



# MONITORING CHLORIDE USING CONDUCTIVITY DATA LOGGERS

PRESENTED TO THE LAKE CHAMPLAIN WATERSHED DEICING CONFERENCE 2017

SEPTEMBER 29, 2017



Presented By



- ❖ Chloride – Sources and Impacts
- ❖ Chloride Standards
- ❖ Sampling Methods
- ❖ Data and Results
  - ❖ Temperature/Precipitation Effects
  - ❖ Seasonality



# Where does chloride come from?

Natural Sources – Soil/Rock and Water Interactions



Road Deicing



Agricultural Runoff



Wastewater Treatment



Water Softeners





# How does chloride affect flora and fauna?

Chloride can:

- ❖ Replace soil nutrients otherwise available to plants
- ❖ 'Salts' will absorb groundwater otherwise available to plant roots
- ❖ Chloride ions accumulate in plant leaves and interfere with chlorophyll production and photosynthesis

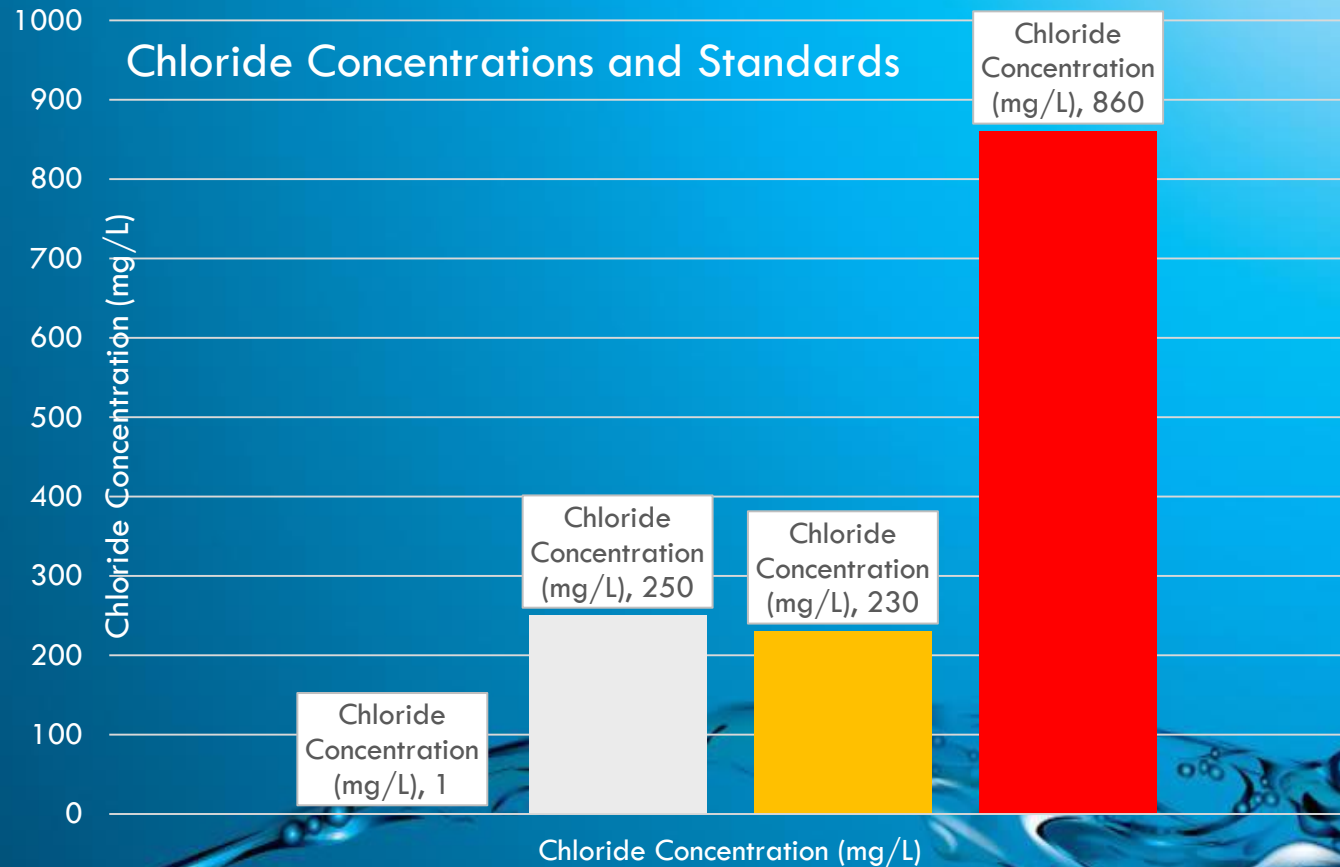


In Fauna:

- ❖ Chloride ions release toxic metals from soil –
- ❖ This can inhibit nutrient availability and decrease DO



# Chloride Levels – Natural and Water Quality Standards



Precipitation and Natural Levels Vary - ~1 mg/L is typical.

Chloride in Drinking Water is a Secondary (Non-Enforced) Criteria for aesthetics. At 250 mg/L water tastes salty.

Chronic Impairment is a four-day average that occurs once every three years.

Acute Impairment is a one-hour average that occurs less than once every three years.

■ Precipitation ■ Drinking Water ■ Chronic Impairment ■ Acute



# Measuring Chloride in Surface Water

- ❖ Equipment
- ❖ Sample Site Setup
- ❖ Conductivity and Specific Conductance – relationship
- ❖ Chloride and Specific Conductance – relationship
  - ❖ Developing a Regression Equation
  - ❖ Vermont's Regression Equation
- ❖ Chloride Trends to Expect
  - ❖ Seasonality – Winter vs. Summer
  - ❖ Precipitation / Melt Effects by Season
- ❖ Weather Data and Data Analysis



# Equipment Selection

**Aqua *TROLL*® Instruments** Conductivity, Temperature,  
Plus Water Level Logging



**Accurate Results**

- Use dynamic density compensation to collect accurate water level data in environments where salinity values may vary.
- Receive factory-calibrated instruments that are validated with NIST®-traceable standards.
- Deploy for long-term monitoring. Instruments operate with very low drift.

