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Bingham County
Planning & Zoning Department
Parcel#RP030301 & RP0304400

January 14, 2025

In regards to the request of changing the R/A Zone to A and the use of a Conditional Use Permit, I strongly oppose. Why? 1)The Comprehensive Plan and the Criteria of the ordinance states "the purpose of this plan is to promote the **orderly development** of the county to **conserve** and **stabilize** the **value of property** and otherwise promote the **health, safety** and **general welfare of the people** living in Bingham County." 2) I consider that the zone change and the conditional use permit, if not opposed to, will put all residents into a very vulnerable state of health when an encroaching cancer, like gravel pits, raises their heads. Gravel pits are like a disease in which their abnormal cells, or the processes they use to mine for gravel, starts to destroy property, water, air and other environmental issues. We find more and more encroaching cancers invading Bingham County and the properties of its residents. According to the Department of Lands, Bingham County has 45 active gravel pits, plus two pending. The product of this cancer has left Bingham County with 23 reclaimed or not able to be usable for farm land or used for home building. "Most of the reclaimed gravel pits do not meet what I think what standards of 'Agricultural Land' should be after the cessation of the mining usage is done. It's not farmable,habitable and is a threat to the underground water. Please tell me what agricultural uses can be performed after the mining is done. Who is going to regulate these abandoned pits? It is a waste of good land. Bingham County is like a checkerboard of gravel pits. Mining this natural resource is supporting the term "urbanization" , which means financial gain for SLT Properties. SLT Properties states "having natural resources closer to urban areas like Blackfoot will allow lower pricing on materials as well as reduction in the emissions produced in transit." To me there is no concern for residents involved with this gravel pit and how it will affect them. Also, it is telling us the citizens that there are "emissions" being produced and placed in the atmosphere. Are these emissions healthy for the atmosphere and us? Is there a concern about the loss of land in our state? Bryan Searle, President Of the Idaho Farm Bureau Federation states the "pressure from developments and growth in the State is driving prices up causing a shift in what's happening to working lands in feeding animals or food production". He continues to say, "the total loss of land for farming is very troubling" The majority of gravel pits are unusable for agricultural uses. Gravel and sand are a non-renewable natural resource. The reclaimed gravel pits are wasteful use of land, and it is not brought back to agricultural form or usage.

Another victim of this cancer is our **water.** My well is 3 feet from our property line with Searle's property line. This precious natural resource, the water in my well or beneath us is very, very needed and important to us. We need to be diligent in protecting it and keeping the aquifer healthy. According to the permit when they start digging and drilling they will go at this time to 21 feet above the shallow groundwater or aquifer. So the base of the pit will be looming 21 feet above the aquifer. This really concerns me. Usage of water in the pit will be during the screening and washing the crushed gravel, preventing dust that is produced as the processing equipment and roads. The pit floor is highly permeable and when water is applied it will infiltrate into the ground and subsequently the water below. Pollutants or pollutant constituents in the gravel pit will be contained through active and passive measures. If there is a spill or release, which is inevitable, they do have 24 hours to clean it up or report it, but common sense tells me it's already too late to stop the seepage in the floor to aquifer. Even when cleaning it up there is seepage. Just think about 25 gallons of petroleum released. We, as residents, will never know of this type of accident which will go on for years. Is there a good chance of the water being contaminated? I think so.

Exhibit
T-2

Another example of gravel pit contamination is a chemical used by gravel pits a lot. Knife River informed us that they will be using Mag Chloride twice a year to help control the dust. Although chloride is used as a nutrient to plants, the amount chloride used to control the dust is much higher and is more harmful than the magnesium. All chloride based chemicals that leach into the soil have detrimental properties to the usability of the ground after and the long term effects of the water. "Any long-term accumulation of chloride can result in reduced soil permeability and fertility. [...] As a result, there could be negative effects on the chemical properties of the soil and its ability to retain water, both of which are important to plant growth." In addition, "Since chloride does not bind to soils, chlorides that enter the subsurface with infiltrating water may reach the groundwater table. [...] Chloride entering groundwater systems is likely to persist for a long time since there is no significant removal mechanism and groundwater moves slowly." Since Knife River will be using this 2 times a year over the next 20 years. The concentration level of the magnesium chloride "makes water unsafe to drink and keeps plants from effectively absorbing water and nutrients. [...] Their roots absorb magnesium chloride from the soil and take it through their water-conducting systems. It then builds up in their leaves, weakening or killing them."

Another casualty of this encroaching cancer is our air. They can't completely stop emissions of hot mix plants, cement plants, spills, dust, and processed gravel, etc entering the atmosphere. It can affect allergies, coughing, headaches, etc. An example of what can be in the air. During the time I worked there, Bingham County courthouse had the air ducts tested because of all the illness and headaches, allergies and coughing that took place and was complained about by the employees. The test found dust with a large amount of potato spores in it. Unbelievable right? Ducts were cleaned and complaints stopped. The gravel pits, dust and chemicals released can add to the air pollution as well as infiltrate our ducts and air systems.
The noise from the pit and congestion of traffic will be a very uncomfortable and difficult nuisance to our peaceful time at home, and at family functions at our home. No berms or planted trees or 150' buffer will not completely block the smells, noise of the asphalt and cement mix plants, the crushing of rock, but it will block the view we have from our home. It will become a cancer to our quality of life that we have worked for, invested in with sweat and hard work. I am really concerned about how that buffer of 150 feet will not protect my precious resource, water.

The final victim of this cancer is my property value. We have talked to real estate agents and they informed us that our lifetime investment, our home will drop 30 to 35% in price. So, I ask myself. If my property value dropped, why not my taxes? If my water is contaminated, who is going to help pay for the different options of finding good water for my home? Water Districts, City of Blackfoot, or digging a deeper well and hopefully it will work? Water is too valuable and expensive to leave in the hands of industry!!

Zone change can be denied due to the unlikelihood of proper rehabilitation, lack of long term accountability, and stewardship and the growing demand on our groundwater. How can I protect my property rights, values and quality of life? I need to appeal to you, the County, and its plan that was developed for residents and the governing body. As a long time resident of this county, I hope you will look out for us and protect us and our investments. Please deny the zone request and the usage of the conditional use permit. There are a couple of resources that are irreplaceable - land and water. It's our duty to be watch dogs over those resources because they provide us with food and life not only for ourselves, but for our dear children.

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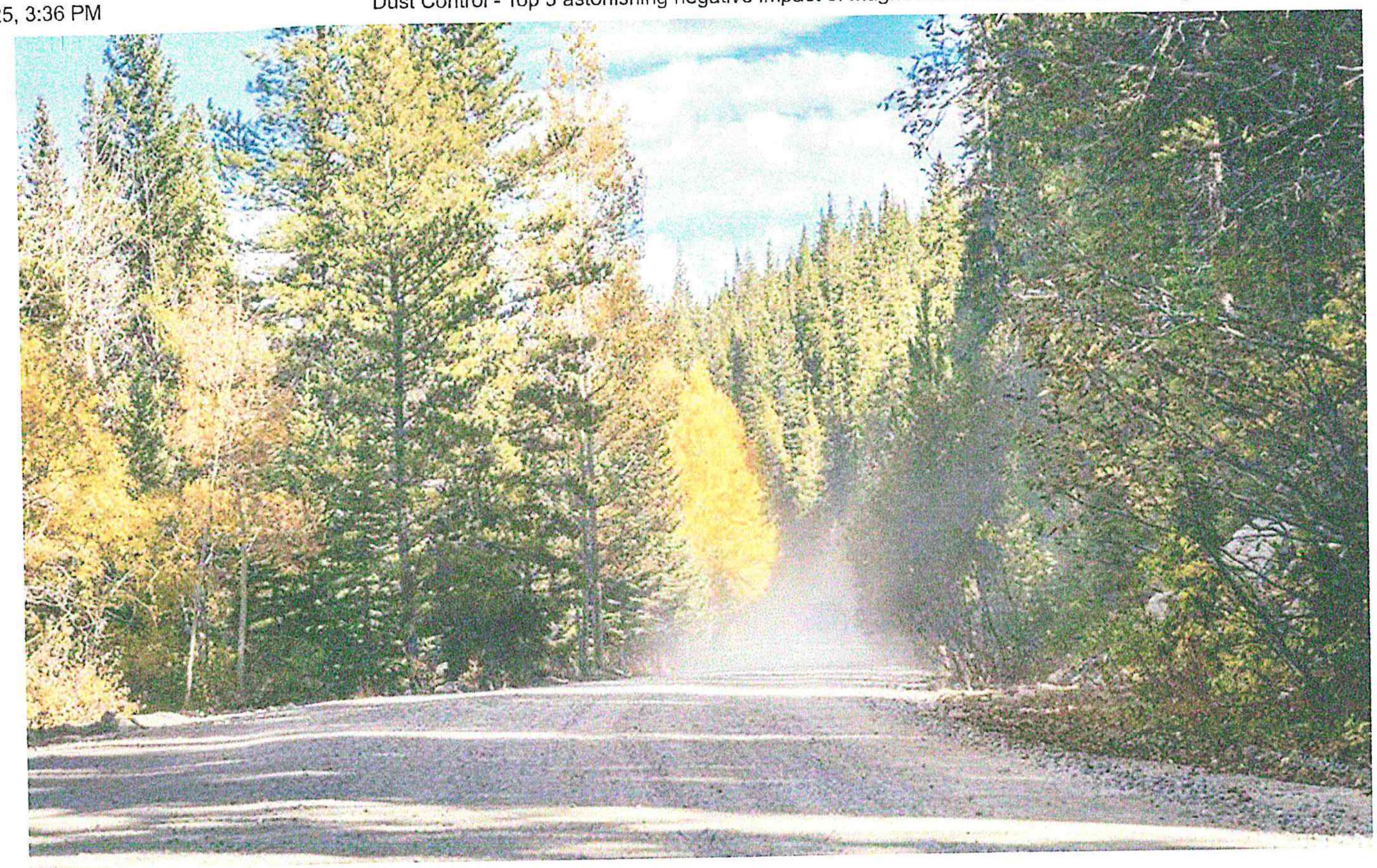
WHY USE MAG-CHLORIDE FOR DUST CONTROL IF YOU CARE ABOUT THE ENVIRONMENT?

