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The Water Project

Is Water Wet?

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Introduction

The goal of this project was to quantify inorganic analytes in water from various sources in the Capital Region[1]. Specifically, we chose to investigate the differences in inorganic ion concentrations in samples from above- and underground natural water sources. Samples were obtained from Wilsey Creek, Delanson Pond, and the Saratoga Springs, the locations of which are labeled on the map below. Tap water was used to compare these natural water sources to a familiar source.

Water sources investigated in this experiment:

Saratoga Springs – obtained from downtown spring
Wilsey Creek – obtained upstream from road crossing in Burtonville
Delanson Pond – obtained from Delanson Farm pond
Tap Water – obtained from sink in S&E building at Union College, Schenectady

Hypothesis 1: Saratoga will have higher concentrations of all solutes because it is an underground spring

Hypothesis 2: Delanson and Wilsey Creek with have similar solute concentrations since they are natural aboveground water sources

Methods

Ion Selective Electrode (ISE)[1]:
- Used to measure the activity of chloride ions in each sample using 2.0 M KNO_3 as an ionic strength adjuster
- An external standard method was performed on all samples (10-100 ppm standards)
- A standard addition method was performed on the Saratoga Springs and tap water samples, only

Ion Chromatography (IC)[2]:
- Dionex ICS-2100 Ion Chromatograph
- Used to analyze the concentrations of various cations and anions
- Ions were separated based on their affinity for the stationary phase of the column

Mass spectrometry (ICP-MS)[2]:
- Agilent 8900 ICP-MS
- Ions in the samples are separated by mass to charge ratio and analyzed by the mass spectrometer

Hach Kit Analysis[2,3]:
- Hach DR/890 Datalogging Colorimeter
- Used to analyze the concentrations of phosphate, nitrate, and sulfate ions
- Data were collected at the site of each water source and in the laboratory

Atomic Absorption Spectrometry (AAS)[4]:
- Perkin Elmer Model 3100
- Used to quantify calcium ion concentrations in the samples based on the absorption of light characteristic to the calcium ion
- Standards between 1 and 10 ppm were used
- Absorption was converted to concentration by the instrument using Beer's Law

pH[5]:
- 2.5 M KNO_3 was used as an ionic strength adjuster
- An H^+ selective electrode was used to measure the activity of H^+ ions in the samples
- Algorithms in the instrument converted the activity measurements to pH measurements

Total Alkalinity[6]:
- Titration method was used with methyl orange indicator to determine the range of total alkalinity based on two color-change points
- Titrant was 0.02 N sulfuric acid

Results

Sample	Average pH	Total Alkalinity Range (ppm $CaCO_3$)
Wilsey Creek	7.16	33 - 39
Delanson Pond	6.98	42 - 49
Saratoga Springs	6.89	1720 - 1800
Tap Water	7.38	157 - 163

Table 1. Average pH and total alkalinity range for the four water samples determined by pH probe and titration, respectively. pH values did not correspond to total alkalinity ranges for all samples.

