Practical Guidance on Stream Crossings to Protect Habitat & Meet Multiple Objectives

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Banded darter

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What’s the problem?

Discuss three elements:

Are road crossings a barrier to aquatic organisms?

What is the consequence of a barrier(s)?

Can such barriers be mitigated?
Question: Are road crossings a barrier to aquatic organisms?
Background - Language Barrier among professions

River Continuum Concept

(Vannote et al 1980)
HWY 41 Roadway Improvement-Allenton Creek Trout Stream Restoration Project 1992-1997

[Diagram of Culvert 1 and Culvert 2 with measurements and flow direction]

Not to Scale
▲ = Limestone Baffles

Language Barrier
8F2: Apron Endwalls for Pipe Arch and Elliptical Pipe

CONCRETE ENDWALLS

REINFORCED CONCRETE PIPE ARCH

REINFORCED CONCRETE ELLIPTICAL PIPE

GENERAL NOTES

DETAILS OF CONSTRUCTION MATERIALS AND WORKMANSHIP NOT SHOWN ON THIS DRAWING. COMPLY WITH THE REQUIREMENTS OF THE STANDARD SPECIFICATIONS AND THE APPLICABLE SPECIAL PROVISIONS.

CONCRETE APRON ENDWALLS MAY NOT BE USED WITH GALVANIZED STEEL OR ALUMINUM CABLE PIPE OR USE STEEL-ALUMINUM STEEL OR ALUMINUM APRON ENDWALLS SHALL BE INSTALLED ON GALVANIZED STEEL OF THE SAME METAL.

ALL THREE PIECE STEEL APRON ENDWALLS SHALL BE GREY SIZES AND GREY PANELS. ALL THREE PIECE STEEL ALUMINUM APRON ENDWALLS FOR 40" X 50" PIPE ARE LIFE SIZED AND LARGER SHALL HAVE GREY SIZES AND GREY CENTER PANELS. THE WIDTH OF THE CENTER PANELS SHALL BE GREATER THAN 25 PERCENT OF THE PIPE ARCH PERIMETER.

LAP SEAMS SHALL BE TOTALLY JOINED BY CALIBRATED NUTS OR BOLTS FOR STEEL UNITS AND ALUMINUM NUTS AND BOLTS FOR ALUMINUM UNITS. FOR THE 40" X 50" SIZE THROUGH 60" X 80" APRON ENDWALLS, THE RINGED OR CENTER PANEL SEAMS SHALL BE FURTHER JOINED BY CALIBRATED STEEL OR ALUMINUM STRIP/CUTTING ANGLES. THE ANGLES SHALL BE ATTACHED BY CALIBRATED NUTS AND BOLTS FOR STEEL OR BOLTS FOR ALUMINUM UNITS.

WHERE TWO OR MORE PIPIES WITH APRON ENDWALLS ARE LAY EQUALLY TO EACH OTHER, THEY SHALL BE SEPARATED BY A DISTANCE ENOUGH TO PROVIDE A MINIMUM CLEARANCE OF 10 INCHES BETWEEN APRON ENDWALLS.

FOR PIPE ARCH SIZES UP TO 60" X 80" ROLLED EDGES MAY BE USED INSTEAD OF STEEL END REINFORCEMENT. SEE SECTION 4-3.

APRON ENDWALLS FOR PIPE ARCH AND ELLIPTICAL PIPE

STATE OF WISCONSIN
DEPARTMENT OF TRANSPORTATION

NOTE: USE WEDGE DEVELOPMENT ENGINEERS.
Language Barrier

Low Flow vs Flood Flow
Fish have limitations

Native Fish Can’t Jump!

These are chinook & coho salmon on the Root River
Ichthyomechanics - Swimming distance curves for several fish lengths (Subcarangiform mode)

(Burst Swimming $(t < 10 \text{ s})$

(Prolonged Swimming $(10 \text{ s} < t < 30 \text{ min})$

(Sustained Swimming $(t > 30 \text{ min})$

(Adapted from Chirs Katopodis, 1993, Culvert Design: Fish Passage At Culvert Highway Crossings)
Ichthyomechanics - Swimming distance curves for several fish lengths (Subcarangiform mode)

(Adapted from Chirs Katopodis, 1993, Culvert Design: Fish Passage At Culvert Highway Crossings)
Peak swimming speeds of fishes

![Graph showing peak swimming speeds of different fish species.](image)

Figure 50. Burst swimming speeds of rainbow trout and some warm and cool water fishes (data from Domenici and Blake 1997).

