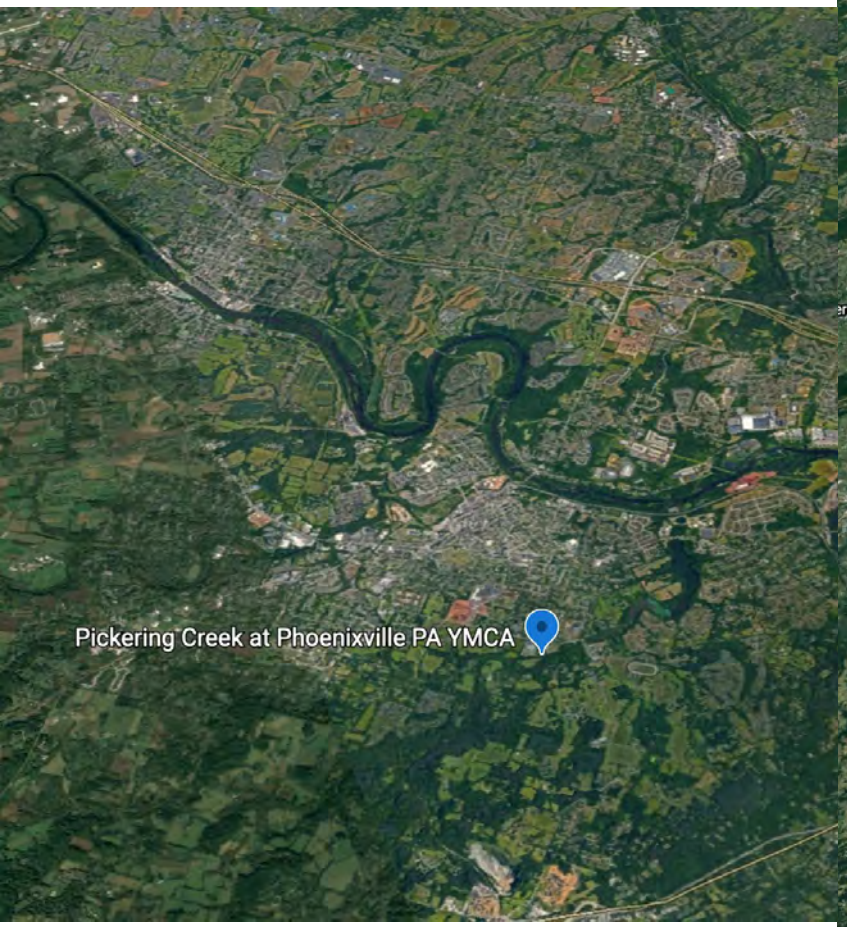
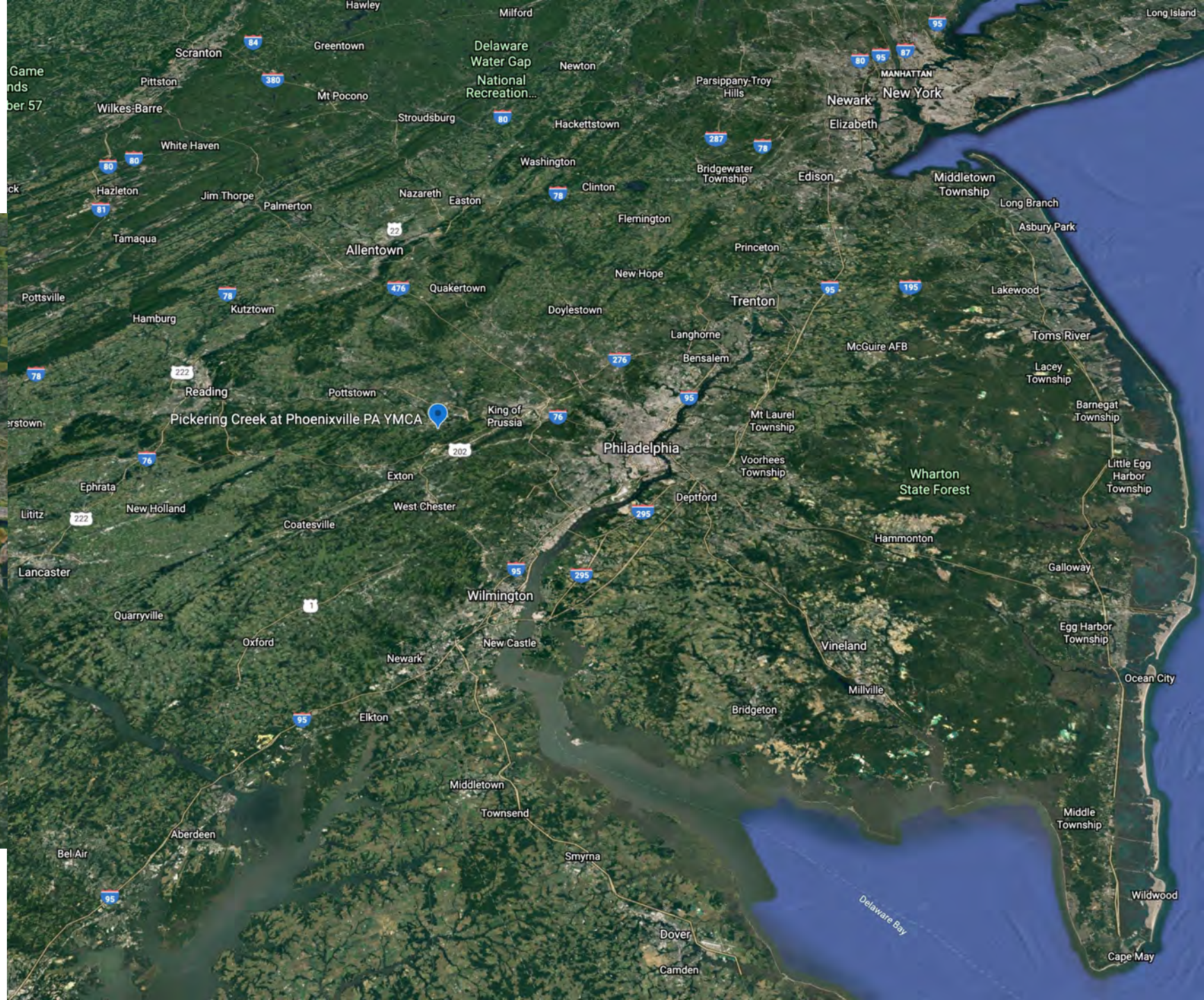
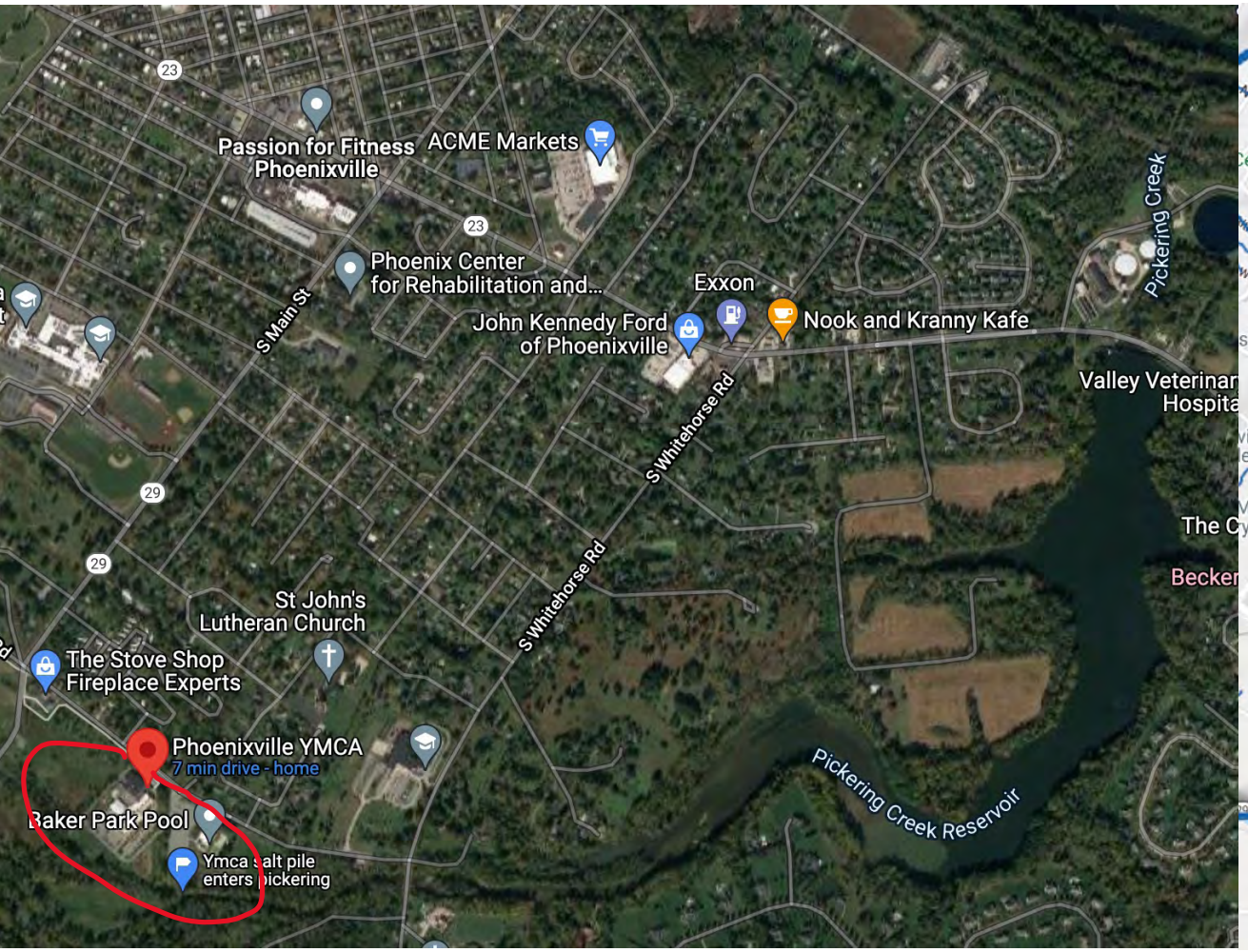
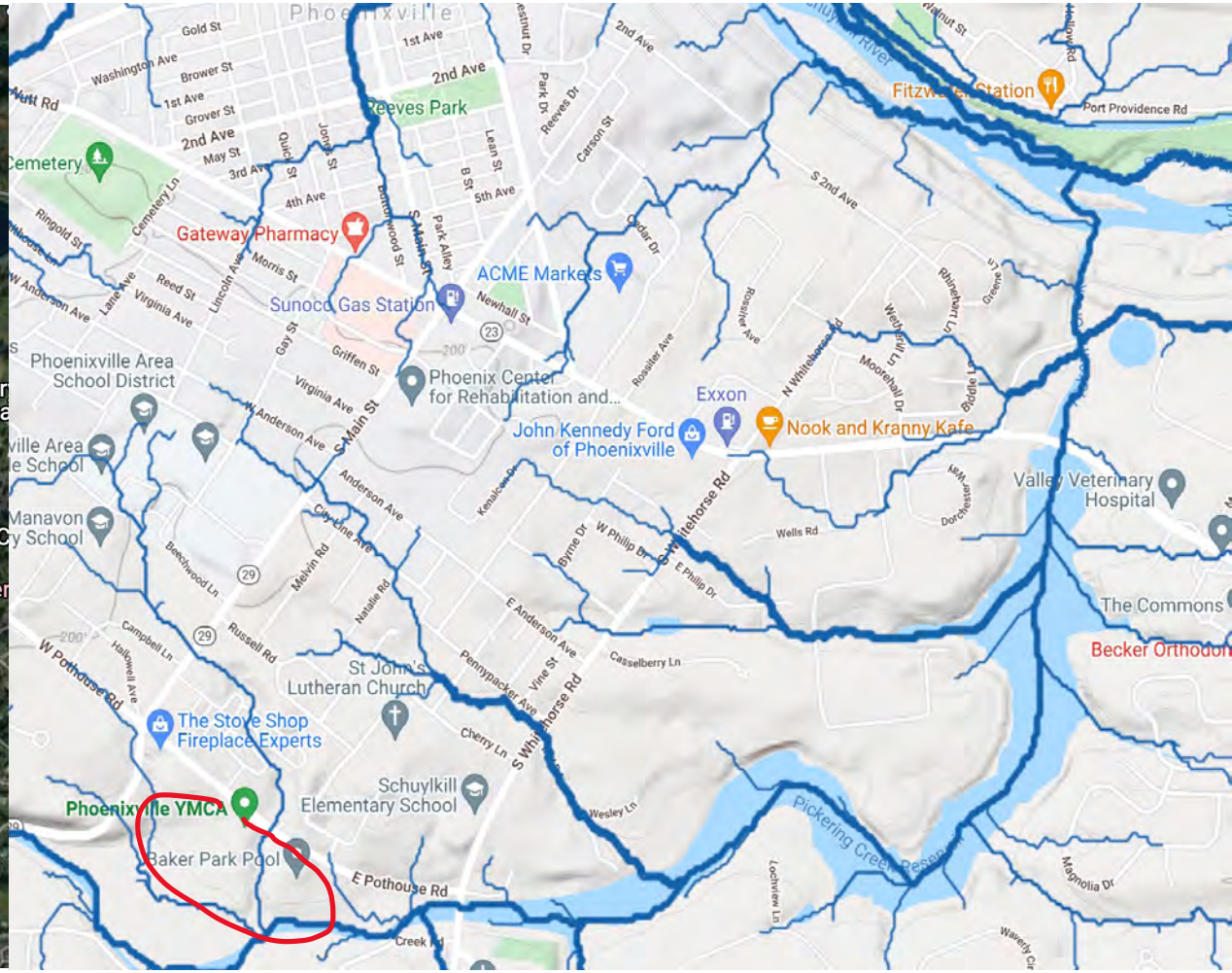
A Stream Runs Through It
--
Using Basic Stream Monitoring Tools to Query Local Trends and Concerns


