



## RESEARCH SERVICES SECTION

# TECHNICAL SUMMARY

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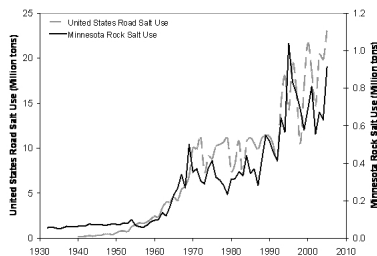
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### Principal Investigators:

Heinz Stefan, University of Minnesota  
Omid Mohseni, University of Minnesota

### PROJECT COST:

\$108,355



This graph shows how annual road salt purchases for deicing have been increasing for both Minnesota and the nation as a whole.



# Environmental Effects of Deicing Salt on Water Quality in the Twin Cities Metropolitan Area

## What Was the Need?

The use of salt to deice roadways in winter plays an important role in keeping Minnesota drivers safe. Nationally, salt use has increased dramatically over the last 50 years, with almost 23 million tons of salt spread on road surfaces in 2005. Minnesota spends nearly \$12 million annually on road deicing products, with approximately 350,000 tons of road salt applied in the Twin Cities Metropolitan Area alone.

Sodium chloride, the primary chemical used for deicing purposes, is readily available, inexpensive and has proven effective in maintaining safer roadways; however, its use is not without unintended consequences. Sodium chloride is highly soluble and easily transported over long distances, dissolving in the runoff from roadways and other impervious surfaces and entering ditches, streams or storm sewers. The runoff eventually finds its way into soil, streams, rivers, lakes, wetlands and groundwater. Research has indicated that this can cause concentrations of chloride that have adverse effects on land and aquatic plants and invertebrates.

Knowing more about what happens to deicing salt after it has completed its job of providing for safer winter roadways will allow winter maintenance managers to make more informed decisions as they manage deicing programs.

## What Was Our Goal?

The objective of this research was to provide baseline information about the seasonal and long-term effects of the use of road salt on water quality in the TCMA through a salt budget analysis to determine sources of chloride concentration and an analysis of the long-term impacts of deicing salt on the water quality of selected lakes in the area.

## What Did We Do?

The project began with a literature review of sodium chloride sources, uses and effects on the environment. Researchers then gathered data on the volume of use of sodium chloride as road salt in the TCMA and related its use to snowfall, lane miles and population.

The team developed a chloride budget (the amount of chloride from all major uses and discharges entering and exiting a watershed) for the TCMA watershed to determine how much of the road salt applied to local roads is exported out of the area by the Mississippi River and how much remains in the area.

Team members examined sodium chloride concentrations in local bodies of water, selecting several lakes for field measurements of chloride and temperature to identify seasonal effects that could be related to road salt application. Finally, researchers analyzed data on chloride concentrations in Minnesota's groundwater from several sources (including the Minnesota Pollution Control Agency, statewide surveys from 1992 to 1996 and 2004 to 2007, county surveys and the Minnesota Department of Health).

## What Did We Learn?

The study revealed a strong correlation between the use of road salt and population, as well as between lane miles and annual salt use. Many of the tested lakes had unexpectedly high sodium and chloride concentrations, with the chloride concentrations

*“We can use the information from this study to better manage our use of road salt, minimizing impacts while still maintaining safe roadways.”*

–Wayne Sandberg,  
Deputy Director of Public Works, Washington County

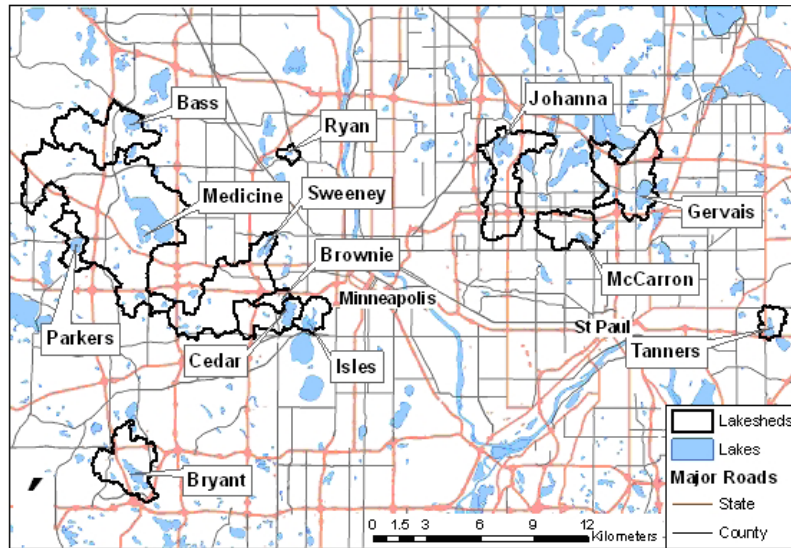
*“There are many ways we can reduce the rates of salt application, including educating the driving public and road salt applicators, as well as improving application technology and road deicing techniques.”*

–Heinz Stefan,  
James L. Record Professor of Civil Engineering, University of Minnesota

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This map shows the Twin Cities area lakes and their watersheds where researchers analyzed seasonal temperature and chloride concentration levels to try to identify the effects of road salt application.

trending upward. While significant problems have yet to be reported, continuation of the present trend of rising chloride levels will result in certain lakes exceeding acceptable levels of chloride in the future. The lakes exhibited a cycle that corresponds to seasonal road salt applications: higher salinity in winter and lower salinity in summer. Lakes with high chloride concentrations are found in the TCMA core; lower concentrations are found in lakes on the TCMA’s periphery.

Approximately 30 percent of the road salt applied in the TCMA is carried away or dissolved by the Mississippi River, leaving 70 percent unaccounted for and assumed to have been retained in local lakes, rivers, streams and groundwater. It is possible, though not proven, that a small amount of the road salt applied in the TCMA is transported out of the area by wind.

Researchers also concluded that shallow groundwater in the TCMA, especially near major roadways, reflects rising chloride concentrations.

### What’s Next?

Salt has proven effective in maintaining safer winter roadways and plays an important role in winter maintenance operations throughout the state. Results of this study suggest that Minnesota should begin to look for ways to minimize the environmental impact of road salt while still maintaining a focus on safety. Further action suggested by this study includes:

- Evaluation of current operational practices to ensure the most appropriate use of road salt
- Educational programs for road operators that focus on when and how to apply salt
- Evaluation of alternative deicing chemicals

*This Technical Summary pertains to the LRRB-produced Report 2008-42, “Study of Environmental Effects of De-Icing Salt on Water Quality in the Twin Cities Metropolitan Area, Minnesota,” published September 2008. The full report can be accessed at <http://www.lrrb.org/PDF/200842.pdf>.*