Minnesota Pollution Control Agency

Twin Cities Metropolitan Area Chloride Monitoring

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Monitoring purpose and goals

As part of the Minnesota Pollution Control Agency's (MPCA) Twin Cities Metropolitan Area (TCMA) Chloride Management Plan project, the MPCA and several local partners are collaboratively sampling 74 lakes, 27 streams, and 8 storm sewers for chloride and related parameters. This monitoring effort has three objectives: to assist the MPCA in developing new monitoring guidance specifically for chloride; to improve the chloride database for the TCMA; and to inform the TCMA Chloride Management Plan. This study will help us to better manage TCMA water resources with respect to chloride while balancing our need for road safety.

Project partners

Monitoring Sub-Group for the TCMA Chloride project

As part of the TCMA Chloride project, several partners have been collaborating to collect chloride and related parameters throughout the 7-county metro area. This group has also assisted in developing the draft Chloride Monitoring Guidance documents which serves as the Monitoring Plan and QAPP for the project; and this group is an advisory team for the data collection and analysis component of the TCMA Chloride project.

US Geological Survey

Metropolitan Council Environmental Services

Minnesota Department of Natural Resources

Capitol Region Watershed District

Ramsey-Washington Metro Watershed District

Rice Creek Watershed District

Minnehaha Creek Watershed District

Minneapolis Park & Recreation Board

Ramsey County

Mississippi Watershed Management Organization

Three Rivers Park District

City of Prior Lake

Figure 1 **Map of lakes part of the TCMA Chloride project**

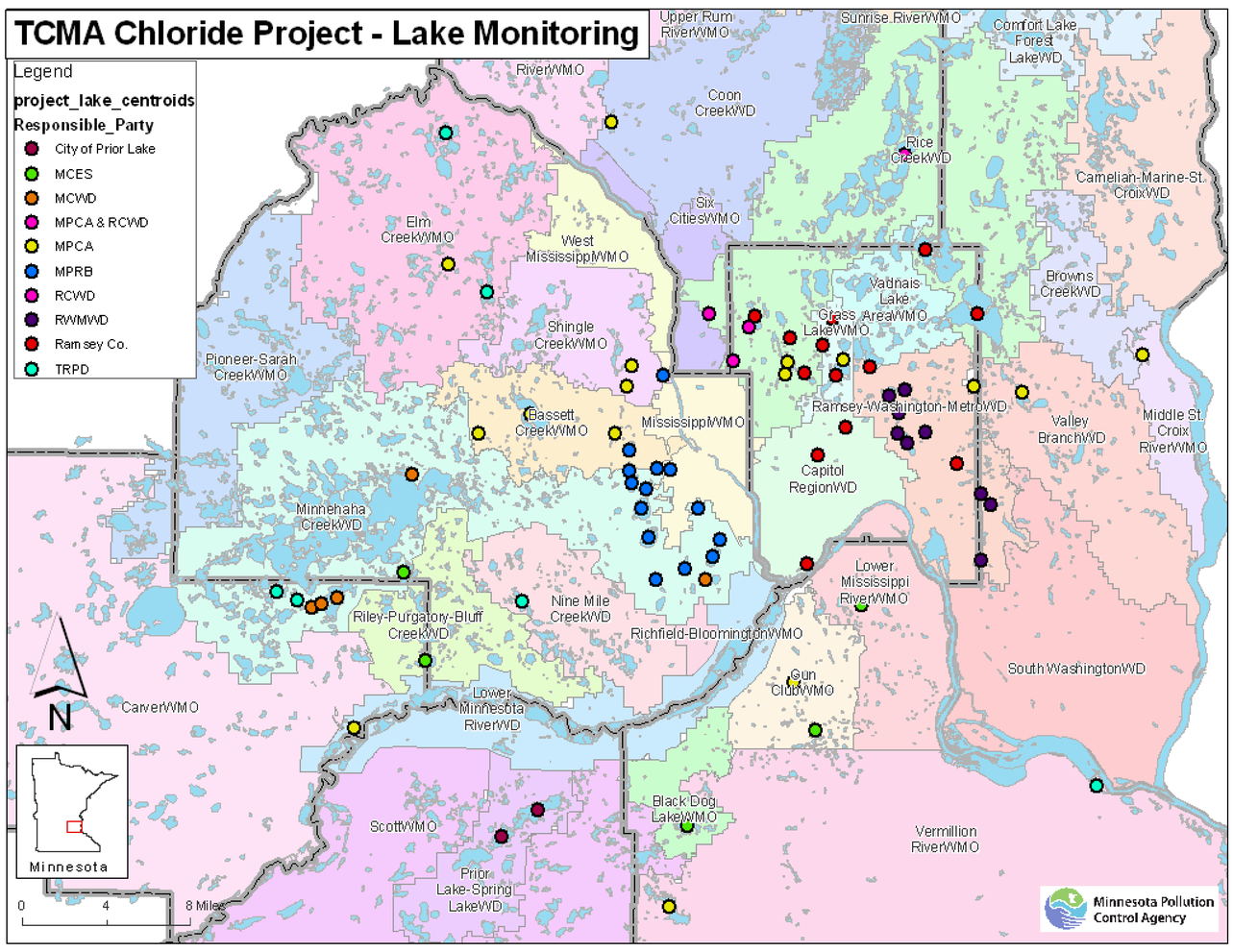


Figure 2 **All available Lake Chloride data**

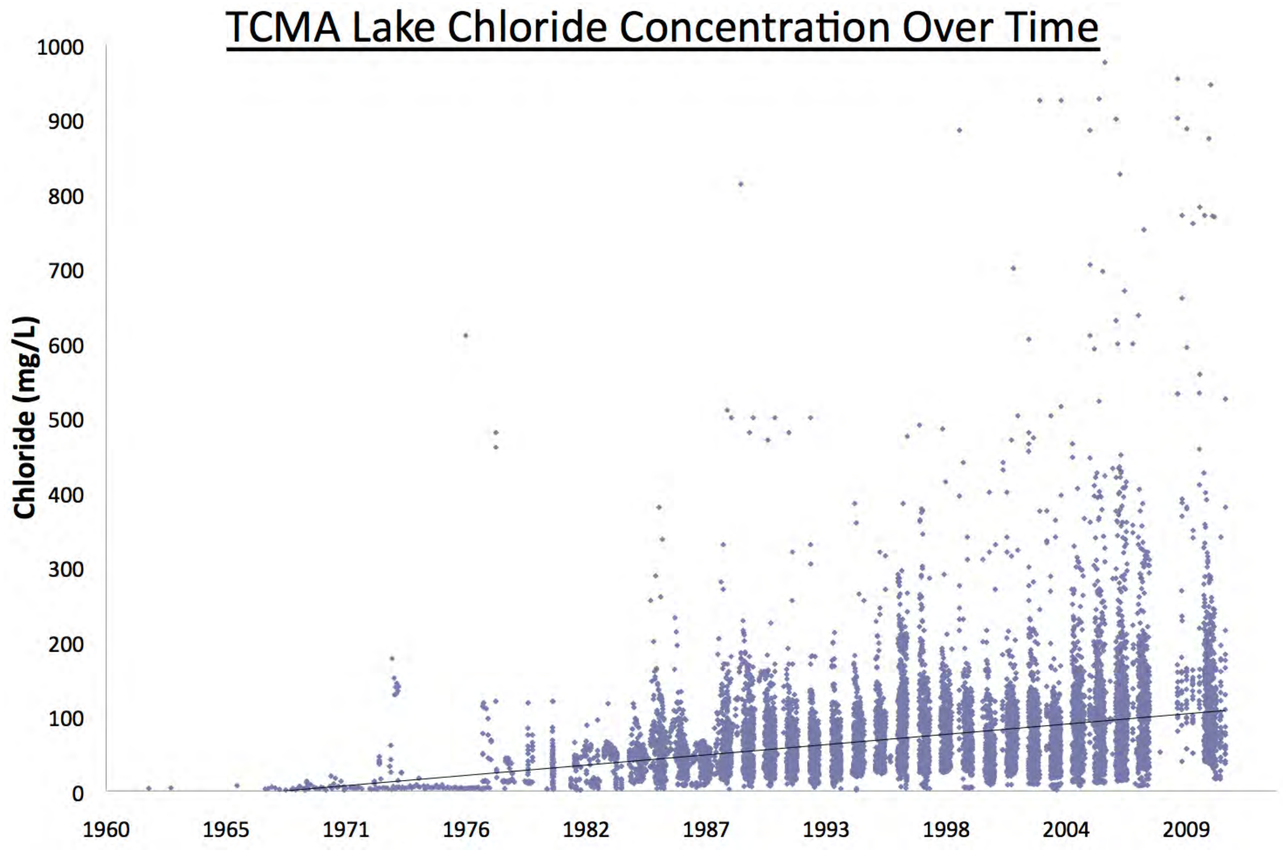


Figure 3 – Chloride lake sampling in the winter.