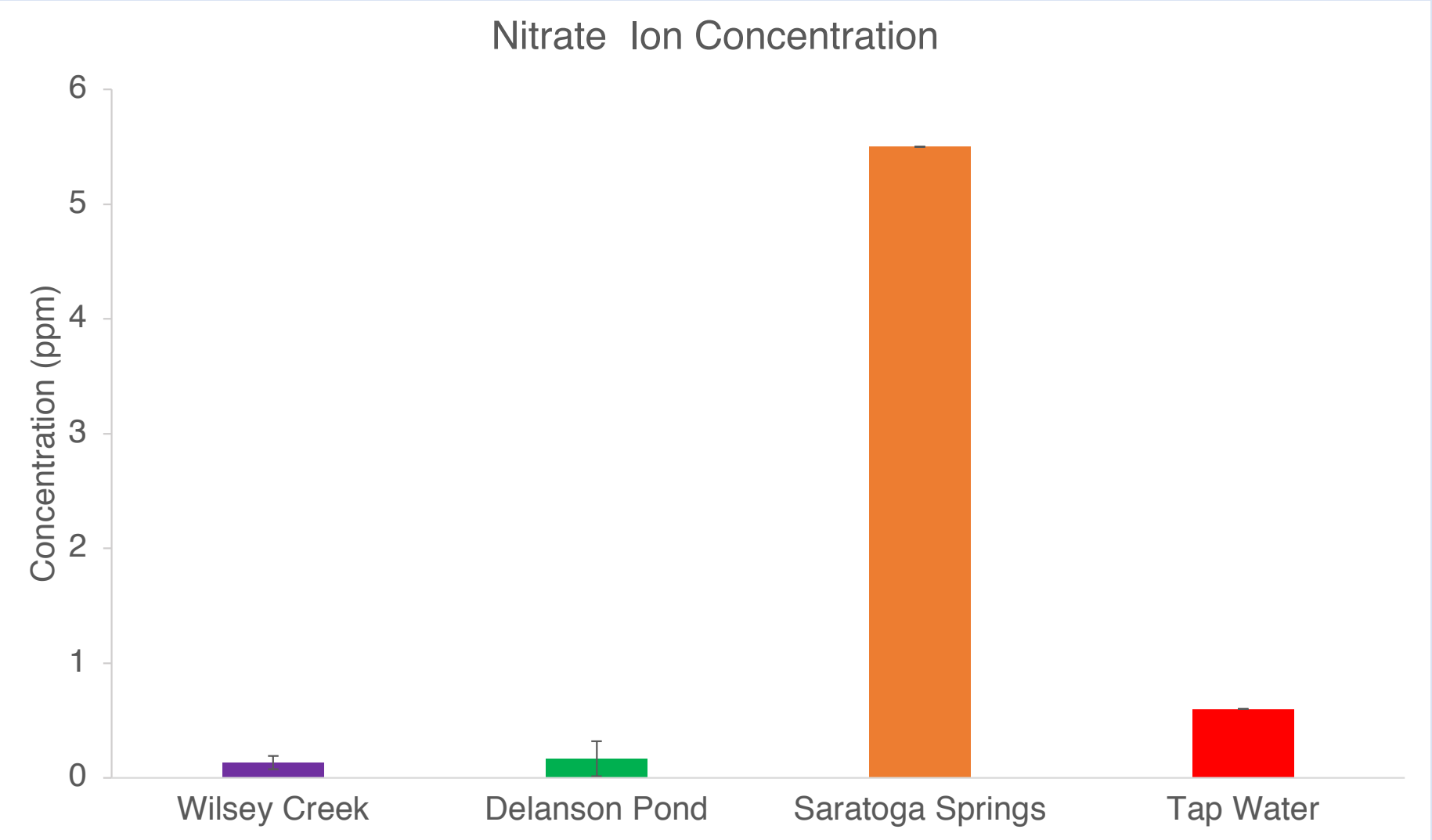

Figure 1. Nitrate ion concentration in ppm for the four water samples determined by Hach Kit analysis and ion chromatography. Error bars represent the standard deviation of the data points.

