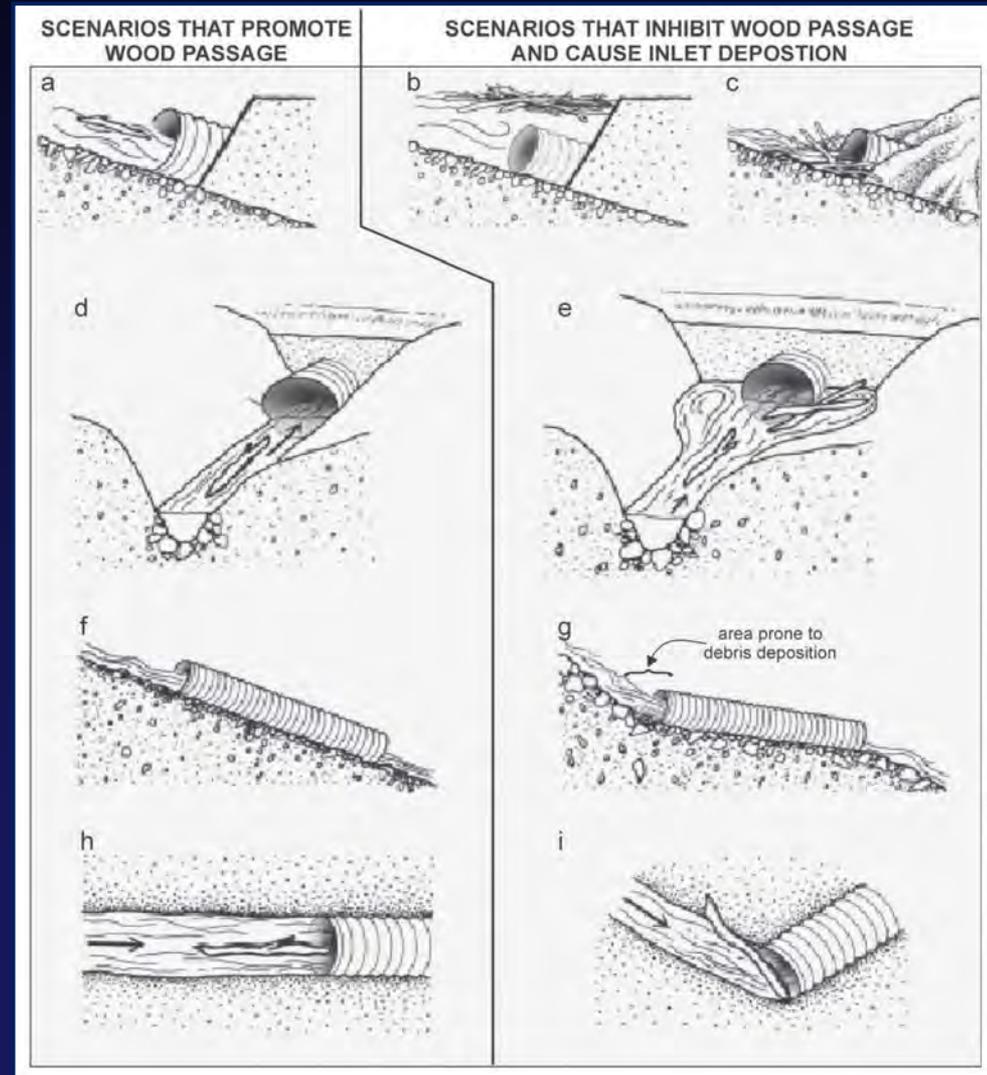
Culvert Maintenance and Failure

Promoting Wood Passage

- No constriction (\geq BF width)
- No headwater ponding
- C. Freeboard on concave profiles
- D. Good alignment

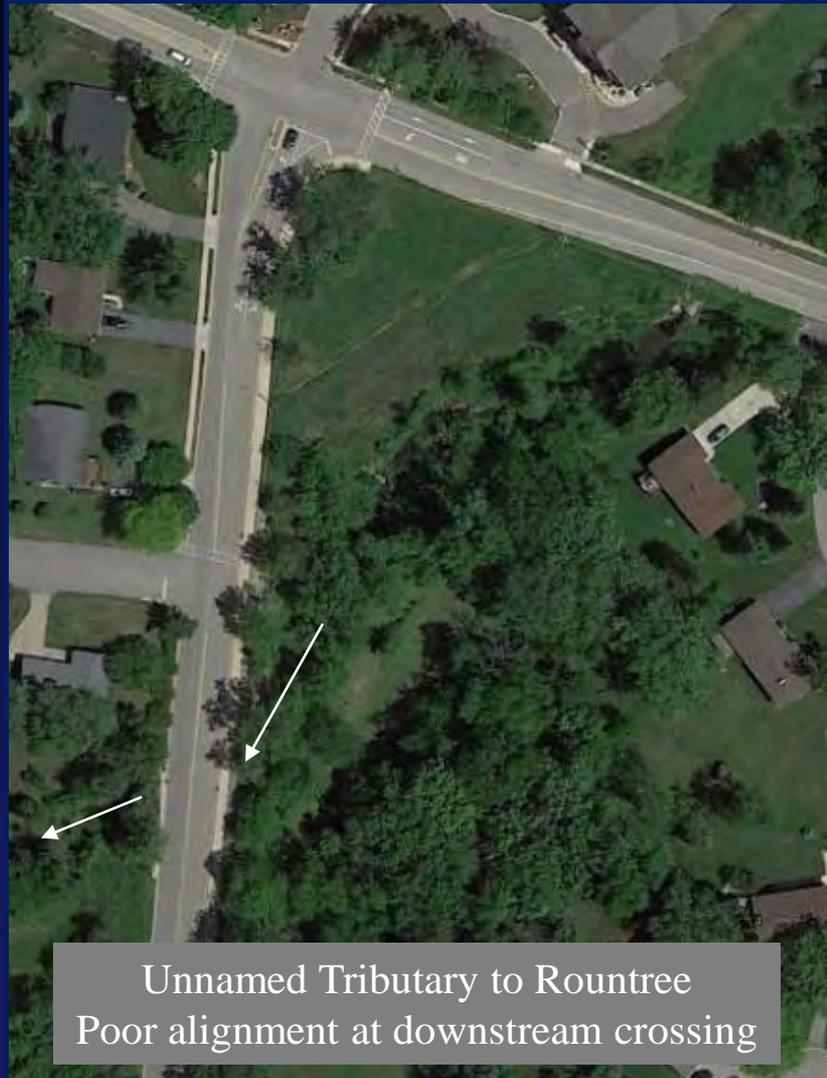


Flanagan, S.A. 2004. Woody Debris Transport through Low-order Stream Channels of Northwest California – Implications for Road-stream Crossing Failure. Arcata, CA: Humboldt State University. 114 p. M.S. Thesis Geology. Available online at: http://www.bof.fire.ca.gov/board/msg_supportedreports.html



Woody Debris

Culvert Maintenance and Failure



Aquatic Organism Passage

Culvert Impacts

- **Culvert Too Steep**
 - Water velocity too high (velocity and exhaustion barriers)
 - Water too shallow (depth barrier)
- **Drop at Outlet (jump barrier)**
- **Behavioral Barriers**

Openness Ratio - Behavioral Barriers

Aquatic Organism Passage

$X\text{-Sec Area (sq m) / Length (m)}$



(Reference: Scott Jackson)