April 7, 2022 News, Press Release

DUST CONTROL – A DISCUSSION OF THE NEGATIVE IMPACT OF MAGNESIUM-CHORIDE ON ROADSIDE VEGETATION



Have you ever traveled down a Colorado mountain road and noticed along the roadsides there seems to be a considerable amount of trees that look sick and dying? If so, you may be seeing vegetation being adversely affected by magnesium chloride.

COMMONLY USED AS DUST SUPPRESSANT AND DEICING / ANTI ICING

Magnesium chloride is commonly used as a dust suppressant agent on unpaved roads in the western parts of the United States during the spring and summer. Likewise, magnesium chloride is used extensively for deicing/anti-icing on paved roads during the winter.

Magnesium chloride is often used as a dust control (https://www.truegridpaver.com/road-dust-control/) agent since it is hygroscopic and deliquescent — it has the ability to absorb moisture from the humid air. This absorbed moisture helps limit dust by keeping the surface of the road damp enough to hold the dust particles down and reduces blow-off as fugitive dust.

A primary reason why magnesium chloride is used in relatively high quantities in the Western United States is because the source is geographically local. The salty waters of the Great Salt Lake of Utah is a major source of magnesium chloride.

NEGATIVES OUTWAY THE POSITIVES

Although magnesium chloride is considered to be less expensive than other dust control agents, the potential negative impact of using salt may outweigh any positive aspects. There are numerous reasons why using magnesium chloride is less than desirable for dust control on unpaved roads. These include:

- Recognized to be harmful to important road side vegetation
- The unpaved road may become slippery when wet if clays are present
- The unpaved road can become a sloppy mess during spring thaw
- The magnesium chloride washes off readily with rain/snow melt
- Repetitive applications may be required to control dust
- Potential to leech chloride into shallow drinking water wells
- Doesn't work well in low humid conditions
- Magnesium chloride is very corrosive especially if the salt is more concentrated
- Attracts wildlife to roads for the salt and create driving hazards

As stated, there are numerous negatives when using magnesium chloride for dust control however, this discussion will focus on the salts impact on roadside vegetation.

It has long been recognized that another salt product, sodium chloride, when used for deicing purposes has negative impacts on road side vegetation. The effect of salts on roadside soils and vegetation are well documented. Likewise, it has also been found that unpaved roadside vegetation impacted from magnesium and/or calcium chlorides applied for dust control purposes have demonstrated similar symptoms to those as sodium chloride.

USE FOR DUST CONTROL EVEN MORE DAMAGING

Even though magnesium chloride is extensively used for deicing purposes, the potential impacts of the salt on roadside soils and vegetation may be much greater when used as dust control agents.

The major differences are that deicing applications are mainly done during the wintery months on paved roads, while dust control is done during the spring and summer months on unpaved roads. The timing of the dust control applications will impact the roadside vegetation differently since they are actively growing and transpiring. Also the absence of snow melt during the dust control season greatly effects the concentration and dilution of the soil salts when compared to deicers. This reduced dilution help keeps the magnesium chloride from washing far downstream with meltwater but enhances downward leaching into the soil therefore increasing the impacts on nearby vegetation.

Magnesium chloride is a simple compound composed of two essential nutrients both required for plant growth, however too much of either magnesium or chloride can harm a plant. Although chloride is an essential nutrient, only very small amounts are beneficial to plants. The chloride is considered do more harm to vegetation than the magnesium.

When magnesium chloride is used for dust control the pathway for chlorides to vegetation is washing/leeching off a road (mainly downslope) into the soils with rainwater or snow melt. A study done by Colorado State University has documented elevated salt concentrations between 9-foot and 320-feet from roads.

Once the chloride gets into the soil it can be taken up by plant roots. When the chloride gets into a plant, it moves up the water-conducting system and accumulates at the margins of leaves or conifer needles. This is where die-back occurs first. At high chloride concentrations, damaged trees may be evident after two years of treatment.

NOTABLE EFFECTS ON VEGETATION

The notable effects that chloride has on vegetation include leaf scorching, marginal necrosis, and needle tip burn. High concentrations of chlorides in soil can affect plant growth and survival both indirectly and directly. At lower chloride concentrations, a reduction in plant growth may be due to osmotic effects that disrupts normal water and nutrient uptake. At high concentrations, chlorides can accumulate at the margins of transpiring leaves or the tips of needles which can cause foliar necrosis and leaf abscission through dehydration and/or specific metabolic disruptions. These could lead to branch and tree die-back. Usual symptoms appear as browning of the leaves beginning at the tip or margin of the leaf and advancement towards the base. The higher the chloride content the greater length of the leaves are injured. In addition, during dry conditions, water stress and dehydration may aggravate chloride toxicity and cause even more extensive damage. Research has shown that injury can occur when the needle/leaf chloride content reaches 5,000- ppm (dry weight) in conifer trees and 10,000-ppm to deciduous species. This may sound like a lot of

Research has shown that injury can occur when the needle/leaf chloride content reaches 5,000- ppm (dry weight) in conifer trees and 10,000-ppm to deciduous species. This may sound like a lot of chloride but it may not be on a roadside that was treated with magnesium chloride. For example, if you apply ½-gallon of a 30% solution of a magnesium chloride solution, you are applying approximately 1.2-pounds or 544,311 milligrams of chloride per square yard of road. The amount of chloride is staggering when a typical one-time application of magnesium chloride may contribute 11,358 pounds of chloride per mile on a 16' wide road! Obviously roads treated more than once a year will greatly increase the chloride concentration. And since magnesium chloride is highly water soluble, 54,200 milligrams per liter, it is easy to understand why it can leach and run-off a treated road so easily.

ENVIRONMENTALLY FRIENDLY CHOICES AVAILABLE SUCH AS EARTHBIND® 100

While the ease of availability and the lower cost of magnesium chloride maybe attractive, the long-term environmental impact is significant. Products such as Earthbind® 100 for dust control can significantly reduce dust from unpaved roads while being environmentally friendly. Earthbind® once cured, is not water-soluble and stays in the road bed and can improve the road base with each application. Learn more about how you can control dust without killing roadside vegetation with Earthbind® 100. (http://www.globalstabilization.com/earthbind-100/)

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January 24, 2023

Environmental impacts of road salt and other de-icing chemicals

An estimated 365,000 tons of road salt is applied in the Twin Cities Metropolitan Area (TCMA) each year. The chloride in road salt flows into our lakes, streams, and groundwater, potentially harming our environment.

Several different types of deicing chemicals exist. Those covered in this section include chloride-based deicers, acetate-based deicers, and carbohydrates. A list of the chemicals approved for use by the MNDOT can be found here (http://www.dot.state.mn.us/products/snow_ice/index.html). This article summarizes environmental effects of de-icing chemicals. Other effects (e.g. on infrastructure) are discussed elsewhere in this manual (http://stormwater.pca.state.mn.us/index.php/Other_impacts_of_road_salt_use).

Contents

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Chloride-based de-icers

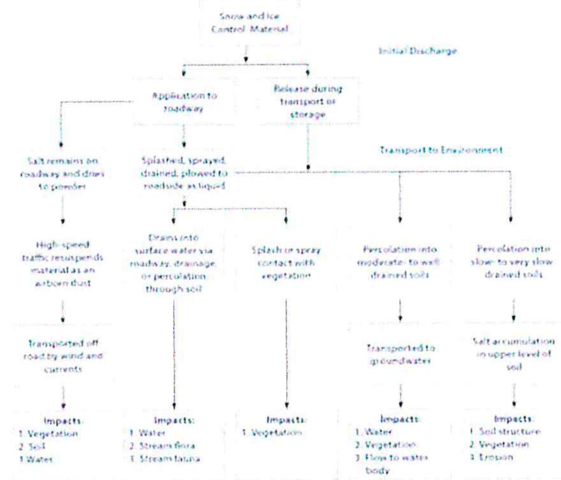
The chloride-based deicers discussed in this section are sodium chloride (NaCl), magnesium chloride ($MgCl_2$), and calcium chloride ($CaCl_2$). Deicers can enter into the environment during storage, transport, and application. The distribution of the deicer is a complex process, an overview of which is provided in the figure to the right. When chloride deicers are dissolved in runoff, the anion and cation dissociate. The following section separately describes the environmental effects of anions (i.e. chloride) and cations (i.e. sodium, calcium, or magnesium).