Price: ~\$2,495.00

## Measurements

- ❖ Conductivity
- ❖ Specific Conductance
- ❖ Water Temperature
- ❖ Salinity
- ❖ Total Dissolved Solids
- ❖ Pressure
- ❖ Resistivity
- ❖ Water Density

## Benefits —

- ❖ Long Battery Life - ~5 years at 15 minute intervals
- ❖ High-accuracy Measurement (+/- 0.5%)
- ❖ Low Drift
- ❖ Factory Calibrated

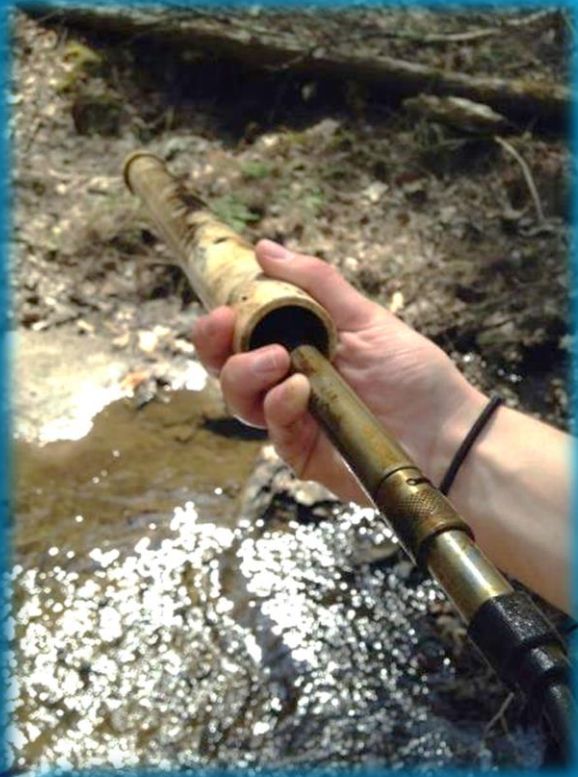
## Other Equipment:

- ❖ Cable and Lock
- ❖ ~3' PVC (perforated)
- ❖ Laptop or tablet
- ❖ Sample Bottles



# Sample Site Setup

Probe Deployed in PVC pipe for protection



Probe Location

Cable and Lock

Pressure Vent





# Sample Site Setup

The Cage Upgrade  
(Thanks to the Town and Village of Essex)

