# Magnesium Chloride - Based Dust Suppression Products and the Health of Roadside Vegetation and Riparian Systems

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## Background and Introduction

Besides its use for snow and ice control, magnesium chloride ($MgCl_2$) is applied to gravel roads during summer months for dust suppression and road stabilization. Dust suppressants are used to control maintenance costs, erosion, and fugitive dust. The use of dust suppressants is increasing in order to control particulates in the interest of air quality.

Research quantifying the impacts of $MgCl_2$ on vegetation is limited. Based on research of sodium chloride (NaCl), symptoms of salt damage can include tip or marginal burn, necrosis, delays in germination, or early fall defoliation (Bicknell and Smith 1975, Kozlowski 1997). Salts in soils can depress osmotic potentials and restrict water uptake by plant roots (Munns 2002). Ion accumulation in woody plants can also cause osmotic stress in plant tissues (Munns 2002, Bernstein 1975). Tree injury due to salt (NaCl) is typified first by inhibition of general growth, followed by specific injuries to foliage and limbs (Jones et al. 1986).

Grand and Larimer County roadside vegetation health plots in spruce-fir, aspen, and lodgepole habitat types.

## Objectives

This project investigates tree, woody shrub, and herbaceous ground cover health along gravel roads in Larimer and Grand Counties, Colorado. The main objectives of this study are to determine if $MgCl_2$:

- is moving from treated gravel roads into roadside systems.
- causes adverse effects to roadside vegetation.
- moves from treated gravel roads into adjacent streams.
- moves from treated gravel roads through drainage systems, culverts, or other pathways.

The project timeline is three years of data collection and analysis. In our completed analysis, we will determine if:

- site factors influence the movement of $MgCl_2$.
- there are needs to implement better management practices in application or maintenance procedures.

**Literature Cited**

Bernstein, L. 1975. Effects of salinity and sodicity on plant growth. *Annu. Rev. Phytopathol* **13**: 295-312.

Bicknell, S. and W. Smith. 1975. Influence of soil salt, at levels characteristic of some roadside environments, on the germination of certain tree seeds. *Plant and Soil* **43**: 719-722

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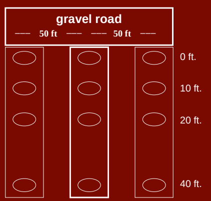
Kozlowski, T. 1997. Responses of woody plants to flooding and salinity. *Tree Physiology Monograph No.1*: 1-29.

Munns, R. 2002. Comparative physiology of salt and H20 stress. *Plant, Cell and Environment* **25**: 239-250.

Walton, G.S. 1969. Phytotoxicity of NaCl and CaCl to Norway Maples. Phytopathology 59: 1412-1415.

## Plot Design and Data Collection

In 2004 and 2005, roadside and drainage vegetation health plots were established on 19 gravel roads treated and untreated with $MgCl_2$ in Larimer and Grand Counties. Plots are in lodgepole, aspen, spruce/fir, and shrubland habitats. Trees, woody shrubs, and herbaceous ground species were rated for health and assessed for abiotic and biotic damages. In roadside plots, soil, foliar, and twig samples were taken at 4 distances from the road in 3 replicated transects per plot. In drainage plots, samples were collected along one transect following water movement. Water has been collected bi-weekly from May-October from 17 stream sampling sites along 14 treated roads, both upstream and downstream from road.



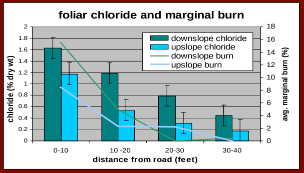

Roadside vegetation health plot layout. Three transects are 20 ft wide X 40 ft. deep. Circles indicate where ground cover data, soil, and foliar samples were taken.

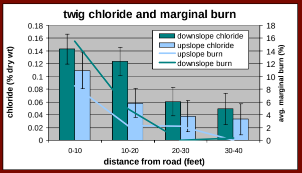
Drainage vegetation health plot. Similar data collection procedures as roadside plot. One transect follows water movement away from the road through culvert or other drainage pattern.