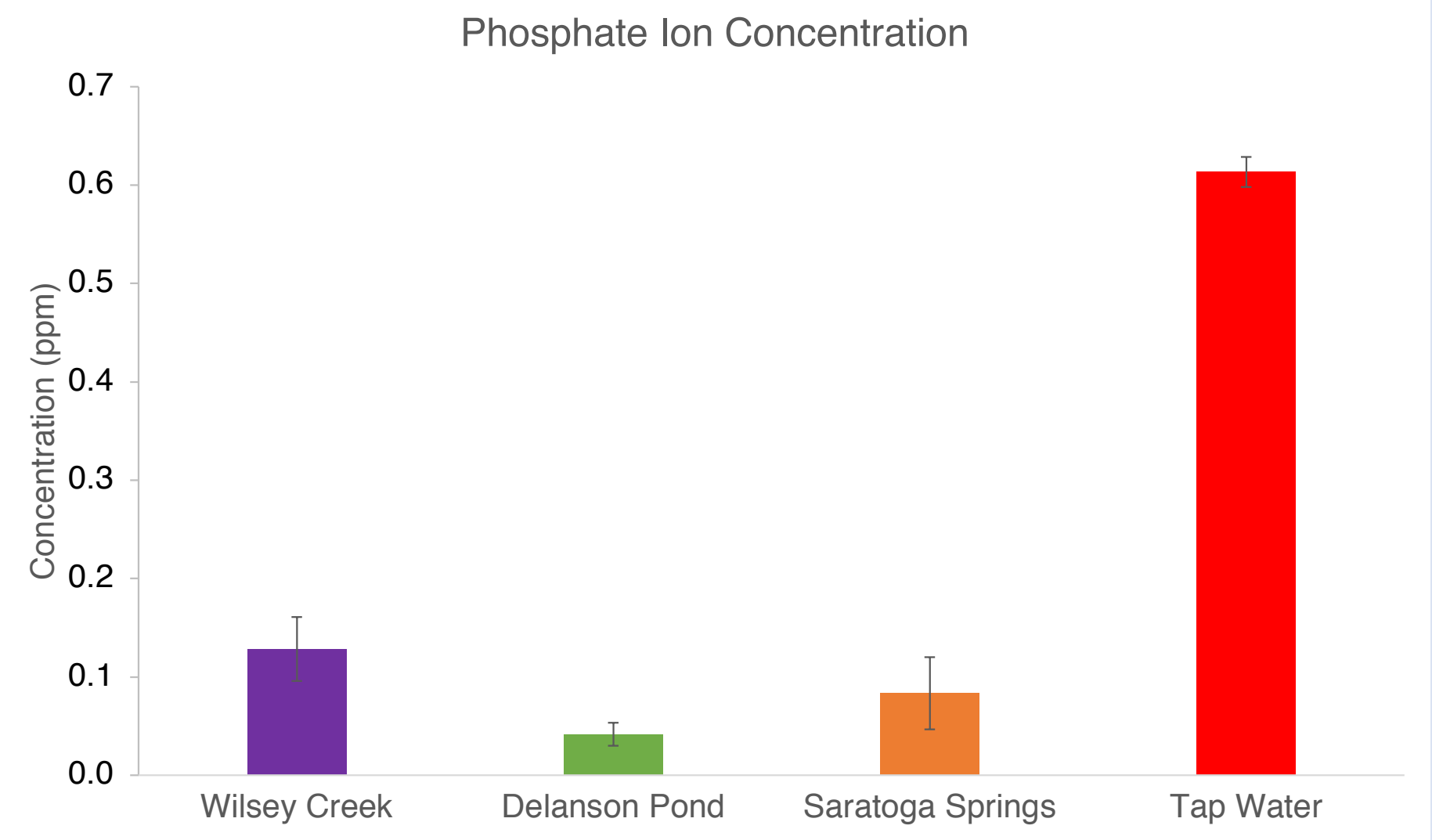

Figure 2. Phosphate ion concentration in ppm for the four water samples determined by Hach Kit analysis. Error bars represent the standard deviation of the data points.

