

# PHD THESIS DEFENSE

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## *De-icing salt impact on Minnesota waters*

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### ABSTRACT

Salt has been widely used for ice and snow control on roads in the US, Canada and other parts of the world affected by adverse winter driving conditions. The primary product used in North America for de-icing of roads is sodium chloride (NaCl), a readily available and inexpensive material that provides adequate treatment to roadways under winter conditions. The primary objective of my research was to determine how road salt applications influence the water quality in a major metropolitan area (Twin Cities metropolitan area (TCMA) of Minneapolis/St Paul, Minnesota, USA). This analysis was done by collecting and analyzing data from area lakes, streams and rivers. Lake data was analyzed further through the development a 0D and 1D model at a daily time step.

It was determined that over 70% of the chloride being applied annually in the TCMA was retained in the watershed instead of entering the Mississippi River and eventually exported to the Gulf of Mexico. Salinity cycles have been observed in area lakes with high concentration in the winter followed by lower concentrations in the spring and summer. Mean annual concentrations in 38 lakes in the TCMA have been rising on average 1.4 mg/L per year over a 22-year period, matching a similar trend in the amount of rock salt the state of Minnesota has purchased. The increasing concentrations are changing the natural mixing behavior in area lakes. In some lakes monomictic behavior has occurred with mixing events only occurring in the fall and not in the spring. The presence of a saline layer at the bottom of the lake prohibited dissolved oxygen from reaching the benthic water layer in the spring, extending the anoxic period of this water layer by 6 months. Simulations conducted without the presence of a saline layer showed complete mixing and oxygenation of the benthic layers in the spring and fall. Lake concentrations are expected to continue to rise, resulting in many lake chloride concentrations throughout the water column reaching above the chronic water quality standard.

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