MONITORING CHLORIDE USING CONDUCTIVITY DATA LOGGERS

PRESENTED TO THE LAKE CHAMPLAIN WATERSHED DEICING CONFERENCE 2017

SEPTEMBER 29, 2017

Presented By

WATERSHED CONSULTING ASSOCIATES, LLC

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

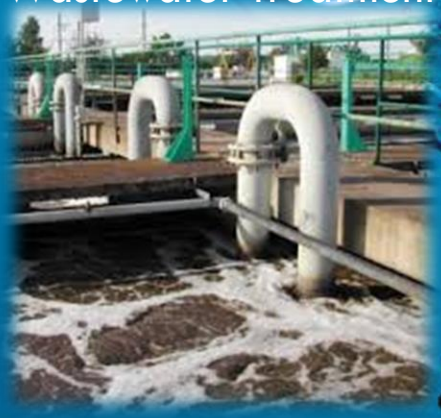
Where does chloride come from?

Natural Sources – Soil/Rock and Water Interactions

Road Deicing

Agricultural Runoff

Wastewater Treatment



Water Softeners

How does chloride affect flora and fauna?

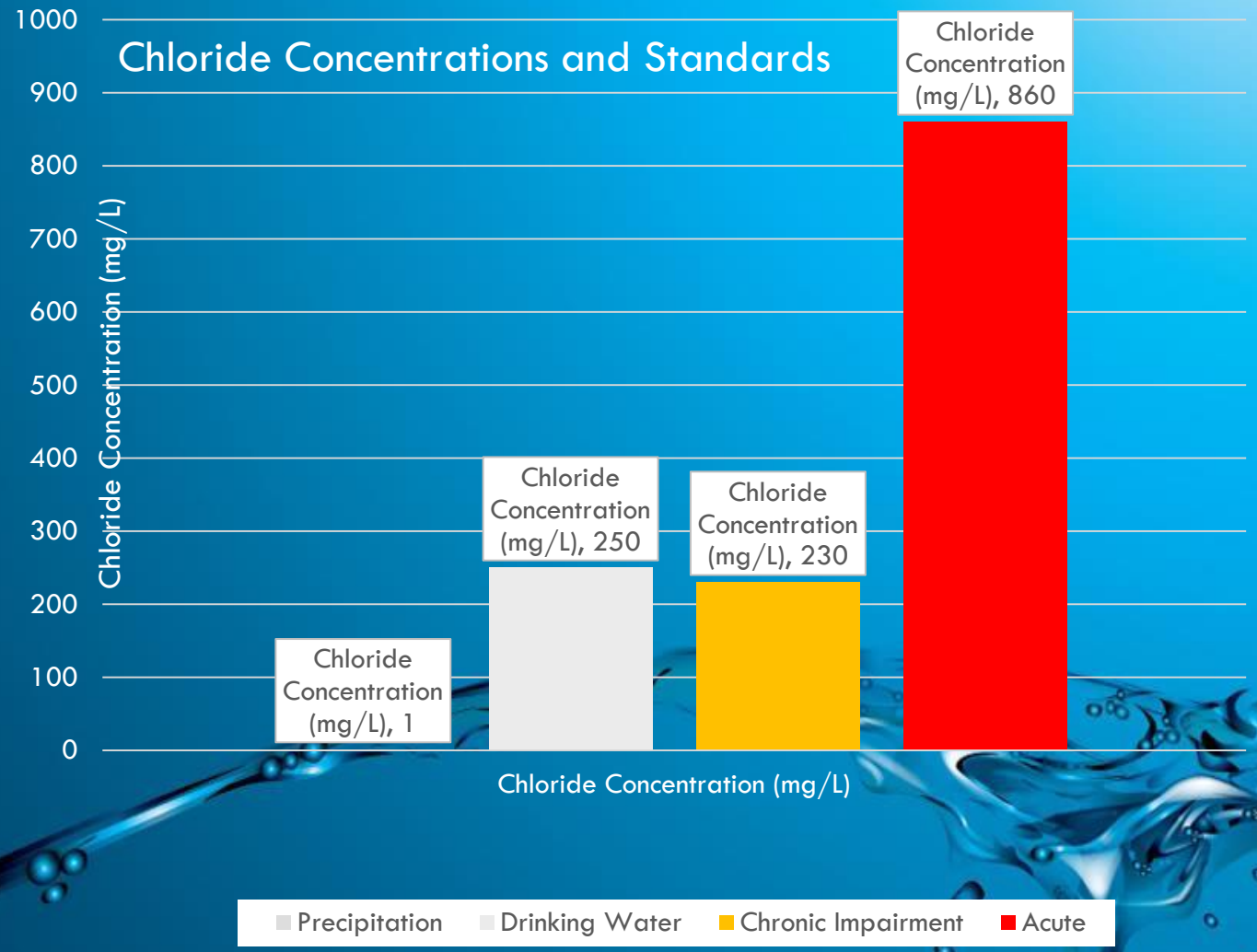
Chloride can:

- 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 - ~1mg/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.

