Washington State Department of Transportation

SR 520 Bridge Replacement and HOV Program

I-5 to Medina: Bridge Replacement and HOV Project

SR 520 Floating Bridge and Landings Project
AKART Study Final Report
December 2017 – November 2019

Prepared for:

Washington State Department of Transportation
SR 520 Bridge Replacement and HOV Program
Floating Bridge and Landings Project
999 3rd Avenue, Suite 900
Seattle, WA 98104

Prepared by:

Parametrix
719 2nd Avenue, Suite 200, Seattle, WA 98104

and

Aspect CONSULTING
401 Second Avenue S, Suite 201, Seattle, WA 98104

May 2020

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1.1. Introduction

1.2. Purpose

This document presents the stormwater monitoring results for the Washington State Department of Transportation (WSDOT) All Known, Available, and Reasonable methods of prevention, control, and Treatment (AKART) analysis for the SR 520 Floating Bridge and Landings (FB&L) project. This is the final report for the period from December 1, 2017, to November 30, 2019.

The storm event monitoring was conducted following the procedures documented in the FB&L Final AKART Quality Assurance Project Plan (QAPP) (WSDOT 2017a) and the FB&L AKART Standard Operating Procedures (SOPs) (WSDOT 2017b). Detailed information regarding the storm events and laboratory analyses are presented in those documents and summarized as applicable in this report.

1.3. Study Background

During the replacement bridge design and environmental review process, WSDOT determined that the floating bridge portion of the project had several features that restricted or prevented the use of stormwater best management practices (BMPs) approved by the Washington State Department of Ecology (Ecology) for treating stormwater discharged from this type of bridge. To address these constraints, WSDOT, in coordination with Ecology, conducted a series of evaluations of available and reasonable technologies that could be applied in the bridge setting, referred to as an AKART analysis (CH2M HILL 2010 and the studies cited therein).

The AKART analysis developed a project approach that met WSDOT's objectives for stormwater treatment and discharge options involving a combination of 1) monthly high-efficiency street sweeping, and 2) modified catch basin/cleaning discharging treated stormwater to spill containment lagoons located in the supplemental stability pontoons (SSPs). The AKART analysis used modeling to predict compliance with Washington water quality criteria for four dissolved metals—copper, cadmium, lead, and zinc—after discharge of treated stormwater to the SSP lagoons and mixing with Lake Washington water in a mixing zone.

After reviewing the AKART analysis (CH2M HILL 2010), Ecology's approval was based on the condition that a monitoring plan would be implemented once the bridge was open to traffic as stated in Ecology's approval letter as follows: "*Ecology-approved monitoring plan that will be implemented once the new floating bridge is open to daily traffic*" (Ecology 2010). A Quality Assurance Project Plan (QAPP) (WSDOT 2014) was then developed and updated (WSDOT 2017a) to establish the monitoring procedure and present an adaptive management process to address the conditions in Ecology's approval of the AKART analysis (Ecology 2010). This

report provides the complete sampling results, summary of BMP activities, and a review of the mixing zone modeling.

1.4. AKART Study Review

1.5. Stormwater Discharges

The goal of this monitoring program is to verify that the predicted concentrations used in the AKART study dilution models match the range of stormwater discharge concentrations being received from the bridge deck by the SSPs, and verify that no more than two exceedances occur which would trigger adaptive management measures. The study deferred to Washington Administrative Code (WAC) 173-201A for the applicable state water quality standards, with the emphasis placed on dissolved metals, which are the regulated metal fractions in Washington. In both natural waterways and stormwater runoff, metals may be present in both dissolved and particulate forms. Related studies have acknowledged that paved surfaces could generate much higher percentages of dissolved metals due to fundamental physical and chemical differences in partitioning of the constituents than what could be expected in natural waterways. Clean sampling techniques and analytical methods have improved the validity of trace data and resulted in fewer artificially elevated results, which led to a regulatory standard of concern with dissolved fractions in the 1990s.

The ratio of dissolved to total metals is influenced by factors such as solubility, water temperature, pH, hardness and chemical characteristics of particles with metal binding sites. Both acute and chronic metals criteria for cadmium, copper, lead and zinc are expressed as functions of hardness: as hardness increases so does the allowable concentration of metals. The primary cationic components of hardness, calcium and magnesium, are non-toxic and can be readily absorbed by living organisms in direct competition with dissolved heavy metals. As a result, as hardness increases, the toxicity of a given concentration of dissolved metals decreases through a reduction in bioavailability. Hardness may play a significant role in determining the level of water quality treatment required to meet water quality standards and adjustments were made to account for the effects.

The analysis of water quality modeling used parameters that the Federal Highway Administration lists as constituents of highway runoff: total suspended solids (TSS), copper, zinc, cadmium and lead. The primary sources of metals from vehicles are friction in engine and suspension systems, brake pad and tire wear, and rust and corrosion. Metals have also been directly linked to plating on guardrails, vehicle emissions, atmospheric deposition, and indirectly through suspended solids.

1.6. AKART BMPs

The AKART analysis (CH2M HILL 2010) determined the most effective stormwater treatment technology to be a combined “treatment train” of stormwater BMPs on the floating portion of the bridge. These BMPs would include the use of high-efficiency street sweeping, modified catch basins, and spill containment lagoons before the stormwater is discharged and mixed with the

waters of Lake Washington. Actions to support AKART BMPs includes regularly scheduled sweeping and cleaning of the modified catch basins. The monitoring program was developed to document treatment actions and to provide regular stormwater sampling as summarized above and detailed in the QAPP. Stormwater sampling would be conducted at the discharge point to the containment lagoons at three locations until a sufficient number of events were captured to characterize runoff from the bridge. Figure 1 shows the locations of the contributing drainage areas and monitoring site locations. The following sections provide additional information on the sweeping operations and modified catch basins.

1.6.1. High-Efficiency Street Sweeping Operations

Under the current AKART sweeping operation, high-efficiency street sweeping consists of six WSDOT full-time employees (FTEs) with an operating train of five vehicles—an advanced warning vehicle, a truck for picking up large debris, a broom sweeper, a regenerative air or vacuum sweeper, and a truck-mounted attenuator. The high-efficiency street sweeping operating train sweeps the inside and outside shoulders from bridge seat to bridge seat with an operation speed of 6 to 9 miles per hour. WSDOT sweeps the bridge once a month during the first four days of the month. A summary of operations during the sampling period is provided in Table 1. A timeline of the sweeping, catch basin maintenance, and sampling events is shown on Figure 2.

Table 1. Sweeping and Catch Basin Cleaning Schedule

Time Period	High efficiency Street Sweeping	Modified Catch Basins with Annual Cleaning
Quarter 1: December 1, 2017 – February 28, 2018	Occurred during the first four calendar days of each month	Cleaned 2/15-21/2018
Quarter 2: March 1, 2018 – May 31, 2018	Occurred during the first four calendar days of each month	No cleaning
Quarter 3: June 1, 2018 – August 31, 2018	Occurred during the first four calendar days of each month	No cleaning
Quarter 4: September 1, 2018 – November 30, 2018	Occurred during the first four calendar days of each month	No cleaning
Quarter 5: December 1, 2018 – February 28, 2019	Occurred during the first four calendar days of each month	No cleaning [1]
Quarter 6: March 1, 2019 – May 31, 2019	Occurred during the first four calendar days of each month	Cleaned 3/17-20/2019
Quarter 7: June 1, 2019 – August 31, 2019	Occurred during the first four calendar days of each month	No cleaning
Quarter 8: September 1, 2019 – November 30, 2019	Occurred during the first four calendar days of each month	No cleaning

1. Cleaning was scheduled for Quarter 5 but was delayed due to snow.

Figure 1. Monitoring Site Locations

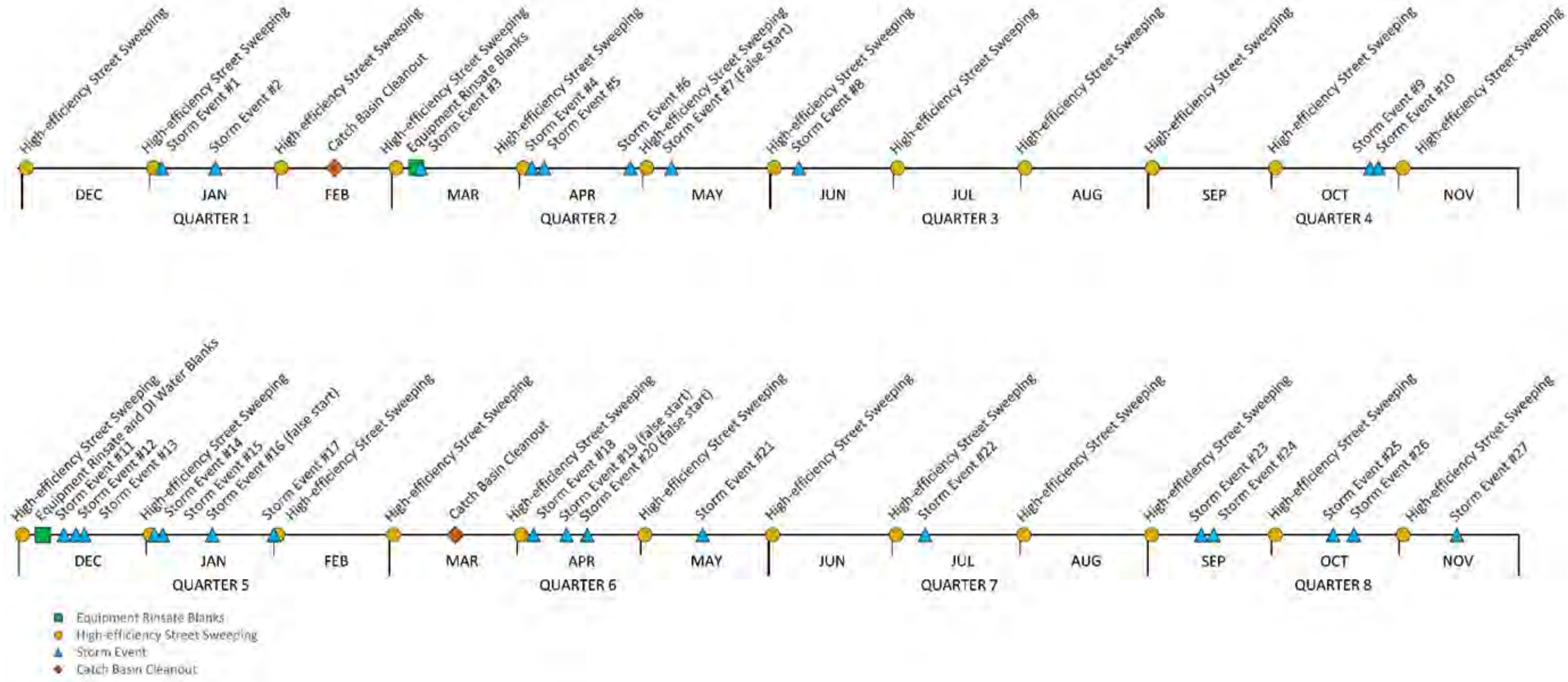


Figure 2. Timeline of Monitoring Program Actions

1.6.2. Modified Catch Basin Characteristics

Stormwater from the bridge deck is discharged to spill containment lagoons from modified catch basins via a storm sewer conveyance system, where mixing occurs with lake water for sufficient dilution before discharge into Lake Washington. The bridge storm sewer conveyance system was designed using peak flow calculations from MGS Flood (Version 4.12) as a basis for sizing storm sewer pipes and catch basins. The storm sewer system was laid out to have no more than 540 lineal feet of pipe on the low-rise section and no more than 1.02 acres of bridge deck draining to any one lagoon for the high-rise sections.

The modified catch basins are designed with sumps (storage areas below the outlet elevation) to provide additional residence time for sediment to settle out and collect before the runoff is conveyed to the spill containment lagoons. The catch basins were sized to meet the minimum requirements specified in the AKART study for the catchment areas for the low-rise and high-rise sections of the bridge in order to meet the basic treatment requirements of 80 percent TSS removed from mean annual runoff, per the Highway Runoff Manual. The catch basins are all 13 inches by 24 inches, with the exception of structure 79. Using the SCS curve number method and a slightly larger volume of runoff for Lake Washington mean annual storm event value, an annual pollutant load was calculated. The design method that produced the largest potential pollutant load and yielded the largest modified catch basin size was used. A 3.69 cubic feet per acre volume sediment pollutant volume chosen and the recommended efficiency factor of 60 percent from the AKART Study was applied. The sediment loading for sizing of modified catch basins was increased to 6.15 cubic feet per acre and multiplied by the respective catchment areas for each catch basin to find the required sump volume, and ultimately required sediment depth to accommodate the expected sediment loading. The load required sump depth was found and then 1-foot additional freeboard depth was added. This was done to separate the stormwater entering the pipe outlet from the sediment storage volume surface according to the Highway Runoff Manual.

The modified catch basins provide one element of the floating bridge stormwater treatment train. Table 2 summarizes the dimensions of the catch basins sized for the stormwater treatment system. Available sump volume by catchment area ratio, which relates to treatment capacity, has been determined to provide a means for comparing the treatment provided against stormwater monitoring results (Table 3).

Table 2. Modified Catch Basin Configurations

Inlet Type	Modified Catch Basin	Catchment Area (Acres)	Modified Sump Dimensions			
			Design Sediment Depth (ft)	Total Sump Depth (ft)	Area (ft^2)	Volume (ft^3)
Type 1	Typical Low Rise Catch Basin	0.10	0.30	1.5	2.2	3.3
Type 2	High Rise Catch Basin	0.21	0.60	2.0	2.2	4.4
Type 3	High Rise Catch Basin	0.69	1.96	3.0	2.2	6.5

1. Source: SR 520 Bridge Replacement and HOV Project Final AKART Quality Assurance Project Plan, 2017.
2. All catch basin areas, including flow splitter FS2, are 13” x 24”, except structure 79.
3. Structure 79 has a catch basin area of 48” x 84” with sediment depth of 74-3/4”.
4. Includes 1 foot of depth for freeboard to separate the stormwater entering the system from sediment storage volume surface.

Table 3. Modified Catch Basin Treatment Storage

Modified Catch Basin #	Bridge Station[1]	Contributing Drainage Area (acres) [2,3,4]	Design Required Sediment Depth (ft) [2]	Provided Total Sediment Depth (ft) [1,5,6]	Excess Sediment Treatment Depth (ft) [7]
520E - West Approach (ENW = 0.83 acre total drainage area) [4]					
4	148+10.00	0.14	0.40	1.5	1.10
5	149+45.00	0.16	0.45	2.5	2.05
6	150+50.00	0.12	0.34	1.5	1.16
7	151+70.00	0.14	0.40	1.5	1.10
8	152+45.00	0.09	0.26	1.5	1.24
9	152+90.24	0.07	0.20	1.5	1.30
10	153+20.00	0.07	0.20	1.5	1.30
520N - Mid-Span Approach (NNW = 0.42 acre total drainage area) [4]					
43	182+90.00	0.10	0.28	1.5	1.22
44	183+80.00	0.10	0.28	1.5	1.22
45	184+70.00	0.10	0.28	1.5	1.22
46	185+60.00	0.10	0.28	1.5	1.22
520U - East Approach (1.79 acres total drainage area, lagoon UNE receives 1.02 acres worth of flow [8,11]) [4]					
75	211+97.79	0.10	0.28	1.5	1.22
76	212+69.62	0.14	0.40	1.5	1.10
77	213+71.00	0.11	0.31	1.5	1.19
78	214+50.00	0.78	2.21	1.5	-0.71 [8,9]
FS2	211+04.97	-	0	1.0 [9]	1.0 [8,11]
79/80	219+81.14	0.66	1.87	6.2 [10]	4.4

1. Source: SR 520 Evergreen Point Bridge Floating Bridge and Landings Bridge Drainage As-Builts (Vol. 14a, 2012).
2. Source: KPFF Technical Memorandum Appendix A-Conveyance Design.
3. Areas used in conveyance calculations include area of barriers and were rounded; sum of individual and total areas may vary slightly as a result.
4. Total area may not be equal to catchment area due to rounding and other total drainage area adjustments.
5. Total sediment depth is the distance from the pipe invert to the bottom of the drainage structure.
6. Flow splitter FS2 and modified catch basin dimensions defined in Table 2.
7. Excess sediment treatment depth is equal to the difference in provided sediment depth and design sediment depth (ft).
8. Flows originate from inlets 75-78 and 80 and bypassed flows continue to FS2. Sediment that is not accommodated in structure 78 is accommodated in the structure FS2 sump.
9. All flows move downgrade from structure 78 to FS2.
10. Inlet 80 is a Neenah foundry grate which drains to a transverse pipe and has no sump, like the other modified catch basins. Flows from inlet 80 are conveyed through structure 79, which provides required sediment storage volume.
11. Bypass flows also continue from flow splitter FS2 on to UNW and TNE.

1.6.3. Catchment Area Characteristics

Table 4 lists each sampling area's catchment characteristics, including time of concentration and 25-year, 24-hour peak flow rate. Sampling locations are shown on Figure 1.

Table 4. Catchment Area Characteristics

Site Characteristics	Monitoring Site Name		
	West	Middle	East
Location	SSP ENW (148+10)	SSP NNW (179+45)	SSP UNE (210+89.57)
Contributing Drainage Area (acres)	0.83	0.42	1.02
Percent Impervious	100	100	100
25-year Flow Rate (cubic feet per second)	1.55	0.83	1.32
Time of Concentration	Approximately 2 minutes	Approximately 8 minutes	Approximately 7 minutes

The West Span reaches a height of 60 feet above the lake surface and has six supplemental stability pontoons receiving runoff. The monitoring site 520E at Pontoon ENW receives runoff from drainage inlets 4-10 (see Figure 3), with a total drainage area of 0.83 acre and a time of concentration of approximately 2 minutes. The pontoon at NEW receives runoff from seven modified catch basins, with six type-1 sumps and one type-2 sump.

The Mid-Span reaches a height of 21 feet above the lake surface and has eight supplemental stability pontoons receiving runoff. The monitoring site 520N at Pontoon NNW receives runoff from drainage inlets 43-46 (see Figure 4), with a total drainage area of 0.42 acre and a time of concentration of approximately 8 minutes. Pontoon NNW is located on the portion of the bridge which was designed for flows in a Sag Condition, and receives runoff from four modified catch basins, all designed with type-1 sumps.

The East Span reaches a height of 88 feet above the lake surface and has eight supplemental stability pontoons receiving runoff. The monitoring site 520U at Pontoon UNE receives runoff from drainage inlets 75-78 and inlet structure 80 (see Figure 5), and flows continue through structure 79, which provides the required sediment storage volume. The total drainage area is 1.79 acres, of which 1.02 acres' worth of flow is directed through flow splitter 2 (FS2) to the UNE lagoon and the remainder is bypassed to UNW and TNE via flow splitter 1(FS1). The system has a time of concentration of approximately 7 minutes and receives runoff from five modified catch basins, with four type-1 sumps and one type-3 sump. As the flows from structure 78 continue to be piped downgrade toward flow splitter FS2, the runoff is mixed with flow from structures 75-77. FS2 provides 1 foot of total sediment depth, which acts as overflow sediment storage for the associated upgrade catch basins.

Figure 3. Sampling Area ENW Modified Catch Basin Drainage Delineation

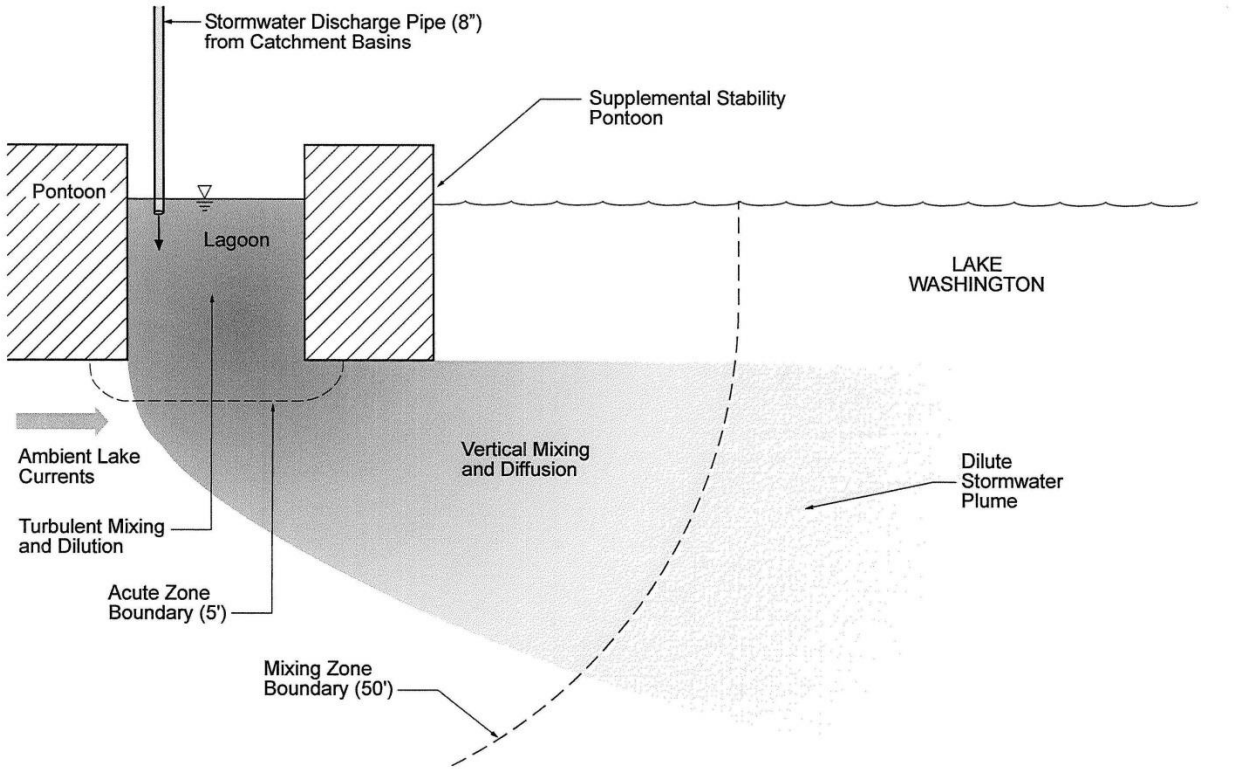
Figure 4. Sampling Area NNW Modified Catch Basin Drainage Delineation

Figure 5. Sampling Area UNE Modified Catch Basin Drainage Delineation

1.7. Dilution Modeling Review

1.7.1. Containment Lagoons and Mixing Zone Dilution

The AKART evaluation used dilution models representing potential bridge stormwater discharges for the replacement floating bridge design (CH2M HILL 2010). In the model, after stormwater has mixed with the lake waters, predicted water quality was compared with the state water quality standards at appropriate distances from the point of discharge, referred to as mixing zone boundaries. Figure 6 shows the three regions where mixing would occur: 1) within the lagoon, 2) at the interface of the lagoon bottom and the lake, and 3) between the interface region and the defined mixing zone boundary.



Source: Figure 4.1, CH2M HILL 2010

Figure 6. Floating Bridge Mixing Process

The 2010 AKART and water quality study developed dilution models representing potential bridge stormwater discharges for the floating bridge designs. Dilution calculations and modeling were developed for a range of stormwater lagoon sizes and for three storm runoff scenarios: the low-volume storm (10th percentile), mean annual storm (50th percentile), and the water quality treatment storm (91st percentile). Three incremental lagoon sizes were evaluated for both Mid-Span and East Approach regions of the bridge (referred to as lagoon size options), and a fourth option was evaluated for the East Approach region.

Ecology's conditional approval letter (Ecology 2010) required a stormwater monitoring plan to confirm the sweeping frequency necessary to meet state water quality standards at the edge of the defined mixing zone that was granted. The overall purpose of the AKART monitoring is to confirm that the four constituents (dissolved cadmium, copper, lead, and zinc) in stormwater discharging to the lagoons do not exceed concentrations that, after applying the mixing zone, would exceed standards at the edge of the mixing zone. In other words, what is the highest concentration of the four constituents measured that would not cause the standard to be exceeded and "trigger" additional measures or "adaptive management"?

The dilution models were developed for the three modeled storm events, and the adaptive management trigger was only applied to the largest of the three events, the water quality treatment storm, which statistically is expected to occur about two times a year. While this is a good screening approach to establish a predictive tool for triggers, it does not reflect actual results at the mixing zone boundary. The trigger values are based on a static volume of water from design storms, not measured runoff volumes. Actual expected concentrations at the mixing zone edge will change based on storm event size; smaller events with the same measured concentration will have lower concentrations at the edge of the mixing zone.

Because runoff volumes are measured, the triggers can be adjusted based on the actual storm size and concentration. This approach would only be applied when an existing trigger value is exceeded and would be used as another evaluation consideration under the adaptive management process. The adaptive management trigger was exceeded once in the Year 1 as discussed in Section 7 of this report; therefore, adaptive management measures do not need to be applied.

1.7.2. Process for Determining Adaptive Management Triggers

WSDOT reviewed available data for characterizing expected discharge concentrations in highway runoff to compare with AKART modeling predictions. In this review, discharge concentrations calculated to equal water quality standards at the edge of the 50-foot mixing zone were determined and compared to available data for untreated highway runoff from western Washington highways (Herrera 2007) (Table 5). This comparison found that untreated maximum concentrations of dissolved copper, cadmium, lead, and zinc in western Washington highway runoff were 4 to 76 times less than these calculated discharge concentrations (Table 5). Thus, the

potential for stormwater discharge with dissolved metal concentrations that would exceed water quality standards at the edge of the 50-foot mixing zone is low.

Table 5. Metal Concentrations – Model versus Measured Runoff

Dissolved Metal	Discharge Concentrations to Comply with Water Quality Standards at the 50-foot Mixing Zone (µg/L)		Measured Western Washington Highway Runoff[1] (µg/L)
	East Approach	Mid-Span	
Cadmium	13	45.5	NR
Copper	67.7	285	3.1 to 18.1 (21)[2]
Lead	242	925.7	3.2 (1)[3]
Zinc	544.4	2,298.7	13 to 134 (22)

NR – Not Reported
1. Data from Herrera (2007).
2. Number in parentheses represents the number of sites contributing to the range in mean concentration.
3. Summary statistics for lead are calculated using only data that were collected after 1990.

The next step in the process back-calculates what the concentration at the point of discharge from the bridge collection and conveyance system would be so that the diluted plume concentrations are equal to relevant water quality criteria at the edge of the mixing zone. The differences in the adaptive management triggers seen in Table 5 for the East Approach and the Mid-Span are the result of the differences in lagoon sizes and contributing roadway areas for these two areas.

1.7.3. Adaptive Management Actions

The need for adaptive management actions would have been triggered when a 1-hour average concentration of any of the four dissolved metals measured in treated stormwater discharged to the SSP lagoons exceed their relevant adaptive management trigger values, as presented in Table 5, twice during the monitoring period[1]. There was one exceedance of the adaptive management trigger during one event; the adaptive management actions do not need to be applied. In addition, the actual storm volume for the trigger event (Mobilization Event 8) was approximately one-tenth the volume of the design storm; therefore, the actual mixing zone edge concentration would be significantly lower (approximately 10 times lower).

[1] Based on the compliance definition established in WAC 173 201A 240 that the 1-hour average concentration does not exceed the acute water quality standard more than once every 3 years on average. Consequently, to exceed an acute standard requires measuring two values greater than that standard in any 3-year period.

1.8. Sampling Methodology

1.9. Water Quality Monitoring Procedures

The storm event monitoring was conducted following the procedures documented in the FB&L Final AKART QAPP (WSDOT 2017a) and the FB&L AKART SOPs (WSDOT 2017b). Refer to these documents for a detailed review of the sampling installation, weather observation, sampling methods, sample analysis, and reporting. The original QAPP (2014) was modified before any sampling began to reflect modifications made by the project team and field lead (Aspect). This included monitoring design and equipment being changed from AVs to the weir boxes. Once published and updated in 2016, the QAPP and SOPs were not further modified in form or publication and no addenda were prepared, although minor adjustments to the approach applied in the QAPP were considered and applied as appropriate, including:

- Recording sample temperature in the field upon collection to ensure sample compliance and acceptance for temperature and chain of custody procedural steps

- The purchase of additional sampling tubing to allow targeting of storms occurring within quick succession

- Acceptance of events which exceeded the defined antecedent dry period, which were documented and approved by Ecology, and have been included in the report

In general, the sampling process involved monitoring weather and rainfall forecasting to mobilize and prepare the sampling devices to collect samples, sampling of continuous flow and precipitation, collecting water quality samples during discrete storm events, collecting and delivering the samples to the laboratory for testing of the project analytes, and reporting the pollutant concentrations. The results were reported each quarter starting December 1, 2017, except for Quarters 4 and 8, which are included in the summary annual and final reports, respectively, as required by the QAPP.

Successful storm sampling followed a few key steps. The full details of coordinating and running a sampling event are included in the SOPs for storm event tracking and targeting (WSDOT 2017b).

1. **Weather tracking.** Local weather forecasts are reviewed daily to identify potential sampling events that may develop within the next week or two. Potential events are identified and tracked in more detail and presented to WSDOT for consideration, when appropriate. The decision to sample a “marginal” event (one that may not meet the qualifying storm criteria) is tracked by the sampling team with an ultimate decision by WSDOT staff with input from the consultant team and WSDOT staff.

2. **Coordination.** If an event looks likely to qualify, the consultant sampling team coordinates with the bridge maintenance crew and AmTest laboratory to ensure access to the bridge and laboratory.
3. **Sample setup.** A final Go or No-Go decision is made at least 24 hours prior to the forecasted start of the event. The sampling crew makes final coordination for access with the bridge crew and sets the stations up for sampling. Setup includes installing a clean sample line, calibrating the sampler and pressure transducer, and deploying a sample bottle and ice.
4. **Sample collection.** The field crew collects all samples at the end of an event. All samples are compared to a validation checklist to ensure that the samples meet the project criteria and are then transported in coolers with ice to AmTest for analysis. Samples are delivered following chain-of-custody (COC) procedures. In addition, all sample lines are removed from the bridge and taken to AmTest for cleaning to prepare for future events.

1.10. Quality Control

1.10.1. Quality Control and Procedures

Quality control procedures were implemented in order to provide high-quality data and followed standard operating procedures (SOPs) for field collection, sample handling, laboratory processing of all samples and associated recordkeeping. These activities were monitored and documented throughout the duration of the program to ensure they remained scientifically and legally defensible in order to meet the requirements of Ecology's conditional approval letter. The quality of raw, unprocessed, and processed data was subject to review in accordance with protocols established by the Measurement Quality Objectives of the QAPP (Ecology and WSDOT 2011).

Additionally, the data quality objectives (DQOs) for this stormwater monitoring program stipulate that the data be representative of the monitoring sites on the bridge and be of a known precision, bias, and accuracy, and that both data reporting and analytical sensitivity be clearly established and adequate for stormwater management program decisions and endpoints. Once established, DQOs became the basis for measurement quality objectives (MQOs), which were used specifically to address instrumental and analytical performance.

The MQOs established for this program received guidance from multiple sources, including Ecology, the U.S. Environmental Protection Agency (EPA), and a combination of laboratory experience and best professional judgment. The MQOs, or acceptance thresholds for the study's data, were based primarily on the data quality indicators (DQIs). These performance measures are expressed in terms of sensitivity, bias, representativeness, precision, accuracy, completeness and comparability. The data were verified by WSDOT to assess sensitivity, accuracy, precision, and comparability; failures to meet the MQOs resulted in data being qualified or rejected. Bias represents systematic error and can be used to describe a tendency or preference in one direction.

Bias in water quality samples will be assessed based on the analyses of method blanks, field blanks, trip blanks, matrix spikes, and laboratory control samples (LCS).

1.10.2. Blanks

Field blanks are sampled to test for bias in the equipment, and if the results are greater than the reporting limit in the QAPP (WSDOT 2017a), the results may indicate that the equipment is a source of contamination. In these cases, the QAPP describes a set of procedures to evaluate and address the blank results, such as source-tracing, cleaning the equipment (which is done after every storm sampling event), and potentially collecting another field blank sample. Blank samples higher than the reporting limit are flagged *B.* Project samples associated with field blanks that are less than five times the high blank concentration are flagged *J* and might not be valid for the AKART evaluation.

A blank sample was collected at each station on March 7, 2018, as part of Mobilization Event 3, and some of the results were above the reporting limit. The analysis results are summarized in Table 6. All the storm event sample results for the first year of monitoring subsequent to the March 7, 2018, blank were each more than five times the respective blank concentration; therefore, none are flagged *J*.

Table 6. Blank Analysis Results Summary – March 7, 2018 [1, 2]

Metal	Reporting Limit (µg/L)	520-E (West Approach)	520-N (Mid-Span)	520-U (East Approach)
Total Recoverable Concentration of Sample (µg/L) *[5 x blank value vs. Associated Stormwater Sample Value]*				
Cd	0.1	-	-	-
Cu	0.1	-	**0.23** *[1.15 vs. 29.5]*	**0.17** *[0.85 vs. 56.3]*
Pb	0.2	-	-	-
Zn	5.0	-	-	-
Dissolved Concentration of Sample (µg/L) *[5 x blank value vs. Associated Stormwater Sample Value]*				
Cd	0.1	-	-	-
Cu	0.1	-	**2.02** *[10.1 vs. 10.9]*	-
Pb	0.1	-	-	-
Zn	1.0	-	**1.95** *[9.75 vs. 25.1]*	**1.14** *[5.70 vs. 23.4]*

1. Cd = cadmium, Cu = copper, Pb = lead, Zn = zinc.
2. "-" Indicates results were below the reporting limit.

A blank sample was collected at each station and a composite deionized water sample was collected on December 7, 2018 (prior to Mobilization Event 11), and some of the results were above the reporting limit. The analysis results are summarized in Table 7. All the storm event sample results for the second year of monitoring were each more than five times the respective blank concentration; therefore, none are flagged *J.* In addition, based on the total copper levels in the deionized water used in the blank, that water may have contributed to the levels seen in the monitoring samples.

Table 7. Blank Analysis Results Summary – December 7, 2018 [1, 2]

Metal	Reporting Limit (µg/L)	520-E (West Approach)	520-N (Mid-Span)	520-U (East Approach)	Composite Deionized Water
Total Recoverable Concentration of Sample (µg/L) *[5 x blank value vs. Associated Stormwater Sample Value]*					
Cd	0.1	-	-	-	
Cu	0.1	**0.14** *[0.7 vs. 40.8]*	**0.14** *[0.7 vs. 15.2]*	**0.20** *[1.0 vs. 40.1]*	**0.17** *[N/A]*
Pb	0.2	-	-	-	
Zn	5.0	-	-	-	-
Dissolved Concentration of Sample (µg/L) *[5 x blank value vs. Associated Stormwater Sample Value]*					
Cd	0.1	-	-	-	-
Cu	0.1	-	-	-	-
Pb	0.1	-	-	-	-
Zn	1.0	-	-	-	-

1. Cd = cadmium, Cu = copper, Pb = lead, Zn = zinc.
2. "-" Indicates results were below the reporting limit.

1.10.3. System Maintenance

The weir boxes were visually inspected for sediment buildup during site visits for maintenance or sampling. When sediment depth exceeded a few inches, the weir boxes were cleaned. The weir boxes were cleaned on December 17, 2018. Each weir box was drained of water and the sediment was removed with a shovel. The sediment from the weirs was deposited into 5-gallon buckets for removal by the bridge maintenance crew.

1.10.4. Clarified Procedures for Sample Transfer to Laboratory

The following changes in the sampling procedures were implemented for the sampling event on January 17, 2018, and after:

1. The water temperature in each weir at the time of collection was recorded on the field sheet and in the notes section of the COC.
2. A generous supply of ice was used for the samples both in the sampler base during collection and in the coolers during transport.
3. The field crew observed the temperature measurements at the laboratory as soon as the sample containers were removed from the coolers and ensured that all measurements were recorded on the COC before they left.

1.10.5. Sample Tubing Turn Around

Potential qualifying events were missed in the early stages of sample collection due to back-to-back weather events moving through before all the sample tubing from a prior event could be cleaned and returned from the laboratory. Additional sets of sample tubing, connectors, and sample containers were ordered to provide at least three complete sets of sampling equipment for each station. This allowed for the targeting of up to three events in quick succession and gave opportunity for AmTest to clean the equipment from the first event by the

time the third one was wrapping up, thus reducing the chances of missing a qualifying event due to lack of decontaminated tubing.

1.11. Deviations and Changes

No deviations from the QAPP or the SOPs were recorded or published during the study, although minor adjustments were made, as described in Section 3.1 . The BMP treatment program and sampling followed both the Final AKART QAPP (WSDOT 2017a) and the FB&L AKART SOPs (WSDOT 2017b). There were no changes or deviations from the BMP treatment programs during the monitoring period.

1.12. Sampling Results

1.13. Summary of Sampling Activity

The monitoring program included treatment and sampling actions for the 2-year monitoring period following the approaches summarized above and detailed in the QAPP. Figure 2 shows a timeline of the actions and event dates during the analysis years. The monitoring program targeted and responded to potential "mobilization events" during which the sampling crew would continue to review the rain forecasts and set up the sampling devices in anticipation of a qualifying storm and successful sample. Not all events resulted in a successful sample, normally due to the forecasted rain dissipating and no longer qualifying to the event criteria. Events that did qualify were sampled, collected, and delivered to the lab for processing and analysis.

1.14. Event Mobilization and Sampling

Table 8 summarizes all storm events for which staff were mobilized, a total of 27, including events that were not sampled or failed a sampling criterion. A total of 10 mobilization events occurred in Year 1 of the analysis, and 17 in Year 2. The 22 required successful events were collected from these 27 mobilizations.

Table 8. Mobilized Storm Events

Date	Mobilization Event No.[1]	Antecedent Period (days)[2]	Inter-event Period (days)[3]	Rainfall Parameters				Site Sample Characteristics						Notes
				Total Depth (inches)	Duration (hours)	Antecedent (inches/6 hours)	Storm Qualifies[4]	Location[5]	Aliquots[6]	Sample Volume (liters)[6]	Sample Vol/Hydro-graph Vol (%)	Sample Evaluated[4]	Sample Qualifies[4]	
Thresholds:				**≥ 0.15**	**> 1**	**< 0.04**			**≥ 10**	**≥ 1**	**> 75**			
Quarter 1: December 1, 2017 – February 28, 2018														
1/4/2018	1	5	-	0.56	23.4	0	✓	E	41	4	100	✓	✓	Samples flagged for potential temperature issue; accepted by Ecology (see Section 5.3.1 in the Monitoring Annual Report).
								N	39	4	99	✓		
								U	34	3.5	100	✓		
1/17/2018	2	0	12	1.13	17.5	0	✓	E	78	< 1	-		✓	West (E): Equipment malfunction. Mid (N): Forecast-based equipment volume settings could not pace with actual larger storm. East (U): No issues. Sample collected.
								N	78	5	64			
								U	77	5	100	✓		
Quarter 2: March 1, 2018 – May 31, 2018														

Table 8. Mobilized Storm Events (continued)

Date	Mobilization Event No.[1]	Antecedent Period (days)[2]	Inter-event Period (days)[3]	Rainfall Parameters				Site Sample Characteristics						Notes
				Total Depth (inches)	Duration (hours)	Antecedent (inches/6 hours)	Storm Qualifies[4]	Location[5]	Aliquots[6]	Sample Volume (liters)[6]	Sample Vol/Hydro-graph Vol (%)	Sample Evaluated[4]	Sample Qualifies[4]	
Thresholds:				**≥ 0.15**	**> 1**	**< 0.04**			**≥ 10**	**≥ 1**	**> 75**			
3/8/2018	3	0	49	0.46	10.25	0	✓	E	51	4	100	✓	✓	
								N	78	8	80	✓		
								U	68	5	100	✓		
4/4/2018	4	2	26	0.30	12.92	0	✓	E	16	1.6	94	✓	✓	Samples flagged for 1.2-hour break in storm[7]; accepted by Ecology. Zinc results flagged for matrix spike test outside of limits; accepted by Ecology (see Attachment 3).
								N	12	1.2	92	✓		
								U	17	1.7	93	✓		
4/7/2018	5	0	3	0.62	10.08	0	✓	E	38	3.8	81	✓	✓	
								N	56	5.6	83	✓		
								U	40	4	78	✓		
4/28/2018	6	6	21	0.39	5.75	0	✓	E	54	4.5	100	✓	✓	
								N	78	7.8	90	✓		
								U	58	6	100	✓		
5/8/2018	7	8	10	0.04	20.5	0		E						Precipitation amount did not qualify, no samples collected.
								N	n/a					
								U						

Table 8. Mobilized Storm Events (continued)

Date	Mobilization Event No.[1]	Antecedent Period (days)[2]	Inter-event Period (days)[3]	Rainfall Parameters: Total Depth (inches)	Duration (hours)	Antecedent (inches/6 hours)	Storm Qualifies[4]	Site Sample Characteristics: Location[5]	Aliquots[6]	Sample Volume (liters)[6]	Sample Vol/Hydrograph Vol (%)	Sample Evaluated[4]	Sample Qualifies[4]	Notes
Thresholds:				**≥ 0.15**	**> 1**	**< 0.04**			**≥ 10**	**≥ 1**	**> 75**			
Quarter 3: June 1, 2018 – August 31, 2018														
6/8/2018	8	3	30	0.21	10.92	0	✓	E N U	13 12 44	1.3 1.2 4.4	100 100 100	✓ ✓ ✓	✓	
Quarter 4: September 1, 2018 – November 30, 2018														
10/25/2018	9	1	138	0.72	23.5	0	✓	E N U	10 23 19	1 ≈2 ≈2	100 100 100	✓ ✓ ✓	✓	Samples flagged for 3.2-hour break in storm[7]; accepted by Ecology (see Attachment 3).
10/27/2018	10	0	1	1.37	27.3	0	✓	E N U	78 78 78	- 7.8 7.8	- 100 87	 ✓ ✓	✓	West (E): Equipment malfunction. Mid (N): No issues. Sample collected. East (U): Sample delivered to laboratory outside holding time; results excluded/rejected.
Quarter 5: December 1, 2018 – February 28, 2019														
12/12/2018	11	0	45	0.26	22.50	0	✓	E N U	18 26 32	2 3 3	100 100 100	✓ ✓ ✓	✓	Samples flagged based on 55-minute break in storm[7]; accepted by Ecology (see Attachment 3). Field duplicate collected at 520E.
12/15/2018	12	0	2	0.72	22.83	0	✓	E N U	40 60 49	4 6 5	100 100 100	✓ ✓ ✓	✓	Samples flagged based on 2.5-hour break in storm[7]; accepted by Ecology (see Attachment 3).
12/17/2018	13	0	1	0.69	15.83	0	✓	E N U	33 40 41	3 4 4	100 100 100	✓ ✓ ✓	✓	Field duplicate collected at 520N.
01/03/2019	14	3	16	0.95	31.00	0	✓	E N U	22 50 38	2 5 4	100 100 100	✓ ✓ ✓	✓	Field duplicate collected at 520U.
01/05/2019	15	0	1	0.26	10.92	0	✓	E N U	41 71 57	4 7 5.7	94 36 99	 		Event ended 12 hours before forecast; crew unable to access samples by hold-time limit, no samples submitted.
01/17/2019	16	4	11	0.07	18.92	0		E N U	n/a			 		Precipitation amount did not qualify, no samples collected.
02/01/2019	17	7	14	0.45	13.75	0	✓	E N U	69 32 78	6.5 3 7.5	100 99 91	✓ ✓ ✓	✓	Field duplicate collected at 520E.
Quarter 6: March 1, 2019 – May 31, 2019														
04/05/2019	18	0	63	0.20	5.00	0	✓	E N U	48 51 63	≈5 ≈5 ≈6	100 100 100	✓ ✓ ✓	✓	Field duplicate collected at 520N.
04/13/2019	19	0	8	0.08	7.92	0		E N U	n/a			 		Precipitation amount did not qualify, no samples collected.
04/18/2019	20	1	5	0.05	10.83	0		E N U	n/a			 		Precipitation amount did not qualify, no samples collected.
05/16/2019	21	0	27	0.58	16.5	0	✓	E N U	18 20 29	≈2 ≈2 ≈3	100 100 100	✓ ✓ ✓	✓	Samples flagged based on 1.3-hour break in storm[7]; accepted by Ecology (see Attachment 3). Field duplicate collected at 520E.
Quarter 7: June 1, 2019 – August 31, 2019														
07/09/2019	22	0	54	0.36	18.42	0		E N U	12 39 42	≈1 ≈4 ≈4	100 100 100	✓ ✓ ✓	✓	Field duplicate collected at 520U.

Table 8. Mobilized Storm Events (continued)

Date	Mobilization Event No.[1]	Antecedent Period (days)[2]	Inter-event Period (days)[3]	Rainfall Parameters: Total Depth (inches)	Duration (hours)	Antecedent (inches/6 hours)	Storm Qualifies[4]	Site Sample Characteristics: Location[5]	Aliquots[6]	Sample Volume (liters)[6]	Sample Vol/Hydrograph Vol (%)	Sample Evaluated[4]	Sample Qualifies[4]	Notes
Thresholds:				**≥ 0.15**	**> 1**	**< 0.04**			**≥ 10**	**≥ 1**	**> 75**			
Quarter 8: September 1, 2019 – November 30, 2019														
09/14/2019	23	1	66	0.53	18.33	0	✓	E	27	3	100	✓		
								N	33	3	100	✓	✓	Field duplicate collected at 520U. Zinc results flagged for matrix spike test outside of limits[8].
								U	30	3	100	✓		
09/17/2019	24	1	2	0.20	15.18	0	✓	E	13	1.3	100	✓		
								N	12	1.2	100	✓	✓	Samples flagged based separate 15- and 5-minute breaks in storm[7]; accepted by Ecology (see Attachment 3). Three aliquots missed at 520U due to sampling error. Zinc results flagged for matrix spike test outside of limits[8].
								U	16	2	87.6	✓		
10/16/2019	25	7	28	0.36	19.00	0	✓	E	25	2	100	✓		
								N	18	2	100	✓	✓	Samples flagged based on 35-minute break in storm[7]; accepted by Ecology (see Attachment 3).
								U	32	3	100	✓		
10/21/2019	26	0	4	0.45	23.75	0	✓	E	29	3	100	✓		
								N	24	2	100	✓	✓	Samples flagged based on 1.8-hour break in storm[7]; accepted by Ecology (see Attachment 3).
								U	38	4	100	✓		
11/15/2019	27	2	24	0.20	2.42	0	✓	E	33	4	100	✓		
								N	22	2	100	✓	✓	
								U	34	3	100	✓		
Number of Qualifying Sampling Events[9]: 27														

1. Mobilization events are also called "Storm Events" in appendix reports. The analysis was scoped for a maximum of 27 storm mobilization events.
2. Number of calendar days with no precipitation recorded prior to a mobilization event.
3. Calculated as the recorded start time of the storm minus the recorded end time of the previous storm.
4. ✓ Indicates that event or sample has been fully reviewed and meets qualification requirements.
5. E: 520-E West Approach Site; N: 520-N Mid-Span Site; U: 520-U East Approach Site (Figure 1).
6. Sample volume noted is a visual field estimate of bottle "percent-full" to check against collected aliquots, which are 100 milliliters each.
7. Length of break in storm is amount of time during which the 6-hour total rainfall was < 0.04".
8. Zinc matrix spike test outside limits occurred for the same reason given for Mobilization Event 4, which was accepted by Ecology (see Attachment 3).
9. The analysis goal is to obtain analyses of at least 22 qualifying sampling events.

1.15. Water Quality Sampling Results

A total of 9 qualifying events were sampled in Year 1 of the analysis, and 13 qualifying events during Year 2, for a total of 22 required events. A summary of the monitoring results is presented in Table 9.

Quarterly reports and the Year 1 annual report presented sample findings and storm details. The 8th quarter report, by agreement, is included in this final report. Detailed information regarding the Quarter 8 storm events and laboratory analyses are presented in Attachments 1 and 2, respectively. In some instances, additional review of Year 2 sample event conditions relative to QAPP guidelines was conducted between WSDOT and Ecology, as documented in Attachment 3.

Table 9. Sampling Results

Date	Mobilization No.[1]	Sampled Parameter[2]: 520-E (West Approach) Cd	Cu	Pb	Zn	520-N (Mid-Span) Cd	Cu	Pb	Zn	520-U (East Approach) Cd	Cu	Pb	Zn
		Dissolved Comparison Values (µg/L)											
		13	67.7	242	544.4	45.5	285	925.7	2298.7	13	67.7	242	544.4
		Dissolved Concentration of Sample (µg/L)											
Quarter 1: December 1, 2017 – February 28, 2018													
01/04/2018	1	< 0.05	11.8	< 0.05	18.4	< 0.05	11.7	< 0.05	27.4	< 0.05	16.7	< 0.05	56.2
01/17/2018	2	-[3]	-[3]	-[3]	-[3]	-[3]	-[3]	-[3]	-[3]	< 0.05	3.76	< 0.05	16.8
Quarter 2: March 1, 2018 – May 31, 2018													
03/08/2018	3	< 0.05	12.1	< 0.1	30.0	< 0.05	10.9	< 0.1	25.1	< 0.05	10.8	< 0.1	23.4
04/04/2018	4	< 0.05	11.5	< 0.1	41.2[4]	< 0.05	10.2	< 0.1	31.7[4]	< 0.05	12.1	< 0.1	33.6[4]
04/07/2018	5	< 0.05	7.00	< 0.1	40.0	< 0.05	5.12	< 0.1	29.0	< 0.05	9.02	0.117	40.2
04/28/2018	6	< 0.05	8.26	< 0.1	23.3	< 0.05	8.67	0.393	25.4	< 0.05	10.9	< 0.1	20.8
05/08/2018	7	*Precipitation amount did not qualify, no samples collected.*											

Table 9. Sampling Results (continued)

Date	Mobilization No.[1]	Sampled Parameter [2]											
		520-E (West Approach)				520-N (Mid-Span)				520-U (East Approach)			
		Cd	Cu	Pb	Zn	Cd	Cu	Pb	Zn	Cd	Cu	Pb	Zn
		Dissolved Comparison Values (µg/L)											
		13	67.7	242	544.4	45.5	285	925.7	2298.7	13	67.7	242	544.4
		Dissolved Concentration of Sample (µg/L)											
Quarter 3: June 1, 2018 – August 31, 2018													
06/08/2018	8	0.129	50.7	0.567	181	0.051	15.5	0.313	69.9	0.130	72.6[5]	2.37	194
Quarter 4: September 1, 2018 – November 30, 2018													
10/25/2018	9	<0.05	5.27	<0.1	21.9	<0.05	5.44	<0.1	20.5	<0.05	10.2	0.100	31.2
10/27/2018	10	-[3]	-[3]	-[3]	-[3]	<0.05	7.20	<0.1	25.0				
Quarter 5: December 1, 2018 – February 28, 2019													
12/12/2018	11	<0.05	13.3	<0.1	56.4	<0.05	9.67	<0.1	24.9	<0.05	14.0	<0.1	53.7
Duplicate[6]		0.061	15.5	<0.1	92.0								
12/15/2018	12	<0.05	8.24	<0.1	31.4	<0.05	6.78	<0.1	17.6	<0.05	6.41	<0.1	20.0
12/17/2018	13	<0.05	2.99	<0.1	11.1	<0.05	3.29	<0.1	12.0	<0.05	2.84	<0.1	10.2
Duplicate[6]						<0.05	3.20	<0.1	9.53				
01/03/2019	14	<0.05	14.1	<0.1	40.0	0.062	12.8	<0.1	37.1	<0.05	13.7	<0.1	46.1
Duplicate[6]										<0.05	13.6	<0.1	40.4
01/05/2019	15	*Holding times exceeded, samples not submitted.*											
01/17/2019	16	*Precipitation amount did not qualify, no samples collected.*											
02/01/2019	17	<0.05	11.0	0.129	33.5	<0.05	9.50	0.446	26.8	<0.05	9.90	0.141	23.2
Duplicate[6]		<0.05	11.8	0.148	34.6								
Quarter 6: March 1, 2019 – May 31, 2019													
04/05/2019	18	<0.05	12.4	0.125	33.8	<0.05	10.6	0.143	29.8	<0.05	15.8	0.134	29.3
Duplicate[6]						<0.05	11.5	0.131	32.9				
04/13/2019	19	*Precipitation amount did not qualify, no samples collected.*											
04/18/2019	20	*Precipitation amount did not qualify, no samples collected.*											
05/16/2019	21	<0.05	5.78	<0.1	28.9	<0.05	5.73	0.149	15.6	<0.05	10.7	<0.1	23.0
Duplicate[6]		<0.05	8.25	<0.1	27.3								
Quarter 7: June 1, 2019 – August 31, 2019													
07/09/2019	22	<0.05	13.9	<0.1	44.7	<0.05	9.79	<0.1	22.2	<0.05	17.1	<0.1	43.5
Duplicate[6]										<0.05	18.2	<0.1	34.9
Quarter 8: September 1, 2019 – November 30, 2019													
9/14/19	23	< 0.05	6.60	< 0.1	20.7[4]	< 0.05	4.91	< 0.1	11.4[4]	< 0.05	5.82	< 0.1	12.6[4]
Duplicate[6]										< 0.05	5.94	< 0.1	13.1[4]
9/17/19	24	< 0.05	13.9	< 0.1	47.4[4]	< 0.05	7.03	< 0.1	19.5[4]	< 0.05	14.0	< 0.1	25.5[4]
Duplicate[6]						< 0.05	6.80	< 0.1	20.3				
10/16/19	25	< 0.05	17.5	0.168	50.2	0.064	11.4	0.183	33.7	< 0.05	15.8	0.146	34.4
10/21/19	26	< 0.05	5.96	0.116	26.9	< 0.05	5.05	0.118	19.4	< 0.05	5.47	< 0.1	16.9
11/15/19	27	< 0.05	7.54	< 0.1	29.6	< 0.05	7.18	< 0.1	19.1	< 0.05	7.00	< 0.1	21.6

1. Mobilization events are also called "Storm Events" in appendix reports. The analysis was scoped for a maximum of 27 storm mobilization events.
2. Cd = cadmium, Cu = copper, Pb = lead, Zn = zinc.
3. Sample not sent to lab for analysis, see notes in Table 8.
4. The lab spike recovery test for this sample was not within control limits; Mobilization Event 4 sample flagged per the QAPP, but it was accepted by Ecology (see Attachment 3). Year 2 samples occurred for the same reason.
5. The sampling result exceeded its corresponding dissolved comparison value.
6. Composited field duplicate samples are collected by a second automated sampler at the same time as the primary during sampling events. The goal is to collect field duplicates at a rate of 10 percent of the total samples throughout the AKART study.

For Year 1, no sample results were greater than the corresponding comparison value for Quarters 1, 2, or 4, but one sample result (dissolved copper at Station 520-U) from Mobilization Event 8 in Quarter 3 exceeded the comparison value. No sample results were greater than the corresponding comparison value for any quarter in Year 2 sampling events. Additional discussion of these results is provided in Sections 6 and 7 below.

1.16. Summary Analysis Of Sampling Program

The AKART monitoring program was conducted to verify whether the range of stormwater discharge concentrations from the replacement bridge deck to the SSPs match the predicted concentrations used in the AKART study dilution models when the bridge deck is swept monthly and to verify that the 50-foot mixing zone will dilute the parameters of interest to concentrations that meet acute and chronic State water quality standards. However, the study design also included elements that can be used to examine variability in storm events and variability in runoff concentrations due to potential sources such as seasonality, rainfall amount, antecedent days, bridge location, and maintenance frequency. Exploratory data analysis was used to evaluate variability in storm events and runoff concentrations relative to these potential sources to inform future WSDOT AKART analyses, maintenance programs, or sampling.

1.17. Sample Size

As stated in the QAPP, a minimum number of sampled events is necessary to establish whether the input parameters used in the AKART study dilution model accurately represent runoff concentrations from the future replacement bridge. The QAPP specified a minimum of 22 qualifying events to achieve a confidence level of 95 percent and a coverage of 80 percent of possible runoff concentrations using a non-parametric tolerance interval approach. A total of 23 valid events were sampled, although one event was not analyzed because holding times were not met and the samples were discarded, leaving 22 qualifying events captured at one or more of the stations. In a few limited circumstances, samples for a qualifying event at one of the individual stations were not valid, reducing the sample size for the station. For 520-N (Mid-Span Approach) and 520-U (East Approach), 21 valid samples were analyzed, providing 94 percent confidence and 80 percent coverage for runoff concentrations at each of these stations. For 520-E (West Approach), 20 samples were collected, providing 93 percent confidence and 80 percent coverage for runoff concentrations at that station.

1.18. Rainfall and Runoff Comparison

Prior to initiating stormwater sampling for this study, the consultants completed a rainfall analysis to develop a relationship between rainfall amount and runoff draining to the sampling devices. A rainfall/runoff relationship for each station was necessary to program monitoring equipment for successful sampling events. This information was also used to help guide storm event tracking and sampling efforts to minimize the sampling of non-qualifying storm events. A summary of this analysis was provided to WSDOT in a November 15, 2017, Technical Memorandum (Parametrix and Aspect 2017) (Attachment 4).

Technical Memorandum Figures 3, 4, and 5 showed the 100-percent theoretical runoff, measured runoff, and rainfall/runoff relationship as a trendline based on measured runoff for each of the sampling stations (520-E, 520-N, and 520-U, respectively). Figures 7, 8, and 9 in this report show the data presented in the Technical Memorandum for all 23 completed sampling events. The

rainfall/runoff data collected during the 23 completed sampling events are also summarized in Attachment 4.

For all three stations, the rainfall/runoff trendlines for the sampling events are comparable to the theoretical and measured rainfall/runoff trendlines from the analysis. For stations 520-E and 520-U, the trendlines are closer to the theoretical rainfall/runoff trendlines than the measured rainfall/runoff trendlines from the analysis, while the trendlines for station 520-N are closer to the measured rainfall/runoff trendline.

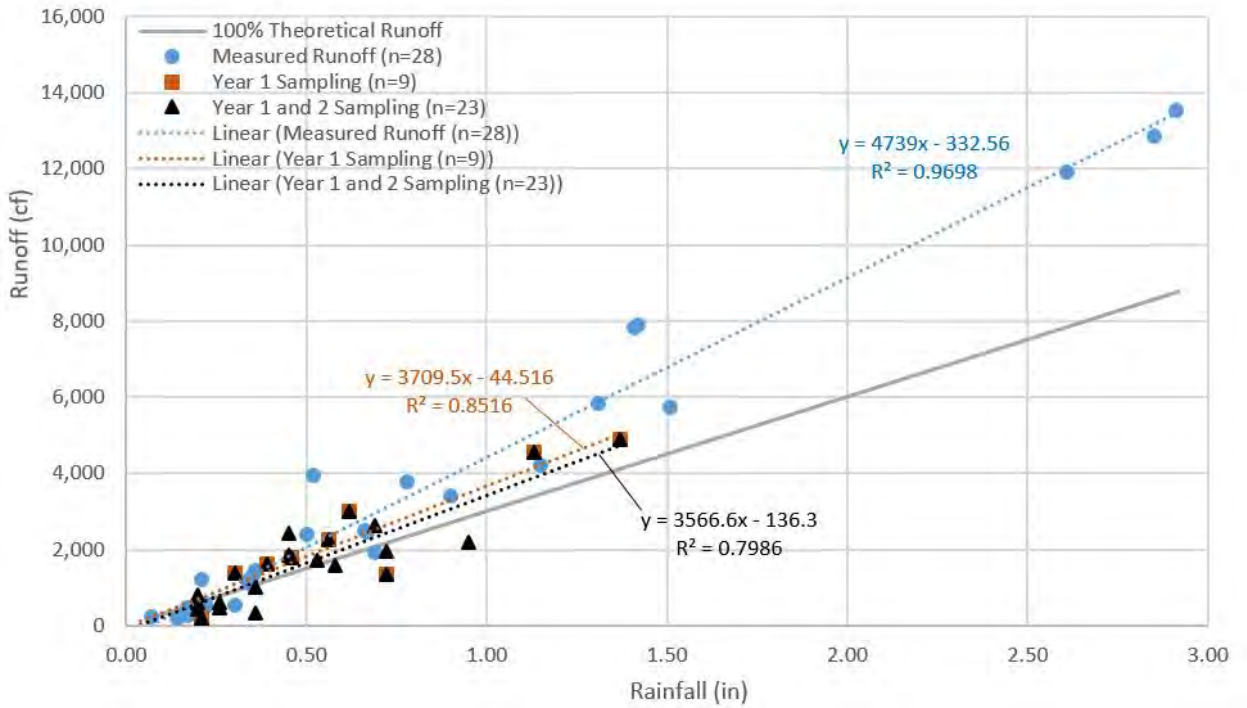


Figure 7. Runoff Analysis - SR 520E at Catchment Area ENW

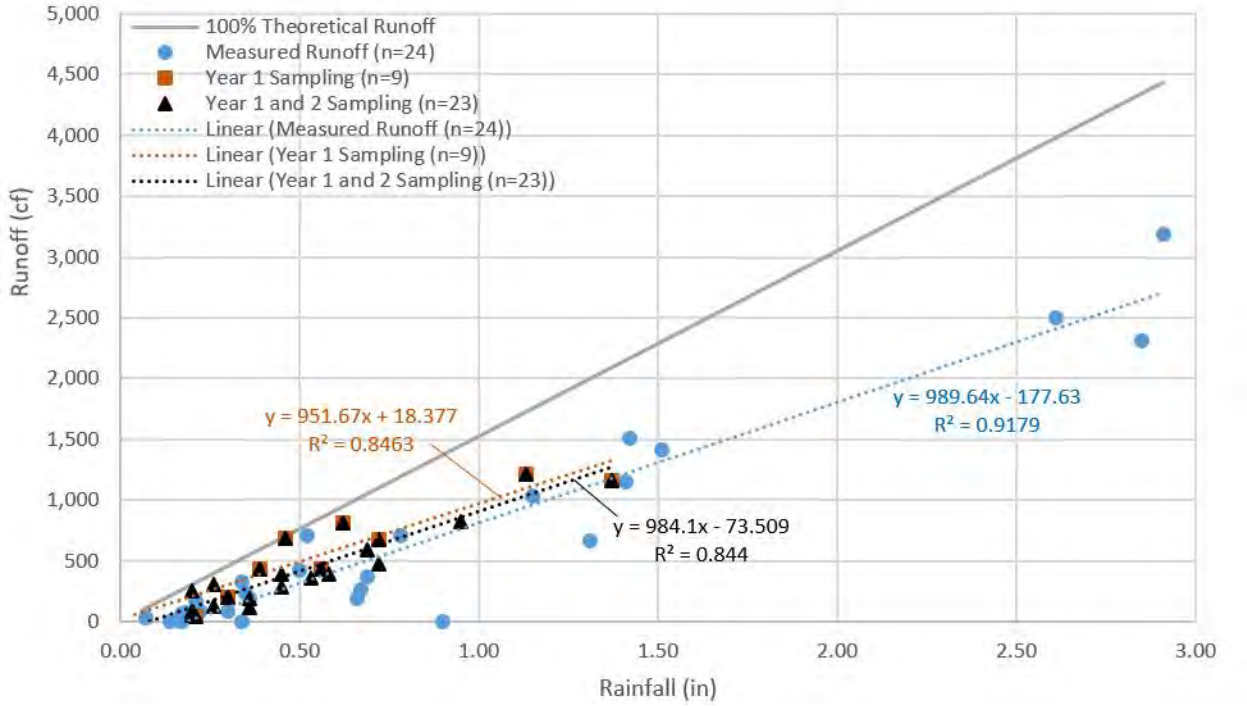


Figure 8. Runoff Analysis - SR 520N at Catchment Area NNW

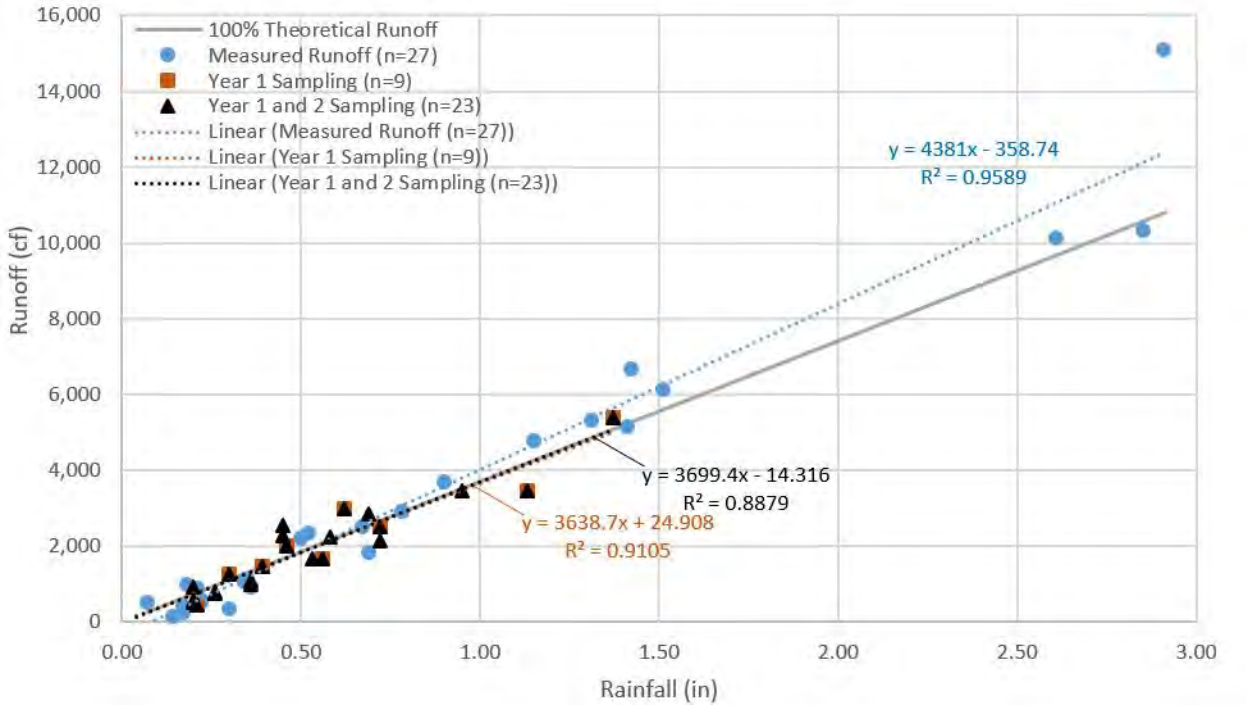


Figure 9. Runoff Analysis - SR 520U for Catchment Area UNE

1.19. Storm Events

Summary statistics for the various storm event variables are presented in Table 10 (additional calculations are provided in Attachment 5). Note that data from Mobilization Event 15 were not included in the summary statistics calculations since there were no samples analyzed from this storm. However, as shown in Figure 10, rainfall depth and duration for this event were similar to those for the storm events with at least one valid sample.

Table 10. Storm Event Monitoring Variable Statistics (n = 22)

Parameter	Number of Samples	Minimum	Maximum	Mean
Rainfall Depth (inches)	22	0.20	1.37	0.53
Rainfall Duration (hours)	22	2.42	31.00	16.53
Minimum Days Since Sweeping	22	0	24	9.4
Maximum Days Since Sweeping	22	3	30	15
Days Since Catch Basin Cleanout [1]	22	15	345	164
Antecedent Days	22	0	7	1.7
Inter-event Period (days) [2]	21	0.77	138	30
Number of Events by Season (Monitoring Quarter)	1 (December-February)	2 (March-June)	3 (July-August)	4 (September-November)
	7	6	2	7

1. Used minimum days since no sampling events occurred during cleanout, so there was only a uniform shift in days between minimum and maximum days for each event.
2. No inter-event period for first storm event.

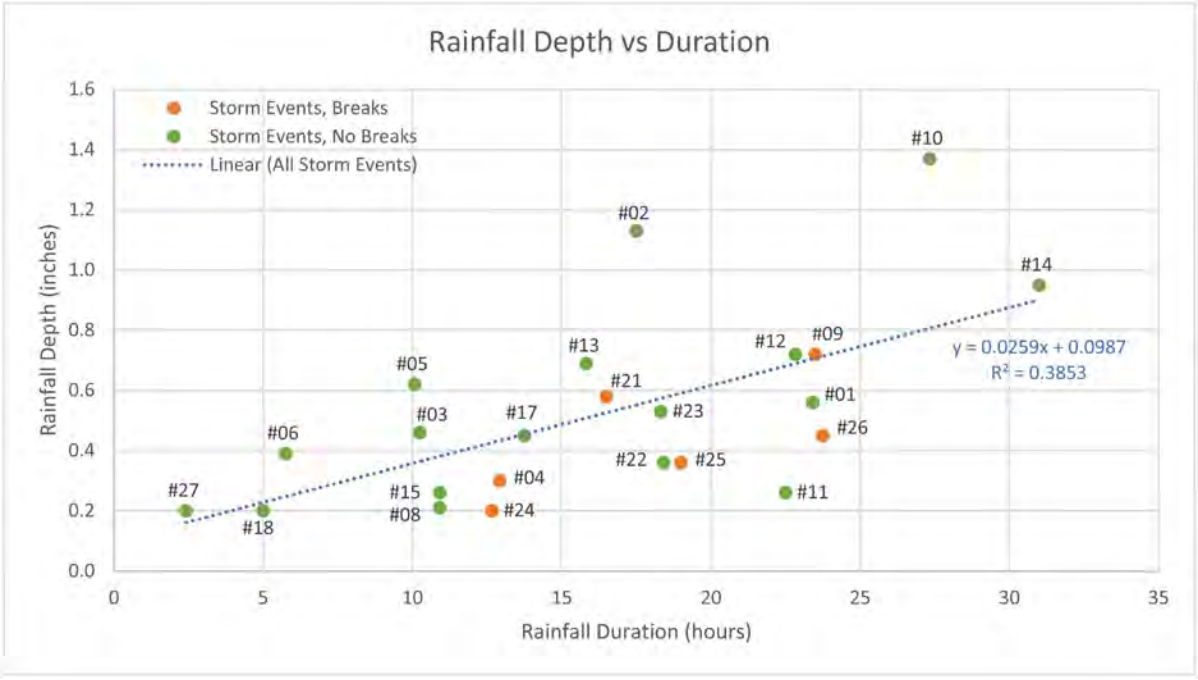


Figure 10. Rainfall Depth versus Duration (n = 23)

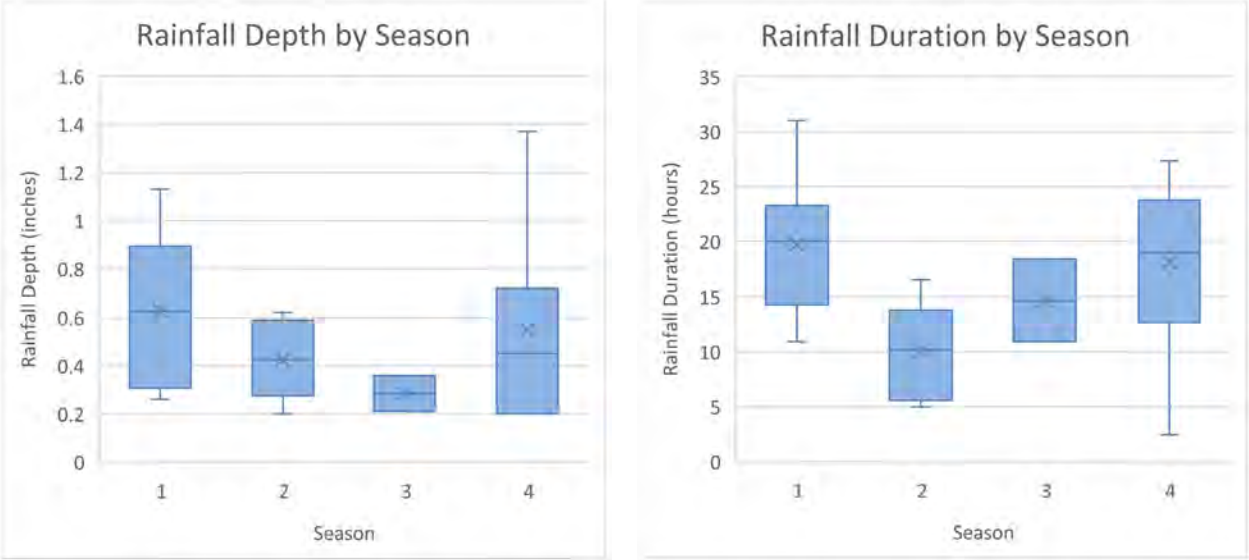
As outlined in the QAPP, at least one qualifying storm event was sampled during each monitoring quarter. As shown in Table 10, the storm durations captured by the study were all well below the consecutive 4-day period the QAPP states is required for comparison with chronic water quality standards, confirming the use of acute water quality standards to develop the adaptive management trigger values.

1.20. Review and Characterization of Sampling Events

Simple linear correlations were calculated between the storm event monitoring variables for the 22 storm events with at least one valid sample (i.e., data for Mobilization Event 15 were not included) to see if there were any strong positive (or negative) associations (Attachment 5). Correlations were calculated both with and without data for Mobilization Event 8 because dissolved copper and zinc values were higher than for other storm events (especially for stations 520-E and 520-U), which could strongly influence correlations. However, all correlations were fairly similar between the data sets with and without Mobilization Event 8, indicating that its storm characteristics were not different from the other sampled storm events. There were no strong associations observed. A moderate correlation was observed between rainfall depth and rainfall duration (0.6094 with Mobilization Event 8; 0.5948 without Mobilization Event 8), indicating that higher rainfall depths are associated with longer storms. This is also illustrated in Figure 10. All but 2 of the 22 storms with at least one valid sample resulted in less than 1 inch of total rainfall.

1.21. Rainfall Depth and Duration

Both depth and duration appear to vary somewhat by season (Figure 11); however, results are limited for the summer season (July – August) since only two storm events were sampled during this season.



Note: 1 = December – February, 2 = March – June, 3 = July – August, 4 = September – November

Figure 11. Rainfall Depth and Duration by Season (n = 23)

1.22. Runoff Volume

Attachment 6 includes a graph for each storm event showing the cumulative rainfall over time since the start of the storm, as recorded by the rain gauge located on the roof of the University of Washington (UW) Atmospheric Sciences (ATG) Building. These graphs show that rainfall patterns vary by storm in terms of depth, duration, and intensity over time during the storm event. However, for most of the storms, cumulative runoff patterns for stations 520-E and 520-U are similar and generally follow the cumulative rainfall pattern. Cumulative runoff patterns for station 520-N also tend to follow the cumulative rainfall pattern, although volumes are lower in magnitude than those for stations 520-E and 520-U. The runoff pattern for Mobilization Event 8 differs from most of the other storms; cumulative runoff appears to lag behind cumulative rainfall until near the end of the storm, when runoff intensity increases over a period of 1 to 2 hours. Mobilization Event 8 is discussed further in Section 7.3.

The drainage areas for stations 520-E and 520-U are larger than the drainage area for station 520-N. This is reflected in the runoff volumes recorded for each station (Figure 12). However, even when adjusted for drainage area size, runoff volumes for stations 520-E and 520-U are higher than the drainage area for station 520-N (Figure 12). This pattern is also apparent when considering runoff volumes by season (Figure 13). Figures 7-9 show the relationship of measured rainfall at the nearby rain station with runoff amount measured at the samplers. These curves also show a variance of runoff response between basins. These differences can be attributed to rainfall variability between stations, measuring accuracy at the weir boxes, or roadway drainage irregularity. For example, the roadway surface on the bridge is grooved, therefore it is possible that the grooves delay or “store” runoff differently in the middle flat section of the bridge when compared to the approaches on the ends of the bridges, which are sloped.

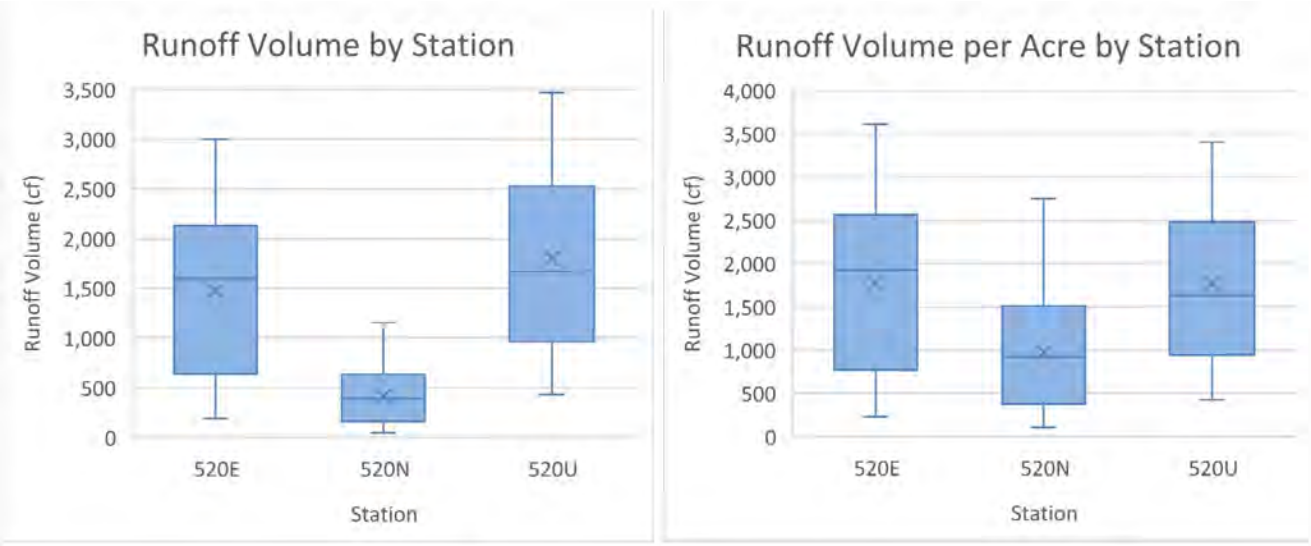


Figure 12. Runoff Volume by Station

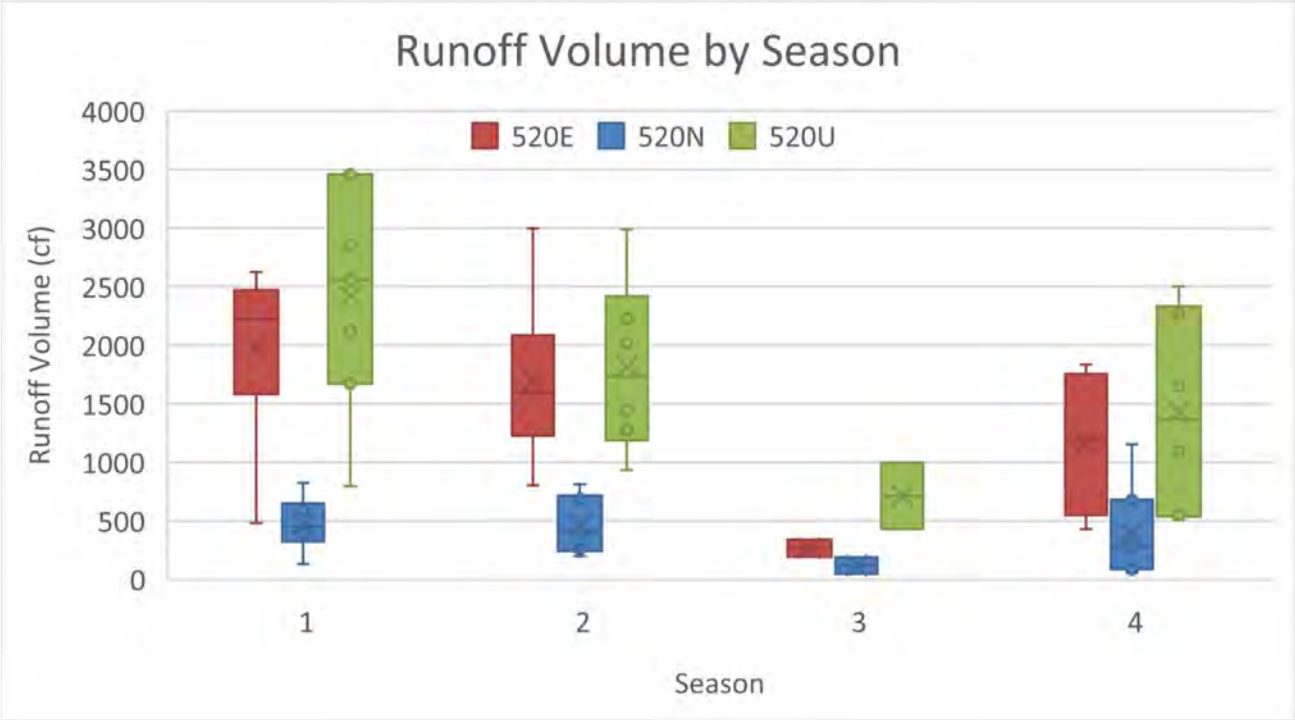


Figure 13. Runoff Volume by Station and Season

1.23. Storms with Intra-event Dry Periods

The QAPP includes multiple criteria for determining whether a storm event is valid, including an antecedent dry period of at least 6 hours with less than 0.4 inch of precipitation. During the study, 8 of the 22 storm events with at least one valid sample included intra-event dry periods of at least 6 hours with less than 0.4 inch of precipitation (Mobilization Events 4, 9, 11, 12, 21, 24, 25, and 26). Sample results from these events were initially considered provisional and required acceptance by Ecology to be included in the study. Ecology's acceptance of Year 1 provisional samples and Year 2 provisional samples are documented in Attachment 3.

As shown in Figure 10, rainfall depth and duration for storm events with intra-event dry periods fall within the range of values for storm events without intra-event dry periods. Figure 14 shows that runoff volumes at the three stations are somewhat lower overall for storm events with intra-event dry periods compared to storm events without intra-event dry periods; however, they are within the range of volumes observed for storm events without intra-event dry periods at all three stations.

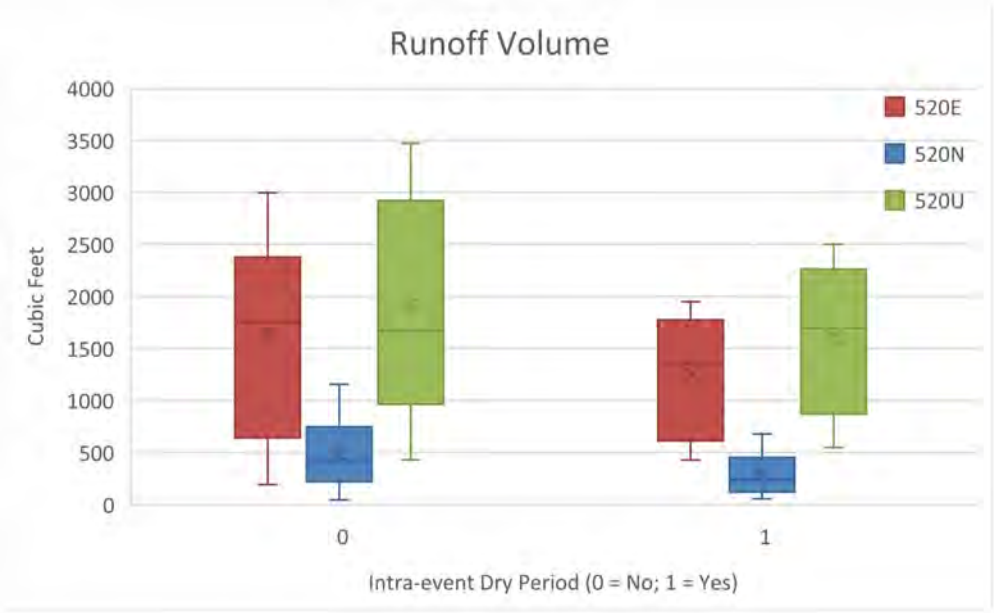


Figure 14. Runoff Volume Based on Intra-event Dry Periods

1.24. Characterization of Sampling Results

1.25. Runoff Concentrations

Summary statistics for the runoff concentrations are presented in Table 11 (additional calculations are provided in Attachment 5). Both dissolved and total cadmium and lead concentrations are very low; at least two-thirds of the dissolved cadmium and lead results are non-detects at all three stations. The maximum dissolved cadmium and lead concentrations at stations 520-E and 520-U are at least 100 times below trigger values, while the maximum dissolved cadmium and lead concentrations at station 520-N are at least 700 times below trigger values. Because the dissolved cadmium and lead concentrations do not appear to be of concern, the remaining analysis focuses on copper and zinc.

Table 11. Runoff Concentration Statistics

Metal (ug/L)	Trigger Value	Number of Exceedances	Percent Non-detects	Minimum	Maximum	Mean
520-E (n = 20)						
Dissolved Cadmium [1]	13	0	95	0.05 U	0.129	0.0540
Dissolved Copper	67.7	0	0	2.99	50.7	11.992
Dissolved Lead [1]	242	0	75	0.05 U	0.567	0.1278
Dissolved Zinc	544.4	0	0	11.1	181	40.52
Total Cadmium [1]	n/a [2]		10	0.05 U	0.291	0.1223
Total Copper	n/a		0	20.9	105	48.16
Total Lead	n/a		0	1.08	8.47	3.917
Total Zinc	n/a		0	54.9	354	171.74
520-N (n = 21)						
Dissolved Cadmium [1]	45.5	0	86	0.05 U	0.064	0.0513
Dissolved Copper	285	0	0	3.29	15.5	8.490
Dissolved Lead [1]	925.7	0	67	0.05 U	0.446	0.1474
Dissolved Zinc	2298.7	0	0	11.4	69.9	25.98
Total Cadmium [1]	n/a		48	0.05 U	0.284	0.0716
Total Copper	n/a		0	10.6	76.2	24.10
Total Lead	n/a		0	0.384	8.18	2.048
Total Zinc	n/a		0	23.2	278	75.24
520-U (n = 21)						
Dissolved Cadmium [1]	13	0	95	0.05 U	0.13	0.0538
Dissolved Copper	67.7	1	0	2.84	**72.6**	13.562
Dissolved Lead [1]	242	0	71	0.05 U	2.37	0.2099
Dissolved Zinc	544.4	0	0	10.2	194	36.84
Total Cadmium [1]	n/a		14	0.05 U	0.334	0.1030
Total Copper	n/a		0	16.8	113	46.89
Total Lead	n/a		0	0.825	12.5	4.0940
Total Zinc	n/a		0	40.7	395	142.79

1. Full detection limit used for non-detects in summary statistic calculations.
2. n/a = not applicable.

Simple linear correlations were calculated between runoff concentrations and monitoring variables to see if there were any strong positive (or negative) associations (Attachment 5). Correlations were calculated both with and without data for Mobilization Event 8 because dissolved copper and zinc values were higher than for other storm events (especially for stations 520-E and 520-U), which could strongly influence correlations. Because many of the correlations differed between those calculated with and without Mobilization Event 8, correlations discussed here are those calculated without data for Mobilization Event 8. As expected, there were strong positive correlations (> 0.70) between rainfall depth and runoff volume and between total concentrations for all four metals at all three stations. There were also strong positive correlations between dissolved copper and dissolved zinc at all three stations (> 0.75). At stations 520-E and 520-U, there were moderate positive correlations between dissolved and total copper (0.5140 at 520-E; 0.6225 at 520-N); positive correlations were weak for dissolved and total zinc (0.2259 at 520-E; 0.2684 at 520-N). Weak positive correlations were observed between dissolved and total concentrations for both copper and zinc, and between antecedent days and dissolved copper or dissolved zinc. Although mostly at weak levels, negative correlations were observed at one or more stations, including between rainfall duration and total metals, runoff volume and dissolved copper or dissolved zinc, between minimum days since sweeping and dissolved copper or dissolved zinc, between days since sweeping and total metals, and between days since catch basin cleanout and total metals. The patterns observed in correlations (magnitude and positive versus negative) were more similar between stations 520-E and 520-U compared to those at station 520-N. Figures 15a and 15b illustrate weak relationships between dissolved copper and zinc concentrations and runoff volumes.

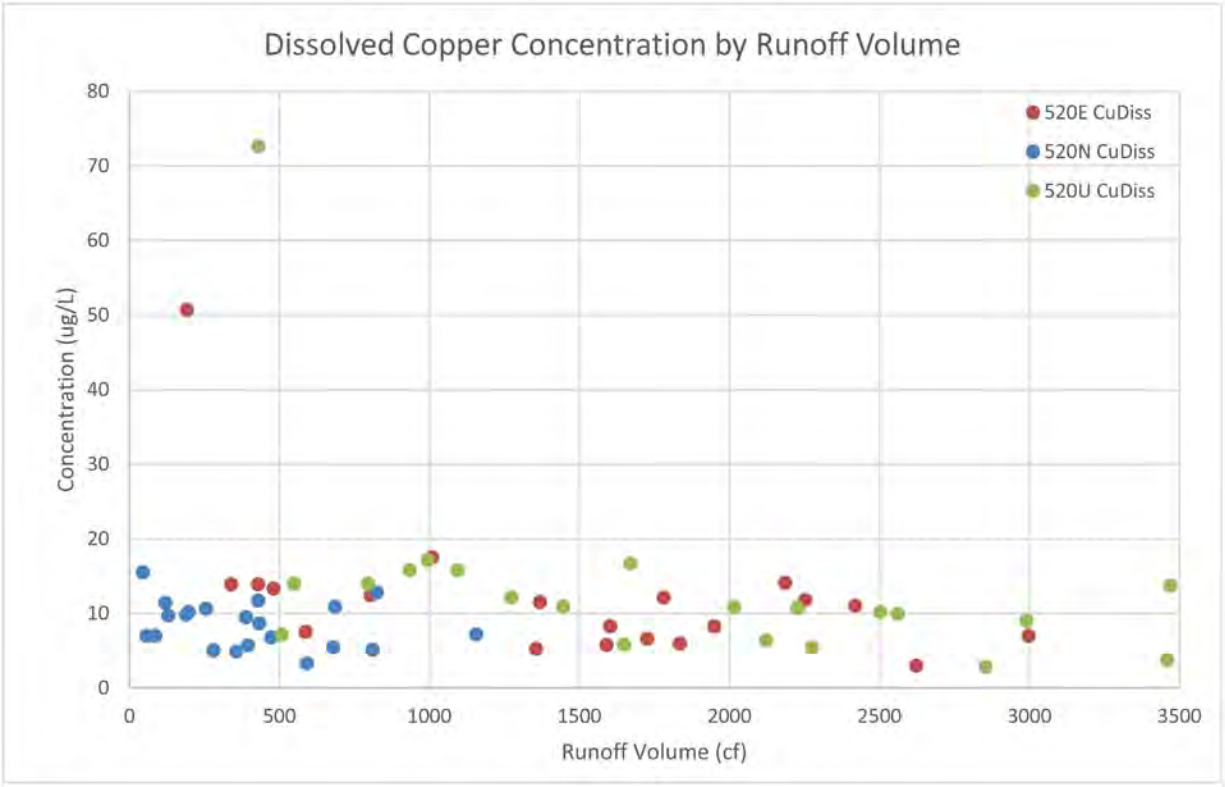


Figure 15a. Dissolved Copper Concentrations by Runoff Volume

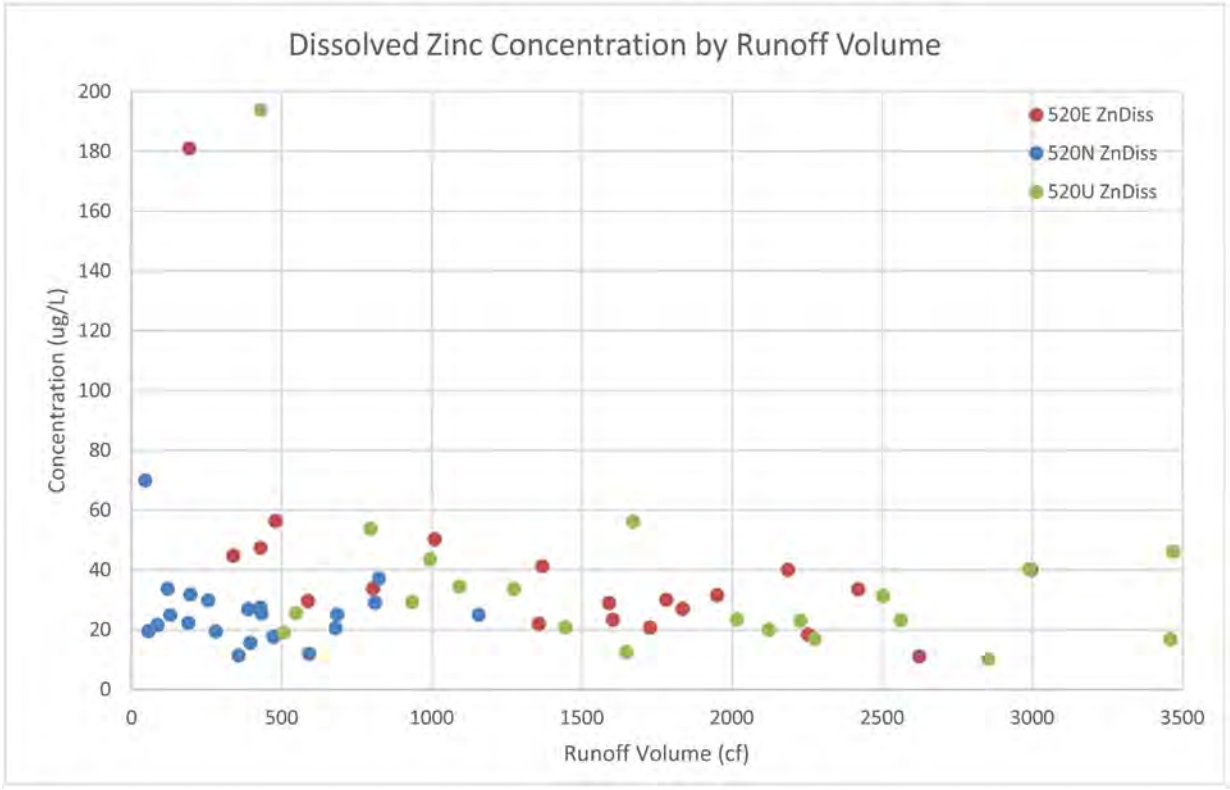
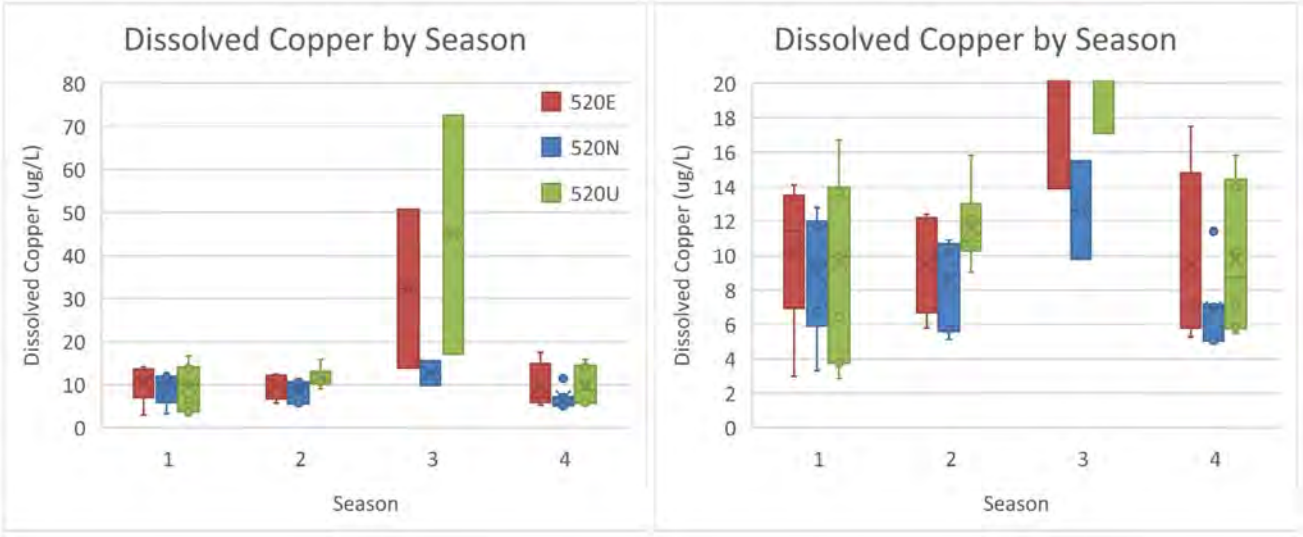


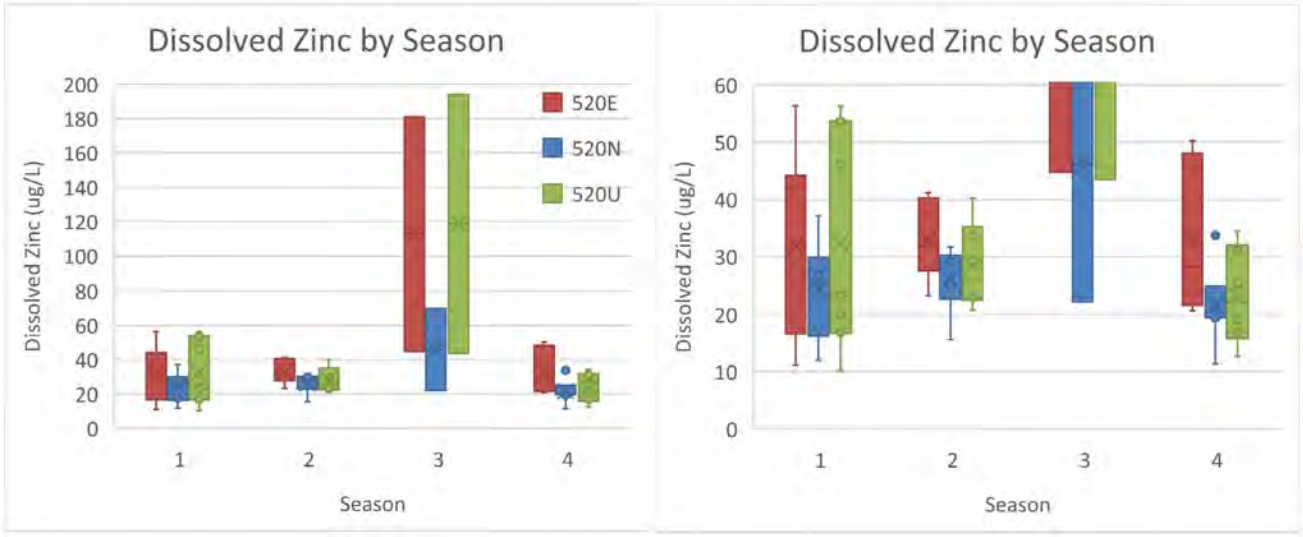
Figure 15b. Dissolved Zinc Concentrations by Runoff Volume

Attachment 7 includes additional graphical summaries of the exploratory data analyses for dissolved copper and dissolved zinc. Runoff concentrations at stations 520-E and 520-U are similar, but somewhat higher than those at station 520-N, and tend to vary somewhat by season (Figures 16a and 16b); however, results are limited for the summer season (July – August) since only two storm events were sampled during this season (including Mobilization Event 8).



Note: two figures are provided to show greater detail; they provide the same information.

