ROAD SALT
FATE AND TRANSPORT CONCEPTUAL MODEL

Presented on February 14, 2019

Water Quality Monitoring and Research Workgroup

CONCEPTUAL SITE MODEL: DEVELOPMENT OBJECTIVES

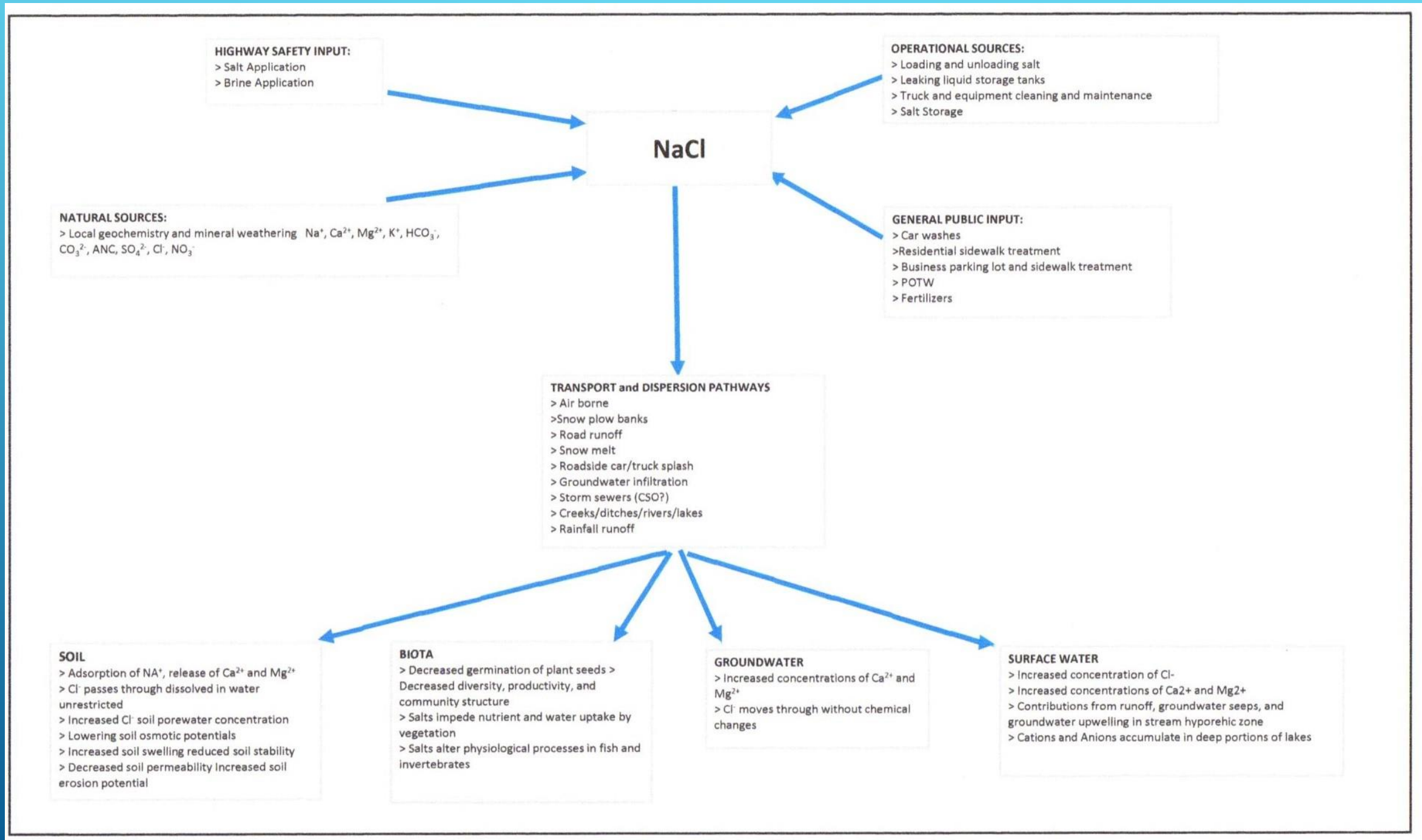
- Gain understanding of deicing compound inputs and fate
- Identify primary and secondary sources
- Define preferential flow pathways
- Determine dispersion and distribution of compounds
- Support development of framework for monitoring program and potential quantitative benchmark tracking

CONCEPTUAL MODEL DEVELOPMENT BACKGROUND

- Obtained 8 main references (2 Canadian and 6 US) – 2 were published articles and required contacting primary authors for a copy
- Sources included – Minnesota, New York, Maryland, Massachusetts, City of Toronto, and Town of Penetanguishene
- Most sources date from 2016 although a Minnesota Pollution Control Agency document was prepared in 2009
- Published articles contain excellent details of data collection, assessment, and interpretation to support water quality trend analysis

CONCEPTUAL SITE MODEL: IMPORTANT FACTORS TO DISCUSS

- Natural and background concentrations of ions
- Identification of local primary and secondary deicing compounds
- Selection of key local environmental conditions
- Factors contributing to mass balance


HIGHWAY SAFETY INPUT:
> Salt Application
> Brine Application
OPERATIONAL SOURCES:
> Loading and unloading salt
> Leaking liquid storage tanks
> Truck and equipment cleaning and maintenance
> Salt Storage
NaCl
NATURAL SOURCES:
> Local geochemistry and mineral weathering Na^+, Ca^{2+}, Mg^{2+}, K^+, HCO_3^-, CO_3^{2-}, ANC, SO_4^{2-}, Cl^-, NO_3^-
GENERAL PUBLIC INPUT:
> Car washes
>Residential sidewalk treatment
> Business parking lot and sidewalk treatment
> POTW
> Fertilizers
TRANSPORT and DISPERSION PATHWAYS
> Air borne
>Snow plow banks
> Road runoff
> Snow melt
> Roadside car/truck splash
> Groundwater infiltration
> Storm sewers (CSO?)
> Creeks/ditches/rivers/lakes
> Rainfall runoff
SOIL
> Adsorption of NA^+, release of Ca^{2+} and Mg^{2+}
> Cl^- passes through dissolved in water unrestricted
> Increased Cl^- soil porewater concentration
> Lowering soil osmotic potentials
> Increased soil swelling reduced soil stability
> Decreased soil permeability Increased soil erosion potential
BIOTA
> Decreased germination of plant seeds > Decreased diversity, productivity, and community structure
> Salts impede nutrient and water uptake by vegetation
> Salts alter physiological processes in fish and invertebrates
GROUNDWATER
> Increased concentrations of Ca^{2+} and Mg^{2+}
> Cl^- moves through without chemical changes
SURFACE WATER
> Increased concentration of Cl-
> Increased concentrations of Ca2+ and Mg2+
> Contributions from runoff, groundwater seeps, and groundwater upwelling in stream hyporehic zone
> Cations and Anions accumulate in deep portions of lakes

CONCEPTUAL SITE MODEL FUTURE CONSIDERATIONS

- Is a quantitative fate and transport model necessary?
- What level of effort required to effectively determine the mass balance and minimize uncertainties?
- What metrics and locations are important to assess trends in ion concentrations?