Pickering Creek at Phoenixville PA YMCA

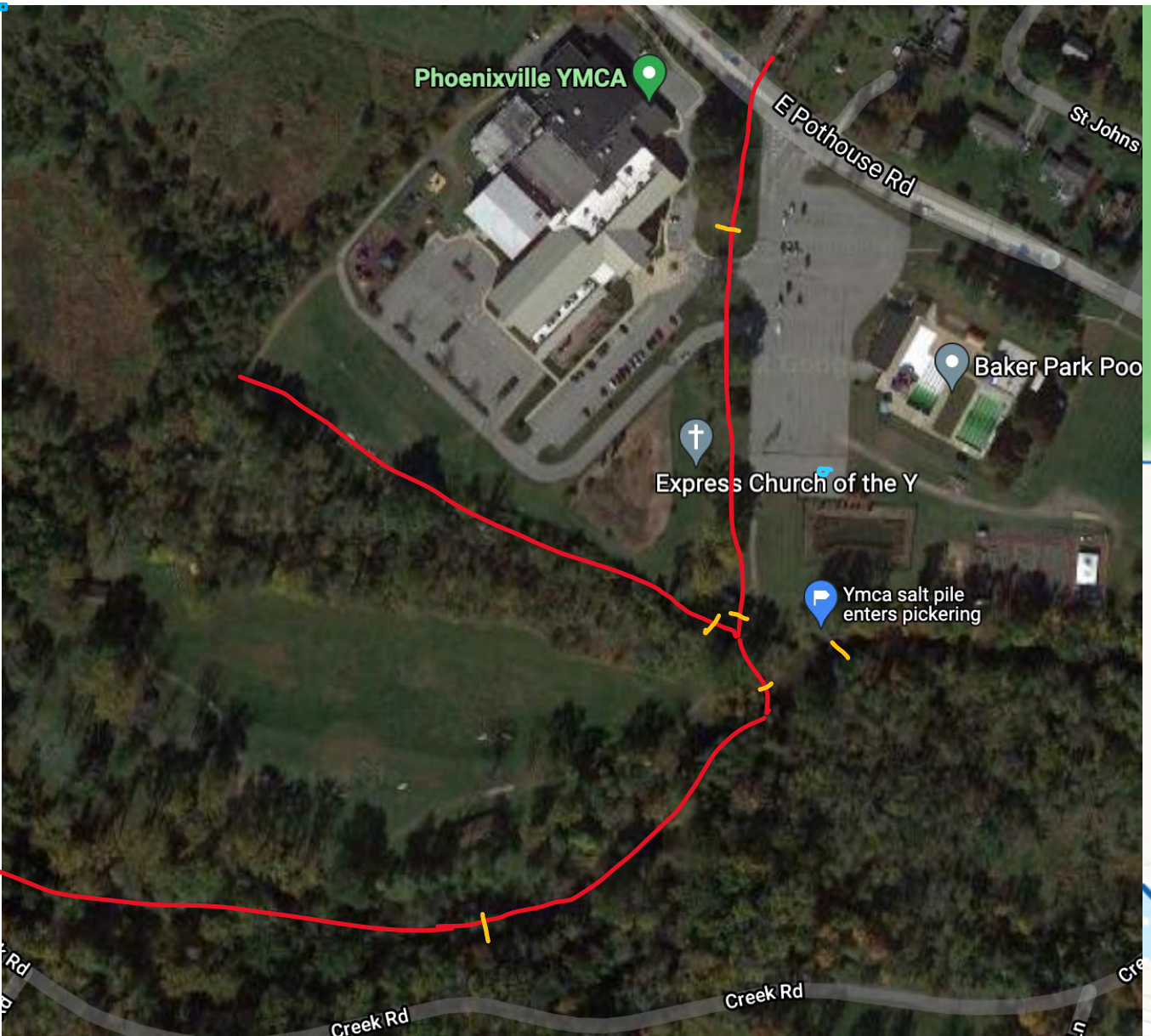

Hawley
Milford
Long Island
Scranton
Greentown
Delaware Water Gap National Recreation...
Newton
MANHATTAN
New York
Newark
Parsippany-Troy Hills
Elizabeth
Pittston
Mt Pocono
Wilkes-Barre
Stroudsburg
Hackettstown
White Haven
Washington
Bridgewater Township
Edison
Middletown Township
Hazleton
Jim Thorpe
Palmerton
Nazareth
Easton
Clinton
Long Branch
Flemington
Asbury Park
Tamaqua
Allentown
Princeton
New Hope
Pottsville
Quakertown
Lakewood
Trenton
Hamburg
Kutztown
Doylestown
Langhorne
Toms River
McGuire AFB
Bensalem
Lacey Township
Reading
Pottstown
Pickering Creek at Phoenixville PA YMCA
King of Prussia
Barnegat Township
Mt Laurel Township
Philadelphia
Voorhees Township
Exton
Wharton State Forest
Little Egg Harbor Township
Ephrata
Deptford
New Holland
Lititz
West Chester
Coatesville
Hammonton
Lancaster
Galloway
Wilmington
Quarryville
Egg Harbor Township
Oxford
New Castle
Vineland
Newark
Ocean City
Millville
Elkton
Bridgeton
Middletown
Townsend
Middle Township
Aberdeen
Bel Air
Smyrna
Wildwood
Delaware Bay
Dover
Cape May
Camden