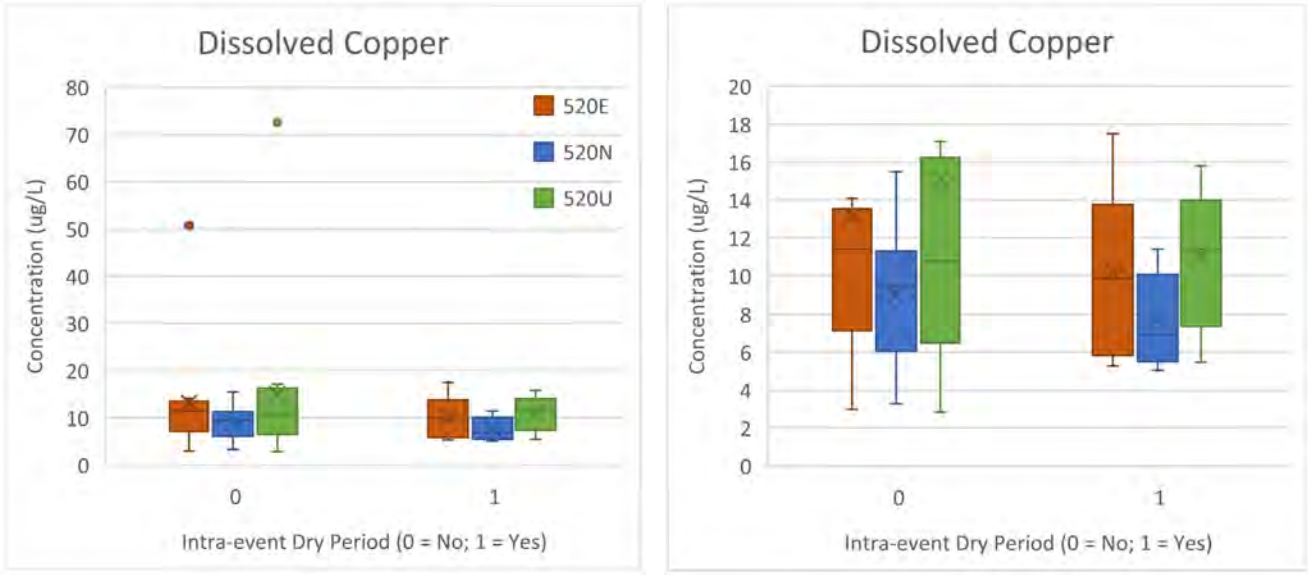
Figure 16a. Dissolved Copper Concentrations by Station and Season.



Note: two figures are provided to show greater detail; they provide the same information.

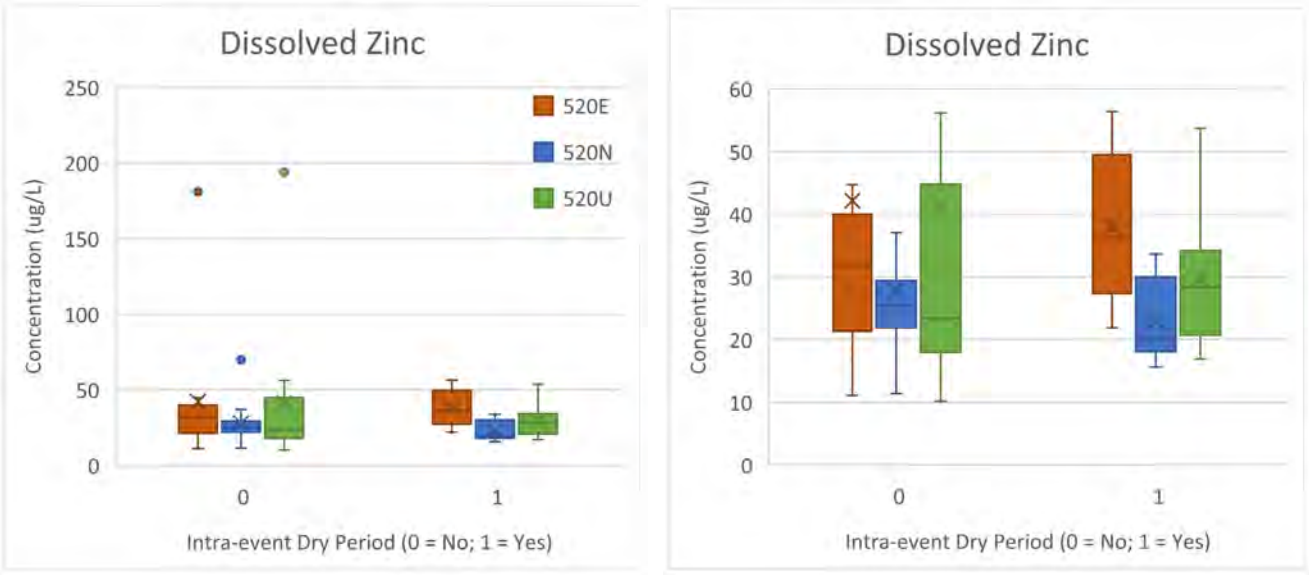
Figure 16b. Dissolved Zinc Concentrations by Station and Season

Runoff concentrations of dissolved copper and zinc were also examined to determine whether levels differed between storms with and without intra-event dry periods (Figures 17a and 17b). Dissolved copper concentrations are similar at each station between the two types of storm events, while there is more variability for dissolved zinc concentrations. As for rainfall depth and duration, the concentrations from storms with intra-event dry periods fall within the ranges of concentrations from storms without intra-event dry periods. Additionally, runoff concentrations did not show any relationship with intra-event period length (Figures 18a and 18b).



Note: two figures are provided to show greater detail; they provide the same information.

Figure 17a. Dissolved Copper Concentrations Based on Intra-event Dry Periods



Note: two figures are provided to show greater detail; they provide the same information.

Figure 17b. Dissolved Zinc Concentrations Based on Intra-event Dry Periods

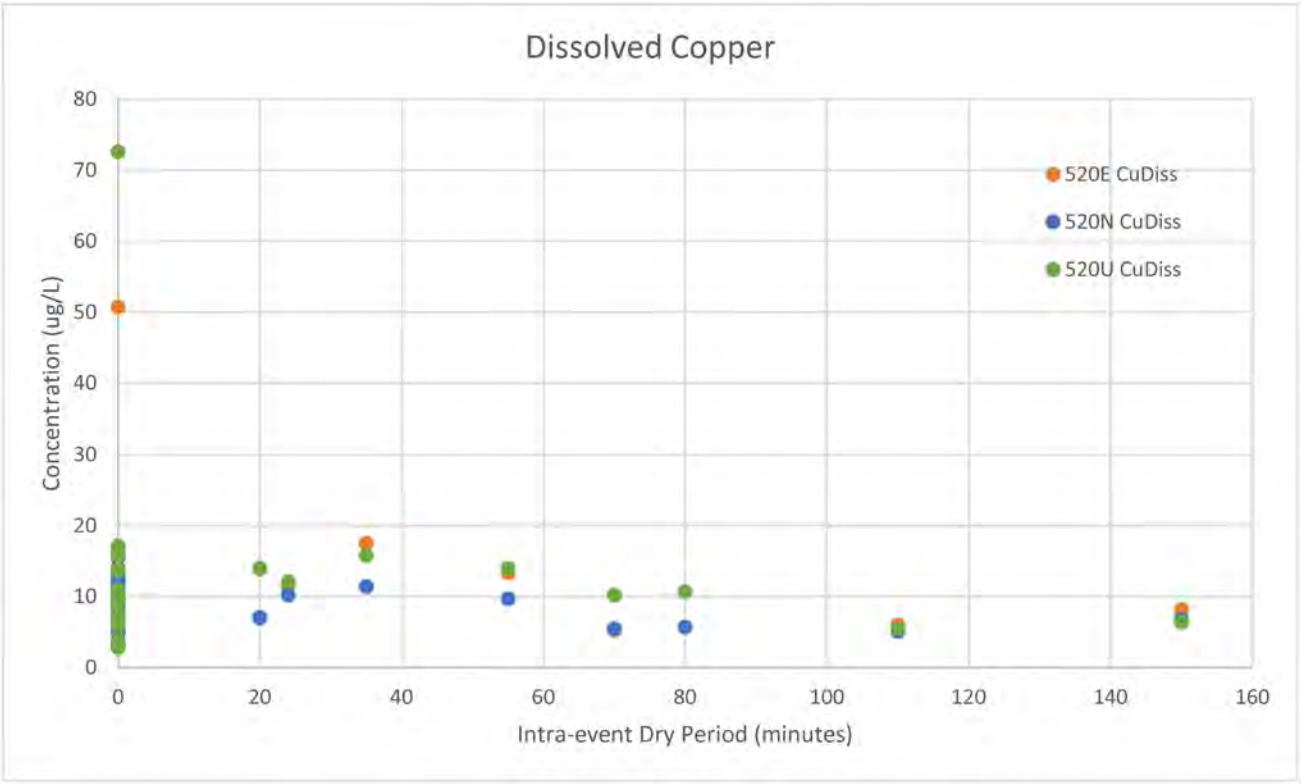


Figure 18a. Dissolved Copper Concentrations by Intra-event Dry Period Length

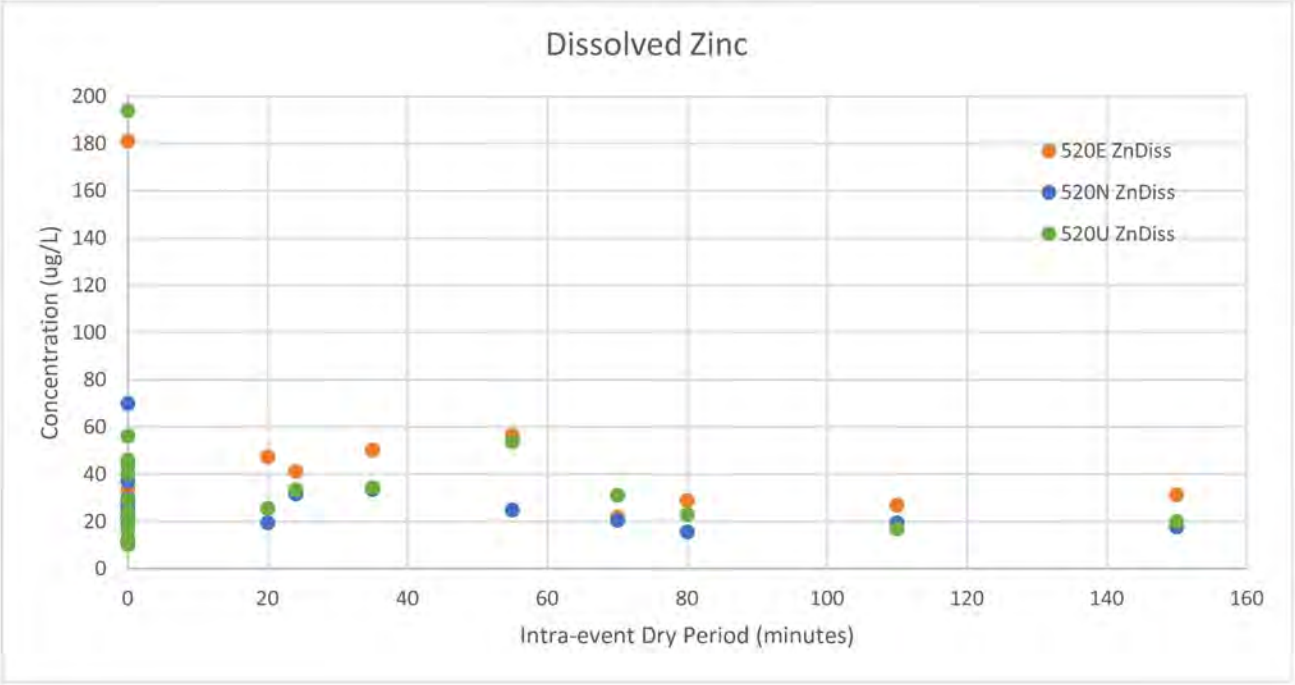


Figure 18b. Dissolved Zinc Concentrations by Intra-event Dry Period Length

1.26. Total Mass Values of Dissolved Copper and Zinc

To assess the relative difference of dissolved copper and zinc generated by storm events with varying rainfall depths and runoff volumes, total mass values of copper and zinc were estimated for each station based on dissolved concentrations and runoff volumes. Total mass values on a per-acre basis were also calculated using each station's basin drainage area. Summary statistics for runoff volumes and total mass values of dissolved copper and zinc are presented in Table 12 (additional calculations are provided in Attachment 5). Graphical summaries of the exploratory data analyses for total mass values of dissolved copper and dissolved zinc are included in Attachment 7.

Table 12. Dissolved Copper and Zinc Runoff Volumes Compared to Total Mass Values

Parameter [1]	Minimum	Maximum	Mean
520-E (n = 20)			
Runoff Volume (cf)	192	2,997	1,476
Total Mass, Dissolved Copper (g)	0.1253	0.8728	0.3921
Total Mass per Acre, Dissolved Copper (g/ac)	0.1510	1.0516	0.4724
Total Mass, Dissolved Zinc (g)	0.4291	3.3946	1.3034
Total Mass per Acre, Dissolved Zinc (g/ac)	0.5170	4.0899	1.5704
520-N (n = 21)			
Runoff Volume (cf)	45	1,156	408
Total Mass, Dissolved Copper (g)	0.01115	0.2987	0.09179
Total Mass per Acre, Dissolved Copper (g/ac)	0.02654	0.7111	0.2186
Total Mass, Dissolved Zinc (g)	0.03092	0.8657	0.2827
Total Mass per Acre, Dissolved Zinc (g/ac)	0.07362	2.0611	0.6731

Table 12. Dissolved Copper and Zinc Runoff Volumes Compared to Total Mass Values (continued)

Parameter [1]	Minimum	Maximum	Mean
520-U (n = 21)			
Runoff Volume (cf)	430	3,470	1,801
Total Mass, Dissolved Copper (g)	0.1031	1.3462	0.5252
Total Mass per Acre, Dissolved Copper (g/ac)	0.1011	1.3198	0.5149
Total Mass, Dissolved Zinc (g)	0.2742	4.5298	1.5232
Total Mass per Acre, Dissolved Zinc (g/ac)	0.2688	4.4409	1.4933
All Stations Combined (n = 22) [2]			
Total Mass per Acre, Dissolved Copper (g/ac)	0.1081	1.1091	0.4463
Total Mass per Acre, Dissolved Zinc (g/ac)	0.3607	3.4676	1.3940

1. cf = cubic feet; g = grams; g/ac = grams per acre.
2. Summary statistics for total mass were not calculated because two of the three stations were not sampled for two Mobilization Events (#2 and #10). For those two events, total mass per acre is based only on the drainage area of the sampled station.

Simple linear correlations were calculated between total mass values and monitoring variables to see if there were any strong positive (or negative) associations (Attachment 5). Other than a moderate positive correlation between rainfall depth and event total mass per acre for dissolved zinc, correlations were weak positive or negative between event total mass per acre for dissolved copper or zinc and rainfall duration, minimum and maximum days since sweeping, inter-event period, and antecedent days. Although weak, similar magnitude negative correlations were observed between event total mass per acre for dissolved copper or zinc and days since study start (< - 0.44) (Figure 19), and slightly lower magnitude negative correlations were observed between rainfall depth and days since study start (< - 0.3).

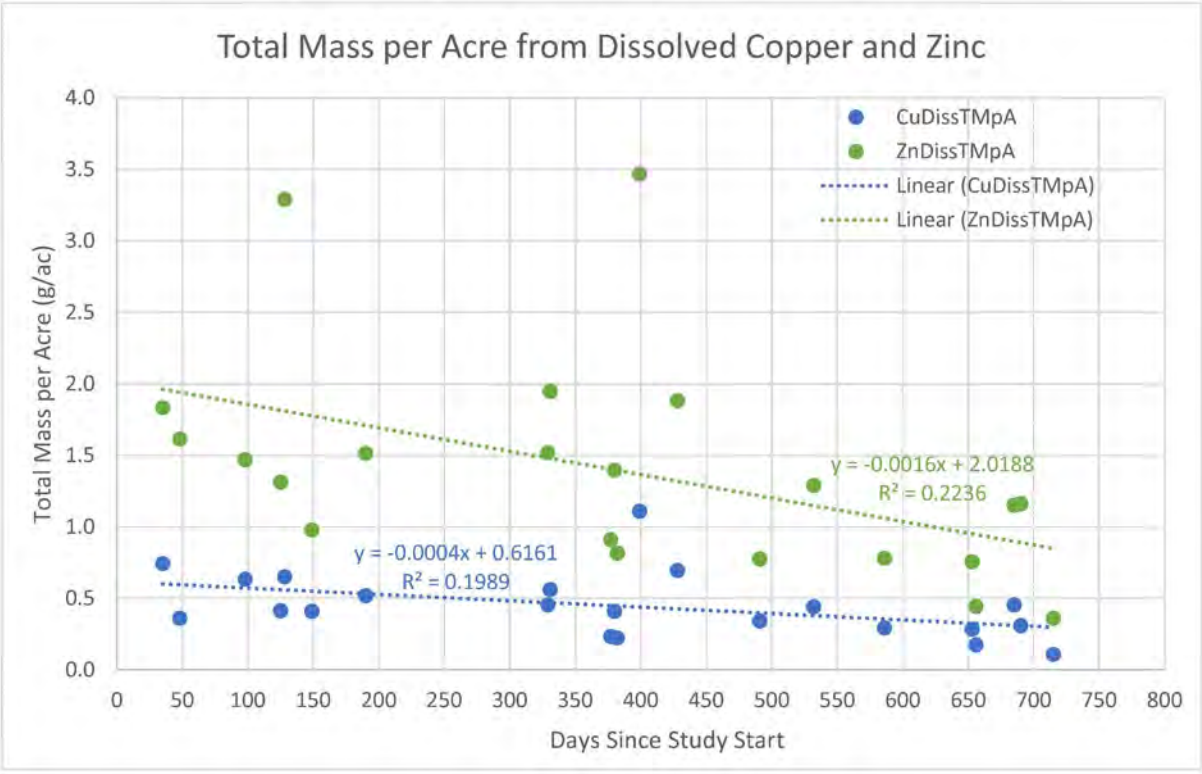


Figure 19. Dissolved Copper and Zinc Mass Over Time

For both dissolved copper and zinc, event total mass per acre values varied somewhat by season (Figure 20).

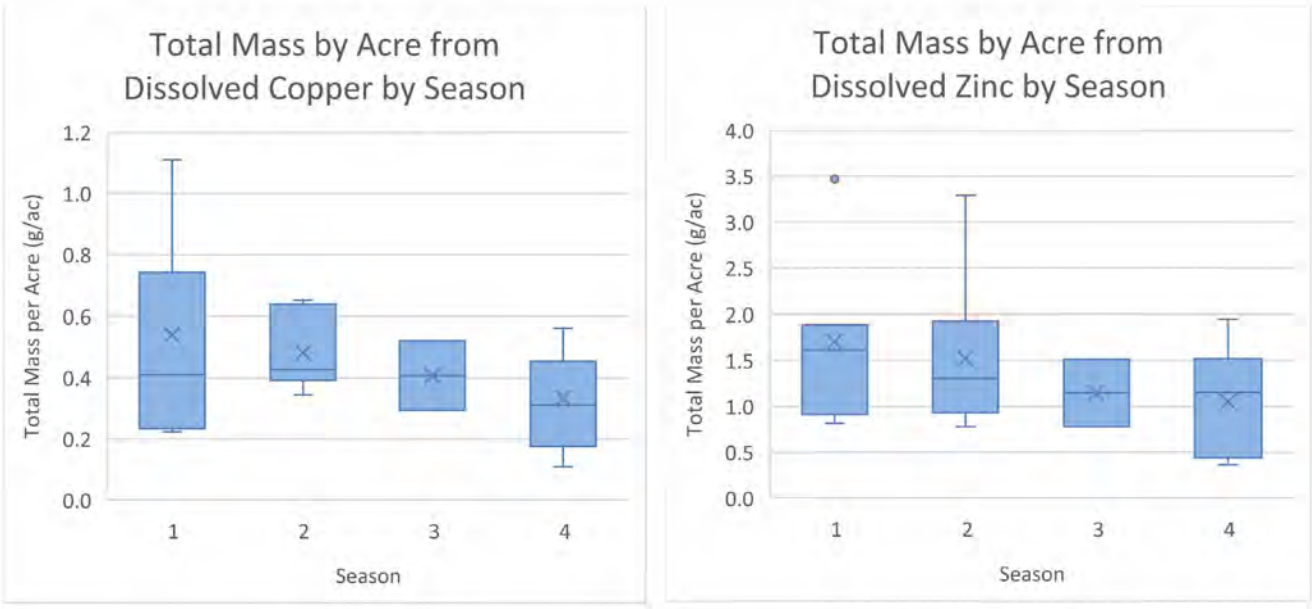
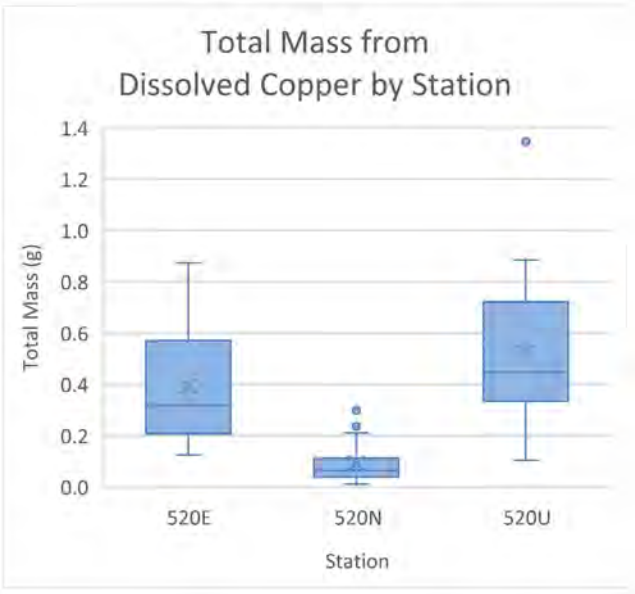


Figure 20. Dissolved Copper and Zinc Mass by Season

On both a total and per-acre basis for the three stations, runoff from stations 520-E and 520-U included more dissolved copper and zinc than runoff from station 520-N (Figures 21a and 21b). This pattern is also apparent on a seasonal basis (Figures 22a and 22b). For station 520-E, there was a moderate positive correlation between total mass from dissolved copper and antecedent days (0.5122 calculated without Mobilization Event 8) and a moderate negative correlation with minimum number of days since sweeping (-0.5372 calculated without Mobilization Event 8). For station 520-U, these correlations were in the same direction but weak, while they were in the same direction and very weak for station 520-N.



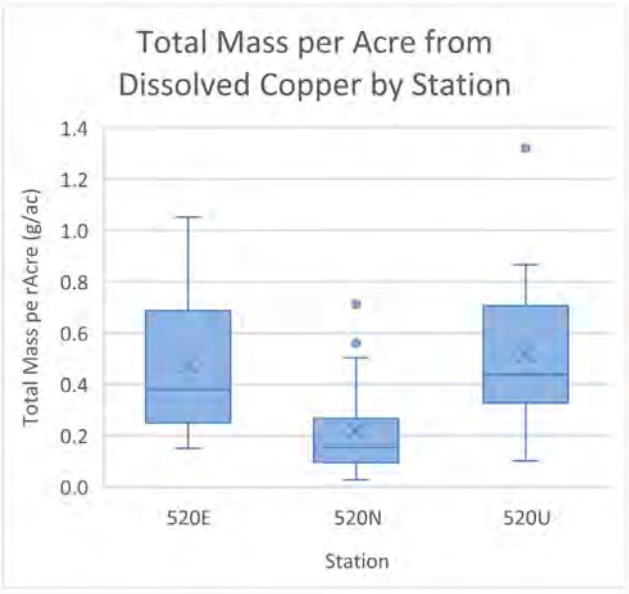
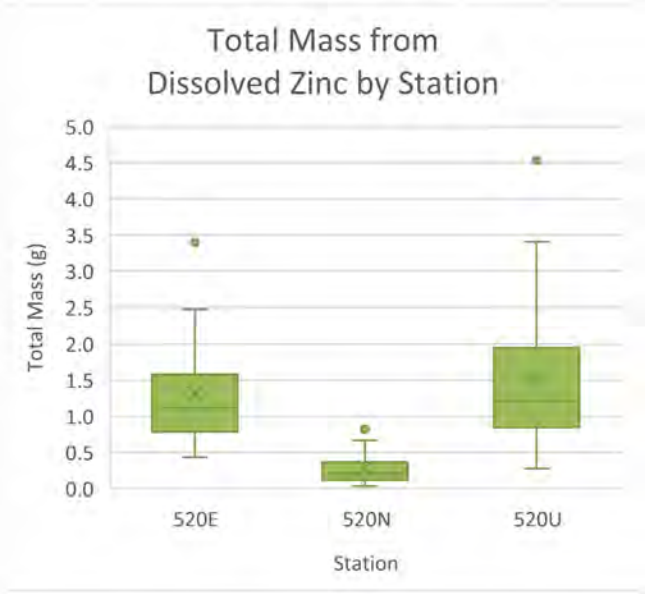


Figure 21a. Dissolved Copper Mass by Station



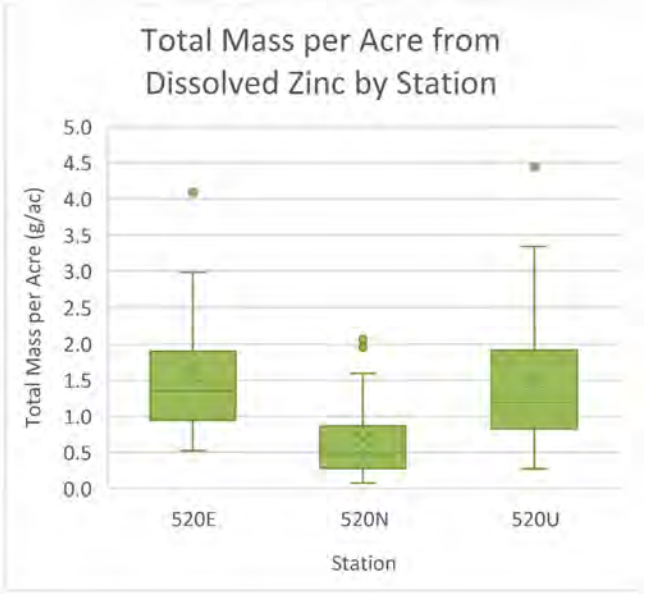


Figure 21b. Dissolved Zinc Mass by Station

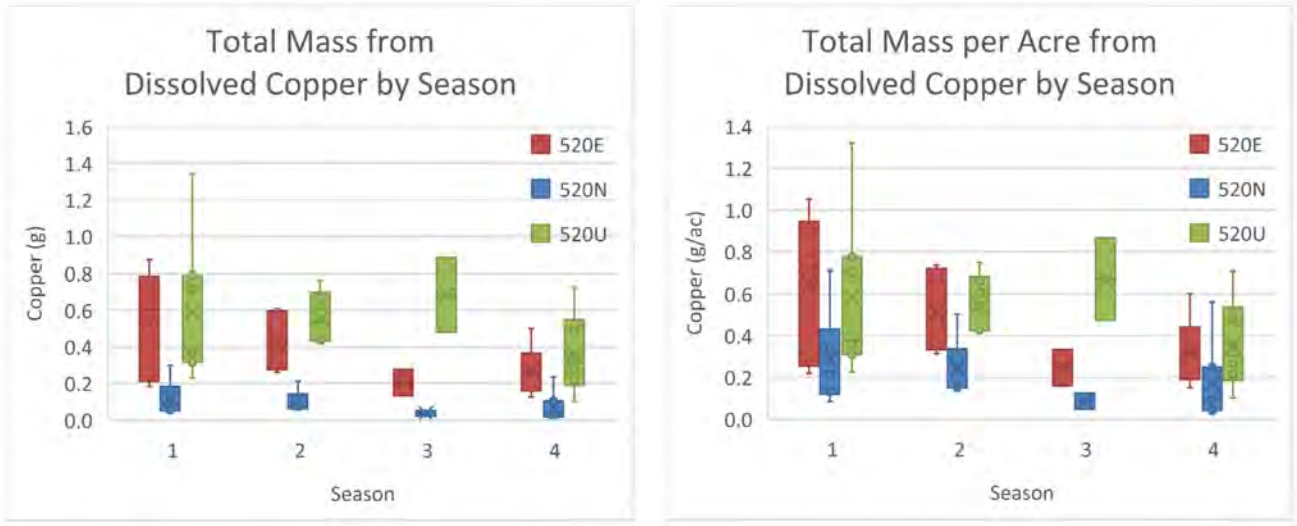


Figure 22a. Dissolved Copper Mass by Station and Season.

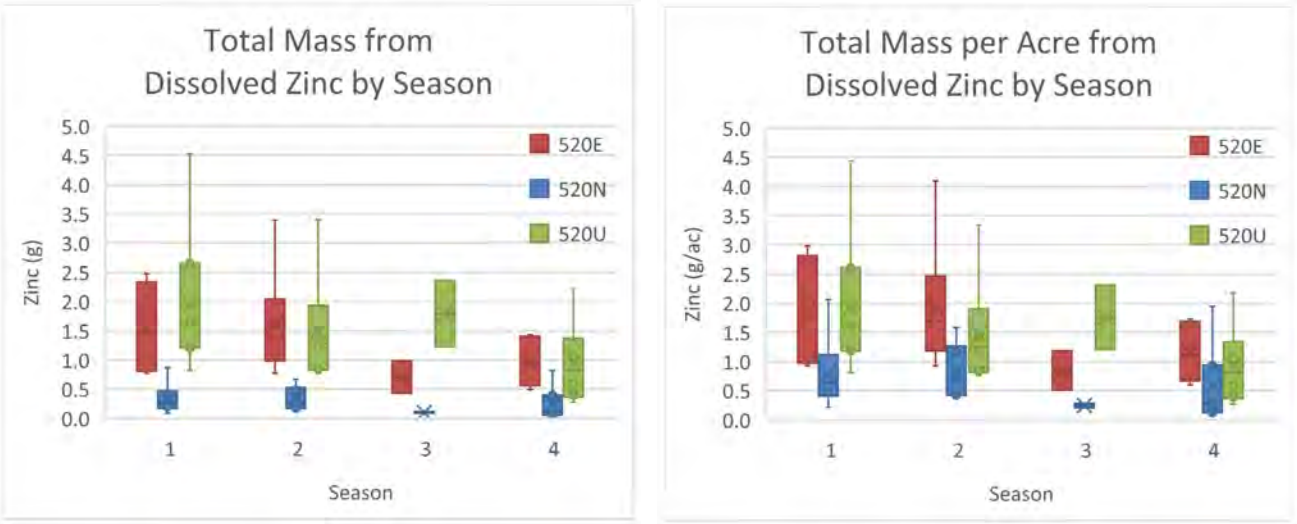


Figure 22b. Dissolved Zinc Mass by Station and Season

1.27. Mobilization Event 8

As discussed in Section 4.3, only one sample result (dissolved copper at Station 520-U) from Mobilization Event 8 exceeded a comparison value. This event is explored further in this section.

Dissolved metal concentrations in samples from all three stations from this event were also elevated compared to those in other samples collected during the study. At station 520-U, the dissolved copper concentration exceeded its comparison value and was four times higher than the next-highest concentration; the dissolved zinc concentration was more than three times higher than the next-highest concentration; the dissolved cadmium concentration was the only detected value; and the lead concentration was about 20 times the other four concentrations detected at that station. At station 520-E, the dissolved copper concentration was not above the comparison value but was almost three times higher than the next-highest concentration; the dissolved zinc concentration was about three

times higher than the next-highest concentration; the dissolved cadmium concentration was the only detected value; and the lead concentration was about three times the other four concentrations detected at that station. At station 520-N, the dissolved copper and zinc concentrations were the highest, but by less than two times and well below the comparison values, and, while detected, the dissolved cadmium and lead concentrations were not the highest at that station.

Factoring in runoff volumes for this event, total mass values of dissolved copper and zinc were not the highest at any of the stations. At station 520-E, the total mass from dissolved copper was second-highest (below that for Mobilization Event 14) and the total mass from dissolved zinc was fourth-highest (below that for Mobilization Events 1, 5, and 14). At stations 520-E and 520-N, total mass values from dissolved copper and zinc were below those for most other storm events.

While runoff volumes were the lowest of all the sampling events at all three stations, other storm event characteristics were not unlike those for the other events. Mobilization Event 8 occurred 4 to 7 days after monthly high-efficiency sweeping and more than 100 days after cleanout of the modified catch basins, while most other events occurred later after sweeping and catch basin cleanout. The event had the fourth-lowest rainfall total (0.21 inch) and sixth-lowest duration (10.92 hours). However, as noted in Section 6.2, the cumulative runoff patterns, especially at Stations 520-E and 520-U, relative to cumulative rainfall differs from most of the other storm events. Cumulative runoff appears to lag behind cumulative rainfall until near the end of the storm, when runoff intensity increases over a period of 1 to 2 hours (Figure 23).

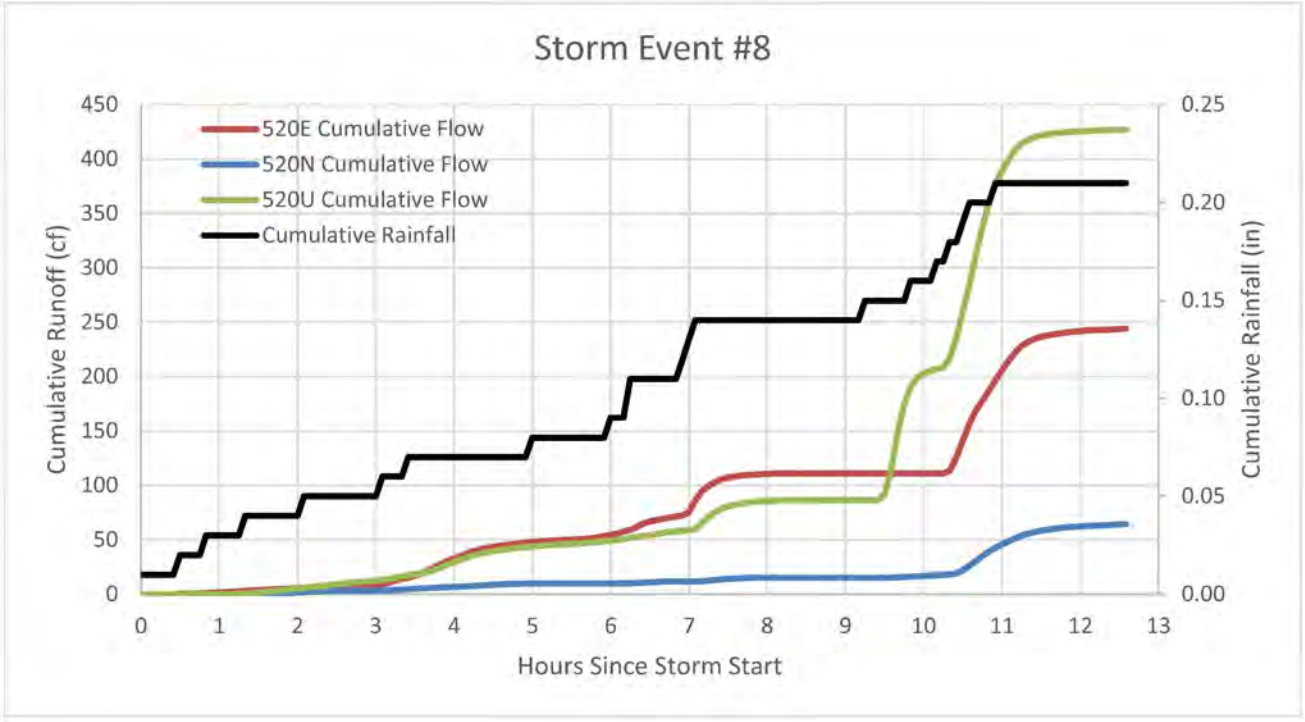


Figure 23. Cumulative Rainfall and Runoff for Mobilization Event 8

Traffic counts and rainfall before each storm event were also examined to see if conditions for Mobilization Event 8 were different from other events. Figures 24a and 24b show traffic counts for the 24 hours prior to storm start for each event and corresponding dissolved copper and zinc runoff concentrations and total mass values by station. Runoff concentrations and total mass values do not appear to increase with increasing traffic counts in the 24 hours prior to each storm. While the runoff concentrations from Mobilization Event 8 for stations 520-E and 520-U were associated with one of the highest traffic counts, another mobilization event (21) followed a 24-hour period with a higher traffic count and its runoff concentrations were similar to those from other events. Total mass values from dissolved copper and zinc also did not show any increasing pattern with traffic counts prior to the storms.

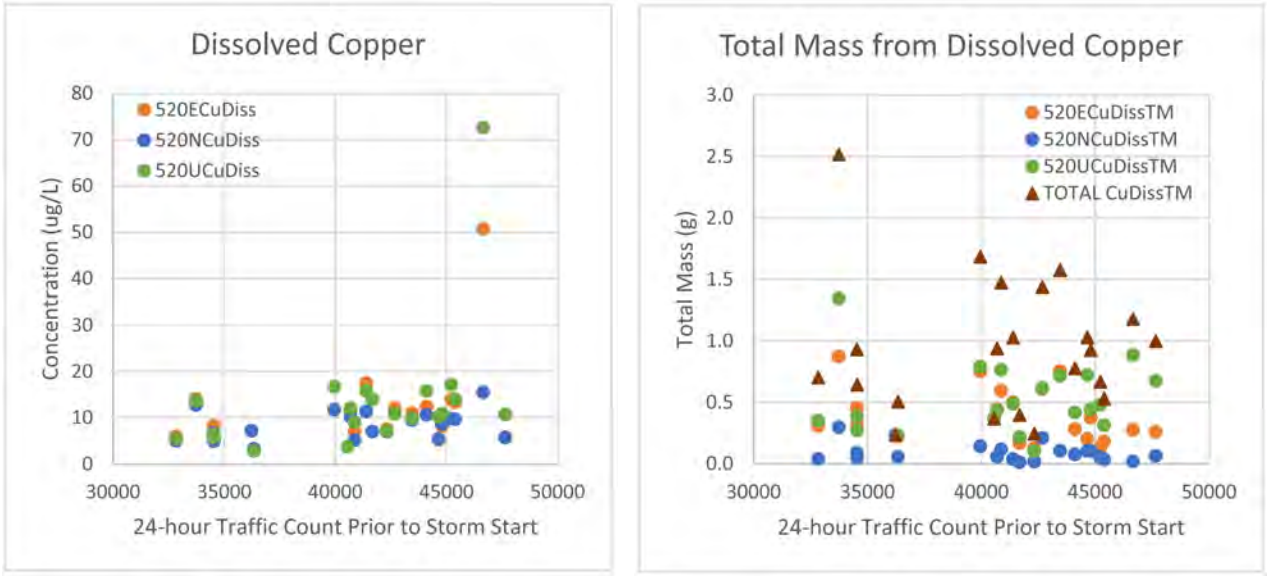


Figure 24a. Dissolved Copper Concentration and Mass by 24-hour Antecedent Traffic Count

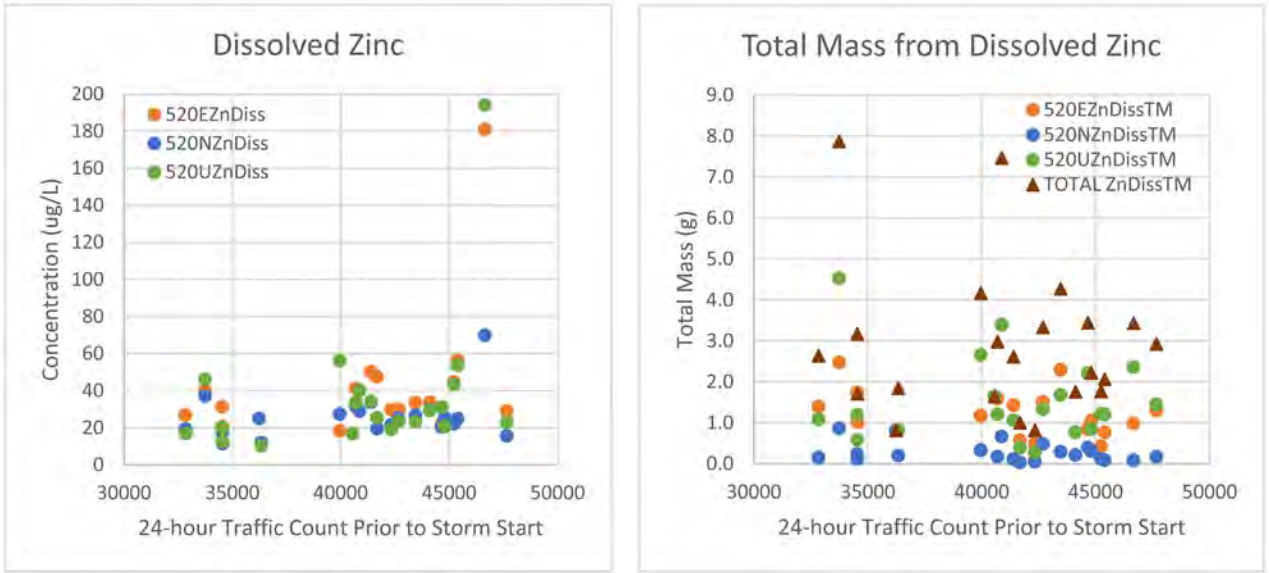


Figure 24b. Dissolved Zinc Concentration and Mass by 24-hour Antecedent Traffic Count

Rainfall totals for the 30 days prior to each storm event were calculated using rainfall data from the rain gauge located on the roof of the UW ATG Building. Only 0.24 inch of rain fell in the 30 days prior to Mobilization Event 8, while more than 0.5 inch fell in the 30 days prior to all other events (Figures 25a and 25b). While there is no strong correlation seen between antecedent conditions before an individual event (see Section 8.2.1 Figures 32a and 32b), low rainfall for long periods can influence loading and washoff rates, especially when combined with the rain pattern shown during Mobilization Event 8.

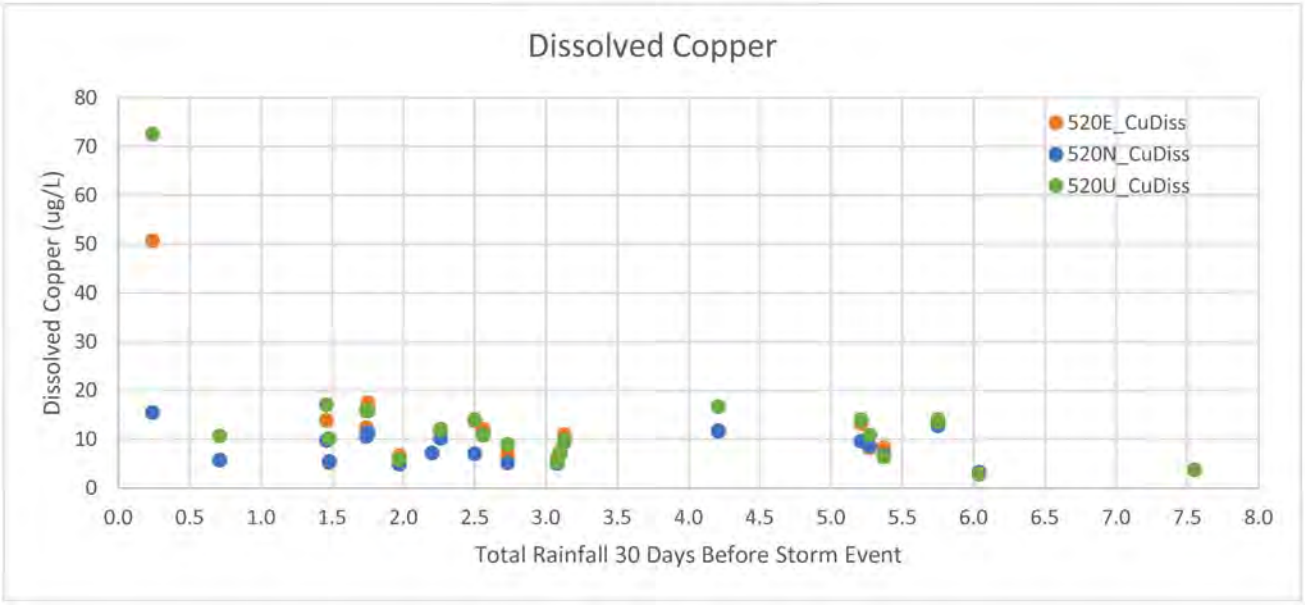


Figure 25a. Dissolved Copper and Total Rainfall 30 Days Before Storm Event

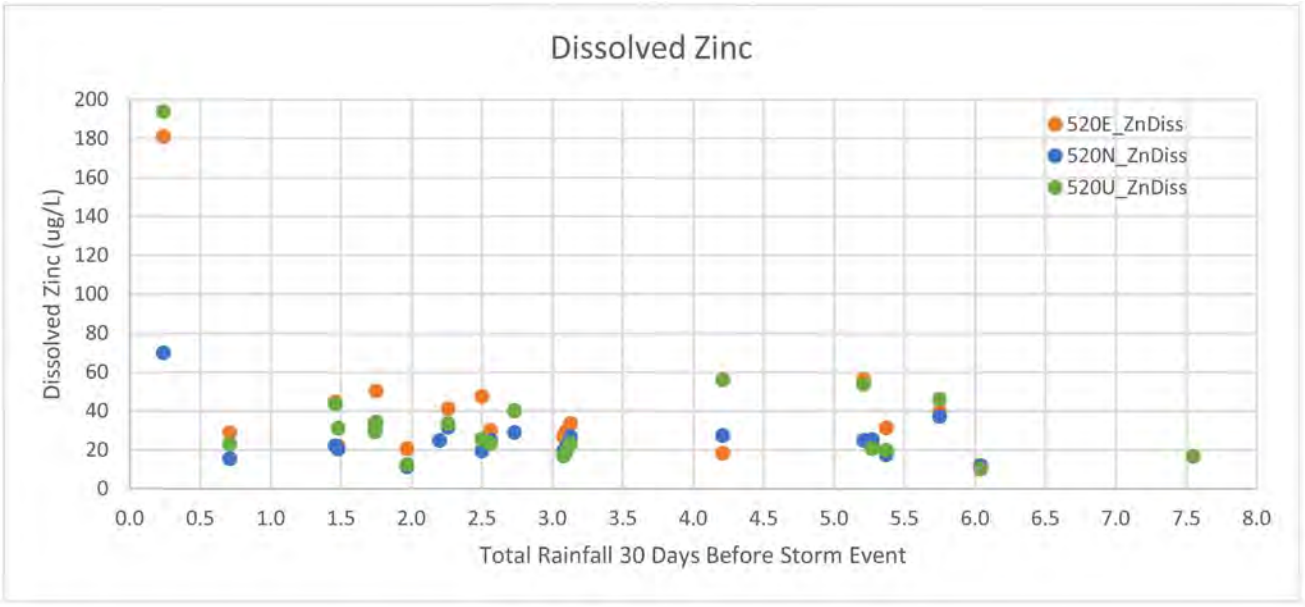


Figure 25b. Dissolved Zinc and Total Rainfall 30 Days Before Storm Event

1.28. Sampling Program Analysis

The AKART sampling program provides data for a number of considerations regarding the characterization of runoff from the floating bridge, the efficacy of the AKART analysis, the chosen treatment and maintenance program, and future considerations for AKART, maintenance, and characterization of stormwater runoff from other highway segments. These can be generally categorized into loading rates, runoff and washoff characteristics (due to rainfall variability), apparent benefits of treatment approaches and their changes over time, and variability between sampling stations. The following sections describe these data interpretations.

1.29. Loading Rates

The pollutants found in stormwater are generally a result of the activities occurring in the catchment areas, which can be described as "pollutant loads." As those pollutants are removed by stormwater or other means, the rate at which they are replaced could be described as "loading rates." Loading rates are often characterized or observed in stormwater as accumulation during dry antecedent conditions, over time during the course of a study or time period, by the intensity of an activity, or by measured amounts of material collected in treatment systems. As described above, these analyses will focus on copper and zinc concentrations.

1.29.1. Antecedent Conditions

One indicator of loading at the bridge is the possible change in concentrations due to the length of time since the preceding storm, or dry antecedent conditions. Presumably, the longer the time since the last storm to "wash off" pollutants, the higher the expected concentration. These are evaluated as total loads, which calculates concentrations multiplied by the storm volume to find the "load." Figures 26a and 26b show the mass of copper and zinc by number of antecedent dry days before the sampling event. As noted in Section 7.2, no strong patterns of antecedent conditions to loading is observed.

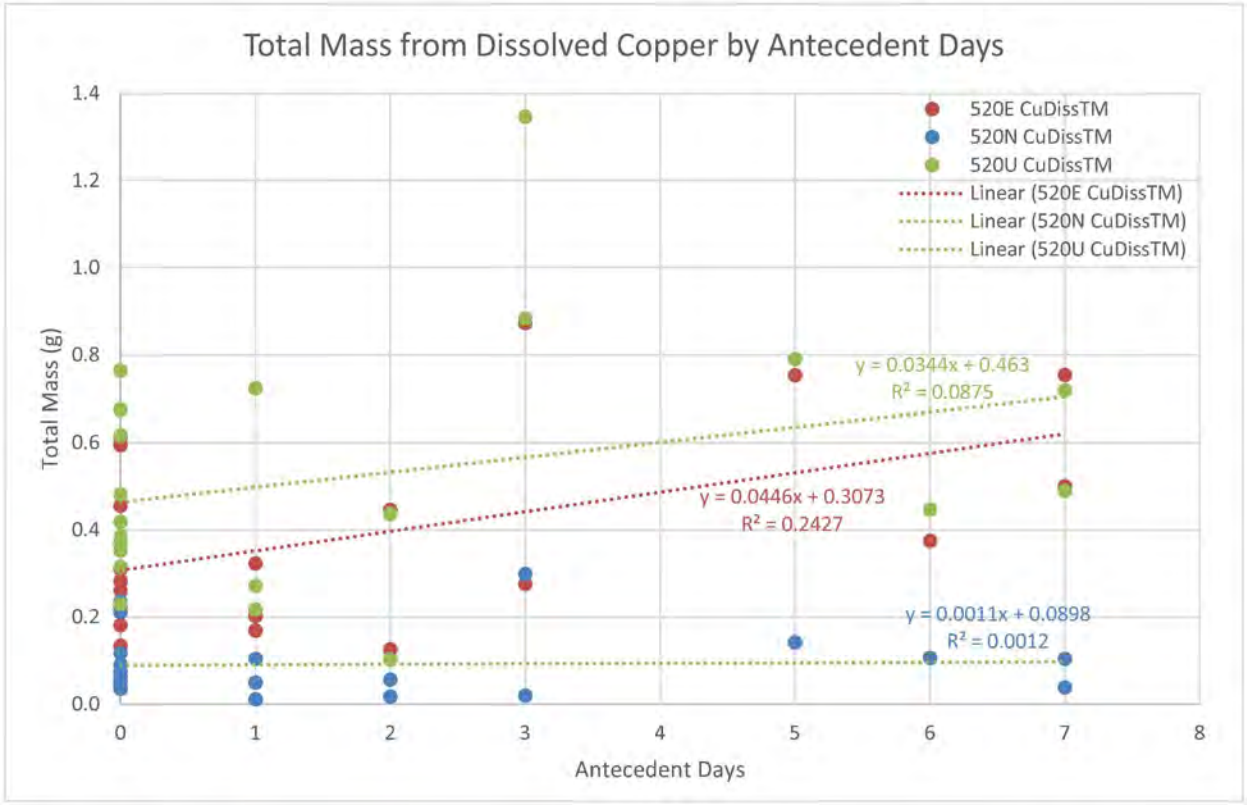


Figure 26a. Dissolved Copper Mass by Number of Antecedent Days

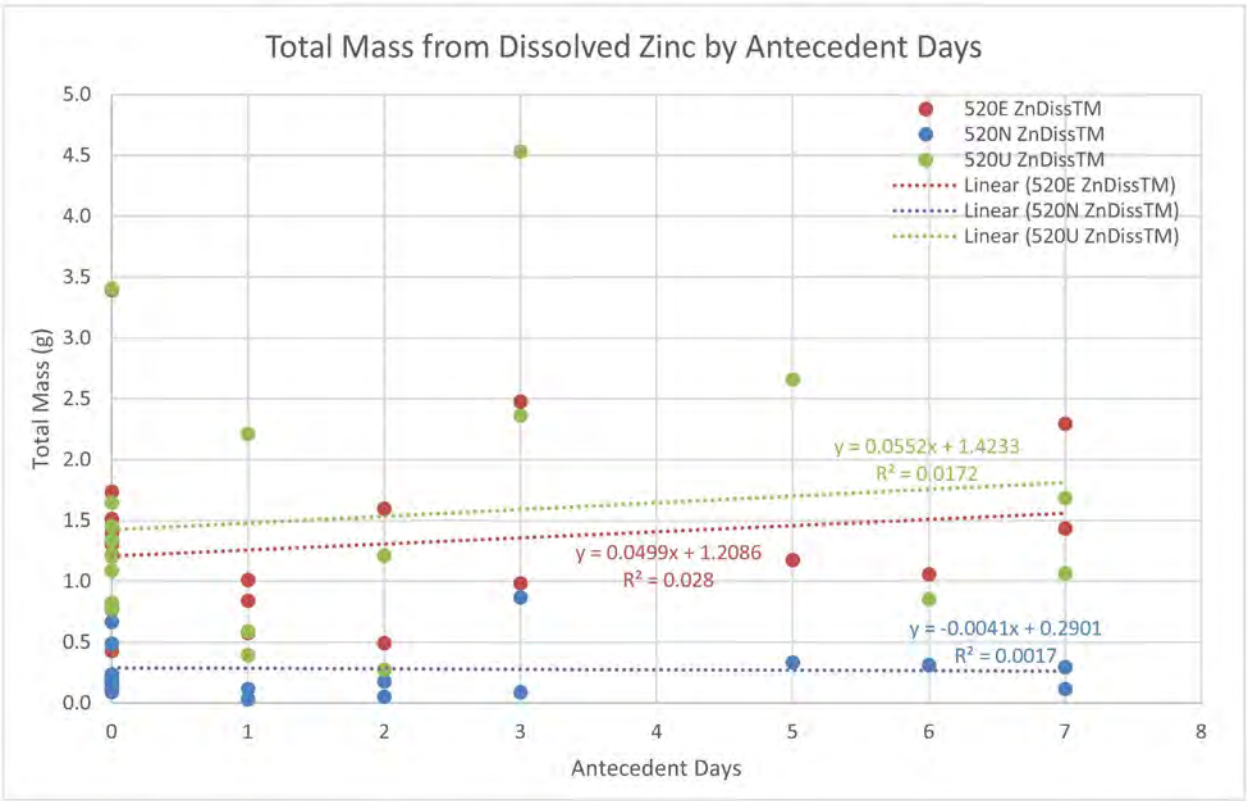


Figure 26b. Dissolved Zinc Mass by Number of Antecedent Days

In addition to antecedent days of no rainfall, the total amount of rainfall before a sampling event was reviewed (see Figures 25a and 25b). The high concentrations found in Mobilization Event 8 were also the preceded by the lowest 30-day rainfall in the study period.

1.29.2. Changes Over Sampling Program Period

The sampling program was initiated shortly after the opening of the bridge to traffic to install the sampling equipment and calibrate it for sampling. Sampling began several months after the installation and after the treatment catch basins were cleaned. Because the loading was very closely related to the start of sampling, there are few expected legacy sources and all loading would be anticipated to come from traffic and other sources in normal operation. Changes in concentrations in the 2 years since sampling was initiated may show a "build-up" of load that may not be addressed by washoff or sweeping. Figures 27a and 27b show mass of copper and zinc since the start of the sampling program. Figure 28 shows the loading per acre (to normalize the loading rate by area) since the start of the program. The trend lines indicate a reduction in loading over time; however, correlations summarized in Section 7.2 indicate a reduction in rainfall depth over time as well, which influences total mass.

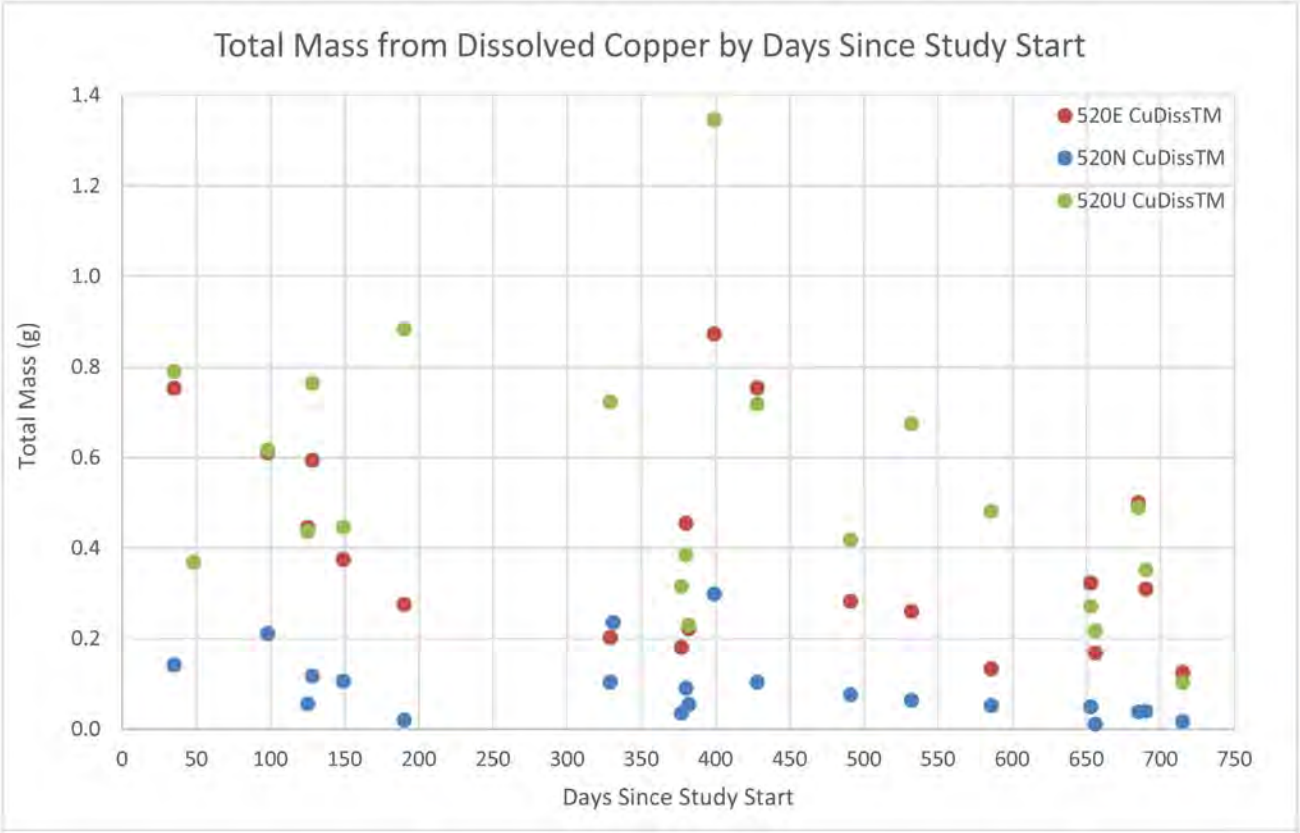


Figure 27a. Dissolved Copper Mass Over Time

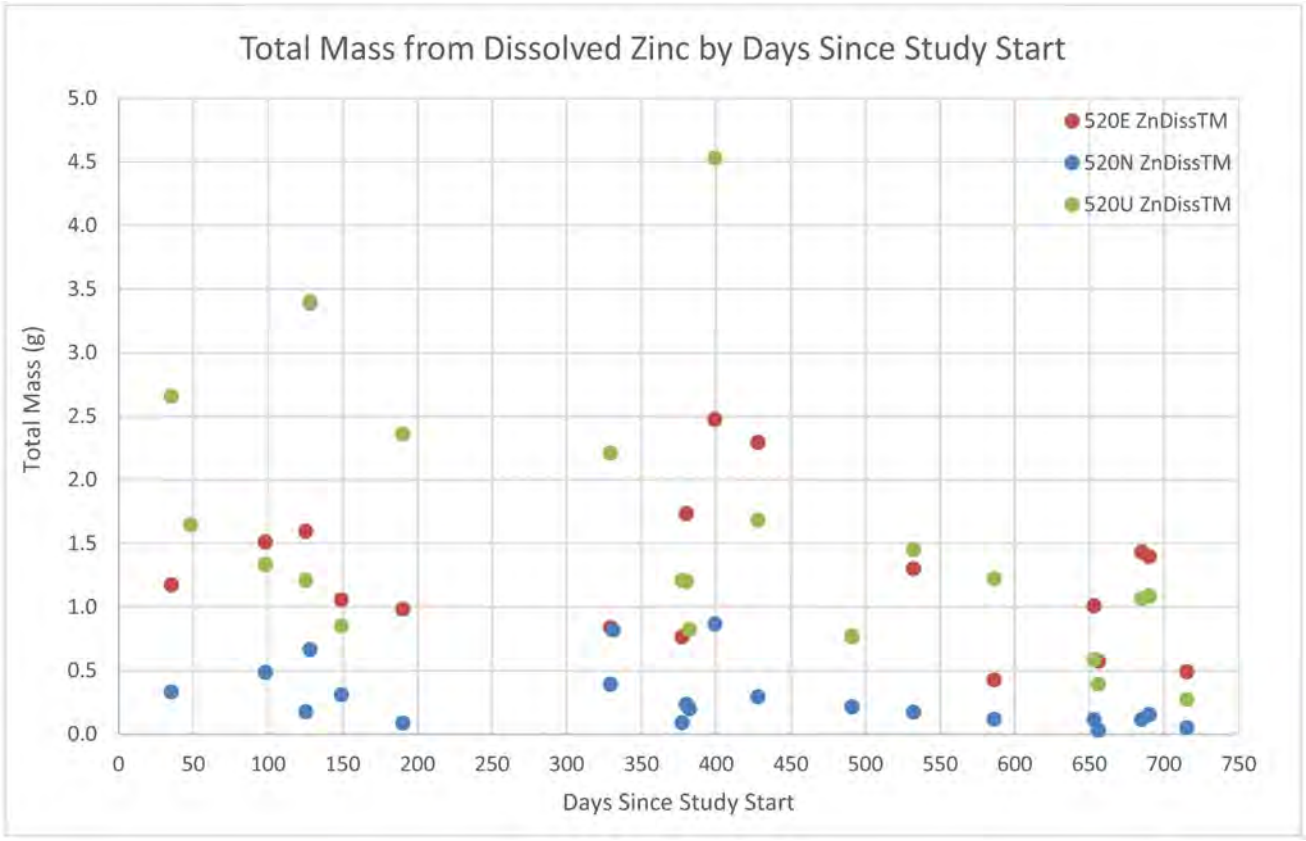


Figure 27b. Dissolved Zinc Mass Over Time

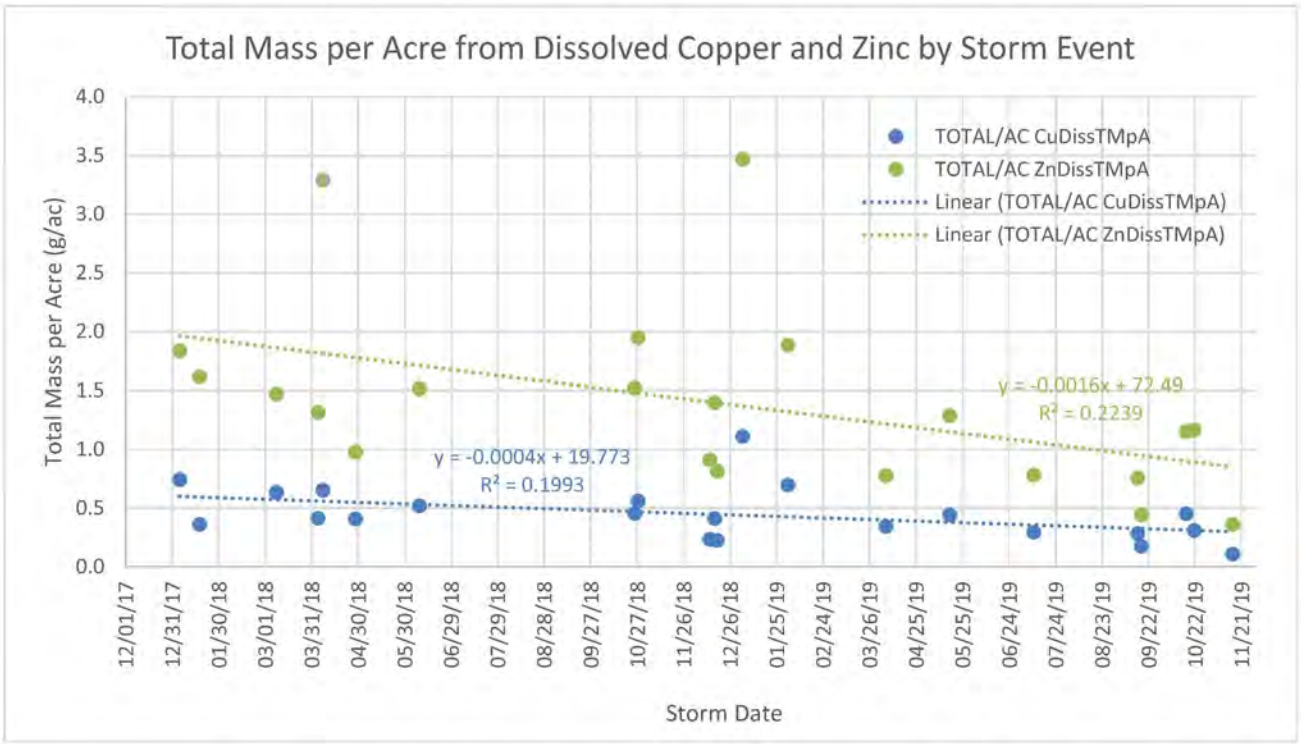


Figure 28. Dissolved Copper and Zinc Mass by Storm Start Date

1.29.3. Variability Due to Vehicle Trips Before Sampling

Vehicular traffic is the predominant source of loading on the bridge. Changes in traffic on or around the sampling event may contribute to loading. Figures 29a, 29b, 30a, and 30b show traffic counts 24 hours before and during the sampling events. Note that higher traffic counts during sampling seem to indicate a slight increase in mass values.

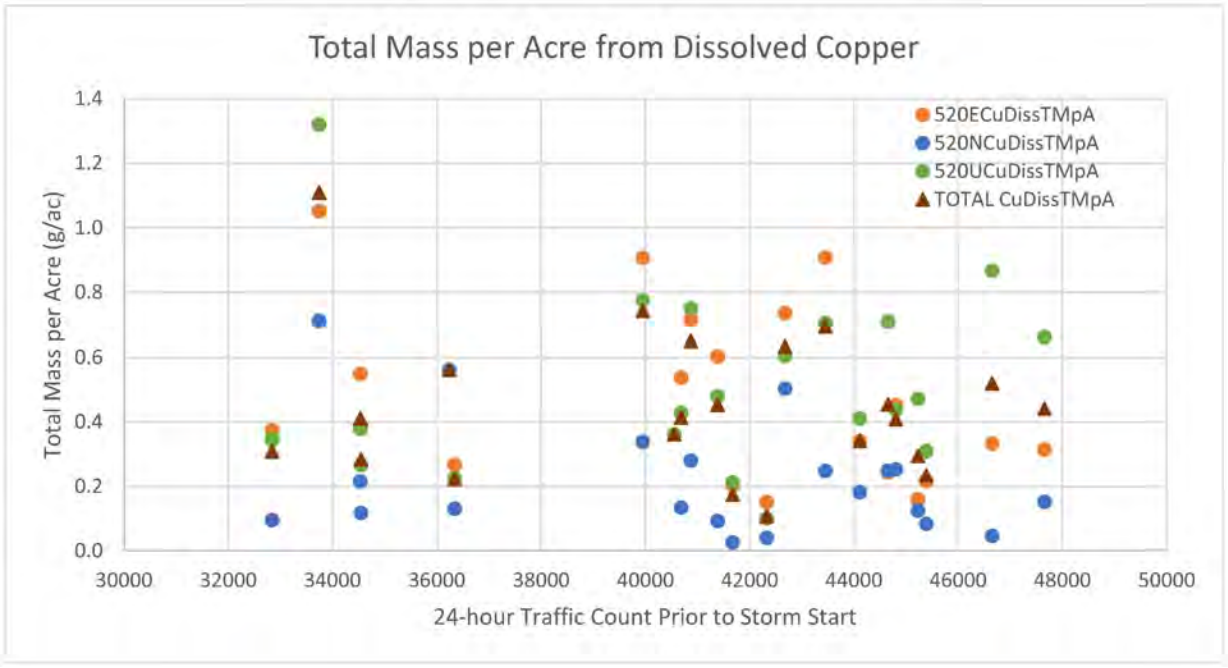


Figure 29a. Dissolved Copper Mass by 24-hour Antecedent Traffic Count

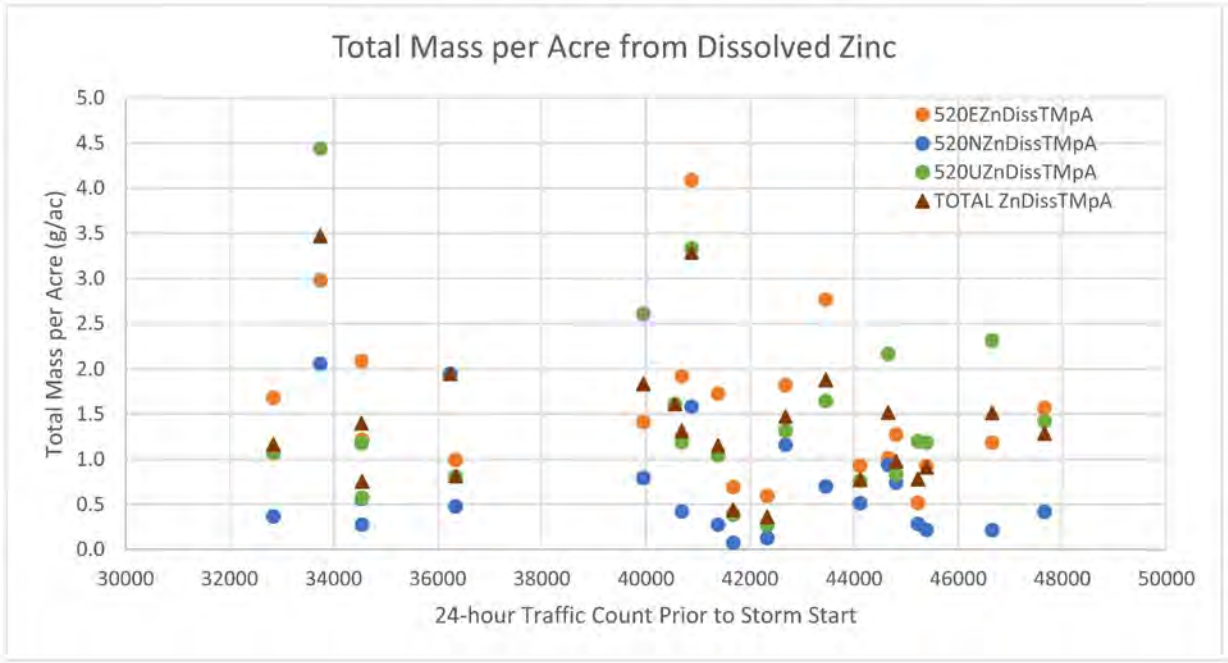


Figure 29b. Dissolved Zinc Mass by 24-hour Antecedent Traffic Count

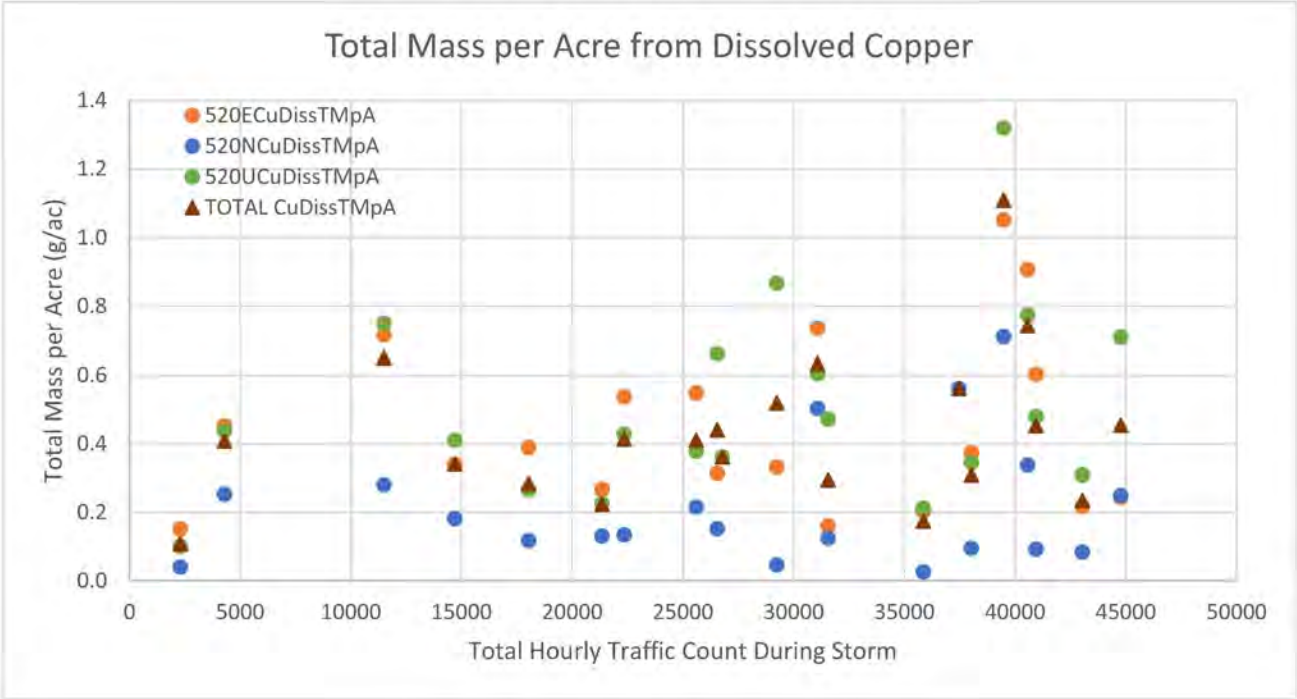


Figure 30a. Dissolved Copper Mass by Total Hourly Traffic Count

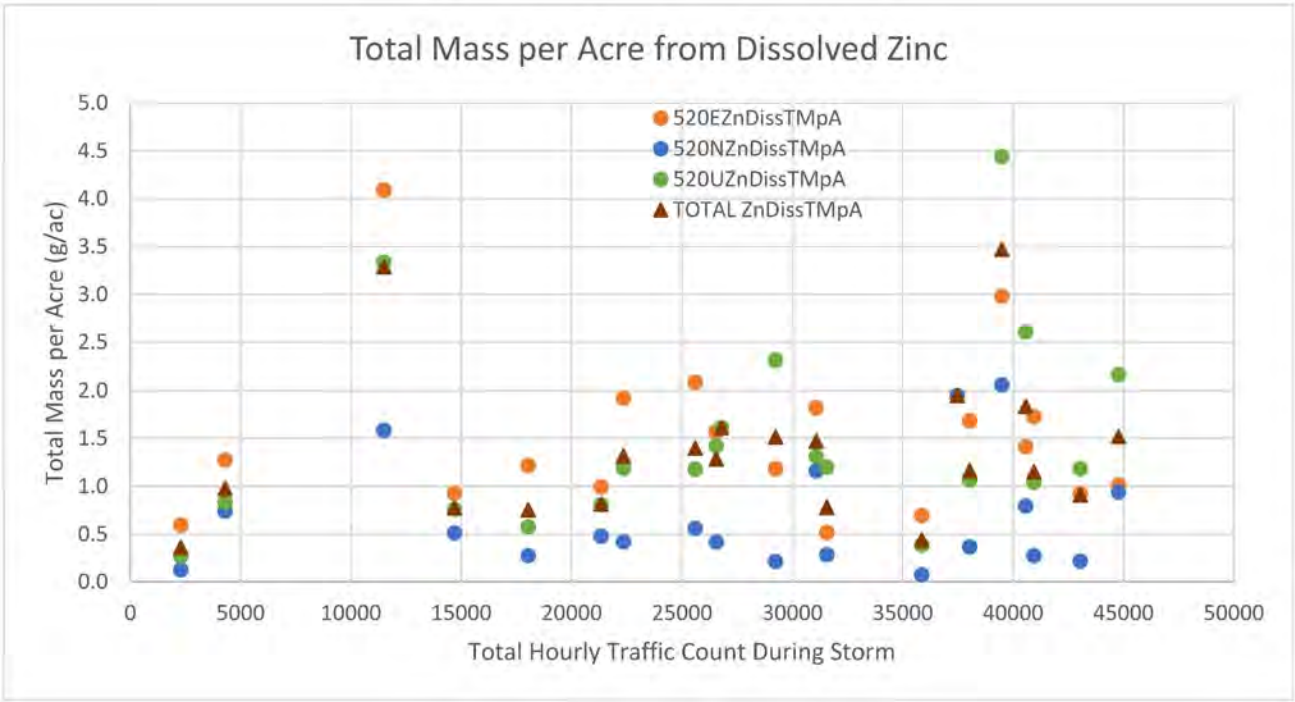


Figure 30b. Dissolved Zinc Mass by Total Hourly Traffic Count

1.29.4. Seasonal Variability

The QAPP required that there be at least one event sampled in each quarter, which was achieved in the program. Loading variability by season is shown in Figure 31. The seasons shown refer to the sampling quarters, where Season 1 is December – February, Season 2 is March – May, Season 3 is June – August, and Season 4 is September – November.

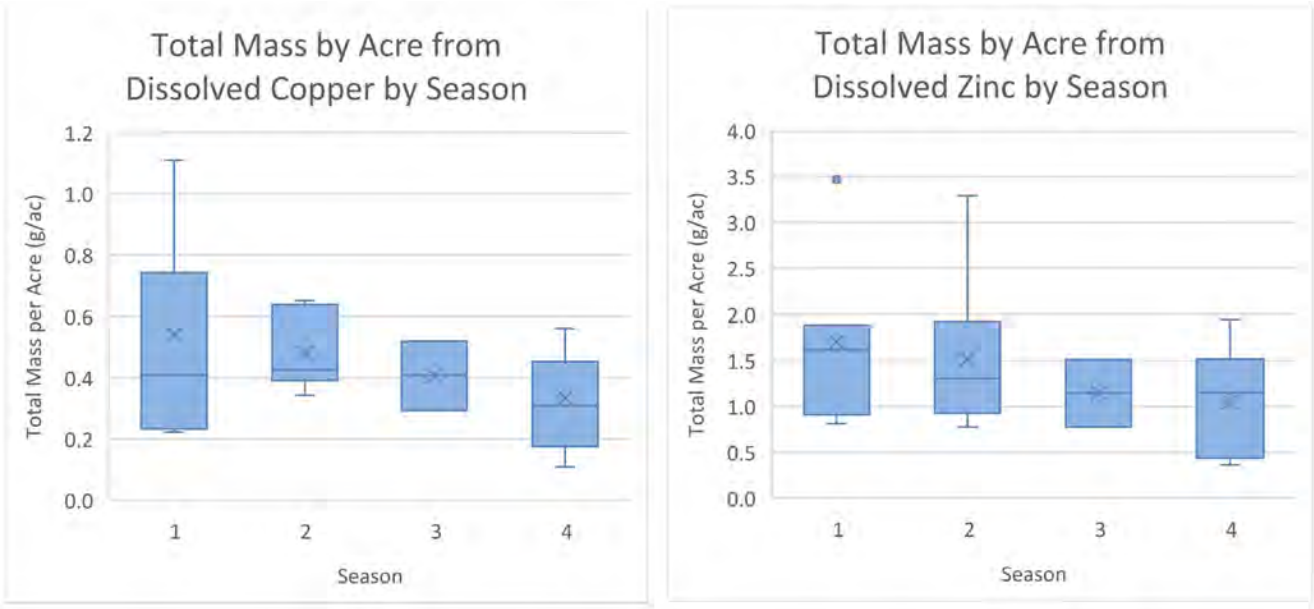


Figure 31. Dissolved Copper and Zinc Mass by Season

1.30. Maintenance

The AKART analysis determined that bridge sweeping with modified catch basins are the BMPS to be applied at the floating bridge. The sampling program results were analyzed to potentially provide insight into the relative benefits of the sweeping and catch basin programs by assessing sampling results by their time since the last maintenance event.

1.30.1. Days Since Sweeping

The number of days since the previous sweeping event could provide an indicator of the efficacy of the sweeping program. The results show virtually no significant variability in total mass per acre discharged when considering the time since sweeping (Figures 32a and 32b). Although the specific sweeping date each month is not known, sweeping occurred during the first 4 days of each month. Figures 32a and 32b show the range of variability, with each mobilization event's total mass per acre plotted against days since sweeping assuming sweeping occurred on the first, second, third, or fourth day of each month. Because there is no clear relationship between total mass per acres and days since last sweeping event, an increase in sweeping frequency is not likely to change discharge results.

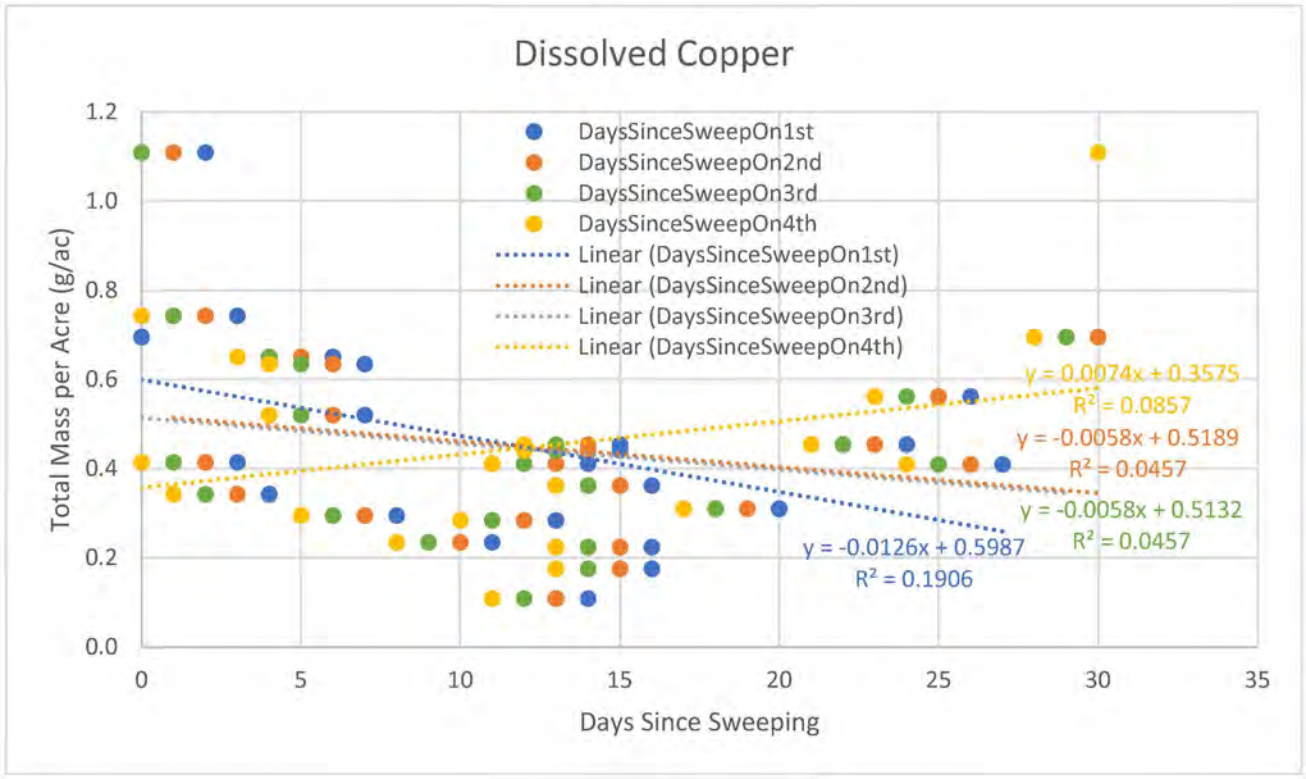


Figure 32a. Dissolved Copper Mass by Days Since Sweeping

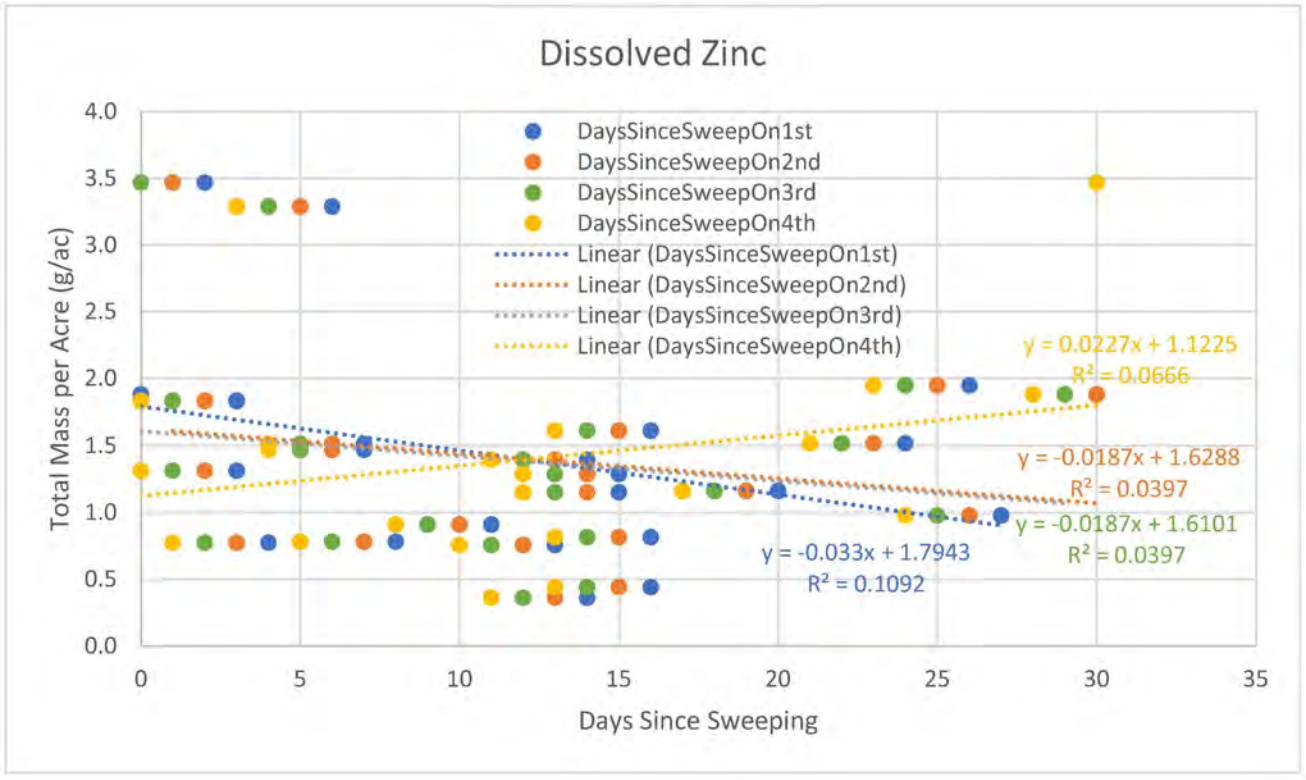


Figure 32b. Dissolved Zinc Mass by Days Since Sweeping

1.30.2. Days Since Catch Basin Cleaning

In addition, the days since the catch basin cleaning were evaluated. Figures 33a and 33b show no variability over the course of the study period or strong trends for days since cleaning.

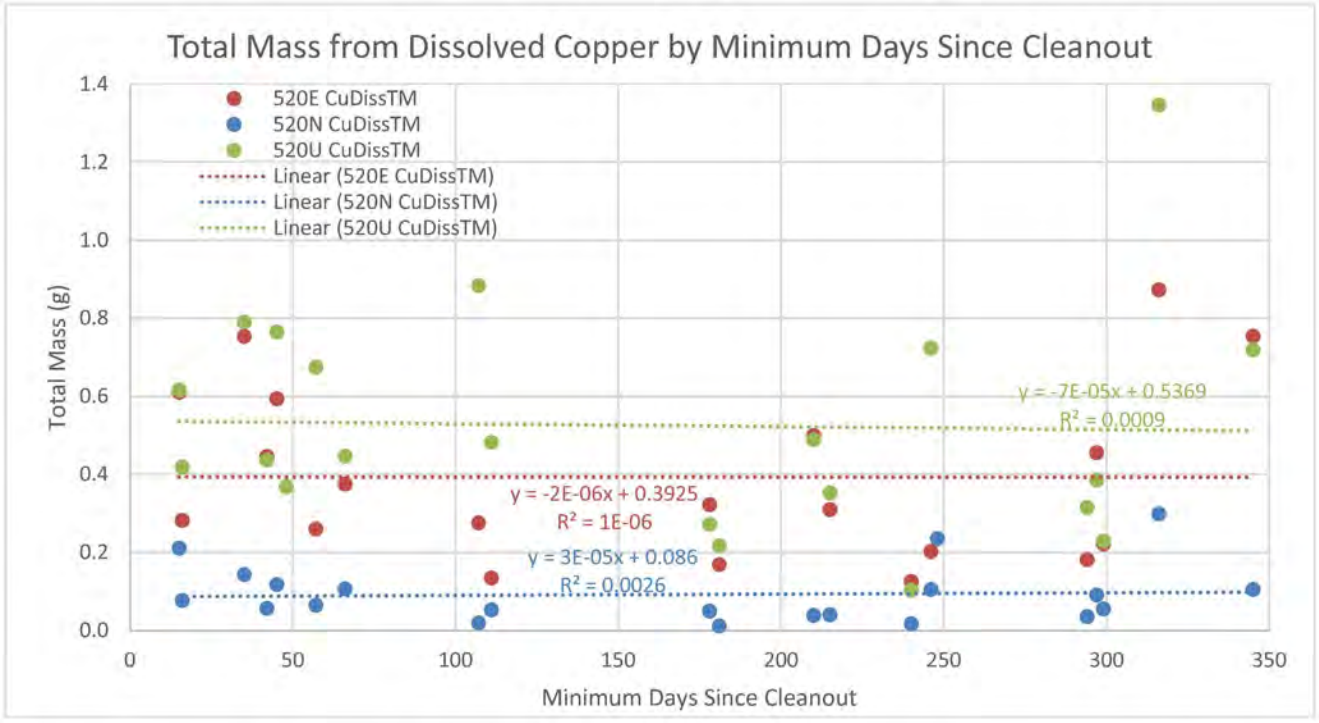


Figure 33a. Dissolved Copper Mass by Days Since Catch Basin Cleanout

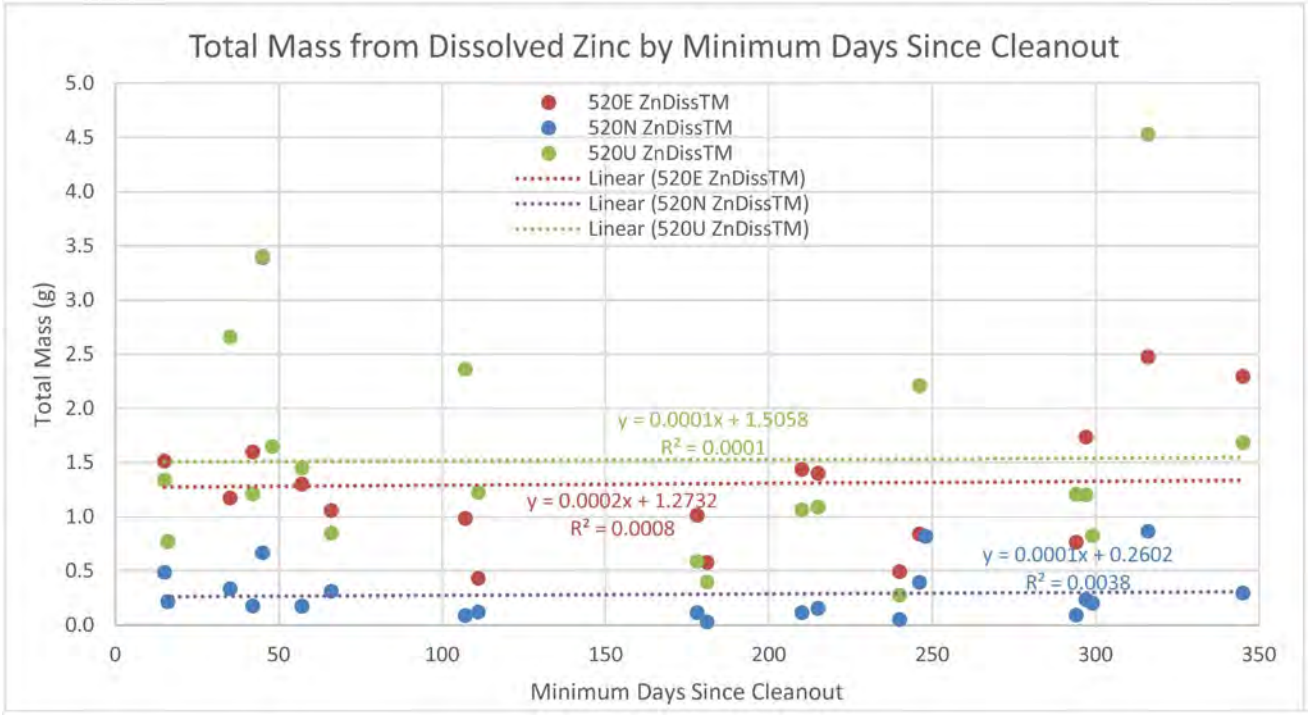


Figure 33b. Dissolved Zinc Mass by Days Since Catch Basin Cleanout

1.31. Findings and Conclusions

1.32. Water Quality Treatment Program

The adaptive management trigger was exceeded once in the Year 1 monitoring period. Dissolved copper at the East Approach in Mobilization Event 8 was measured at 72.6 µg/L compared to the trigger value of 67.7 µg/L. No dissolved metal concentrations in samples collected during Year 2 exceeded the trigger. In addition, there was a significant contingency factor built into the trigger value by using the water quality storm volume, which means that the actual concentration at the mixing zone was far lower than that acceptable by the trigger value. Consequently, no adaptive management measures are required, and the monitoring results confirmed that monthly high-efficiency sweeping and modified catch basins were sufficient to meet state water quality standards at the edge of the defined mixing zone conditionally granted by Ecology.

1.33. Evaluation of AKART Study Approach

The BMP treatment program and sampling followed the Final AKART QAPP (WSDOT 2017a) and the FB&L AKART SOPs (WSDOT 2017b). There were no proposed changes or deviations from the BMP treatment or sampling programs as devised.

1.34. BMP Maintenance Improvements

In reviewing the performance of the BMP treatment plan, potential improvements to the WSDOT maintenance of the drainage conveyance system were identified. The QAPP outlines that both high-efficiency sweeping of the bridge deck will occur monthly, and that the modified catch basins will undergo annual cleaning to remove trapped sediments and associated pollutants by vactoring out the sump settling basins. The plan does not specifically address maintenance of the modular expansion joints, which have surface areas where silt and pollutants could become trapped and accumulate. It is possible that the high-efficiency sweeping is not able to fully remove sediments that get trapped in the surface features of the modular expansion joints. This may need to be inspected periodically and vactored as needed to keep the BMP treatment functioning as intended.

There are drainage structures on the floating bridge that collect silt and pollutants which may not be readily identified as catch basins because the structures have solid locking lids. Table 13 identifies three flow splitter structures (FS1 and FS2in the westbound lanes, and FS3 in the eastbound lanes) which have rectangular solid locking covers. There are two large structures located near the modular expansion joint on the east high-rise (Structure 79, in the westbound lanes and Structure 179, in the eastbound lanes) that have very deep sumps and round locking covers. If these structures do not receive the same level of cleaning as the other modified catch basins, it could create the potential for precipitation events to flush the accumulated silts and pollutants when the structures become full. Table 13 identifies the drainage and roadway structures for which additional maintenance is recommended. The Maintenance Addendum included in Attachment 8 provides a table and

accompanying As-Built Bridge Stormwater plan so that WSDOT bridge maintenance crews can easily locate and maintain the identified drainage structures and include them in the annual cleaning schedule.

Table 13. Drainage and Roadway Structures Identified for Additional Maintenance

Structure #	Station	Receiving SSP	Plan Sheet
West High-Rise Modular Expansion Joints	ML 237+13.00 ML 139+03.00 MR 239+03.00 MR 237+13.00	N/A	T1.14
East High-Rise Modular Expansion Joints	ML 215+37.00 ML 217+28.00 MR 217+28.00 MR 215+37.00	N/A	T1.13
FS1	ML 209+07.92	TNY/UNW	DR1.58
FS2	ML 211+04.97	UNE/UNW/TNE	DR1.58
FS3	MR 211+05.03	USE/USW	DR1.58
79	ML 215+30.29	UNE/UNW/TNE	DR1.61
179	MR 215+31.05	USE	DR1.61

1.35. Suggested Dilution Modeling Considerations

Section 2.3 describes the actual mixing zone calculation approach. When future trigger values are considered, a joint concentration and storm volume trigger should be used, while still maintaining a contingency multiplier factor of two or more.

1.36. Considerations for Future AKART Monitoring

Analysis of the data has demonstrated the effectiveness of the total AKART approach applied at the floating bridge. There are multiple components, including the sweeping and modified catch basins, as well as other elements such as the grooved pavement, catch basin spacing, gutter flow, and sloped approaches and flat roadway sections. The study was not able to discern the relative value or impact of the various components. It may be valuable to evaluate a "control" segment of the new non-bridge portion of the SR 520 highway that does not include modified catch basins or suspend sweeping for a segment of the highway to provide a side-by-side comparison.

The configuration of the stabilization pontoon lagoons is unique to the floating bridge. If AKART and mixing zones are to be applied in the future, additional analysis of other mixing zone configurations and conditions would be needed.

1.37. References

CH2M HILL. 2010. SR 520 Bridge Replacement and HOV Program 1-5 to Medina: Bridge Replacement and HOV Project. AKART and Water Quality Studies for SR 520 Replacement Floating Bridge. Prepared for the Washington State Department of Transportation and Federal Highway Administration by CH2M HILL. April 2010.

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Herrera (Herrera Environmental Consultants, Inc.) 2007. White Paper. Untreated Highway Runoff in Western Washington. Prepared for Washington State Department of Transportation, P.O. Box 47332, Olympia, Washington 98504-7332 by Herrera Environmental Consultants, Inc., 2200 Sixth Avenue, Suite 1100. Seattle, Washington 98121. May 16, 2007.

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WSDOT (Washington State Department of Transportation). 2013. Stormwater Monitoring: Chemical Data Validation Guidance and Criteria. Version 1.2. Author Mingta Lin, Pyron Environmental, Inc., Data Quality Expert. January 17, 2013.

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WSDOT (Washington State Department of Transportation). 2017a. SR 520 Floating Bridge and Landings Project Final AKART Quality Assurance Project Plan. Prepared for the Washington State Department of Transportation by Parametrix and Environ. November 2017.

WSDOT (Washington State Department of Transportation). 2017b. SR 520 Floating Bridge and Landings Project AKART Standard Operating Procedures. Prepared for the Washington State Department of Transportation by Parametrix and Environ. November 2017.

Attachment 7

Graphical Summaries of Exploratory Data Analysis

Attachment 8

Suggested Maintenance Activities Improvement Addendum

Attachment 1

Mobilization Event Summaries

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Mobilization Event 23 | 09/14/2019

January 13, 2020

Storm Summary Report

Re: September 14, 2019, Storm Event

Project No. 160418

Introduction

This Storm Summary Report summarizes the storm sampling event that began on September 14, 2019, and includes a summary and documentation of all sampling-related activities. The September 14, 2019, event is the twenty-third storm sample event for the SR-520 Bridge AKART Stormwater Monitoring Project.