Protective Cage

Anchor

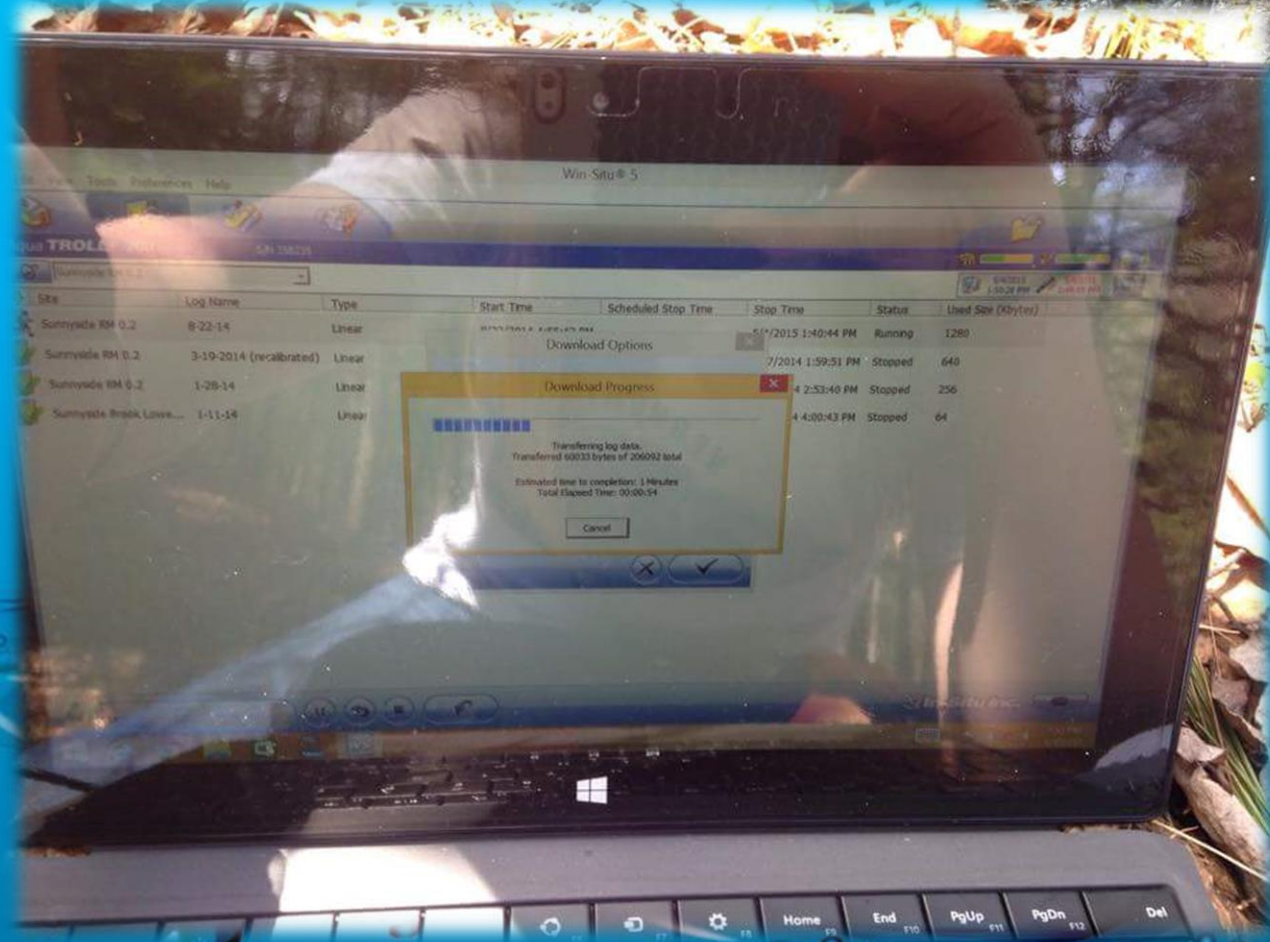
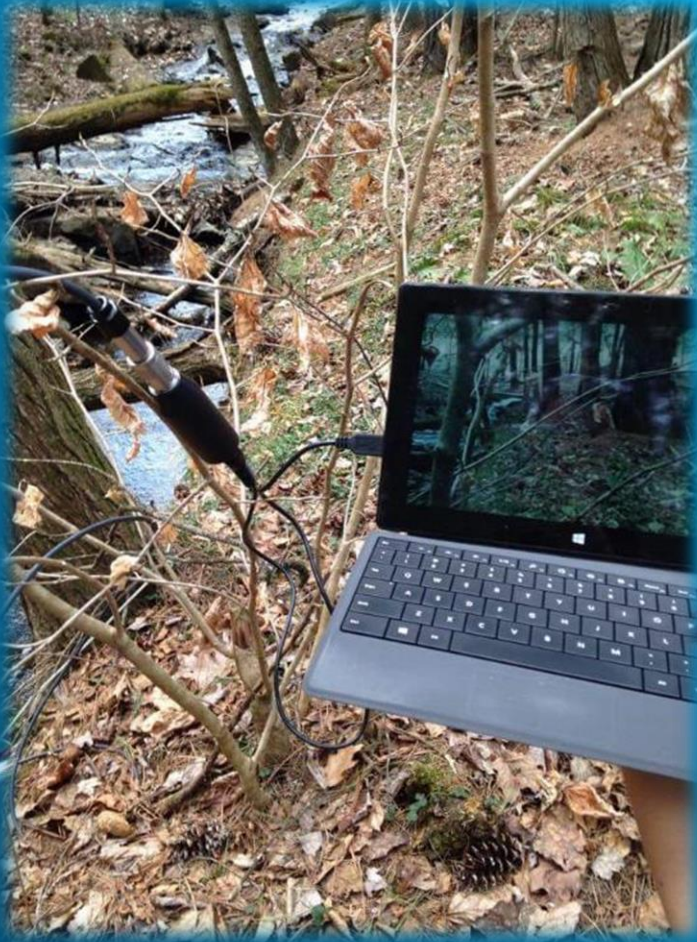
Cable and Lock





# Sample Site Setup

Probe connects to laptop for data download





# Conductivity and Specific Conductance - relationship

Conductivity – measurement of ability of water to conduct electricity

Increased by dissolved salts in water (ions)

Measures in microSiemens or microohms per centimeter

Specific Conductance – corrected conductivity for temperature (normalized)