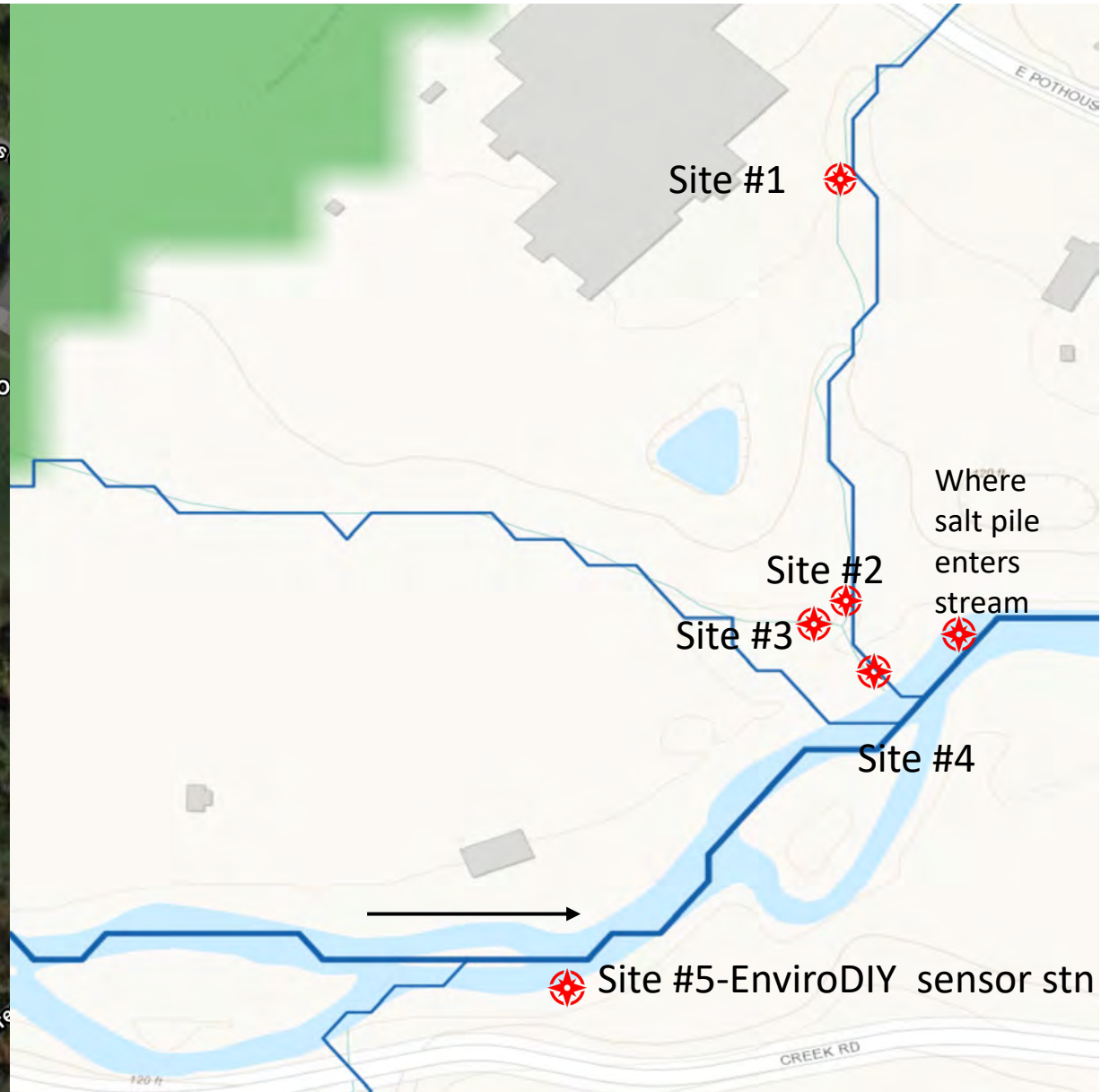
Pickering Creek headwater in moderate-high developed land