Chloride

The chloride component of chloride-based deicers does not easily precipitate, is not biodegradable, is not readily involved in biological process, and does not adsorb significantly to mineral/soil surface (Levelton Consultants Ltd., 2008). As such, chloride is highly mobile and can impact the soil, vegetation, groundwater, surface water, and air. Stefan et al. (https://stormwater.pca.state.mn.us/index.php?title=References_for_Smart_Salting_%28S2%29_and_road_salt_winter_maintenance) (2008) found around 30 percent of the salt applied to the roads in the TCMA makes its way to the Mississippi River. This suggests that the remaining 70 percent is either blown away, transported into the ground water, or stays within the soil, lakes, or wetlands.

Soil

Deicers reach the soil via runoff, splashing, spraying, or plowing. In general, chloride concentrations are the greatest within 2 to 3 meters from the road edge (Berthouex and Prior (https://stormwater.pca.state.mn.us/index.php?title=References_for_Smart_Salting_%28S2%29_and_road_salt_winter_maintenance), 1968). Others, such as Norrstrom and Bergstedt (https://stormwater.pca.state.mn.us/index.php?title=References_for_Smart_Salting_%28S2%29_and_road_salt_winter_maintenance) (2001) have found salts as far out as 10 meters from the road edge, with the highest concentration within 6 meters. The distance that the salts will be transported through the soils depends on subsurface conditions. Long-term accumulation of chloride can result in reduced soil permeability and fertility, as well as increased soil alkalinity and density. As a result, there could be negative effects on the chemical properties of the soil and its ability to retain water, both of which are important to plant growth and erosion control (National Research Council, 1991 (https://stormwater.pca.state.mn.us/index.php?title=References_for_Smart_Salting_%28S2%29_and_road_salt_winter_maintenance)). Another adverse effect of chloride in soil is its potential to release the metals sorbed to the soil particles (National Research Council, 1991; Amrhein et al., 1992 (https://stormwater.pca.state.mn.us/index.php?title=References_for_Smart_Salting_%28S2%29_and_road_salt_winter_maintenance); Backstrom et al., 2004 (https://stormwater.pca.state.mn.us/index.php?title=References_for_Smart_Salting_%28S2%29_and_road_salt_winter_maintenance)).



Environmental pathway model modified (Reprinted from NCHRP Report 577 (http://cdnassets.hw.net/66/66/ac492fa045acb567aba3fc7d9886/nchrp-rpt-577.pdf): Guidelines for the Selection of Snow and Ice Control Materials to Mitigate Environmental Impacts, with permission from the Transportation Research Board)

Vegetation

Roadside vegetation can be negatively impacted by absorption of chloride through the plant roots, or from accumulating on the foliage and branches. The symptoms associated with salt impacts are similar to those of a drought; stunted growth, brown and falling leaves/needles, dying limbs, and premature plant depths (National Research Council, 1991). The image to the right shows the browning of needles due to elevated salt levels. The effect of chloride on plants has been seen at distances of100 to 650 feet off the road (Fischel, 2001 (https://stormwater.pca.state.mn.us/index.php?title=References_for_Smart_Salting_%28S2%29_and_road_salt_winter_maintenance)). The level of chloride that must be reached before the plant is harmed depends on the type of vegetation. Developers and planners often use salt tolerant vegetation near the road's edge to lessen the impact of salt.

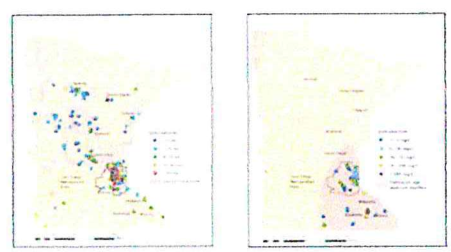
Groundwater

Since chloride does not bind to soils, chlorides that enter the subsurface with infiltrating water may reach the groundwater table. Howard and Haynes (https://journals.lib.unb.ca/index.php/GC/article/view/3784/4298) (1993) found that 55 percent of salt applied to a catchment in Toronto enters temporary storage in shallow sub-surface waters. Cusack (n.d.) estimated that approximately 45 percent of chlorides applied as road salt will be carried to the groundwater. Chloride entering groundwater systems is likely to persist for a long time since there is no significant removal mechanism and groundwater moves slowly.

Effect of chloride on roadside trees. (Reprinted with permission from Bill Cook, Michigan State University Extension)

Chloride is naturally present in Minnesota due to weathering of geologic materials. In urban areas, most of the chloride found in shallow groundwater likely comes from the use of deicing salts. Kroening and Ferrey (https://www.pca.state.mn.us/sites/default/files/wq-am1-06.pdf) (2013) reported on the conditions of Minnesota's groundwater from 2007 to 2011. Sand and gravel aquifers in the TCMA had chloride concentrations that ranged from less than 1 milligrams per liter to 8,900 milligrams per liter, with a median concentration of 86 mg/L. Approximately 27 percent of the monitoring wells located in the TMCA sand and gravel aquifers were above the Secondary Maximum Contaminant Level (SMCL) of 250 milligrams per liter. The SMCL is based on aesthetic concerns, specifically taste. Statewide the median chloride levels in sand and gravel aquifers was 17 milligrams per liter, with only 1 percent of the monitoring wells showing chloride levels above the SMCL. In bedrock aquifers, chloride concentrations ranged from less than 0.5 milligrams per liter to 680 milligrams per liter, but in general did not exceed the secondary SMCL of 250 milligrams per liter. Chloride concentrations were highest in shallow groundwater, typically at depths of 30 feet or less below the ground surface.

Surface waters



Chloride concentrations in the ambient groundwater from sand and gravel aquifers and from select Paleozoic-age bedrock aquifers in Minnesota, 2007-2011. (Reprinted from Kroening and Ferrey (https://stormwater.pca.state.mn.us/index.php?title=References_for_Smart_Salting_%28S2%29_and_road_salt_winter_maintenance), 2013 with permission)

Chloride concentrations in surface waters tend to follow a seasonal distribution. Concentrations usually increase in the winter and decrease in the summer (Novotny et al., 2007). The chronic chloride pollution standard has been set at 230 mg/L and the acute standard at 860 mg/L by the MPCA in Minnesota Rules Chapters 7050 (https://www.revisor.mn.gov/rules/?id=7050) and 7052 (https://www.revisor.mn.gov/rules/?id=7052). These limits are based on the findings that chronic concentrations of 230 mg/L are harmful to aquatic life, while concentrations above the acute standards are lethal and sub-lethal to aquatic plants and invertebrates. Stefan et al. (https://stormwater.pca.state.mn.us/index.php?title=References_for_Smart_Salting_%28S2%29_and_road_salt_winter_maintenance) (2008) reported that to date there are no documented exceedances of the acute standard in the Twin Cities. However, there are 21 lakes, 22 streams, and 4 wetlands that are impaired for chloride.

Salt-containing water has a higher density than non-salt-containing water and will sink to the bottom of the water body. This can result in chemical stratification and disrupt the lake mixing patterns (New Hampshire Department of Environmental Service (https://stormwater.pca.state.mn.us/index.php?title=References_for_Smart_Salting_%28S2%29_and_road_salt_winter_maintenance), N.D.; Novotny et al., 2007 (https://stormwater.pca.state.mn.us/index.php?title=References_for_Smart_Salting_%28S2%29_and_road_salt_winter_maintenance)). Effects on surface waters may be minimized by the dilution of the deicers as they are transported to the surface water. Dilutions of 1:100 to 1:500 are estimated to mitigate negative impacts of the deicer (Fischel, 2001 (https://stormwater.pca.state.mn.us/index.php?title=References_for_Smart_Saltin g_%28S2%29_and_road_salt_winter_maintenance)). Small ponds and slow streams are estimated to be most impacted by deicers because the likelihood of dilution and dispersion is lower in those environments (Fischel, 2001).

Air

A small percentage of the total applied chloride is evidenced to be transported by air. Blomqvist and Johansson (https://stormwater.pca.state.mn.us/index.php?title=References_for_Smart_Salting_%28S2%29_and_road_salt_winter_maintenance) (1999) found some deicing road salts can be transported by air 40m from the application site. Kelsey and Hootman (https://stormwater.pca.state.mn.us/index.php?title=References_for_Smart_Salting_%28S2%29_and_road_salt_winter_maintenance) (1992) found that sodium chloride was detected at a height of 49 feet (15 meters) within 220 feet (67 meters) of the highway. Kelsey and Hootman (1992) also found evidence of a positive correlation between plume height, and the travel distance of the constituent. The Connecticut DOT found road salt powder could travel as far as 300 feet laterally under heavy traffic conditions. Chloride transported by air can affect soil and surface/groundwater, but deposition on the vegetation is the primary concern (Levelton Consultants Ltd., 2008 (https://stormwater.pca.state.mn.us/index.php?title=References_for_Smart_Salting_%28S2%29_and_road_salt_winter_maintenance)).

