Impacts of Road Crossings on Streams

Dale Higgins, retired hydrologist, USDA Forest Service

Culvert and Road Impacts

Water Quality: Sediment, Temperature

Channel Morphology

Aquatic Organisms

Woody Material

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**

Frequent Washout Solutions

Sediment Sources

Solutions:

- **bankfull width**
- **HW/D <0.8 at Q_{100}**
- **proper construction**

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

Embankment Erosion

Sediment Sources

Embankment Erosion Solutions

Sediment Sources

Stable side-slopes 2:1 or less, adequate riprap, properly sized culvert with HW/D < 0.8 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

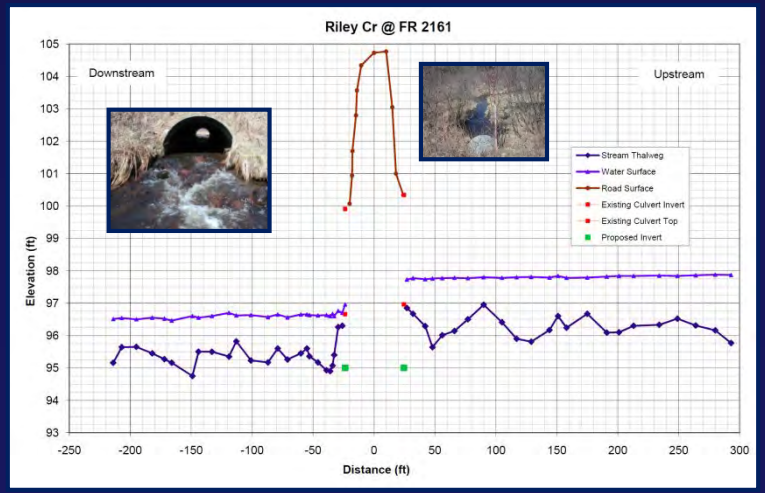
Channel Morphology Impacts

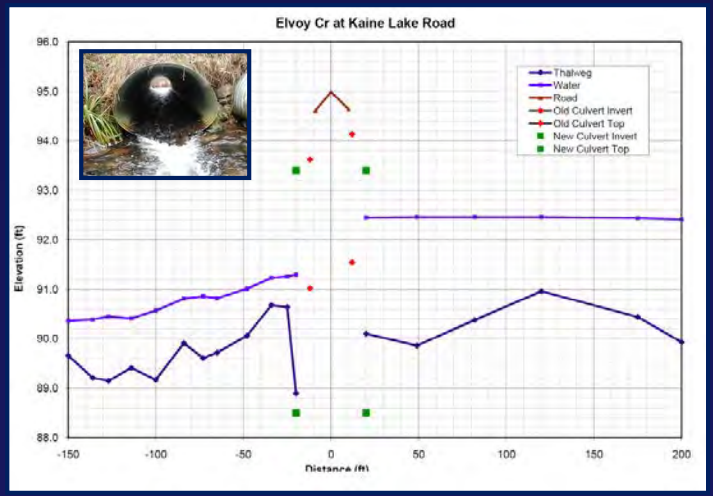
Downstream Sediment

Channel Morphology Impacts

Upstream Ponding

