Communities Addressing Chloride Case Study: Morris Minnesota


Morris treatment ponds drain into the Pomme de Terre River

The problem:
High chloride levels in wastewater discharged into the Pomme de Terre River

The solution:
Centralized lime softening water treatment plant in combination with city ordinance to restrict individual water softener use

Main implementation challenge:
Lack of funding

Minnesota municipalities are wrestling with high chloride levels in their wastewater. Chloride is one of the components of salt, which is used in forms such as sodium chloride (table salt), calcium chloride and magnesium chloride (road salts). Sodium chloride is commonly used in home water softeners and by water treatment plants to treat "hard" water. Minnesota generally has groundwater with high levels of calcium and magnesium that must be removed through softening in order to improve taste and prevent lime scale buildup in appliances, pipes and water fixtures. The majority of home water softeners use sodium chloride (NaCl) in a softening process than replaces calcium and magnesium ions with sodium, while the chloride ions are discharged in the wastewater and eventually end up in the environment.

High chloride use can lead to environmental issues. Chloride released into local lakes and streams does not break down, and instead accumulates in the environment, potentially reaching levels that are toxic to aquatic wildlife and plants. Because salt water is more dense than fresh water, it settles at the bottom of lakes preventing the natural mixing of oxygen and nutrients and in effect creating a "dead zone."

The Minnesota Pollution Control Agency (MPCA) has authority to require discharges to comply with water quality standards using the Clean Water Act and National Pollutant Discharge Elimination System (NPDES) permits. This ensures the protection of aquatic plants, invertebrates and fish. Compliance schedules and variances can be used to assist in meeting permit requirements. Both permitting tools allow time to comply with the permit; however, the variance process considers economic factors that allow more flexible timelines, and offers the potential for renewal of a variance if the permit goal remains unachievable. The variance process may take longer than a compliance schedule and requires approval by the Environmental Protection Agency (EPA). Each community needs to determine which tool is appropriate for their situation.

Morris background:

The City of Morris discharges wastewater into the Pomme de Terre River under a permit regulated by the MPCA. The permit requires the city to comply with chloride effluent limits bby December 31, 2020. Morris' sewage treatment ponds discharge directly into the river and consistently have chloride levels near 800 mg/L. Minnesota Rule 7050.0222 Subp. 2 sets water quality standards for lakes and streams at 230 mg/L, and at 400 mg/L for larger flowing rivers. The City of Morris must find a way to reduce its chloride levels by half.

City Demographics

Total Population	Number of Households	Persons per household	Median Household Income
5,418	1,998	2.21	$51,292

Morris is located in Stevens County and has 5,418 residents who receive their water from the Morris Water Treatment Plant. This water is obtained through five wells approximately 60-80 feet deep that draw from the Quaternary-age Water Table aquifer. This aquifer is located between layers of limestone bedrock that deposit minerals in the groundwater resulting in a water hardness level of 40-45 grains that remains unchanged as the water is distributed to individual households. Morris residents and businesses use approximately 700,000 gallons of water per day.

Treatment ponds near the Pomme de Terre River

To deal with such hard water, the Morris Sun Tribune reports that more than 90% of the 1,972 of the households in Morris use a water softener. The recommended water hardness level for taste and to prevent the buildup of lime on pipes and home appliances is less than 5 grains, though many homeowners prefer levels closer to 0 grains. Individual home water softeners are the most substantial contributors of chloride in Morris though some industries release wastewater with brine byproducts that contain chloride as well.

Solutions

Some communities have been successful in meeting chloride standards through local ordinances that require residents to upgrade to high-efficiency water softeners and use on-demand settings rather than a set amount of salt use, a change that can reduce salt use by up to 80%. The Center for Small Towns constructed a model for Morris that examined a number of scenarios to determine if high-efficiency water softeners alone would be enough to meet the chloride standard. They determined that Morris residents would need to reduce their salt use by 72% and their water use by a third in order to bring household wastewater discharged to the sewage treatment ponds within the MPCA's chloride standard. When factoring in commercial and industrial sources, reducing salt and water use alone is not a realistic solution and would not result in outcomes that meet the MPCA's 2020 standard.

