May 2023

Elucidating Unique Sources and Persistent Hydrologic Pathways of Chloride to Perennial Freshwater Streams: Root River Analog in a Cold-Weather Environment

Leah Elizabeth Dechant
University of Wisconsin-Milwaukee

ELUCIDATING UNIQUE SOURCES AND PERSISTENT HYDROLOGIC PATHWAYS OF CHLORIDE TO PERENNIAL FRESHWATER STREAMS: ROOT RIVER ANALOG IN A COLD-WEATHER ENVIRONMENT

by

Leah E. Dechant

A Thesis Submitted in

Partial Fulfillment of the

Requirements for the Degree of

Master of Science

in Geosciences

at

The University of Wisconsin-Milwaukee

May 2023

ABSTRACT

ELUCIDATING UNIQUE SOURCES AND PERSISTENT HYDROLOGIC PATHWAYS OF CHLORIDE TO PERENNIAL FRESHWATER STREAMS: ROOT RIVER ANALOG IN A COLD-WEATHER ENVIRONMENT

by

Leah E. Dechant

The University of Wisconsin-Milwaukee, 2023
Under the Supervision of Professor Dr. Charles J Paradis

Chloride in freshwater streams is increasing in concentration, persisting throughout the year, and contributing to the salinization of water resources. The primary source and pathway of chloride in cold-weather environments are thought to be road salt and runoff. However, mounting evidence displays that other sources and pathways of chloride play an important role yet studies to elucidate them at a high resolution, both temporally and spatially, and across diverse land use are lacking. In this study, chloride was quantified continuously for an urban and rural stream year-round in a watershed thought to be heavily impacted by road salt. Bivariate mixing diagrams and hydrograph separation showed that road salt and groundwater were the predominant source and pathway of chloride year-round and across the watershed. Soil leaching and chloride budget data showed that soils served as both sources and pathways across the watershed and chloride persisted year-round.

Dedicated to my past, present, and future self.

TABLE OF CONTENTS

LIST OF FIGURES ..... ***vii***

LIST OF TABLES ..... ***viii***

ACKNOWLEDGEMENTS ..... ***ix***

CHAPTER 1: INTRODUCTION ***1***

Problem **1**

Objectives **3**

Previous Work **4**

Sources of Chloride 4
Hydrologic Pathways 5
Land Use 5
Temporal Changes 5
Sampling Frequency 6

CHAPTER 2: MATERIALS & METHODS ***7***

Study Site: Perennial stream in cold weather environment analog **7**

Root River 7
Climate 10

Water Sample Collection **11**

Discrete 11
Continuous 11

Near-surface Soil Sample Collection **13**

Analytical Procedure & Calculations **14**

Water Samples 14
Quantifying Continuous Chloride 14
Distinguishing Unique Sources of Chloride 14
Persistent Pathways of Chloride 14
Near-surface Soil Samples 15
Mass Loading of Chloride 15
Chloride Budget: Road Salt 16
Supplemental Data: Alkalinity, Total Dissolved Solids, and pH 17

CHAPTER 3: RESULTS & DISCUSSION ***19***

Results **19**

Chloride 19
Continuous Chloride 20
Unique Sources of Chloride 21
Continuous Chloride, Streamflow, and Precipitation 24
Persistent Hydrological Pathways of Chloride 27
Near-surface Soils and Batch Leaching Comparison 28
Mass Loading of Chloride 32
Chloride Budget: Road Salt 35

Supplemental Results **38**

Isotopes 38

Alkalinity 43
Total Dissolved Solids 45
pH 48
Nitrate, Sulfate, and Potassium 50

***CHAPTER 4: CONCLUSIONS* 53**

***CHAPTER 5: FUTURE IMPLICATIONS* 55**

Waukesha Water Diversion 55
Overview 55
The Water 56
Implications to the Root River and Beyond 57

Open-Source Data 58
Surface Water Integrated Monitoring Systems (SWIMS) 58
Predictive Modeling and Mechanistic Processes 58

***REFERENCES* 59**

***APPENDIX A: Standard Operating Procedures* 64**
pH 64
Alkalinity 67
Total Dissolved Solids 70
Near-surface Batch Leaching 72

***APPENDIX B: Stream Water Sample Data* 74**
Anion Data (Cl^-, NO_3, SO_4, SiO_2) 74
Cation Data (K^+ and Na^+) 84
Halide Data (Br^- and I^-) 95
Total Nitrogen Data (TN) 105

***APPENDIX C: Stream Water Data* 116**
Streamflow Data 116
Specific Conductance Data 126

***APPENDIX D: Field Site Data* 136**
Precipitation Data 136
Temperature Data 146

***APPENDIX E: Proxy Water Sample Data* 156**
Isotope Data 156
Alkalinity, pH, and Total Dissolved Solids Data 166
Isotope Averages 176
Alkalinity Averages 176
Total Dissolved Solid Averages 176
pH Averages 177

***APPENDIX F: Soil Data* 178**
Field Parameters and Data 178
UW Forage and Soil Analysis Data 180
R^2 Values for Data Regressions 181

LIST OF FIGURES

Figure 1	Study Site	8
Figure 2	Sources of Chloride within the Root River watershed	10
Figure 3	Soil Sampling Locations	13
Figure 4	Chloride Concentrations versus Time	20
Figure 5	Chloride Concentrations versus Specific Conductance	21
Figure 6	Chloride/Bromide Ratios versus Chloride Concentrations	22
Figure 7	Total Nitrogen versus Chloride/Bromides Ratios	24
Figure 8	Continuous Chloride Concentration, Streamflow, and Precipitation	26
Figure 9	Flow-based Hydrographic Separation	28
Figure 10	Chloride Concentrations versus Soluble Salts	30
Figure 11	Organic Matter % versus Chloride Concentrations	30
Figure 12	Soluble Salts Overtime	32
Figure 13	Mass Loading of Chloride	34
Figure 14	Stable Water Isotopes versus Global Water Meteoric Line	39
Figure 15	Stable Water Isotopes versus Streamflow	41
Figure 16	Stable Water Isotopes versus Climate Temperatures	42
Figure 17	Alkalinity versus Chloride Concentrations	43
Figure 18	Alkalinity versus Streamflow	45
Figure 19	Total Dissolved Solids versus Chloride Concentrations	46
Figure 20	Total Dissolved Solids versus Streamflow	47
Figure 21	pH versus Chloride Concentration	48
Figure 22	pH versus Streamflow	49
Figure 23	Nitrate and Sulfate Concentrations versus Streamflow	51
Figure 24	Potassium Concentrations versus Streamflow	52
Figure 25	Waukesha’s Water Diversion	56

LIST OF TABLES

Table 1	Study Site Parameters	8
Table 2	Chloride Budget for Road Salt	34
Table 3	Mass Balance for Chloride	35

ACKNOWLEDGEMENTS

First and foremost, I want to thank my advisor, Charles J Paradis, for recognizing my potential and unique skills that generated an all-encompassing thesis to contribute to the field of geosciences. Charlie has allowed me to grow academically, professionally, and personally by supporting and respecting my work during our scholarship. I appreciate Charlie's mentorship, enthusiasm, and character that I will miss after our days of scholarship. I thank both Timothy Grundl and Laura Herrick for serving on my committee and providing diverse expertise and guidance during our scholarship. I thank Timothy Wahl who contributed expertise on geochemical analysis and supported my research over the past two years. I thank Nick Neureuther for offering field assistance and providing materials that allowed this research to expand beyond its initial bounds. Thanks to my five Support for Undergraduate Research Fellows assistants: Dylan Childs, Autumn Routson, Samuel Sellars, Anna Sniadach, and Riley Thomas for their time and support over our scholarship.

Tremendous thanks to Dr. Jennifer L. B. Anderson, my undergraduate research advisor who provided lifelong research experiences, expertise, and mentorship that inspired me to pursue a Master of Science. Through our scholarship, I gained skills invaluable to my life and research and learned how to ask questions, which is how I got to writing this. Along with Mark Cintala, Roland Montes, Frank Cardenas, and Christopher Cline who respected and supported me during laboratory work at NASA Johnson Space Center. Exposure to such insightful and passionate researchers allowed me to understand the future I would like to have. Additionally, I need to thank my undergraduate department who supported me during my program, research, teaching, and covid-19 graduation. I thank all my friends and fellow graduate students for your unconditional support and camaraderie that has gotten me to this point. I thank my parents, Lori

Dechant and Dan Dechant, and my sisters, Alexa and Kayelin for all their support throughout my post-secondary education journey. While they have not always understood what I was doing, where I was, or why I did it, I hope they are happy to know I have successfully completed what I set out to do.

I dedicate this work to the memory of Stephen T. Allard, Ph.D. Thank you for what you have done to allow me to be the geologist I want to be while using my hands and living a life I am happy to call mine.

CHAPTER 1: INTRODUCTION

Problem

Chloride in freshwater streams is increasing in concentration, persisting throughout the year, and contributing to the salinization of water resources in the United States and abroad. The Great Lakes region, specifically Lake Michigan, has steadily seen chloride concentrations increasing overtime, ~ 1-2 mg/L in the 1800s to > 15 mg/L in 2020 attributed to the tributary loading of chloride into Lake Michigan (Dugan et al., 2021). Salinization of freshwater in the Great Lakes region has been tied to urban land and human-dominated landscapes (Dugan et al., 2020; Moore et al., 2020; Stets et al., 2020) suggesting the primary source of chloride is road salts (i.e., NaCl, $MgCl_2$, $CaCl_2$). Chloride (Cl^-), the negatively charged ionic form of chlorine, accounts for 60 weight% of the mass of NaCl, the most common compound used in road salts. Chloride accounts for higher percentages in other compounds of $MgCl_2$ and $CaCl_2$.

Road salts were first used across the United States for winter road maintenance during the winter of 1941-1942 when a total of 5,000 tons was applied. Today 10-20 million tons of road salts are applied each winter across the country (Kelly et al., 2010). The Wisconsin Department of Transportation applied 324,264 tons of road salts to 35,177 state lane miles across Wisconsin; 70,415 tons was applied to 6,143 state lane miles in the Southeast Region (Kenosha, Milwaukee, Ozaukee, Racine, Walworth, Washington, and Waukesha counties) of Wisconsin during the 2020-2021 winter (Wisconsin DOT, 2021).

Across Wisconsin tributaries and streams have been investigated for chloride concentrations over recent years. The Wisconsin Department of Natural Resources measures chloride concentrations for the state’s 26 largest river systems. Demonstrating a steep increase in chloride loads with an increase from 600,000 to 800,000 tons over 18 years (*DNR reminds Wisconsinites to reduce salt use this winter, n.d.*). Suggesting the hydrologic pathway of chloride to freshwater streams is predominantly runoff during spring snow and ice melt. Specifically for the Root River the Southeastern Wisconsin Regional Planning Commission (SEWRPC) conducted a 48-year assessment and found increasing chloride concentrations, with concentrations occasionally exceeding State of Wisconsin chronic (395 mg/L) and acute (757 mg/L) levels for chloride (SEWRPC, 2014). During their prospectus for a study of chloride in the environment showed high chloride concentrations in the Root River during drought conditions, suggesting that chloride may be accumulating in the groundwater (SEWRPC, 2014).

Data for chloride concentrations in streams are highly localized temporally and spatially due to predominant assumptions. However, there is mounting evidence that other unique sources (landfill leachate, septic effluent, and animal waste) and persistent pathways (groundwater flow and soil porewater flow) of chloride play an important role yet studies to elucidate them, at high resolutions, both temporally and spatially, across a diverse watershed are lacking.

Objectives

The objectives of this study include: 1) distinguish unique sources of chloride in freshwater streams and 2) elucidate persistent hydrologic pathways year-round, discretely, continuously, and across a diverse watershed.

Previous Work

Freshwater resources are rapidly increasing in salinity throughout the United States and abroad (Cunillera-Montcusi et al., 2022; Kaushal at al., 2018) thus efforts to better characterize the unique sources and persistent pathways of salts and their predominant and mobile components, such as chloride, are important. Chloride in the environment can be challenging to adequately characterize due to its multiple potential sources and pathways and its inherent variability across space and time (Fay and Shi, 2012; Dugan et al., 2021). Previous studies have made notable progress at characterizing chloride in the natural environment, yet many could be improved by utilizing established field-based methods to address the following five fundamental knowledge gaps: 1) identification of chloride sources, 2) assessment of multiple hydrological pathways, 3) consideration of diverse land use, 4) evaluation of year-round data, and 5) analysis of high-frequency data.

Sources of Chloride

Application of source characterization techniques are lacking to distinguish unique chloride sources in a watershed (Mackie et al., 2022). Common sources of chloride in the environment include road salt, water softening, septic effluent, animal waste, fertilizers, and wastewater effluent (Granato et al., 2015). An established field-based method to help identify the potential sources of chloride in water relies on analyzing the ratios of chloride, bromide, and total nitrogen (Panno et al., 2006). The importance in understanding the dominant source of chloride is imperative for calculating the mass balance of chloride within a system and implementing efficient plans to monitor and mitigate chloride sources.

Hydrologic Pathways

Investigation of chloride in natural waters is common, however, the investigation of chloride in natural waters via a multiple systems approach is less so. Considering both groundwater (i.e., groundwater flow and interflow) and surface water (i.e., direct infiltration and runoff) would allow for a holistic characterization of chloride in the environment. Established field-based methods to identify these pathways of chloride rely on separating stream hydrographs into the basic components of streamflow; direct precipitation, runoff, and baseflow (Cherry, 2019). This method could provide information about the unique sources and persistent pathways of chloride unseen by groundwater or surface water analysis alone (Granato et al., 2015).

Land Use

Studies on chloride transport previous to 2012 were primarily focused on urbanized areas until Todd and Kaltenecker (2012) and Oswald et al. (2015) demonstrated that rural and less urbanized areas were also impacted by chloride. More recently, a review by Mackie et al (2022) explicitly called for studies to incorporate rural areas, in addition to urban areas, to better characterize the unique sources and persistent pathways of chloride to freshwater resources. Investigating the underrepresented areas also vulnerable to chloride contamination will not only diversify the data available but strengthen the understanding of chloride in the environment and across a diverse watershed.

Temporal Changes

Previous studies primarily focused on warmer seasons, with little recognition of the temporal contribution of groundwater to surface water outside of the warmer seasons (Mackie et al., 2022). This masks temporal patterns of potentially unique chloride sources entering a stream's hydrologic systems during colder months. Continued sampling year-round will further the understanding of chloride sources temporally and allow for advanced relationships between chloride sources, chloride concentrations, and hydrologic pathways.

Sampling Frequency

The absence of continuous chloride concentration data challenges the ability to adequately characterize chloride transport, due to fluctuations that occur on a high-frequency scale (i.e., hourly, daily, or weekly) that are not seen on a low-frequency scale (i.e., monthly or yearly) (Bester et al., 2006). Additionally, difficulties with chloride legacy (long-lasting presence) exist because chloride persists in the environment after addition. Galella at al (2021) recently demonstrated the importance of high-frequency data to adequately characterize pulses and exceedances of chloride in watersheds. The application of high-frequency and continuous sampling will fill the gap between low-frequency and discrete sampling, increasing the reliability of the data and potentially highlight unknown relationships between chloride sources and pathways.

CHAPTER 2: MATERIALS & METHODS

Study Site: Perennial stream in cold weather environment analog

Root River

This study was conducted on the Root River in Racine County, Wisconsin located within Lake Michigan's drainage basin in Southeastern Wisconsin (Fig 1). The Root River is a perennial freshwater stream in a cold weather environment thought to be heavily impacted by road salt. It consists of 117 miles of streams with nine sub-watersheds that eventually drain approximately 198 square miles of land into Lake Michigan (Fig 1). Two field sites, urban (site 1) and rural (site 2), within this stream's watershed, were utilized to investigate the potential effects of diverse land use on chloride in the environment. The urban site is located south of Quarry Lake Park in the City of Racine, Wisconsin, representing urban influences on the mass loading of chloride (Fig 1). The urban site immediately drains a heavily urbanized sub-watershed in addition to 99% of the entire Root River watershed with a total of 31.37% urban land coverage (Table 1). The rural site is located on the Root River Canal, west of Koerber Park in Racine County, Wisconsin, representing rural influences on the mass loading of chloride (Fig 1). The rural site drains lightly urbanized sub watersheds with 11.43% urban land coverage, dominated by agricultural practices (Table 1).

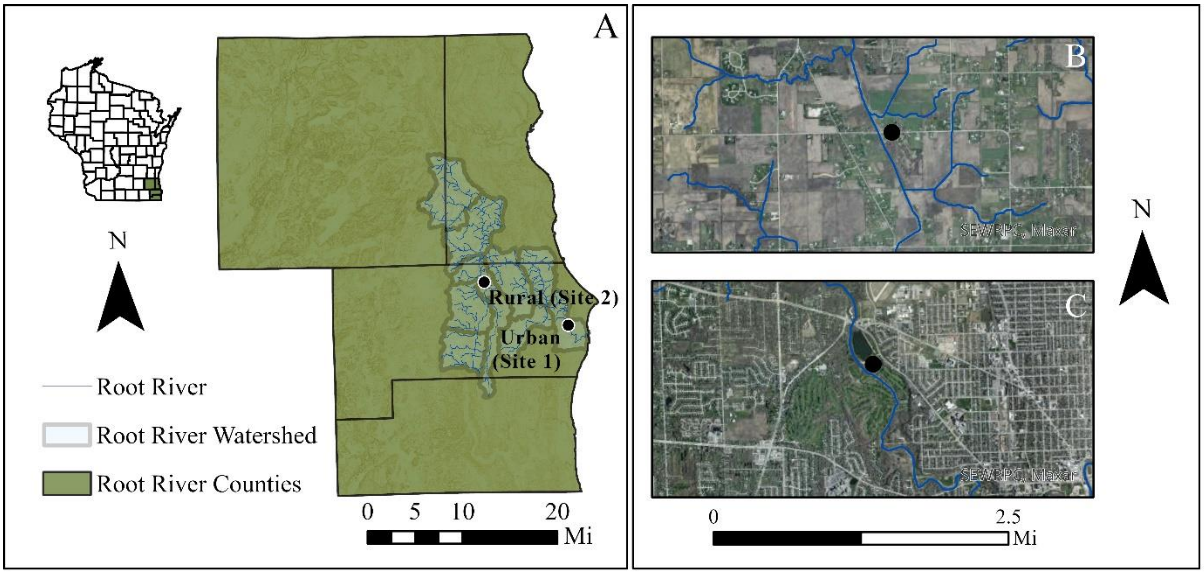

Fig 1 Root River study site and field sites, A) displays the regional area, watershed, sub watersheds, and the stream channel with field sites urban and rural labeled B) displays the rural site with the river channel C) displays the urban site with the river channel.

Table 1 Site parameters: Latitude, Longitude, Drainage Area, and Percent Urban Land Coverage.

Site	Latitude	Longitude	Total area (Mi^2) for drainage area	Area (Mi^2) of urban land[A] coverage for drainage area	% urban land coverage for drainage area
urban (site 1)	42.7466813	-87.820891	196.91	61.78	31.37
rural (site 2)	42.815407	-87.992601	57.92	6.62	11.43

[A] Urban land includes four types: Developed (open space), Developed (low intensity), Developed (medium intensity), and Developed (high intensity)

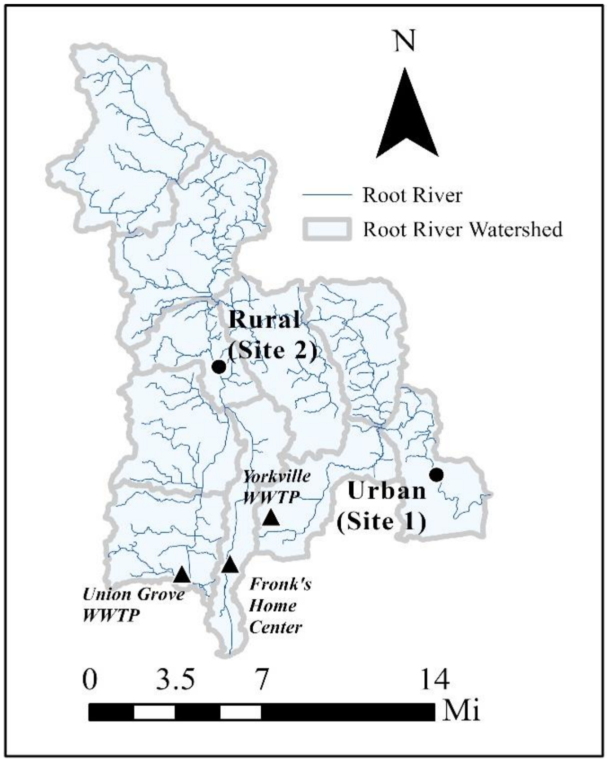

Fig. 2. Map of the Root River Watershed with field sites and point source non-road salt sources of chloride including Wastewater Treatment Plants (WWTP) and septic effluent from residential housing.

Chloride on the Root River

In addition to road salt, both field sites were potentially impacted by effluent from wastewater treatment plants (WWTP) or residential housing septic systems (Fig 2). The rural site receives effluent from Union Grove's WWTP upstream (Fig 2). The urban site, downstream of the rural site, receives effluent from Union Grove's WWTP in addition to Yorkville's WWTP and Fronk's Home Center (Fig 2). While these three locations possibly introduced measurable levels of chloride to the streams, the substantial distance between these sources and the field sites were thought to limit their impact on chloride levels.

Geology and Soils

Both field sites sit over Silurian and Devonian age sedimentary rocks with a gentle dip to the east-southeast. Depth to bedrock ranges from 50 – 500ft across the watershed. Repeated glaciations from the Lake Michigan Lobe during the Pleistocene influenced the surface bedrock of the Root River watershed and surrounding areas, creating irregularities, and depositing glacial till out-wash, and glaciolacustrine deposits. The Root River's perennial baseflow is provided by the Silurian Dolomite and sand-and-gravel aquifers which are hydraulically connected (Zaporozec et al., 1996). Local lithologies for both sites from top to bottom are as follows: Urban: Clay (21ft), Hardpan (27ft), Gravel (1ft), Limestone (108ft). Rural: Clay (55ft), Sand/Gravel (40ft), Limestone (45ft). Local lithologies were constructed by proximal well boring logs from the Wisconsin Department of Natural Resources. The surface soils (uppermost 5 feet) within the Root River watershed field sites, urban and rural, are characterized by slow to very slow infiltration (SSURGO, 2022).

Climate

The Root River lies within a continental climate, representing the transition between mild and polar climates which endure extreme seasonal changes; colder winters, and longer-lasting snow. In 2021 the Root River watershed, in Racine County alone, received an accumulation of 23.37 inches and 43.8 inches of precipitation and snow, respectively. The historic normal for Racine County are 37.04 inches and 41.4 inches of precipitation and snow, respectively (USDC, 2021).

Water Sample Collection

Discrete

Manual grab samples of stream water were collected at a high-frequency from both sites three times per week from 7/15/21 – 8/18/21 and 6/1/22 – 8/24/22; precipitation samples were also collected when available (Fig 1). Between the high-frequency sampling, lower-frequency grab sampling, once every two weeks, were conducted to further understand year-round data, at both field sites (Fig 1). Two 250-mL surface water samples were collected at 1-hour intervals at each field site. One 250-mL precipitation sample was collected from rain catchments constructed to collect and store precipitation to minimize evaporation, preserving the sample at each field site. Clean opaque Nalgene 250-mL vials were used to collect the water samples. Additionally, at the urban field site, stormwater drain effluent upstream of the sampling site and lake water samples from Quarry Lake were collected in consistent volumes of 250-mL. Each 250-mL sample was separated into two labeled 50-mL vials and one labeled 150-mL vial. The two 50-mL vials were Corning, self-standing centrifuge tubes and contained filtered (0.2 microns) water samples, filled with no headspace, sealed with parafilm, and preserved on ice. The one 150-mL vial was filled with no headspace and preserved on ice. Preparation of the water samples (i.e., surface water, precipitation, stormwater drain effluent, and Quarry Lake) was conducted directly after collection in the field.

Continuous

Automatic streamflow and measurements of stream conductance, temperature, and depth were taken from United States Geological Survey (USGS) gaging stations, #04087240 and #04087233, and Southeastern Wisconsin Regional Planning Commission (SEWRPC) CTD probes, Root River at Horlick z6-04959 and Root River Canal z6-08204, respectively for the urban and rural field sites. Data was collected from 7/15/21 – 8/24/22 at intervals of 15 minutes and 5 minutes, for streamflow and CTD, respectively. CTD probes introduced continuous measurements, eliminating gaps between grab samples, and allowing for an annual and high-frequency look into the Root River. Lastly, precipitation accumulation and climate temperature data were taken from the National Oceanic and Atmospheric Administration using the closest field stations, Racine Batten Airport and Caledonia 3.6 WNW, for urban and rural field sites, respectively. The Caledonia 3.6 WNW data was supplemented with Union Grove Wastewater Treatment Plant information when the Caledonia data was unavailable. Precipitation was collected at intervals of daily precipitation accumulation (inches) and temperature (Celsius) was taken in daily range (high and low).

Near-surface Soil Sample Collection

Manual soil sampling via hand-push auger of near-surface soils was conducted on 7/13/22 and 8/24/22 at both field sites (Fig 1). Soil samples were collected along the right and left riverbanks at both field sites (Fig 3). Grass and overlying debris were removed before soil sampling. The auger was pushed approximately 12 inches into the ground surface (or until stopped by impenetrable substrate material) and rotated 360 degrees to efficiently retrieve a complete soil sample. Once retrieved, soil samples were photographed for depth and fresh soil color analysis (Tables F.1 and F.2). Soil samples were transferred from the auger into labeled sterile Nasco WHIRL-PAK bags or clean Ziploc bags. Soil samples were preserved in an opaque box to eliminate exposure to precipitation and UV light. The urban site had additional lake sediment taken from Quarry Lake (Fig 3). The rural site had additional soil samples based on land use (i.e., woodlands, pasture, roadside ditch, agricultural fields, and rural land use) (Fig 3).

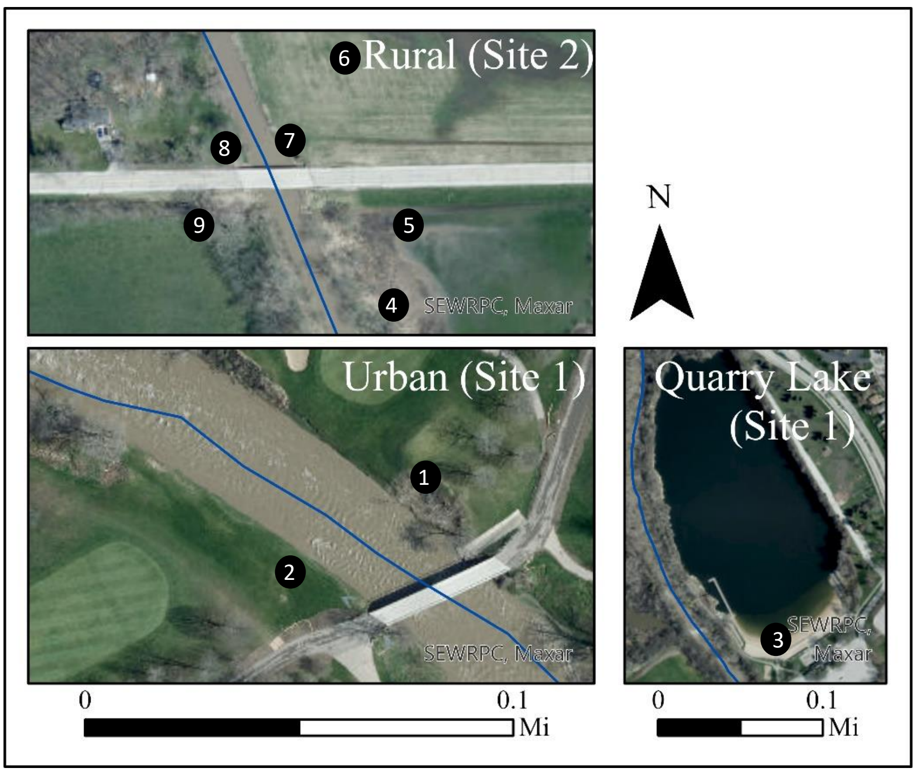

Fig. 3. Root River field sites with soil sampling locations 1-9.

Analytical Procedure & Calculations

Water Samples

All water samples in 50-mL vials underwent ion analysis at the University of Wisconsin-Milwaukee School of Freshwater Science. Analysis of anions was quantified by a Dionex ICS-1000 ion chromatograph, using a carbonate buffer to separate the samples through an anion exchange column, which is then measured by conductivity. Analysis of cations was quantified by a Thermo Scientific iCE 3000 series AA spectrometer, using flame atomic adsorption spectrometry. Total nitrogen (TN) was quantified by a Shimadzu TOC-L analyzer with an added TN unit.

Quantifying Continuous Chloride

The linear relationship between specific conductance (µS/cm) from the CTD probes and chloride concentrations (mg/L) from grab samples were used to calculate and characterize continuous chloride concentrations from continuous conductance measurements.

Distinguishing Unique Sources of Chloride

Specific conductance and bivariate mixing diagrams (Cl/Br ratios vs. Cl and Cl/Br ratios vs. total nitrogen) were made to distinguish the dominant source of chloride. This was done by plotting discrete grab samples against seven unique end-members; precipitation, agricultural, road salt, and septic effluent, basin brines, animal waste, sea water, landfill leachate, and pristine aquifers with known concentrations of Cl/Br ratios, Cl^-, and TN (Panno et al., 2006).

Persistent Pathways of Chloride

Hydrograph separation of continuous streamflow from the USGS was conducted to indicate the dominant chloride pathway to the Root River annually and across the watershed at both field sites. Flow-based separation was completed in WHAT, a web-based hydrograph analysis tool (WHAT, 2023). Utilizing a recursive digital filter-based separation module (Eq 1) based on Eckhardt (2015). Baseflow index (BFI_{max}) was provided by WHAT at 80 (Eq 1).

$$\textbf{\textit{(Eq 1)}}\ b_k = [(1 - BFI_{max}) * a * b_{k-1} + (1 - a) * \ BFI_{max} * y_k]/(1 - a * BFI_{max})$$

Where: b_k = baseflow at time step k, b_{k-1} = baseflow at time step k-1, y_k = total streamflow at time step k, BFI_{max} = baseflow index (ratio of baseflow to the total flow), a = filter parameter.

Near-surface Soil Samples

All soil samples were air-dried, ground, and sieved (<2mm). Soil samples from 7/13/22 underwent batch leachate analysis in Paradis Lab at the University of Wisconsin-Milwaukee. The soil leachate procedure followed UW Soil and Forage Analysis Lab and the Department of Energy protocols (Appendix A). The procedure consisted of a 1:10 weight ratio for soil to deionized water, agitating the sample at 200 RPM/4 hours, centrifuge for 30 minutes, decanting the liquid into a 100-mL volumetric flask, filtering (0.2 microns), and quantifying the soil leachate for total soluble salts using a conductance electrode. Soil samples from 8/24/22 underwent batch leachate analysis for total soluble salts in addition to chemical (pH, organic matter, P, K, Ca, Mg, Na, and Cl) and physical analysis (percent sand, silt, and clay) at UW Soil and Forage Analysis Lab. Values for each soil sample were plotted against one another to quantify the temporal variability of total soluble salts.

Mass Loading of Chloride

The mass loading of chloride was quantified as the product of the calculated chloride concentration and the streamflow (Petre et l., 2021) for both urban and rural streams over the duration of the study (Eq 2). Chloride concentrations were measured either directly from grab samples or indirectly from continuous conductivity data. Streamflow data were obtained from dedicated gaging stations that are installed and maintained by the United States Geological Survey (USGS, 2022).

$$\textbf{(Eq 2)}\ Ml = C \ x \ Q$$

Where: Ml= Mass Loading (M/T), C= Concentration (M/L^3), Q=Streamflow (L^3/T)

Chloride Budget: Road Salt

A chloride budget for road salt within the Root River watersheds was generated to understand the mass balance of chloride via road salt applied to the watershed versus the mass load of chloride measured in the stream annually. Historic salt purchase bid data from the Wisconsin Department of Transportation was used to estimate the amount of chloride introduced to the watershed annually. Total NaCl was calculated using values of NaCl purchased and area of the county or municipality who purchased the salt (Eq 3). The mass of NaCl in the Root River was calculated by normalizing the total NaCl by the area of each county or municipality within the Root River watershed (Eq 4). The mass of NaCl in the Root River watershed was normalized to the mass of chloride (Eq 5). These budget estimates are under the following restrictions: 1) all NaCl purchased is applied, 2) NaCl application is homogenous across the county or municipality, 3) assumes that no other application of NaCl occurred. This third restriction is thought to play are large role as private application of NaCl is not accounted for but it has been estimated to account for 50% of NaCl application.

(Eq 3) *NaCl Purchased = Seasonal + Early*

Where: NaCl Purchased = Mass of NaCl (Tons/Yr), Seasonal = Seasonal Purchases of NaCl (Tons/Yr), Early = Early Purchases of NaCl (Tons/Yr)

(Eq 4) $Total\ NaCl = \ NaCl\ Purchased\ x\ AR$

Where: Total NaCl = Mass of NaCl in the Root River Watersheds (Tons/Yr), NaCl Purchased = Mass of NaCl ($Tons/Yr$*), AR = Area Ratio within the Root River Watersheds (urban or rural)*

(Eq 5) $Total\ Cl = \ Total\ NaCl\ x\ .607$

Where: Total Cl = Total Mass of chloride in the Root River Watersheds (Tons/Yr), Total NaCl = Total Mass of NaCl in the Root River watersheds(Tons/Yr), .607 = Precent weight of Cl^- *in NaCl*

Supplemental Data: Alkalinity, Total Dissolved Solids, and pH

All 150-mL samples collected and prepared underwent water quality analysis in the Paradis Lab at the University of Wisconsin – Milwaukee. Alkalinity, Total Dissolved Solids, and pH were quantified with a Hach Kit and ion-specific electrodes, respectively (Appendix A). The application of common water quality parameters was used to investigate if low-level, economical, and accessible data can yield the same results as high-level, expensive, and less accessible data. Regressions (Cl vs. Alkalinity, Cl vs. Total Dissolved Solids, and Cl vs. pH) were made to discover if the data of interest could serve as a proxy for chloride concentrations across the watersheds. Values of alkalinity, total dissolved solids, and pH were plotted against streamflow to reinforce persistent pathways of water across the watersheds.

A portion of the 50-mLvials underwent stable water isotope analysis of $\delta^{18}O\text{-}H_2O$ and $\delta^{2}H\text{-}H_2O$ using Picarro L2130-i analyzer. Data for stable water isotopes were plotted against the Global Meteoric Water Line (GMWL) to observe the effect of evaporation on the water samples.

Data were plotted against streamflow to elucidate the potential lag-time of chloride entering the stream from persisting within the watershed. Lastly, data was plotted against climate temperature to understand the relationship between stable water isotopes and streamflow year-round.

CHAPTER 3: RESULTS & DISCUSSION

Results

Chloride

The concentrations of chloride from discrete grab samples ranged from 41 to 462 mg/L across both urban and rural streams over the duration of the study (Fig 4) (Table B.1). These results showed that chloride can vary in concentration temporally, giving reason to consider unique chloride sources outside of the winter months, where road salt is assumed as the source of chloride (Mackie et al., 2022). Chloride levels either approached or exceeded the State of Wisconsin chronic toxicity threshold (395 mg/L) in both watersheds during the winter months of January, February, and March (Fig 4). The chloride concentrations from January 2022 on the streams exceed previous January concentrations by approximately > 300 mg/L (Dugan et al., 2022) and follow regional trends of increasing chloride concentrations in surface waters (Corsi et al., 2015). These results showed that chloride levels in the rural watershed were notably higher in the summer months of June, July, and August as compared to the urban watershed (Fig 4). This suggested that patterns of land use and flow contributions potentially influenced chloride concentrations, evident with the urban and rural watersheds alternating high-to-low chloride concentrations temporally. These results further support that chloride contamination is not unique to urban land use (Todd and Kaltenecker, 2012; Oswald et al., 2015). These results showed that chloride levels notably decreased in both watersheds during the spring months of April and May yet persisted in the summer months of June, July, and August in exceedance of 100 mg/L (Fig 4). Moreover, these results further demonstrated that chloride may persist in both rural and urban streams year-round (Yozzo et al., 2005) with no apparent decreasing over the summer months.

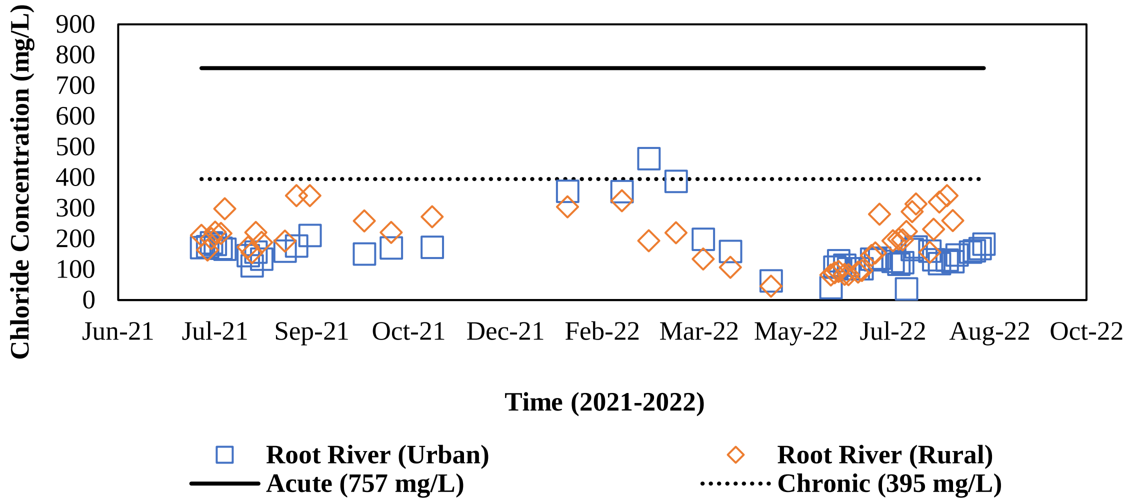

Fig. 4. Chloride concentrations (mg/L) for discrete grab samples from the Root River within both urban and rural streams.

Continuous Chloride

The concentrations of chloride versus specific conductance (Table C.2) showed a strong linear relationship across both urban and rural streams as evidenced by r-squared values of 0.89 and 0.76, respectively (Fig 5). These results suggested that specific conductance was a reliable proxy for chloride concentration and allowed for a high-frequency estimation of chloride levels year-round. The chloride versus conductance data plotted above the geogenic (Ca-Mg-HCO_3) level and within the range of anthropogenic (Na-Cl) levels (Panno et al., 2006) (Fig 5). These results suggested that the salinization of the stream water from both field sites was anthropogenic (Panno et al., 2006).

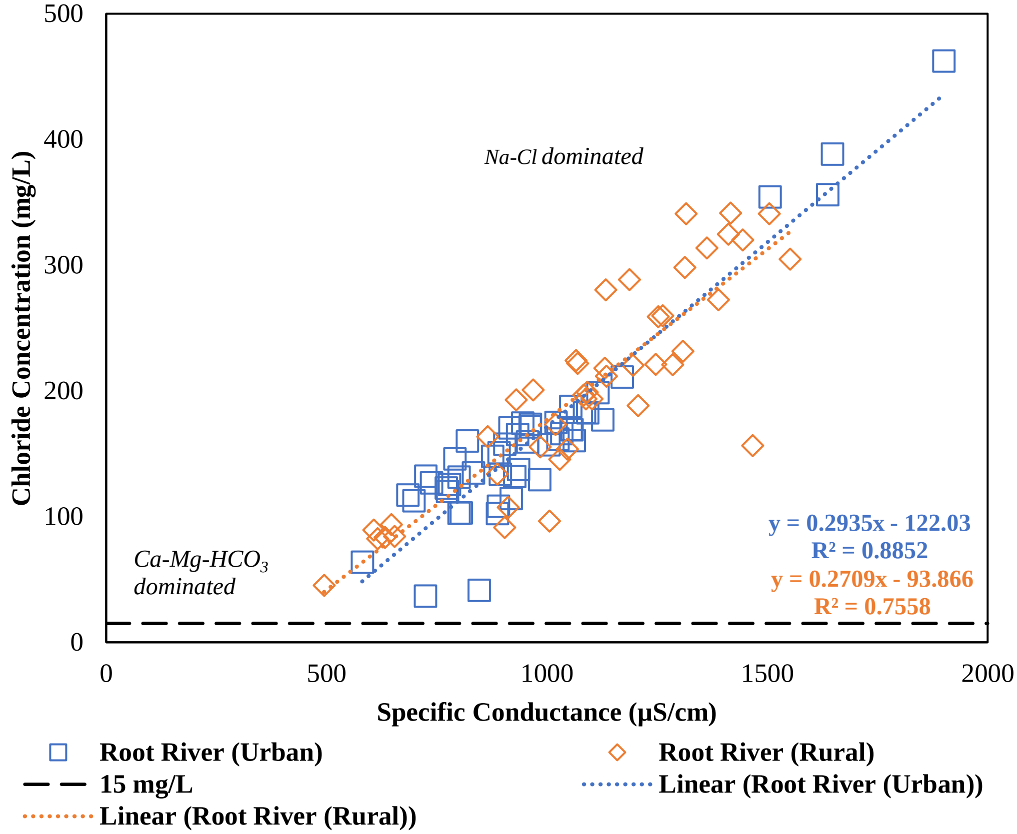

Fig. 5. Chloride Concentrations (mg/L) vs. Specific Conductance (µS/cm) from CTD for discrete grab samples from the Root River within both urban and rural streams.

Unique Sources of Chloride

The chloride/bromide ratios versus chloride data plotted mostly within well-known endmembers for chloride sources (Panno et al., 2006) (Fig 6) (Tables B.1 and B.3). Notably, all grab samples plotted within the Road Salt and Septic Effluent group except for precipitation which plotted within its designated endmember group (Fig 6). These results strongly suggested that the dominant source of chloride was road salt and/or septic effluent, even during non-winter months. However, the uncertainty between these two sources is due to the use of halite in both road salts and water softeners. The results for road salt and septic effluent as chloride sources were consistent with previous studies investigating sources of chloride with chloride/bromide ratios (Pilon and Howard, 1987; Roy and Malencia, 2013; Roy, 2019). Grab samples visually separated into distinguishable groups based on the type of grab sample (Fig 6). Visual separation of grab samples based on sample type showed how variable chloride impacts water within the same watershed and that precipitation has negligible concentrations of chloride and bromide.