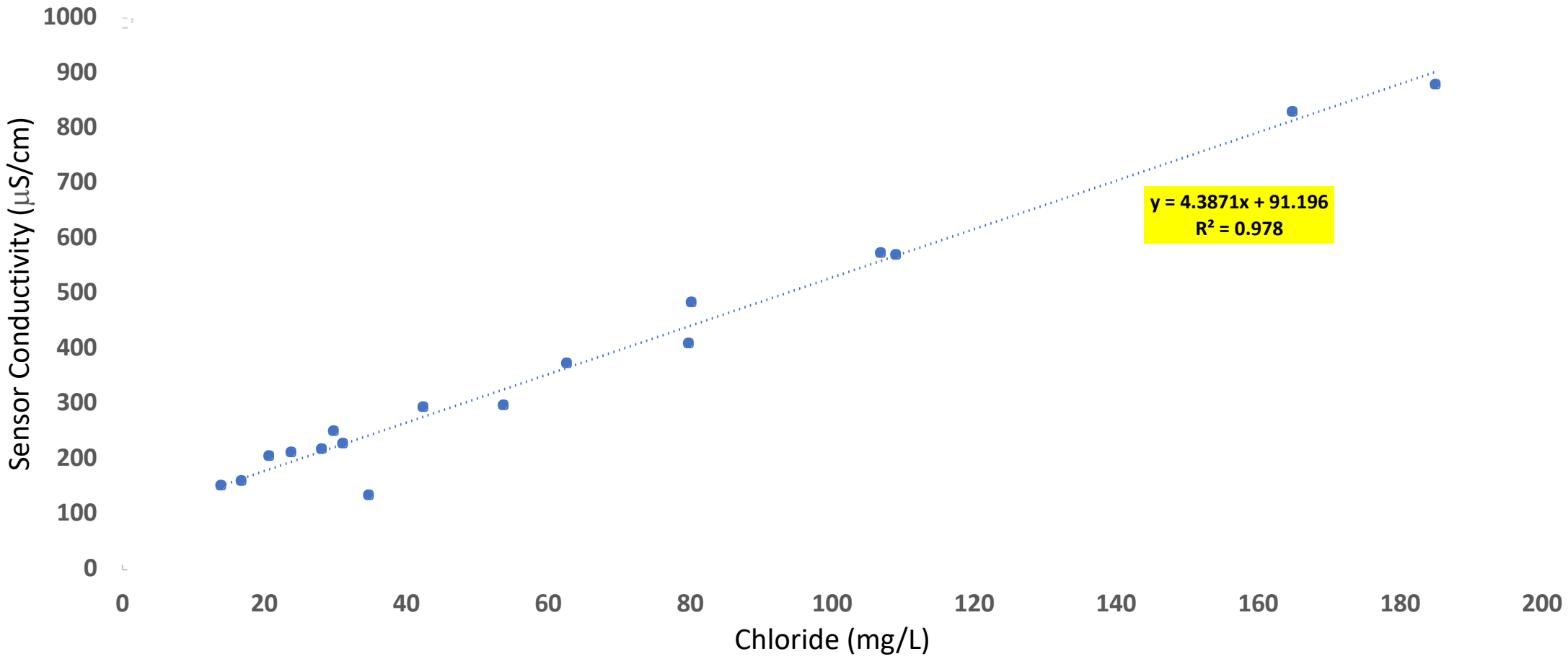


Pickering Creek headwater in moderate-high developed land

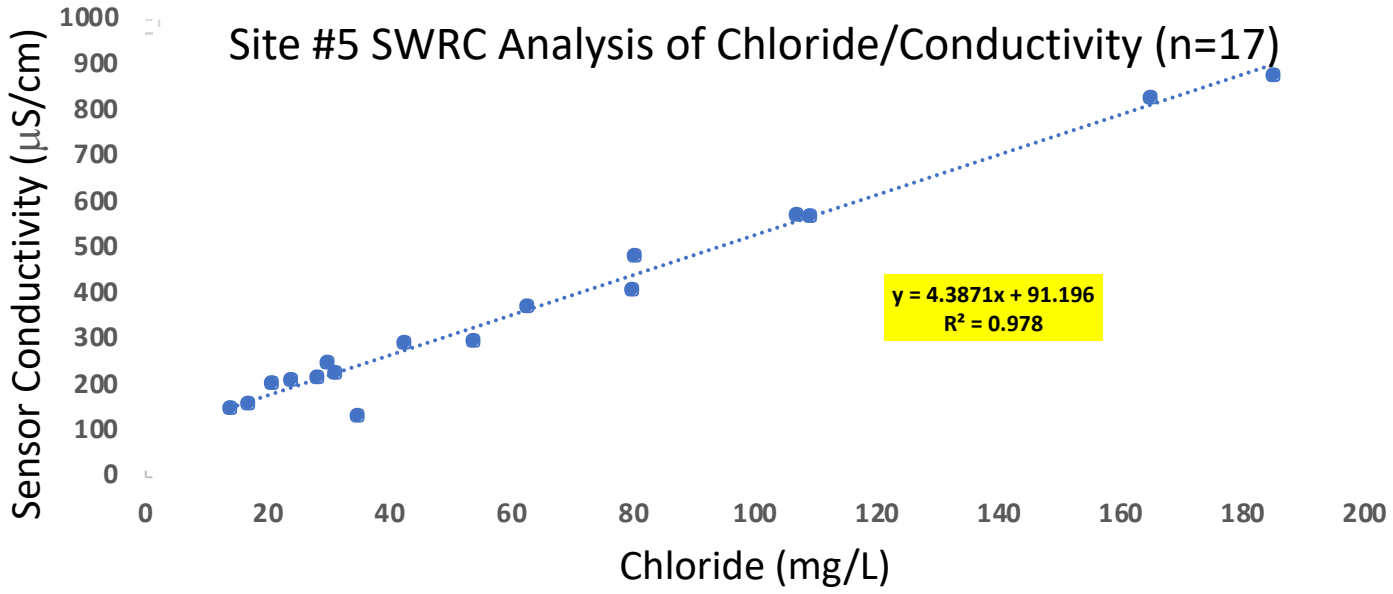


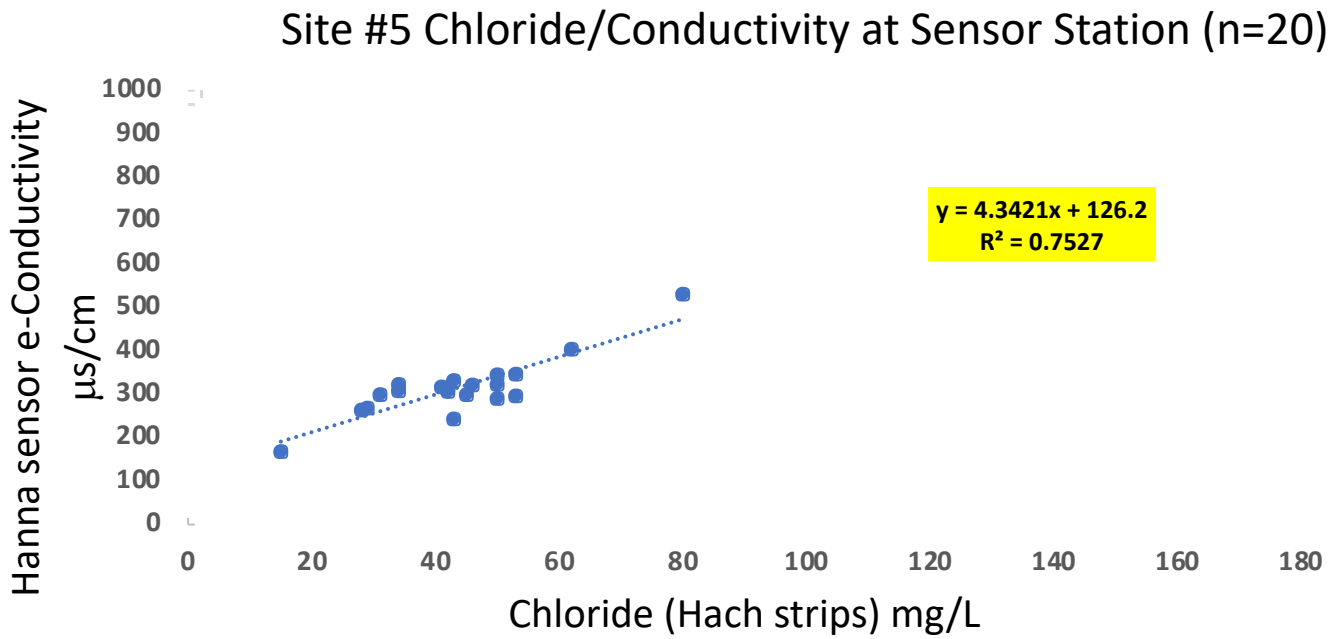


Site #5
Pickering Mainstem-downstream (SHPK6S) Conductivity/Chlorides (n=17)
In-stream continuous monitoring with SWRC Lab analysis of Chlorides