Culvert Too High on Flat Streams, Channel Morphology Impacts





Upstream Ponding

Frequent Washouts on Flat Streams

Channel Morphology Impacts

Upstream Ponding

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Upstream Ponding

Frequent Washouts on Flat Streams

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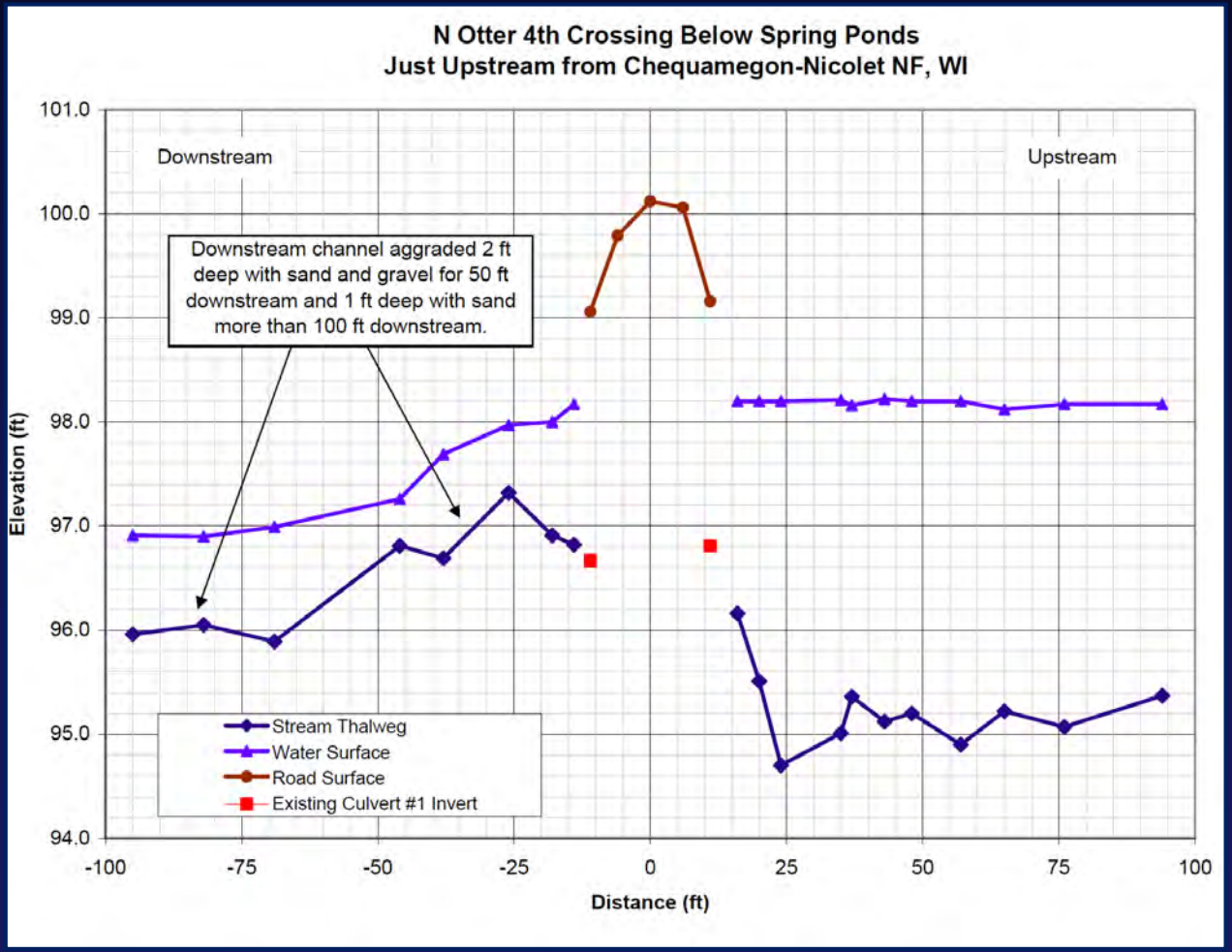
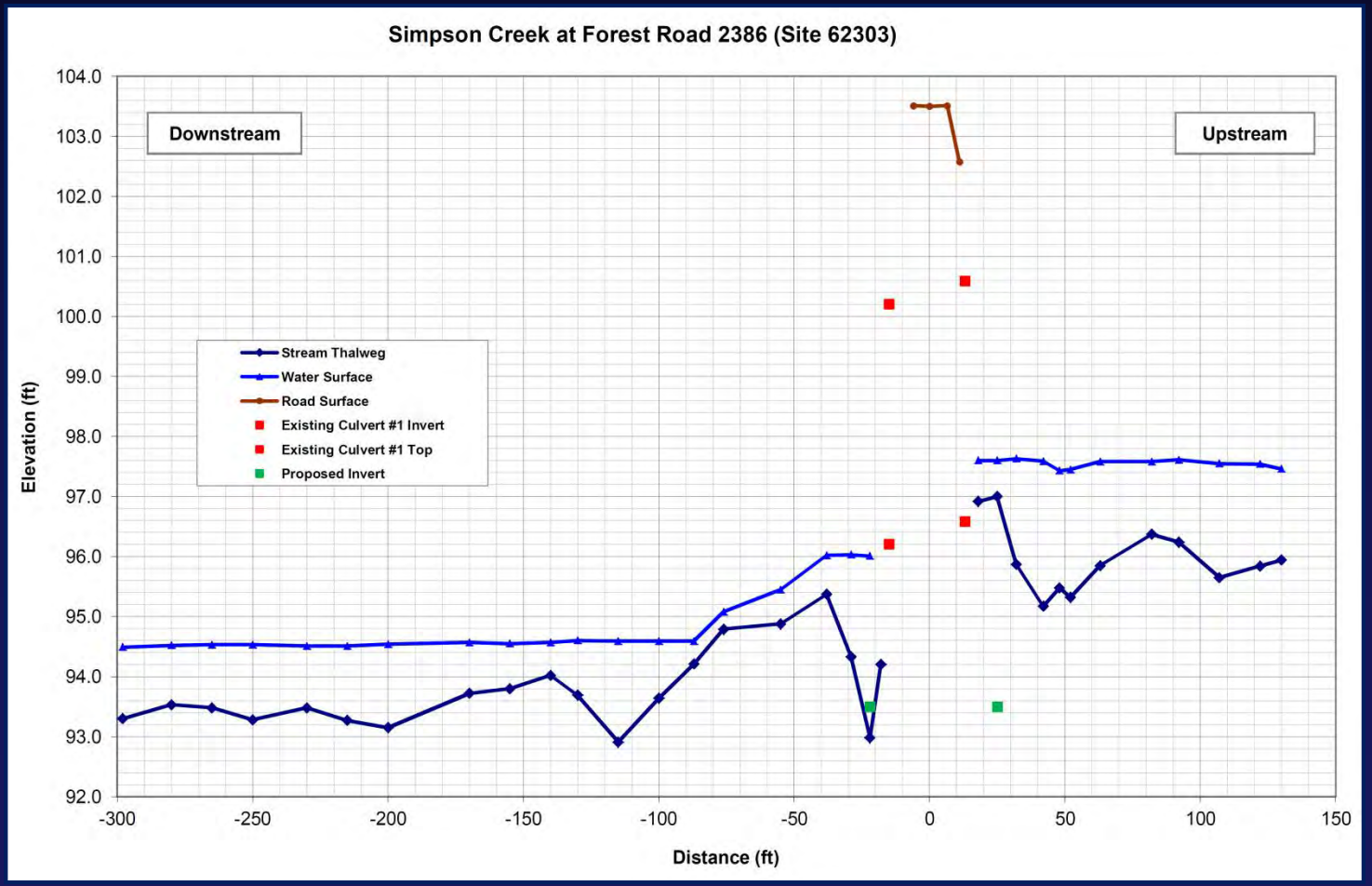
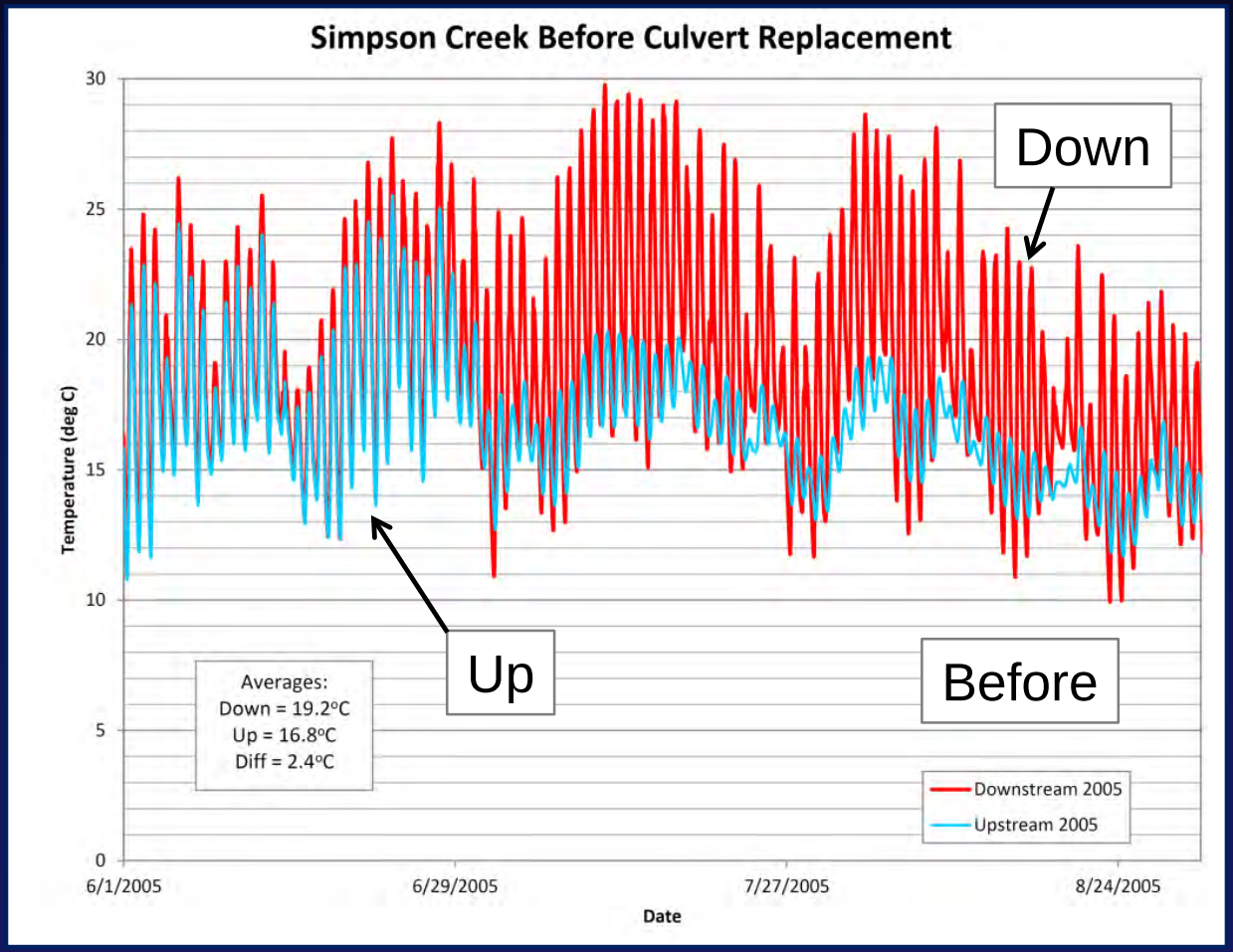


