

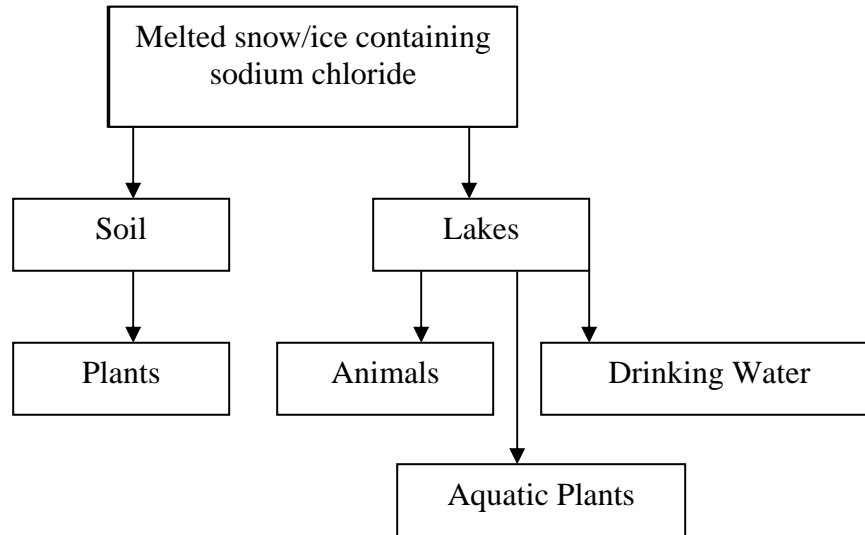
## **Impact of Road Salt on the Chloride Levels in the soil around Edgewood Campus**

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**ABSTRACT:** Snow and ice is present in the environment during the winter months. The snow and ice during the winter months are countered with road salt. In the U.S. about 10 million tons of road salt is used each year (Road Salt Use for Winter Maintenance 2000). As the number of road ways increase, there will continue to be an increase in the use of road salt usage. Road salt is used to provide traction on the slick road surfaces; by deicing the snow and ice. The road salt is used to penetrate through the accumulation of snow and ice to break its bond with the pavement. When the weather gets warmer, the melted snow and ice carrying sodium chloride, find their ways to our lakes, streams, and soil, and can have a negative impact on the environment. Streams and lakes contain low levels of naturally occurring salts, including chloride. These salts are essential to the aquatic organisms that live there. However, high concentrations of chloride are harmful to aquatic plants and animals. We are studying how the road salt is distributed in the soil around Edgewood College, relative to distance from the curb. We also studied chloride levels at different depths. In order to do this we are testing the conductivity of the soil samples and the chloride levels within the soil samples. Closer to the curb we expect to see the upper layer to have greater chloride and conductivity levels, where as we believe the deeper levels farther from the curb will have the greater chloride and conductivity levels.

### **INTRODUCTION:**

Snow accumulation during the winter months can create unsafe driving conditions. The use of road salt to deice on roads and other surfaces, such as sidewalks is a method used to promote safe motor vehicle and pedestrian travel. According to the Salt Institute, the total number of accidents is eight times higher before deicing than after deicing, on a two-lane roadway (Madison DPI 2000 road salt report). The most commonly used deicing salt is sodium chloride (NaCl), which is readily available and inexpensive and effective. Wisconsin has a Road Weather Information System that provides highway maintenance managers with information about how much salt should be used on the roads. Previously the managers had to guess how much they should use. This system has helped highway maintenance managers become more proficient and economical in terms of how much salt is used (Wisconsin Department of Transportation 2003-04). Today, salt is a necessary and generally accepted part of the winter environment, however many do not think of the negative impacts that the salt has. According to a 1991 lake wingra study, road salt causes corrosion worth 3.5-7 billion per year in the U.S. The average amount of salt used on road ways is about 250 tons per year in the Lake Wingra watershed in the last decade (lakewingra.org). Those 250 tons become an environmental issue when the ice/snow melts because the water then soaks in the groundwater and into storm sewers into lakes/streams. Approximately 45% of road salt will be carried away overland and flow into lakes or streams, while 55% is absorbed in the shallow aquifer below the surface and slowly moves to contaminate groundwater and habitat around (Madison DPI 2000 road salt report).