Lakes monitoring

Seventy four lakes throughout the TCMA were selected to be monitored for chloride (Figure 1) based on several criteria including:

1. Road density of the watershed
2. Existing available data near or above the State's water quality standard
3. The calculated Osgood Index (depth to surface area ratio) of the lake.

The monitoring procedure being followed includes collecting chloride samples at the surface and near the bottom of the lake along with a conductivity profile. Sample collection is being targeted at 5 time periods: Winter – January through February (sampling window to be determined by ice conditions), Early Spring – Mid March to Mid April (target sample event as close to after ice out as possible), Late Spring – 3 weeks after ice out (early May), Summer – July through August, and Fall – Mid October through Mid November.

Figure 2 – **Graph of all available Lake Chloride data:** Shows an increasing trend in both chloride concentration and sampling activity over time. Data set includes both surface and near-bottom samples.

Minneapolis Park & Recreation Board chloride data analysis for lakes

The Minneapolis Park and Recreation Board (MPRB) has been monitoring surface water for chloride since 1994. In 2001MPRB began collecting chloride samples from the bottom of each lake in the winter regime and then expanded the lake bottom sampling again in 2006 to every time a surface chloride sample was collected. Sampling was conducted at most lakes one time in winter, once in April and October, and twice per month from May through September. As a part of a project funded by MnDOT, the MPRB sampled chloride in Diamond Lake every 2 weeks beginning in April and ending in November from 2004 through 2008. Both because of anticipation for the TCMA chloride study and also because of the high variability in the data collected during the Diamond Lake –MnDOT project, MPRB began sampling chloride concentrations monthly beginning in 2010.

As shown at right in Figures 4-8, chloride concentrations were typically highest in the April and May samples. In Diamond Lake, chloride at that time crossed above the chronic standard of 230 mg/L every year. If the normal sampling schedule had been applied to Diamond Lake in 2006 and 2007, many of the exceedances would not have been documented. This situation led partly to the increased 2010 MPRB chloride sampling regime.

Figure 4 - Diamond Lake: In the 1990s samples were collected in May, August, and October. From 2004-2008 and 2010-2011 samples were collected twice per month. Peaks on the graph above are mainly April or May samples. The highest chloride occurred on June 26, 2006. It is possible that land-disturbing activity from the 35W project within the watershed exposed chloride laden soils that contributed to the 2006 peak. Diamond Lake is very shallow, less than 1m during low water.

Figure 5 - Brownie Lake: Brownie Lake is meromictic, and as expected, the bottom water contains significantly higher chloride concentrations than water at the surface. The sampling frequency of Brownie has changed over the years. In 2010, chloride was sampled at the surface and 12 m monthly from April –October.

Figure 6 - Powderhorn Lake: Except for the February samples 2010 and 2011, data from the top and bottom of Powderhorn Lake track together. Past deep water sampling may have been catching times when the lake was stratified and/or times when the summer or winter aerator was not functioning, as most of the samples were from April and February.

Figure 7 - Wirth Lake: Surface sampling: Like several of the other large Minneapolis Lakes, Wirth shows a rise in surface water chlorides beginning in approximately 2007. Bottom waters: 2010 and particularly 2011 bottom water chlorides were significantly higher than in earlier sampling. Land-disturbing activity adjacent to the lake may be allowing chlorides in the soil to be released. Although the 2011 North Minneapolis tornado impacted the lake and caused Bassett Creek to back up into the lake, the 2nd highest 2011 chloride bottom water samples were prior to the 5/22 tornado. Iron-rich groundwater influences Wirth Lake. Bottom water samples are often blackish and sulfur-smelling. Is Wirth developing a chemoclime or is something else going on?

Figure 8 - Wirth Lake: Without deep water sampling, the picture at Wirth Lake would be incomplete. See again Figure 7.