Storm Validation Summary

The event began on September 14, 2019, at 21:15 after an antecedent dry period exceeding 6 hours. The event ended September 15, 2019, at 15:35. The total measured rainfall for the event was 0.53 inches over a period of 18.33 hours. All three stations were targeted for sampling and enabled on the rising limb of the storm hydrograph. A duplicate sample was taken at station 520U. This is the third and final duplicate needed for 520U. All three stations met the sample validation criteria for sample volume, minimum number of aliquots, and percent coverage of the storm runoff (see Table 1). All samples were submitted to the laboratory within the 24-hour hold time. The water temperature was at least 15.24 degrees Celsius (C) at the time of collection, and the samples were iced and at or below 1.1 degrees C when they were submitted to the lab.

Hydrographs

The attached hydrographs show the water level and flow rate in each weir along with markers for each sample aliquot and 5-minute rain data.

Storm Tracking

The Go-No-Go field sheet documents the weather forecasts and the decision to target prior to the September 14, 2019, event (Attachment A). The printout from the National Weather Forecast shows the latest forecast roughly 12 hours and 40 minutes prior to the beginning of the rainfall (Attachment B).

Storm Field Sheets

The field sheets document the field and storm control procedures for the event (Attachment C and D). The field sheets also include the Chain-of-Custody (COC) form (Attachment E).

Aspect Consulting, LLC 710 2nd Avenue Suite 550 Seattle, WA 98104 206.328.7443 www.aspectconsulting.com

Attachments

Table 1. Storm Validation Summary	*(Included with Quarterly Report attachment)*
520E_091419 Hydrograph	*(Included with Quarterly Report attachment)*
520N_091419 Hydrograph	*(Included with Quarterly Report attachment)*
520U_091419 Hydrograph	*(Included with Quarterly Report attachment)*
Attachment A. Storm Tracking Sheet Go-No-Go Sheets	*(On file)*
Attachment B. National Weather Service Forecast Sheet	*(On file)*
Attachment C. Storm Control Sheets	*(On file)*
Attachment D. Field Sheets	*(On file)*
Attachment E. Chain of Custody	*(On file)*

V:\160418 SR-520 Bridge Stormwater Monitoring\Deliverables\Storm Summaries 2019\23_091419\Storm 23 Summary Report 091419_20200113.docx

Table 1. Storm Validation Summary

Mobilization Event 23 | 09/14/2019

Project No. 160418

SR-520 Floating Bridge Stormwater Monitoring Storm and Sample Validation Checklist

Storm Date	September 14, 2019	
Storm Event Number	23	
Criterion	**Y / N**	**Value**
Rainfall Depth ≥ 0.15	Y	0.53
Rainfall Duration > 1 hr	Y	18.33
Antecedent Rainfall < 0.04" in 6 hrs	Y	0

Notes:

	Station					
	520-E		520-N		520-U	
Criterion	**Y / N**	**Value**	**Y / N**	**Value**	**Y / N**	**Value**
Aliquots ≥ 10	Y	27	Y	33	Y	30
Sample Volume ≥ 1 liter	Y	~3	Y	~3	Y	~3
Does Sample cover more than 75% of hydrograph?	Y	100.0%	Y	100.0%	Y	100.0%
Sample Valid Y / N?	Y		Y		Y	

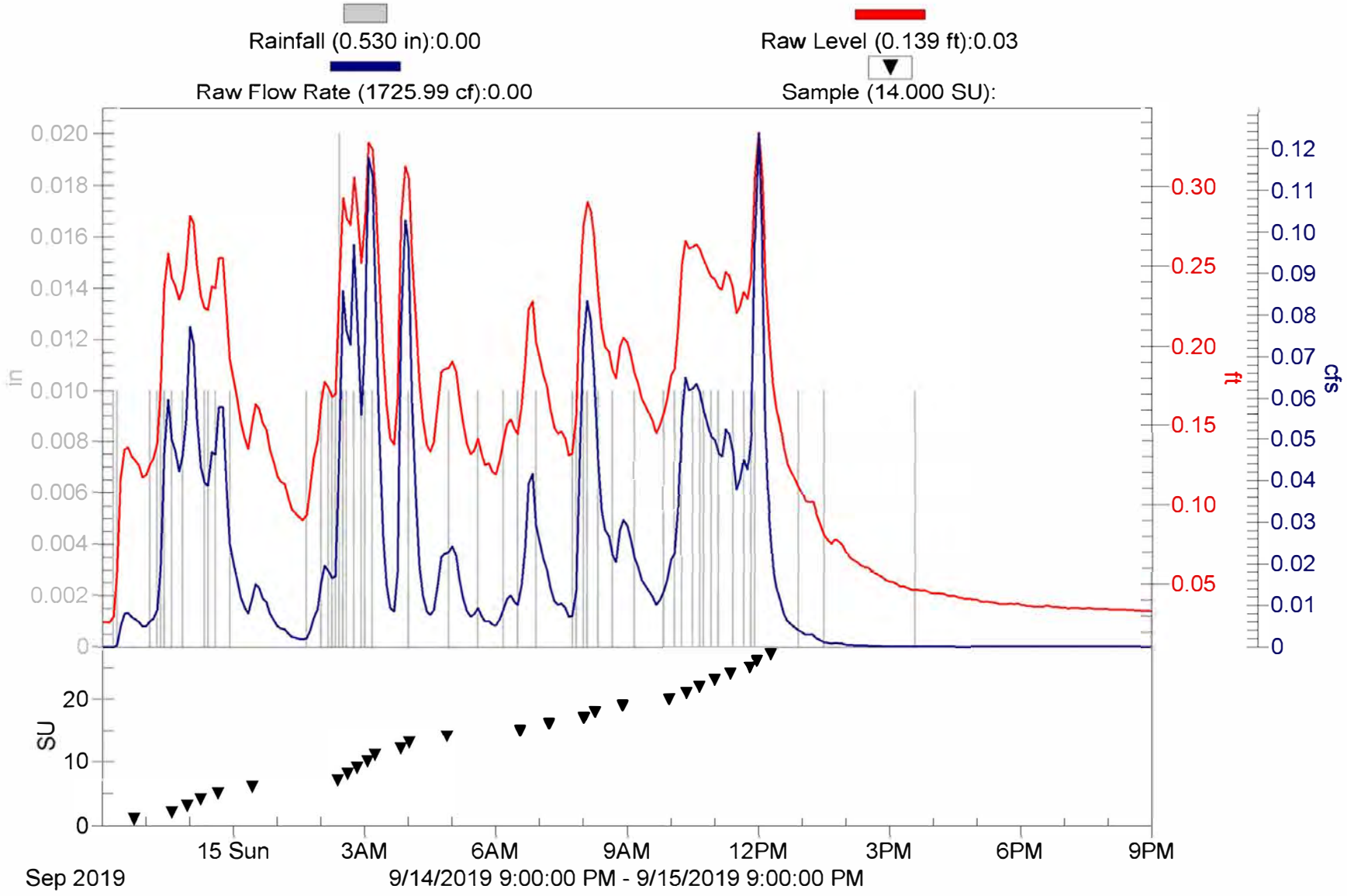
Notes:

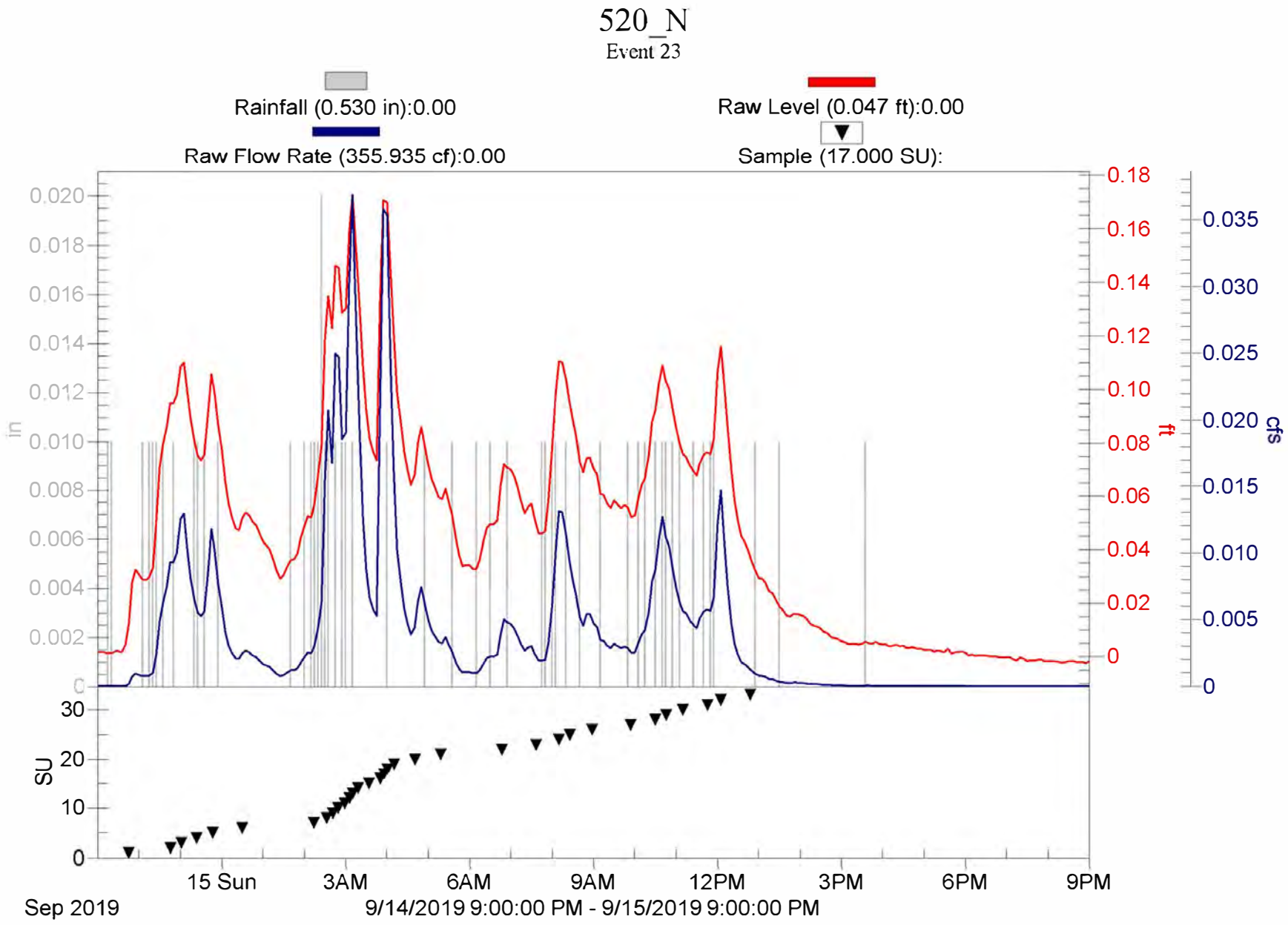
Storm Summary Description

Total measured rainfall of 0.53 inches. All samples are valid and a duplicate was collected at 520U.

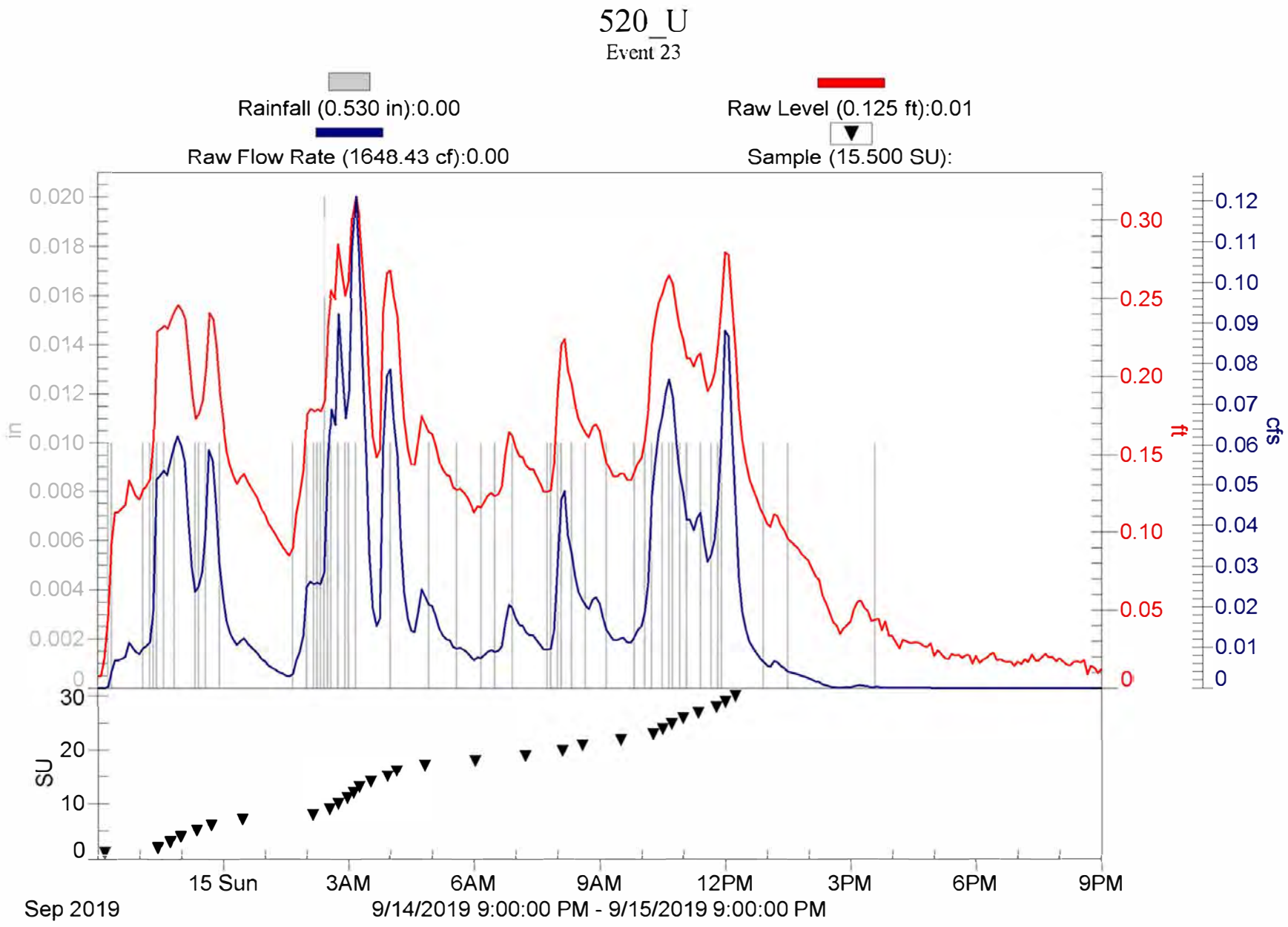
520_E

Event 23




520_N
Event 23
Rainfall (0.530 in):0.00
Raw Level (0.047 ft):0.00
Raw Flow Rate (355.935 cf):0.00
Sample (17.000 SU):
in
ft
cfs
SU
0.020
0.018
0.016
0.014
0.012
0.010
0.008
0.006
0.004
0.002
0
0.18
0.16
0.14
0.12
0.10
0.08
0.06
0.04
0.02
0
0.035
0.030
0.025
0.020
0.015
0.010
0.005
0
30
20
10
0
15 Sun
3AM
6AM
9AM
12PM
3PM
6PM
9PM
Sep 2019
9/14/2019 9:00:00 PM - 9/15/2019 9:00:00 PM

Mobilization Event 23 | 09/14/2019



Storm Event #23 Monitoring Data

Date & Time[1]	UW ATG Rainfall (in)	Station 520-E Level (ft)	Station 520-E Flow Rate (cfs)	Station 520-E Temperature (°C)	Station 520-E Sample (SU)	Station 520-N Level (ft)	Station 520-N Flow Rate (cfs)	Station 520-N Temperature (°C)	Station 520-N Sample (SU)	Station 520-U Level (ft)	Station 520-U Flow Rate (cfs)	Station 520-U Temperature (°C)	Station 520-U Sample (SU)
9/14/2019 21:05	0.00	0.027	0.000	18.617		0.010	0.000	18.778		0.009	0.000	18.194	
9/14/2019 21:10	0.00	0.027	0.000	18.555		0.010	0.000	18.725		0.021	0.000	18.049	1
9/14/2019 21:15	0.01	0.031	0.000	18.486		0.009	0.000	18.660		0.048	0.000	17.915	
9/14/2019 21:20	0.01	0.059	0.001	18.415		0.010	0.000	18.586		0.094	0.004	17.789	
9/14/2019 21:25	0.00	0.117	0.007	18.349		0.010	0.000	18.508		0.114	0.007	17.697	
9/14/2019 21:30	0.00	0.135	0.011	18.275		0.010	0.000	18.427		0.114	0.007	17.631	
9/14/2019 21:35	0.00	0.137	0.011	18.197		0.010	0.000	18.346		0.116	0.008	17.557	
9/14/2019 21:40	0.00	0.132	0.010	18.119		0.013	0.000	18.283		0.119	0.008	17.480	
9/14/2019 21:44					1								
9/14/2019 21:45	0.00	0.128	0.009	18.047		0.021	0.000	18.223	1	0.134	0.012	17.425	
9/14/2019 21:50	0.00	0.125	0.008	17.974		0.036	0.000	18.173		0.130	0.010	17.348	
9/14/2019 21:55	0.00	0.118	0.007	17.893		0.041	0.000	18.124		0.124	0.009	17.257	
9/14/2019 22:00	0.00	0.120	0.007	17.804		0.039	0.000	18.049		0.122	0.009	17.197	
9/14/2019 22:05	0.01	0.126	0.008	17.713		0.037	0.000	17.966		0.128	0.010	17.097	
9/14/2019 22:10	0.00	0.130	0.009	17.625		0.037	0.000	17.896		0.131	0.011	16.978	
9/14/2019 22:15	0.01	0.139	0.012	17.559		0.038	0.000	17.845		0.135	0.012	16.887	
9/14/2019 22:20	0.01	0.178	0.024	17.505		0.042	0.000	17.809		0.160	0.019	16.819	
9/14/2019 22:25	0.01	0.237	0.053	17.451		0.059	0.001	17.788		0.230	0.052	16.741	
9/14/2019 22:26													2
9/14/2019 22:30	0.00	0.259	0.068	17.387		0.079	0.003	17.780		0.232	0.053	16.655	
9/14/2019 22:35	0.01	0.243	0.057	17.337		0.088	0.004	17.759		0.234	0.054	16.559	
9/14/2019 22:36					2								
9/14/2019 22:40	0.00	0.239	0.054	17.300		0.094	0.005	17.721		0.232	0.053	16.490	
9/14/2019 22:44													3
9/14/2019 22:45	0.00	0.230	0.049	17.265		0.103	0.007	17.667		0.239	0.058	16.424	
9/14/2019 22:46									2				
9/14/2019 22:50	0.01	0.236	0.053	17.232		0.103	0.007	17.602		0.244	0.061	16.380	
9/14/2019 22:55	0.00	0.251	0.062	17.203		0.106	0.008	17.530		0.247	0.063	16.346	
9/14/2019 22:57					3								
9/14/2019 22:59													4
9/14/2019 23:00	0.00	0.283	0.087	17.186		0.117	0.010	17.464		0.244	0.061	16.312	
9/14/2019 23:02									3				
9/14/2019 23:05	0.00	0.278	0.082	17.167		0.118	0.010	17.406		0.238	0.057	16.296	
9/14/2019 23:10	0.00	0.251	0.062	17.138		0.108	0.008	17.362		0.215	0.043	16.286	

Storm Event #23 Monitoring Data

Date & Time[1]	UW ATG Rainfall (in)	Station 520-E Level (ft)	Station 520-E Flow Rate (cfs)	Station 520-E Temperature (°C)	Station 520-E Sample (SU)	Station 520-N Level (ft)	Station 520-N Flow Rate (cfs)	Station 520-N Temperature (°C)	Station 520-N Sample (SU)	Station 520-U Level (ft)	Station 520-U Flow Rate (cfs)	Station 520-U Temperature (°C)	Station 520-U Sample (SU)
9/14/2019 23:15	0.00	0.232	0.050	17.113	4	0.098	0.006	17.328		0.189	0.030	16.282	
9/14/2019 23:20	0.01	0.225	0.046	17.099		0.089	0.005	17.294		0.175	0.024	16.276	
9/14/2019 23:23													5
9/14/2019 23:24									4				
9/14/2019 23:25	0.01	0.223	0.045	17.090		0.084	0.004	17.262		0.178	0.026	16.273	
9/14/2019 23:30	0.00	0.238	0.054	17.079		0.082	0.004	17.223		0.187	0.029	16.267	
9/14/2019 23:35	0.01	0.237	0.053	17.064		0.084	0.004	17.188		0.207	0.039	16.257	
9/14/2019 23:39					5								
9/14/2019 23:40	0.00	0.256	0.066	17.051		0.100	0.006	17.154		0.242	0.060	16.259	
9/14/2019 23:44													6
9/14/2019 23:45	0.00	0.256	0.066	17.034		0.114	0.009	17.114		0.238	0.057	16.252	
9/14/2019 23:47									5				
9/14/2019 23:50	0.00	0.225	0.046	17.013		0.107	0.008	17.074		0.220	0.046	16.237	
9/14/2019 23:55	0.01	0.193	0.030	16.995		0.095	0.006	17.041		0.191	0.031	16.220	
9/15/2019 00:00	0.00	0.180	0.024	16.982		0.086	0.004	17.016		0.171	0.023	16.197	
9/15/2019 00:05	0.00	0.168	0.020	16.977		0.074	0.003	16.986		0.154	0.017	16.175	
9/15/2019 00:10	0.00	0.153	0.015	16.983		0.066	0.002	16.962		0.144	0.014	16.160	
9/15/2019 00:15	0.00	0.143	0.012	16.996		0.060	0.002	16.950		0.137	0.012	16.153	
9/15/2019 00:20	0.00	0.136	0.011	17.009		0.056	0.001	16.947		0.133	0.011	16.150	
9/15/2019 00:25	0.00	0.150	0.014	17.020		0.056	0.001	16.943		0.136	0.012	16.142	
9/15/2019 00:26					6								
9/15/2019 00:29													7
9/15/2019 00:30	0.00	0.165	0.019	17.030		0.060	0.001	16.939	6	0.139	0.013	16.139	
9/15/2019 00:35	0.00	0.162	0.018	17.040		0.062	0.002	16.940		0.134	0.011	16.143	
9/15/2019 00:40	0.00	0.152	0.015	17.052		0.061	0.002	16.953		0.130	0.010	16.149	
9/15/2019 00:45	0.00	0.148	0.014	17.065		0.058	0.001	16.987		0.127	0.010	16.161	
9/15/2019 00:50	0.00	0.135	0.011	17.080		0.057	0.001	17.017		0.123	0.009	16.197	
9/15/2019 00:55	0.00	0.127	0.009	17.106		0.054	0.001	17.061		0.116	0.007	16.236	
9/15/2019 01:00	0.00	0.119	0.007	17.148		0.051	0.001	17.111		0.113	0.007	16.256	
9/15/2019 01:05	0.00	0.115	0.006	17.185		0.050	0.001	17.149		0.107	0.006	16.269	
9/15/2019 01:10	0.00	0.114	0.006	17.202		0.048	0.001	17.167		0.103	0.005	16.282	
9/15/2019 01:15	0.00	0.105	0.005	17.211		0.045	0.001	17.188		0.100	0.005	16.309	
9/15/2019 01:20	0.00	0.099	0.004	17.225		0.040	0.000	17.225		0.096	0.004	16.349	
9/15/2019 01:25	0.00	0.096	0.003	17.242		0.038	0.000	17.266		0.093	0.004	16.376	

Storm Event #23 Monitoring Data

Date & Time[1]	UW ATG Rainfall (in)	Station 520-E Level (ft)	Station 520-E Flow Rate (cfs)	Station 520-E Temperature (°C)	Station 520-E Sample (SU)	Station 520-N Level (ft)	Station 520-N Flow Rate (cfs)	Station 520-N Temperature (°C)	Station 520-N Sample (SU)	Station 520-U Level (ft)	Station 520-U Flow Rate (cfs)	Station 520-U Temperature (°C)	Station 520-U Sample (SU)
9/15/2019 01:30	0.00	0.094	0.003	17.268		0.039	0.000	17.310		0.090	0.003	16.394	
9/15/2019 01:35	0.00	0.092	0.003	17.307		0.042	0.000	17.353		0.087	0.003	16.419	
9/15/2019 01:40	0.01	0.095	0.003	17.344		0.045	0.001	17.404		0.092	0.004	16.454	
9/15/2019 01:45	0.00	0.111	0.006	17.370		0.045	0.001	17.438		0.114	0.007	16.488	
9/15/2019 01:50	0.00	0.130	0.009	17.390		0.047	0.001	17.452		0.124	0.009	16.504	
9/15/2019 01:55	0.00	0.141	0.012	17.400		0.053	0.001	17.449		0.141	0.013	16.495	
9/15/2019 02:00	0.01	0.165	0.019	17.392		0.057	0.001	17.432		0.178	0.025	16.463	
9/15/2019 02:05	0.00	0.179	0.024	17.377		0.061	0.002	17.410		0.181	0.027	16.424	
9/15/2019 02:09													8
9/15/2019 02:10	0.01	0.175	0.023	17.365		0.060	0.001	17.379		0.180	0.026	16.392	
9/15/2019 02:14									7				
9/15/2019 02:15	0.01	0.169	0.020	17.355		0.066	0.002	17.351		0.181	0.027	16.357	
9/15/2019 02:20	0.01	0.171	0.021	17.337		0.077	0.003	17.329		0.180	0.026	16.333	
9/15/2019 02:23					7								
9/15/2019 02:25	0.02	0.241	0.056	17.312		0.088	0.004	17.311		0.187	0.029	16.302	
9/15/2019 02:30	0.01	0.294	0.096	17.261		0.127	0.012	17.277		0.235	0.055	16.248	
9/15/2019 02:33									8				9
9/15/2019 02:35	0.01	0.282	0.086	17.222		0.143	0.017	17.238		0.257	0.070	16.176	
9/15/2019 02:37					8								
9/15/2019 02:40	0.00	0.277	0.082	17.185		0.131	0.013	17.207		0.251	0.066	16.105	
9/15/2019 02:42									9				
9/15/2019 02:45	0.01	0.307	0.108	17.151		0.155	0.021	17.176		0.287	0.094	16.040	10
9/15/2019 02:49									10				
9/15/2019 02:50	0.00	0.285	0.088	17.118	9	0.154	0.020	17.148		0.271	0.081	15.987	
9/15/2019 02:55	0.01	0.253	0.064	17.094		0.137	0.015	17.110		0.254	0.068	15.950	
9/15/2019 02:58													11
9/15/2019 02:59									11				
9/15/2019 03:00	0.01	0.278	0.082	17.069		0.138	0.015	17.079		0.263	0.074	15.914	
9/15/2019 03:04					10								
9/15/2019 03:05	0.00	0.329	0.130	17.017		0.167	0.025	17.048		0.303	0.109	15.882	
9/15/2019 03:06									12				
9/15/2019 03:07													12
9/15/2019 03:10	0.01	0.324	0.125	16.986		0.181	0.031	17.019		0.317	0.123	15.849	
9/15/2019 03:11									13				

Storm Event #23 Monitoring Data

Date & Time[1]	UW ATG Rainfall (in)	Station 520-E Level (ft)	Station 520-E Flow Rate (cfs)	Station 520-E Temperature (°C)	Station 520-E Sample (SU)	Station 520-N Level (ft)	Station 520-N Flow Rate (cfs)	Station 520-N Temperature (°C)	Station 520-N Sample (SU)	Station 520-U Level (ft)	Station 520-U Flow Rate (cfs)	Station 520-U Temperature (°C)	Station 520-U Sample (SU)
9/15/2019 03:14					11								
9/15/2019 03:15	0.00	0.291	0.093	16.965		0.162	0.023	17.005		0.303	0.109	15.806	13
9/15/2019 03:18									14				
9/15/2019 03:20	0.00	0.246	0.059	16.944		0.139	0.016	16.985		0.274	0.083	15.781	
9/15/2019 03:25	0.00	0.197	0.032	16.918		0.117	0.010	16.962		0.241	0.059	15.776	
9/15/2019 03:30	0.00	0.163	0.018	16.889		0.101	0.007	16.938		0.195	0.033	15.782	
9/15/2019 03:31													14
9/15/2019 03:34									15				
9/15/2019 03:35	0.00	0.143	0.012	16.857		0.090	0.005	16.923		0.164	0.020	15.810	
9/15/2019 03:40	0.00	0.139	0.011	16.824		0.085	0.004	16.912		0.150	0.016	15.844	
9/15/2019 03:45	0.00	0.168	0.020	16.792		0.082	0.004	16.893		0.155	0.017	15.862	
9/15/2019 03:50	0.00	0.283	0.087	16.742	12	0.141	0.016	16.844		0.244	0.061	15.879	
9/15/2019 03:51									16				
9/15/2019 03:55	0.00	0.314	0.114	16.676		0.179	0.030	16.790		0.268	0.078	15.857	15
9/15/2019 03:56									17				
9/15/2019 04:00	0.01	0.307	0.107	16.620		0.178	0.030	16.761		0.270	0.080	15.821	
9/15/2019 04:01					13				18				
9/15/2019 04:05	0.00	0.257	0.067	16.570		0.153	0.020	16.737		0.253	0.067	15.790	
9/15/2019 04:08													16
9/15/2019 04:10	0.00	0.217	0.042	16.555		0.129	0.013	16.715		0.241	0.059	15.760	
9/15/2019 04:11									19				
9/15/2019 04:15	0.00	0.178	0.024	16.554		0.107	0.008	16.699		0.203	0.037	15.721	
9/15/2019 04:20	0.00	0.155	0.016	16.549		0.096	0.006	16.688		0.174	0.024	15.706	
9/15/2019 04:25	0.00	0.138	0.011	16.542		0.085	0.004	16.687		0.156	0.018	15.711	
9/15/2019 04:30	0.00	0.134	0.010	16.526		0.078	0.003	16.684		0.146	0.015	15.737	
9/15/2019 04:35	0.00	0.140	0.012	16.511		0.073	0.003	16.673		0.145	0.014	15.773	
9/15/2019 04:40	0.00	0.164	0.019	16.509		0.076	0.003	16.669		0.161	0.019	15.787	
9/15/2019 04:41									20				
9/15/2019 04:45	0.00	0.185	0.026	16.530		0.089	0.005	16.681		0.176	0.025	15.787	
9/15/2019 04:48													17
9/15/2019 04:50	0.00	0.187	0.027	16.566		0.094	0.005	16.702		0.172	0.023	15.769	
9/15/2019 04:53					14								
9/15/2019 04:55	0.01	0.188	0.028	16.606		0.088	0.004	16.727		0.167	0.021	15.753	
9/15/2019 05:00	0.00	0.192	0.029	16.647		0.080	0.003	16.749		0.165	0.021	15.744	

Storm Event #23 Monitoring Data

Date & Time[1]	UW ATG Rainfall (in)	Station 520-E Level (ft)	Station 520-E Flow Rate (cfs)	Station 520-E Temperature (°C)	Station 520-E Sample (SU)	Station 520-N Level (ft)	Station 520-N Flow Rate (cfs)	Station 520-N Temperature (°C)	Station 520-N Sample (SU)	Station 520-U Level (ft)	Station 520-U Flow Rate (cfs)	Station 520-U Temperature (°C)	Station 520-U Sample (SU)
9/15/2019 05:05	0.00	0.185	0.027	16.686		0.075	0.003	16.763		0.157	0.018	15.746	
9/15/2019 05:10	0.00	0.168	0.020	16.737		0.072	0.002	16.776		0.148	0.015	15.752	
9/15/2019 05:15	0.00	0.152	0.015	16.785		0.068	0.002	16.790		0.142	0.014	15.758	
9/15/2019 05:18									21				
9/15/2019 05:20	0.00	0.139	0.011	16.826		0.067	0.002	16.805		0.138	0.013	15.771	
9/15/2019 05:25	0.00	0.133	0.010	16.858		0.071	0.002	16.809		0.137	0.012	15.777	
9/15/2019 05:30	0.00	0.135	0.010	16.869		0.066	0.002	16.813		0.130	0.011	15.771	
9/15/2019 05:35	0.01	0.143	0.012	16.866		0.061	0.002	16.817		0.129	0.010	15.757	
9/15/2019 05:40	0.00	0.133	0.010	16.876		0.052	0.001	16.820		0.130	0.010	15.758	
9/15/2019 05:45	0.00	0.126	0.008	16.886		0.046	0.001	16.822		0.128	0.010	15.777	
9/15/2019 05:50	0.00	0.127	0.009	16.896		0.042	0.001	16.812		0.124	0.009	15.797	
9/15/2019 05:55	0.00	0.122	0.008	16.895		0.043	0.001	16.805		0.120	0.008	15.809	
9/15/2019 06:00	0.00	0.120	0.007	16.889		0.043	0.001	16.808		0.115	0.007	15.812	
9/15/2019 06:01													18
9/15/2019 06:05	0.00	0.129	0.009	16.876		0.041	0.000	16.808		0.118	0.008	15.810	
9/15/2019 06:10	0.01	0.141	0.012	16.861		0.041	0.000	16.809		0.118	0.008	15.812	
9/15/2019 06:15	0.00	0.151	0.015	16.847		0.045	0.001	16.810		0.121	0.009	15.825	
9/15/2019 06:20	0.00	0.155	0.016	16.825		0.052	0.001	16.810		0.125	0.009	15.832	
9/15/2019 06:25	0.00	0.149	0.014	16.804		0.057	0.001	16.811		0.127	0.010	15.831	
9/15/2019 06:30	0.01	0.145	0.013	16.781		0.058	0.001	16.815		0.125	0.009	15.832	
9/15/2019 06:34					15								
9/15/2019 06:35	0.00	0.164	0.019	16.770		0.058	0.001	16.820		0.126	0.010	15.829	
9/15/2019 06:40	0.00	0.190	0.029	16.766		0.059	0.001	16.816		0.131	0.011	15.830	
9/15/2019 06:45	0.00	0.224	0.046	16.758		0.072	0.003	16.803		0.152	0.016	15.828	
9/15/2019 06:47									22				
9/15/2019 06:50	0.00	0.229	0.048	16.751		0.080	0.003	16.785		0.167	0.021	15.805	
9/15/2019 06:55	0.01	0.203	0.035	16.746		0.079	0.003	16.753		0.164	0.020	15.770	
9/15/2019 07:00	0.00	0.194	0.030	16.742		0.078	0.003	16.708		0.157	0.018	15.744	
9/15/2019 07:05	0.00	0.183	0.026	16.746		0.076	0.003	16.692		0.151	0.016	15.735	
9/15/2019 07:10	0.00	0.176	0.023	16.747		0.072	0.002	16.700		0.150	0.016	15.748	
9/15/2019 07:14					16								19
9/15/2019 07:15	0.00	0.161	0.018	16.753		0.067	0.002	16.705		0.145	0.014	15.772	
9/15/2019 07:20	0.00	0.150	0.014	16.754		0.062	0.002	16.706		0.142	0.014	15.785	
9/15/2019 07:25	0.00	0.146	0.013	16.761		0.064	0.002	16.707		0.142	0.014	15.787	

Storm Event #23 Monitoring Data

Date & Time[1]	UW ATG Rainfall (in)	Station 520-E Level (ft)	Station 520-E Flow Rate (cfs)	Station 520-E Temperature (°C)	Station 520-E Sample (SU)	Station 520-N Level (ft)	Station 520-N Flow Rate (cfs)	Station 520-N Temperature (°C)	Station 520-N Sample (SU)	Station 520-U Level (ft)	Station 520-U Flow Rate (cfs)	Station 520-U Temperature (°C)	Station 520-U Sample (SU)
9/15/2019 07:30	0.00	0.147	0.014	16.784		0.066	0.002	16.711		0.138	0.012	15.785	
9/15/2019 07:35	0.00	0.143	0.012	16.821		0.060	0.001	16.728		0.133	0.011	15.793	
9/15/2019 07:37									23				
9/15/2019 07:40	0.00	0.132	0.010	16.840		0.055	0.001	16.745		0.128	0.010	15.813	
9/15/2019 07:45	0.01	0.133	0.010	16.819		0.054	0.001	16.755		0.128	0.010	15.824	
9/15/2019 07:50	0.01	0.157	0.017	16.775		0.055	0.001	16.762		0.129	0.010	15.828	
9/15/2019 07:55	0.00	0.234	0.052	16.709		0.067	0.002	16.744		0.146	0.015	15.839	
9/15/2019 08:00	0.01	0.277	0.082	16.627		0.088	0.004	16.710		0.189	0.030	15.853	
9/15/2019 08:02					17								
9/15/2019 08:05	0.01	0.291	0.094	16.568		0.107	0.008	16.681		0.222	0.047	15.852	
9/15/2019 08:07													20
9/15/2019 08:10	0.00	0.285	0.088	16.523		0.119	0.010	16.647	24	0.226	0.050	15.821	
9/15/2019 08:15	0.00	0.268	0.074	16.485		0.119	0.010	16.613		0.206	0.038	15.814	
9/15/2019 08:17					18								
9/15/2019 08:20	0.01	0.235	0.052	16.466		0.112	0.009	16.591		0.197	0.034	15.816	
9/15/2019 08:25	0.00	0.212	0.039	16.456		0.104	0.007	16.579		0.185	0.028	15.811	
9/15/2019 08:26									25				
9/15/2019 08:30	0.00	0.201	0.034	16.468		0.097	0.006	16.579		0.175	0.025	15.798	
9/15/2019 08:35	0.00	0.198	0.032	16.485		0.091	0.005	16.576		0.170	0.023	15.785	
9/15/2019 08:36													21
9/15/2019 08:40	0.01	0.186	0.027	16.515		0.081	0.004	16.579		0.166	0.021	15.783	
9/15/2019 08:45	0.00	0.181	0.025	16.549		0.077	0.003	16.579		0.163	0.020	15.779	
9/15/2019 08:50	0.00	0.201	0.034	16.567		0.083	0.004	16.576		0.170	0.023	15.769	
9/15/2019 08:55	0.00	0.207	0.036	16.575	19	0.083	0.004	16.575		0.172	0.023	15.766	
9/15/2019 08:58									26				
9/15/2019 09:00	0.00	0.203	0.035	16.582		0.079	0.003	16.566		0.167	0.022	15.770	
9/15/2019 09:05	0.00	0.196	0.031	16.593		0.077	0.003	16.562		0.156	0.018	15.782	
9/15/2019 09:10	0.01	0.185	0.026	16.614		0.069	0.002	16.564		0.147	0.015	15.795	
9/15/2019 09:15	0.00	0.177	0.023	16.638		0.069	0.002	16.575		0.142	0.014	15.816	
9/15/2019 09:20	0.00	0.168	0.020	16.657		0.066	0.002	16.593		0.137	0.012	15.838	
9/15/2019 09:25	0.00	0.164	0.019	16.674		0.064	0.002	16.608		0.138	0.012	15.854	
9/15/2019 09:30	0.00	0.159	0.017	16.684		0.067	0.002	16.606		0.139	0.013	15.857	
9/15/2019 09:31													22
9/15/2019 09:35	0.00	0.154	0.015	16.691		0.066	0.002	16.608		0.139	0.013	15.842	

Storm Event #23 Monitoring Data

Date & Time[1]	UW ATG Rainfall (in)	Station 520-E Level (ft)	Station 520-E Flow Rate (cfs)	Station 520-E Temperature (°C)	Station 520-E Sample (SU)	Station 520-N Level (ft)	Station 520-N Flow Rate (cfs)	Station 520-N Temperature (°C)	Station 520-N Sample (SU)	Station 520-U Level (ft)	Station 520-U Flow Rate (cfs)	Station 520-U Temperature (°C)	Station 520-U Sample (SU)
9/15/2019 09:40	0.00	0.146	0.013	16.688		0.064	0.002	16.602		0.135	0.012	15.821	
9/15/2019 09:45	0.00	0.151	0.015	16.679		0.065	0.002	16.595		0.135	0.012	15.803	
9/15/2019 09:50	0.01	0.159	0.017	16.671		0.064	0.002	16.596		0.141	0.013	15.782	
9/15/2019 09:54									27				
9/15/2019 09:55	0.00	0.168	0.020	16.662		0.061	0.002	16.593		0.147	0.015	15.776	
9/15/2019 09:58					20								
9/15/2019 10:00	0.00	0.183	0.026	16.657		0.061	0.002	16.589		0.150	0.016	15.761	
9/15/2019 10:05	0.01	0.187	0.027	16.647		0.068	0.002	16.579		0.161	0.019	15.735	
9/15/2019 10:10	0.00	0.212	0.039	16.617		0.073	0.003	16.561		0.180	0.027	15.706	
9/15/2019 10:15	0.01	0.253	0.063	16.571		0.075	0.003	16.542		0.224	0.048	15.675	
9/15/2019 10:17													23
9/15/2019 10:20	0.00	0.267	0.074	16.526		0.084	0.004	16.523		0.239	0.057	15.631	
9/15/2019 10:23					21								
9/15/2019 10:25	0.00	0.263	0.071	16.481		0.097	0.006	16.500		0.249	0.064	15.594	
9/15/2019 10:30	0.01	0.263	0.071	16.441		0.101	0.007	16.479	28	0.255	0.069	15.538	
9/15/2019 10:31													24
9/15/2019 10:35	0.00	0.265	0.072	16.423		0.111	0.008	16.450		0.263	0.075	15.499	
9/15/2019 10:40	0.01	0.262	0.070	16.412	22	0.118	0.010	16.418		0.267	0.078	15.468	
9/15/2019 10:44													25
9/15/2019 10:45	0.01	0.255	0.065	16.406		0.112	0.009	16.397		0.261	0.073	15.456	
9/15/2019 10:46									29				
9/15/2019 10:50	0.00	0.250	0.062	16.404		0.109	0.008	16.391		0.247	0.063	15.460	
9/15/2019 10:55	0.01	0.245	0.058	16.399		0.102	0.007	16.388		0.234	0.054	15.462	
9/15/2019 11:00	0.00	0.243	0.057	16.384		0.094	0.005	16.369		0.226	0.049	15.459	26
9/15/2019 11:01					23								
9/15/2019 11:05	0.01	0.238	0.054	16.372		0.089	0.005	16.338		0.214	0.043	15.460	
9/15/2019 11:10	0.00	0.237	0.053	16.360		0.085	0.004	16.299	30	0.214	0.043	15.463	
9/15/2019 11:15	0.00	0.248	0.060	16.357		0.084	0.004	16.265		0.209	0.040	15.467	
9/15/2019 11:20	0.00	0.245	0.059	16.365		0.080	0.003	16.238		0.215	0.043	15.477	
9/15/2019 11:22													27
9/15/2019 11:23					24								
9/15/2019 11:25	0.01	0.238	0.054	16.380		0.078	0.003	16.221		0.217	0.044	15.492	
9/15/2019 11:30	0.00	0.222	0.044	16.407		0.076	0.003	16.213		0.203	0.037	15.523	
9/15/2019 11:35	0.00	0.227	0.047	16.430		0.081	0.004	16.223		0.193	0.032	15.555	

Storm Event #23 Monitoring Data

Date & Time[1]	UW ATG Rainfall (in)	Station 520-E Level (ft)	Station 520-E Flow Rate (cfs)	Station 520-E Temperature (°C)	Station 520-E Sample (SU)	Station 520-N Level (ft)	Station 520-N Flow Rate (cfs)	Station 520-N Temperature (°C)	Station 520-N Sample (SU)	Station 520-U Level (ft)	Station 520-U Flow Rate (cfs)	Station 520-U Temperature (°C)	Station 520-U Sample (SU)
9/15/2019 11:40	0.01	0.235	0.052	16.443		0.084	0.004	16.252		0.196	0.034	15.591	
9/15/2019 11:45	0.00	0.231	0.049	16.454		0.085	0.004	16.292		0.204	0.038	15.643	
9/15/2019 11:46									31				
9/15/2019 11:48													28
9/15/2019 11:49					25								
9/15/2019 11:50	0.01	0.245	0.058	16.473		0.085	0.004	16.327		0.222	0.047	15.717	
9/15/2019 11:55	0.01	0.307	0.108	16.468		0.090	0.005	16.353		0.247	0.063	15.781	
9/15/2019 11:59					26								
9/15/2019 12:00	0.00	0.335	0.137	16.467		0.115	0.009	16.363		0.282	0.090	15.825	
9/15/2019 12:01													29
9/15/2019 12:05	0.00	0.308	0.109	16.468		0.125	0.012	16.369	32	0.280	0.089	15.820	
9/15/2019 12:10	0.00	0.243	0.057	16.473		0.111	0.008	16.379		0.252	0.066	15.801	
9/15/2019 12:15	0.00	0.206	0.036	16.478		0.095	0.006	16.390		0.220	0.046	15.805	30
9/15/2019 12:18					27								
9/15/2019 12:20	0.00	0.178	0.024	16.488		0.078	0.003	16.395		0.183	0.028	15.808	
9/15/2019 12:25	0.00	0.162	0.018	16.489		0.067	0.002	16.403		0.162	0.020	15.804	
9/15/2019 12:30	0.00	0.150	0.014	16.493		0.059	0.001	16.417		0.147	0.015	15.795	
9/15/2019 12:35	0.00	0.136	0.011	16.504		0.053	0.001	16.432		0.136	0.012	15.786	
9/15/2019 12:40	0.00	0.127	0.009	16.518		0.051	0.001	16.430		0.130	0.011	15.780	
9/15/2019 12:45	0.00	0.122	0.008	16.534		0.048	0.001	16.424		0.124	0.009	15.777	
9/15/2019 12:48									33				
9/15/2019 12:50	0.00	0.118	0.007	16.549		0.044	0.001	16.414		0.118	0.008	15.778	
9/15/2019 12:55	0.01	0.112	0.006	16.563		0.041	0.000	16.406		0.113	0.007	15.780	
9/15/2019 13:00	0.00	0.108	0.005	16.576		0.038	0.000	16.405		0.108	0.006	15.790	
9/15/2019 13:05	0.00	0.103	0.005	16.589		0.038	0.000	16.409		0.105	0.006	15.807	
9/15/2019 13:10	0.00	0.103	0.004	16.576		0.036	0.000	16.405		0.113	0.007	15.806	
9/15/2019 13:15	0.00	0.103	0.004	16.563		0.033	0.000	16.400		0.112	0.007	15.795	
9/15/2019 13:20	0.00	0.095	0.003	16.568		0.033	0.000	16.405		0.107	0.006	15.813	
9/15/2019 13:25	0.00	0.089	0.003	16.588		0.030	0.000	16.425		0.103	0.005	15.827	
9/15/2019 13:30	0.01	0.083	0.002	16.612		0.028	0.000	16.447		0.098	0.004	15.838	
9/15/2019 13:35	0.00	0.080	0.002	16.622		0.026	0.000	16.460		0.096	0.004	15.844	
9/15/2019 13:40	0.00	0.077	0.002	16.624		0.024	0.000	16.473		0.094	0.004	15.849	
9/15/2019 13:45	0.00	0.080	0.002	16.634		0.024	0.000	16.493		0.092	0.004	15.867	
9/15/2019 13:50	0.00	0.079	0.002	16.655		0.025	0.000	16.523		0.088	0.003	15.899	

Storm Event #23 Monitoring Data

Date & Time[1]	UW ATG Rainfall (in)	Station 520-E Level (ft)	Station 520-E Flow Rate (cfs)	Station 520-E Temperature (°C)	Station 520-E Sample (SU)	Station 520-N Level (ft)	Station 520-N Flow Rate (cfs)	Station 520-N Temperature (°C)	Station 520-N Sample (SU)	Station 520-U Level (ft)	Station 520-U Flow Rate (cfs)	Station 520-U Temperature (°C)	Station 520-U Sample (SU)
9/15/2019 13:55	0.00	0.076	0.002	16.667		0.025	0.000	16.553		0.086	0.003	15.941	
9/15/2019 14:00	0.00	0.072	0.001	16.663		0.024	0.000	16.574		0.084	0.003	15.975	
9/15/2019 14:05	0.00	0.068	0.001	16.674		0.024	0.000	16.589		0.079	0.002	16.003	
9/15/2019 14:10	0.00	0.066	0.001	16.686		0.023	0.000	16.610		0.074	0.002	16.032	
9/15/2019 14:15	0.00	0.065	0.001	16.690		0.021	0.000	16.617		0.072	0.002	16.046	
9/15/2019 14:20	0.00	0.063	0.001	16.671		0.020	0.000	16.619		0.062	0.001	16.060	
9/15/2019 14:25	0.00	0.062	0.001	16.664		0.020	0.000	16.602		0.057	0.001	16.073	
9/15/2019 14:30	0.00	0.061	0.001	16.648		0.019	0.000	16.581		0.051	0.000	16.089	
9/15/2019 14:35	0.00	0.060	0.001	16.612		0.018	0.000	16.546		0.045	0.000	16.105	
9/15/2019 14:40	0.00	0.058	0.001	16.584		0.018	0.000	16.504		0.042	0.000	16.116	
9/15/2019 14:45	0.00	0.057	0.001	16.549		0.016	0.000	16.474		0.037	0.000	16.100	
9/15/2019 14:50	0.00	0.056	0.000	16.515		0.016	0.000	16.446		0.041	0.000	16.062	
9/15/2019 14:55	0.00	0.054	0.000	16.463		0.015	0.000	16.407		0.043	0.000	16.001	
9/15/2019 15:00	0.00	0.053	0.000	16.445		0.014	0.000	16.375		0.045	0.000	15.954	
9/15/2019 15:05	0.00	0.053	0.000	16.450		0.014	0.000	16.363		0.053	0.001	15.926	
9/15/2019 15:10	0.00	0.052	0.000	16.463		0.013	0.000	16.379		0.058	0.001	15.941	
9/15/2019 15:15	0.00	0.050	0.000	16.475		0.014	0.000	16.406		0.058	0.001	15.979	
9/15/2019 15:20	0.00	0.050	0.000	16.505		0.014	0.000	16.443		0.054	0.001	16.022	
9/15/2019 15:25	0.00	0.049	0.000	16.549		0.013	0.000	16.496		0.051	0.000	16.087	
9/15/2019 15:30	0.00	0.048	0.000	16.592		0.014	0.000	16.554		0.045	0.000	16.175	
9/15/2019 15:35	0.01	0.048	0.000	16.635		0.014	0.000	16.617		0.046	0.000	16.262	
9/15/2019 15:40	0.00	0.048	0.000	16.675		0.014	0.000	16.666		0.047	0.000	16.341	

Notes:

[1] All times are as recorded by automatic datalogger and transmitted to the sampling lead's computer via telemetry and do not exactly match times on field notes or chain of custody (COC) forms.

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Mobilization Event 24 | 09/17/2019

January 15, 2020

Storm Summary Report

Re: September 17, 2019, Storm Event

Project No. 160418

Introduction

This Storm Summary Report summarizes the storm sampling event that began on September 17, 2019, and includes a summary and documentation of all sampling-related activities. The September 17, 2019, event is the twenty-fourth storm sample event for the SR-520 Bridge AKART Stormwater Monitoring Project.

Storm Validation Summary

The event began on September 17, 2019, at 8:20 after an antecedent dry period exceeding 6 hours. The event ended September 17, 2019, at 21:00. The total measured rainfall for the event was 0.20 inches over a period of 12.67 hours. All three stations were targeted for sampling and enabled on the rising limb of the storm hydrograph. A sampler error at 520U caused it to miss aliquots 1, 15, and 19, but the sample still represented 87.6 percent of the storm. A duplicate sample was taken at station 520N. This is the third and final duplicate needed for 520N. All three stations met the sample validation criteria for sample volume, minimum number of aliquots, and percent coverage of the storm runoff (see Table 1). All samples were submitted to the laboratory within the 24-hour hold time. The water temperature was at least 14.56 degrees Celsius (C) at the time of collection, and the samples were iced and at or below 6.0 degrees C when they were submitted to the lab.

Two unforecasted intra-event dry periods occurred during the sampling event where the 6-hour rainfall total was less than the end-of-storm criteria of 0.04 inches. The first began at 16:55 after 0.16 inches of accumulation and lasted 15 minutes. The second occurred at 20:20 and lasted only 5 minutes before an additional 0.03 inches fell before the end of the storm, totaling 0.20 inches of accumulation. Per previous discussions with Parametrix and WSDOT staff, the samples were submitted to the lab.

Hydrographs

The attached hydrographs show the water level and flow rate in each weir along with markers for each sample aliquot and 5-minute rain data.

Storm Tracking

The Go-No-Go field sheet documents the weather forecasts and the decision to target prior to the September 17, 2019, event (Attachment A). The printout from the National Weather Forecast shows the latest forecast roughly 2 hours and 35 minutes prior to the beginning of the rainfall (Attachment B).

Storm Field Sheets

The field sheets document the field and storm control procedures for the event (Attachment C and D). The field sheets also include the Chain-of-Custody (COC) form (Attachment E).

Attachments

Table 1. Storm Validation Summary	*(Included with Quarterly Report attachment)*
520E_091719 Hydrograph	*(Included with Quarterly Report attachment)*
520N_091719 Hydrograph	*(Included with Quarterly Report attachment)*
520U_091719 Hydrograph	*(Included with Quarterly Report attachment)*
Attachment A. Storm Tracking Sheet Go-No-Go Sheets	*(On file)*
Attachment B. National Weather Service Forecast Sheet	*(On file)*
Attachment C. Storm Control Sheets	*(On file)*
Attachment D. Field Sheets	*(On file)*
Attachment E. Chain of Custody	*(On file)*

V:\160418 SR-520 Bridge Stormwater Monitoring\Deliverables\Storm Summaries 2019\24_091719\Storm 24 Summary Report 091719_20200115.docx

Table 1. Storm Validation Summary

Mobilization Event 24 | 09/17/2019

Project No. 160418

SR-520 Floating Bridge Stormwater Monitoring Storm and Sample Validation Checklist

Storm Date	**September 17, 2019**	
Storm Event Number	**24**	
Criterion	**Y / N**	**Value**
Rainfall Depth ≥ 0.15	Y	0.2
Rainfall Duration > 1 hr	Y	12.67
Antecedent Rainfall < 0.04" in 6 hrs	Y	0

Notes:

	Station					
	520-E		**520-N**		**520-U**	
Criterion	**Y / N**	**Value**	**Y / N**	**Value**	**Y / N**	**Value**
Aliquots ≥ 10	Y	13	Y	12	Y	16
Sample Volume ≥ 1 liter	Y	~1	Y	~1	Y	~2
Does Sample cover more than 75% of hydrograph?	Y	100.0%	Y	100.0%	Y	87.6%
Sample Valid Y / N?	Y		Y		Y	

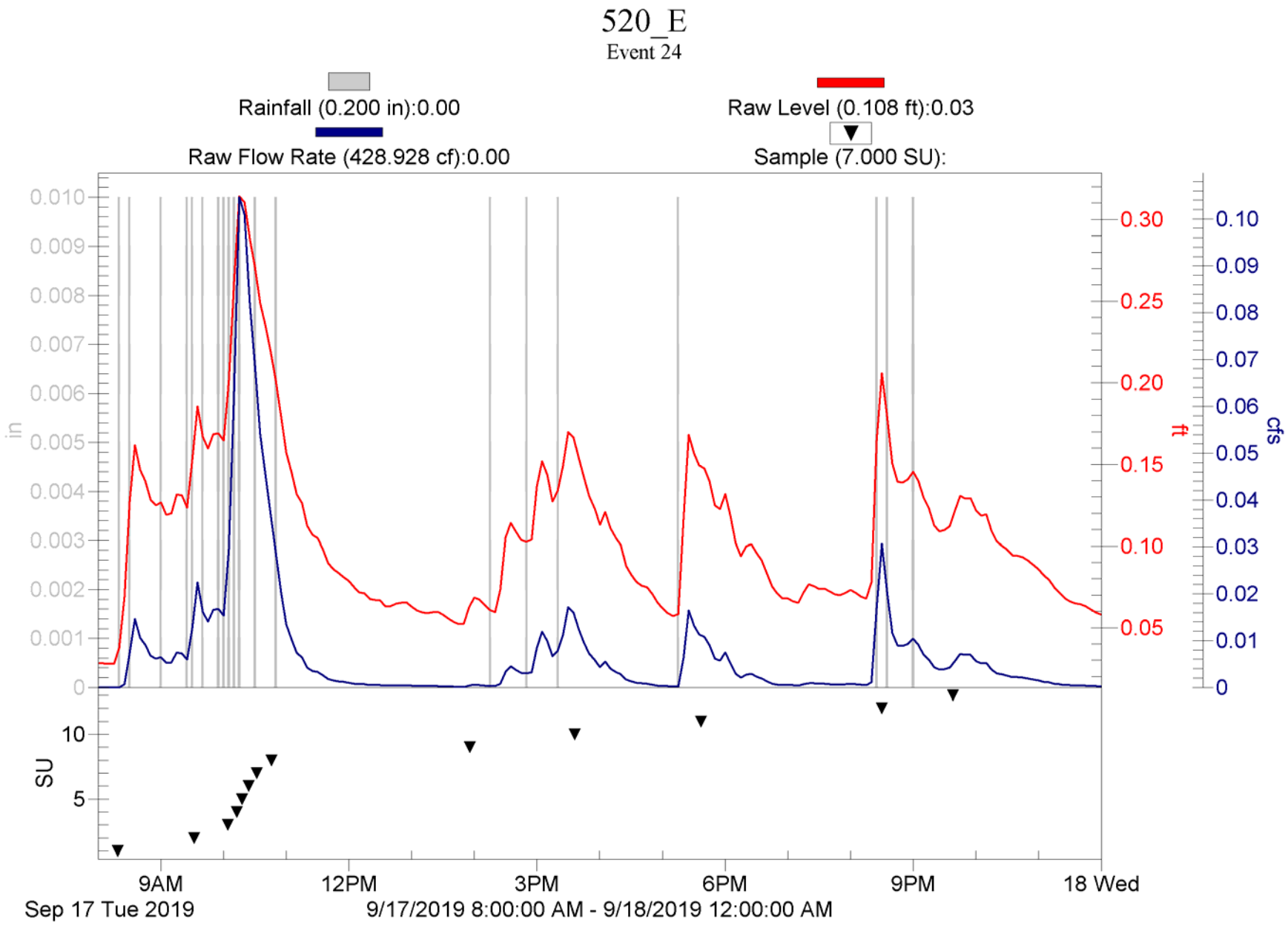
Notes:

Three aliquots were missed on 520U due to sampler error. 87 percent of hydrograph was still covered.

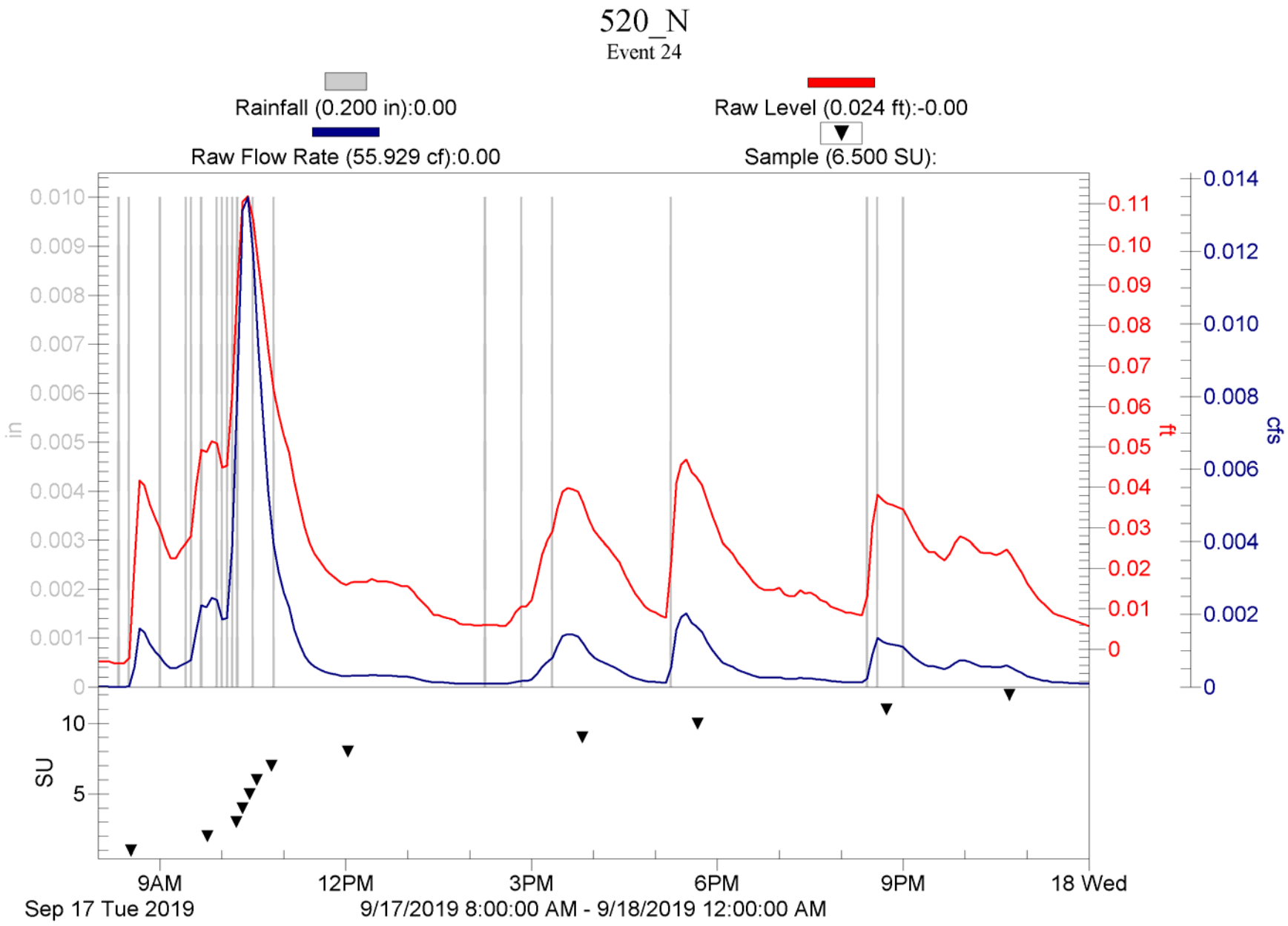
Storm Summary Description

Initial rainfall of 0.16 inches, followed by a 15 minute period with a 6-hour rainfall intensity of less than 0.04 inches, and then 0.01 inches. A second 5 minute period with a 6-hour rainfall intensity of less than 0.04 inches was followed by 0.03 inches, totaling 0.20 inches for the event. All samples were successful and a duplicate was collected at 520N.

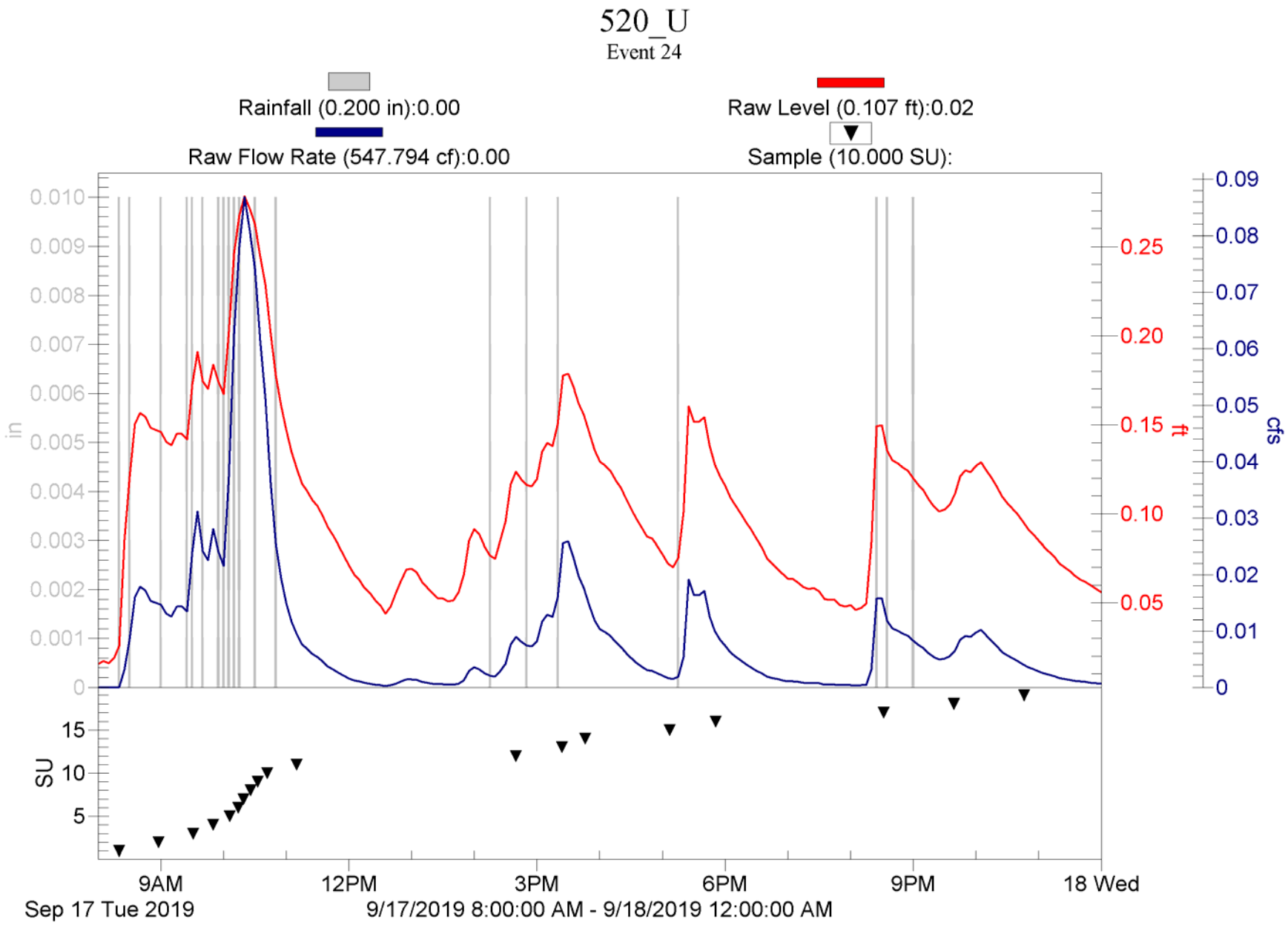
Mobilization Event 24 | 09/17/2019



Mobilization Event 24 | 09/17/2019



Mobilization Event 24 | 09/17/2019



Mobilization Event 24 | 09/17/2019

Storm Event #24 Monitoring Data

Date & Time[1]	UW ATG Rainfall (in)	Station 520-E Level (ft)	Station 520-E Flow Rate (cfs)	Station 520-E Temperature (°C)	Station 520-E Sample (SU)	Station 520-N Level (ft)	Station 520-N Flow Rate (cfs)	Station 520-N Temperature (°C)	Station 520-N Sample (SU)	Station 520-U Level (ft)	Station 520-U Flow Rate (cfs)	Station 520-U Temperature (°C)	Station 520-U Sample (SU)
9/17/2019 08:15	0.00	0.030	0.000	16.417		0.007	0.000	16.630		0.023	0.000	16.110	
9/17/2019 08:19					1								
9/17/2019 08:20	0.01	0.040	0.000	16.401		0.007	0.000	16.571		0.030	0.000	16.046	1
9/17/2019 08:25	0.00	0.071	0.001	16.377		0.007	0.000	16.490		0.090	0.003	15.995	
9/17/2019 08:30	0.01	0.130	0.009	16.346		0.008	0.000	16.409		0.125	0.009	15.940	
9/17/2019 08:32									1				
9/17/2019 08:35	0.00	0.164	0.019	16.311		0.031	0.000	16.339		0.155	0.017	15.890	
9/17/2019 08:40	0.00	0.149	0.014	16.272		0.052	0.001	16.276		0.161	0.019	15.808	
9/17/2019 08:45	0.00	0.142	0.012	16.237		0.051	0.001	16.210		0.159	0.019	15.730	
9/17/2019 08:50	0.00	0.131	0.009	16.200		0.046	0.001	16.145		0.153	0.017	15.655	
9/17/2019 08:55	0.00	0.127	0.009	16.156		0.043	0.001	16.084		0.152	0.016	15.591	
9/17/2019 08:58													2
9/17/2019 09:00	0.01	0.129	0.009	16.109		0.040	0.000	16.026		0.150	0.016	15.517	
9/17/2019 09:05	0.00	0.121	0.008	16.057		0.036	0.000	15.966		0.145	0.014	15.445	
9/17/2019 09:10	0.00	0.122	0.008	16.001		0.033	0.000	15.900		0.143	0.014	15.378	
9/17/2019 09:15	0.00	0.134	0.010	15.951		0.033	0.000	15.837		0.149	0.016	15.309	
9/17/2019 09:20	0.00	0.133	0.010	15.905		0.035	0.000	15.809		0.149	0.016	15.255	
9/17/2019 09:25	0.01	0.126	0.008	15.857		0.036	0.000	15.788		0.146	0.015	15.206	
9/17/2019 09:30	0.01	0.156	0.016	15.814		0.038	0.000	15.757		0.177	0.025	15.154	
9/17/2019 09:31													3
9/17/2019 09:32					2								
9/17/2019 09:35	0.00	0.188	0.028	15.782		0.050	0.001	15.744		0.195	0.033	15.102	
9/17/2019 09:40	0.01	0.170	0.021	15.750		0.060	0.001	15.741		0.179	0.026	15.098	
9/17/2019 09:45	0.00	0.162	0.018	15.735		0.059	0.001	15.740		0.174	0.024	15.096	
9/17/2019 09:46									2				
9/17/2019 09:50	0.00	0.171	0.021	15.733		0.062	0.002	15.741		0.188	0.030	15.096	4
9/17/2019 09:55	0.01	0.171	0.021	15.726		0.061	0.002	15.743		0.178	0.026	15.084	
9/17/2019 10:00	0.01	0.167	0.020	15.711		0.055	0.001	15.723		0.172	0.023	15.053	
9/17/2019 10:04					3								
9/17/2019 10:05	0.01	0.204	0.035	15.695		0.056	0.001	15.689		0.207	0.039	15.022	
9/17/2019 10:06													5
9/17/2019 10:10	0.01	0.265	0.072	15.671		0.073	0.003	15.666		0.251	0.066	14.990	
9/17/2019 10:13					4								
9/17/2019 10:14									3				6

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Storm Event #24 Monitoring Data

Date & Time[1]	UW ATG Rainfall (in)	Station 520-E Level (ft)	Station 520-E Flow Rate (cfs)	Station 520-E Temperature (°C)	Station 520-E Sample (SU)	Station 520-N Level (ft)	Station 520-N Flow Rate (cfs)	Station 520-N Temperature (°C)	Station 520-N Sample (SU)	Station 520-U Level (ft)	Station 520-U Flow Rate (cfs)	Station 520-U Temperature (°C)	Station 520-U Sample (SU)
9/17/2019 10:15	0.01	0.317	0.117	15.628		0.100	0.006	15.662		0.272	0.081	14.970	
9/17/2019 10:18					5								
9/17/2019 10:19													7
9/17/2019 10:20	0.00	0.313	0.113	15.596		0.121	0.011	15.638	4	0.283	0.091	14.949	
9/17/2019 10:24					6								
9/17/2019 10:25	0.00	0.291	0.093	15.569		0.122	0.011	15.589		0.276	0.085	14.936	
9/17/2019 10:26													8
9/17/2019 10:27									5				
9/17/2019 10:30	0.01	0.273	0.079	15.537		0.116	0.010	15.553		0.267	0.078	14.924	
9/17/2019 10:32					7								
9/17/2019 10:33													9
9/17/2019 10:34									6				
9/17/2019 10:35	0.00	0.251	0.062	15.509		0.105	0.007	15.526		0.249	0.064	14.916	
9/17/2019 10:40	0.00	0.238	0.053	15.481		0.095	0.006	15.491		0.233	0.054	14.913	
9/17/2019 10:42													10
9/17/2019 10:45	0.00	0.222	0.044	15.431		0.084	0.004	15.444		0.206	0.038	14.915	
9/17/2019 10:46					8								
9/17/2019 10:48									7				
9/17/2019 10:50	0.01	0.204	0.035	15.378		0.075	0.003	15.383		0.182	0.027	14.923	
9/17/2019 10:55	0.00	0.182	0.025	15.336		0.068	0.002	15.322		0.166	0.021	14.927	
9/17/2019 11:00	0.00	0.160	0.017	15.305		0.063	0.002	15.270		0.151	0.016	14.925	
9/17/2019 11:05	0.00	0.148	0.014	15.275		0.059	0.001	15.233		0.139	0.013	14.939	
9/17/2019 11:10	0.00	0.134	0.010	15.256		0.052	0.001	15.206		0.130	0.010	14.961	11
9/17/2019 11:15	0.00	0.129	0.009	15.249		0.046	0.001	15.187		0.121	0.009	14.974	
9/17/2019 11:20	0.00	0.115	0.006	15.249		0.040	0.000	15.172		0.117	0.008	14.982	
9/17/2019 11:25	0.00	0.110	0.005	15.261		0.037	0.000	15.156		0.112	0.007	14.991	
9/17/2019 11:30	0.00	0.107	0.005	15.278		0.034	0.000	15.150		0.109	0.006	15.010	
9/17/2019 11:35	0.00	0.101	0.004	15.293		0.032	0.000	15.151		0.103	0.005	15.037	
9/17/2019 11:40	0.00	0.092	0.003	15.316		0.030	0.000	15.161		0.097	0.004	15.070	
9/17/2019 11:45	0.00	0.089	0.003	15.344		0.029	0.000	15.179		0.092	0.004	15.116	
9/17/2019 11:50	0.00	0.086	0.002	15.384		0.028	0.000	15.210		0.087	0.003	15.168	
9/17/2019 11:55	0.00	0.084	0.002	15.435		0.027	0.000	15.251		0.081	0.002	15.223	
9/17/2019 12:00	0.00	0.081	0.002	15.496		0.026	0.000	15.306		0.076	0.002	15.285	
9/17/2019 12:02									8				

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Storm Event #24 Monitoring Data

Date & Time[1]	UW ATG Rainfall (in)	Station 520-E Level (ft)	Station 520-E Flow Rate (cfs)	Station 520-E Temperature (°C)	Station 520-E Sample (SU)	Station 520-N Level (ft)	Station 520-N Flow Rate (cfs)	Station 520-N Temperature (°C)	Station 520-N Sample (SU)	Station 520-U Level (ft)	Station 520-U Flow Rate (cfs)	Station 520-U Temperature (°C)	Station 520-U Sample (SU)
9/17/2019 12:05	0.00	0.077	0.002	15.565		0.027	0.000	15.367		0.071	0.002	15.351	
9/17/2019 12:10	0.00	0.074	0.001	15.635		0.027	0.000	15.425		0.067	0.001	15.412	
9/17/2019 12:15	0.00	0.074	0.001	15.692		0.027	0.000	15.478		0.063	0.001	15.462	
9/17/2019 12:20	0.00	0.070	0.001	15.743		0.027	0.000	15.530		0.060	0.001	15.503	
9/17/2019 12:25	0.00	0.070	0.001	15.791		0.028	0.000	15.578		0.056	0.001	15.539	
9/17/2019 12:30	0.00	0.069	0.001	15.848		0.027	0.000	15.630		0.053	0.001	15.571	
9/17/2019 12:35	0.00	0.065	0.001	15.915		0.027	0.000	15.697		0.049	0.000	15.611	
9/17/2019 12:40	0.00	0.066	0.001	15.985		0.027	0.000	15.770		0.052	0.001	15.660	
9/17/2019 12:45	0.00	0.067	0.001	16.039		0.027	0.000	15.849		0.060	0.001	15.704	
9/17/2019 12:50	0.00	0.068	0.001	16.074		0.026	0.000	15.910		0.067	0.001	15.736	
9/17/2019 12:55	0.00	0.068	0.001	16.098		0.026	0.000	15.939		0.073	0.002	15.760	
9/17/2019 13:00	0.00	0.066	0.001	16.117		0.026	0.000	15.954		0.074	0.002	15.768	
9/17/2019 13:05	0.00	0.063	0.001	16.119		0.025	0.000	15.953		0.072	0.002	15.770	
9/17/2019 13:10	0.00	0.062	0.001	16.115		0.023	0.000	15.941		0.066	0.001	15.778	
9/17/2019 13:15	0.00	0.061	0.001	16.107		0.022	0.000	15.927		0.063	0.001	15.785	
9/17/2019 13:20	0.00	0.062	0.001	16.103		0.020	0.000	15.909		0.060	0.001	15.790	
9/17/2019 13:25	0.00	0.062	0.001	16.099		0.019	0.000	15.895		0.057	0.001	15.795	
9/17/2019 13:30	0.00	0.061	0.001	16.097		0.019	0.000	15.889		0.057	0.001	15.804	
9/17/2019 13:35	0.00	0.058	0.001	16.097		0.018	0.000	15.889		0.055	0.001	15.819	
9/17/2019 13:40	0.00	0.056	0.000	16.098		0.018	0.000	15.891		0.056	0.001	15.834	
9/17/2019 13:45	0.00	0.055	0.000	16.101		0.018	0.000	15.898		0.061	0.001	15.851	
9/17/2019 13:50	0.00	0.055	0.000	16.103		0.017	0.000	15.907		0.070	0.002	15.862	
9/17/2019 13:55	0.00	0.065	0.001	16.103		0.016	0.000	15.922		0.089	0.003	15.883	
9/17/2019 13:56					9								
9/17/2019 14:00	0.00	0.071	0.001	16.111		0.017	0.000	15.935		0.096	0.004	15.922	
9/17/2019 14:05	0.00	0.070	0.001	16.129		0.016	0.000	15.949		0.093	0.004	15.972	
9/17/2019 14:10	0.00	0.067	0.001	16.151		0.016	0.000	15.958		0.086	0.003	16.022	
9/17/2019 14:15	0.01	0.064	0.001	16.174		0.016	0.000	15.963		0.081	0.002	16.071	
9/17/2019 14:20	0.00	0.062	0.001	16.191		0.016	0.000	15.960		0.079	0.002	16.114	
9/17/2019 14:25	0.00	0.076	0.002	16.187		0.016	0.000	15.953		0.090	0.003	16.146	
9/17/2019 14:30	0.00	0.108	0.005	16.157		0.016	0.000	15.948		0.100	0.005	16.169	
9/17/2019 14:35	0.00	0.117	0.007	16.141		0.016	0.000	15.955		0.121	0.009	16.184	
9/17/2019 14:40	0.00	0.111	0.006	16.142		0.018	0.000	15.961		0.128	0.010	16.193	12
9/17/2019 14:45	0.00	0.106	0.005	16.143		0.020	0.000	15.966		0.124	0.009	16.207	

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Date & Time[1]	UW ATG Rainfall (in)	Station 520-E Level (ft)	Station 520-E Flow Rate (cfs)	Station 520-E Temperature (°C)	Station 520-E Sample (SU)	Station 520-N Level (ft)	Station 520-N Flow Rate (cfs)	Station 520-N Temperature (°C)	Station 520-N Sample (SU)	Station 520-U Level (ft)	Station 520-U Flow Rate (cfs)	Station 520-U Temperature (°C)	Station 520-U Sample (SU)
9/17/2019 14:50	0.01	0.105	0.005	16.145		0.021	0.000	15.976		0.121	0.008	16.224	
9/17/2019 14:55	0.00	0.107	0.005	16.153		0.021	0.000	15.988		0.120	0.008	16.237	
9/17/2019 15:00	0.00	0.139	0.011	16.153		0.023	0.000	16.001		0.124	0.009	16.231	
9/17/2019 15:05	0.00	0.155	0.016	16.153		0.028	0.000	16.009		0.140	0.013	16.192	
9/17/2019 15:10	0.00	0.146	0.013	16.159		0.034	0.000	16.007		0.144	0.014	16.128	
9/17/2019 15:15	0.00	0.130	0.009	16.168		0.037	0.000	16.004		0.143	0.014	16.067	
9/17/2019 15:20	0.01	0.137	0.011	16.168		0.040	0.000	15.988		0.155	0.017	16.005	
9/17/2019 15:24													13
9/17/2019 15:25	0.00	0.152	0.015	16.164		0.045	0.001	15.965		0.182	0.027	15.950	
9/17/2019 15:30	0.00	0.173	0.022	16.150		0.049	0.001	15.933		0.183	0.028	15.904	
9/17/2019 15:35	0.00	0.169	0.021	16.114		0.050	0.001	15.889		0.176	0.025	15.872	
9/17/2019 15:36					10								
9/17/2019 15:40	0.00	0.157	0.016	16.079		0.050	0.001	15.848		0.167	0.021	15.845	
9/17/2019 15:45	0.00	0.145	0.013	16.062		0.049	0.001	15.829		0.160	0.019	15.820	
9/17/2019 15:46													14
9/17/2019 15:49									9				
9/17/2019 15:50	0.00	0.133	0.010	16.069		0.046	0.001	15.833		0.151	0.016	15.809	
9/17/2019 15:55	0.00	0.126	0.008	16.087		0.043	0.001	15.850		0.140	0.013	15.804	
9/17/2019 16:00	0.00	0.116	0.006	16.114		0.040	0.000	15.874		0.134	0.011	15.808	
9/17/2019 16:05	0.00	0.123	0.008	16.141		0.038	0.000	15.902		0.132	0.011	15.826	
9/17/2019 16:10	0.00	0.114	0.006	16.167		0.037	0.000	15.934		0.129	0.010	15.859	
9/17/2019 16:15	0.00	0.108	0.005	16.200		0.035	0.000	15.967		0.124	0.009	15.898	
9/17/2019 16:20	0.00	0.103	0.004	16.233		0.034	0.000	16.004		0.119	0.008	15.943	
9/17/2019 16:25	0.00	0.091	0.003	16.265		0.032	0.000	16.040		0.113	0.007	15.991	
9/17/2019 16:30	0.00	0.085	0.002	16.299		0.029	0.000	16.077		0.107	0.006	16.044	
9/17/2019 16:35	0.00	0.081	0.002	16.331		0.027	0.000	16.113		0.102	0.005	16.100	
9/17/2019 16:40	0.00	0.078	0.002	16.358		0.024	0.000	16.148		0.097	0.004	16.148	
9/17/2019 16:45	0.00	0.078	0.002	16.380		0.023	0.000	16.180		0.092	0.004	16.187	
9/17/2019 16:50	0.00	0.073	0.001	16.402		0.021	0.000	16.206		0.091	0.003	16.220	
9/17/2019 16:55	0.00	0.068	0.001	16.423		0.020	0.000	16.229		0.087	0.003	16.253	
9/17/2019 17:00	0.00	0.064	0.001	16.443		0.020	0.000	16.251		0.082	0.003	16.283	
9/17/2019 17:05	0.00	0.061	0.001	16.458		0.019	0.000	16.272		0.077	0.002	16.306	
9/17/2019 17:07													15
9/17/2019 17:10	0.00	0.060	0.001	16.473		0.018	0.000	16.291		0.075	0.002	16.322	

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Date & Time[1]	UW ATG Rainfall (in)	Station 520-E Level (ft)	Station 520-E Flow Rate (cfs)	Station 520-E Temperature (°C)	Station 520-E Sample (SU)	Station 520-N Level (ft)	Station 520-N Flow Rate (cfs)	Station 520-N Temperature (°C)	Station 520-N Sample (SU)	Station 520-U Level (ft)	Station 520-U Flow Rate (cfs)	Station 520-U Temperature (°C)	Station 520-U Sample (SU)
9/17/2019 17:15	0.01	0.061	0.001	16.489		0.032	0.000	16.301		0.080	0.002	16.336	
9/17/2019 17:20	0.00	0.119	0.007	16.495		0.052	0.001	16.303		0.106	0.006	16.351	
9/17/2019 17:25	0.00	0.171	0.021	16.493		0.056	0.001	16.312		0.165	0.021	16.371	
9/17/2019 17:30	0.00	0.159	0.017	16.503		0.057	0.001	16.324		0.157	0.018	16.360	
9/17/2019 17:35	0.00	0.152	0.015	16.511		0.054	0.001	16.341		0.157	0.018	16.348	
9/17/2019 17:37					11								
9/17/2019 17:40	0.00	0.150	0.014	16.520		0.053	0.001	16.359		0.159	0.019	16.327	
9/17/2019 17:41									10				
9/17/2019 17:45	0.00	0.142	0.012	16.530		0.051	0.001	16.376		0.143	0.014	16.303	
9/17/2019 17:50	0.00	0.127	0.009	16.546		0.047	0.001	16.395		0.133	0.011	16.281	
9/17/2019 17:51													16
9/17/2019 17:55	0.00	0.125	0.008	16.566		0.043	0.001	16.415		0.126	0.009	16.256	
9/17/2019 18:00	0.00	0.134	0.010	16.584		0.040	0.000	16.432		0.120	0.008	16.228	
9/17/2019 18:05	0.00	0.121	0.007	16.604		0.037	0.000	16.447		0.114	0.007	16.206	
9/17/2019 18:10	0.00	0.104	0.005	16.628		0.036	0.000	16.465		0.109	0.006	16.193	
9/17/2019 18:15	0.00	0.096	0.004	16.647		0.034	0.000	16.486		0.105	0.005	16.187	
9/17/2019 18:20	0.00	0.103	0.004	16.664		0.032	0.000	16.512		0.100	0.005	16.183	
9/17/2019 18:25	0.00	0.104	0.005	16.678		0.030	0.000	16.540		0.096	0.004	16.182	
9/17/2019 18:30	0.00	0.099	0.004	16.689		0.029	0.000	16.562		0.091	0.003	16.179	
9/17/2019 18:35	0.00	0.094	0.003	16.698		0.027	0.000	16.582		0.086	0.003	16.174	
9/17/2019 18:40	0.00	0.086	0.002	16.713		0.026	0.000	16.606		0.080	0.002	16.185	
9/17/2019 18:45	0.00	0.078	0.002	16.724		0.025	0.000	16.635		0.077	0.002	16.211	
9/17/2019 18:50	0.00	0.073	0.001	16.735		0.025	0.000	16.667		0.074	0.002	16.220	
9/17/2019 18:55	0.00	0.071	0.001	16.741		0.025	0.000	16.686		0.071	0.002	16.208	
9/17/2019 19:00	0.00	0.071	0.001	16.742		0.026	0.000	16.678		0.069	0.001	16.171	
9/17/2019 19:05	0.00	0.069	0.001	16.721		0.024	0.000	16.643		0.068	0.001	16.109	
9/17/2019 19:10	0.00	0.068	0.001	16.683		0.024	0.000	16.585		0.066	0.001	16.039	
9/17/2019 19:15	0.00	0.075	0.001	16.633		0.024	0.000	16.520		0.064	0.001	15.966	
9/17/2019 19:20	0.00	0.079	0.002	16.581		0.025	0.000	16.456		0.063	0.001	15.888	
9/17/2019 19:25	0.00	0.078	0.002	16.541		0.024	0.000	16.395		0.063	0.001	15.811	
9/17/2019 19:30	0.00	0.076	0.002	16.512		0.025	0.000	16.346		0.061	0.001	15.754	
9/17/2019 19:35	0.00	0.077	0.002	16.489		0.024	0.000	16.300		0.057	0.001	15.690	
9/17/2019 19:40	0.00	0.075	0.001	16.455		0.023	0.000	16.262		0.057	0.001	15.635	
9/17/2019 19:45	0.00	0.073	0.001	16.417		0.022	0.000	16.224		0.057	0.001	15.584	

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Date & Time[1]	UW ATG Rainfall (in)	Station 520-E Level (ft)	Station 520-E Flow Rate (cfs)	Station 520-E Temperature (°C)	Station 520-E Sample (SU)	Station 520-N Level (ft)	Station 520-N Flow Rate (cfs)	Station 520-N Temperature (°C)	Station 520-N Sample (SU)	Station 520-U Level (ft)	Station 520-U Flow Rate (cfs)	Station 520-U Temperature (°C)	Station 520-U Sample (SU)
9/17/2019 19:50	0.00	0.073	0.001	16.386		0.021	0.000	16.194		0.054	0.001	15.553	
9/17/2019 19:55	0.00	0.074	0.001	16.361		0.021	0.000	16.170		0.053	0.001	15.513	
9/17/2019 20:00	0.00	0.076	0.002	16.337		0.020	0.000	16.147		0.054	0.001	15.484	
9/17/2019 20:05	0.00	0.074	0.001	16.312		0.020	0.000	16.126		0.051	0.000	15.458	
9/17/2019 20:10	0.00	0.072	0.001	16.285		0.020	0.000	16.106		0.052	0.000	15.434	
9/17/2019 20:15	0.00	0.071	0.001	16.260		0.019	0.000	16.084		0.054	0.001	15.408	
9/17/2019 20:20	0.00	0.080	0.002	16.232		0.019	0.000	16.057		0.089	0.003	15.405	
9/17/2019 20:25	0.01	0.167	0.020	16.208		0.024	0.000	16.025		0.154	0.017	15.405	
9/17/2019 20:30	0.00	0.208	0.037	16.180	12	0.041	0.000	15.996		0.155	0.017	15.379	
9/17/2019 20:32													17
9/17/2019 20:35	0.01	0.182	0.025	16.140		0.049	0.001	15.970		0.141	0.013	15.355	
9/17/2019 20:40	0.00	0.153	0.015	16.102		0.047	0.001	15.950		0.135	0.012	15.310	
9/17/2019 20:44									11				
9/17/2019 20:45	0.00	0.142	0.012	16.072		0.047	0.001	15.930		0.133	0.011	15.281	
9/17/2019 20:50	0.00	0.142	0.012	16.053		0.046	0.001	15.915		0.131	0.011	15.248	
9/17/2019 20:55	0.00	0.144	0.013	16.035		0.046	0.001	15.906		0.129	0.010	15.206	
9/17/2019 21:00	0.01	0.148	0.014	16.018		0.045	0.001	15.893		0.125	0.009	15.165	
9/17/2019 21:05	0.00	0.143	0.012	16.003		0.043	0.001	15.878		0.121	0.008	15.131	
9/17/2019 21:10	0.00	0.132	0.010	15.990		0.040	0.000	15.863		0.118	0.008	15.104	
9/17/2019 21:15	0.00	0.126	0.008	15.983		0.038	0.000	15.850		0.113	0.007	15.078	
9/17/2019 21:20	0.00	0.115	0.006	15.986		0.036	0.000	15.838		0.109	0.006	15.051	
9/17/2019 21:25	0.00	0.112	0.006	15.980		0.035	0.000	15.827		0.106	0.006	15.026	
9/17/2019 21:30	0.00	0.113	0.006	15.968		0.035	0.000	15.812		0.107	0.006	15.004	
9/17/2019 21:35	0.00	0.115	0.006	15.951		0.034	0.000	15.795		0.110	0.006	14.985	
9/17/2019 21:38					13								
9/17/2019 21:39													18
9/17/2019 21:40	0.00	0.125	0.008	15.928		0.033	0.000	15.779		0.116	0.007	14.969	
9/17/2019 21:45	0.00	0.133	0.010	15.899		0.034	0.000	15.756		0.126	0.010	14.958	
9/17/2019 21:50	0.00	0.132	0.010	15.873		0.037	0.000	15.730		0.129	0.010	14.950	
9/17/2019 21:55	0.00	0.132	0.010	15.847		0.038	0.000	15.709		0.128	0.010	14.936	
9/17/2019 22:00	0.00	0.125	0.008	15.821		0.038	0.000	15.692		0.132	0.011	14.921	
9/17/2019 22:05	0.00	0.121	0.007	15.799		0.037	0.000	15.681		0.134	0.011	14.904	
9/17/2019 22:10	0.00	0.122	0.008	15.779		0.036	0.000	15.672		0.129	0.010	14.879	
9/17/2019 22:15	0.00	0.112	0.006	15.757		0.035	0.000	15.664		0.125	0.009	14.852	

Mobilization Event 24 | 09/17/2019

Storm Event #24 Monitoring Data

Date & Time[1]	UW ATG Rainfall (in)	Station 520-E Level (ft)	Station 520-E Flow Rate (cfs)	Station 520-E Temperature (°C)	Station 520-E Sample (SU)	Station 520-N Level (ft)	Station 520-N Flow Rate (cfs)	Station 520-N Temperature (°C)	Station 520-N Sample (SU)	Station 520-U Level (ft)	Station 520-U Flow Rate (cfs)	Station 520-U Temperature (°C)	Station 520-U Sample (SU)
9/17/2019 22:20	0.00	0.105	0.005	15.748		0.034	0.000	15.660		0.120	0.008	14.832	
9/17/2019 22:25	0.00	0.103	0.004	15.749		0.034	0.000	15.663		0.115	0.007	14.815	
9/17/2019 22:30	0.00	0.101	0.004	15.754		0.034	0.000	15.667		0.111	0.007	14.797	
9/17/2019 22:35	0.00	0.097	0.004	15.760		0.035	0.000	15.667		0.108	0.006	14.781	
9/17/2019 22:40	0.00	0.097	0.004	15.759		0.035	0.000	15.660		0.105	0.005	14.770	
9/17/2019 22:43									12				
9/17/2019 22:45	0.00	0.096	0.004	15.753		0.034	0.000	15.654		0.101	0.005	14.757	
9/17/2019 22:46													19
9/17/2019 22:50	0.00	0.094	0.003	15.744		0.032	0.000	15.643		0.096	0.004	14.740	

Notes:

[1] All times are as recorded by automatic datalogger and transmitted to the sampling lead's computer via telemetry and do not exactly match times on field notes or chain of custody (COC) forms.

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Mobilization Event 25 | 10/16/2019

January 15, 2020

Storm Summary Report

Re: October 16, 2019, Storm Event

Project No. 160418

Introduction

This Storm Summary Report summarizes the storm sampling event that began on October 16, 2019, and includes a summary and documentation of all sampling-related activities. The October 16, 2019, event is the twenty-fifth storm sample event for the SR-520 Bridge AKART Stormwater Monitoring Project.

Storm Validation Summary

The event began on October 16, 2019, at 5:00 after an antecedent dry period exceeding 6 hours. The event ended October 17, 2019, at 00:00. The total measured rainfall for the event was 0.36 inches over a period of 19.00 hours. All three stations were targeted for sampling and enabled on the rising limb of the storm hydrograph. All three stations met the sample validation criteria for sample volume, minimum number of aliquots, and percent coverage of the storm runoff (see Table 1). All samples were submitted to the laboratory within the 24-hour hold time. The water temperature was at least 11.8 degrees Celsius (C) at the time of collection, and the samples were iced and at or below 2.5 degrees C when they were submitted to the lab.

An unforecasted intra-event dry period occurred during the sample event. An initial rainfall depth of 0.20 inches in the first 11.75 hours was followed by a 35-minute period during which the 6-hour rainfall total was less than the end-of-storm criteria of 0.04 inches. The intra-event dry period was then followed by an additional 0.16 inches of rain for a total event depth of 0.36 inches. Per previous discussions with Parametrix and WSDOT staff, the samples were submitted to the lab.

Hydrographs

The attached hydrographs show the water level and flow rate in each weir along with markers for each sample aliquot and 5-minute rain data.

Storm Tracking

The Go-No-Go field sheet documents the weather forecasts and the decision to target prior to the October 16, 2019, event (Attachment A). The printout from the National Weather Forecast shows the latest forecast roughly 22 hours prior to the beginning of the rainfall (Attachment B).

Storm Field Sheets

The field sheets document the field and storm control procedures for the event (Attachment C and D). The field sheets also include the Chain-of-Custody (COC) forms (Attachment E).