Upstream Ponding

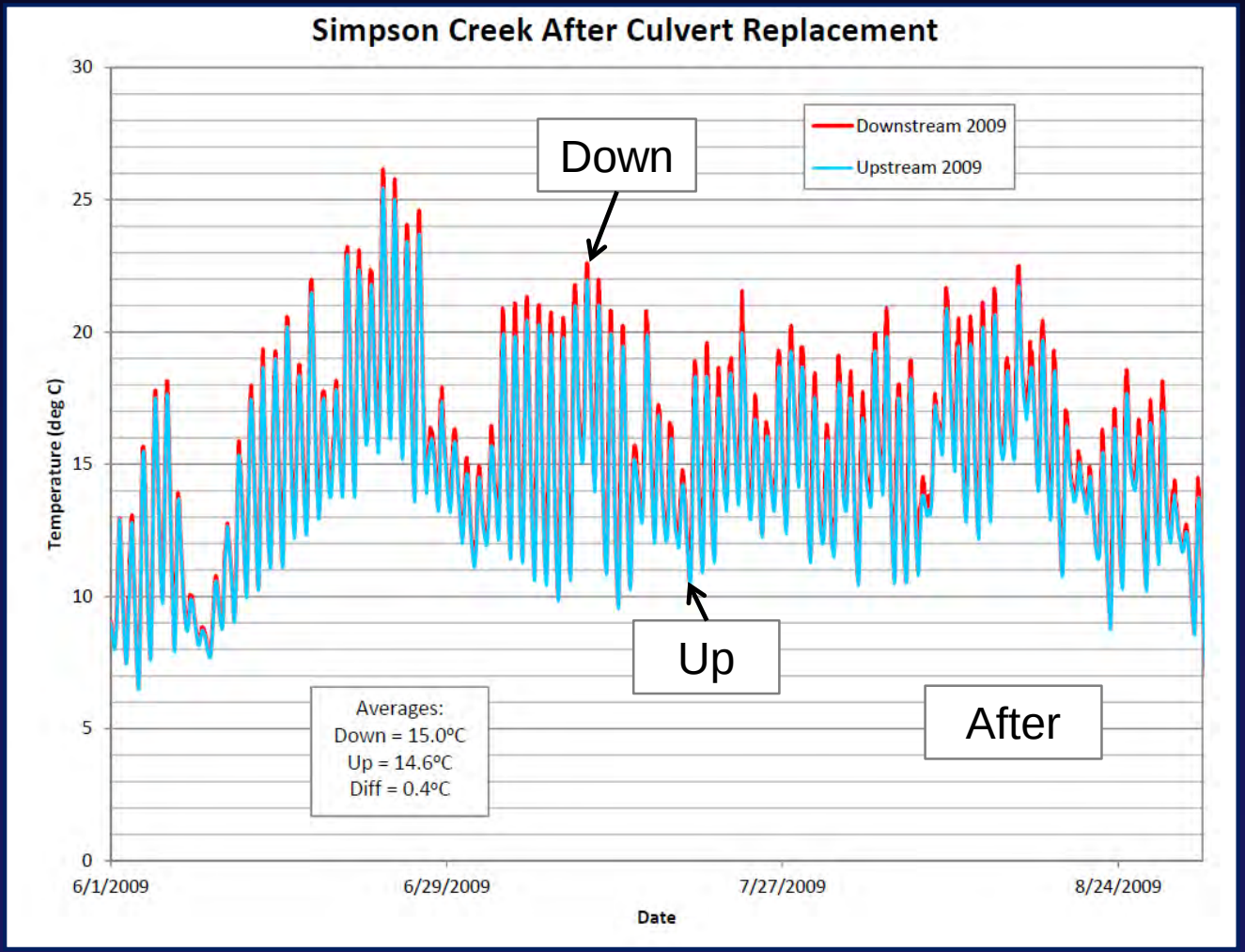
Water Temperature (and other) Impacts



Upstream Ponding
Water Temperatures Impacts



Upstream Ponding
Water Temperatures Impacts



Upstream Ponding

Water Temperature (and other) Impacts

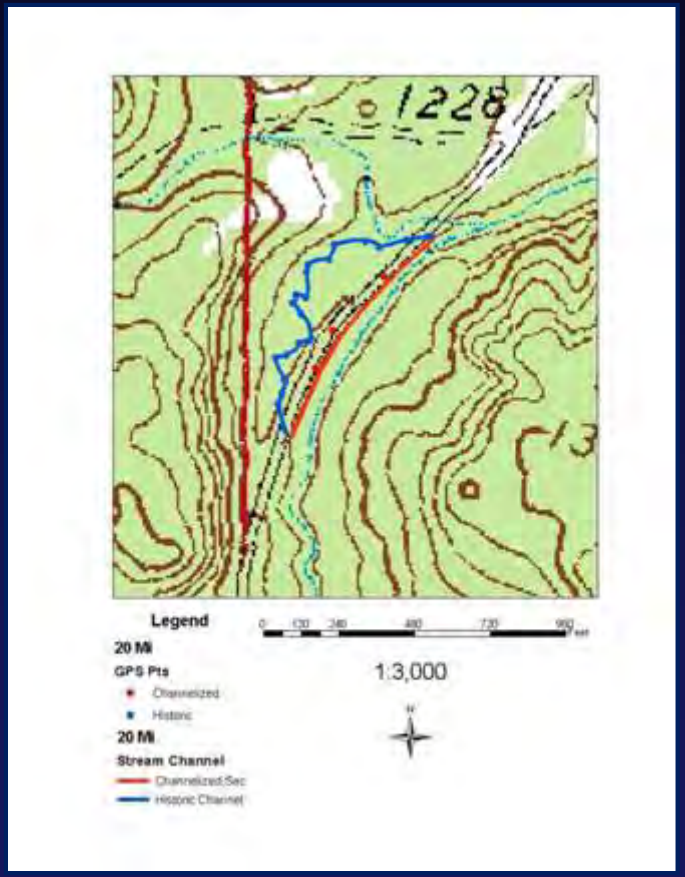
Gravel Bed Accumulation on Steep Streams