Figure 4

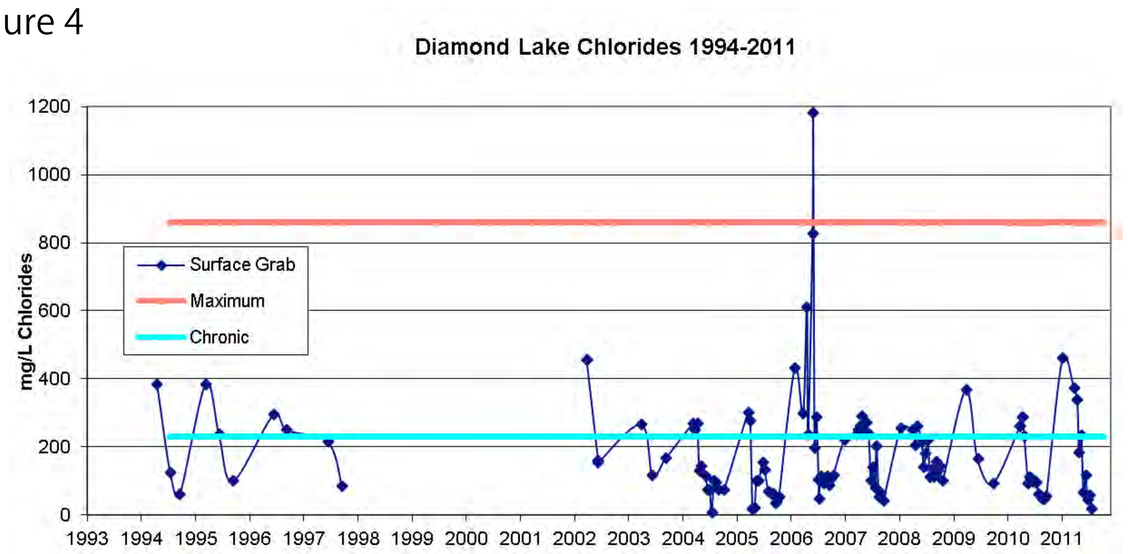


Figure 5

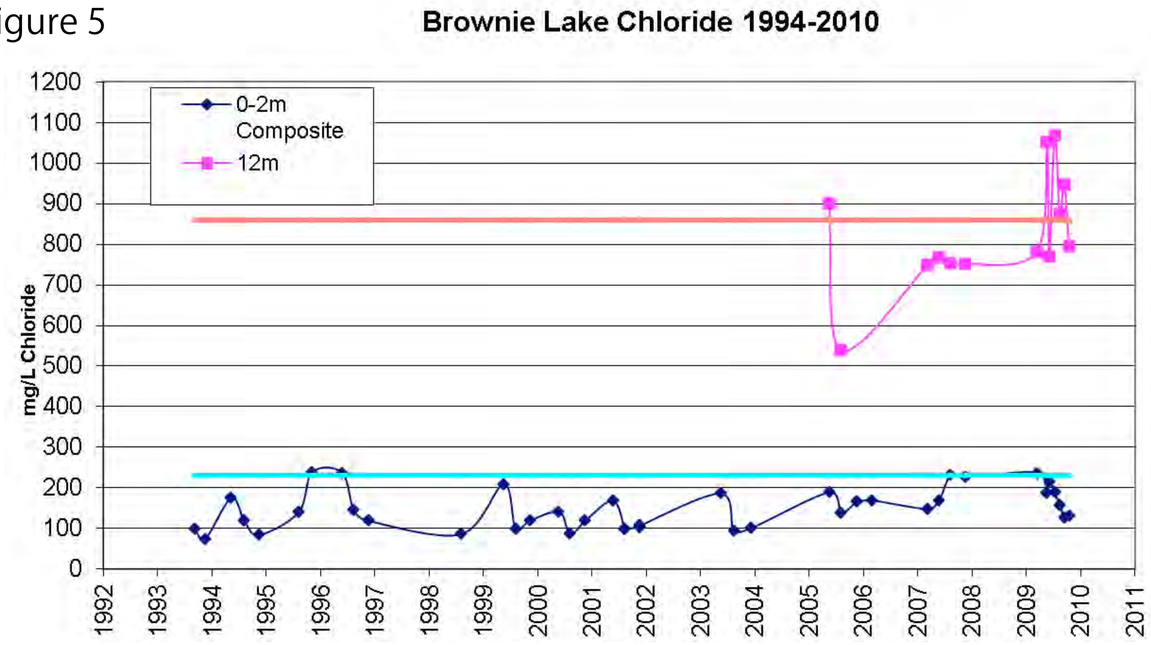


Figure 6

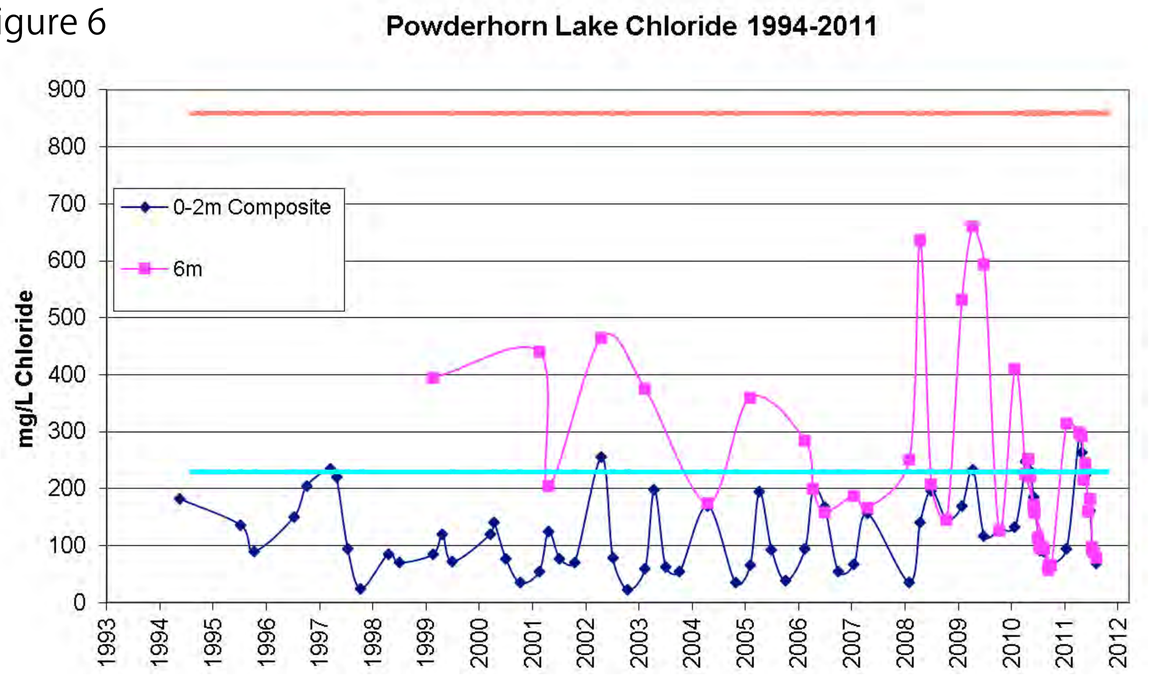


Figure 7

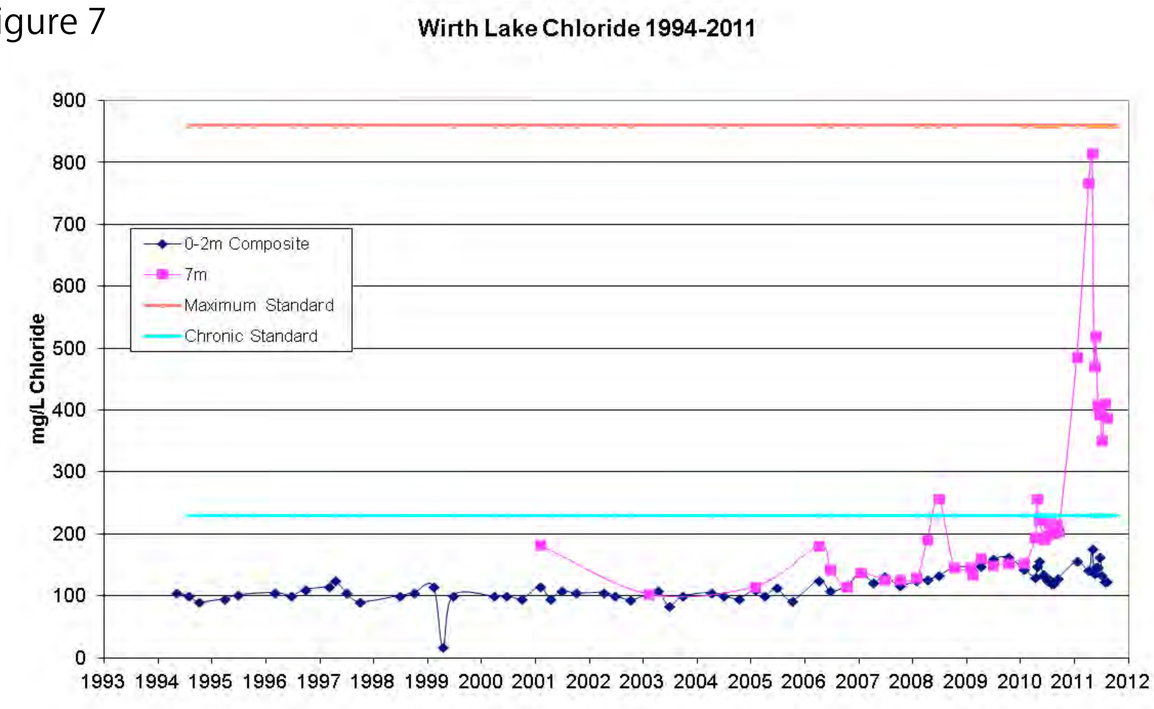
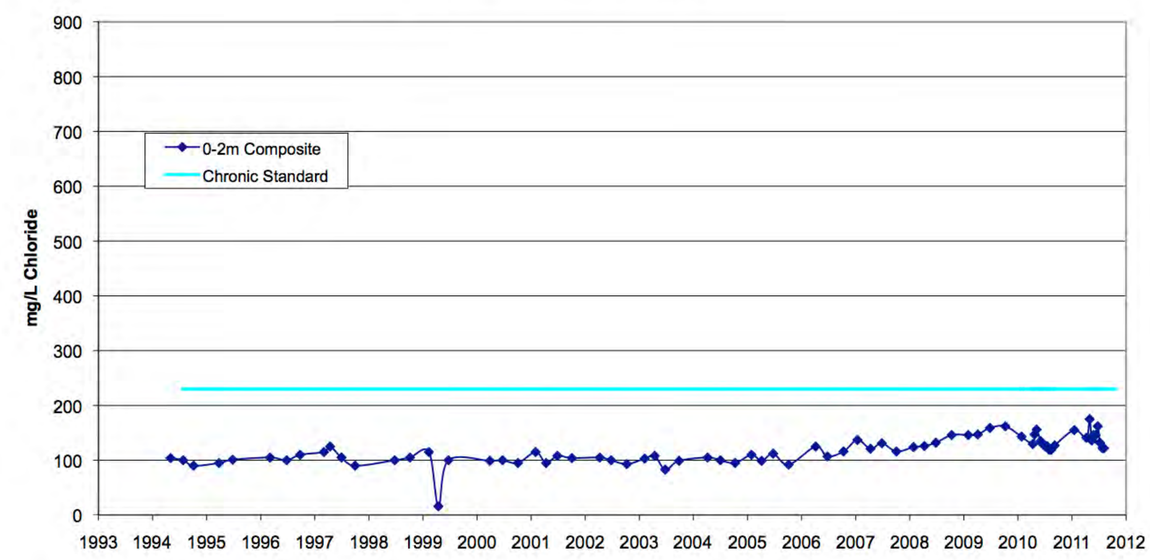


Figure 8



Stream and storm sewer monitoring

The streams and storm sewer monitoring component of this project rely on existing water quality stations. The stream locations are operated by MCES, USGS and 1 new MPCA site. The storm sewer locations are operated by the Capitol Region Watershed District and the Mississippi Watershed