Attachments

Table 1. Storm Validation Summary	*(Included with Quarterly Report attachment)*
520E_101619 Hydrograph	*(Included with Quarterly Report attachment)*
520N_101619 Hydrograph	*(Included with Quarterly Report attachment)*
520U_101619 Hydrograph	*(Included with Quarterly Report attachment)*
Attachment A. Storm Tracking Sheet Go-No-Go Sheets	*(On file)*
Attachment B. National Weather Service Forecast Sheet	*(On file)*
Attachment C. Storm Control Sheets	*(On file)*
Attachment D. Field Sheets	*(On file)*
Attachment E. Chain of Custody	*(On file)*

V:\160418 SR-520 Bridge Stormwater Monitoring\Deliverables\Storm Summaries 2019\25_101619\Storm 25 Summary Report 101619_20200115.docx

Table 1. Storm Validation Summary

Mobilization Event 25 | 10/16/2019

Project No. 160418

SR-520 Floating Bridge Stormwater Monitoring Storm and Sample Validation Checklist

Storm Date	**October 16, 2019**	
Storm Event Number	**25**	
Criterion	**Y / N**	**Value**
Rainfall Depth ≥ 0.15	Y	0.36
Rainfall Duration > 1 hr	Y	19
Antecedent Rainfall < 0.04" in 6 hrs	Y	0

Notes:

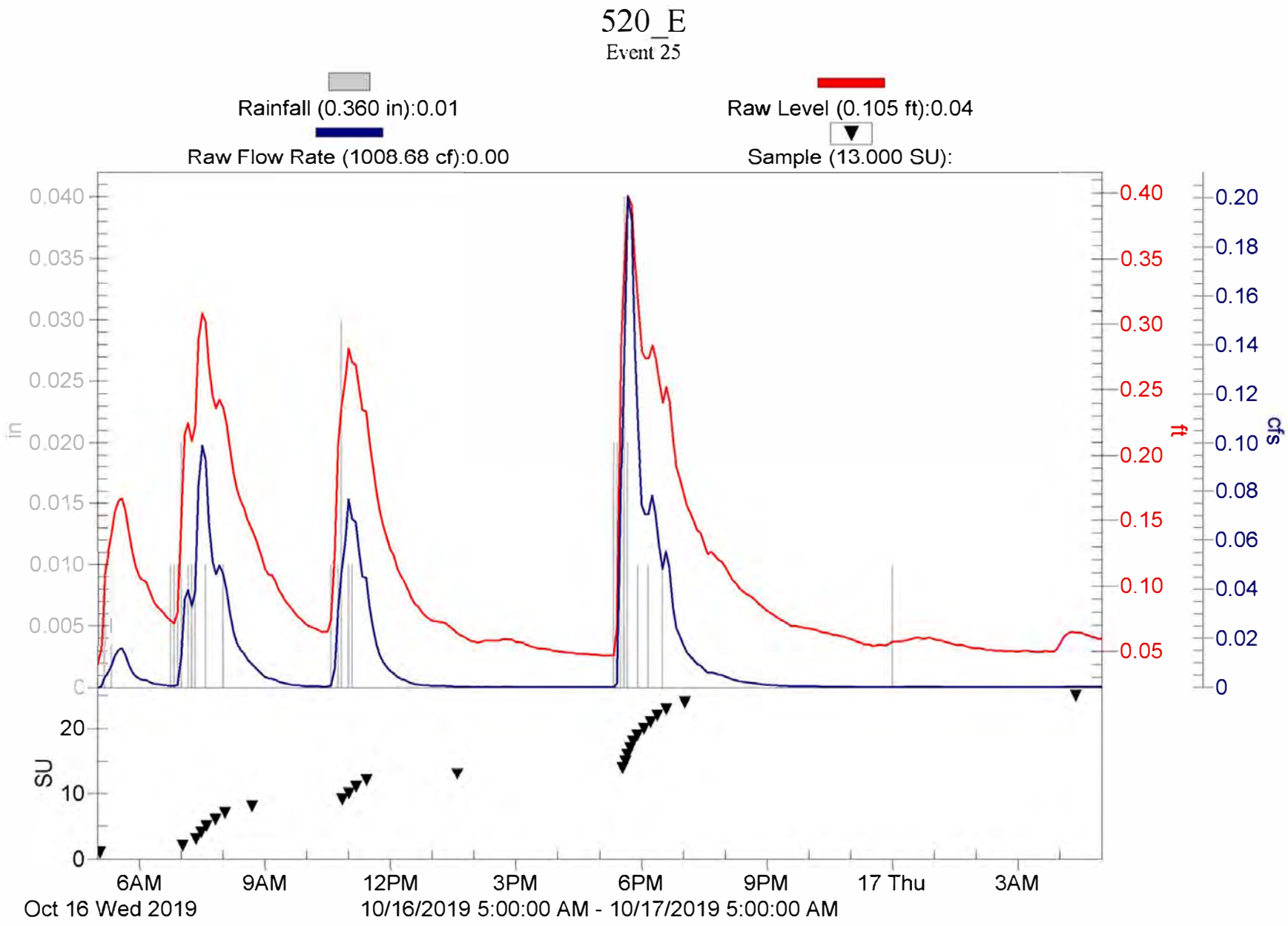
	Station					
	520-E		**520-N**		**520-U**	
Criterion	**Y / N**	**Value**	**Y / N**	**Value**	**Y / N**	**Value**
Aliquots ≥ 10	Y	25	Y	18	Y	32
Sample Volume ≥ 1 liter	Y	~2	Y	~2	Y	~3
Does Sample cover more than 75% of hydrograph?	Y	100.0%	Y	100.0%	Y	100.0%
Sample Valid Y / N?	Y		Y		Y	

Notes:

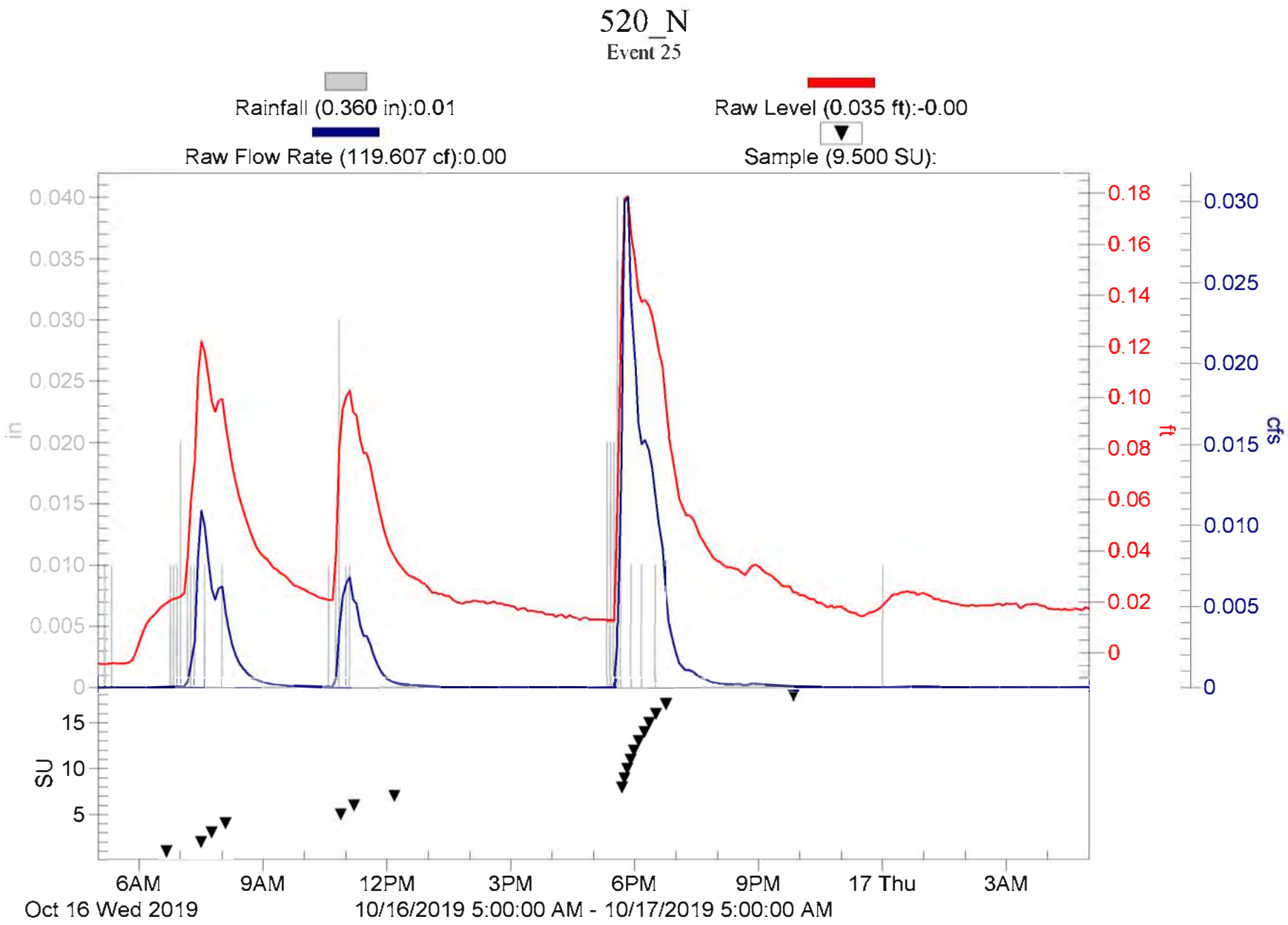
Storm Summary Description

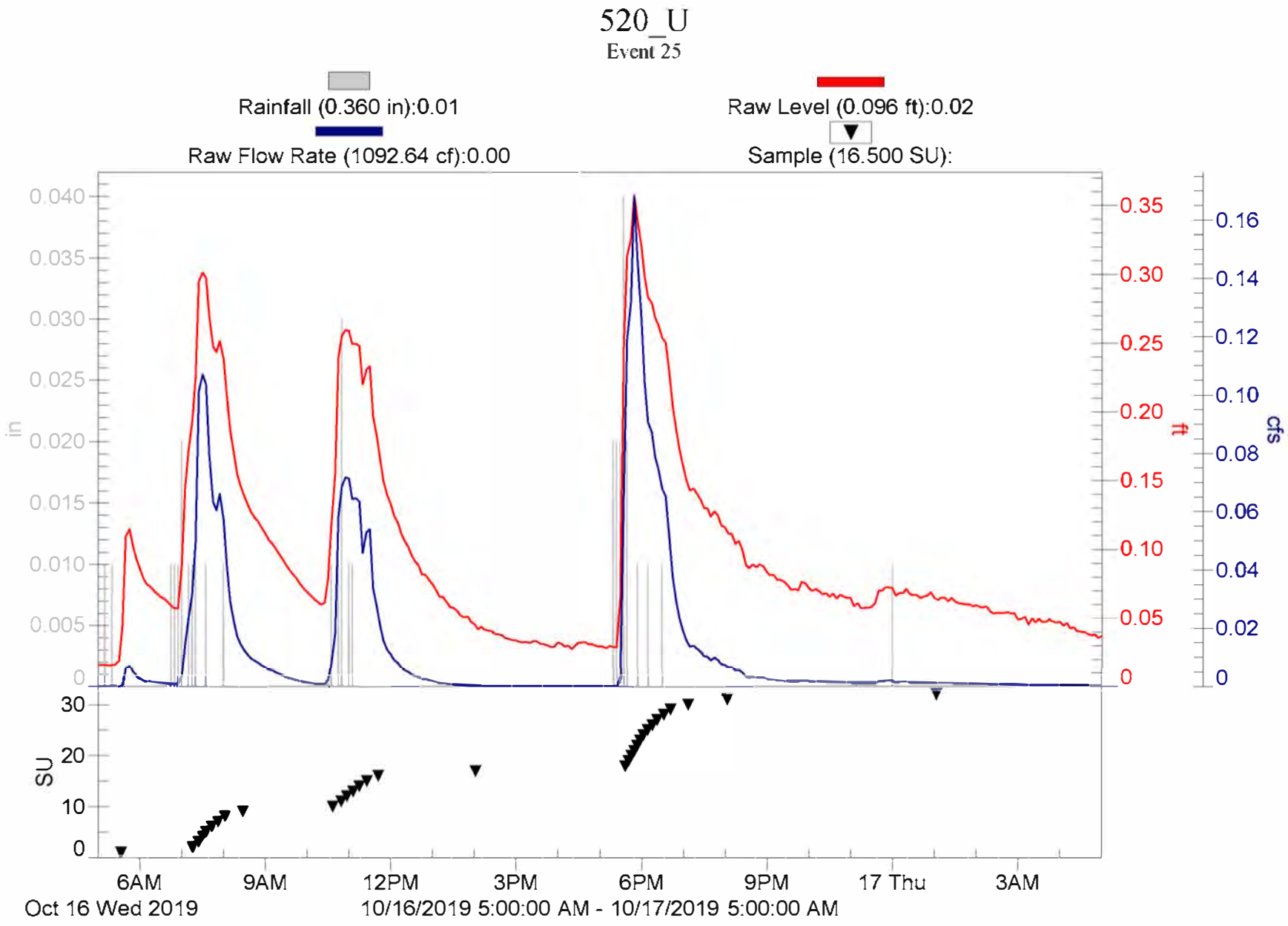
Initial rainfall of 0.20 inches, followed by a 35-minute period with a 6-hour rainfall intensity of <0.04 in/hr.and then 0.16 inches. Total rainfall of 0.36 inches over 19 hours. All samples were successful.

Mobilization Event 25 | 10/16/2019



Mobilization Event 25 | 10/16/2019




520_U
Event 25
Rainfall (0.360 in):0.01
Raw Level (0.096 ft):0.02
Raw Flow Rate (1092.64 cf):0.00
Sample (16.500 SU):
in
ft
cfs
SU
0.040
0.035
0.030
0.025
0.020
0.015
0.010
0.005
0
0.35
0.30
0.25
0.20
0.15
0.10
0.05
0
0.16
0.14
0.12
0.10
0.08
0.06
0.04
0.02
0
30
20
10
0
6AM
9AM
12PM
3PM
6PM
9PM
17 Thu
3AM
Oct 16 Wed 2019
10/16/2019 5:00:00 AM - 10/17/2019 5:00:00 AM

Storm Event #25 Monitoring Data

Date & Time[1]	UW ATG Rainfall (in)	Station 520-E Level (ft)	Station 520-E Flow Rate (cfs)	Station 520-E Temperature (°C)	Station 520-E Sample (SU)	Station 520-N Level (ft)	Station 520-N Flow Rate (cfs)	Station 520-N Temperature (°C)	Station 520-N Sample (SU)	Station 520-U Level (ft)	Station 520-U Flow Rate (cfs)	Station 520-U Temperature (°C)	Station 520-U Sample (SU)
10/16/2019 04:55	0.00	0.035	0.000	13.538		-0.005	0.000	13.765		0.016	0.000	13.310	
10/16/2019 05:00	0.01	0.036	0.000	13.511		-0.004	0.000	13.737		0.016	0.000	13.306	
10/16/2019 05:04					1								
10/16/2019 05:05	0.00	0.047	0.000	13.482		-0.004	0.000	13.708		0.016	0.000	13.301	
10/16/2019 05:10	0.01	0.104	0.005	13.452		-0.004	0.000	13.675		0.016	0.000	13.289	
10/16/2019 05:15	0.00	0.121	0.008	13.417		-0.004	0.000	13.639		0.015	0.000	13.271	
10/16/2019 05:20	0.01	0.135	0.010	13.380		-0.004	0.000	13.597		0.016	0.000	13.251	
10/16/2019 05:25	0.00	0.152	0.015	13.344		-0.004	0.000	13.547		0.016	0.000	13.228	
10/16/2019 05:30	0.00	0.160	0.017	13.323		-0.004	0.000	13.506		0.019	0.000	13.199	
10/16/2019 05:33													1
10/16/2019 05:35	0.00	0.162	0.018	13.308		-0.004	0.000	13.467		0.044	0.001	13.159	
10/16/2019 05:40	0.00	0.153	0.015	13.295		-0.004	0.000	13.434		0.109	0.006	13.093	
10/16/2019 05:45	0.00	0.135	0.010	13.283		-0.004	0.000	13.407		0.114	0.007	13.044	
10/16/2019 05:50	0.00	0.121	0.007	13.277		-0.003	0.000	13.378		0.103	0.005	13.001	
10/16/2019 05:55	0.00	0.110	0.005	13.269		0.000	0.000	13.342		0.094	0.004	12.958	
10/16/2019 06:00	0.00	0.102	0.004	13.259		0.004	0.000	13.307		0.086	0.003	12.920	
10/16/2019 06:05	0.00	0.100	0.004	13.246		0.008	0.000	13.279		0.079	0.002	12.888	
10/16/2019 06:10	0.00	0.098	0.004	13.236		0.011	0.000	13.261		0.075	0.002	12.864	
10/16/2019 06:15	0.00	0.091	0.003	13.228		0.013	0.000	13.251		0.073	0.002	12.842	
10/16/2019 06:20	0.00	0.084	0.002	13.209		0.015	0.000	13.248		0.070	0.001	12.812	
10/16/2019 06:25	0.00	0.080	0.002	13.184		0.016	0.000	13.241		0.068	0.001	12.784	
10/16/2019 06:30	0.00	0.077	0.002	13.164		0.018	0.000	13.225		0.065	0.001	12.759	
10/16/2019 06:35	0.00	0.074	0.001	13.126		0.019	0.000	13.207		0.064	0.001	12.740	
10/16/2019 06:40	0.00	0.071	0.001	13.082		0.020	0.000	13.193	1	0.062	0.001	12.735	
10/16/2019 06:45	0.01	0.069	0.001	13.046		0.021	0.000	13.169		0.059	0.001	12.736	
10/16/2019 06:50	0.01	0.067	0.001	13.013		0.021	0.000	13.144		0.057	0.001	12.728	
10/16/2019 06:55	0.01	0.075	0.001	12.983		0.022	0.000	13.128		0.057	0.001	12.727	
10/16/2019 07:00	0.02	0.147	0.013	12.961		0.022	0.000	13.118		0.089	0.004	12.724	
10/16/2019 07:02					2								
10/16/2019 07:05	0.00	0.211	0.039	12.936		0.024	0.000	13.103		0.145	0.014	12.715	
10/16/2019 07:10	0.01	0.220	0.043	12.915		0.037	0.000	13.077		0.171	0.023	12.697	
10/16/2019 07:15	0.01	0.206	0.036	12.901		0.059	0.001	13.045		0.193	0.032	12.666	
10/16/2019 07:16													2
10/16/2019 07:20	0.01	0.218	0.042	12.884		0.075	0.003	13.011		0.224	0.049	12.625	

Storm Event #25 Monitoring Data

Date & Time[1]	UW ATG Rainfall (in)	Station 520-E Level (ft)	Station 520-E Flow Rate (cfs)	Station 520-E Temperature (°C)	Station 520-E Sample (SU)	Station 520-N Level (ft)	Station 520-N Flow Rate (cfs)	Station 520-N Temperature (°C)	Station 520-N Sample (SU)	Station 520-U Level (ft)	Station 520-U Flow Rate (cfs)	Station 520-U Temperature (°C)	Station 520-U Sample (SU)
10/16/2019 07:21					3								
10/16/2019 07:24													3
10/16/2019 07:25	0.00	0.284	0.087	12.861		0.109	0.008	12.976		0.295	0.101	12.569	
10/16/2019 07:29					4								
10/16/2019 07:30	0.00	0.303	0.104	12.833		0.122	0.011	12.925	2	0.301	0.107	12.495	4
10/16/2019 07:35	0.01	0.297	0.098	12.795		0.118	0.010	12.870		0.298	0.104	12.423	5
10/16/2019 07:36					5								
10/16/2019 07:40	0.00	0.263	0.071	12.760		0.108	0.008	12.807		0.269	0.079	12.350	
10/16/2019 07:43													6
10/16/2019 07:45	0.00	0.240	0.055	12.716		0.098	0.006	12.735	3	0.248	0.063	12.279	
10/16/2019 07:49					6								
10/16/2019 07:50	0.00	0.231	0.050	12.668		0.095	0.005	12.666		0.243	0.061	12.210	
10/16/2019 07:52													7
10/16/2019 07:55	0.00	0.238	0.054	12.626		0.099	0.006	12.600		0.252	0.066	12.145	
10/16/2019 08:00	0.01	0.232	0.050	12.586		0.099	0.006	12.534		0.239	0.057	12.076	
10/16/2019 08:02													8
10/16/2019 08:03					7								
10/16/2019 08:05	0.00	0.220	0.043	12.538		0.089	0.005	12.468	4	0.212	0.042	12.006	
10/16/2019 08:10	0.00	0.201	0.034	12.489		0.081	0.004	12.398		0.187	0.029	11.939	
10/16/2019 08:15	0.00	0.181	0.025	12.438		0.073	0.003	12.337		0.169	0.022	11.886	
10/16/2019 08:20	0.00	0.168	0.020	12.381		0.066	0.002	12.290		0.154	0.017	11.843	
10/16/2019 08:25	0.00	0.161	0.018	12.334		0.061	0.002	12.251		0.146	0.015	11.810	
10/16/2019 08:28													9
10/16/2019 08:30	0.00	0.154	0.016	12.296		0.056	0.001	12.223		0.138	0.012	11.791	
10/16/2019 08:35	0.00	0.145	0.013	12.265		0.052	0.001	12.201		0.132	0.011	11.785	
10/16/2019 08:40	0.00	0.140	0.012	12.244		0.048	0.001	12.196		0.127	0.010	11.783	
10/16/2019 08:42					8								
10/16/2019 08:45	0.00	0.133	0.010	12.232		0.044	0.001	12.198		0.123	0.009	11.779	
10/16/2019 08:50	0.00	0.126	0.008	12.233		0.041	0.000	12.206		0.120	0.008	11.780	
10/16/2019 08:55	0.00	0.117	0.007	12.241		0.039	0.000	12.221		0.115	0.007	11.797	
10/16/2019 09:00	0.00	0.108	0.005	12.251		0.038	0.000	12.244		0.112	0.007	11.825	
10/16/2019 09:05	0.00	0.104	0.005	12.257		0.037	0.000	12.264		0.107	0.006	11.864	
10/16/2019 09:10	0.00	0.103	0.004	12.266		0.035	0.000	12.280		0.104	0.005	11.900	
10/16/2019 09:15	0.00	0.098	0.004	12.288		0.033	0.000	12.292		0.101	0.005	11.934	

Storm Event #25 Monitoring Data

Date & Time[1]	UW ATG Rainfall (in)	Station 520-E Level (ft)	Station 520-E Flow Rate (cfs)	Station 520-E Temperature (°C)	Station 520-E Sample (SU)	Station 520-N Level (ft)	Station 520-N Flow Rate (cfs)	Station 520-N Temperature (°C)	Station 520-N Sample (SU)	Station 520-U Level (ft)	Station 520-U Flow Rate (cfs)	Station 520-U Temperature (°C)	Station 520-U Sample (SU)
10/16/2019 09:20	0.00	0.092	0.003	12.312		0.032	0.000	12.306		0.097	0.004	11.967	
10/16/2019 09:25	0.00	0.087	0.003	12.335		0.031	0.000	12.322		0.093	0.004	12.000	
10/16/2019 09:30	0.00	0.083	0.002	12.361		0.031	0.000	12.340		0.089	0.003	12.036	
10/16/2019 09:35	0.00	0.080	0.002	12.389		0.029	0.000	12.364		0.085	0.003	12.074	
10/16/2019 09:40	0.00	0.076	0.002	12.415		0.027	0.000	12.397		0.082	0.002	12.114	
10/16/2019 09:45	0.00	0.073	0.001	12.435		0.027	0.000	12.429		0.079	0.002	12.160	
10/16/2019 09:50	0.00	0.070	0.001	12.453		0.026	0.000	12.462		0.075	0.002	12.206	
10/16/2019 09:55	0.00	0.068	0.001	12.472		0.025	0.000	12.495		0.072	0.002	12.256	
10/16/2019 10:00	0.00	0.065	0.001	12.494		0.025	0.000	12.529		0.069	0.001	12.319	
10/16/2019 10:05	0.00	0.064	0.001	12.513		0.024	0.000	12.572		0.067	0.001	12.387	
10/16/2019 10:10	0.00	0.063	0.001	12.529		0.023	0.000	12.620		0.064	0.001	12.452	
10/16/2019 10:15	0.00	0.062	0.001	12.538		0.023	0.000	12.663		0.062	0.001	12.506	
10/16/2019 10:20	0.00	0.060	0.001	12.544		0.022	0.000	12.692		0.060	0.001	12.531	
10/16/2019 10:25	0.00	0.060	0.001	12.548		0.021	0.000	12.700		0.061	0.001	12.533	
10/16/2019 10:30	0.00	0.060	0.001	12.550		0.021	0.000	12.701		0.079	0.002	12.527	
10/16/2019 10:35	0.01	0.069	0.001	12.554		0.021	0.000	12.697		0.117	0.008	12.514	
10/16/2019 10:37													10
10/16/2019 10:40	0.00	0.121	0.007	12.552		0.021	0.000	12.693		0.154	0.018	12.498	
10/16/2019 10:45	0.01	0.203	0.035	12.546		0.038	0.001	12.686		0.240	0.059	12.456	
10/16/2019 10:49													11
10/16/2019 10:50	0.03	0.232	0.050	12.546		0.080	0.004	12.658		0.255	0.069	12.406	
10/16/2019 10:51					9								
10/16/2019 10:53									5				
10/16/2019 10:55	0.00	0.252	0.063	12.540		0.096	0.006	12.625		0.259	0.072	12.361	
10/16/2019 10:57													12
10/16/2019 11:00	0.01	0.277	0.081	12.525		0.101	0.006	12.588		0.259	0.071	12.314	
10/16/2019 11:01					10								
10/16/2019 11:05	0.01	0.266	0.073	12.511		0.103	0.007	12.553		0.249	0.064	12.271	
10/16/2019 11:06													13
10/16/2019 11:10	0.00	0.264	0.071	12.498		0.095	0.005	12.512		0.250	0.065	12.225	
10/16/2019 11:11					11								
10/16/2019 11:12									6				
10/16/2019 11:15	0.00	0.247	0.059	12.481		0.093	0.005	12.465		0.248	0.064	12.189	14
10/16/2019 11:20	0.00	0.230	0.049	12.460		0.084	0.004	12.423		0.220	0.046	12.163	

Storm Event #25 Monitoring Data

Date & Time[1]	UW ATG Rainfall (in)	Station 520-E Level (ft)	Station 520-E Flow Rate (cfs)	Station 520-E Temperature (°C)	Station 520-E Sample (SU)	Station 520-N Level (ft)	Station 520-N Flow Rate (cfs)	Station 520-N Temperature (°C)	Station 520-N Sample (SU)	Station 520-U Level (ft)	Station 520-U Flow Rate (cfs)	Station 520-U Temperature (°C)	Station 520-U Sample (SU)
10/16/2019 11:25	0.00	0.229	0.048	12.441		0.078	0.003	12.396		0.231	0.053	12.154	
10/16/2019 11:26					12								15
10/16/2019 11:30	0.00	0.206	0.036	12.438		0.078	0.003	12.395		0.233	0.054	12.178	
10/16/2019 11:35	0.00	0.187	0.027	12.458		0.074	0.003	12.413		0.197	0.034	12.221	
10/16/2019 11:40	0.00	0.166	0.019	12.498		0.066	0.002	12.447		0.182	0.027	12.282	
10/16/2019 11:42													16
10/16/2019 11:45	0.00	0.151	0.015	12.549		0.060	0.001	12.481		0.165	0.021	12.365	
10/16/2019 11:50	0.00	0.140	0.012	12.598		0.053	0.001	12.517		0.149	0.016	12.473	
10/16/2019 11:55	0.00	0.131	0.009	12.648		0.048	0.001	12.555		0.139	0.013	12.601	
10/16/2019 12:00	0.00	0.123	0.008	12.695		0.043	0.001	12.595		0.133	0.011	12.737	
10/16/2019 12:05	0.00	0.118	0.007	12.740		0.040	0.000	12.639		0.125	0.009	12.859	
10/16/2019 12:10	0.00	0.108	0.005	12.785		0.038	0.000	12.687		0.119	0.008	12.966	
10/16/2019 12:11									7				
10/16/2019 12:15	0.00	0.103	0.004	12.828		0.035	0.000	12.733		0.112	0.007	13.052	
10/16/2019 12:20	0.00	0.098	0.004	12.872		0.034	0.000	12.781		0.106	0.006	13.133	
10/16/2019 12:25	0.00	0.092	0.003	12.926		0.032	0.000	12.831		0.102	0.005	13.209	
10/16/2019 12:30	0.00	0.086	0.002	12.988		0.030	0.000	12.876		0.096	0.004	13.271	
10/16/2019 12:35	0.00	0.081	0.002	13.057		0.030	0.000	12.928		0.092	0.004	13.323	
10/16/2019 12:40	0.00	0.079	0.002	13.137		0.029	0.000	13.003		0.088	0.003	13.369	
10/16/2019 12:45	0.00	0.075	0.001	13.224		0.029	0.000	13.091		0.082	0.002	13.415	
10/16/2019 12:50	0.00	0.072	0.001	13.312		0.028	0.000	13.186		0.082	0.003	13.486	
10/16/2019 12:55	0.00	0.070	0.001	13.397		0.027	0.000	13.274		0.078	0.002	13.580	
10/16/2019 13:00	0.00	0.068	0.001	13.480		0.025	0.000	13.343		0.075	0.002	13.644	
10/16/2019 13:05	0.00	0.067	0.001	13.548		0.023	0.000	13.393		0.070	0.002	13.694	
10/16/2019 13:10	0.00	0.067	0.001	13.611		0.024	0.000	13.442		0.065	0.001	13.725	
10/16/2019 13:15	0.00	0.067	0.001	13.670		0.023	0.000	13.492		0.065	0.001	13.741	
10/16/2019 13:20	0.00	0.066	0.001	13.727		0.023	0.000	13.540		0.062	0.001	13.769	
10/16/2019 13:25	0.00	0.064	0.001	13.787		0.022	0.000	13.592		0.058	0.001	13.823	
10/16/2019 13:30	0.00	0.061	0.001	13.856		0.022	0.000	13.658		0.057	0.001	13.894	
10/16/2019 13:35	0.00	0.059	0.001	13.927		0.021	0.000	13.727		0.055	0.001	13.956	
10/16/2019 13:36					13								
10/16/2019 13:40	0.00	0.057	0.000	13.994		0.020	0.000	13.783		0.052	0.000	14.006	
10/16/2019 13:45	0.00	0.056	0.000	14.059		0.019	0.000	13.814		0.051	0.000	14.045	
10/16/2019 13:50	0.00	0.054	0.000	14.120		0.019	0.000	13.834		0.051	0.000	14.078	

Storm Event #25 Monitoring Data

Date & Time[1]	UW ATG Rainfall (in)	Station 520-E Level (ft)	Station 520-E Flow Rate (cfs)	Station 520-E Temperature (°C)	Station 520-E Sample (SU)	Station 520-N Level (ft)	Station 520-N Flow Rate (cfs)	Station 520-N Temperature (°C)	Station 520-N Sample (SU)	Station 520-U Level (ft)	Station 520-U Flow Rate (cfs)	Station 520-U Temperature (°C)	Station 520-U Sample (SU)
10/16/2019 13:55	0.00	0.053	0.000	14.165		0.020	0.000	13.852		0.047	0.000	14.115	
10/16/2019 14:00	0.00	0.052	0.000	14.197		0.020	0.000	13.864		0.046	0.000	14.159	
10/16/2019 14:02													17
10/16/2019 14:05	0.00	0.051	0.000	14.228		0.021	0.000	13.879		0.042	0.000	14.201	
10/16/2019 14:10	0.00	0.052	0.000	14.253		0.020	0.000	13.897		0.044	0.000	14.238	
10/16/2019 14:15	0.00	0.053	0.000	14.273		0.020	0.000	13.908		0.042	0.000	14.262	
10/16/2019 14:20	0.00	0.053	0.000	14.291		0.020	0.000	13.916		0.041	0.000	14.285	
10/16/2019 14:25	0.00	0.053	0.000	14.306		0.019	0.000	13.921		0.040	0.000	14.305	
10/16/2019 14:30	0.00	0.053	0.000	14.318		0.019	0.000	13.924		0.038	0.000	14.318	
10/16/2019 14:35	0.00	0.053	0.000	14.329		0.020	0.000	13.920		0.038	0.000	14.332	
10/16/2019 14:40	0.00	0.054	0.000	14.336		0.019	0.000	13.919		0.037	0.000	14.351	
10/16/2019 14:45	0.00	0.054	0.000	14.341		0.019	0.000	13.915		0.035	0.000	14.364	
10/16/2019 14:50	0.00	0.054	0.000	14.343		0.019	0.000	13.911		0.034	0.000	14.373	
10/16/2019 14:55	0.00	0.053	0.000	14.340		0.019	0.000	13.905		0.034	0.000	14.376	
10/16/2019 15:00	0.00	0.052	0.000	14.341		0.018	0.000	13.899		0.033	0.000	14.379	
10/16/2019 15:05	0.00	0.051	0.000	14.349		0.018	0.000	13.898		0.032	0.000	14.389	
10/16/2019 15:10	0.00	0.051	0.000	14.363		0.017	0.000	13.903		0.032	0.000	14.414	
10/16/2019 15:15	0.00	0.050	0.000	14.379		0.017	0.000	13.916		0.032	0.000	14.454	
10/16/2019 15:20	0.00	0.049	0.000	14.393		0.017	0.000	13.936		0.032	0.000	14.494	
10/16/2019 15:25	0.00	0.048	0.000	14.406		0.016	0.000	13.954		0.033	0.000	14.530	
10/16/2019 15:30	0.00	0.047	0.000	14.418		0.016	0.000	13.980		0.033	0.000	14.568	
10/16/2019 15:35	0.00	0.047	0.000	14.433		0.016	0.000	14.006		0.031	0.000	14.605	
10/16/2019 15:40	0.00	0.047	0.000	14.456		0.016	0.000	14.022		0.031	0.000	14.644	
10/16/2019 15:45	0.00	0.046	0.000	14.485		0.016	0.000	14.039		0.030	0.000	14.678	
10/16/2019 15:50	0.00	0.046	0.000	14.515		0.015	0.000	14.059		0.028	0.000	14.706	
10/16/2019 15:55	0.00	0.045	0.000	14.545		0.015	0.000	14.087		0.029	0.000	14.719	
10/16/2019 16:00	0.00	0.045	0.000	14.573		0.015	0.000	14.112		0.032	0.000	14.727	
10/16/2019 16:05	0.00	0.044	0.000	14.598		0.014	0.000	14.131		0.031	0.000	14.730	
10/16/2019 16:10	0.00	0.044	0.000	14.621		0.015	0.000	14.144		0.029	0.000	14.738	
10/16/2019 16:15	0.00	0.043	0.000	14.640		0.015	0.000	14.152		0.029	0.000	14.747	
10/16/2019 16:20	0.00	0.044	0.000	14.658		0.014	0.000	14.164		0.027	0.000	14.767	
10/16/2019 16:25	0.00	0.043	0.000	14.674		0.015	0.000	14.190		0.030	0.000	14.794	
10/16/2019 16:30	0.00	0.043	0.000	14.690		0.014	0.000	14.217		0.032	0.000	14.824	
10/16/2019 16:35	0.00	0.043	0.000	14.706		0.014	0.000	14.233		0.032	0.000	14.841	

Storm Event #25 Monitoring Data

Date & Time[1]	UW ATG Rainfall (in)	Station 520-E Level (ft)	Station 520-E Flow Rate (cfs)	Station 520-E Temperature (°C)	Station 520-E Sample (SU)	Station 520-N Level (ft)	Station 520-N Flow Rate (cfs)	Station 520-N Temperature (°C)	Station 520-N Sample (SU)	Station 520-U Level (ft)	Station 520-U Flow Rate (cfs)	Station 520-U Temperature (°C)	Station 520-U Sample (SU)
10/16/2019 16:40	0.00	0.042	0.000	14.716		0.013	0.000	14.240		0.032	0.000	14.854	
10/16/2019 16:45	0.00	0.042	0.000	14.720		0.014	0.000	14.244		0.031	0.000	14.859	
10/16/2019 16:50	0.00	0.042	0.000	14.719		0.014	0.000	14.238		0.031	0.000	14.861	
10/16/2019 16:55	0.00	0.042	0.000	14.716		0.013	0.000	14.226		0.030	0.000	14.856	
10/16/2019 17:00	0.00	0.041	0.000	14.714		0.013	0.000	14.215		0.029	0.000	14.852	
10/16/2019 17:05	0.00	0.041	0.000	14.714		0.013	0.000	14.217		0.029	0.000	14.842	
10/16/2019 17:10	0.00	0.041	0.000	14.718		0.013	0.000	14.230		0.028	0.000	14.828	
10/16/2019 17:15	0.00	0.042	0.000	14.727		0.013	0.000	14.242		0.030	0.000	14.821	
10/16/2019 17:20	0.02	0.041	0.000	14.734		0.012	0.000	14.254		0.029	0.000	14.817	
10/16/2019 17:25	0.02	0.063	0.001	14.732		0.013	0.000	14.254		0.029	0.000	14.817	
10/16/2019 17:30	0.02	0.278	0.083	14.536		0.013	0.000	14.239		0.066	0.003	14.795	
10/16/2019 17:33					14								
10/16/2019 17:35	0.04	0.343	0.145	14.413		0.061	0.002	14.150		0.247	0.066	14.656	
10/16/2019 17:37					15								18
10/16/2019 17:40	0.02	0.392	0.207	14.357	16	0.130	0.013	14.008		0.314	0.119	14.481	
10/16/2019 17:42									8				19
10/16/2019 17:44					17								
10/16/2019 17:45	0.00	0.385	0.198	14.332		0.178	0.030	13.936	9	0.326	0.132	14.322	
10/16/2019 17:46													20
10/16/2019 17:48					18								
10/16/2019 17:49									10				
10/16/2019 17:50	0.00	0.341	0.143	14.320		0.179	0.030	13.942		0.357	0.168	14.162	21
10/16/2019 17:54					19				11				22
10/16/2019 17:55	0.01	0.309	0.110	14.299		0.163	0.024	13.967		0.339	0.146	14.043	
10/16/2019 17:58													23
10/16/2019 17:59									12				
10/16/2019 18:00	0.00	0.273	0.078	14.267		0.154	0.020	13.974		0.321	0.127	13.947	
10/16/2019 18:03													24
10/16/2019 18:04					20								
10/16/2019 18:05	0.00	0.268	0.074	14.232		0.142	0.016	13.986		0.298	0.104	13.864	
10/16/2019 18:06									13				
10/16/2019 18:09													25
10/16/2019 18:10	0.01	0.268	0.075	14.192		0.137	0.015	13.989		0.283	0.091	13.794	
10/16/2019 18:13					21								

Storm Event #25 Monitoring Data

Date & Time[1]	UW ATG Rainfall (in)	Station 520-E Level (ft)	Station 520-E Flow Rate (cfs)	Station 520-E Temperature (°C)	Station 520-E Sample (SU)	Station 520-N Level (ft)	Station 520-N Flow Rate (cfs)	Station 520-N Temperature (°C)	Station 520-N Sample (SU)	Station 520-U Level (ft)	Station 520-U Flow Rate (cfs)	Station 520-U Temperature (°C)	Station 520-U Sample (SU)
10/16/2019 18:14									14				
10/16/2019 18:15	0.00	0.278	0.082	14.151		0.138	0.015	13.995		0.279	0.088	13.741	
10/16/2019 18:16													26
10/16/2019 18:20	0.00	0.268	0.075	14.115		0.136	0.015	13.991		0.268	0.079	13.679	
10/16/2019 18:21									15				
10/16/2019 18:23					22								27
10/16/2019 18:25	0.00	0.251	0.062	14.076		0.132	0.014	13.983		0.263	0.075	13.609	
10/16/2019 18:30	0.01	0.235	0.052	14.042		0.125	0.012	13.979		0.254	0.068	13.553	
10/16/2019 18:31									16				
10/16/2019 18:32													28
10/16/2019 18:35	0.00	0.246	0.059	14.025		0.118	0.010	13.984		0.250	0.065	13.494	
10/16/2019 18:36					23								
10/16/2019 18:40	0.00	0.235	0.052	14.020		0.112	0.009	13.994		0.231	0.053	13.449	
10/16/2019 18:42													29
10/16/2019 18:45	0.00	0.204	0.035	14.021		0.097	0.006	14.008	17	0.204	0.038	13.434	
10/16/2019 18:50	0.00	0.184	0.026	14.027		0.085	0.004	14.022		0.188	0.030	13.431	
10/16/2019 18:55	0.00	0.176	0.023	14.036		0.077	0.003	14.036		0.173	0.024	13.435	
10/16/2019 19:00	0.00	0.165	0.019	14.043		0.068	0.002	14.056		0.160	0.019	13.444	
10/16/2019 19:02					24								
10/16/2019 19:05	0.00	0.155	0.016	14.047		0.060	0.002	14.072		0.150	0.016	13.459	
10/16/2019 19:07													30
10/16/2019 19:10	0.00	0.150	0.014	14.058		0.057	0.001	14.083		0.143	0.014	13.480	
10/16/2019 19:15	0.00	0.143	0.012	14.062		0.054	0.001	14.085		0.144	0.014	13.498	
10/16/2019 19:20	0.00	0.136	0.011	14.058		0.054	0.001	14.073		0.140	0.013	13.513	
10/16/2019 19:25	0.00	0.134	0.010	14.046		0.052	0.001	14.057		0.136	0.012	13.526	
10/16/2019 19:30	0.00	0.126	0.008	14.031		0.049	0.001	14.039		0.130	0.010	13.545	
10/16/2019 19:35	0.00	0.119	0.007	14.023		0.046	0.001	14.031		0.130	0.010	13.562	
10/16/2019 19:40	0.00	0.120	0.007	14.026		0.043	0.001	14.036		0.124	0.009	13.584	
10/16/2019 19:45	0.00	0.118	0.007	14.042		0.041	0.000	14.049		0.128	0.010	13.615	
10/16/2019 19:50	0.00	0.114	0.006	14.060		0.039	0.000	14.071		0.125	0.009	13.649	
10/16/2019 19:55	0.00	0.113	0.006	14.072		0.037	0.000	14.095		0.117	0.008	13.682	
10/16/2019 20:00	0.00	0.109	0.005	14.071		0.036	0.000	14.115		0.116	0.007	13.707	
10/16/2019 20:03													31
10/16/2019 20:05	0.00	0.104	0.005	14.063		0.036	0.000	14.124		0.111	0.007	13.725	

Storm Event #25 Monitoring Data

Date & Time[1]	UW ATG Rainfall (in)	Station 520-E Level (ft)	Station 520-E Flow Rate (cfs)	Station 520-E Temperature (°C)	Station 520-E Sample (SU)	Station 520-N Level (ft)	Station 520-N Flow Rate (cfs)	Station 520-N Temperature (°C)	Station 520-N Sample (SU)	Station 520-U Level (ft)	Station 520-U Flow Rate (cfs)	Station 520-U Temperature (°C)	Station 520-U Sample (SU)
10/16/2019 20:10	0.00	0.099	0.004	14.059		0.034	0.000	14.129		0.111	0.007	13.734	
10/16/2019 20:15	0.00	0.096	0.004	14.054		0.033	0.000	14.132		0.104	0.005	13.743	
10/16/2019 20:20	0.00	0.093	0.003	14.047		0.033	0.000	14.130		0.106	0.006	13.746	
10/16/2019 20:25	0.00	0.090	0.003	14.032		0.033	0.000	14.123		0.100	0.005	13.742	
10/16/2019 20:30	0.00	0.088	0.003	14.006		0.033	0.000	14.108		0.089	0.003	13.718	
10/16/2019 20:35	0.00	0.087	0.002	13.976		0.032	0.000	14.084		0.087	0.003	13.674	
10/16/2019 20:40	0.00	0.085	0.002	13.943		0.031	0.000	14.051		0.089	0.003	13.634	
10/16/2019 20:45	0.00	0.082	0.002	13.906		0.032	0.000	14.017		0.087	0.003	13.611	
10/16/2019 20:50	0.00	0.080	0.002	13.871		0.034	0.000	13.980		0.089	0.003	13.600	
10/16/2019 20:55	0.00	0.078	0.002	13.837		0.035	0.000	13.942		0.088	0.003	13.590	
10/16/2019 21:00	0.00	0.075	0.001	13.802		0.034	0.000	13.906		0.084	0.003	13.578	
10/16/2019 21:05	0.00	0.073	0.001	13.765		0.033	0.000	13.871		0.081	0.002	13.560	
10/16/2019 21:10	0.00	0.072	0.001	13.729		0.032	0.000	13.838		0.081	0.002	13.544	
10/16/2019 21:15	0.00	0.070	0.001	13.694		0.031	0.000	13.806		0.078	0.002	13.529	
10/16/2019 21:20	0.00	0.068	0.001	13.667		0.030	0.000	13.777		0.078	0.002	13.519	
10/16/2019 21:25	0.00	0.067	0.001	13.647		0.029	0.000	13.754		0.076	0.002	13.518	
10/16/2019 21:30	0.00	0.065	0.001	13.637		0.028	0.000	13.742		0.074	0.002	13.526	
10/16/2019 21:35	0.00	0.063	0.001	13.630		0.026	0.000	13.736		0.071	0.002	13.538	
10/16/2019 21:40	0.00	0.064	0.001	13.620		0.026	0.000	13.731		0.071	0.002	13.530	
10/16/2019 21:45	0.00	0.063	0.001	13.610		0.026	0.000	13.727		0.070	0.002	13.508	
10/16/2019 21:50	0.00	0.063	0.001	13.602		0.024	0.000	13.728		0.076	0.002	13.502	
10/16/2019 21:51									18				
10/16/2019 21:55	0.00	0.062	0.001	13.595		0.024	0.000	13.726		0.075	0.002	13.508	
10/16/2019 22:00	0.00	0.061	0.001	13.584		0.022	0.000	13.723		0.072	0.002	13.514	
10/16/2019 22:05	0.00	0.061	0.001	13.573		0.023	0.000	13.714		0.070	0.001	13.519	
10/16/2019 22:10	0.00	0.060	0.001	13.565		0.022	0.000	13.705		0.071	0.002	13.519	
10/16/2019 22:15	0.00	0.059	0.001	13.563		0.021	0.000	13.697		0.070	0.001	13.518	
10/16/2019 22:20	0.00	0.059	0.001	13.561		0.021	0.000	13.692		0.067	0.001	13.519	
10/16/2019 22:25	0.00	0.058	0.001	13.559		0.020	0.000	13.688		0.068	0.001	13.517	
10/16/2019 22:30	0.00	0.057	0.001	13.564		0.020	0.000	13.685		0.065	0.001	13.512	
10/16/2019 22:35	0.00	0.057	0.000	13.566		0.019	0.000	13.681		0.068	0.001	13.508	
10/16/2019 22:40	0.00	0.056	0.000	13.561		0.018	0.000	13.677		0.065	0.001	13.501	
10/16/2019 22:45	0.00	0.056	0.000	13.558		0.019	0.000	13.673		0.067	0.001	13.492	
10/16/2019 22:50	0.00	0.055	0.000	13.562		0.018	0.000	13.667		0.066	0.001	13.481	

Storm Event #25 Monitoring Data

Date & Time[1]	UW ATG Rainfall (in)	Station 520-E Level (ft)	Station 520-E Flow Rate (cfs)	Station 520-E Temperature (°C)	Station 520-E Sample (SU)	Station 520-N Level (ft)	Station 520-N Flow Rate (cfs)	Station 520-N Temperature (°C)	Station 520-N Sample (SU)	Station 520-U Level (ft)	Station 520-U Flow Rate (cfs)	Station 520-U Temperature (°C)	Station 520-U Sample (SU)
10/16/2019 22:55	0.00	0.054	0.000	13.567		0.018	0.000	13.661		0.065	0.001	13.464	
10/16/2019 23:00	0.00	0.053	0.000	13.571		0.018	0.000	13.649		0.065	0.001	13.443	
10/16/2019 23:05	0.00	0.052	0.000	13.568		0.017	0.000	13.633		0.059	0.001	13.421	
10/16/2019 23:10	0.00	0.051	0.000	13.558		0.016	0.000	13.615		0.061	0.001	13.403	
10/16/2019 23:15	0.00	0.050	0.000	13.547		0.016	0.000	13.599		0.057	0.001	13.385	
10/16/2019 23:20	0.00	0.049	0.000	13.534		0.016	0.000	13.581		0.058	0.001	13.344	
10/16/2019 23:25	0.00	0.049	0.000	13.514		0.015	0.000	13.557		0.058	0.001	13.267	
10/16/2019 23:30	0.00	0.048	0.000	13.495		0.014	0.000	13.530		0.058	0.001	13.170	
10/16/2019 23:35	0.00	0.048	0.000	13.482		0.015	0.000	13.502		0.061	0.001	13.088	
10/16/2019 23:40	0.00	0.049	0.000	13.470		0.016	0.000	13.481		0.070	0.002	13.050	
10/16/2019 23:45	0.00	0.048	0.000	13.459		0.016	0.000	13.464		0.070	0.002	13.042	
10/16/2019 23:50	0.00	0.048	0.000	13.444		0.017	0.000	13.448		0.072	0.002	13.037	
10/16/2019 23:55	0.00	0.050	0.000	13.425		0.018	0.000	13.432		0.072	0.002	13.041	
10/17/2019 00:00	0.01	0.051	0.000	13.406		0.019	0.000	13.417		0.072	0.002	13.049	
10/17/2019 00:05	0.00	0.051	0.000	13.385		0.020	0.000	13.404		0.067	0.001	13.055	
10/17/2019 00:10	0.00	0.051	0.000	13.363		0.022	0.000	13.388		0.069	0.001	13.044	
10/17/2019 00:15	0.00	0.052	0.000	13.341		0.023	0.000	13.364		0.068	0.001	13.001	
10/17/2019 00:20	0.00	0.052	0.000	13.311		0.023	0.000	13.335		0.071	0.002	12.921	
10/17/2019 00:25	0.00	0.053	0.000	13.277		0.024	0.000	13.303		0.068	0.001	12.865	
10/17/2019 00:30	0.00	0.054	0.000	13.246		0.024	0.000	13.271		0.067	0.001	12.836	
10/17/2019 00:35	0.00	0.054	0.000	13.219		0.024	0.000	13.246		0.067	0.001	12.824	
10/17/2019 00:40	0.00	0.054	0.000	13.194		0.024	0.000	13.227		0.065	0.001	12.829	
10/17/2019 00:45	0.00	0.053	0.000	13.165		0.024	0.000	13.210		0.066	0.001	12.838	
10/17/2019 00:50	0.00	0.054	0.000	13.129		0.023	0.000	13.194		0.066	0.001	12.839	
10/17/2019 00:55	0.00	0.054	0.000	13.097		0.023	0.000	13.181		0.069	0.001	12.842	
10/17/2019 01:00	0.00	0.053	0.000	13.066		0.023	0.000	13.170		0.065	0.001	12.853	
10/17/2019 01:03													32
10/17/2019 01:05	0.00	0.052	0.000	13.036		0.023	0.000	13.158		0.063	0.001	12.862	
10/17/2019 01:10	0.00	0.052	0.000	13.005		0.022	0.000	13.149		0.065	0.001	12.869	
10/17/2019 01:15	0.00	0.051	0.000	12.977		0.021	0.000	13.141		0.065	0.001	12.875	
10/17/2019 01:20	0.00	0.050	0.000	12.956		0.021	0.000	13.132		0.062	0.001	12.871	
10/17/2019 01:25	0.00	0.050	0.000	12.948		0.020	0.000	13.128		0.065	0.001	12.856	
10/17/2019 01:30	0.00	0.049	0.000	12.954		0.020	0.000	13.126		0.062	0.001	12.840	
10/17/2019 01:35	0.00	0.048	0.000	12.952		0.020	0.000	13.126		0.061	0.001	12.818	

Storm Event #25 Monitoring Data

Date & Time[1]	UW ATG Rainfall (in)	Station 520-E Level (ft)	Station 520-E Flow Rate (cfs)	Station 520-E Temperature (°C)	Station 520-E Sample (SU)	Station 520-N Level (ft)	Station 520-N Flow Rate (cfs)	Station 520-N Temperature (°C)	Station 520-N Sample (SU)	Station 520-U Level (ft)	Station 520-U Flow Rate (cfs)	Station 520-U Temperature (°C)	Station 520-U Sample (SU)
10/17/2019 01:40	0.00	0.048	0.000	12.947		0.019	0.000	13.130		0.061	0.001	12.791	
10/17/2019 01:45	0.00	0.048	0.000	12.952		0.019	0.000	13.123		0.060	0.001	12.753	
10/17/2019 01:50	0.00	0.046	0.000	12.962		0.019	0.000	13.106		0.060	0.001	12.717	
10/17/2019 01:55	0.00	0.046	0.000	12.969		0.019	0.000	13.086		0.058	0.001	12.693	
10/17/2019 02:00	0.00	0.046	0.000	12.974		0.018	0.000	13.078		0.060	0.001	12.680	
10/17/2019 02:05	0.00	0.046	0.000	12.987		0.018	0.000	13.077		0.058	0.001	12.671	
10/17/2019 02:10	0.00	0.046	0.000	12.994		0.019	0.000	13.075		0.058	0.001	12.657	
10/17/2019 02:15	0.00	0.044	0.000	12.996		0.018	0.000	13.071		0.058	0.001	12.638	
10/17/2019 02:20	0.00	0.045	0.000	12.998		0.018	0.000	13.058		0.055	0.001	12.623	
10/17/2019 02:25	0.00	0.044	0.000	13.001		0.018	0.000	13.046		0.053	0.001	12.603	
10/17/2019 02:30	0.00	0.044	0.000	13.007		0.019	0.000	13.038		0.054	0.001	12.586	
10/17/2019 02:35	0.00	0.044	0.000	13.009		0.018	0.000	13.031		0.054	0.001	12.567	
10/17/2019 02:40	0.00	0.044	0.000	13.011		0.019	0.000	13.027		0.054	0.001	12.558	
10/17/2019 02:45	0.00	0.044	0.000	13.000		0.019	0.000	13.026		0.054	0.001	12.568	
10/17/2019 02:50	0.00	0.044	0.000	12.974		0.019	0.000	13.034		0.053	0.001	12.568	
10/17/2019 02:55	0.00	0.044	0.000	12.941		0.018	0.000	13.042		0.053	0.001	12.570	
10/17/2019 03:00	0.00	0.043	0.000	12.905		0.019	0.000	13.046		0.049	0.000	12.573	
10/17/2019 03:05	0.00	0.044	0.000	12.869		0.019	0.000	13.058		0.050	0.000	12.593	
10/17/2019 03:10	0.00	0.044	0.000	12.846		0.019	0.000	13.079		0.051	0.000	12.613	
10/17/2019 03:15	0.00	0.044	0.000	12.835		0.019	0.000	13.100		0.045	0.000	12.629	
10/17/2019 03:20	0.00	0.043	0.000	12.837		0.017	0.000	13.108		0.050	0.000	12.637	
10/17/2019 03:25	0.00	0.043	0.000	12.846		0.018	0.000	13.105		0.047	0.000	12.624	
10/17/2019 03:30	0.00	0.043	0.000	12.848		0.019	0.000	13.100		0.049	0.000	12.603	
10/17/2019 03:35	0.00	0.043	0.000	12.849		0.019	0.000	13.093		0.047	0.000	12.583	
10/17/2019 03:40	0.00	0.044	0.000	12.833		0.019	0.000	13.087		0.047	0.000	12.558	
10/17/2019 03:45	0.00	0.043	0.000	12.807		0.019	0.000	13.080		0.049	0.000	12.532	
10/17/2019 03:50	0.00	0.043	0.000	12.786		0.018	0.000	13.070		0.048	0.000	12.521	
10/17/2019 03:55	0.00	0.045	0.000	12.776		0.018	0.000	13.052		0.047	0.000	12.519	
10/17/2019 04:00	0.00	0.049	0.000	12.774		0.017	0.000	13.041		0.047	0.000	12.512	
10/17/2019 04:05	0.00	0.054	0.000	12.783		0.017	0.000	13.034		0.045	0.000	12.494	
10/17/2019 04:10	0.00	0.057	0.000	12.811		0.017	0.000	13.019		0.046	0.000	12.476	
10/17/2019 04:15	0.00	0.058	0.001	12.845		0.017	0.000	13.007		0.043	0.000	12.465	
10/17/2019 04:20	0.00	0.058	0.001	12.875		0.017	0.000	13.005		0.043	0.000	12.472	
10/17/2019 04:23					25								

Storm Event #25 Monitoring Data

Date & Time[1]	UW ATG Rainfall (in)	Station 520-E Level (ft)	Station 520-E Flow Rate (cfs)	Station 520-E Temperature (°C)	Station 520-E Sample (SU)	Station 520-N Level (ft)	Station 520-N Flow Rate (cfs)	Station 520-N Temperature (°C)	Station 520-N Sample (SU)	Station 520-U Level (ft)	Station 520-U Flow Rate (cfs)	Station 520-U Temperature (°C)	Station 520-U Sample (SU)
10/17/2019 04:25	0.00	0.058	0.001	12.903		0.017	0.000	13.010		0.040	0.000	12.489	

Notes:

[1] All times are as recorded by automatic datalogger and transmitted to the sampling lead's computer via telemetry and do not exactly match times on field notes or chain of custody (COC) forms.

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Mobilization Event 26 | 10/21/2019

January 15, 2020

Storm Summary Report

Re: October 21, 2019, Storm Event

Project No. 160418

Introduction

This Storm Summary Report summarizes the storm sampling event that began on October 21, 2019, and includes a summary and documentation of all sampling-related activities. The October 21, 2019, event is the twenty-sixth storm sample event for the SR-520 Bridge AKART Stormwater Monitoring Project.

Storm Validation Summary

The event began on October 21, 2019, at 9:10 after an antecedent dry period exceeding 6 hours. The event ended October 22, 2019, at 8:55. The total measured rainfall for the event was 0.45 inches over a period of 23.75 hours. All three stations were targeted for sampling and enabled on the rising limb of the storm hydrograph. All three stations met the sample validation criteria for sample volume, minimum number of aliquots, and percent coverage of the storm runoff (see Table 1). All samples were submitted to the laboratory within the 24-hour hold time. The water temperature was at least 12.2 degrees Celsius (C) at the time of collection, and the samples were iced and at or below 2.3 degrees C when they were submitted to the lab.

An unforecasted intra-event dry period occurred during the sample event. An initial rainfall depth of 0.31 inches in the first 18.33 hours was followed by a 1-hour-and-50-minute period during which the 6-hour rainfall total was less than the end-of-storm criteria of 0.04 inches. The intra-event dry period was then followed by an additional 0.14 inches of rain for a total event depth of 0.45 inches. Per previous discussions with Parametrix and WSDOT staff, the samples were submitted to the lab.

Hydrographs

The attached hydrographs show the water level and flow rate in each weir along with markers for each sample aliquot and 5-minute rain data.

Storm Tracking

The Go-No-Go field sheet documents the weather forecasts and the decision to target prior to the October 21, 2019, event (Attachment A). The printout from the National Weather Forecast shows the latest forecast roughly 11 hours and 30 minutes prior to the beginning of the rainfall (Attachment B).

Storm Field Sheets

The field sheets document the field and storm control procedures for the event (Attachment C and D). The field sheets also include the Chain-of-Custody (COC) form (Attachment E).

Attachments

Table 1. Storm Validation Summary	*(Included with Quarterly Report attachment)*
520E_102119 Hydrograph	*(Included with Quarterly Report attachment)*
520N_102119 Hydrograph	*(Included with Quarterly Report attachment)*
520U_102119 Hydrograph	*(Included with Quarterly Report attachment)*
Attachment A. Storm Tracking Sheet Go-No-Go Sheets	*(On file)*
Attachment B. National Weather Service Forecast Sheet	*(On file)*
Attachment C. Storm Control Sheets	*(On file)*
Attachment D. Field Sheets	*(On file)*
Attachment E. Chain of Custody	*(On file)*

V:\160418 SR-520 Bridge Stormwater Monitoring\Deliverables\Storm Summaries 2019\26_102119\Storm 26 Summary Report 102119_20200115.docx

Table 1. Storm Validation Summary

Mobilization Event 26 | 10/21/2019

Project No. 160418

SR-520 Floating Bridge Stormwater Monitoring Storm and Sample Validation Checklist

Storm Date	**October 21, 2019**	
Storm Event Number	**26**	
Criterion	**Y / N**	**Value**
Rainfall Depth ≥ 0.15	Y	0.45
Rainfall Duration > 1 hr	Y	23.75
Antecedent Rainfall < 0.04" in 6 hrs	Y	0

Notes:

	Station					
	520-E		**520-N**		**520-U**	
Criterion	**Y / N**	**Value**	**Y / N**	**Value**	**Y / N**	**Value**
Aliquots ≥ 10	Y	29	Y	24	Y	38
Sample Volume ≥ 1 liter	Y	~3	Y	~2	Y	~4
Does Sample cover more than 75% of hydrograph?	Y	100.0%	Y	100.0%	Y	100.0%
Sample Valid Y / N?	Y		Y		Y	

Notes:

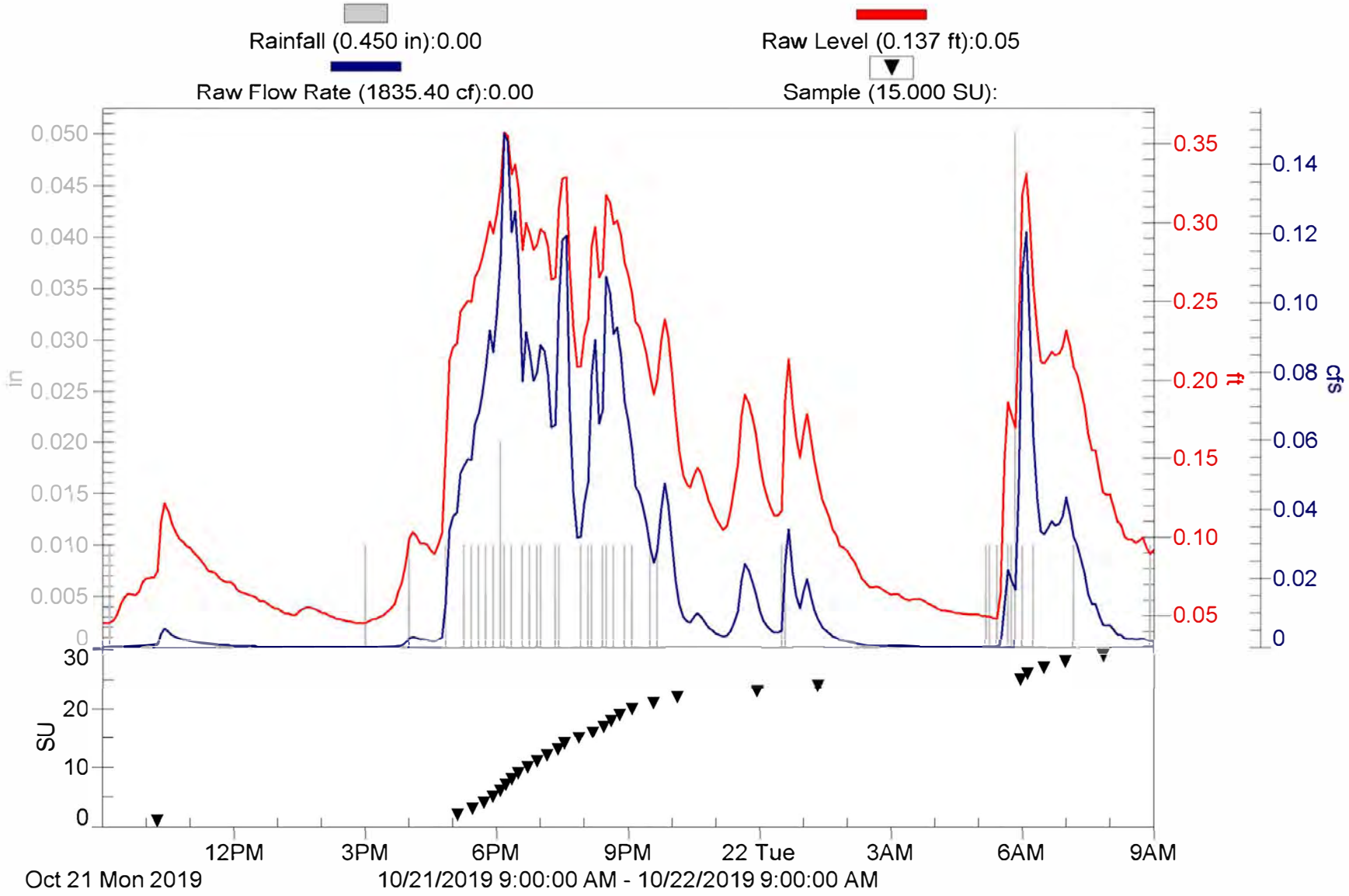
Storm Summary Description

Initial rainfall of 0.31 inches, followed by a 1-hour-and-50-minute period with a 6-hour rainfall intensity of <0.04 in/hr., and then 0.14 inches. The event totaled 0.45 inches over 23.75 hours. All samples were successful.

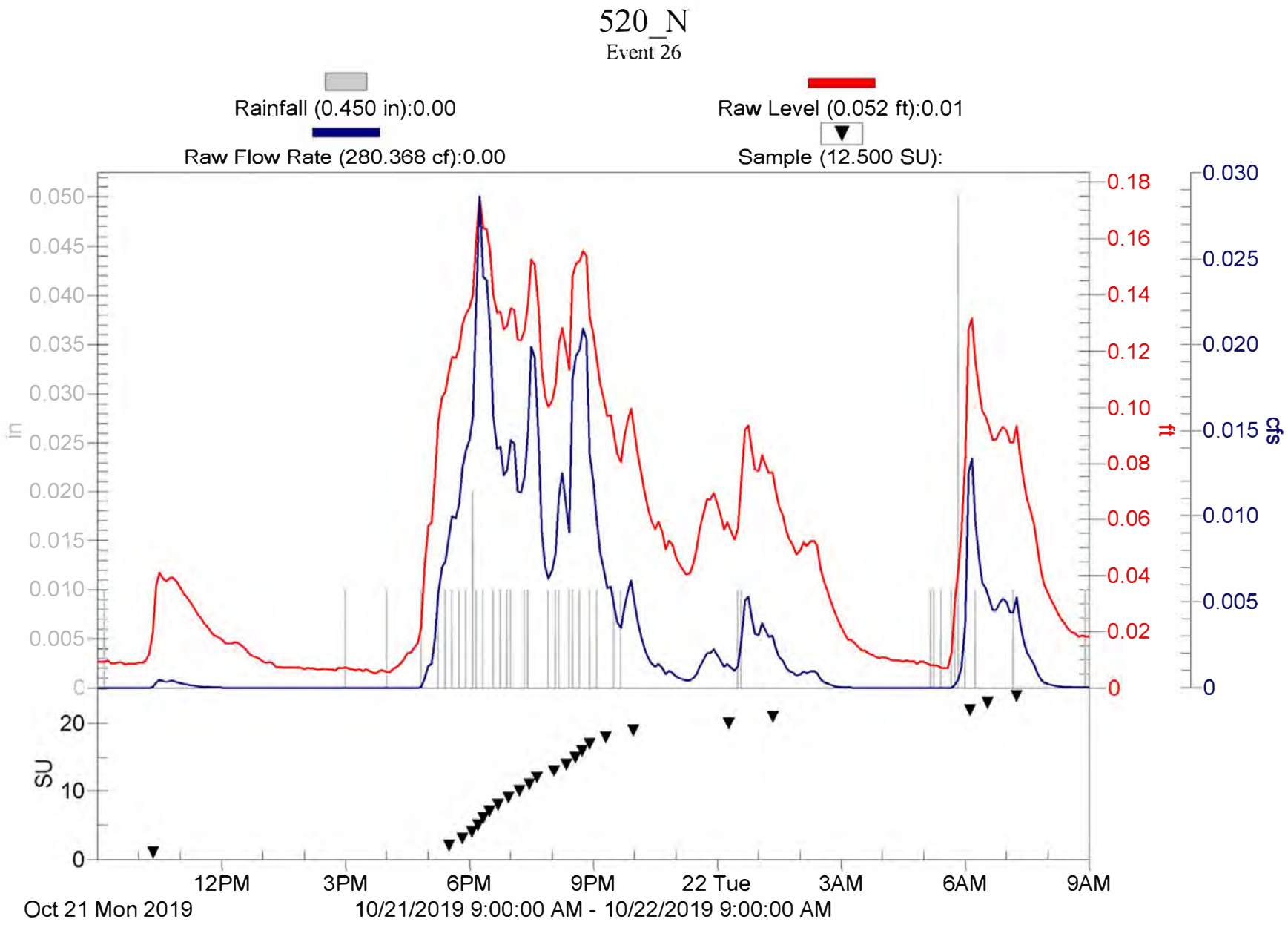
Mobilization Event 26 | 10/21/2019

520_E

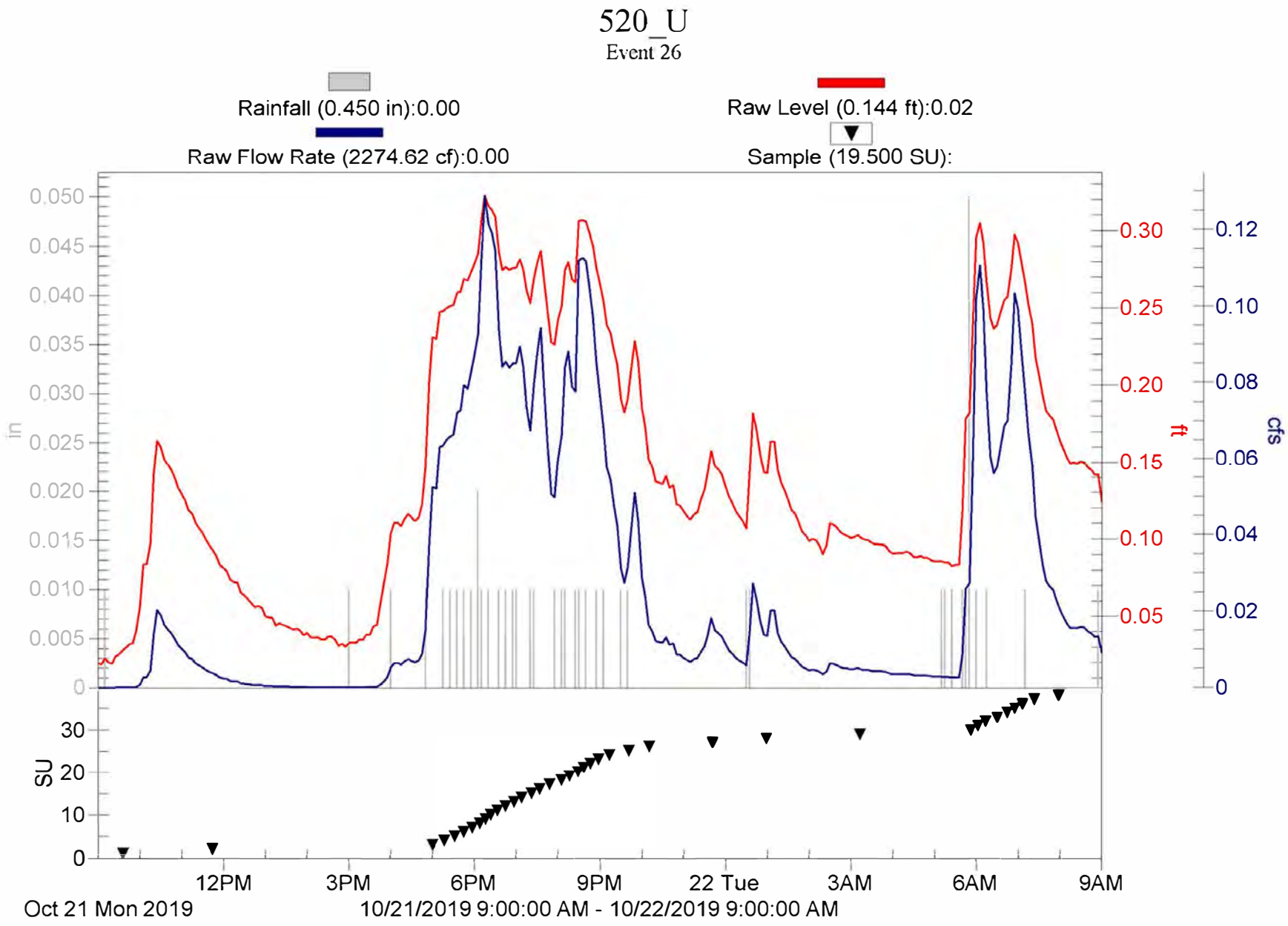
Event 26



Mobilization Event 26 | 10/21/2019



Mobilization Event 26 | 10/21/2019



Storm Event #26 Monitoring Data

Date & Time[1]	UW ATG Rainfall (in)	Station 520-E Level (ft)	Station 520-E Flow Rate (cfs)	Station 520-E Temperature (°C)	Station 520-E Sample (SU)	Station 520-N Level (ft)	Station 520-N Flow Rate (cfs)	Station 520-N Temperature (°C)	Station 520-N Sample (SU)	Station 520-U Level (ft)	Station 520-U Flow Rate (cfs)	Station 520-U Temperature (°C)	Station 520-U Sample (SU)
10/21/2019 09:05	0.00	0.039	0.000	12.672		0.011	0.000	12.559		0.021	0.000	12.241	
10/21/2019 09:10	0.01	0.039	0.000	12.662		0.011	0.000	12.545		0.025	0.000	12.220	
10/21/2019 09:15	0.00	0.041	0.000	12.644		0.011	0.000	12.531		0.023	0.000	12.192	
10/21/2019 09:20	0.00	0.045	0.000	12.625		0.011	0.000	12.516		0.022	0.000	12.162	
10/21/2019 09:25	0.00	0.051	0.000	12.610		0.011	0.000	12.501		0.026	0.000	12.140	
10/21/2019 09:30	0.00	0.056	0.000	12.600		0.011	0.000	12.489		0.028	0.000	12.120	
10/21/2019 09:35	0.00	0.058	0.001	12.593		0.011	0.000	12.477		0.030	0.000	12.104	
10/21/2019 09:36													1
10/21/2019 09:40	0.00	0.057	0.001	12.587		0.010	0.000	12.469		0.032	0.000	12.086	
10/21/2019 09:45	0.00	0.057	0.000	12.585		0.011	0.000	12.468		0.035	0.000	12.066	
10/21/2019 09:50	0.00	0.059	0.001	12.578		0.010	0.000	12.465		0.036	0.000	12.037	
10/21/2019 09:55	0.00	0.065	0.001	12.567		0.010	0.000	12.462		0.043	0.000	12.008	
10/21/2019 10:00	0.00	0.068	0.001	12.562		0.011	0.000	12.464		0.059	0.001	11.993	
10/21/2019 10:05	0.00	0.068	0.001	12.563		0.011	0.000	12.468		0.086	0.003	11.973	
10/21/2019 10:10	0.00	0.068	0.001	12.565		0.012	0.000	12.472		0.087	0.003	11.947	
10/21/2019 10:15	0.00	0.072	0.001	12.556	1	0.014	0.000	12.456		0.100	0.005	11.917	
10/21/2019 10:20	0.00	0.103	0.005	12.511		0.021	0.000	12.414		0.146	0.015	11.857	
10/21/2019 10:21									1				
10/21/2019 10:25	0.00	0.115	0.006	12.460		0.038	0.000	12.369		0.167	0.021	11.803	
10/21/2019 10:30	0.00	0.110	0.005	12.427		0.043	0.001	12.351		0.163	0.020	11.752	
10/21/2019 10:35	0.00	0.102	0.004	12.411		0.041	0.000	12.351		0.155	0.017	11.699	
10/21/2019 10:40	0.00	0.097	0.004	12.406		0.040	0.000	12.351		0.151	0.016	11.660	
10/21/2019 10:45	0.00	0.092	0.003	12.414		0.041	0.000	12.344		0.147	0.015	11.626	
10/21/2019 10:50	0.00	0.091	0.003	12.428		0.041	0.000	12.322		0.143	0.014	11.589	
10/21/2019 10:55	0.00	0.088	0.003	12.423		0.040	0.000	12.297		0.136	0.012	11.567	
10/21/2019 11:00	0.00	0.087	0.003	12.412		0.037	0.000	12.280		0.131	0.011	11.556	
10/21/2019 11:05	0.00	0.084	0.002	12.407		0.036	0.000	12.275		0.128	0.010	11.551	
10/21/2019 11:10	0.00	0.082	0.002	12.401		0.034	0.000	12.277		0.121	0.008	11.553	
10/21/2019 11:15	0.00	0.078	0.002	12.397		0.032	0.000	12.286		0.119	0.008	11.569	
10/21/2019 11:20	0.00	0.076	0.002	12.410		0.030	0.000	12.310		0.113	0.007	11.595	
10/21/2019 11:25	0.00	0.072	0.001	12.449		0.028	0.000	12.341		0.110	0.006	11.629	
10/21/2019 11:30	0.00	0.072	0.001	12.507		0.027	0.000	12.380		0.106	0.006	11.671	
10/21/2019 11:35	0.00	0.071	0.001	12.577		0.025	0.000	12.429		0.102	0.005	11.718	
10/21/2019 11:40	0.00	0.068	0.001	12.654		0.023	0.000	12.480		0.099	0.005	11.776	

Storm Event #26 Monitoring Data

Date & Time[1]	UW ATG Rainfall (in)	Station 520-E Level (ft)	Station 520-E Flow Rate (cfs)	Station 520-E Temperature (°C)	Station 520-E Sample (SU)	Station 520-N Level (ft)	Station 520-N Flow Rate (cfs)	Station 520-N Temperature (°C)	Station 520-N Sample (SU)	Station 520-U Level (ft)	Station 520-U Flow Rate (cfs)	Station 520-U Temperature (°C)	Station 520-U Sample (SU)
10/21/2019 11:45	0.00	0.066	0.001	12.708		0.022	0.000	12.531		0.095	0.004	11.832	2
10/21/2019 11:50	0.00	0.065	0.001	12.751		0.021	0.000	12.578		0.092	0.004	11.879	
10/21/2019 11:55	0.00	0.065	0.001	12.792		0.020	0.000	12.611		0.086	0.003	11.923	
10/21/2019 12:00	0.00	0.063	0.001	12.846		0.019	0.000	12.645		0.084	0.003	11.970	
10/21/2019 12:05	0.00	0.060	0.001	12.914		0.018	0.000	12.686		0.082	0.003	12.028	
10/21/2019 12:10	0.00	0.058	0.001	12.979		0.018	0.000	12.733		0.077	0.002	12.092	
10/21/2019 12:15	0.00	0.058	0.001	13.035		0.018	0.000	12.779		0.075	0.002	12.167	
10/21/2019 12:20	0.00	0.057	0.000	13.082		0.018	0.000	12.828		0.075	0.002	12.244	
10/21/2019 12:25	0.00	0.056	0.000	13.116		0.018	0.000	12.873		0.068	0.001	12.322	
10/21/2019 12:30	0.00	0.055	0.000	13.131		0.017	0.000	12.893		0.066	0.001	12.403	
10/21/2019 12:35	0.00	0.053	0.000	13.134		0.016	0.000	12.899		0.064	0.001	12.460	
10/21/2019 12:40	0.00	0.053	0.000	13.131		0.014	0.000	12.903		0.062	0.001	12.485	
10/21/2019 12:45	0.00	0.052	0.000	13.122		0.013	0.000	12.897		0.059	0.001	12.505	
10/21/2019 12:50	0.00	0.050	0.000	13.106		0.013	0.000	12.888		0.060	0.001	12.511	
10/21/2019 12:55	0.00	0.048	0.000	13.091		0.012	0.000	12.881		0.058	0.001	12.510	
10/21/2019 13:00	0.00	0.048	0.000	13.079		0.011	0.000	12.872		0.053	0.001	12.518	
10/21/2019 13:05	0.00	0.047	0.000	13.072		0.011	0.000	12.864		0.052	0.001	12.532	
10/21/2019 13:10	0.00	0.045	0.000	13.070		0.011	0.000	12.866		0.052	0.000	12.536	
10/21/2019 13:15	0.00	0.045	0.000	13.073		0.011	0.000	12.877		0.047	0.000	12.535	
10/21/2019 13:20	0.00	0.044	0.000	13.079		0.009	0.000	12.887		0.048	0.000	12.532	
10/21/2019 13:25	0.00	0.045	0.000	13.084		0.009	0.000	12.878		0.047	0.000	12.527	
10/21/2019 13:30	0.00	0.047	0.000	13.082		0.009	0.000	12.857		0.046	0.000	12.519	
10/21/2019 13:35	0.00	0.048	0.000	13.069		0.009	0.000	12.829		0.045	0.000	12.507	
10/21/2019 13:40	0.00	0.049	0.000	13.052		0.009	0.000	12.801		0.044	0.000	12.490	
10/21/2019 13:45	0.00	0.049	0.000	13.033		0.009	0.000	12.774		0.045	0.000	12.477	
10/21/2019 13:50	0.00	0.048	0.000	13.014		0.009	0.000	12.754		0.043	0.000	12.472	
10/21/2019 13:55	0.00	0.047	0.000	12.994		0.009	0.000	12.739		0.040	0.000	12.473	
10/21/2019 14:00	0.00	0.046	0.000	12.979		0.009	0.000	12.731		0.042	0.000	12.477	
10/21/2019 14:05	0.00	0.045	0.000	12.970		0.009	0.000	12.732		0.039	0.000	12.482	
10/21/2019 14:10	0.00	0.044	0.000	12.968		0.009	0.000	12.740		0.039	0.000	12.490	
10/21/2019 14:15	0.00	0.043	0.000	12.970		0.009	0.000	12.754		0.039	0.000	12.502	
10/21/2019 14:20	0.00	0.042	0.000	12.977		0.008	0.000	12.767		0.038	0.000	12.515	
10/21/2019 14:25	0.00	0.042	0.000	12.986		0.009	0.000	12.782		0.038	0.000	12.533	
10/21/2019 14:30	0.00	0.041	0.000	12.996		0.009	0.000	12.796		0.040	0.000	12.555	

Storm Event #26 Monitoring Data

Date & Time[1]	UW ATG Rainfall (in)	Station 520-E Level (ft)	Station 520-E Flow Rate (cfs)	Station 520-E Temperature (°C)	Station 520-E Sample (SU)	Station 520-N Level (ft)	Station 520-N Flow Rate (cfs)	Station 520-N Temperature (°C)	Station 520-N Sample (SU)	Station 520-U Level (ft)	Station 520-U Flow Rate (cfs)	Station 520-U Temperature (°C)	Station 520-U Sample (SU)
10/21/2019 14:35	0.00	0.040	0.000	13.008		0.008	0.000	12.810		0.040	0.000	12.576	
10/21/2019 14:40	0.00	0.040	0.000	13.021		0.009	0.000	12.827		0.038	0.000	12.590	
10/21/2019 14:45	0.00	0.039	0.000	13.035		0.008	0.000	12.843		0.034	0.000	12.599	
10/21/2019 14:50	0.00	0.039	0.000	13.052		0.009	0.000	12.862		0.035	0.000	12.608	
10/21/2019 14:55	0.00	0.039	0.000	13.068		0.009	0.000	12.882		0.033	0.000	12.612	
10/21/2019 15:00	0.01	0.039	0.000	13.081		0.009	0.000	12.899		0.036	0.000	12.609	
10/21/2019 15:05	0.00	0.040	0.000	13.094		0.009	0.000	12.911		0.036	0.000	12.594	
10/21/2019 15:10	0.00	0.042	0.000	13.103		0.009	0.000	12.920		0.036	0.000	12.568	
10/21/2019 15:15	0.00	0.042	0.000	13.107		0.008	0.000	12.926		0.038	0.000	12.538	
10/21/2019 15:20	0.00	0.043	0.000	13.104		0.009	0.000	12.929		0.037	0.000	12.511	
10/21/2019 15:25	0.00	0.044	0.000	13.102		0.008	0.000	12.929		0.041	0.000	12.482	
10/21/2019 15:30	0.00	0.046	0.000	13.098		0.009	0.000	12.927		0.041	0.000	12.449	
10/21/2019 15:35	0.00	0.048	0.000	13.096		0.008	0.000	12.924		0.046	0.000	12.440	
10/21/2019 15:40	0.00	0.051	0.000	13.096		0.007	0.000	12.926		0.047	0.000	12.448	
10/21/2019 15:45	0.00	0.059	0.001	13.097		0.007	0.000	12.929		0.061	0.001	12.457	
10/21/2019 15:50	0.00	0.065	0.001	13.098		0.008	0.000	12.933		0.073	0.002	12.471	
10/21/2019 15:55	0.00	0.077	0.002	13.100		0.008	0.000	12.945		0.087	0.003	12.498	
10/21/2019 16:00	0.01	0.093	0.003	13.104		0.008	0.000	12.960		0.106	0.006	12.534	
10/21/2019 16:05	0.00	0.097	0.004	13.110		0.008	0.000	12.977		0.113	0.007	12.587	
10/21/2019 16:10	0.00	0.094	0.003	13.123		0.009	0.000	12.998		0.113	0.007	12.653	
10/21/2019 16:15	0.00	0.090	0.003	13.143		0.009	0.000	13.026		0.111	0.007	12.729	
10/21/2019 16:20	0.00	0.090	0.003	13.168		0.011	0.000	13.053		0.116	0.007	12.806	
10/21/2019 16:25	0.00	0.089	0.003	13.198		0.012	0.000	13.080		0.119	0.008	12.881	
10/21/2019 16:30	0.00	0.085	0.002	13.233		0.014	0.000	13.115		0.117	0.008	12.966	
10/21/2019 16:35	0.00	0.083	0.002	13.275		0.015	0.000	13.155		0.114	0.007	13.042	
10/21/2019 16:40	0.00	0.089	0.003	13.331		0.017	0.000	13.202		0.117	0.008	13.114	
10/21/2019 16:45	0.00	0.096	0.004	13.412		0.018	0.000	13.249		0.125	0.009	13.168	
10/21/2019 16:50	0.01	0.145	0.013	13.477		0.024	0.000	13.285		0.149	0.016	13.207	
10/21/2019 16:55	0.00	0.207	0.036	13.528		0.045	0.001	13.298		0.205	0.038	13.238	
10/21/2019 17:00	0.00	0.215	0.040	13.606		0.059	0.001	13.322		0.234	0.054	13.259	3
10/21/2019 17:05	0.00	0.217	0.042	13.691		0.061	0.002	13.367		0.233	0.054	13.291	
10/21/2019 17:07					2								
10/21/2019 17:10	0.00	0.237	0.053	13.759		0.077	0.003	13.401		0.250	0.065	13.314	
10/21/2019 17:15	0.01	0.241	0.055	13.829		0.097	0.006	13.429		0.251	0.066	13.324	

Storm Event #26 Monitoring Data

Date & Time[1]	UW ATG Rainfall (in)	Station 520-E Level (ft)	Station 520-E Flow Rate (cfs)	Station 520-E Temperature (°C)	Station 520-E Sample (SU)	Station 520-N Level (ft)	Station 520-N Flow Rate (cfs)	Station 520-N Temperature (°C)	Station 520-N Sample (SU)	Station 520-U Level (ft)	Station 520-U Flow Rate (cfs)	Station 520-U Temperature (°C)	Station 520-U Sample (SU)
10/21/2019 17:17													4
10/21/2019 17:20	0.00	0.244	0.058	13.895		0.106	0.007	13.475		0.253	0.067	13.358	
10/21/2019 17:25	0.01	0.244	0.057	13.949		0.108	0.008	13.536		0.254	0.068	13.395	
10/21/2019 17:27					3								
10/21/2019 17:30	0.00	0.259	0.068	13.991		0.114	0.009	13.597		0.255	0.068	13.424	
10/21/2019 17:31									2				
10/21/2019 17:32													5
10/21/2019 17:35	0.01	0.264	0.071	14.014		0.120	0.010	13.660		0.263	0.074	13.445	
10/21/2019 17:40	0.00	0.272	0.077	14.031		0.120	0.010	13.738		0.263	0.075	13.475	
10/21/2019 17:43					4								
10/21/2019 17:45	0.01	0.281	0.085	14.055		0.123	0.011	13.812		0.272	0.082	13.509	6
10/21/2019 17:50	0.00	0.294	0.096	14.093		0.131	0.013	13.873	3	0.271	0.081	13.539	
10/21/2019 17:55	0.01	0.287	0.090	14.147	5	0.135	0.014	13.930		0.276	0.085	13.578	
10/21/2019 17:57													7
10/21/2019 18:00	0.00	0.299	0.101	14.199		0.138	0.015	13.995		0.281	0.089	13.617	
10/21/2019 18:04									4				
10/21/2019 18:05	0.02	0.318	0.118	14.237	6	0.142	0.016	14.056		0.288	0.095	13.655	
10/21/2019 18:08													8
10/21/2019 18:10	0.01	0.351	0.154	14.264		0.162	0.023	14.101		0.309	0.115	13.681	
10/21/2019 18:13					7				5				
10/21/2019 18:15	0.00	0.349	0.152	14.284		0.177	0.029	14.140		0.325	0.131	13.695	
10/21/2019 18:16													9
10/21/2019 18:20	0.01	0.325	0.125	14.308		0.166	0.025	14.188	6	0.319	0.124	13.712	
10/21/2019 18:21					8								
10/21/2019 18:24													10
10/21/2019 18:25	0.00	0.331	0.132	14.327		0.165	0.025	14.228		0.316	0.122	13.733	
10/21/2019 18:29									7				
10/21/2019 18:30	0.00	0.315	0.116	14.338	9	0.158	0.022	14.254		0.312	0.117	13.755	
10/21/2019 18:33													11
10/21/2019 18:35	0.01	0.276	0.081	14.359		0.142	0.016	14.285		0.289	0.096	13.779	
10/21/2019 18:40	0.00	0.294	0.096	14.375		0.136	0.015	14.315		0.278	0.086	13.799	
10/21/2019 18:42									8				
10/21/2019 18:43					10								
10/21/2019 18:45	0.01	0.287	0.090	14.378		0.136	0.015	14.331		0.280	0.088	13.807	12

Storm Event #26 Monitoring Data

Date & Time[1]	UW ATG Rainfall (in)	Station 520-E Level (ft)	Station 520-E Flow Rate (cfs)	Station 520-E Temperature (°C)	Station 520-E Sample (SU)	Station 520-N Level (ft)	Station 520-N Flow Rate (cfs)	Station 520-N Temperature (°C)	Station 520-N Sample (SU)	Station 520-U Level (ft)	Station 520-U Flow Rate (cfs)	Station 520-U Temperature (°C)	Station 520-U Sample (SU)
10/21/2019 18:50	0.00	0.277	0.081	14.381		0.130	0.013	14.347		0.278	0.086	13.817	
10/21/2019 18:55	0.01	0.280	0.084	14.386		0.131	0.013	14.364		0.279	0.087	13.825	
10/21/2019 18:56					11								
10/21/2019 18:57									9				13
10/21/2019 19:00	0.01	0.289	0.092	14.387		0.137	0.015	14.380		0.279	0.088	13.846	
10/21/2019 19:05	0.00	0.287	0.090	14.386		0.137	0.015	14.393		0.284	0.092	13.863	
10/21/2019 19:08													14
10/21/2019 19:09					12								
10/21/2019 19:10	0.00	0.279	0.083	14.388		0.126	0.012	14.412		0.278	0.087	13.863	
10/21/2019 19:13									10				
10/21/2019 19:15	0.00	0.258	0.067	14.391		0.126	0.012	14.427		0.265	0.076	13.881	
10/21/2019 19:20	0.01	0.259	0.068	14.392		0.130	0.013	14.440		0.256	0.069	13.895	
10/21/2019 19:22													15
10/21/2019 19:24					13								
10/21/2019 19:25	0.01	0.303	0.104	14.383		0.139	0.015	14.445		0.271	0.081	13.894	
10/21/2019 19:27									11				
10/21/2019 19:30	0.00	0.322	0.123	14.366		0.155	0.021	14.436		0.281	0.089	13.901	
10/21/2019 19:33					14								
10/21/2019 19:34													16
10/21/2019 19:35	0.00	0.323	0.124	14.349		0.153	0.020	14.430		0.290	0.097	13.906	
10/21/2019 19:38									12				
10/21/2019 19:40	0.00	0.264	0.071	14.343		0.138	0.015	14.428		0.271	0.081	13.917	
10/21/2019 19:45	0.00	0.228	0.048	14.346		0.116	0.009	14.443		0.252	0.066	13.934	
10/21/2019 19:48													17
10/21/2019 19:50	0.00	0.202	0.034	14.360		0.106	0.007	14.465		0.231	0.052	13.945	
10/21/2019 19:53					15								
10/21/2019 19:55	0.01	0.203	0.034	14.380		0.102	0.007	14.492		0.229	0.051	13.974	
10/21/2019 20:00	0.00	0.222	0.044	14.395		0.105	0.007	14.512		0.245	0.061	13.980	
10/21/2019 20:03									13				
10/21/2019 20:05	0.01	0.232	0.050	14.407		0.110	0.008	14.524		0.254	0.068	13.991	18
10/21/2019 20:10	0.01	0.279	0.083	14.410		0.125	0.012	14.527		0.278	0.086	13.992	
10/21/2019 20:12					16								
10/21/2019 20:15	0.00	0.291	0.094	14.403		0.130	0.013	14.520		0.283	0.091	13.990	
10/21/2019 20:17													19

Storm Event #26 Monitoring Data

Date & Time[1]	UW ATG Rainfall (in)	Station 520-E Level (ft)	Station 520-E Flow Rate (cfs)	Station 520-E Temperature (°C)	Station 520-E Sample (SU)	Station 520-N Level (ft)	Station 520-N Flow Rate (cfs)	Station 520-N Temperature (°C)	Station 520-N Sample (SU)	Station 520-U Level (ft)	Station 520-U Flow Rate (cfs)	Station 520-U Temperature (°C)	Station 520-U Sample (SU)
10/21/2019 20:20	0.00	0.259	0.068	14.397		0.123	0.011	14.507		0.271	0.081	13.984	
10/21/2019 20:21									14				
10/21/2019 20:25	0.01	0.264	0.071	14.402		0.115	0.009	14.501		0.270	0.080	13.989	
10/21/2019 20:27					17								
10/21/2019 20:29													20
10/21/2019 20:30	0.01	0.311	0.112	14.406		0.149	0.019	14.488		0.309	0.115	13.991	
10/21/2019 20:34									15				
10/21/2019 20:35	0.00	0.306	0.107	14.413		0.153	0.020	14.477		0.310	0.115	13.983	
10/21/2019 20:37					18								21
10/21/2019 20:40	0.01	0.293	0.095	14.424		0.154	0.020	14.469		0.309	0.115	13.977	
10/21/2019 20:44									16				
10/21/2019 20:45	0.00	0.295	0.097	14.430		0.158	0.022	14.467		0.302	0.108	13.972	
10/21/2019 20:47													22
10/21/2019 20:49					19								
10/21/2019 20:50	0.00	0.286	0.089	14.434		0.156	0.021	14.468		0.293	0.099	13.979	
10/21/2019 20:55	0.01	0.269	0.075	14.436		0.134	0.014	14.465	17	0.279	0.088	13.996	
10/21/2019 20:58													23
10/21/2019 21:00	0.00	0.260	0.069	14.434		0.128	0.012	14.463		0.268	0.078	14.007	
10/21/2019 21:05	0.01	0.249	0.061	14.431		0.119	0.010	14.465		0.257	0.070	14.024	
10/21/2019 21:06					20								
10/21/2019 21:10	0.00	0.231	0.049	14.434		0.110	0.008	14.473		0.242	0.060	14.043	
10/21/2019 21:14													24
10/21/2019 21:15	0.00	0.227	0.047	14.440		0.105	0.007	14.481		0.237	0.056	14.058	
10/21/2019 21:18									18				
10/21/2019 21:20	0.00	0.220	0.043	14.454		0.099	0.006	14.494		0.226	0.049	14.069	
10/21/2019 21:25	0.00	0.211	0.038	14.468		0.099	0.006	14.511		0.216	0.044	14.080	
10/21/2019 21:30	0.01	0.196	0.031	14.484		0.093	0.005	14.535		0.194	0.033	14.106	
10/21/2019 21:35	0.00	0.185	0.026	14.508	21	0.086	0.004	14.561		0.185	0.029	14.139	
10/21/2019 21:40	0.01	0.194	0.030	14.534		0.083	0.004	14.589		0.194	0.033	14.168	
10/21/2019 21:42													25
10/21/2019 21:45	0.00	0.219	0.043	14.552		0.092	0.005	14.612		0.215	0.043	14.190	
10/21/2019 21:50	0.00	0.232	0.050	14.566		0.098	0.006	14.633		0.231	0.053	14.195	
10/21/2019 21:55	0.00	0.221	0.044	14.586		0.102	0.007	14.660		0.219	0.045	14.210	
10/21/2019 21:58									19				

Storm Event #26 Monitoring Data

Date & Time[1]	UW ATG Rainfall (in)	Station 520-E Level (ft)	Station 520-E Flow Rate (cfs)	Station 520-E Temperature (°C)	Station 520-E Sample (SU)	Station 520-N Level (ft)	Station 520-N Flow Rate (cfs)	Station 520-N Temperature (°C)	Station 520-N Sample (SU)	Station 520-U Level (ft)	Station 520-U Flow Rate (cfs)	Station 520-U Temperature (°C)	Station 520-U Sample (SU)
10/21/2019 22:00	0.00	0.196	0.031	14.620		0.093	0.005	14.697		0.189	0.030	14.232	
10/21/2019 22:05	0.00	0.170	0.021	14.668		0.085	0.004	14.743		0.176	0.025	14.261	
10/21/2019 22:08					22								
10/21/2019 22:10	0.00	0.148	0.014	14.708		0.078	0.003	14.788		0.155	0.017	14.301	
10/21/2019 22:11													26
10/21/2019 22:15	0.00	0.133	0.010	14.744		0.071	0.002	14.821		0.149	0.016	14.345	
10/21/2019 22:20	0.00	0.127	0.009	14.776		0.065	0.002	14.853		0.140	0.013	14.393	
10/21/2019 22:25	0.00	0.125	0.008	14.802		0.061	0.002	14.880		0.139	0.013	14.434	
10/21/2019 22:30	0.00	0.133	0.010	14.807		0.059	0.001	14.888		0.139	0.013	14.454	
10/21/2019 22:35	0.00	0.138	0.011	14.813		0.061	0.002	14.890		0.144	0.014	14.458	
10/21/2019 22:40	0.00	0.134	0.010	14.825		0.057	0.001	14.902		0.136	0.012	14.466	
10/21/2019 22:45	0.00	0.125	0.008	14.841		0.051	0.001	14.925		0.138	0.012	14.490	
10/21/2019 22:50	0.00	0.117	0.007	14.865		0.054	0.001	14.943		0.125	0.009	14.520	
10/21/2019 22:55	0.00	0.112	0.006	14.892		0.053	0.001	14.959		0.125	0.009	14.551	
10/21/2019 23:00	0.00	0.105	0.005	14.916		0.049	0.001	14.975		0.121	0.008	14.581	
10/21/2019 23:05	0.00	0.102	0.004	14.933		0.046	0.001	14.990		0.118	0.008	14.608	
10/21/2019 23:10	0.00	0.098	0.004	14.942		0.044	0.001	14.998		0.116	0.007	14.621	
10/21/2019 23:15	0.00	0.101	0.004	14.943		0.043	0.001	15.007		0.119	0.008	14.626	
10/21/2019 23:20	0.00	0.111	0.006	14.941		0.043	0.001	15.012		0.120	0.008	14.641	
10/21/2019 23:25	0.00	0.124	0.008	14.939		0.046	0.001	15.014		0.128	0.010	14.651	
10/21/2019 23:30	0.00	0.140	0.012	14.930		0.051	0.001	15.009		0.135	0.012	14.653	
10/21/2019 23:35	0.00	0.171	0.021	14.917		0.059	0.001	14.997		0.147	0.015	14.646	
10/21/2019 23:40	0.00	0.185	0.026	14.902		0.064	0.002	14.988		0.161	0.019	14.636	
10/21/2019 23:43													27
10/21/2019 23:45	0.00	0.179	0.024	14.891		0.069	0.002	14.981		0.150	0.016	14.631	
10/21/2019 23:50	0.00	0.170	0.021	14.881		0.069	0.002	14.981		0.148	0.015	14.625	
10/21/2019 23:55	0.00	0.159	0.017	14.886		0.071	0.002	14.994		0.145	0.014	14.620	
10/21/2019 23:57					23								
10/22/2019 00:00	0.00	0.141	0.012	14.895		0.067	0.002	15.007		0.137	0.012	14.622	
10/22/2019 00:05	0.00	0.128	0.009	14.901		0.063	0.002	15.015		0.131	0.011	14.629	
10/22/2019 00:10	0.00	0.120	0.007	14.907		0.058	0.001	15.022		0.127	0.010	14.635	
10/22/2019 00:15	0.00	0.112	0.006	14.925		0.061	0.002	15.028		0.121	0.008	14.641	
10/22/2019 00:17									20				
10/22/2019 00:20	0.00	0.108	0.005	14.950		0.058	0.001	15.037		0.118	0.008	14.650	

Storm Event #26 Monitoring Data

Date & Time[1]	UW ATG Rainfall (in)	Station 520-E Level (ft)	Station 520-E Flow Rate (cfs)	Station 520-E Temperature (°C)	Station 520-E Sample (SU)	Station 520-N Level (ft)	Station 520-N Flow Rate (cfs)	Station 520-N Temperature (°C)	Station 520-N Sample (SU)	Station 520-U Level (ft)	Station 520-U Flow Rate (cfs)	Station 520-U Temperature (°C)	Station 520-U Sample (SU)
10/22/2019 00:25	0.00	0.108	0.005	14.976		0.055	0.001	15.054		0.115	0.007	14.664	
10/22/2019 00:30	0.01	0.111	0.006	15.002		0.059	0.001	15.078		0.110	0.006	14.685	
10/22/2019 00:35	0.01	0.182	0.025	15.028		0.075	0.003	15.094		0.147	0.015	14.705	
10/22/2019 00:40	0.00	0.208	0.037	15.054		0.094	0.005	15.113		0.185	0.029	14.717	
10/22/2019 00:45	0.00	0.178	0.024	15.084		0.096	0.006	15.134		0.173	0.024	14.722	
10/22/2019 00:50	0.00	0.157	0.017	15.115		0.088	0.004	15.150		0.159	0.019	14.731	
10/22/2019 00:55	0.00	0.144	0.013	15.140		0.080	0.003	15.162		0.147	0.015	14.749	
10/22/2019 01:00	0.00	0.161	0.018	15.161		0.079	0.003	15.186		0.146	0.015	14.768	28
10/22/2019 01:05	0.00	0.173	0.022	15.181		0.085	0.004	15.200		0.167	0.021	14.769	
10/22/2019 01:10	0.00	0.156	0.016	15.198		0.082	0.004	15.205		0.166	0.021	14.747	
10/22/2019 01:15	0.00	0.141	0.012	15.211		0.079	0.003	15.198		0.148	0.015	14.729	
10/22/2019 01:20	0.00	0.130	0.009	15.225	24	0.079	0.003	15.183		0.140	0.013	14.720	
10/22/2019 01:21									21				
10/22/2019 01:25	0.00	0.118	0.007	15.236		0.072	0.003	15.168		0.134	0.011	14.712	
10/22/2019 01:30	0.00	0.112	0.006	15.244		0.066	0.002	15.155		0.128	0.010	14.704	
10/22/2019 01:35	0.00	0.107	0.005	15.246		0.064	0.002	15.148		0.122	0.009	14.703	
10/22/2019 01:40	0.00	0.098	0.004	15.247		0.058	0.001	15.147		0.120	0.008	14.705	
10/22/2019 01:45	0.00	0.095	0.003	15.252		0.055	0.001	15.144		0.114	0.007	14.702	
10/22/2019 01:50	0.00	0.088	0.003	15.261		0.053	0.001	15.142		0.108	0.006	14.712	
10/22/2019 01:55	0.00	0.087	0.003	15.262		0.050	0.001	15.148		0.105	0.006	14.732	
10/22/2019 02:00	0.00	0.085	0.002	15.261		0.051	0.001	15.155		0.102	0.005	14.746	
10/22/2019 02:05	0.00	0.081	0.002	15.260		0.054	0.001	15.156		0.103	0.005	14.745	
10/22/2019 02:10	0.00	0.078	0.002	15.257		0.053	0.001	15.159		0.102	0.005	14.744	
10/22/2019 02:15	0.00	0.073	0.001	15.250		0.054	0.001	15.154		0.099	0.005	14.755	
10/22/2019 02:20	0.00	0.068	0.001	15.240		0.054	0.001	15.149		0.094	0.004	14.776	
10/22/2019 02:25	0.00	0.065	0.001	15.229		0.053	0.001	15.142		0.099	0.005	14.801	
10/22/2019 02:30	0.00	0.062	0.001	15.215		0.045	0.001	15.134		0.113	0.007	14.826	
10/22/2019 02:35	0.00	0.062	0.001	15.200		0.040	0.000	15.123		0.112	0.007	14.834	
10/22/2019 02:40	0.00	0.063	0.001	15.183		0.037	0.000	15.111		0.111	0.006	14.833	
10/22/2019 02:45	0.00	0.062	0.001	15.167		0.033	0.000	15.097		0.108	0.006	14.826	
10/22/2019 02:50	0.00	0.060	0.001	15.147		0.030	0.000	15.081		0.106	0.006	14.823	
10/22/2019 02:55	0.00	0.058	0.001	15.120		0.027	0.000	15.065		0.105	0.005	14.813	
10/22/2019 03:00	0.00	0.057	0.001	15.096		0.024	0.000	15.046		0.104	0.005	14.802	
10/22/2019 03:05	0.00	0.058	0.001	15.074		0.021	0.000	15.028		0.104	0.005	14.783	

Storm Event #26 Monitoring Data

Date & Time[1]	UW ATG Rainfall (in)	Station 520-E Level (ft)	Station 520-E Flow Rate (cfs)	Station 520-E Temperature (°C)	Station 520-E Sample (SU)	Station 520-N Level (ft)	Station 520-N Flow Rate (cfs)	Station 520-N Temperature (°C)	Station 520-N Sample (SU)	Station 520-U Level (ft)	Station 520-U Flow Rate (cfs)	Station 520-U Temperature (°C)	Station 520-U Sample (SU)
10/22/2019 03:10	0.00	0.058	0.001	15.050		0.019	0.000	15.011		0.106	0.006	14.766	
10/22/2019 03:13													29
10/22/2019 03:15	0.00	0.056	0.000	15.024		0.019	0.000	14.984		0.104	0.005	14.756	
10/22/2019 03:20	0.00	0.054	0.000	14.994		0.018	0.000	14.962		0.103	0.005	14.744	
10/22/2019 03:25	0.00	0.054	0.000	14.972		0.017	0.000	14.942		0.102	0.005	14.727	
10/22/2019 03:30	0.00	0.054	0.000	14.953		0.016	0.000	14.923		0.101	0.005	14.711	
10/22/2019 03:35	0.00	0.055	0.000	14.925		0.015	0.000	14.907		0.100	0.005	14.704	
10/22/2019 03:40	0.00	0.054	0.000	14.895		0.014	0.000	14.903		0.100	0.005	14.697	
10/22/2019 03:45	0.00	0.053	0.000	14.869		0.014	0.000	14.891		0.100	0.005	14.691	
10/22/2019 03:50	0.00	0.052	0.000	14.842		0.013	0.000	14.867		0.099	0.005	14.681	
10/22/2019 03:55	0.00	0.051	0.000	14.819		0.013	0.000	14.835		0.096	0.004	14.669	
10/22/2019 04:00	0.00	0.050	0.000	14.796		0.013	0.000	14.805		0.094	0.004	14.655	
10/22/2019 04:05	0.00	0.048	0.000	14.774		0.013	0.000	14.779		0.094	0.004	14.639	
10/22/2019 04:10	0.00	0.047	0.000	14.753		0.012	0.000	14.761		0.094	0.004	14.621	
10/22/2019 04:15	0.00	0.047	0.000	14.734		0.012	0.000	14.745		0.094	0.004	14.604	
10/22/2019 04:20	0.00	0.047	0.000	14.717		0.012	0.000	14.727		0.095	0.004	14.584	
10/22/2019 04:25	0.00	0.046	0.000	14.700		0.012	0.000	14.706		0.094	0.004	14.568	
10/22/2019 04:30	0.00	0.046	0.000	14.679		0.012	0.000	14.682		0.092	0.004	14.554	
10/22/2019 04:35	0.00	0.046	0.000	14.657		0.012	0.000	14.659		0.091	0.004	14.543	
10/22/2019 04:40	0.00	0.045	0.000	14.637		0.012	0.000	14.637		0.092	0.004	14.526	
10/22/2019 04:45	0.00	0.045	0.000	14.616		0.012	0.000	14.614		0.091	0.004	14.507	
10/22/2019 04:50	0.00	0.045	0.000	14.594		0.011	0.000	14.586		0.091	0.004	14.490	
10/22/2019 04:55	0.00	0.045	0.000	14.571		0.012	0.000	14.558		0.090	0.003	14.469	
10/22/2019 05:00	0.00	0.045	0.000	14.547		0.011	0.000	14.531		0.089	0.003	14.446	
10/22/2019 05:05	0.00	0.044	0.000	14.521		0.011	0.000	14.504		0.089	0.003	14.428	
10/22/2019 05:10	0.01	0.044	0.000	14.494		0.010	0.000	14.477		0.089	0.003	14.403	
10/22/2019 05:15	0.01	0.043	0.000	14.467		0.010	0.000	14.454		0.088	0.003	14.382	
10/22/2019 05:20	0.00	0.042	0.000	14.444		0.010	0.000	14.434		0.088	0.003	14.361	
10/22/2019 05:25	0.01	0.042	0.000	14.424		0.010	0.000	14.417		0.086	0.003	14.350	
10/22/2019 05:30	0.00	0.058	0.001	14.407		0.009	0.000	14.400		0.087	0.003	14.338	
10/22/2019 05:35	0.00	0.143	0.012	14.396		0.009	0.000	14.380		0.087	0.003	14.318	
10/22/2019 05:40	0.01	0.180	0.024	14.379		0.015	0.000	14.357		0.121	0.008	14.295	
10/22/2019 05:45	0.01	0.172	0.021	14.347		0.033	0.000	14.329		0.182	0.027	14.274	
10/22/2019 05:50	0.05	0.163	0.018	14.271		0.044	0.001	14.257		0.186	0.029	14.223	

Storm Event #26 Monitoring Data

Date & Time[1]	UW ATG Rainfall (in)	Station 520-E Level (ft)	Station 520-E Flow Rate (cfs)	Station 520-E Temperature (°C)	Station 520-E Sample (SU)	Station 520-N Level (ft)	Station 520-N Flow Rate (cfs)	Station 520-N Temperature (°C)	Station 520-N Sample (SU)	Station 520-U Level (ft)	Station 520-U Flow Rate (cfs)	Station 520-U Temperature (°C)	Station 520-U Sample (SU)
10/22/2019 05:54													30
10/22/2019 05:55	0.00	0.231	0.050	14.122		0.058	0.001	14.080		0.243	0.060	14.120	
10/22/2019 05:58					25								
10/22/2019 06:00	0.01	0.312	0.113	13.961		0.084	0.004	13.907		0.299	0.105	14.013	
10/22/2019 06:04													31
10/22/2019 06:05	0.00	0.325	0.125	13.806		0.130	0.013	13.771		0.308	0.114	13.863	
10/22/2019 06:07					26				22				
10/22/2019 06:10	0.00	0.294	0.096	13.603		0.134	0.014	13.619		0.296	0.102	13.693	
10/22/2019 06:15	0.01	0.254	0.064	13.416		0.119	0.010	13.486		0.270	0.080	13.523	32
10/22/2019 06:20	0.00	0.225	0.046	13.273		0.108	0.008	13.388		0.247	0.063	13.368	
10/22/2019 06:25	0.00	0.206	0.036	13.171		0.101	0.007	13.309		0.240	0.058	13.260	
10/22/2019 06:30	0.00	0.205	0.035	13.102	27	0.099	0.006	13.242		0.242	0.060	13.168	
10/22/2019 06:32													33
10/22/2019 06:33									23				
10/22/2019 06:35	0.00	0.209	0.037	13.048		0.095	0.006	13.179		0.251	0.066	13.078	
10/22/2019 06:40	0.00	0.212	0.039	12.992		0.091	0.005	13.110		0.258	0.071	12.994	
10/22/2019 06:45	0.00	0.210	0.038	12.931		0.091	0.005	13.038		0.260	0.073	12.899	
10/22/2019 06:46													34
10/22/2019 06:50	0.00	0.211	0.038	12.867		0.094	0.005	12.967		0.279	0.087	12.799	
10/22/2019 06:55	-9.00	0.215	0.041	12.799		0.095	0.006	12.900		0.300	0.106	12.714	
10/22/2019 06:57													35
10/22/2019 06:59					28								
10/22/2019 07:00	0.00	0.226	0.046	12.736		0.094	0.005	12.837		0.296	0.102	12.626	
10/22/2019 07:05	0.00	0.216	0.041	12.670		0.090	0.005	12.779		0.282	0.090	12.557	
10/22/2019 07:08													36
10/22/2019 07:10	0.01	0.202	0.034	12.609		0.090	0.005	12.733		0.270	0.080	12.494	
10/22/2019 07:15	0.00	0.198	0.032	12.556		0.096	0.006	12.688	24	0.256	0.069	12.441	
10/22/2019 07:20	0.00	0.188	0.028	12.499		0.084	0.004	12.637		0.243	0.061	12.397	
10/22/2019 07:25	0.00	0.177	0.023	12.435		0.076	0.003	12.598		0.221	0.047	12.358	37
10/22/2019 07:30	0.00	0.160	0.017	12.394		0.069	0.002	12.576		0.210	0.041	12.331	
10/22/2019 07:35	0.00	0.149	0.014	12.365		0.065	0.002	12.561		0.197	0.034	12.308	
10/22/2019 07:40	0.00	0.149	0.014	12.339		0.060	0.001	12.536		0.187	0.029	12.284	
10/22/2019 07:45	0.00	0.136	0.011	12.324		0.052	0.001	12.514		0.184	0.028	12.259	
10/22/2019 07:50	0.00	0.122	0.008	12.314		0.044	0.001	12.502		0.181	0.027	12.233	

Storm Event #26 Monitoring Data

Date & Time[1]	UW ATG Rainfall (in)	Station 520-E Level (ft)	Station 520-E Flow Rate (cfs)	Station 520-E Temperature (°C)	Station 520-E Sample (SU)	Station 520-N Level (ft)	Station 520-N Flow Rate (cfs)	Station 520-N Temperature (°C)	Station 520-N Sample (SU)	Station 520-U Level (ft)	Station 520-U Flow Rate (cfs)	Station 520-U Temperature (°C)	Station 520-U Sample (SU)
10/22/2019 07:51					29								
10/22/2019 07:55	0.00	0.121	0.007	12.305		0.039	0.000	12.493		0.175	0.024	12.210	
10/22/2019 08:00	0.00	0.121	0.007	12.293		0.036	0.000	12.486		0.168	0.022	12.189	38
10/22/2019 08:05	0.00	0.112	0.006	12.278		0.034	0.000	12.489		0.162	0.020	12.172	
10/22/2019 08:10	0.00	0.104	0.005	12.267		0.031	0.000	12.504		0.157	0.018	12.160	
10/22/2019 08:15	0.00	0.102	0.004	12.266		0.029	0.000	12.528		0.153	0.017	12.154	
10/22/2019 08:20	0.00	0.094	0.003	12.273		0.027	0.000	12.551		0.153	0.017	12.151	
10/22/2019 08:25	0.00	0.092	0.003	12.286		0.025	0.000	12.570		0.153	0.017	12.150	
10/22/2019 08:30	0.00	0.093	0.003	12.301		0.023	0.000	12.583		0.154	0.017	12.149	
10/22/2019 08:35	0.00	0.090	0.003	12.311		0.022	0.000	12.596		0.153	0.017	12.149	
10/22/2019 08:40	0.00	0.092	0.003	12.315		0.022	0.000	12.606		0.150	0.016	12.150	
10/22/2019 08:45	0.00	0.094	0.003	12.323		0.021	0.000	12.611		0.148	0.015	12.151	
10/22/2019 08:50	0.00	0.087	0.003	12.330		0.021	0.000	12.610		0.145	0.014	12.156	
10/22/2019 08:55	0.01	0.083	0.002	12.334		0.021	0.000	12.612		0.145	0.014	12.159	
10/22/2019 09:00	0.00	0.086	0.002	12.337		0.021	0.000	12.616		0.127	0.010	12.162	
10/22/2019 09:05	0.00	0.085	0.002	12.337		0.020	0.000	12.619		0.115	0.007	12.163	
10/22/2019 09:10	0.00	0.084	0.002	12.336		0.020	0.000	12.622		0.113	0.007	12.163	
10/22/2019 09:15	0.00	0.082	0.002	12.334		0.019	0.000	12.623		0.109	0.006	12.163	
10/22/2019 09:20	0.00	0.077	0.002	12.331		0.018	0.000	12.620		0.106	0.006	12.160	
10/22/2019 09:25	0.00	0.075	0.001	12.327		0.018	0.000	12.616		0.102	0.005	12.152	
10/22/2019 09:30	0.00	0.075	0.001	12.316		0.017	0.000	12.607		0.099	0.005	12.148	
10/22/2019 09:35	0.00	0.075	0.002	12.308		0.016	0.000	12.591		0.098	0.004	12.148	

Notes:

[1] All times are as recorded by automatic datalogger and transmitted to the sampling lead's computer via telemetry and do not exactly match times on field notes or chain of custody (COC) forms.