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 –

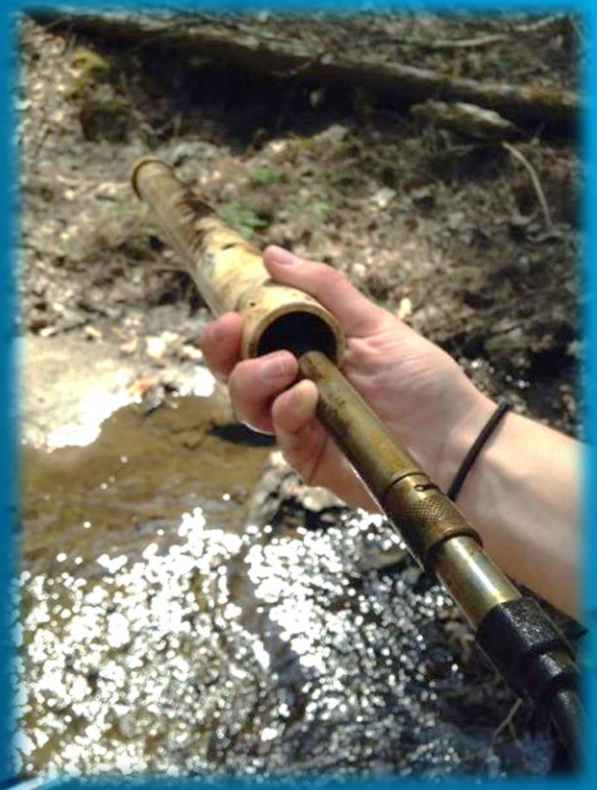
- Long Battery Life - ~5 years at 15 minute intervals
- High-accuracy Measurement (+/- 0.5%)
- Low Drift
- Factory Calibrated