Sodium, magnesium, and calcium

The cation components of chloride-based deicers (i.e. sodium, magnesium, and calcium) can also impact the environment. Sodium ions can change the structure of soil, causing a decrease in permeability, and infiltration (Davis et al., 2012 (https://stormwater.pca.state.mn.us/index.php?title=References_for_Smart_Salting_%28S2%29_and_road_salt_winter_maintenance)). Sodium can also reduce the amount of calcium, magnesium, and other nutrients in the soil by raising the alkalinity of the soil and reducing the ion exchange capacity (National Research Council, 1991 (https://stormwater.pca.state.mn.us/index.php?title=References_for_Smart_Salting_%28S2%29_and_road_salt_winter_maintenance)). Magnesium and calcium can improve soil structure by causing soil particles (particularly clays) to form aggregates, resulting in improved drainage (Amrhein, and Strong, 1990 (https://stormwater.pca.state.mn.us/index.php?title=References_for_Smart_Salting_%28S2%29_and_road_salt_winter_maintenance)). The presence of chloride, magnesium, and calcium may also result in the mobilization of heavy metals sorbed to soil particles (Amrhein, and Strong, 1990; Backstrom et al., 2003 (https://stormwater.pca.state.mn.us/index.php?title=References_for_Smart_Salting_%28S2%29_and_road_salt_winter_maintenance))

Sodium, magnesium, and chloride in surface and groundwater can affect the hardness of water. The hardness of water will be reduced if there are elevated levels of sodium and will be increased if there are elevated levels of calcium and magnesium (Cheng and Guthrie, 1998 (https://stormwater.pca.state.mn.us/index.php?title=References_for_Smart_Salting_%28S2%29_and_road_salt_winter_maintenance)). An increase in water hardness has shown evidence of decreasing the toxicity of heavy metals (Lewis, 1997 (https://stormwater.pca.state.mn.us/index.php?title=References_for_Smart_Salting_%28S2%29_and_road_salt_winter_maintenance)).

Corrosion inhibitors

In order to reduce the corrosive effects of some of the chloride-based deicers, corrosion inhibitors can be added. Corrosion inhibitors can include heavy metals, inorganic ions, and organic substances (Levelton Consultants Ltd., 2008). The toxicity and environmental effects of corrosion inhibitors vary greatly and are dependent on the composition (Pilgrim, 2013 (https://stormwater.pca.state.mn.us/index.php?title=References_for_Smart_Salting_%28S2%29_and_road_salt_winter_maintenance)). In general, the inhibitors that contain organic components consume oxygen during decay. The oxygen consumption can lead to anoxic conditions in the soil, groundwater, or surface water (Fischel, 2001). At colder temperatures, the rate of decomposition will decrease and there will be an increased potential for the inhibitors to reach the groundwater (Cheng and Guthrie, 1998).

Acetates

Much of the information on the environmental impacts of acetate-based deicers is based on studies regarding calcium-magnesium acetate (CMA) Therefore, much of the information presented in this section is related specifically to CMA. Modeling studies have estimated that the concentrations of CMA in the runoff from highways is between 10 and 100 mg/L, with a maximum concentration of 5,000 ppm. The typical annual mass loading is estimated to be 10 tons/linear-mile (Horner, 1988 (https://stormwater.pca.state.mn.us/index.php?title=References_for_Smart_Salting_%28S2%29_and_road_salt_winter_maintenance)). Despite high mass loading, runoff and receiving water are predicted to dilute the concentration.

Soil

The characteristics of acetate suggest it would be absorbed to the soil surface and not carried away with the runoff. Once in infiltrating water, acetate can be mobile, however Horner (1988) found that less than 10 percent of the acetate applied to test plots were found in the underlying soil and groundwater. The sodium and potassium contained in other types of acetates are less likely to adsorb to the soils and therefore have a greater potential to leach into groundwater (Cheng and Guthrie, 1998).

Horner (1988) did not note any effects of acetate on soil plasticity, moisture-density characteristics, unconfined compression strength, or shear strengths in medium texture soils. An increase in permeability was noted. In the Horner (1988) study, the test sites that received an addition of CMA were found to have an increase in permeability up to 20 times more than that of the control plots. There is uncertainty about CMA causing the release of metals from soil (Amrhein et al., 1992; Horner, 1992; Granato et al., 1995 (https://stormwater.pca.state.mn.us/index.php?title=References_for_Smart_Salting_%28S2%29_and_road_salt_winter_maintenance); Levelton Consultants Ltd., 2008; McFarland and O'Reilly, 1992 (https://stormwater.pca.state.mn.us/index.php?title=References_for_Smart_Salting_%28S2%29_and_road_salt_winter_maintenance)). Another concern is that acetate-based deicers consume oxygen when degrading.

Surface water and groundwater

Acetate-based deicers dissociate when in water. The metal ion persists, but the acetate ion will degrade (Fortin et al, 2014 (https://stormwater.pca.state.mn.us/index.php?title=References_for_Smart_Salting_%28S2%29_and_road_salt_winter_maintenance)). Degradation of the acetate ion consumes oxygen, which is one of the biggest environmental concerns associated with the use of acetate-based deicers. At temperatures between 10°C and 20°C, the biological oxygen demand (BOD) was fully applied within 5 to 10 days of the acetate being deposited into the water. At a water temperature of 2°C decomposition took 100 days (Horner, 1992).

Modeling studies have predicted CMA concentrations in the highway runoff range from 10 to 100 ppm, with a maximum concentration of 5,000 ppm. Evidence has shown that at a concentration of 100 ppm and a temperature of 20°C, CMA will completely deplete the oxygen in the water. At concentrations of 10 ppm the dissolved oxygen in ponds was reduced by approximately 50% (Brenner and Horner, 1992 (https://stormwater.pca.state.mn.us/index.php?title=References_for_Smart_Salting_%28S2%29_and_road_salt_winter_maintenance)).

Dispersion and dilution are likely to mitigate the negative effects of CMA, and the environments most likely to be severely affected are slow moving streams and small ponds (Fischel, 2001 (https://stormwater.pca.state.mn.us/index.php?title=References_for_Smart_Salting_%28S2%29_and_road_salt_winter_maintenance)). The potential for mitigation through dispersion and dilution is confirmed by two studies of CMA and BOD. McFarland and O'Reilly (https://stormwater.pca.state.mn.us/index.php?title=References_for_Smart_Salting_%28S2%29_and_road_salt_winter_maintenance) (1992) found that CMA did not negatively impact the dissolved oxygen (DO) levels in the surface waters in most of the scenarios that were tested. A study on Bear Creek in Clackamas County, Oregon, did not find a correlation between CMA concentrations and BOD (Tanner and Wood, 2000 (https://stormwater.pca.state.mn.us/index.php?title=References_for_Smart_Salting_%28S2%29_and_road_salt_winter_maintenance)).

Carbohydrates

Carbohydrate-based deicers are often made from the fermentation of grains or the processing of sugars such as cane or beet sugar (Rubin et al., 2010). Small quantities of carbohydrates are sometimes used with other deicers. Alone carbohydrates do not aid in melting ice or snow; however, their use can help reduce the freezing point of ice further than salt and can help salt stick better to the road surface (Fortin et al, 2014; Rhodan and Sanburn, 2014 (https://stormwater.pca.state.mn.us/index.php?title=References_for_Smart_Salting_%28S2%29_and_road_salt_winter_maintenance)). Carbohydrates are not corrosive to steel, and at high concentrations, carbohydrates can act as a corrosion inhibitor for salt brines.

There is evidence that the use of carbohydrates in the United States is increasing. For example, sales of a beet based product called Beet Heet were around 900,000 gallons at the end of the winter season in 2013. By February of 2014, 1.5 million gallons of Beet Heet had been sold. The Morton Arboretum in Lisle, Il uses beet juice in their deicers. The beet juice additive has minimal environmental affects, and helps the salt stick where applied. With the addition of beet juice, the arboretum is using nine times less salt, and saving an estimated $14,000 in material costs (The Morton Arboretum, 2014 (https://stormwater.pca.state.mn.us/index.php?title=References_for_Smart_Salting_%28S2%29_and_road_salt_winter_maintenance)). Another unconventional additive that has been used is cheese brine. Wisconsin has used a cheese brine in at least six counties in the state (Rhodan and Sanburn, 2014).

Fu et al. (https://stormwater.pca.state.mn.us/index.php?title=References_for_Smart_Salting_%28S2%29_and_road_salt_winter_maintenance) (2012) looked at two beet molasses-based deicers in comparison with a salt brine deicer. When used as a prewetting material, there was no statistically significant difference between any of the chemicals. When used as an anti-icing material, the organic material performed 30% better.

The decay of the alternative additives in the environment will contribute to BOD (most specifically for the organic additives). Depending on the nature of the unconventional additive, nutrients could be released during the decay process which could be a potential source of pollution (Fortin et al, 2014 (https://stormwater.pca.state.mn.us/index.php?title=References_for_Smart_Salting_%28S2%29_and_road_salt_winter_maintenance)). Brenner and Horner (https://stormwater.pca.state.mn.us/index.php?title=References_for_Smart_Salting_%28S2%29_and_road_salt_winter_maintenance) (2012) compared the BOD requirements of a corn based CMA and a reagent based CMA. The corn based CMA had a higher BOD than the reagent based CMA.