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Mobilization Event 27 | 11/15/2019

January 15, 2020

Storm Summary Report

Re: November 15, 2019, Storm Event

Project No. 160418

Introduction

This Storm Summary Report summarizes the storm sampling event that began on November 15, 2019, and includes a summary and documentation of all sampling-related activities. The November 15, 2019, event is the twenty-seventh storm sample event for the SR-520 Bridge AKART Stormwater Monitoring Project.

Storm Validation Summary

The event began on November 15, 2019, at 4:20 after an antecedent dry period exceeding 6 hours. The event ended November 15, 2019, at 6:45. The total measured rainfall for the event was 0.20 inches over a period of 2.42 hours. All three stations were targeted for sampling and enabled on the rising limb of the storm hydrograph. All three stations met the sample validation criteria for sample volume, minimum number of aliquots, and percent coverage of the storm runoff (see Table 1). All samples were submitted to the laboratory within the 24-hour hold time. The water temperature was at least 12.06 degrees Celsius (C) at the time of collection, and the samples were iced and at or below 4.6 degrees C when they were submitted to the lab.

Hydrographs

The attached hydrographs show the water level and flow rate in each weir along with markers for each sample aliquot and 5-minute rain data.

Storm Tracking

The Go-No-Go field sheet documents the weather forecasts and the decision to target prior to the November 15, 2019, event (Attachment A). The printout from the National Weather Forecast shows the latest forecast roughly 8 hours and 20 minutes prior to the beginning of the rainfall (Attachment B).

Storm Field Sheets

The field sheets document the field and storm control procedures for the event (Attachment C and D). The field sheets also include the Chain-of-Custody (COC) form (Attachment E).

Attachments

Table 1. Storm Validation Summary	*(Included with Quarterly Report attachment)*
520E_111519 Hydrograph	*(Included with Quarterly Report attachment)*
520N_111519 Hydrograph	*(Included with Quarterly Report attachment)*
520U_111519 Hydrograph	*(Included with Quarterly Report attachment)*
Attachment A. Storm Tracking Sheet Go-No-Go Sheets	*(On file)*
Attachment B. National Weather Service Forecast Sheet	*(On file)*
Attachment C. Storm Control Sheets	*(On file)*
Attachment D. Field Sheets	*(On file)*
Attachment E. Chain of Custody	*(On file)*

V:\160418 SR-520 Bridge Stormwater Monitoring\Deliverables\Storm Summaries 2019\27_111519\Storm 27 Summary Report 111519_20200115.docx

Table 1. Storm Validation Summary

Mobilization Event 27 | 11/15/2019

Project No. 160418

SR-520 Floating Bridge Stormwater Monitoring Storm and Sample Validation Checklist

Storm Date	**November 15, 2019**	
Storm Event Number	**27**	
Criterion	**Y / N**	**Value**
Rainfall Depth ≥ 0.15	Y	0.2
Rainfall Duration > 1 hr	Y	2.42
Antecedent Rainfall < 0.04" in 6 hrs	Y	0

Notes:

	Station					
	520-E		**520-N**		**520-U**	
Criterion	**Y / N**	**Value**	**Y / N**	**Value**	**Y / N**	**Value**
Aliquots ≥ 10	Y	33	Y	22	Y	34
Sample Volume ≥ 1 liter	Y	~4	Y	~2	Y	~3
Does Sample cover more than 75% of hydrograph?	Y	100.0%	Y	100.0%	Y	100.0%
Sample Valid Y / N?	Y		Y		Y	

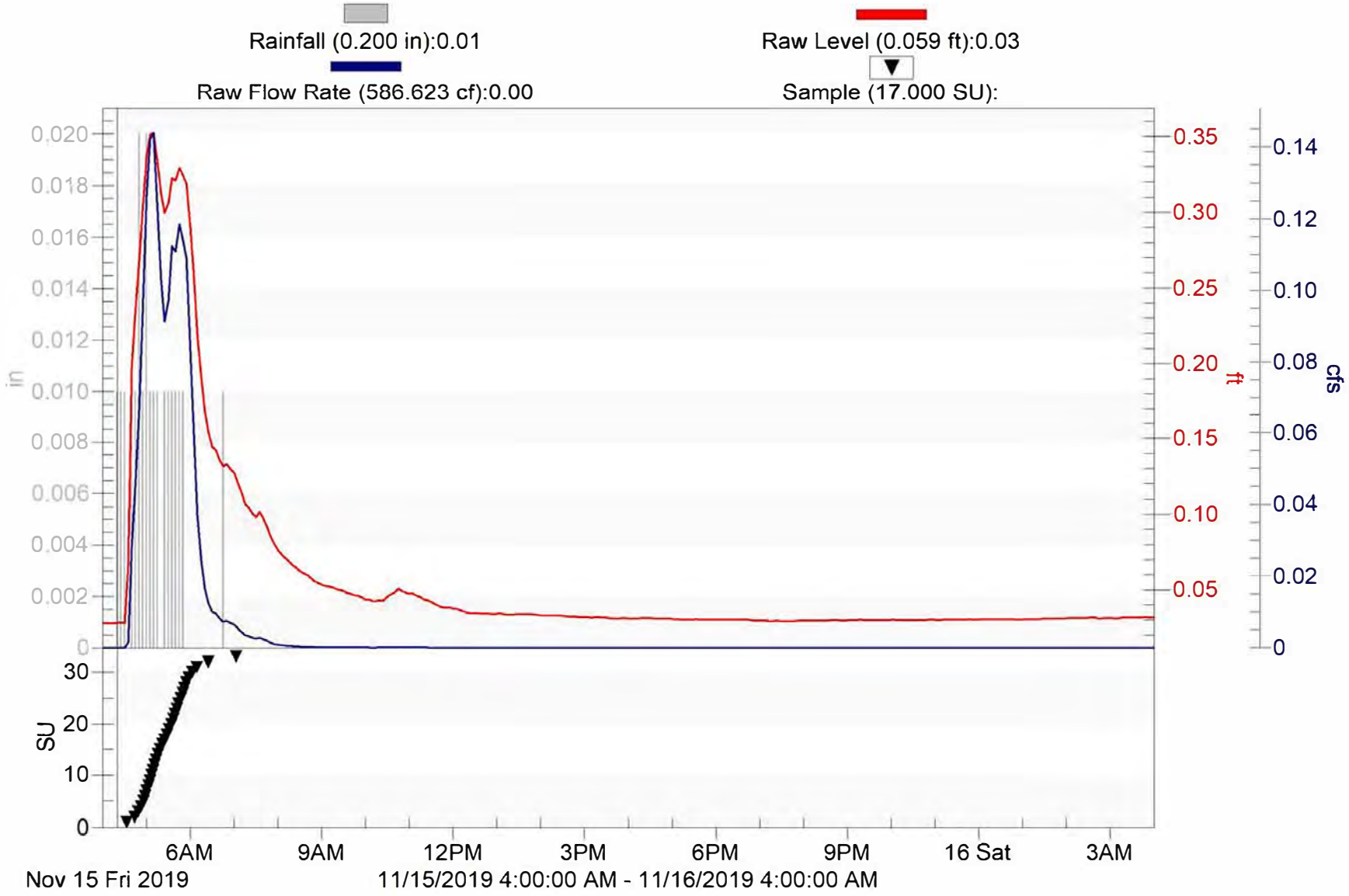
Notes:

Storm Summary Description

The event totaled 0.20 inches over 2.42 hours. All samples were successful.

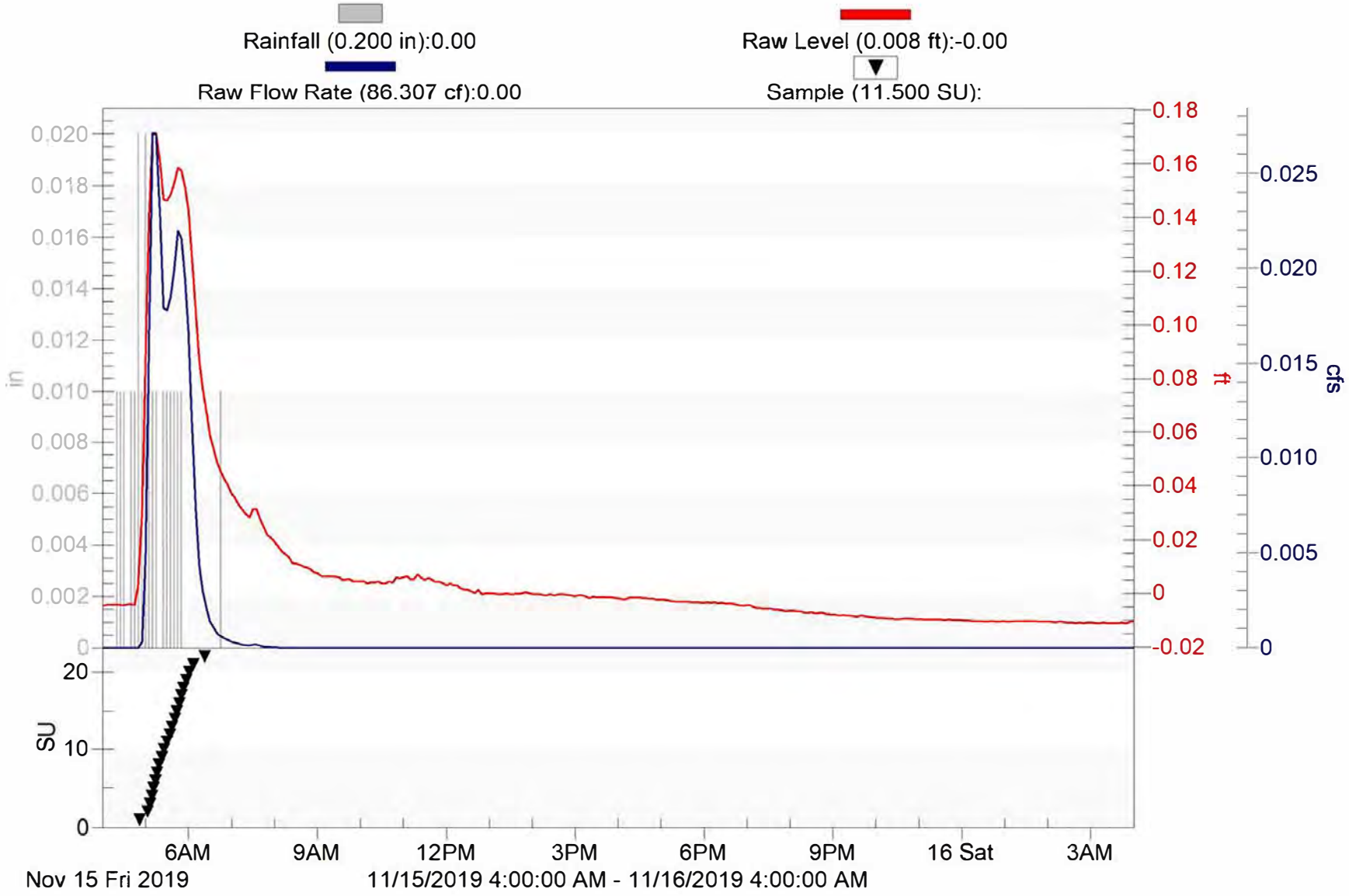
520_E

Event 27



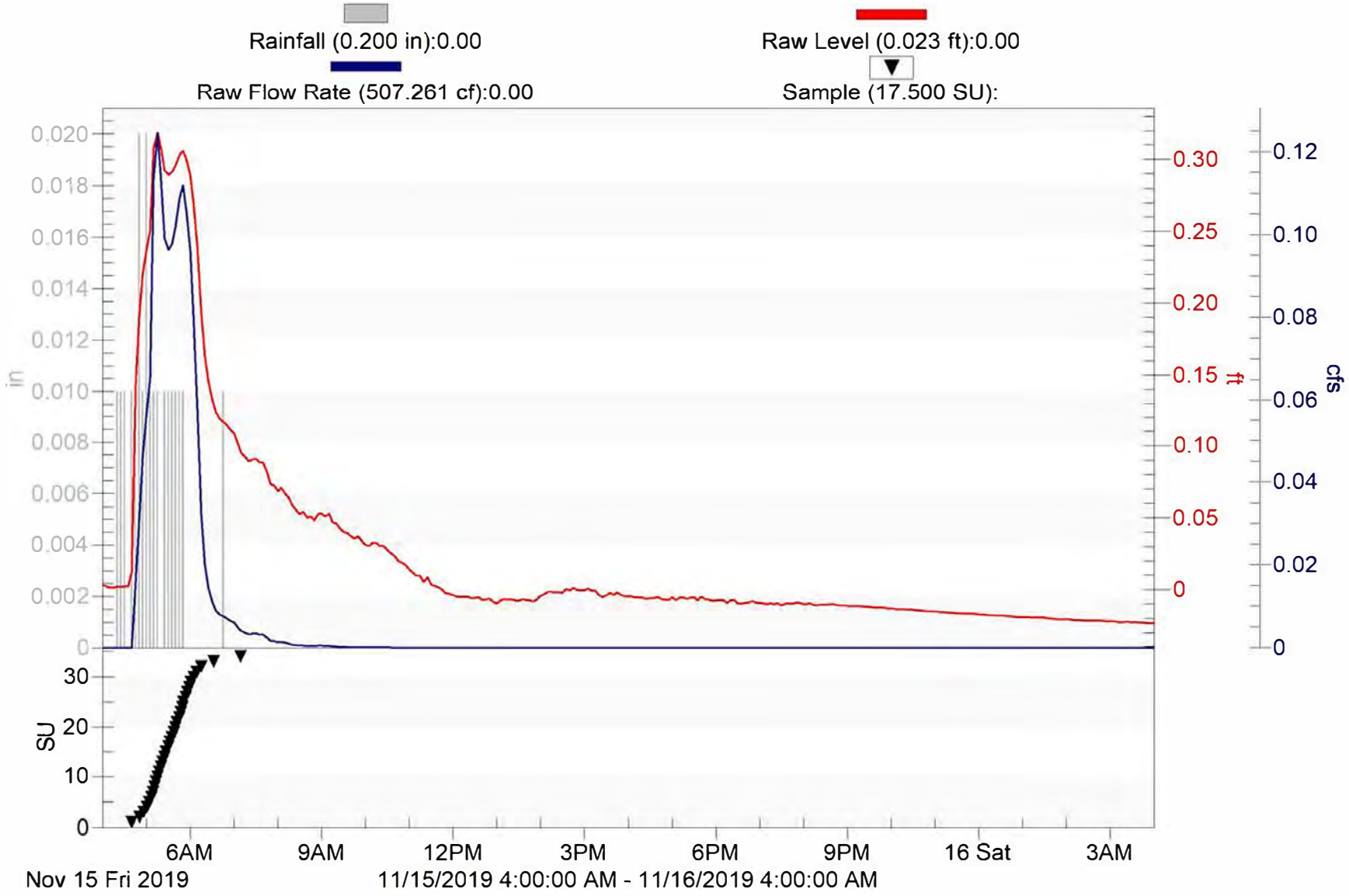
520_N

Event 27



520_U

Event 27



Storm Event #27 Monitoring Data

Date & Time[1]	UW ATG Rainfall (in)	Station 520-E Level (ft)	Station 520-E Flow Rate (cfs)	Station 520-E Temperature (°C)	Station 520-E Sample (SU)	Station 520-N Level (ft)	Station 520-N Flow Rate (cfs)	Station 520-N Temperature (°C)	Station 520-N Sample (SU)	Station 520-U Level (ft)	Station 520-U Flow Rate (cfs)	Station 520-U Temperature (°C)	Station 520-U Sample (SU)
11/15/2019 04:15	0.00	0.032	0.000	11.159		0.005	0.000	11.168		0.021	0.000	11.045	
11/15/2019 04:20	0.01	0.032	0.000	11.120		0.005	0.000	11.123		0.022	0.000	11.007	
11/15/2019 04:25	0.01	0.032	0.000	11.077		0.005	0.000	11.080		0.021	0.000	10.972	
11/15/2019 04:30	0.01	0.032	0.000	11.031		0.004	0.000	11.036		0.022	0.000	10.923	
11/15/2019 04:33					1								
11/15/2019 04:35	0.00	0.070	0.001	10.982		0.005	0.000	10.986		0.022	0.000	10.862	
11/15/2019 04:40	0.01	0.201	0.034	10.940		0.005	0.000	10.924		0.032	0.000	10.803	1
11/15/2019 04:44					2								
11/15/2019 04:45	0.01	0.242	0.056	10.877		0.004	0.000	10.858		0.164	0.020	10.754	
11/15/2019 04:49					3								
11/15/2019 04:50	0.02	0.272	0.077	10.818		0.012	0.000	10.795		0.210	0.040	10.683	
11/15/2019 04:51													2
11/15/2019 04:52									1				
11/15/2019 04:53					4								
11/15/2019 04:55	0.01	0.306	0.107	10.764		0.040	0.000	10.740		0.239	0.058	10.601	
11/15/2019 04:56					5								3
11/15/2019 04:58					6								
11/15/2019 05:00	0.02	0.341	0.143	10.710	7	0.098	0.006	10.694		0.258	0.071	10.521	
11/15/2019 05:01													4
11/15/2019 05:03					8				2				
11/15/2019 05:04													5
11/15/2019 05:05	0.01	0.355	0.159	10.654	9	0.151	0.019	10.654		0.270	0.080	10.448	
11/15/2019 05:06									3				
11/15/2019 05:07					10								6
11/15/2019 05:09					11				4				7
11/15/2019 05:10	0.01	0.356	0.161	10.595		0.180	0.031	10.615		0.328	0.134	10.355	
11/15/2019 05:11					12				5				8
11/15/2019 05:13					13								9
11/15/2019 05:14									6				
11/15/2019 05:15	0.01	0.336	0.138	10.538		0.180	0.031	10.586		0.338	0.146	10.240	10
11/15/2019 05:16					14				7				
11/15/2019 05:17													11
11/15/2019 05:19					15				8				
11/15/2019 05:20	0.00	0.317	0.117	10.486		0.169	0.026	10.557		0.327	0.133	10.132	12

Storm Event #27 Monitoring Data

Date & Time[1]	UW ATG Rainfall (in)	Station 520-E Level (ft)	Station 520-E Flow Rate (cfs)	Station 520-E Temperature (°C)	Station 520-E Sample (SU)	Station 520-N Level (ft)	Station 520-N Flow Rate (cfs)	Station 520-N Temperature (°C)	Station 520-N Sample (SU)	Station 520-U Level (ft)	Station 520-U Flow Rate (cfs)	Station 520-U Temperature (°C)	Station 520-U Sample (SU)
11/15/2019 05:22					16								13
11/15/2019 05:23									9				
11/15/2019 05:25	0.01	0.304	0.105	10.438	17	0.155	0.021	10.516		0.312	0.118	10.058	14
11/15/2019 05:26									10				
11/15/2019 05:27													15
11/15/2019 05:28					18								
11/15/2019 05:30	0.01	0.310	0.111	10.402		0.155	0.021	10.459	11	0.309	0.115	9.983	16
11/15/2019 05:31					19								
11/15/2019 05:32													17
11/15/2019 05:34					20				12				
11/15/2019 05:35	0.01	0.327	0.127	10.364		0.157	0.021	10.397		0.311	0.116	9.908	18
11/15/2019 05:37					21				13				
11/15/2019 05:38													19
11/15/2019 05:39					22								
11/15/2019 05:40	0.01	0.325	0.126	10.322		0.161	0.023	10.335		0.315	0.121	9.834	20
11/15/2019 05:41									14				
11/15/2019 05:42					23								21
11/15/2019 05:44					24				15				
11/15/2019 05:45	0.01	0.333	0.134	10.279		0.167	0.025	10.278		0.323	0.128	9.764	22
11/15/2019 05:47					25				16				23
11/15/2019 05:49													24
11/15/2019 05:50	0.01	0.328	0.129	10.230	26	0.166	0.025	10.223	17	0.326	0.132	9.702	
11/15/2019 05:51													25
11/15/2019 05:52					27								
11/15/2019 05:53									18				
11/15/2019 05:54													26
11/15/2019 05:55	0.00	0.323	0.124	10.177	28	0.160	0.023	10.169		0.319	0.125	9.648	
11/15/2019 05:56													27
11/15/2019 05:57									19				
11/15/2019 05:58					29								
11/15/2019 05:59													28
11/15/2019 06:00	0.00	0.293	0.095	10.124		0.151	0.019	10.124		0.309	0.114	9.601	
11/15/2019 06:01									20				29
11/15/2019 06:03					30								

Storm Event #27 Monitoring Data

Date & Time[1]	UW ATG Rainfall (in)	Station 520-E Level (ft)	Station 520-E Flow Rate (cfs)	Station 520-E Temperature (°C)	Station 520-E Sample (SU)	Station 520-N Level (ft)	Station 520-N Flow Rate (cfs)	Station 520-N Temperature (°C)	Station 520-N Sample (SU)	Station 520-U Level (ft)	Station 520-U Flow Rate (cfs)	Station 520-U Temperature (°C)	Station 520-U Sample (SU)
11/15/2019 06:05	0.00	0.261	0.070	10.068		0.134	0.014	10.084		0.287	0.094	9.560	30
11/15/2019 06:07									21				
11/15/2019 06:09					31								31
11/15/2019 06:10	0.00	0.223	0.045	10.021		0.113	0.009	10.048		0.259	0.071	9.524	
11/15/2019 06:15	0.00	0.194	0.030	9.980		0.095	0.006	10.019		0.212	0.042	9.494	32
11/15/2019 06:20	0.00	0.172	0.022	9.942		0.084	0.004	9.991		0.183	0.028	9.474	
11/15/2019 06:23									22				
11/15/2019 06:25	0.00	0.158	0.017	9.905	32	0.076	0.003	9.958		0.166	0.021	9.458	
11/15/2019 06:30	0.00	0.148	0.014	9.861		0.067	0.002	9.921		0.153	0.017	9.426	
11/15/2019 06:32													33
11/15/2019 06:35	0.00	0.146	0.013	9.823		0.062	0.002	9.889		0.144	0.014	9.380	
11/15/2019 06:40	0.00	0.140	0.012	9.789		0.057	0.001	9.853		0.139	0.013	9.337	
11/15/2019 06:45	0.01	0.135	0.010	9.748		0.054	0.001	9.813		0.137	0.012	9.291	
11/15/2019 06:50	0.00	0.137	0.011	9.690		0.051	0.001	9.769		0.134	0.012	9.242	
11/15/2019 06:55	0.00	0.134	0.010	9.633		0.048	0.001	9.724		0.131	0.011	9.196	
11/15/2019 07:00	0.00	0.131	0.010	9.588		0.045	0.001	9.685		0.129	0.010	9.161	
11/15/2019 07:03					33								
11/15/2019 07:05	0.00	0.125	0.008	9.551		0.044	0.001	9.648		0.122	0.009	9.141	
11/15/2019 07:09													34
11/15/2019 07:10	0.00	0.119	0.007	9.522		0.041	0.000	9.617		0.115	0.007	9.132	
11/15/2019 07:15	0.00	0.111	0.006	9.501		0.039	0.000	9.599		0.112	0.007	9.134	
11/15/2019 07:20	0.00	0.108	0.005	9.491		0.038	0.000	9.586		0.109	0.006	9.127	
11/15/2019 07:25	0.00	0.105	0.005	9.484		0.036	0.000	9.581		0.110	0.006	9.122	
11/15/2019 07:30	0.00	0.102	0.004	9.479		0.040	0.000	9.578		0.111	0.007	9.108	
11/15/2019 07:35	0.00	0.106	0.005	9.487		0.039	0.000	9.582		0.108	0.006	9.087	
11/15/2019 07:40	0.00	0.101	0.004	9.501		0.036	0.000	9.599		0.108	0.006	9.089	
11/15/2019 07:45	0.00	0.096	0.003	9.520		0.033	0.000	9.623		0.101	0.005	9.112	
11/15/2019 07:50	0.00	0.089	0.003	9.536		0.030	0.000	9.648		0.093	0.004	9.149	

Notes:

[1] All times are as recorded by automatic datalogger and transmitted to the sampling lead's computer via telemetry and do not exactly match times on field notes or chain of custody (COC) forms.

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Attachment 2

Laboratory Analysis Summaries

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Am Test Inc.
13600 NE 126TH PL
Suite C
Kirkland, WA 98034
(425) 885-1664
www.amtestlab.com

Professional Analytical Services

ANALYSIS REPORT

WSDOT Environmental Services
Water Quality Data Steward
Olympia, WA 98504-7332
Attention: BRIAN DOBBINS
Project Name: SR520 AKART
Project #: MS7489-99
PO Number: SR520-091619
All results reported on an as received basis.

Date Received: 09/16/19
Date Reported: 6/7/18

Mobilization Event 23 | 09/14/2019

AMTEST Identification Number **19-A015116**
Client Identification **520E-091519-23**
Sampling Date **09/15/19, 12:18**

Total Metals EPA 200.8

PARAMETER	RESULT	UNITS	Q	D.L.	METHOD	ANALYST	DATE
Cadmium	0.084	ug/L		0.05	EPA 200.8	AY	10/09/19
Copper	20.9	ug/L		0.1	EPA 200.8	AY	10/09/19
Lead	1.08	ug/L		0.1	EPA 200.8	AY	10/09/19
Zinc	54.9	ug/L	N	0.5	EPA 200.8	AY	10/09/19
Acid Dig.(Tot Metals)	Y				EPA 3010	JDM	09/24/19

Dissolved Metals EPA 200.8

PARAMETER	RESULT	UNITS	Q	D.L.	METHOD	ANALYST	DATE
Dissolved Cadmium	< 0.05	ug/L		0.05	EPA 200.8	AY	09/23/19
Dissolved Copper	6.60	ug/L		0.1	EPA 200.8	AY	09/23/19
Dissolved Lead	< 0.1	ug/L		0.1	EPA 200.8	AY	09/23/19
Dissolved Zinc	20.7	ug/L	N	0.5	EPA 200.8	AY	09/23/19
Acid Dig. (Diss Metals)	Y				EPA 3005	AY	09/16/19

AMTEST Identification Number **19-A015117**
Client Identification **520N-091519-23**
Sampling Date **09/15/19, 12:48**

Total Metals EPA 200.8

PARAMETER	RESULT	UNITS	Q	D.L.	METHOD	ANALYST	DATE
Cadmium	< 0.05	ug/L		0.05	EPA 200.8	AY	10/09/19
Copper	10.6	ug/L		0.1	EPA 200.8	AY	10/09/19
Lead	0.384	ug/L		0.1	EPA 200.8	AY	10/09/19
Zinc	23.2	ug/L	N	0.5	EPA 200.8	AY	10/09/19
Acid Dig.(Tot Metals)	Y				EPA 3010	JDM	09/24/19

Dissolved Metals EPA 200.8

PARAMETER	RESULT	UNITS	Q	D.L.	METHOD	ANALYST	DATE
Dissolved Cadmium	< 0.05	ug/L		0.05	EPA 200.8	AY	09/23/19
Dissolved Copper	4.91	ug/L		0.1	EPA 200.8	AY	09/23/19
Dissolved Lead	< 0.1	ug/L		0.1	EPA 200.8	AY	09/23/19
Dissolved Zinc	11.4	ug/L	N	0.5	EPA 200.8	AY	09/23/19
Acid Dig. (Diss Metals)	Y				EPA 3005	AY	09/16/19

AMTEST Identification Number **19-A015118**
Client Identification **520U-091519-23**
Sampling Date **09/15/19, 12:15**

Total Metals EPA 200.8

PARAMETER	RESULT	UNITS	Q	D.L.	METHOD	ANALYST	DATE
Cadmium	< 0.05	ug/L		0.05	EPA 200.8	AY	10/09/19
Copper	16.8	ug/L		0.1	EPA 200.8	AY	10/09/19
Lead	0.825	ug/L		0.1	EPA 200.8	AY	10/09/19
Zinc	40.7	ug/L	N	0.5	EPA 200.8	AY	10/09/19
Acid Dig.(Tot Metals)	Y				EPA 3010	JDM	09/24/19

Dissolved Metals EPA 200.8

PARAMETER	RESULT	UNITS	Q	D.L.	METHOD	ANALYST	DATE
Dissolved Cadmium	< 0.05	ug/L		0.05	EPA 200.8	AY	09/23/19
Dissolved Copper	5.82	ug/L		0.1	EPA 200.8	AY	09/23/19
Dissolved Lead	< 0.1	ug/L		0.1	EPA 200.8	AY	09/23/19
Dissolved Zinc	12.6	ug/L	N	0.5	EPA 200.8	AY	09/23/19
Acid Dig. (Diss Metals)	Y				EPA 3005	AY	09/16/19

AMTEST Identification Number **19-A015119**
Client Identification **520U-091519-DUP**
Sampling Date **09/15/19, 12:15**

Total Metals EPA 200.8

PARAMETER	RESULT	UNITS	Q	D.L.	METHOD	ANALYST	DATE
Cadmium	< 0.05	ug/L		0.05	EPA 200.8	AY	10/09/19
Copper	16.8	ug/L		0.1	EPA 200.8	AY	10/09/19
Lead	0.869	ug/L		0.1	EPA 200.8	AY	10/09/19
Zinc	43.3	ug/L	N	0.5	EPA 200.8	AY	10/09/19
Acid Dig.(Tot Metals)	Y				EPA 3010	JDM	09/24/19

Dissolved Metals EPA 200.8

PARAMETER	RESULT	UNITS	Q	D.L.	METHOD	ANALYST	DATE
Dissolved Cadmium	< 0.05	ug/L		0.05	EPA 200.8	AY	09/23/19
Dissolved Copper	5.94	ug/L		0.1	EPA 200.8	AY	09/23/19
Dissolved Lead	< 0.1	ug/L		0.1	EPA 200.8	AY	09/23/19
Dissolved Zinc	13.1	ug/L	N	0.5	EPA 200.8	AY	09/23/19
Acid Dig. (Diss Metals)	Y				EPA 3005	AY	09/16/19

N = The Matrix Spike sample recovery is not within control limits. See case narrative.

Case Narrative:

The temperature of the sample(s) upon arrival at the laboratory was 1.1 degrees Celcius.

Case Narrative:

One of the Total Zinc matrix spike results associated with this analytical batch, was outside of the acceptable levels. All other QA/QC was within limits, therefore it is attributed to matrix interference.

One of the Dissolved Zinc matrix spike results associated with this analytical batch, was outside of the acceptable levels. All other QA/QC was within limits, therefore it is attributed to matrix interference.

No further corrective action was taken.

Aaron W. Young
Laboratory Manager

Am Test Inc.
13600 NE 126TH PL
Suite C
Kirkland, WA 98034
(425) 885-1664
www.amtestlab.com

Professional Analytical Services

ANALYSIS REPORT

WSDOT Environmental Services
Water Quality Data Steward
Olympia, WA 98504-7332
Attention: BRIAN DOBBINS
Project Name: SR520 AKART
Project #: MS7489-99
PO Number: SR520-091819
All results reported on an as received basis.

Date Received: 09/18/19
Date Reported: 6/7/18

Mobilization Event 24 | 09/17/2019

AMTEST Identification Number **19-A015232**
Client Identification **520E-091719-24**
Sampling Date **09/17/19, 21:38**

Total Metals EPA 200.8

PARAMETER	RESULT	UNITS	Q	D.L.	METHOD	ANALYST	DATE
Cadmium	0.101	ug/L		0.05	EPA 200.8	AY	10/09/19
Copper	57.8	ug/L		0.1	EPA 200.8	AY	10/09/19
Lead	3.66	ug/L		0.1	EPA 200.8	AY	10/09/19
Zinc	177.	ug/L	N	0.5	EPA 200.8	AY	10/09/19
Acid Dig.(Tot Metals)	Y				EPA 3010	JDM	09/24/19

Dissolved Metals EPA 200.8

PARAMETER	RESULT	UNITS	Q	D.L.	METHOD	ANALYST	DATE
Dissolved Cadmium	< 0.05	ug/L		0.05	EPA 200.8	AY	09/23/19
Dissolved Copper	13.9	ug/L		0.1	EPA 200.8	AY	09/23/19
Dissolved Lead	< 0.1	ug/L		0.1	EPA 200.8	AY	09/23/19
Dissolved Zinc	47.4	ug/L	N	0.5	EPA 200.8	AY	09/23/19
Acid Dig. (Diss Metals)	Y				EPA 3005	AY	09/18/19

AMTEST Identification Number **19-A015233**
Client Identification **520N-091719-24**
Sampling Date **09/17/19, 22:43**

Total Metals EPA 200.8

PARAMETER	RESULT	UNITS	Q	D.L.	METHOD	ANALYST	DATE
Cadmium	< 0.05	ug/L		0.05	EPA 200.8	AY	10/09/19
Copper	16.4	ug/L		0.1	EPA 200.8	AY	10/09/19
Lead	0.753	ug/L		0.1	EPA 200.8	AY	10/09/19
Zinc	47.0	ug/L	N	0.5	EPA 200.8	AY	10/09/19
Acid Dig.(Tot Metals)	Y				EPA 3010	JDM	09/24/19

Dissolved Metals EPA 200.8

PARAMETER	RESULT	UNITS	Q	D.L.	METHOD	ANALYST	DATE
Dissolved Cadmium	< 0.05	ug/L		0.05	EPA 200.8	AY	09/23/19
Dissolved Copper	7.03	ug/L		0.1	EPA 200.8	AY	09/23/19
Dissolved Lead	< 0.1	ug/L		0.1	EPA 200.8	AY	09/23/19
Dissolved Zinc	19.5	ug/L	N	0.5	EPA 200.8	AY	09/23/19
Acid Dig. (Diss Metals)	Y				EPA 3005	AY	09/18/19

AMTEST Identification Number **19-A015234**
Client Identification **520N-091719-DUP**
Sampling Date **09/17/19, 22:43**

Total Metals EPA 200.8

PARAMETER	RESULT	UNITS	Q	D.L.	METHOD	ANALYST	DATE
Cadmium	< 0.05	ug/L		0.05	EPA 200.8	AY	10/09/19
Copper	16.2	ug/L		0.1	EPA 200.8	AY	10/09/19
Lead	0.788	ug/L		0.1	EPA 200.8	AY	10/09/19
Zinc	45.6	ug/L	N	0.5	EPA 200.8	AY	10/09/19
Acid Dig.(Tot Metals)	Y				EPA 3010	JDM	09/24/19

Dissolved Metals EPA 200.8

PARAMETER	RESULT	UNITS	Q	D.L.	METHOD	ANALYST	DATE
Dissolved Cadmium	< 0.05	ug/L		0.05	EPA 200.8	AY	09/23/19
Dissolved Copper	6.80	ug/L		0.1	EPA 200.8	AY	09/23/19
Dissolved Lead	< 0.1	ug/L		0.1	EPA 200.8	AY	09/23/19
Dissolved Zinc	20.3	ug/L	N	0.5	EPA 200.8	AY	09/23/19
Acid Dig. (Diss Metals)	Y				EPA 3005	AY	09/18/19

AMTEST Identification Number **19-A015235**
Client Identification **520U-091719-24**
Sampling Date **09/17/19, 22:46**

Total Metals EPA 200.8

PARAMETER	RESULT	UNITS	Q	D.L.	METHOD	ANALYST	DATE
Cadmium	0.085	ug/L		0.05	EPA 200.8	AY	10/09/19
Copper	60.5	ug/L		0.1	EPA 200.8	AY	10/09/19
Lead	3.86	ug/L		0.1	EPA 200.8	AY	10/09/19
Zinc	155.	ug/L	N	0.5	EPA 200.8	AY	10/09/19
Acid Dig.(Tot Metals)	Y				EPA 3010	JDM	09/24/19

Dissolved Metals EPA 200.8

PARAMETER	RESULT	UNITS	Q	D.L.	METHOD	ANALYST	DATE
Dissolved Cadmium	< 0.05	ug/L		0.05	EPA 200.8	AY	09/23/19
Dissolved Copper	14.0	ug/L		0.1	EPA 200.8	AY	09/23/19
Dissolved Lead	< 0.1	ug/L		0.1	EPA 200.8	AY	09/23/19
Dissolved Zinc	25.5	ug/L	N	0.5	EPA 200.8	AY	09/23/19
Acid Dig. (Diss Metals)	Y				EPA 3005	AY	09/18/19

N = The Matrix Spike sample recovery is not within control limits. See case narrative.

Case Narrative:

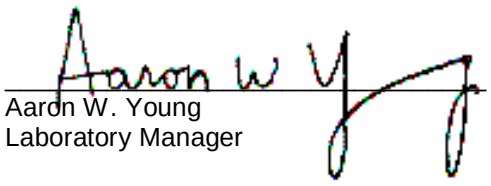
The temperature of the sample(s) upon arrival at the laboratory was 6.0 degrees Celcius.

Case Narrative:

One of the Total Zinc matrix spike results associated with this analytical batch, was outside of the acceptable levels. All other QA/QC was within limits, therefore it is attributed to matrix interference.

One of the Dissolved Zinc matrix spike results associated with this analytical batch, was outside of the acceptable levels. All other QA/QC was within limits, therefore it is attributed to matrix interference.

No further corrective action was taken.



Aaron W. Young
Laboratory Manager

Am Test Inc.
13600 NE 126TH PL
Suite C
Kirkland, WA 98034
(425) 885-1664
www.amtestlab.com

Professional Analytical Services

ANALYSIS REPORT

WSDOT Environmental Services
Water Quality Data Steward
Olympia, WA 98504-7332
Attention: BRIAN DOBBINS
Project Name: SR520 AKART
Project #: MS7489-99
PO Number: SR520-101719
All results reported on an as received basis.

Date Received: 10/17/19
Date Reported: 6/7/18

Mobilization Event 25 | 10/16/2019

AMTEST Identification Number **19-A017067**
Client Identification **520E-101719-25**
Sampling Date **10/17/19, 04:23**

Total Metals EPA 200.8

PARAMETER	RESULT	UNITS	Q	D.L.	METHOD	ANALYST	DATE
Cadmium	0.121	ug/L		0.05	EPA 200.8	AY	10/30/19
Copper	79.1	ug/L		0.1	EPA 200.8	AY	10/30/19
Lead	5.15	ug/L		0.1	EPA 200.8	AY	10/30/19
Zinc	252.	ug/L		0.5	EPA 200.8	AY	10/30/19
Acid Dig.(Tot Metals)	Y				EPA 3010	HKL	10/28/19

Dissolved Metals EPA 200.8

PARAMETER	RESULT	UNITS	Q	D.L.	METHOD	ANALYST	DATE
Dissolved Cadmium	< 0.05	ug/L		0.05	EPA 200.8	AY	10/18/19
Dissolved Copper	17.5	ug/L		0.1	EPA 200.8	AY	10/18/19
Dissolved Lead	0.168	ug/L		0.1	EPA 200.8	AY	10/18/19
Dissolved Zinc	50.2	ug/L		0.5	EPA 200.8	AY	10/18/19
Acid Dig. (Diss Metals)	Y				EPA 3005	AY	10/17/19

WSDOT Environmental Services
Project Name: SR520 AKART
AmTest ID: 19-A017068

Mobilization Event 25 | 10/16/2019

AMTEST Identification Number **19-A017068**
Client Identification **520N-101719-25**
Sampling Date **10/16/19, 21:51**

Total Metals EPA 200.8

PARAMETER	RESULT	UNITS	Q	D.L.	METHOD	ANALYST	DATE
Cadmium	0.058	ug/L		0.05	EPA 200.8	AY	10/30/19
Copper	30.9	ug/L		0.1	EPA 200.8	AY	10/30/19
Lead	1.89	ug/L		0.1	EPA 200.8	AY	10/30/19
Zinc	81.3	ug/L		0.5	EPA 200.8	AY	10/30/19
Acid Dig.(Tot Metals)	Y				EPA 3010	HKL	10/28/19

Dissolved Metals EPA 200.8

PARAMETER	RESULT	UNITS	Q	D.L.	METHOD	ANALYST	DATE
Dissolved Cadmium	0.064	ug/L		0.05	EPA 200.8	AY	10/18/19
Dissolved Copper	11.4	ug/L		0.1	EPA 200.8	AY	10/18/19
Dissolved Lead	0.183	ug/L		0.1	EPA 200.8	AY	10/18/19
Dissolved Zinc	33.7	ug/L		0.5	EPA 200.8	AY	10/18/19
Acid Dig. (Diss Metals)	Y				EPA 3005	AY	10/17/19

AMTEST Identification Number **19-A017069**
Client Identification **520U-101719-25**
Sampling Date **10/17/19, 01:03**

Total Metals EPA 200.8

PARAMETER	RESULT	UNITS	Q	D.L.	METHOD	ANALYST	DATE
Cadmium	0.065	ug/L		0.05	EPA 200.8	AY	10/30/19
Copper	64.9	ug/L		0.1	EPA 200.8	AY	10/30/19
Lead	9.72	ug/L		0.1	EPA 200.8	AY	10/30/19
Zinc	181.	ug/L		0.5	EPA 200.8	AY	10/30/19
Acid Dig.(Tot Metals)	Y				EPA 3010	HKL	10/28/19

Dissolved Metals EPA 200.8

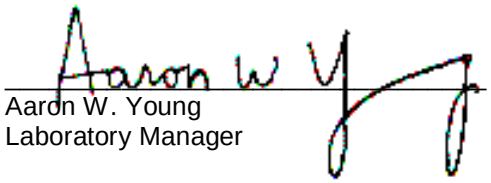
PARAMETER	RESULT	UNITS	Q	D.L.	METHOD	ANALYST	DATE
Dissolved Cadmium	< 0.05	ug/L		0.05	EPA 200.8	AY	10/18/19
Dissolved Copper	15.8	ug/L		0.1	EPA 200.8	AY	10/18/19
Dissolved Lead	0.146	ug/L		0.1	EPA 200.8	AY	10/18/19
Dissolved Zinc	34.4	ug/L		0.5	EPA 200.8	AY	10/18/19
Acid Dig. (Diss Metals)	Y				EPA 3005	AY	10/17/19

Case Narrative:

The temperature of the sample(s) upon arrival at the laboratory wa< 0.5 degrees Celcius.

WSDOT Environmental Services
Project Name: SR520 AKART
AmTest ID: 19-A017069

Mobilization Event 25 | 10/16/2019



Aaron W. Young
Laboratory Manager

Am Test Inc.
13600 NE 126TH PL
Suite C
Kirkland, WA 98034
(425) 885-1664
www.amtestlab.com

Professional Analytical Services

ANALYSIS REPORT

WSDOT Environmental Services
Water Quality Data Steward
Olympia, WA 98504-7332
Attention: BRIAN DOBBINS
Project Name: SR520 AKART
Project #: MS7489-99
PO Number: SR520-102219
All results reported on an as received basis.

Date Received: 10/22/19
Date Reported: 6/7/18

Mobilization Event 26 | 10/21/2019

AMTEST Identification Number **19-A017302**
Client Identification **520E-102219-26**
Sampling Date **10/22/19, 07:51**

Total Metals EPA 200.8

PARAMETER	RESULT	UNITS	Q	D.L.	METHOD	ANALYST	DATE
Cadmium	0.073	ug/L		0.05	EPA 200.8	HKL	11/05/19
Copper	38.4	ug/L		0.1	EPA 200.8	HKL	11/05/19
Lead	3.27	ug/L		0.1	EPA 200.8	HKL	11/05/19
Zinc	140.	ug/L		0.5	EPA 200.8	HKL	11/05/19
Acid Dig.(Tot Metals)	Y				EPA 3010	HKL	11/01/19

Dissolved Metals EPA 200.8

PARAMETER	RESULT	UNITS	Q	D.L.	METHOD	ANALYST	DATE
Dissolved Cadmium	< 0.05	ug/L		0.05	EPA 200.8	AY	10/30/19
Dissolved Copper	5.96	ug/L		0.1	EPA 200.8	AY	10/30/19
Dissolved Lead	0.116	ug/L		0.1	EPA 200.8	AY	10/30/19
Dissolved Zinc	26.9	ug/L		0.5	EPA 200.8	AY	10/30/19
Acid Dig. (Diss Metals)	Y				EPA 3005	HKL	10/22/19

Mobilization Event 26 | 10/21/2019

AMTEST Identification Number **19-A017303**
Client Identification **520N-102219-26**
Sampling Date **10/22/19, 07:15**

Total Metals EPA 200.8

PARAMETER	RESULT	UNITS	Q	D.L.	METHOD	ANALYST	DATE
Cadmium	< 0.05	ug/L		0.05	EPA 200.8	HKL	11/05/19
Copper	17.3	ug/L		0.1	EPA 200.8	HKL	11/05/19
Lead	1.23	ug/L		0.1	EPA 200.8	HKL	11/05/19
Zinc	55.9	ug/L		0.5	EPA 200.8	HKL	11/05/19
Acid Dig.(Tot Metals)	Y				EPA 3010	HKL	11/01/19

Dissolved Metals EPA 200.8

PARAMETER	RESULT	UNITS	Q	D.L.	METHOD	ANALYST	DATE
Dissolved Cadmium	< 0.05	ug/L		0.05	EPA 200.8	AY	10/30/19
Dissolved Copper	5.05	ug/L		0.1	EPA 200.8	AY	10/30/19
Dissolved Lead	0.118	ug/L		0.1	EPA 200.8	AY	10/30/19
Dissolved Zinc	19.4	ug/L		0.5	EPA 200.8	AY	10/30/19
Acid Dig. (Diss Metals)	Y				EPA 3005	HKL	10/22/19

AMTEST Identification Number **19-A017304**
Client Identification **520U-102219-26**
Sampling Date **10/22/19, 08:00**

Total Metals EPA 200.8

PARAMETER	RESULT	UNITS	Q	D.L.	METHOD	ANALYST	DATE
Cadmium	0.061	ug/L		0.05	EPA 200.8	HKL	11/05/19
Copper	31.3	ug/L		0.1	EPA 200.8	HKL	11/05/19
Lead	2.58	ug/L		0.1	EPA 200.8	HKL	11/05/19
Zinc	92.3	ug/L		0.5	EPA 200.8	HKL	11/05/19
Acid Dig.(Tot Metals)	Y				EPA 3010	HKL	11/01/19

Dissolved Metals EPA 200.8

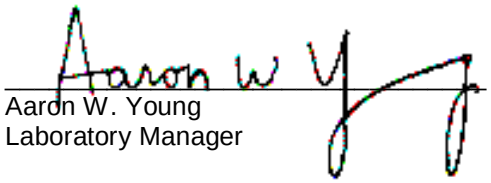
PARAMETER	RESULT	UNITS	Q	D.L.	METHOD	ANALYST	DATE
Dissolved Cadmium	< 0.05	ug/L		0.05	EPA 200.8	AY	10/30/19
Dissolved Copper	5.47	ug/L		0.1	EPA 200.8	AY	10/30/19
Dissolved Lead	< 0.1	ug/L		0.1	EPA 200.8	AY	10/30/19
Dissolved Zinc	16.9	ug/L		0.5	EPA 200.8	AY	10/30/19
Acid Dig. (Diss Metals)	Y				EPA 3005	HKL	10/22/19

Case Narrative:

The temperature of the sample(s) upon arrival at the laboratory was 2.3 degrees Celcius.

WSDOT Environmental Services
Project Name: SR520 AKART
AmTest ID: 19-A017304

Mobilization Event 26 | 10/21/2019



Aaron W. Young
Laboratory Manager

Am Test Inc.
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Suite C
Kirkland, WA 98034
(425) 885-1664
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Professional Analytical Services

ANALYSIS REPORT

WSDOT Environmental Services
Water Quality Data Steward
Olympia, WA 98504-7332
Attention: BRIAN DOBBINS
Project Name: SR520 AKART
Project #: MS7489-99
PO Number: SR520-111519
All results reported on an as received basis.

Date Received: 11/15/19
Date Reported: 6/7/18

Mobilization Event 27 | 11/15/2019

AMTEST Identification Number **19-A018917**
Client Identification **520E-111519-27**
Sampling Date **11/15/19, 07:03**

Total Metals EPA 200.8

PARAMETER	RESULT	UNITS	Q	D.L.	METHOD	ANALYST	DATE
Cadmium	0.052	ug/L		0.05	EPA 200.8	HKL	11/22/19
Copper	29.6	ug/L		0.1	EPA 200.8	HKL	11/22/19
Lead	2.08	ug/L		0.1	EPA 200.8	HKL	11/22/19
Zinc	94.9	ug/L		0.5	EPA 200.8	HKL	11/22/19
Acid Dig.(Tot Metals)	Y				EPA 3010	HKL	11/22/19

Dissolved Metals EPA 200.8

PARAMETER	RESULT	UNITS	Q	D.L.	METHOD	ANALYST	DATE
Dissolved Cadmium	< 0.05	ug/L		0.05	EPA 200.8	HKL	11/18/19
Dissolved Copper	7.54	ug/L		0.1	EPA 200.8	HKL	11/18/19
Dissolved Lead	< 0.1	ug/L		0.1	EPA 200.8	HKL	11/18/19
Dissolved Zinc	29.6	ug/L		0.5	EPA 200.8	HKL	11/18/19
Acid Dig. (Diss Metals)	Y				EPA 3005	KF	11/16/19

Mobilization Event 27 | 11/15/2019

AMTEST Identification Number **19-A018918**
Client Identification **520U-111519-27**
Sampling Date **11/15/19, 07:09**

Total Metals EPA 200.8

PARAMETER	RESULT	UNITS	Q	D.L.	METHOD	ANALYST	DATE
Cadmium	0.083	ug/L		0.05	EPA 200.8	HKL	11/22/19
Copper	24.1	ug/L		0.1	EPA 200.8	HKL	11/22/19
Lead	1.62	ug/L		0.1	EPA 200.8	HKL	11/22/19
Zinc	70.4	ug/L		0.5	EPA 200.8	HKL	11/22/19
Acid Dig.(Tot Metals)	Y				EPA 3010	HKL	11/22/19

Dissolved Metals EPA 200.8

PARAMETER	RESULT	UNITS	Q	D.L.	METHOD	ANALYST	DATE
Dissolved Cadmium	< 0.05	ug/L		0.05	EPA 200.8	HKL	11/18/19
Dissolved Copper	7.18	ug/L		0.1	EPA 200.8	HKL	11/18/19
Dissolved Lead	< 0.1	ug/L		0.1	EPA 200.8	HKL	11/18/19
Dissolved Zinc	19.1	ug/L		0.5	EPA 200.8	HKL	11/18/19
Acid Dig. (Diss Metals)	Y				EPA 3005	KF	11/16/19

AMTEST Identification Number **19-A018919**
Client Identification **520N-111519-27**
Sampling Date **11/15/19, 06:23**

Total Metals EPA 200.8

PARAMETER	RESULT	UNITS	Q	D.L.	METHOD	ANALYST	DATE
Cadmium	< 0.05	ug/L		0.05	EPA 200.8	HKL	11/22/19
Copper	24.6	ug/L		0.1	EPA 200.8	HKL	11/22/19
Lead	3.37	ug/L		0.1	EPA 200.8	HKL	11/22/19
Zinc	63.5	ug/L		0.5	EPA 200.8	HKL	11/22/19
Acid Dig.(Tot Metals)	Y				EPA 3010	HKL	11/22/19

Dissolved Metals EPA 200.8

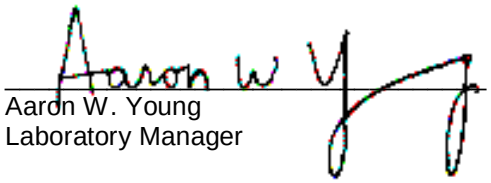
PARAMETER	RESULT	UNITS	Q	D.L.	METHOD	ANALYST	DATE
Dissolved Cadmium	< 0.05	ug/L		0.05	EPA 200.8	HKL	11/18/19
Dissolved Copper	7.00	ug/L		0.1	EPA 200.8	HKL	11/18/19
Dissolved Lead	< 0.1	ug/L		0.1	EPA 200.8	HKL	11/18/19
Dissolved Zinc	21.6	ug/L		0.5	EPA 200.8	HKL	11/18/19
Acid Dig. (Diss Metals)	Y				EPA 3005	KF	11/16/19

Case Narrative:

The temperature of the sample(s) upon arrival at the laboratory was 4.6 degrees Celcius.

WSDOT Environmental Services
Project Name: SR520 AKART
AmTest ID: 19-A018919

Mobilization Event 27 | 11/15/2019



Aaron W. Young
Laboratory Manager

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Attachment 3

Sample Validity Review

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From: Nolan, Robert (ECY) <rnol461@ECY.WA.GOV>
Sent: Thursday, May 16, 2019 8:57 AM
To: Dobbins, Brian <DobbinB@wsdot.wa.gov>
Subject: RE: SR520 Floating Bridge AKART Annual Report - Initial Questions from Brian

Hi Brian,

I have reviewed your requests and agree with your reasoning. You may include the noted data and sampling events as qualifying events.

Thanks for asking and for coordinating with me.

Bobb

From: Dobbins, Brian [mailto:DobbinB@wsdot.wa.gov]
Sent: Tuesday, May 14, 2019 2:12 PM
To: Nolan, Robert (ECY) <rnol461@ECY.WA.GOV>
Subject: SR520 Floating Bridge AKART Annual Report - Initial Questions from Brian

Bobb,

As you recall, we met on March 14th to discuss the status of the SR 520 AKART monitoring program. We talked about progress and questions we had as part of our annual report preparation, specifically five of our sampled and lab-processed events fell outside the normal parameters for collection and processing procedures. As a follow-up to that meeting, I am asking if you could review our rationale for keeping and processing those events and provide your opinion if those events will count toward the 22 qualifying events. The following are our rationale for including them in our data set.

1. ***The 1/4/2018 storm had issues with temperature readings. The laboratory did not record the sample temperature at the time of intake. The original Chain of Custody (COC) did not have a temperature listed on the water sample transportation cooler. The corrected COC has a temperature of 16.5°C.***
   WSDOT published guidance on sample temperature as part of their addendum to their 2014 NPDES permit as approved by Ecology. In the *Stormwater Monitoring: Chemical Data Validation and Guidance* (2014), the topic of temperature in relation to sample validity is discussed in Table 9. Table 9 shows that if the cooler temperature is ≥6° C and the sample transit time is ≤ 24 hours, then no action would be required.
   All three sample stations met the sample validation criteria for sample volume, minimum number of aliquots and percent coverage of the storm runoff. All samples were submitted to the laboratory with the 24-hour hold time. Per Table 9, this would require no further action and the sample should be accepted.
   It is not clear how the laboratory recorded a temperature reading of 16.5°C. During sample collection the maximum water temperature at 520E was 9.1°C, the maximum water temperature at 520N was 8.9°C, and the maximum water temperature at 520U was 9.8°C. The maximum air temperature at a nearby UW Atmospheric Sciences thermometer was 10.9°C for the period between the start of the event and the time the samples were submitted to the lab. All samples were placed in coolers on ice for the roughly 1-hour transit time to the laboratory. The (COC) did not have a cooler temperature listed on it.

At some point in the 30 minutes between sample delivery and filtration, laboratory staff recorded a temperature reading of 16.5°C. This temperature reading can only be explained as a reading or recording error, or the increase due to warming in the lab that may have occurred in the 30 minutes between the sample being removed from the ice and filtering. Because the sample meets the minimum temperature requirements and maximum allowable holding time of 24 hours, we request that this sample be accepted in the monitoring data set.

2. ***The 4/4/2018 storm is a composite made from two back to back storm events that exceeded the 6-hour dry period cut off between the two storm events by 24 minutes.***

   The composite storm refers to the fact that there was a greater than 6-hour dry delay (6 hours and 24 minutes) between two rainfall periods that were combined into one event for sampling. This dry period in the middle of the 12.92-hour storm was not forecasted.

   A review of the hydrographs from this event shows that all three stations continued to flow throughout the lull. 520E records flow throughout the lull, and although the flow rates round down to 0 at 520N and 520U, the water levels remained above the invert of the weir notches (0.02 foot at 520N and 0.01 foot at 520U). This means the water level was below where the weir could accurately measure, but both sides continued to discharge at a very low rate and there was no hydrologic separation of the early and later portions of the 4/4/18 event.

   The loading rate of metals on the SR 520 floating bridge is almost entirely driven by the traffic driving across it. Each car contributes as it crosses the bridge and the loading is relatively constant. Each storm generates runoff, which will wash these metals off the road at a rate driven by the rainfall intensity and total depth. During any given event, it is assumed the cars continue to contribute their load regardless of whether or not it is actively raining or if it is dry. The distribution of rain over any period is what "washes off" pollutants; short gaps of no rainfall are not expected to affect results.

   We believe that this event meets the intent of the event definition and should be included in the data set.

3. ***The 4/4/2018 Dissolved Zinc matrix spike results associated with the analytical batch were outside of the acceptable limits. What does this mean and why would the lab state "No further corrective action taken"?***

   AmTest Laboratory runs matrix spikes to determine if there are instrument errors at the lab. Both low matrix spike results came from the same sample. Per discussion with the lab, every other internal QC result for that batch of samples was within the established limits, and the low matrix spike results were due to interference of that particular sample with the added spike rather than an instrument error. Interference, not instrument errors can happen as tests samples come from a multitude of sources such as industrial processes, drinking water and agriculture. Some samples contain elements that can interfere with matrix spikes and samples.

   The dissolved zinc matrix spike in the duplicate sample from the 520U site produced results of 101% and 102% well within the accepted limits. The lab indicated that the combination of excellent matrix spike results on the 520U sample and the acceptable results of all the other internal lab QC tests indicate that the results from the 4/4/18 event are accurate. The failed matrix spike for dissolved zinc is the isolated result of interference of that particular sample with the spike testing process. Thus, no corrective action was taken or is required.

   We request that this sampling event be included in the data set without any qualification.

4. ***The 10/25/2018 storm is a composite made from two storm events. Describe the effect on the sampling results for dissolved heavy metals.***

   The composite storm refers to the fact that there was an unforecasted dry period of 1 hour and 10 minutes longer than 6-hour allowed delay between the two rainfall periods. A dry period longer than 6-hours signals the end of the storm. The total rainfall for this event was 0.72 inches over a period of 23.5 hours.

   A review of the hydrographs from this event shows that 520N and 520U continued to flow throughout the lull. The water levels remained above the invert of the weir notches (0.02 foot at

520N and 0.01 foot at 520U). Similar to the 4/4/18 event, the stations maintained or only very briefly interrupted a hydrologic connection between the two portions of the event.
We believe that this event meets the intent of the event definition with a gap of 7 hours and 10 minutes, and should be included in the data set as a single event.

5. ***The 10/27/2018 storm came earlier than was forecasted and finished early. As a result we did not have crews lined up early to take the samples to the lab within the required 24 hours.***
The QAPP and other WSDOT guidance documents state that samples outside of the holding time should be rejected. The sample from 520U was submitted more than 31 hours after collection and will be rejected. However, the sample from 520N was submitted 17 hours and 28 minutes after the last aliquot was collected and satisfies all the criteria in the QAPP. The sample from the 10/27/2018 storm at 520N is valid, and will be included in the data set.

We are continuing to make progress toward completion of the sampling the 22 required events and request a response on your assessment of these events so that we can determine and coordinate the resources needed to monitor for and capture the remaining events.
Thanks for your consideration Bobb.
What do you think?
Brian

From: Nolan, Robert (ECY) <rnol461@ECY.WA.GOV>
Sent: Friday, December 6, 2019 9:19 AM
To: Dobbins, Brian <DobbinB@wsdot.wa.gov>
Subject: RE: SR 520 AKART Year 2 Data Point Outliers Justification for Use in Data Set

Hi Brian,

I agree that these short gaps in rainfall that exceed the six hour time gap established criteria for "storm event" are acceptable for our purposes. Please include them in the data set and count them as qualifying events.

Hopefully your team has collected sufficient events to wrap up sampling. November has been uncharacteristically dry and December seems to be following the same pattern.

And enjoy this holiday season!

Bobb

From: Dobbins, Brian <DobbinB@wsdot.wa.gov>
Sent: Thursday, December 5, 2019 1:41 PM
To: Nolan, Robert (ECY) <rnol461@ECY.WA.GOV>
Subject: SR 520 AKART Year 2 Data Point Outliers Justification for Use in Data Set

Bobb,

I hope the holidays are treating you well. They are treating me well as our last AKART storm was captured on November 15, 2019.

Similar to what occurred in Year 1 of the monitoring program, six of our sampled and lab-processed events fell outside the normal parameters for collection and processing procedures, specifically regarding inter-event dry periods.

The SR 520 Floating Bridge and Landings Project Final AKART Quality Assurance Project Plan (QAPP) section 6.2.2 Qualifying Storm Events defines the parameters of a qualifying storm event.

- *Rainfall volume: 0.15 inch minimum, no fixed maximum*
- *Rainfall duration: 1 hour minimum, no fixed maximum*
- *Storm start (antecedent dry period): 6 hours minimum with less than 0.04 inch of rain*
- *Storm end (post-storm dry period): 6 hours minimum with less than 0.04 inch of rain*

Our rational for keeping and processing these events is the same as we presented for the Year 1 events and is as follows:

The loading rate of metals on the SR 520 floating bridge is almost entirely driven by the traffic driving across it. Each car contributes as it crosses the bridge and the loading is relatively constant. Each storm generates runoff, which will wash these metals off the road at a rate driven by the rainfall intensity and total depth. During any given event, it is assumed that cars continue to contribute their load regardless of whether or not it is actively raining or if it is dry. The distribution of rain over any period is what "washes off" pollutants; short gaps of no rainfall are not expected to affect results.

We believe that these Year 2 events also meet the intent of the event definition and should be included in the data set. We request that Ecology review our rationale for keeping and processing these events and provide an opinion whether these events will count toward the 22 qualifying events. The following are brief descriptions of these events.

1. ***The 12/12/18 storm (Event #11) is a composite made from two storm events that exceeded the 6-hour dry period cut-off between the two storm events by 55 minutes.***

   The total rainfall for the event was 0.26 inch over 22.5 hours. Rainfall intensity was low throughout the event, and during the morning of December 13, 2019, the 6-hour rainfall total fell below 0.04 inches for 55 minutes. It should be noted that rain continued to fall at a very light rate (0.01 inch every 100 to 145 minutes) throughout this period but was not sufficient to maintain a running 6-hour total ≥ 0.04 inch.

2. ***The 12/15/18 storm (Event #12) is a composite made from two storm events that exceeded the 6-hour dry period cut-off between the two storm events by 2 hours, 30 minutes.***

   The total rainfall for the event was 0.72 inch over 22.8 hours. An unforecasted intra-event dry period occurred during the sample event. An initial rainfall depth of 0.41 inch in the first 3.5 hours was followed by a 4-hour, 35-minute period between rain gauge tips that produced a 2-hour, 30-minute period with a 6-hour rainfall total below 0.04 inch, which meets the end-of-storm criteria of 0.04 inches in 6 hours. The intra-event dry period was then followed by an additional 0.31 inch of rain.

3. ***The 5/16/19 storm (Event #21) is a composite made from two storm events that exceeded the 6-hour dry period cut-off between the two storm events by 1 hour, 20 minutes.***

   The total rainfall for the event was 0.58 inch over 16.5 hours. An unforecasted intra-event dry period occurred during the sample event. An initial rainfall depth of 0.08 inch in the first 2 hours was followed by a 5-hour, 40-minute dry period that produced a 1-hour, 20-minute period with a 6-hour rainfall total below 0.04 inch. The intra-event dry period was then followed by an additional 0.50 inch of rain.

4. ***The 9/17/19 storm (Event #24) is a composite made from three storm events that exceeded the 6-hour dry period cut-off between the two storm events by 15 minutes and 5 minutes, respectively.***

   The total measured rainfall for the event was 0.20 inches over a period of 15.18 hours. Two unforecasted intra-event dry periods occurred during the sampling event where the 6-hour rainfall total was less than the end-of-storm criteria of 0.04 inches. The first began at 16:55 after 0.16 inches of accumulation and lasted 15 minutes. The second occurred at 20:20 and lasted only 5 minutes before an additional 0.03 inches fell before the end of the storm, totaling 0.20 inches of accumulation.

5. ***The 10/16/19 storm (Event #25) is a composite made from two storm events that exceeded the 6-hour dry period cut-off between the two storm events by 35 minutes.***

The total measured rainfall for the event was 0.36 inches over a period of 19.00 hours. An unforecasted intra-event dry period occurred during the sample event. An initial rainfall depth of 0.20 inches in the first 11.75 hours was followed by a 35-minute period during which the 6-hour rainfall total was less than the end-of-storm criteria of 0.04 inches. The intra-event dry period was then followed by an additional 0.16 inches of rain for a total event depth of 0.36 inches.

6. ***The 10/21/19 storm (Event #26) is a composite made from two storm events that exceeded the 6-hour dry period cut-off between the two storm events by 1 hour, 50 minutes.***

   The total measured rainfall for the event was 0.45 inches over a period of 23.75 hours. An unforecasted intra-event dry period occurred during the sample event. An initial rainfall depth of 0.31 inches in the first 18.33 hours was followed by a 1 hour and 50 minute period during which the 6-hour rainfall total was less than the end-of-storm criteria of 0.04 inches. The intra-event dry period was then followed by an additional 0.14 inches of rain for a total event depth of 0.45 inches.

Brian Dobbins, PE
WSDOT AWV & SR 520 Program
206-770-3518

****

Year 1 email to Ecology:

Bobb,

As you recall, we met on March 14th to discuss the status of the SR 520 AKART monitoring program. We talked about progress and questions we had as part of our annual report preparation, specifically five of our sampled and lab-processed events fell outside the normal parameters for collection and processing procedures. As a follow-up to that meeting, I am asking if you could review our rationale for keeping and processing those events and provide your opinion if those events will count toward the 22 qualifying events. The following are our rationale for including them in our data set.

1. ***The 1/4/2018 storm had issues with temperature readings. The laboratory did not record the sample temperature at the time of intake. The original Chain of Custody (COC) did not have a temperature listed on the water sample transportation cooler. The corrected COC has a temperature of 16.5°C.***
   WSDOT published guidance on sample temperature as part of their addendum to their 2014 NPDES permit as approved by Ecology. In the *Stormwater Monitoring: Chemical Data Validation and Guidance* (2014), the topic of temperature in relation to sample validity is discussed in Table 9. Table 9 shows that if the cooler temperature is ≥6° C and the sample transit time is ≤ 24 hours, then no action would be required.
   All three sample stations met the sample validation criteria for sample volume, minimum number of aliquots and percent coverage of the storm runoff. All samples were submitted to the laboratory with the 24-hour hold time. Per Table 9, this would require no further action and the sample should be accepted.
   It is not clear how the laboratory recorded a temperature reading of 16.5°C. During sample collection the maximum water temperature at 520E was 9.1°C, the maximum water temperature at 520N was 8.9°C, and the maximum water temperature at 520U was 9.8°C. The maximum air temperature at a nearby UW Atmospheric Sciences thermometer was 10.9°C for the period between the start of the event and the time the samples were submitted to the lab. All samples were placed in coolers on ice for the roughly 1-hour transit time to the laboratory. The (COC) did not have a cooler temperature listed on it.
   At some point in the 30 minutes between sample delivery and filtration, laboratory staff recorded a temperature reading of 16.5°C. This temperature reading can only be explained as a reading or recording error, or the increase due to warming in the lab that may have occurred in the 30 minutes between the sample being removed from the ice and filtering. Because the sample meets the minimum temperature requirements and maximum allowable holding time of 24 hours, we request that this sample be accepted in the monitoring data set.

2. ***The 4/4/2018 storm is a composite made from two back to back storm events that exceeded the 6-hour dry period cut off between the two storm events by 24 minutes.***
   The composite storm refers to the fact that there was a greater than 6-hour dry delay (6 hours and 24 minutes) between two rainfall periods that were combined into one event for sampling. This dry period in the middle of the 12.92-hour storm was not forecasted.
   A review of the hydrographs from this event shows that all three stations continued to flow throughout the lull. 520E records flow throughout the lull, and although the flow rates round down to 0 at 520N and 520U, the water levels remained above the invert of the weir notches (0.02 foot at 520N and 0.01 foot at 520U). This means the water level was below where the weir could accurately measure, but both sides continued to discharge at a very low rate and there was no hydrologic separation of the early and later portions of the 4/4/18 event.

   The loading rate of metals on the SR 520 floating bridge is almost entirely driven by the traffic driving across it. Each car contributes as it crosses the bridge and the loading is relatively constant. Each storm generates runoff, which will wash these metals off the road at a rate driven by the rainfall intensity and total depth. During any given event, it is assumed the cars continue to contribute their load regardless of whether or not it is actively raining or if it is dry. The distribution of rain over any period is what "washes off" pollutants; short gaps of no rainfall are not expected to affect results. We believe that this event meets the intent of the event definition and should be included in the data set.

3. ***The 4/4/2018 Dissolved Zinc matrix spike results associated with the analytical batch were outside of the acceptable limits. What does this mean and why would the lab state "No further corrective action taken"?***
   AmTest Laboratory runs matrix spikes to determine if there are instrument errors at the lab. Both low matrix spike results came from the same sample. Per discussion with the lab, every other internal QC result for that batch of samples was within the established limits, and the low matrix spike results were due to interference of that particular sample with the added spike rather than an instrument error. Interference, not instrument errors can happen as tests samples come from a multitude of sources such as industrial processes, drinking water and agriculture. Some samples contain elements that can interfere with matrix spikes and samples. The dissolved zinc matrix spike in the duplicate sample from the 520U site produced results of 101% and 102% well within the accepted limits. The lab indicated that the combination of excellent matrix spike results on the 520U sample and the acceptable results of all the other internal lab QC tests indicate that the results from the 4/4/18 event are accurate. The failed matrix spike for dissolved zinc is the isolated result of interference of that particular sample with the spike testing process. Thus, no corrective action was taken or is required. We request that this sampling event be included in the data set without any qualification.

4. ***The 10/25/2018 storm is a composite made from two storm events. Describe the effect on the sampling results for dissolved heavy metals.***
   The composite storm refers to the fact that there was an unforecasted dry period of 1 hour and 10 minutes longer than 6-hour allowed delay between the two rainfall periods. A dry period longer than 6-hours signals the end of the storm. The total rainfall for this event was 0.72 inches over a period of 23.5 hours.

   A review of the hydrographs from this event shows that 520N and 520U continued to flow throughout the lull. The water levels remained above the invert of the weir notches (0.02 foot at 520N and 0.01 foot at 520U). Similar to the 4/4/18 event, the stations maintained or only very briefly interrupted a hydrologic connection between the two portions of the event. We believe that this event meets the intent of the event definition with a gap of 7 hours and 10 minutes, and should be included in the data set as a single event.

5. ***The 10/27/2018 storm came earlier than was forecasted and finished early. As a result we did not have crews lined up early to take the samples to the lab within the required 24 hours.***
   The QAPP and other WSDOT guidance documents state that samples outside of the holding time should be rejected. The sample from 520U was submitted more than 31 hours after collection and will be rejected. However, the sample from 520N was submitted 17 hours and 28 minutes after the last aliquot was collected and satisfies all the criteria in the QAPP. The sample from the 10/27/2018 storm at 520N is valid, and will be included in the data set.

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Attachment 4

Precipitation and Runoff Comparison Data

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Data Used to Develop and Update Rainfall/Runoff Relationships

		520-E (ENW)		520-N (NNW)		520-U (UNE)		
Storm Date	Total Rainfall (in)	Total Runoff (ct)	Calculated 100% Runoff (cf)	Total Runoff (cf)	Calculated 100% Runoff (cf)	Total Runoff (cf)	Calculated 100% Runoff (cf)	Data Source
9/1/2016	0.69	1903.8	2078.9	372.6	1052.0	1848.0	2554.8	
9/19/2016	0.30	516.9	903.9	83.6	457.4	359.0	1110.8	
10/1/2016	0.14	182.3	421.8	*data gap during event*		149.0	518.4	
10/3/2016	0.17	249.3	512.2	*data gap during event*		229.5	629.4	
10/6/2016	0.34	1101.3	1024.4	*data gap during event*		1058.6	1258.9	
10/7/2016	0.90	3410.0	2711.6	*data gap during event*		3698.2	3332.3	
10/13/2016	2.91	13527.4	8767.5	3186.2	4436.6	15104.6	10774.6	
10/19/2016	1.51	5736.1	4549.5	1410.9	2302.1	6123.0	5590.9	
10/22/2016	0.22	497.1	662.8	84.8	335.4	511.0	814.6	
10/26/2016	1.42	7881.2	4278.3	1507.9	2164.9	6662.1	5257.7	
10/29/2016	0.22	582.0	662.8	80.9	335.4	594.6	814.6	
11/5/2016	1.15	4200.4	3464.8	1029.1	1753.3	4774.6	4258.0	
11/13/2016	0.34	1222.3	1024.4	323.0	518.4	1138.0	1258.9	
1/17/2017	2.85	12861.8	8586.8	2310.9	4345.1	10343.2	10552.4	Parametrix and Aspect (2017)
12/5/2016	0.21	1202.8	632.7	167.2	320.2	897.9	777.5	
12/19/2016	0.78	3789.0	2350.1	705.1	1189.2	2928.7	2888.0	
12/26/2016	0.36	1439.7	1084.6	187.1	548.9	927.6	1332.9	
1/22/2017	0.17	459.1	512.2	62.5	259.2	403.5	629.4	
2/3/2017	1.41	7834.3	4248.2	1145.3	2149.7	5142.1	5220.7	
2/14/2017	2.61	11917.1	7863.7	2496.8	3979.2	10132.1	9663.8	
3/2/2017	0.50	2404.7	1506.5	424.8	762.3	2219.2	1851.3	
3/8/2017	0.67	2467.1	2018.6	262.4	1021.5	2503.5	2480.7	
3/17/2017	1.31	5838.7	3946.9	669.5	1997.2	5333.9	4850.4	
4/2/2017	0.07	212.9	210.9	29.6	106.7	503.6	259.2	
4/12/2017	0.66	2480.0	1988.5	193.3	1006.2	*data gap during event*		
5/15/2017	0.35	1323.2	1054.5	235.4	533.6	1097.6	1295.9	
6/15/2017	0.52	3944.7	1566.7	705.7	792.8	2342.1	1925.4	
8/31/2017	0.18	311.4	542.3	73.4	274.4	984.9	666.5	
1/4/2018	0.56	2253	1687.2	429	853.8	1670	2073.5	Mobilization 1
1/17/2018	1.13	4541	3404.6	1213	1722.8	3460	4183.9	Mobilization 2
3/8/2018	0.46	1781	1385.9	685	701.3	2016	1703.2	Mobilization 3
4/4/2018	0.30	1368	903.9	196	457.4	1273	1110.8	Mobilization 4
4/7/2018	0.62	2997	1868.0	811	945.3	2990	2295.6	Mobilization 5
4/28/2018	0.39	1603	1175.0	433	594.6	1445	1444.0	Mobilization 6
5/8/2018	0.04	*no data*	120.5	*no data*	61.0	*no data*	148.1	Mobilization 7 (false start)
6/8/2018	0.21	192	632.7	45	320.2	430	777.5	Mobilization 8
10/25/2018	0.72	1356	2169.3	679	1097.7	2503	2665.9	Mobilization 9
10/27/2018	1.37	4875	4127.7	1156	2088.7	5396	5072.6	Mobilization 10
12/12/2018	0.26	480	783.4	129	396.4	795	962.7	Mobilization 11
12/15/2018	0.72	1950	2169.3	472	1097.7	2123	2665.9	Mobilization 12
12/17/2018	0.69	2623	2078.9	591	1052.0	2853	2554.8	Mobilization 13
1/3/2019	0.95	2186	2862.3	824	1448.4	3470	3517.5	Mobilization 14
1/5/2019	0.26	613	783.4	301	396.4	742	962.7	Mobilization 15
1/17/2019	0.07	*no data*	210.9	*no data*	106.7	*no data*	259.2	Mobilization 16 (false start)
2/1/2019	0.45	2420	1355.8	388	686.1	2561	1666.2	Mobilization 17
4/5/2019	0.20	804	602.6	255	304.9	934	740.5	Mobilization 18
4/13/2019	0.08	*no data*	241.0	*no data*	122.0	*no data*	296.2	Mobilization 19 (false start)
4/18/2019	0.05	*no data*	150.6	*no data*	76.2	*no data*	185.1	Mobilization 20 (false start)
5/16/2019	0.58	1590	1747.5	395	884.3	2227	2147.5	Mobilization 21
7/9/2019	0.36	339	1084.6	189	548.9	994	1332.9	Mobilization 22
9/14/2019	0.53	1726	1596.8	356	808.0	1648	1962.4	Mobilization 23
9/17/2019	0.20	429	602.6	56	304.9	548	740.5	Mobilization 24
10/16/2019	0.36	1009	1084.6	120	548.9	1093	1332.9	Mobilization 25
10/21/2019	0.45	1835	1355.8	280	686.1	2275	1666.2	Mobilization 26
11/15/2019	0.20	587	602.6	86	304.9	507	740.5	Mobilization 27
Drainage Area (ac)		0.83		0.42		1.02		
Theoretical Runoff (cf/in)		3012.9		1524.6		3702.6		

ac = acres

cf = cubic feet

in = inches

Paramerix and Aspect. 2017. Rainfall and Runoff Analysis. Technical Memorandum prepared for the Washington Department of Transportation by Parametrix and Aspect. November 15, 2017.

Parametrix
ENGINEERING . PLANNING . ENVIRONMENTAL SCIENCES

719 2ND AVENUE, SUITE 200 | SEATTLE, WA 98104 | P 206.394.3700

TECHNICAL MEMORANDUM

DATE: November 15, 2017

TO: Mark Allison, WSDOT

FROM: Paul Fendt and Sarah Rife, Parametrix and Bryan Berkompas, Aspect

SUBJECT: Rainfall and Runoff Analysis

CC:

PROJECT NUMBER: 554-1800-068

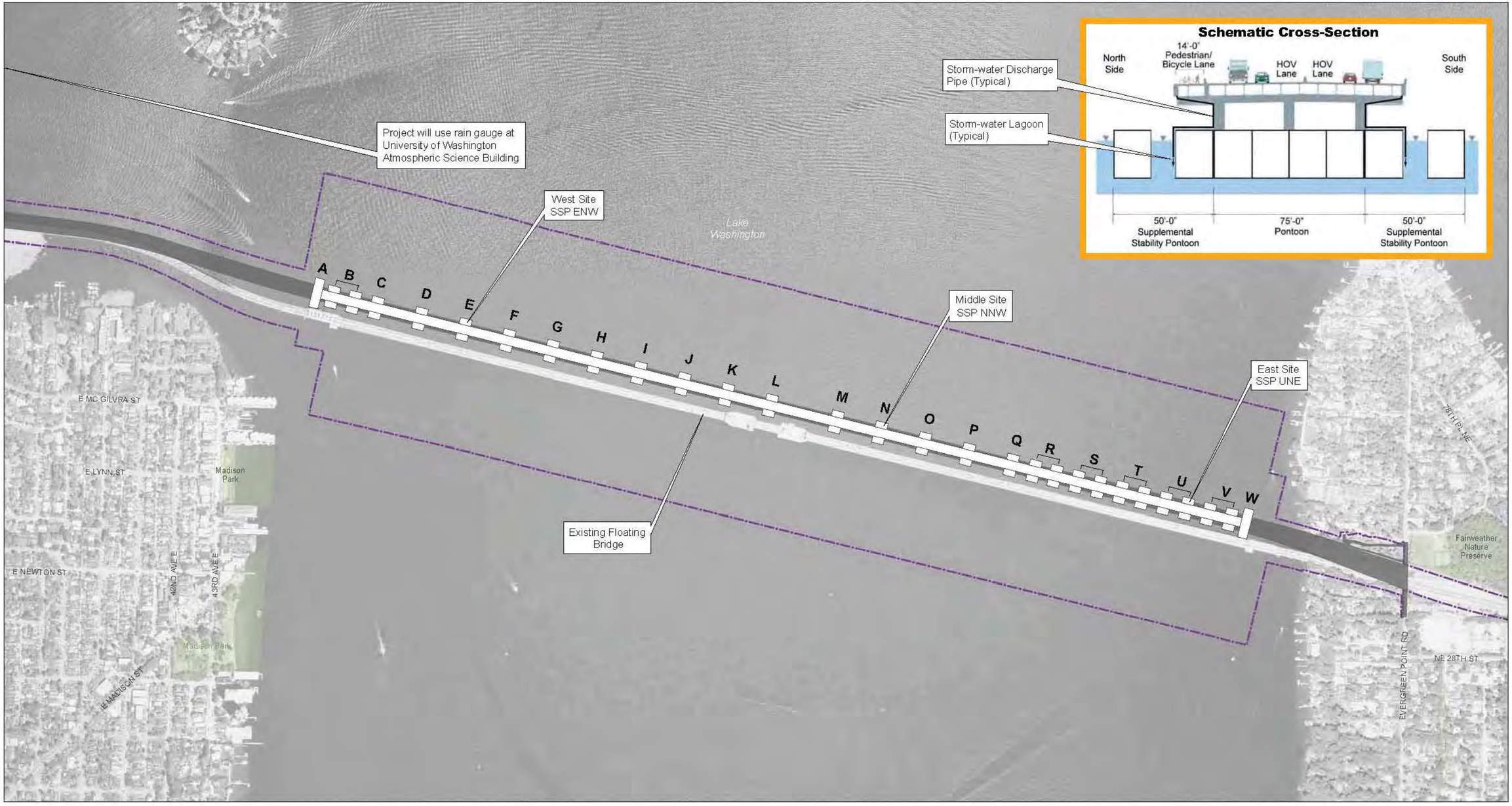
PROJECT NAME: SR 520 Floating Bridge and Landing Project AKART Stormwater Monitoring

INTRODUCTION

Washington Department of Transportation (WSDOT) is sampling stormwater at locations on the SR 520 floating bridge to support the All Known, Available and Reasonable Technologies (AKART) Stormwater Monitoring Plan for the SR 520 Bridge Replacement and HOV Program (the Program) (Figure 1). A model was created to predict water quality and the appropriate mixing zone boundaries. Stormwater samples taken from the bridge will determine if current mixing zone boundaries are effective. As part of this sampling and modeling analysis, a relationship between rainfall amounts and runoff draining to the sampling devices is needed.

Establishment of a rainfall/runoff relationship at each sampling location is essential to programming monitoring equipment that collects the minimum 10 aliquots recommended by Department of Ecology guidance for a successful sampling event. Prior to commencement of storm event sampling, flow and precipitation monitoring were observed for a full calendar year, which provided the necessary range of precipitation and runoff flow data to establish the rainfall/runoff relationships for the various weather patterns throughout a calendar year.

The rainfall analysis was conducted from September 1, 2016, to August 31, 2017, to provide an estimate of runoff compared to predicted rainfall. A trendline based on the data collected has determined the estimated runoff from storm events. The sample rate for composite samples can be determined using runoff estimates and will be used to program sampling equipment at each site to capture the beginning of the storm hydrograph. Furthermore, this information will help guide storm event tracking and sampling efforts to minimize the sampling of non-qualifying storm events. Refer to the project Quality Assurance Project Plan (QAPP) for a detailed description of the project sampling plan approach (Parametrix 2014 and amended in 2016).



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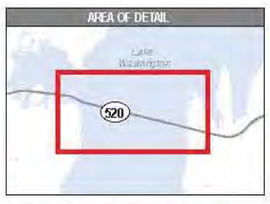

- Pontoons
- Limits of Construction
- Edge of Pavement
- Park

N

0 250 500 1,000 Feet

Source: King County (2008) GIS Data (Streams, Streets, Water Bodies), CH2M HILL (2008) GIS Data (Park). Horizontal datum for all layers is NAD83(91), vertical datum for layers is NAVD88.

Figure 1 Monitoring Site Locations

I-5 to Medina: Bridge Replacement and HOV Project

(Reproduced from Figure 2.1, CH2M Hill 2010)

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ANALYSIS

Drainage areas conveying water to the monitoring station locations were delineated by the SR 520 drainage design team. Drainage areas for the selected monitoring sites are provided in Table 1. The detailed delineation boundaries are shown on Figures 2a and 2b.