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

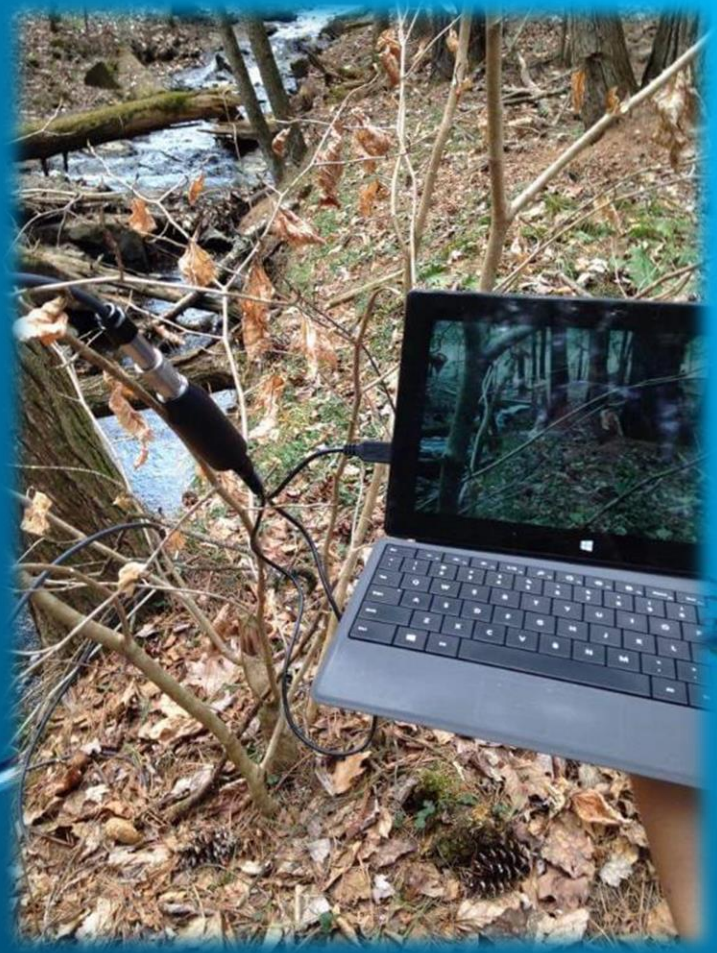
Pressure Vent

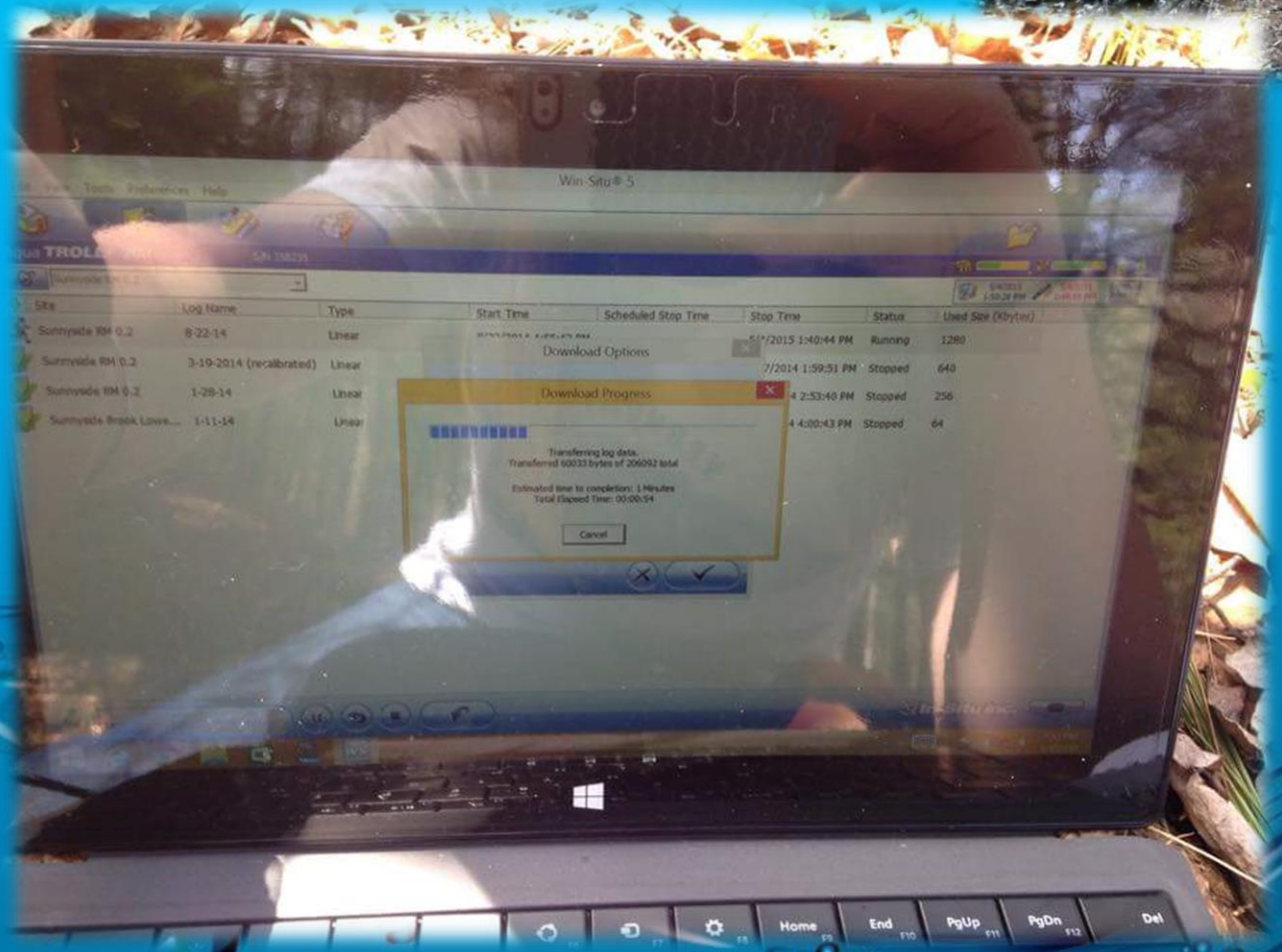
Sample Site Setup

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