Knowing that there can be a negative impact on the soil, lake Wingra, and its habitat, we began studying how the road salt is distributed in the soil around Edgewood College, relative to distance from the curb. We also studied chloride levels at different depths. In order to do this we are testing the conductivity of soil samples and the chloride levels within the soil samples. We believe the deeper levels farther from the curb will have the greater chloride and conductivity levels because we think that as the salt soaks into the soil it will become farther from the curb.

### **Materials and Methods:**

In order to conduct this project we chose two different sites, which would be affected by road salt use. Our sites are located in the rain gardens in front and behind the Edgedome on the Edgewood campus. We determined to gather soils samples before winter hits, October 2006, and then towards spring when the snow melts, March 2007. At each site we took samples at a half meter, one meter, and two meters in from the curb. We also took a total of four samples at each distance and mixed them together in a plastic bag. This is to gain a better sample of the soil in the testing area. The tool we used to get the soil is a core sampler, which is a metal tube. We pushed the tube into the soil about 10 inches, this was an informal procedure; 10 inches worth of soil was then brought up. For each sample we tested the top one to three inches and the seven to ten inches. We did this see if salt concentration varies depending on how deep the soil was. We put the soil samples into labeled bags, based on site and depth. Once our samples were collected we did two tests to gather our data; tested the conductivity and the chloride levels of each sites samples. Testing the conductivity was important because this test gives a general idea of how many impurities are dissolved in a water sample. The chloride test, told us how much is evident in the soil.

Our first step for the conductivity test was to measure out 250mL of deionized water. We also weighed the water to 250g, to double check that we had 250mL. Next we measured eight milliliters of soil and added it to the two hundred and fifty milliliters of deionized water (it's important to note that even though we took and weighed the same amount of soil from each sample, there was a tendency for the deeper samples to weigh more, we believe this could be that the soil is more compact at the deeper levels). We then stirred the solutions. Once the solutions were stirred we measured the conductivity by sticking the conductivity meter into the solution. We documented our data.

Then we continued with the chloride test. We first filtered the solutions by using the vacuum pump as follows: we added a filter to the top and put our solution of soil and de-ionized water (per site measurement) in the top of the machine. After 250 milliliters of our solution was filtered through we

were able to begin the chloride test. We then followed the low-range instructions of the Chloride Test Kit to determine the amount of chloride in the solutions. Again, this will then tell us how much salt is evident in the soil. We then repeated the same procedure for the samples we took in March; which was after the snow melted.

**Results:**

Distance from Curb

Site	Depth	0.5 meter	1 meter	2 meter
1: Front of Dome	Shallow: 1-3 in	10 $\mu\text{S/cm}$	15 $\mu\text{S/cm}$	5 $\mu\text{S/cm}$
	Deep: 7-10 in	9 $\mu\text{S/cm}$	3 $\mu\text{S/cm}$	11 $\mu\text{S/cm}$
2: Behind Dome	Shallow: 1-3in	122 $\mu\text{S/cm}$	57 $\mu\text{S/cm}$	53 $\mu\text{S/cm}$
	Deep: 7-10 in	144 $\mu\text{S/cm}$	26 $\mu\text{S/cm}$	27 $\mu\text{S/cm}$

Figure 1: This chart shows the conductivity of each site (in front of and behind the Edgedome) at each meter marking and depth mark.

	Depth Shallow	Depth Deep
Site 1: .5m	1.418	1.22
Site 1: 1m	2.022	0.311
Site 1: 2m	0.936	1.311
Site 2: .5m	16.712	14.551
Site 2: 1m	8.444	2.863
Site 2: 2m	8.746	3.165

Figure 2: This chart shows the Standard Conductivity for each sites depth and meter marking. The Standard Conductivity was taken by dividing the conductivity (from figure 1) by the mass of the sample.