Table 1. Monitoring Site Drainage Characteristics

Site Characteristics	Monitoring Site Name		
	ENW (West)	NNW (Middle)	UNW (East)
Location	SSP ENW (148+10)	SSP NNW (179+45)	SSP UNE (210+89.57)
Contributing Drainage Area (acres)	0.83	0.42	1.02
Percent Impervious	100	100	100
Time of Concentration	Approx. 2 minutes	Approx. 8 minutes	Approx. 7 minutes

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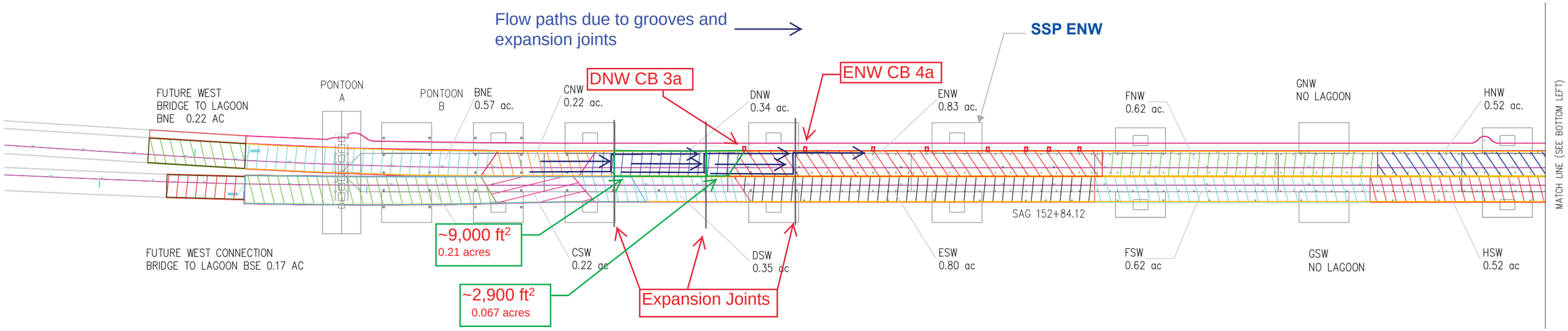
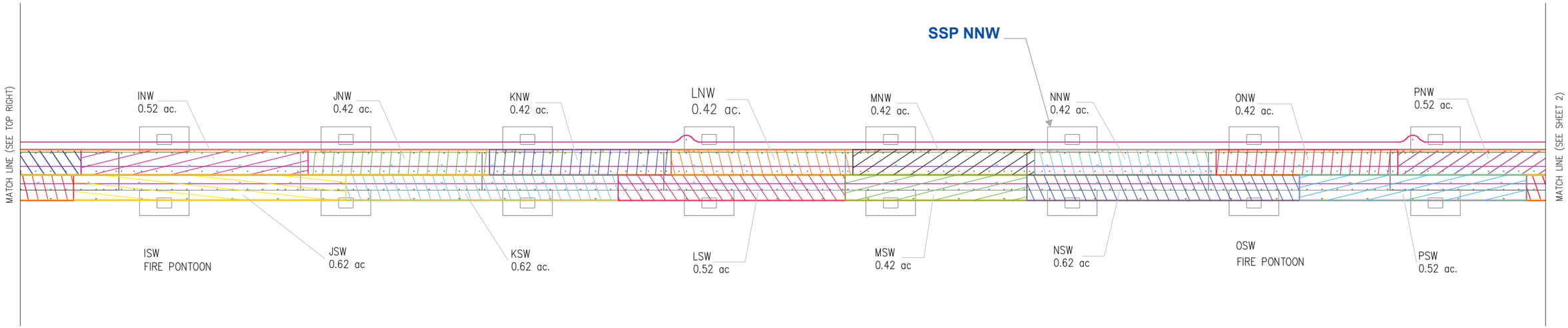
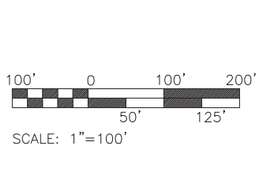


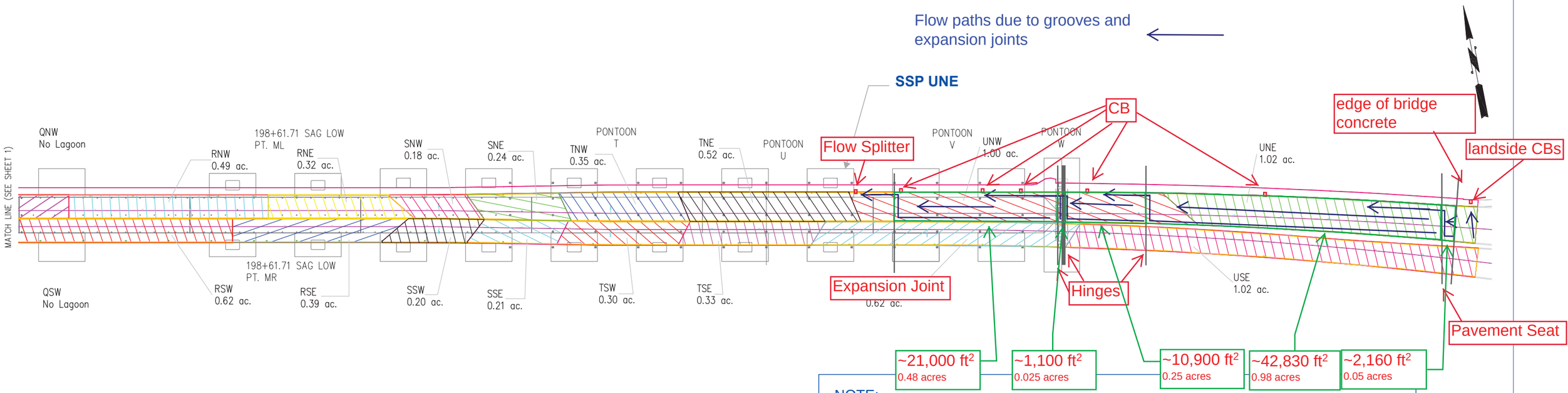




kpff Consulting Engineers
101 Stewart Street, Suite 400
Seattle, Washington 98101
(206) 382-0600 Fax (206) 382-0500

520 BRIDGE AND LANDINGS
BRIDGE DRAINAGE BASINS
FIGURE 2a

DATE: 2012-09-25	SCALE: 1" = 100'-0"
DRAWN BY: A. SEETHOFF	SHT 1 OF 2



NOTE:

Runoff from the UNE catchment area is collected in catch basins and conveyed west via the enclosed storm drain system. The conveyance system bypasses Pontoons W and V because downpouts and stormwater lagoons are not designed at those pontoons.

A flow splitter directs flows from the conveyance system to the downspout that outfalls into the stormwater lagoon on **SSP UNE**.

100' 0 100' 200'

50' 125'

SCALE: 1"=100'

kpff Consulting Engineers

101 Stewart Street, Suite 400
Seattle, Washington 98101
(206) 382-0600 Fax (206) 382-0500

520 BRIDGE AND LANDINGS
BRIDGE DRAINAGE BASINS
FIGURE 2b

DATE: 2012-09-25	SCALE: 1" = 100'-0"
DRAWN BY: A. SEETHOFF	SHT 1 OF 2

Runoff from storm events between September 1, 2016, and August 31, 2017, was measured and compared to the theoretical runoff. The 100 percent theoretical runoff was calculated using drainage area (Table 1) times the rainfall depth measured at the nearby rainfall station. Figures 3 through 5 show the theoretical runoff, trend line, and measured runoff for the SR520 catchment areas ENW, NNW, and UNE, respectively. Raw data are provided in Appendix A.

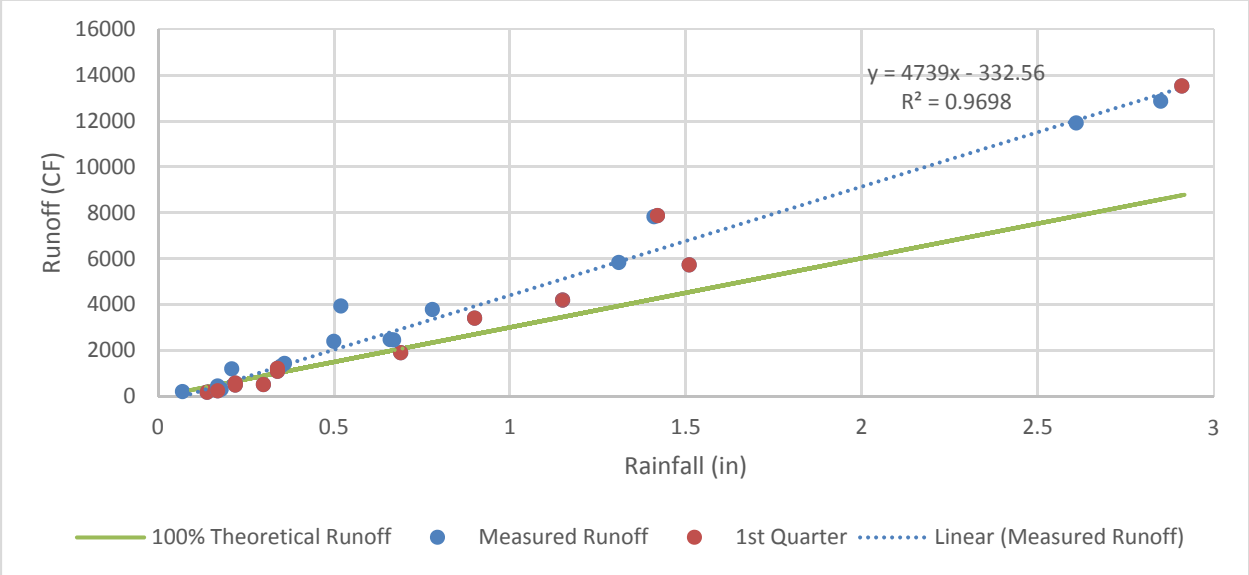


Figure 3. Runoff Analysis for SR 520 Catchment Area ENW

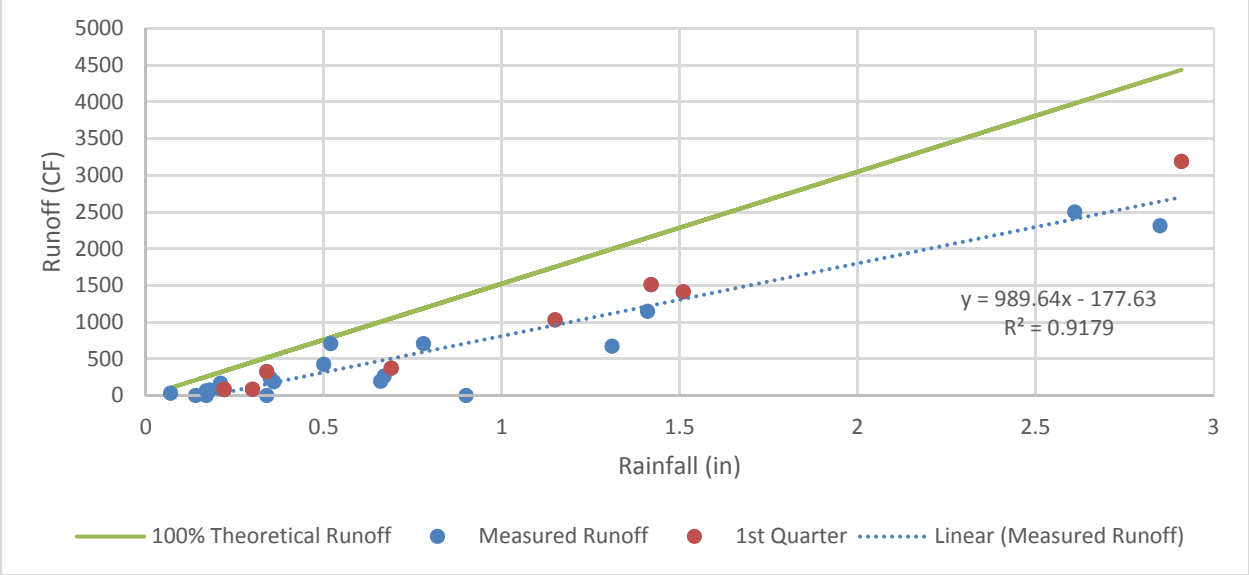


Figure 4.Runoff Analysis for SR 520 Catchment Area NNW

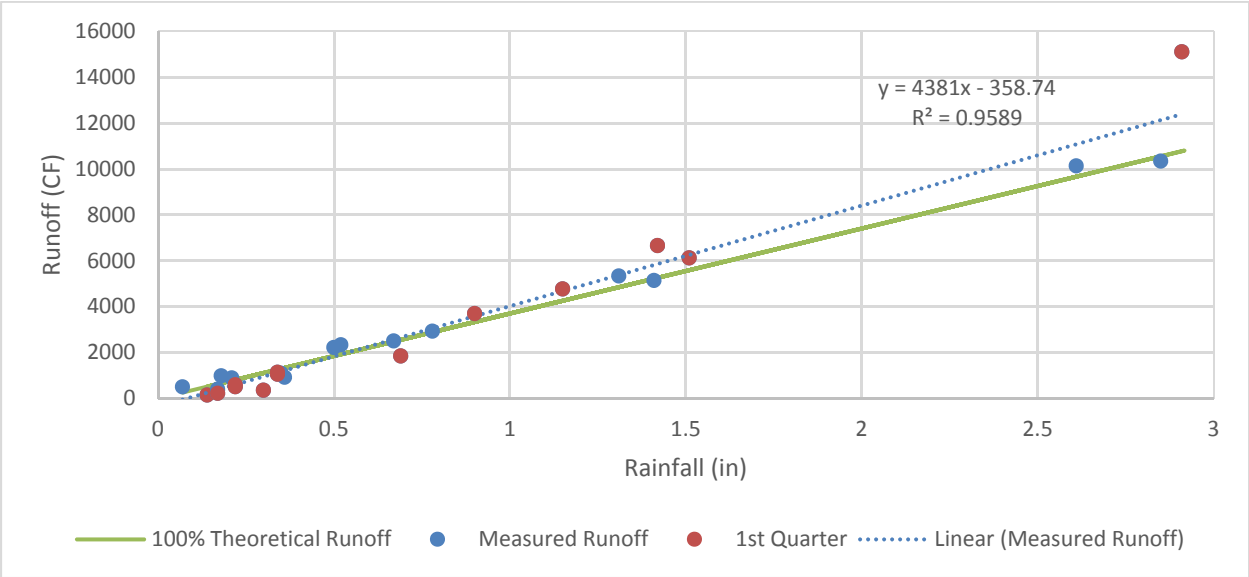


Figure 5.Runoff Analysis for SR 520 Catchment Area UNE

Review of results from the first several months of data collection found that the runoff amounts exceeded the theoretical runoff at UNE and ENW. The runoff and rainfall relationships should be nearly direct because the basins are small and 100 percent impervious. The drainage areas from the plans were checked and confirmed that no changes occurred during final design or construction. A site review was made to observe runoff during a rainfall event to determine if flow patterns match the designed drainage basins. The site review identified potential causes of some differences and notes are provided on Figures 2a and 2b. In general, the actual drainage area of ENW is probably larger due to the pavement grooves. Some runoff is bypassing catch basins and sediment filled expansion joints, and the ENW drainage basin is picking up an undetermined amount of additional runoff from the next two upstream drainage basins. This additional drainage area could diminish over time or with some expansion joint cleaning or pavement wear and grinding.

Drainage basin UNE is not as straightforward to evaluate. The total drainage area estimated upstream of the flow splitter is 1.79 acres. This is actually slightly less than is indicated on the drawing. Note that although the drawing shows a portion downstream of the easternmost expansion joint going to UNW, it is not going through the splitter but is instead picked up by an inlet downstream of the splitter. Note also that the drawings indicate that a portion of the asphalt on the east end of the bridge drains into UNE but reconnaissance found three inlets at the junction of the asphalt and pavement. The asphalt is draining to these inlets, while the entire paved portion is brought into the UNE basin due to the grooves. This indicates that the flow splitter is not fully functioning as it was designed (see Figure 2b).

Trendlines were used in the measured data to predict runoff for future events. Table 2 shows the equations of the trendlines for each catchment area for predicting future runoff based on rainfall amount and its coefficient of determination (R2, goodness of fit). These equations also show that there is an initial abstraction[1] by the pavement that does not result in runoff until a certain amount of rain falls. That "triggering" amount of rainfall to create runoff varies depending on the catchment area. This is calculated by solving rainfall amount for when runoff = 0. For catchment areas ENW, NNW, and UNE, the amounts are 0.14 inches, 0.14 inches, and 0.07 inches,

[1] Initial abstraction is the amount of rainfall that "wets" the pavement and is ultimately stored there and does not become part of the runoff.

respectively. When calculating predictive runoff, anything less than these amounts would calculate as negative runoff which should be assumed as 0.0 cubic feet (cf). These abstraction values are higher than non-grooved pavement and is most likely caused by water filling the grooves and the catchbasins first before becoming runoff. As storm events less than 0.15 inches will not be tested, the runoff equations should accurately predict storm events greater than 0.15 inches of rain.

Table 2. Future Runoff Equations for Rainfall Predictions

Catchment Area	Predicted Runoff Volume Equation	R2	Calculated Rainfall Abstraction (in)
Catchment ENW	Runoff (cf) = 4739 x Rainfall (in) -332.56	0.9698	0.14
Catchment NNW	Runoff (cf) = 989.64 x Rainfall (in) -177.63	0.9179	0.14
Catchment UNE	Runoff (cf) = 4381 x Rainfall (in) -358.74	0.9589	0.07

RESULTS AND SAMPLE RATE

The results show the actual basin response across a range of rainfall events. Construction within the ENW, NNW, and UNE drainage basins is complete and the resultant theoretical runoff amounts are not expected to change. During the sampling period, additional runoff data will be added and checked to determine if the curves appreciably change.

Figures 3, 4, and 5 show the trend lines for actual runoff from the bridge by actual rainfall amount. These lines and the associated equations shown in Table 2 will be used to program the samplers to collect flow-weighted composite samples at each site. The predicted rainfall for each event will be used in the Table 2 equations to estimate the total runoff volume. The predicted total runoff volume will then be divided by the desired number of aliquots to set the pacing rate. For example, if the predicted 24-hour rainfall is 0.30 inches and the rainfall-runoff curve for ENW is:

Runoff (cf) = 4739 x Rainfall (in) -332.56

then the predicted runoff volume is approximately 1,090 cubic feet.

The predicted runoff is then divided by the number of aliquots needed for a qualifying sample. As a rule of thumb, targeting 20 to 25 aliquots for each event should ensure that the minimum of 10 aliquots are collected during an event. If targeting 20 aliquots at ENW from the 0.3-inch event above, the pacing rate would be:

1,090 cf / 20 = 54.5 cf

This can be rounded up or down based on confidence in the forecasted rainfall depths, or used directly as calculated.

REFERENCES

Parametrix. 2014. SR 520 Floating Bridge and Landings Project Final AKART Quality Assurance Project Plan. Prepared for Washington State Department of Transportation. July 2014 (amended in 2016).

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Appendix A

Raw Rainfall Data

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Date	Rain (in)	ENW Runoff (cf)	ENW Runoff/ Acre (cf/acre)	ENW Calculated 100% Runoff	NNW Runoff (cf)	NNW Runoff/ Acre (cf/acre)	NNW Calculated 100% Runoff	UNW Runoff (cf)	UNW Runoff/ Acre (cf/acre)	UNW Calculated 100% Runoff	
9/1/2016	0.69	1903.8	2293.8	2078.9	372.6	887.2	1052.0	1848.0	1811.8	2554.8	
9/19/2016	0.3	516.9	622.8	903.9	83.6	199.1	457.4	359.0	352.0	1110.8	
10/1/2016	0.14	182.3	219.6	421.8	data gap during event			149.0	146.1	518.4	
10/3/2016	0.17	249.3	300.4	512.2	data gap during event			229.5	225.0	629.4	low intensity 2 day event
10/6/2016	0.34	1101.3	1326.9	1024.4	data gap during event			1058.6	1037.9	1258.9	
10/7/2016	0.9	3410.0	4108.4	2711.6	data gap during event			3698.2	3625.7	3332.3	long dragged out falling limb at both sites
10/13/2016	2.91	13527.4	16298.0	8767.5	3186.2	7586.3	4436.6	15104.6	14808.4	10774.6	
10/19/2016	1.51	5736.1	6911.0	4549.5	1410.9	3359.3	2302.1	6123.0	6002.9	5590.9	
10/22/2016	0.22	497.1	598.9	662.8	84.8	202.0	335.4	511.0	501.0	814.6	
10/26/2016	1.42	7881.2	9495.4	4278.3	1507.9	3590.3	2164.9	6662.1	6531.4	5257.7	
10/29/2016	0.22	582.0	701.2	662.8	80.9	192.5	335.4	594.6	582.9	814.6	
11/5/2016	1.15	4200.4	5060.7	3464.8	1029.1	2450.2	1753.3	4774.6	4681.0	4258.0	
11/13/2016	0.34	1222.3	1472.6	1024.4	323.0	769.2	518.4	1138.0	1115.7	1258.9	
1/17/2017	2.85	12861.8	15496.1	8586.8	2310.9	5502.2	4345.1	10343.2	10140.4	10552.4	
12/5/2016	0.21	1202.8	1449.2	632.7	167.2	398.2	320.2	897.9	880.2	777.5	
12/19/2016	0.78	3789.0	4565.0	2350.1	705.1	1678.8	1189.2	2928.7	2871.3	2888.0	
12/26/2016	0.36	1439.7	1734.5	1084.6	187.1	445.6	548.9	927.6	909.4	1332.9	
1/22/2017	0.17	459.1	553.1	512.2	62.5	148.9	259.2	403.5	395.6	629.4	
2/3/2017	1.41	7834.3	9438.9	4248.2	1145.3	2726.8	2149.7	5142.1	5041.3	5220.7	
2/14/2017	2.61	11917.1	14358.0	7863.7	2496.8	5944.8	3979.2	10132.1	9933.4	9663.8	
3/2/2017	0.5	2404.7	2897.2	1506.5	424.8	1011.5	762.3	2219.2	2175.7	1851.3	
3/8/2017	0.67	2467.1	2972.4	2018.6	262.4	624.7	1021.5	2503.5	2454.4	2480.7	
3/17/2017	1.31	5838.7	7034.5	3946.9	669.5	1594.0	1997.2	5333.9	5229.3	4850.4	
4/2/2017	0.07	212.9	256.6	210.9	29.6	70.5	106.7	503.6	493.8	259.2	
4/12/2017	0.66	2480.0	2987.9	1988.5	193.3	460.2	1006.2				
5/15/2017	0.35	1323.2	1594.2	1054.5	235.4	560.6	533.6	1097.6	1076.1	1295.9	
6/15/2017	0.52	3944.7	4752.6	1566.7	705.7	1680.3	792.8	2342.1	2296.2	1925.4	
8/31/2017	0.18	311.4	375.2	542.3	73.4	174.7	274.4	984.9	965.6	666.5	

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Attachment 5

Summary Statistics

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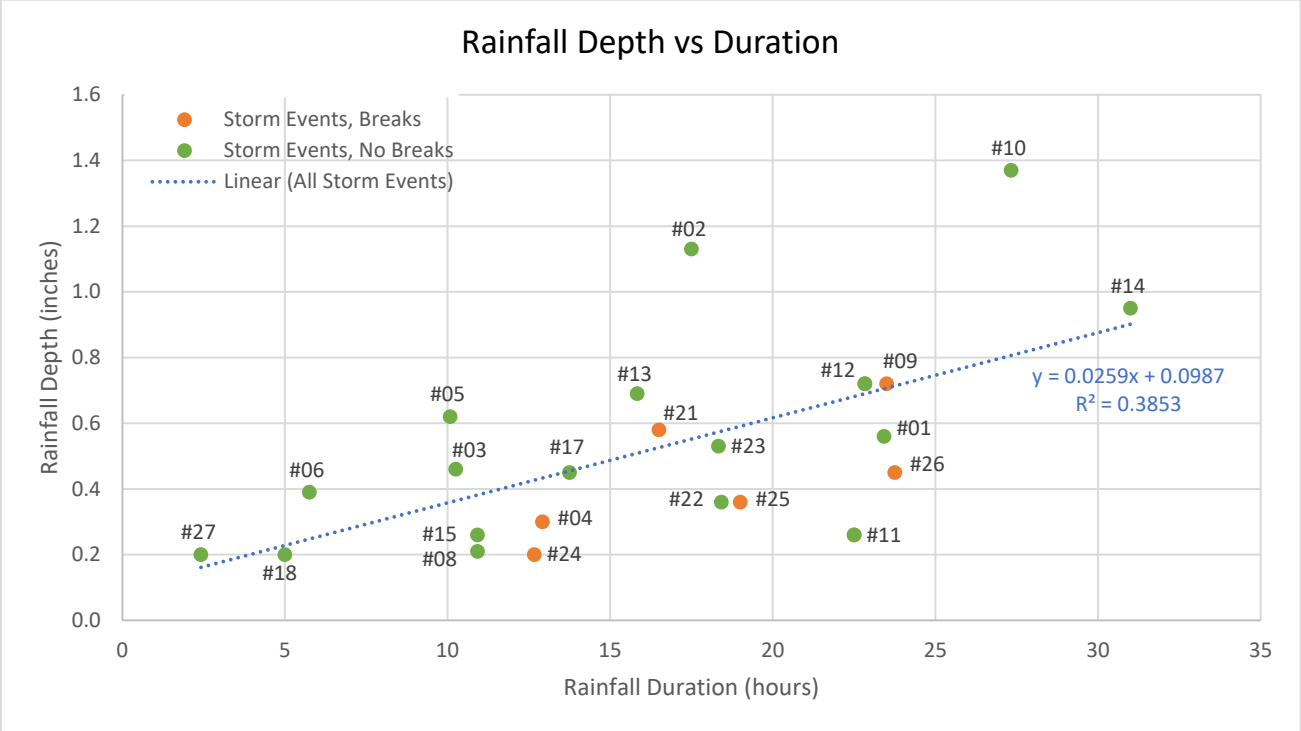
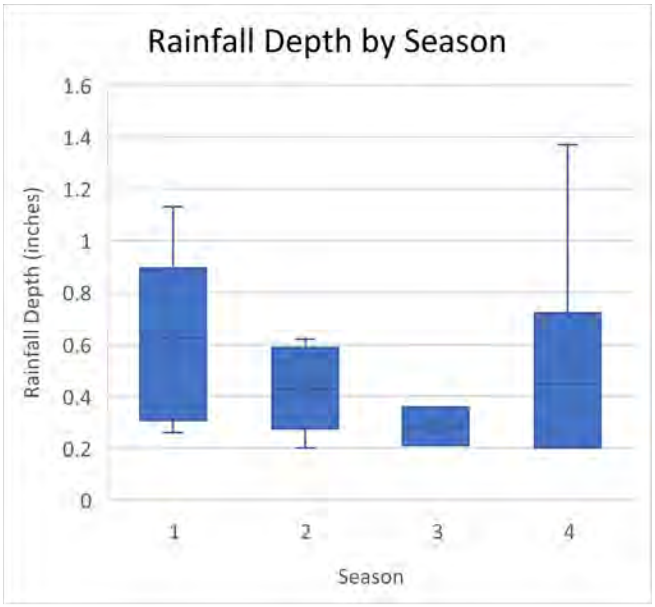
Summary Statistics - Storm Events

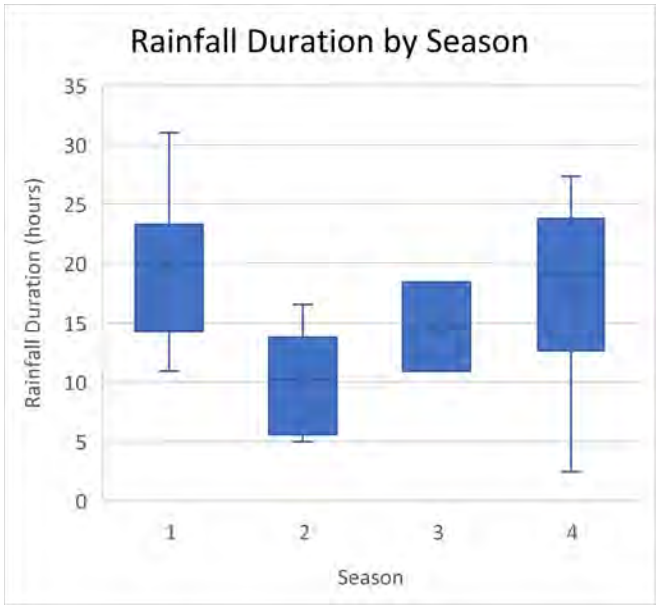
All Storm Events (n=23)	Count	Minimum	Maximum	Median	Mean	Standard Deviation
Rainfall Depth (in)	23	0.20	1.37	0.45	0.520	0.3069
Rainfall Duration (hr)	23	2.417	31.00	16.50	16.286	7.3561
Mininum Days Since Sweeping	23	0	24	10	9.0	7.47
Maximum Days Since Sweeping	23	3	30	14	14.2	8.43
Minimum Days Since CB Cleanout	23	15	345	181	170.8	114.11
Maximum Days Since CB Cleanout	23	19	351	184	175.3	114.93
Antecedent Days	23	0	7	0	1.7	2.39
Inter-event Period (days)	22	0.77	138.4	22.21	28.51	32.095
CuDissTMpA (g/ac)	22	0.1081	1.1091	0.4117	0.44630	0.224325
ZnDissTMpA (g/ac)	22	0.3607	3.4676	1.3016	1.39396	0.778433

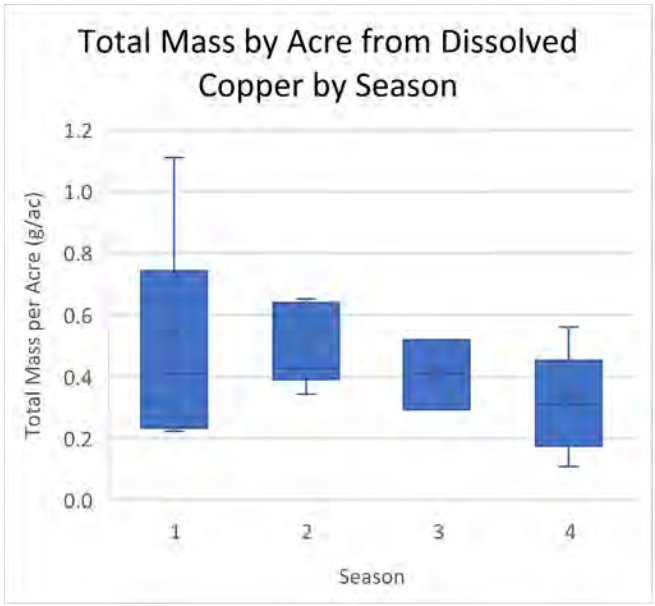
Excluding Event 15 (n=22)	Count	Minimum	Maximum	Median	Mean	Standard Deviation
Rainfall Depth (in)	22	0.20	1.37	0.455	0.532	0.3087
Rainfall Duration (hr)	22	2.417	31.00	17.00	16.530	7.4334
Mininum Days Since Sweeping	22	0	24	10.5	9.4	7.43
Maximum Days Since Sweeping	22	3	30	14.5	14.7	8.32
Minimum Days Since CB Cleanout	22	15	345	179.5	164.1	112.08
Maximum Days Since CB Cleanout	22	19	351	182.5	168.5	112.85
Antecedent Days	22	0	7	0.5	1.7	2.41
Inter-event Period (days)	21	0.77	138.4	23.81	29.80	32.299
CuDissTMpA (g/ac)	22	0.1081	1.1091	0.4117	0.44630	0.224325
ZnDissTMpA (g/ac)	22	0.3607	3.4676	1.3016	1.39396	0.778433

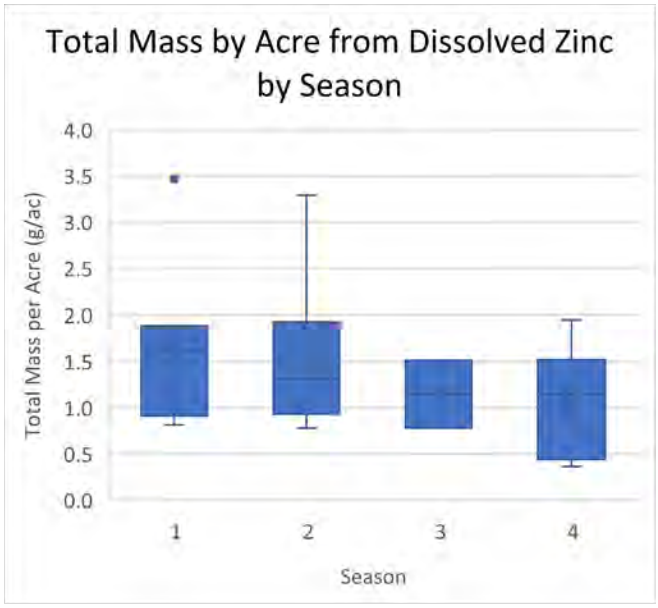


Summary Statistics - Storm Events

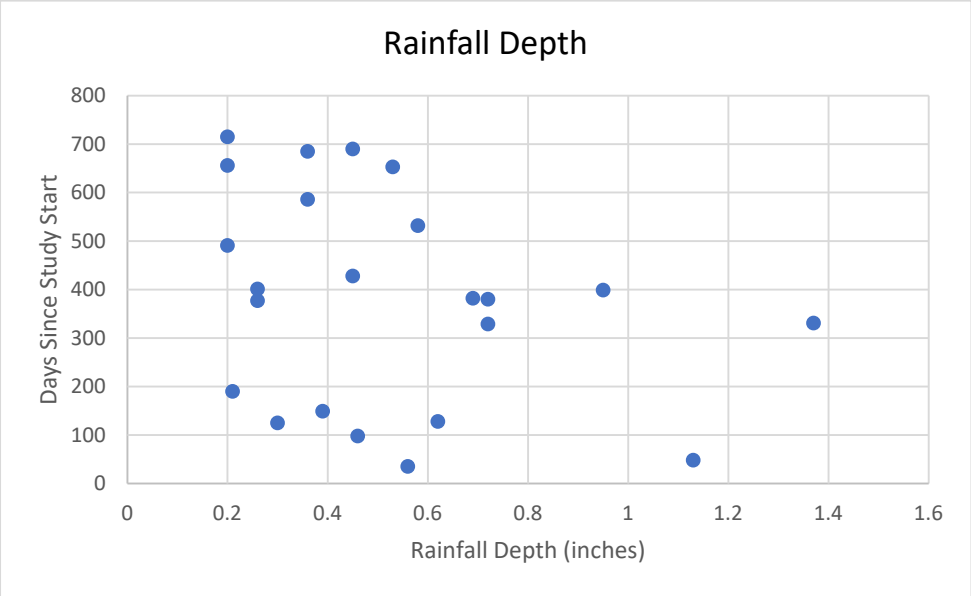


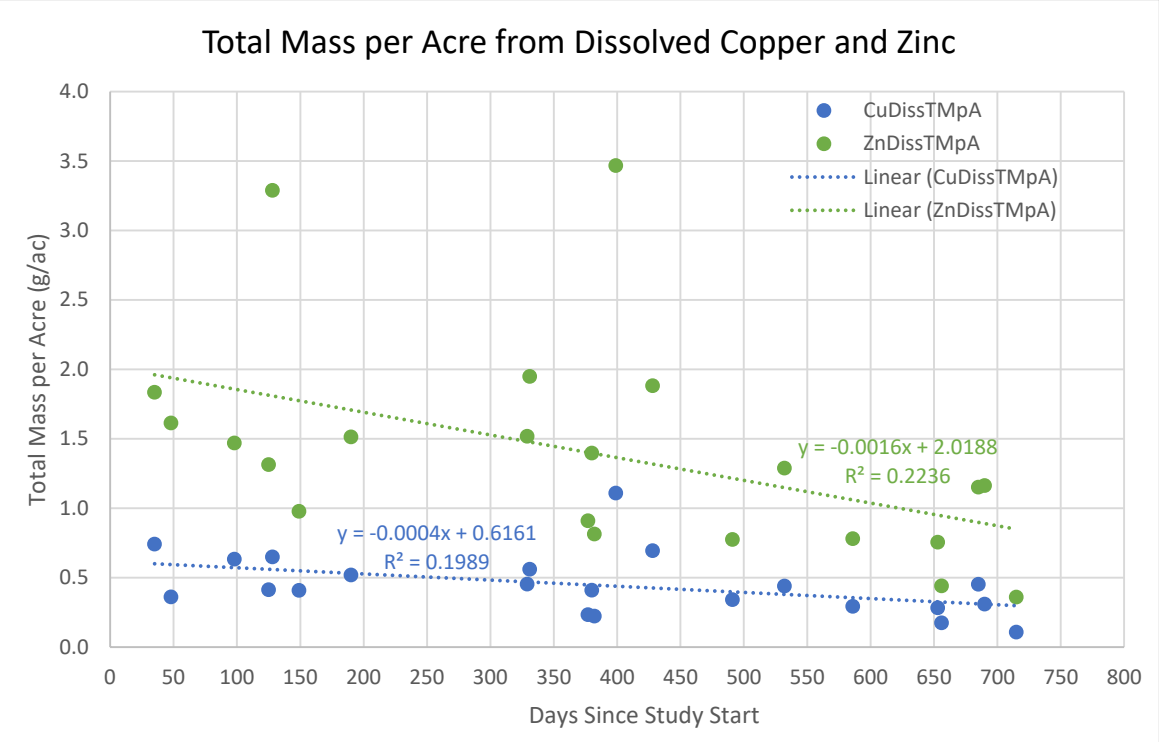






Summary Statistics - Storm Events





Summary Statistics - Station Samples

	Minimum	Maximum	Median	Mean	Standard Deviation
520E (n = 20)					
Dissolved Cadmium (ug/L)	0.05	0.129	0.05	0.054	0.018
Dissolved Copper (ug/L)	2.99	50.7	11.3	12.0	9.86
Dissolved Lead (ug/L)	0.05	0.567	0.1	0.128	0.106
Dissolved Zinc (ug/L)	11.1	181	32.5	40.5	35.0
Total Cadmium (ug/L)	0.05	0.291	0.097	0.122	0.066
Total Copper (ug/L)	20.9	105	41.5	48.2	23.3
Total Lead (ug/L)	1.08	8.47	3.185	3.92	2.17
Total Zinc (ug/L)	54.9	354	152	172	85.5
Total Mass, Dissolved Copper (g)	0.1253	0.8728	0.3161	0.3921	0.2238
Total Mass per Acre, Dissolved Copper (g/ac)	0.1510	1.0516	0.3809	0.4724	0.2696
Total Mass, Dissolved Zinc (g)	0.4291	3.3946	1.1158	1.3034	0.7365
Total Mass per Acre, Dissolved Zinc (g/ac)	0.5170	4.0899	1.3443	1.5704	0.8874
Total Mass, Total Copper (g)	0.3581	3.7775	1.9004	1.8127	1.0749
Total Mass per Acre, Total Copper (g/ac)	0.4314	4.5512	2.2896	2.1840	1.2950
Total Mass, Total Zinc (g)	1.1039	15.9384	7.1858	6.6673	4.4388
Total Mass per Acre, Total Zinc (g/ac)	1.3300	19.2029	8.6576	8.0329	5.3480
Runoff Volume (cf)	192	2,997	1,597	1,476	817
Storm Runoff Intensity (cf/hr)	17.6	297	95.2	116	84.3
520N (n = 21)					
Dissolved Cadmium (ug/L)	0.05	0.064	0.05	0.051	0.004
Dissolved Copper (ug/L)	3.29	15.5	8.67	8.49	3.10
Dissolved Lead (ug/L)	0.05	0.446	0.1	0.147	0.104
Dissolved Zinc (ug/L)	11.4	69.9	25	26.0	12.1
Total Cadmium (ug/L)	0.05	0.284	0.058	0.072	0.050
Total Copper (ug/L)	10.6	76.2	18.2	24.1	14.6
Total Lead (ug/L)	0.384	8.18	1.23	2.05	1.81
Total Zinc (ug/L)	23.2	278	53.4	75.2	56.2
Total Mass, Dissolved Copper (g)	0.01115	0.2987	0.0641	0.09179	0.0756
Total Mass per Acre, Dissolved Copper (g/ac)	0.02654	0.7111	0.1526	0.2186	0.1801
Total Mass, Dissolved Zinc (g)	0.03092	0.8657	0.2008	0.2827	0.2407
Total Mass per Acre, Dissolved Zinc (g/ac)	0.07362	2.0611	0.4781	0.6731	0.5730
Total Mass, Total Copper (g)	0.02601	0.7373	0.2000	0.2566	0.2048
Total Mass per Acre, Total Copper (g/ac)	0.06192	1.7555	0.4761	0.6109	0.4877
Total Mass, Total Zinc (g)	0.07453	2.0074	0.5471	0.8174	0.7120
Total Mass per Acre, Total Zinc (g/ac)	0.1775	4.7795	1.3027	1.9461	1.6953
Runoff Volume (cf)	45	1,156	388	408	295
Storm Runoff Intensity (cf/hr)	4.12	80.5	23.9	29.2	22.8
520U (n = 21)					
Dissolved Cadmium (ug/L)	0.05	0.13	0.05	0.054	0.017
Dissolved Copper (ug/L)	2.84	72.6	10.8	13.6	14.2
Dissolved Lead (ug/L)	0.05	2.37	0.1	0.210	0.495
Dissolved Zinc (ug/L)	10.2	194	25.5	36.8	38.2
Total Cadmium (ug/L)	0.05	0.334	0.087	0.103	0.061
Total Copper (ug/L)	16.8	113	41.3	46.9	22.1
Total Lead (ug/L)	0.825	12.5	3.77	4.094	2.648
Total Zinc (ug/L)	40.7	395	132	143	71.4
Total Mass, Dissolved Copper (g)	0.1031	1.3462	0.4460	0.5252	0.2836
Total Mass per Acre, Dissolved Copper (g/ac)	0.1011	1.3198	0.4373	0.5149	0.2780
Total Mass, Dissolved Zinc (g)	0.2742	4.5298	1.2112	1.5232	1.0275
Total Mass per Acre, Dissolved Zinc (g/ac)	0.2688	4.4409	1.1874	1.4933	1.0073
Total Mass, Total Copper (g)	0.3460	4.6477	2.2822	2.1731	1.1278
Total Mass per Acre, Total Copper (g/ac)	0.3392	4.5565	2.2375	2.1305	1.1056
Total Mass, Total Zinc (g)	1.0107	13.3248	7.5838	6.8114	3.8355
Total Mass per Acre, Total Zinc (g/ac)	0.9909	13.0635	7.4351	6.6779	3.7603
Runoff Volume (cf)	430	3,470	1,670	1,801	953
Storm Runoff Intensity (cf/hr)	35.3	297	107	130	74.8

Correlations (All storms with at least 1 sample)

Storm Events	Rainfall Depth	Rainfall Duration	Min. Days Since Sweeping	Max. Days Since Sweeping	Min. Days Since Cleanout	Antecedent Days	Inter-event Period	Total/ac CuDissTMpA	Total/ac ZnDissTMpA	Days Since Study Start
Rainfall Depth	1.0000									
Rainfall Duration	0.6094	1.0000								
Min. Days Since Sweeping	0.3517	0.1561	1.0000							
Max. Days Since Sweeping	0.4694	0.3643	0.5689	1.0000						
Min. Days Since Cleanout	0.1974	0.4682	0.2325	0.6322	1.0000					
Antecedent Days	-0.2228	-0.0965	-0.1209	0.2799	0.1156	1.0000				
Inter-event Period	-0.1759	0.0234	0.0394	-0.1071	-0.1109	-0.0784	1.0000			
Total/ac CuDissTMpA	0.4088	0.3970	-0.3801	0.2415	0.0026	0.3582	-0.0795	1.0000		
Total/ac ZnDissTMpA	0.5403	0.3993	-0.2835	0.2177	0.0290	0.1093	-0.1931	0.8810	1.0000	
Days Since Study Start	-0.3075	0.0343	0.1934	0.2125	0.4585	-0.0505	0.0370	-0.4460	-0.4728	1.0000

Station 520E	Dissolved Cadmium	Dissolved Copper	Dissolved Lead	Dissolved Zinc	Total Cadmium	Total Copper	Total Lead	Total Zinc	Runoff Volume	CuDissTM	ZnDissTM
Dissolved Cadmium	1.0000										
Dissolved Copper	0.9242	1.0000									
Dissolved Lead	0.9799	0.9283	1.0000								
Dissolved Zinc	0.9449	0.9672	0.9519	1.0000							
Total Cadmium	0.3495	0.4342	0.3562	0.3434	1.0000						
Total Copper	0.5751	0.6921	0.6277	0.6353	0.7460	1.0000					
Total Lead	0.3781	0.4395	0.3951	0.3751	0.8767	0.8993	1.0000				
Total Zinc	0.3559	0.4602	0.3842	0.4054	0.8224	0.9312	0.9715	1.0000			
Runoff Volume	-0.3700	-0.5041	-0.3994	-0.5079	-0.1182	-0.3921	-0.1801	-0.2727	1.0000		
CuDissTM	-0.1225	-0.0016	-0.1308	-0.1242	0.2353	0.0508	0.1022	0.0712	0.6544	1.0000	
ZnDissTM	-0.1021	-0.0965	-0.0791	-0.0584	0.0285	-0.0674	-0.0318	-0.0613	0.7208	0.7669	1.0000
Rainfall Depth	-0.2806	-0.3916	-0.3223	-0.3929	-0.2567	-0.3601	-0.2451	-0.2837	0.7388	0.4963	0.5159
Rainfall Duration	-0.1601	-0.1107	-0.1840	-0.1313	-0.2102	-0.1551	-0.2013	-0.1073	0.2354	0.2961	0.1719
Min. Days Since Sweeping	-0.1517	-0.3125	-0.1247	-0.2370	-0.5293	-0.3355	-0.3493	-0.3568	-0.0976	-0.5084	-0.3672
Max. Days Since Sweeping	-0.1993	-0.2471	-0.1454	-0.2350	-0.4140	-0.2907	-0.3888	-0.3885	0.2370	0.1639	0.1532
Min. Days Since Cleanout	-0.1222	-0.1446	-0.0690	-0.0949	-0.4128	-0.3166	-0.4773	-0.3998	0.0951	-0.0012	0.0279
Antecedent Days	0.1049	0.2392	0.1567	0.1051	0.0364	0.1447	-0.0011	0.0106	0.0871	0.4926	0.1673
Inter-event Period	-0.0171	-0.0307	-0.0246	-0.0586	0.1836	-0.0874	-0.0206	-0.0384	-0.3047	-0.2827	-0.3715
Days Since Study Start	-0.2234	-0.1892	-0.1198	-0.1469	-0.2884	0.0022	-0.1447	-0.0758	-0.3663	-0.4605	-0.3617

Station 520N	Dissolved Cadmium	Dissolved Copper	Dissolved Lead	Dissolved Zinc	Total Cadmium	Total Copper	Total Lead	Total Zinc	Runoff Volume	CuDissTM	ZnDissTM
Dissolved Cadmium	1.0000										
Dissolved Copper	0.4095	1.0000									
Dissolved Lead	0.0117	0.2887	1.0000								
Dissolved Zinc	0.3024	0.8112	0.3804	1.0000							
Total Cadmium	-0.0807	0.2559	0.0725	0.1984	1.0000						
Total Copper	0.1804	0.5733	0.1084	0.5276	0.8657	1.0000					
Total Lead	-0.0389	0.2072	0.1491	0.2144	0.7992	0.8104	1.0000				
Total Zinc	0.0576	0.4753	-0.0282	0.3725	0.8810	0.9520	0.8240	1.0000			
Runoff Volume	0.0255	-0.2580	-0.1815	-0.1844	-0.0207	-0.1902	-0.0021	-0.1178	1.0000		
CuDissTM	0.2817	0.2137	-0.1052	0.0619	0.0683	0.0541	0.0740	0.0935	0.8344	1.0000	
ZnDissTM	0.2361	0.0541	-0.1110	0.0886	0.0553	-0.0024	0.1134	0.0309	0.9145	0.9305	1.0000
Rainfall Depth	0.1365	-0.2682	-0.2345	-0.2042	-0.1909	-0.3143	-0.2354	-0.2676	0.9039	0.7363	0.7951
Rainfall Duration	0.3421	-0.0289	-0.3636	-0.1216	-0.3472	-0.3535	-0.5482	-0.2930	0.4122	0.4319	0.3922
Min. Days Since Sweeping	-0.0902	-0.5306	0.0396	-0.3658	-0.3445	-0.4481	-0.1870	-0.4866	0.2308	-0.0601	0.0194
Max. Days Since Sweeping	0.2733	-0.2198	0.3883	-0.1797	-0.2947	-0.3819	-0.2554	-0.4712	0.4015	0.3721	0.3796
Min. Days Since Cleanout	0.2582	-0.2321	0.0674	-0.1957	-0.3398	-0.3904	-0.4426	-0.4603	0.1190	0.0507	0.0616
Antecedent Days	0.4612	0.4677	0.6573	0.3474	-0.0965	0.0905	0.0799	0.0431	-0.2052	0.0352	-0.0414
Inter-event Period	-0.0855	0.0461	-0.1277	-0.0426	0.2302	0.1009	0.0234	0.1194	-0.0558	-0.0578	-0.1115
Days Since Study Start	0.2243	-0.3247	-0.1082	-0.3614	-0.0518	-0.1115	-0.1944	-0.2124	-0.4073	-0.4448	-0.4537

Station 520U	Dissolved Cadmium	Dissolved Copper	Dissolved Lead	Dissolved Zinc	Total Cadmium	Total Copper	Total Lead	Total Zinc	Runoff Volume	CuDissTM	ZnDissTM
Dissolved Cadmium	1.0000										
Dissolved Copper	0.9545	1.0000									
Dissolved Lead	0.9990	0.9563	1.0000								
Dissolved Zinc	0.9417	0.9768	0.9393	1.0000							
Total Cadmium	0.1283	0.2192	0.1394	0.1688	1.0000						
Total Copper	0.4389	0.5857	0.4537	0.5028	0.7677	1.0000					
Total Lead	0.0654	0.2089	0.0841	0.1356	0.7336	0.8523	1.0000				
Total Zinc	0.2412	0.3798	0.2543	0.3148	0.8792	0.9555	0.9052	1.0000			
Runoff Volume	-0.3295	-0.4566	-0.3386	-0.3616	-0.1196	-0.3823	-0.1789	-0.2555	1.0000		
CuDissTM	0.2899	0.3781	0.2903	0.4401	0.1784	0.2385	0.1289	0.1772	0.4086	1.0000	
ZnDissTM	0.1871	0.2334	0.1801	0.3621	0.0795	0.0786	0.0277	0.0668	0.5490	0.9151	1.0000
Rainfall Depth	-0.2572	-0.3775	-0.2775	-0.2772	-0.1958	-0.3735	-0.1951	-0.2682	0.9039	0.3551	0.5167
Rainfall Duration	-0.1621	-0.1382	-0.1743	-0.0316	-0.3133	-0.2254	-0.1867	-0.2363	0.4390	0.3920	0.4673
Min. Days Since Sweeping	-0.1570	-0.2700	-0.1620	-0.3107	-0.3926	-0.4571	-0.3459	-0.4666	0.0527	-0.4003	-0.3831
Max. Days Since Sweeping	-0.2014	-0.2691	-0.1941	-0.2833	-0.3334	-0.3963	-0.3410	-0.4476	0.4372	0.2076	0.1463
Min. Days Since Cleanout	-0.1075	-0.1748	-0.0943	-0.1327	-0.3225	-0.3033	-0.3081	-0.3638	0.1513	-0.0293	0.0120
Antecedent Days	0.1117	0.2036	0.1237	0.1628	-0.1657	0.0444	0.1267	-0.0774	-0.1261	0.2959	0.1312
Inter-event Period	-0.0095	0.0675	-0.0072	0.0489	0.3230	0.0725	0.0584	0.1185	-0.1488	0.0974	-0.0139
Days Since Study Start	-0.1935	-0.1772	-0.1719	-0.2661	-0.1128	-0.0263	0.0139	-0.0963	-0.3276	-0.3795	-0.4570

Correlations (All storms with at least 1 sample, excluding Mobilization Event 8)

Storm Events	Rainfall Depth	Rainfall Duration	Min. Days Since Sweeping	Max. Days Since Sweeping	Min. Days Since Cleanout	Antecedent Days	Inter-event Period	Total/ac CuDissTMpA	Total/ac ZnDissTMpA	Days Since Study Start
Rainfall Depth	1.0000									
Rainfall Duration	0.5948	1.0000								
Min. Days Since Sweeping	0.3270	0.1324	1.0000							
Max. Days Since Sweeping	0.4428	0.3417	0.5546	1.0000						
Min. Days Since Cleanout	0.1769	0.4585	0.2183	0.6261	1.0000					
Antecedent Days	-0.2023	-0.0783	-0.1039	0.3130	0.1308	1.0000				
Inter-event Period	-0.1806	0.0239	0.0402	-0.1099	-0.1118	-0.0793	1.0000			
Total/ac CuDissTMpA	0.4391	0.4164	-0.3742	0.2628	0.0110	0.3530	-0.0799	1.0000		
Total/ac ZnDissTMpA	0.5642	0.4112	-0.2818	0.2298	0.0331	0.1061	-0.1933	0.8814	1.0000	
Days Since Study Start	-0.3687	0.0023	0.1677	0.1803	0.4479	-0.0288	0.0381	-0.4414	-0.4753	1.0000

Station 520E	Dissolved Cadmium	Dissolved Copper	Dissolved Lead	Dissolved Zinc	Total Cadmium	Total Copper	Total Lead	Total Zinc	Runoff Volume	CuDissTM	ZnDissTM
Dissolved Cadmium	1.0000										
Dissolved Copper	0.0000	1.0000									
Dissolved Lead	0.0000	0.2974	1.0000								
Dissolved Zinc	0.0000	0.7516	0.3981	1.0000							
Total Cadmium	0.0000	0.3107	0.0732	0.0429	1.0000						
Total Copper	0.0000	0.5140	0.3927	0.3430	0.7111	1.0000					
Total Lead	0.0000	0.2547	0.1329	0.0586	0.8584	0.9003	1.0000				
Total Zinc	0.0000	0.3677	0.1900	0.2259	0.7972	0.9503	0.9674	1.0000			
Runoff Volume	0.0000	-0.4570	-0.1983	-0.5205	0.0127	-0.2359	-0.0467	-0.1624	1.0000		
CuDissTM	0.0000	0.2945	-0.0541	-0.0260	0.2991	0.1493	0.1617	0.1238	0.6605	1.0000	
ZnDissTM	0.0000	-0.0057	0.1051	0.1168	0.0689	-0.0107	0.0074	-0.0269	0.7391	0.7641	1.0000
Rainfall Depth	0.0000	-0.3610	-0.2471	-0.4067	-0.1764	-0.2531	-0.1565	-0.2050	0.7121	0.4849	0.5103
Rainfall Duration	0.0000	0.0987	-0.1375	0.0618	-0.1668	-0.0781	-0.1540	-0.0546	0.1921	0.2822	0.1584
Min. Days Since Sweeping	0.0000	-0.4563	0.1215	-0.2895	-0.5143	-0.3070	-0.3190	-0.3279	-0.1674	-0.5372	-0.3892
Max. Days Since Sweeping	0.0000	-0.1680	0.2550	-0.1455	-0.3751	-0.2196	-0.3455	-0.3468	0.1794	0.1434	0.1363
Min. Days Since Cleanout	0.0000	-0.0835	0.2561	0.0633	-0.3980	-0.3033	-0.4691	-0.3841	0.0541	-0.0164	0.0157
Antecedent Days	0.0000	0.3746	0.2715	0.0185	-0.0002	0.1037	-0.0443	-0.0287	0.1363	0.5122	0.1799
Inter-event Period	0.0000	-0.0394	-0.0486	-0.1345	0.2048	-0.0949	-0.0151	-0.0345	-0.3345	-0.2864	-0.3754
Days Since Study Start	0.0000	0.0464	0.5091	0.2013	-0.2303	0.1639	-0.0667	0.0040	-0.4958	-0.5043	-0.3965

Station 520N	Dissolved Cadmium	Dissolved Copper	Dissolved Lead	Dissolved Zinc	Total Cadmium	Total Copper	Total Lead	Total Zinc	Runoff Volume	CuDissTM	ZnDissTM
Dissolved Cadmium	1.0000										
Dissolved Copper	0.4887	1.0000									
Dissolved Lead	0.0191	0.1261	1.0000								
Dissolved Zinc	0.5739	0.8044	0.1499	1.0000							
Total Cadmium	-0.0800	0.2707	0.0594	0.2885	1.0000						
Total Copper	0.1975	0.4959	-0.0154	0.4773	0.9030	1.0000					
Total Lead	-0.0387	0.2320	0.1536	0.3636	0.7994	0.8543	1.0000				
Total Zinc	0.0614	0.4570	-0.0999	0.4182	0.8873	0.9632	0.8340	1.0000			
Runoff Volume	0.0216	-0.1364	-0.0882	0.0966	-0.0077	-0.1058	0.0027	-0.0726	1.0000		
CuDissTM	0.2849	0.3912	-0.0284	0.4536	0.0807	0.1384	0.0796	0.1370	0.8254	1.0000	
ZnDissTM	0.2371	0.1778	-0.0480	0.4475	0.0652	0.0642	0.1185	0.0651	0.9147	0.9281	1.0000
Rainfall Depth	0.1364	-0.1756	-0.1643	-0.0136	-0.1852	-0.2569	-0.2382	-0.2366	0.8981	0.7221	0.7870
Rainfall Duration	0.3442	0.0685	-0.3296	0.0334	-0.3445	-0.3202	-0.5532	-0.2717	0.3859	0.4109	0.3729
Min. Days Since Sweeping	-0.0940	-0.5309	0.1057	-0.4290	-0.3417	-0.4245	-0.1867	-0.4720	0.1964	-0.0983	-0.0101
Max. Days Since Sweeping	0.2757	-0.1359	0.5075	-0.0163	-0.2915	-0.3397	-0.2575	-0.4518	0.3660	0.3427	0.3554
Min. Days Since Cleanout	0.2582	-0.1952	0.1235	-0.1618	-0.3369	-0.3718	-0.4442	-0.4484	0.0869	0.0235	0.0389
Antecedent Days	0.4661	0.4820	0.6662	0.4641	-0.1025	0.0567	0.0785	0.0241	-0.1822	0.0614	-0.0213
Inter-event Period	-0.0856	0.0586	-0.1348	-0.0694	0.2307	0.1095	0.0235	0.1231	-0.0598	-0.0603	-0.1145
Days Since Study Start	0.2262	-0.2532	-0.0314	-0.3322	-0.0425	-0.0414	-0.1955	-0.1813	-0.5012	-0.5173	-0.5152

Station 520U	Dissolved Cadmium	Dissolved Copper	Dissolved Lead	Dissolved Zinc	Total Cadmium	Total Copper	Total Lead	Total Zinc	Runoff Volume	CuDissTM	ZnDissTM
Dissolved Cadmium	1.0000										
Dissolved Copper	0.0000	1.0000									
Dissolved Lead	0.0000	0.2083	1.0000								
Dissolved Zinc	0.0000	0.7766	-0.0928	1.0000							
Total Cadmium	0.0000	0.3271	0.2503	0.1440	1.0000						
Total Copper	0.0000	0.6225	0.3735	0.2961	0.7983	1.0000					
Total Lead	0.0000	0.4923	0.4123	0.2203	0.7328	0.9185	1.0000				
Total Zinc	0.0000	0.5168	0.3017	0.2684	0.8814	0.9743	0.9184	1.0000			
Runoff Volume	0.0000	-0.5047	-0.2209	-0.1615	-0.0825	-0.2802	-0.1670	-0.1921	1.0000		
CuDissTM	0.0000	0.3553	0.0158	0.5189	0.1488	0.1294	0.1151	0.1154	0.5579	1.0000	
ZnDissTM	0.0000	0.1870	-0.1522	0.5626	0.0570	-0.0040	0.0157	0.0227	0.6584	0.9156	1.0000
Rainfall Depth	0.0000	-0.4582	-0.4687	-0.1077	-0.1699	-0.3002	-0.1849	-0.2198	0.8978	0.4645	0.5950
Rainfall Duration	0.0000	0.0562	-0.2761	0.3645	-0.2989	-0.1739	-0.1788	-0.2059	0.4138	0.4648	0.5134
Min. Days Since Sweeping	0.0000	-0.4078	-0.1147	-0.4901	-0.3802	-0.4375	-0.3405	-0.4473	0.0011	-0.3753	-0.3646
Max. Days Since Sweeping	0.0000	-0.2632	0.1602	-0.2843	-0.3166	-0.3498	-0.3354	-0.4198	0.4010	0.2837	0.1912
Min. Days Since Cleanout	0.0000	-0.2433	0.2911	-0.0941	-0.3131	-0.2867	-0.3035	-0.3502	0.1234	0.0019	0.0329
Antecedent Days	0.0000	0.3273	0.2673	0.1722	-0.1827	-0.0052	0.1204	-0.1082	-0.0952	0.2770	0.1130
Inter-event Period	0.0000	0.2718	0.0585	0.1958	0.3272	0.0855	0.0592	0.1247	-0.1611	0.1054	-0.0122
Days Since Study Start	0.0000	0.0256	0.4787	-0.2542	-0.0904	0.0665	0.0272	-0.0521	-0.4225	-0.3444	-0.4366

Attachment 6

Storm Event Cumulative Rainfall and Runoff Graphs

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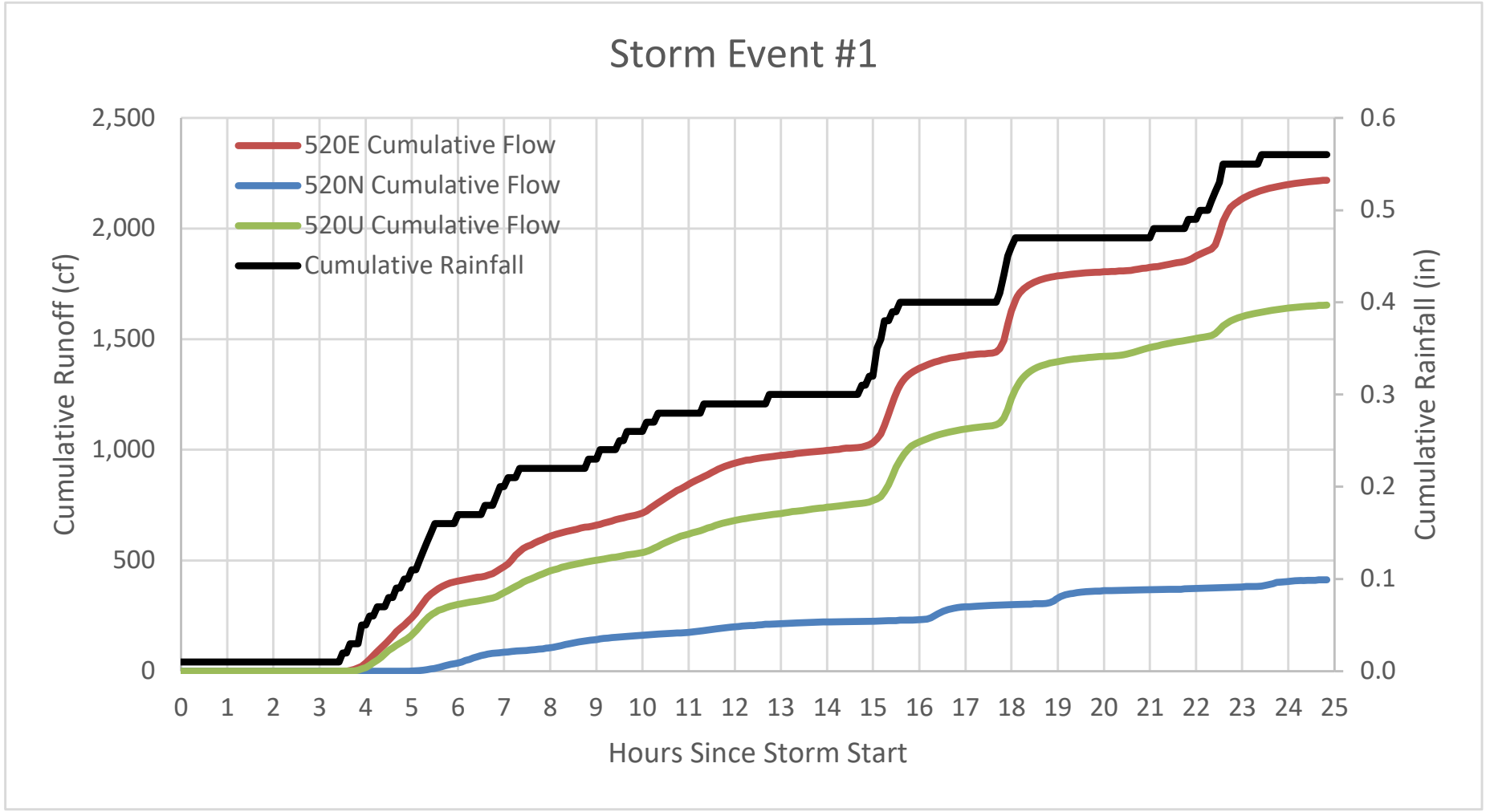
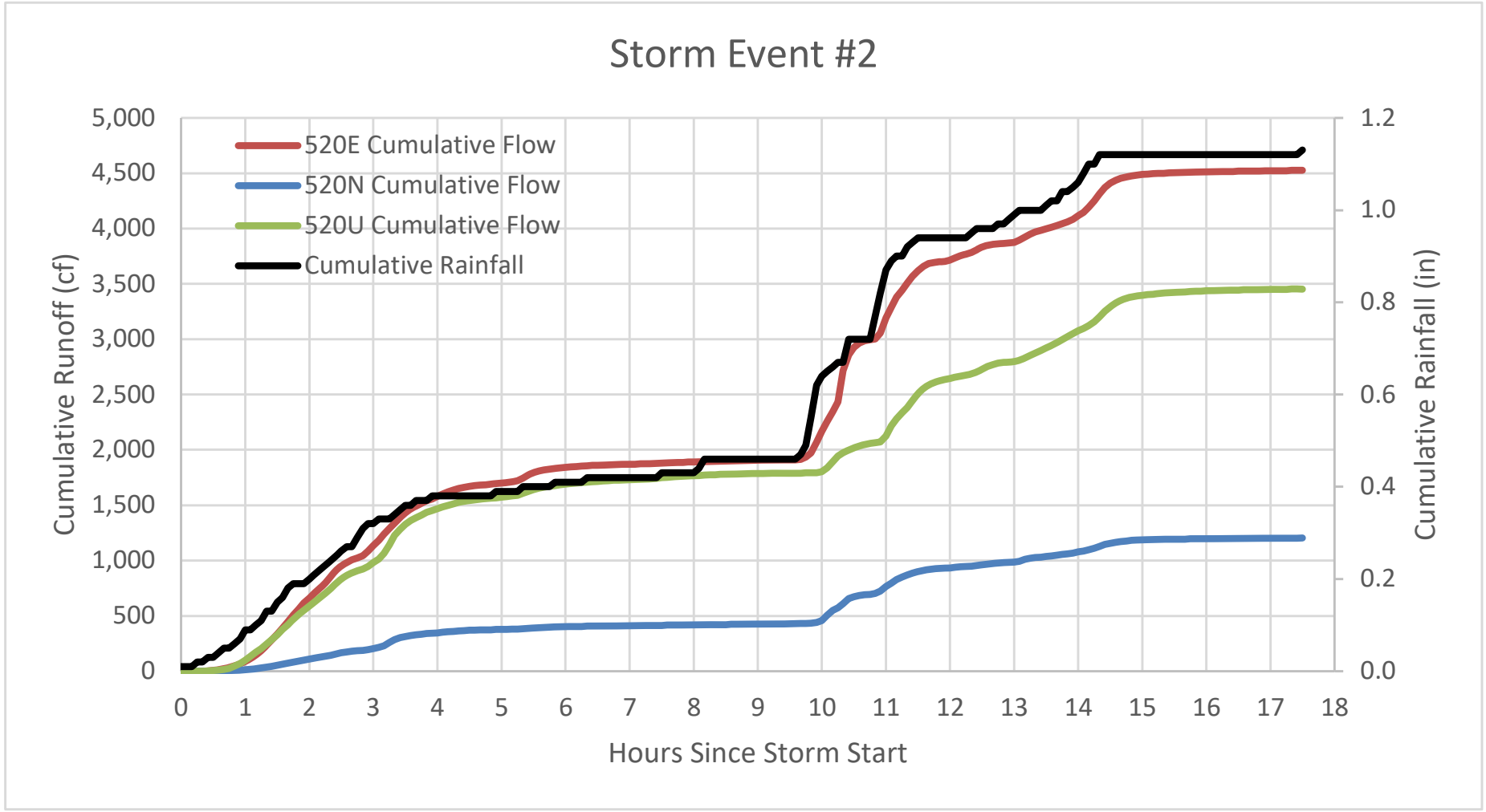
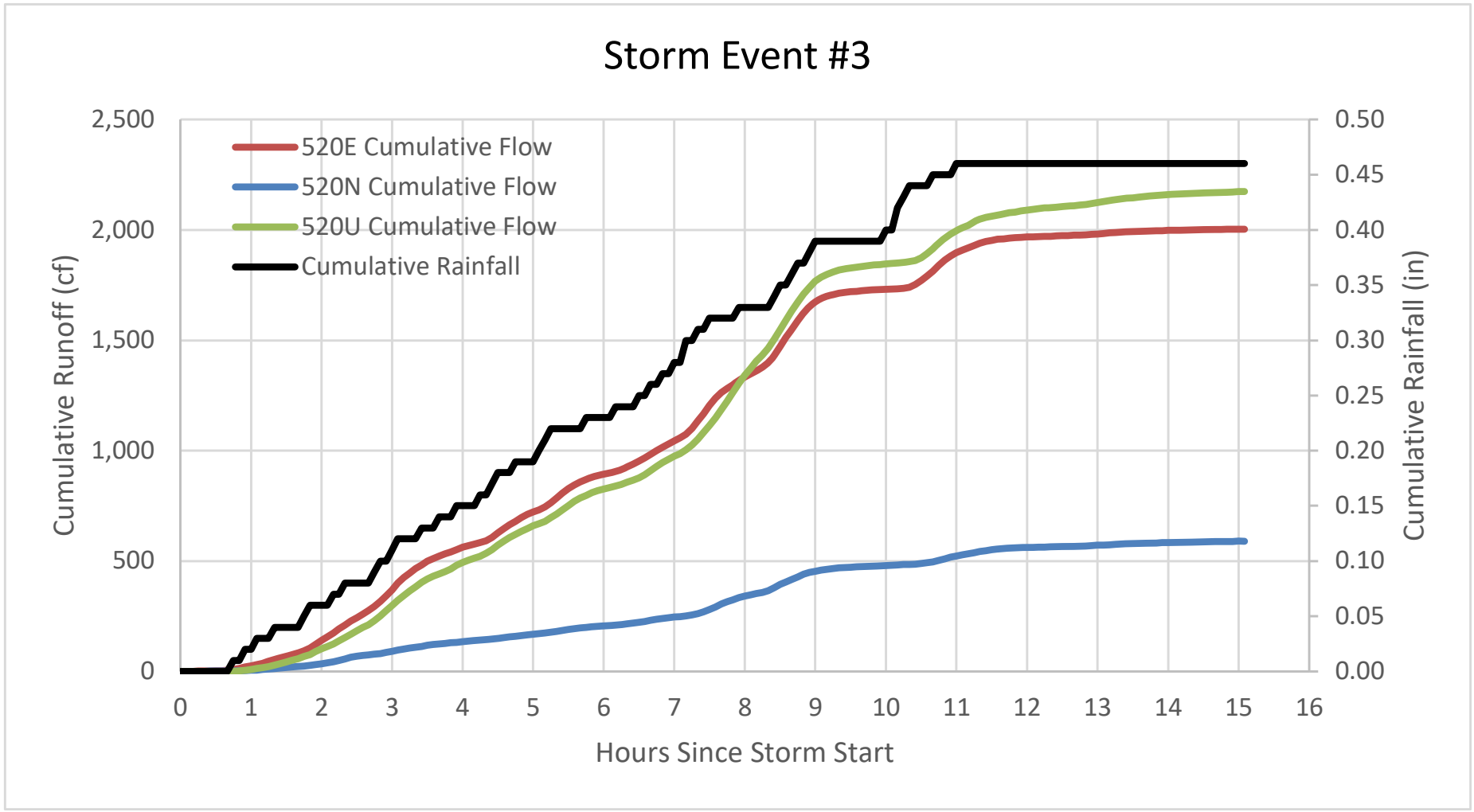
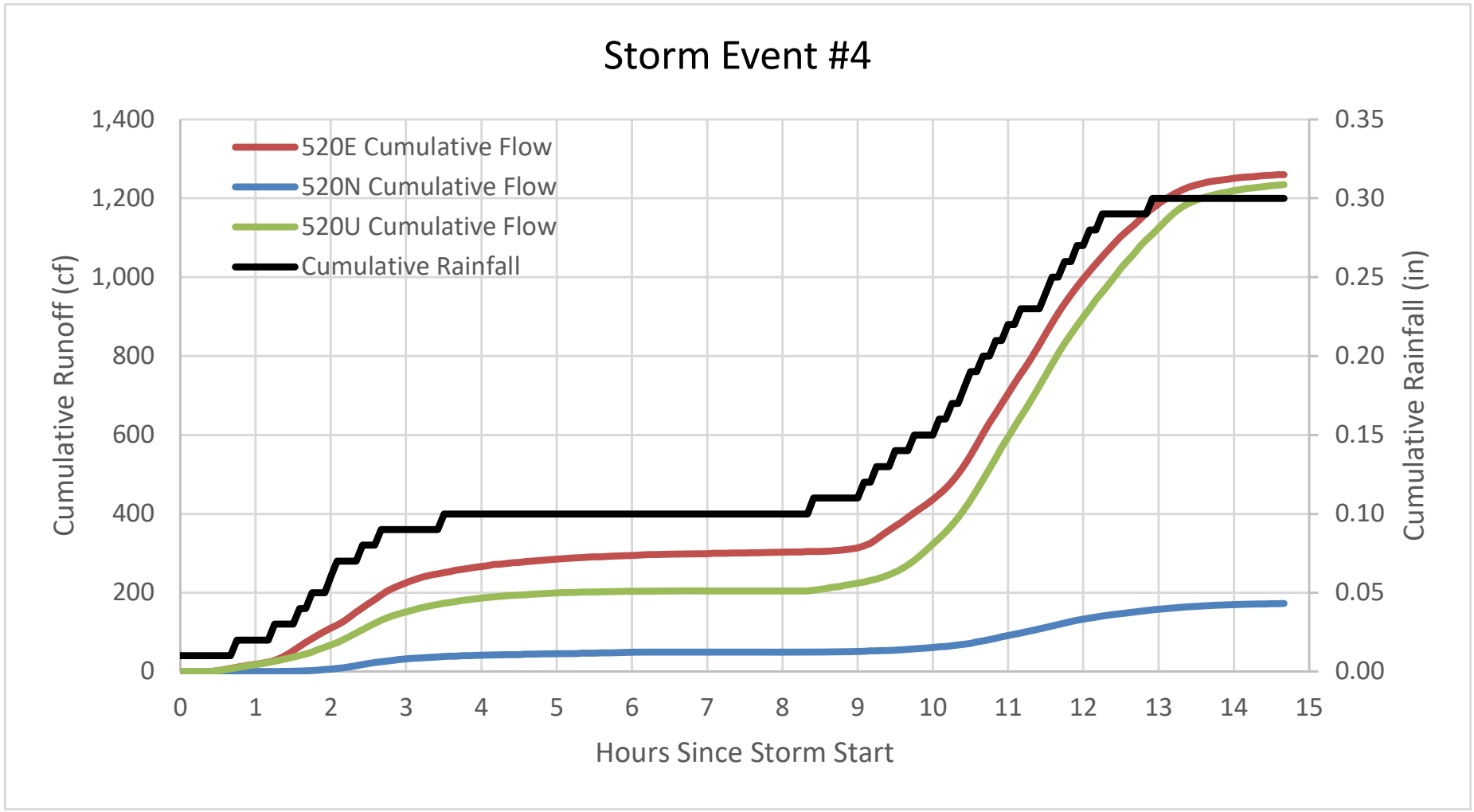
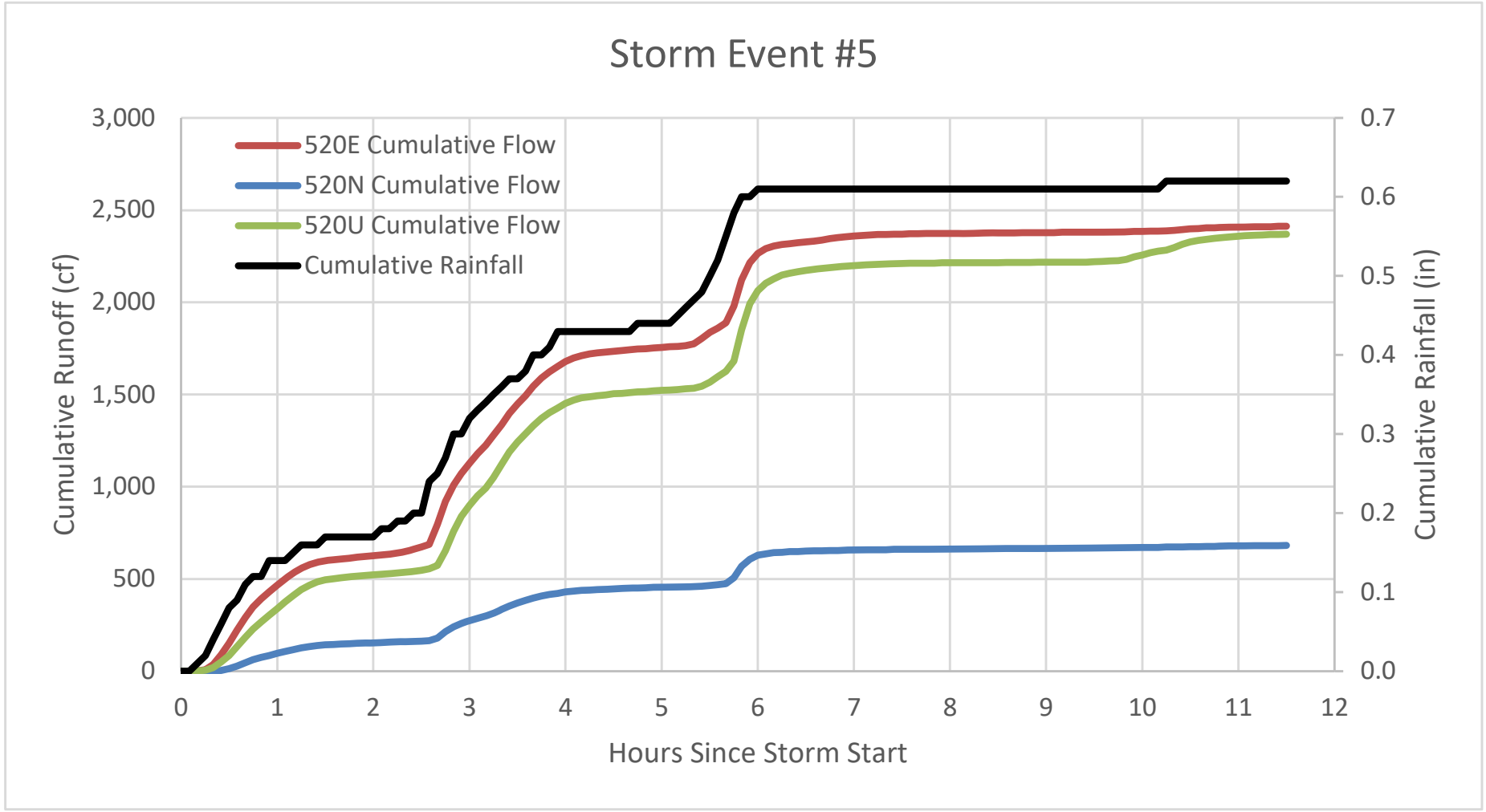
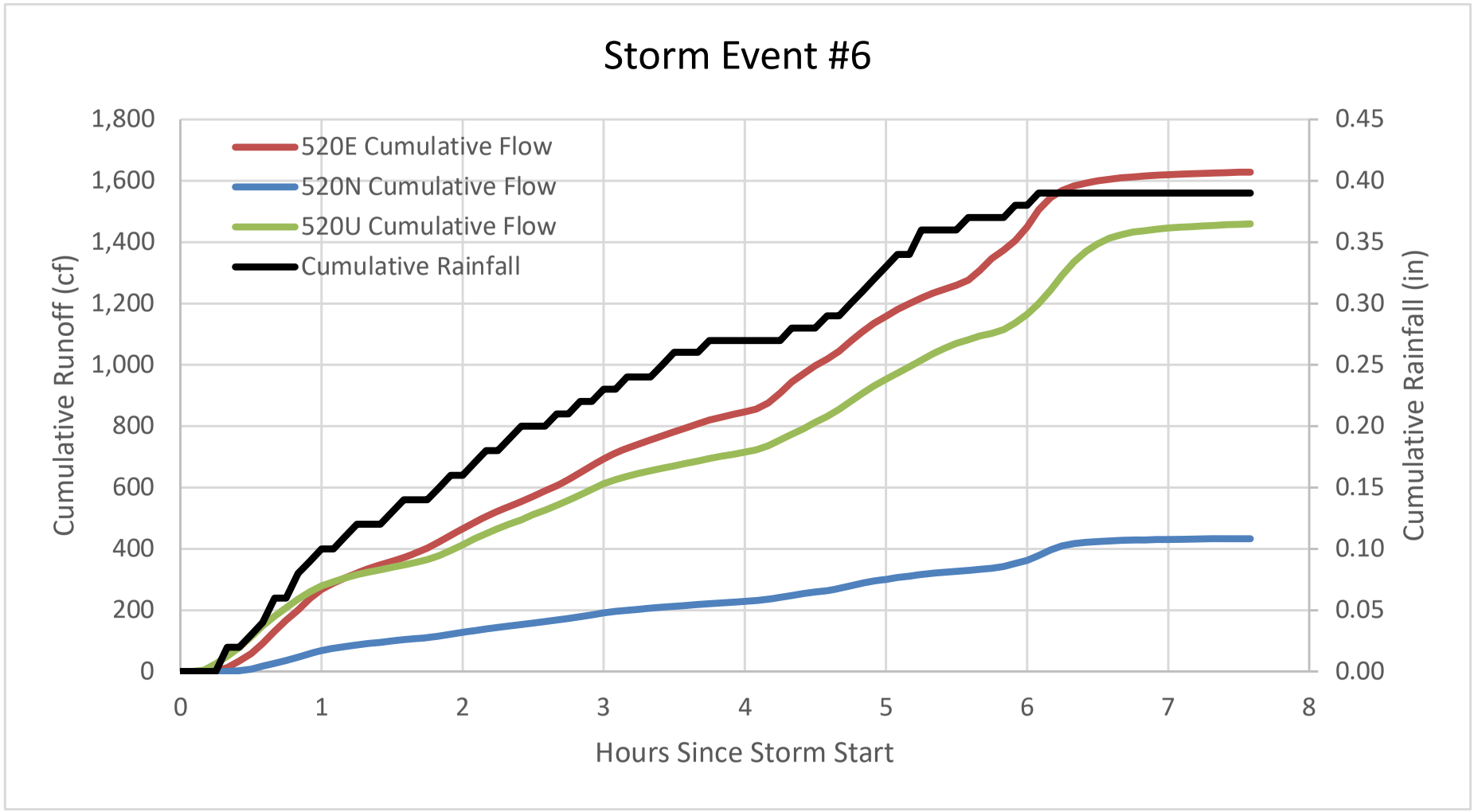

Storm Event #1
520E Cumulative Flow
520N Cumulative Flow
520U Cumulative Flow
Cumulative Rainfall
Cumulative Runoff (cf)
Cumulative Rainfall (in)
Hours Since Storm Start
2,500
2,000
1,500
1,000
500
0
0.6
0.5
0.4
0.3
0.2
0.1
0.0
0 1 2 3 4 5 6 7 8 9 10 11 12 13 14 15 16 17 18 19 20 21 22 23 24 25

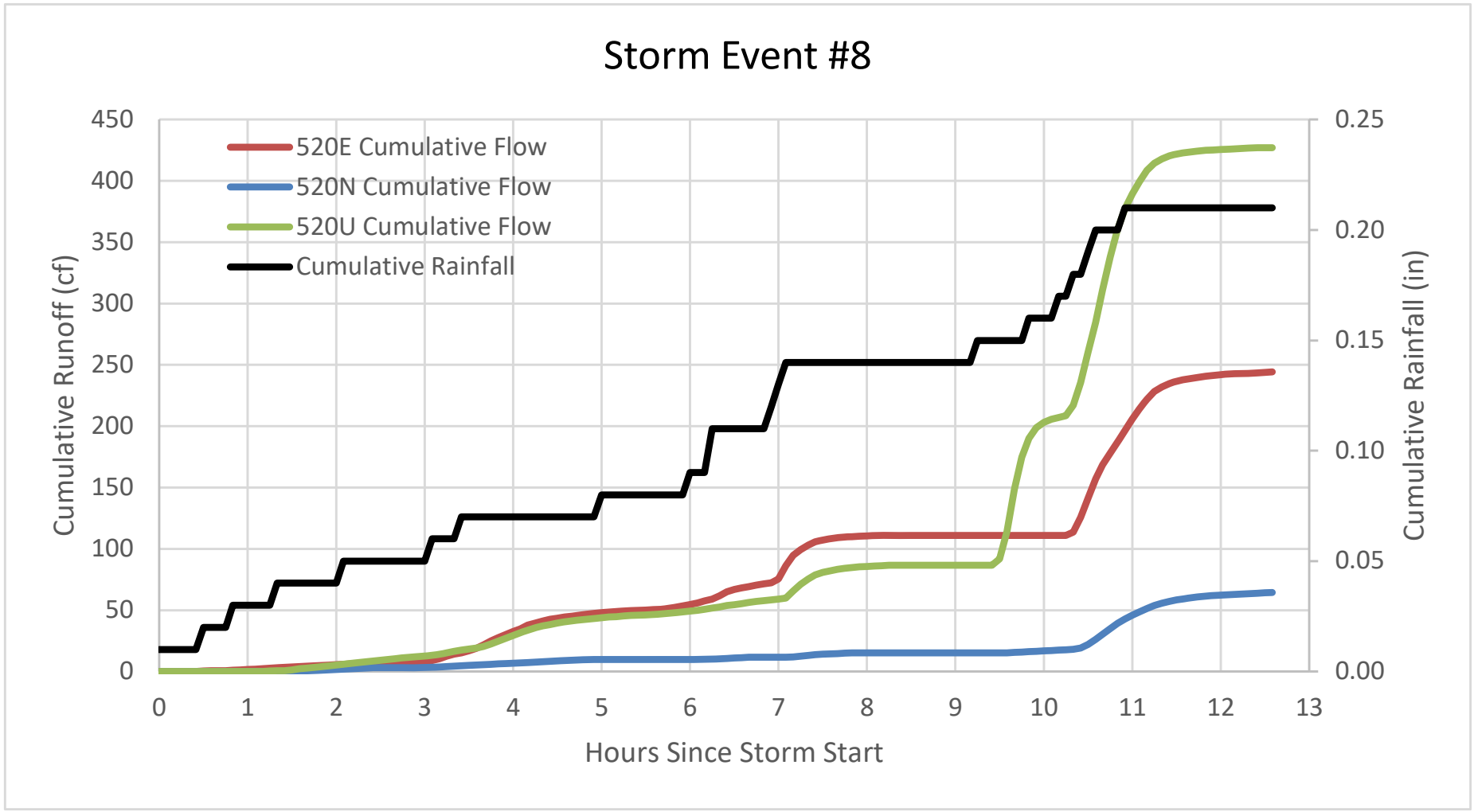

Storm Event #2
520E Cumulative Flow
520N Cumulative Flow
520U Cumulative Flow
Cumulative Rainfall
Cumulative Runoff (cf)
Cumulative Rainfall (in)
Hours Since Storm Start
5,000
4,500
4,000
3,500
3,000
2,500
2,000
1,500
1,000
500
0
1.2
1.0
0.8
0.6
0.4
0.2
0.0
0 1 2 3 4 5 6 7 8 9 10 11 12 13 14 15 16 17 18

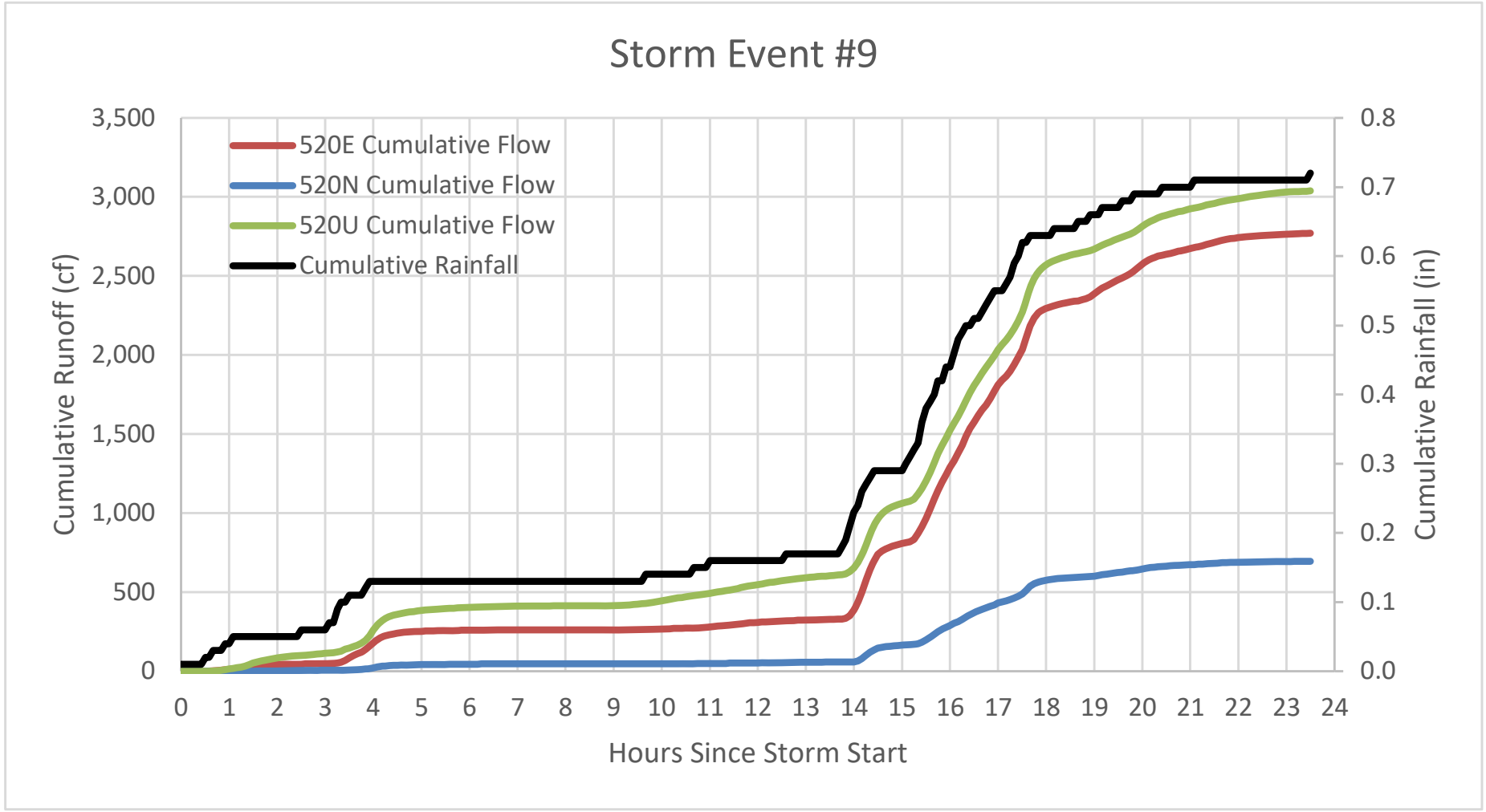

Storm Event #3
520E Cumulative Flow
520N Cumulative Flow
520U Cumulative Flow
Cumulative Rainfall
Cumulative Runoff (cf)
Cumulative Rainfall (in)
Hours Since Storm Start
2,500
2,000
1,500
1,000
500
0
0.50
0.45
0.40
0.35
0.30
0.25
0.20
0.15
0.10
0.05
0.00
0
1
2
3
4
5
6
7
8
9
10
11
12
13
14
15
16

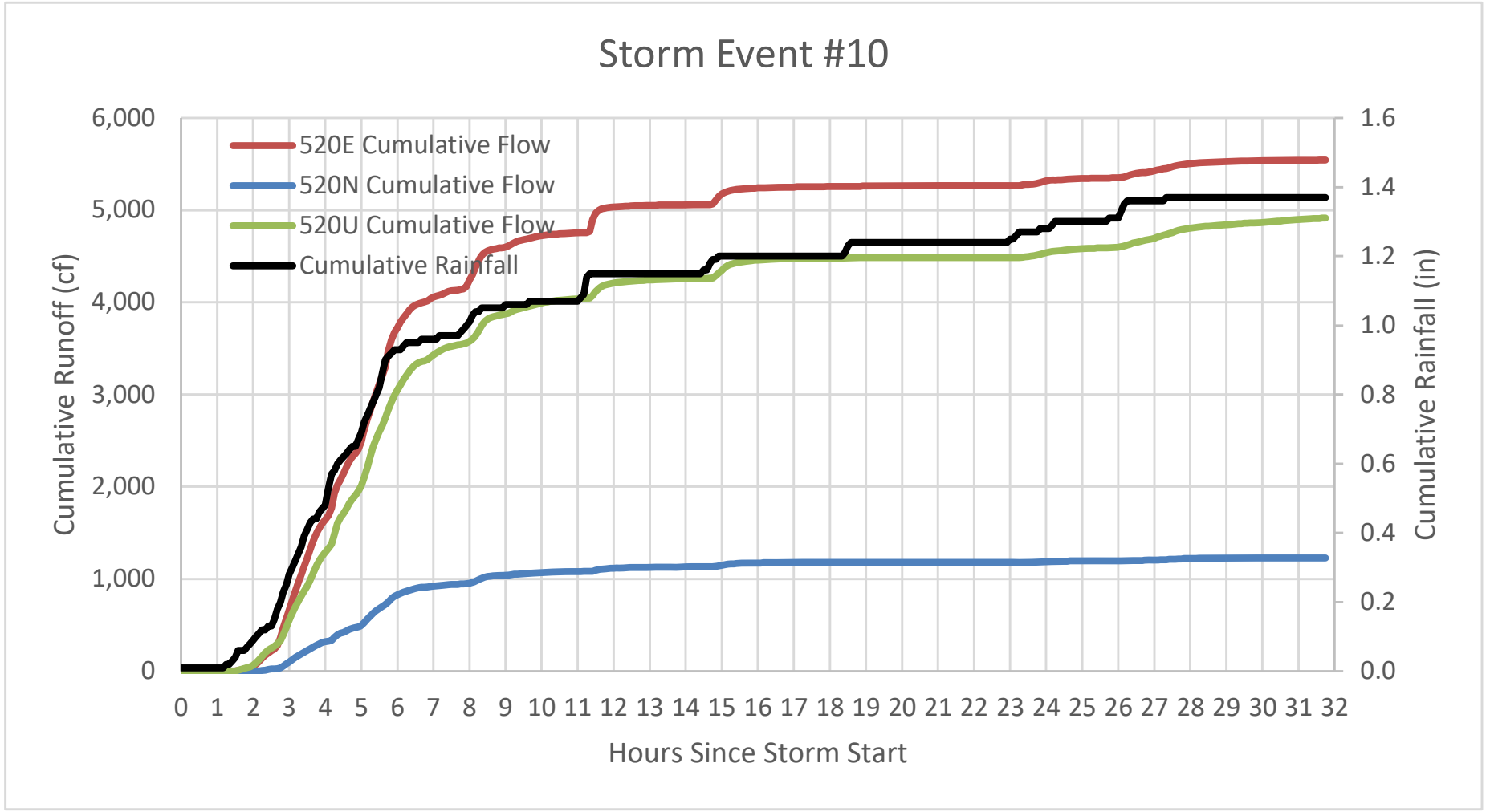

Storm Event #4
520E Cumulative Flow
520N Cumulative Flow
520U Cumulative Flow
Cumulative Rainfall
Cumulative Runoff (cf)
Cumulative Rainfall (in)
Hours Since Storm Start
1,400
1,200
1,000
800
600
400
200
0
0.35
0.30
0.25
0.20
0.15
0.10
0.05
0.00
0
1
2
3
4
5
6
7
8
9
10
11
12
13
14
15

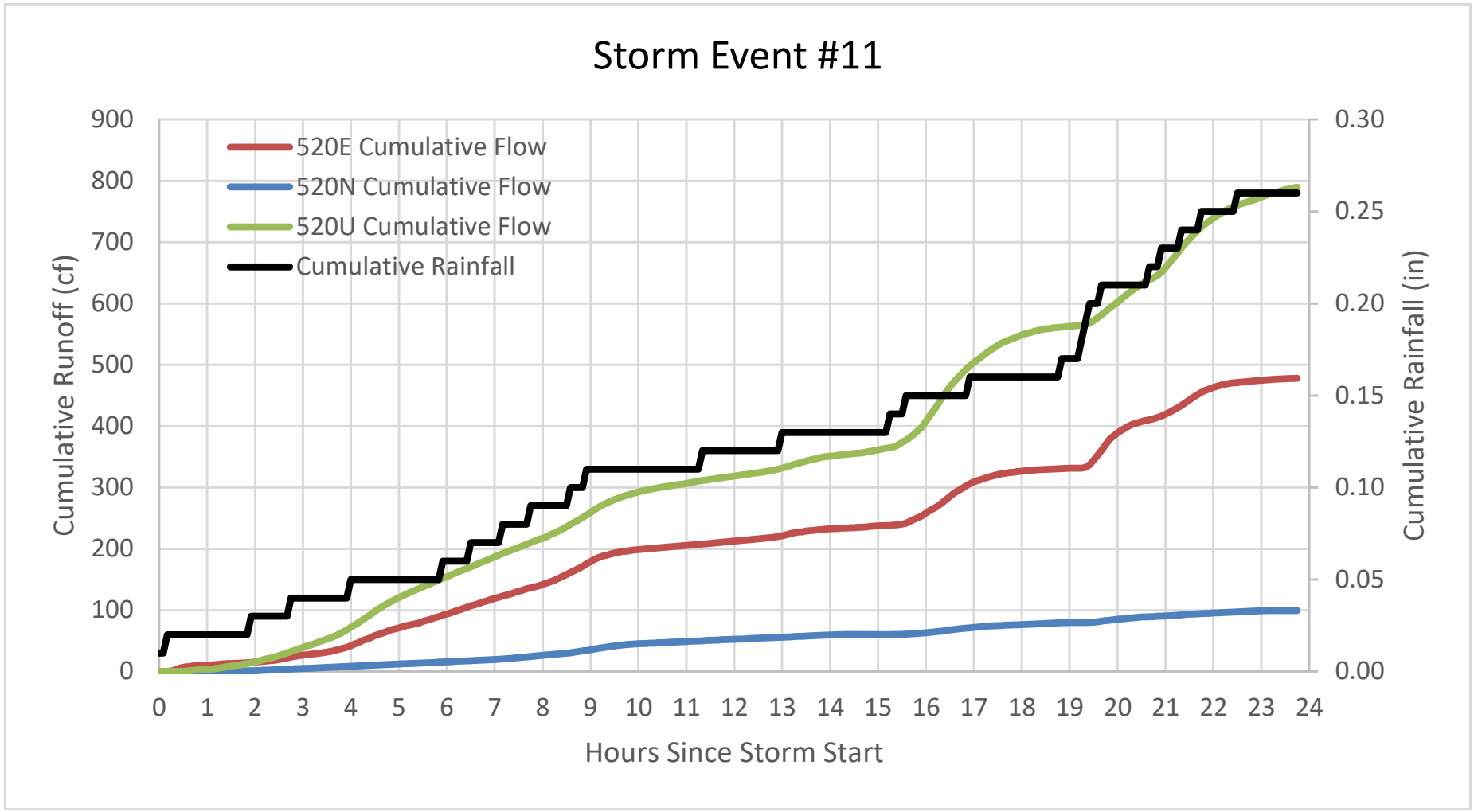

Storm Event #5
520E Cumulative Flow
520N Cumulative Flow
520U Cumulative Flow
Cumulative Rainfall
Cumulative Runoff (cf)
Cumulative Rainfall (in)
Hours Since Storm Start
3,000
2,500
2,000
1,500
1,000
500
0
0.7
0.6
0.5
0.4
0.3
0.2
0.1
0.0
0
1
2
3
4
5
6
7
8
9
10
11
12