Channel Morphology Impacts

Solutions:

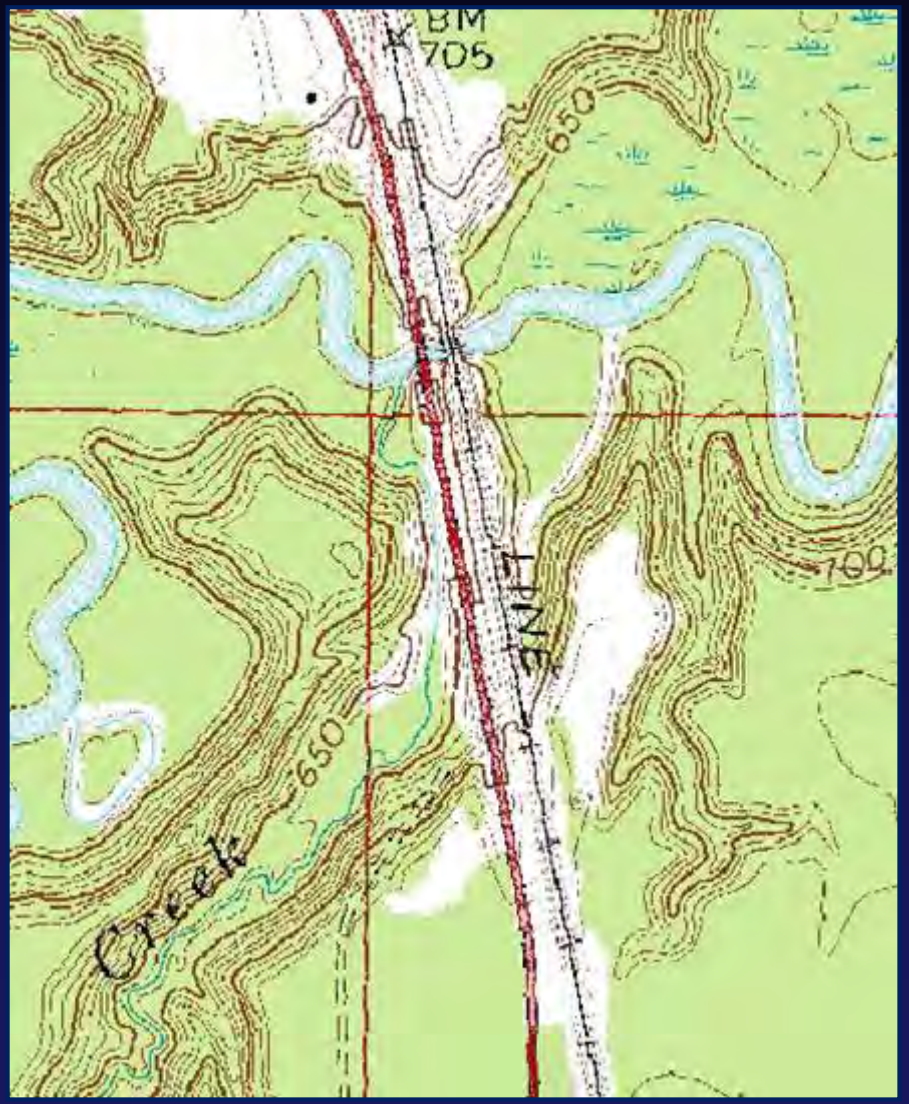
- Maintain transport of gravel and cobble sediment
- Stream simulation
- Bankfull width channel
- Natural bedforms and profile