Replication of correlation of conductivity and chlorides
2017-18 with 2018-21

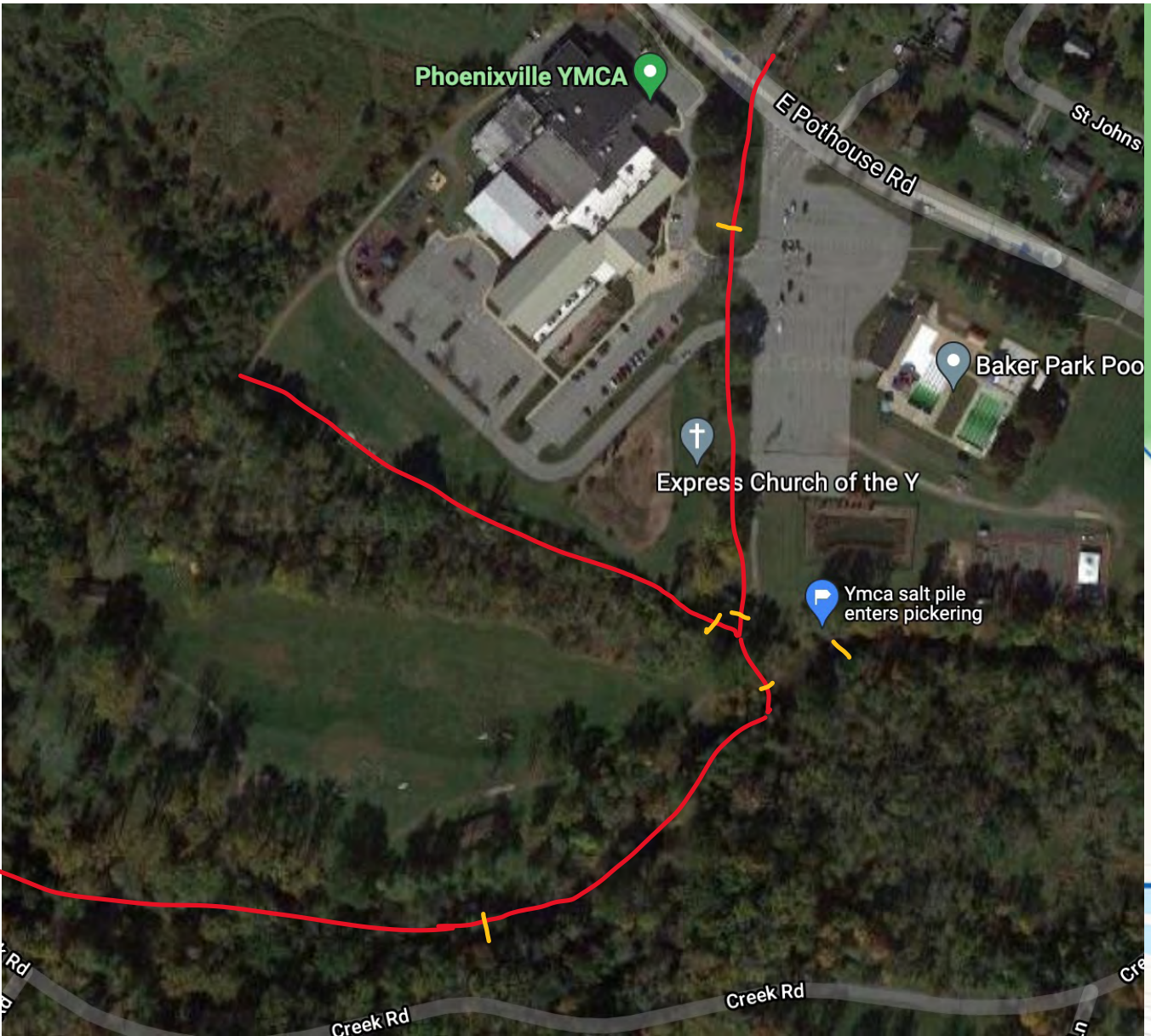


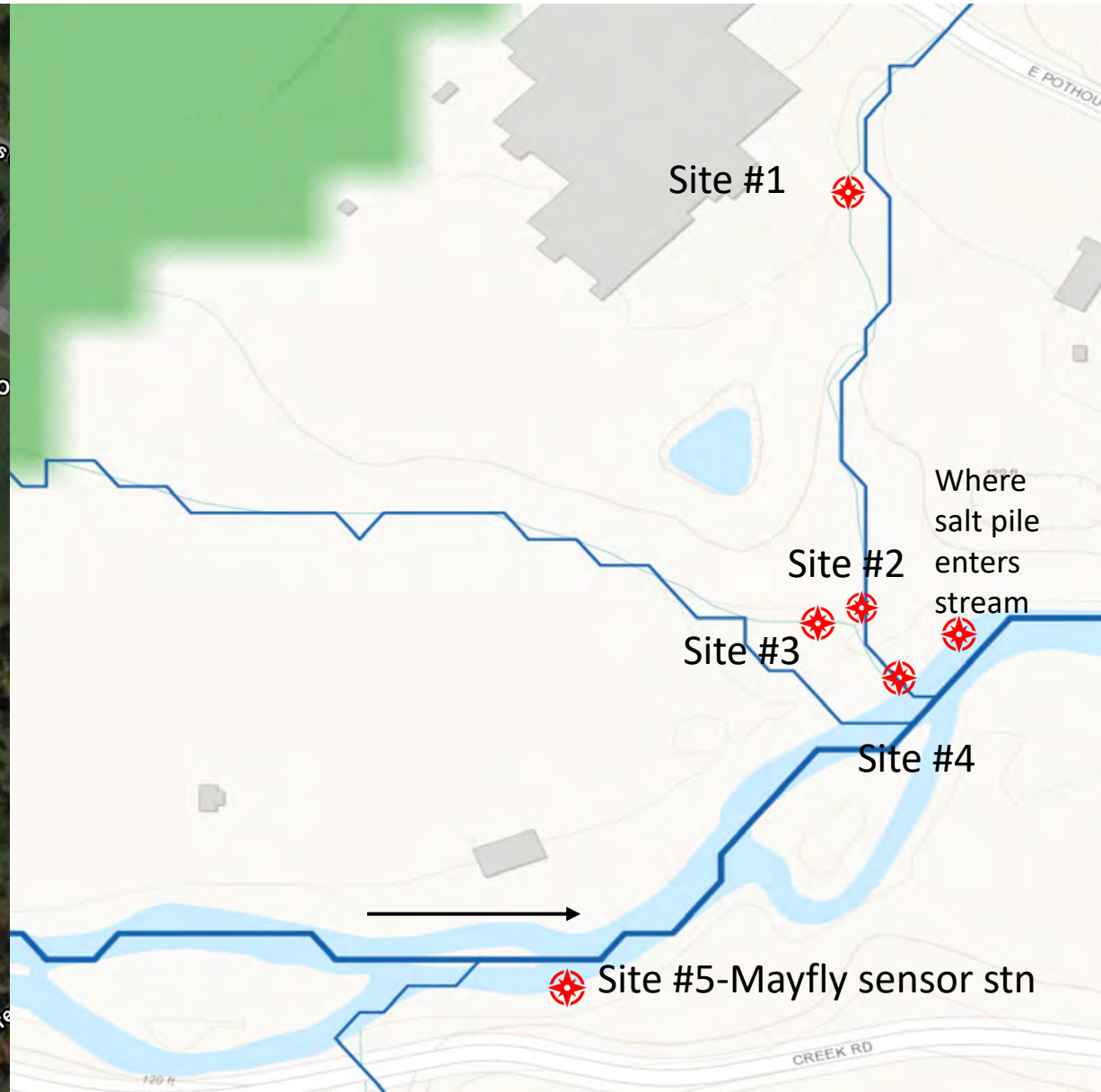


Water Quality Measurements for 2018-2021 study

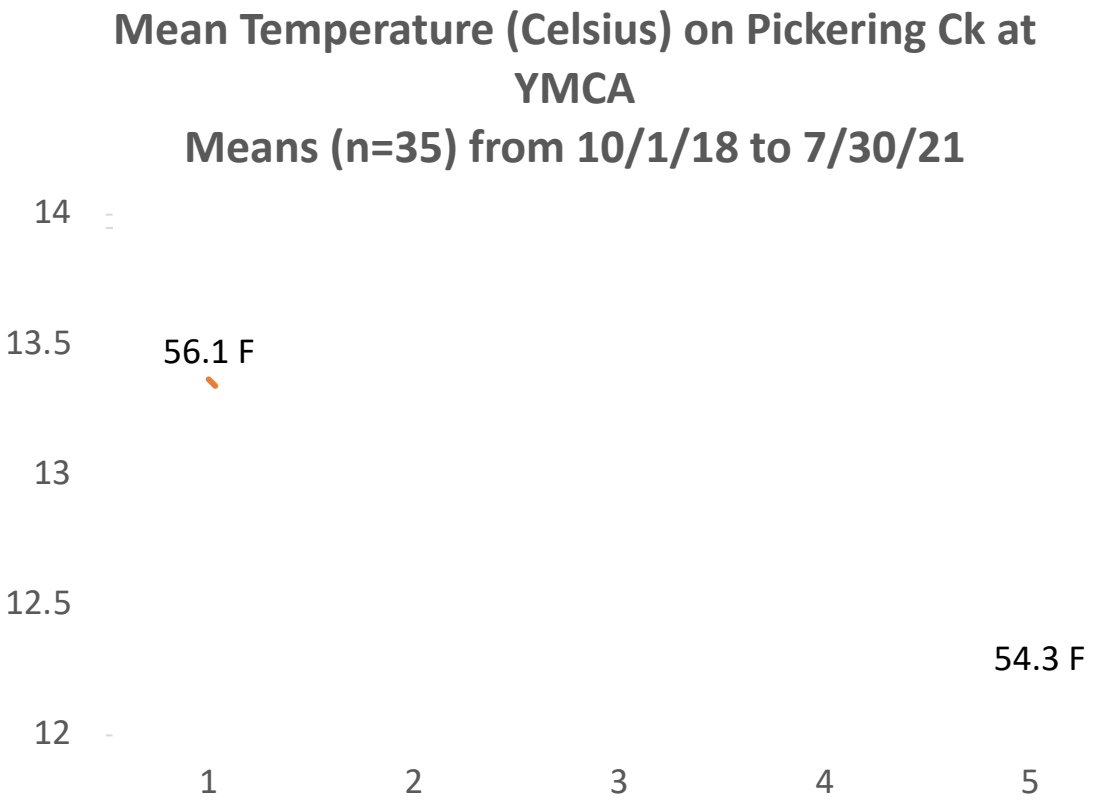
- EnviroDIY station with Mayfly logger
  - Depth
  - Temperature
  - Conductivity
  - Turbidity
- Hanna conductivity meter
- Chlorides (Hach chloride strips, low range)
  - %NaCl (sodium chloride)
  - Cl- mg/L (chlorides)
- Also measured (Hach 5-in-1 water quality strips)
  - pH
  - total hardness – $CaCO_3$
  - Total alkalinity ppm
  - Free chlorine and total chlorine

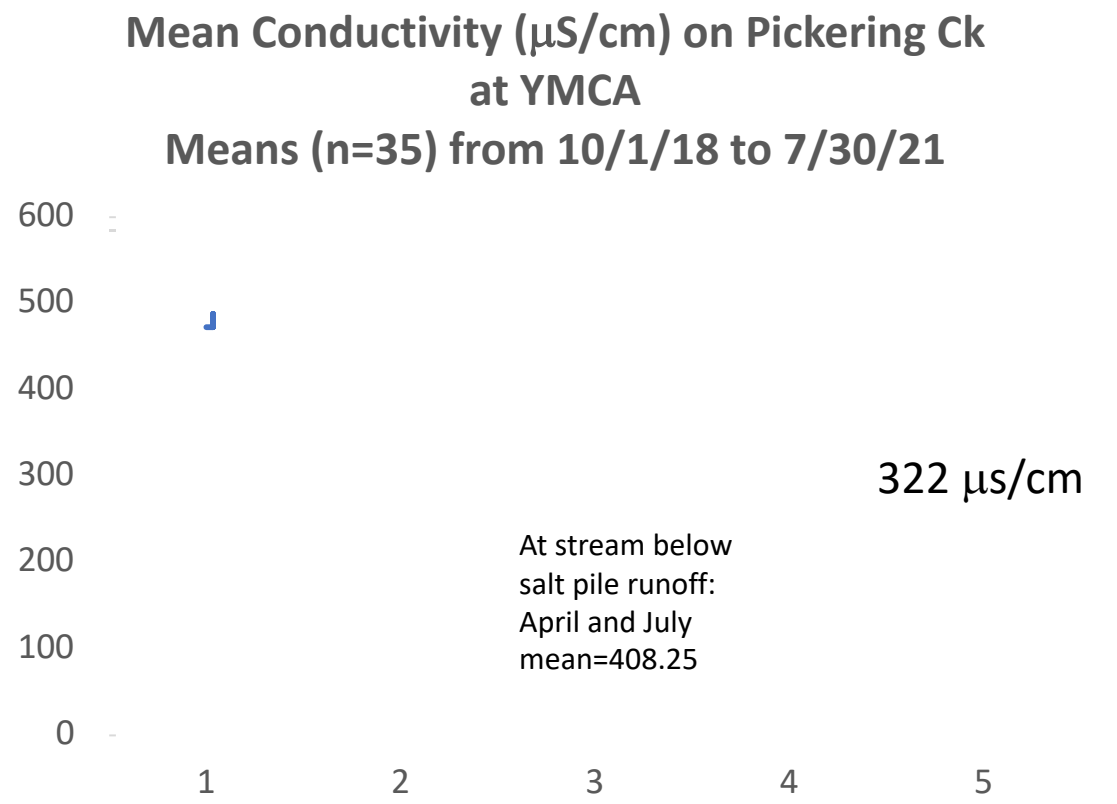
Pickering Creek headwater in moderate-high developed land



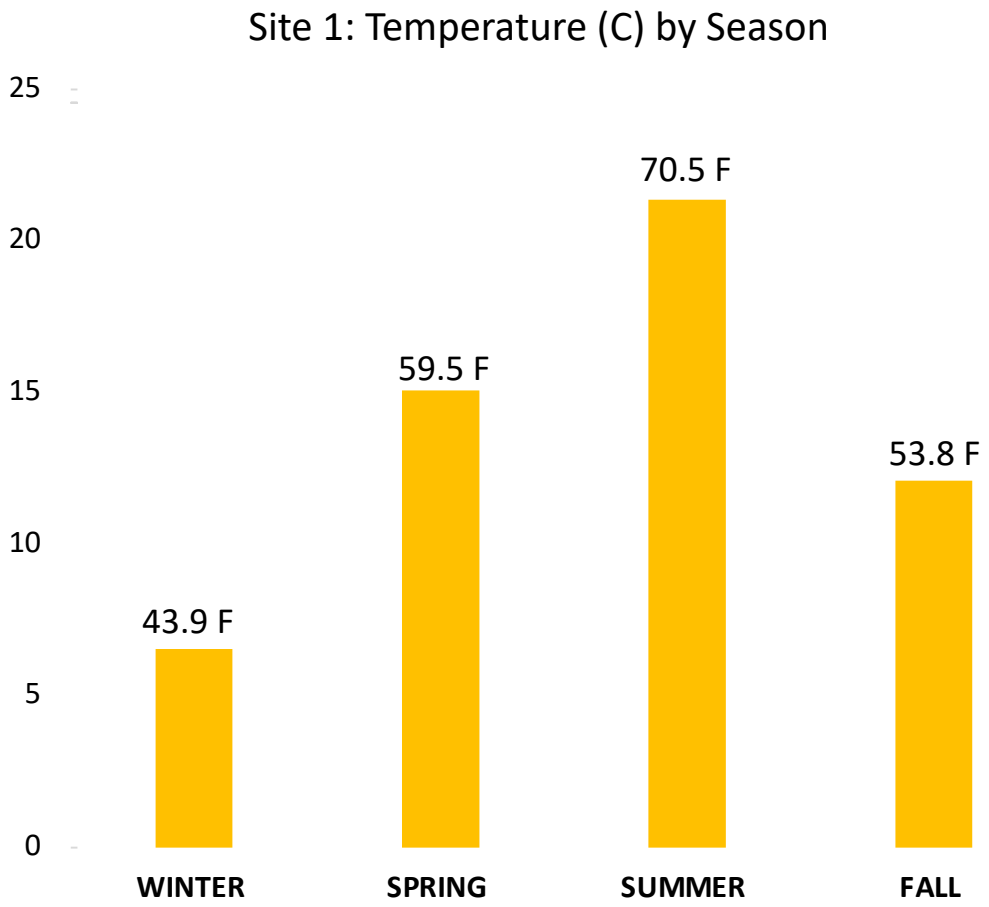


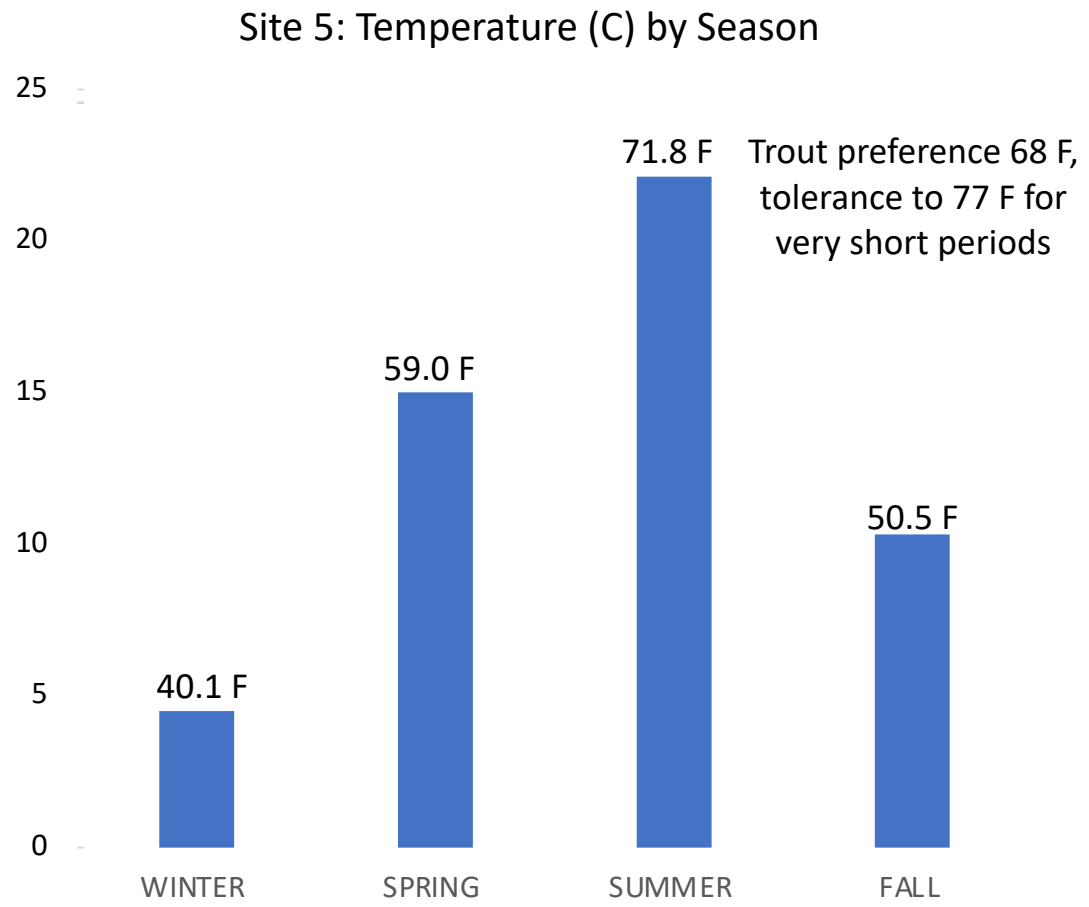
Temperature and Conductivity Contamination from Suburban Stormwater Runoff
Sites 1, 2, 3, 4, 5





