Sources of Chloride to Minnesota Waters
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We use salt for many purposes
High chloride levels in rivers, lakes, and streams can be harmful to aquatic life, vegetation, and ecosystems.
Chloride pollution can lead to high replacement costs for drinking water wells and other infrastructure.
Chloride is an invisible problem to most people.
We all can agree that winter road maintenance is a critical service
Elevated chloride levels have also been observed in more rural or suburban areas with agricultural or residential land uses.

(MPCA 2019, Cunningham *et al.* 2013, David *et al.* 2016)
Characterizing chloride sources can help inform solutions to reduce chloride levels in water resources.
What are the major sources of chloride pollution in Minnesota?

How much chloride do they release into the environment every year?
Statewide chloride budget

1. Estimate chloride loading from major sources
2. Do a mass balance for WWTPs with monitoring data
3. Use results to estimate for all WWTPs and septic systems
Estimated annual statewide chloride contributions from:

- Wastewater treatment plants
- Industries
- KCl fertilizer (potash)
- Deicing salt
- Atmospheric deposition
- Dust suppressant use
- Livestock excreta
- Residential septic systems
Data used in the analysis included:

• Previous research estimates on chloride loading from livestock excreta
• Monitoring data for WWTPs and industries
• Sales records for fertilizer and road salt
• MPCA survey data on septic systems
• Spatial atmospheric deposition data
• Survey data on dust suppressant use
Road salt was found to be the largest chloride source in Minnesota, followed by fertilizer and WWTPs.
Fertilizer sales in Minnesota
Fertilizer is a major chloride source statewide, but there is little research on its effects on groundwater and surface water quality.
WWTPs were the third highest source of chloride to the environment in Minnesota.
What are the major chloride sources discharging to WWTPs?
MOST OF MINNESOTA HAS VERY HARD GROUNDWATER
Survey on water softening practices
Estimated chloride discharging to WWTPs from:

- Excreta
- Household products
- Drinking water background & chlorination
- Wastewater chlorination
- Water softening
- Commercial organizations
- Industry
Data used in the analysis included:

• Previous research estimates on chloride loading from household products, excreta, chlorination
• Census population data
• WWTP monitoring
• Industrial monitoring data
• Groundwater pumping data
• Groundwater quality data for drinking water wells
Household and commercial water softeners were the largest contributors of chloride to WWTPs statewide.
Industry was the second largest source of chloride to WWTPs statewide.
Household water softeners contribute 132,500 t of chloride to the environment every year, and commercial softeners add 62,500 t.

Nearly all of this chloride is in areas with hard or very hard water.
Timer-based water softeners are estimated to contribute over 40% of the chloride from softening.
Increasing efficiency of salt use can have meaningful benefits for groundwater and surface water quality.
Future research can characterize chloride loading from different commercial and industrial sources.
Septic systems, livestock, dust suppressant, and permitted industries were lesser sources statewide, but may be important to water quality at the local scale.
The relative importance of chloride sources depends on characteristics of the watershed or sewershed.
The relative importance of chloride sources depends on characteristics of the watershed or sewershed. Local chloride issues will need local solutions.
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More information and resources at
www.wrc.umn.edu/watersoftening
Thank you! Questions?

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