Encroachment and Channelization
Channel Morphology



20 Mile Creek and Forest Road 378

Floodplain Encroachment by Roads



Downstream Scour

Channel Morphology Impacts

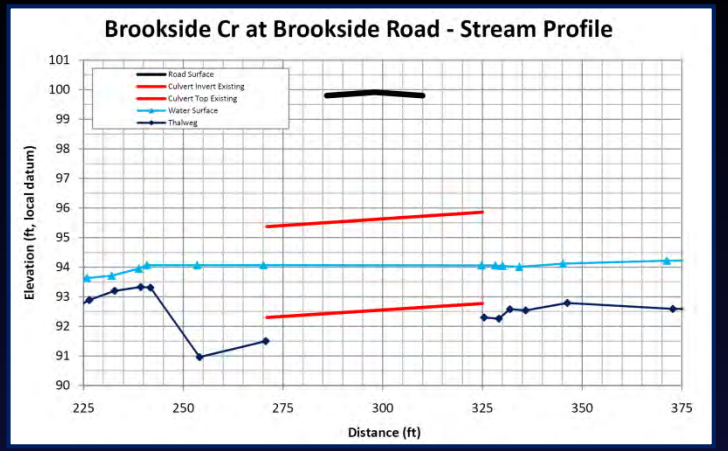
Upstream

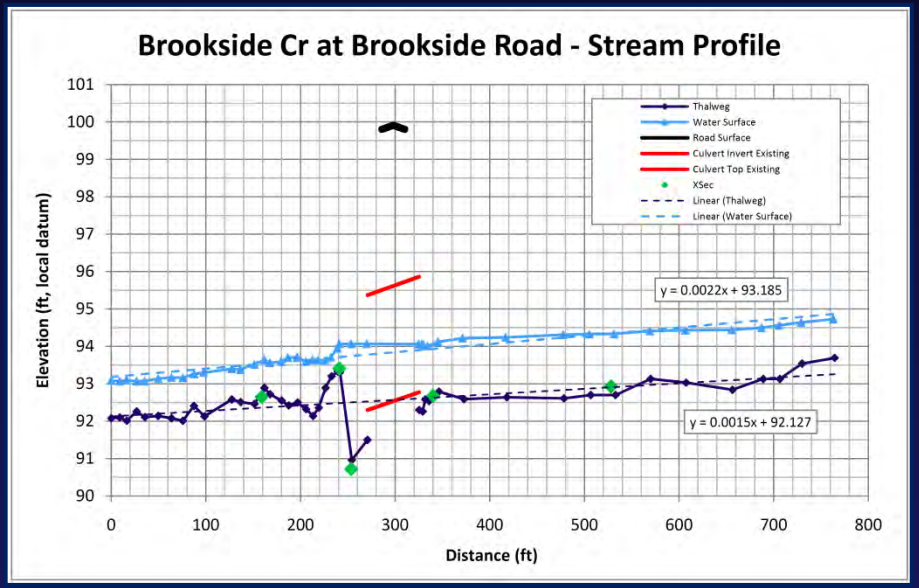
Downstream

Solution: bankfull width culvert set at the proper elevation

Downstream Scour Plunge Pool

Channel Morphology Impacts



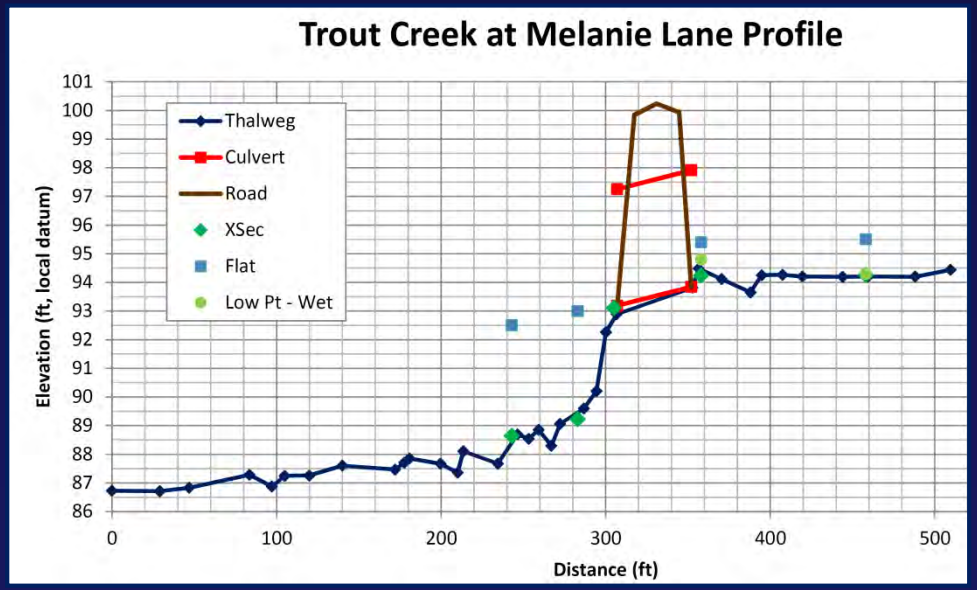


Culverts that constrict the channel too much can elevate the headwater and cause extreme velocities at high flows. This scours a large plunge pool with an elevated tailwater control that ponds water upstream. The lower upstream velocities can cause the channel to aggrade and allow vegetation to encroach.