The DENCO II ethanol plant discharges chloride into the Pomme de Terre River and is also required to meet wastewater discharge chloride levels by 2020, at which time they would be required to buy softened water. If Morris were to build a new water treatment plant, the capacity would need to increase beyond current operations in order to meet this increased demand.

Reverse osmosis systems are extremely effective at treating hard water as well as iron, manganese, sulfates, and total dissolved solids. Reverse osmosis systems are sold in individual cells that can be easily replaced, removed, or added on to depending on the changing needs of a community. Another benefit of these systems is that they are much easier to maintain and require less personnel and maintenance than more traditional systems.

Some of the major disadvantages of a reverse osmosis system are the up-front expense, and that water is used less efficiently. Approximately 25% of water passing through the system is discharged as contaminated wastewater, which also must meet MPCA discharge standards. In some communities specific factors or circumstances could make reverse osmosis the best alternative. The Morris City Council considered the technology, but ultimately decided it is cost prohibitive and would create the new problem of high chloride concentrations in discharged plant wastewater.
Lime or soda ash softening is a common method of water treatment used by Minnesota municipalities to reduce total dissolved solids, and remove iron and other contaminants. Through lime softening the water hardness level is greatly reduced, but usually not to zero. Residents might continue to use home water softeners, but would only need a fraction of the salt. A disadvantage of lime softening is the plant maintenance cost, however the solid waste byproduct can be used in agricultural settings as a liming agent, an advantage over reverse osmosis.

Project Description

In 2013, the Morris City Council began to look at options to address its chloride problem. The University of Minnesota Morris worked with the Center for Small Towns to complete a chloride discharge assessment to determine the scope of the problem and find possible solutions. Morris needed to hire an engineering firm to look into the feasibility of each alternative and propose a design for a new water treatment plant. Morris was eligible for a $7 million grant through Minnesota Public Facilities Authority's (PFA) Point Source Implementation Grant Program (PSIG), and the City Manager, Blaine Hill, hoped that they could also take advantage of a low interest loan program through the Minnesota Department of Health's Drinking Water Revolving Fund. In order to be eligible for the loan, the city needed to spend $725,000 to hire a team of engineers to create a design for the new treatment plant. Morris was able to produce the funds and hire Bolton & Menk to complete the design. Engineer Kris Swanson led a team who determined that lime softening was the best and most cost-effective option to address Morris' chloride levels. Bolton & Menk developed a design for a new estimated $14 million lime softening water treatment plant and presented this to the city council. Mr. Hill, along with other community leaders, attended listening sessions throughout the state and lobbied at the capitol for other sources of funding.

Concept drawing of the proposed plant by Bolton and Menk

Conclusion
Without increased funding, the construction of the plant is on hold. The residents of Morris currently pay an average of $26 per month for water, and the city council does not want to raise average rates beyond $53 per month. Though an increase of 192% might seem extreme, Mr. Hill says that the savings in salt used for water softening every month can help offset the water rate increase. If the project were to proceed at current funding levels, the cost of water would rise even further.

Moving forward, Mr. Hill continues to lobby the state legislature for water infrastructure spending and is optimistic. Morris has opened the project and is receiving new bids. With current project funding, the average water bill for residents would be $40 per month, an affordable amount for a community with a median family income of $42,000 per year according to the city council.

Once built, the new water treatment plant will reduce the water hardness level to between 5 and 7 grains. Some residents may decide to stop softening their water, however Morris plans to issue a city ordinance requiring all residents to switch to on-demand, high efficiency water softeners to further reduce salt use. The savings in wear and tear on appliances, water usage, and decreased spending on salt will help to offset the cost of switching to an on-demand system. For example, Mr. Hill states that when he upgraded his own home water softener, he went from using three bags of salt a month to three bags of salt every three to four months.

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