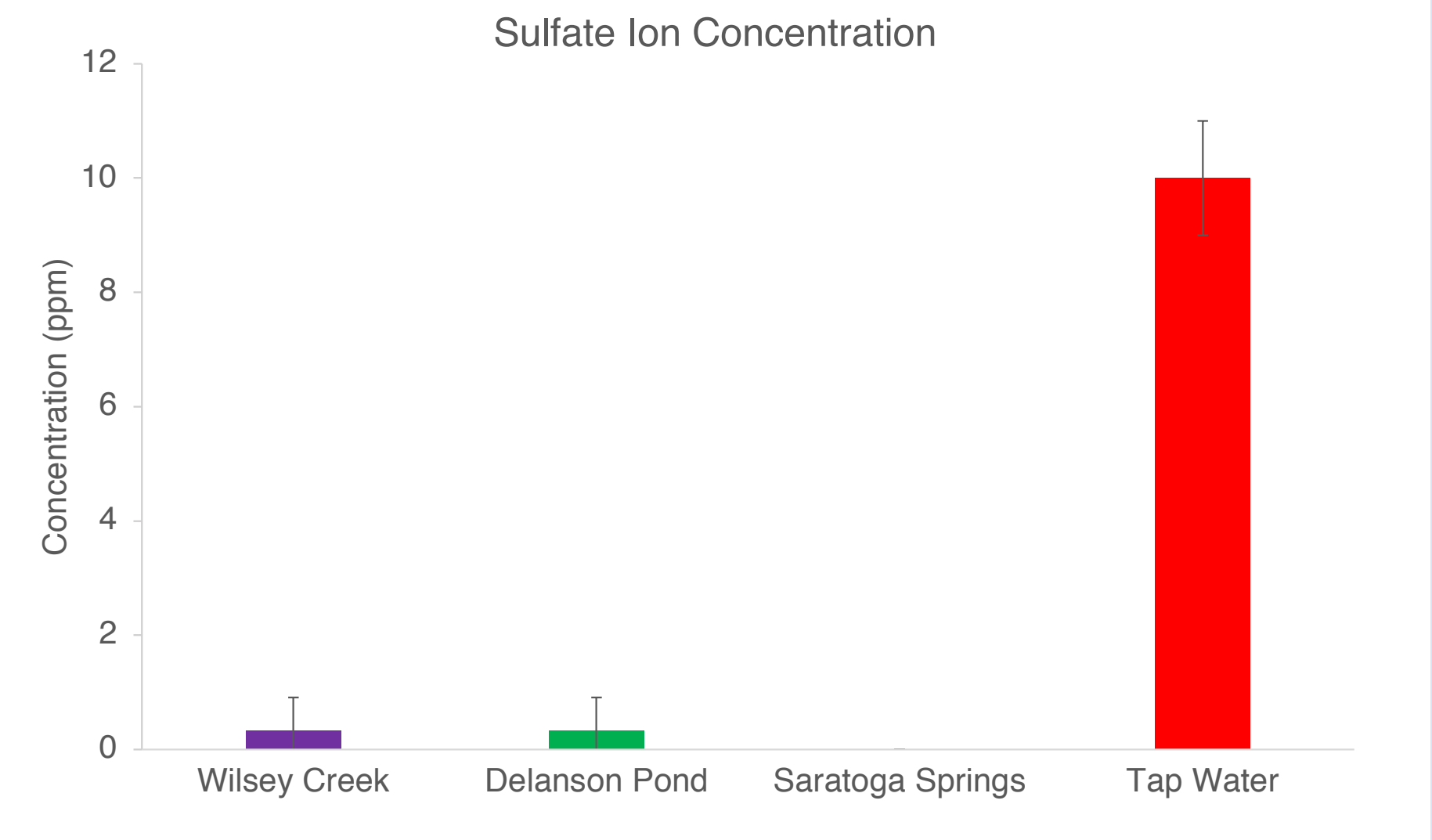

Figure 3. Sulfate ion concentration in ppm for the four water samples determined by Hach Kit analysis. Error bars represent the standard deviation of the data points.