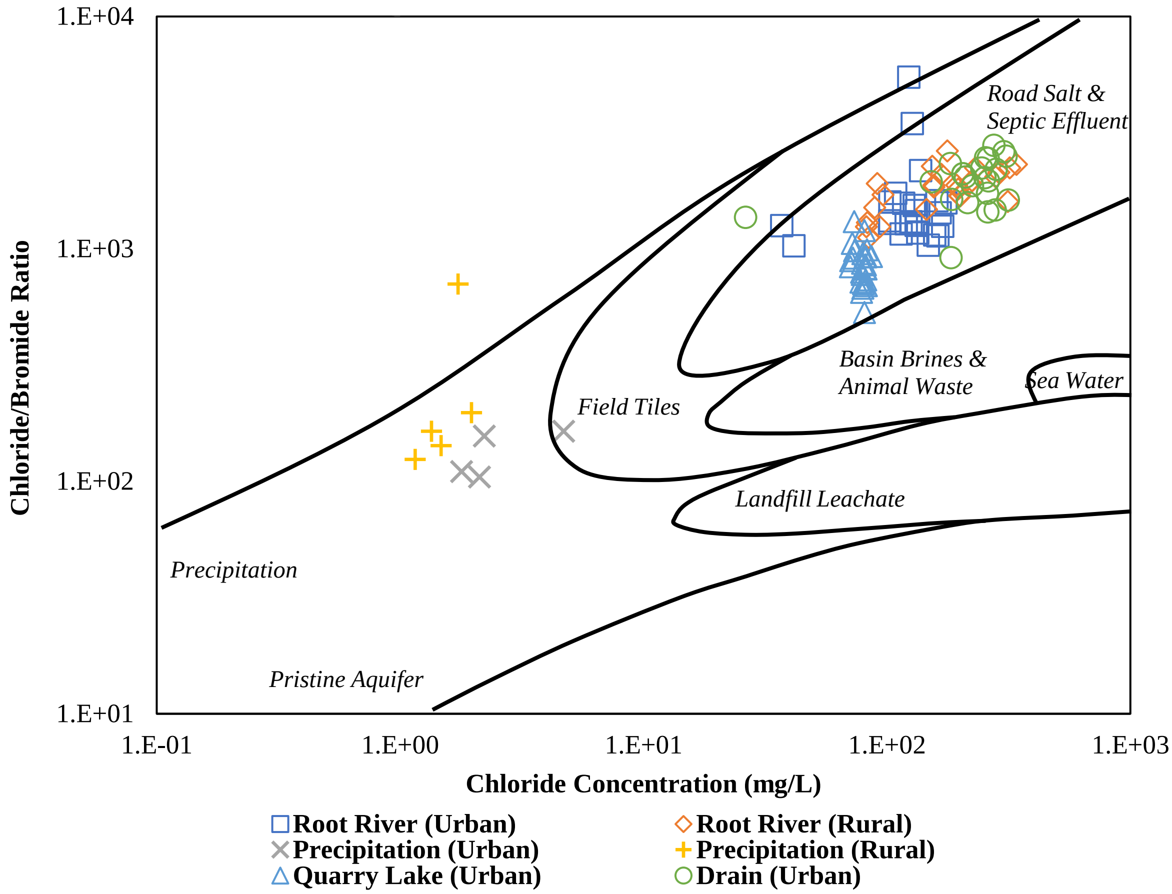

Fig. 6. Chloride/Bromide Ratio vs. Chloride Concentration (mg/L) bivariate mixing diagram for all grab samples across the watershed collected from 6/1/22 – 8/24/22. Chloride source grouping according to (Panno et al., 2006).

The total nitrogen versus chloride/bromide ratios data plotted within well-known endmembers for affected waters (Panno et al., 2006) (Fig 7) (Table B.4). Samples mostly plotted within the road salt, as opposed to septic effluent, endmembers (Fig 7). These results distinguished road salt apart from septic effluent as a unique source of chloride with the use of total nitrogen as a reliable indicator (Panno et al., 2006). However, the rural site plotted at the upper end of the road salt endmember, indicating the potential for Union Grove's WWTP effluent to influence chloride levels (Figs 7 & 2). The precipitation data plotted mostly away from all other endmembers (Fig 7) indicating the precipitation has lower levels of TN, Cl^-, and Br. These results indicated that the predominant and persistent source of chloride in both streams was road salt and not septic effluent. These results were consistent with previous studies aimed at elucidating the unique sources of chloride in stream water (Pilon and Howard, 1987; Roy and Malencia, 2012; Roy, 2019) yet they demonstrated that road salt contamination is not necessarily unique to urban area within a watershed and can persist year-round.

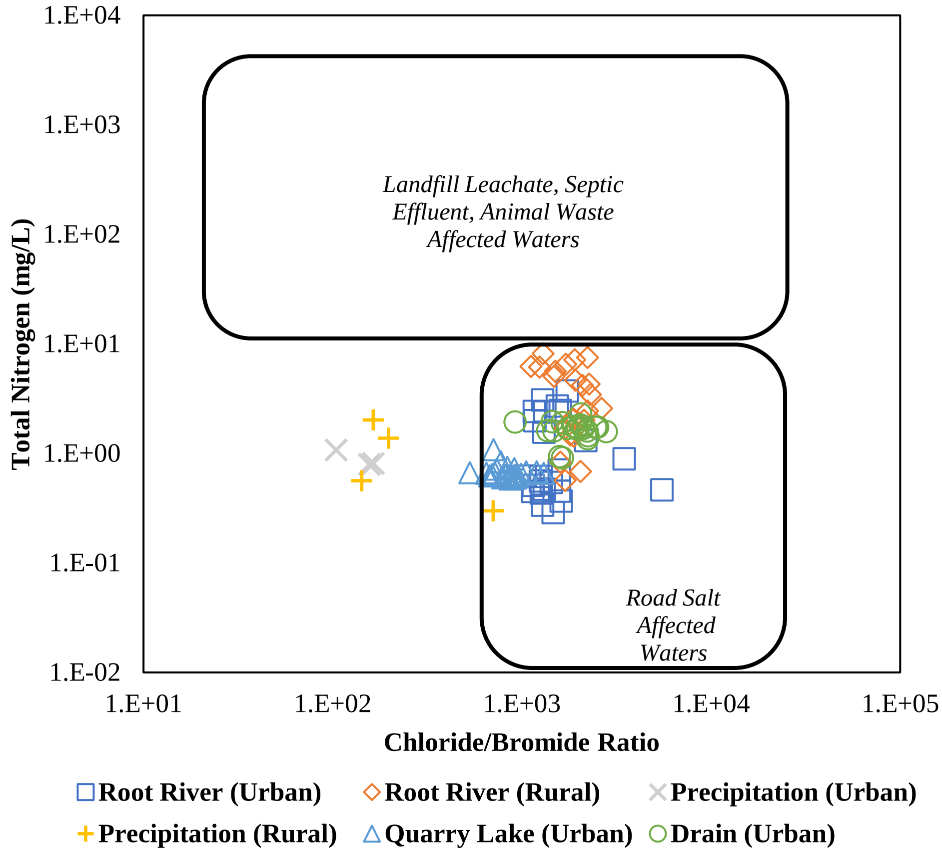

Fig. 7. Total Nitrogen (mg/L) vs. Chloride/Bromide Ratios bivariate mixing diagram for all grab samples across the watershed collected from 6/1/22 – 8/24/22. Affected water grouping according to (Panno et al., 2006).

Continuous Chloride, Streamflow, and Precipitation

The continuous estimates of chloride concentrations from the CTD ranged from 5.5 to 677 mg/L compared to discrete grab sample chloride concentrations that only ranged from 41 to 462 mg/L in both stream over the duration of the study (Fig 8) (Table C.2). The discrepancy between continuous and discrete chloride concentrations solidified the importance of sampling frequency (Bester et al., 2006) in the context of chloride concentrations. These results indicated that chloride levels, particularly in the winter months, exceeded the chronic (395 mg/L) and approached acute (757 mg/L) thresholds of chloride for the State of Wisconsin. These chloride exceedances were not fully captured by discrete grab samples (Fig 4) and further demonstrated the importance of high-frequency characterization of water quality (Bester et a., 2006; Galella et al., 2021). The continuous chloride levels decreased slightly in both streams during the spring months yet persisted in the summer months in exceedance of 100 mg/L (Fig 8). These results further demonstrated that chloride may persist in both rural and urban streams year-round with no apparent decrease over the summer months.

Streamflow ranged from approximately 1 to 1,000 ft^3/s across both urban and rural streams over the duration of the study (Fig 8) (Table C.1). Streamflow decreased during the winter months and increased during the spring months across both streams (Fig 8). However, it should be mentioned that the USGS often estimates flows in the winter as ice may impact the gages. These results were consistent with winter dominated by snow and ice followed with spring dominated by melting and runoff. Daily precipitation totals ranged from approximately 1 to 1.5 inches across both field sites over the duration of the study (Fig 8) (Table D.1). Discrete precipitation events (urban site 1.25 inches on 4/22/22; rural site 1.23 inches on 5/1/22) preceded discrete streamflow events (urban site 1156 ft^3/s on 4/25/22; rural site 470 ft^3/s on 5/4/22) and sustained precipitation coincided with sustained streamflow (Fig 8). These results were consistent with precipitation being the primary cause of streamflow events.

Continuous chloride concentrations were relatively constant, except for spring months, on a log scale unlike streamflow (Fig 8). Chloride levels decreased during the spring months when streamflow was high but rebounded to previous levels and remained relatively constant as compared to streamflow year-round (Fig 8). This observation suggests that precipitation can impact chloride concentrations (Fig 8) yet streamflow was impacted at greater magnitudes (Fig 8). These results suggested that pathways of road salt to the streams in addition to precipitation-driven runoff, existed throughout the summer.

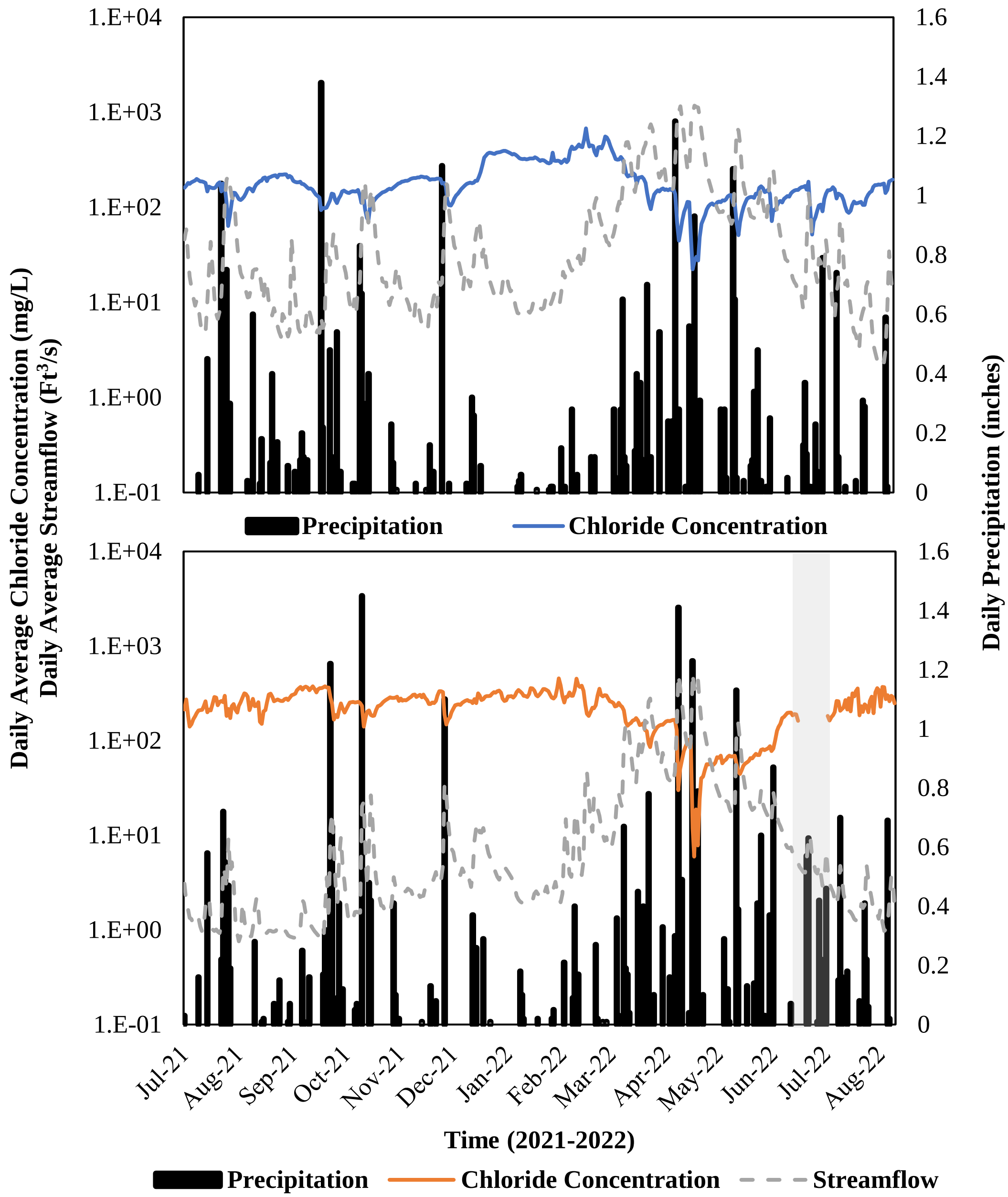

Fig. 8. Continuous Chloride Concentration (mg/L), Streamflow (Ft^3/s), and Precipitation (inches) top) urban stream and field site and bottom) rural stream and field site over the duration of the study.

Persistent Hydrological Pathways of Chloride

Hydrograph separation of streamflow into its two most basic components of runoff and baseflow demonstrated that baseflow accounted for 53.9% and 54.3% of the total streamflow for the urban and rural streams, respectively over the duration of the study (Fig 9). Baseflow was assumed to represent the pathway of groundwater to stream water recharge (Freeze and Cherry, 1979). These results indicated that chloride-ruch groundwater from road salts persisted year-round in both stream and served as a continuous pathway for chloride to enter the stream. These results were consistent with similar observations from previous studies (Howard and Haynes, 1993; Novotny et al., 1999; Perera et al., 2013; SERWPC, 2014) yet provided higher frequency annual data across both urban and rural area within a watershed. The 46.1% and 45.7% attributed to runoff for the urban and rural streams, respectively by the WHAT analysis tool did not separate between runoff and interflow (Fig 9). Interflow represents the pathways of soil porewater to stream water during large precipitation events (Freeze and Cherry, 1979) and may have occurred during this study. There is evidence that interflow plays a role in chloride transport as a pathway during and following precipitation events (Novotny et al., 1999; Betts et al., 2015) and that the characterization of soils as salt sources and pathways are important (Kincaid and Findlay, 2009; Lovett et al., 2005; Likens, 1995). If the soils above the water table contained residual road salt and if interflow occurred, then soil porewater, in addition to groundwater, may have served as a persistent pathway for chloride to enter both streams in this study; the following section was aimed at addressing this possibility.

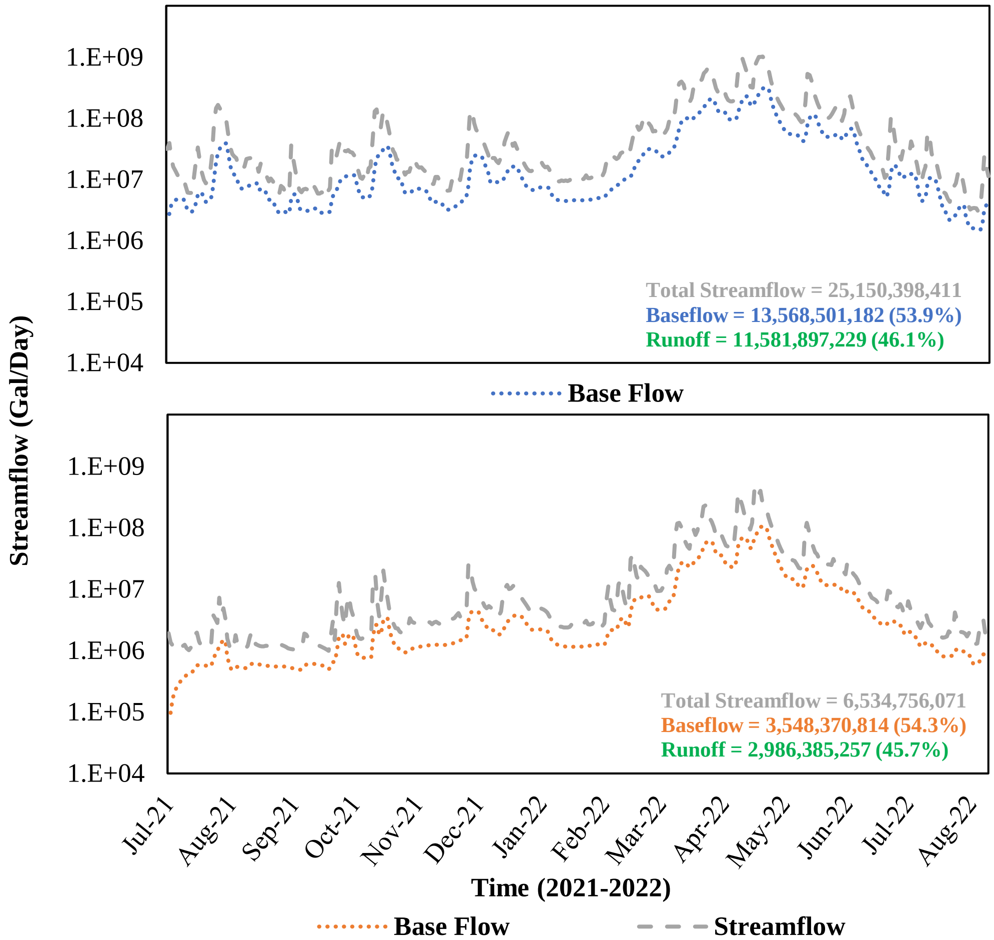

Fig. 9. Flow-based hydrographic separation for the top) urban stream and bottom) rural stream over the duration of the study.

Near-surface Soils and Batch Leaching Comparison

The concentrations of leachable chloride versus soluble salts of the near-surface soils showed a strong linear relationship across both urban and rural field sites as evidenced by an r-squared value of 0.77 (Fig 10). These results agreed with previous studies (Kincaid and Findlay, 2009) and demonstrated that soils at both field sites had the potential to serve as secondary sources of chloride from road salts. Chloride concentrations of near-surface soil samples ranged from 10.5 to 97 mg/kg (Fig 10 & Table F.3). Higher chloride concentrations in the soils resulted in more soluble salts leached from the soil (Fig 10).

The % of soluble salts leached (Eq 6) versus organic matter % showed a strong linear relationship across both urban and rural near-surface soils collected on 8/24/22 as evidenced by an r-squared value of 0.80 (Fig 11). The organic matter of near-surface soils ranged from 0.2 to 8.4 % (Fig 11). Higher organic matter in soils resulted in less soluble salts leached from the soil from 7/13/22 – 8/24/22 (Fig 11). These results connected soluble salt retention to organic matter, implying that the type of soil may affected chloride transport within the near-surface soils, consistent with previous studies (Kincaid and Findlay, 2009).

(Eq 6) $$\%\ soluble\ salts\ leached = \frac{[soluble\ salts_f - soluble\ salts_i]}{|soluble\ salts_i|} x\ 100$$

Where: % soluble salts leach = the concentration of soluble salts leached relative to the initial concentration, soluble salts$_f$ *= final concentration of soluble salts, soluble salts*$_i$ *= initial concentration of soluble salts*

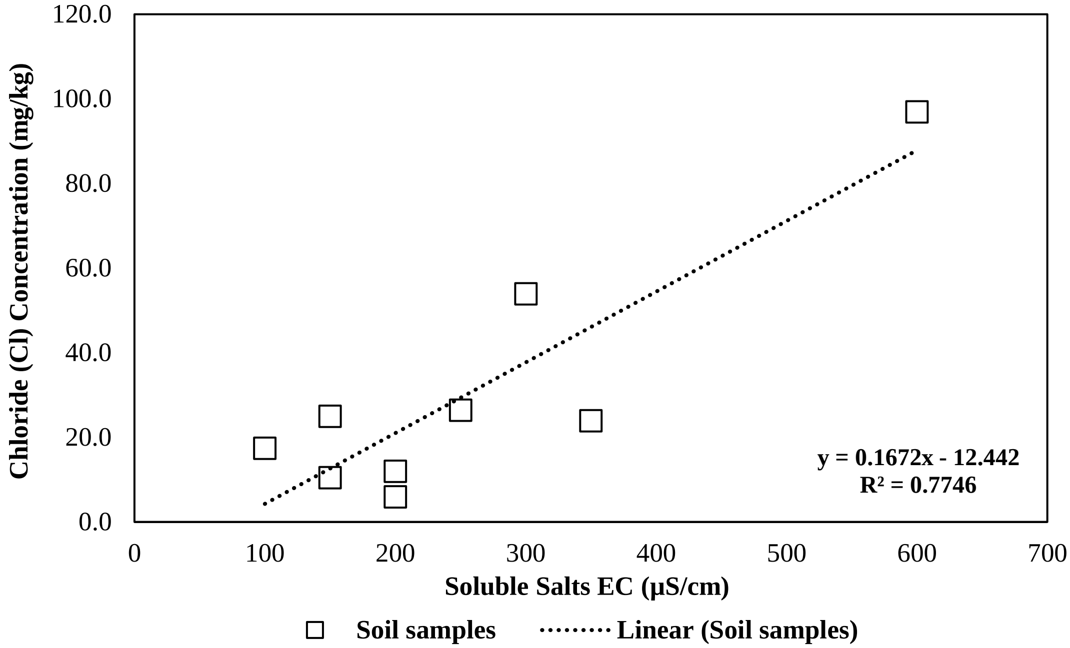

Fig. 10. Soluble Salts (µS/cm) vs. Chloride Concentration (mg/kg) for all soil samples collected on 8/24/22 across the urban and rural field sites.

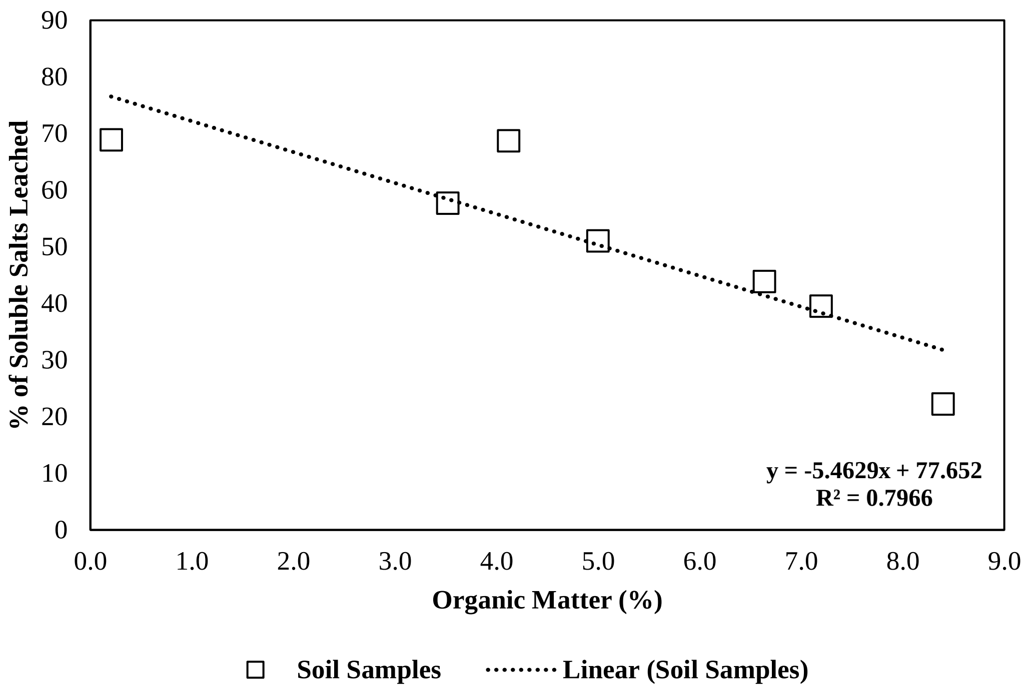

Fig. 11. Organic Matter % vs. % Soluble Salts Leached from 7/13/22 – 8/24/22 for all soil samples collected on 8/24/22 across both urban and rural field sites.

The soluble salt concentrations for discrete soil samples from 7/13/22 and 8/24/22 collected within both urban and rural soils yield specific conductivity values from 307 to 592 and 100 to 600 μS/cm, respectively (Fig 12). Batch leaching experiments showed that most near-surface soil samples decreased variably in soluble salt concentrations after multiple natural leaching events during summer month precipitation (Fig 12). These results support the idea that chloride is less conservative in the environment, particularly in soils (Bastviken et al., 2006).

There is an exception for two near-surface soil samples, 4 & 6, which increased in soluble salt concentrations (Fig 12). Both near-surface soil samples are from the rural watershed suggesting two probable explanations for the increase in soluble salt concentrations: 1) attributed to another local source of chloride, potash fertilizers (KCl) or Union Grove's WWTP and 2) attributed to delayed migration of chloride from road salt over the years due to the presence of organic matter. It should be highlighted that stream water at the rural site plotted on the upper limit of the road salt endmember (Fig 7) and could have been affected by wastewater or septic effluent. However, the two soil locations that increase are from woodlands lining a baseball field and an active agricultural field, respectively (Fig 3 & 12). Eliminating wastewater and septic effluent as reasonable sources leaving chloride-rich fertilizers as the probable source for increased soluble salt concentrations.

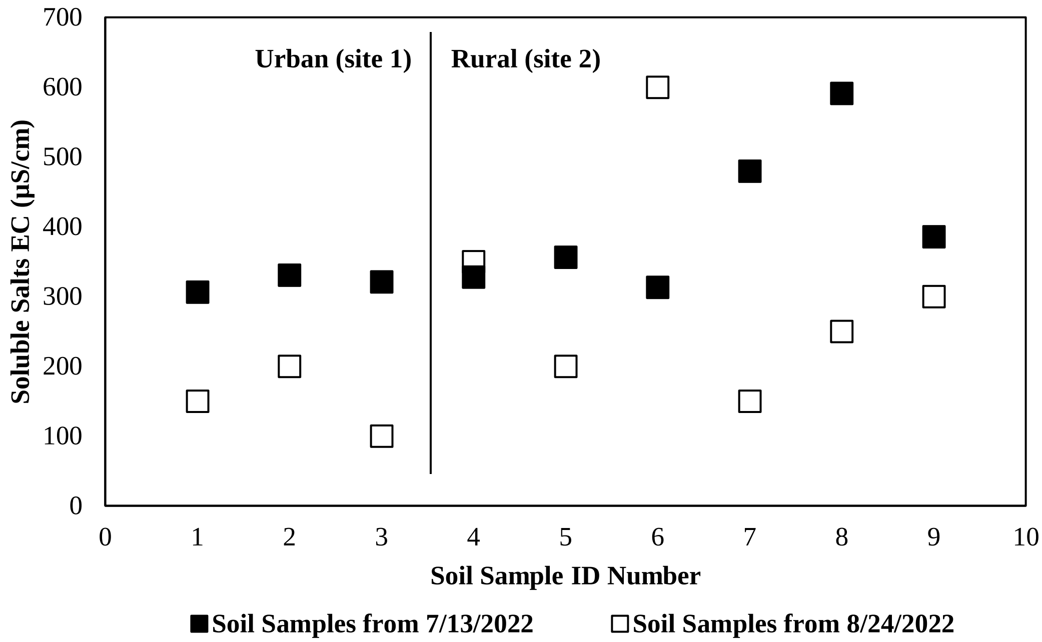

Fig. 12. Soluble Salts (µS/cm) for all near-surface soil samples collected on 7/13/22 and 8/24/22 across the urban and rural field sites.

It should be mentioned that no other chemical or physical constituents analyzed for near-surface soil samples across the watershed had significant, r-squared values with % soluble salts leached from soils (Table F.4).

Mass Loading of Chloride

The total mass loading of chloride peaked during the spring months when streamflow was relatively high for both stream (Fig 13). These results were consistent with winters dominated by road salt application followed by springs dominated by precipitation and runoff. The trend of chloride mass loading more closely reflected that of streamflow (Fig 13) as compared to chloride concentration (Fig 8). Streamflow varied over orders of magnitudes whereas concentration was less variable over the duration of the study and for both streams. These results demonstrated that streamflow and not chloride concentration was largely responsible for the mass loading of chloride. The mass loading of chloride persisted into the late summer months for both streams (Fig 13). These results further suggested that groundwater and soil porewater served as secondary sources of road salt and that baseflow and interflow served as persistent pathways of chloride to both streams. Overall, the annual mass loading of chloride was 12,412 tons per year (Fig 13) for the Root River watershed.

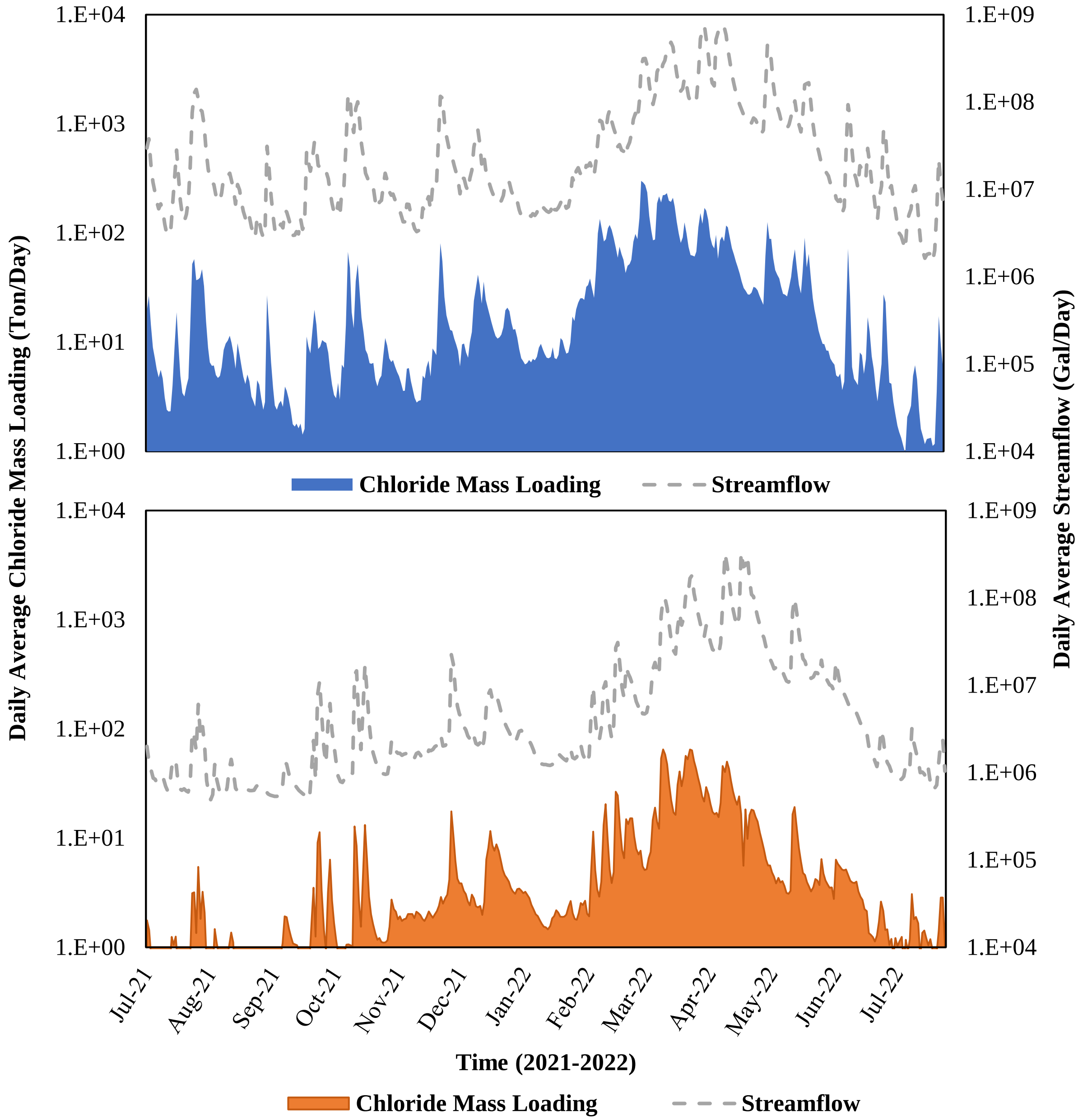

Fig. 13. Chloride Mass Loading (Ton/Day) and Daily Average Streamflow (Gal/Day) for top) urban stream and bottom) rural stream over the duration of the study.

Chloride Budget: Road Salt

The total mass of NaCl purchased (Tons/Yr) was calculated at 67,639 (Table 2). The total mass of NaCl in the Root River watershed at the urban and rural field sites was calculated at 13,673 and 1,055 (Tons/Yr) (Table 2). These estimates were normalized to the total mass of Cl in the Root River watershed (Tons/Yr) and were calculated at 8,299 and 640 for the urban and rural field sites, respectively (Table 3).

The mass of chloride applied (Cl^- into the Root River watershed) compared to chloride mass loading (Cl^- out of the Root River watershed) showed that more chloride was being loaded out of the Root River watershed than what was applied, a mass imbalance. The mass imbalance of the urban and rural field sites was estimated at 4,604 and 2,004 (Tons/Yr) (Table 3), following previous studies (Paine, 1979; Howard and Haynes, 1993; Perera et al., 2013).

Table 2 Chloride Budget for Road Salt: Buyer, NaCl Purchased, Area of County or Municipality within the Root River watershed, NaCl in the Root River watersheds.

County and Municipality	NaCl Purchased (Tons/Yr)[B]	Area Ratio in the urban watershed[C]	Area Ratio in the rural waterhsed[C]	NaCl in the Urban watershed (Tons/Yr)	NaCl in the Rural watershed (Tons/Yr)
Waukesha	-	-	-	-	-
Muskego	3,300	0.11	-	363	-
New Berlin	5,500	0.25	-	1,375	-
SOW[A]	10,300	0.02	-	150	-
Milwaukee	-	-	-	-	-
Franklin	2,400	0.91	-	1,456	-
Hales Corners	700	1.00	-	200	-
Greenfield	2,400	0.54	-	1,296	-
West Allis	3,000	0.26	-	780	-
Greendale	1,650	0.98	-	1,469	-
Oak Creek	3,500	0.25	-	875	-
SOW	17,300	0.24	-	3,522	-
Racine	-	-	-	-	-
Raymond	200	0.95	0.63	191	126
Caledonia[D]	256	0.79	0.04	202	10
Yorkville[D]	187	0.87	0.82	163	153
Union Grove[D]	15	0.53	0.53	7	8
Mt. Pleasant[D]	191	0.35	0.01	67	2
SOW	9,700	0.34	0.16	1,513	712
Kenosha	-	-	-	-	-
Paris	2,400	0.01	0.01	24	24
SOW	6,800	0.01	0.01	20	20
Total	**67,639**	**-**	**-**	**13,673**	**1,055**

[A] SOW = State of Wisconsin, assumed NaCl to apply on Interstates and State Highways.
[B] NaCl Purchased taken from Historic Wisconsin Department of Transportation Salt Purchase Bids, includes seasonal and early purchases for 2021-2022.
[C] Area Ratio within the Root River watershed provided by SWERPC.
[D] These values were estimated from known Raymond NaCl purchase values per Mi^2.

Table 3 Mass Balance of Chloride: Total Mass of NaCl Applied, Total Mass of Cl Applied, Total Cl Load, and Mass Imbalance with confidence intervals based on percent error. Total Cl Load data is for one year ranging from 8/24/21 - 8/24/22.

Site	Total Mass of NaCl Applied (Tons/Yr)	Total Mass of Cl Applied (Tons/Yr)	Total Load of Chloride (Tons/Yr)	Mass Imbalance of Chloride (Tons/Yr)
Urban (site 1)	13,673	8,299	12,903 ± 2,580	4,604 ± 920
Rural (site 2)	1,055	640	2,644 ± 449	2,004 ± 340

Supplemental Results

Isotopes

All discrete water samples were plotted against the Global Meteoric Water Line (GMWL) (Fig 14) and shared similar slopes except for Quarry Lake and both urban and rural stream samples. These results showed the variability of isotopes signatures due to water samples type (i.e., stream, lake, or precipitation) demonstrating the evaporative enrichment of heavier isotopes of oxygen and hydrogen in surface waters (Kulsawat and Nochit, 2019). Quarry Lake and discrete stream water samples for the urban and rural streams have slopes of 5.03, 6.57, and 6.51, respectively compared to slopes for drain and precipitation samples for urban and rural field sites of 7.54, 7.43, and 7.62, respectively (Tables E.1 & E.3). These results suggested that a variable mix of water is contributing to the streamflow in both urban and rural streams based on stable water isotope data.

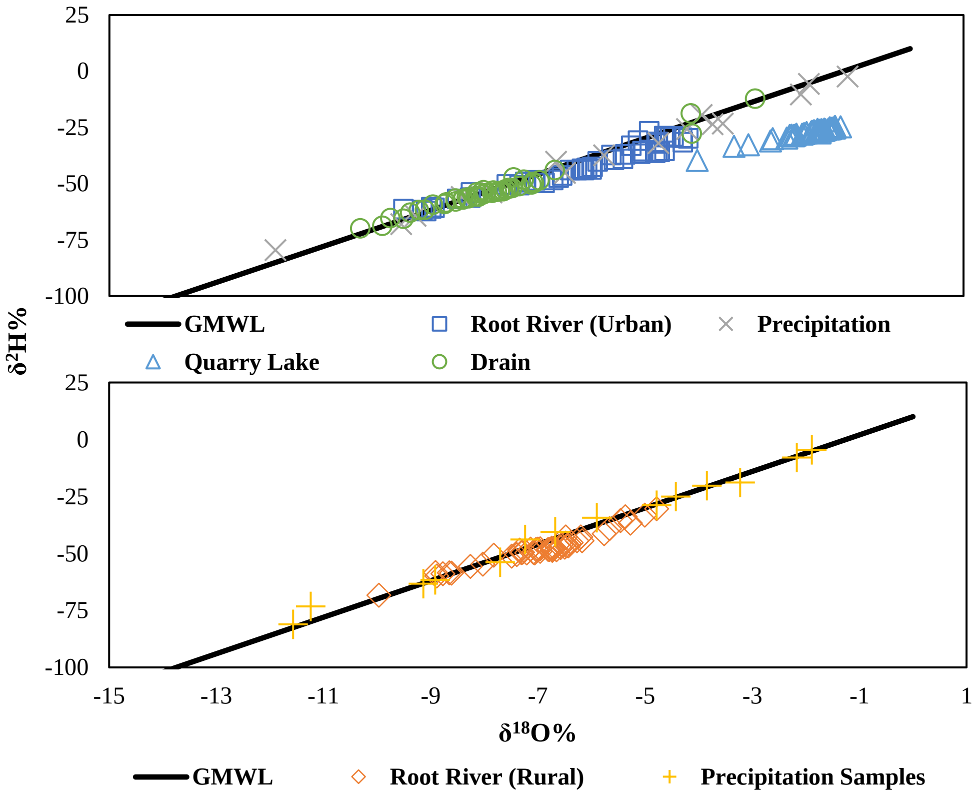

Fig. 14. Stable water isotope δ^2H% vs. δ^{18}O% for discrete water samples with the GMWL top) urban stream and field site and bottom) rural stream and field site.

The stable water isotopes δ^2H-H_2O and δ^{18}O-H_2O demonstrated no strong relationship with streamflow but showed a lag in isotope signatures gradually shifting over the span of months (Fig 15). Both isotopes δ^2H-H_2O and δ^{18}O-H_2O values peaked during the summer months yet surrounded by a gradual rising or falling limb (Fig 15). Additionally, when the event and pre-event stream samples were separated (Fig B.1) the isotopic signatures of δ^2H-H_2O and δ^{18}O-H_2O for discrete event stream samples correspond with discrete pre-event stream samples compared to precipitation samples (Tables E.1 & E.3). These results do not mean that precipitation had little to no influence but further elucidating groundwater, as baseflow, as the dominant source of water and therefore chloride year-round and across the watershed. The lag showed by isotope data alone (Fig 15) further supports the possibility that groundwater persists within the watershed before being gradually loaded into the stream across the watershed year-round.

Isotope data was compared to climate temperature data (Table D.2) to further understand the flux in isotope signatures from winter to non-winters months (Fig 15). Results demonstrated that colder climate temperature water samples were depleted in stable water isotope compared to warmer climate temperature water samples (Fig 16). These results showed the isotopic influence winter precipitation had on the stream water where winter precipitation is depleted in $\delta^2H\text{-}H_2O$ and $\delta^{18}O\text{-}H_2O$ compared to non-winter precipitation (Dansgaard, 1964; Tian et al., 2018). This phenomenon is due to air temperatures when the precipitation is falling. Since heavier stable water isotopes condense more readily than lighter isotopes, $\delta^{18}O\text{-}H_2O$ content in precipitation is a function of air temperature at the surface (Eq 7) (Dansgaard, 1964).

Results for the both the urban and rural streams show small but visible fluxes in $\delta^2H\text{-}H_2O$ and $\delta^{18}O\text{-}H_2O$ during the summer months following increased streamflow (Fig 15). These results suggested that winter water persisting in groundwater of the watershed was entering the stream shortly after large streamflow events (Fig 15). These results indicate the possibility that a portion of the precipitation during events gradually infiltration into the groundwater and pushed winter water or a winter water precipitation mix into the stream.

