



TECHNICAL SUMMARY

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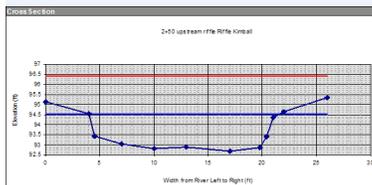
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LRRB PROJECT COST:

\$83,428



To determine bankfull width, researchers analyzed cross sections of channels upstream from culverts.



RESEARCH SERVICES

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Accommodating Fish Passage at River Crossings

What Was the Need?

To allow streams to pass under roads, engineers build tunnel-like structures called culverts. However, some culvert designs can have an impact on the stability and ecology of streams. If the slope of a culvert is steeper than that of a stream or its cross-sectional area smaller, the velocity of water running through it will be greater. Increased water velocities impede fish and other aquatic organisms by hindering movement upstream and creating other conditions that overmatch their swimming abilities, including turbulence, inadequate depth and abrupt changes in water surface elevation at culvert inlets and outlets. A culvert may also destabilize the stream itself, with changes in water flow leading to erosion that propagates upstream in a process called head cutting.

Improving culvert design will benefit the environment by accommodating fish passage and preventing stream disruption as well as reducing culvert maintenance costs.

To minimize these effects, some culverts in Minnesota are recessed into the stream bed, allowing natural sediment to accumulate in a way that reduces water velocity so that it more closely matches stream velocity. Other design improvements include matching a culvert's slope to that of the stream and its width to the "bankfull width" of the stream. Bankfull width is realized during biennial flooding, when water completely fills the stream channel and the water surface height coincides with bank margins. Other methods for managing water velocity include the use of side barrels—additional culverts placed at a higher elevation to accommodate increased flow during flooding, relieving pressure on the main barrel.

While Minnesota is considering expanding the use of such environmentally friendly culverts, they can be more expensive than standard culverts, and there was little data on whether they are effective.

What Was Our Goal?

The objective of this project was to assess how well the use of recessed culverts in Minnesota makes hydraulic conditions, including reduced water velocities, more amenable to the passage of fish at river crossings.

What Did We Do?

Researchers conducted field surveys to evaluate the effectiveness of recessed culverts at 19 sites in various regions of Minnesota, chosen to cover the state's key geographic conditions and represent areas with important fish populations.

Researchers determined the effectiveness of culverts primarily by measuring the amount of sediment in the recessed culvert barrel. The lack of sediment indicated an improperly functioning culvert. Researchers also compared the stream's bankfull width, slope and water velocity to that of the culvert; evaluated whether the stream had been destabilized by the presence of the culvert; examined site work plans to determine whether culvert or stream channel dimensions had changed between installation and the time of the survey; and took photographs of each site.

“The lesson of this study is that recessing culverts is not enough. Culvert widths must be matched as closely as possible to those of streams.”

—Petra DeWall,
Assistant State Hydraulics
Engineer, MnDOT Office
of Bridges and Structures

“Implementing the proper culvert designs will not only improve ecology but reduce maintenance costs involved in removing debris.”

—John Nieber,
Professor, University of
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and Biosystems
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Wide floodplains common in Minnesota sometimes require that culverts be designed with multiple barrels to handle additional flood capacity so that the water velocity in the main barrel does not become too great.

What Did We Learn?

Thirteen of the 19 sites surveyed used recessed culverts, and six of these were not functioning properly, with a lack of sediment in the recessed culvert barrel. This lack of sediment accumulation was caused by two factors: improperly sized culverts and an accumulation of sediment in side barrels. Researchers ruled out several other possible causes in each case, including an improper culvert slope, a recent large flood event, lack of sediment transfer from the riverbed and the culvert not in place long enough to accumulate sediment.

At 13 sites, including all six sites that had insufficient sediment accumulation, the recessed culvert width was less than the width of the bankfull channel. At seven sites, sediment had accumulated in side barrels to a depth that could reduce its flow during flooding, forcing water through the main barrel at greater velocities and so washing out its sediment.

These problems were most prevalent for wider channels, suggesting that it is more difficult in such cases to design a culvert that is wide enough to match natural stream conditions. Researchers recommend remedying such problems by collecting better data on streams so that culverts can be designed to more closely match their conditions as well as improving designs to address the challenges of Minnesota’s wider channels and floodplains.

What’s Next?

Researchers recommend developing a GIS-based tool that can be used collaboratively by local transportation agencies, MnDOT and the Minnesota Department of Natural Resources to determine what locations in Minnesota require culverts designed to accommodate the passage of fish. This tool would incorporate information about topography, geology, land use, stream characteristics and other factors.

This Technical Summary pertains to the LRRB-produced Report 2011-19, “Performance Assessment of Oversized Culverts to Accommodate Fish Passage,” published August 2011. The full report can be accessed at <http://www.lrrb.org/PDF/201119.pdf>.