



## TECHNICAL SUMMARY

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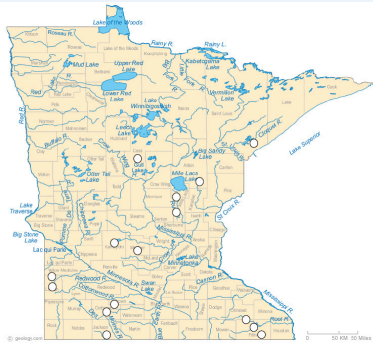
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### Principal Investigators:

John Nieber, University of Minnesota  
Bruce Wilson, University of Minnesota

### PROJECT COST:

\$50,663



To assess the cost of fish passage culvert designs, work plans were obtained from 15 installations (indicated by circles) in the state.



**RESEARCH**  
SERVICES SECTION

# Cost Analysis of Fish-Friendly Culvert Designs

## What Was the Need?

Because of Minnesota's abundance of lakes, rivers and streams, there are thousands of culverts to allow these waters to flow beneath the roads that cross over them. Many objectives are considered when designing modern culvert projects, including upstream and downstream flooding impacts, maintaining or enhancing wetland functions, flood plain management, public safety and cost. An additional increasing concern has been that in some streams, culvert designs present obstacles for migrating fish: shallow water, turbulence, high flow velocity and perched inlets (culvert openings that are too high for the fish to enter). One study showed that 67 percent of the culverts in the Pine-Popple region of Wisconsin either partially or totally blocked the passage of fish.

Recent designs that focus on matching the culvert to the natural characteristics of the stream are currently being implemented in certain areas of Minnesota where fish passage is a concern. County engineers needed more information about the necessity, function and additional costs associated with these culverts. Most research in this area has focused on salmon and trout in the Western United States.

## What Was Our Goal?

The objectives of this project were to study concerns about fish passage as they apply to Minnesota fish species and environments, gather information about current culvert design practices in the state, and produce a cost analysis of alternative culvert designs.

## What Did We Do?

Researchers first reviewed fish passage research from the East and West Coast regions. Although there were some differences with regard to fish species, landscape and water movement characteristics, the problems causing the blockage of fish passage were similar enough to warrant the evaluation of these studies.

To produce a statewide picture of current culvert design and installation practices, researchers administered surveys and conducted phone interviews with county engineers and Department of Natural Resources personnel. They additionally reviewed statewide general and county construction permits for evidence of culvert usage practices.

Investigators analyzed the cost differential between a stream simulation culvert design and traditional culvert placement by re-engineering 12 culverts at 12 separate Minnesota stream crossings and determining the cost differential for installing the stream simulation design. Stream simulation buries the culvert approximately 1 foot underground; this gives water moving through the culvert some characteristics of natural water movement.

In addition, researchers analyzed the costs of three strategies used as additions to in-place designs to facilitate fish passage:

- Baffles, which use panels inside the culvert to slow down water flow
- Roughened channels, which add rock and sediment to create diversity in flow rates and patterns
- Backwater weirs, which are dams constructed to hold water upstream so as to elevate the water level and eliminate a perched culvert, or downstream to slow water flow

*“This project effectively demonstrated that fish passage culvert designs are not excessively more expensive than traditional designs, especially when compared to overall construction costs.”*

—John Nieber,  
Professor, University of  
Minnesota Department  
of Bioproducts and  
Biosystems Engineering

*“There is still concern about the cost of the stream simulation designs. More study is needed to determine if these designs actually improve fish passage with the fish and environments we have in our state.”*

—Alan Forsberg,  
Public Works Director,  
Blue Earth County

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Erosion has created a dropoff distance between the water and culvert opening. Salmon swimming upstream would not be able to enter these culverts and continue their passage.

### What Did We Learn?

Researchers found that while species of fish and the stream environments are quite different between coastal regions and Minnesota, there is sufficient potential to warrant studying coastal techniques for possible application here.

The interviews, surveys and permit reviews revealed that there is no regional or state-wide ranking or prioritization system for fish passage in the state, and that prioritizing culvert design for fish passage is done on a case-by-case basis, primarily depending on potential benefits to fish resources. Alternative fish passage designs were found to be used less than 30 percent of the time, and there was a relatively low level of expertise among both agency and DNR staff regarding fish passage design and where it should be applied. Researchers did determine, however, that some aspects of various alternative designs are being implemented in different areas of the state.

When culverts designed using modern methods were compared to those using alternative fish passage designs, they were found to be generally similar; however, the cost of setting the bottoms of the fish passage designs into the stream bed and sometimes wider spans resulted in an average cost increase of 10 percent. No decrease in maintenance or erosion was documented with the fish passage designs.

The three existing culvert additions studied—baffles, roughened channels and backwater weirs—averaged between 10 percent and 15 percent of the culvert cost.

### What's Next?

Three follow-up studies are currently being pursued to address these questions:

- What is the actual impact on fish populations and aquatic life by conventional culvert designs?
- What ecological effects and maintenance costs would result with stream simulation design?
- Does Minnesota need a statewide guidance document addressing regional fish concerns and local geographical conditions for the purpose of prioritizing and suggesting a best fit culvert design?

The Minnesota Local Technical Assistance Program offered [a workshop on culvert design, installation and maintenance](#) that included the findings of this study.

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*This Technical Summary pertains to the LRRB-produced Report 2009-20, “Cost Analysis of Alternative Culvert Installation Practices in Minnesota,” published June 2009. The full report can be accessed at <http://www.lrrb.org/PDF/200920.pdf>. For more information about the follow-up studies mentioned, please contact [research@state.mn.us](mailto:research@state.mn.us).*