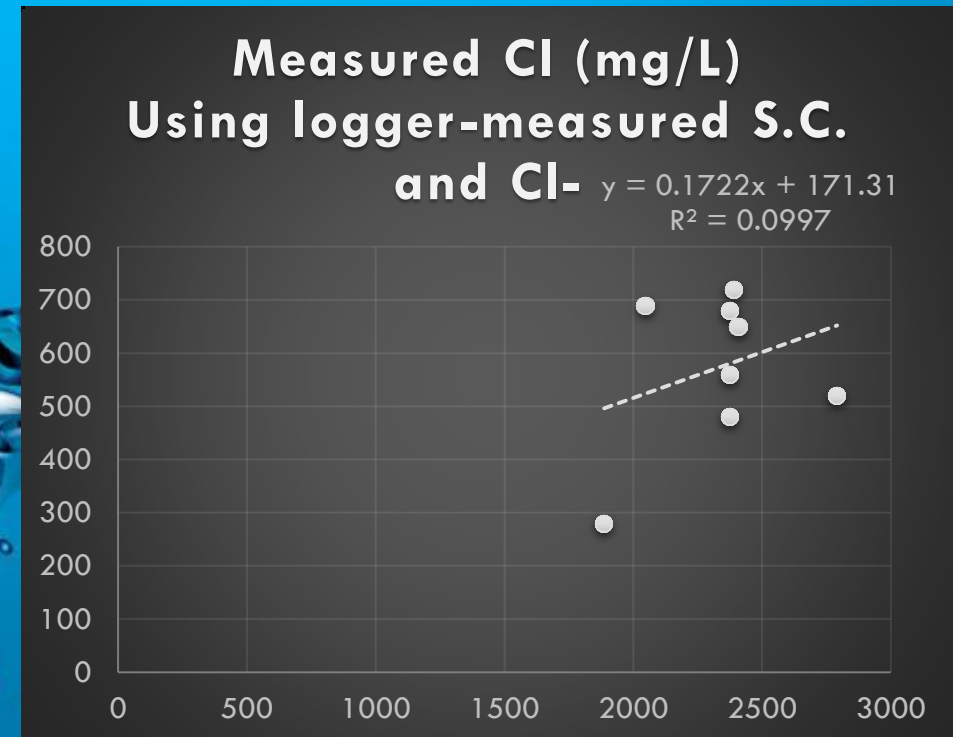
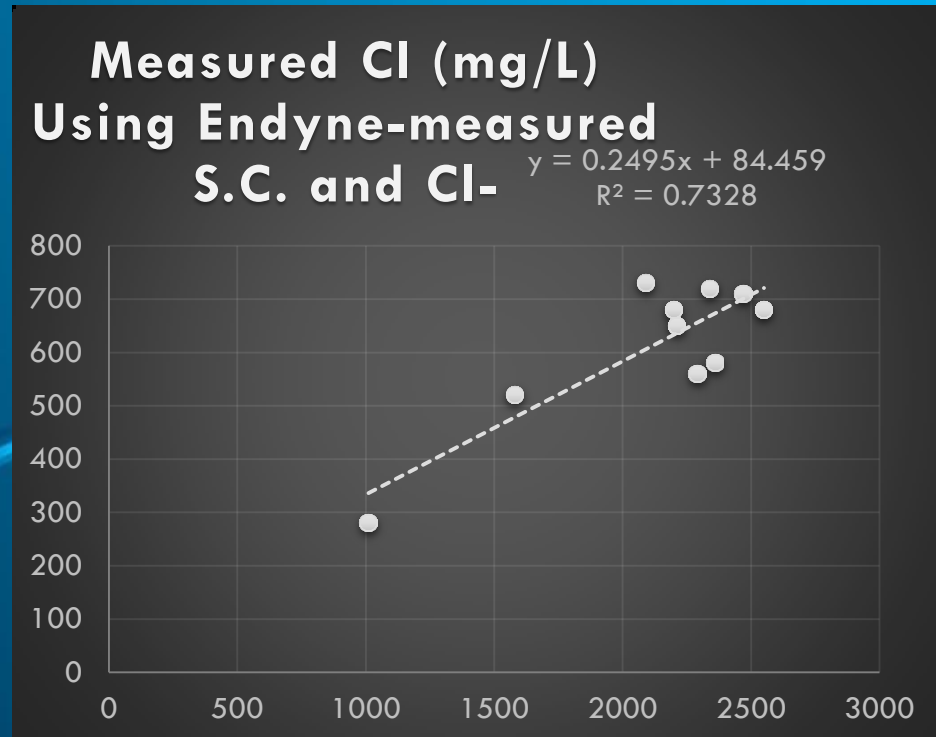
# Specific Conductance and Chloride- relationship

## Relationship:

- ❖ Develop Simple Linear Regression –  $y = mx + b$
- ❖ Collect water samples for chloride analysis at same time logger measures SC
- ❖ Match them together to create regression

## Limitations:

- ❖ If n (number of samples) is low, regression isn't overly predictive (low R-squared)
- ❖ If sampled events are all from high Cl concentration sites, regression misses low/middle events (under-predicts)