Management Organization. Through the TCMA Chloride project we are targeting the winter months and including conductivity where needed.

The MCES stream locations include: Bassett Creek at Irving Ave, Battle Creek below Hwy-61, Beltline Interceptor above Warner Rd, Bevens Creek (Lower) at Co Rd 40, Bevens Creek (Upper) at Maplewood Rd, Bluff Creek Inlet to Rice Lake, Browns Creek at Dellwood Rd, Cannon River near Welch, Carver Creek at Co Rd 40, Credit River near 126th St in Savage, Crow River at Rockford, Crow River South Fork near Mayer, Eagle Creek above 126th Street, Fish Creek above Hwy-61, Minnehaha Creek at 32nd Ave, Nine Mile Creek below 106th St, Riley Creek Creek Inlet to Grass Lake, Rum River at Anoka Dam, Sand Creek upstream of Louisville Swamp, Silver Creek at Hwy 95, Valley Creek at Putnam Blvd, Vermillion River below Hwy-61. There are 3 USGS stream sites: Elm, Rice and Shingle Creek. The MPCA site is on Ravens Creek. And local partners are collecting chloride date from Kohlman and Gervias Creeks and Elm Creek at Hamel. The storm sewer monitoring stations are located in the Capitol Region Watershed District (3) and the Mississippi WMO (4).