Other deicers

Sodium Ferrocyanide and Ferric Ferrocyanide have been used as anti-caking additives for deicing (CTC and Associates LLC, 2004 (https://stormwater.pca.state.mn.us/index.php?title=References_for_Smart_Salting_%28S2%29_and_road_salt_winter_maintenance)). Cyanide is harmful to the environment if it is leached into groundwater or carried to surface water. An overview of 13 deicing products found a cyanide range from less than 0.0003 parts per million (ppm) to 0.33 ppm (Fischel, 2001). Issues related to Cyanide in groundwater are contained in the infiltration section of the MN Stormwater Manual. Other chemicals that have been found at trace levels in deicers are arsenic, lead, and mercury (Dindorf, 2008 (https://stormwater.pca.state.mn.us/index.php?title=References_for_Smart_Salting_%28S2%29_and_road_salt_winter_maintenance)).

Summary

There are many chemicals associated with deicing that have both similar and unique properties and environmental effects. The following table summarizes the corrosion and environmental impacts of the deicing agents described in this article. Care should be taken when determining which chemicals are best for the intended application and for the environment surrounding the application area.

Table summarizing of properties of deicing agents. Adapted from Local Road Research Board, 2012 (https://stormwater.pca.state.mn.us/index.php?title=References_for_Smart_Salting_%28S2%29_and_road_salt_winter_maintenance), Ketcham et al., 1996 (https://stormwater.pca.state.mn.us/index.php?title=References_for_Smart_Salting_%28S2%29_and_road_salt_winter_maintenance) and Levelton Consultants Ltd., 2008 (https://stormwater.pca.state.mn.us/index.php?title=References_for_Smart_Salting_%28S2%29_and_road_salt_winter_maintenance).
Link to this table

Category	Type	Lowest Practical Melting Pavement Temperature	Potential for corrosion impairment[3]			Environmental Impact			
			Atmospheric Corrosion to Metals	Concrete Matrix	Concrete Reinforcing	Water Quality/Aquatic Life	Air Quality	Soils	Vegetation
Chloride Based Deicers	Sodium Chloride	15°F	High: will initiate and	Low/moderate: Will exacerbate	High: Will initiate	Moderate: Excessive chloride loading/metals	Low: Leads to reduced	Moderate/High: Sodium accumulation	High: Spray causes foliage damage;

Category	Type	Lowest Practical Melting Pavement Temperature	Potential for corrosion impairment[3] Atmospheric Corrosion to Metals	Concrete Matrix	Concrete Reinforcing	Environmental Impact Water Quality/Aquatic Life	Air Quality	Soils	Vegetation
			accelerate corrosion	scaling; low risk of paste attack	corrosion of rebar	contaminants; ferrocyanide additives	abrasives use	breaks down soil structure and decreases permeability and soil stability; potential for metals to mobilize	osmotic stress harms roots, chloride toxicosis
	Calcium Chloride	-20°F	High; Will initiate and accelerate corrosion; higher potential for corrosion related to hydroscopic properties	Low/moderate; Will exacerbate scaling; low risk of paste attack	High: Will initiate corrosion of rebar	Moderate: Excessive chloride loading; heavy metal contamination	Low: Leads to reduced abrasives use	Low/Moderate: Improves soil structure; increases permeability; potential for metals to mobilize	High: Spray causes foliage damage; osmotic stress harms roots, chloride toxicosis
	Magnesium Chloride	-10°F	High; Will initiate and accelerate corrosion; higher potential for corrosion related to hydroscopic properties	Moderate/high: Will exacerbate scaling; risk of paste deterioration from magnesium	High: Will initiate corrosion of rebar, evidence suggest MgCl2 has the highest potential for corrosion of chloride produces	Moderate: Excessive chloride loading; heavy metal contamination	Low: Leads to reduced abrasives	Low/Moderate: Improves soil structure; increases permeability; potential for metals to mobilize	High: Spray causes foliage damage; osmotic stress harms roots, chloride toxicosis
	Calcium Magnesium Acetate	20°F [1] (https://www.cryotech.com/snow-and-ice-control-chemicals-for-airports-operations)	Low/moderate; Potential to initiate and accelerate corrosion due to elevated conductivity	Moderate/high: Will exacerbate scaling; risk of pate deterioration from magnesium reactions	Low; probably little or no effect	High: Organic content leading to oxygen demand	Low: Leads to reduced abrasives use	Low/Moderate: Improves soil structure; increases permeability; potential for metals to mobilize	Low: Little or no adverse effect; osmotic stress at high levels
Acetate Based Deicers	Potassium Acetate	-26°F [2] (https://www.cryotech.com/snow-and-ice-control-chemicals-for-airports-operations)	Low/moderate; Potential to initiate and accelerate corrosion due to elevated conductivity	[3] (https://ascelibrary.org/doi/10.1061/%28ASCE%29MT.1943-5533.0001754)	Low; probably little or no effect [4] (https://ascelibrary.org/doi/10.1061/%28ASCE%29MT.1943-5533.0001754)	High: Organic content leading to oxygen demand	Low: Leads to reduced abrasives use		
	Sodium Acetate	0°F [5] (https://www.cryotech.com/snow-and-ice-control-chemicals-for-airports-operations)				Relative aquatic toxicity: high			
Carbohydrates	Beet Juice	NA	Low; Potential to initiate and accelerate corrosion due to elevated conductivity clams of mitigation of corrosion require further evaluation	Low; Probably little or no effect	Low; Probably little or no effect: claims of mitigation of corrosion require further evaluation	High Organic matter leading to oxygen demand; nutrient enrichment by phosphorus and nitrogen; heavy metals	Low: Leads to reduced abrasive use	Low: Probably little or no effect; limited information available	Low: Probably little or no effect
	Molasses	NA							
	Corn Syrup	NA							

Links

- The New Hampshire Department of Environmental Services maintains a website (http://des.nh.gov/organization/divisions/water/wmb/was/salt-reduction-initiative/impacts.htm) that provides information on the environmental, health, and economic impacts of road salt. Environmental impacts include impacts to water quality, human health, pets, wildlife, aquatic life, vegetation, and soil. The page includes a link to a document (http://www.rebuildingi93.com/documents/environmental/Chloride%20TMDL%20Toxicological%20Evaluation.pdf) that provides detailed discussions of environmental impacts.
- The British Columbia Ministry of Environment produced a report, *Ambient Water Quality guidelines for Chloride* (http://www.env.gov.bc.ca/wat/wq/BC guidelines/chloride/chloride.html), that discusses guidelines for chloride and includes detailed discussion on environmental effects of chloride.
- New Hampshire Department of Environmental Services - Hazard Identification for Human and Ecological Effects of Sodium Chloride Road Salt (http://www.rebuildingi93.com/documents/environmental/Chloride%20TMDL%20Toxicological%20Evaluation.pdf)
- Colorado Department of Transportation - Studies of Environmental Effects of Magnesium Chloride deicer in Colorado (https://www.codot.gov/programs/research/pdfs/1999/magchlorideenveffects.pdf)
- Occidental Chemical Corporation - Calcium chloride effects on water and the natural environment (http://oxycalciumchloride.com/highway-ice-melting/best-practices/managing-impact/effect-on-water-natural-environment)