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 microohmos per centimeter

Specific Conductance – corrected conductivity for temperature (normalized)

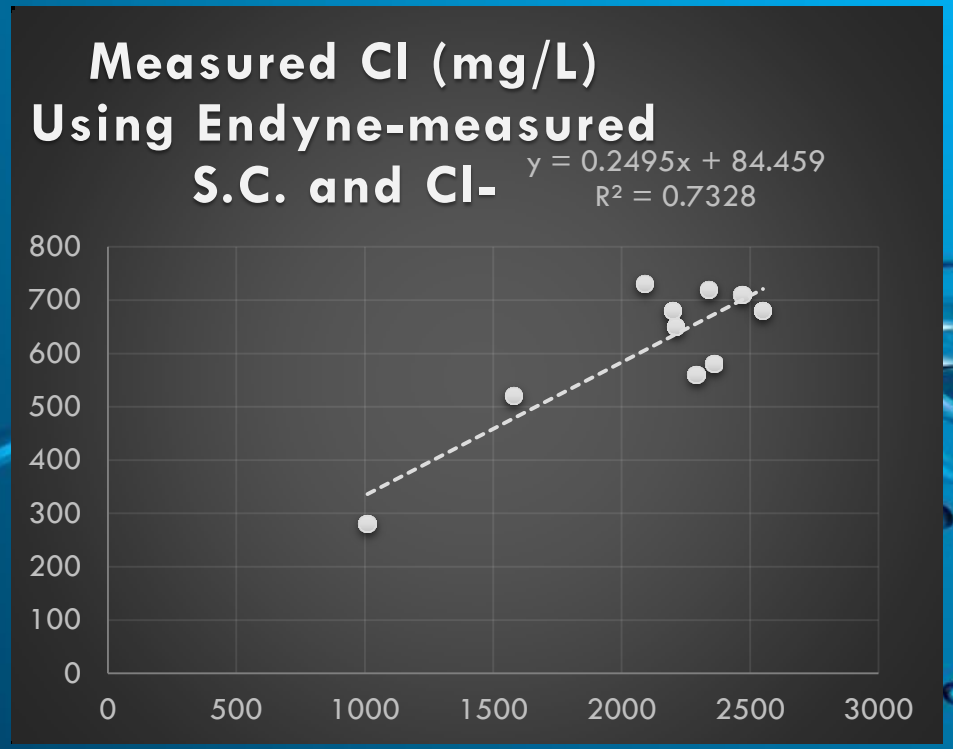
Specific Conductance and Chloride- relationship

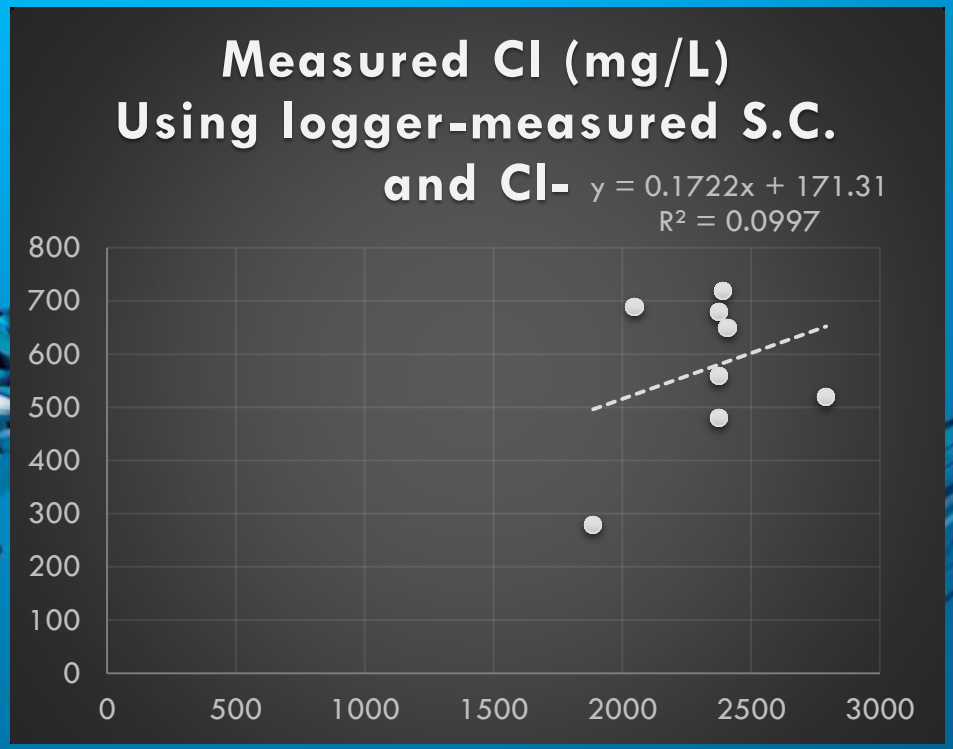
Relationship:

- 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 Cl 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

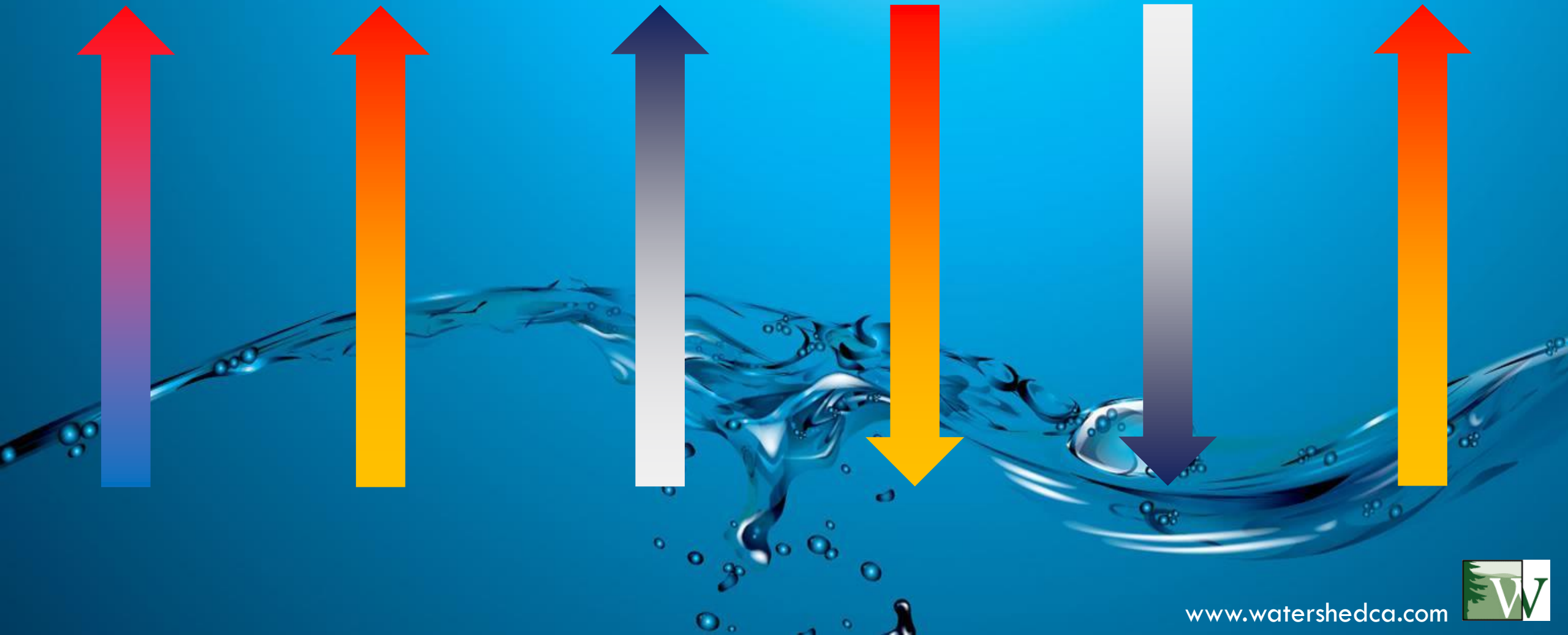
Increased Temperature = Increased Chloride

