Water with a Grain of Salt

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Widened roads + snow = more salt into water bodies.

Is this true? Yes and no. The total “mass” of salts may increase; however, the roadway drainage salinity may or may not be higher than the receiving water body’s. The purpose of this paper is to describe the process of quantification of additional salt to receiving water bodies as a result of deicing efforts on widened roads, since the amount of salt applied is directly related to road width.

Salt, as a chemical-based deicer, is commonly used in cold regions to manage snow on roads. Some local government entities mix sand with salt to improve traction (SI, 2008). However, to avoid clogging, sand-salt mix is not used in areas with storm drain pipes.

“The solution to pollution is dilution” is no longer a valid statement and it is not even acceptable. Most entities governing receiving water bodies (e.g. canal companies, Department of Environmental Quality and Department of Water Resources) require water discharged into their systems to be “as good as or better than” their waters. In most cases, storm drain systems include detention basin(s) to attenuate water quantity/quality peak flows before being released to receiving water bodies.

Generally, pollutants adhere to sediments which are carried along storm water. In addition to salts, typical pollutants include hydrocarbons, pesticides and heavy metals. The “first flush” flows pick up the loose dust along with pollutants. Detention basins trap the sediments as water velocities come to minimum allowing smaller sediment particles to settle down.

Ok, what is salt?

When we say “salt”, people generally mean Sodium Chloride (NaCl) and any of its forms; e.g. table salt. A “salt” is an ionic compound of a cation and an anion. Both ions could be organic, inorganic, mono-atomic and polyatomic. It is generally formed by replacing all or part of the hydrogen ions of an acid with metal ions. Common deicer salts are NaCl, Calcium Chloride ($CaCl_2$), Potassium Chloride (KCl), and Magnesium Chloride ($MgCl_2$). Commercial products may include a blend of these salts. Brine is a water solution with salinity of 50,000 ppm or higher (Table 1).

Table 1: Salinity in Water Solution

Water	Salinity (ppm)
Fresh	<500
Brackish	500 - 30,000
Saline	30,000 – 50,000
Brine	> 50,000

How does deicing work?

Salt dissolves in water through an exothermic reaction (releases energy in form of heat), creating local temperature higher than the ambient, which induces more melting of ice, which in turn is more water for the salt to dissolve in creating brine which has a lower freezing point, and the “good cycle” is on (Figure 1).

How do we determine additional salt input?

First, an estimate of the salt application rate is needed. Application rates vary greatly depending on the location and the storm. They range between 25 and 400 kg/km.lane (MOP, 2008), (TRB, 2007), (OMT, 2003). Most municipalities determine rates based on general guidelines and experience (UDOT, 2008).

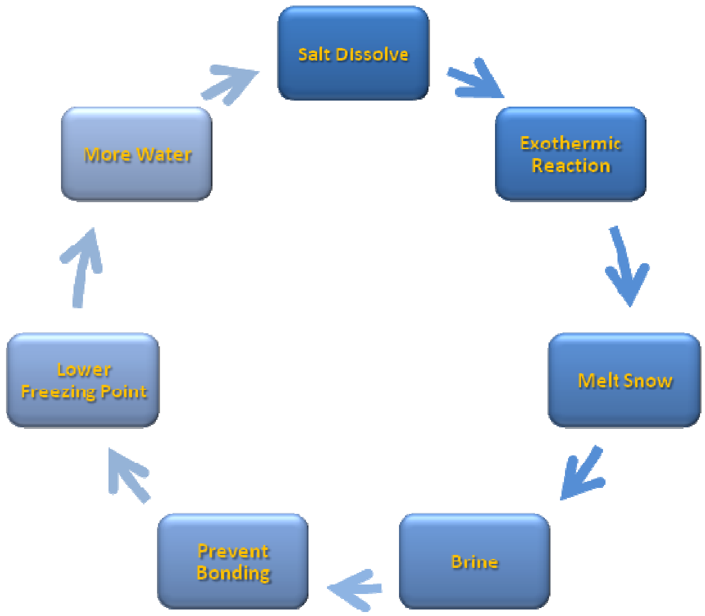

Figure 1: Deicing Mechanism; the "Good Cycle".