Headcuts and Culverts

Channel Morphology Impacts

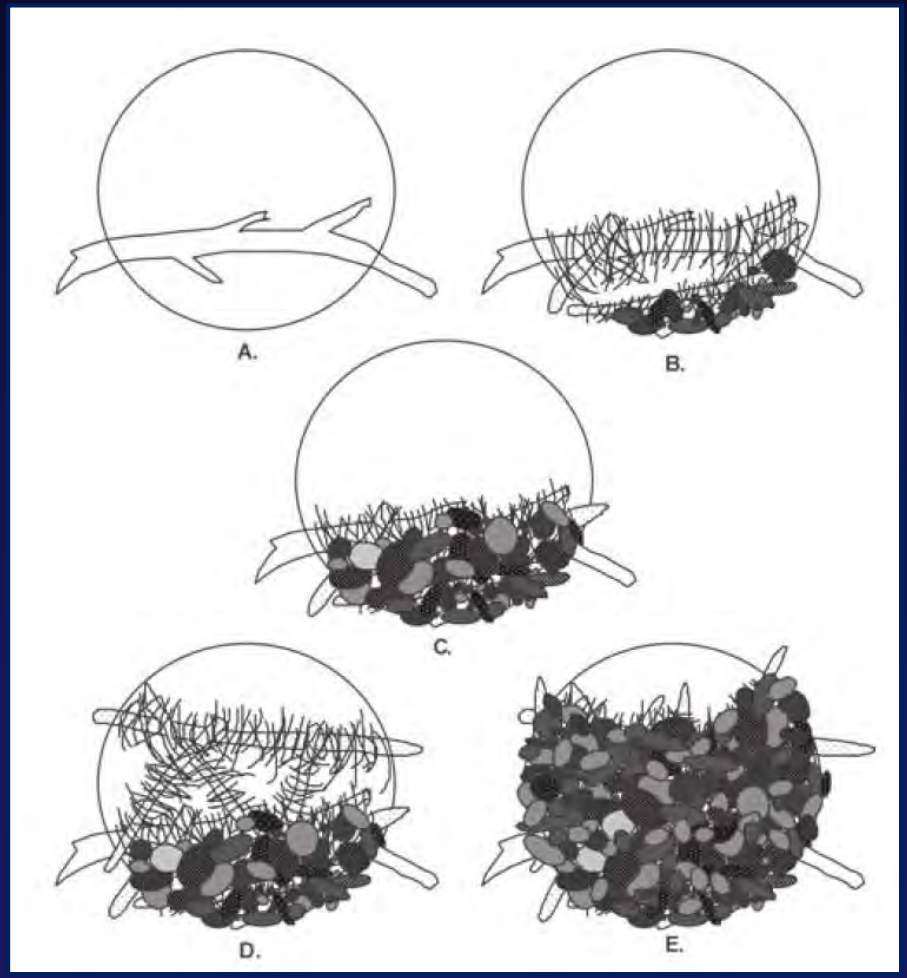
In cases where a channel has degraded and a headcut has extended up to the culvert, grade controls may be necessary when replacing the culvert to ensure the headcut does not extend upstream.