Aadland 2010, Reconnecting Rivers: Natural Channel Design in Dam Removal and Fish Passage
Ichthyomechanics - (Anguilliform mode)

American Brook Lamprey

(Adapted from Chirs Katopodis, 1993, Culvert Design: Fish Passage At Culvert Highway Crossings)
Fish need to move to gain access to a variety of habitats for specific needs:

• **To survive** [protection from predators, reduction in competition, thermal stress, low dissolved oxygen]

• **To grow** [access to abundant & high quality food, food needs change with size/age, food quality varies by reach]

• **To reproduce** [requirements can include substrates, water depth, water velocity, temperatures, critical seasons of year—migration distances can require many miles]
Question: Are road crossings a barrier to aquatic organisms?
Answer: Yes, they can be.

What is the consequence of a barrier(s)?
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Low-head dams?
What is the consequence of a barrier(s)?

Low-head dams?

Answer: Fish species fragmentation and localized extinction.

Answer: The negative effects of multiple dams can be cumulative.

Question: Can a culvert function like a low-head dam?
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Yes
Road Crossings are potential fish passage barriers

Fish passage strategy

1. Must be based on a watershed scale
2. Must account for both upstream and downstream passage
These crossings affect the quantity and extent of flooding and velocity of flows.
Cumulatively-These structures determine flood flow and low flow hydrology, sediment transport, and stream gradient and morphology.
Design considerations to improve fish passage cannot be based upon assessment of just the structure.
Design considerations to improve fish passage for a road crossing must include consideration of the existing stream channel both upstream and downstream as well as the structure itself.

- Provide adequate depth & width
- Manage water velocity above, below and within culvert
- Inlet and outlet protection
Maintenance of Slope & Sinuosity are important for protection of streambed and bank stability.
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Bankfull/active channel
Low flow channel
Width
Depth
Velocities
Pool-riffle structure
Slope
Sinuosity
Erosion
deposition
Substrate diversity
Substrate composition
- Install culvert below existing stream grade

- Provide adequate depth

(Katopodis, 1992)
Crossing structures should be as wide as the stream to ensure that water flow is not restricted and water velocity is not increased.
This proposed design does not account or address needs for stream sediment transport, stability, and/or fish passage considerations.
CTH G

COARSE AGGREGATE MIX (TYP)
FIELDSTONE BOULDERS (TYP)

TOP OF BANK

12'

STREAM BED

(+1.51)

NATIVE SOIL

(-0.97)

CULVERT PIPE
ENDWALL BOTTOM
POOL SECTION
RIFLE SECTION

EL 78.03

ELLiptical pipe
Type of stream crossing order of preference:

- Bridge → Open-bottom Arch → Open-bottom box → Closed bottom box → Pipe Arch culvert → Elliptical (squashed pipe) culvert → Round (or pipe) culvert
RECOMMENDATIONS TO ENHANCE FISH AND WILDLIFE PASSAGE FOR THE LOW FLOW CULVERT AT THE STH 38 ROAD CROSSING STRUCTURE OF HUSHER CREEK: PLAN VIEW

Source: Tom Slaatski (SEWRPC).
DATE: 10-10-07
A combination of medium and light riprap were used to construct these baffles. Larger stones were used at the base of the structure and smaller diameter stone were used to fill in voids to help support the weight of the structure.

Coarse aggregate/riprap stone mixture would normally have been placed throughout the entire bottom of this low-flow culvert to a depth of at least 1 foot, which would have provided more natural and stable substrates within the culvert. These substrates would have been sized to remain stable at the highest modeled velocities and would have added more strength to the baffles inside the culvert. However, substrates were not placed within the bottom of the low flow culvert because the elevation of the culvert was placed too high in comparison to the existing streambed upstream and downstream. If substrates were added in this situation, they would have acted like a dam and impeded passage of fishes during low flow. So they were not recommended in this case.

Source: SEWRPC.
CONSTRUCTED RIPRAP STREAMBANK AND BAFFLE RETROFITS TO IMPROVE FISH AND WILDLIFE PASSAGE AT THE INLET OF THE LOW FLOW CULVERT AT STH 38 (LOOKING DOWNSTREAM): OCTOBER 12, 2010-OCTOBER 24, 2011

OCTOBER 12, 2010

SEPTEMBER 15, 2011

JUNE 7, 2011

OCTOBER 27, 2011

Source: SEWRPC.
Thank you
References


References