# Specific Conductance and Chloride- relationship

**VT - New CI Regression 2016:**

**Chloride (mg/L) = 0.292 \* [Specific Conductance Value (uS/cm)] - 69.72**

**R-squared: 0.94 (good)**

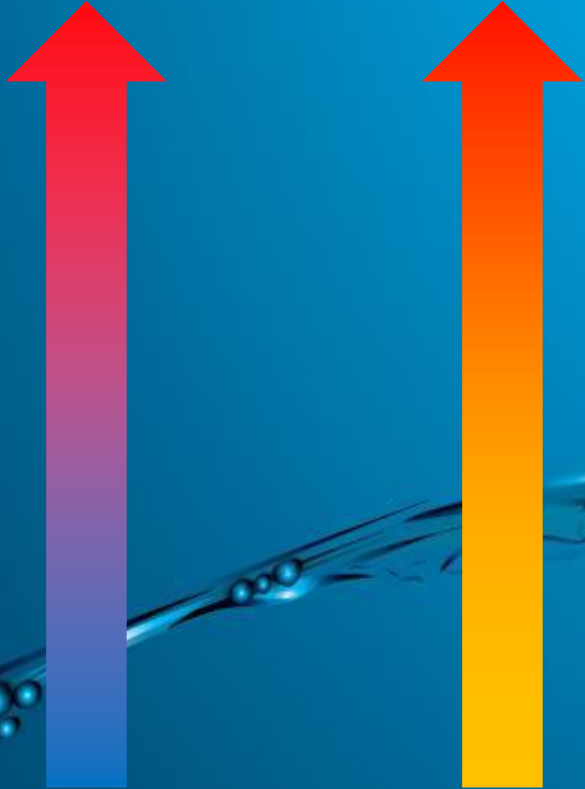
**n = 441**



# Chloride Trends to Expect

Winter

Increased Temperature = Increased Chloride



Summer

Increased Precipitation = Decreased Chloride