	Site 1 Chloride Levels (mg/L)	Site 2 Chloride Levels (mg/L)
1-3 inches 1/2 meter	5	25
7-10 inches 1/2 meter	15	50
1-3 inches 1 meter	10	35
7-10 inches 1 meter	20	55
1-3 inches 2 meter	15	15
7-10 inches 2 meter	20	20

Figure 3: This chart shows the chloride levels for each site at each depth and meter marking. It's important to know the chloride levels so we could continue and figure out the Standard Chloride Levels.

Standardized Chloride Level for 1-3 inches

Standardized Chloride Level for 7-10 inches

Site 1: 1/2meter	0.018	0.085
Site 1: 1meter	0.051	0.129
Site 1: 2meter	0.047	0.104
Site 2: 1/2meter	0.068	0.142
Site 2: 1meter	0.056	0.041
Site 2: 2meter	0.083	0.059

Figure 4: This chart shows the next step. It's important to find the standardized chloride level because based on this information the chloride parts per thousand in the soil can be determined.

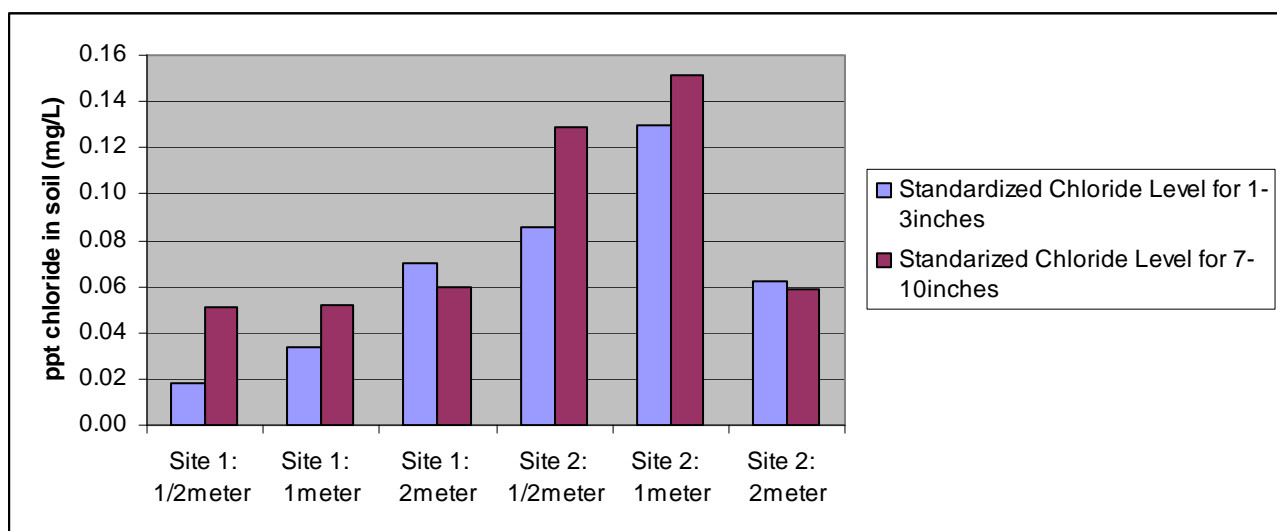


Figure 5: This graph is a comparison of the different chloride levels parts per thousand and the distances; from both sites, as well as the depth that each sample was taken at.