Related pages

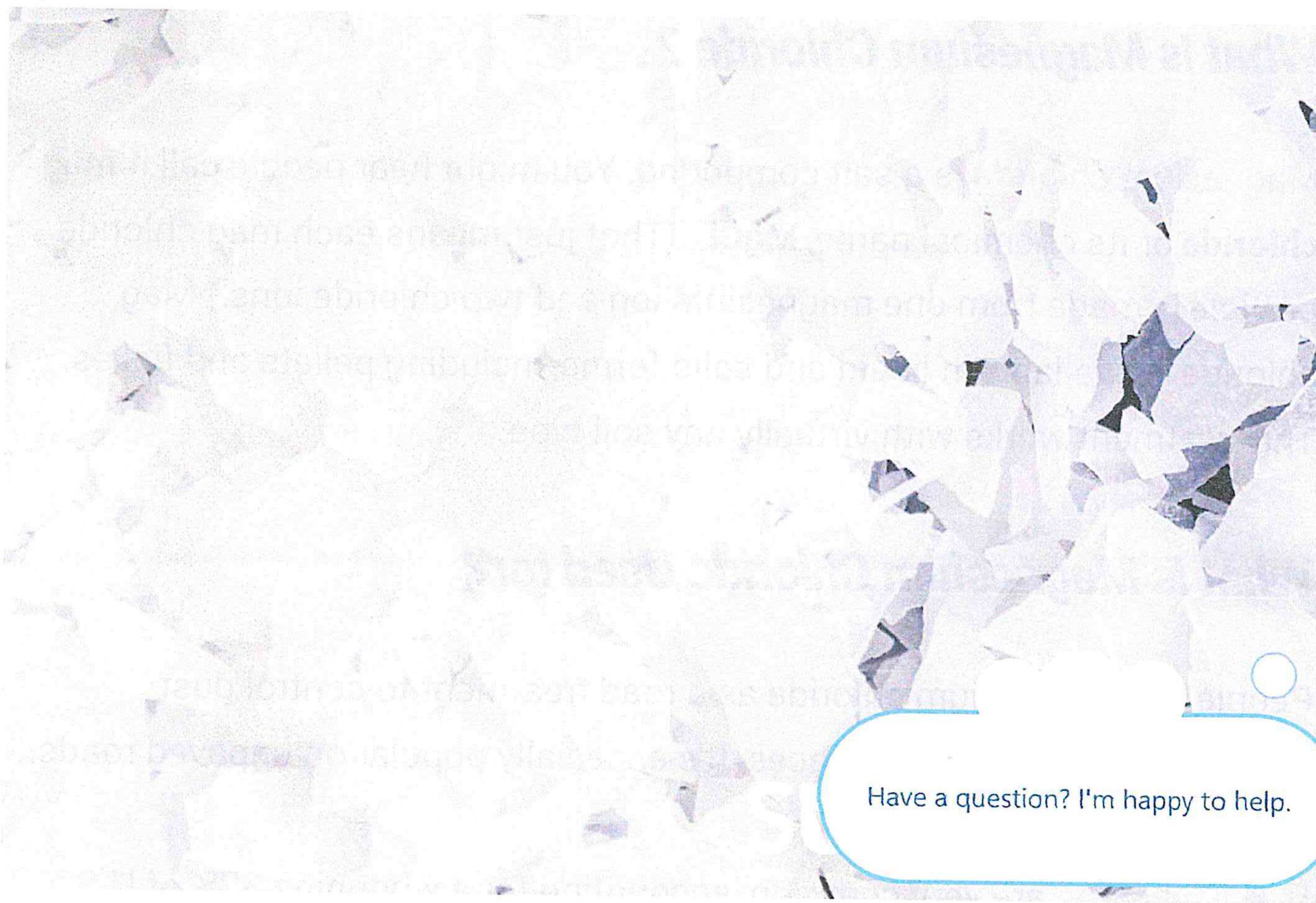
- Overview and impacts of road salt and deicers
  - How salt works and overview of deicing chemicals
  - Environmental impacts of road salt and other de-icing chemicals
  - Other impacts of deicer use
- Information on costs and economic impacts of road salt
- Management tools
  - Minnesota Statewide Chloride Management Plan (https://www.pca.state.mn.us/sites/default/files/wq-s1-94.pdf)
  - Smart Salting Assessment tool (SSAt)
  - Model Ordinances (https://www.pca.state.mn.us/water/statewide-chloride-resources)
  - Model Snow and Ice Policies (https://www.pca.state.mn.us/water/statewide-chloride-resources)
- MPCA Smart Salting Training Program
  - Smart Salting Training Program (https://www.pca.state.mn.us/water/smart-salting-training)
  - Smart Salting Training Calendar (https://www.pca.state.mn.us/water/smart-salting-training-calendar/2021-01)
  - Resources for Winter Maintenance Professionals (https://www.pca.state.mn.us/water/salt-applicators)
  - Chloride Reduction Assistance (https://www.pca.state.mn.us/water/statewide-chloride-resources)
- Education Resources
  - Educational resources for Smart Salting (S2). For more information on chloride resources, see Statewide chloride resources (https://www.pca.state.mn.us/water/statewide-chloride-resources)
  - Success stories: salt reduction and cost saving examples
  - Technical reports and Chloride TMDLs (https://www.pca.state.mn.us/water/statewide-chloride-resources)
  - Chloride and NPDES Permits (https://www.pca.state.mn.us/water/water-permit-holders-and-chloride)
- References for Smart Salting (S2) and road salt winter maintenance
- Chloride and groundwater
  - Impacts of stormwater infiltration on chloride in Minnesota groundwater (https://www.mgwa.org/documents/whitepapers/impacts_of_stormwater_infiltration_on_chloride_in_minnesota_groundwater.pdf) - White paper produced for the Minnesota Groundwater Association
  - Calculator for estimating chloride loading to groundwater (https://stormwater.pca.state.mn.us/index.php?title=File:Chloride_groundwater_loading_calculator.xlsx)
  - Guidance for calculator to estimate chloride loading to groundwater from infiltration

SUBSTRATA
SOLUTIONS POWERED BY ENZYMES

Soil stabilization | Magnesium chloride | Environment | Dust control |
6 min read

What Is Magnesium Chloride, and What's It Used for?

April 26, 2024



Magnesium chloride is a dust control solution, road deicer, and soil stabilizer. Many county governments use it on both paved and unpaved roads, but it does have drawbacks.

Let's explore what magnesium chloride is, what it's used for, how to apply it, and its downsides like costly reapplications and environmental damage.

What Is Magnesium Chloride ?

Magnesium chloride is a salt compound. You might hear people call it **mag chloride** or its chemical name, **$MgCl_2$**. (That just means each mag chloride particle is made from one magnesium ion and two chloride ions.) Mag chloride is available in liquid and solid forms, including pellets and flakes. The treatment works with virtually any soil type.

What Is Magnesium Chloride Used for?

People use magnesium chloride as a road treatment to control dust, stabilize soil, and de-ice surfaces. It's especially popular on unpaved roads.

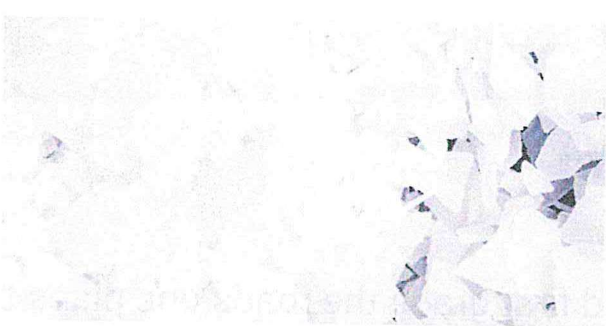
Unpaved roads are very common, accounting for a whopping 32% of U.S. public roads in 2020.[1] That's because they're often more cost-effective than paved roads. They're cheaper to construct and maintain, and they're suited for low-traffic areas.

However, improper maintenance can lead to dangerous driving conditions like potholes, ruts, and excessive road dust. To combat these issues, many people use magnesium chloride as a dust suppressant, road stabilizer, and deicer.

Magnesium Chloride Dust Control

Magnesium chloride is hygroscopic, meaning it pulls moisture from the air. That keeps roads damp much longer than water alone, lowering the amount of dust that comes off the road. It also creates a moisture barrier that bonds the soil particles together, preventing them from coming off the ground.

Magnesium chloride resists evaporation, so a single application can last for three to six months. However, it needs regular reapplications over time, making it only a temporary dust control solution.



Is magnesium chloride the best solution for controlling dust on dirt roads? Check out these options before you decide!

SEE MORE DUST CONTROL SOLUTIONS

Magnesium Chloride Soil Stabilization

Magnesium chloride bonds dirt particles together, creating a hard surface that gives the road stability. The particles bond because mag chloride's hygroscopic nature pulls moisture out of the air and makes them stick together.

Unpaved roads harden as the magnesium chloride penetrates the surface. However, since mag chloride relies on moisture that's already in the air, it's not ideal for hot, dry climates with low moisture.

Magnesium Chloride Road Salt

Mag chloride is a popular road deicer. It melts ice quickly by pulling moisture from the ice—and since ice is made of water, it disappears when its moisture's gone. Mag chloride also lowers the freezing point of water, helping keep the road from refreezing later.

Some people confuse magnesium chloride with rock salt, which is sodium chloride. They're both salt, but they're not the same. Mag chloride works in negative Fahrenheit temperatures (something rock salt won't do), and it works faster than rock salt. That makes $MgCl_2$ more effective for higher traffic roads.

Applying Magnesium Chloride

To apply magnesium chloride, one should first grade the roads one plans to treat. Grading ensures the road is smooth and ready to absorb water.

Next, use a water truck to wet the road. This lets the magnesium chloride penetrate the soil instead of staying on the surface. Finally, apply the mag chloride to the damp road. You can use a tanker truck to spray liquid mag chloride, or use a truck with a spinner attachment to disperse solid flakes or pellets. Some counties mix liquid and solid mag chloride for more effective road treatment.

Magnesium chloride starts working immediately, so it should begin to produce results during application.

Negatives of Magnesium Chloride

While $MgCl_2$ is an effective dust control and soil stabilization method, it has drawbacks:

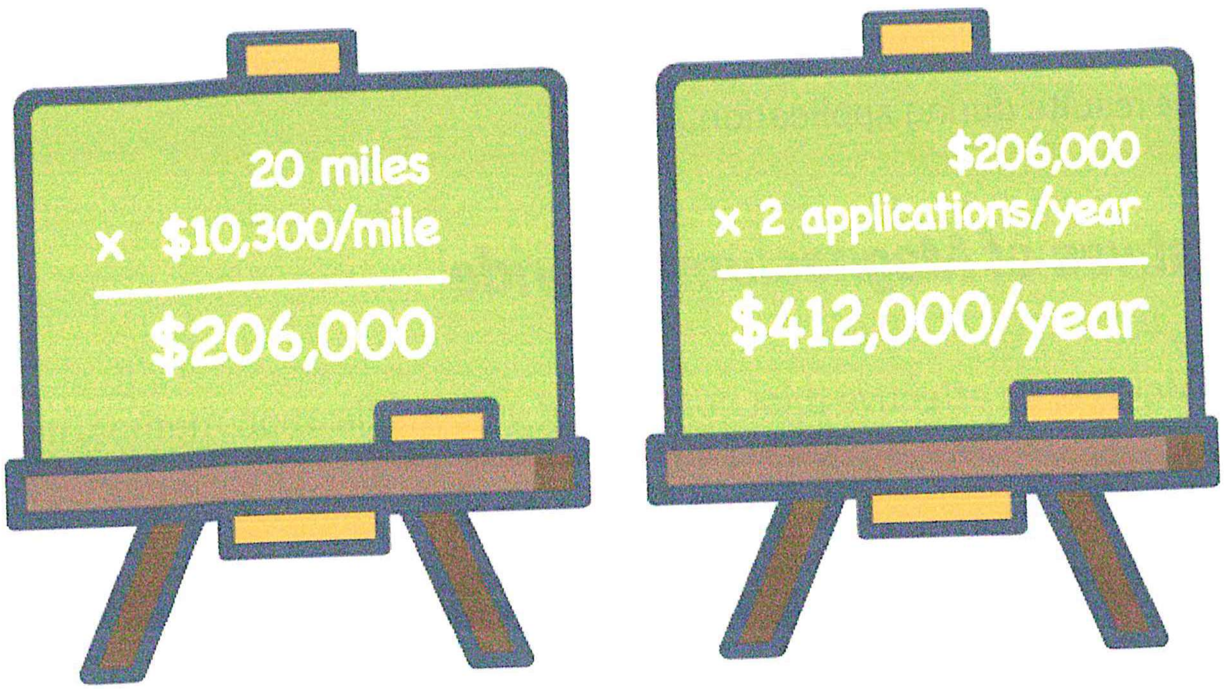
- Costly reapplications
- Environmental damage
- Corrosion
- Climate requirements