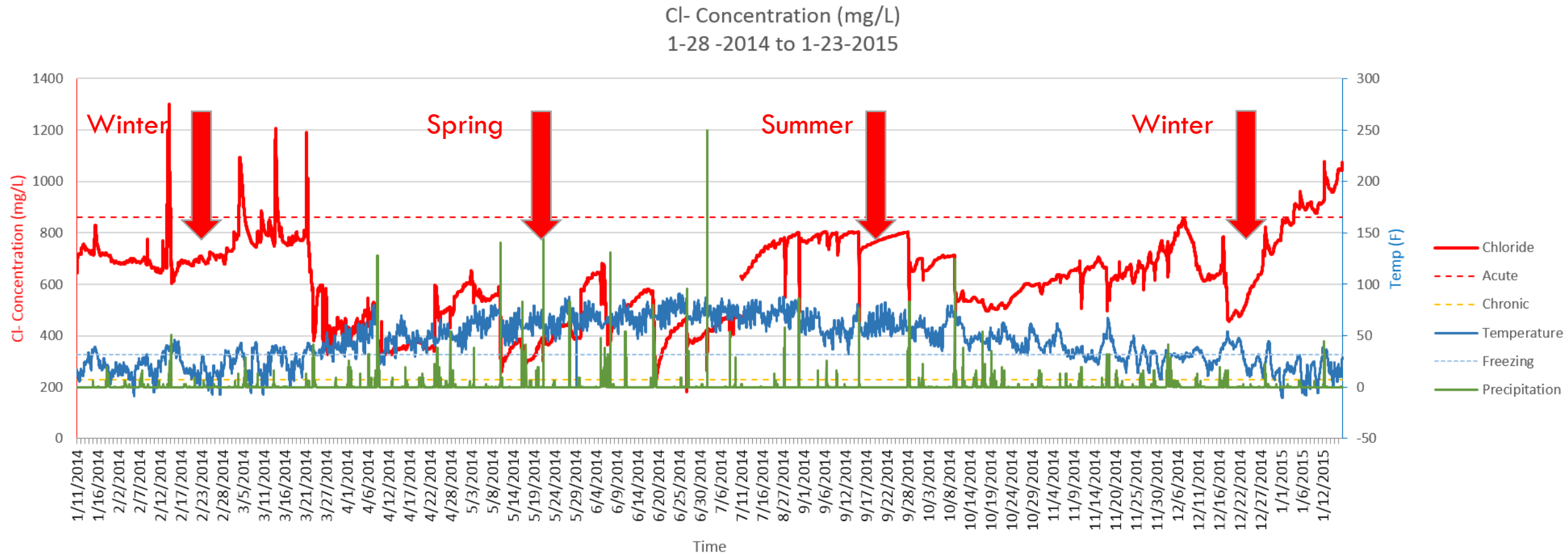
Summer

Decreased Precipitation = Increased Chloride





# Data

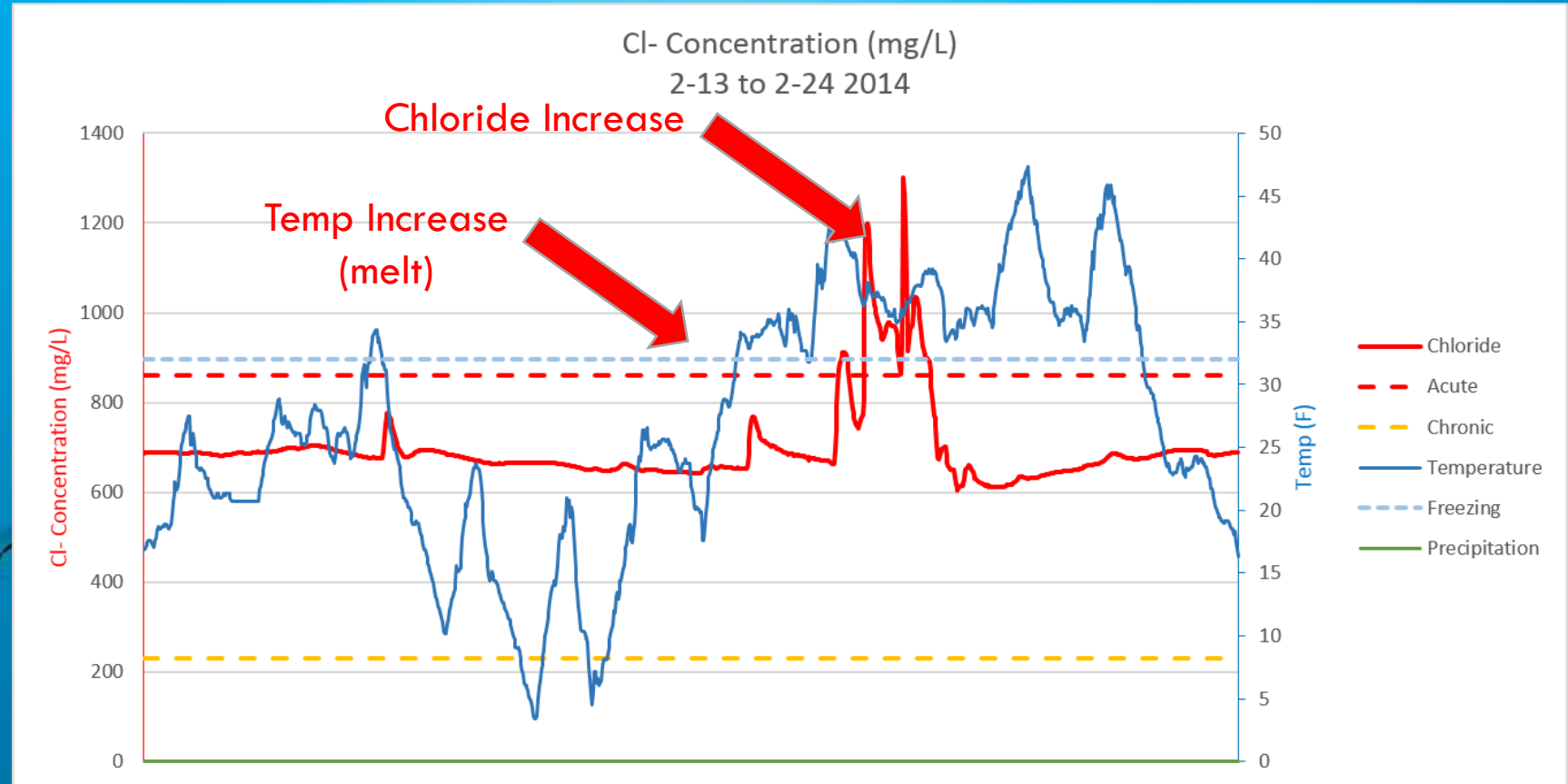


# Data – Winter Patterns

## General Trends –

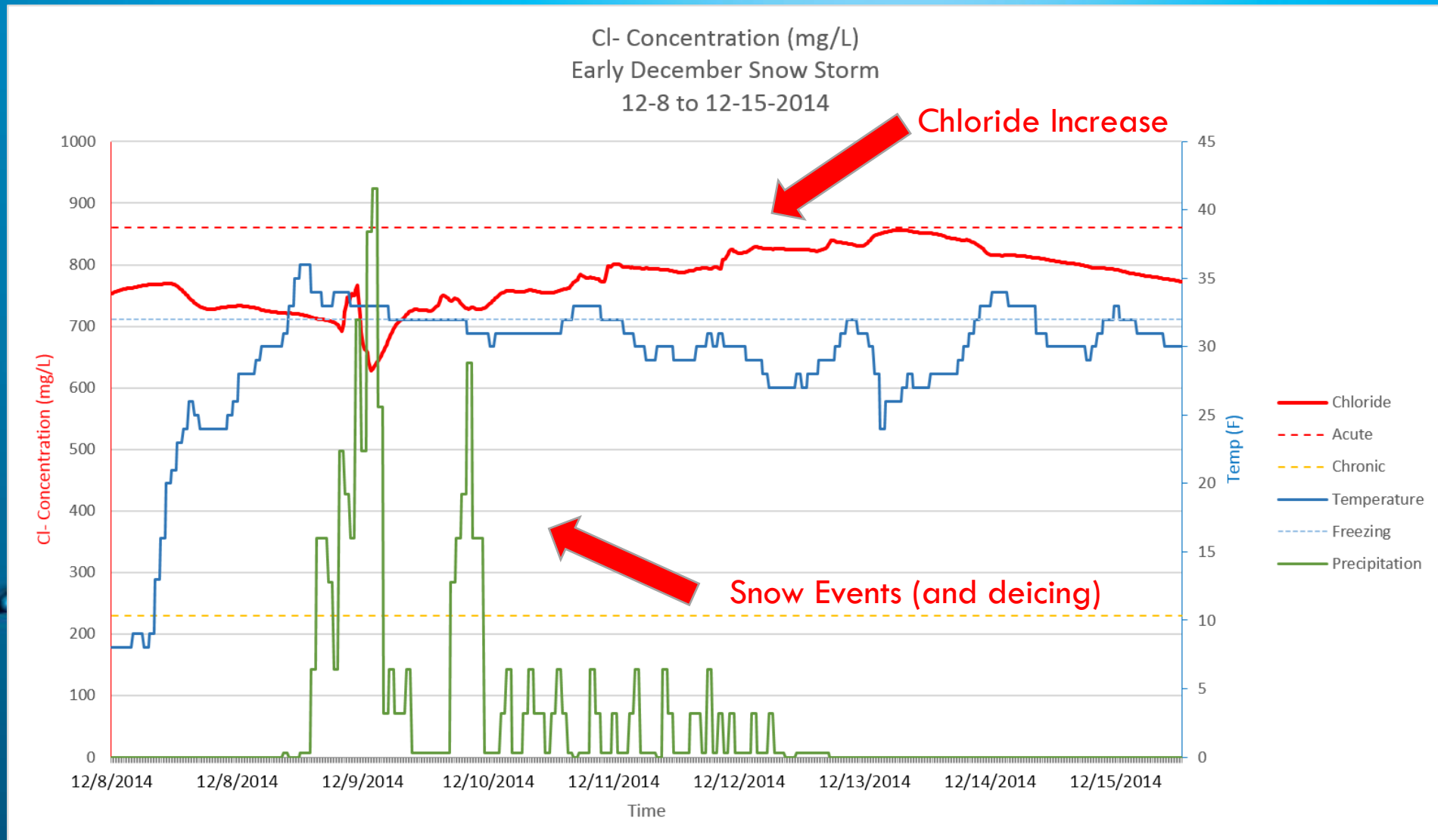
- ❖ Cl levels generally higher in winter
- ❖ When Temp rises, Cl rises
- ❖ When temp lowers, Cl lowers
- ❖ ~Linear Relationship