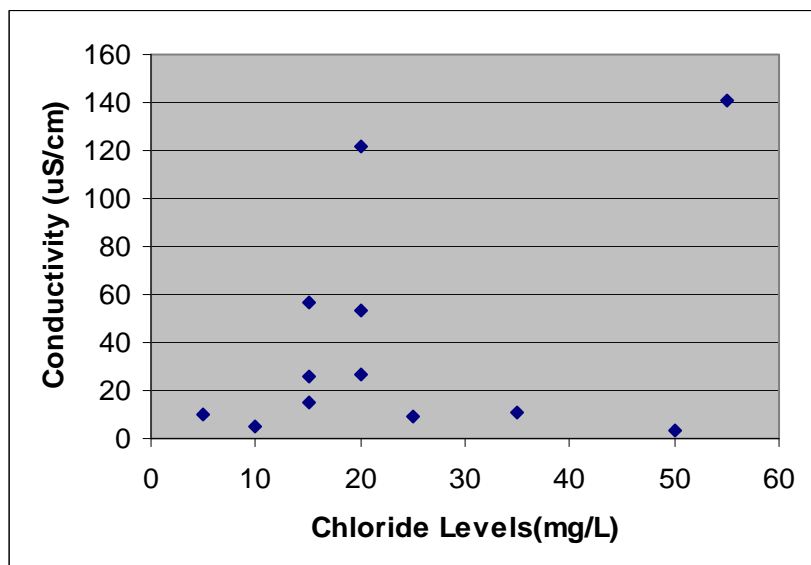


Figure 6: This scatter graph shows how the chloride levels in the soil affect the conductivity of the soil

sample.

**Data from spring:**

-Distance from curb-

Site	Depth	½ meter	1 meter	2 meter
1: Front of Dome	Shallow: 1-3 in	29 µS/cm	13 µS/cm	11 µS/cm
	Deep: 7-10 in	17 µS/cm	17 µS/cm	9 µS/cm
2: Behind Dome	Shallow: 1-3 in	38 µS/cm	39 µS/cm	18 µS/cm
	Deep: 7-10 in	20 µS/cm	28 µS/cm	20 µS/cm

Figure 1: This chart shows the conductivity of each site (in front of and behind the Edgedome) at each meter marking and depth mark.

-Distance from curb-

Site	Depth	½ meter	1 meter	2 meter
1. Front of Dome	Shallow: 1-3 in	2.09 µS/cm	0.82 µS/cm	0.75 µS/cm
	Deep: 7-10 in	1.03 µS/cm	1.11 µS/cm	0.62 µS/cm
2. Behind Dome	Shallow: 1-3 in	2.22 µS/cm	2.21 µS/cm	1.14 µS/cm
	Deep: 7-10 in	1.08 µS/cm	1.66 µS/cm	1.12 µS/cm

Figure 2: This chart shows the Standard Conductivity for each sites depth and meter marking. The Standard Conductivity was taken by dividing the conductivity (from figure 1) by the mass of the sample.

-Chloride Levels mg/L

Site	Depth	½ meter	1 meter	2 meter
1. Front of Dome	Shallow: 1-3 in	15	30	15
	Deep: 7-10 in	30	25	40
2. Behind Dome	Shallow: 1-3 in	20	20	35
	Deep: 7-10 in	40	25	35

Figure 3: This chart shows the chloride levels for each site at each depth and meter marking.

-Standardized Chloride Levels mg/L

Site	Depth	½ meter	1 meter	2 meter
1. Front of Dome	Shallow: 1-3 in	0.03	0.05	0.03
	Deep: 7-10 in	0.03	0.03	0.06
2. Behind Dome	Shallow: 1-3 in	0.04	0.04	0.06
	Deep: 7-10 in	0.05	0.04	0.05

Figure 4: This chart shows the next step after figure 3. It's important to find the standardized chloride level because once that information is given; one can find the chloride parts per thousand in the soil.