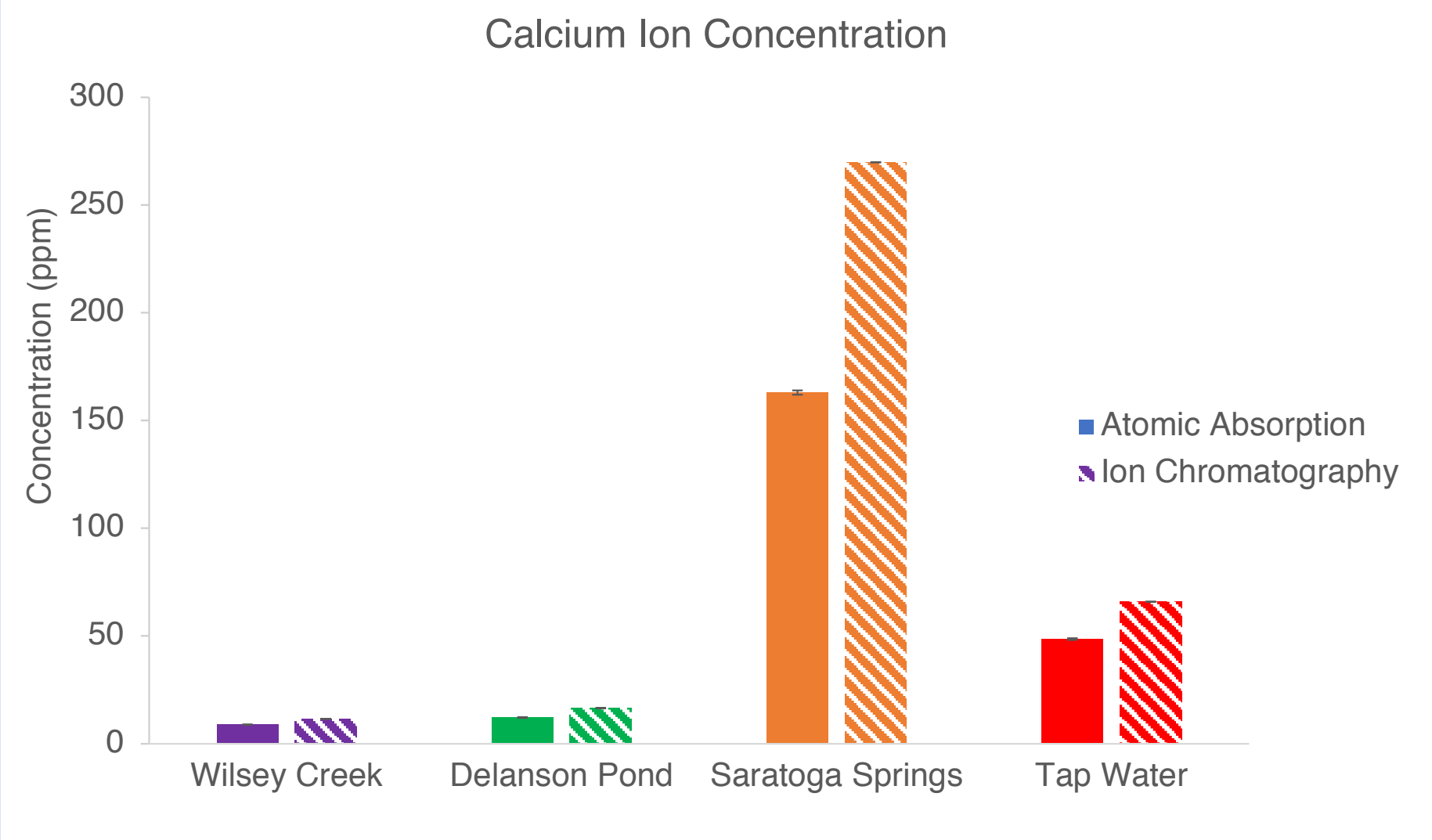

Figure 4. Calcium ion concentration in ppm for the four water samples determined by atomic absorption spectrophotometry and ion chromatography. Error bars represent the standard deviation of the data points.