Summer

Increased Precipitation = Decreased Chloride

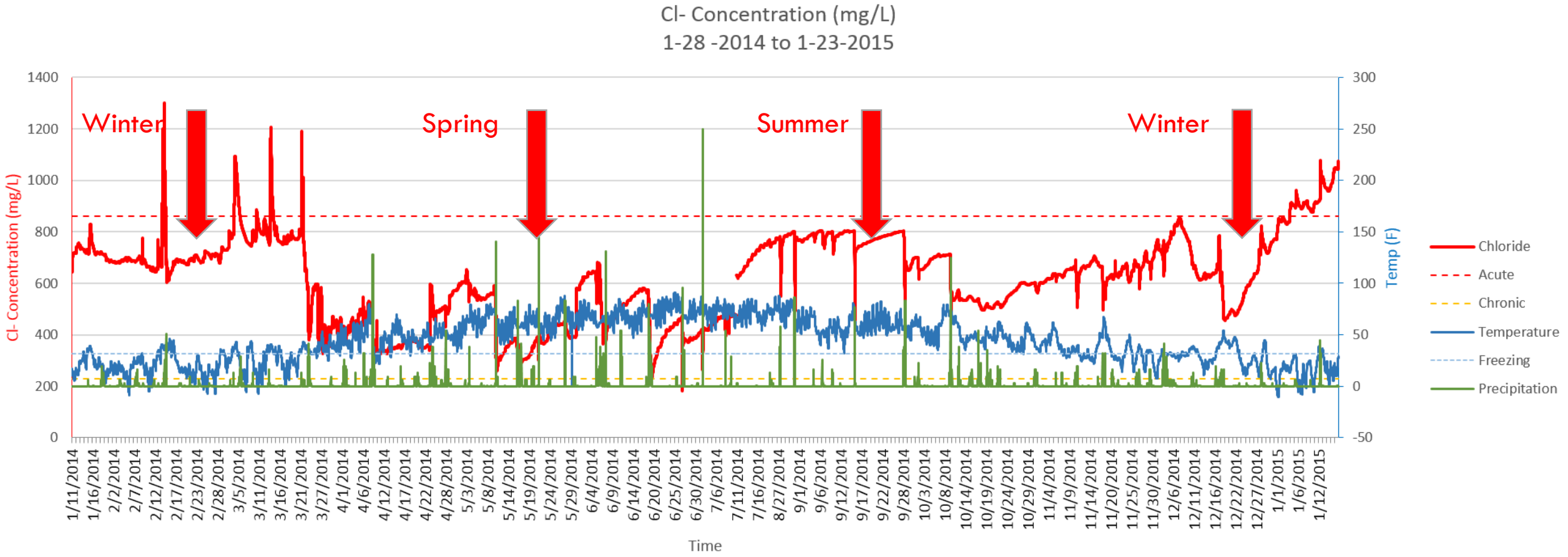
Summer

Decreased Precipitation = Increased Chloride



www.watershedca.com

Data

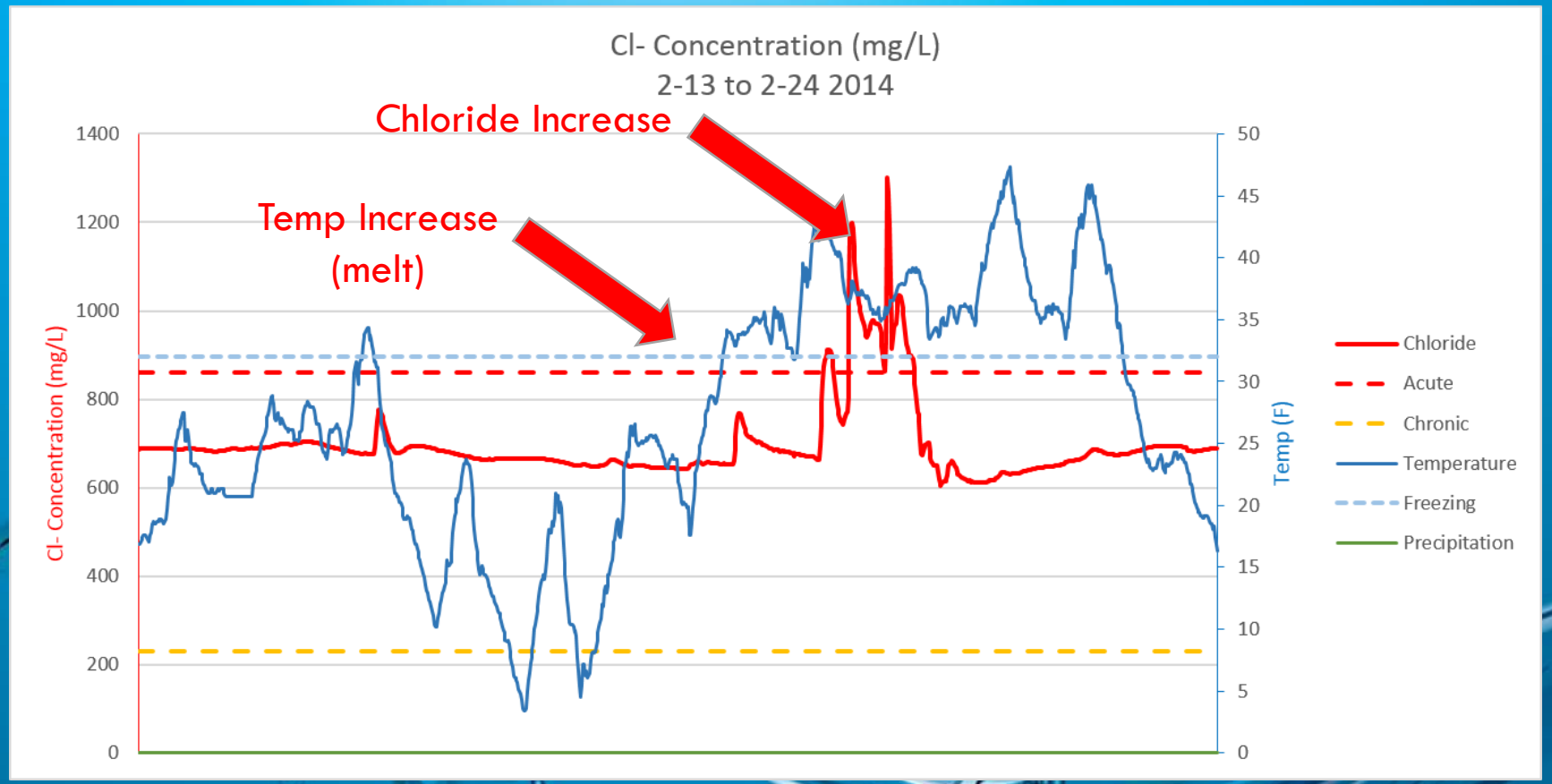

Cl- Concentration (mg/L)
1-28 -2014 to 1-23-2015
Winter
Spring
Summer
Winter
Cl- Concentration (mg/L)
Temp (F)
Time
Chloride
Acute
Chronic
Temperature
Freezing
Precipitation