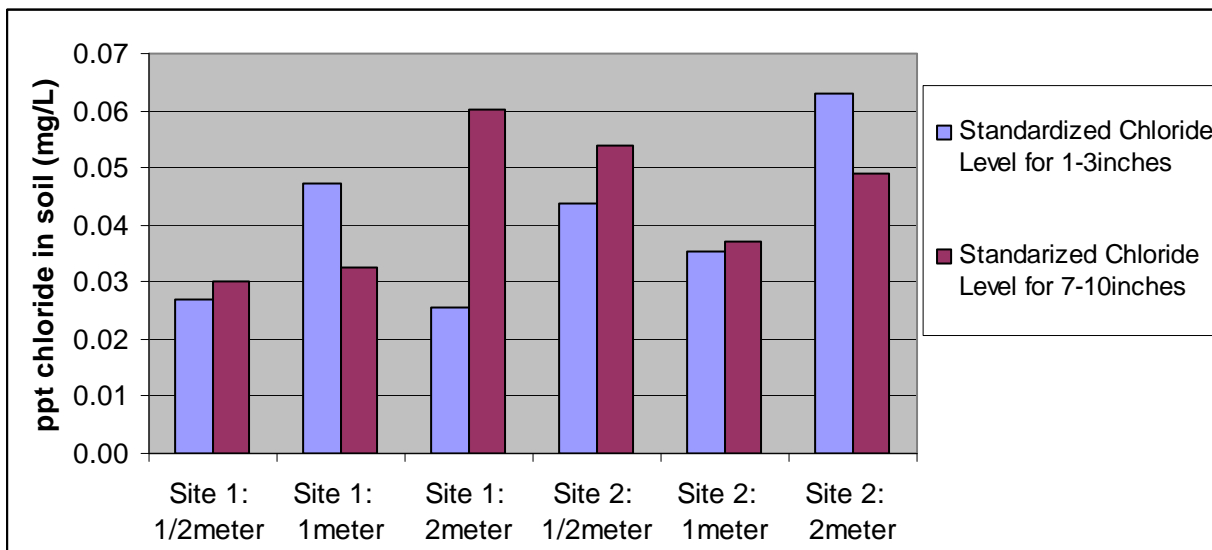


Figure 5: This graph is a comparison of the different chloride levels parts per thousand and the distances; from both sites, as well as the depth that each sample was taken at.

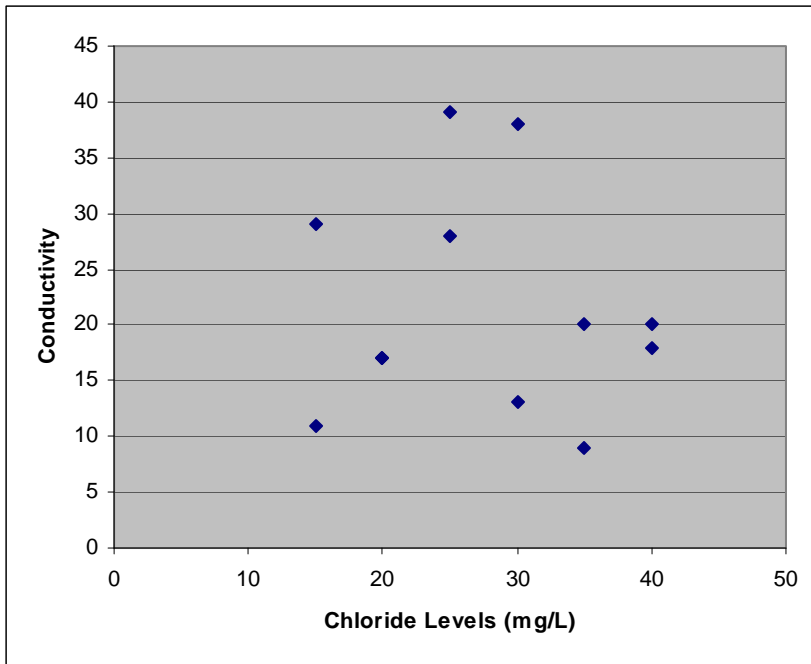


Figure 6: This scatter graph shows how the chloride levels in the soil affect the conductivity of the soil sample. Here we notice that the mid chloride levels created the highest conductivity as well as the higher chloride levels creating some of the lower conductivity readings.