Streams

The primary goal for the current winter chloride stream monitoring effort is to collect grab samples at existing flow stations during winter thaw and rain events, as well as track baseflow conditions through regular chloride monitoring.

Figure 9 – Elm Creek at Hamel: During summer base flow conditions, chloride concentrations are very high in Elm Creek. Groundwater is the primary contributor of base flow; so it appears that the groundwater feeding Elm Creek has acquired very high chloride concentrations, which substantially impacts the stream. Additional sampling upstream and downstream from this location shows that concentrations are elevated at this particular sample location. The chloride concentrations become diluted during precipitation events.

Figure 10 – Eagle Creek: Chloride concentrations are usually below the chronic chloride water quality standard; however the base flow conditions for this stream are increasing over time, indicating that chloride is infiltrating into the groundwater.

Capitol Region Watershed District storm sewer data

Captital Region Watershed District (CRWD) covers 40 square miles and includes portions of the cities of Falcon Heights, Lauderdale, Maplewood, Roseville and St. Paul and is completely urbanized, with 42% coverage by impervious surfaces, and is drained almost solely by underground storm sewers. In 2009, CRWD began collecting continuous real-time flow data at five of its sites through the winter months. Real-time conductivity data was collected at three of these sites. Winter baseflow samples are collected monthly and analyzed for nutrients, solids, chloride, and metals. Snowmelt samples are also collected.

Underground storm sewers that have continuous baseflow through winter remain mostly unfrozen, making it feasible to house standalone flow modules. Air temperatures within storm tunnels are generally warm enough to keep equipment within operating temperature range. Sources of baseflow in storm sewers include upstream lakes and wetlands, groundwater, and permitted discharges.

CRWD began collecting continuous real-time flow data in 2009 at five of its sites through the winter months. These loggers recorded water depth (level) and velocity. In 2010, CRWD partnered with the MPCA to add 3 loggers to also record continuous conductivity and temperature data. Specific conductivity values for the three sites ranged from 0.2 to 4.2 mS/cm. Water temperature values for the three sites ranged from 0 to 19.7 degrees Celsius from December to April.

Figure 13 – Storm Sewer Chloride Concentrations: CRWD Trout Brook monitoring location.

Project website

Please visit the project website for more information about the monitoring effort and the overall TCMA Management Plan project:

www.pca.state.mn.us/oxpg9f1

Contact information

For more information contact:

Brooke Asleson, MPCA 651-757-2205

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Figure 9

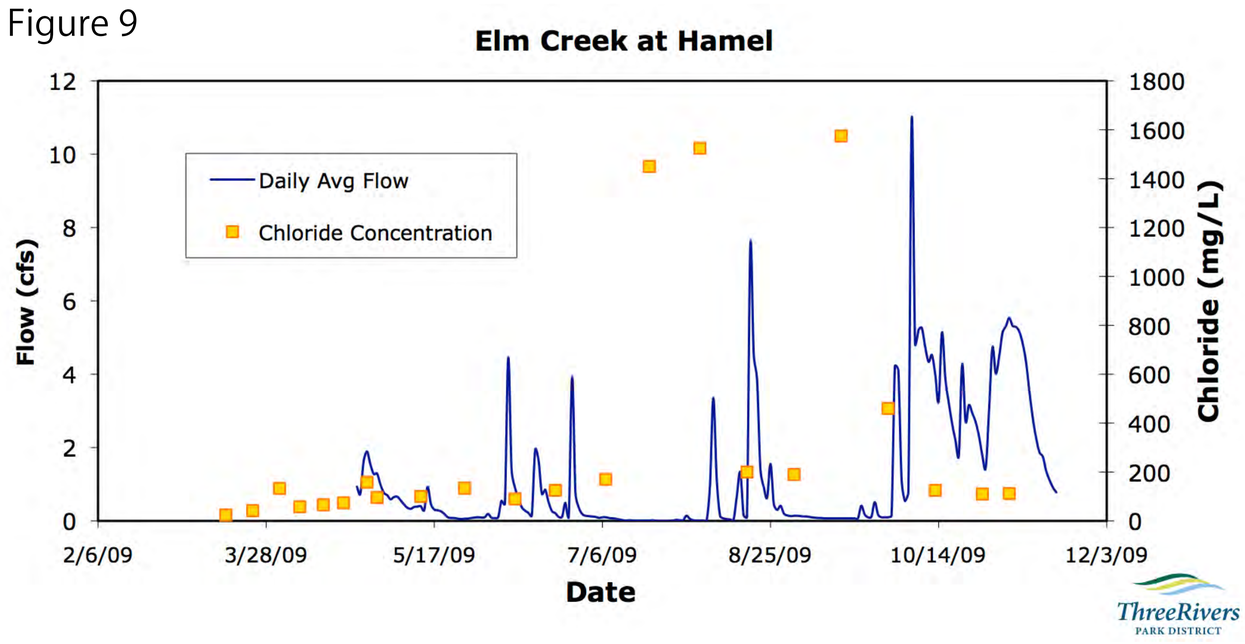

Figure 10

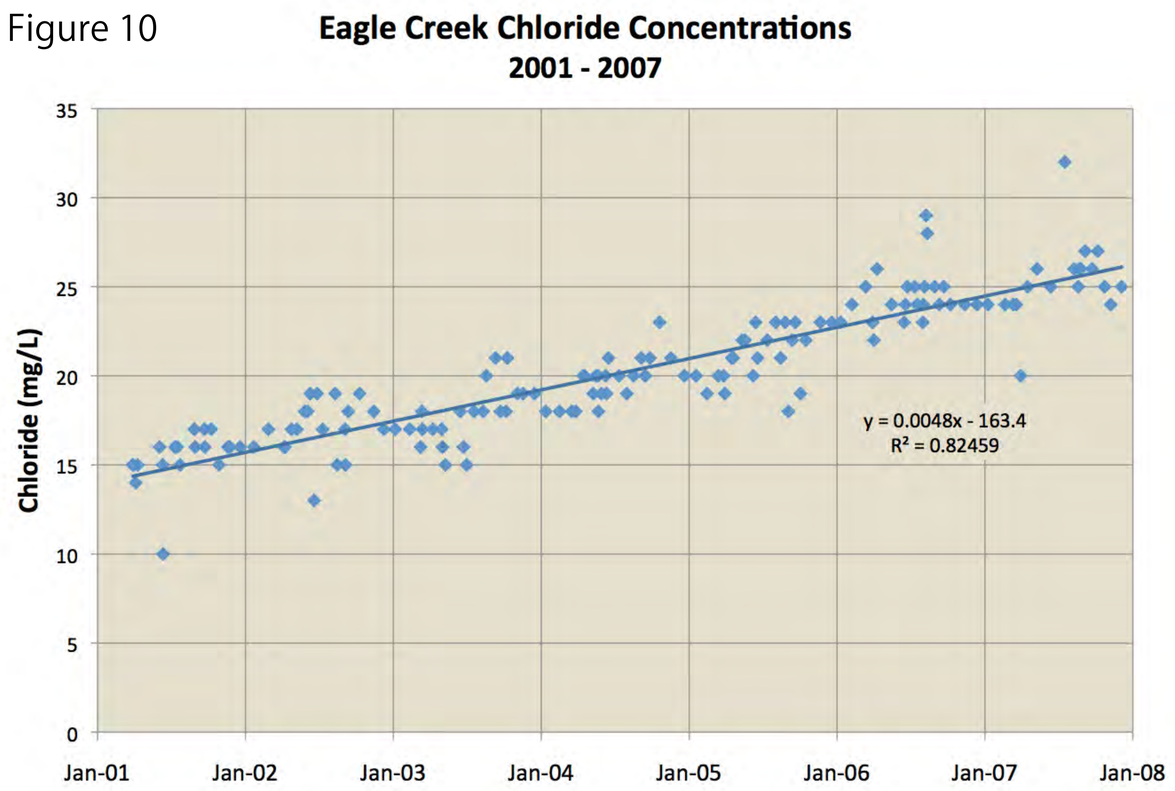

Figure 11 – Photo of entrance to CRWD's East Kittsondale site: Confined space entry procedures are followed when sampling stormwater.

Figure 12– Photo of Phalen Creek site: In some cases groundwater discharges directly from the storm sewer walls and freezes. Effort must be made to prevent cables from being lodged in ice and becoming completely frozen.

Figure 13