(Eq 7) $\delta 18O - H2O = 0.69t - 13.6\%$

Where: t = air temperature at the surface (C)

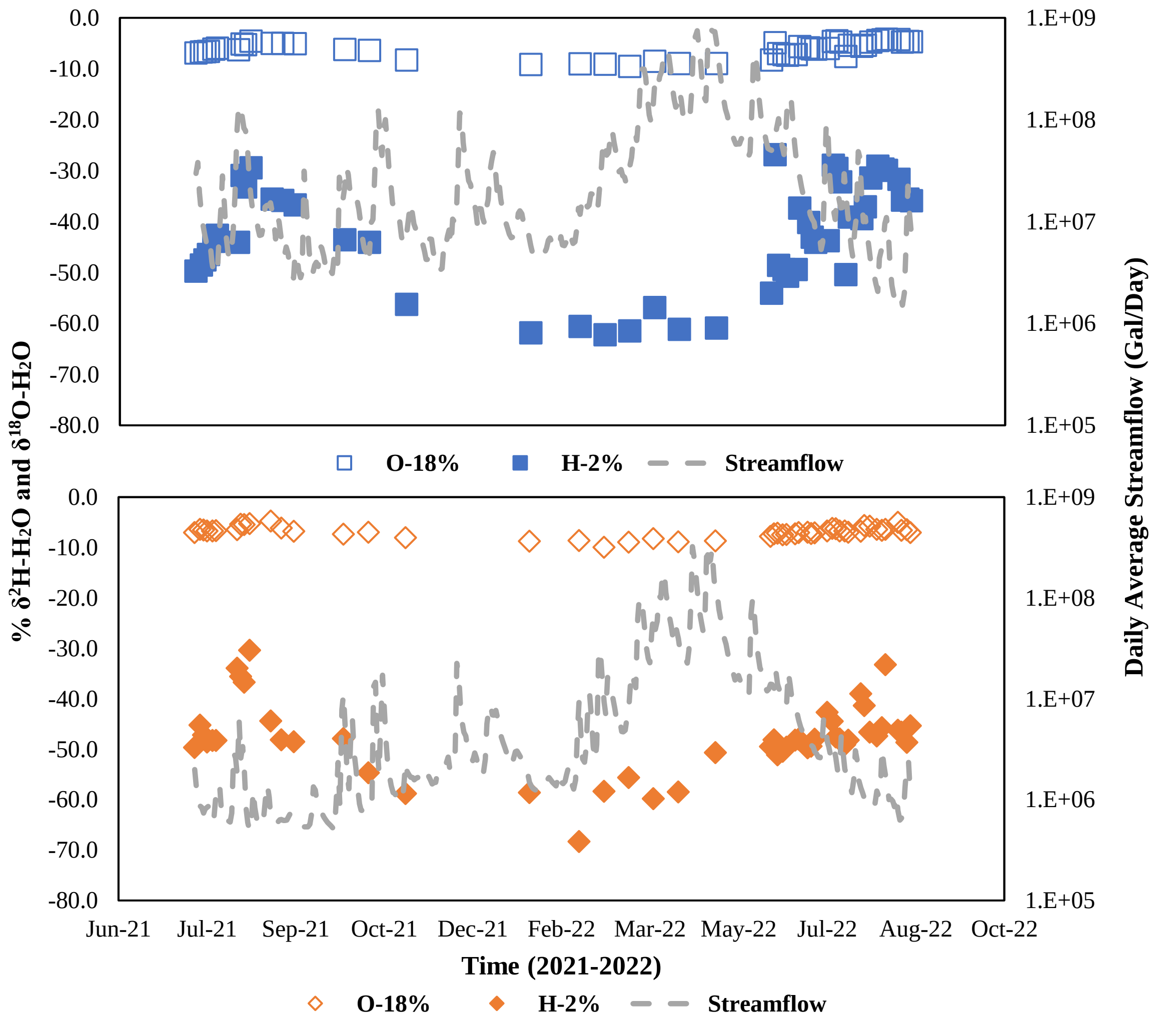

Fig. 15. Stable water isotopes δ^{2}H-H$_2$O % and δ^{18}O-H$_2$O % vs. Daily Average Streamflow (Gal/Day) temporally for top) urban stream and bottom) rural stream.

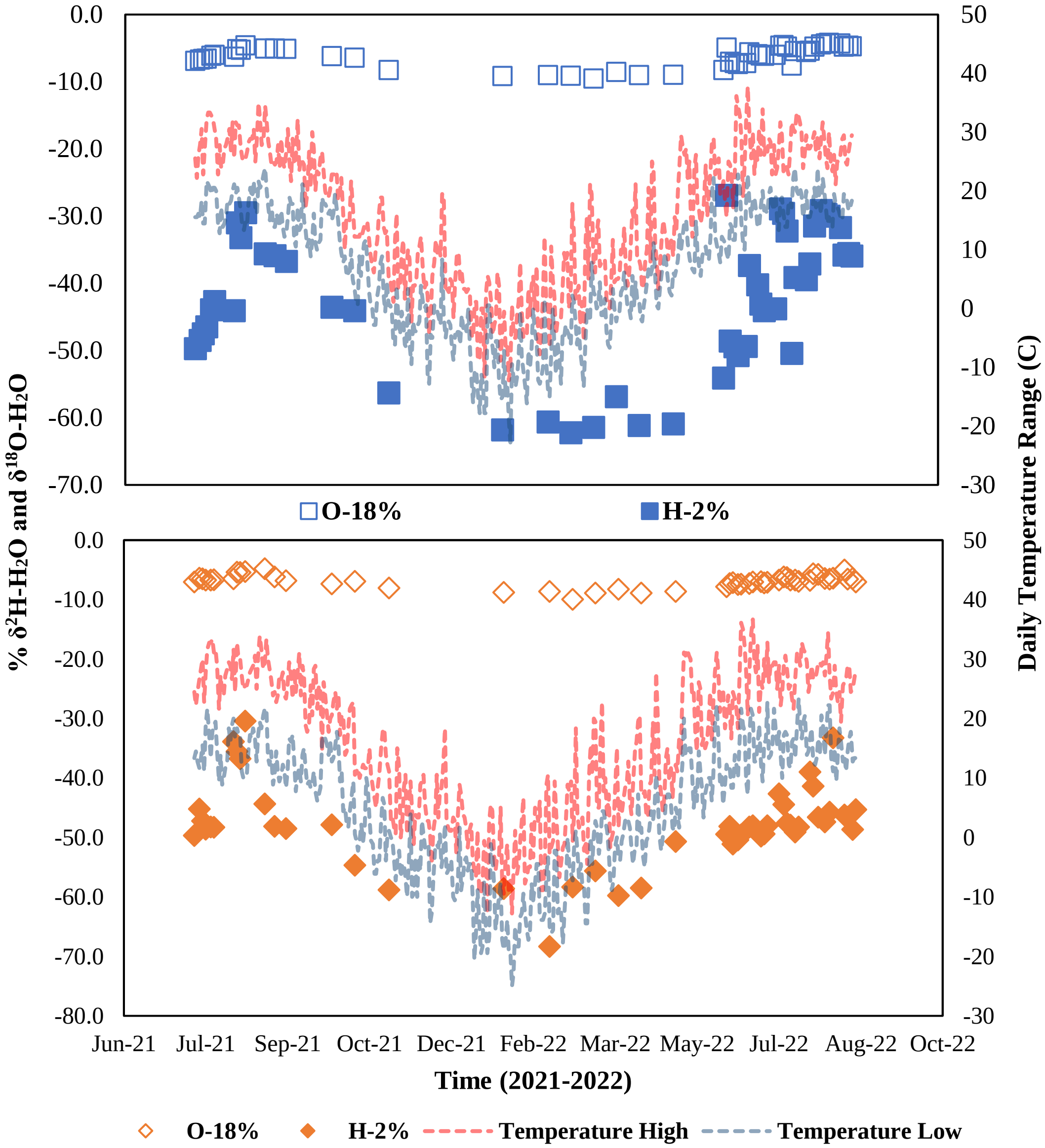

Fig. 16. Stable water isotopes δ^2H-H_2O % and δ^{18}O-H_2O % vs. Daily Temperature Range (C) temporally for top) urban stream and field site and bottom) rural stream and field site.

Isotope data was also used to calculate d-excess (Eq 8) which refers to the isotope composition of $\delta^2H\text{-}H_2O$ and $\delta^{18}O\text{-}H_2O$ in water and can elucidate the source and moisture evolution during transport (Bershaw, 2018). However, to do the complexity of d-excess a discussion for d-excess in context to this study was removed yet d-excess values are provided (Table E.1).

$$\textbf{(Eq 8)} \quad d = \delta D - 8\,x\,\delta 18O$$

Where: d = d-excess, δD = hydrogen in water, $\delta^{18}O$ *= oxygen in water*

Alkalinity

Alkalinity ($CaCO_3$) and chloride (mg/L) concentrations shared no strong relationship year-round or across the watersheds (Fig 17). Alkalinity was not a reliable proxy for chloride concentrations within the study area.

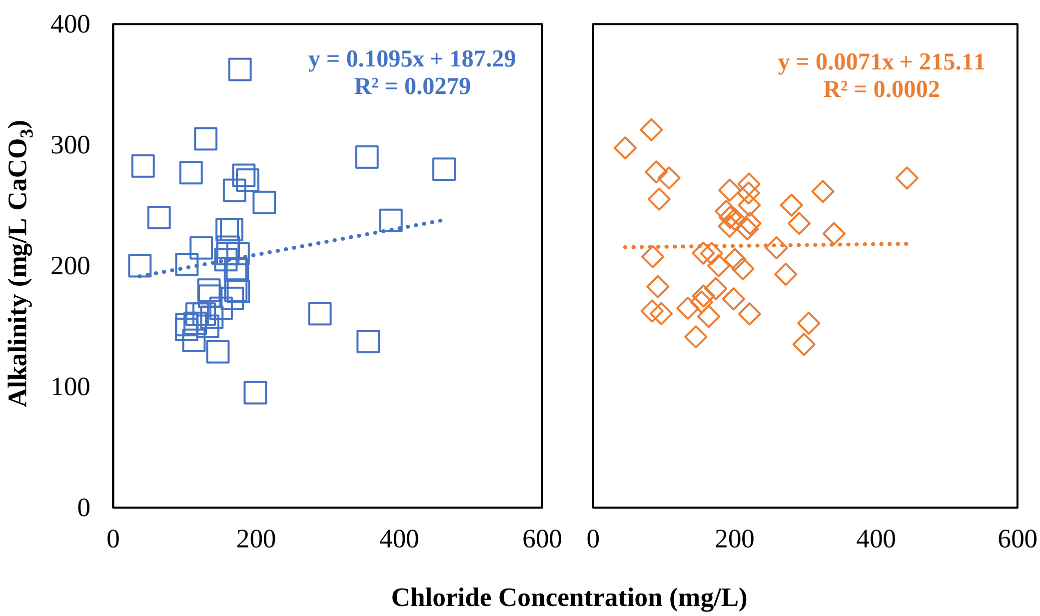

Fig. 17. Chloride concentrations versus Alkalinity for discrete stream samples year-round from both right) urban stream and left) rural stream.

Alkalinity for discrete stream water samples from both streams was plotted against streamflow (Fig 18) results showed a weak inverse relationship to streamflow year-round and across the watershed (Fig 18). This result suggested that the precipitation initiating streamflow fluctuations were not completely entering the stream at large quantities during the fluctuations, and therefore went into other compartments or was processed (i.e., soil water, groundwater, evaporation, transpiration). The results from discrete stream water samples both pre-event and event samples were significantly higher in alkalinity and closer in concentration compared to precipitation samples (Tables E.2 and E.4). This results further suggested that groundwater, as baseflow, dominated the hydrologic pathway of water entering the stream. Overall, the increased alkalinity values for stream water samples compared to precipitation is consistent with surface and groundwater samples that are collected from carbonate-rich sedimentary basins, like the Root River watershed.

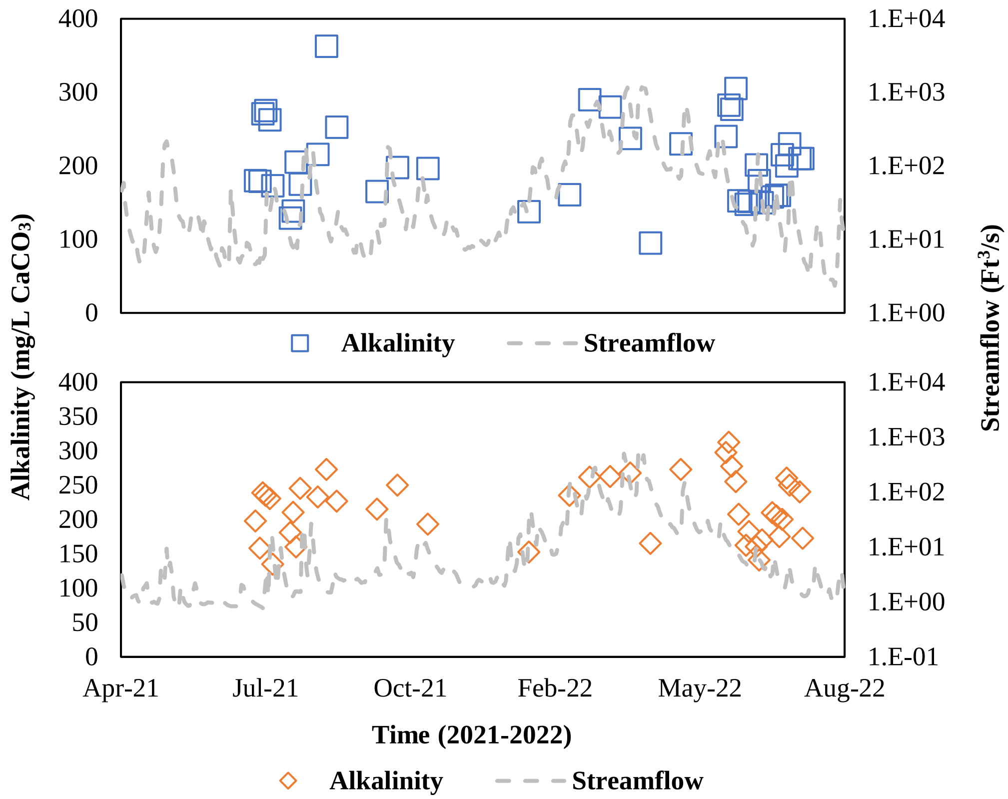

Fig. 18. Alkalinity versus Streamflow temporally for top) urban stream and bottom) rural stream.

Total Dissolved Solids

The results from total dissolved solids (mg/L) versus chloride concentration (mg/L) showed no strong relation, year-round or across the watersheds (Fig 19). Total dissolved solids, unlike specific conductance, accounts for all dissolved solids present in a liquid, conductive or not. Specific conductance is a measurement of the electrical current in water due to the presence of charged ions (i.e., chloride). However, it should be mentioned that total dissolved solids was measured with a conductance probe like continuous chloride estimates. The lack of a strong linear relationship between total dissolved solids and conductance may be attributed to the presence of other ions present in the water samples in addition to chloride yet chloride was the dominant ion present at both streams year-round (Table B.1). These result showed that total dissolved solids were not a reliable proxy for chloride concentrations within the study area.

However, this proxy had the highest r-squared values compared to alkalinity and pH, but it was still insignificant (Fig 19).

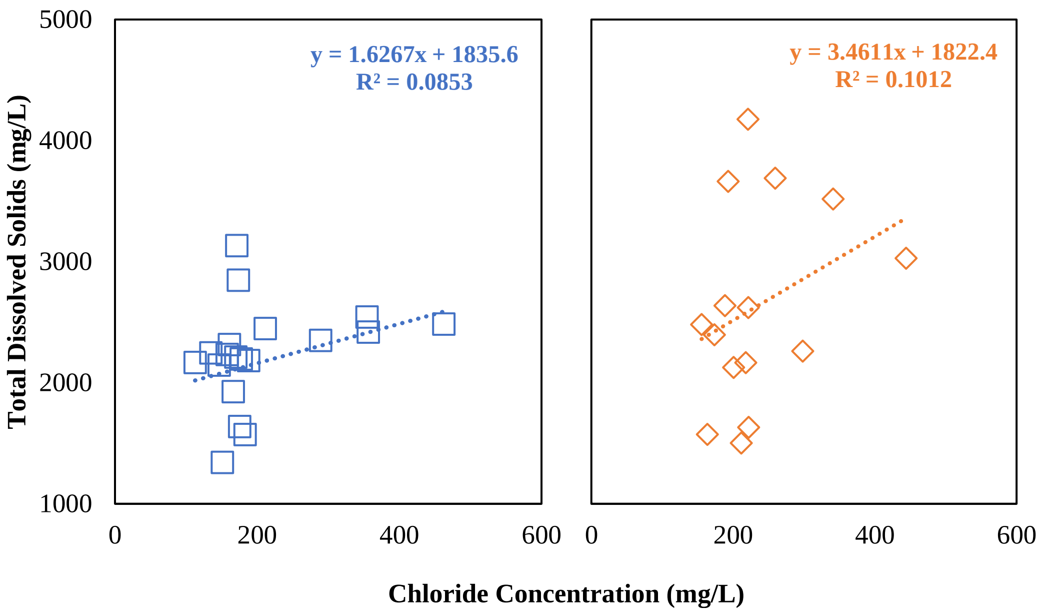

Fig. 19. Total Dissolved Solids versus Chloride Concentrations for discrete Root River samples from 6/6/22 – 8/24/22 from both right) urban stream and left) rural stream.

Results of total dissolved solids plotted against streamflow showed that total dissolved solids shared a weak direct relationship with streamflow year-round for the urban stream (Fig 20). Results showed that total dissolved solids in the rural stream shared a similar relationship as the urban stream but distinctly increased steadily after a precipitation event in July 2022 (Fig 20). Results from discrete pre-event stream water samples compared to discrete event stream water samples displayed that on average 81% of the total dissolved solids during events were derived from groundwater, as baseflow (Eq 9) (Tables E.2 and E.5) like Rumsey et al. (2017). Results from the rural stream suggested the presence of other sources besides chloride via road salt to the stream water samples. Based on rural land use dominating the rural stream and field site highlighted the potential that agricultural activities or Union Grove's WWTP (Fig 2) may have generated large inputs of dissolved solids aside from baseflow, including direct and runoff inputs. Additionally, biological action in and around the stream during the warmer months may also influence total dissolved solids.

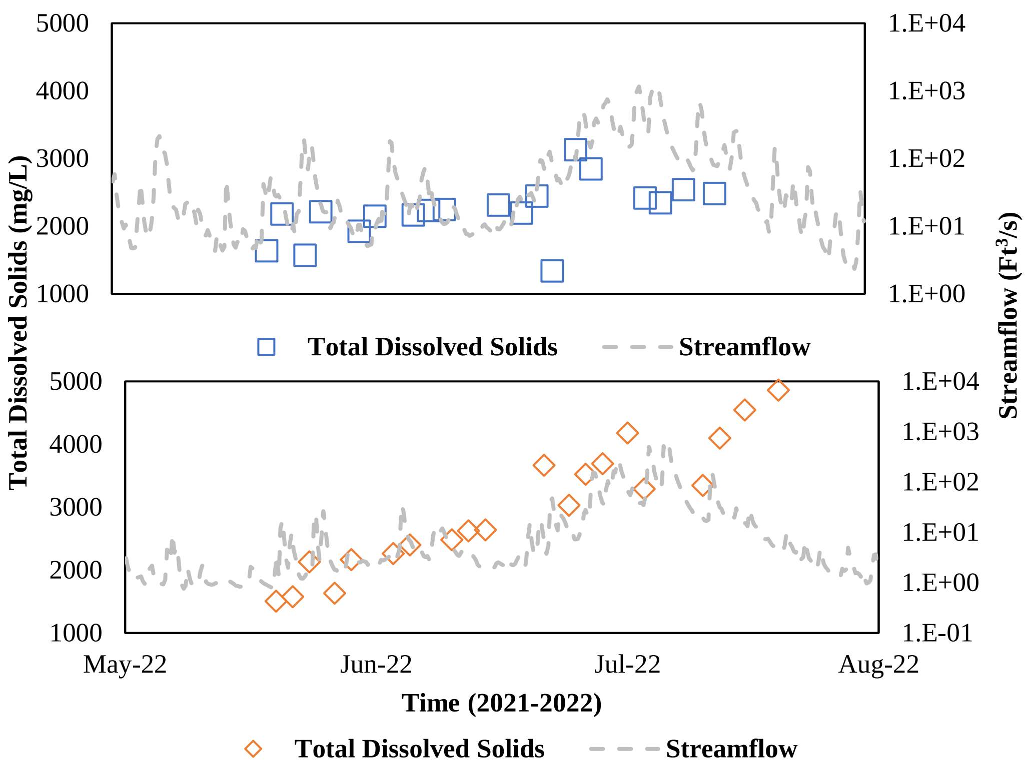

Fig. 20. Total Dissolved Solids versus Streamflow temporally for top) urban stream and bottom) rural stream.

$$\textbf{\textit{(Eq 9)}}\ \%TDS_{bf} = \frac{TDS_{pre-event}}{TDS_{event}}\ x\ 100$$

Where: $\%TDS_{bf}$ = Percent Contribution of Total Dissolved Solids from Baseflow, $TDS_{pre-event}$ = Total Dissolved Solid Concentration Pre-event, TDS_{event} = Total Dissolved Solid Concentration Event *pH*

pH versus chloride concentrations (mg/L) showed a weak inverse relationship year-round and across the watershed (Fig 21). It showed that pH was not a reliable proxy for chloride concentrations within the study area.

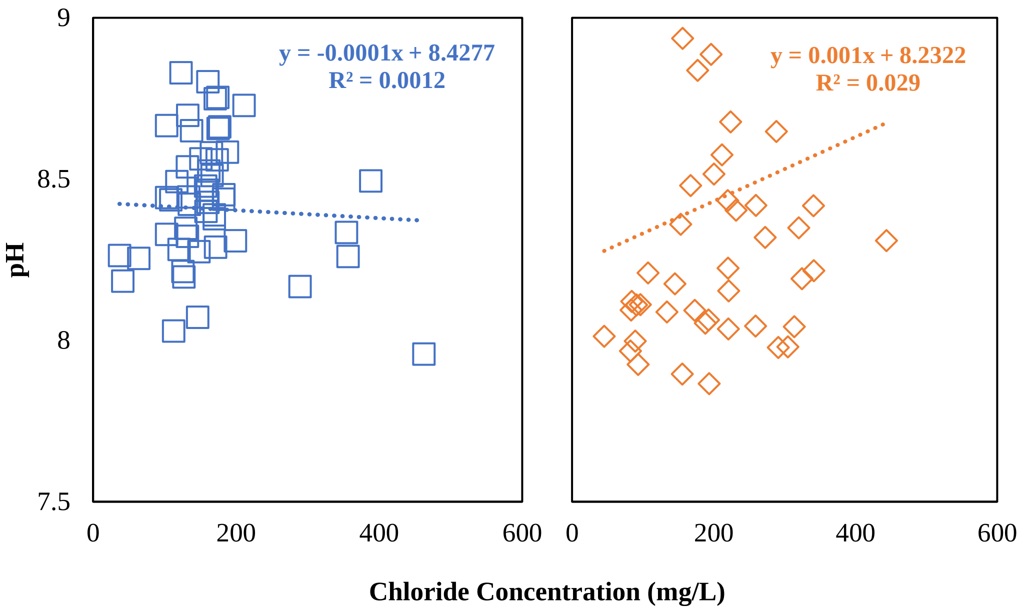

Fig. 21. Chloride concentrations versus pH for discrete stream water samples year-round from both right) urban stream and left) rural stream.

pH was plotted against streamflow and results showed that pH shared a weak relationship with streamflow but showed a seasonal shift between warm and cold months across the watershed (Fig 22). Results of pH also showed that the average pH for precipitation samples were lower for the urban and rural streams respectively compared to the higher event and pre-event pH values for discrete stream water samples across the watershed (Tables E.2 and E.6). It should be mentioned that the average precipitation pH values were 7.14 and 7.10, for the urban and rural field sites, respectively (Tables E.2 and E.6). These values are not consistent with established values of pH for precipitation (US EPA, 2023) values were higher. This inconsistency could be due to the precipitation water samples sitting exposed to the atmosphere between collection times or contamination of an unknown alkaline source. This result strongly suggested that advanced precipitation catchments are needed for future studies.

pH values peaked during the summer months of June, July, and August (Fig 22). These results suggested that groundwater, as baseflow, was transported to the streamflow during precipitation events during the summer, delivering the chloride stored in the subsurface with higher pH values compared to precipitation. Similar to total dissolved solids in the rural stream, pH also increased significantly during the summer months (Fig 22).

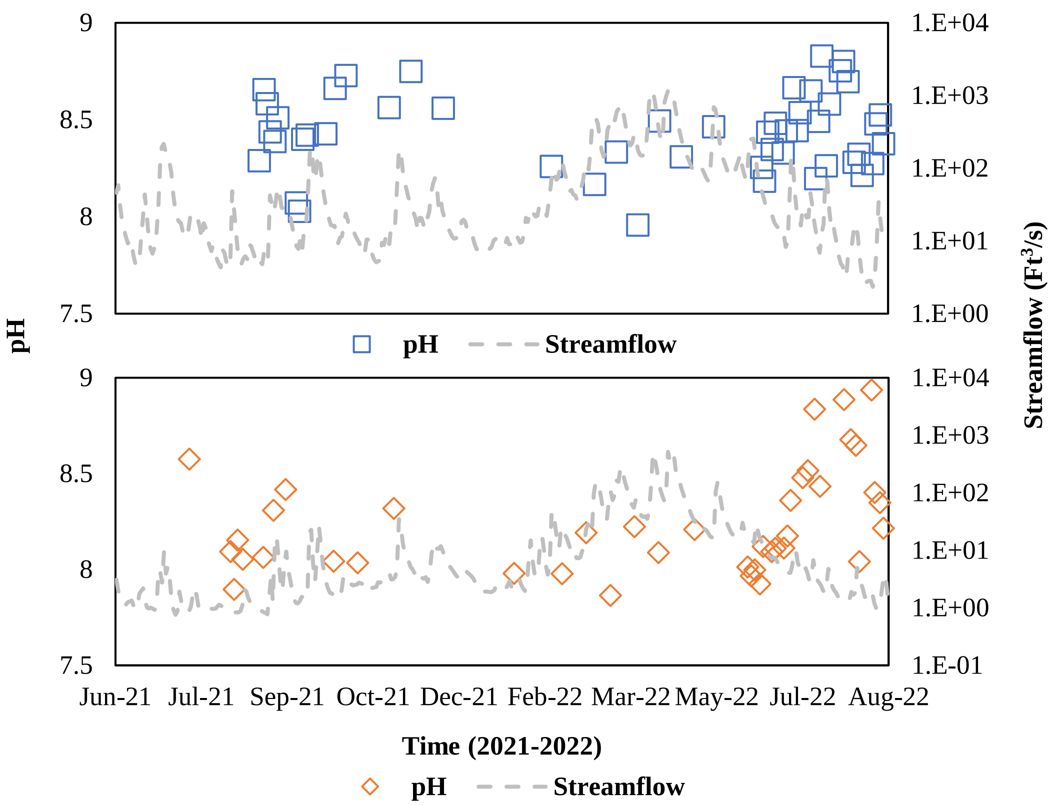

Fig. 22. pH versus Streamflow temporally for top) urban stream and bottom) rural stream.

Nitrate, Sulfate, and Potassium

The results of increased total dissolved solids in the rural stream during the summer months of 2022 (Fig 20) suggested the presence of other ions in addition to chloride may be important (Table B.1 and B.2). The concentrations of nitrate (NO_3) and sulfate (SO_4) were plotted over time for each stream (Fig 23). Results showed that levels of NO_3 and SO_4 were noticeably higher in the rural stream compared to the urban stream, over the duration of the study (Fig 23). Results showed that nitrate levels ranged from approximately 26.4 to 1.64 and 47.3 to 1.15 mg/L for the urban and rural streams, respectively (Fig 23). These ranges suggested that the rural streams was possibly introduced to nitrate and nitrate-bearing substances like ammonium nitrate (AN) fertilizer more than the urban stream. Results also showed that sulfate levels ranged from approximately 143 to 12.4 mg/L and 189 to 46.7 and for the urban and rural streams, respectively (Fig 23). These ranges also suggested that the rural stream was introduced to sulfate and sulfate-bearing substances like ammonium sulfate (AS) and single superphosphate (SSP) fertilizers more than the urban stream. While nitrate and sulfate fertilizers are not chloride-bearing the presence of fertilizers gave reason to investigate unique chloride-bearing fertilizers with potassium concentrations, looking into potassium chloride fertilizers (KCl) (Fig 24).

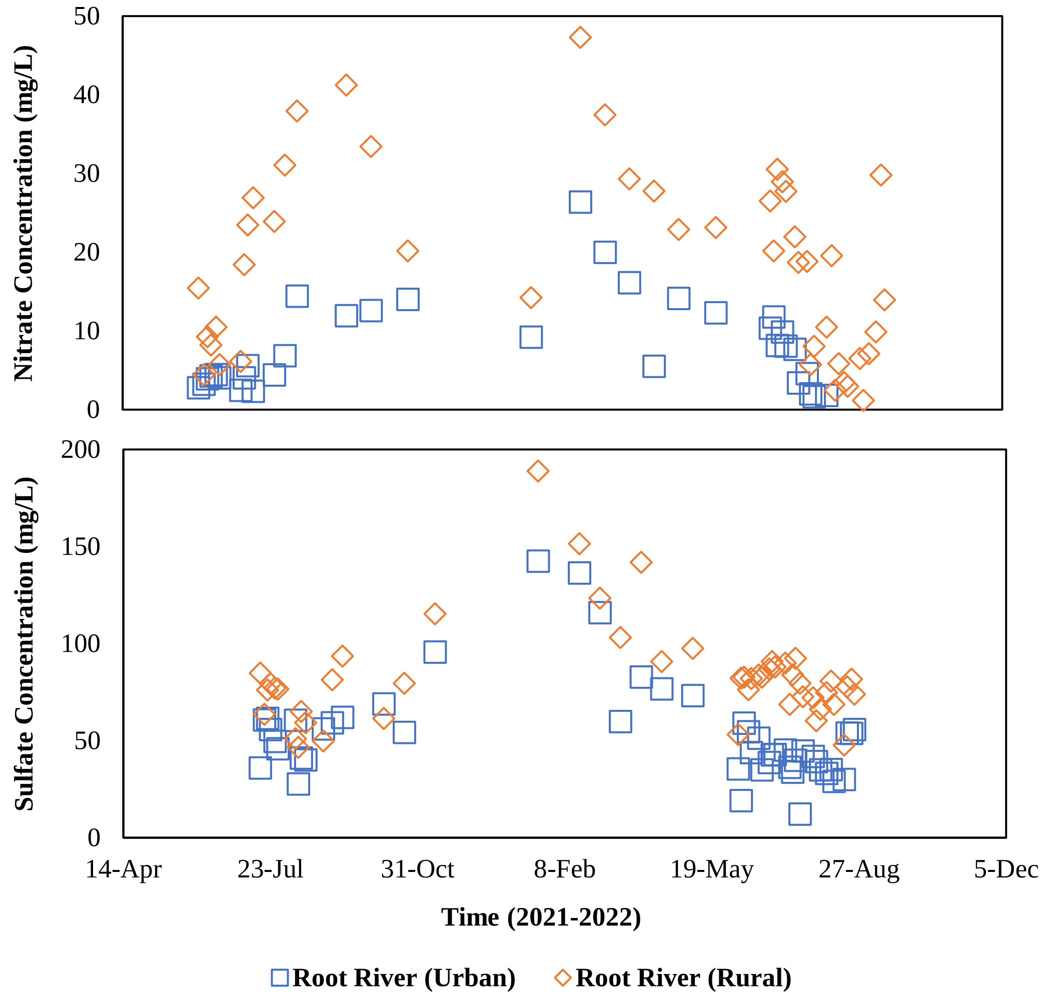

Fig. 23. Concentrations of nitrate and sulfate for all discrete Root River samples for both the urban and rural streams over the duration of the study top) nitrate concentrations and bottom) sulfate concentrations.

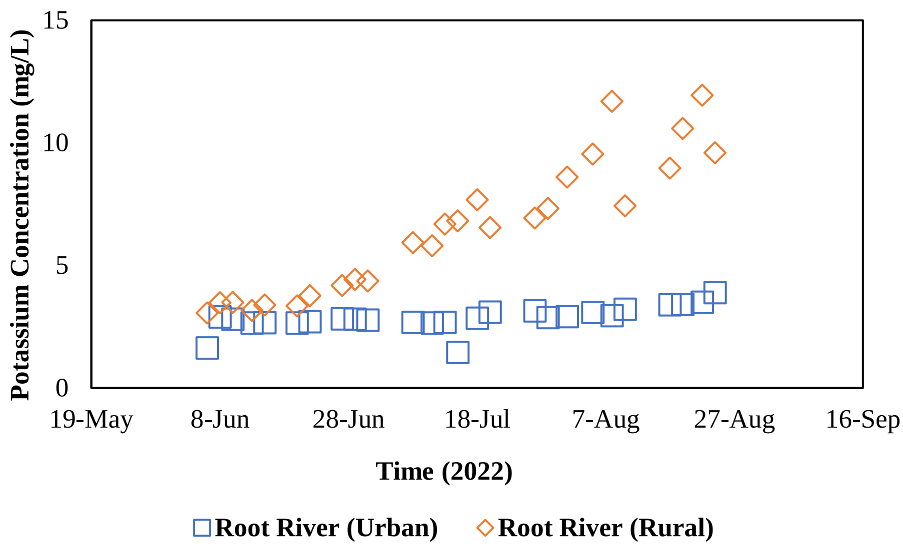

Fig. 24. Concentration of potassium for all discrete Root River sample for both the urban and rural streams over the 2022 summer sampling season 6/6/22 – 8/24/22.

Potassium concentrations were plotted over time for both urban and rural stream (Fig 24). The notable observation was the elevated concentration and increase of potassium during the summer months in the rural site stream compared to the urban stream (Fig 24). This observation demonstrated that potassium fertilizers may have had an influence on chloride concentrations in the rural watershed. However, previous results from Cl^-, Br^-, and TN bivariate mixing plots (Figs 6 & 7) strongly suggested that the source of chloride was road salt not fertilizers via field tiles. These results suggested that further separation techniques may lead to the understanding of how KCl effects chloride concentrations in stream water. As a whole, the results of NO_3, SO_4, and K^+ demonstrated the importance of land use diversity and introducing unique chloride sources when investigating chloride in freshwater perennial streams.

CHAPTER 4: CONCLUSIONS

The results of this study clearly demonstrated that utilizing established field-based methods in addition to supplemental data can adequately characterize the unique sources and persistent pathways of chloride to freshwater perennial streams across diverse land uses, year-round, and at high frequencies. The predominant source of chloride in both urban and rural streams was road salt, as evident by chloride, bromide, and nitrogen bivariate mixing plots. The successful identification of the source of chloride in the streams was the most important knowledge gap to bridge toward the best management practices of road salt application in any cold-weather environment. The predominant pathway of chloride to both urban and rural streams was groundwater, as baseflow, as evident by hydrograph separation data analysis. However, the pathways of chloride to both streams via soil porewater flow, or interflow, also likely occurred over the duration of this study, as evident by salt leaching data. The successful identification of the pathways of chloride to the streams was important to better understand the hydrological compartments that can store and move salts to freshwater resources.

The peak concentrations of chloride may have exceeded the chronic level of 395 mg/L and possibly even the acute level of 757 mg/L in both streams, as evident by year-round and high-frequency conductance measurements. These data had two important implications: 1) the aquatic life in both streams may have been negatively impacted by road salts at certain points in time, 2) one or more secondary sources for chloride to enter streams persisted into the late summer. The mass loading of chloride was calculated at 12,903 and 2,644 tons for the urban and rural streams, respectively.

The chloride budget generated for road salt estimated that 8,299 and 640 tons of chloride were introduced to the urban and rural field sites, respectively. Utilizing historic salt purchasing data and assuming no other contributions of road salt in the watershed. When chloride introduced to the watershed was compared to chloride removed via chloride loading a mass imbalance of 4,604 and 2,004 tons for the urban and rural field sites was discovered. More chloride was loaded out of the watershed than what is introduced, further supporting the possibility that chloride persists in the watershed and is subsequently introduced into the stream.

The results of supplemental data showed that stable water isotopes were able to highlight the persistence and lag time of groundwater entering the stream. Furthermore, alkalinity, total dissolved solids, and pH supported the result of groundwater, as baseflow, was the predominant pathway. Results showed that pre-event stream water samples closely resembled event stream water samples, not precipitation samples.

The results of this study implied that road salt applied during the winter may persist throughout the summer across urban and rural areas within a watershed in groundwater and soil porewater with the potential to exceed chronic and acute levels of aquatic toxicity.

CHAPTER 5: FUTURE IMPLICATIONS

Waukesha Water Diversion

Overview

The City of Waukesha in Waukesha County, WI has successfully proposed and will implement a Great Lakes Diversion by 2023. The diversion was proposed due to supply water of Waukesha being over the U.S. Environmental Protection Agency's water quality standard for radium under the Safe Drinking Water Act (Wisconsin DNR, 2019). The diversion includes taking water from Lake Michigan for use by the City of Waukesha, replacing the current water with water that meets quality standards for radium. Before the diversion the City of Waukesha relied predominately on a deep aquifer for water supply which overtime with high yield pumping caused depressed water levels and have compounded the concentration of radium (Wisconsin DNR, 2019). With the diversion the City of Waukesha will pump water from the City of Milwaukee, obtained from Lake Michigan, to the City of Waukesha for use, treatment, and then return the water via the Root River back into Lake Michigan. The importance of the Root River within the Waukesha Water Diversion return route is its drainage basin that acts as a tributary for Lake Michigan. The City of Waukesha sits beyond the Lake Michigan divide which is the geographic marker for the separation of water to return to Lake Michigan or the Mississippi River (Fig 25). Under the Great Lakes Compact water taken from Lake Michigan must be returned to Lake Michigan.

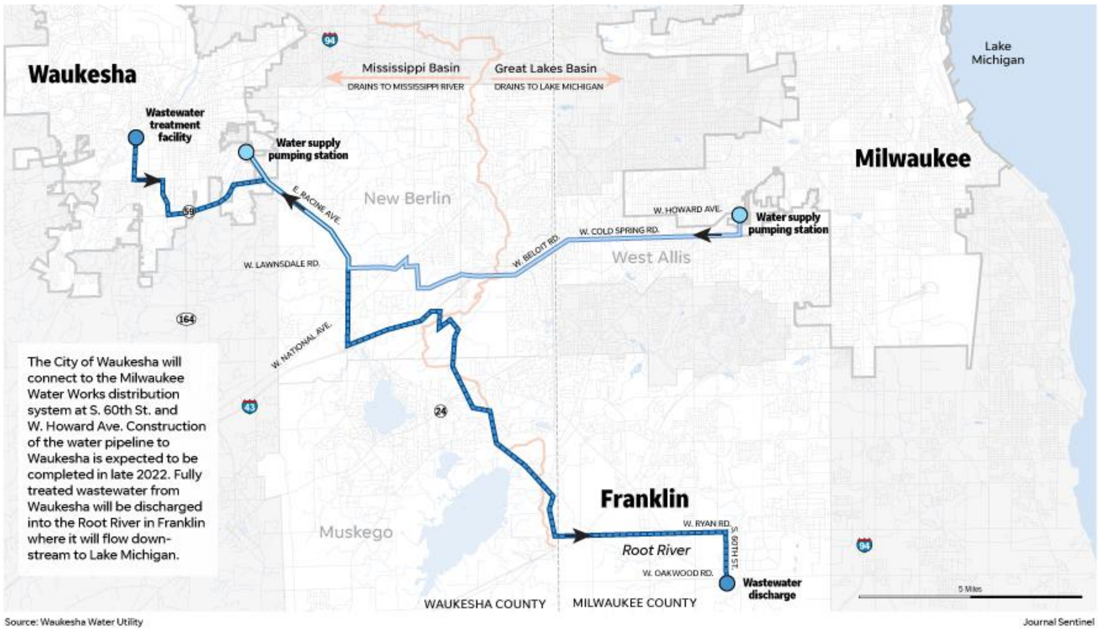

Fig. 25. Waukesha's Water Diversion intake and return pipelines. The water will be returned with pipes until Racine County, WI where it will discharge into the Root River and be naturally transported back into Lake Michigan (Waukesha Water Utility, n.d.).

The Water

This diversion will return about an additional 8.2 million gallons per day (13 ft3/s) of water that will travel through the Root River to Lake Michigan (Wisconsin DNR, 2019). The water returned has been flagged for numerous sources of chloride: residential and commercial water softening, residential (non-softened), groundwater infiltration and inflow, industrial softening and industrial processes, road salt, hauled waste, and ferric chloride at Waukesha's Wastewater Treatment Plant (Wisconsin DNR, 2019). This will introduce a new streamflow and baseflow concentration of chloride. Potentially modifying current concentrations of chloride on the Root River. However, this future change does not impact the results of this study.

Implications to the Root River and Beyond

These results not only set a precedent for chloride monitoring and management in the future but serve as a baseline for the Root River prior to the diversion. Data from this study may be used to compare concentrations of constituents, compartments of streamflow, and the unique sources and persistent pathways of chloride before and after the diversion at a high frequency, year-round, and across the Root River watershed.

Open-Source Data

Surface Water Integrated Monitoring Systems (SWIMS)

Data from this study will soon be open-source on the Surface Water Integrated Monitoring System via the Wisconsin Department of Natural Resources and Water Quality Exchange Network with the Environmental Protection Agency. Applications of these results and data is not restricted and may be used for education, predictive modeling, understanding mechanistic processes, and answering more or new questions in context of the data.

Predictive Modeling and Mechanistic Processes

This work provides a comprehensive, high-frequency, diverse, and unique set of data for the Root River watershed. Allowing the user to generate predictive models from mechanistic insight provided by known results for the concentration, unique sources, and persistent pathways of chloride. This predictive modeling is not restricted to the Root River watershed and may have applications to any perennial freshwater stream in a cold weather environment.

REFERENCES

Bastviken, D., Sandén, P., Svensson, T., Ståhlberg, A. C., Magounakis, M., & Oberg, G. (2006). Chloride retention and release in a boreal forest soil: effects of soil water residence time and nitrogen and chloride loads. *Environmental science & technology*, *40*(9), 2977–2982. https://doi.org/10.1021/es0523237

Bershaw, J. (2018). Controls on Deuterium Excess across Asia. *Geosciences*, *8*(7), 257. MDPI AG. Retrieved from http://dx.doi.org/10.3390/geosciences8070257Bester, M. L., Frind, E. O., Molson, J. W., & Rudolph, D. L. (2006). Numerical Investigation of Road Salt Impact on an Urban Wellfield. *Groundwater*, *44*(2), 165–175. https://doi.org/10.1111/j.1745-6584.2005.00126.x

Bester, M. L., Frind, E. O., Molson, J. W., & Rudolph, D. L. (2006). Numerical Investigation of Road Salt Impact on an Urban Wellfield. *Groundwater*, *44*(2), 165–175. https://doi.org/10.1111/j.1745-6584.2005.00126.x

Betts, A., Gharabaghi, B., McBean, E., Levison, J., & Parker, B. (2015). Salt vulnerability assessment methodology for municipal supply wells. *Journal of Hydrology*, *531*, 523–533. https://doi.org/10.1016/j.jhydrol.2015.11.004

Cherry, M. A., 2019. Streamflow Gain and Loss, Hydrograph Separation, and Water Quality of Abandoned Mine Lands in the Daniel Boone National Forest, Eastern Kentucky, 2015–17. United States Geological Survey.