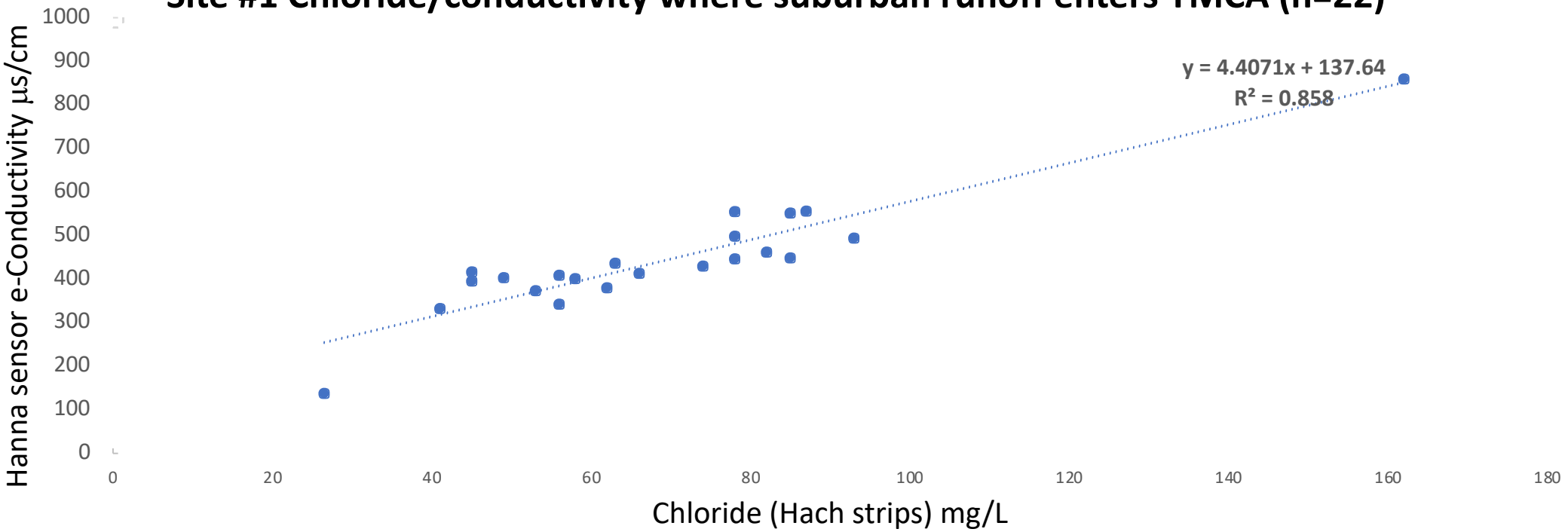
Seasonal Temperature
Site 1 (runoff) versus Site 5 (mainstem)

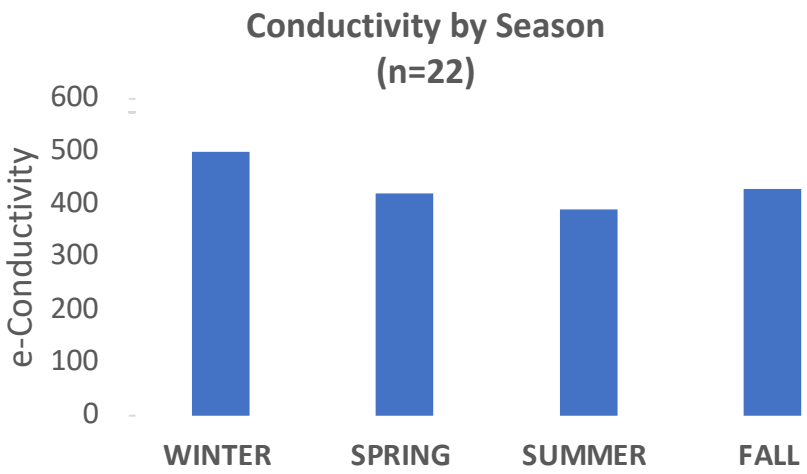


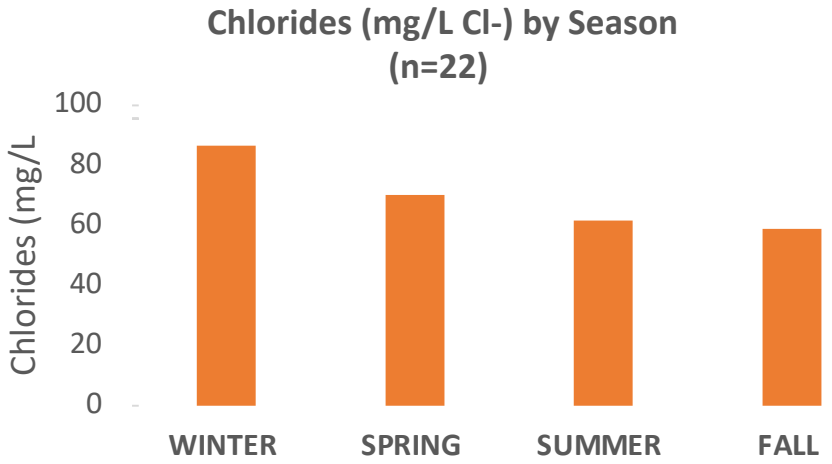


Pickering Creek, Winter 2018

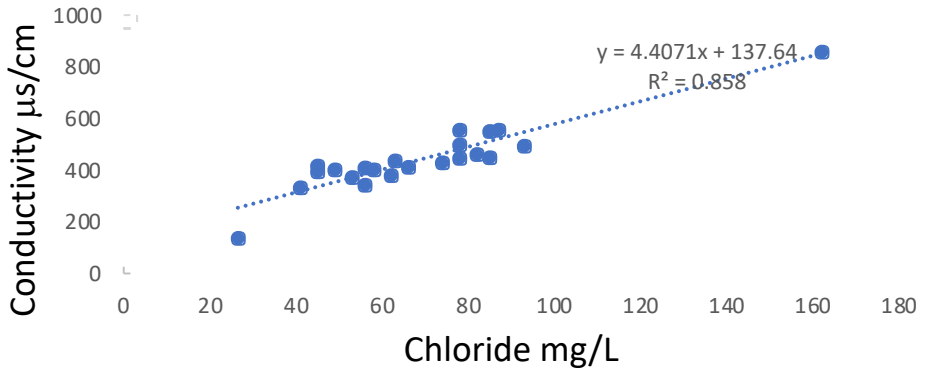
Site #1 Chloride/conductivity where suburban runoff enters YMCA (n=22)



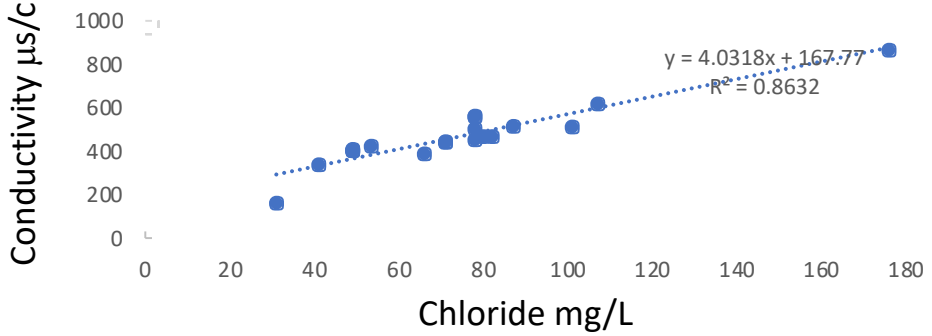




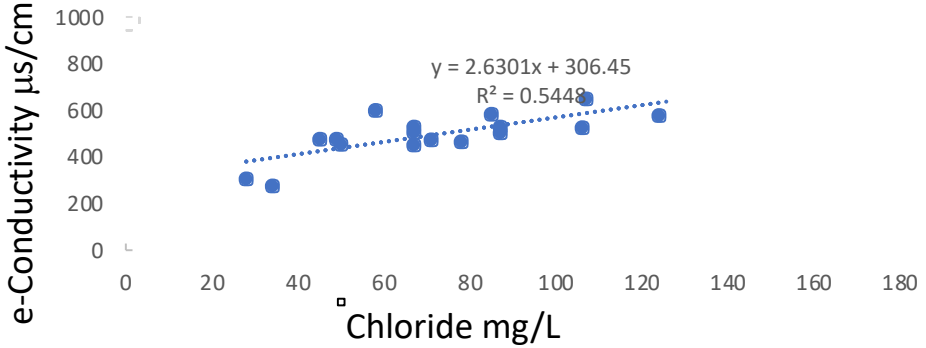
Site #1 Suburban runoff enters YMCA (n=22)