Data – Winter Patterns

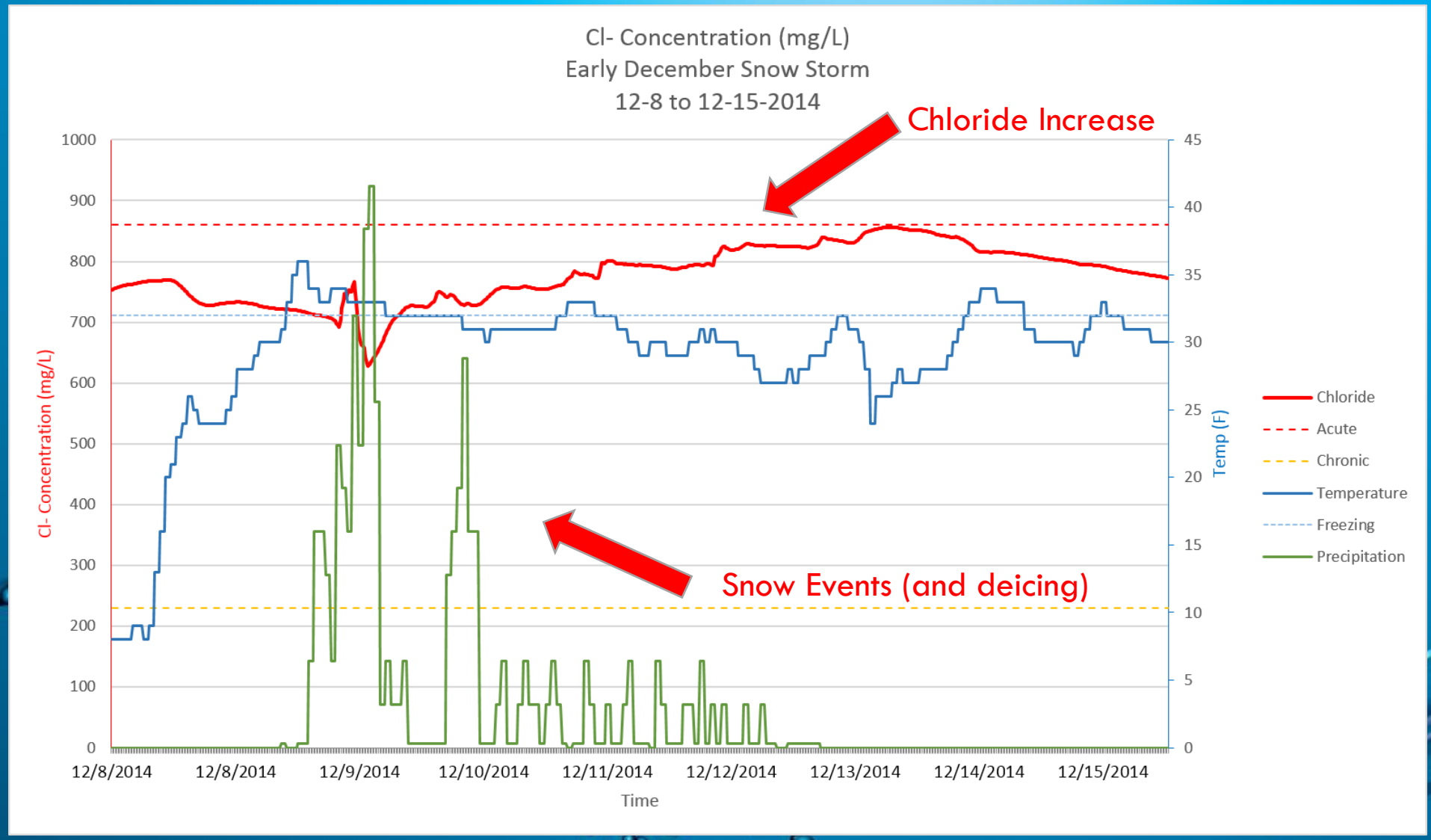
General Trends –

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

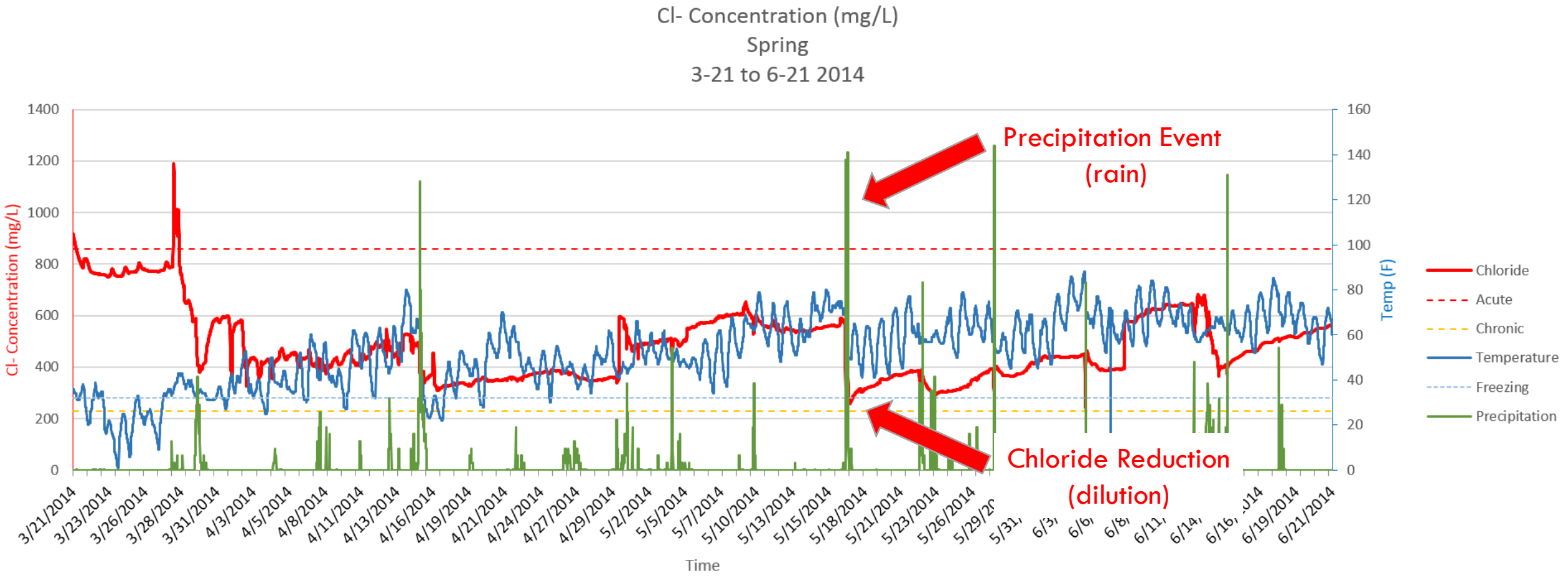
Winter Melt Pattern:



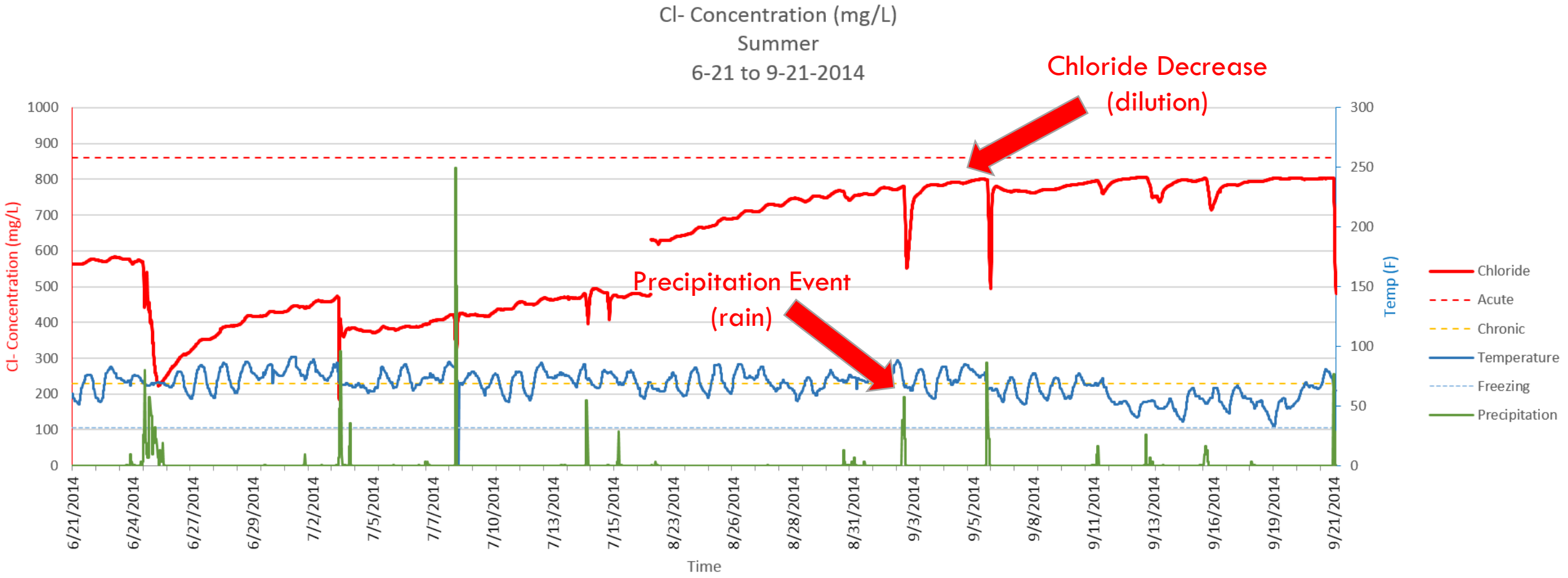
Data – Winter Patterns



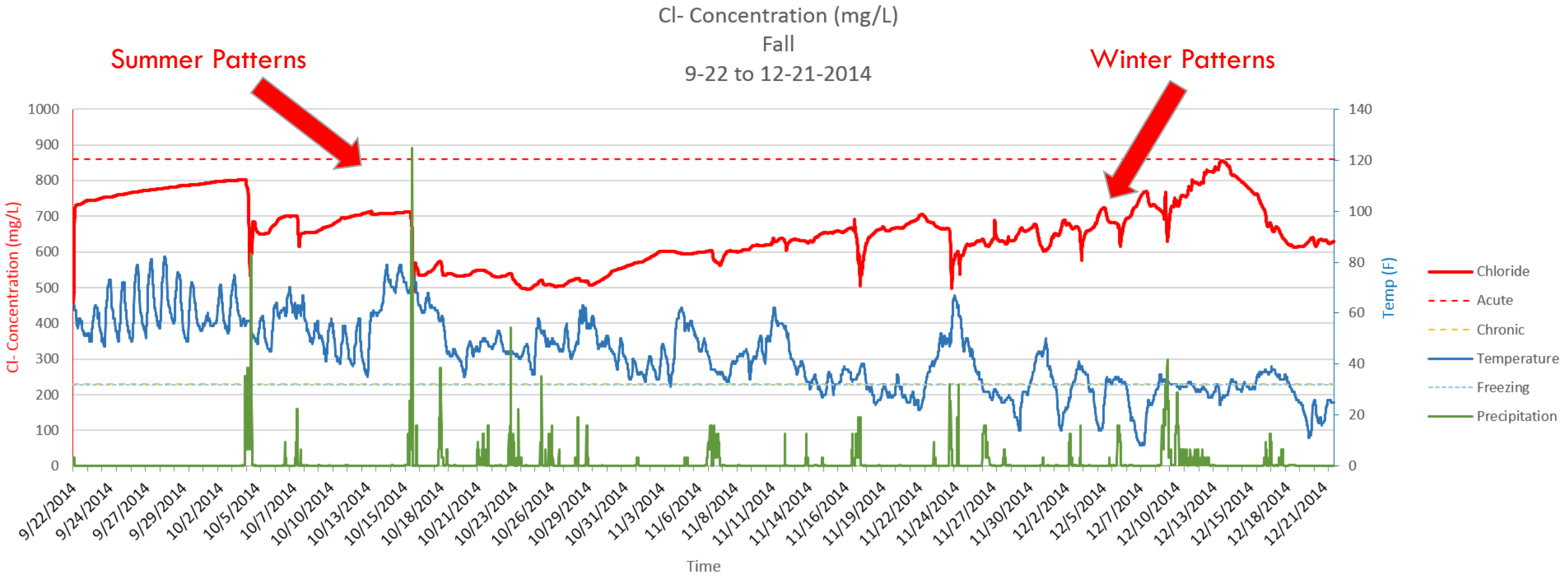
Data – Spring Patterns



Data – Summer Patterns

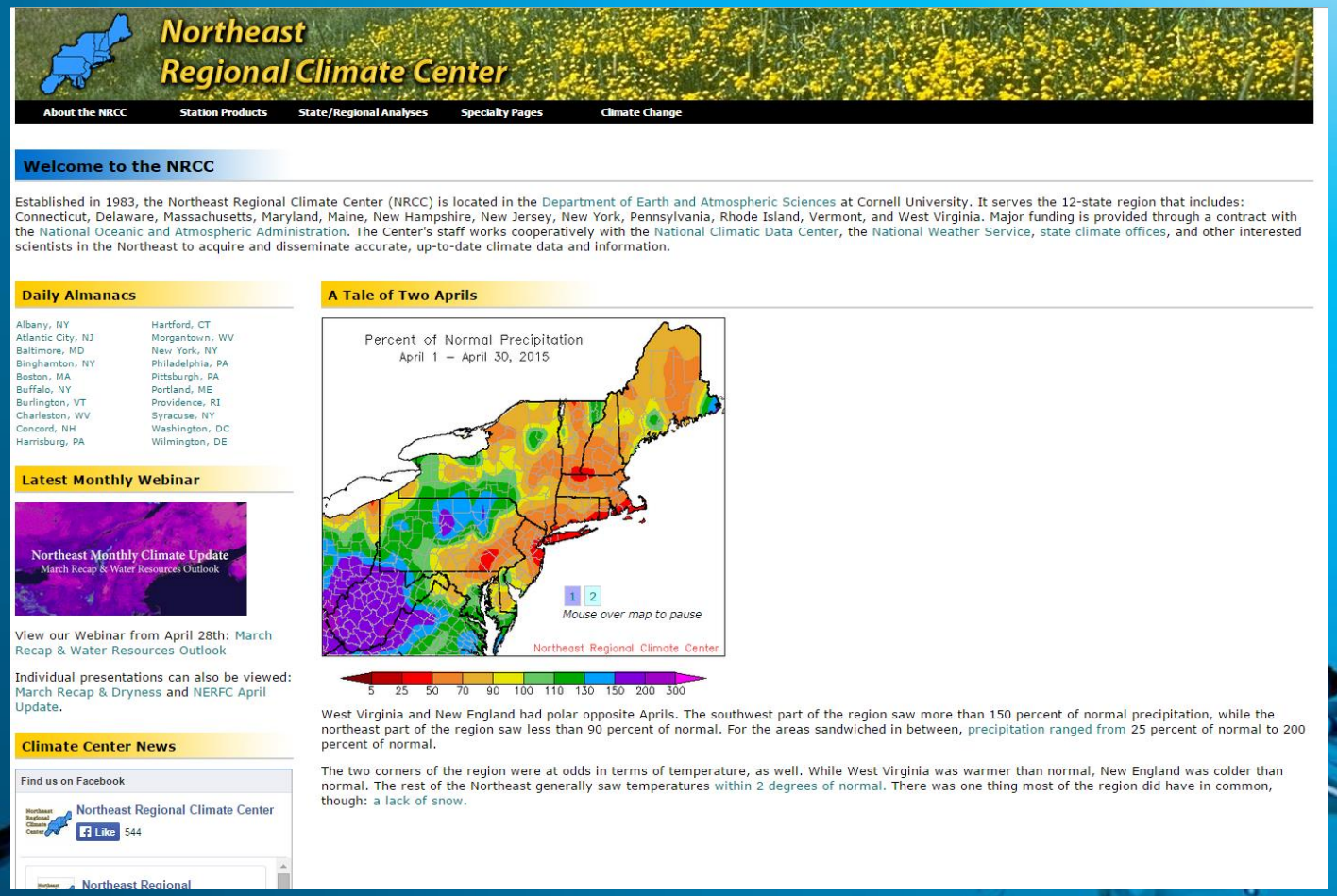


Data – Fall Patterns



Weather Data – to understand patterns

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



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

Resources:

- Chloride Assessment of Select Urban Streams in Chittenden County VT – July 1007 – 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

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