Costly Reapplications

As we mentioned before, road managers must continuously reapply magnesium chloride, as it wears down. This increases maintenance costs over time.

Costs vary greatly by geography, location, type of magnesium chloride, and use. Generally, liquid magnesium chloride deicer averages $0.50 to $2.50 per gallon.[2] For dust control, one application typically costs over $10,300 per mile of road.

Imagine Soil County treats 20 miles of unpaved public roads with magnesium chloride twice a year for dust control. Here's how that adds up:



In 10 years, Soil County would spend $4.1 million on magnesium chloride road treatments for dust control alone—if prices didn't increase.

Deicing is also costly. Since road commissions must apply magnesium chloride road salt before each snow, many counties and cities only deice a few roads. Before a 2016 snowstorm, Portland, Oregon, treated 518 miles of streets with 10,000 gallons of mag chloride—covering only about 25% of the city's public roads.[3,4]

Some counties offset reapplication costs by not treating the road's full width or by asking residents to pay for treatments on county-owned roads.

Environmental Damage

There's a lot of debate about magnesium chloride's environmental impact, so let's start by looking at both sides.

Some people say magnesium chloride is environmentally safe. After all, it's a naturally occurring compound. The Environmental Protection Agency (EPA) approved it, and the U.S. Forest Service uses it. Companies also use it to meet PM-10 regulations, which require suppressing tiny, inhalable dust particles to protect people's respiratory health. That all sounds good so far.

However, others say magnesium chloride is only safe if you can keep it on the road—which is almost impossible. It easily washes off with rain and snowmelt. It then leeches into surrounding soil and groundwater. Like all salt compounds, magnesium chloride builds up in soil and water over time. People believe that build-up eventually harms the environment, and studies on mag chloride support this belief.

Research shows that highly concentrated magnesium chloride makes water unsafe to drink, harms aquatic wildlife, and keeps plants from effectively absorbing water and nutrients. Colorado State University found that magnesium chloride is especially tough on plants downhill from treated areas. Plants need both magnesium and chloride to grow, but too much of either is unhealthy. Their roots absorb magnesium chloride from the soil and take it through their water-conducting systems. It then builds up in their leaves, weakening or killing them. Vegetation affected by magnesium chloride exhibits leaf scorching, marginal necrosis, needle tip burn, and stunted growth.[7] See attached Colorado Study

Magnesium chloride's negative environmental impact is easy to overlook because it happens slowly over time. A winter deicing treatment won't affect plants immediately because they aren't actively growing then. The impact happens months or years later. To that end, some counties have banned magnesium chloride, and some states like Montana are reducing its use.

Corrosion

Another drawback is magnesium chloride's corrosive nature. Some people claim it's less corrosive than rock salt, but studies show that the two can be equally corrosive.[5] Magnesium chloride eats away at metal, meaning it damages metal components of bridges and cars driving on treated roads.

Magnesium chloride specifically corrodes vehicles' undercarriages, putting brake lines, ball joints, wheel bearings, and other essential parts at risk. It even erodes wiring harnesses and causes electrical problems.

There is no fixing corrosion; there's only the option of replacing ruined parts, which quickly gets expensive. The trucking industry alone spends an estimated $2.4 to $4 billion annually for repairs due to magnesium chloride road treatments.[6]

Corrosion damage is almost impossible to prevent. To effectively prevent corrosion, people must wash their vehicle's undercarriage immediately after driving on treated roads. However, that's virtually impossible in freezing weather. In summer, they'd leave the car wash only to drive home on the same roads, defeating the purpose.

There's a reason cars in states that use mag chloride heavily are so rusty! And adding a rust inhibitor to liquid magnesium chloride? That'll cost you extra.

Climate Requirements

While magnesium chloride treatments work on any type of soil, they do have climate requirements. They're only effective in high-humidity climates with moist air.

Magnesium chloride isn't effective in dry climates with low humidity and moisture content. In fact, trying to use mag chloride in low-moisture areas just dries out the soil, rendering the treatment useless, yielding dust, and making the surface unstable.

Summary

Magnesium chloride is an effective dust suppressant, soil stabilizer, and deicer. It's simple to apply. However, it has some serious drawbacks, including:

- Costly reapplications
- Environmental damage
- Corrosion
- Climate requirements

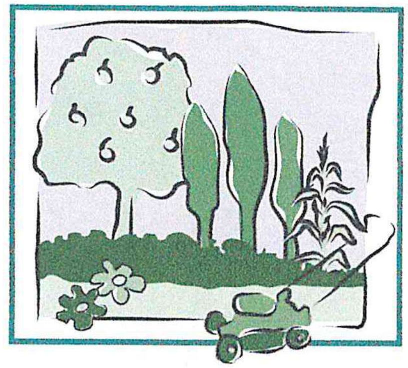
While many counties still use magnesium chloride, you can find affordable, effective, and eco-friendly alternatives.

PREVIOUS STORY

Colorado State University
Extension

Magnesium Chloride Toxicity in Trees

Fact Sheet No. **7.425** Gardening Series | **Trees and Shrubs**



by B.A. Goodrich and W.R. Jacobi*

Quick Facts

- Magnesium chloride ($MgCl_2$) is a salt compound composed of Mg^{+2} and Cl^- ions.
- Magnesium chloride ($MgCl_2$) is used as a dust suppressant and road stabilizer on non-paved roads and as a deicing product on paved roads and sidewalks.
- $MgCl_2$ based products can move from treated roads into adjacent soils through precipitation.
- Trees take up soil magnesium and chloride through roots and accumulate them in leaves.
- To avoid chloride toxicity in roadside trees, use non-chloride based products to treat for dust suppression and deicing purposes.

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$MgCl_2$ Uses for Road Treatments

Along highways and city streets, liquid magnesium chloride ($MgCl_2$) deicing solutions are applied during snow events, as preventative deicers, and as anti-icing treatments. Granulated $MgCl_2$ is also commonly applied to sidewalks, driveways, and walkways in smaller quantities. Liquid $MgCl_2$ solutions are applied to non-paved roads during spring and summer months for dust suppression and road stabilization, especially in arid regions.

$MgCl_2$ Toxicity: Biology

Chloride (Cl^-) and magnesium (Mg^{+2}) are both essential nutrients important for normal plant growth. Too much of either nutrient may harm a plant, although foliar chloride concentrations are more strongly related with foliar damage than magnesium. High concentrations of $MgCl_2$ ions in the soil may be toxic or change water relationships such that the plant cannot easily accumulate water and nutrients. Once inside the plant, chloride moves through the water-conducting system and accumulates at the margins of leaves or needles, where dieback occurs first. Leaves are weakened or killed, which can lead to the death of the tree.

Symptoms of Chloride Toxicity

Chloride toxicity in woody plants initially develops as a marginal necrosis on deciduous leaves (Figure 1) or a tip burn or necrosis on conifer needles (Figure 2). Generally, the higher the foliar chloride concentrations, the more extensive the necrosis becomes. In prolonged exposures, necrosis moves

Figure 1: Marginal burn on roadside aspen leaves.

toward the middle of the leaf in deciduous species and towards the base of the needle in conifers. Early leaf loss can also occur.

Necrosis is usually more severe on older conifer needles (i.e., those nearest the trunk). Sometimes newly flushed, or current season, needles are unaffected and remain green throughout the summer and fall. Deciduous species may not exhibit symptoms for several months after flushing new leaves. In some cases, foliar damage may appear on branches in a spiral pattern in the tree crown (Figure 3).

Some symptoms associated with exposure to deicing salt spray, aerosols, or road dust differ from root absorption. The side of the tree facing the road may exhibit more damage and needles may have surface deposits of salt crystals or dust. Trees exposed to $MgCl_2$ aerosols are often, but not always, in soils with high $MgCl_2$ concentrations and thus may show a range of symptoms.