Cunillera-Montcusi, D., M. Beklioglu, M. Canedo-Arguelles, E. Jeppesen, R. Ptacnik, C. A. Amorim, S. E. Arnott, S. A. Berger, S. Brucet, H. A. Dugan, M. Gerhard, Z. Horvath, S. Langenheder, J. C. Nejstgaard, M. Reinikainen, M. Striebel, P. Urrutia-Cordero, C. F. Vad, E. Zadereev & M. Matias, 2022. Freshwater salinisation: a research agenda for a saltier world. Trends in Ecology & Evolution 37(5):440-453 doi:10.1016/j.tree.2021.12.005.

Corsi, S. R., Cicco, L. A. D., Lutz, M. A., & Hirsch, R. M. (2015). River chloride trends in snow-affected urban watersheds: Increasing concentrations outpace urban growth rate and are common among all seasons. *Science of The Total Environment*, *508*, 488–497. https://doi.org/10.1016/j.scitotenv.2014.12.012

Dansgaard, W. (1964). Stable isotopes in precipitation. *Tellus*, *16*(4), 436–468. https://doi.org/10.1111/j.2153-3490.1964.tb00181.x

Dugan, H. A., Skaff, N. K., Doubek, J. P., Bartlett, S. L., Burke, S. M., Krivak-Tetley, F. E., Summers, J. C., Hanson, P. C., & Weathers, K. C. (2020). Lakes at Risk of Chloride Contamination. *Environmental Science & Technology*, *54*(11), 6639–6650. https://doi.org/10.1021/acs.est.9b07718

Dugan, H., Rock, L., Kendall, A., & Mooney, R. (2021). Tributary chloride loading into Lake Michigan. *Limnology and Oceanography Letters*, *8*. https://doi.org/10.1002/lol2.10228

DNR reminds Wisconsinites to reduce salt use this winter. Wisconsin DNR. (n.d.). Retrieved April 15, 2023, from https://dnr.wisconsin.gov/newsroom/release/40396

Eckhardt, K. (2005). How to construct recursive digital filters for baseflow separation. *Hydrological Processes*, *19*(2), 507–515. https://doi.org/10.1002/hyp.5675

Fay, L., & Shi, X. (2012). Environmental Impacts of Chemicals for Snow and Ice Control: State of the Knowledge. *Water, Air, & Soil Pollution*, *223*(5), 2751–2770. https://doi.org/10.1007/s11270-011-1064-6

Freeze, R. A. & J. A. Cherry, 1979. Groundwater. Prentice-Hall, Inc., Englewood Cliffs, New Jersey 07632.

Galella, J. G., S. S. Kaushal, K. L. Wood, J. E. Reimer & P. M. Mayer, 2021. Sensors track mobilization of 'chemical cocktails' in streams impacted by road salts in the Chesapeake Bay watershed. Environmental Research Letters 16(3) doi:10.1088/1748-9326/abe48f.

Granato, G. E., DeSimone, L. A., Barbaro, J. R., & Jeznach, L. C. (2015). *Methods for evaluating potential sources of chloride in surface waters and groundwaters of the conterminous United States* (Report No. 2015–1080; Open-File Report, p. 104). USGS Publications Warehouse. https://doi.org/10.3133/ofr20151080

Howard, K. W., & Haynes, J. (1993). Groundwater contamination due to road de-icing chemicals—salt balance implications. *Geoscience Canada*.

Kaushal, S. S., G. E. Likens, M. L. Pace, R. M. Utz, S. Haq, J. Gorman & M. Grese, 2018. Freshwater salinization syndrome on a continental scale. Proceedings of the National Academy of Sciences of the United States of America 115(4):E574-E583 doi:10.1073/pnas.1711234115.

Kelly, V.R., Findlay, S.E.G., Schlesinger, W.H., Chatrchyan, A.M., Menking, K. (2010). Road Salt: Moving Toward the Solution. The Cary Institute of Ecosystem Studies.

Kincaid, D., & Findlay, S. (2009). Sources of Elevated Chloride in Local Streams: Groundwater and Soils as Potential Reservoirs. *Water Air and Soil Pollution*, *203*, 335–342. https://doi.org/10.1007/s11270-009-0016-x

Kulsawat, W., & Nochit, P. (2019). Stable isotopes relationship between precipitation and surface water, Phitsanulok. *Journal of Physics: Conference Series*, *1380*(1), 012162. https://doi.org/10.1088/1742-6596/1380/1/012162

Likens, G. E. (2013). *Biogeochemistry of a forested ecosystem*. Springer Science & Business Media.

Lovett, G. M., Likens, G. E., Buso, D. C., Driscoll, C. T., & Bailey, S. W. (2005). The biogeochemistry of chlorine at Hubbard Brook, New Hampshire, USA. *Biogeochemistry*, *72*(2), 191–232. https://doi.org/10.1007/s10533-004-0357-x

Mackie, C., Lackey, R., Levison, J., & Rodrigues, L. (2022). Groundwater as a source and pathway for road salt contamination of surface water in the Lake Ontario Basin: A review. *Journal of Great Lakes Research*, *48*(1), 24–36. https://doi.org/10.1016/j.jglr.2021.11.015

Moore, J., Fanelli, R. M., & Sekellick, A. J. (2020). 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. *Environmental Science & Technology*, *54*(2), 778–789. https://doi.org/10.1021/acs.est.9b04316

Novotny, V., Smith, D. W., Kuemmel, D. A., Mastriano, J., & Bartosova, A. (1999). Urban and highway snowmelt: minimizing the impact on receiving water. *Water Environment Research Foundation, Alexandria, VA.*

Oswald, C. J., Giberson, G., Nicholls, E., Wellen, C., & Oni, S. (2019). Spatial distribution and extent of urban land cover control watershed-scale chloride retention. *Science of The Total Environment*, *652*, 278–288. https://doi.org/10.1016/j.scitotenv.2018.10.242

Panno, S. V., Hackley, K. C., Hwang, H. H., Greenberg, S. E., Krapac, I. G., Landsberger, S., & O'Kelly, D. J. (2006). Characterization and Identification of Na-Cl Sources in Ground Water. *Groundwater*, *44*(2), 176–187. https://doi.org/10.1111/j.1745-6584.2005.00127.x

Paine, R. L. (1979). *Chlorides in the Don River watershed resulting from road de-icing salt*. University of Toronto. Institute for Environmental Studies. Snow and Ice Control Working Group.

Perera, N., Gharabaghi, B., & Howard, K. (2013). Groundwater chloride response in the Highland Creek watershed due to road salt application: A re-assessment after 20years. *Journal of Hydrology*, *479*, 159–168. https://doi.org/10.1016/j.jhydrol.2012.11.057

Petre, M. A., D. P. Genereux, L. Koropeckyj-Cox, D. R. U. Knappe, S. Duboscq, T. E. Gilmore & Z. R. Hopkins, 2021. Per- and Polyfluoroalkyl Substance (PFAS) Transport from Groundwater to Streams near a PFAS Manufacturing Facility in North Carolina, USA. Environmental Science & Technology 55(9):5848-5856 doi:10.1021/acs.est.0c07978.

Pilon, P. E., & Howard, K. W. F. (1987). Contamination of Subsurface Waters by Road De-icing Chemicals. *Water Quality Research Journal*, *22*(1), 157–172. https://doi.org/10.2166/wqrj.1987.012

Roy, J. W. (2019). Endobenthic Organisms Exposed to Chronically High Chloride from Groundwater Discharging along Freshwater Urban Streams and Lakeshores. *Environmental Science & Technology*, *53*(16), 9389–9397. https://doi.org/10.1021/acs.est.9b02288

Roy, J. W., & Malenica, A. (2013). Nutrients and toxic contaminants in shallow groundwater along Lake Simcoe urban shorelines. *Inland Waters*, *3*(2), 125–138. https://doi.org/10.5268/IW-3.2.521

Rumsey, C. A., Miller, M. P., Schwarz, G. E., Hirsch, R. M., & Susong, D. D. (2017). The role of baseflow in dissolved solids delivery to streams in the Upper Colorado River Basin. *Hydrological Processes*, *31*(26), 4705–4718. https://doi.org/10.1002/hyp.11390

SEWRPC. (2014). A Restoration Plan for the Root River Watershed. Southeastern Wisconsin Regional Planning Commission, Waukesha, Wisconsin. *Southeastern Wisconsin Regional Planning Commission Community Assistance Planning Report No. 316.*

SEWRPC. (2016). Prospectus for a chloride impact study for the southeastern Wisconsin region. Southeastern Regional Planning Commission, Waukesha, Wisconsin. *Southeastern Wisconsin Regional Planning Commission Technical Report*, *41*.

SSURGO, 2022. Soil Survey Geographic Database. https://wwwnrcsusdagov/resources/data-and-reports/soil-survey-geographic-database-ssurgo.

Stets, E. G., Sprague, L. A., Oelsner, G. P., Johnson, H. M., Murphy, J. C., Ryberg, K., Vecchia, A. V., Zuellig, R. E., Falcone, J. A., & Riskin, M. L. (2020). Landscape Drivers of Dynamic Change in Water Quality of U.S. Rivers. *Environmental Science & Technology*, *54*(7), 4336–4343. https://doi.org/10.1021/acs.est.9b05344

Tian, C., Wang, L., Kaseke, K. F., & Bird, B. (2018). Stable isotope compositions (δ2H, δ18O and δ17O) of rainfall and snowfall in the central United States. *Scientific Reports*, *8*. https://doi.org/10.1038/s41598-018-25102-7

Todd, A. K., & Kaltenecker, M. G. (2012). Warm season chloride concentrations in stream habitats of freshwater mussel species at risk. *Environmental Pollution*, *171*, 199–206. https://doi.org/10.1016/j.envpol.2012.07.040

US EPA, 2023. Web interface. United States Environmental Protection Agency.

USDC, United States Department of Commerce N. O. A. A. (2005, November 7). PF data server-PFDS/HDSC/OWP. Retrieved January 14, 2023, from

USGS, 2022. National Water Information System: Web Interface. United States Geological Survey, Reston, Virgina.

Waukesha Water Utility. (n.d.). Retrieved April 25, 2023, from https://waukesha-water.com/

What: Web-based Hydrograph Analysis Tool, baseflow separation, direct runoff, stream flow, USGS daily, monthly, yearly stream flow. (n.d.). Retrieved January 1, 2023, from https://engineering.purdue.edu/mapserve/WHAT/

Wisconsin DNR. (2019). Final Environmental Impact Assessment. City of Waukesha Proposed Great Lakes Diversion. https://widnr.widen.net/s/rb5ftmfj2g/waukeshaproposeddiversionfinaleis

Wisconsin DOT. (2021). Annual Winter Maintenance Report 2020/2021. Wisconsin Department of Transportation. https://wisconsindot.gov/Documents/doing-bus/local-gov/hwy-mnt/winter-maintenance/annual-report-2020-21.pdf

Yozzo, D. J., Andersen, J. L., Cianciola, M. M., Nieder, W. C., Millar, D. E., Ciparis, S., et al. (2005). Ecological profile of the Hudson River National Estuarine Research Reserve. Published under Contract to the New York State Department of Environmental Conservation [C00464].

Zaporozec, A. and Eaton, T.T. (1996). Ground-water resource inventory in urbanized areas. American Institute of Hydrology Proceedings, Conference on Hydrology and Hydrogeology of Urban and Urbanizing Areas, Proceedings, p. RM21-RM32.

APPENDIX A: Standard Operating Procedures

pH

Calibrating the pH Probe
You need to calibrate the pH probe every time you use it.

Materials:

- Gloves
- KIMTECH wipes
- pH Probe
- Pink pH 4.01 +/- 0.01 solution (#910104)
- Yellow pH 7.00 +/- 0.01 solution (#BB8871)
- Blue pH 10.00 +/- 0.02 solution (#BB8870)
- 200-mL Beaker
- DI water
- 50-mL beakers (3 total)

Step A)

Turn on the probe machine and select the channel you need "Channel 1: pH". Take the pH probe, remove the cap, and refill the filling solution if needed. Attach the probe to the probe arm, this will hold the probe and can be used to lower and remove the probe from samples.

Step B)

Next, you will prepare the standard solutions. You will need three 50-mL beakers, one beaker per pH standard solution. For each solution designate a known beaker and fill the beaker approximately 15-20-mL with its designated pH solution.

Step C)

To begin calibration press "Calibrate" (f1). Follow the instructions prompted to you on the screen. It will prompt you to rinse the prob with DI water and wipe dry with a KIMTECH wipe. Next, it will prompt you to place the probe into the first pH solution (4.0 is always first, working up in pH). When the calibration is done stabilizing and says "Ready" check to see if the number on the screen matches the exact number on the bottle for that solution. If not, press "edit" (f3). Enter the value on the bottle and press "accept". The screen will continue to prompt you through this motion until all three pH solutions have been calibrated. When completed select "calibration done" and then "measure", this will take you back to the pH measuring screen.

Step D)

Once complete rinse the probe with DI water and wipe dry with a KIMTECH wipe. Take the three beakers of pH solutions and dump them down the sink. Triple-rinse the beakers with DI water and hang them to dry. **<u>Place the protective cap back onto the pH probe</u>**, place the pH probe back into its housing containment, clean up any messes, and throw all trash away.

Measuring the pH of Water Samples

You will measure the pH of all your water samples each day.

Materials:

- Gloves
- KIMTECH wipes
- pH Probe
- Water Samples
- 50-mL beakers (7 or 5 total, one for each water sample being tested)
- 200-mL beaker
- DI water
- 50-mL beaker

Step A)

Prep the samples and pour 10-20-mL of each water sample into a designated 50-mL beaker for that sample.

Step B)

Place the 200-mL beaker under the probe and rinse off the probe with DI water and wipe dry with a KIMTECH wipe. Place a beaker with a water sample onto the bench, to test the pH carefully lower the probe arm so that the probe is fully submerged. DO NOT bang the probe on the bottom of the beaker. Once the probe is placed press “measure”. Allow the machine to stabilize, once stabilized record the pH measurement in your lab book.

Step C)

Remove the probe from the 50mL beaker and place the 50mL back onto the table. Place the 200-mL beaker under the probe and rinse off the probe with DI water. Finally, wipe the probe off with a KIMTECH wipe.

Step D)

Repeat steps B and C until all samples have been tested for pH. Note, have a setup that you can follow to ensure each sample is tested once and not duplicated. Use tape or set the samples behind the beaker to label/keep track of what is in the beaker. We all have our way to organize just make sure you use what is best for you to reduce error.

Step E)

Triple rinse out all beakers with DI water and hang them to dry, **place the protective cap back onto the pH probe**, place the pH probe back into its housing containment, clean up any messes, and throw all trash away.

Alkalinity

Making A Standard

You will make alkalinity standards each time you switch out the digital titration cartridge. These standards help show the deviation between calculated and measured for each cartridge.

Materials:

- Sodium Carbonate
- Weighing boat (small)
- Scale
- Scoop
- Stir Plate
- Pill
- Magic Wand (magnetic wand)
- Graduated Cylinder
- DI Water
- 200-mL beaker
- Erlenmeyer Flask
- 10-mL pipet and pipet tips
- Titration Hach Kit
- Waste Jar
- Glass Lens
- Gloves
- Safety Glasses (we are dealing with Sulfuric Acid; it is heavily diluted, but safety is first)

Step A)

Turn on the scale, measure the weigh boat, zero the scale, remove the weigh boat, add sodium carbonate, and place it on the scale. Add and remove sodium carbonate until you have desired amount (0.106g).

Step B)

Measure out 200-mL of DI water and place it into a 200-mL beaker. Put the beaker on the stir plate. Add (0.106g) of sodium carbonate. Add the pill and turn the stir plate to level 9. Place a glass lens on top of the beaker to stop the evaporative effect. Stir until completely dissolved. Usually about 2-3 minutes.

Step C)

Once dissolved turn off the stir plate and remove the pill with the magic wand. Remove the beaker.

Step D)

Now we will dilute the solution 10-fold. Using a 10mL pipet measure out 90mL of DI water into the Erlenmeyer flask, change pipet tips and measure out 10mL of the solution into the Erlenmeyer flask. Once both solutions are in the flask give it a swirl to mix.

Step F)

Follow the SOP pages 2-4. Carefully read and follow the instructions. Use Table 3 and Page 4 to calculate Carbonate Alkalinity using the P and Total alkalinity values you will measure.

You should be in the range of 30ppm ($\pm$ 5), calculate errors and record them in your lab book.

Step G)

Triple-rinse all glassware with DI and hang to dry. Triple-rinse all pipet tips with DI water and layout on a paper towel to dry.

Step E)

Remove the delivery tube and run DI water through the tube for 10 seconds, and it lay to dry with the Titration Hach Kit. Place the cap back onto the acid cartridge and remove it from the apparatus. To do so you will need to retract the plunger and slide the acid cartridge out. Place all material back into the Titration Hach Kit box for safekeeping. Remove your gloves, wash your hands, and wipe off the area to ensure all acid drops/spills are cleaned up. **You can skip this step if you are going to be completing the analysis of samples next, if not you must do this step**

Sample analysis

You will measure alkalinity for each sample type for each sample date.

Materials:

- SOP (Standard Operating Procedure)
- 10mL pipet and tips (enough tips for each sample)
- Gloves
- Safety Glasses (we are dealing with Sulfuric Acid; it is heavily diluted, but safety is first)
- KIMTECH wipes
- Erlenmeyer flask (enough for each sample or wash in between samples)
- Titration Hach Kit
- Waste Jar
- Water Samples

Step A)

Take samples from the fridge or cooler and allow them to sit on the bench for at least one hour, allowing them to reach room temperature.

Step B)

Next, you will prep the samples. Grab enough Erlenmeyer flasks to house each sample. Add 100-mL of a sample to its designated Erlenmeyer flask. Do so by using a 10mL pipet (pipet 10mL into the flask 10x). Between each sample replace the pipet tip and discard the used tips by the sink for cleaning later.

Step C)

Follow the SOP pages 2-4. Carefully read and follow the instructions. Use Table 3 on page 4 to calculate Carbonate Alkalinity using P and Total Alkalinity values you will measure. Record your findings in your lab book. Show your work!

Step D)

Once complete pour the titration solution into the waste jar. When the jar is full or you are done with analysis pour it into the long-term storage container on the table by the fridge that says, “Root River Alkalinity Waste”. Triple-rinse all Erlenmeyer flasks with DI water and hang them to dry. Triple-rinse all pipet tips and layout on a paper towel to dry.

Step E)

Remove the delivery tube and run DI water through the tube for 10 seconds, and lay it to dry with the Titration Hach Kit. Place the cap back onto the acid cartridge and remove it from the apparatus. To do so you will need to retract the plunger and slide the acid cartridge out. Place all material back into the Titration Hach Kit box for safekeeping. Remove your gloves, wash your hands, and wipe off the area to ensure all acid drops/spills are cleaned up.

Total Dissolved Solids

Estimating Total Dissolved Solids with conductance

Materials

- 0.2 Micron Filters
- 30-mL of Liquid Sample
- 50-mL sample vial
- NaCl standard solutions
  - 0 ppm
  - 7.8125 ppm
  - 15.625 ppm
  - 31.25 ppm
  - 62.5 ppm
  - 125 ppm
  - 250 ppm
  - 500 ppm
  - 1000 ppm
  - 2000 ppm
- Thermofisher Conductivity Probe
- Sharpie
- Logbook/paper
- Excel or spreadsheet program
- DI water
- KIMTECH WIPES

Step A) Filter approximately 30-mL of a sample through a 0.2-micron filter into a 50-mL sample vial. Each vial should have the proper nomenclature used by the lab; write on vial using sharpie.

Step B) Turn probe to conductivity setting on channel three.

Step C)Run all 10 NaCl standard solutions (lowest concentration to highest concentration) in order to develop a calibration curve. <u>Rinse the probe with DI water and dry with chem wipe in-between each sample.</u> Write down numbers produced in logbook.

Step D) Begin testing filtered samples. <u>Rinse the probe with DI water and dry with chem wipe in-between each sample.</u>

Step E) Once all the samples have been tested it is time to put the values into Excel in order to get the TDS value. Plot the values into a scatter plot TDS (x-axis) and NaCl (y-axis).

Step F) On one Excel sheet should be the calibration curve developed from the 10 standard solutions. Use a Linear Regression.

Step G) The formula created by the linear regression can then be used to find the TDS of the samples tested in the same period. This data should be placed on a different Excel sheet. Note: A new calibration curve should be produced for each day water samples are tested.

Near-surface Batch Leaching

Soil batch leaching workflow (1:10) adapted from standard batch leaching (DOE)

Materials

- 0.2 Micron Filters
- 8g of soil sample
- Scale
- Shaker table
- Centrifuge
- 2mm Sieve
- Mortar and Pestle (glazed)
- Notebook
- DI water
- Funnel
- Pipet (50-mL)
- 100-mL volumetric flask
- 50-mL Centrifuge Vials
- Coffee Filters (natural)
- Measuring spoon

Step A) Air dry samples (no oven heat).

Step B) Hand grind and sieve the sample.

- Record dry mass (grams)
- Grind and remove leaf litter (twigs, leaves, roots…)
- Record ground mass
- Sieve sample at 2mm
- Record sieved mass

Step C) Place 8g ± 10 mg of soil in a 50mL plastic centrifuge tube.
**First label the tube with S.S. #-A/B, Date, Ratio (1:10), and Date (see example).*

Step D) Add 40mL of DI water (run sink for 10 seconds to flush out debris). Use pipet with a clean pipet tip.

Step E) Agitate for 4 hours (using shaker table, timer for 4 hours, speed at 200).

Step F) Remove vials from the shaker table and place into centrifuge for 30 minutes at ½ speed. Centrifuge is on the 3rd floor teaching lab (can only complete 4 vials at a time).

Step G) Decant into a 100mL volumetric flask. Use a clean funnel and measuring spoon to hold back sediment, wash materials in-between samples.

Step H) Add another 40mL of test solution (DI water) to the test tube. Use pipet with clean pipet tip.

Step I) Agitate for 30 minutes (using shaker table, set timer for 30 minutes, speed at 200).

Step J) Remove vials from the shaker table and place into centrifuge for 30 minutes at ½ speed. Centrifuge is on the 3rd floor teaching lab (can only complete 4 vials at a time).

Step K) Decant into the *same* 100mL volumetric flask (step G). Use a clean funnel and measuring spoon to hold back sediment, wash materials in-between.

Step L) Pre-filter decantate through a coffee filter into a clean flask/beaker, allow gravity to filter the water through then allow the pre-filtered decantate to settle for 2 - 4 days. Make sure to cover the pre-filtered decantate when settling to ensure there is no contamination or evaporation.

Step M) Filter the 80mL decantate through a 0.2 micron filter. Filter the 80mL into 2 orange self-standing centrifuge vials, F_1 = 50mL and F_2 = rest of solution.

**First label tubes with S.S, #-A/B (F_1/F_2), Date, Ratio (1:10), SFS/Lap, and Date (see examples).*

**Use 50mL syringes, box above my bench, use a new one for each soil sample. Triple rinse when done.*

Step N) Place vials in fridge on a holding try until analysis. Use a systemic layout for easy reading and grouping.

Step O) Clean all materials used. Triple rinse with DI water and sit to dry.

APPENDIX B: Stream Water Sample Data

Anion Data (Cl^-, NO_3, SO_4, SiO_2)

Table B.1 Stream Water Sample Data from 7/16/21 – 8/24/22 for all discrete grab samples across the watershed. Date, represents when the sample was collected with an A, B, or C to represent duplicates. Site, represents where the sample was taken with a 1, 2, Q, D, RW for site 1, site 2, Quarry Lake, Drain, and Rain Water, respectively. Data for chloride, nitrate, sulfate, and silica are provided in mg/L. If a "-" is present the sample was not taken due to availability or safety reasons or analysis yielded results below detectable limits.

Date	Site	Cl [mg/L]	NO3 [mg/L]	SO4 [mg/L]	SiO2 [mg/L]
7/16 1 A	1	171.368	BDL	36.074	1.645
7/16 1 B	1	171.590	BDL	37.009	1.383
7/16 1 C	1	172.678	BDL	37.334	1.575
7/16 2 A	2	211.610	15.454	84.869	6.375
7/16 2 B	2	213.543	15.794	84.778	6.375
7/16 2 C	2	214.813	15.470	84.627	6.268
7/16 Q A	Q	81.881	BDL	52.859	0.291
7/19 1 A	1	174.906	BDL	60.795	0.540
7/19 1 B	1	174.702	BDL	61.152	0.565
7/19 2 A	2	163.542	BDL	63.603	0.106
7/19 2 B	2	163.553	BDL	63.258	0.174
7/19 Q A	Q	82.716	BDL	51.748	0.242
7/21 1 A	1	187.848	BDL	61.714	1.709
7/21 1 B	1	189.248	BDL	61.489	1.756
7/21 2 A	2	200.608	BDL	76.172	0.205
7/21 2 B	2	202.030	BDL	76.592	0.212
7/21 Q A	Q	82.875	BDL	52.056	0.247
7/21 D A	D	321.472	13.356	49.829	18.818
7/23 1 A	1	182.582	BDL	55.869	2.103
7/23 1 B	1	183.419	BDL	56.248	2.109
7/23 2 A	2	221.885	BDL	79.401	0.211
7/23 2 B	2	227.059	BDL	79.601	0.145
7/23 Q A	Q	80.918	BDL	50.496	0.226
7/23 D A	D	327.420	11.813	47.707	20.793
7/26 1 A	1	169.609	2.806	49.727	3.184
7/26 1 B	1	168.144	2.762	49.711	3.181

7/26 2 A	2	217.901	4.416	77.099	0.169
7/26 2 B	2	218.562	2.578	77.396	0.211
7/26 Q A	Q	76.365	BDL	49.568	0.287
7/26 D A	D	309.848	12.444	44.356	20.618
7/28 1 A	1	166.144	3.252	46.052	3.478
7/28 1 B	1	169.233	3.227	46.365	3.289
7/28 2 A	2	298.039	BDL	76.601	0.113
7/28 2 B	2	299.684	BDL	77.023	0.168
7/28 Q A	Q	77.581	BDL	49.388	0.276
7/28 D A	D	289.027	12.760	43.731	18.238
8/9 1 A	1	146.013	3.929	60.705	6.648
8/9 1 B	1	138.964	4.015	54.068	6.680
8/9 2 A	2	173.314	9.255	51.151	2.637
8/9 2 B	2	179.888	9.765	53.902	2.984
8/9 Q A	Q	80.113	BDL	54.524	0.288
8/9 D A	D	37.214	3.133	8.762	4.096
8/9 RW 1A	RW 1	2.151	2.770	2.589	0.555
8/9RW 2A	RW 2	6.160	1.406	2.524	0.779
8/11 1 A	1	112.646	4.303	27.811	8.866
8/11 1 B	1	112.880	4.267	28.293	9.029
8/11 2 A	2	155.538	8.185	46.707	10.253
8/11 2 B	2	155.420	7.274	46.887	10.393
8/11 Q A	Q	74.550	BDL	48.458	0.284
8/11 D A	D	131.417	8.296	32.626	14.860
8/11 RW 1A	RW 1	1.253	0.941	BDL	0.225
8/11RW 2A	RW 2	7.049	1.598	1.911	1.516
8/13 1 A	1	157.600	4.466	41.137	8.477
8/13 1 B	1	159.534	4.536	41.712	8.513
8/13 2 A	2	221.142	10.491	65.077	11.042
8/13 2 B	2	220.804	10.918	66.359	10.994
8/13 Q A	Q	79.936	BDL	52.666	0.229
8/13 D A	D	184.692	10.586	43.444	17.229
8/13 RW 1A	RW 1	0.832	1.516	1.052	0.097
8/16 1 A	1	134.731	4.039	40.241	9.795
8/16 1 B	1	133.322	3.704	40.466	9.802
8/16 2 A	2	188.249	5.711	59.259	10.338
8/16 2 B	2	189.343	5.878	59.702	10.215
8/16 Q A	Q	76.085	BDL	49.953	0.231

8/16 D A	D	215.590	11.292	44.435	18.212
8/28 1 A	1	160.632	2.474	56.192	8.539
8/28 1 B	1	160.539	2.420	56.673	8.641
8/28 2 A	2	192.906	6.112	49.859	9.445
8/28 2 B	2	192.525	6.103	49.987	9.535
8/28 Q A	Q	81.004	BDL	53.683	0.397
8/28 D A	D	265.017	12.680	46.030	20.295
8/28 RW 1 A	RW 1	4.502	3.248	3.102	0.482
9/3 1 A	1	177.154	4.060	59.285	7.561
9/3 1 B	1	176.017	4.127	59.302	7.591
9/3 2 A	2	443.778	18.401	81.388	7.794
9/3 2 B	2	443.379	18.752	81.593	7.716
9/3 Q A	Q	78.223	BDL	48.908	0.344
9/3 D A	D	209.561	10.206	38.608	15.854
9/10 1 A	1	211.105	5.618	62.150	4.921
9/10 1 B	1	214.223	5.560	62.453	4.972
9/10 2 A	2	340.837	23.468	93.563	7.354
9/10 2 B	2	343.455	23.442	94.216	7.409
9/10 Q A	Q	86.759	BDL	53.577	0.333
9/10 D A	D	304.058	16.551	51.293	19.738
10/8 1 A	1	150.756	2.344	68.985	4.573
10/8 1 B	1	150.321	2.366	69.438	4.594
10/8 2 A	2	259.040	26.908	61.461	7.765
10/8 2 B	2	270.550	26.879	63.573	7.957
10/8 Q A	Q	81.293	BDL	52.540	0.354
10/8 D A	D	105.536	8.148	33.440	13.733
10/8 RW 1	RW 1	3.327	0.479	2.204	0.654
10/8 RW 2	RW 2	47.364	3.880	26.893	5.998
10/22 1 A	1	170.781	4.414	54.442	7.160
10/22 1 B	1	172.199	4.164	54.725	7.124
10/22 2 A	2	220.938	23.903	79.682	7.335
10/22 2 B	2	222.368	23.161	79.605	7.420
10/22 Q A	Q	74.441	BDL	51.570	0.250
10/22 D A	D	207.424	10.877	42.989	16.143
10/22 RW 1	RW 1	1.223	BDL	0.949	0.287
11/12 1 A	1	173.438	6.862	95.780	7.845
11/12 1 B	1	177.136	7.044	102.341	7.835

11/12 2 A	2	272.576	31.074	115.402	3.596
11/12 2 B	2	271.356	30.484	118.448	3.662
11/12 Q A	Q	81.152	BDL	58.017	0.187
11/12 D A	D	179.343	7.479	44.688	13.796
11/12 RW 1	RW 1	1.173	BDL	1.065	0.125
11/12 RW 2	RW 2	12.741	2.279	5.852	3.312
1/21 1 A	1	356.215	14.447	142.615	2.828
1/21 1 B	1	351.791	14.336	141.576	2.774
1/21 2 A	2	304.709	37.931	188.917	5.635
1/21 2 B	2	305.374	38.893	187.489	5.785
1/21 Q A	Q	77.984	BDL	55.360	2.078
1/21 D A	D	340.678	14.271	58.961	16.166
2/4 1 A	1	289.092	11.952	136.570	2.458
2/4 1 B	1	290.823	11.913	135.861	2.462
2/4 2 A	2	291.343	41.233	151.558	5.844
2/4 2 B	2	293.109	41.732	151.712	5.903
-	-	-	-	-	-
2/4 D A	D	899.395	18.093	64.439	14.029
2/18 1 A	1	354.406	12.586	116.122	1.925
2/18 1 B	1	322.771	12.073	118.979	1.440
2/18 2 A	2	324.714	33.444	123.548	5.999
2/18 2 B	2	308.814	30.337	103.219	6.610
2/18 Q A	Q	68.471	1.449	43.747	0.075
2/18 D A	D	1041.850	19.995	67.391	12.286
3/4 1 A	1	462.406	14.008	59.978	4.983
3/4 1 B	1	467.505	14.002	59.461	4.949
3/4 2 A	2	193.467	20.175	103.132	7.815
3/4 2 B	2	192.737	19.814	103.268	6.489
-	-	-	-	-	-
3/4 D A	D	924.657	19.706	64.509	12.071
3/18 1 A	1	388.369	9.220	82.977	1.508
3/18 1 B	1	388.243	9.182	83.045	1.440
3/18 2 A	2	220.303	14.239	142.006	2.190
3/18 2 B	2	216.732	14.563	141.833	2.246
3/18 Q A	Q	73.534	0.837	49.235	0.056
3/18 D A	D	470.831	13.485	59.568	14.310
4/1 1 A	1	198.748	26.373	76.747	6.851

4/1 1 B	1	202.712	26.178	75.493	6.901
4/1 2 A	2	133.909	47.283	90.916	9.442
4/1 2 B	2	128.108	47.818	91.080	9.534
4/1 Q A	Q	78.269	0.899	51.845	0.072
4/1 D A	D	280.415	14.637	47.516	11.421
4/1 RW 1	RW 1	1.996	2.222	1.420	0.138
4/1 RW 2	RW 2	29.844	-	4.623	0.371
4/15 1 A	1	159.382	19.997	73.400	6.116
4/15 1 B	1	162.209	21.052	72.752	6.032
4/15 2 A	2	107.301	37.453	97.666	7.135
4/15 2 B	2	107.685	37.534	97.671	7.130
4/15 Q A	Q	79.953	1.105	53.046	0.060
4/15 D A	D	290.273	17.119	57.927	13.387
4/15 RW 1	RW 1	0.886	1.077	0.910	0.129
4/15 RW 2	RW 2	2.466	1.393	1.314	0.195
5/6 1 A	1	63.724	16.131	35.550	9.673
5/6 1 B	1	66.386	16.784	37.079	10.028
5/6 2 A	2	45.318	29.333	53.165	10.707
5/6 2 B	2	45.348	29.119	53.025	10.671
5/6 Q A	Q	73.643	-	49.538	0.167
5/6 D A	D	31.789	2.948	10.791	3.408
5/6 RW 1	RW 1	0.685	1.751	0.978	0.101
5/6 RW 2	RW 2	0.464	1.289	0.897	0.142
6/6 1 A	1	41.410	5.528	19.305	2.428
6/6 1 B	1	84.240	12.299	39.093	4.013
6/6 2 A	2	82.542	27.773	82.186	4.205
6/6 2 B	2	82.309	27.794	81.793	4.226
6/6 Q A	Q	73.804	-	50.515	0.090
6/6 D A	D	26.279	3.027	8.839	2.224
6/6 RW 1	RW 1	1.533	-	3.053	0.674
6/6 RW 2	RW 2	1.155	2.190	1.316	0.420
6/8 1 A	1	108.435	14.126	59.216	5.622
6/8 1 B	1	109.395	14.341	60.308	5.555
6/8 2 A	2	89.302	22.890	82.823	5.924
6/8 2 B	2	89.524	22.960	82.909	5.945
6/8 Q A	Q	76.611	-	53.934	0.035
6/8 D A	D	199.880	9.666	50.814	13.667
6/10 1 A	1	129.375	12.295	54.739	6.775

6/10 1 B	1	129.756	12.171	53.786	6.711
6/10 2 A	2	93.527	23.131	76.389	7.422
6/10 2 B	2	93.971	23.589	77.146	7.435
6/10 Q A	Q	72.099	-	50.839	0.044
6/10 D A	D	182.014	8.932	46.573	14.417
6/10 RW 1		-	-	-	-
6/10 RW 2	RW2	1.733	-	1.292	0.367
6/13 1 A	1	114.441	10.353	44.038	5.746
6/13 1 B	1	113.835	10.640	44.078	5.716
6/13 2 A	2	84.172	26.509	82.039	6.303
6/13 2 B	2	84.221	26.802	82.097	6.316
6/13 Q A	Q	71.123	-	51.286	0.044
6/13 D A	D	210.255	11.226	52.530	15.510
6/15 1 A	1	102.575	11.775	51.479	6.153
6/15 1 B	1	104.538	11.674	51.076	6.077
6/15 2 A	2	83.315	20.156	83.888	6.278
6/15 2 B	2	85.398	20.274	83.830	6.525
6/15 Q A	Q	70.919	-	51.345	0.068
6/15 D A	D	252.380	8.879	55.485	15.913
6/20 1 A	1	102.898	8.150	35.036	8.400
6/20 1 B	1	102.245	8.338	35.183	8.233
6/20 2 A	2	91.343	30.545	82.779	5.855
6/20 2 B	2	92.516	30.072	83.353	5.849
6/20 Q A	Q	72.589	-	52.559	0.073
6/20 D A	D	261.191	12.266	57.302	17.263
6/20 RW 1		-	-	-	-
6/20 RW 2	RW2	1.475	-	1.283	0.665
6/22 1 A	1	102.796	9.878	38.897	6.928
6/22 1 B	1	102.999	9.366	39.105	6.838
6/22 2 A	2	96.500	28.940	87.097	5.079
6/22 2 B	2	96.303	29.376	87.554	5.097
6/22 Q A	Q	73.450	-	54.141	0.111
6/22 D A	D	275.139	11.835	57.583	17.313
6/27 1 A	1	133.800	8.086	42.797	6.391
6/27 1 B	1	135.455	8.888	43.393	6.394
6/27 2 A	2	145.530	27.724	90.866	4.865
6/27 2 B	2	145.592	27.649	91.387	4.847
6/27 Q A	Q	86.622	-	50.131	0.099

6/27 D A	D	337.434	12.451	54.413	16.876
6/29 1 A	1	132.034	7.665	42.980	5.195
6/29 1 B	1	132.178	7.516	42.879	5.074
6/29 2 A	2	153.652	21.947	88.110	3.021
6/29 2 B	2	151.977	22.001	87.225	2.996
6/29 Q A	Q	79.851	-	46.838	0.095
6/29 D A	D	308.793	12.561	51.349	17.220
7/1 1 A	1	137.700	3.417	45.319	3.604
7/1 1 B	1	137.563	3.152	45.167	3.357
7/1 2 A	2	167.478	18.678	90.026	3.154
7/1 2 B	2	166.844	18.118	89.618	3.160
7/1 Q A	Q	78.751	-	46.083	0.121
7/1 D A	D	301.790	7.674	49.494	17.521
7/8 1 A	1	127.060	4.603	36.397	5.891
7/8 1 B	1	124.532	4.426	33.763	5.749
7/8 2 A	2	200.290	18.829	68.659	0.733
7/8 2 B	2	197.549	17.845	67.443	0.891
7/8 Q A	Q	81.450	-	46.895	0.121
7/8 D A	D	260.331	11.047	43.930	15.271
7/11 1 A	1	117.148	2.031	33.908	5.190
7/11 1 B	1	119.538	2.209	34.031	5.197
7/11 2 A	2	156.353	5.706	84.113	0.129
7/11 2 B	2	159.161	6.244	84.092	0.106
7/11 Q A	Q	82.200	-	47.442	0.134
7/11 D A	D	254.075	9.048	42.666	15.502
7/13 1 A	1	122.822	-	40.064	2.620
7/13 1 B	1	124.861	-	40.356	2.590
7/13 2 A	2	177.462	8.043	92.548	0.091
7/13 2 B	2	179.789	8.249	92.838	0.105
7/13 Q A	Q	81.337	-	47.315	0.133
7/13 D A	D	204.848	8.509	39.324	15.169
7/15 1 A	1	36.954	1.642	12.365	1.069
7/15 1 B	1	96.133	1.145	29.053	1.202
7/15 2 A	2	219.922	10.462	79.600	0.247
7/15 2 B	2	214.986	8.958	78.763	0.312
7/15 Q A	Q	80.861	-	46.149	0.137
7/15 D A	D	17.083	2.908	5.960	1.949

7/15 RW 1	RW1	1.791	1.470	2.587	0.376
7/15 RW 2	RW2	0.738	0.990	0.638	0.102
7/18 1 A	1	165.266	1.800	44.849	0.752
7/18 1 B	1	166.148	-	44.987	0.722
7/18 2 A	2	280.381	19.570	72.773	0.096
7/18 2 B	2	280.482	19.927	73.123	0.078
7/18 Q A	Q	82.361	-	47.246	0.179
7/18 D A	D	214.769	10.546	43.947	16.155
7/18 RW 1	RW1	-	-	-	0.240
7/20 1 A	1	174.474	-	42.004	0.342
7/20 1 B	1	179.392	-	42.883	0.354
7/20 2 A	2	193.711	2.472	72.248	0.122
7/20 2 B	2	193.872	2.163	71.830	0.210
7/20 Q A	Q	80.902	-	47.767	0.196
7/20 D A	D	314.740	9.986	49.365	17.744
7/27 1 A	1	160.240	-	39.382	2.518
7/27 1 B	1	155.433	-	39.202	2.483
7/27 2 A	2	198.832	5.844	60.325	0.190
7/27 2 B	2	203.658	6.008	60.782	0.205
7/27 Q A	Q	82.094	-	46.607	0.268
7/27 D A	D	224.743	8.324	44.059	16.509
7/27 RW 1	RW1	2.120	1.821	3.097	0.272
7/27 RW 2	RW2	1.349	2.116	1.672	0.517
7/29 1 A	1	132.227	-	35.109	2.473
7/29 1 B	1	132.756	-	35.380	2.477
7/29 2 A	2	196.601	-	66.201	0.169
7/29 2 B	2	199.228	-	66.569	0.171
7/29 Q A	Q	81.773	-	47.940	0.147
7/29 D A	D	245.152	7.622	44.677	16.871
8/1 1 A	1	120.036	-	33.251	4.305
8/1 1 B	1	119.603	-	33.311	4.365
8/1 2 A	2	224.104	3.431	74.912	0.213
8/1 2 B	2	227.086	3.463	74.827	0.216
8/1 Q A	Q	79.619	-	46.886	0.162
8/1 D A	D	281.167	7.350	46.457	17.866
8/5 1 A	1	131.626	-	35.271	5.604
8/5 1 B	1	133.526	-	35.567	5.586

8/5 2 A	2	288.526	2.956	80.858	0.189
8/5 2 B	2	293.524	3.147	81.200	0.183
8/5 Q A	Q	81.847	-	47.580	0.247
8/5 D A	D	258.579	8.394	43.518	16.126
8/8 1 A	1	125.701	-	29.086	4.816
8/8 1 B	1	133.366	-	31.027	4.941
8/8 2 A	2	313.766	6.479	68.660	0.159
8/8 2 B	2	319.607	6.836	68.948	0.183
8/8 Q A	Q	78.314	-	45.902	0.238
8/8 D A	D	32.957	2.738	11.938	5.463
8/8 RW 1	RW1	2.221	2.282	3.304	0.441
8/8 RW 2	RW2	-	1.814	-	0.619
8/10 1 A	1	147.971	-	30.140	6.079
8/10 1 B	1	147.067	-	29.971	6.133
8/10 2 A	2	156.363	1.152	47.827	0.250
8/10 2 B	2	158.520	0.851	48.209	0.254
8/10 Q A	Q	78.767	-	46.199	0.252
8/10 D A	D	183.185	7.300	39.284	15.695
8/17 1 A	1	157.140	-	54.045	4.584
8/17 1 B	1	155.565	-	52.947	4.570
8/17 2 A	2	231.392	7.122	77.865	0.676
8/17 2 B	2	231.952	7.295	77.923	0.593
8/17 Q A	Q	79.150	-	46.268	0.299
8/17 D A	D	184.223	7.224	36.243	13.941
8/19 1 A	1	161.799	-	53.818	5.718
8/19 1 B	1	162.153	-	52.920	5.793
8/19 2 A	2	319.937	9.853	81.730	0.344
8/19 2 B	2	322.266	10.404	81.745	0.290
8/19 Q A	Q	79.726	-	46.865	0.239
8/19 D A	D	278.672	8.503	45.318	17.456
8/22 1 A	1	169.225	-	55.927	5.811
8/22 1 B	1	170.334	-	56.047	5.781
8/22 2 A	2	341.444	29.794	73.989	1.668
8/22 2 B	2	350.655	31.106	74.391	1.848
8/22 Q A	Q	80.281	-	46.729	0.299
8/22 D A	D	152.108	6.441	36.589	14.466
8/22 RW 1	RW1	4.699	2.733	7.604	0.659
8/22 RW 2	RW2	1.965	1.785	0.973	0.262

8/24 1 A	1	183.016	-	65.206	3.954
8/24 1 B	1	183.639	-	66.018	3.920
8/24 2 A	2	259.632	13.937	58.734	0.384
8/24 2 B	2	258.270	13.354	58.400	0.350
8/24 Q A	Q	82.916	-	49.115	0.255
8/24 D A	D	259.337	7.696	46.246	17.230

Cation Data (K^+ and Na^+)

Table B.2 Stream Water Sample Data from 6/6/22 – 8/24/22 for all discrete grab samples across the watershed. Date, represents when the sample was collected. Site, represents where the sample was taken with a 1, 2, Q, D, RW for site 1, site 2, Quarry Lake, Drain, and Rain Water, respectively. Additionally, the site has i, ii, or iii to represent duplicates. Data for potassium and sodium are provided in mg/L. If a "-" is present the sample was not taken due to availability or safety reasons or analysis yielded results below detectable limits.