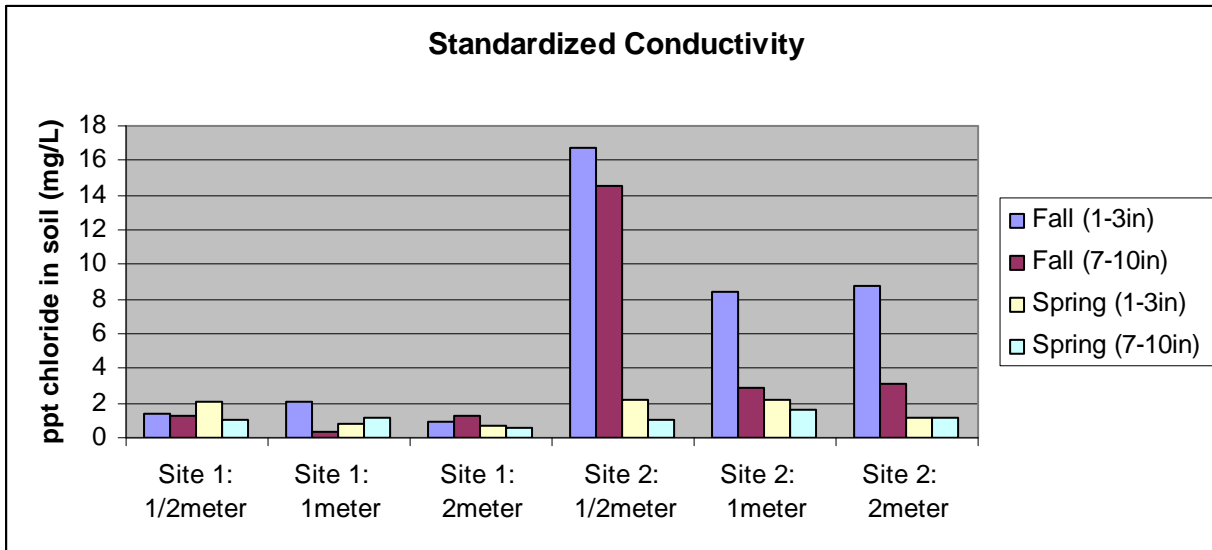


Figure 7: This graph shows the comparison between the standardized conductivity within the time that the samples were taken (fall/spring), as well as comparing the depth/distance of the samples. It is important to do this so that our hypothesis can be answered, because we were searching for the differences between seasons.

**Discussion:**

November 8, 2006

For each sample area we took three samples around the core sample; we collected the top 1-3cm

and the 7-10cm; the distances from the curb for the core samples we took were 0.5m, 1m, and 2m.

Site 1: In front of the Edgedome in the gravel. It was difficult to get samples at this site because the soil was hard.

Site 2: Next to the rain garden behind the Edgedome, next to the grade school parking lot, halfway between the curb and the plants. The first sample was at the start of the grass.

February 7, 2007

For site 2 the 1 meter sample for the first 1-3cm. was soft; whereas, the 7-10cm. sample of soil was hard and clumpy.

For site 2 the samples were hard for the 7-10cm at the 0.5m, 1m, and 2m. The samples at for the 1-3cm distances were soft soil samples.

We hypothesized that there would be higher levels in the samples that were both deeper and farther away from the curb. The data shows that our hypothesis is correct by saying that the deeper samples have higher levels. However, our data does not show that distance from the curb always made a difference. Our data for our fall samples show that behind the Edgedome, has higher levels of conductivity, and more so at the shallower depths. However when continuing to figure 2, the deeper samples have a higher chloride level. None the less our fall samples do show that our second site, behind the Edgedome, have higher levels. We feel that our data for the site 2 samples may have been affected by the construction that is going on behind the Edgedome. It may affect the samples by allowing more than just salt to penetrate into the soil. Our spring samples, show still that site 2 has the higher levels of both chloride and conductivity. When looking at the graphs, that compare the depth, they do show that our hypothesis is correct by saying that the deeper samples have greater levels. The one thing that our data doesn't show constantly is that distance from the curb mattered. We also stated that after the winter months, the soil would have higher levels of chloride and conductivity because the snow (which contains road salt) would melt into the soil. Our data in figure seven does not prove our hypothesis correct, because it shows that the sites had greater levels in the fall than in the spring. Our data, like stated before could have been skewed by the construction on Edgewood's campus, as well as the fact that the 2006-2007 winter weather was rather mild. For further research and recommendations, we feel that it is important to track this experiment over the years because it monitors the health of the soil in the rain gardens. The information from this experiment also can help Edgewood see the affects of road salt usage, since it is a private facility and doesn't have a set amount that they can or can not use, in like the city of Madison. We also feel that beyond keeping track of the salt being used, that Edgewood use not only salt for deicing, but start to use a sand mixture. All the recommendations and further research will be extremely beneficial because Lake Wingra surrounds Edgewood's campus. We are hopeful that the recommendations and further research can occur, being that Edgewood recently became one of the first Green campus' around Wisconsin.

## **References:**

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