Abiotic Disorders Similar to Chloride Toxicity

Drought effects, dehydration, winter burn, and some herbicide damage also appear as tip or marginal burning on trees. Water stress and dehydration may exacerbate chloride toxicity and cause even more extensive damage. There is no known method to fully separate the symptoms of chloride toxicity

*B.A. Goodrich, department of bioagricultural sciences and pest management; and W.R. Jacobi, Colorado State University Extension specialist and professor, department of bioagricultural sciences and pest management. 7/08

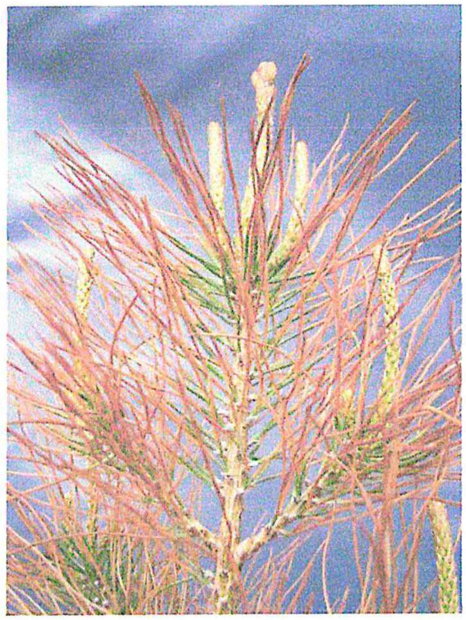

Figure 2: Tip burn on conifer foliage. Low severity of tip burn (left). High severity of tip burn (right).

with water stress. Follow the diagnosis questions below and collect foliar samples to determine chloride content.

Diagnosis

Eliminating other major biotic (insects, diseases) or abiotic (herbicide) damages to trees is the first diagnostic step, although these issues may also occur on trees already stressed by chloride toxicity. The next major factors useful in determining whether a tree is exposed to chloride are position and distance from the road, position in drainage or culvert areas, and eventually measuring chloride concentration in foliage.

Diagnostic Questions:

1. Does foliar damage occur only along the road or are many trees in the area affected?

Eliminate other potential causes by looking at the distribution of symptoms in the area. If many non-roadside trees in the area have similar symptoms this may be drought, winter burn, or needlecast fungi causing tip necrosis or a band of necrosis in the center of the needle. Check for insect frass and galleries on the stem, galls and cankers on stems and branches, or potential root disease and other biotic agents that might be causing stress to the tree. CSU Extension Bulletin 506A: *Insects and Diseases of Woody Plants in Colorado* lists common biotic damage agents, signs, and symptoms for many species of woody plants.

2. Are herbicides applied along the road or the walkway?

Some patterns of damage on herbicide-affected leaves include cupping and deformation of leaf shape in addition to marginal necrosis.

3. Is the road treated with $MgCl_2$?

If the road is or has been treated with $MgCl_2$ products, it may have washed into surrounding soils. A splash and aerosol zone also occurs along treated paved roads and contributes to foliar accumulation of $MgCl_2$. At very high soil concentrations, $MgCl_2$ damage may appear on trees after two years of treatment.

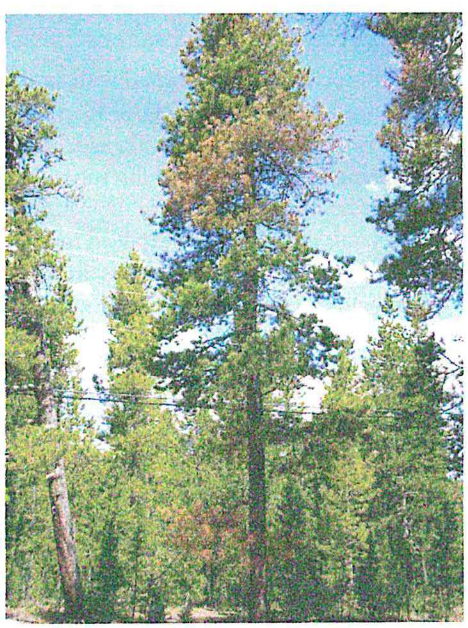

Figure 3: Necrotic foliage "spiral" on roadside lodgepole pine crown.

Additional Resources

- CSU fact sheet 2.932, *Environmental Disorders of Woody Plants*
- CSU fact sheet 0.503, *Managing Saline Soils*
- CSU fact sheet 0.520, *Selecting an Analytical Laboratory*
- CSU fact sheet 0.521, *Diagnosing Saline and Sodic Soil Problems*
- CSU fact sheet 7.227, *Growing Turf on Salt-Affected Sites*
- Cranshaw, W., Leatherman, D., Jacobi, W.R., Tisserat, N. 2014. Colorado State University Extension. Insects and Diseases of Woody Plants in Colorado. Bulletin 506A. 322 pp.
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- Swift, C.E. 2007. An analysis of plant problems related to Magnesium Chloride use for summer dust control on gravel roads in a mountain community in Colorado.
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Table 1. Foliar chloride concentrations (ppm) in seven common Colorado roadside tree species.[1,2]

	Roadside Field Trees		Shadehouse Trees	
Species	**Background**	**Severe Foliar Damage[3]**	**Severe Foliar Damage[4]**	**Complete Foliar Damage[5]**
lodepole pine	< 1,000	4,000	9,000	17,000
aspen	< 2,500	20,000	28,000	40,000
Engelmann spruce	< 1,000	6,500	—	—
subalpine fir	< 2,000	5,000	—	—
ponderosa pine	< 1,500	7,500	8,000	22,000
Douglas-fir	< 800	—	10,000	17,000
limber pine	< 700	—	—	—

[1]Concentrations in parts per million (ppm) (1 ppm = 1 mg/kg = 0.0001% dry weight)
[2]Concentration data from: Goodrich 2008 and ongoing shadehouse trials at CSU (non-published data). Dashes (-) indicate concentrations are not known.
[3]Concentrations necessary to cause ~50% crown damage in roadside field trees*
[4]Concentrations necessary to cause ~50% crown damage in shadehouse trial trees*
[5]Concentrations necessary to cause 100% crown damage in shadehouse trial trees*
*Experimental shadehouse trees are well-watered and not exposed to drought stress like roadside field trees growing in ambient conditions.

4. Is the tree downhill from the road?

While trees uphill of $MgCl_2$ may exhibit damage, the majority of foliar damage occurs on trees downhill from the road edge.

5. How far is the tree from the road edge?

On straight segments of non-paved roads most damage symptoms occur within 20 feet from the road. Along $MgCl_2$ treated highways, a splash zone may extend 300 feet due to snowplowing, traffic, and the resulting aerial spray.

6. Is the tree in an area where a culvert discharges water from the road?

In areas where culverts discharge water from the road and areas adjacent to sharply banked roads, water and $MgCl_2$ ions are concentrated and diverted into drainage areas. High concentrations of $MgCl_2$ ions in soil and plant tissue have been measured up to 300 feet from non-paved roads in drainage areas. No research is available on $MgCl_2$ movement through culvert and drainage areas along highways treated for deicing purposes.

Recommendations for Sample Collection

- Chloride concentrations in leaves, rather than the soil, are a better indicator of potential damage to roadside trees.
- Collect foliar samples towards the end of summer or beginning of fall along non-paved roads. Collect samples in spring if trees are along roads treated for deicing purposes in the winter.
- Collect at least 30 grams (a handful or half a small paper lunch bag full) of two-year-old needles (from conifers) or current leaves (from deciduous trees) exhibiting tip burn from at least three different branches. Avoid collecting needles or leaves from shaded or the lowest branches. Avoid leaves that are not fully developed. Store samples in a cloth or paper bag (not plastic).
- Lightly rinse foliage with distilled water prior to analysis to eliminate dust or aerially deposited salts. If foliage has crystallized salt deposits, chloride concentrations will be extremely high and not indicative of foliar cellular content. If aerial spray or dust is suspected as causing needle symptoms, the water leachate (water used to rinse the foliage) can also be collected and tested for chloride content or electrical conductivity (EC: estimates the amount of total dissolved salts in a solution).
- If possible, ship samples the same day. If same day shipping is not possible store samples in a dry area or oven on low heat (less than 100 degrees F).
- Close and seal the shipping container to avoid contamination. Mail samples directly to the laboratory of your choice for analysis (see fact sheet 0.520, *Selecting an Analytical Laboratory* for a list of laboratory recommendations).
- Compare results of chemical analysis with the information in Table 1 to determine if the tree is exposed to chloride salts.

Management

- No chemical treatments can reclaim saline soils (high in soluble salts), although proper drainage and flushing the soil with water can remove $MgCl_2$ ions from the upper soil profiles (see fact sheet 0.503, *Managing Saline Soils*). Tree roots are extensive and may not benefit as much as agricultural crops from soil flushing.
- Use non-chloride based products on roads that run through forested areas, or on roads with sharp curves and steep slopes.
- Lowering application rates of $MgCl_2$ may still cause damage to sensitive conifers. Even the lowest application rates may become concentrated in roadside ditches and move off the road via culvert systems and into drainage areas.
- Do not apply dust suppression products to non-paved roads immediately before or during rain.
- Select and use more tolerant trees if tolerance has been experimentally proven.
- Reduce exposure to deicing salts by minimizing the splash zone and aerial drift of deicing particulates (straw, fencing, other structures).
- The effectiveness of washing accumulated surface depositions from needles is not known, but it may help maintain healthy needles. Additional leaching to move salt through the soil is needed after needles are washed.