Date	Site	K [mg/L]	Na [mg/L]
6/6/2022	1A1i	1.63356	28.09438
	1A1ii	1.64703	28.16968
	1B1i	2.21325	54.37332
	1B1ii	2.20657	52.89334
	2A1i	3.09925	47.97432
	2A1ii	3.02273	46.67198
	2B1i	3.12710	48.00099
	2B1ii	3.03851	47.94473
	QA1i	4.42650	42.35986
	QA1ii	4.43748	42.05939
	DA1i	1.32654	17.22622
	DA1ii	1.33338	17.00682
	RW1Ai	1.16197	0.59159
	RW1Aii	1.16159	0.61017
	RW2Ai	0.43445	1.14722
	RW2Aii	0.46398	1.14317
6/8/2022	1A1i	2.90515	67.26929
	1A1ii	2.90056	66.90575
	1B1i	2.90259	66.44112
	1B1ii	2.82222	66.95269
	2A1i	3.48738	50.78611
	2A1ii	3.48240	51.09435
	2B1i	3.48746	50.46487
	2B1ii	3.44756	51.12108
	QA1i	4.86977	42.58829
	QA1ii	4.99474	43.36703
	DA1i	3.48753	115.18290
	DA1ii	3.50605	114.17046
	RW1Ai	-	-
	RW1Aii	-	-

	RW2Ai	-	-
	RW2Aii	-	-
6/10/2022	1A1i	2.84801	79.04170
	1A1ii	2.78555	79.70658
	1B1i	2.79197	80.47858
	1B1ii	2.78050	78.09714
	2A1i	3.50053	64.44442
	2A1ii	3.47745	64.12617
	2B1i	3.47128	64.59954
	2B1ii	3.42550	64.95341
	QA1i	4.66095	42.03585
	QA1ii	4.62275	41.44090
	DA1i	2.92353	126.32112
	DA1ii	2.97835	129.02496
	RW1Ai	-	-
	RW1Aii	-	-
	RW2Ai	0.14395	0.30056
	RW2Aii	0.13905	0.27106
6/13/2022	1A1i	2.65056	77.25074
	1A1ii	2.65577	77.03320
	1B1i	2.73717	76.19970
	1B1ii	2.70796	75.88345
	2A1i	3.16932	50.69051
	2A1ii	3.16627	51.12681
	2B1i	3.14300	50.68581
	2B1ii	3.17332	50.04521
	QA1i	4.91848	42.10831
	QA1ii	4.96731	42.12518
	DA1i	3.62867	132.42133
	DA1ii	3.59752	131.17070
	RW1Ai	-	-
	RW1Aii	-	-
	RW2Ai	-	-
	RW2Aii	-	-
6/15/2022	1A1i	2.68162	68.58276
	1A1ii	2.67237	69.41399
	1B1i	2.76545	70.58093
	1B1ii	2.75667	70.79214
	2A1i	3.41239	51.28804
	2A1ii	3.36935	51.12091

	2B1i	3.38491	52.20777
	2B1ii	3.37369	52.76492
	QA1i	4.79439	41.92682
	QA1ii	4.77732	42.68997
	DA1i	4.77341	155.51816
	DA1ii	4.71154	154.91426
	RW1Ai	-	-
	RW1Aii	-	-
	RW2Ai	-	-
	RW2Aii	-	-
6/20/2022	1A1i	2.66535	69.80226
	1A1ii	2.65904	70.78970
	1B1i	2.87139	69.80924
	1B1ii	2.90185	72.00996
	2A1i	3.35256	54.31458
	2A1ii	3.34736	54.36549
	2B1i	3.36494	54.41538
	2B1ii	3.32157	55.55329
	QA1i	4.89292	43.42563
	QA1ii	4.83211	44.32796
	DA1i	4.33662	155.12677
	DA1ii	4.36864	159.26782
	RW1Ai	-	-
	RW1Aii	-	-
	RW2Ai	1.20402	1.03399
	RW2Aii	1.20134	1.01009
6/22/2022	1A1i	2.72639	68.37226
	1A1ii	2.69439	68.55853
	1B1i	2.75243	76.46769
	1B1ii	2.71542	68.71959
	2A1i	3.80220	58.14071
	2A1ii	3.73194	58.80248
	2B1i	3.71812	57.77249
	2B1ii	3.66222	57.02128
	QA1i	5.02176	45.29906
	QA1ii	5.03635	44.18290
	DA1i	4.40311	159.84111
	DA1ii	4.37888	160.74635
	RW1Ai	-	-
	RW1Aii	-	-
	RW2Ai	-	-

	RW2Aii	-	-
6/27/2022	1A1i	2.82626	74.48711
	1A1ii	2.82871	73.38577
	1B1i	2.88399	75.95190
	1B1ii	2.84216	74.81194
	2A1i	4.18595	74.43475
	2A1ii	4.19183	74.47250
	2B1i	4.24346	74.29171
	2B1ii	4.23865	74.12726
	QA1i	4.91345	43.69872
	QA1ii	4.81114	43.12956
	DA1i	4.30596	168.46722
	DA1ii	4.24373	168.59523
	RW1Ai	-	-
	RW1Aii	-	-
	RW2Ai	-	-
	RW2Aii	-	-
6/29/2022	1A1i	2.80072	76.65131
	1A1ii	2.84064	75.47391
	1B1i	2.81912	75.18706
	1B1ii	2.81734	76.10481
	2A1i	4.43952	81.77696
	2A1ii	4.42877	83.10909
	2B1i	4.36136	81.15683
	2B1ii	4.29526	81.29797
	QA1i	5.05740	44.53030
	QA1ii	5.12475	44.30062
	DA1i	4.18056	161.13840
	DA1ii	4.20016	160.85759
	RW1Ai	-	-
	RW1Aii	-	-
	RW2Ai	-	-
	RW2Aii	-	-
7/1/2022	1A1i	2.79726	80.91193
	1A1ii	2.74436	81.56433
	1B1i	2.90983	80.56528
	1B1ii	2.87238	78.34367
	2A1i	4.35700	90.18499
	2A1ii	4.37255	89.26137
	2B1i	4.40546	90.18178

	2B1ii	4.33672	88.84347
	QA1i	4.94483	48.94282
	QA1ii	4.93981	48.82674
	DA1i	4.85938	162.42862
	DA1ii	4.84784	162.76144
	RW1Ai	-	-
	RW1Aii	-	-
	RW2Ai	-	-
	RW2Aii	-	-
7/8/2022	1A1i	2.72000	71.00000
	1A1ii	2.66000	71.78000
	1B1i	2.72000	68.61000
	1B1ii	2.76000	69.99000
	2A1i	5.96000	106.52000
	2A1ii	5.90000	105.52000
	2B1i	5.87000	103.64000
	2B1ii	5.79000	101.78000
	QA1i	4.75000	43.44000
	QA1ii	4.72000	44.46000
	DA1i	4.82000	133.95000
	DA1ii	4.83000	135.13000
	RW1Ai	-	-
	RW1Aii	-	-
	RW2Ai	-	-
	RW2Aii	-	-
7/11/2022	1A1i	2.69071	68.87500
	1A1ii	2.62341	68.25685
	1B1i	2.70573	68.86700
	1B1ii	2.68674	69.80532
	2A1i	5.81305	92.05687
	2A1ii	5.79703	91.43574
	2B1i	5.89943	90.52194
	2B1ii	5.78692	90.32520
	QA1i	5.07325	47.11370
	QA1ii	5.24879	44.83262
	DA1i	4.16235	131.66779
	DA1ii	4.17795	132.29721
	RW1Ai	-	-
	RW1Aii	-	-
	RW2Ai	-	-
	RW2Aii	-	-

7/13/2022	1A1i	2.74079	79.06371
	1A1ii	2.63174	78.66763
	1B1i	2.63984	77.44134
	1B1ii	2.62277	79.29245
	2A1i	6.71025	114.77772
	2A1ii	6.66518	115.04668
	2B1i	6.65548	116.40160
	2B1ii	6.65811	115.68665
	QA1i	5.03533	45.07305
	QA1ii	4.98262	45.34039
	DA1i	3.47446	126.69131
	DA1ii	3.42919	129.11311
	RW1Ai	-	-
	RW1Aii	-	-
	RW2Ai	-	-
	RW2Aii	-	-
7/15/2022	1A1i	1.46040	25.56570
	1A1ii	1.44659	23.09423
	1B1i	2.29829	60.06156
	1B1ii	2.27505	60.42918
	2A1i	6.80656	132.36948
	2A1ii	6.83048	130.48668
	2B1i	6.74933	127.17537
	2B1ii	6.55459	126.54507
	QA1i	5.06395	45.28724
	QA1ii	5.07290	45.32279
	DA1i	1.18305	12.35431
	DA1ii	1.16717	12.71571
	RW1Ai	1.61162	0.74609
	RW1Aii	1.60671	0.72121
	RW2Ai	0.16313	0.30336
	RW2Aii	0.15943	0.26759
7/18/2022	1A1i	2.88094	97.12566
	1A1ii	2.81411	98.30563
	1B1i	2.88013	96.63998
	1B1ii	2.85600	96.96038
	2A1i	7.78106	149.10097
	2A1ii	7.57054	150.70871
	2B1i	7.42138	148.29160
	2B1ii	7.41000	149.16045

	QA1i	5.04132	44.11512
	QA1ii	5.10147	44.58518
	DA1i	3.27775	121.65392
	DA1ii	3.23246	123.60933
	RW1Ai	0.09609	2.68724
	RW1Aii	0.09795	2.70473
	RW2Ai	-	-
	RW2Aii	-	-
7/20/2022	1A1i	3.08583	100.32083
	1A1ii	3.11277	99.94699
	1B1i	2.96211	100.43803
	1B1ii	2.94854	99.45737
	2A1i	6.58568	106.20075
	2A1ii	6.51294	105.49297
	2B1i	6.43898	106.79495
	2B1ii	6.53741	105.57832
	QA1i	5.07462	44.22915
	QA1ii	5.02354	44.63821
	DA1i	4.24789	155.51404
	DA1ii	4.24263	153.30945
	RW1Ai	-	-
	RW1Aii	-	-
	RW2Ai	-	-
	RW2Aii	-	-
7/27/2022	1A1i	3.16594	92.87163
	1A1ii	3.15139	94.02110
	1B1i	3.32628	93.82295
	1B1ii	3.10934	93.61221
	2A1i	7.19734	118.34489
	2A1ii	7.19761	117.80406
	2B1i	6.96556	120.47303
	2B1ii	6.90784	120.70342
	QA1i	4.99144	44.21280
	QA1ii	5.03248	45.96666
	DA1i	3.99780	130.73346
	DA1ii	3.97147	132.06158
	RW1Ai	0.22535	1.30483
	RW1Aii	0.23160	1.25170
	RW2Ai	0.68740	0.96458
	RW2Aii	0.68229	0.91049

7/29/2022	1A1i	2.88588	81.30988
	1A1ii	2.87160	80.13724
	1B1i	2.96674	81.05418
	1B1ii	2.98199	81.15939
	2A1i	7.31426	121.79718
	2A1ii	7.35195	120.36355
	2B1i	7.15559	125.06078
	2B1ii	7.37688	122.37929
	QA1i	5.08079	45.14101
	QA1ii	5.05165	44.23796
	DA1i	3.91777	143.91684
	DA1ii	3.92320	143.16039
	RW1Ai	-	-
	RW1Aii	-	-
	RW2Ai	-	-
	RW2Aii	-	-
8/1/2022	1A1i	2.92544	74.48715
	1A1ii	2.91380	72.51942
	1B1i	2.95275	74.44225
	1B1ii	3.00156	72.72852
	2A1i	8.71922	142.41298
	2A1ii	8.48352	137.76238
	2B1i	8.54009	140.18872
	2B1ii	8.44911	139.97783
	QA1i	5.13197	56.22899
	QA1ii	5.01514	45.86222
	DA1i	4.25489	161.29573
	DA1ii	4.19874	155.04280
	RW1Ai	-	-
	RW1Aii	-	-
	RW2Ai	-	-
	RW2Aii	-	-
8/5/2022	1A1i	3.09974	77.78510
	1A1ii	3.08561	77.16589
	1B1i	3.19914	77.68921
	1B1ii	3.20901	77.25270
	2A1i	9.64191	159.53449
	2A1ii	9.44912	157.89256
	2B1i	9.62257	159.43662
	2B1ii	9.45794	161.30832
	QA1i	5.19142	43.73916

	QA1ii	5.16865	43.33745
	DA1i	4.74095	139.43218
	DA1ii	4.73926	139.53427
	RW1Ai	-	-
	RW1Aii	-	-
	RW2Ai	-	-
	RW2Aii	-	-
8/8/2022	1A1i	2.95638	73.92799
	1A1ii	2.96148	74.07396
	1B1i	3.09157	81.21220
	1B1ii	3.02643	78.86034
	2A1i	11.74100	172.67082
	2A1ii	11.64822	170.65765
	2B1i	11.77324	172.71812
	2B1ii	11.27979	173.11682
	QA1i	5.03433	42.72681
	QA1ii	4.99787	43.16991
	DA1i	1.58803	24.13150
	DA1ii	1.59243	25.89452
	RW1Ai	0.23506	1.22189
	RW1Aii	0.23257	1.22994
	RW2Ai	0.34311	0.22452
	RW2Aii	0.34983	0.22409
8/10/2022	1A1i	3.22634	89.21761
	1A1ii	3.20622	88.86498
	1B1i	3.33362	90.90119
	1B1ii	3.25949	90.09023
	2A1i	7.45743	98.37959
	2A1ii	7.39920	97.35721
	2B1i	7.54348	97.15679
	2B1ii	7.54412	98.16678
	QA1i	4.99979	43.87238
	QA1ii	4.94753	2.18154
	DA1i	3.56358	112.69548
	DA1ii	3.58377	112.58617
	RW1Ai	-	-
	RW1Aii	-	-
	RW2Ai	-	-
	RW2Aii	-	-
8/17/2022	1A1i	3.42339	95.47282

	1A1ii	3.36723	93.71986
	1B1i	3.45488	94.21714
	1B1ii	3.38542	94.10441
	2A1i	9.07558	157.48229
	2A1ii	8.87351	154.06673
	2B1i	8.82127	155.96603
	2B1ii	8.77843	156.81139
	QA1i	5.03058	43.73592
	QA1ii	4.95411	43.09584
	DA1i	3.42752	112.08257
	DA1ii	3.42030	110.80467
	RW1Ai	-	-
	RW1Aii	-	-
	RW2Ai	-	-
	RW2Aii	-	-
8/19/2022	1A1i	3.43620	95.38226
	1A1ii	3.38991	97.87476
	1B1i	3.66761	96.63093
	1B1ii	3.74583	98.52225
	2A1i	10.58632	192.16242
	2A1ii	10.59282	189.23808
	2B1i	10.69871	187.43625
	2B1ii	10.82439	189.10622
	QA1i	4.72101	45.93174
	QA1ii	4.65848	46.24297
	DA1i	4.71692	153.71477
	DA1ii	4.76347	155.88596
	RW1Ai	-	-
	RW1Aii	-	-
	RW2Ai	-	-
	RW2Aii	-	-
8/22/2022	1A1i	3.50351	102.94807
	1A1ii	3.51748	102.10329
	1B1i	3.52217	102.64769
	1B1ii	3.49561	101.50216
	2A1	11.77797	209.62483
	2A1ii	12.10691	205.46802
	2B1i	12.02094	213.95128
	2B1ii	11.87388	214.16914
	QA1i	5.00870	43.86695
	QA1ii	4.98716	43.78114

	DA1i	3.17390	95.05995
	DA1ii	3.17026	93.25944
	RW1Ai	0.40208	2.23633
	RW1Aii	0.40022	2.21879
	RW2Ai	0.68648	0.81675
	RW2Aii	0.68254	0.83281
8/24/2022	1A1i	3.87389	106.92970
	1A1ii	3.91498	107.67078
	1B1i	3.80421	105.73705
	1B1ii	3.83703	106.99603
	2A1i	9.60724	151.36191
	2A1ii	9.58374	150.12335
	2B1i	9.91876	145.89024
	2B1ii	9.91956	148.57358
	QA1i	4.65638	45.83807
	QA1ii	4.68113	45.31774
	DA1i	4.23259	139.74002
	DA1ii	4.22267	139.70578
	RW1Ai	-	-
	RW1Aii	-	-
	RW2Ai	-	-
	RW2Aii	-	-

Halide Data (Br^- and I^-)

Table B.3 Stream Water Sample Data from 6/6/22 – 8/24/22 for all discrete grab samples across the watershed. Date, represents when the sample was collected. Site, represents where the sample was taken with a 1, 2, Q, D, RW for site 1, site 2, Quarry Lake, Drain, and Rain Water, respectively. Additionally, the site has A, B, or C to represent duplicates. Data for iodide and bromide are provided in mg/L. If a "-" is present the sample was not taken due to availability or safety reasons or analysis yielded results below detectable limits.

Date	Site	I [mg/L]	Br [mg/L]
6/6/2022	1A1	0.2056	0.0426
	1A2	0.0442	0.0376
	1B1	0.0249	0.0637
	1B2	0.0183	0.0627
	2A1	0.0155	0.0669
	2A2	0.0138	0.0660
	2B1	0.0129	0.0660
	2B2	0.0121	0.0666
	QA1	0.0100	0.0751
	QA2	0.0092	0.0755
	DA1	0.0316	0.0206
	DA2	0.0149	0.0179
	RW1A1	0.0104	0.0146
	RW1A2	0.0085	0.0133
	RW2A1	0.0074	0.0093
	RW2A2	0.0071	0.0093
6/10/2022	1A1	0.0115	0.0748
	1A2	0.0104	0.0746
	1B1	0.0099	0.0744
	1B2	0.0108	0.0744
	2A1	0.0104	0.0622
	2A2	0.0104	0.0623
	2B1	0.0100	0.0628
	2B2	0.0100	0.0650
	QA1	0.0075	0.0696
	QA2	0.0058	0.0673
	DA1	0.0156	0.0789
	DA2	0.0200	0.0774
	RW2A1	0.0078	0.0041

	RW2A2	0.0025	0.0008
6/13/2022	1A1	0.2411	0.0766
	1A2	0.0714	0.0725
	1B1	0.0397	0.0728
	1B2	0.0241	0.0740
	2A1	0.0184	0.0695
	2A2	0.0137	0.0660
	2B1	0.0043	0.0844
	2B2	0.0059	0.0824
	QA1	0.0038	0.0813
	QA2	0.0028	0.0787
	DA1	0.0552	0.1062
	DA2	0.0405	0.1003
	RW2A1	-	-
	RW2A2	-	-
6/15/2022	1A1	0.0201	0.0879
	1A2	0.0183	0.0889
	1B1	0.0130	0.0872
	1B2	0.0109	0.0865
	2A1	0.0133	0.0753
	2A2	0.0091	0.0738
	2B1	0.0098	0.0746
	2B2	0.0230	0.0745
	QA1	0.0095	0.0887
	QA2	0.0043	0.0809
	DA1	0.0142	0.1217
	DA2	0.0218	0.1273
	RW2A1	-	-
	RW2A2	-	-
6/20/2022	1A1	0.0150	0.0814
	1A2	0.0133	0.0787
	1B1	0.0146	0.0730
	1B2	0.0122	0.0726
	2A1	0.0094	0.0701
	2A2	0.0108	0.0708
	2B1	0.0116	0.0721
	2B2	0.0186	0.0733
	QA1	0.0097	0.0810
	QA2	0.0064	0.0785
	DA1	0.0215	0.1421

	DA2	0.0301	0.1238
	RW2A1	0.0129	0.0134
	RW2A2	0.0031	0.0073
6/22/2022	1A1	0.1964	0.0665
	1A2	0.0600	0.0626
	1B1	0.0368	0.0601
	1B2	0.0274	0.0579
	2A1	0.0216	0.0515
	2A2	0.0186	0.0498
	2B1	0.0170	0.0491
	2B2	0.0174	0.0499
	QA1	0.0114	0.0492
	QA2	0.0092	0.0633
	DA1	0.0651	0.0999
	DA2	0.0461	0.0972
	RW2A1	-	-
	RW2A2	-	-
6/27/2022	1A1	0.1214	0.0988
	1A2	0.0439	0.1041
	1B1	0.0268	0.0998
	1B2	0.0221	0.0999
	2A1	0.0156	0.0841
	2A2	0.0140	0.0866
	2B1	0.0130	0.0860
	2B2	0.0123	0.0858
	QA1	0.0101	0.0937
	QA2	0.0090	0.0934
	DA1	0.0333	0.1273
	DA2	0.0271	0.1422
	RW2A1	-	-
	RW2A2	-	-
6/29/2022	1A1	0.0201	0.1075
	1A2	0.0258	0.1183
	1B1	0.0194	0.1158
	1B2	0.0158	0.1070
	2A1	0.0190	0.1045
	2A2	0.0142	0.1038
	2B1	0.0129	0.0845
	2B2	0.0114	0.0856
	QA1	0.0085	0.0852

	QA2	0.0076	0.0824
	DA1	0.0205	0.1616
	DA2	0.0237	0.1319
	RW2A1	-	-
	RW2A2	-	-
7/1/2022	1A1	0.0180	0.1096
	1A2	0.0131	0.1014
	1B1	0.0120	0.0953
	1B2	0.0113	0.0903
	2A1	0.0127	0.0716
	2A2	0.0083	0.0764
	2B1	0.0089	0.0879
	2B2	0.0136	0.0871
	QA1	0.0071	0.0957
	QA2	0.0069	0.1032
	DA1	0.0148	0.1169
	DA2	0.0151	0.1136
	RW2A1	-	-
	RW2A2	-	-
7/8/2022	1A1	0.0137	0.0590
	1A2	0.0115	0.0579
	1B1	0.0124	0.0515
	1B2	0.0106	0.0684
	2A1	0.0144	0.0890
	2A2	0.0129	0.1025
	2B1	0.0375	0.1150
	2B2	0.0200	0.1111
	QA1	0.0161	0.0899
	QA2	0.0109	0.0867
	DA1	0.0152	0.1150
	DA2	0.0152	0.0975
	RW1A1	-	-
	RW1A2	-	-
	RW2A1	-	-
	RW2A2	-	-
7/11/2022	1A1	0.0121	0.0349
	1A2	0.0077	0.0327
	1B1	0.0122	0.0335
	1B2	0.0169	0.0719
	2A1	0.0165	0.0890

	2A2	0.0161	0.0967
	2B1	0.0109	0.1075
	2B2	0.0107	0.0969
	QA1	0.0074	0.0837
	QA2	0.0080	0.0943
	DA1	0.0345	0.1026
	DA2	0.0208	0.1037
	RW1A1	-	-
	RW1A2	-	-
	RW2A1	-	-
	RW2A2	-	-
7/13/2022	1A1	0.0104	0.0783
	1A2	0.0119	0.0778
	1B1	0.0098	0.0828
	1B2	0.0089	0.0776
	2A1	0.0156	0.0989
	2A2	0.0154	0.0938
	2B1	0.0152	0.0982
	2B2	0.0105	0.0991
	QA1	0.0064	0.0982
	QA2	0.0057	0.0994
	DA1	0.0184	0.0976
	DA2	0.0195	0.0969
	RW1A1	-	-
	RW1A2	-	-
	RW2A1	-	-
	RW2A2	-	-
7/15/2022	1A1	0.0534	0.0092
	1A2	0.0278	0.0043
	1B1	0.0212	0.0389
	1B2	0.0166	0.0403
	2A1	0.0163	0.0826
	2A2	0.0150	0.0841
	2B1	0.0159	0.0845
	2B2	0.0159	0.0770
	QA1	0.0083	0.0696
	QA2	0.0060	0.0653
	DA1	0.0188	-
	DA2	0.0086	-
	RW1A1	0.0058	-
	RW1A2	0.0068	-

	RW2A1	0.0071	-
	RW2A2	0.0031	-
7/18/2022	1A1	0.1690	0.1379
	1A2	0.1270	0.1243
	1B1	0.1028	0.1296
	1B2	0.0993	0.1444
	2A1	0.0940	0.1434
	2A2	0.0884	0.1485
	2B1	0.0661	0.1227
	2B2	0.1340	0.1330
	QA1	0.0694	0.1139
	QA2	0.0418	0.1237
	DA1	0.0965	0.1226
	DA2	0.1311	0.1491
	RW1A1	0.0403	0.0220
	RW1A2	0.0145	0.0114
	RW2A1	-	-
	RW2A2	-	-
7/20/2022	1A1	0.0587	0.1160
	1A2	0.0342	0.1282
	1B1	0.0280	0.1333
	1B2	0.0266	0.1368
	2A1	0.0174	0.0762
	2A2	0.0170	0.1140
	2B1	0.0166	0.1282
	2B2	0.0168	0.1580
	QA1	0.0120	0.1494
	QA2	0.0100	0.1554
	DA1	0.0398	0.2143
	DA2	0.0242	0.1730
	RW1A1	-	-
	RW1A2	-	-
	RW2A1	-	-
	RW2A2	-	-
7/27/2022	1A1	0.0606	0.1012
	1A2	0.0318	0.1019
	1B1	0.0220	0.0947
	1B2	0.0183	0.0967
	2A1	0.0153	0.1192
	2A2	0.0068	0.0925

	2B1	0.0071	0.1077
	2B2	0.0088	0.1058
	QA1	0.0069	0.1034
	QA2	0.0057	0.0975
	DA1	0.0338	0.1177
	DA2	0.0188	0.1222
	RW1A1	0.0061	0.0230
	RW1A2	0.0023	0.0177
	RW2A1	-	0.0094
	RW2A2	-	0.0071
7/29/2022	1A1	0.0751	0.0776
	1A2	0.0415	0.0864
	1B1	0.0307	0.0829
	1B2	0.0279	0.0813
	2A1	0.0277	0.1140
	2A2	0.0258	0.1187
	2B1	0.0223	0.1082
	2B2	0.0207	0.1128
	QA1	0.0149	0.0975
	QA2	0.0142	0.0943
	DA1	0.0539	0.1095
	DA2	0.0357	0.1104
	RW1A1	-	-
	RW1A2	-	-
	RW2A1	-	-
	RW2A2	-	-
8/1/2022	1A1	0.0792	0.0798
	1A2	0.0399	0.0844
	1B1	0.0279	0.0810
	1B2	0.0233	0.0843
	2A1	0.0215	0.1231
	2A2	0.0200	0.1252
	2B1	-	-
	2B2	0.0182	0.1194
	QA1	0.0084	0.0955
	QA2	0.0061	0.0883
	DA1	0.0193	0.1273
	DA2	0.0304	0.1281
	RW1A1	-	-
	RW1A2	-	-
	RW2A1	-	-

	RW2A2	-	-
8/5/2022	1A1	0.1205	0.1034
	1A2	0.0699	0.1018
	1B1	0.0548	0.1004
	1B2	0.0517	0.1032
	2A1	0.0496	0.1472
	2A2	0.0477	0.1463
	2B1	0.0446	0.1432
	2B2	0.0390	0.1237
	QA1	0.0185	0.1132
	QA2	0.0150	0.1094
	DA1	0.0854	0.1493
	DA2	0.0681	0.1485
	RW1A1	-	-
	RW1A2	-	-
	RW2A1	-	-
	RW2A2	-	-
8/8/2022	1A1	0.1176	0.0976
	1A2	0.0947	0.1013
	1B1	0.0844	0.1104
	1B2	0.0810	0.1033
	2A1	0.0751	0.1434
	2A2	0.0706	0.1510
	2B1	0.0652	0.1491
	2B2	0.0649	0.1434
	QA1	0.0376	0.1183
	QA2	0.0327	0.0995
	DA1	0.0686	0.0371
	DA2	0.0437	0.0347
	RW1A1	0.0253	0.0148
	RW1A2	0.0169	0.0136
	RW2A1	-	-
	RW2A2	0.0106	0.0118
8/10/2022	1A1	0.2426	0.1170
	1A2	0.1947	0.1090
	1B1	0.1599	0.1150
	1B2	0.1542	0.1052
	2A1	0.1064	0.0968
	2A2	0.0936	0.0991
	2B1	0.0907	0.0788

	2B2	0.0855	0.0817
	QA1	0.0622	0.1171
	QA2	0.0565	0.1256
	DA1	0.1914	0.1092
	DA2	0.1812	0.1150
	RW1A1	-	-
	RW1A2	-	-
	RW2A1	-	-
	RW2A2	-	-
8/17/2022	1A1	0.1380	0.1499
	1A2	0.1194	0.1530
	1B1	0.1107	0.1337
	1B2	0.0930	0.1464
	2A1	0.0864	0.1309
	2A2	0.0861	0.1155
	2B1	0.0704	0.1328
	2B2	0.0731	0.1329
	QA1	0.0421	0.1113
	QA2	0.0332	0.0931
	DA1	0.1320	0.1340
	DA2	0.1265	0.1164
	RW1A1	-	-
	RW1A2	-	-
	RW2A1	-	-
	RW2A2	-	-
8/19/2022	1A1	0.0524	0.1457
	1A2	0.0359	0.1362
	1B1	0.0289	0.1447
	1B2	0.0271	0.1306
	2A1	0.0247	0.1415
	2A2	0.0246	0.1460
	2B1	0.0230	0.1478
	2B2	0.0222	0.1344
	QA1	0.0155	0.1167
	QA2	0.0135	0.1193
	DA1	0.0597	0.1543
	DA2	0.0355	0.1325
	RW1A1	-	-
	RW1A2	-	-
	RW2A1	-	-
	RW2A2	-	-

8/22/2022	1A1	0.1219	0.1442
	1A2	0.0829	0.1537
	1B1	0.0679	0.1520
	1B2	0.0584	0.1419
	2A1	0.0603	0.1566
	2A2	0.0540	0.1503
	2B1	0.0503	0.1439
	2B2	0.0455	0.1435
	QA1	0.0214	0.1111
	QA2	0.0203	0.1159
	DA1	0.0848	0.1010
	DA2	0.0681	0.1099
	RW1A1	0.0283	0.0307
	RW1A2	0.0153	0.0266
	RW2A1	0.0110	0.0117
	RW2A2	0.0079	0.0083
8/24/2022	1A1	0.0443	0.1409
	1A2	0.0397	0.1520
	1B1	0.0524	0.1401
	1B2	0.0326	0.1481
	2A1	0.0287	0.1112
	2A2	0.0264	0.1141
	2B1	0.0229	0.1080
	2B2	0.0211	0.1027
	QA1	0.0095	0.0838
	QA2	0.0071	0.0835
	DA1	0.0618	0.1170
	DA2	0.0449	0.1164
	RW1A1	-	-
	RW1A2	-	-
	RW2A1	-	-
	RW2A2	-	-

Total Nitrogen Data (TN)

Table B.4 Stream Water Sample Data from 6/8/22 – 8/24/22 for all discrete grab samples across the watershed. Date, represents when the sample was collected. Site, represents where the sample was taken with a 1, 2, Q, D, RW for site 1, site 2, Quarry Lake, Drain, and Rain Water, respectively. Additionally, the site has A, B, or C to represent duplicates. Data for total nitrogen is provided in mg/L. If a "-" is present the sample was not taken due to availability or safety reasons or analysis yielded results below detectable limits.

Date	Site	TN [mg/L]
6/8/2022	1A1	3.709
	1A2	3.7545
	1B1	3.631
	1B2	3.68
	2A1	6.388
	2A2	6.368
	2B1	6.3175
	2B2	6.3185
	QA1	0.85345
	QA2	0.68935
	DA1	1.8545
	DA2	1.77
6/10/2022	1A1	2.744
	1A2	2.7
	1B1	2.632
	1B2	2.61
	2A1	5.6545
	2A2	5.58
	2B1	5.619
	2B2	5.662
	QA1	0.6467
	QA2	0.71155
	DA1	1.6175
	DA2	1.6215
	RW1A1	-
	RW1A2	-
	RW2A1	0.279
	RW2A2	0.3205
6/13/2022	1A1	2.432
	1A2	2.4

	1B1	2.44
	1B2	2.4385
	2A1	6.1325
	2A2	6.172
	2B1	6.227
	2B2	6.2245
	QA1	0.61485
	QA2	0.6279
	DA1	2.2285
	DA2	2.379
	RW1A1	-
	RW1A2	-
	RW2A1	-
	RW2A2	-
6/15/2022	1A1	3.0725
	1A2	3.121
	1B1	3.0365
	1B2	3.012
	2A1	6.2795
	2A2	6.1295
	2B1	6.114
	2B2	6.107
	QA1	0.74925
	QA2	0.74895
	DA1	1.791
	DA2	1.858
	RW1A1	-
	RW1A2	-
	RW2A1	-
	RW2A2	-
6/20/2022	1A1	2.439
	1A2	2.497
	1B1	2.43
	1B2	2.431
	2A1	8.2945
	2A2	7.928
	2B1	7.747
	2B2	7.638
	QA1	0.72465
	QA2	0.72915
	DA1	1.836

	DA2	1.8025
	RW1A1	-
	RW1A2	-
	RW2A1	0.5625
	RW2A2	0.5654
6/22/2022	1A1	2.4025
	1A2	2.3685
	1B1	2.346
	1B2	2.3415
	2A1	7.1865
	2A2	7.1545
	2B1	7.179
	2B2	7.207
	QA1	0.6597
	QA2	0.6589
	DA1	1.714
	DA2	1.731
	RW1A1	-
	RW1A2	-
	RW2A1	-
	RW2A2	-
6/27/2022	1A1	2.0145
	1A2	1.9715
	1B1	2.006
	1B2	2.0205
	2A1	6.531
	2A2	6.492
	2B1	6.555
	2B2	6.542
	QA1	0.61055
	QA2	0.64915
	DA1	1.5755
	DA2	1.5875
	RW1A1	-
	RW1A2	-
	RW2A1	-
	RW2A2	-
6/29/2022	1A1	1.651
	1A2	1.469
	1B1	1.61

	1B2	1.5755
	2A1	5.0455
	2A2	5.0805
	2B1	5.174
	2B2	5.2705
	QA1	0.6094
	QA2	0.61485
	DA1	1.7605
	DA2	1.7345
	RW1A1	-
	RW1A2	-
	RW2A1	-
	RW2A2	-
7/1/2022	1A1	1.295
	1A2	1.3245
	1B1	1.263
	1B2	1.2785
	2A1	4.305
	2A2	4.2815
	2B1	4.308
	2B2	4.359
	QA1	0.63285
	QA2	0.56525
	DA1	1.833
	DA2	1.727
	RW1A1	-
	RW1A2	-
	RW2A1	-
	RW2A2	-
7/8/2022	1A1	0.86
	1A2	0.93
	1B1	0.84
	1B2	0.96
	2A1	4.18
	2A2	4.2
	2B1	3.97
	2B2	3.98
	QA1	0.63
	QA2	0.63
	DA1	1.72
	DA2	1.76

	RW1A1	-
	RW1A2	-
	RW2A1	-
	RW2A2	-
7/11/2022	1A1	0.71815
	1A2	0.6972
	1B1	0.72815
	1B2	0.7016
	2A1	1.6875
	2A2	1.6835
	2B1	1.621
	2B2	1.6275
	QA1	0.58715
	QA2	0.6048
	DA1	1.7485
	DA2	1.7175
	RW1A1	-
	RW1A2	-
	RW2A1	-
	RW2A2	-
7/13/2022	1A1	0.44185
	1A2	0.49055
	1B1	0.48845
	1B2	0.50165
	2A1	2.064
	2A2	2.0525
	2B1	2.12
	2B2	2.1105
	QA1	0.6385
	QA2	0.62705
	DA1	1.687
	DA2	1.718
	RW1A1	-
	RW1A2	-
	RW2A1	-
	RW2A2	-
7/15/2022	1A1	0.636
	1A2	0.60125
	1B1	0.54105
	1B2	0.59195

	2A1	2.4125
	2A2	2.745
	2B1	2.233
	2B2	2.5315
	QA1	0.67975
	QA2	0.6769
	DA1	0.9789
	DA2	0.8922
	RW1A1	8.0975
	RW1A2	7.914
	RW2A1	0.6469
	RW2A2	0.68645
7/18/2022	1A1	0.52975
	1A2	0.5602
	1B1	0.4955
	1B2	0.5018
	2A1	4.66
	2A2	4.6295
	2B1	4.758
	2B2	4.6355
	QA1	0.6013
	QA2	0.67635
	DA1	1.8625
	DA2	1.9575
	RW1A1	2.796
	RW1A2	2.2185
	RW2A1	-
	RW2A2	-
7/20/2022	1A1	0.4555
	1A2	0.45255
	1B1	0.45345
	1B2	0.4386
	2A1	0.67295
	2A2	0.69315
	2B1	0.6819
	2B2	0.64015
	QA1	0.66495
	QA2	0.67115
	DA1	1.755
	DA2	1.77
	RW1A1	-

	RW1A2	-
	RW2A1	-
	RW2A2	-
7/27/2022	1A1	0.39115
	1A2	0.34645
	1B1	0.35165
	1B2	0.39035
	2A1	1.4255
	2A2	1.445
	2B1	1.42
	2B2	1.657
	QA1	0.62505
	QA2	0.63395
	DA1	1.3835
	DA2	1.5165
	RW1A1	1.0695
	RW1A2	1.0715
	RW2A1	2.064
	RW2A2	1.991
7/29/2022	1A1	0.23035
	1A2	0.34995
	1B1	0.35685
	1B2	0.3597
	2A1	0.6072
	2A2	0.5226
	2B1	0.5782
	2B2	0.53385
	QA1	0.6602
	QA2	0.59735
	DA1	1.6065
	DA2	1.611
	RW1A1	-
	RW1A2	-
	RW2A1	-
	RW2A2	-
8/1/2022	1A1	0.33805
	1A2	0.3358
	1B1	0.4232
	1B2	0.3722
	2A1	1.398

	2A2	1.5565
	2B1	1.655
	2B2	1.399
	QA1	0.59075
	QA2	0.5773
	DA1	1.6115
	DA2	1.7765
	RW1A1	-
	RW1A2	-
	RW2A1	-
	RW2A2	-
8/5/2022	1A1	0.40635
	1A2	0.4663
	1B1	0.4478
	1B2	0.7464
	2A1	1.687
	2A2	1.4195
	2B1	1.392
	2B2	1.65
	QA1	0.7289
	QA2	0.70265
	DA1	1.9515
	DA2	1.935
	RW1A1	-
	RW1A2	-
	RW2A1	-
	RW2A2	-
8/8/2022	1A1	0.41225
	1A2	0.53475
	1B1	0.4382
	1B2	0.51765
	2A1	2.021
	2A2	1.9925
	2B1	2.741
	2B2	2.1095
	QA1	0.6656
	QA2	0.66225
	DA1	0.9164
	DA2	0.9089
	RW1A1	0.77885
	RW1A2	0.8068

	RW2A1	1.052
	RW2A2	0.88685
8/10/2022	1A1	0.5508
	1A2	0.6925
	1B1	0.66255
	1B2	0.5916
	2A1	0.8269
	2A2	0.8354
	2B1	0.7584
	2B2	0.78565
	QA1	0.656
	QA2	0.66
	DA1	1.628
	DA2	1.597
	RW1A1	-
	RW1A2	-
	RW2A1	-
	RW2A2	-
8/17/2022	1A1	0.4649
	1A2	0.5593
	1B1	0.5627
	1B2	0.5901
	2A1	2.0615
	2A2	2.0375
	2B1	2.019
	2B2	2.067
	QA1	0.9626
	QA2	0.71525
	DA1	1.7085
	DA2	1.672
	RW1A1	-
	RW1A2	-
	RW2A1	-
	RW2A2	-
8/19/2022	1A1	0.4294
	1A2	0.4717
	1B1	0.57175
	1B2	0.4994
	2A1	2.484
	2A2	2.4075

	2B1	2.674
	2B2	2.447
	QA1	0.6156
	QA2	0.63165
	DA1	1.892
	DA2	2.0135
	RW1A1	-
	RW1A2	-
	RW2A1	-
	RW2A2	-
8/22/2022	1A1	0.48305
	1A2	0.64375
	1B1	0.40505
	1B2	0.4839
	2A1	7.629
	2A2	7.4265
	2B1	7.662
	2B2	7.772
	QA1	1.5185
	QA2	0.65015
	DA1	1.3555
	DA2	1.389
	RW1A1	0.8197
	RW1A2	0.80005
	RW2A1	1.271
	RW2A2	1.489
8/24/2022	1A1	0.41975
	1A2	0.4884
	1B1	0.408
	1B2	0.4585
	2A1	3.4835
	2A2	3.405
	2B1	3.458
	2B2	3.2795
	QA1	0.64435
	QA2	0.64425
	DA1	1.727
	DA2	1.7635
	RW1A1	-
	RW1A2	-
	RW2A1	-

RW2A2 -

APPENDIX C: Stream Water Data

Streamflow Data

Table C.1 Streamflow data from the USGS in Daily Averages for both urban and rural streams. Data for streamflow is provided in ft^3/s and Gal/Day.