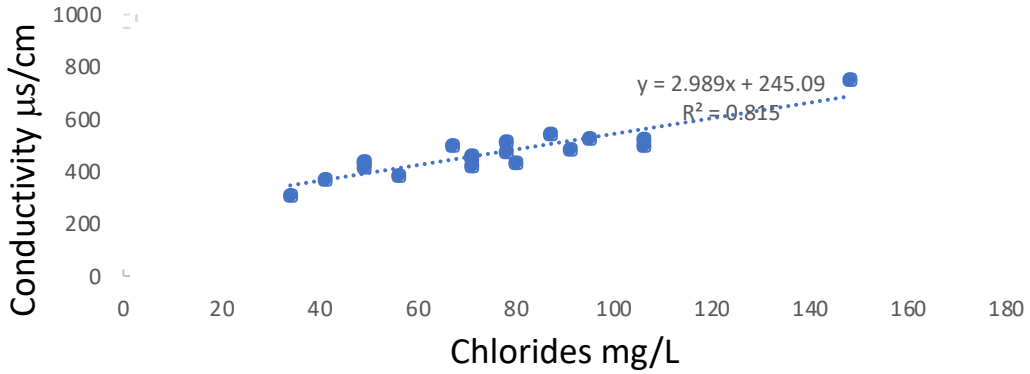
Site #2 (n=19)



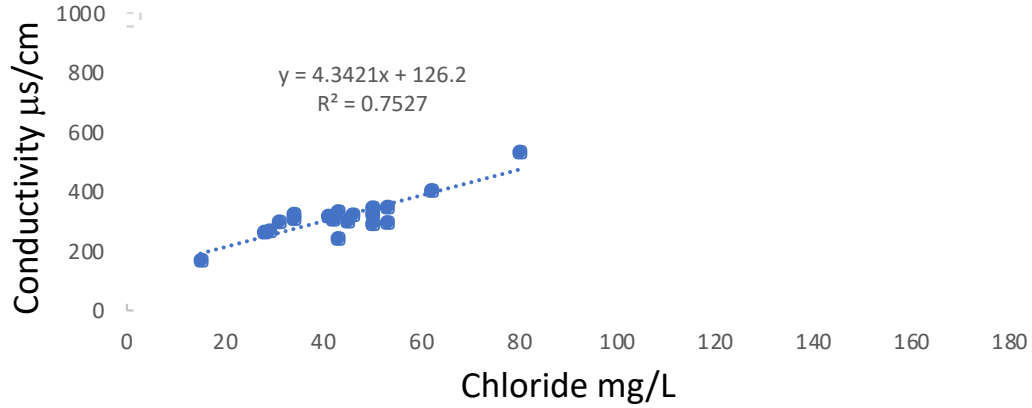
Site #3 Lateral UNT below YMCA parking lot (n=17)



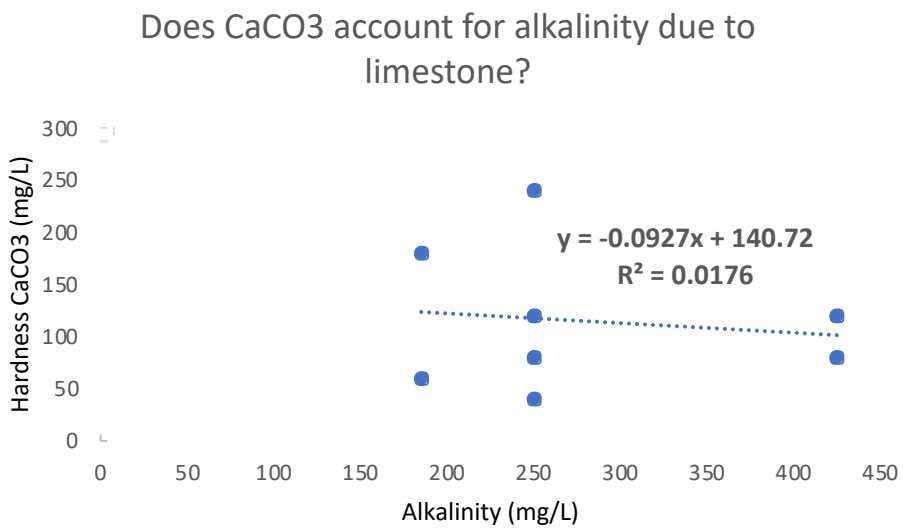
Site #4 Chloride/Conductivity where UNTS enter Pickering Mainstem (n=19)



Site #5 Chloride/Conductivity at Sensor Station (n=20)



Alkalinity			Hardness (CaCO3) Calcium Carbonate		
mg/L			mg/L		
Site 3 (n=8)	Site 1 (n=10)	Site 5 (n=9)	Site 3 (n=8)	Site 1 (n=10)	Site 5 (n=9)
115	104	70	277.5	302.5	245.3



EPA Aquatic Life Criteria for Cl (1988)

- CHRONIC criterion is 230 mg/L (based on 4-day average)
- ACUTE criterion is 860 mg/L (based on 1-hour average)
- Each criterion not to be exceeded more than once in 3 year period.

Federal and state chloride toxicity criteria:

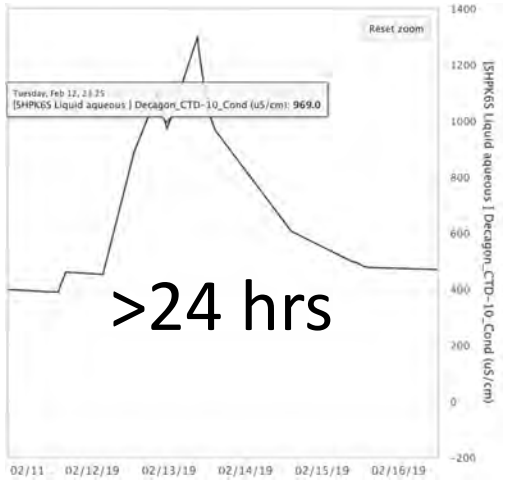
Organization and standard	Natural Chloride Level (mg/l)	
	5-15	
	Chronic/Long-Term Threshold (mg/l)	Acute/Short-Term Threshold (mg/l)
U.S. EPA Aquatic Life	230	860
U.S. EPA Secondary Drinking Water	250	
Michigan Surface Water Quality	150	640
Canadian Council of Ministers of the Environment	120	640
New York Ambient Water Quality	250	
Delaware River Basin Commission, Delaware River Zone 3	180	
Delaware River Basin Commission, Delaware River Zone 2	50	
Maryland Dept of Environment, MD Bio Stressor ID Process	50	

- When chloride exceeds any of these threshold it is evidence that salt is creating conditions that are stressful/lethal

Duration of aquatic chronic exposure exceedance in High Quality stream

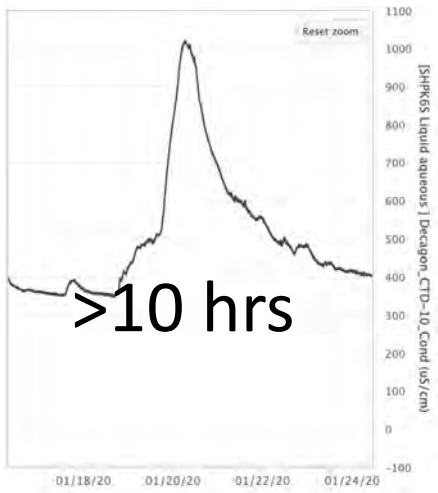
12 hours

2018



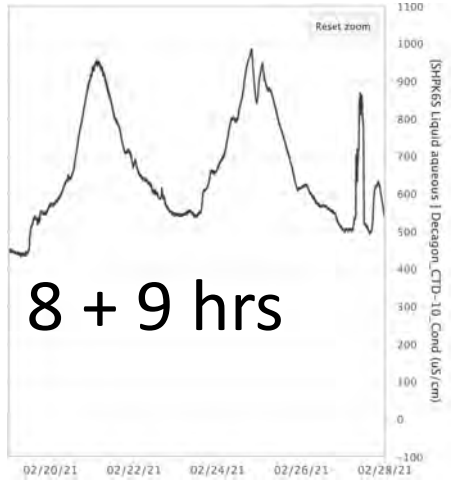
>24 hrs

2019



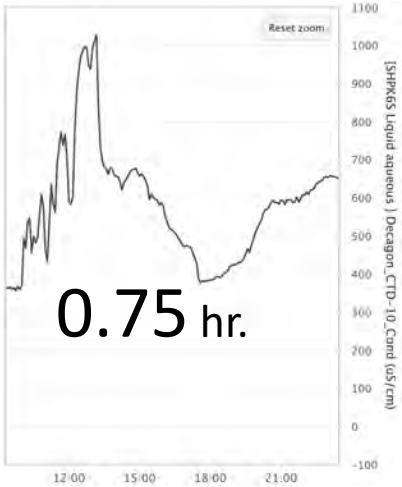
>10 hrs

2020



8 + 9 hrs

2021



0.75 hr.