## Winter Melt Pattern:

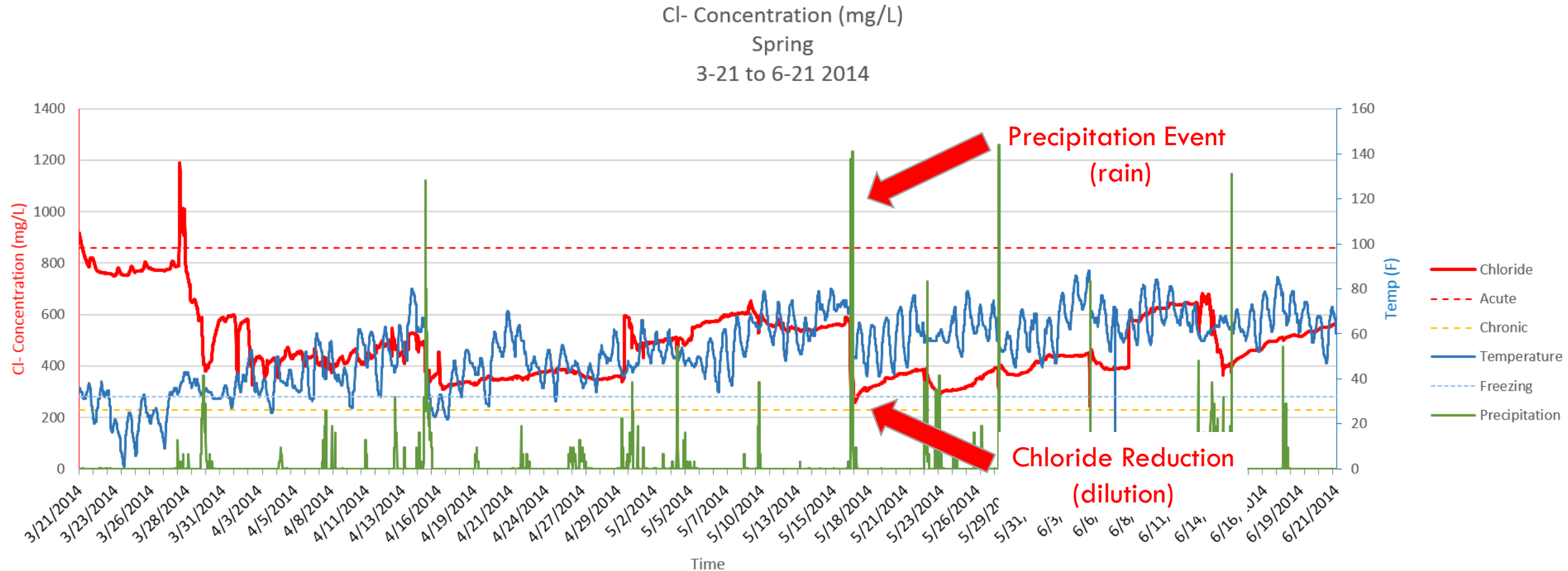




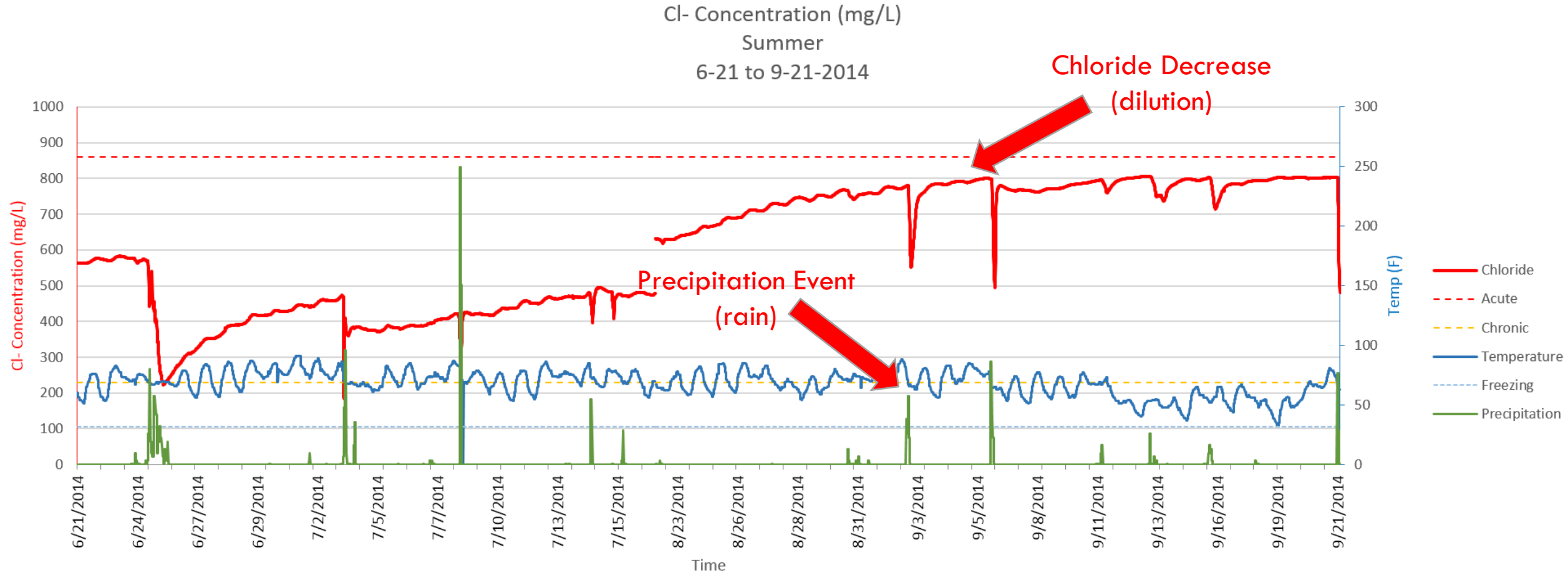
# Data – Winter Patterns



# Data – Spring Patterns

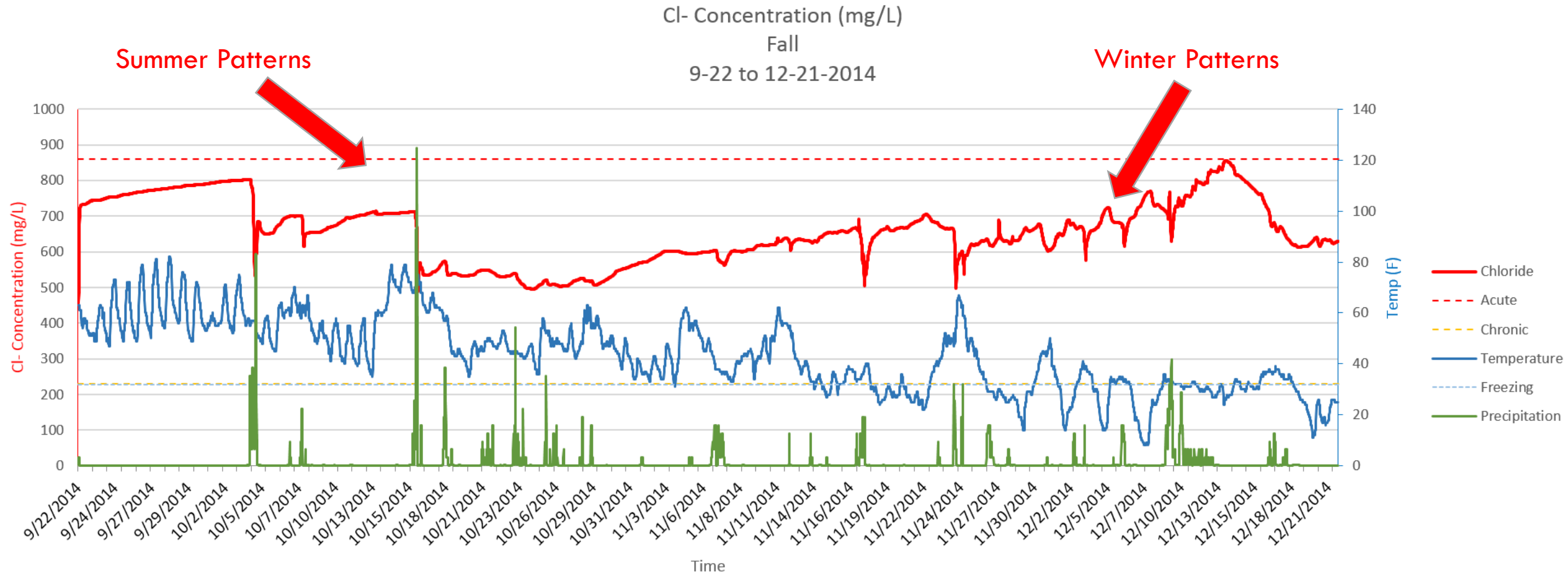


# Data – Summer Patterns





# Data – Fall Patterns



# Weather Data – to understand patterns

<http://www.nrcc.cornell.edu/>

**Northeast Regional Climate Center**

About the NRCC Station Products State/Regional Analyses Specialty Pages Climate Change

### Welcome to the NRCC

Established in 1983, the Northeast Regional Climate Center (NRCC) is located in the Department of Earth and Atmospheric Sciences at Cornell University. It serves the 12-state region that includes: Connecticut, Delaware, Massachusetts, Maryland, Maine, New Hampshire, New Jersey, New York, Pennsylvania, Rhode Island, Vermont, and West Virginia. Major funding is provided through a contract with the National Oceanic and Atmospheric Administration. The Center's staff works cooperatively with the National Climatic Data Center, the National Weather Service, state climate offices, and other interested scientists in the Northeast to acquire and disseminate accurate, up-to-date climate data and information.

#### Daily Almanacs

Albany, NY	Hartford, CT
Atlantic City, NJ	Morgantown, WV
Baltimore, MD	New York, NY
Binghamton, NY	Philadelphia, PA
Boston, MA	Pittsburgh, PA
Buffalo, NY	Portland, ME
Burlington, VT	Providence, RI
Charleston, WV	Syracuse, NY
Concord, NH	Washington, DC
Harrisburg, PA	Wilmington, DE

#### Latest Monthly Webinar

**Northeast Monthly Climate Update**  
March Recap & Water Resources Outlook

View our Webinar from April 28th: March Recap & Water Resources Outlook

Individual presentations can also be viewed: March Recap & Dryness and NERFC April Update.