Woody Debris

Culvert Maintenance and Failure

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

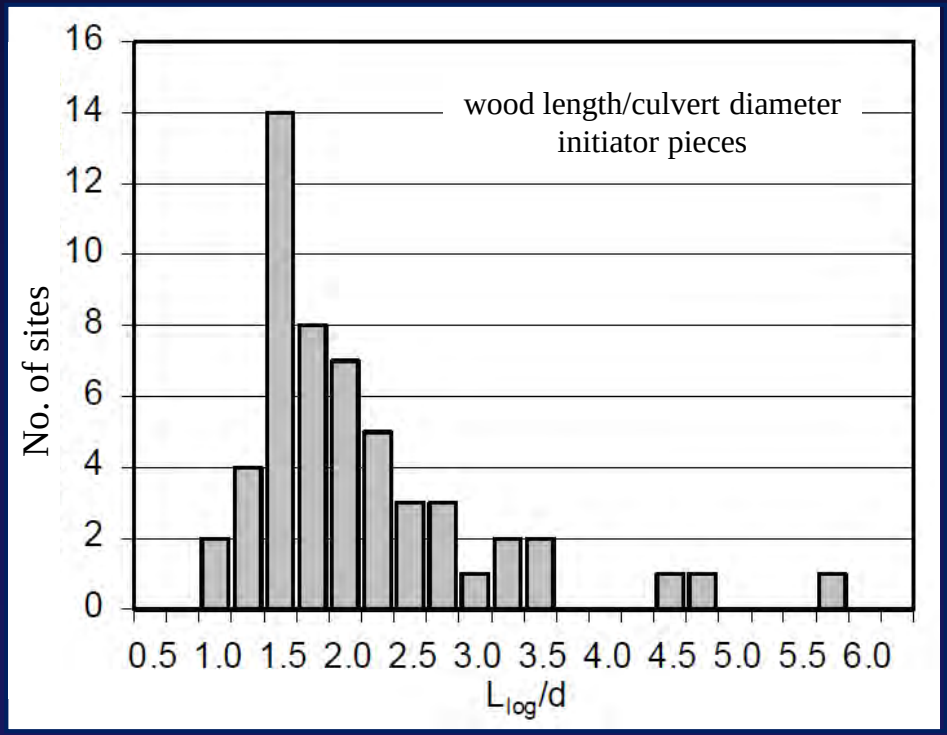


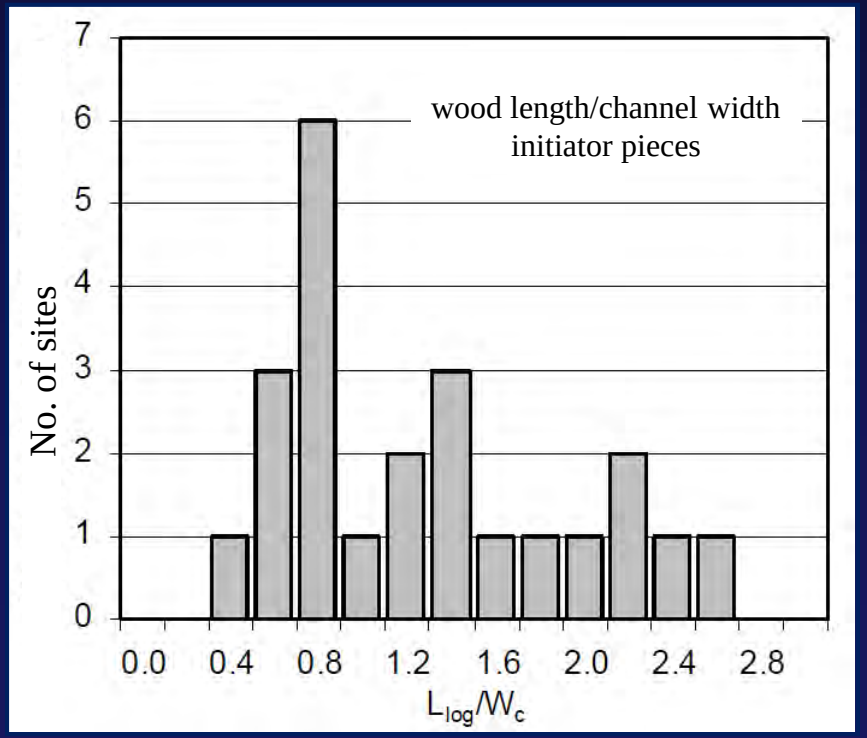
A. Initiator piece
B. Sediment and detritus accumulation
C. Debris consolidates
D. Second initiator piece
E. Plug grows upward

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

STREAM NOTES

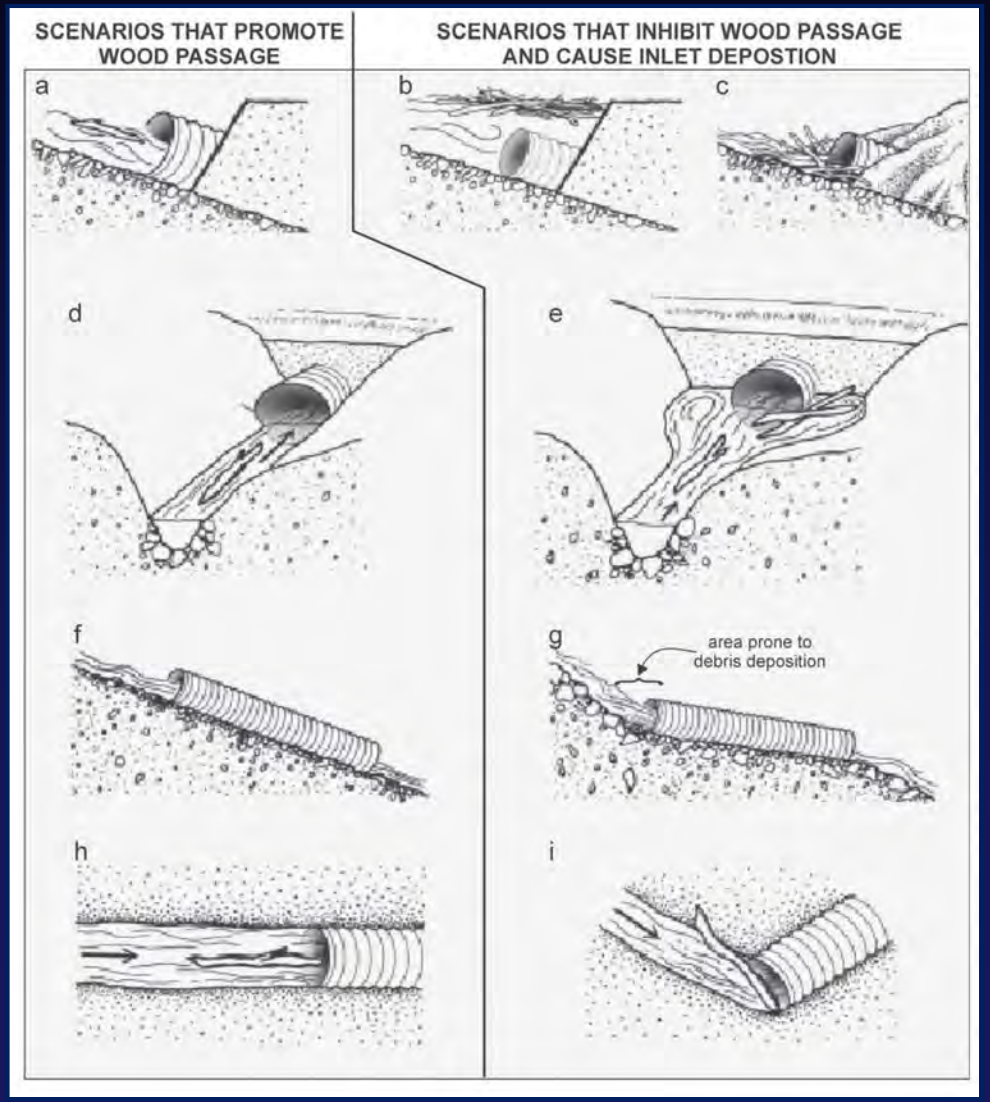
To Aid In Securing Favorable Conditions of Water Flows

Rocky Mountain Research Station — October 2005

Woody Debris Transport at Road-Stream Crossings

by Sam A. Flanagan

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

Unnamed Tributary to Rountree
Poor alignment at downstream crossing

Poor alignment

Openings much smaller than channel width