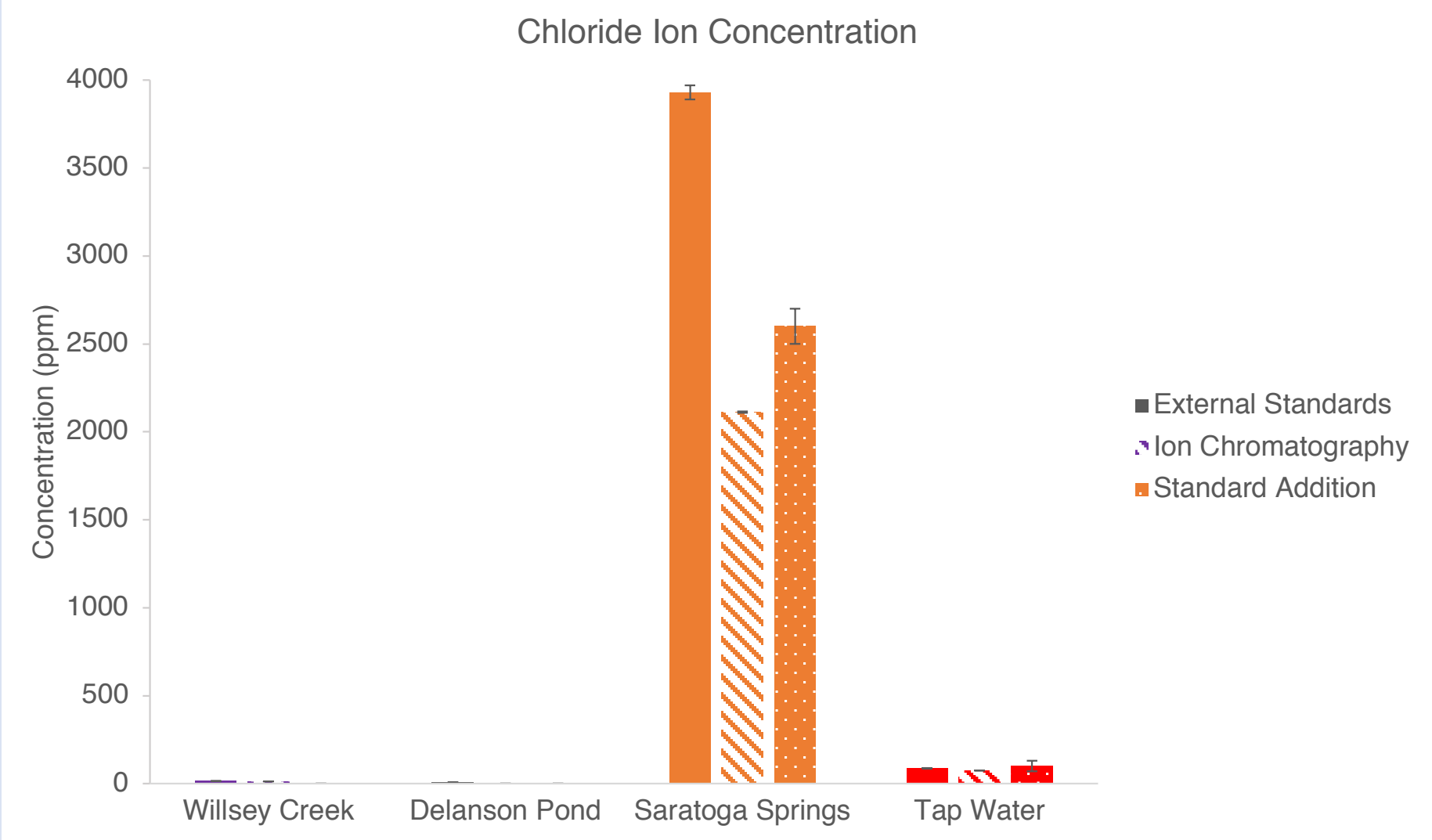

Figure 5. Chloride ion concentration in ppm for the four water samples determined by external standards with an ion sensitive electrode, ion chromatography, and standard addition with an ion sensitive electrode. Standard addition was only done for the Saratoga Springs and Tap Water samples. Error bars represent the standard deviation of the data points.

Ion	Sulfate Concentration			Phosphate Concentration		
Samples compared	Saratoga Springs and Wilsey Creek	Saratoga Springs and Delanson Pond	Saratoga Springs and Tap Water	Saratoga Springs and Wilsey Creek	Saratoga Springs and Delanson Pond	Saratoga Springs and Tap Water
t_{table}[7]	4.303	4.303	4.303	2.776	2.776	2.447
t_{calc}	0.985	0.985	17.321	1.39	2.16	20.9

Table S1. t-tests at the 95% confidence level for Hypothesis 1.

Ion	t_{table}[7]	t_{calc}
Nitrate	4.303	0.354
Phosphate	2.447	1.865
Sulfate	4.303	0
Calcium	4.303	39.584
Chloride	4.303	7.168

Table S2. t-tests at the 95% confidence level for Hypothesis 2.

Discussion and Conclusions

Hypothesis 1:
- Saratoga Springs water had greater total alkalinity than all other samples by a factor of at least 10
- The Saratoga Springs sample had significantly greater concentrations of nitrate, chloride, and calcium ions
- Difference in sulfate concentration was only statistically significant, using Type 2 t-tests at the 95% confidence level, between Saratoga Springs and Tap water, as shown in Table S1
- Difference in phosphate concentration was only statistically significant, using Type 2 t-tests at the 95% confidence level, between Saratoga Springs and Tap water, as shown in Table S1
- The statistical differences in ion concentration could be due to the mixing of the meteoric water line with the crystalline brine deposits underground[8,9]

Hypothesis 2:
- pH values of Wilsey Creek and Delanson Pond were not significantly different
- Alkalinity ranges for Wilsey and Delanson Pond were within 3 ppm and therefore are not significantly different
- The rest of the ion concentrations were compared using Type 2 t-tests at the 95% confidence level, the results of which are shown in Table S2
- The samples were not statistically significantly different in their nitrate, sulfate, or phosphate ion concentrations, per the t-tests
- The samples were significantly different in their calcium and chloride concentrations
- Significant differences in calcium concentration could be attributed to slightly acidic water reacting with nearby limestone, putting more calcium into Delanson Pond than in Wilsey Creek[10]
- Significant differences in chloride concentration could be attributed to the road near Wilsey Creek, causing runoff of salt during the winter season, while there is not a road near Delanson Pond[11]

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