	Daily Average Urban (site 1)		**Daily Average Rural (site 2)**	
Date	**[ft^3/s]**	**[Gal/Day]**	**[ft^3/s]**	**[Gal/Day]**
7/16/2021	45.94479	29694900	3.082188	1992070
7/17/2021	58.65937	37912551	1.975104	1276543
7/18/2021	29.76771	19239376	1.638646	1059085
7/19/2021	18.76042	12125176	1.341042	866738
7/20/2021	14.41146	9314370.5	1.301458	841154.6
7/21/2021	11.32875	7321963.7	1.136354	734445
7/22/2021	9.239896	5971901.8	1.251354	808771.5
7/23/2021	10.51563	6796427.2	1.293958	836307.3
7/24/2021	8.970417	5797732.8	1.34125	866872.7
7/25/2021	6.187917	3999355.7	1.082083	699368.9
7/26/2021	4.776979	3087442.8	0.953438	616222.9
7/27/2021	4.696354	3035333.5	1.072188	692973
7/28/2021	4.820104	3115315.3	1.776146	1147953
7/29/2021	10.19844	6591423.5	1.976042	1277149
7/30/2021	20.62083	13327595	2.193229	1417521
7/31/2021	43.45729	28087186	1.286771	831661.9
8/1/2021	22.87396	14783828	1.010208	652914.8
8/2/2021	11.48958	7425913	0.973333	629081.9
8/3/2021	7.787813	5033395.6	1.009063	652174.2
8/4/2021	6.720417	4343519.5	0.957917	619117.8
8/5/2021	8.047187	5201034.1	0.924479	597506.6
8/6/2021	11.93854	7716082.4	1.137396	735118.3
8/7/2021	27.50833	17779103	4.569271	2953197
8/8/2021	116.3229	75181479	3.984896	2575506
8/9/2021	195.9479	126644470	2.758229	1782690
8/10/2021	216.0833	139658332	9.361563	6050537
8/11/2021	169.5521	109584394	3.926458	2537737
8/12/2021	127.625	82486207	5.187708	3352904
8/13/2021	121.2083	78339006	3.172708	2050575
8/14/2021	85.66667	55367823	1.251458	808838.8
8/15/2021	43.55104	28147779	0.91375	590572.2
8/16/2021	26.96563	17428342	0.7575	489585.1
8/17/2021	20.38333	13174095	0.868542	561353.2

8/18/2021	18.47813	11942726	1.917708	1239447
8/19/2021	17.59479	11371813	1.284118	829947.1
8/20/2021	13.22813	8549562.1	0.996667	644162.6
8/21/2021	11.30208	7304728.6	0.916667	592457.3
8/22/2021	11.45208	7401676.1	0.851667	550446.6
8/23/2021	14.05521	9084120.1	0.861667	556909.8
8/24/2021	21.50625	13899855	1.051667	679710
8/25/2021	22.29167	14407483	1.663333	1075041
8/26/2021	22.14167	14310536	2.193333	1417589
8/27/2021	23.72604	15334544	1.628333	1052420
8/28/2021	19.51146	12610587	1.021667	660320.5
8/29/2021	15.34167	9915580	0.951667	615078.3
8/30/2021	10.47313	6768958.7	0.92	594611.6
8/31/2021	17.59583	11372486	0.91	588148.5
9/1/2021	15.19479	9820652.2	0.93	601074.8
9/2/2021	10.7899	6973693.1	0.978333	632313.5
9/3/2021	8.634271	5580476	0.985	636622.2
9/4/2021	7.276667	4703033.4	0.961667	621541.5
9/5/2021	8.718958	5635211	0.963333	622618.7
9/6/2021	7.503229	4849464.6	0.971667	628004.7
9/7/2021	5.739896	3709792.3	1.061667	686173.2
9/8/2021	4.894271	3163250.4	1.13	730338.2
9/9/2021	4.332708	2800303.1	1.083333	700176.8
9/10/2021	7.559792	4886021.9	1.056667	682941.6
9/11/2021	6.851771	4428416	0.998333	645239.8
9/12/2021	5.130208	3315740.9	0.938333	606460.8
9/13/2021	4.363125	2819961.9	0.876667	566604.6
9/14/2021	4.935833	3190113	0.853333	551523.8
9/15/2021	48.24792	31183449	0.838333	541829.1
9/16/2021	26.53646	17150964	0.83	536443.1
9/17/2021	13.09688	8464733	0.83	536443.1
9/18/2021	7.719271	4989096	0.833333	538597.5
9/19/2021	5.347083	3455910.9	0.881667	569836.2
9/20/2021	4.814167	3111477.8	1.1	710948.7
9/21/2021	5.762604	3724469	2.065	1334645
9/22/2021	6.182917	3996124.2	1.931667	1248469
9/23/2021	5.623542	3634590.6	1.475	953317.6
9/24/2021	9.016458	5827490.3	1.278333	826208.6
9/25/2021	8.533437	5515305.7	1.185	765885.6
9/26/2021	7.154792	4624263.5	1.111667	718489.1
9/27/2021	5.862396	3788966.1	1.035	668938.1
9/28/2021	4.584688	2963161.5	0.966667	624773.1
9/29/2021	4.613958	2982079.7	0.92	594611.6

9/30/2021	5.091667	3290830.7	0.88	568759
10/1/2021	4.772396	3084480.6	0.846667	547215.1
10/2/2021	7.147187	4619348.8	0.808333	522439.6
10/3/2021	5.391667	3484725.8	0.768333	496586.9
10/4/2021	6.127083	3960038.1	1.656667	1070732
10/5/2021	42.22604	27291409	3.596667	2324587
10/6/2021	32.16667	20789864	1.285	830517.3
10/7/2021	24.96875	16137728	12.00256	7757461
10/8/2021	34.04167	22001708	17.24063	11142909
10/9/2021	53.7	34707223	7.378542	4768877
10/10/2021	44.55833	28798808	2.879583	1861124
10/11/2021	29.06667	18786281	1.979063	1279102
10/12/2021	27.52604	17790549	5.658333	3657077
10/13/2021	29.11563	18817923	9.548229	6171183
10/14/2021	25.56875	16525518	4.603021	2975011
10/15/2021	24.45	15802451	3.144271	2032196
10/16/2021	20.44167	13211797	2.060521	1331750
10/17/2021	14.73438	9523077	1.409375	910903
10/18/2021	10.71552	6925623.3	1.218646	787631.5
10/19/2021	8.419063	5441383.2	1.195521	772685.4
10/20/2021	7.775208	5025249.3	1.306563	844453.6
10/21/2021	10.76375	6956794.6	1.549583	1001522
10/22/2021	7.557083	4884271.4	1.56125	1009062
10/23/2021	15.26458	9865759.7	1.523229	984488.9
10/24/2021	16.22708	10487840	1.517083	980516.7
10/25/2021	47.97813	31009078	20.44833	13216105
10/26/2021	173.3844	112061269	22.61042	14613497
10/27/2021	187.75	121346017	5.61875	3631494
10/28/2021	90.61458	58565746	2.839479	1835204
10/29/2021	69.13229	44681375	7.913438	5114589
10/30/2021	130.3104	84221838	26.46042	17101817
10/31/2021	155.375	100421504	13.17417	8514688
11/1/2021	88.97292	57504709	5.877292	3798594
11/2/2021	51.13646	33050362	3.544896	2291126
11/3/2021	35.775	23121991	2.618438	1692341
11/4/2021	23.63958	15278665	2.130104	1376723
11/5/2021	20.79167	13438008	1.810417	1170103
11/6/2021	16.64792	10759832	1.780104	1150512
11/7/2021	16.16458	10447445	1.5793	1020728
11/8/2021	16.16146	10445425	1.5036	971802.2
11/9/2021	11.11365	7182938.2	1.480417	956818.5
11/10/2021	9.338646	6035725.6	1.494792	966109.3
11/11/2021	11.05885	7147525.4	2.025521	1309129

11/12/2021	11.52927	7451563.7	3.615	2336436
11/13/2021	16.49479	10660864	2.923229	1889333
11/14/2021	23.72604	15334544	2.709375	1751115
11/15/2021	19.59167	12662427	2.577188	1665680
11/16/2021	14.62917	9455079.1	2.566563	1658813
11/17/2021	13.21771	8542829.6	2.439688	1576812
11/18/2021	13.68021	8841751.2	2.523021	1630671
11/19/2021	11.78021	7613748.9	2.552604	1649791
11/20/2021	10.48281	6775219.9	2.742604	1772592
11/21/2021	9.440104	6101299.8	2.663542	1721492
11/22/2021	7.924063	5121456.3	2.577813	1666084
11/23/2021	6.59	4259229	2.270625	1467544
11/24/2021	6.593438	4261450.7	2.558542	1653629
11/25/2021	10.46271	6762226.3	2.64125	1707085
11/26/2021	10.40896	6727486.7	2.455417	1586978
11/27/2021	7.935313	5128727.4	2.219688	1434622
11/28/2021	6.433542	4158107.3	2.271875	1468351
11/29/2021	5.494583	3551242.6	2.293542	1482355
11/30/2021	5.078646	3282415.1	2.795	1806456
12/1/2021	5.224063	3376400.4	2.756563	1781613
12/2/2021	5.384792	3480282.4	2.841667	1836617
12/3/2021	9.459896	6114091.5	3.066771	1982106
12/4/2021	8.76	5661736.9	3.153333	2038053
12/5/2021	11.15354	7208723.6	3.5625	2302504
12/6/2021	12.79792	8271511.1	4.095417	2646937
12/7/2021	9.03625	5840282	3.117188	2014691
12/8/2021	16.3125	10543046	3.155417	2039399
12/9/2021	15.30729	9893362.8	3.39625	2195054
12/10/2021	15.95417	10311449	4.779688	3089193
12/11/2021	54.63021	35308432	34.67135	22408686
12/12/2021	179.7365	116166729	26.92188	17400065
12/13/2021	171.5729	110890493	13.80417	8921868
12/14/2021	92.27083	59636208	8.925104	5768447
12/15/2021	63.07188	40764425	7.205625	4657118
12/16/2021	50.69583	32765579	6.609167	4271617
12/17/2021	38.96771	25185492	5.183333	3350076
12/18/2021	35.59688	23006865	4.775	3086164
12/19/2021	28.82813	18632107	4.061042	2624720
12/20/2021	23.86354	15423413	3.783229	2445165
12/21/2021	20.02292	12941151	4.483021	2897453
12/22/2021	13.73323	8876019.5	4.026146	2602166
12/23/2021	20.80625	13447433	3.342708	2160449
12/24/2021	20.6	13314130	3.211563	2075687

12/25/2021	16.69271	10788781	3.411146	2204682
12/26/2021	14.72292	9515671.3	2.832917	1830962
12/27/2021	20.68333	13367990	3.871354	2502122
12/28/2021	25.48646	16472331	8.700833	5623496
12/29/2021	46.95938	30350642	12.20625	7889107
12/30/2021	61.58958	39806395	13.68021	8841751
12/31/2021	73.75729	47670591	10.72917	6934443
1/1/2022	53.27396	34431865	10.66531	6893173
1/2/2022	30.21771	19530219	11.89198	7685988
1/3/2022	39.82083	25736882	9.708854	6274997
1/4/2022	25.95	16771926	7.889333	5099010
1/5/2022	20.95	13540341	6.453333	4170899
1/6/2022	17.38333	11235144	5.738333	3708782
1/7/2022	15.1	9759386.7	5.085	3286522
1/8/2022	13.18333	8520612.5	4.555	2943974
1/9/2022	11.61667	7508049.2	4.061667	2625124
1/10/2022	10.75	6947907.8	3.626667	2343976
1/11/2022	10.875	7028697.4	3.39	2191015
1/12/2022	11.49167	7427259.5	3.95	2552952
1/13/2022	13.11458	8476178.2	4.61	2979521
1/14/2022	18.61354	12030248	4.693333	3033381
1/15/2022	19.66771	12711574	4.368333	2823328
1/16/2022	18.45833	11929935	4.076667	2634819
1/17/2022	14.80625	9569531.1	3.845	2485089
1/18/2022	13.11667	8477524.6	3.568333	2306274
1/19/2022	13.62604	8806742.4	3.218333	2080064
1/20/2022	11.26771	7282511.4	2.75	1777372
1/21/2022	8.957917	5789653.8	2.288333	1478989
1/22/2022	7.715938	4986941.6	2.096667	1355111
1/23/2022	7.641667	4938939.1	1.993333	1288325
1/24/2022	7.215	4663177.2	1.936667	1251701
1/25/2022	7.456667	4819370.4	1.918333	1239851
1/26/2022	7.895345	5102895.6	1.915	1237697
1/27/2022	7.622604	4926618.7	1.881667	1216153
1/28/2022	8.127292	5252806.8	1.863333	1204304
1/29/2022	7.789687	5034607.5	1.916667	1238774
1/30/2022	8.391875	5423811.5	2.028333	1310946
1/31/2022	10.17552	6576612.1	2.406667	1555470
2/1/2022	10.66659	6893995.5	2.551667	1649186
2/2/2022	9.693333	6264966.1	2.42	1564087
2/3/2022	9.201667	5947193.6	2.293333	1482220
2/4/2022	8.691667	5617571.9	2.193333	1417589
2/5/2022	8.430339	5448671.4	2.115	1366960

2/6/2022	8.78875	5680318.5	2.518333	1627642
2/7/2022	10.99792	7108140.5	2.883333	1863547
2/8/2022	9.081458	5869500.9	2.298333	1485452
2/9/2022	8.983438	5806148.4	2.235	1444518
2/10/2022	9.646771	6234872	2.34	1512382
2/11/2022	10.82208	6994496.4	2.75	1777372
2/12/2022	12.44286	8042030.1	3.235	2090835
2/13/2022	10.62833	6869272.5	2.526667	1633028
2/14/2022	9.441667	6102309.7	2.183333	1411125
2/15/2022	9.778704	6320142.4	1.965	1270013
2/16/2022	12.62875	8162175.8	2.42	1564087
2/17/2022	20.91923	13520454	7.493333	4843069
2/18/2022	18.2	11762969	14.83333	9587036
2/19/2022	24.95556	16129200	6.525	4217218
2/20/2022	27.29479	17641088	3.901667	2521713
2/21/2022	23.67083	15298862	3.638333	2351517
2/22/2022	21.59556	13957575	5.005	3234817
2/23/2022	22.26667	14391325	14.45833	9344667
2/24/2022	28.98261	18731953	16.96667	10965845
2/25/2022	28.64375	18512943	9.595	6201412
2/26/2022	31.05	20068143	5.201667	3361926
2/27/2022	26.475	17111243	3.788333	2448464
2/28/2022	22.075	14267448	5.43	3509501
3/1/2022	33.57292	21698747	41.73333	26972963
3/2/2022	54.64375	35317185	47.65	30797005
3/3/2022	95.51875	61735392	25.2	16287188
3/4/2022	91.69896	59266596	14.43333	9328509
3/5/2022	69.48438	44908933	10.93333	7066399
3/6/2022	73.71354	47642315	25.2	16287188
3/7/2022	107.9615	69777326	21.13333	13658833
3/8/2022	125.8125	81314758	18.84894	12182388
3/9/2022	93.28333	60290604	16.00521	10344438
3/10/2022	77.37813	50010798	12.6875	8200147
3/11/2022	65.94688	42622586	10.0949	6524503
3/12/2022	47.54271	30727661	8.7125	5631037
3/13/2022	50.15326	32414905	9.538958	6165191
3/14/2022	43.6375	28203658	7.314375	4727405
3/15/2022	42.15208	27243608	7.280417	4705457
3/16/2022	36.70938	23725893	7.526042	4864209
3/17/2022	47.47708	30685246	9.744687	6298157
3/18/2022	53.48854	34570554	12.11563	7830534
3/19/2022	65.83646	42551222	23.37292	15106313
3/20/2022	97.93021	63293958	28.11042	18168240

3/21/2022	115	74326455	22.32604	14429700
3/22/2022	96.49792	62368244	19.99167	12920954
3/23/2022	159.3531	102992634	95.75	61884853
3/24/2022	398.9583	257853553	153.8333	99425099
3/25/2022	483.8438	312716441	151.2396	97748714
3/26/2022	486.9167	314702519	118.3969	76521913
3/27/2022	403.5938	260849502	75.35521	48703352
3/28/2022	246.3542	159222886	50.56042	32678057
3/29/2022	172.5729	111536810	38.60313	24949856
3/30/2022	144.8542	93621710	35.22917	22769209
3/31/2022	184.5521	119279149	70.62813	45648158
4/1/2022	340.3229	219956487	104.0042	67219661
4/2/2022	390.0729	252110757	75.25313	48637374
4/3/2022	340.0417	219774710	90.81563	58695682
4/4/2022	415.2083	268356204	163.1771	1.05E+08
4/5/2022	462.6354	299009135	155.1458	1E+08
4/6/2022	610.6042	394643853	259.0417	1.67E+08
4/7/2022	661.0833	427269397	278.5208	1.8E+08
4/8/2022	750.2083	484872399	174.9479	1.13E+08
4/9/2022	662.2396	428016701	133.0521	85993823
4/10/2022	477.7813	308798144	101.8635	65836139
4/11/2022	327.4167	211614958	80.68646	52149030
4/12/2022	244.1875	157822532	62.18333	40190145
4/13/2022	205.7292	132966258	54.85625	35454527
4/14/2022	220.0104	142196472	74.50417	48153309
4/15/2022	294.5521	190374019	61.48542	39739070
4/16/2022	242.4688	156711675	47.69896	30828648
4/17/2022	178.6146	115441642	39.88229	25776603
4/18/2022	154.75	100017556	38.17292	24671805
4/19/2022	148.4063	95917482	39.13854	25295905
4/20/2022	149.8438	96846563	35.01146	22628501
4/21/2022	160.5313	103754076	47.06146	30416621
4/22/2022	306.3542	198001906	133.0719	86006615
4/23/2022	816.6042	527785155	500.9479	3.24E+08
4/24/2022	1013.938	655325043	373.7813	2.42E+08
4/25/2022	1156.479	747452146	258.7708	1.67E+08
4/26/2022	823.5521	532275712	161.2188	1.04E+08
4/27/2022	549.5729	355198319	114.3646	73915774
4/28/2022	339.6354	219512144	89.27604	57700623
4/29/2022	254.8229	164696383	73.25	47342720
4/30/2022	237.1563	153278116	95.66667	61830993
5/1/2022	800.9688	517679720	517.4896	3.34E+08
5/2/2022	968.5	625958015	350.7396	2.27E+08

5/3/2022	1175.313	759624449	364.4792	2.36E+08
5/4/2022	1141.354	737676601	469.866	3.04E+08
5/5/2022	1127.604	728789742	249.75	1.61E+08
5/6/2022	901.1667	582439337	169.5625	1.1E+08
5/7/2022	628.7604	406378546	160.4479	1.04E+08
5/8/2022	451.9479	292101622	118.8438	76810736
5/9/2022	323.7292	209231664	93.7875	60616456
5/10/2022	250.1354	161666772	74.58333	48204476
5/11/2022	196.9375	127284054	60.96563	39403120
5/12/2022	169.6979	109678648	53.82083	34785320
5/13/2022	144.0625	93110043	42.66458	27574846
5/14/2022	125.9479	81402280	35.87708	23187969
5/15/2022	109.375	70690922	31.13438	20122676
5/16/2022	96.66042	62473271	27.47396	17756886
5/17/2022	88.55625	57235410	23.75833	15355415
5/18/2022	89.59479	57906637	24.82604	16045493
5/19/2022	89.22396	57666961	26.34583	17027760
5/20/2022	101.4667	65579632	23.06667	14908379
5/21/2022	97.05104	62725738	22.42813	14495678
5/22/2022	85.66458	55366477	19.62604	12684644
5/23/2022	74.80417	48347205	17.28542	11171859
5/24/2022	67.09167	43362485	16.76146	10833215
5/25/2022	73.90833	47768212	17.64792	11406149
5/26/2022	209.6042	135470736	105.9313	68465168
5/27/2022	690.3125	446160704	152.5417	98590272
5/28/2022	643.1667	415689551	101.4	65536544
5/29/2022	472.9688	305687744	61.39583	39681171
5/30/2022	253.8438	164063531	42.12604	27226777
5/31/2022	167.8229	108466804	31.25104	20198079
6/1/2022	136.3021	88094354	29.01563	18753292
6/2/2022	115.75	74811193	24.09375	15572200
6/3/2022	95.78229	61905723	20.44792	13215836
6/4/2022	80.85208	52256076	18.55313	11991200
6/5/2022	79.01771	51070488	19.22184	12423401
6/6/2022	77.38958	50018203	21.58736	13952275
6/7/2022	85.73958	55414950	21.50779	13900852
6/8/2022	106.1792	68625400	19.67662	12717336
6/9/2022	127.6563	82506405	29.96279	19365461
6/10/2022	158.5938	102501837	21.65938	13998822
6/11/2022	111.0552	71776869	19.19792	12407940
6/12/2022	85.99688	55581242	17.34167	11208214
6/13/2022	70.51875	45577467	15.67604	10131692
6/14/2022	107.4615	69454167	15.06146	9734477

6/15/2022	243.6563	157479177	13.33542	8618906
6/16/2022	251.875	162791094	28.66146	18524388
6/17/2022	256.2188	165598534	21.525	13911973
6/18/2022	156.5938	101209203	16.08125	10393585
6/19/2022	90.66979	58601428	13.71979	8867335
6/20/2022	64.61146	41759484	12.49896	8078289
6/21/2022	51.06458	33003908	11.075	7157961
6/22/2022	42.4125	27411920	9.451042	6108369
6/23/2022	33.48125	21639501	8.0875	5227089
6/24/2022	28.32917	18309622	7.4175	4794056
6/25/2022	27.31042	17651187	7.302083	4719461
6/26/2022	24.07396	15559409	7.495417	4844415
6/27/2022	22.12083	14297071	6.552083	4234723
6/28/2022	18.09271	11693625	5.672813	3666435
6/29/2022	16.34688	10565263	5.361354	3465134
6/30/2022	15.25625	9860373.7	5.145521	3325638
7/1/2022	12.13792	7844941.9	4.639063	2998305
7/2/2022	11.2875	7295303.1	4.381042	2831542
7/3/2022	11.8651	7668618.5	4.099063	2649294
7/4/2022	8.251875	5333327.1	4.024063	2600820
7/5/2022	9.706875	6273718.3	5.309271	3431472
7/6/2022	40.74375	26333378	9.91875	6410657
7/7/2022	143.7125	92883832	9.647292	6235209
7/8/2022	104.1563	67317955	5.842083	3775838
7/9/2022	42.82813	27680545	5.177708	3346441
7/10/2022	24.19896	15640198	4.141771	2676897
7/11/2022	20.39167	13179481	3.946771	2550865
7/12/2022	16.28125	10522849	4.886458	3158201
7/13/2022	28.79063	18607870	3.989792	2578670
7/14/2022	26.56771	17171162	2.920521	1887582
7/15/2022	21.13125	13657486	3.225417	2084642
7/16/2022	21.27813	13752414	6.748958	4361967
7/17/2022	45.62083	29485520	4.381458	2831811
7/18/2022	30.52917	19731519	3.084792	1993753
7/19/2022	18.3125	11835680	2.739271	1770437
7/20/2022	13.63125	8810108.6	2.467083	1594518
7/21/2022	8.596771	5556239.1	2.096875	1355246
7/22/2022	6.913542	4468339.5	1.817083	1174412
7/23/2022	12.72865	8226740.2	2.45625	1587516
7/24/2022	16.97604	10971904	4.731875	3058291
7/25/2022	75.17083	48584187	3.734479	2413657
7/26/2022	65.66875	42442829	2.379583	1537965
7/27/2022	26.34167	17025067	2.02375	1307984

7/28/2022	15.45104	9986270.9	1.835313	1186194
7/29/2022	17.10521	11055387	1.586771	1025557
7/30/2022	12.04792	7786773.4	1.544792	998425.1
7/31/2022	8.802708	5689340	1.429375	923829.4
8/1/2022	6.098958	3941860.5	1.301979	841491.3
8/2/2022	4.871042	3148237	1.265938	818196.9
8/3/2022	4.531875	2929027.9	1.304375	843039.7
8/4/2022	3.800833	2456543.2	1.399688	904641.8
8/5/2022	3.181146	2056028.6	1.888132	1220332
8/6/2022	6.780625	4382433.2	1.697582	1097176
8/7/2022	8.100417	5235437	1.830462	1183058
8/8/2022	9.199896	5946049.1	4.935208	3189709
8/9/2022	14.72813	9519037.6	3.379375	2184148
8/10/2022	16.98646	10978637	2.695385	1742073
8/11/2022	11.83375	7648353.8	2.128854	1375915
8/12/2022	5.954271	3848346.5	1.550213	1001929
8/13/2022	3.655417	2362557.9	1.564086	1010895
8/14/2022	3.01375	1947837.9	1.485745	960262
8/15/2022	2.523854	1631209.9	1.314267	849432.9
8/16/2022	2.783229	1798848.3	1.705205	1102103
8/17/2022	2.8375	1833924.5	1.197079	773692.3
8/18/2022	2.81875	1821806	0.97125	627735.4
8/19/2022	2.339583	1512112.5	1.014839	655907.5
8/20/2022	3.085	1993887.9	1.113789	719861.1
8/21/2022	8.613646	5567145.7	2.021014	1306216
8/22/2022	34.36042	22207721	3.56977	2307203
8/23/2022	18.58333	12010724	3.676237	2376014
8/24/2022	11.79022	7620217.9	1.611556	1041576

Specific Conductance Data

Table C.2 Specific Conductance data from the CTD probes in Daily Averages for both urban and rural streams. Data for specific conductance is provided in mS/cm.

Date	**Daily Average Conductance [mS/cm] Urban (site 1)**	**Daily Average Conductance [mS/cm] Rural (site 2)**
7/16/2021	0.961177083	1.13482971
7/17/2021	0.990614583	1.35159375
7/18/2021	1.033003472	1.026399306
7/19/2021	1.019947917	0.865736111
7/20/2021	1.040458333	0.899513889
7/21/2021	1.053614583	0.968503472
7/22/2021	1.071131944	1.015888889
7/23/2021	1.091930556	1.069583333
7/24/2021	1.073833333	1.115048611
7/25/2021	1.055767361	1.121246528
7/26/2021	1.054184028	1.131267361
7/27/2021	1.043756944	1.193201389
7/28/2021	1.032871528	1.3126875
7/29/2021	0.91609375	1.08365625
7/30/2021	0.978010417	1.132618056
7/31/2021	0.965829861	1.117576389
8/1/2021	0.959347222	1.248138889
8/2/2021	0.957555556	1.412579861
8/3/2021	0.973621528	1.401527778
8/4/2021	1.017645833	1.217815972
8/5/2021	1.039229167	1.293805556
8/6/2021	0.914777778	1.319951389
8/7/2021	1.023979167	1.288006944
8/8/2021	0.9845625	1.448090278
8/9/2021	0.791	1.019253472
8/10/2021	0.633583333	1.147899306
8/11/2021	0.697569444	0.984760417
8/12/2021	0.804847222	1.20240625
8/13/2021	0.903736111	1.246392361
8/14/2021	0.898100694	1.131381944
8/15/2021	0.865784722	1.080027778
8/16/2021	0.83303125	1.2070625
8/17/2021	0.823753472	1.286829861
8/18/2021	0.83475	1.4018125

8/19/2021	0.857336806	1.512375
8/20/2021	0.895524306	1.499149306
8/21/2021	0.945666667	1.420229167
8/22/2021	0.959642361	1.121552083
8/23/2021	0.9483125	1.242013889
8/24/2021	0.916861111	1.371190972
8/25/2021	0.969715278	1.203583333
8/26/2021	1.008409722	1.205013889
8/27/2021	1.030482639	1.286
8/28/2021	1.061493056	0.930229167
8/29/2021	1.065072917	0.903319444
8/30/2021	1.110982639	1.099958333
8/31/2021	1.1216875	1.125375
9/1/2021	1.057621528	1.279215278
9/2/2021	1.113048611	1.481569444
9/3/2021	1.126204861	1.504767361
9/4/2021	1.138086806	1.417638889
9/5/2021	1.154267361	1.307878472
9/6/2021	1.158222222	1.330711806
9/7/2021	1.122090278	1.354309028
9/8/2021	1.169326389	1.328951389
9/9/2021	1.169336806	1.313416667
9/10/2021	1.170416667	1.315545139
9/11/2021	1.174913194	1.364572917
9/12/2021	1.172510417	1.378475694
9/13/2021	1.118288194	1.335215278
9/14/2021	1.147368056	1.396604167
9/15/2021	1.122986111	1.460003472
9/16/2021	1.066569444	1.476871528
9/17/2021	1.050975694	1.507451389
9/18/2021	1.041434028	1.607475694
9/19/2021	1.042506944	1.66209375
9/20/2021	1.051475694	1.708385417
9/21/2021	1.02053125	1.626909722
9/22/2021	1.01375	1.690370787
9/23/2021	0.993336806	1.724746528
9/24/2021	0.967128472	1.687715278
9/25/2021	0.95278125	1.606003472
9/26/2021	0.954697917	1.662416667
9/27/2021	0.938642361	1.73546875
9/28/2021	0.906357639	1.644402778
9/29/2021	0.879951389	1.541472222
9/30/2021	0.864256944	1.634788194

10/1/2021	0.848295139	1.675510417
10/2/2021	0.734670139	1.673329861
10/3/2021	0.751340278	1.700729167
10/4/2021	0.74971875	1.73015625
10/5/2021	0.755072917	1.690256944
10/6/2021	0.779517361	1.689163194
10/7/2021	0.817263889	1.3905625
10/8/2021	0.891197917	1.252534722
10/9/2021	0.885579861	0.962215278
10/10/2021	0.827326389	1.036427083
10/11/2021	0.794774306	1.001857639
10/12/2021	0.838861111	1.119982639
10/13/2021	0.871076389	1.261465278
10/14/2021	0.916246528	1.150847222
10/15/2021	0.927864583	1.077871528
10/16/2021	0.912291667	1.136538194
10/17/2021	0.902142361	1.205722222
10/18/2021	0.899986111	1.278378472
10/19/2021	0.912864583	1.285822917
10/20/2021	0.918996528	1.292069444
10/21/2021	0.916986111	1.283673611
10/22/2021	0.915496528	1.284868056
10/23/2021	0.934482639	1.292211806
10/24/2021	0.87175	1.268534722
10/25/2021	0.797274306	1.209777778
10/26/2021	0.908003472	0.864704861
10/27/2021	0.741083333	1.000434028
10/28/2021	0.681086806	1.092746528
10/29/2021	0.663121528	1.116125
10/30/2021	0.76790625	1.033729167
10/31/2021	0.841125	1.0201875
11/1/2021	0.814756944	1.025635417
11/2/2021	0.83365625	1.125267361
11/3/2021	0.857395833	1.202586806
11/4/2021	0.873270833	1.213524306
11/5/2021	0.890520833	1.23878125
11/6/2021	0.905902778	1.286215278
11/7/2021	0.9138125	1.321953333
11/8/2021	0.925041667	1.356836806
11/9/2021	0.938451389	1.375600694
11/10/2021	0.950763889	1.41075
11/11/2021	0.941951389	1.395319444
11/12/2021	0.961885417	1.389118056

11/13/2021	0.980756944	1.398361111
11/14/2021	0.999538194	1.425284722
11/15/2021	1.020732639	1.313503472
11/16/2021	1.033701389	1.3795625
11/17/2021	1.048048611	1.327118056
11/18/2021	1.054993056	1.335114583
11/19/2021	1.063684028	1.331795139
11/20/2021	1.065236111	1.360173611
11/21/2021	1.072194444	1.38784375
11/22/2021	1.092493056	1.420934028
11/23/2021	1.1059375	1.468368056
11/24/2021	1.108170139	1.484138889
11/25/2021	1.110888889	1.418263889
11/26/2021	1.121788194	1.446902778
11/27/2021	1.118857639	1.474590278
11/28/2021	1.133513889	1.404902778
11/29/2021	1.131864583	1.480927083
11/30/2021	1.118840278	1.393909722
12/1/2021	1.123076389	1.336972222
12/2/2021	1.108055556	1.246819444
12/3/2021	1.078003472	1.248347222
12/4/2021	1.089559028	1.281510417
12/5/2021	1.086791667	1.269711806
12/6/2021	1.089618056	1.316385417
12/7/2021	1.097003472	1.456989583
12/8/2021	1.099083333	1.579100694
12/9/2021	1.094118056	1.575777778
12/10/2021	1.021298611	1.545892361
12/11/2021	1.031857639	1.045434028
12/12/2021	0.986128472	0.892357639
12/13/2021	0.822277778	0.963336806
12/14/2021	0.773822917	1.002493056
12/15/2021	0.771743056	1.082270833
12/16/2021	0.798670139	1.149652778
12/17/2021	0.837513889	1.219489583
12/18/2021	0.870194444	1.234211806
12/19/2021	0.892065972	1.240163194
12/20/2021	0.920638889	1.229909722
12/21/2021	0.945694444	1.276760417
12/22/2021	0.972072917	1.305263889
12/23/2021	0.997243056	1.327173611
12/24/2021	1.016916667	1.340527778
12/25/2021	1.027	1.311354167

12/26/2021	1.038579861	1.310944444
12/27/2021	1.028590278	1.266371528
12/28/2021	1.034833333	1.359475694
12/29/2021	1.063708333	1.266229167
12/30/2021	1.062871528	1.517177083
12/31/2021	1.132763889	1.453861111
1/1/2022	1.214583333	1.335489583
1/2/2022	1.362298611	1.359135417
1/3/2022	1.557631944	1.4243125
1/4/2022	1.618940972	1.439961806
1/5/2022	1.6718125	1.443100694
1/6/2022	1.699291667	1.44384375
1/7/2022	1.690833333	1.508569444
1/8/2022	1.669493056	1.554243056
1/9/2022	1.664260417	1.53028125
1/10/2022	1.693111111	1.579427083
1/11/2022	1.711225694	1.598097222
1/12/2022	1.714333333	1.535902778
1/13/2022	1.737652778	1.377958333
1/14/2022	1.754277778	1.314940972
1/15/2022	1.75275	1.334628472
1/16/2022	1.739652778	1.433274306
1/17/2022	1.710451389	1.42909375
1/18/2022	1.674673611	1.437635417
1/19/2022	1.645395833	1.398100694
1/20/2022	1.659413194	1.456152778
1/21/2022	1.636756944	1.551402778
1/22/2022	1.590246528	1.612496528
1/23/2022	1.536760417	1.569361111
1/24/2022	1.518454861	1.511194444
1/25/2022	1.510361111	1.450802083
1/26/2022	1.518201389	1.441163194
1/27/2022	1.507795139	1.413697917
1/28/2022	1.513836806	1.498961806
1/29/2022	1.528006944	1.668069444
1/30/2022	1.526277778	1.659479167
1/31/2022	1.529503472	1.5921875
2/1/2022	1.563663194	1.467579861
2/2/2022	1.539548611	1.433788194
2/3/2022	1.496701389	1.483194444
2/4/2022	1.466725694	1.546211806
2/5/2022	1.49	1.639774306
2/6/2022	1.48046875	1.639548611

2/7/2022	1.451020833	1.617295139
2/8/2022	1.421440972	1.574784722
2/9/2022	1.405725694	1.4684375
2/10/2022	1.427711806	1.397166667
2/11/2022	1.694534722	1.374774306
2/12/2022	1.476069444	1.429527778
2/13/2022	1.462420139	1.671149306
2/14/2022	1.472097222	2.028197917
2/15/2022	1.460788194	1.766795139
2/16/2022	1.4115	1.439465278
2/17/2022	1.455184028	1.280472222
2/18/2022	1.505854167	1.411704861
2/19/2022	1.432680556	1.422024306
2/20/2022	1.482260417	1.543506944
2/21/2022	1.765211806	1.445409722
2/22/2022	1.903204861	1.445097222
2/23/2022	1.812017361	1.603107639
2/24/2022	1.825465278	2.010652778
2/25/2022	1.893222222	1.761701389
2/26/2022	1.982479167	1.709114583
2/27/2022	1.904069444	1.751559028
2/28/2022	1.882559028	1.583538194
3/1/2022	2.175673611	1.226125
3/2/2022	2.725197917	1.058295139
3/3/2022	2.203645833	1.018850694
3/4/2022	1.90003125	1.088267361
3/5/2022	1.948357639	1.170899306
3/6/2022	1.92728125	1.159954861
3/7/2022	1.722756944	1.219371528
3/8/2022	1.615565972	1.453548611
3/9/2022	1.869204861	1.650100694
3/10/2022	1.891506944	1.470920139
3/11/2022	1.837	1.431888889
3/12/2022	2.00290625	1.465868056
3/13/2022	2.319423611	1.455798611
3/14/2022	2.2738125	1.386222222
3/15/2022	2.126364583	1.309291667
3/16/2022	1.908194444	1.295465278
3/17/2022	1.760395833	1.268541667
3/18/2022	1.6478125	1.19521875
3/19/2022	1.515142361	1.208190972
3/20/2022	1.496670139	1.276659722
3/21/2022	1.502225694	1.216159722

3/22/2022	1.574565972	1.187142361
3/23/2022	1.5076875	1.118739583
3/24/2022	1.372440972	0.927083333
3/25/2022	1.177920139	0.877677083
3/26/2022	1.133295139	0.898475694
3/27/2022	1.157006944	0.915708333
3/28/2022	1.152361111	0.951201389
3/29/2022	1.194493056	0.958354167
3/30/2022	1.166795139	0.984340278
3/31/2022	1.017184028	0.94790625
4/1/2022	1.115190972	0.887326389
4/2/2022	1.121145833	0.893673611
4/3/2022	1.129864583	0.90915625
4/4/2022	1.095086806	0.823618056
4/5/2022	1.030392361	0.8126875
4/6/2022	0.899246528	0.691166667
4/7/2022	0.795371528	0.661277778
4/8/2022	0.742041667	0.74603125
4/9/2022	0.818402778	0.794003472
4/10/2022	0.882111111	0.828052083
4/11/2022	0.910357639	0.859361111
4/12/2022	0.932663194	0.879548611
4/13/2022	0.916197917	0.888552083
4/14/2022	0.941826389	0.887989583
4/15/2022	0.955614583	0.911690972
4/16/2022	0.934399306	0.936986111
4/17/2022	0.944611111	0.943854167
4/18/2022	0.93009375	0.941913194
4/19/2022	0.946423611	0.947409722
4/20/2022	0.9315625	0.958222222
4/21/2022	0.951326389	0.959642361
4/22/2022	0.883878472	0.820125
4/23/2022	0.652524306	0.457135417
4/24/2022	0.56790625	0.530767361
4/25/2022	0.602538194	0.576600694
4/26/2022	0.664302083	0.631333333
4/27/2022	0.721395833	0.667631944
4/28/2022	0.759243056	0.697475694
4/29/2022	0.803996528	0.725253472
4/30/2022	0.803159722	0.693788194
5/1/2022	0.568597222	0.302322917
5/2/2022	0.491802083	0.368489583
5/3/2022	0.5085	0.415569444

5/4/2022	0.518975694	0.375357639
5/5/2022	0.509871528	0.435711806
5/6/2022	0.5808125	0.494246528
5/7/2022	0.644392361	0.500288194
5/8/2022	0.671017361	0.527795139
5/9/2022	0.701204861	0.554434028
5/10/2022	0.738826389	0.552777778
5/11/2022	0.767590278	0.559670139
5/12/2022	0.782454861	0.547194444
5/13/2022	0.791322917	0.552524306
5/14/2022	0.777364583	0.562288194
5/15/2022	0.778923611	0.594427083
5/16/2022	0.80246875	0.589958333
5/17/2022	0.808694444	0.602378472
5/18/2022	0.802145833	0.559902778
5/19/2022	0.82121875	0.572586806
5/20/2022	0.817916667	0.580059028
5/21/2022	0.827649306	0.594732639
5/22/2022	0.859440972	0.602402778
5/23/2022	0.873993056	0.596857639
5/24/2022	0.874097222	0.599861111
5/25/2022	0.794868056	0.603486111
5/26/2022	0.786857639	0.561659722
5/27/2022	0.647510417	0.520166667
5/28/2022	0.589944444	0.511
5/29/2022	0.652701389	0.5285
5/30/2022	0.710711806	0.547
5/31/2022	0.762149306	0.557433333
6/1/2022	0.801725694	0.564295455
6/2/2022	0.836048611	0.572
6/3/2022	0.848368056	0.588523438
6/4/2022	0.853090278	0.586777778
6/5/2022	0.854371528	0.600594595
6/6/2022	0.846038194	0.615431034
6/7/2022	0.890006944	0.607640625
6/8/2022	0.889399306	0.606726563
6/9/2022	0.961840278	0.640963636
6/10/2022	0.983184028	0.647004808
6/11/2022	0.960197917	0.639573427
6/12/2022	0.910427083	0.647184028
6/13/2022	0.918395833	0.654090278
6/14/2022	0.940861111	0.670059028
6/15/2022	0.88703125	0.632552083

6/16/2022	0.659920139	0.651340278
6/17/2022	0.735225694	0.717830189
6/18/2022	0.733840278	0.815695804
6/19/2022	0.769934028	0.863083333
6/20/2022	0.805399306	0.903829861
6/21/2022	0.813916667	0.985857639
6/22/2022	0.800204861	1.00571875
6/23/2022	0.833736111	1.038243056
6/24/2022	0.848364583	1.073059028
6/25/2022	0.863861111	1.07853125
6/26/2022	0.858173611	1.080010417
6/27/2022	0.894038194	1.028604167
6/28/2022	0.91265625	1.053427083
6/29/2022	0.926409722	1.046569444
6/30/2022	0.933618056	0.945121528
7/1/2022	0.935451389	-
7/2/2022	0.956222222	-
7/3/2022	0.969173611	-
7/4/2022	0.977069444	-
7/5/2022	0.987881944	-
7/6/2022	0.940631944	-
7/7/2022	1.051729167	-
7/8/2022	0.737684028	-
7/9/2022	0.592006944	-
7/10/2022	0.658916667	-
7/11/2022	0.684229167	-
7/12/2022	0.732052083	-
7/13/2022	0.770829861	-
7/14/2022	0.781166667	-
7/15/2022	0.724253472	-
7/16/2022	0.836194444	-
7/17/2022	0.887350694	1.021930556
7/18/2022	0.933375	0.947326389
7/19/2022	0.931336806	0.998805556
7/20/2022	0.9448125	1.035864583
7/21/2022	0.969972222	1.089597222
7/22/2022	0.943385417	1.313670139
7/23/2022	0.837461806	1.306934028
7/24/2022	0.889579861	1.111107639
7/25/2022	0.879902778	1.14234375
7/26/2022	0.86596875	1.178420139
7/27/2022	0.819177083	1.339503472
7/28/2022	0.76753125	1.133677083

7/29/2022	0.7249375	1.380222222
7/30/2022	0.714579861	1.102003472
7/31/2022	0.730722222	1.518079861
8/1/2022	0.774246528	1.432815972
8/2/2022	0.808677083	1.57778125
8/3/2022	0.790229167	1.659006944
8/4/2022	0.792763889	1.028190972
8/5/2022	0.799965278	1.201916667
8/6/2022	0.80384375	1.091194444
8/7/2022	0.778368056	1.237649306
8/8/2022	0.77815625	1.203479167
8/9/2022	0.839232639	1.08365625
8/10/2022	0.8760625	1.317642361
8/11/2022	0.905767361	1.419854167
8/12/2022	0.919951389	1.065677083
8/13/2022	0.973586806	1.541659722
8/14/2022	0.998954861	1.670135417
8/15/2022	1.001284722	1.612913194
8/16/2022	1.007673611	1.187107639
8/17/2022	1.004395833	1.707270833
8/18/2022	1.014982639	1.706930556
8/19/2022	1.024815972	1.363166667
8/20/2022	0.897857639	1.466715278
8/21/2022	0.93365625	1.308638889
8/22/2022	1.056482639	1.444447917
8/23/2022	1.0713125	1.416260417
8/24/2022	1.085083333	1.263003425

APPENDIX D: Field Site Data

Precipitation Data

Table D.1 Precipitation data from NOAA in Daily Accumulation for both urban and rural field sites. Data for Daily Accumulation provided in inches.