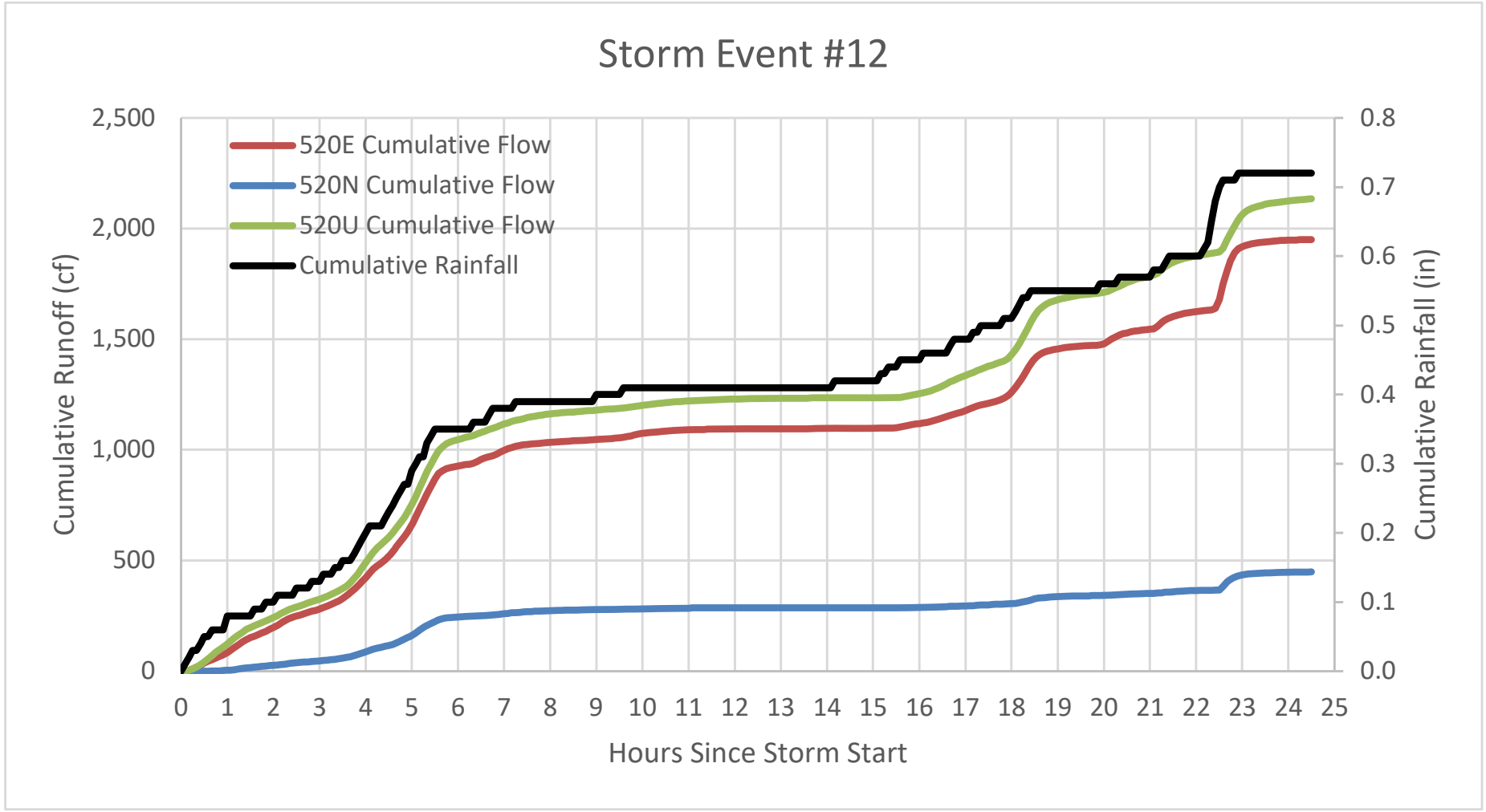

Storm Event #6
520E Cumulative Flow
520N Cumulative Flow
520U Cumulative Flow
Cumulative Rainfall
Cumulative Runoff (cf)
Cumulative Rainfall (in)
Hours Since Storm Start
1,800
1,600
1,400
1,200
1,000
800
600
400
200
0
0.45
0.40
0.35
0.30
0.25
0.20
0.15
0.10
0.05
0.00
0
1
2
3
4
5
6
7
8

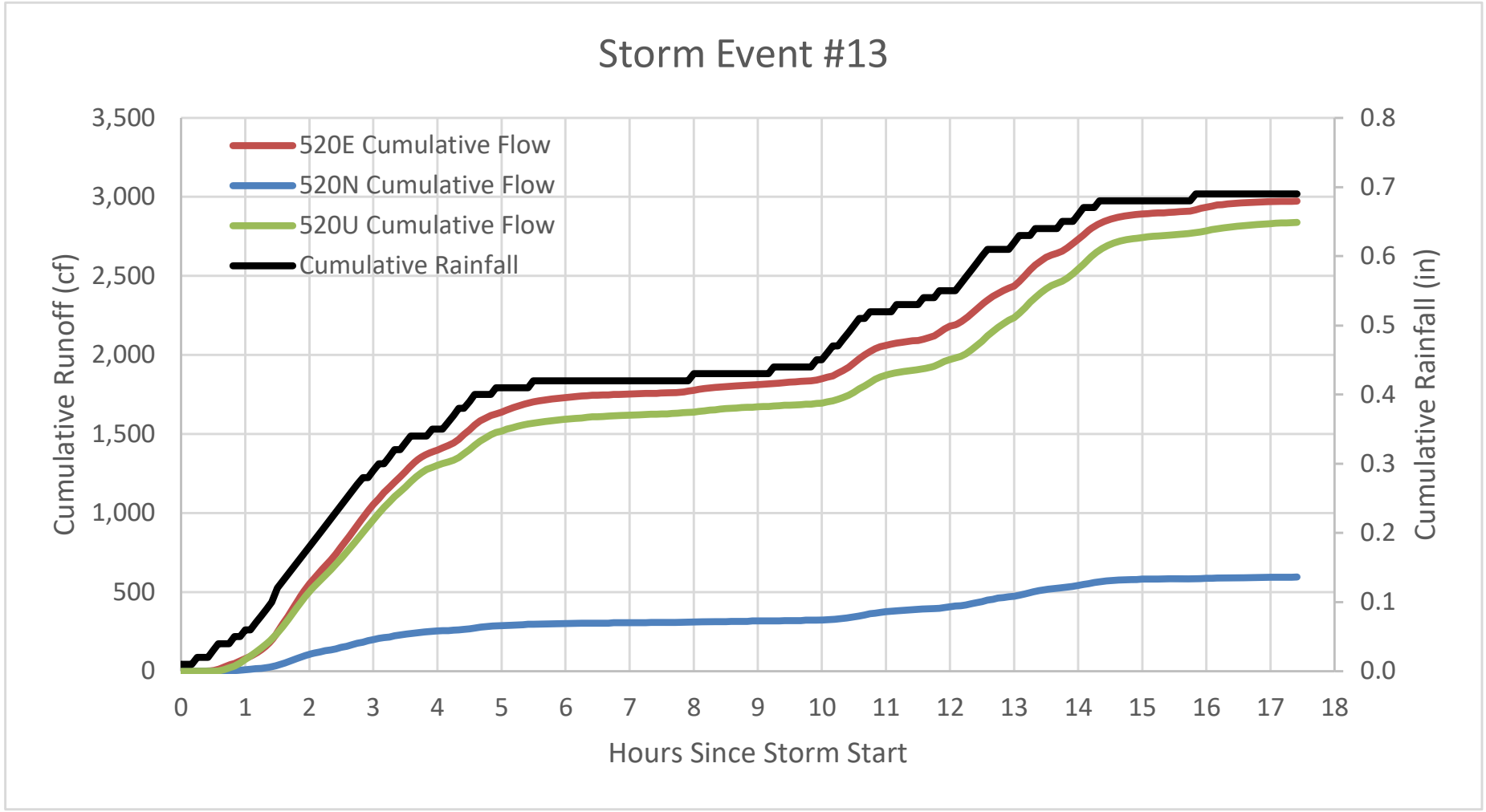

Storm Event #8
520E Cumulative Flow
520N Cumulative Flow
520U Cumulative Flow
Cumulative Rainfall
Cumulative Runoff (cf)
Cumulative Rainfall (in)
Hours Since Storm Start
0
50
100
150
200
250
300
350
400
450
0.00
0.05
0.10
0.15
0.20
0.25
0
1
2
3
4
5
6
7
8
9
10
11
12
13

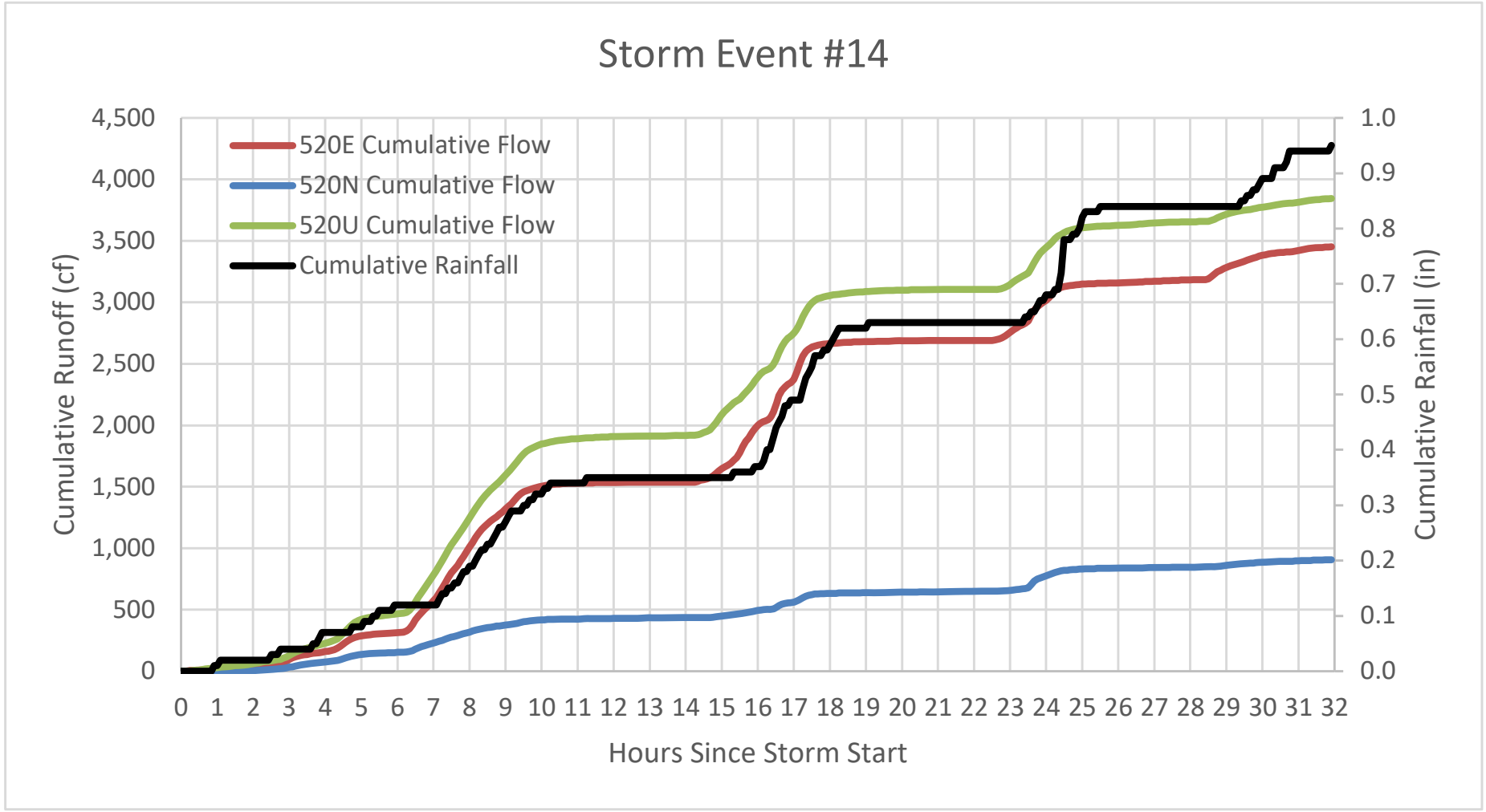

Storm Event #9
520E Cumulative Flow
520N Cumulative Flow
520U Cumulative Flow
Cumulative Rainfall
Cumulative Runoff (cf)
Cumulative Rainfall (in)
Hours Since Storm Start
3,500
3,000
2,500
2,000
1,500
1,000
500
0
0.8
0.7
0.6
0.5
0.4
0.3
0.2
0.1
0.0
0 1 2 3 4 5 6 7 8 9 10 11 12 13 14 15 16 17 18 19 20 21 22 23 24

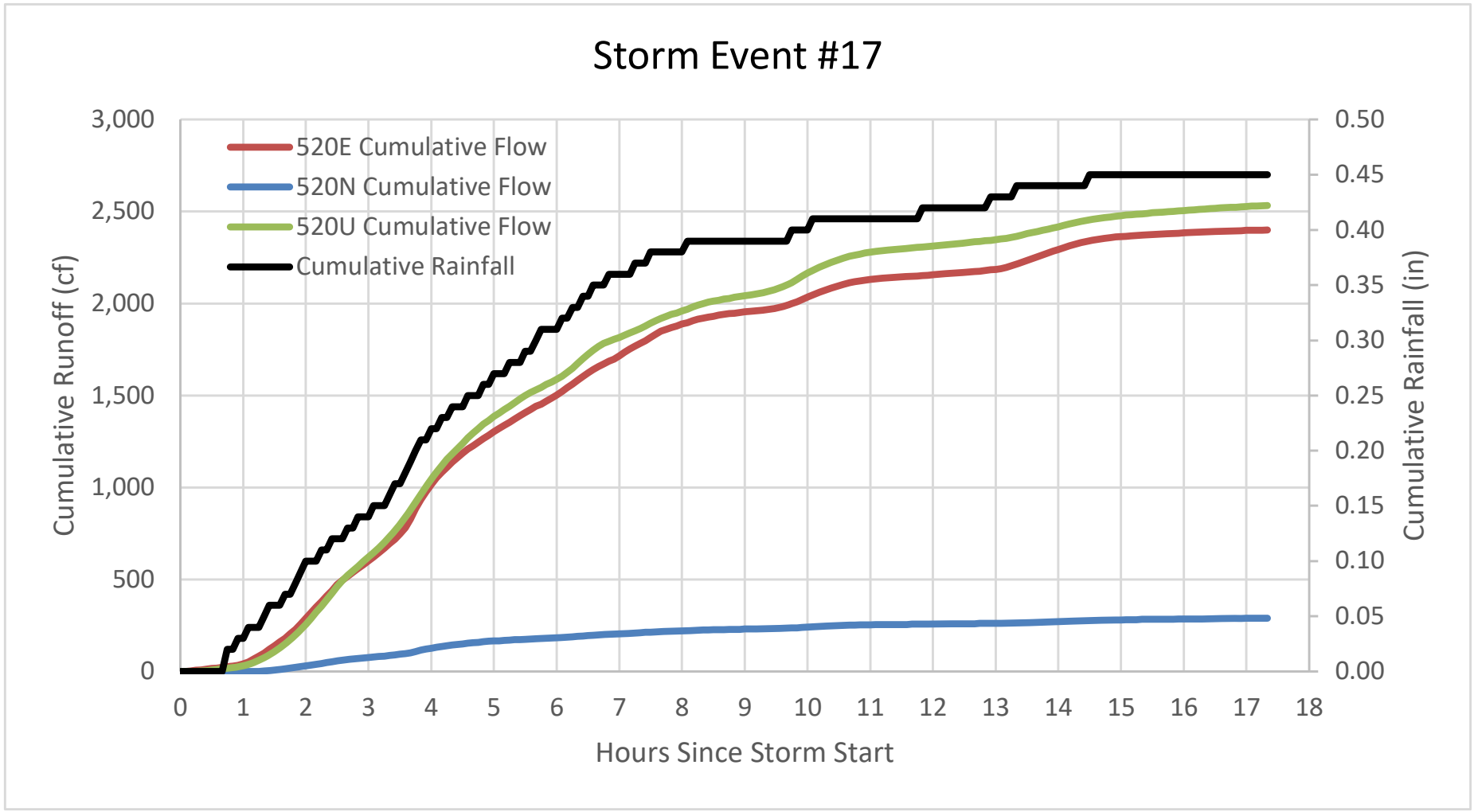

Storm Event #10
520E Cumulative Flow
520N Cumulative Flow
520U Cumulative Flow
Cumulative Rainfall
Cumulative Runoff (cf)
Cumulative Rainfall (in)
Hours Since Storm Start
6,000
5,000
4,000
3,000
2,000
1,000
0
1.6
1.4
1.2
1.0
0.8
0.6
0.4
0.2
0.0
0 1 2 3 4 5 6 7 8 9 10 11 12 13 14 15 16 17 18 19 20 21 22 23 24 25 26 27 28 29 30 31 32

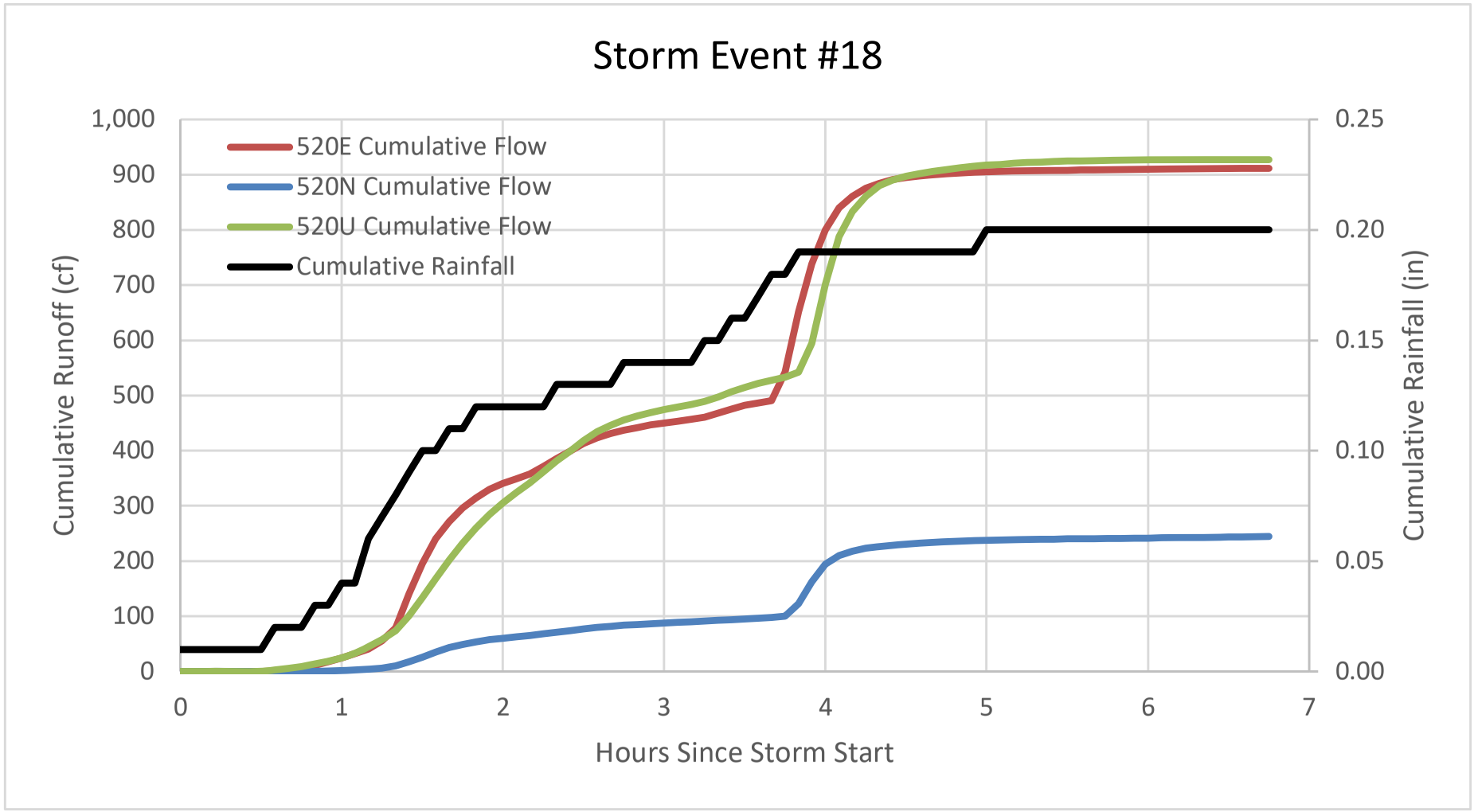

Storm Event #11
520E Cumulative Flow
520N Cumulative Flow
520U Cumulative Flow
Cumulative Rainfall
Cumulative Runoff (cf)
Cumulative Rainfall (in)
Hours Since Storm Start
0
100
200
300
400
500
600
700
800
900
0.00
0.05
0.10
0.15
0.20
0.25
0.30
0 1 2 3 4 5 6 7 8 9 10 11 12 13 14 15 16 17 18 19 20 21 22 23 24

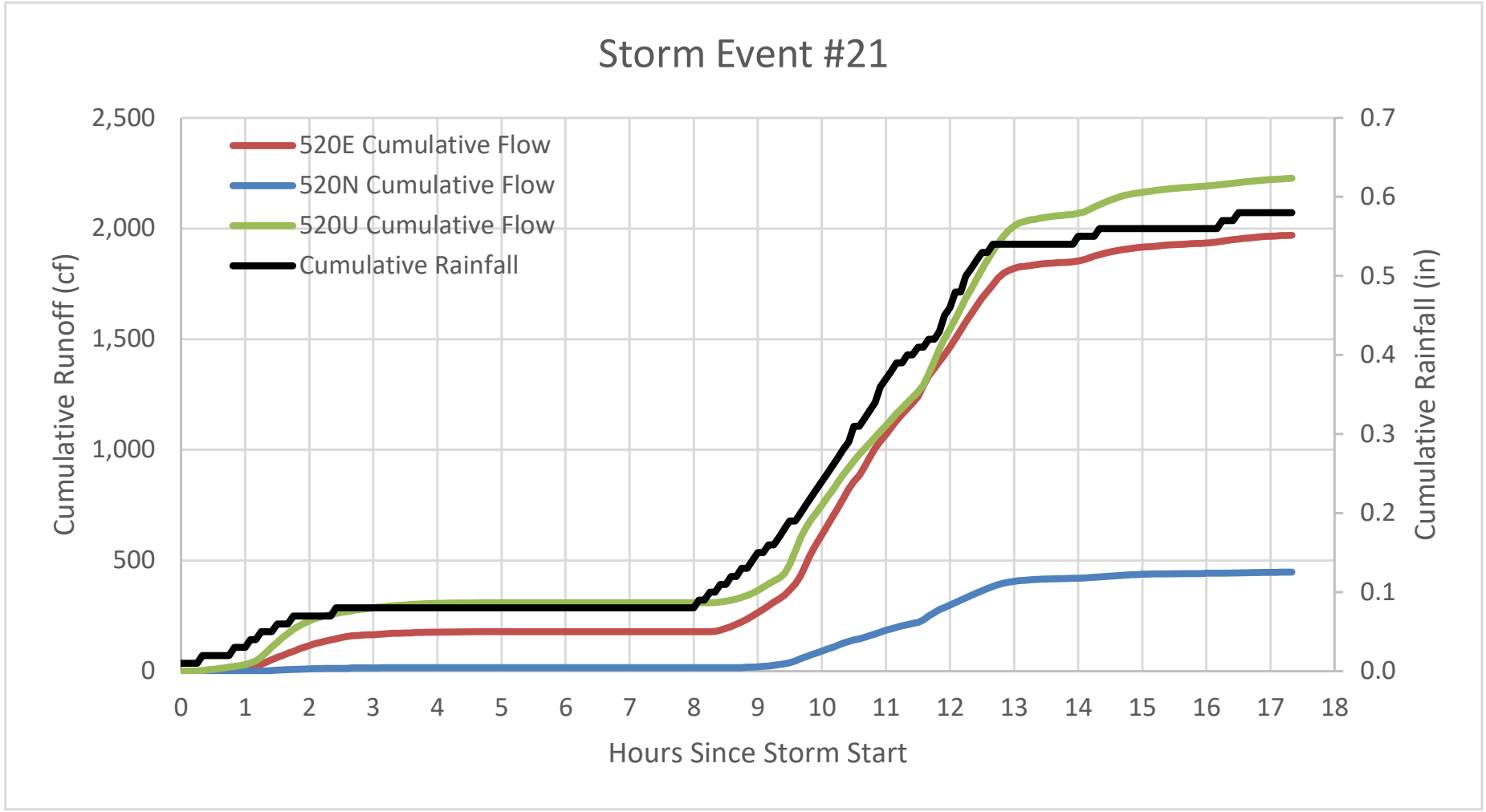

Storm Event #12
520E Cumulative Flow
520N Cumulative Flow
520U Cumulative Flow
Cumulative Rainfall
Cumulative Runoff (cf)
Cumulative Rainfall (in)
Hours Since Storm Start
2,500
2,000
1,500
1,000
500
0
0.8
0.7
0.6
0.5
0.4
0.3
0.2
0.1
0.0
0 1 2 3 4 5 6 7 8 9 10 11 12 13 14 15 16 17 18 19 20 21 22 23 24 25

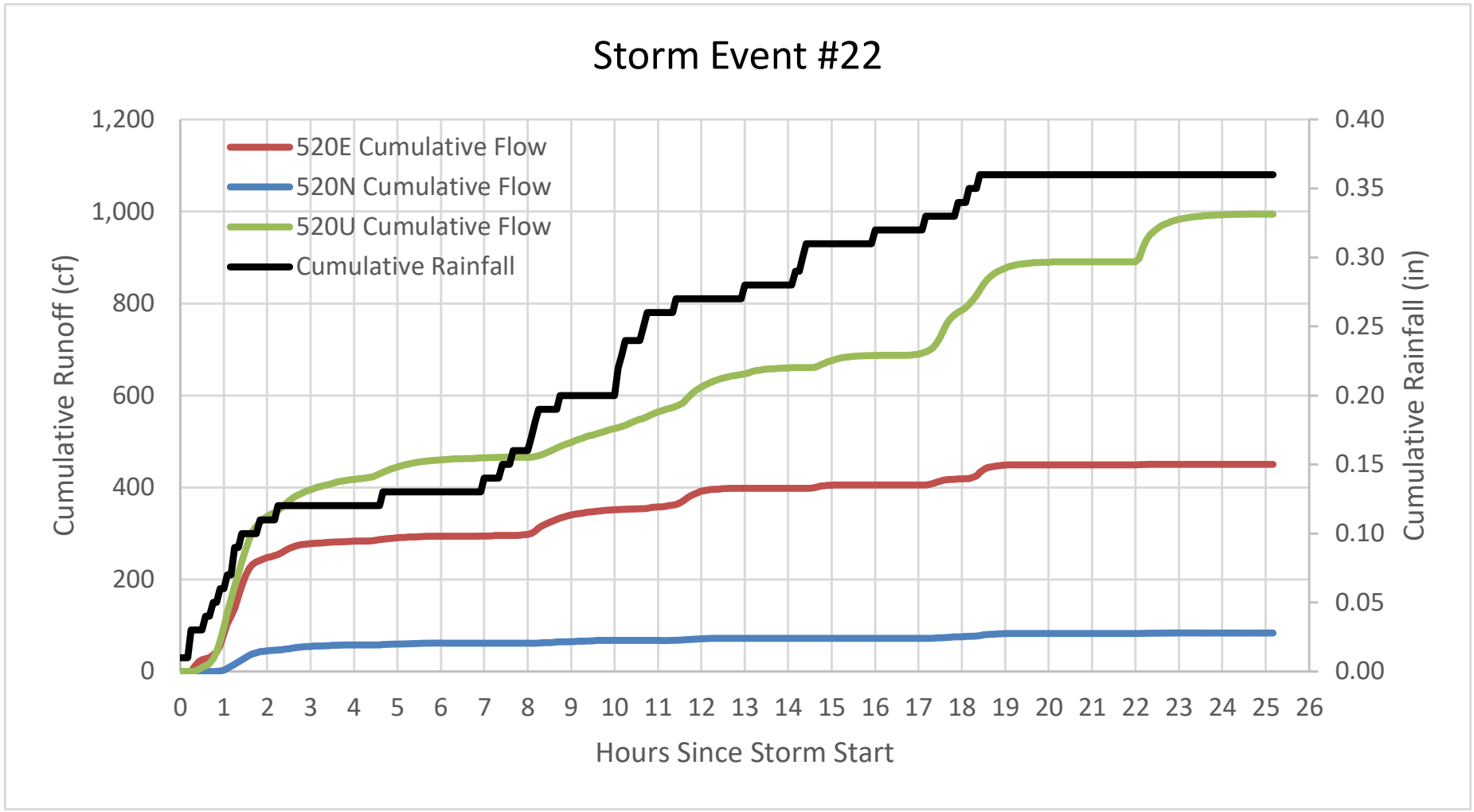

Storm Event #13
520E Cumulative Flow
520N Cumulative Flow
520U Cumulative Flow
Cumulative Rainfall
Cumulative Runoff (cf)
Cumulative Rainfall (in)
Hours Since Storm Start
3,500
3,000
2,500
2,000
1,500
1,000
500
0
0.8
0.7
0.6
0.5
0.4
0.3
0.2
0.1
0.0
0 1 2 3 4 5 6 7 8 9 10 11 12 13 14 15 16 17 18

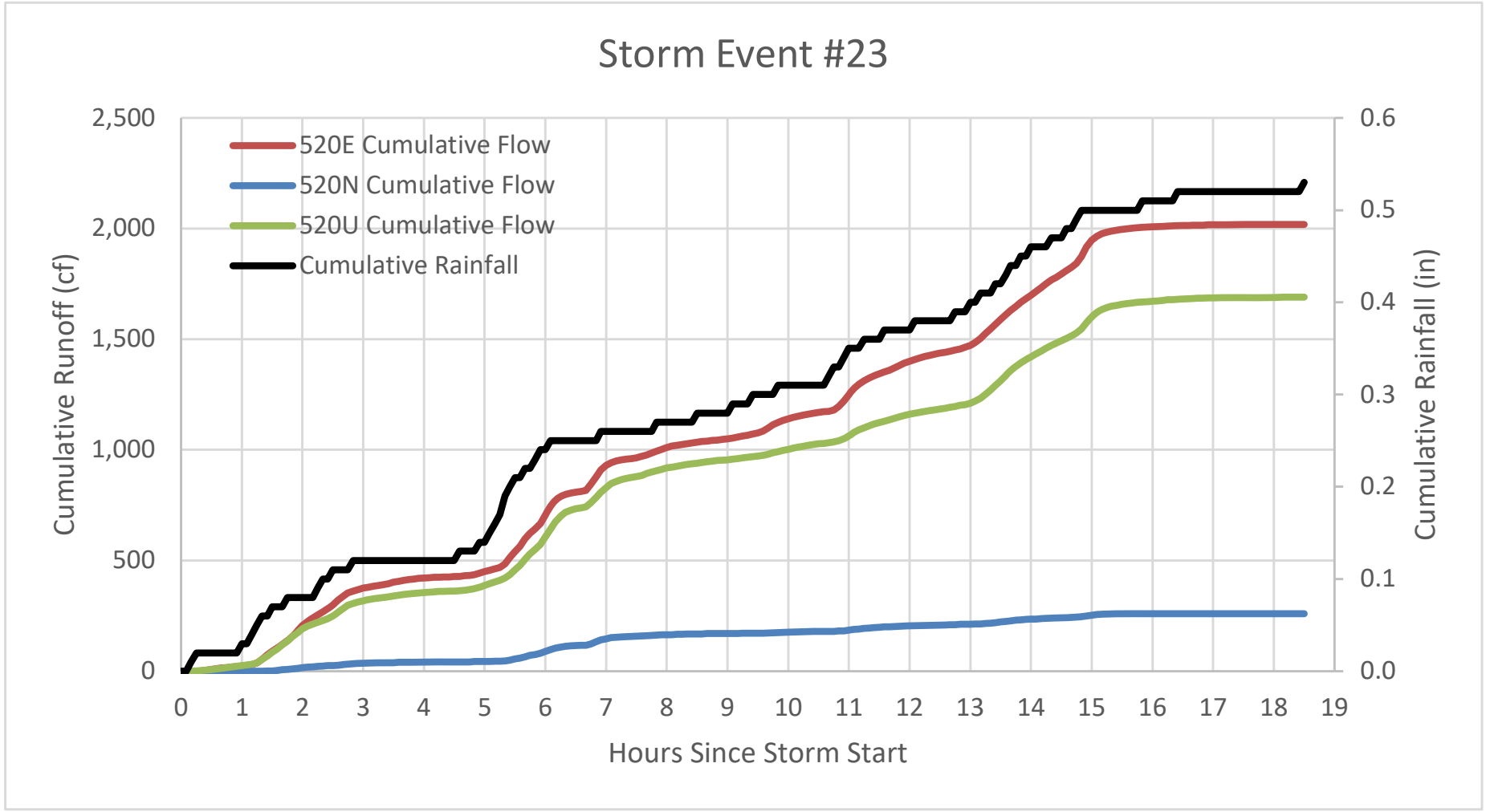

Storm Event #14
520E Cumulative Flow
520N Cumulative Flow
520U Cumulative Flow
Cumulative Rainfall
Cumulative Runoff (cf)
Cumulative Rainfall (in)
Hours Since Storm Start
4,500
4,000
3,500
3,000
2,500
2,000
1,500
1,000
500
0
1.0
0.9
0.8
0.7
0.6
0.5
0.4
0.3
0.2
0.1
0.0
0 1 2 3 4 5 6 7 8 9 10 11 12 13 14 15 16 17 18 19 20 21 22 23 24 25 26 27 28 29 30 31 32

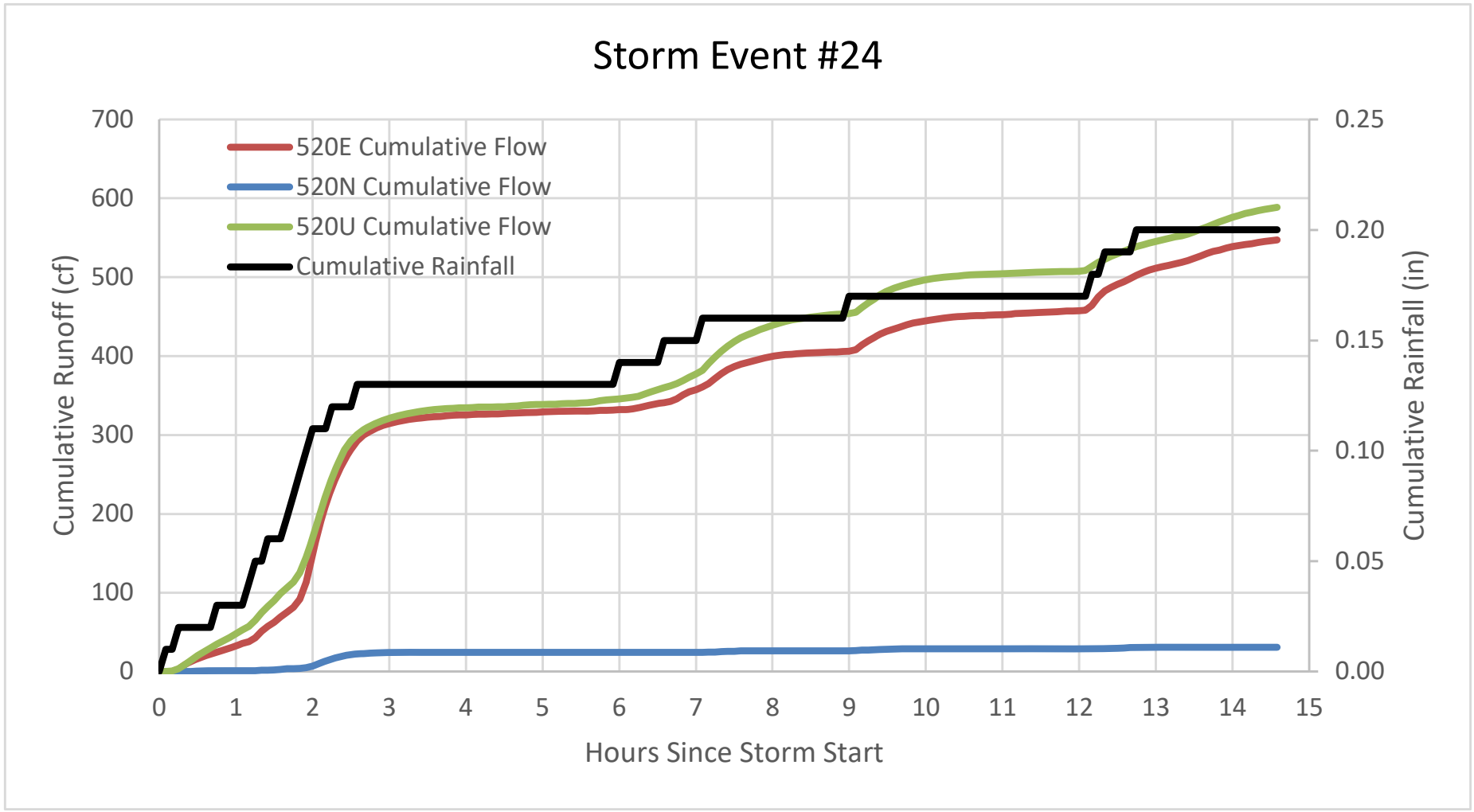

Storm Event #17
520E Cumulative Flow
520N Cumulative Flow
520U Cumulative Flow
Cumulative Rainfall
Cumulative Runoff (cf)
Cumulative Rainfall (in)
Hours Since Storm Start
3,000
2,500
2,000
1,500
1,000
500
0
0.50
0.45
0.40
0.35
0.30
0.25
0.20
0.15
0.10
0.05
0.00
0 1 2 3 4 5 6 7 8 9 10 11 12 13 14 15 16 17 18

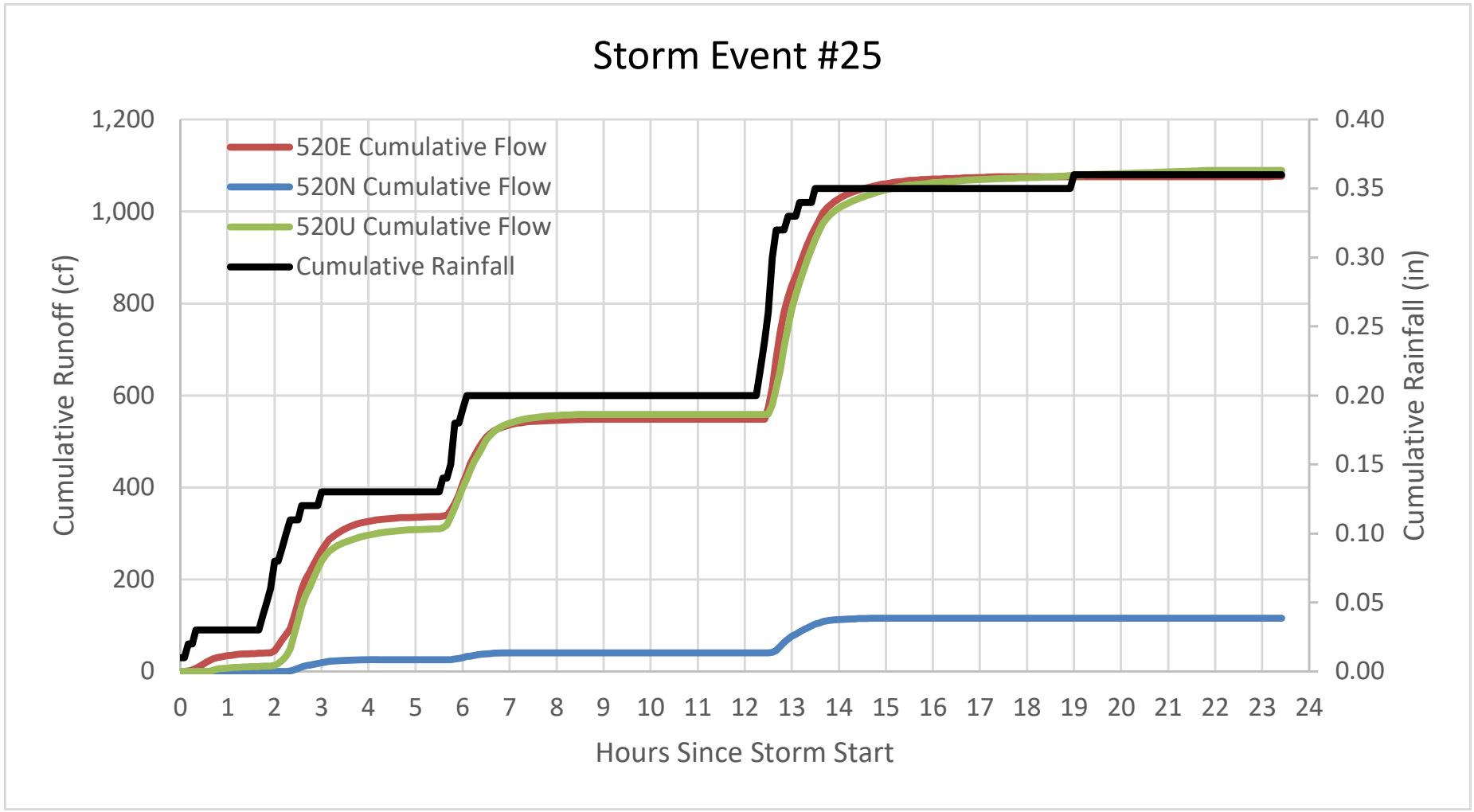

Storm Event #18
520E Cumulative Flow
520N Cumulative Flow
520U Cumulative Flow
Cumulative Rainfall
Cumulative Runoff (cf)
Cumulative Rainfall (in)
Hours Since Storm Start
1,000
900
800
700
600
500
400
300
200
100
0
0.25
0.20
0.15
0.10
0.05
0.00
0
1
2
3
4
5
6
7

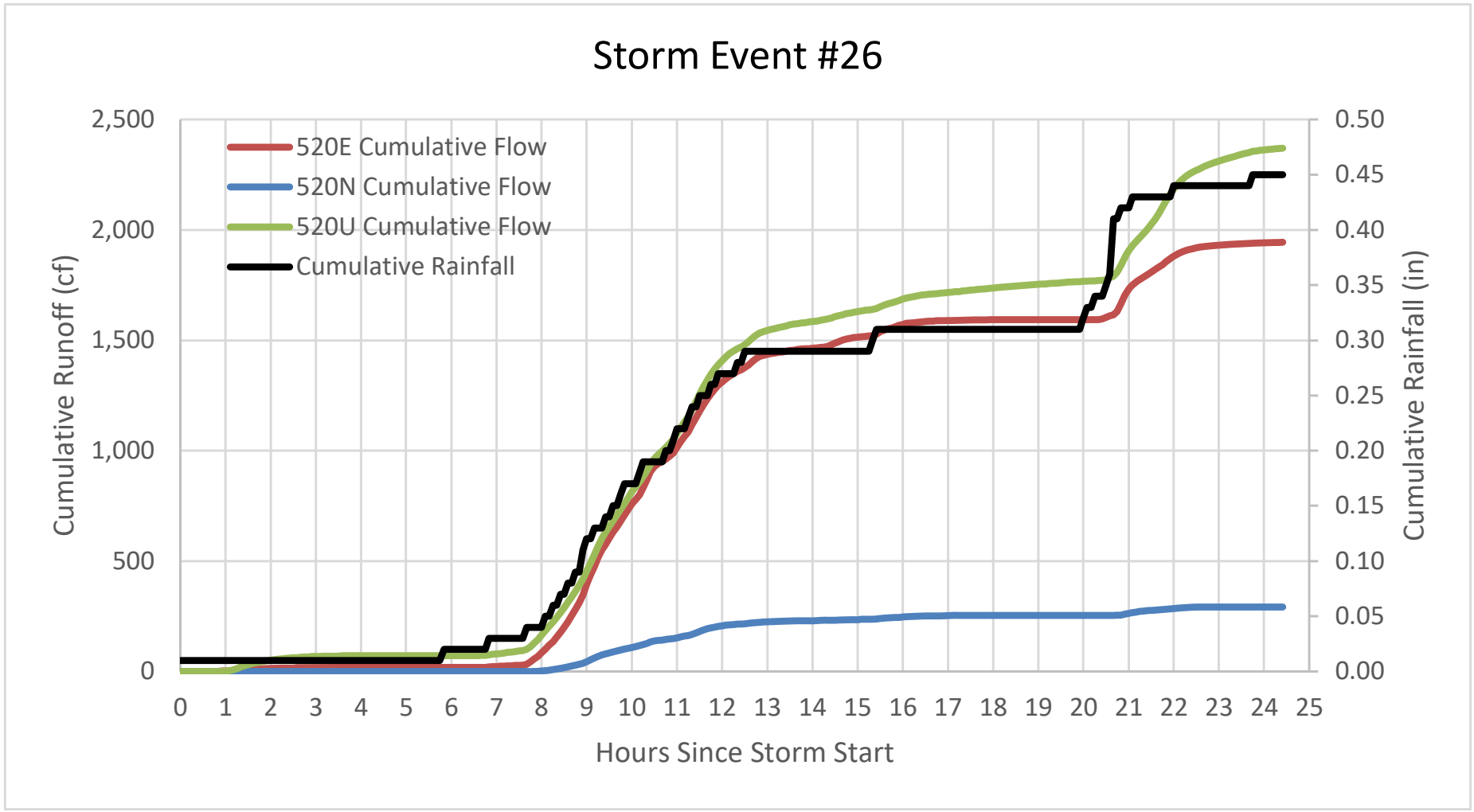

Storm Event #21
520E Cumulative Flow
520N Cumulative Flow
520U Cumulative Flow
Cumulative Rainfall
Cumulative Runoff (cf)
Cumulative Rainfall (in)
Hours Since Storm Start
2,500
2,000
1,500
1,000
500
0
0.7
0.6
0.5
0.4
0.3
0.2
0.1
0.0
0 1 2 3 4 5 6 7 8 9 10 11 12 13 14 15 16 17 18

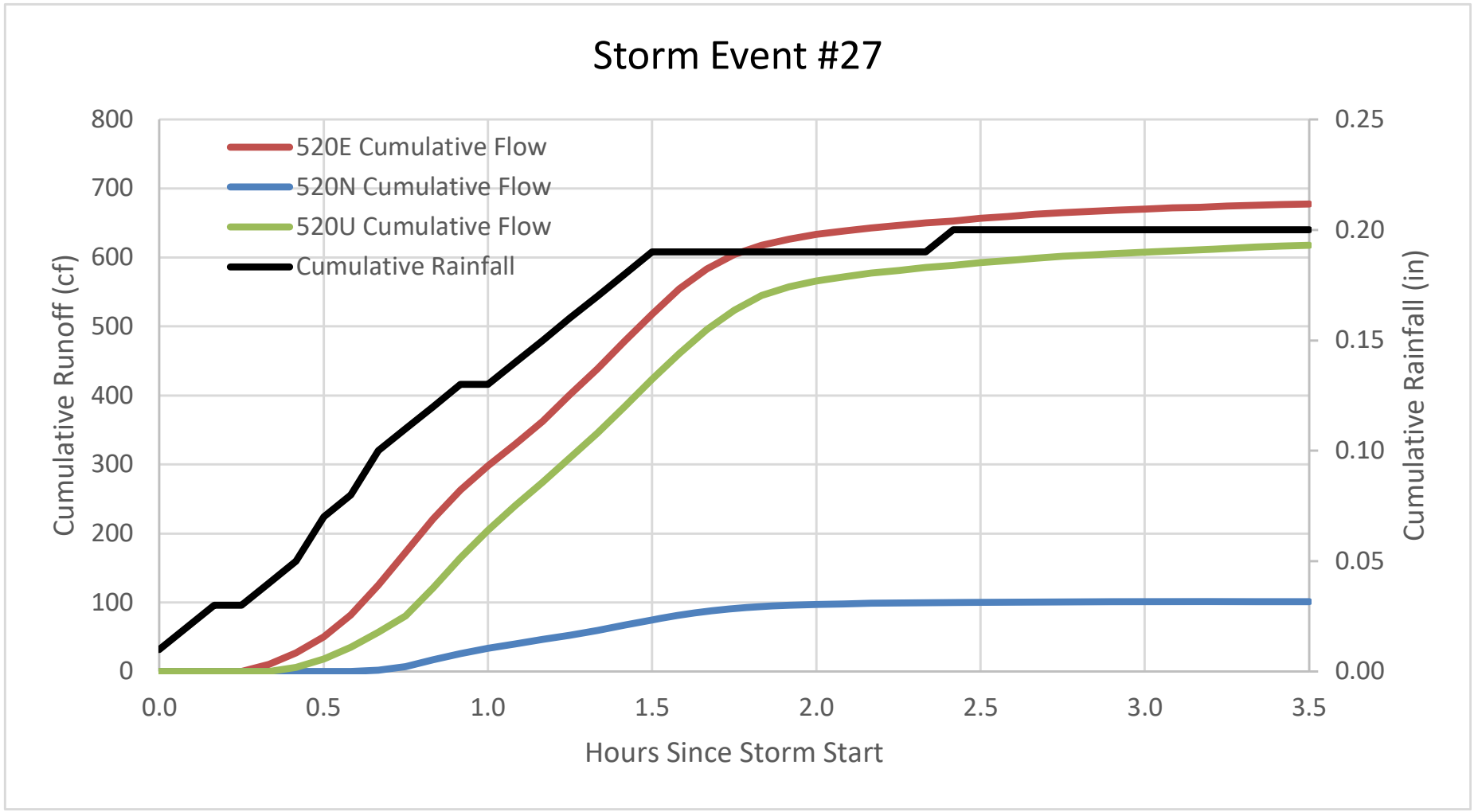

Storm Event #22
520E Cumulative Flow
520N Cumulative Flow
520U Cumulative Flow
Cumulative Rainfall
Cumulative Runoff (cf)
Cumulative Rainfall (in)
Hours Since Storm Start
0
200
400
600
800
1,000
1,200
0.00
0.05
0.10
0.15
0.20
0.25
0.30
0.35
0.40
0 1 2 3 4 5 6 7 8 9 10 11 12 13 14 15 16 17 18 19 20 21 22 23 24 25 26


Storm Event #23
520E Cumulative Flow
520N Cumulative Flow
520U Cumulative Flow
Cumulative Rainfall
Cumulative Runoff (cf)
Cumulative Rainfall (in)
Hours Since Storm Start
2,500
2,000
1,500
1,000
500
0
0.6
0.5
0.4
0.3
0.2
0.1
0.0
0 1 2 3 4 5 6 7 8 9 10 11 12 13 14 15 16 17 18 19


Storm Event #24
520E Cumulative Flow
520N Cumulative Flow
520U Cumulative Flow
Cumulative Rainfall
Cumulative Runoff (cf)
Cumulative Rainfall (in)
Hours Since Storm Start
0
100
200
300
400
500
600
700
0.00
0.05
0.10
0.15
0.20
0.25
0
1
2
3
4
5
6
7
8
9
10
11
12
13
14
15


Storm Event #25
520E Cumulative Flow
520N Cumulative Flow
520U Cumulative Flow
Cumulative Rainfall
Cumulative Runoff (cf)
Cumulative Rainfall (in)
Hours Since Storm Start
0
200
400
600
800
1,000
1,200
0.00
0.05
0.10
0.15
0.20
0.25
0.30
0.35
0.40
0 1 2 3 4 5 6 7 8 9 10 11 12 13 14 15 16 17 18 19 20 21 22 23 24


Storm Event #26
520E Cumulative Flow
520N Cumulative Flow
520U Cumulative Flow
Cumulative Rainfall
Cumulative Runoff (cf)
Cumulative Rainfall (in)
Hours Since Storm Start
2,500
2,000
1,500
1,000
500
0
0.50
0.45
0.40
0.35
0.30
0.25
0.20
0.15
0.10
0.05
0.00
0 1 2 3 4 5 6 7 8 9 10 11 12 13 14 15 16 17 18 19 20 21 22 23 24 25


Storm Event #27
520E Cumulative Flow
520N Cumulative Flow
520U Cumulative Flow
Cumulative Rainfall
Cumulative Runoff (cf)
Cumulative Rainfall (in)
Hours Since Storm Start
800
700
600
500
400
300
200
100
0
0.25
0.20
0.15
0.10
0.05
0.00
0.0
0.5
1.0
1.5
2.0
2.5
3.0
3.5

Attachment 7

Graphical Summaries of Exploratory Data Analysis

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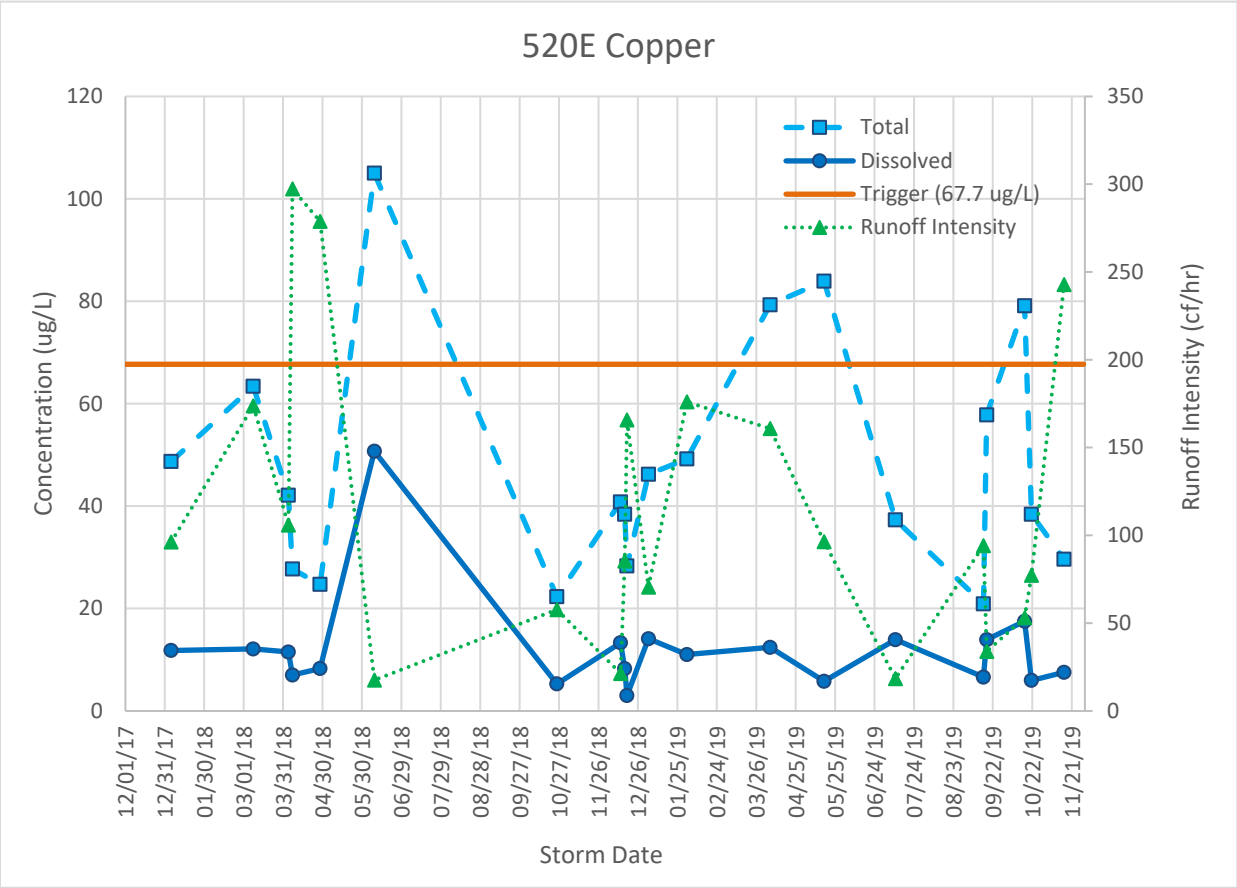
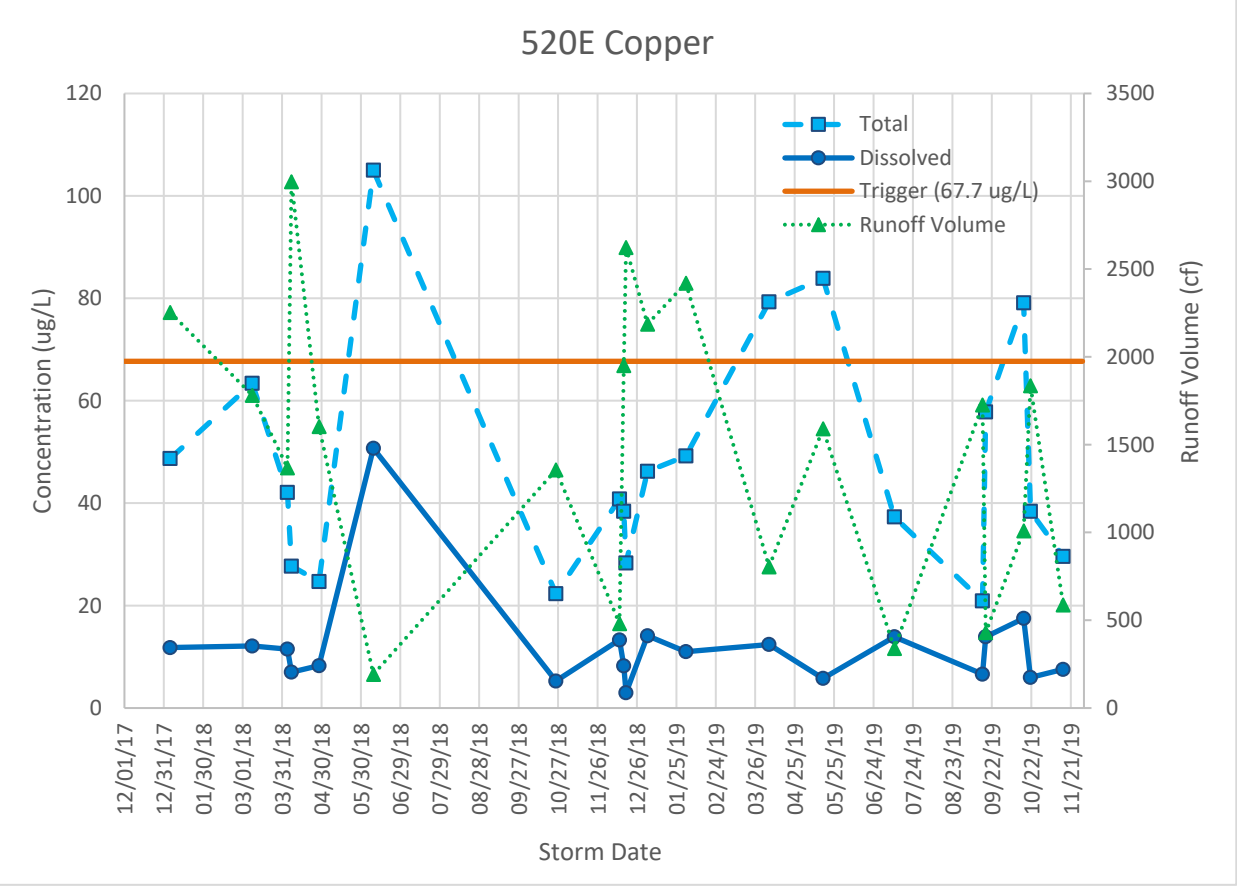
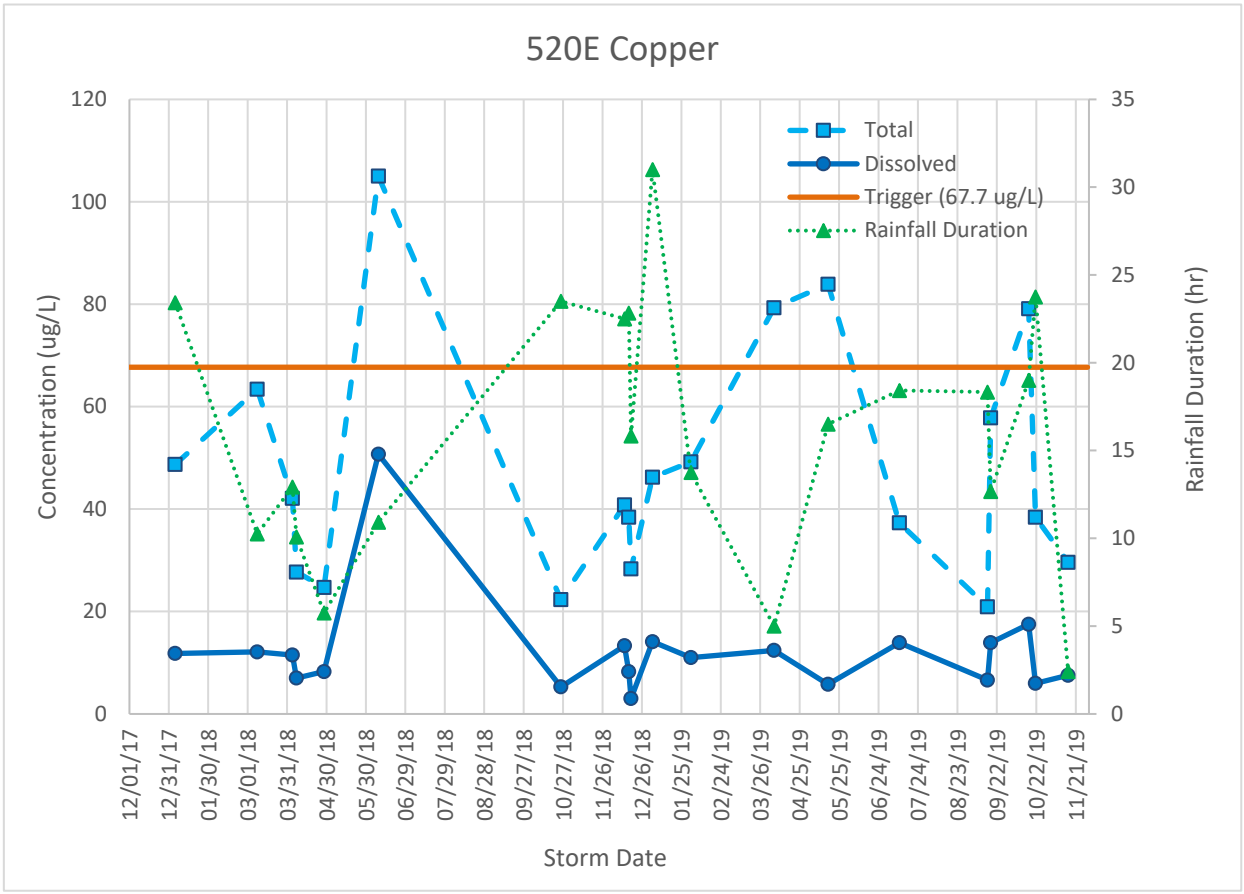

520E Copper
Total
Dissolved
Trigger (67.7 ug/L)
Runoff Intensity
Concentration (ug/L)
Runoff Intensity (cf/hr)
Storm Date
0
20
40
60
80
100
120
0
50
100
150
200
250
300
350
12/01/17
12/31/17
01/30/18
03/01/18
03/31/18
04/30/18
05/30/18
06/29/18
07/29/18
08/28/18
09/27/18
10/27/18
11/26/18
12/26/18
01/25/19
02/24/19
03/26/19
04/25/19
05/25/19
06/24/19
07/24/19
08/23/19
09/22/19
10/22/19
11/21/19


520E Copper
Total
Dissolved
Trigger (67.7 ug/L)
Runoff Volume
Concentration (ug/L)
Runoff Volume (cf)
Storm Date
0
20
40
60
80
100
120
0
500
1000
1500
2000
2500
3000
3500
12/01/17
12/31/17
01/30/18
03/01/18
03/31/18
04/30/18
05/30/18
06/29/18
07/29/18
08/28/18
09/27/18
10/27/18
11/26/18
12/26/18
01/25/19
02/24/19
03/26/19
04/25/19
05/25/19
06/24/19
07/24/19
08/23/19
09/22/19
10/22/19
11/21/19


520E Copper
Total
Dissolved
Trigger (67.7 ug/L)
Rainfall Duration
Concentration (ug/L)
Rainfall Duration (hr)
Storm Date
0
20
40
60
80
100
120
0
5
10
15
20
25
30
35
12/01/17
12/31/17
01/30/18
03/01/18
03/31/18
04/30/18
05/30/18
06/29/18
07/29/18
08/28/18
09/27/18
10/27/18
11/26/18
12/26/18
01/25/19
02/24/19
03/26/19
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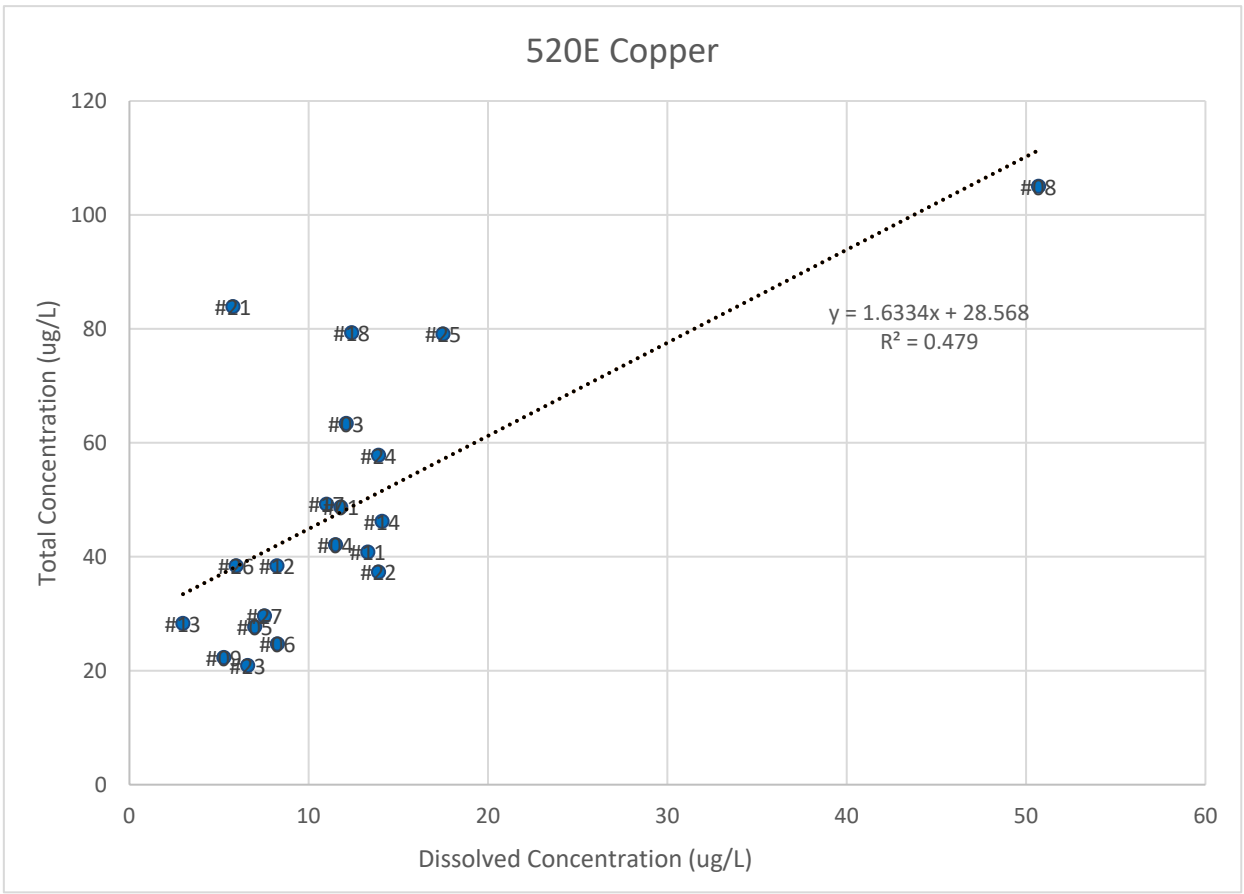
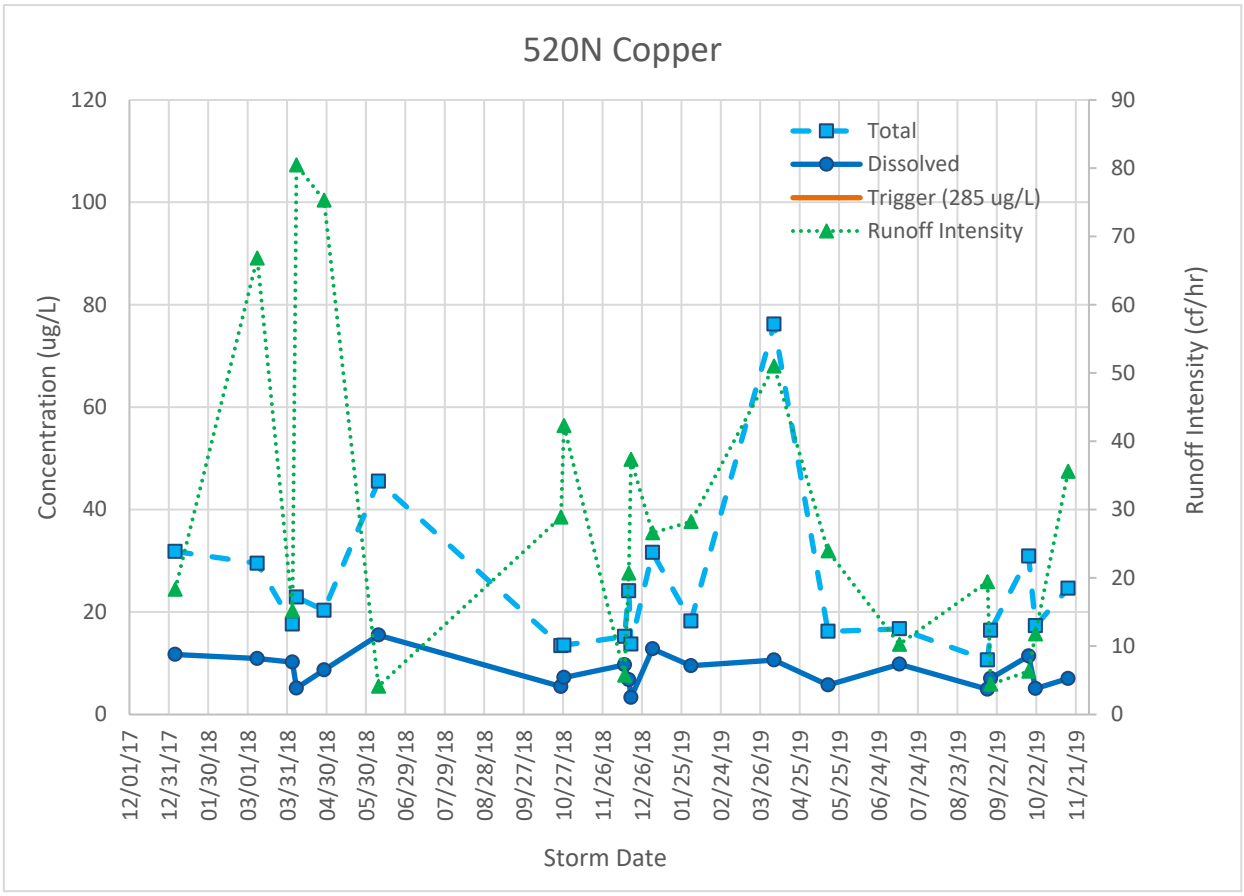
08/23/19
09/22/19
10/22/19
11/21/19


520E Copper
y = 1.6334x + 28.568
R² = 0.479
Total Concentration (ug/L)
Dissolved Concentration (ug/L)
0
20
40
60
80
100
120
0
10
20
30
40
50
60


520N Copper
Total
Dissolved
Trigger (285 ug/L)
Runoff Intensity
Concentration (ug/L)
Runoff Intensity (cf/hr)
Storm Date
0
20
40
60
80
100
120
0
10
20
30
40
50
60
70
80
90
12/01/17
12/31/17
01/30/18
03/01/18
03/31/18
04/30/18
05/30/18
06/29/18
07/29/18
08/28/18
09/27/18
10/27/18
11/26/18
12/26/18
01/25/19
02/24/19
03/26/19
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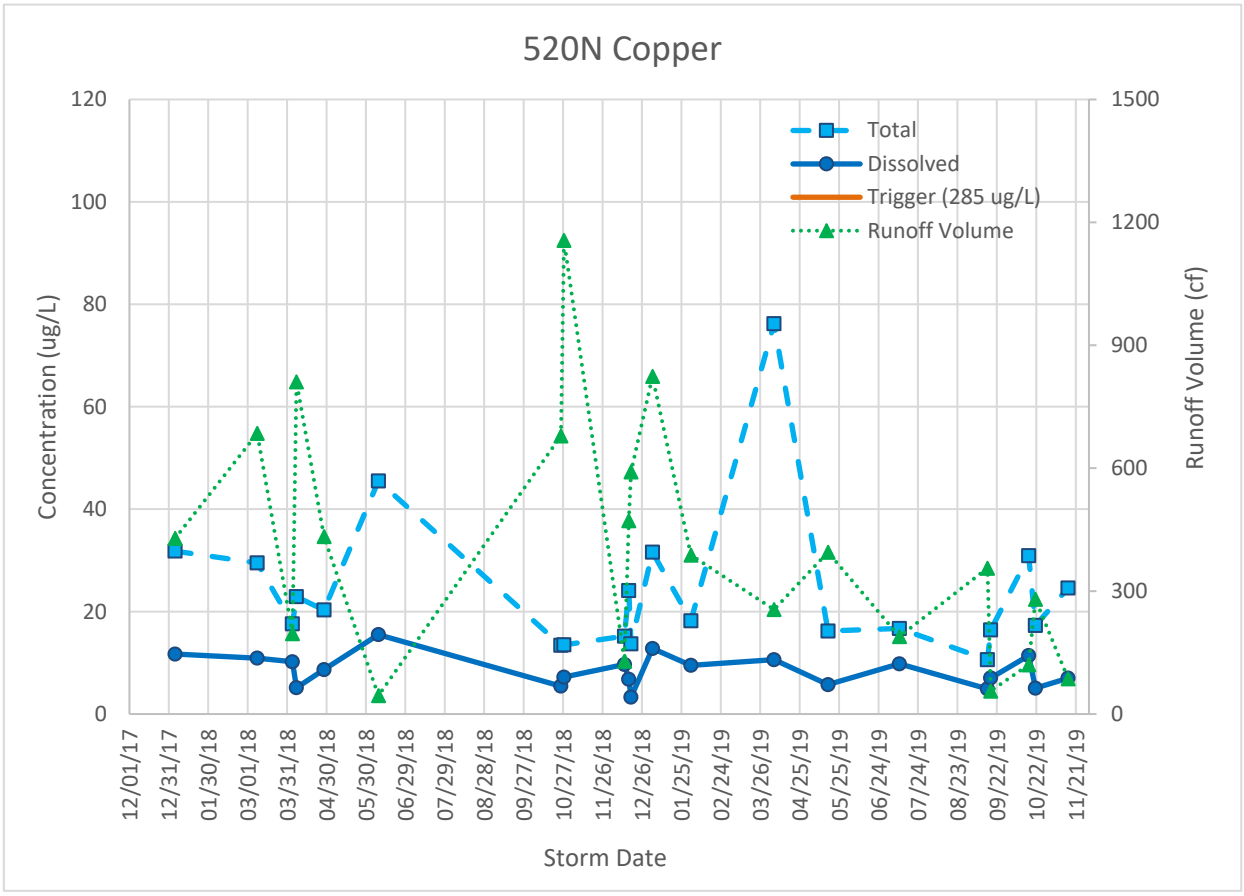
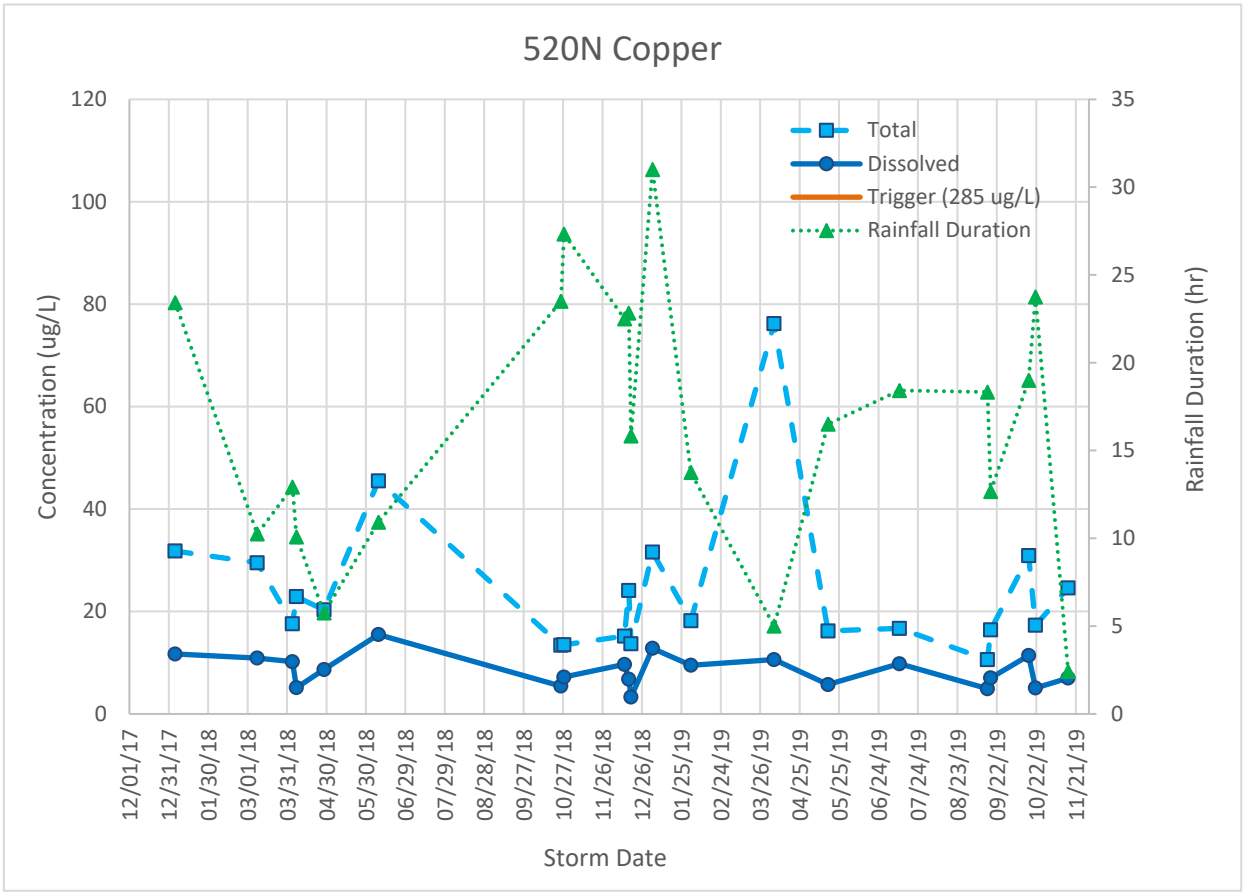
06/24/19
07/24/19
08/23/19
09/22/19
10/22/19
11/21/19


520N Copper
Total
Dissolved
Trigger (285 ug/L)
Runoff Volume
Concentration (ug/L)
Runoff Volume (cf)
Storm Date
0
20
40
60
80
100
120
0
300
600
900
1200
1500
12/01/17
12/31/17
01/30/18
03/01/18
03/31/18
04/30/18
05/30/18
06/29/18
07/29/18
08/28/18
09/27/18
10/27/18
11/26/18
12/26/18
01/25/19
02/24/19
03/26/19
04/25/19
05/25/19
06/24/19
07/24/19
08/23/19
09/22/19
10/22/19
11/21/19


520N Copper
Total
Dissolved
Trigger (285 ug/L)
Rainfall Duration
Concentration (ug/L)
Rainfall Duration (hr)
Storm Date
120
100
80
60
40
20
0
35
30
25
20
15
10
5
0
12/01/17
12/31/17
01/30/18
03/01/18
03/31/18
04/30/18
05/30/18
06/29/18
07/29/18
08/28/18
09/27/18
10/27/18
11/26/18
12/26/18
01/25/19
02/24/19
03/26/19
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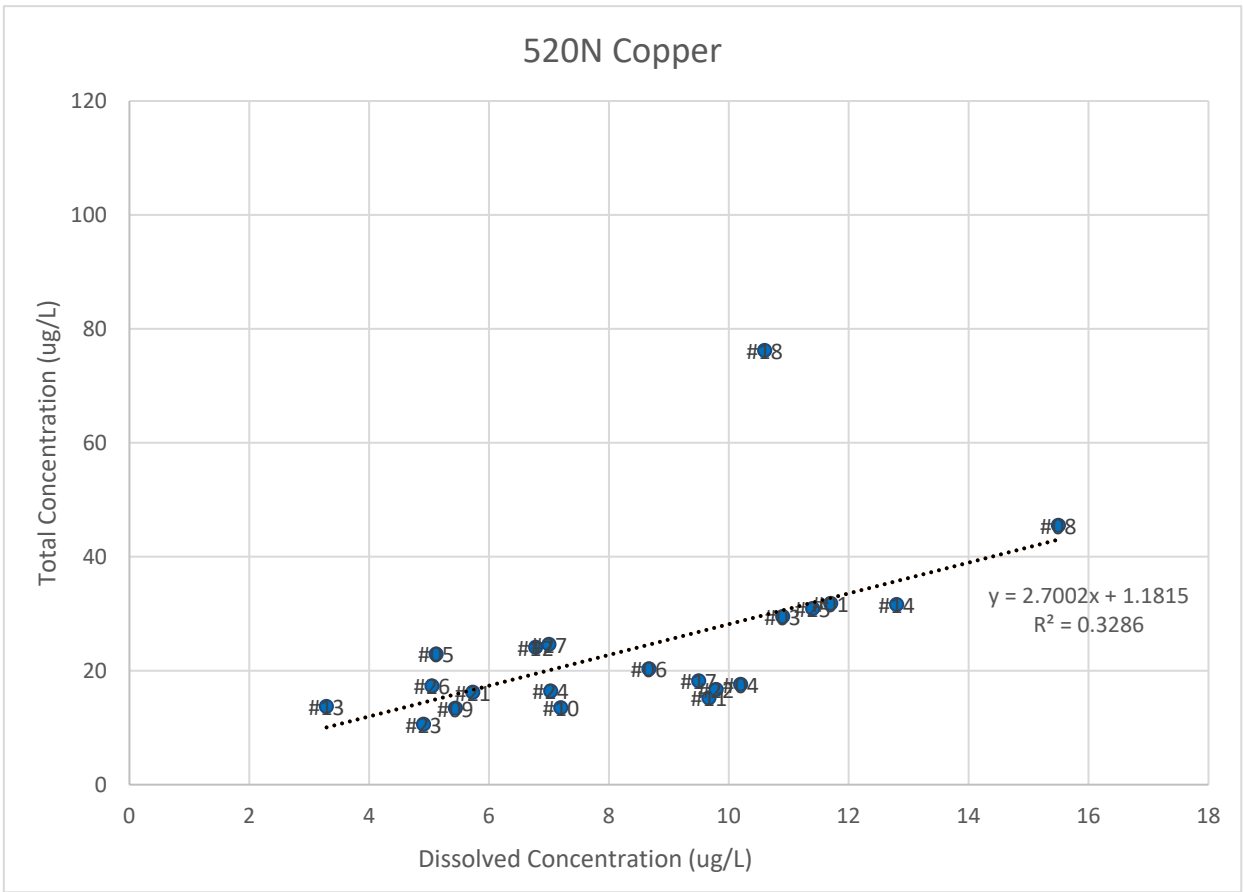
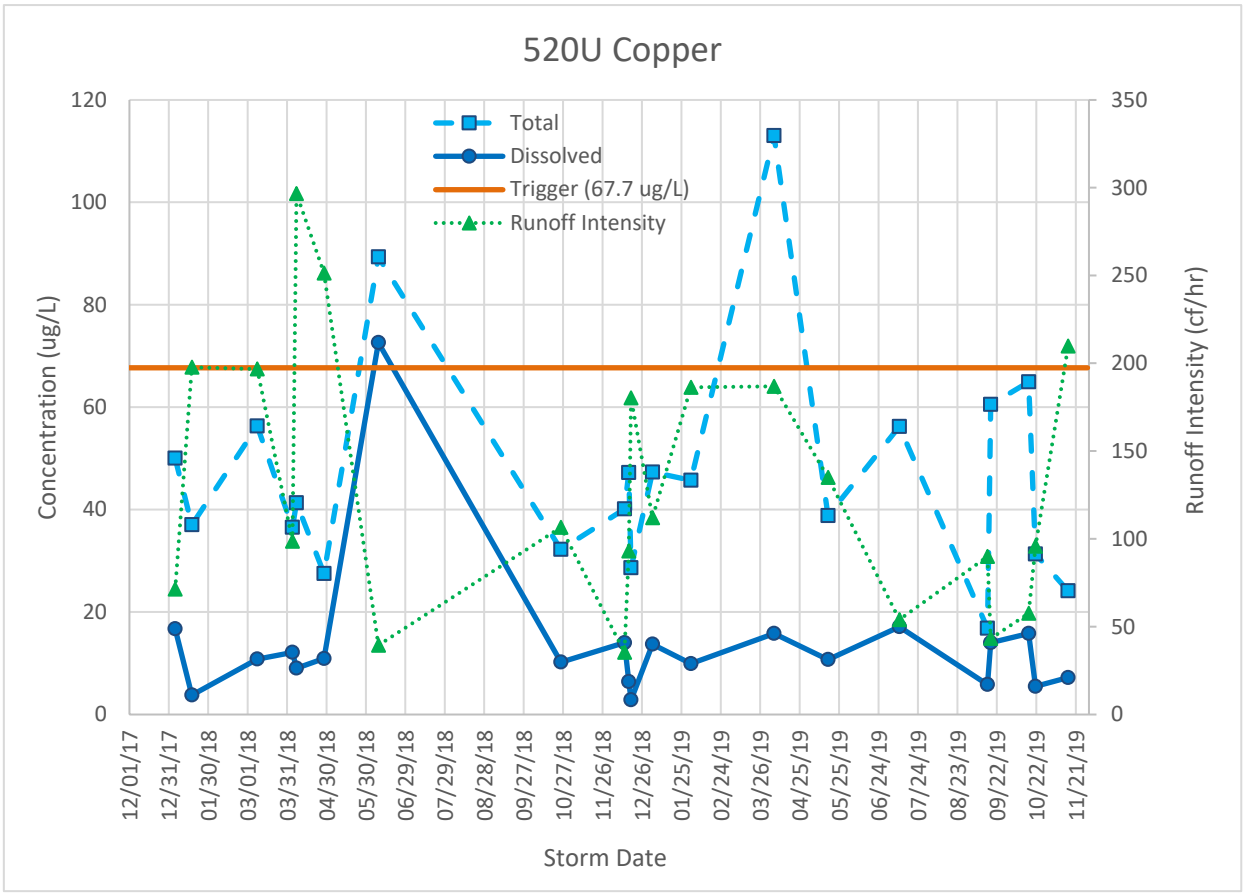
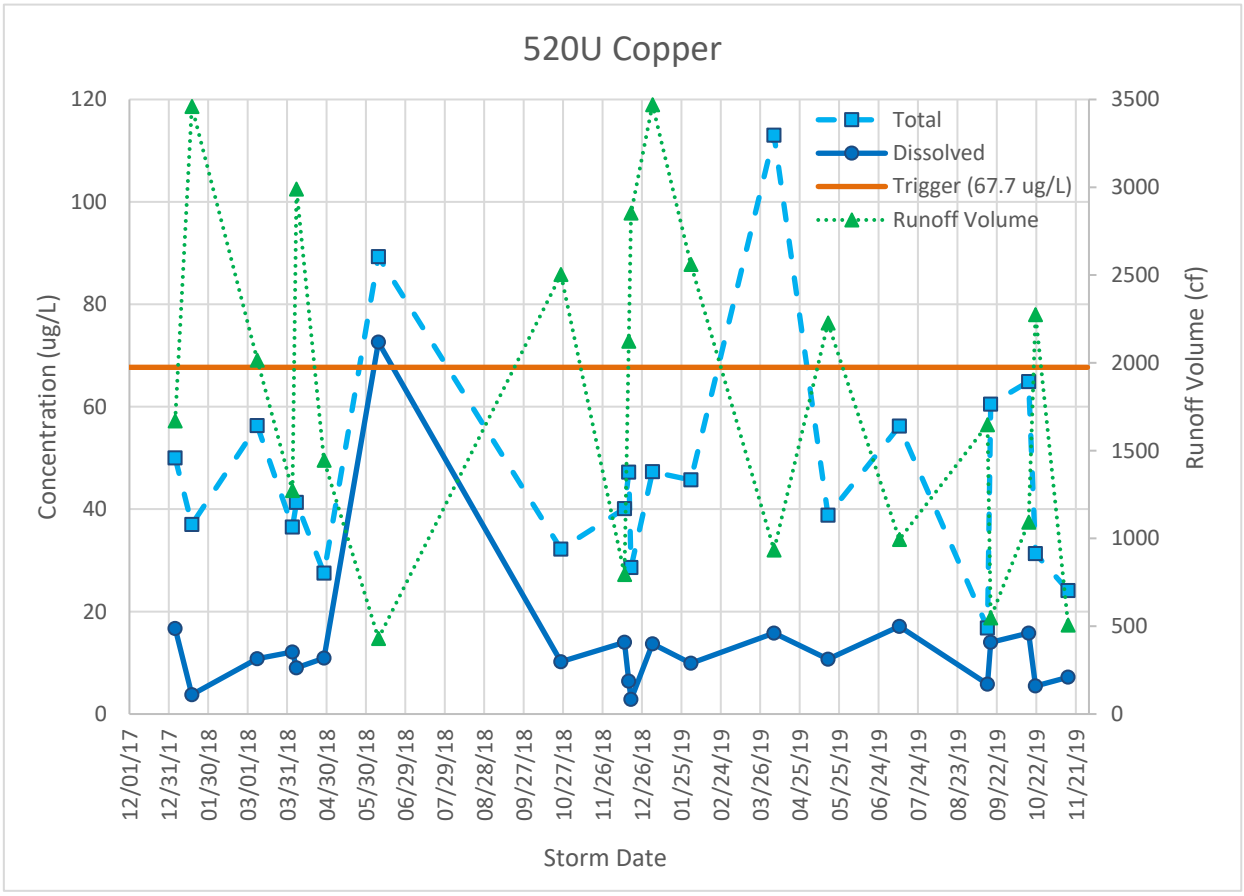
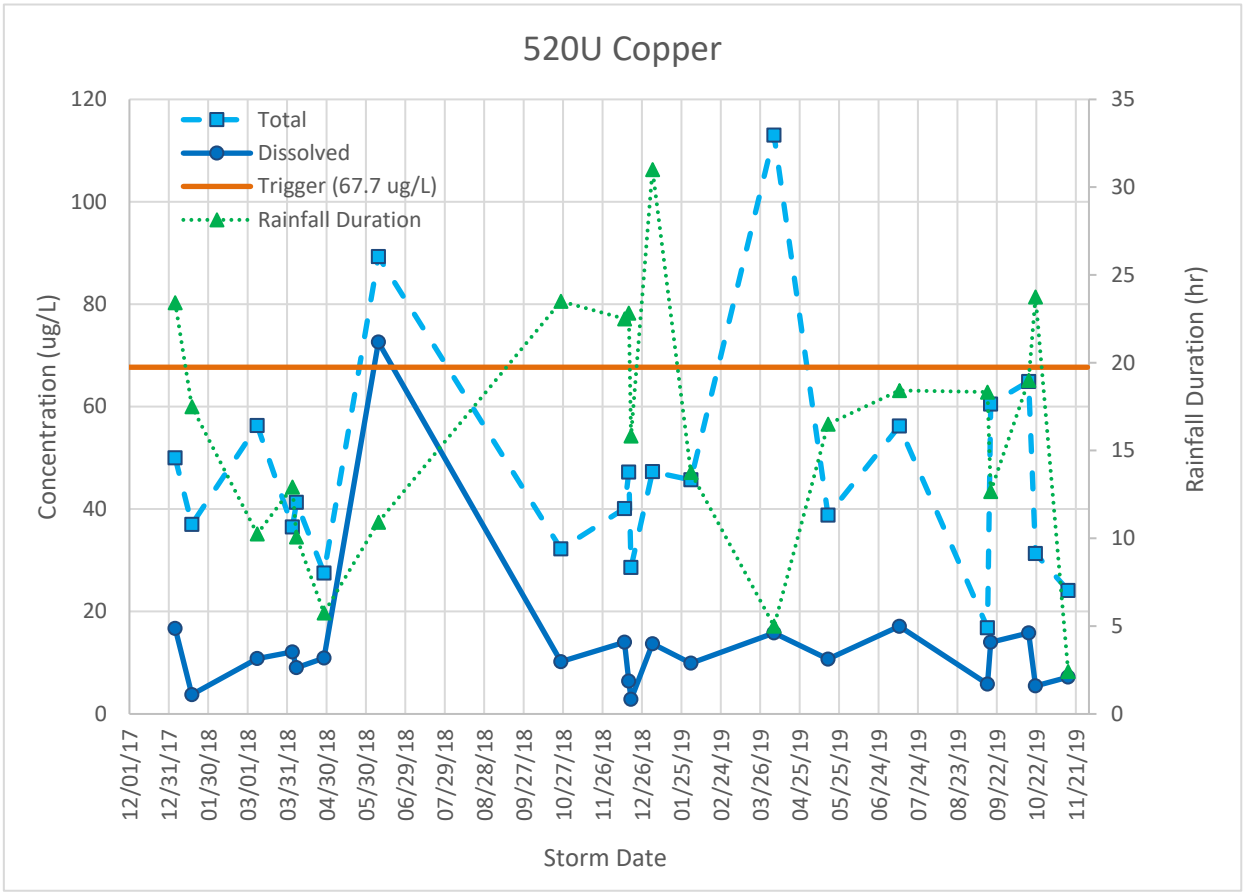
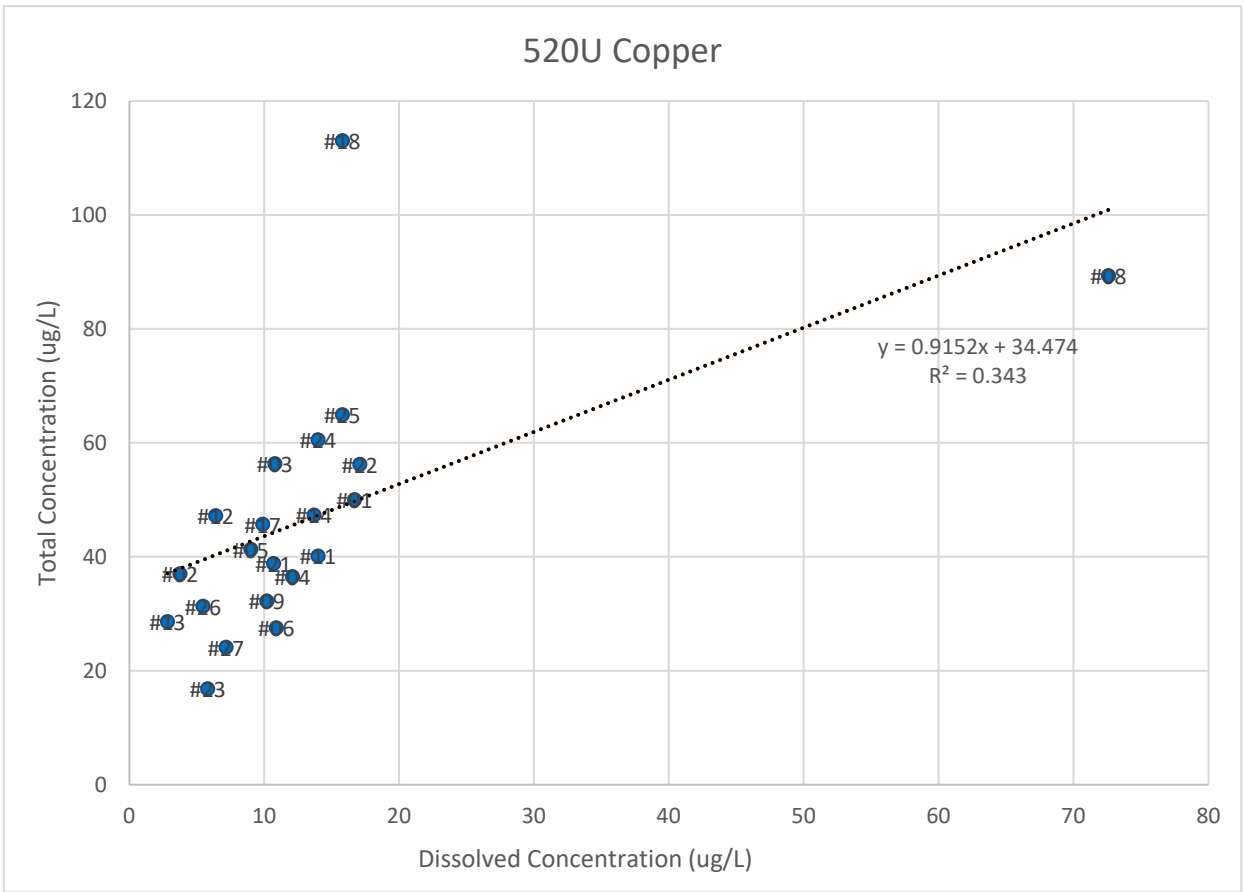
07/24/19
08/23/19
09/22/19
10/22/19
11/21/19

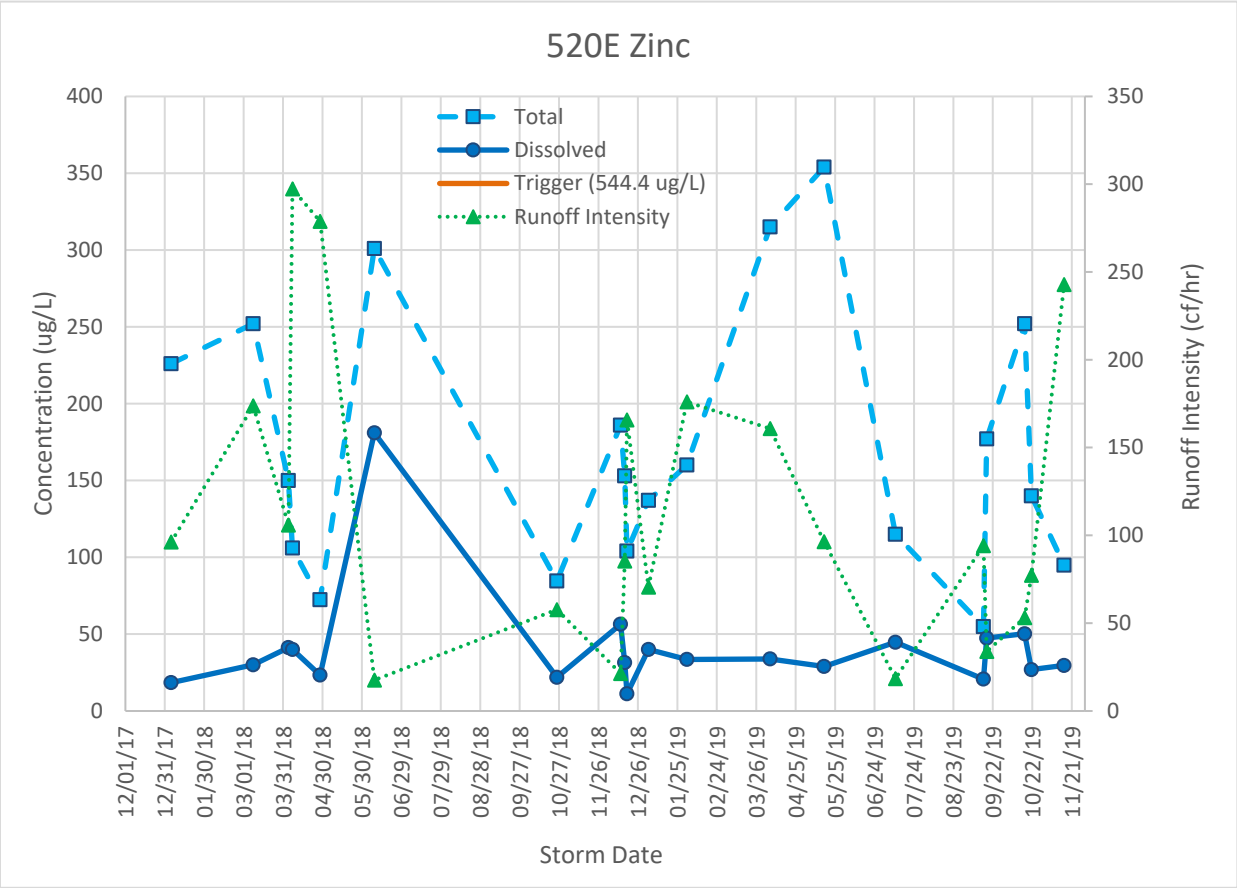

520N Copper
Total Concentration (ug/L)
Dissolved Concentration (ug/L)
y = 2.7002x + 1.1815
R² = 0.3286
120
100
80
60
40
20
0
0
2
4
6
8
10
12
14
16
18