Secondly, existing and proposed (widened) roadway surface area that contributes to the water body is calculated. Winter snowfall, snow water equivalent and number of storms per winter are used to determine the volume of collected water per storm.

Using the application rate, roadway area, salt-sand ratio and assay, the total amount of applied salt is determined. Hence, average TDS (and Chloride concentrations) for the water collected in the pond for existing and proposed conditions are calculated.

Once TDS, Chloride, and other constituents are calculated, few comparisons are necessary to evaluate if widening the road has adversely affected the receiving waters:

1. Proposed TDS/Chloride against existing.
2. Proposed TDS/Chloride against receiving water body's.
3. Proposed TDS/Chloride against designated use water quality standards.

If the proposed concentrations are higher than existing conditions or than the receiving water body's, a mass balance equation may be used to estimate resultant concentration:

$$C_{Output} * Q_{Output} = C_{Pond} * Q_{Pond} + C_{Stream} * Q_{Stream}$$

Where:

C_{Output} = TDS downstream the discharge point (ppm).

Q_{Output} = Flow downstream the discharge point (cfs).

C_{Pond} = Pond TDS (ppm).

Q_{Pond} = Pond discharge rate (cfs)

C_{Stream} = Base level TDS (ppm)

Q_{Stream} = Stream operating flow (cfs)

To alleviate the direct effect on the environment, the following may be considered.

- Depending on the pond temporal geometrics, the salinity gradient (i.e. higher saline water is closer to pond bottom) may be significant, so that a raised pond outlet may be located in a lower salinity zone in the profile; closer to surface. This will help release "less saline" waters.
- Generally, storm water ponds allow residence time; therefore, filtration and sedimentation may take place, before discharging to receiving waters.
- Operating seasons of water bodies must be taken into consideration, for example most canal companies do not operate in winter where deicing salt input peaks.

Finally, as seen in Figure 2 , the basic steps in quantifying additional salt input are:

1. Data collection and assumptions,

2. Estimate concentrations and

3. Compare against regulations.

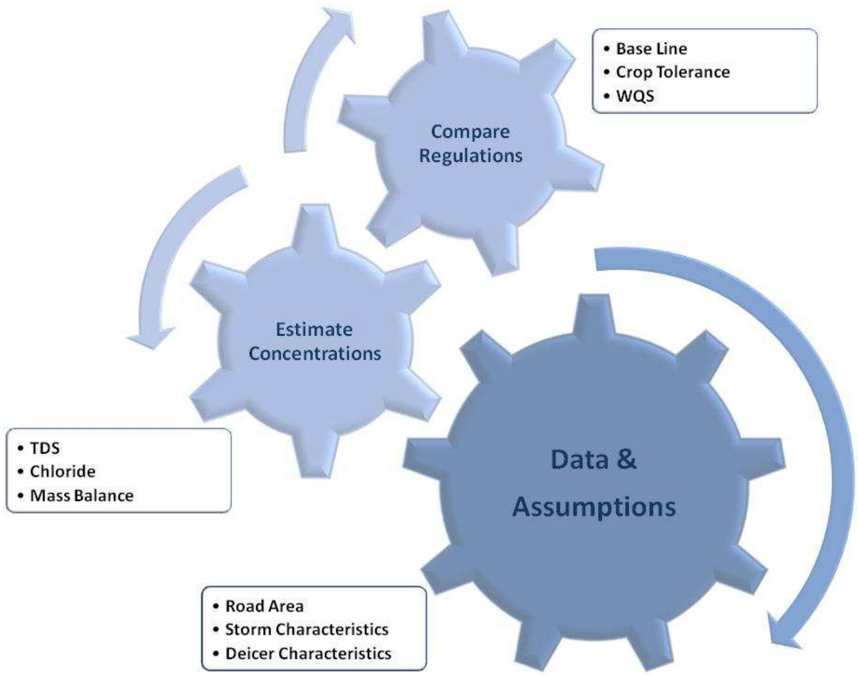

Figure 2: Salt Input Flow Chart

In summary, and since stormwater could be viewed as the only water supply, on this planet, great attention must be given to reduce polluting it. With approximately 25 million tons of deicing salt used each year in the US (TRB, 2007), great attention must be directed towards better management and efficient application of deicing salts in cold areas. The public will not endure a man-made replica of the Great Salt Lake where TDS is 300,000 ppm.

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