Date	**Daily Precipitation Accumulation (inches) Urban (site 1)**	**Daily Precipitation Accumulation (inches) Rural (site 2)**
7/16/2021	0	0.03
7/17/2021	0	0
7/18/2021	0	0
7/19/2021	0	0
7/20/2021	0	0
7/21/2021	0	0
7/22/2021	0	0
7/23/2021	0	0
7/24/2021	0.06	0.16
7/25/2021	0	0
7/26/2021	0	0
7/27/2021	0	0
7/28/2021	0	0
7/29/2021	0.45	0.58
7/30/2021	0	0
7/31/2021	0	0
8/1/2021	0	0
8/2/2021	0	0
8/3/2021	0	0
8/4/2021	0	0
8/5/2021	0	0
8/6/2021	1.04	0.22
8/7/2021	0.05	0.72
8/8/2021	0.08	0.55
8/9/2021	0.75	0
8/10/2021	0.29	0.47
8/11/2021	0.3	0.19
8/12/2021	0	0
8/13/2021	0	0
8/14/2021	0	0
8/15/2021	0	0
8/16/2021	0	0

8/17/2021	0	0
8/18/2021	0	0
8/19/2021	0	0
8/20/2021	0	0
8/21/2021	0.04	0
8/22/2021	0	0
8/23/2021	0	0
8/24/2021	0.6	0
8/25/2021	0	0.28
8/26/2021	0	0
8/27/2021	0	0
8/28/2021	0.03	0
8/29/2021	0.18	0.01
8/30/2021	0	0.02
8/31/2021	0	0
9/1/2021	0	0
9/2/2021	0	0
9/3/2021	0.1	0
9/4/2021	0.4	0
9/5/2021	0.04	0.07
9/6/2021	0	0
9/7/2021	0.17	0
9/8/2021	0	0.15
9/9/2021	0	0
9/10/2021	0	0
9/11/2021	0	0
9/12/2021	0	0
9/13/2021	0.09	0.01
9/14/2021	0	0.07
9/15/2021	0	0
9/16/2021	0	0
9/17/2021	0.07	0
9/18/2021	0	0
9/19/2021	0	0
9/20/2021	0.11	0
9/21/2021	0.2	0.25
9/22/2021	0.12	0.01
9/23/2021	0	0
9/24/2021	0.11	0
9/25/2021	0	0.16
9/26/2021	0	0
9/27/2021	0	0
9/28/2021	0	0

9/29/2021	0	0
9/30/2021	0	0
10/1/2021	0	0
10/2/2021	1.38	0
10/3/2021	0.22	0.17
10/4/2021	0	0.32
10/5/2021	0	0.02
10/6/2021	0	0
10/7/2021	0.48	1.22
10/8/2021	0.12	0.67
10/9/2021	0	0.01
10/10/2021	0.12	0.03
10/11/2021	0.54	0.09
10/12/2021	0.07	0.41
10/13/2021	0.07	0
10/14/2021	0	0.12
10/15/2021	0	0
10/16/2021	0	0
10/17/2021	0	0
10/18/2021	0	0
10/19/2021	0	0
10/20/2021	0.03	0
10/21/2021	0.03	0.05
10/22/2021	0	0.07
10/23/2021	0	0
10/24/2021	0.83	0
10/25/2021	0.67	1.45
10/26/2021	0	0
10/27/2021	0	0
10/28/2021	0.3	0
10/29/2021	0.4	0.48
10/30/2021	0	0.42
10/31/2021	0	0
11/1/2021	0	0
11/2/2021	0	0
11/3/2021	0	0
11/4/2021	0	0
11/5/2021	0	0
11/6/2021	0	0
11/7/2021	0	0
11/8/2021	0	0
11/9/2021	0	0
11/10/2021	0	0

11/11/2021	0.23	0
11/12/2021	0.1	0.41
11/13/2021	0	0.1
11/14/2021	0.01	0.02
11/15/2021	0	0.02
11/16/2021	0	0
11/17/2021	0	0
11/18/2021	0	0
11/19/2021	0	0
11/20/2021	0	0
11/21/2021	0	0
11/22/2021	0	0
11/23/2021	0	0
11/24/2021	0	0
11/25/2021	0.03	0
11/26/2021	0	0
11/27/2021	0	0
11/28/2021	0	0.01
11/29/2021	0	0
11/30/2021	0	0
12/1/2021	0.01	0
12/2/2021	0	0
12/3/2021	0.16	0.13
12/4/2021	0	0
12/5/2021	0.07	0
12/6/2021	0	0.08
12/7/2021	0	0
12/8/2021	0	0
12/9/2021	0	0
12/10/2021	1.1	0
12/11/2021	0	1.1
12/12/2021	0	0
12/13/2021	0	0
12/14/2021	0.03	0
12/15/2021	0	0
12/16/2021	0	0
12/17/2021	0	0
12/18/2021	0	0
12/19/2021	0	0
12/20/2021	0	0
12/21/2021	0	0
12/22/2021	0	0
12/23/2021	0	0

12/24/2021	0.03	0
12/25/2021	0	0
12/26/2021	0	0
12/27/2021	0.32	0.37
12/28/2021	0.26	0
12/29/2021	0	0.26
12/30/2021	0	0
12/31/2021	0	0
1/1/2022	0.09	0
1/2/2022	0	0.29
1/3/2022	0	0
1/4/2022	0	0
1/5/2022	0	0
1/6/2022	0	0.01
1/7/2022	0	0
1/8/2022	0	0
1/9/2022	0	0
1/10/2022	0	0
1/11/2022	0	0
1/12/2022	0	0
1/13/2022	0	0
1/14/2022	0	0
1/15/2022	0	0
1/16/2022	0	0
1/17/2022	0	0
1/18/2022	0	0
1/19/2022	0	0
1/20/2022	0	0
1/21/2022	0	0
1/22/2022	0.02	0
1/23/2022	0.04	0.18
1/24/2022	0.06	0.1
1/25/2022	0	0.02
1/26/2022	0	0
1/27/2022	0	0
1/28/2022	0	0
1/29/2022	0	0
1/30/2022	0	0
1/31/2022	0	0
2/1/2022	0	0
2/2/2022	0.01	0.02
2/3/2022	0	0
2/4/2022	0	0

2/5/2022	0	0
2/6/2022	0	0
2/7/2022	0	0
2/8/2022	0	0
2/9/2022	0.01	0
2/10/2022	0.02	0.02
2/11/2022	0.02	0.05
2/12/2022	0	0
2/13/2022	0	0
2/14/2022	0	0
2/15/2022	0	0
2/16/2022	0.15	0
2/17/2022	0.01	0.21
2/18/2022	0.02	0
2/19/2022	0	0
2/20/2022	0	0
2/21/2022	0	0
2/22/2022	0.28	0.09
2/23/2022	0	0.4
2/24/2022	0.02	0
2/25/2022	0.06	0.17
2/26/2022	0	0
2/27/2022	0	0
2/28/2022	0	0
3/1/2022	0	0
3/2/2022	0	0
3/3/2022	0	0
3/4/2022	0	0
3/5/2022	0.12	0
3/6/2022	0.01	0
3/7/2022	0.12	0.27
3/8/2022	0	0.02
3/9/2022	0	0
3/10/2022	0	0
3/11/2022	0	0.01
3/12/2022	0	0
3/13/2022	0	0.01
3/14/2022	0	0
3/15/2022	0	0
3/16/2022	0	0
3/17/2022	0	0
3/18/2022	0.28	0
3/19/2022	0.05	0.36

3/20/2022	0	0.03
3/21/2022	0	0
3/22/2022	0.28	0
3/23/2022	0.65	0.67
3/24/2022	0.12	0.19
3/25/2022	0.09	0.17
3/26/2022	0	0.04
3/27/2022	0	0
3/28/2022	0	0
3/29/2022	0	0
3/30/2022	0.14	0
3/31/2022	0.4	0.45
4/1/2022	0	0.03
4/2/2022	0.37	0
4/3/2022	0.11	0.4
4/4/2022	0.11	0.25
4/5/2022	0.02	0
4/6/2022	0.7	0.78
4/7/2022	0.03	0
4/8/2022	0.12	0.04
4/9/2022	0	0.1
4/10/2022	0	0
4/11/2022	0	0
4/12/2022	0	0
4/13/2022	0.54	0
4/14/2022	0	0.33
4/15/2022	0	0
4/16/2022	0	0
4/17/2022	0	0
4/18/2022	0.24	0.16
4/19/2022	0	0.03
4/20/2022	0.24	0
4/21/2022	0.02	0.3
4/22/2022	1.25	0.09
4/23/2022	0	1.41
4/24/2022	0.28	0
4/25/2022	0	0.49
4/26/2022	0	0
4/27/2022	0	0
4/28/2022	0.02	0
4/29/2022	0	0.04
4/30/2022	0.56	0
5/1/2022	0	1.23

5/2/2022	0	0
5/3/2022	0.93	0.18
5/4/2022	0	0.79
5/5/2022	0	0
5/6/2022	0.31	0
5/7/2022	0	0.1
5/8/2022	0	0
5/9/2022	0	0
5/10/2022	0	0
5/11/2022	0	0
5/12/2022	0	0
5/13/2022	0	0
5/14/2022	0	0
5/15/2022	0	0
5/16/2022	0	0
5/17/2022	0	0
5/18/2022	0.28	0
5/19/2022	0	0.29
5/20/2022	0.28	0
5/21/2022	0.05	0.12
5/22/2022	0	0.01
5/23/2022	0	0
5/24/2022	0	0
5/25/2022	1.09	0
5/26/2022	0.65	1.13
5/27/2022	0.05	0.39
5/28/2022	0	0
5/29/2022	0	0
5/30/2022	0	0
5/31/2022	0.04	0
6/1/2022	0	0.13
6/2/2022	0	0
6/3/2022	0	0
6/4/2022	0.09	0
6/5/2022	0.11	0.14
6/6/2022	0.34	0.06
6/7/2022	0	0.41
6/8/2022	0.48	0
6/9/2022	0	0.64
6/10/2022	0.04	0
6/11/2022	0	0.03
6/12/2022	0	0.01
6/13/2022	0.02	0

6/14/2022	0	0.37
6/15/2022	0.25	0
6/16/2022	0	0.87
6/17/2022	0	0
6/18/2022	0	0
6/19/2022	0	0
6/20/2022	0	0
6/21/2022	0	0
6/22/2022	0	0
6/23/2022	0	0
6/24/2022	0	0
6/25/2022	0.05	0
6/26/2022	0	0.07
6/27/2022	0	0
6/28/2022	0	0
6/29/2022	0	0
6/30/2022	0	0
7/1/2022	0	0
7/2/2022	0	0
7/3/2022	0	0
7/4/2022	0.16	0
7/5/2022	0.37	0.57
7/6/2022	0.13	0.63
7/7/2022	0	0
7/8/2022	0.02	0
7/9/2022	0	0
7/10/2022	0.02	0
7/11/2022	0.23	0.01
7/12/2022	0.07	0.42
7/13/2022	0	0.22
7/14/2022	0	0
7/15/2022	0.79	0.02
7/16/2022	0	0.46
7/17/2022	0	0
7/18/2022	0	0
7/19/2022	0	0
7/20/2022	0	0
7/21/2022	0	0
7/22/2022	0	0
7/23/2022	0.74	0.15
7/24/2022	0.12	0.7
7/25/2022	0	0.16
7/26/2022	0	0

7/27/2022	0	0
7/28/2022	0.02	0.18
7/29/2022	0	0
7/30/2022	0	0
7/31/2022	0	0
8/1/2022	0	0
8/2/2022	0	0
8/3/2022	0.04	0
8/4/2022	0	0.08
8/5/2022	0	0
8/6/2022	0	0
8/7/2022	0.31	0.41
8/8/2022	0.29	0.22
8/9/2022	0	0.06
8/10/2022	0	0
8/11/2022	0	0
8/12/2022	0	0
8/13/2022	0	0
8/14/2022	0	0
8/15/2022	0	0
8/16/2022	0	0
8/17/2022	0	0
8/18/2022	0	0
8/19/2022	0	0
8/20/2022	0.59	0.69
8/21/2022	0.02	0.02
8/22/2022	0	0
8/23/2022	0	0
8/24/2022	0	0

Temperature Data

Table D.2 Temperature data from NOAA in Daily Range for both urban and rural field sites. Data for Daily Range provided in Celsius with High and Low temperature values.

	Daily Temperature Range (Celsius) Urban (site 1)		Daily Temperature Range (Celsius) Rural (site 2)	
Date	**High**	**Low**	**High**	**Low**
7/16/2021	25.55556	15.55556	24.44444	13.33333
7/17/2021	22.22222	15.55556	22.22222	14.44444
7/18/2021	26.11111	16.11111	24.44444	12.77778
7/19/2021	27.77778	15.55556	26.66667	11.66667
7/20/2021	30.55556	18.33333	28.33333	13.33333
7/21/2021	22.77778	14.44444	30	15.55556
7/22/2021	27.22222	14.44444	22.77778	11.11111
7/23/2021	32.22222	21.66667	27.77778	18.88889
7/24/2021	33.33333	21.11111	31.66667	21.66667
7/25/2021	33.33333	20.55556	32.77778	17.22222
7/26/2021	32.77778	19.44444	32.77778	13.33333
7/27/2021	32.22222	20.55556	33.33333	17.77778
7/28/2021	30.55556	20.55556	31.11111	18.88889
7/29/2021	28.88889	20	31.66667	19.44444
7/30/2021	22.77778	14.44444	28.88889	14.44444
7/31/2021	27.77778	12.77778	21.66667	9.444444
8/1/2021	23.88889	17.22222	27.22222	13.88889
8/2/2021	24.44444	13.88889	24.44444	8.888889
8/3/2021	27.22222	14.44444	23.88889	10
8/4/2021	27.77778	15.55556	27.22222	11.66667
8/5/2021	28.88889	18.33333	28.33333	12.77778
8/6/2021	30.55556	17.77778	29.44444	18.33333
8/7/2021	26.66667	18.33333	28.88889	16.11111
8/8/2021	31.66667	20	26.66667	18.88889
8/9/2021	25.55556	21.11111	31.66667	20
8/10/2021	31.66667	19.44444	24.44444	16.66667
8/11/2021	31.11111	20.55556	32.77778	18.33333
8/12/2021	31.11111	18.88889	30	17.22222
8/13/2021	27.22222	16.66667	30	17.22222
8/14/2021	25.55556	13.88889	27.22222	11.11111
8/15/2021	26.11111	13.33333	25	10
8/16/2021	25.55556	15	25.55556	10.55556
8/17/2021	26.66667	14.44444	25.55556	10.55556
8/18/2021	28.33333	18.33333	26.66667	14.44444

8/19/2021	28.88889	20.55556	27.77778	17.22222
8/20/2021	28.88889	18.88889	28.33333	16.66667
8/21/2021	30.55556	21.66667	28.88889	18.33333
8/22/2021	25	17.22222	30.55556	16.66667
8/23/2021	28.88889	16.11111	25	12.77778
8/24/2021	35	21.66667	30.55556	17.22222
8/25/2021	32.22222	20.55556	33.88889	19.44444
8/26/2021	27.77778	21.11111	31.66667	18.33333
8/27/2021	28.88889	22.77778	28.33333	20.55556
8/28/2021	34.44444	23.88889	29.44444	21.66667
8/29/2021	31.66667	20	33.33333	21.66667
8/30/2021	28.33333	17.22222	30	13.33333
8/31/2021	26.66667	15	28.33333	12.22222
9/1/2021	24.44444	18.33333	26.66667	14.44444
9/2/2021	25	13.88889	23.88889	8.888889
9/3/2021	24.44444	13.88889	24.44444	10.55556
9/4/2021	25	16.11111	22.77778	14.44444
9/5/2021	27.77778	15	23.88889	11.11111
9/6/2021	23.88889	13.88889	27.22222	9.444444
9/7/2021	28.88889	16.66667	26.66667	10.55556
9/8/2021	25	13.88889	27.77778	12.22222
9/9/2021	23.88889	12.22222	23.88889	11.11111
9/10/2021	26.66667	12.77778	23.33333	8.333333
9/11/2021	30.55556	15.55556	25.55556	11.11111
9/12/2021	25	18.88889	29.44444	16.66667
9/13/2021	21.66667	17.77778	27.22222	16.11111
9/14/2021	28.88889	17.77778	23.33333	17.22222
9/15/2021	24.44444	11.66667	28.33333	12.77778
9/16/2021	25.55556	10.55556	24.44444	7.777778
9/17/2021	32.22222	17.22222	27.22222	10.55556
9/18/2021	23.33333	13.33333	31.11111	11.66667
9/19/2021	25.55556	13.88889	23.88889	9.444444
9/20/2021	25	21.11111	28.88889	13.88889
9/21/2021	24.44444	15	27.22222	15
9/22/2021	17.22222	13.33333	18.88889	11.66667
9/23/2021	19.44444	10.55556	17.77778	8.888889
9/24/2021	26.66667	11.66667	18.88889	9.444444
9/25/2021	20.55556	8.888889	25.55556	8.333333
9/26/2021	30	11.66667	20.55556	8.888889
9/27/2021	27.22222	16.11111	28.33333	11.11111
9/28/2021	20	11.11111	28.88889	7.777778
9/29/2021	23.33333	10	21.66667	6.111111
9/30/2021	22.77778	11.11111	25.55556	7.222222

10/1/2021	25.55556	11.66667	24.44444	8.333333
10/2/2021	26.66667	18.88889	14.44444	16.11111
10/3/2021	23.33333	17.77778	26.11111	17.22222
10/4/2021	20	17.77778	23.88889	16.66667
10/5/2021	18.88889	17.22222	20.55556	15.55556
10/6/2021	18.88889	16.11111	17.77778	13.88889
10/7/2021	20	16.66667	20	16.11111
10/8/2021	22.77778	15	20.55556	12.77778
10/9/2021	22.77778	16.11111	22.77778	13.33333
10/10/2021	22.77778	19.44444	24.44444	15.55556
10/11/2021	23.33333	17.22222	21.66667	17.77778
10/12/2021	18.33333	15	23.88889	15.55556
10/13/2021	19.44444	11.66667	17.22222	9.444444
10/14/2021	22.22222	9.444444	20.55556	11.11111
10/15/2021	16.11111	7.777778	20.55556	4.444444
10/16/2021	10	8.888889	13.88889	5
10/17/2021	15.55556	6.111111	14.44444	2.222222
10/18/2021	15.55556	6.111111	18.33333	1.666667
10/19/2021	15	5.555556	21.66667	4.444444
10/20/2021	21.66667	10	22.22222	6.666667
10/21/2021	17.77778	5	22.77778	9.444444
10/22/2021	12.22222	3.333333	10.55556	0.555556
10/23/2021	12.22222	1.111111	11.11111	-0.55556
10/24/2021	12.22222	0.555556	11.66667	-2.22222
10/25/2021	12.22222	8.888889	10	-0.55556
10/26/2021	13.33333	5.555556	11.11111	2.222222
10/27/2021	12.77778	8.888889	12.22222	-0.55556
10/28/2021	13.88889	11.11111	11.66667	1.666667
10/29/2021	13.33333	11.66667	11.66667	10
10/30/2021	14.44444	7.222222	11.66667	8.333333
10/31/2021	11.66667	2.777778	15	3.333333
11/1/2021	8.888889	0.555556	10.55556	-0.55556
11/2/2021	7.222222	0	8.333333	-1.11111
11/3/2021	6.111111	-2.77778	6.666667	-6.11111
11/4/2021	9.444444	-2.77778	5	-6.11111
11/5/2021	11.66667	2.222222	8.333333	-3.88889
11/6/2021	16.11111	3.888889	10.55556	-3.88889
11/7/2021	18.88889	7.777778	15	2.777778
11/8/2021	18.88889	8.888889	17.77778	6.666667
11/9/2021	13.88889	2.222222	18.33333	5.555556
11/10/2021	12.77778	-0.55556	13.88889	-3.88889
11/11/2021	13.33333	4.444444	12.22222	0.555556
11/12/2021	5	0.555556	11.11111	1.111111

11/13/2021	5	0.555556	2.777778	0
11/14/2021	2.777778	-0.55556	3.333333	-0.55556
11/15/2021	1.111111	-6.11111	1.666667	-3.88889
11/16/2021	11.66667	-6.11111	0.555556	-7.22222
11/17/2021	16.11111	3.888889	15	-3.88889
11/18/2021	3.333333	-1.11111	11.66667	-2.22222
11/19/2021	3.888889	-4.44444	0	-6.66667
11/20/2021	9.444444	-0.55556	2.777778	-4.44444
11/21/2021	11.66667	-2.22222	8.333333	-4.44444
11/22/2021	1.666667	-6.11111	10.55556	-6.66667
11/23/2021	6.666667	-6.66667	0.555556	-10
11/24/2021	10	3.333333	5.555556	-3.88889
11/25/2021	8.333333	-6.11111	9.444444	3.888889
11/26/2021	-2.22222	-9.44444	4.444444	-10
11/27/2021	3.888889	-2.22222	-1.11111	-9.44444
11/28/2021	3.888889	-3.88889	3.888889	-3.33333
11/29/2021	4.444444	-3.88889	3.333333	-10
11/30/2021	9.444444	-2.77778	3.333333	-3.33333
12/1/2021	10.55556	-2.22222	8.888889	-5.55556
12/2/2021	12.22222	3.888889	9.444444	2.777778
12/3/2021	6.666667	1.111111	10.55556	0.555556
12/4/2021	3.333333	0	5.555556	-1.66667
12/5/2021	4.444444	0.555556	2.777778	-1.11111
12/6/2021	2.222222	-11.1111	2.777778	-1.11111
12/7/2021	-4.44444	-12.7778	0.555556	-14.4444
12/8/2021	-1.11111	-4.44444	-4.44444	-12.7778
12/9/2021	5.555556	-5	1.111111	-7.22222
12/10/2021	7.777778	0.555556	3.333333	-1.66667
12/11/2021	11.66667	-0.55556	10.55556	-1.11111
12/12/2021	9.444444	-0.55556	3.333333	-1.66667
12/13/2021	10.55556	-1.66667	7.777778	0.555556
12/14/2021	8.888889	-2.77778	8.333333	-5
12/15/2021	19.44444	8.333333	11.66667	-2.77778
12/16/2021	19.44444	-1.11111	18.33333	2.222222
12/17/2021	2.777778	-5	2.777778	-6.11111
12/18/2021	3.333333	-2.77778	1.666667	-5.55556
12/19/2021	2.777778	-2.22222	1.111111	-3.88889
12/20/2021	5	-2.77778	1.111111	-3.88889
12/21/2021	4.444444	-6.66667	3.333333	-10
12/22/2021	-1.66667	-8.88889	2.777778	-10.5556
12/23/2021	4.444444	-4.44444	-2.77778	-10
12/24/2021	9.444444	-4.44444	3.888889	-7.22222
12/25/2021	9.444444	-3.33333	8.888889	1.666667

12/26/2021	5	-6.11111	7.222222	-8.88889
12/27/2021	6.111111	-1.11111	3.888889	-6.66667
12/28/2021	3.333333	-3.33333	3.333333	-3.88889
12/29/2021	3.333333	-2.77778	1.666667	-3.33333
12/30/2021	2.777778	-3.88889	-1.66667	-5.55556
12/31/2021	3.333333	0	1.111111	-4.44444
1/1/2022	2.222222	-6.66667	2.222222	-4.44444
1/2/2022	-4.44444	-12.2222	-3.88889	-10.5556
1/3/2022	-5	-16.1111	-5.55556	-20.5556
1/4/2022	1.111111	-10.5556	-6.66667	-16.1111
1/5/2022	1.111111	-10.5556	1.111111	-8.88889
1/6/2022	-8.88889	-14.4444	-8.88889	-13.8889
1/7/2022	-8.33333	-17.7778	-9.44444	-19.4444
1/8/2022	0	-11.1111	-7.22222	-18.3333
1/9/2022	0	-12.7778	-0.55556	-7.22222
1/10/2022	-11.6667	-17.7778	-2.22222	-15
1/11/2022	2.777778	-17.7778	-12.7778	-19.4444
1/12/2022	5.555556	0.555556	2.777778	-16.6667
1/13/2022	4.444444	0.555556	5.555556	-1.11111
1/14/2022	1.111111	-5	4.444444	-2.77778
1/15/2022	-4.44444	-6.66667	-2.77778	-7.77778
1/16/2022	-2.77778	-10	-5.55556	-15.5556
1/17/2022	-1.66667	-5.55556	-3.33333	-12.7778
1/18/2022	6.111111	-5.55556	-3.33333	-10
1/19/2022	3.888889	-12.2222	5	-7.77778
1/20/2022	-8.88889	-15.5556	-7.77778	-17.2222
1/21/2022	-3.33333	-15	-9.44444	-18.8889
1/22/2022	-0.55556	-7.22222	-4.44444	-17.7778
1/23/2022	-6.66667	-15	-1.11111	-13.8889
1/24/2022	-6.11111	-12.7778	-9.44444	-19.4444
1/25/2022	-12.2222	-18.8889	-6.66667	-19.4444
1/26/2022	-9.44444	-22.7778	-12.7778	-25
1/27/2022	0.555556	-9.44444	-5.55556	-22.7778
1/28/2022	-5	-12.2222	1.111111	-15
1/29/2022	-5	-13.3333	-6.11111	-18.3333
1/30/2022	-1.11111	-11.6667	-4.44444	-18.3333
1/31/2022	1.111111	-8.33333	-0.55556	-13.3333
2/1/2022	7.777778	-0.55556	2.777778	-12.7778
2/2/2022	-0.55556	-8.33333	6.666667	-9.44444
2/3/2022	-5	-10.5556	-7.77778	-12.7778
2/4/2022	-4.44444	-13.3333	-6.66667	-15.5556
2/5/2022	-4.44444	-16.1111	-5	-17.2222
2/6/2022	3.333333	-7.22222	-5	-15.5556

2/7/2022	-1.11111	-10	2.222222	-7.77778
2/8/2022	3.888889	-6.66667	-3.33333	-10.5556
2/9/2022	5.555556	0	5	-7.77778
2/10/2022	0	-3.88889	4.444444	-4.44444
2/11/2022	7.222222	-5.55556	2.777778	-4.44444
2/12/2022	-5.55556	-12.2222	6.111111	-13.3333
2/13/2022	-7.77778	-12.7778	-8.88889	-13.8889
2/14/2022	-3.33333	-11.6667	-8.88889	-13.8889
2/15/2022	2.222222	-10	-3.88889	-12.7778
2/16/2022	12.22222	1.666667	8.888889	-6.11111
2/17/2022	1.666667	-8.88889	10.55556	-3.33333
2/18/2022	0	-13.8889	-2.77778	-15
2/19/2022	-6.66667	-15	-1.66667	-16.1111
2/20/2022	10.55556	-7.77778	-0.55556	-15.5556
2/21/2022	5	0	9.444444	-2.22222
2/22/2022	2.222222	-6.11111	3.888889	-2.22222
2/23/2022	-4.44444	-11.1111	-1.11111	-12.7778
2/24/2022	-2.22222	-5.55556	-6.66667	-11.6667
2/25/2022	-2.22222	-8.88889	-4.44444	-12.2222
2/26/2022	-1.66667	-12.7778	-1.66667	-17.7778
2/27/2022	3.333333	-4.44444	-1.11111	-12.7778
2/28/2022	9.444444	-5	3.333333	-7.77778
3/1/2022	7.777778	-2.77778	8.888889	0
3/2/2022	9.444444	-3.88889	7.777778	-4.44444
3/3/2022	0	-4.44444	9.444444	-6.11111
3/4/2022	3.333333	-6.11111	-0.55556	-7.22222
3/5/2022	17.77778	2.222222	4.444444	-1.11111
3/6/2022	12.77778	1.111111	18.33333	1.111111
3/7/2022	1.666667	-2.22222	3.888889	-2.22222
3/8/2022	2.777778	-6.11111	1.666667	-6.66667
3/9/2022	3.888889	-3.33333	2.777778	-4.44444
3/10/2022	-2.77778	-7.22222	3.333333	-8.33333
3/11/2022	1.111111	-10	-2.22222	-8.33333
3/12/2022	-5.55556	-13.3333	-0.55556	-14.4444
3/13/2022	10.55556	-6.11111	-4.44444	-14.4444
3/14/2022	15.55556	0	10.55556	-5
3/15/2022	5	-1.11111	15.55556	0
3/16/2022	21.11111	-2.22222	10.55556	-4.44444
3/17/2022	19.44444	7.777778	20	0.555556
3/18/2022	7.777778	2.777778	19.44444	2.777778
3/19/2022	6.111111	2.222222	5	1.666667
3/20/2022	12.77778	0	5	-2.77778
3/21/2022	15	0.555556	16.11111	-0.55556

3/22/2022	7.222222	4.444444	22.77778	4.444444
3/23/2022	7.777778	-1.11111	7.777778	4.444444
3/24/2022	7.777778	-1.11111	10	2.777778
3/25/2022	8.333333	1.666667	3.333333	1.111111
3/26/2022	1.666667	-3.88889	7.222222	-2.22222
3/27/2022	0.555556	-6.11111	-1.66667	-7.22222
3/28/2022	0	-6.66667	0	-8.88889
3/29/2022	4.444444	-2.22222	1.111111	-7.22222
3/30/2022	11.66667	3.333333	7.777778	-1.66667
3/31/2022	4.444444	0	15	0
4/1/2022	5	-2.22222	1.666667	-3.33333
4/2/2022	5	-0.55556	6.666667	-3.88889
4/3/2022	5.555556	-0.55556	3.888889	-0.55556
4/4/2022	10	2.777778	6.111111	0.555556
4/5/2022	8.888889	3.333333	8.333333	2.777778
4/6/2022	13.88889	6.111111	8.888889	3.333333
4/7/2022	7.222222	3.333333	12.77778	2.777778
4/8/2022	3.888889	0	6.111111	1.666667
4/9/2022	6.111111	0	3.888889	-1.66667
4/10/2022	11.11111	-1.66667	8.888889	-4.44444
4/11/2022	16.66667	5.555556	14.44444	-1.66667
4/12/2022	15	0.555556	16.11111	-1.66667
4/13/2022	21.11111	4.444444	19.44444	7.222222
4/14/2022	8.333333	1.666667	20.55556	0.555556
4/15/2022	8.333333	1.666667	7.222222	1.666667
4/16/2022	7.222222	-1.66667	7.222222	-3.33333
4/17/2022	3.333333	-2.22222	7.777778	-5
4/18/2022	4.444444	0.555556	3.888889	-0.55556
4/19/2022	8.333333	2.222222	3.333333	0
4/20/2022	10	4.444444	8.888889	1.666667
4/21/2022	20.55556	6.666667	9.444444	4.444444
4/22/2022	7.777778	5.555556	19.44444	2.777778
4/23/2022	25	6.666667	10.55556	5
4/24/2022	23.33333	11.11111	27.77778	10.55556
4/25/2022	11.11111	5.555556	20.55556	7.222222
4/26/2022	7.777778	0.555556	10	0.555556
4/27/2022	3.333333	0	7.222222	-2.22222
4/28/2022	7.222222	3.333333	4.444444	0
4/29/2022	12.22222	6.111111	6.666667	2.222222
4/30/2022	15	7.222222	13.33333	6.111111
5/1/2022	12.77778	9.444444	15	7.222222
5/2/2022	12.22222	7.222222	10	7.222222
5/3/2022	8.333333	4.444444	11.66667	5.555556

5/4/2022	11.11111	2.777778	6.666667	1.666667
5/5/2022	11.66667	2.222222	11.11111	1.111111
5/6/2022	8.888889	6.111111	12.22222	5
5/7/2022	15.55556	5.555556	11.11111	3.888889
5/8/2022	13.33333	6.666667	16.66667	1.666667
5/9/2022	20	8.333333	13.88889	8.333333
5/10/2022	24.44444	12.77778	23.88889	12.22222
5/11/2022	29.44444	10	31.11111	20
5/12/2022	27.22222	12.77778	30.55556	13.88889
5/13/2022	26.11111	15	31.66667	13.88889
5/14/2022	27.22222	15	30.55556	15
5/15/2022	22.22222	11.11111	30	15
5/16/2022	25	8.888889	23.88889	10.55556
5/17/2022	15.55556	7.222222	24.44444	5
5/18/2022	12.22222	6.666667	17.77778	8.333333
5/19/2022	23.88889	6.111111	14.44444	6.111111
5/20/2022	26.11111	15	26.11111	14.44444
5/21/2022	17.22222	9.444444	25	11.11111
5/22/2022	16.66667	7.222222	15.55556	8.333333
5/23/2022	14.44444	5.555556	16.66667	3.333333
5/24/2022	16.11111	8.888889	15	7.222222
5/25/2022	17.77778	10	16.11111	8.888889
5/26/2022	24.44444	10.55556	19.44444	10
5/27/2022	15.55556	8.333333	24.44444	10
5/28/2022	20	8.333333	16.11111	6.111111
5/29/2022	23.33333	12.22222	22.77778	10.55556
5/30/2022	28.88889	20	27.77778	18.88889
5/31/2022	28.88889	22.22222	31.11111	22.22222
6/1/2022	22.77778	12.22222	27.77778	16.66667
6/2/2022	23.88889	10.55556	21.11111	9.444444
6/3/2022	25.55556	9.444444	24.44444	10.55556
6/4/2022	19.44444	7.777778	25	5.555556
6/5/2022	20	12.22222	18.33333	8.888889
6/6/2022	21.66667	11.66667	20.55556	12.22222
6/7/2022	18.33333	11.11111	23.88889	11.11111
6/8/2022	15.55556	9.444444	21.66667	11.66667
6/9/2022	25	8.333333	16.66667	8.333333
6/10/2022	24.44444	14.44444	24.44444	8.333333
6/11/2022	22.22222	13.88889	23.33333	13.88889
6/12/2022	17.22222	11.66667	21.66667	12.22222
6/13/2022	22.77778	11.66667	18.33333	10
6/14/2022	36.11111	17.77778	27.22222	16.11111
6/15/2022	34.44444	22.77778	36.11111	21.66667

6/16/2022	32.77778	20.55556	35	18.88889
6/17/2022	28.88889	14.44444	32.22222	17.77778
6/18/2022	18.88889	11.11111	27.77778	9.444444
6/19/2022	24.44444	10	20.55556	7.222222
6/20/2022	32.22222	18.33333	27.77778	16.66667
6/21/2022	37.77778	22.77778	33.88889	21.66667
6/22/2022	30.55556	18.33333	36.66667	20.55556
6/23/2022	25.55556	15.55556	29.44444	12.77778
6/24/2022	30	18.33333	27.77778	12.77778
6/25/2022	22.77778	18.88889	32.22222	15.55556
6/26/2022	26.66667	16.66667	21.11111	18.88889
6/27/2022	25	13.88889	26.11111	12.22222
6/28/2022	30.55556	13.88889	25	9.444444
6/29/2022	26.11111	17.22222	30	16.11111
6/30/2022	33.88889	20	26.66667	16.11111
7/1/2022	26.11111	16.66667	32.77778	22.77778
7/2/2022	27.77778	16.66667	26.11111	13.33333
7/3/2022	26.66667	16.11111	29.44444	13.88889
7/4/2022	28.88889	19.44444	28.88889	15.55556
7/5/2022	28.33333	20.55556	29.44444	21.66667
7/6/2022	22.77778	17.77778	29.44444	18.33333
7/7/2022	27.77778	16.66667	25	15.55556
7/8/2022	22.77778	19.44444	28.88889	17.77778
7/9/2022	23.88889	15	22.22222	13.88889
7/10/2022	27.22222	13.33333	24.44444	10
7/11/2022	31.66667	18.33333	28.88889	17.22222
7/12/2022	29.44444	18.88889	30.55556	17.77778
7/13/2022	23.33333	16.11111	28.33333	17.22222
7/14/2022	24.44444	13.88889	25	12.22222
7/15/2022	23.88889	13.88889	25.55556	11.66667
7/16/2022	22.77778	17.77778	23.33333	16.11111
7/17/2022	26.66667	18.33333	21.66667	16.66667
7/18/2022	31.66667	17.22222	26.66667	13.33333
7/19/2022	30.55556	22.22222	31.11111	18.88889
7/20/2022	30	23.88889	30.55556	23.33333
7/21/2022	33.33333	20	28.88889	18.88889
7/22/2022	32.77778	19.44444	32.77778	16.66667
7/23/2022	31.66667	20.55556	31.66667	19.44444
7/24/2022	30	19.44444	31.11111	20.55556
7/25/2022	23.88889	15.55556	29.44444	13.88889
7/26/2022	26.11111	17.22222	24.44444	14.44444
7/27/2022	29.44444	20	26.11111	16.66667
7/28/2022	27.22222	15.55556	28.88889	18.33333

7/29/2022	27.22222	15.55556	26.66667	12.77778
7/30/2022	27.77778	16.66667	26.66667	12.22222
7/31/2022	28.88889	17.77778	27.77778	13.33333
8/1/2022	30	20.55556	29.44444	16.66667
8/2/2022	26.66667	17.22222	29.44444	13.88889
8/3/2022	29.44444	23.88889	28.88889	20.55556
8/4/2022	25.55556	17.77778	29.44444	18.88889
8/5/2022	28.88889	16.11111	27.22222	13.88889
8/6/2022	31.66667	22.22222	30.55556	18.33333
8/7/2022	28.88889	20	34.44444	22.22222
8/8/2022	25.55556	17.22222	27.22222	22.22222
8/9/2022	23.88889	14.44444	23.33333	13.33333
8/10/2022	30	15.55556	24.44444	11.11111
8/11/2022	24.44444	13.88889	28.88889	15
8/12/2022	23.33333	13.88889	24.44444	9.444444
8/13/2022	26.11111	19.44444	22.77778	13.88889
8/14/2022	21.11111	17.77778	24.44444	18.33333
8/15/2022	25	17.22222	19.44444	16.11111
8/16/2022	25	16.66667	25.55556	12.77778
8/17/2022	26.11111	15.55556	26.11111	13.88889
8/18/2022	28.88889	15	26.66667	11.11111
8/19/2022	29.44444	19.44444	28.88889	14.44444
8/20/2022	25	18.33333	28.88889	16.66667
8/21/2022	24.44444	18.33333	24.44444	17.77778
8/22/2022	26.66667	16.66667	25	12.77778
8/23/2022	28.33333	17.22222	26.66667	13.33333
8/24/2022	29.44444	18.33333	28.33333	13.33333

APPENDIX E: Proxy Water Sample Data

Isotope Data

Table E.1 Stream Water Sample Data from 7/16/21 – 8/24/22 for all discrete grab samples across the watershed. Date, represents when the sample was collected. Additionally, the date has A, B, or C to represent duplicates. Site, represents where the sample was taken with a 1, 2, Q, D, RW for site 1, site 2, Quarry Lake, Drain, and Rain Water, respectively. Data provided for stable water isotopes and d-excess values. If a "-" is present the sample was not taken due to availability or safety reasons or analysis yielded results below detectable limits.