2022

CHRONIC criterion is 230 mg/L (>900 uS/cm based on 4-day average):
Stresses aquatic life, leads to declines in abundance and diversity of species

ENVIRONMENTAL Science & Technology

ACS AUTHORCHOICE Article

Cite This: Environ. Sci. Technol. 2020, 54, 778−789

pubs.acs.org/est

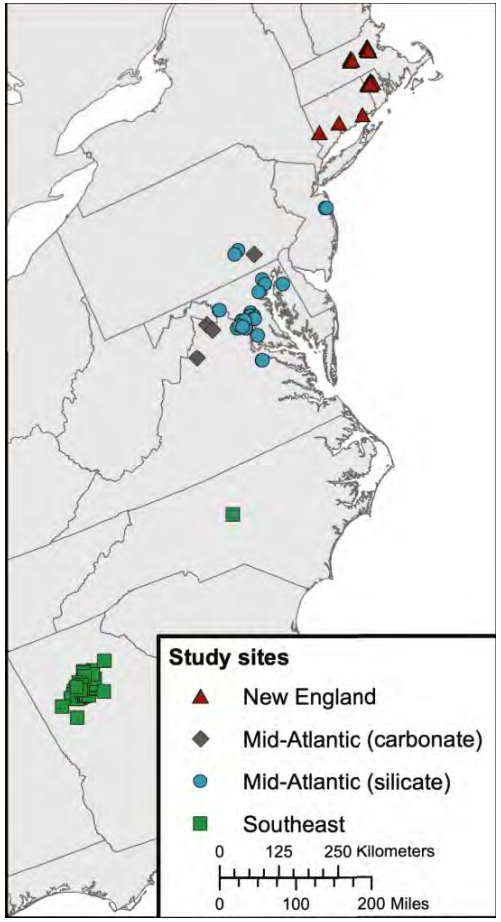
Nearly 30 million hi-freq obs

High-Frequency Data Reveal Deicing Salts Drive Elevated Specific Conductance and Chloride along with Pervasive and Frequent Exceedances of the U.S. Environmental Protection Agency Aquatic Life Criteria for Chloride in Urban Streams

Joel Moore,*[†,‡] Rosemary M. Fanelli,[§] and Andrew J. Sekellick[§]

[†]Department of Physics, Astronomy, and Geosciences and [‡]Environmental Science and Studies Program, Towson University, 8000 York Road, Towson, Maryland 21252, United States

[§]U.S. Geological Survey, Maryland−Delaware-District of Columbia Water Science Center, 5522 Research Park Drive, Catonsville, Maryland 21228, United States



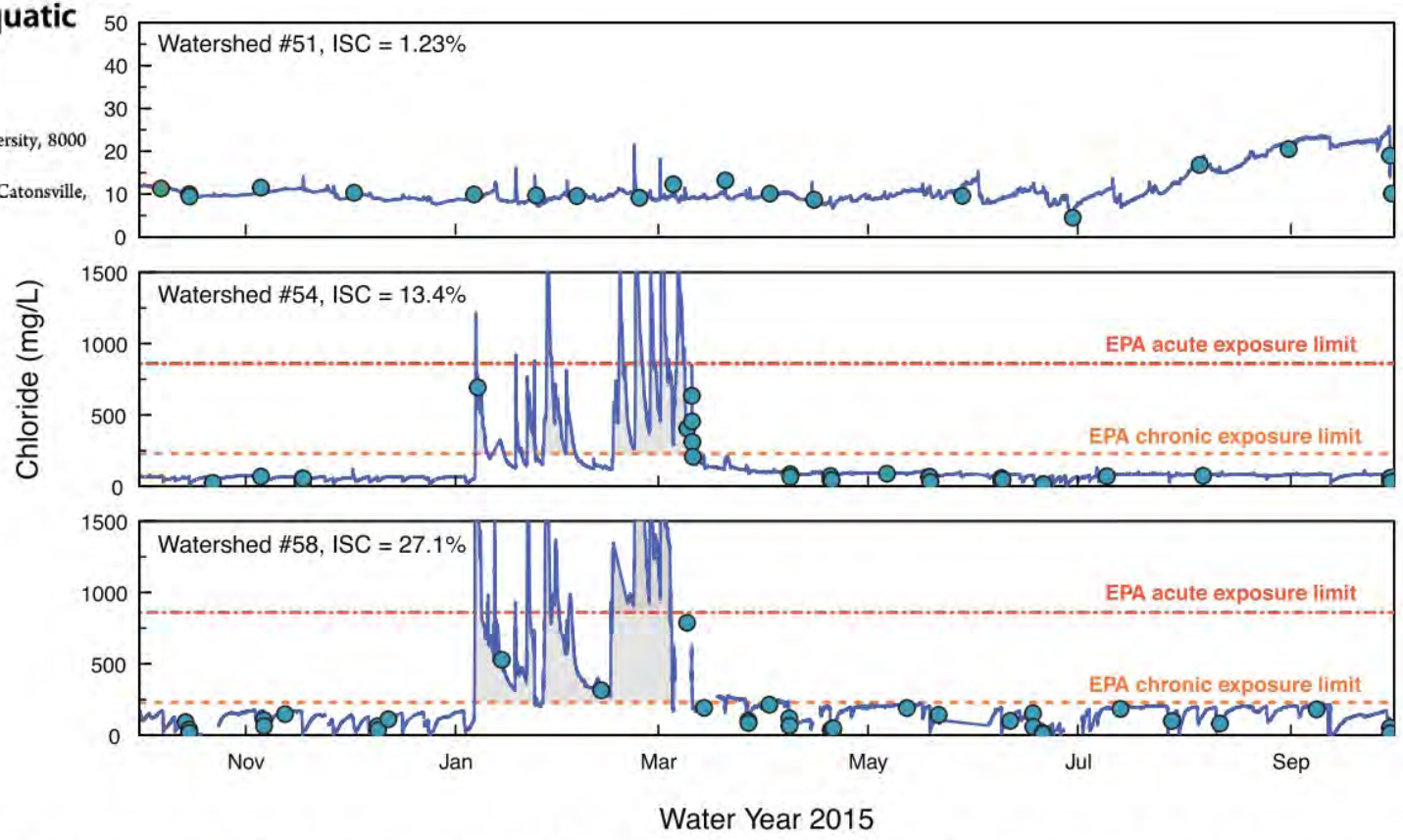


Figure 4. High-frequency (lines) and discrete (symbols) [Cl] chloride concentrations [Cl] in water year 2015 for three Mid-Atlantic watersheds (#51, #54, and #58; Table S1) with differing impervious surface cover. The lighter and darker gray shaded areas represent periods above the chronic and acute [Cl] exceedance thresholds, respectively. Note the differences in the *y*-axis limits. Though maximum [Cl] reached 2758 and ~4881 mg/L for watersheds #42 and #47, respectively, the *y*-axis limits are set at 1500 mg/L to allow for the visualization of nonwinter concentrations. High-frequency results (5 or 15 min intervals) are plotted and so more events may appear than were calculated with rolling 4 day averages.

STREAM NATURAL VARIATION AND REFERENCES FOR SPEC-CONDUCTIVITY AND MAJOR IONS (MICHAEL GRIFFITH, 2014)

Ecoregion[a]	No.[b]	*n* and percentiles	Sp. Cond. (µS/cm)	pH	Ca^{2+} (µeq/L)	Mg^{2+} (µeq/L)	Na^{+} (µeq/L)	K^{+} (µeq/L)	HCO_3^{-} (µeq/L)	SO_4^{2-} (µeq/L)	Cl^{-} (µeq/L)	
Corn Belt Plains		Maximum	1101.0	8.29	5426.6	3804.2	5496.2	213.2	5606.7	1488.7	6186.4	
		Minimum	464.8	7.11	2083.4	1667.1	259.9	11.5	2908.4	256.5	400.3	
08.02.04 Eastern Corn Belt Plains	55	*n*	24[c]	24	24	24	24	24	9	24	24	
		Maximum	267.0	8.50	6478.8	3909.5	14,401.4	207.2	5881.3	4570.9	16,484.3	
		Minimum	442.5	7.45	2204.7	1389.8	193.5	38.3	3643.8	431.2	371.2	
08.03.01 Northern Piedmont	64	*n*	95	95	95	95	95	95	74	95	95	
		Maximum	1125.6	9.36	4151.7	2303.2	4545.5	164.8	2884.8	1272.1	6647.4	235.6
		75th	297.8	7.80	1352.3	695.9	535.1	72.1	1079.6	389.3	662.9	24.5
		Mean	216.1	6.75	943.6	531.9	501.2	55.2	763.3	292.3	652.1	23.1
		Median	178.0	7.44	753.5	479.6	311.0	45.1	467.6	235.3	432.5	15.3
		25th	108.2	7.18	360.7	255.4	200.3	32.7	284.7	99.1	223.1	7.9
		Minimum	24.9	4.96	37.0	47.6	50.5	17.3	6.5	25.6	50.5	1.8

Ecoregion[a]	No.[b]	*n* and percentiles	Sp. Cond. (µS/cm)	pH	Ca^{2+} (µeq/L)	Mg^{2+} (µeq/L)	Na^{+} (µeq/L)	K^{+} (µeq/L)	HCO_3^{-} (µeq/L)	SO_4^{2-} (µeq/L)	Cl^{-} (µeq/L)
Atlantic Coastal Plain		Maximum	2740.0	7.76	2047.9	2412.3	1274.9	282.6	1525.1	1809.6	2006.6
		75th	186.4	7.13	731.1	371.2	408.7	101.4	483.9	345.7	448.5
		Mean	191.1	5.49	550.7	336.3	351.9	82.6	356.5	266.0	435.1
		Median	131.0	6.58	456.5	287.8	295.3	66.9	184.7	181.2	344.2
		25th	94.4	6.08	299.4	182.9	235.0	45.5	80.1	132.0	288.9
		Minimum	48.6	4.32	43.0	55.1	137.2	22.3	4.1	19.4	127.2

Environmental impacts of chloride contamination

https://storymaps.arcgis.com/stories/f998c640cc7d4fc9bca0d0aba8adffeb

Chloride Above These Levels Can Be Toxic

mg/L (PPM)

Short Exposure	Long Term Exposure	Species
2540	400	Snail
6570	430	Fathead minnow
6740	900	Rainbow trout
8000	800	Channel catfish
8390	850	Carp

Temperature affects acute mayfly responses to elevated salinity: implications for toxicity of road de-icing salts

John K. Jackson and David H. Funk

Stroud Water Research Center, 970 Spencer Road, Avondale, PA 19311, USA

"We observed a significant or nearly significant decrease in toxicity as temperature decreased for all four [Mayfly] species…However, this is not to suggest that elevated (but not peak) salt concentrations during winter are not contributing to overall impairment [of macroinvertebrate assemblages]".

New Hampshire: First in the Country to Use Salts on Winter Roads, First to Use a TMDL - 2013

- TMDL targets DOT, Towns, and Parking Lots
- BMPS:
  - Anti-icing,
  - Pre-wetting salt,
  - Calibration of salt needs,
  - Training – classroom, hands-on
  - Salt accounting – Salt Management System
  - MS4 Requirements
  - Voluntary certification program for salt applicators and provide limited liability – proposed legislation, died (inexpedient to legislate)