## Results: Foliar Chemistry

Salt tolerance of woody plants is difficult to quantify and varies with environmental factors (Kozlowski 1997). Tip burn on conifers and marginal burn on deciduous species may be caused by osmotic stress or ion accumulation in the leaf (Bernstein 1975, Kozlowski 1997). If leaf burn in our plots is a symptom of salinity stress or high ion concentrations, correlations between foliar/twig chloride levels, distance away from salt source, and percent of tip or marginal burn should exist.

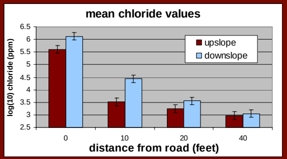
- Foliar and twig chloride values are highest closest to the road and decrease as distance from road increases.
- Aspen appear to be uptaking and accumulating more foliar chloride closer to the road ($p<0.001$) and downslope from the road ($p=0.04$).
- Preliminary analysis shows a significant ($p<0.001$) yet weak correlation between average marginal burn and foliar chloride concentrations in aspen ($R^2=0.293$).
- Aspen accumulate more chloride in leaves than twigs and a weaker correlation between twig chloride and marginal burn exists ($R^2=0.214$).
- Not all foliar data has undergone analysis as these are preliminary results (presently n=141 out of approximately 200 trees).
- Data is currently combined into one average. In continued analysis, data will be analyzed separately by county, plots, and roads.



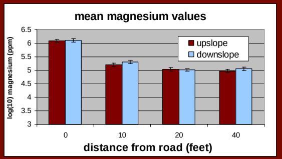




**Cooperators: Larimer County Road and Bridge Dept., Grand County Dept. of Road and Bridge, Colorado State Forest Service, and USDA Forest Service: Arapahoe and Roosevelt National Forests – Canyon Lakes and Sulfur Districts.**

## Results: Soil Chemistry



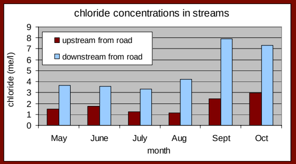

Mean soil chloride values ($log^{10}$ +/- 1 SE) at 4 distances from the road.




Mean soil magnesium values ($log^{10}$ +/- 1SE) at 4 distances from the road

- Chloride values were significantly higher directly on the road shoulder (0 feet).
- Downslope chloride significantly higher than upslope values at 0 and 10 feet.
- Upslope and downslope differences between 20 and 40 feet were not significant.
- There were no sig. differences between slope positions for mean $Mg^{+2}$ values.

## Results: Stream Chemistry




Water chloride concentrations in stream samples..

- Water samples collected downstream from treated roads are significantly higher in chloride than upstream samples.
- Downstream chloride concentrations were higher during fall than spring ($p=0.04$) or summer ($p=0.02$) months.

## Discussion and Continued Research

Preliminary analysis (averaging over county, plot, and road) showed the chloride component of $MgCl_2$ appears to be moving from roads approximately 10–20 feet. Plots were distributed between 2 counties on 19 gravel roads, and all roads have been treated and maintained differently over the years. In continuing analysis all county, plot and road data will be analyzed separately to determine site differences. Sample and tree health data from drainage vegetation health plots will also be analyzed as the next step of this project, to determine if chloride moves with water off the road through specific culvert or drainage channels. A controlled greenhouse study is in progress this year to quantify impacts of $MgCl_2$ on common roadside vegetation without potential interactions with other environmental factors.

Aspen trees appeared to be taking up the chloride component of $MgCl_2$ downslope from the road and accumulating it in leaves. Chloride accumulation in leaves can cause osmotic stress, leading to dehydration injury (i.e. leaf burn) typical of drought (Kozlowski 1997, Walton 1969). Preliminary analysis showed a weak but significant correlation between foliar chloride and leaf burn symptoms in our aspen plots.

Preliminary analysis of water samples showed significant differences in chloride concentrations due to slope and time of year. Chloride appears to be moving into streams adjacent to treated gravel roads. The extent of movement at individual stream sampling sites and roads is currently under analysis.

Data collection and analysis over the next year will allow us to better determine if there are adverse effects on soil, vegetation, or water quality from to $MgCl_2$ – based products. This information will help environmental managers, transportation officials, arborists, and the scientific community more fully understand the environmental impacts of applying dust suppressants along various roadside systems.