Date	Site	δ^2H-H_2O	δ^{18}O-H_2O	d-excess
7/16 A	1	-6.852490	-49.66216	5.157762
7/16 B	1	-6.754092	-49.13724	4.895499
7/16 1 C	1	-6.774966	-49.1915	5.008188
7/16 2 A	2	-7.056949	-49.69234	6.763248
7/16 2 B	2	-7.102558	-49.99003	6.83044
7/16 2 C	2	-7.132542	-50.29755	6.762787
7/16 Q A	Q	-1.687937	-27.44876	-13.9453
7/19 1 A	1	-6.689227	-48.46815	5.045669
7/19 1 B	1	-6.723429	-48.27746	5.509972
7/19 2 A	2	-6.376465	-45.193	5.818717
7/19 2 B	2	-6.286746	-44.97863	5.315342
7/19 Q A	Q	-2.025378	-28.091	-11.888
7/21 1 A	1	-6.58921	-47.46309	5.250591
7/21 1 B	1	-6.482255	-46.788	5.070045
7/21 2 A	2	-6.495699	-47.21177	4.753825
7/21 2 B	2	-6.573387	-47.3382	5.248895
7/21 Q A	Q	-1.853949	-27.12405	-12.2925
7/21 D A	D	-8.517839	-57.99328	10.14943
7/23 1 A	1	-6.523074	-46.42771	5.756882
7/23 1 B	1	-6.466779	-45.87852	5.85571
7/23 2 A	2	-6.728015	-48.60495	5.219173
7/23 2 B	2	-6.625006	-48.40333	4.596712
7/23 Q A	Q	-1.76333	-26.71191	-12.6053
7/23 D A	D	-8.692376	-58.41786	11.12115
7/26 1 A	1	-6.125321	-43.87252	5.130051

7/26 1 B	1	-6.131254	-43.58042	5.469616
7/26 2 A	2	-6.718287	-48.25495	5.491346
7/26 2 B	2	-6.682925	-48.1628	5.300604
7/26 Q A	Q	-1.840348	-26.79751	-12.0747
7/26 D A	D	-8.514867	-56.74834	11.3706
7/28 1 A	1	-5.949478	-42.64949	4.946339
7/28 1 B	1	-5.816911	-41.94818	4.58711
7/28 2 A	2	-6.646184	-48.2692	4.900279
7/28 2 B	2	-6.620708	-48.1752	4.790461
7/28 Q A	Q	-1.762556	-27.01153	-12.9111
7/28 D A	D	-8.383188	-56.97895	10.08655
8/9 1 A	1	-6.243499	-44.00817	5.939824
8/9 1 B	1	-6.342309	-44.14633	6.592142
8/9 2 A	2	-6.478754	-42.76986	9.060174
8/9 2 B	2	-6.609464	-43.04926	9.826456
8/9 Q A	Q	-1.689666	-26.23845	-12.7211
8/9 D A	D	-2.905487	-12.30688	10.93702
8/9 RW1 A	RW1	-4.716674	-32.1086	5.62479
8/9 RW2 A	RW2	-4.42371	-24.97985	10.40984
8/11 1 A	1	-5.099131	-30.93199	9.86106
8/11 1 B	1	-5.015846	-30.3802	9.746573
8/11 2 A	2	-5.365523	-33.90404	9.020149
8/11 2 B	2	-5.316385	-33.926	8.605083
8/11 Q A	Q	-1.729074	-26.2794	-12.4468
8/11 D A	D	-6.656198	-44.0223	9.227292
8/11 RW1 A	RW1	-3.906494	-19.48447	11.76748
8/11 RW2 A	RW2	-3.83939	-20.25707	10.45805
8/13 1 A	1	-5.22323	-33.16834	8.617499
8/13 1 B	1	-5.171601	-32.65149	8.721315
8/13 2 A	2	-5.452691	-35.55138	8.070146
8/13 2 B	2	-5.471335	-35.66206	8.108619
8/13 Q A	Q	-1.737333	-25.94424	-12.0456
8/13 D A	D	-7.23699	-48.25177	9.644153
8/13 RW1 A	RW1	-1.173958	-2.427223	6.964443
8/16 1 A	1	-4.571541	-29.42315	7.149175
8/16 1 B	1	-4.503103	-28.29059	7.734238
8/16 2 A	2	-5.267005	-36.72915	5.406893
8/16 2 B	2	-5.336278	-37.00655	5.683666

8/16 Q A	Q	-1.612032	-25.72606	-12.8298
8/16 D A	D	-7.809808	-53.19628	9.282185
8/28 1 A	1	-5.013105	-35.55422	4.55062
8/28 1 B	1	-5.040585	-35.21613	5.10855
8/28 2 A	2	-4.77797	-30.40454	7.819224
8/28 2 B	2	-4.699473	-30.04053	7.555248
8/28 Q A	Q	-1.407353	-24.62849	-13.3697
8/28 D A	D	-8.119435	-54.04332	10.91216
8/28 RW1 A	RW1	-1.897694	-5.764326	9.417225
9/3 1 A	1	-5.004204	-35.82958	4.204057
9/3 1 B	1	-5.009714	-35.44179	4.635923
9/3 2 A	2	-6.168756	-44.37728	4.972764
9/3 2 B	2	-6.315613	-44.75506	5.76984
9/3 Q A	Q	-1.421549	-24.78051	-13.4081
9/3 D A	D	-7.453811	-52.05364	7.576856
9/10 1 A	1	-5.05758	-36.70598	3.754656
9/10 1 B	1	-4.975057	-35.89991	3.900544
9/10 2 A	2	-6.802315	-48.1234	6.295114
9/10 2 B	2	-6.798356	-48.15394	6.232915
9/10 Q A	Q	-1.511375	-25.25958	-13.1686
9/10 D A	D	-8.045675	-54.20162	10.16378
10/8 1 A	1	-6.150234	-43.51279	5.689088
10/8 1 B	1	-6.031094	-42.73936	5.509394
10/8 2 A	2	-7.33756	-48.495	10.20548
10/8 2 B	2	-7.347019	-48.34842	10.42774
10/8 Q A	Q	-1.666392	-26.08698	-12.7558
10/8 D A	D	-7.431315	-47.29054	12.15997
10/8 RW 1	RW1	-6.631702	-40.27203	12.78159
10/8 RW 2	RW2	-7.232429	-43.82626	14.03317
10/22 1 A	1	-6.369522	-44.04831	6.907873
10/22 1 B	1	-6.399244	-43.39015	7.803803
10/22 2 A	2	-6.953379	-47.87215	7.75488
10/22 2 B	2	-6.90202	-47.69514	7.521016
10/22 Q A	Q	-1.804718	-26.56763	-12.1299
10/22 D A	D	-7.503828	-51.99066	8.03997
10/22 RW 1	RW1	-4.181874	-25.75225	7.702734
11/12 1 A	1	-8.239744	-56.2478	9.670158

11/12 1 B	1	-8.24209	-56.10577	9.830958
11/12 2 A	2	-8.021178	-54.6818	9.487628
11/12 2 B	2	-7.939216	-54.43656	9.077172
11/12 Q A	Q	-2.129805	-28.06656	-11.0281
11/12 D A	D	-9.205633	-61.78444	11.86063
11/12 RW 1	RW1	-11.8907	-79.64594	15.47965
11/12 RW 2	RW2	-11.23429	-73.19405	16.68024
1/21 1 A	1	-9.140475	-61.78506	11.33873
1/21 1 B	1	-9.101861	-61.16079	11.6541
1/21 2 A	2	-8.766255	-58.79947	11.33057
1/21 2 B	2	-8.670674	-58.53747	10.82792
1/21 Q A	Q	-3.303357	-33.43142	-7.00457
1/21 D A	D	-8.718226	-59.17466	10.57115
2/4 1 A	1	-8.974597	-60.58158	11.2152
2/4 1 B	1	-8.917855	-60.13416	11.20869
2/4 2 A	2	-8.607326	-58.61872	10.23989
2/4 2 B	2	-8.639153	-58.66723	10.44599
2/4 D A	D	-9.891167	-68.85137	10.27797
2/18 1 A	1	-9.06927	-62.19965	10.35451
2/18 1 B	1	-8.951326	-61.46037	10.15023
2/18 2 A	2	-9.965791	-68.33312	11.39321
2/18 2 B	2	-10.32046	-71.00828	11.55537
2/18 Q A	Q	-3.993144	-39.73021	-7.78506
2/18 D A	D	-10.30442	-69.9679	12.46747
3/4 1 A	1	-9.492464	-61.40858	14.53113
3/4 1 B	1	-9.342273	-60.66407	14.07411
3/4 2 A	2	-8.90621	-58.34243	12.90725
3/4 2 B	2	-8.903237	-58.26068	12.96522
3/4 D A	D	-9.741116	-65.34351	12.58542
3/18 1 A	1	-8.487078	-56.82603	11.0706
3/18 1 B	1	-8.42331	-56.3685	11.01798
3/18 2 A	2	-8.256569	-55.60986	10.44269
3/18 2 B	2	-8.318801	-55.62331	10.9271
3/18 Q A	Q	-2.57697	-30.03642	-9.42066
3/18 D A	D	-9.0937	-61.68657	11.06303

4/1 1 A	1	-8.970842	-61.11861	10.64812
4/1 1 B	1	-8.89914	-60.76996	10.42315
4/1 2 A	2	-8.881006	-59.79104	11.25701
4/1 2 B	2	-8.848674	-59.70941	11.07998
4/1 Q A	Q	-2.31091	-29.80371	-11.3164
4/1 D A	D	-9.491486	-65.62534	10.30655
4/1 RW 1	RW1	-9.26445	-64.33451	9.781091
4/1 RW 2	RW2	-8.909877	-61.54434	9.734673
4/1 1 A	1	-8.910775	-60.87958	10.40662
4/1 1 B	1	-8.848571	-60.44222	10.34635
4/1 2 A	2	-8.651572	-58.4759	10.73668
4/1 2 B	2	-8.663153	-58.50697	10.79825
4/1 Q A	Q	-2.616486	-31.00105	-10.0692
4/1 D A	D	-9.36829	-62.98239	11.96393
4/1 RW 1	RW1	-9.534724	-68.07364	8.204151
4/1 RW 2	RW2	-11.56608	-81.03633	11.49231
5/6 1 A	1	-8.230638	-54.03671	11.8084
5/6 1 B	1	-8.129517	-53.15882	11.87732
5/6 2 A	2	-7.818036	-50.68211	11.86218
5/6 2 B	2	-7.78604	-50.54288	11.74544
5/6 Q A	Q	-3.030252	-32.83841	-8.5964
5/6 D A	D	-8.944454	-59.42399	12.13164
5/6 RW 1	RW1	-5.735207	-37.51963	8.362025
5/6 RW 2	RW2	-5.895902	-34.3247	12.84252
6/6 1 A	1	-4.886825	-26.85004	12.24456
6/6 1 B	1	-6.106588	-39.18202	9.670684
6/6 2 A	2	-7.28195	-49.443	8.812602
6/6 2 B	2	-7.285181	-49.35183	8.929622
6/6 Q A	Q	-2.260482	-28.62152	-10.5377
6/6 D A	D	-4.107719	-18.82617	14.03558
6/6 RW 1	RW1	-3.700214	-23.69562	5.906084
6/6 RW 2	RW2	-4.782705	-28.79061	9.471029
6/8 1 A	1	-7.020882	-48.5301	7.636956
6/8 1 B	1	-7.004122	-48.07998	7.952992
6/8 2 A	2	-7.1315	-48.11578	8.936212
6/8 2 B	2	-7.139999	-48.13822	8.981777
6/8 Q A	Q	-2.220764	-28.51142	-10.7453
6/8 D A	D	-7.584025	-52.56231	8.109886

6/10 1 A	1	-7.202824	-49.37219	8.250401
6/10 1 B	1	-7.150669	-48.81897	8.386379
6/10 2 A	2	-7.486004	-51.10661	8.78143
6/10 2 B	2	-7.48492	-50.91721	8.962156
6/10 Q A	Q	-2.181827	-28.74768	-11.2931
6/10 D A	D	-7.833626	-54.12871	8.540298
6/6 RW 1	RW1	-	-	-
6/10 RW 2	RW2	-9.134376	-63.17418	9.900828
6/13 1 A	1	-7.320384	-50.71379	7.849282
6/13 1 B	1	-7.305087	-50.49696	7.943736
6/13 2 A	2	-7.389041	-50.4409	8.671435
6/13 2 B	2	-7.376274	-50.30445	8.705741
6/13 Q A	Q	-2.157496	-28.55912	-11.2992
6/13 D A	D	-8.106327	-55.77112	9.079496
6/15 1 A	1	-7.209581	-49.34935	8.327297
6/15 1 B	1	-7.184772	-49.02156	8.456619
6/15 2 A	2	-7.307489	-49.57299	8.88692
6/15 2 B	2	-7.302431	-49.59751	8.821937
6/15 Q A	Q	-2.179773	-28.64694	-11.2088
6/15 D A	D	-8.146874	-55.74704	9.42795
6/20 1 A	1	-5.597046	-37.31642	7.459951
6/20 1 B	1	-5.562242	-37.13348	7.364458
6/50 2 A	2	-7.032431	-48.21554	8.043905
6/20 2 B	2	-7.014487	-48.20316	7.912733
6/20 Q A	Q	-1.986124	-27.77486	-11.8859
6/20 D A	D	-8.267784	-56.49807	9.644198
6/6 RW 1	RW1	-	-	-
6/20 RW 2	RW2	-1.883278	-4.563341	10.50288
6/22 1 A	1	-5.85433	-40.16881	6.665829
6/22 1 B	1	-5.851575	-39.96139	6.851213
6/22 2 A	2	-6.996619	-48.00839	7.964564
6/22 2 B	2	-7.011352	-48.05241	8.038399
6/22 Q A	Q	-1.938542	-27.3372	-11.8289
6/22 D A	D	-8.306473	-56.30316	10.14863
6/27 1 A	1	-6.053275	-43.04781	5.378394
6/27 1 B	1	-6.101544	-42.96308	5.849273
6/27 2 A	2	-7.201673	-49.75392	7.859465
6/27 2 B	2	-7.213411	-49.77718	7.930111

6/27 Q A	Q	-1.944411	-27.47402	-11.9187
6/27 D A	D	-8.385884	-57.02546	10.06161
6/29 1 A	1	-6.105411	-44.01405	4.829236
6/29 1 B	1	-6.07699	-43.49869	5.117229
6/29 2 A	2	-7.081184	-49.40496	7.244519
6/29 2 B	2	-7.090738	-49.35828	7.367621
6/29 Q A	Q	-1.761379	-26.91564	-12.8246
6/29 D A	D	-8.377738	-57.16736	9.854548
7/1 1 A	1	-5.967346	-43.73854	4.00023
7/1 1 B	1	-5.8647	-43.15795	3.759646
7/1 2 A	2	-6.706323	-48.02494	5.625648
7/1 2 B	2	-6.71234	-48.01614	5.682575
7/1 Q A	Q	-1.617356	-26.43336	-13.4945
7/1 D A	D	-8.083316	-55.82109	8.845441
7/8 1 A	1	-4.606695	-28.89692	7.956647
7/8 1 B	1	-4.489892	-27.6287	8.290431
7/8 2 A	2	-6.192969	-42.67781	6.865938
7/8 2 B	2	-6.151673	-42.40942	6.803963
7/8 Q A	Q	-1.690324	-26.44563	-12.923
7/8 D A	D	-7.322952	-51.20796	7.375652
7/11 1 A	1	-4.496014	-29.56236	6.405756
7/11 1 B	1	-4.555316	-29.54357	6.898961
7/11 2 A	2	-6.264756	-44.46473	5.653319
7/11 2 B	2	-6.287084	-44.59958	5.697097
7/11 Q A	Q	-1.584204	-26.01278	-13.3391
7/11 D A	D	-7.049729	-49.79443	6.603401
7/13 1 A	1	-4.733532	-32.15513	5.713128
7/13 1 B	1	-4.648273	-31.62718	5.559003
7/13 2 A	2	-6.74002	-47.57663	6.343528
7/13 2 B	2	-6.133387	-46.30149	2.765607
7/13 Q A	Q	-1.726266	-26.52245	-12.7123
7/13 D A	D	-7.623552	-53.44151	7.546908
7/15 1 A	1	-7.55585	-50.3778	10.06901
7/15 1 B	1	-6.196881	-42.12203	7.453019
7/15 2 A	2	-6.721541	-47.92681	5.845518
7/15 2 B	2	-6.641693	-47.78834	5.345202
7/15 Q A	Q	-1.671912	-26.65711	-13.2818

7/15 D A	D	-7.992726	-53.06221	10.8796
7/15 RW 1	RW1	-8.402425	-55.98053	11.23888
7/15 RW 2	RW2	-7.698469	-53.7821	7.805651
7/18 1 A	1	-5.382999	-39.07483	3.989157
7/18 1 B	1	-5.400199	-38.87774	4.323856
7/18 2 A	2	-6.950855	-49.06253	6.544317
7/18 2 B	2	-6.974791	-49.16292	6.635408
7/18 Q A	Q	-1.62712	-26.36112	-13.3442
7/18 D A	D	-7.682281	-53.40654	8.051705
7/18 RW 1	RW1	-7.844539	-54.03321	8.723108
7/20 1 A	1	-5.549227	-39.40889	4.984924
7/20 1 B	1	-5.548986	-39.25836	5.133532
7/20 2 A	2	-6.777892	-48.23376	5.989374
7/20 2 B	2	-6.78126	-48.23388	6.016198
7/20 Q A	Q	-1.645042	-26.2213	-13.061
7/20 D A	D	-7.944492	-54.3251	9.230837
7/27 1 A	1	-5.337799	-37.0618	5.640593
7/27 1 B	1	-5.31208	-36.93807	5.558575
7/27 2 A	2	-5.656639	-39.00937	6.243738
7/27 2 B	2	-5.671061	-39.11395	6.254536
7/27 Q A	Q	-1.533233	-25.78122	-13.5154
7/27 D A	D	-7.522928	-51.94605	8.237376
7/27 RW 1	RW1	-2.04941	-10.41192	5.983357
7/27 RW 2	RW2	-2.162981	-7.889711	9.414134
7/29 1 A	1	-4.730525	-31.4243	6.419896
7/29 1 B	1	-4.699278	-31.03229	6.561933
7/29 2 A	2	-5.761677	-41.35408	4.73934
7/29 2 B	2	-5.733555	-41.50136	4.367074
7/29 Q A	Q	-1.492371	-25.62667	-13.6877
7/29 D A	D	-7.689739	-53.4445	8.073411
8/1 1 A	1	-4.436376	-29.1005	6.390509
8/1 1 B	1	-4.3926	-28.59377	6.547034
8/1 2 A	2	-6.429643	-46.59902	4.838122
8/1 2 B	2	-6.448885	-46.6479	4.94318
8/1 Q A	Q	-1.507932	-25.64	-13.5765
8/1 D A	D	-8.000179	-54.7785	9.22293
8/5 1 A	1	-4.270531	-29.65695	4.507296

8/5 1 B	1	-4.254656	-29.15858	4.878667
8/5 2 A	2	-6.571435	-47.39988	5.1716
8/5 2 B	2	-6.571435	-47.58966	4.981813
8/5 Q A	Q	-1.49314	-25.53005	-13.5849
8/5 D A	D	-7.5825	-52.80785	7.85215
8/8 1 A	1	-4.161472	-29.93976	3.352018
8/8 1 B	1	-4.189894	-30.10256	3.416593
8/8 2 A	2	-6.407674	-45.71315	5.548244
8/8 2 B	2	-6.456964	-45.71613	5.93958
8/8 Q A	Q	-1.419138	-25.43535	-14.0823
8/8 D A	D	-4.094674	-27.76538	4.992005
8/8 RW 1	RW1	-3.511716	-23.38088	4.712851
8/8 RW 2	RW2	-3.220417	-18.79877	6.964571
8/10 1 A	1	-4.26089	-31.66124	2.425884
8/10 1 B	1	-4.271444	-31.39617	2.775375
8/10 2 A	2	-4.998671	-33.22754	6.761829
8/10 2 B	2	-5.026734	-33.43122	6.782645
8/10 Q A	Q	-1.457874	-25.4027	-13.7397
8/10 D A	D	-6.944101	-48.5565	6.996306
8/17 1 A	1	-4.731224	-35.77014	2.07965
8/17 1 B	1	-4.665274	-35.21741	2.104784
8/17 2 A	2	-6.561301	-46.20656	6.283853
8/17 2 B	2	-6.538394	-46.12299	6.184154
8/17 Q A	Q	-1.494016	-25.50839	-13.5563
8/17 D A	D	-7.094566	-50.4656	6.290935
8/19 1 A	1	-4.602941	-35.53322	1.290308
8/19 1 B	1	-4.649078	-35.35476	1.83786
8/19 2 A	2	-6.466174	-46.60354	5.125857
8/19 2 B	2	-6.51428	-46.70135	5.412897
8/19 Q A	Q	-1.407811	-25.07549	-13.813
8/19 D A	D	-7.743937	-53.66167	8.289825
8/22 1 A	1	-4.692856	-35.90066	1.642186
8/22 1 B	1	-4.682166	-35.60747	1.849856
8/22 2 A	2	-7.011903	-48.66776	7.427467
8/22 2 B	2	-7.059226	-48.93654	7.537263
8/22 Q A	Q	-1.48693	-25.38229	-13.4868
8/22 D A	D	-7.066312	-49.27243	7.258063
8/22 RW 1	RW1	-6.466372	-45.30825	6.42273

8/22 RW 2	RW2	-6.671397	-40.52814	12.84304
8/24 1 A	1	-4.778733	-36.40139	1.828478
8/24 1 B	1	-4.725165	-36.03057	1.770752
8/24 2 A	2	-6.478383	-45.3299	6.497165
8/24 2 B	2	-6.445113	-45.29569	6.265217
8/24 Q A	Q	-1.302925	-24.75393	-14.3305
8/24 D A	D	-7.520321	-52.24868	7.913882

Alkalinity, pH, and Total Dissolved Solids Data

Table E.2 Stream Water Sample Data from 7/16/21 – 8/24/22 for all discrete grab samples across the watershed. Date, represents when the sample was collected. Additionally, the date has A, B, or C to represent duplicates. Site, represents where the sample was taken with a 1, 2, Q, D, RW for site 1, site 2, Quarry Lake, Drain, and Rain Water, respectively. Data provided for Alkalinity (mg/L) as $CaCo_3$, pH, and Total Dissolved Solids (Mm/L). If a "-" is present the sample was not taken due to availability or safety reasons or analysis yielded results below detectable limits.

Date	**Site**	**Alkalinity [mg/L] CaCO3**	**pH**	**TDS [mg/L]**
7/16 1 A 1	1	178	8.288	-
7/16 1 B 1	1	182	8.291	-
7/16 1 C 1	1	180	8.313	-
7/16 2 A 1	2	215	8.837	-
7/16 2 B 1	2	214	8.878	-
7/16 2 C 1	2	208	8.906	-
7/16 Q A 1	Q	128	9.107	-
7/19 1 A	1	178	8.638	-
7/19 1 B	1	180	8.676	-
7/19 2 A	2	164	9.148	-
7/19 2 B	2	152	9.16	-
7/19 Q A	Q	130	9.187	-
7/21 1 A	1	273	8.567	-
7/21 1 B	1	269	8.601	-
7/21 2 A	2	240	9.288	-
7/21 2 B	2	237	9.399	-
7/21 Q A	Q	205	9.264	-
7/21 D A	D	435	8.335	-
7/23 1 A	1	275	8.396	-
7/23 1 B	1	275	8.481	-
7/23 2 A	2	235	9.443	-
7/23 2 B	2	235	9.517	-
7/23 Q A	Q	210	9.298	-
7/23 D A	D	430	8.256	-
7/26 1 A	1	265	8.344	-

7/26 1 B	1	260	8.435	-
7/26 2 A	2	233	9.543	-
7/26 2 B	2	228	9.704	-
7/26 Q A	Q	166	9.306	-
7/26 D A	D	432	8.357	-
7/28 1 A	1	172	8.388	-
7/28 1 B	1	174	8.635	-
7/28 2 A	2	135	9.666	-
7/28 2 B	2	135	9.812	-
7/28 Q A	Q	134	9.316	-
7/28 D A	D	283	8.246	-
8/9 1 A	1	-	8.088	-
8/9 1 B	1	-	8.056	-
8/9 2 A	2	-	8.057	-
8/9 2 B	2	-	8.129	-
8/9 Q A	Q	-	9.427	-
8/9 D A	D	-	8.148	-
8/9 RW 1A	RW 1	-	7.117	-
8/9RW 2A	RW 2	-	7.061	-
8/11 1 A	1	-	8.041	-
8/11 1 B	1	-	8.018	-
8/11 2 A	2	-	7.882	-
8/11 2 B	2	-	7.91	-
8/11 Q A	Q	-	9.371	-
8/11 D A	D	-	8.316	-
8/11 RW 1A	RW 1	-	6.743	-
8/11RW 2A	RW 2	-	7.015	-
8/13 1 A	1	133	8.332	-
8/13 1 B	1	125	8.468	-
8/13 2 A	2	184	8.141	-
8/13 2 B	2	178	8.165	-
8/13 Q A	Q	125	9.436	-
8/13 D A	D	272	8.409	-
8/13 RW 1A	RW 1	10	7.172	-
8/16 1 A	1	132	8.349	-
8/16 1 B	1	145	8.496	-
8/16 2 A	2	211	8.034	-
8/16 2 B	2	210	8.072	-

8/16 Q A	Q	117	8.42	-
8/16 D A	D	245	8.334	-
8/28 1 A	1	-	8.348	-
8/28 1 B	1	-	8.509	-
8/28 2 A	2	-	8.036	-
8/28 2 B	2	-	8.09	-
8/28 Q A	Q	-	9.523	-
8/28 D A	D	-	8.312	-
8/28 RW 1 A	RW 1	-	7.31	-
9/3 1 A	1	-	8.669	-
9/3 1 B	1	-	8.655	-
9/3 2 A	2	-	8.337	-
9/3 2 B	2	-	8.282	-
9/3 Q A	Q	-	9.395	-
9/3 D A	D	-	8.308	-
9/10 1 A	1	-	8.703	-
9/10 1 B	1	-	8.755	-
9/10 2 A	2	-	8.437	-
9/10 2 B	2	-	8.398	-
9/10 Q A	Q	-	9.276	-
9/10 D A	D	-	8.268	-
10/8 1 A	1	190	8.566	-
10/8 1 B	1	220	8.561	-
10/8 2 A	2	160	8.046	-
10/8 2 B	2	160	8.042	-
10/8 Q A	Q	140	9.07	-
10/8 D A	D	110	8.462	-
10/8 RW 1	RW 1	9	7.413	-
10/8 RW 2	RW 2	40	7.415	-
10/22 1 A	1	175	8.698	-
10/22 1 B	1	175	8.802	-
10/22 2 A	2	245	8.073	-
10/22 2 B	2	245	7.998	-
10/22 Q A	Q	219	8.852	-
10/22 D A	D	301	8.418	-
10/22 RW 1	RW 1	5	7.37	-
11/12 1 A	1	211	8.552	-

11/12 1 B	1	220	8.568	-
11/12 2 A	2	235	8.326	-
11/12 2 B	2	230	8.313	-
11/12 Q A	-Q	175	8.554	-
11/12 D A	D	275	8.358	-
11/12 RW 1	RW 1	10	6.771	-
11/12 RW 2	RW 2	25	6.881	-
1/21 1 A	1	-	8.229	-
1/21 1 B	1	-	8.292	-
1/21 2 A	2	-	8.003	-
1/21 2 B	2	-	7.956	-
1/21 Q A	Q	-	8.396	-
1/21 D A	D	-	7.661	-
2/4 1 A	1	385	8.158	-
2/4 1 B	1	340	8.177	-
2/4 2 A	2	270	7.959	-
2/4 2 B	2	275	7.997	-
2/4 D A	D	-	8.401	-
2/18 1 A	1	201	8.362	-
2/18 1 B	1	304	8.307	-
2/18 2 A	2	228	8.268	-
2/18 2 B	2	225	8.115	-
2/18 Q A	Q	135	8.148	-
2/18 D A	D	287	8.335	-
3/4 1 A	1	170	7.958	-
3/4 1 B	1	160	7.958	-
3/4 2 A	2	220	7.783	-
3/4 2 B	2	210	7.948	-
3/4 D A	D	290	8.178	-
3/18 1 A	1	200	8.48	-
3/18 1 B	1	195	8.51	-
3/18 2 A	2	250	8.238	-
3/18 2 B	2	250	8.209	-
3/18 Q A	Q	180	8.71	-
3/18 D A	D	340	8.479	-

4/1 1 A	1	-	8.313	-
4/1 1 B	1	-	8.305	-
4/1 2 A	2	-	8.039	-
4/1 2 B	2	-	8.137	-
4/1 Q A	Q	-	8.38	-
4/1 D A	D	-	8.431	-
4/1 RW 1	RW 1	-	7.015	-
4/1 RW 2	RW 2	-	7.015	-
4/15 1 A	1	193	8.496	-
4/15 1 B	1	200	8.435	-
4/15 2 A	2	200	8.214	-
4/15 2 B	2	186	8.203	-
4/15 Q A	Q	280	8.807	-
4/15 D A	D	310	8.412	-
4/15 RW 1	RW 1	10	7.024	-
4/15 RW 2	RW 2	7	6.917	-
5/6 1 A	1	135	8.253	-
5/6 1 B	1	140	8.257	-
5/6 2 A	2	150	8.026	-
5/6 2 B	2	155	8	-
5/6 Q A	Q	176	9.033	-
5/6 D A	D	99	8.199	-
5/6 RW 1	RW 1	10	6.975	-
5/6 RW 2	RW 2	5	6.99	-
6/6 1 A	1	131	8.087	682.335
6/6 1 B	1	190	8.281	1233.040
6/6 2 A	2	230	7.887	1505.192
6/6 2 B	2	240	8.047	1500.157
6/6 Q A	Q	175	8.884	1077.580
6/6 D A	D	80	7.598	387.431
6/6 RW 1	RW 1	20	7.04	91.968
6/6 RW 2	RW 2	10	7.063	69.095
6/8 1 A	1	290	8.409	1635.561
6/8 1 B	1	290	8.464	1645.991
6/8 2 A	2	265	8.007	1570.826
6/8 2 B	2	258	7.988	1578.558
6/8 Q A	Q	180	9.142	1076.681
6/8 D A	D	340	8.292	2107.049

6/10 1 A	1	310	8.346	2138.119
6/10 1 B	1	250	8.349	2232.164
6/10 2 A	2	250	7.855	2131.849
6/10 2 B	2	275	7.995	2123.49
6/10 Q A	Q	175	9.027	1438.629
6/10 D A	D	381	8.323	2846.595
6/10 RW 1				
6/10 RW 2	RW2	8	7.059	55.03197
6/13 1 A	1	225	8.455	1559.138
6/13 1 B	1	250	8.511	1587.19
6/13 2 A	2	265	8.115	1632.864
6/13 2 B	2	270	8.126	1629.447
6/13 Q A	Q	170	9.054	1085.132
6/13 D A	D	325	8.293	2430.725
6/15 1 A	1	60	8.338	2323.391
6/15 1 B	1	130	8.32	2106.561
6/15 2 A	2	170	8.085	2156.928
6/15 2 B	2	160	8.102	2175.737
6/15 Q A	Q	140	9.039	1471.441
6/15 D A	D	42	8.187	3532.082
6/20 1 A	1	230	8.397	1924.113
6/20 1 B	1	230	8.49	1932.264
6/20 2 A	2	270	8.089	2261.423
6/20 2 B	2	275	8.13	2263.513
6/20 Q A	Q	160	9.125	1476.039
6/20 D A	D	360	8.287	3753.612
6/20 RW 1				
6/20 RW 2	RW2	11	7.568	87.65531
6/22 1 A	1	240	8.636	2010.426
6/22 1 B	1	240	8.696	2286.5018
6/22 2 A	2	295	8.081	2269.7826
6/22 2 B	2	300	8.141	2523.678
6/22 Q A	Q	155	9.097	1978.66
6/22 D A	D	380	8.308	1448.452
6/27 1 A	1	280	8.404	2169.467
6/27 1 B	1	285	8.486	2169.636
6/27 2 A	2	325	8.176	2476.638
6/27 2 B	2	300	8.175	2485.042

6/27 Q A	Q	150	8.963	1456.185
6/27 D A	D	370	8.319	3881.096
6/29 1 A	1	264	8.469	2232.164
6/29 1 B	1	290	8.607	2236.344
6/29 2 A	2	285	8.395	2627.145
6/29 2 B	2	270	8.325	2614.616
6/29 Q A	Q	155	9.06	1445.526
6/29 D A	D	360	8.338	3864.376
7/1 1 A	1	290	8.586	2257.243
7/1 1 B	1	320	8.714	2242.614
7/1 2 A	2	260	8.471	2629.245
7/1 2 B	2	250	8.488	2643.875
7/1 Q A	Q	160	8.978	1443.018
7/1 D A	D	360	8.194	3835.118
7/8 1 A	1	155	8.206	2390.301
7/8 1 B	1	150	8.189	2242.9396
7/8 2 A	2	210	8.478	3691.791
7/8 2 B	2	205	8.553	3638.3816
7/8 Q A	Q	140	9.162	1922.726
7/8 D A	D	295	8.153	4393.3963
7/11 1 A	1	150	8.486	2190.5013
7/11 1 B	1	145	8.499	2204.582
7/11 2 A	2	165	8.925	3036.312
7/11 2 B	2	160	9.098	3021.7458
7/11 Q A	Q	150	9.219	1936.0784
7/11 D A	D	315	8.189	4308.4268
7/13 1 A	1	150	8.791	2437.7396
7/13 1 B	1	153	8.869	2461.0506
7/13 2 A	2	180	8.754	3482.4106
7/13 2 B	2	185	8.919	3556.9098
7/13 Q A	Q	160	9.191	1920.8112
7/13 D A	D	290	8.261	3838.0842
7/15 1 A	1	-	7.921	819.665
7/15 1 B	1	-	8.607	1866.0183
7/15 2 A	2	-	8.337	3785.2138
7/15 2 B	2	-	8.53	3597.7642
7/15 Q A	Q	-	9.195	1910.2372

7/15 D A	D	-	7.5	483.93796
7/15 RW 1	RW1	-	6.633	167.89313
7/15 RW 2	RW2	-	6.67	70.203048
7/18 1 A	1	-	8.556	3136.3498
7/18 1 B	1	-	8.608	3133.9466
7/18 2 A	2	-	8.933	4179.3386
7/18 2 B	2	-	9.109	4174.5322
7/18 Q A	Q	-	9.206	1929.9434
7/18 D A	D	-	8.386	4083.2106
7/18 RW 1	RW1	-	6.779	73.855912
7/20 1 A	1	200	8.729	-
7/20 1 B	1	202	8.779	-
7/20 2 A	2	160	8.975	-
7/20 2 B	2	161	9.144	-
7/20 Q A	Q	140	9.184	-
7/20 D A	D	325	8.348	-
7/27 1 A	1	180	8.751	2850.2898
7/27 1 B	1	180	8.853	2847.869
7/27 2 A	2	142	9.085	3310.2418
7/27 2 B	2	140	9.284	3264.2466
7/27 Q A	Q	150	9.223	1929.6596
7/27 D A	D	360	8.305	4198.6754
7/27 RW 1	RW1	15	7.257	182.8587
7/27 RW 2	RW2	18	7.384	150.29894
7/29 1 A	1	150	8.657	2434.8805
7/29 1 B	1	150	8.739	2408.2517
7/29 2 A	2	175	8.769	3346.5538
7/29 2 B	2	165	9.003	3336.8706
7/29 Q A	Q	150	9.239	1955.078
7/29 D A	D	315	8.329	4462.5426
8/1 1 A	1	165	8.243	2353.2996
8/1 1 B	1	150	8.321	2348.9421
8/1 2 A	2	210	8.636	4089.7394
8/1 2 B	2	210	8.718	4099.4226
8/1 Q A	Q	160	9.167	1972.9919
8/1 D A	D	340	8.247	4929.757
8/5 1 A	1	160	8.282	2548.7994

8/5 1 B	1	160	8.364	2539.087
8/5 2 A	2	220	8.53	4544.6976
8/5 2 B	2	190	8.764	4539.8414
8/5 Q A	Q	150	9.147	1975.0394
8/5 D A	D	290	8.172	4576.2629
8/8 1 A	1	160	8.218	2396.8003
8/8 1 B	1	160	8.209	2577.9366
8/8 2 A	2	170	8.01	4853.0663
8/8 2 B	2	180	8.074	4865.2068
8/8 Q A	Q	140	9.137	1988.1511
8/8 D A	D	80	7.996	1003.5566
8/8 RW 1	RW1	15	7.383	211.97168
8/8 RW 2	RW2		7.122	101.97875
8/10 1 A	1	220	8.259	-
8/10 1 B	1	210	8.292	-
8/10 2 A	2	190	8.819	-
8/10 2 B	2	210	9.053	-
8/10 Q A	Q	160	9.164	-
8/10 D A	D	290	8.363	-
8/17 1 A	1	200	8.428	-
8/17 1 B	1	200	8.53	-
8/17 2 A	2	260	8.321	-
8/17 2 B	2	260	8.485	-
8/17 Q A	Q	160	9.191	-
8/17 D A	D	260	8.383	-
8/19 1 A	1	240	8.463	-
8/19 1 B	1	220	8.588	-
8/19 2 A	2	250	8.283	-
8/19 2 B	2	250	8.415	-
8/19 Q A	Q	170	9.171	-
8/19 D A	D	355	8.345	-
8/22 1 A	1	200	8.375	-
8/22 1 B	1	220	8.381	-
8/22 2 A	2	240	8.187	-
8/22 2 B	2	240	8.244	-
8/22 Q A	Q	151	9.194	-
8/22 D A	D	275	8.381	-
8/22 RW 1	RW1	10	7.687	-

8/22 RW 2	RW2	10	7.167	-
8/24 1 A	1	200	8.429	-
8/24 1 B	1	220	8.475	-
8/24 2 A	2	170	8.354	-
8/24 2 B	2	175	8.482	-
8/24 Q A	Q	160	9.179	-
8/24 D A	D	320	8.42	-

Isotope Averages

Table E.3 Data for averages of pre-event, precipitation, and event samples.

	Urban (site 1)			Rural (site 2)		
	Pre-Event	**Precipitation**	**Event**	**Pre-Event**	**Precipitation**	**Event**
AVG. δ^2H-H_2O [%]	-42.91	-35.61	-42.37	-48.34	-39.76	-47.16
AVG. $\delta^{18}O$-H_2O [%]	-6.20	-5.68	-6.14	-6.91	-6.19	-6.94

Alkalinity Averages

Table E.4 Data for averages of pre-event, precipitation, and event samples.

	Urban (site 1)			Rural (site 2)		
	Pre-Event	**Precipitation**	**Event**	**Pre-Event**	**Precipitation**	**Event**
AVG. Alkalinity (mg/L)	216	12.1	193	234	13.7	187

Total Dissolved Solid Averages

Table E.5 Data for averages of pre-event, precipitation, and event samples.

	Urban (site 1)			Rural (site 2)		
	Pre-Event	**Precipitation**	**Event**	**Pre-Event**	**Precipitation**	**Event**
AVG. TDS (mg/L)	1971	145.7	2412	2794	98.04	3414

pH Averages

Table E.6 Data for averages of pre-event, precipitation, and event samples.

	Urban (site 1)			Rural (site 2)		
	Pre-Event	**Precipitation**	**Event**	**Pre-Event**	**Precipitation**	**Event**
AVG. pH	8.40	7.14	8.39	8.49	7.09	8.40

APPENDIX F: Soil Data

Field Parameters and Data

Table F.1 Near-Surface Soil ID Numbers, Location, Type, Depth, and Color for both sets of soil samples

Soil ID Number	Latitude	Longitude	Sample Type[A]	Sample Depth (in)	Sample Color[B]
1	42° 44’ 43” N	87° 49’ 14” W	Streambank (Right)	4.5	3/2 10yr
2	42° 44’ 42” N	87° 49’ 15” W	Streambank (Left)	4	3/2 10yr
3	42° 44’ 50” N	87° 49’ 18” W	Quarry Lake Sediment	<12[C]	4/2 10yr
4	42° 48’ 55” N	87° 59’ 39” W	Tallgrass/Woodlands	10	3/1 10yr
5	42° 48’ 56” N	87° 59’ 39” W	Ditch	8.5	3/1 10yr
6	42° 48’ 57” N	87° 59’ 41” W	Agricultural Land	7	2/1 10yr
7	42° 48’ 56” N	87° 59’ 42” W	Streambank (Left)	12	2/1 10yr
8	42° 48’ 56” N	87° 59’ 43” W	Streambank (Right)	6	3/1 10yr
9	42° 48’ 55” N	87° 49’ 42” W	Animal Pasture	4.5	3/2 10yr

from 7/23/22.

[A] Stream bank samples were taken oriented in an upstream direction.
[B] Sample color (Value/Chroma Hue) was determined using Munsell Soil Color Book, 1973.
[C] Quarry Lake Sediment was taken from unconsolidated beach sediment; the exact depth is not measurable.

Table F.2 Near-Surface Soil ID Numbers, Location, Type, Depth, and Color for both sets of soil samples from 8/24/22.

Soil ID Number	**Latitude**	**Longitude**	**Sample Type[A]**	**Sample Depth (in)**	**Sample Color[B]**
1	42° 44' 43" N	87° 49' 14" W	Streambank (Right)	8.5	3/2 10yr
2	42° 44' 42" N	87° 49' 15" W	Streambank (Left)	4	3/2 10yr
3	42° 44' 50" N	87° 49' 18" W	Quarry Lake Sediment	<12[C]	4/2 10yr
4	42° 48' 55" N	87° 59' 39" W	Tallgrass/Woodlands	12	3/1 10yr
5	42° 48' 56" N	87° 59' 39" W	Ditch	12	3/1 10yr
6	42° 48' 57" N	87° 59' 41" W	Agricultural Land	10	2/1 10yr
7	42° 48' 56" N	87° 59' 42" W	Streambank (Left)	12	2/1 10yr
8	42° 48' 56" N	87° 59' 43" W	Streambank (Right)	12	3/1 10yr
9	42° 48' 55" N	87° 49' 42" W	Animal Pasture	11	3/2 10yr

[A] Stream bank samples were taken oriented in an upstream direction.
[B] Sample color (Value/Chroma Hue) was determined from Munsell Soil Color Book, 1973.
[C] Quarry Lake Sediment was taken from unconsolidated beach sediment; the exact depth is not measurable.

UW Forage and Soil Analysis Data

Table F.3 Near-Surface Soil Samples ID Numbers, Chemical, and Physical analysis for soil samples taken on 8/24/22, analysis completed at UW Soil and Forage Analysis Lab.

Soil ID Number	pH	OM (%)[A]	P (mg/kg)	K (mg/kg)	Ca (mg/kg)	Mg (mg/kg)	Na (mg/kg)	Cl (mg/kg)	Sample Texture[B]
1	7.6	5.0	19.4	128.4	1922.0	483.1	2.6	10.5	Sandy Clay Loam
2	7.5	7.2	21.9	232.4	2101.0	557.9	1.5	12.0	Loam
3	7.4	0.2	7.2	11.2	937.2	72.4	2.9	17.5	Sandy Loam
4	7.5	6.5	18.9	104.1	2691.7	730.6	20.3	24.0	Clay Loam
5	7.6	6.6	17.4	53.3	3089.4	711.7	3.1	6.0	Loam
6	7.6	2.7	20.9	53.4	3017.1	291.5	17.5	97.0	Sandy Loam
7	7.9	4.1	41.8	73.3	3488.1	399.4	15.8	25.0	Clay Loam
8	8.1	3.5	40.5	87.9	2487.7	280.3	28.6	26.5	Loam
9	7.7	8.4	13.4	120.9	2708.8	499.7	26.7	54.0	Loam

[A] OM, organic matter as % mass, was quantified from loss of ignition (LOI).
[B] Sample texture was determined by the United States Department of Agriculture (USDA) classifications of percent sand, silt, and clay from hydrometer results.

R^2 Values for Data Regressions

Table F.4 R^2 values for Near-Surface Soil Sample % Soluble Salts Leached vs. Chemical and Physical constituents, for all soil samples except #4 and #6.

	pH	**P**	**K**	**Ca**	**Mg**	**Na**	**% Sand**	**% Silt**	**% Clay**
R^2	0.0215	0.1412	0.3074	0.0392	0.4198	0.0352	0.095	0.1465	0.0177