#### Climate Center News

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#### A Tale of Two Aprils

Percent of Normal Precipitation  
April 1 – April 30, 2015

Mouse over map to pause

Northeast Regional Climate Center

5 25 50 70 90 110 130 150 200 300

West Virginia and New England had polar opposite Aprils. The southwest part of the region saw more than 150 percent of normal precipitation, while the northeast part of the region saw less than 90 percent of normal. For the areas sandwiched in between, precipitation ranged from 25 percent of normal to 200 percent of normal.

The two corners of the region were at odds in terms of temperature, as well. While West Virginia was warmer than normal, New England was colder than normal. The rest of the Northeast generally saw temperatures within 2 degrees of normal. There was one thing most of the region did have in common, though: a lack of snow.

## Why NRCC?

- ❖ They can provide daily, 1-hour interval measurements of temperature and precipitation
- ❖ Better than NOAA – NOAA data isn't up to date yet
- ❖ For 15-minute logging – you have to interpolate data from 1-hour to 15-minute increments
- ❖ \$5/month, \$14 service charge annually

Contact:  
Jessica Spaccio  
[nrcc@cornell.edu](mailto:nrcc@cornell.edu)

## Resources:

- ❖ Chloride Assessment of Select Urban Streams in Chittenden County VT – July 1 007 – VT DEC
- ❖ Data Report for Chloride TMDL for Waterbodies in the I-93 Corridor – December 2007 - NH DES
- ❖ NH I-93 Corridor Chloride TMDL – Quality Assurance Project Plan – June 2006 – NH DES
- ❖ Estimating Chloride Concentrations of Road-Salt Constituents in Highway-Runoff from Measurements of Specific Conductance – 1999 – USGS (Granato and Smith)





# Questions?

Contact [dana@watershedca.com](mailto:dana@watershedca.com)

[www.watershedca.com](http://www.watershedca.com)