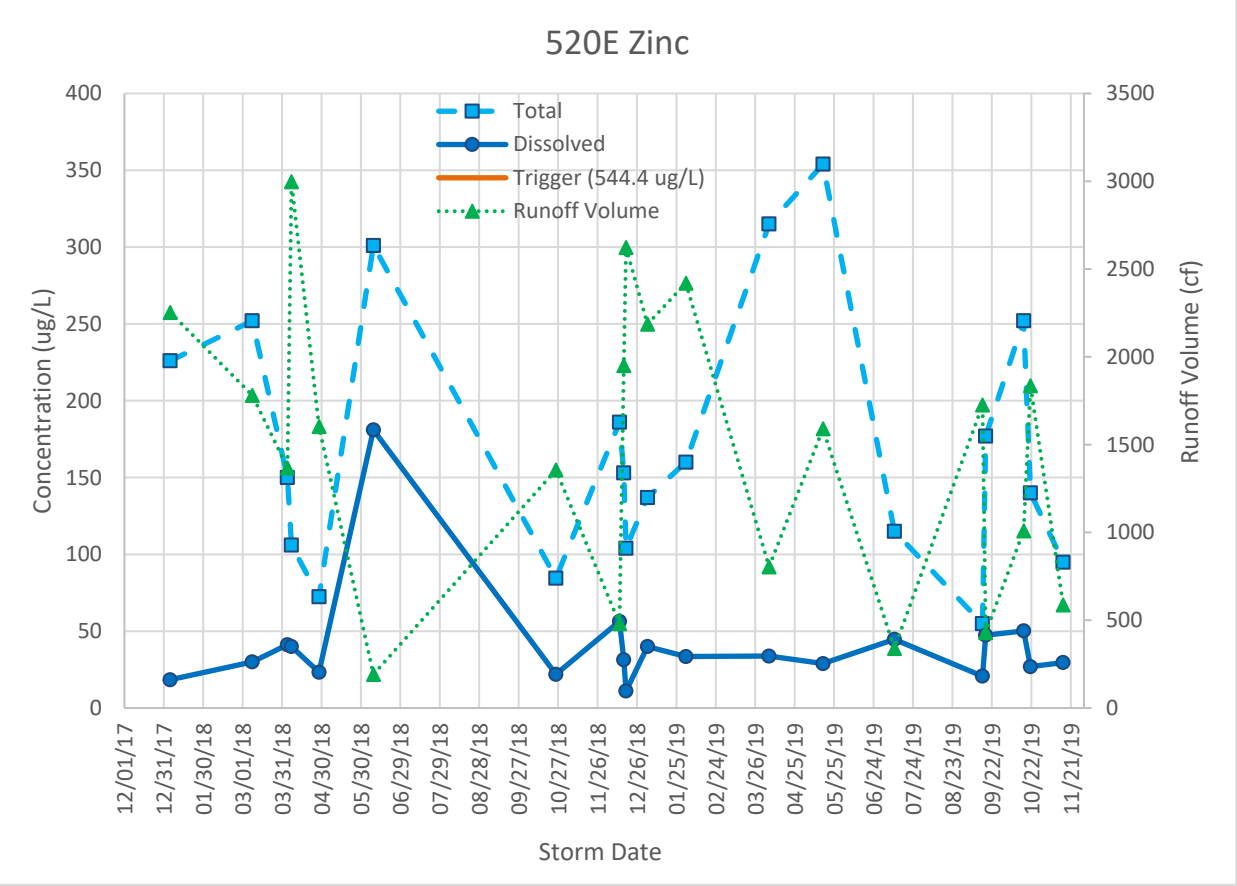

520U Copper
Total
Dissolved
Trigger (67.7 ug/L)
Runoff Intensity
Concentration (ug/L)
Runoff Intensity (cf/hr)
Storm Date
0
20
40
60
80
100
120
0
50
100
150
200
250
300
350
12/01/17
12/31/17
01/30/18
03/01/18
03/31/18
04/30/18
05/30/18
06/29/18
07/29/18
08/28/18
09/27/18
10/27/18
11/26/18
12/26/18
01/25/19
02/24/19
03/26/19
04/25/19
05/25/19
06/24/19
07/24/19
08/23/19
09/22/19
10/22/19
11/21/19

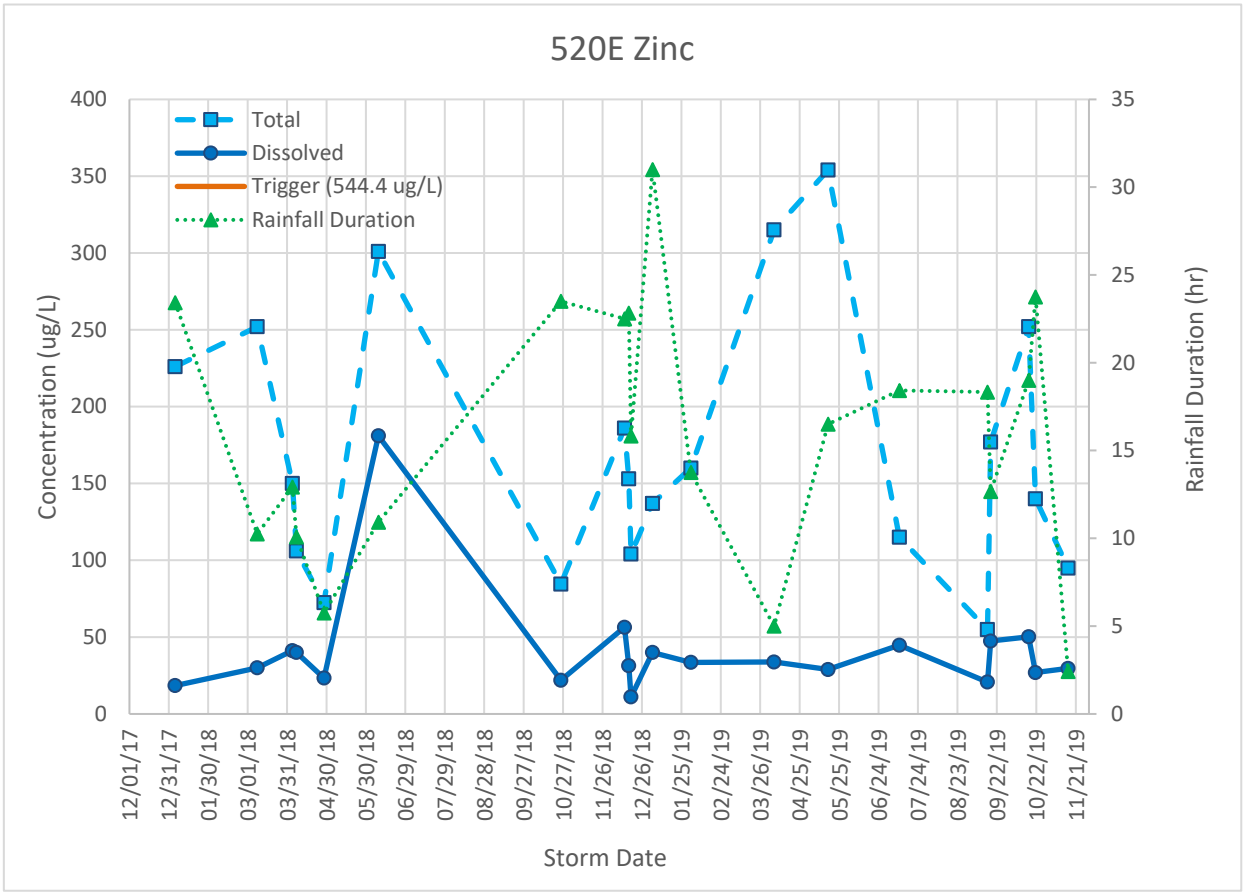

520U Copper
Total
Dissolved
Trigger (67.7 ug/L)
Runoff Volume
Concentration (ug/L)
Runoff Volume (cf)
Storm Date
0
20
40
60
80
100
120
0
500
1000
1500
2000
2500
3000
3500
12/01/17
12/31/17
01/30/18
03/01/18
03/31/18
04/30/18
05/30/18
06/29/18
07/29/18
08/28/18
09/27/18
10/27/18
11/26/18
12/26/18
01/25/19
02/24/19
03/26/19
04/25/19
05/25/19
06/24/19
07/24/19
08/23/19
09/22/19
10/22/19
11/21/19

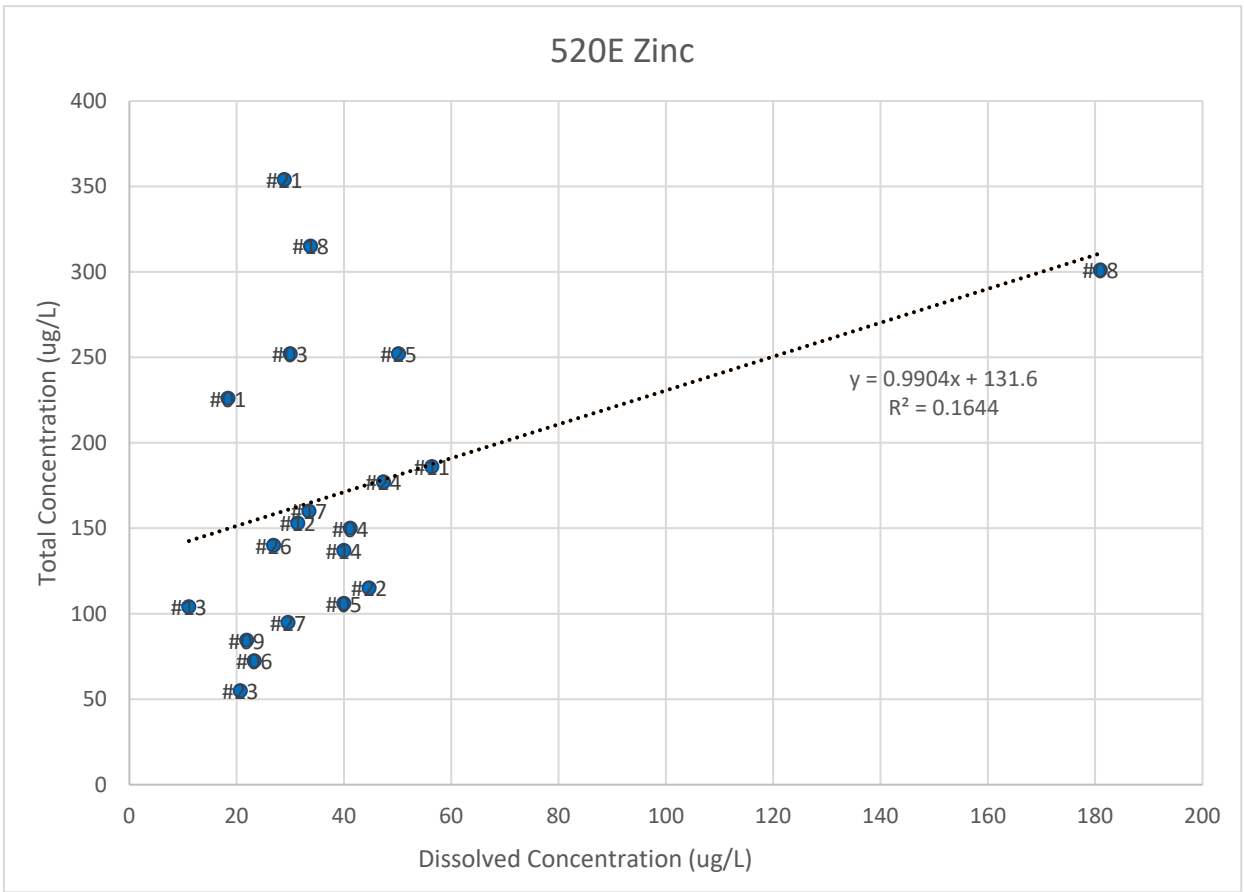

520U Copper
Total
Dissolved
Trigger (67.7 ug/L)
Rainfall Duration
Concentration (ug/L)
Rainfall Duration (hr)
Storm Date
120
100
80
60
40
20
0
35
30
25
20
15
10
5
0
12/01/17
12/31/17
01/30/18
03/01/18
03/31/18
04/30/18
05/30/18
06/29/18
07/29/18
08/28/18
09/27/18
10/27/18
11/26/18
12/26/18
01/25/19
02/24/19
03/26/19
04/25/19
05/25/19
06/24/19
07/24/19
08/23/19
09/22/19
10/22/19
11/21/19

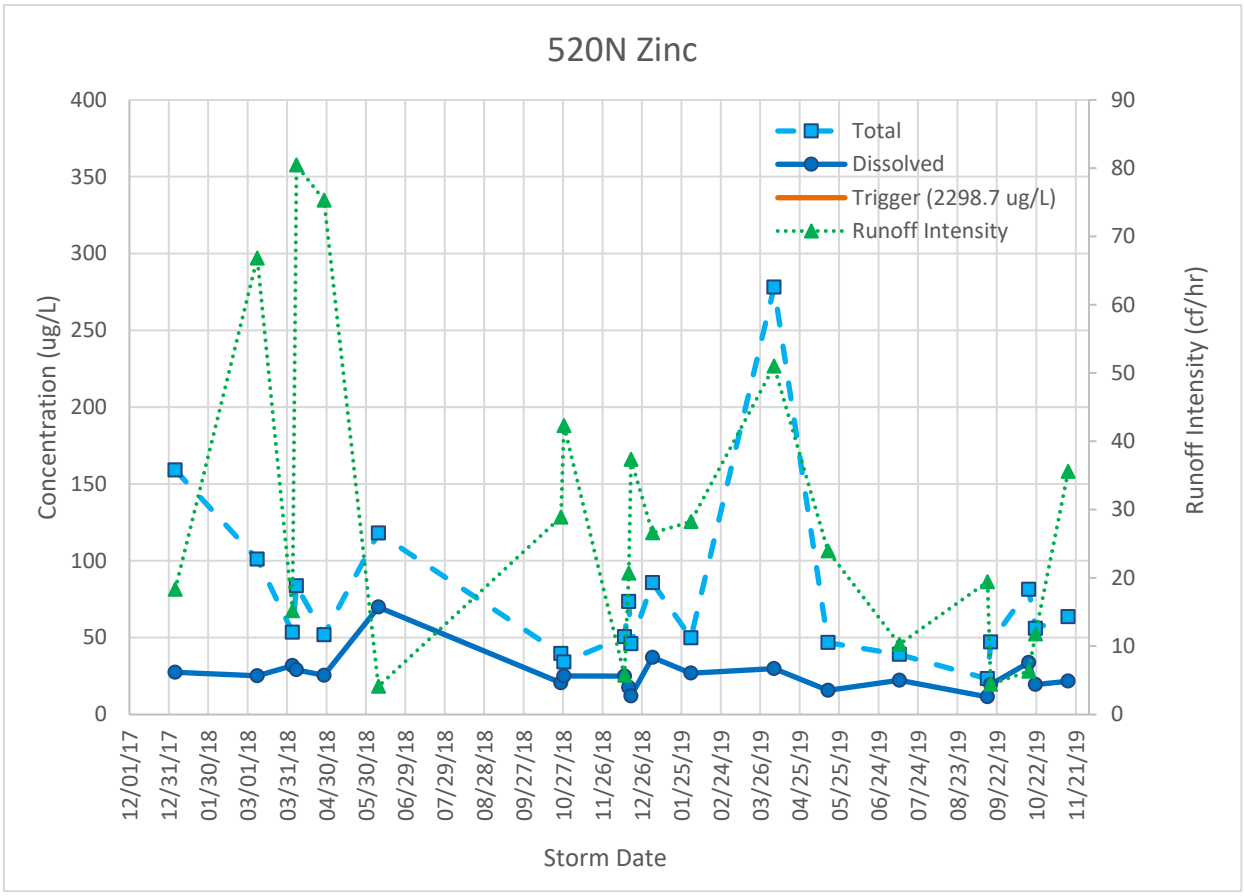

520U Copper
Total Concentration (ug/L)
Dissolved Concentration (ug/L)
y = 0.9152x + 34.474
R² = 0.343
120
100
80
60
40
20
0
0
10
20
30
40
50
60
70
80

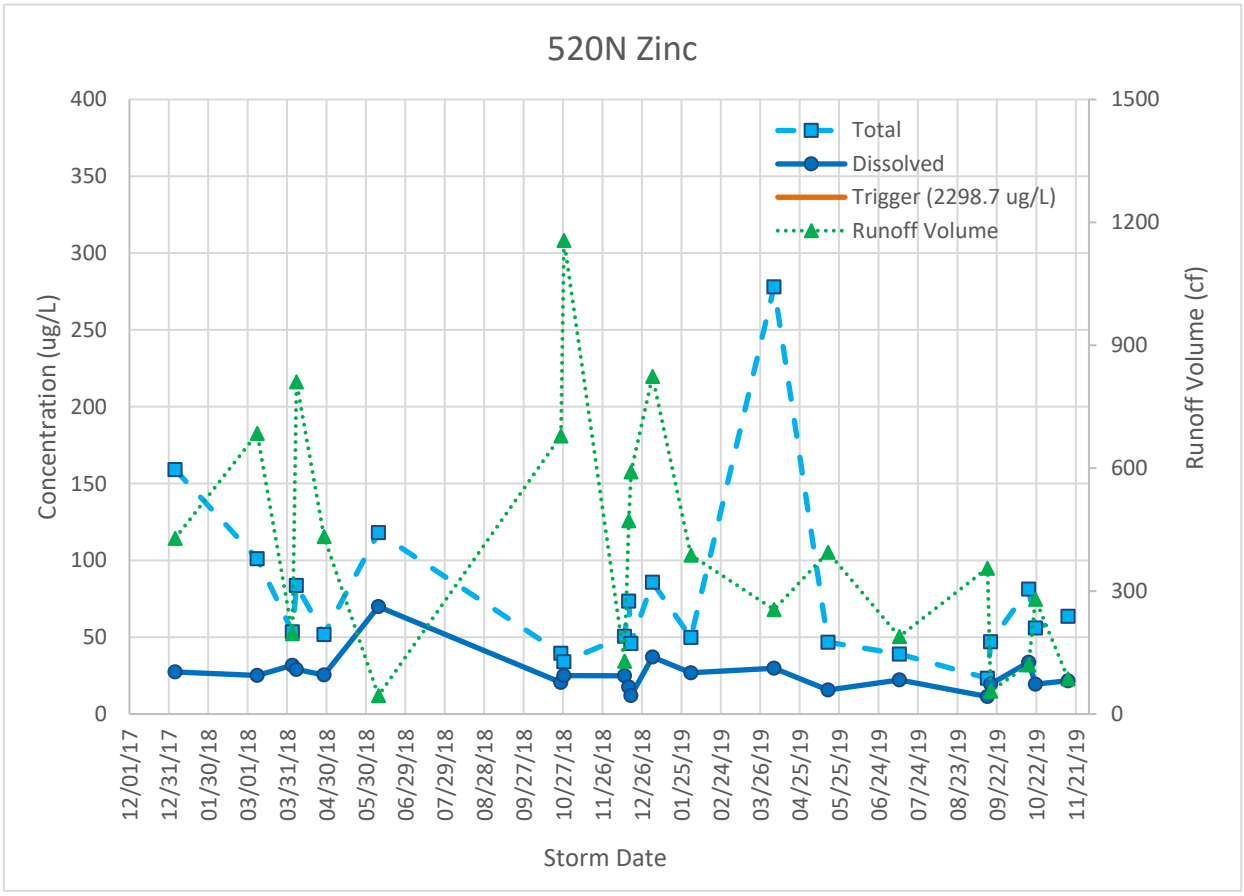

520E Zinc
Total
Dissolved
Trigger (544.4 ug/L)
Runoff Intensity
Concentration (ug/L)
Runoff Intensity (cf/hr)
Storm Date
0
50
100
150
200
250
300
350
400
12/01/17
12/31/17
01/30/18
03/01/18
03/31/18
04/30/18
05/30/18
06/29/18
07/29/18
08/28/18
09/27/18
10/27/18
11/26/18
12/26/18
01/25/19
02/24/19
03/26/19
04/25/19
05/25/19
06/24/19
07/24/19
08/23/19
09/22/19
10/22/19
11/21/19

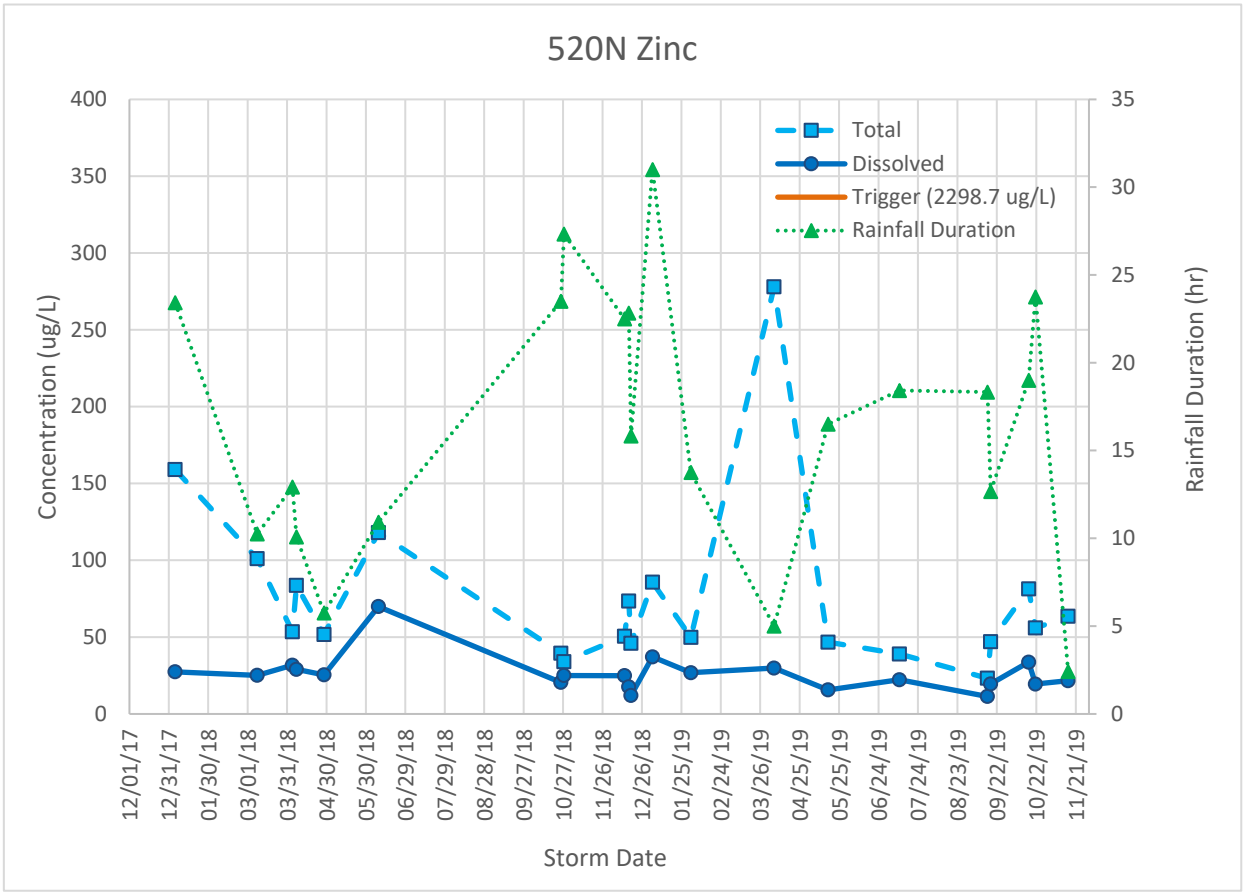

520E Zinc
Total
Dissolved
Trigger (544.4 ug/L)
Runoff Volume
Concentration (ug/L)
Runoff Volume (cf)
Storm Date
0
50
100
150
200
250
300
350
400
0
500
1000
1500
2000
2500
3000
3500
12/01/17
12/31/17
01/30/18
03/01/18
03/31/18
04/30/18
05/30/18
06/29/18
07/29/18
08/28/18
09/27/18
10/27/18
11/26/18
12/26/18
01/25/19
02/24/19
03/26/19
04/25/19
05/25/19
06/24/19
07/24/19
08/23/19
09/22/19
10/22/19
11/21/19

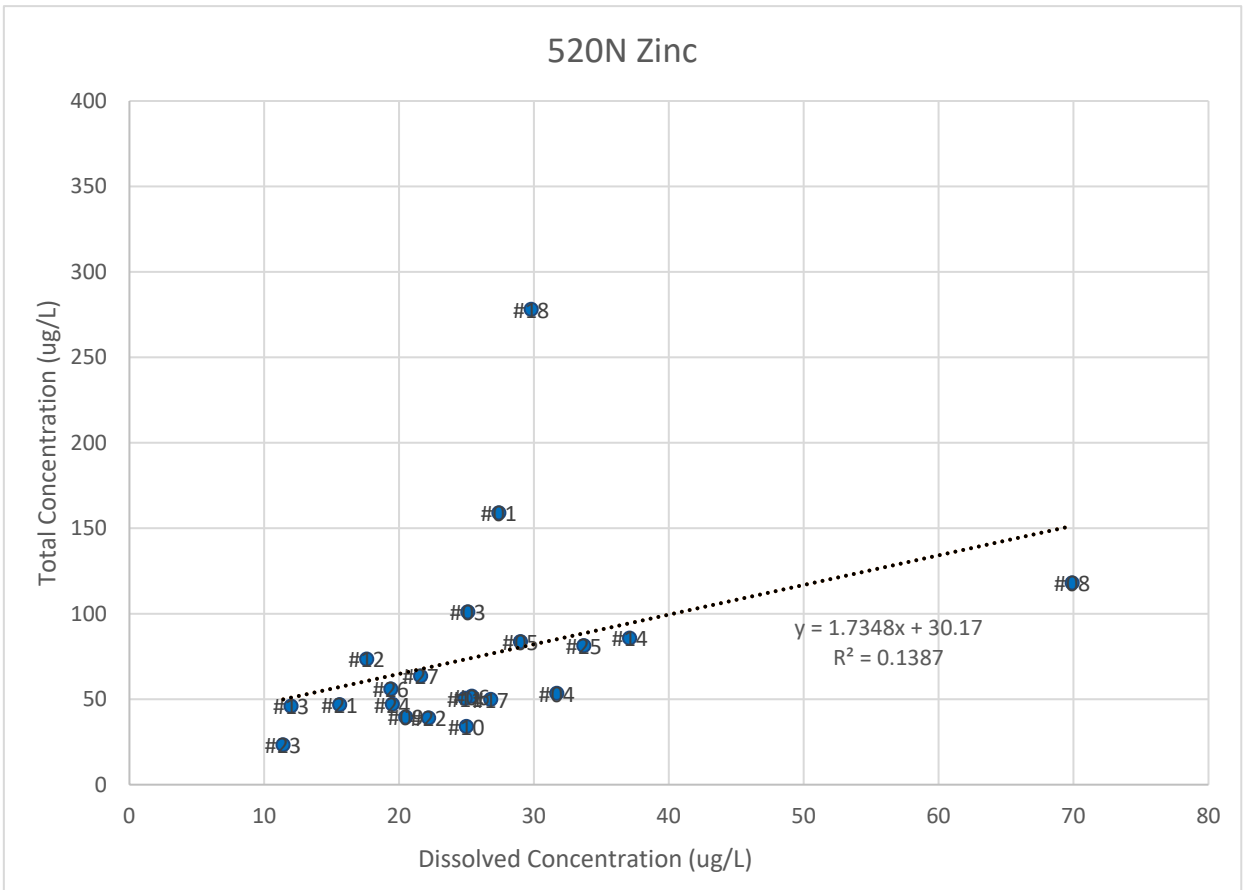

520E Zinc
Total
Dissolved
Trigger (544.4 ug/L)
Rainfall Duration
Concentration (ug/L)
Rainfall Duration (hr)
Storm Date
0
50
100
150
200
250
300
350
400
0
5
10
15
20
25
30
35
12/01/17
12/31/17
01/30/18
03/01/18
03/31/18
04/30/18
05/30/18
06/29/18
07/29/18
08/28/18
09/27/18
10/27/18
11/26/18
12/26/18
01/25/19
02/24/19
03/26/19
04/25/19
05/25/19
06/24/19
07/24/19
08/23/19
09/22/19
10/22/19
11/21/19

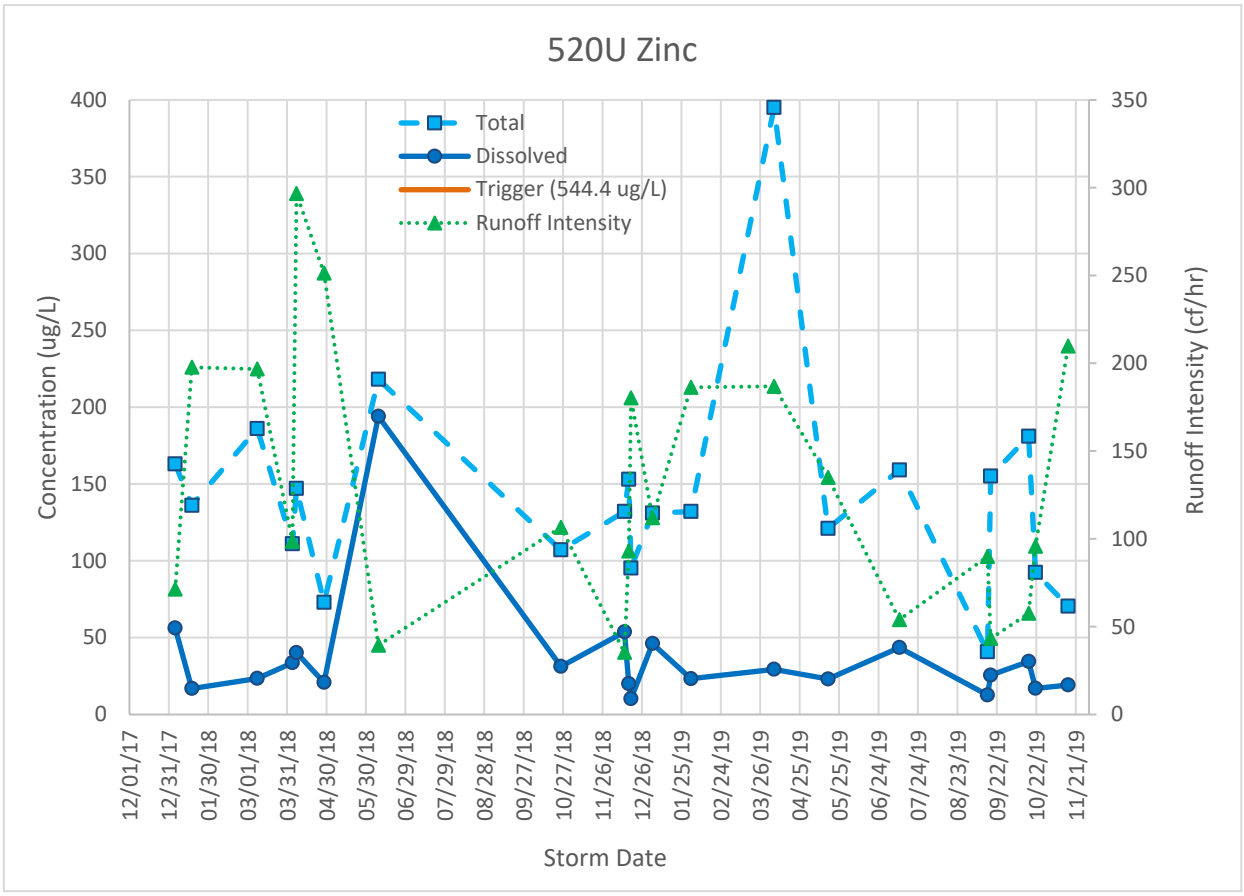

520E Zinc
Total Concentration (ug/L)
Dissolved Concentration (ug/L)
y = 0.9904x + 131.6
R² = 0.1644
0
50
100
150
200
250
300
350
400
0
20
40
60
80
100
120
140
160
180
200

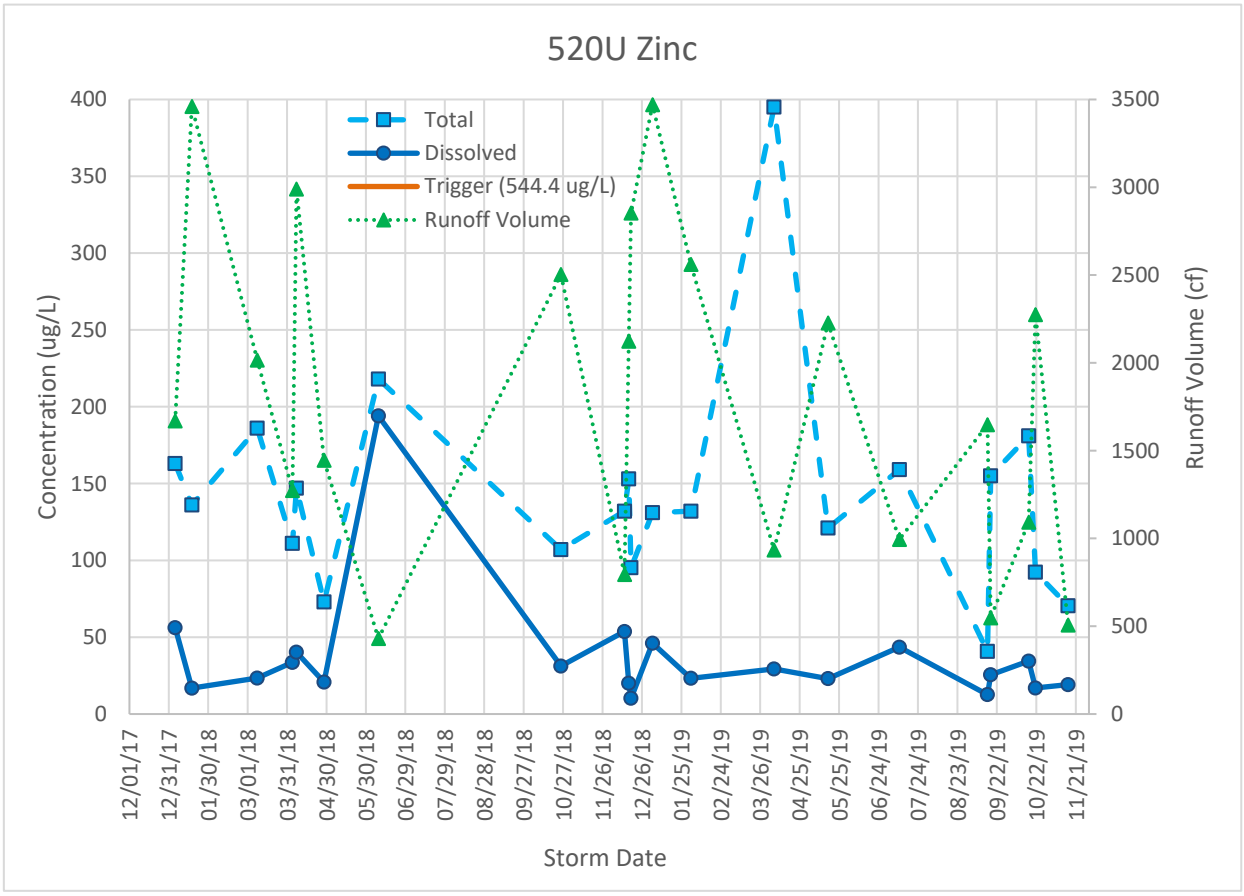

520N Zinc
Total
Dissolved
Trigger (2298.7 ug/L)
Runoff Intensity
Concentration (ug/L)
Runoff Intensity (cf/hr)
Storm Date
0
50
100
150
200
250
300
350
400
0
10
20
30
40
50
60
70
80
90
12/01/17
12/31/17
01/30/18
03/01/18
03/31/18
04/30/18
05/30/18
06/29/18
07/29/18
08/28/18
09/27/18
10/27/18
11/26/18
12/26/18
01/25/19
02/24/19
03/26/19
04/25/19
05/25/19
06/24/19
07/24/19
08/23/19
09/22/19
10/22/19
11/21/19

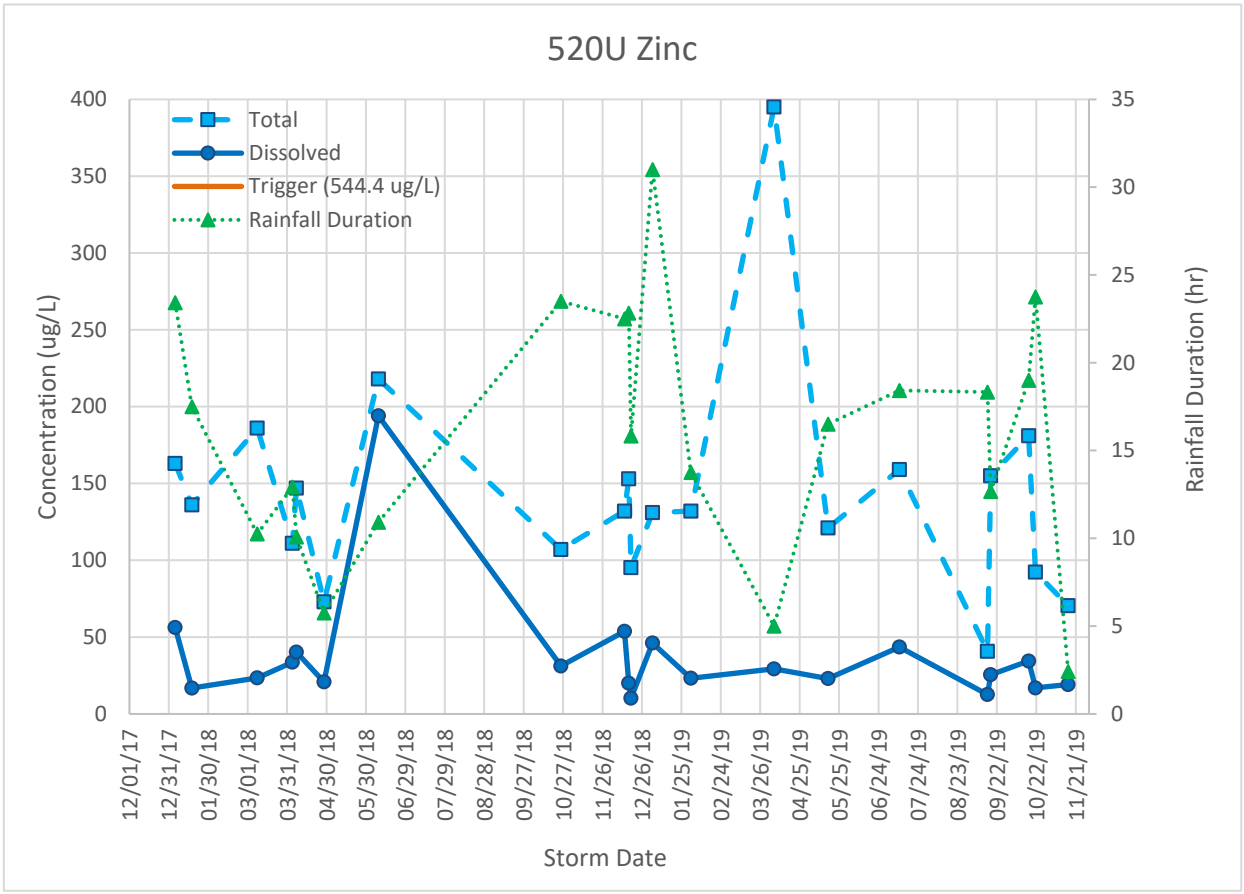

520N Zinc
Total
Dissolved
Trigger (2298.7 ug/L)
Runoff Volume
Concentration (ug/L)
Runoff Volume (cf)
Storm Date
0
50
100
150
200
250
300
350
400
0
300
600
900
1200
1500
12/01/17
12/31/17
01/30/18
03/01/18
03/31/18
04/30/18
05/30/18
06/29/18
07/29/18
08/28/18
09/27/18
10/27/18
11/26/18
12/26/18
01/25/19
02/24/19
03/26/19
04/25/19
05/25/19
06/24/19
07/24/19
08/23/19
09/22/19
10/22/19
11/21/19

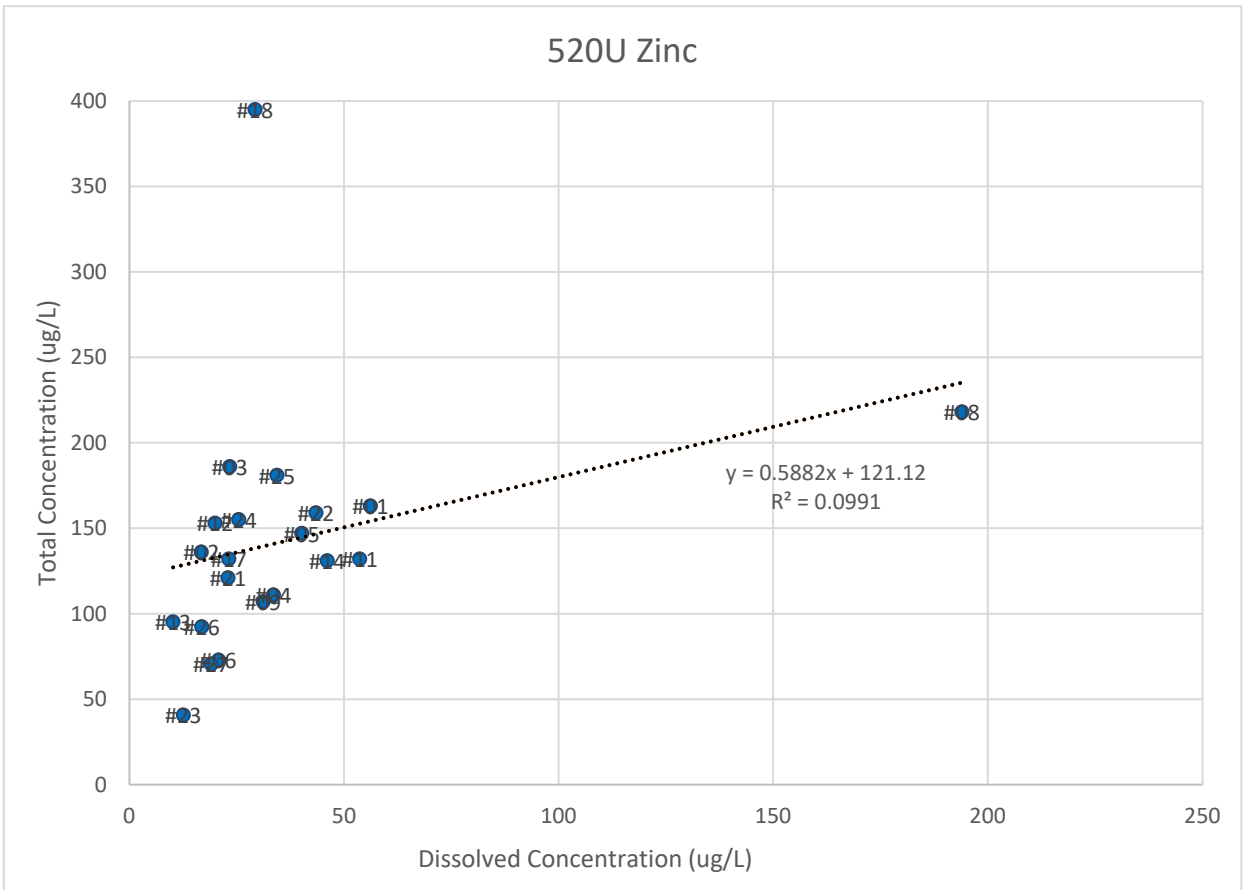

520N Zinc
Total
Dissolved
Trigger (2298.7 ug/L)
Rainfall Duration
Concentration (ug/L)
Rainfall Duration (hr)
Storm Date
0
50
100
150
200
250
300
350
400
0
5
10
15
20
25
30
35
12/01/17
12/31/17
01/30/18
03/01/18
03/31/18
04/30/18
05/30/18
06/29/18
07/29/18
08/28/18
09/27/18
10/27/18
11/26/18
12/26/18
01/25/19
02/24/19
03/26/19
04/25/19
05/25/19
06/24/19
07/24/19
08/23/19
09/22/19
10/22/19
11/21/19

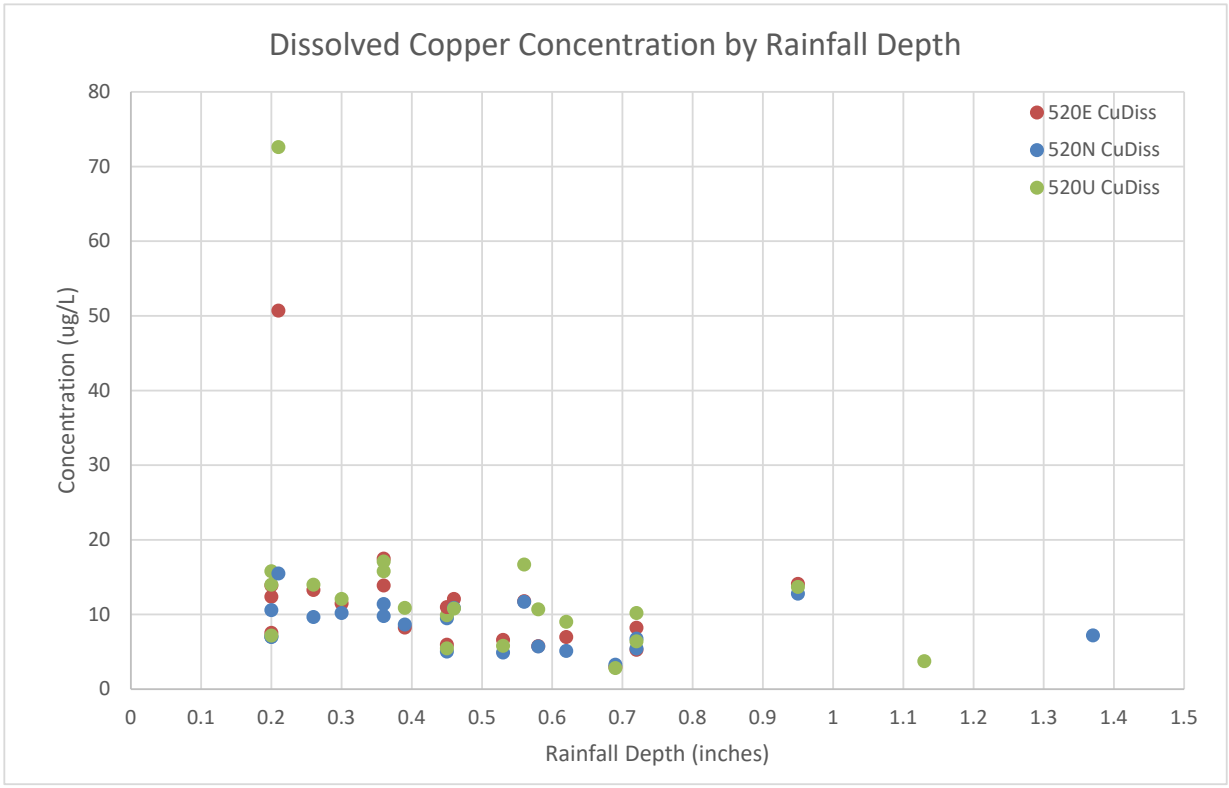

520N Zinc
Total Concentration (ug/L)
Dissolved Concentration (ug/L)
y = 1.7348x + 30.17
R² = 0.1387
0
50
100
150
200
250
300
350
400
0
10
20
30
40
50
60
70
80

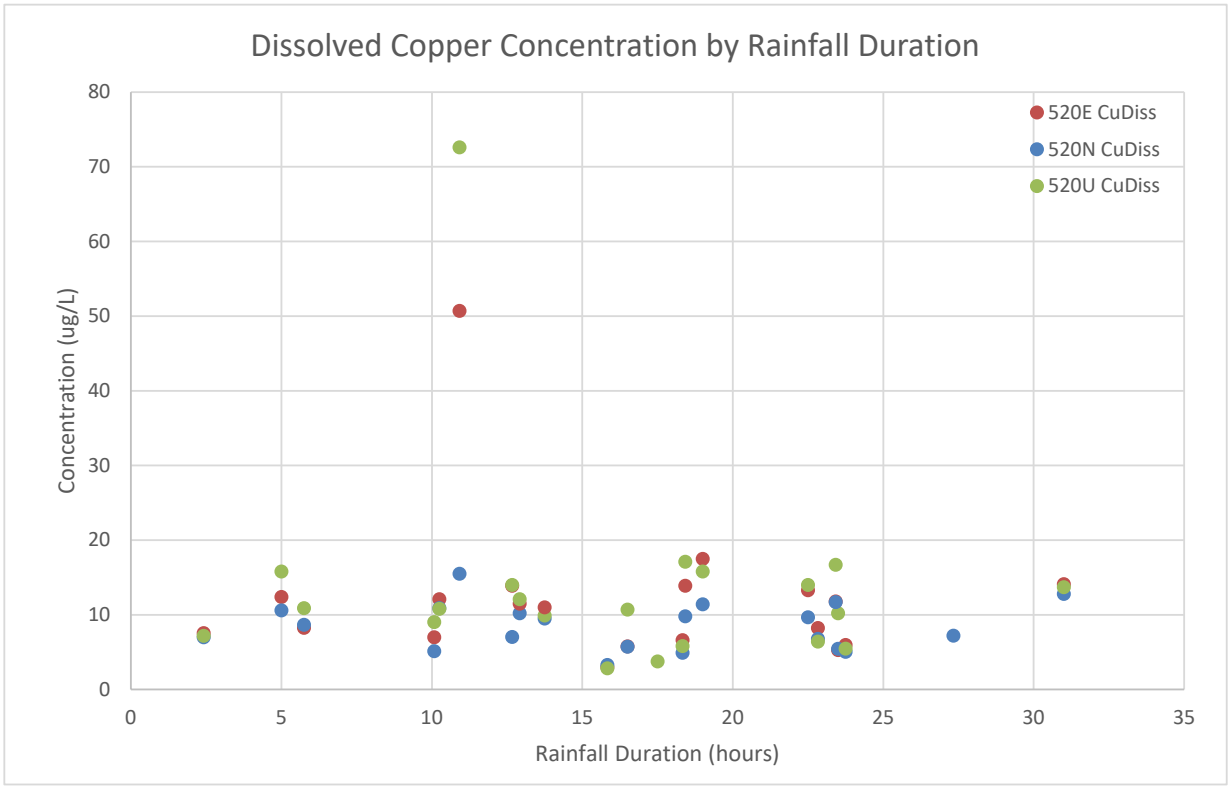

520U Zinc
Total
Dissolved
Trigger (544.4 ug/L)
Runoff Intensity
Concentration (ug/L)
Runoff Intensity (cf/hr)
Storm Date
0
50
100
150
200
250
300
350
400
12/01/17
12/31/17
01/30/18
03/01/18
03/31/18
04/30/18
05/30/18
06/29/18
07/29/18
08/28/18
09/27/18
10/27/18
11/26/18
12/26/18
01/25/19
02/24/19
03/26/19
04/25/19
05/25/19
06/24/19
07/24/19
08/23/19
09/22/19
10/22/19
11/21/19

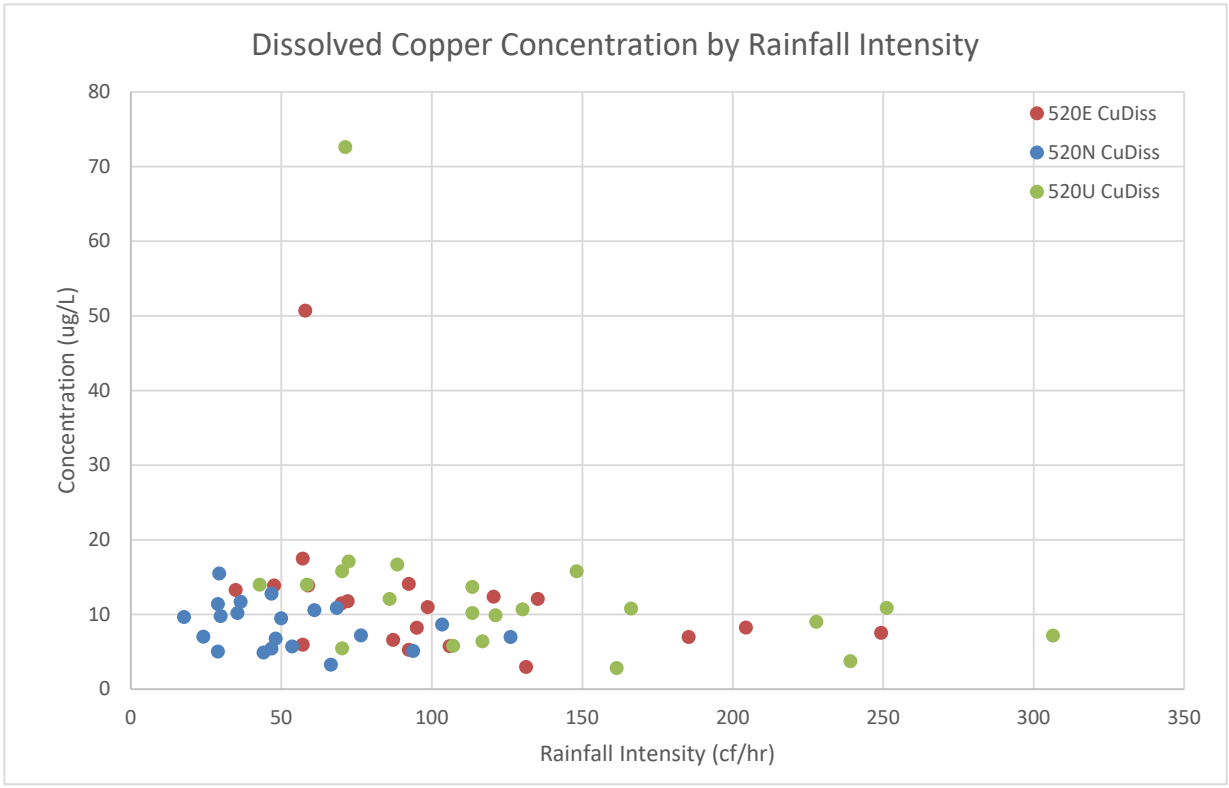

520U Zinc
Total
Dissolved
Trigger (544.4 ug/L)
Runoff Volume
Concentration (ug/L)
Runoff Volume (cf)
Storm Date
0
50
100
150
200
250
300
350
400
500
1000
1500
2000
2500
3000
3500
12/01/17
12/31/17
01/30/18
03/01/18
03/31/18
04/30/18
05/30/18
06/29/18
07/29/18
08/28/18
09/27/18
10/27/18
11/26/18
12/26/18
01/25/19
02/24/19
03/26/19
04/25/19
05/25/19
06/24/19
07/24/19
08/23/19
09/22/19
10/22/19
11/21/19

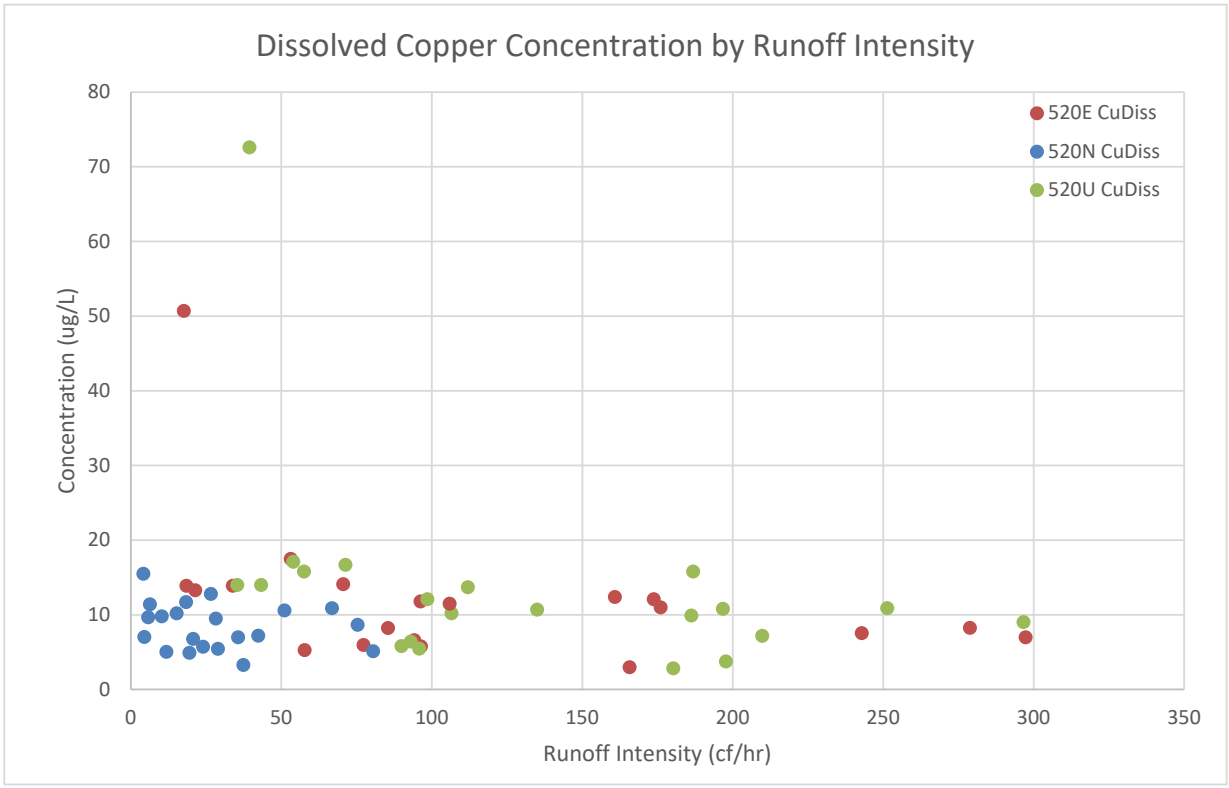

520U Zinc
Total
Dissolved
Trigger (544.4 ug/L)
Rainfall Duration
Concentration (ug/L)
Rainfall Duration (hr)
Storm Date
0
50
100
150
200
250
300
350
400
0
5
10
15
20
25
30
35
12/01/17
12/31/17
01/30/18
03/01/18
03/31/18
04/30/18
05/30/18
06/29/18
07/29/18
08/28/18
09/27/18
10/27/18
11/26/18
12/26/18
01/25/19
02/24/19
03/26/19
04/25/19
05/25/19
06/24/19
07/24/19
08/23/19
09/22/19
10/22/19
11/21/19

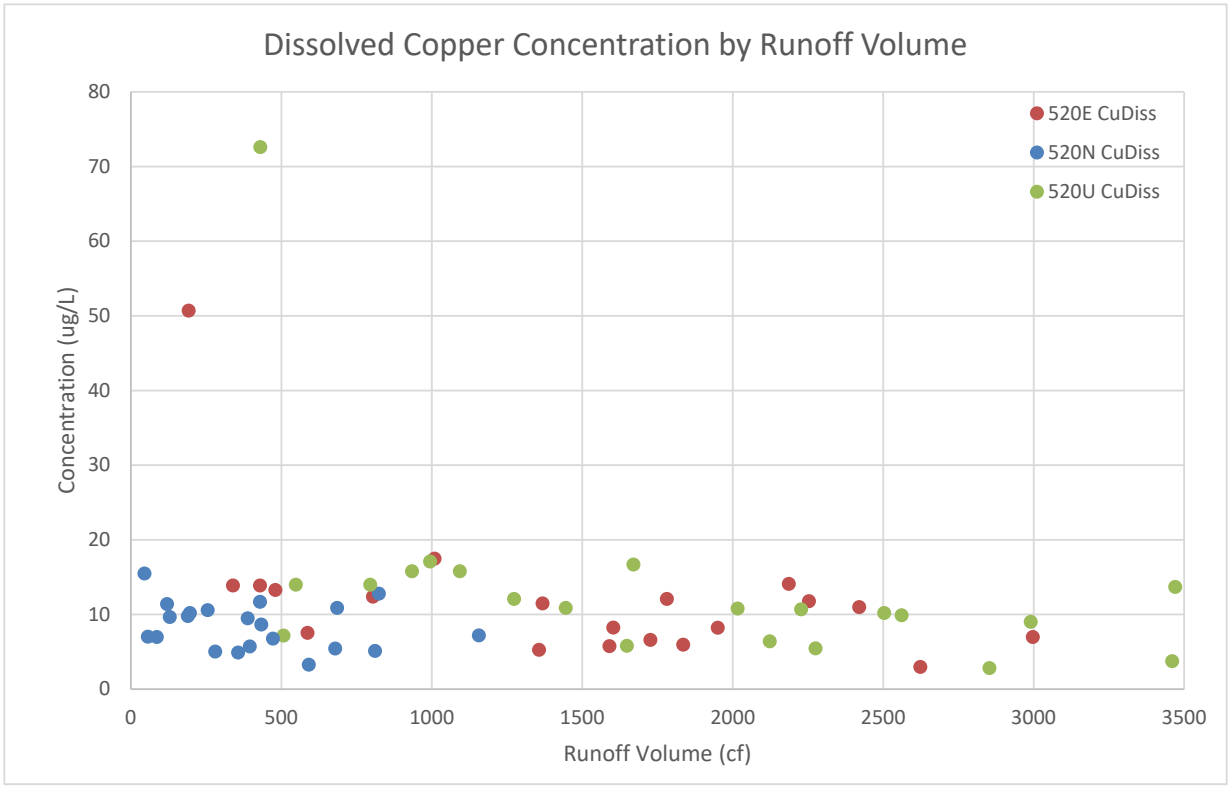

520U Zinc
Total Concentration (ug/L)
Dissolved Concentration (ug/L)
y = 0.5882x + 121.12
R² = 0.0991
0
50
100
150
200
250
300
350
400

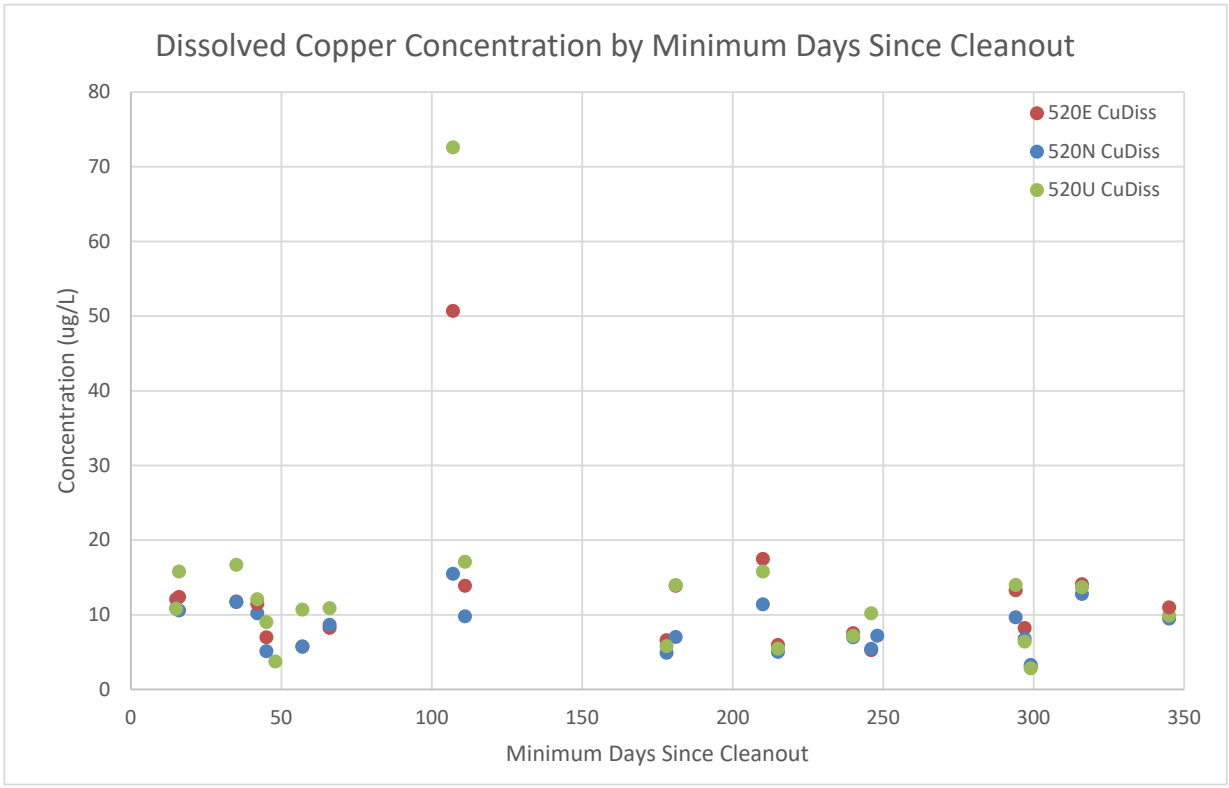

Dissolved Copper Concentration by Rainfall Depth
Concentration (ug/L)
Rainfall Depth (inches)
520E CuDiss
520N CuDiss
520U CuDiss
0
10
20
30
40
50
60
70
80
0
0.1
0.2
0.3
0.4
0.5
0.6
0.7
0.8
0.9
1
1.1
1.2
1.3
1.4
1.5

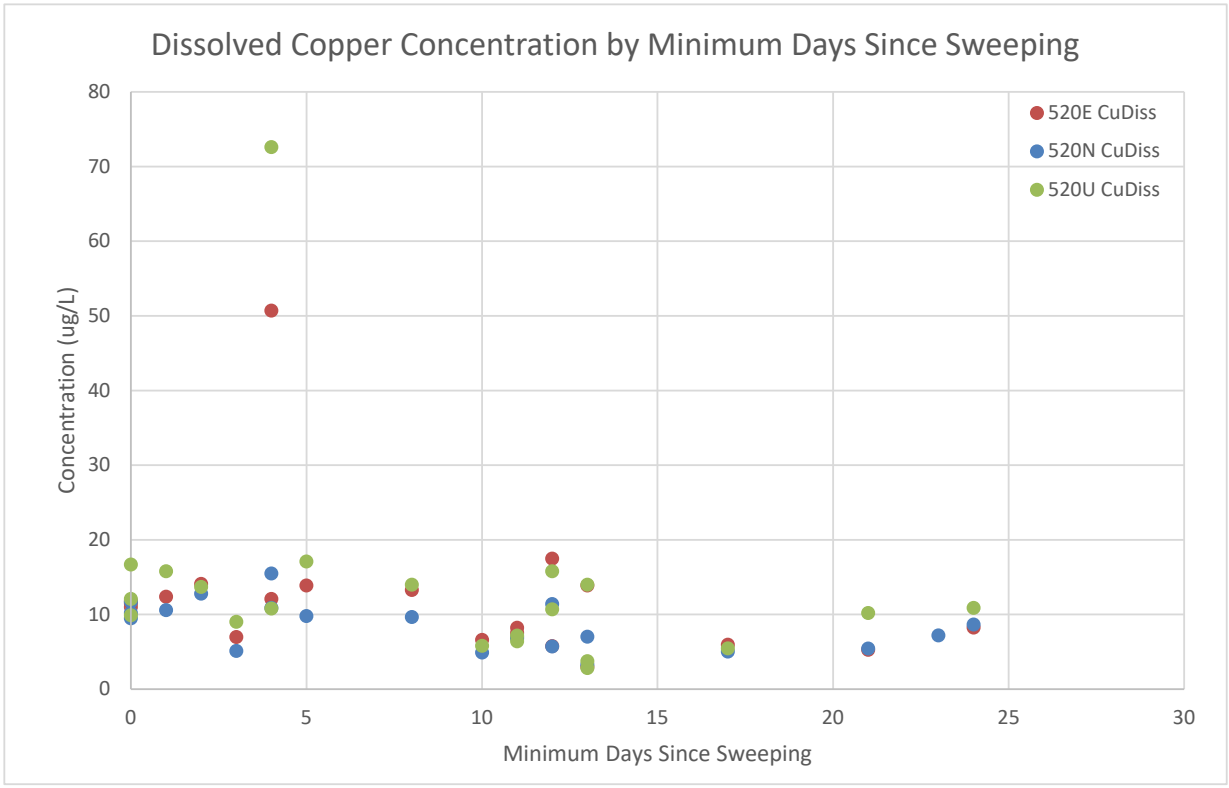

Dissolved Copper Concentration by Rainfall Duration
Concentration (ug/L)
Rainfall Duration (hours)
520E CuDiss
520N CuDiss
520U CuDiss
0
10
20
30
40
50
60
70
80
0
5
10
15
20
25
30
35

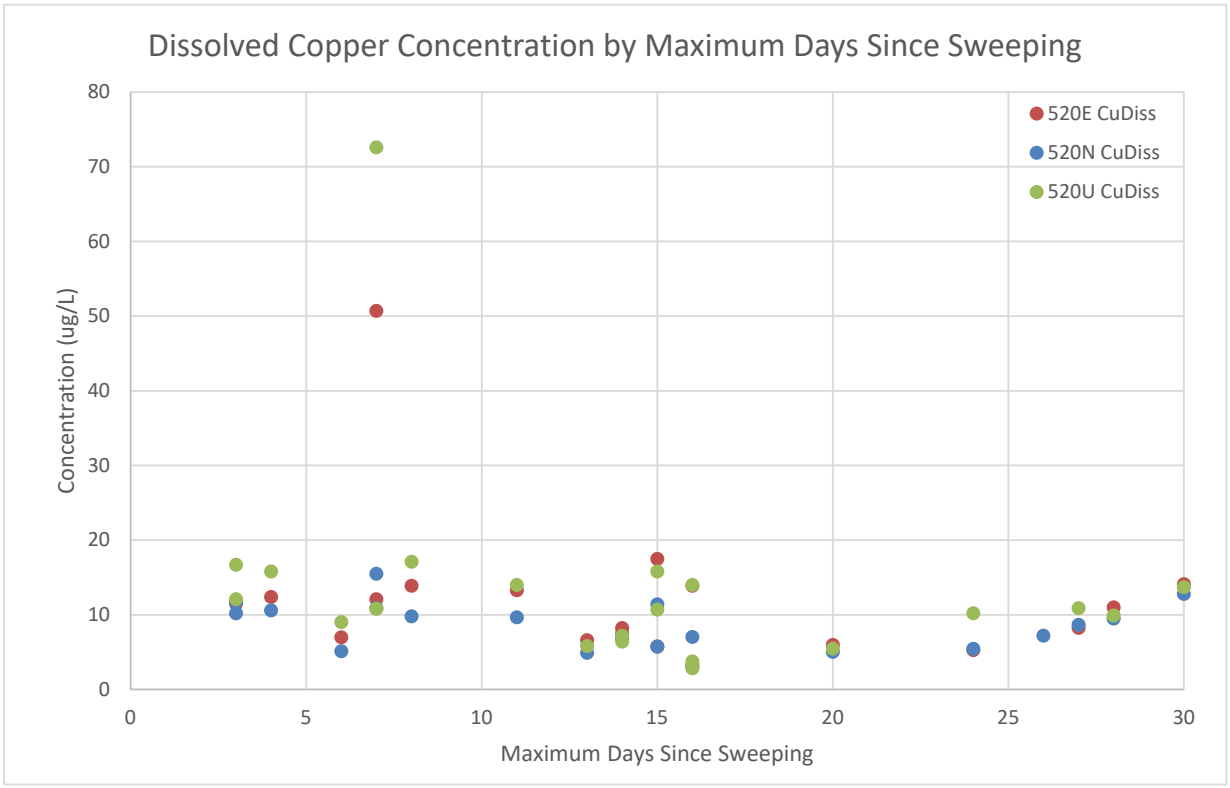

Dissolved Copper Concentration by Rainfall Intensity
Concentration (ug/L)
Rainfall Intensity (cf/hr)
520E CuDiss
520N CuDiss
520U CuDiss
0
10
20
30
40
50
60
70
80
0
50
100
150
200
250
300
350

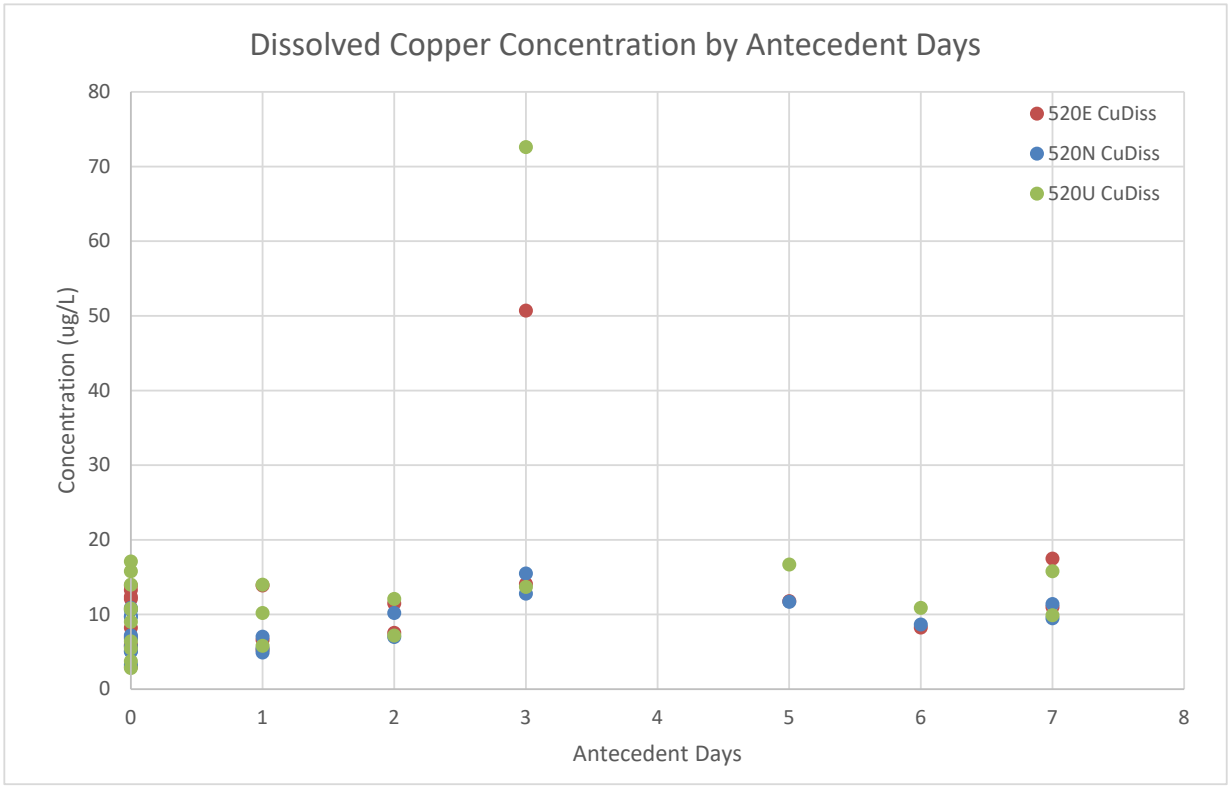

Dissolved Copper Concentration by Runoff Intensity
Concentration (ug/L)
Runoff Intensity (cf/hr)
520E CuDiss
520N CuDiss
520U CuDiss
0
10
20
30
40
50
60
70
80
0
50
100
150
200
250
300
350

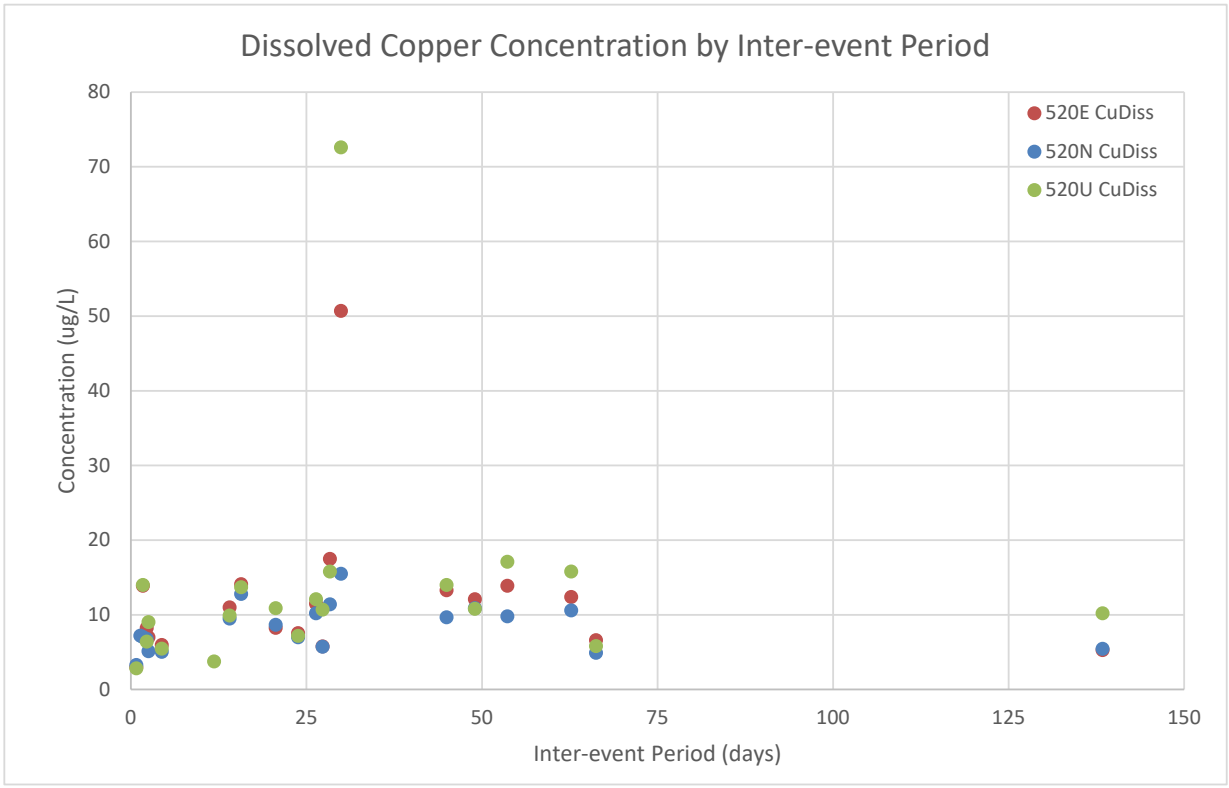

Dissolved Copper Concentration by Runoff Volume
Concentration (ug/L)
Runoff Volume (cf)
520E CuDiss
520N CuDiss
520U CuDiss
0
10
20
30
40
50
60
70
80
0
500
1000
1500
2000
2500
3000
3500

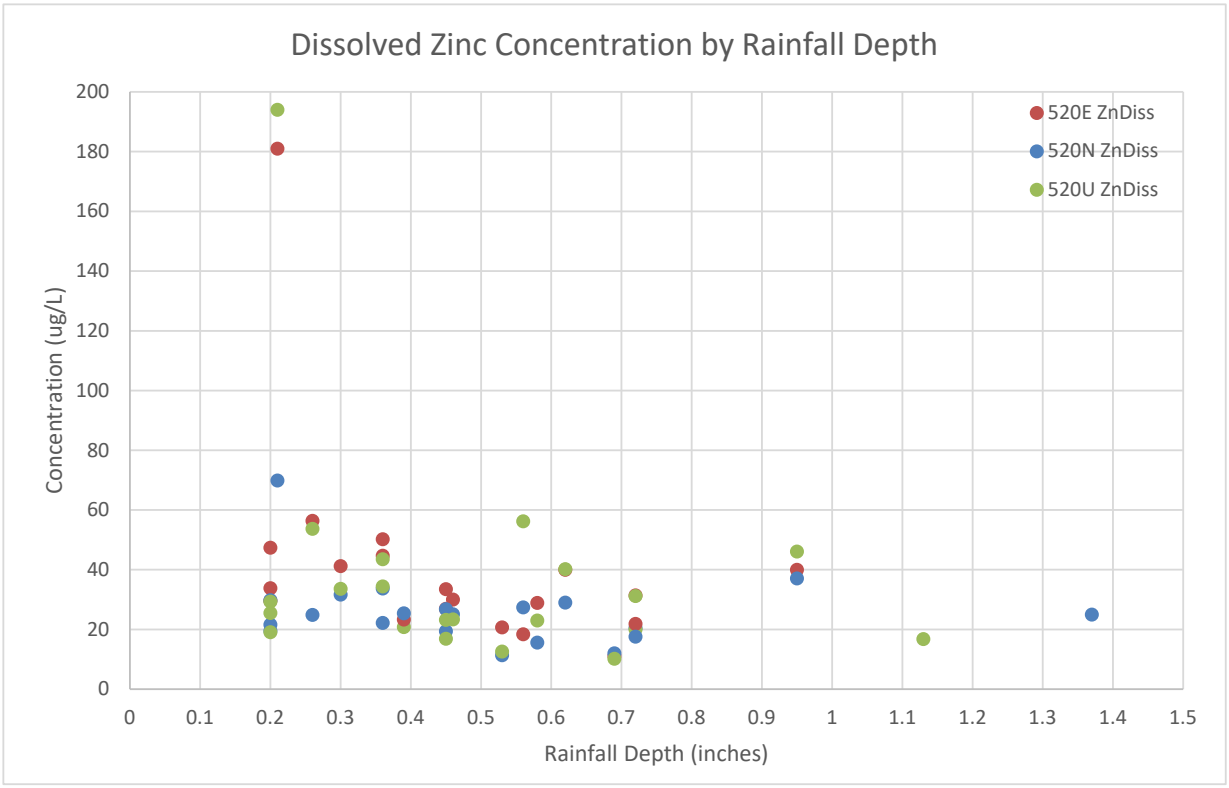

Dissolved Copper Concentration by Minimum Days Since Cleanout
Concentration (ug/L)
Minimum Days Since Cleanout
520E CuDiss
520N CuDiss
520U CuDiss
0
10
20
30
40
50
60
70
80
0
50
100
150
200
250
300
350

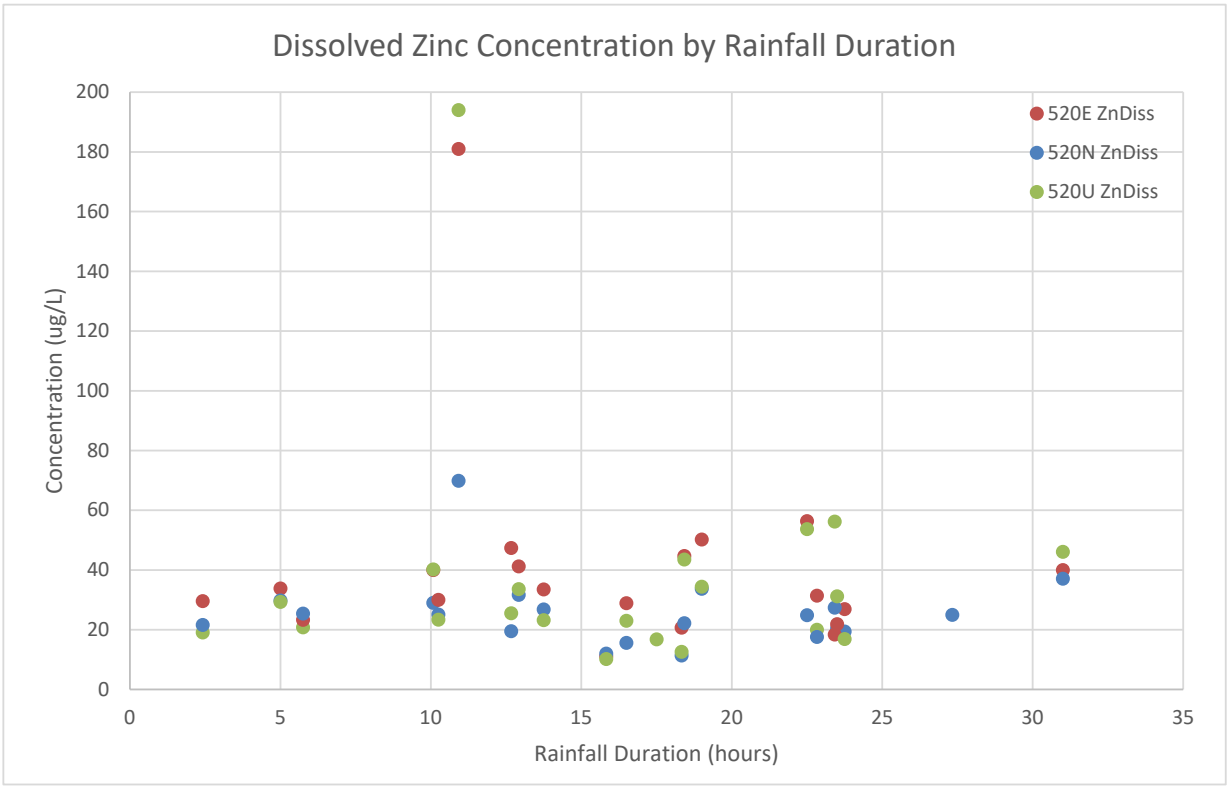

Dissolved Copper Concentration by Minimum Days Since Sweeping
520E CuDiss
520N CuDiss
520U CuDiss
Concentration (ug/L)
Minimum Days Since Sweeping
0
10
20
30
40
50
60
70
80
0
5
10
15
20
25
30

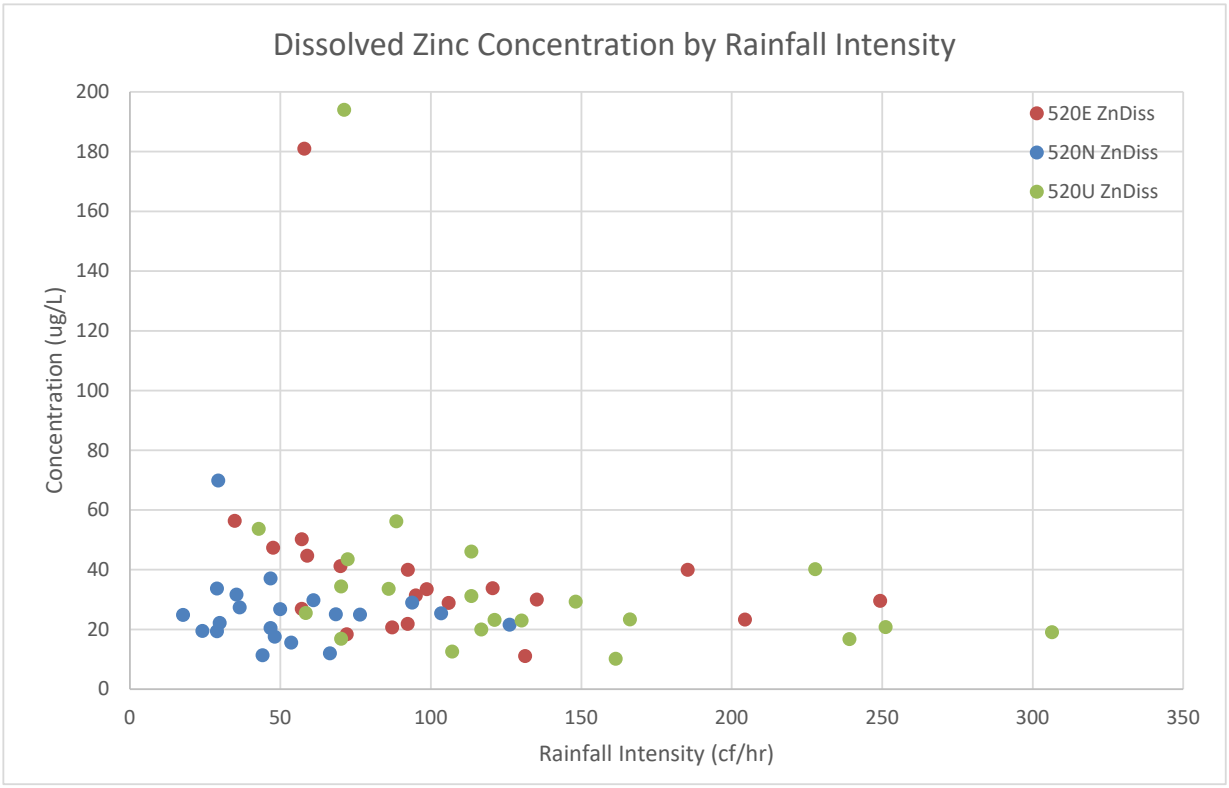

Dissolved Copper Concentration by Maximum Days Since Sweeping
520E CuDiss
520N CuDiss
520U CuDiss
Concentration (ug/L)
Maximum Days Since Sweeping
0
10
20
30
40
50
60
70
80
0
5
10
15
20
25
30

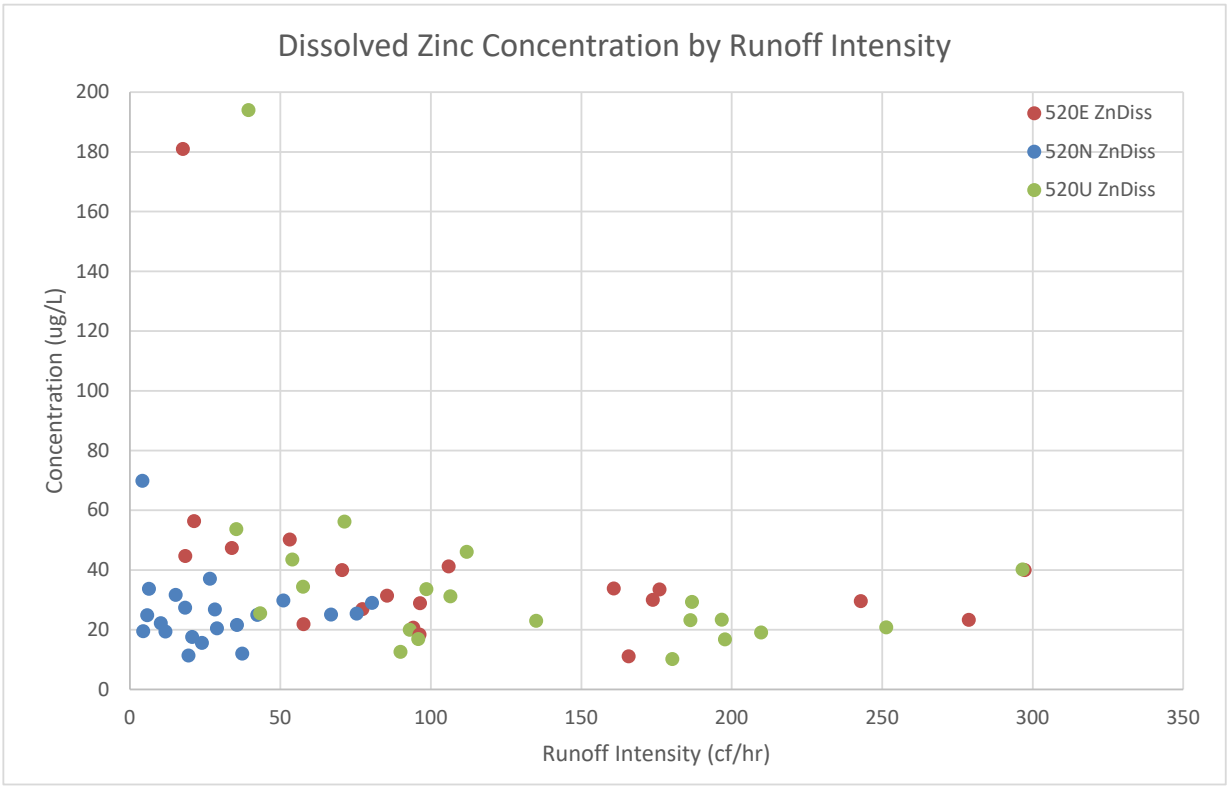

Dissolved Copper Concentration by Antecedent Days
Concentration (ug/L)
Antecedent Days
520E CuDiss
520N CuDiss
520U CuDiss
0
10
20
30
40
50
60
70
80
0
1
2
3
4
5
6
7
8

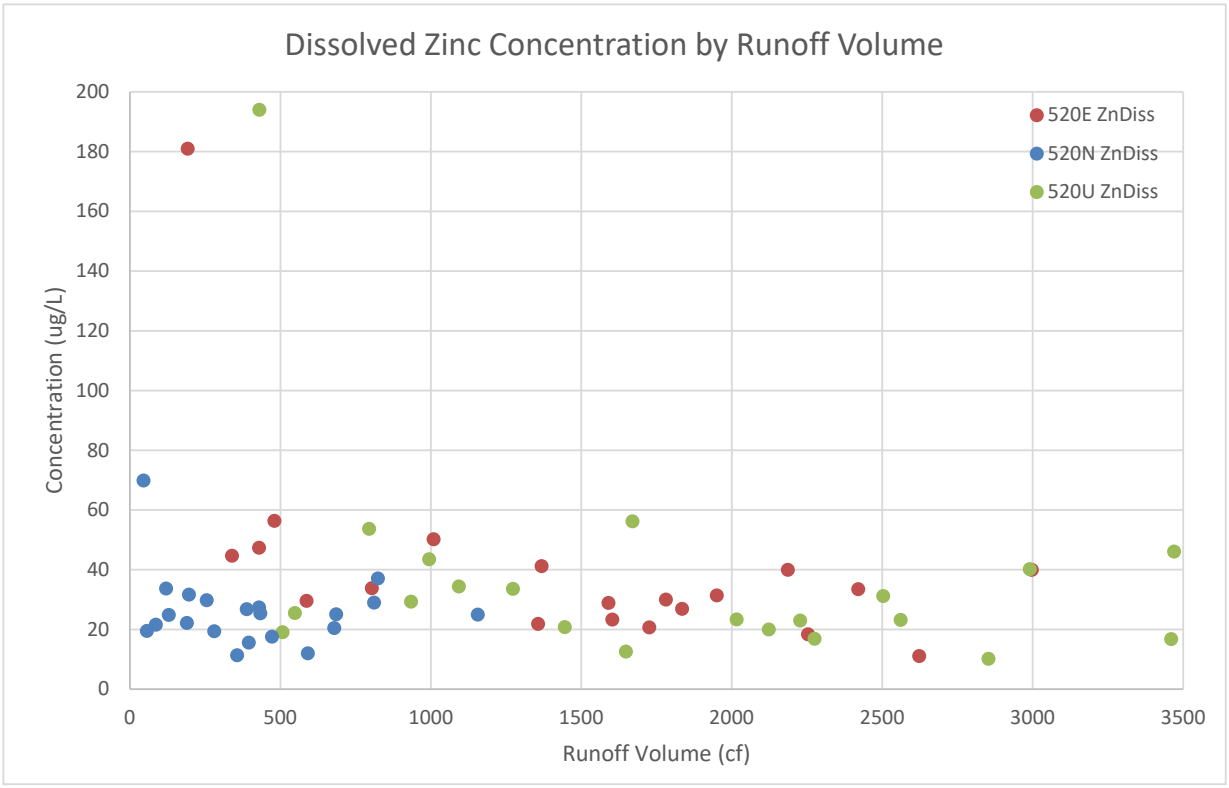

Dissolved Copper Concentration by Inter-event Period
Concentration (ug/L)
Inter-event Period (days)
520E CuDiss
520N CuDiss
520U CuDiss
0
10
20
30
40
50
60
70
80
0
25
50
75
100
125
150

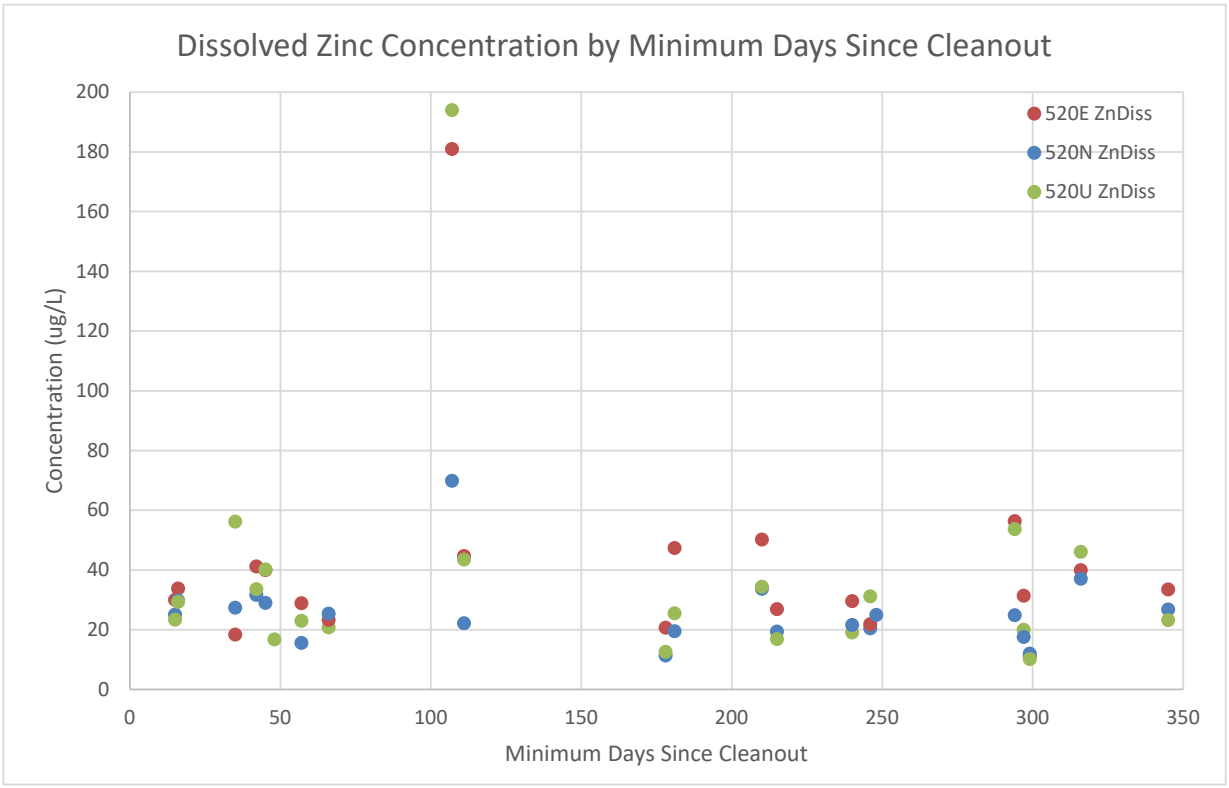

Dissolved Zinc Concentration by Rainfall Depth
Concentration (ug/L)
Rainfall Depth (inches)
520E ZnDiss
520N ZnDiss
520U ZnDiss
0
20
40
60
80
100
120
140
160
180
200
0
0.1
0.2
0.3
0.4
0.5
0.6
0.7
0.8
0.9
1
1.1
1.2
1.3
1.4
1.5

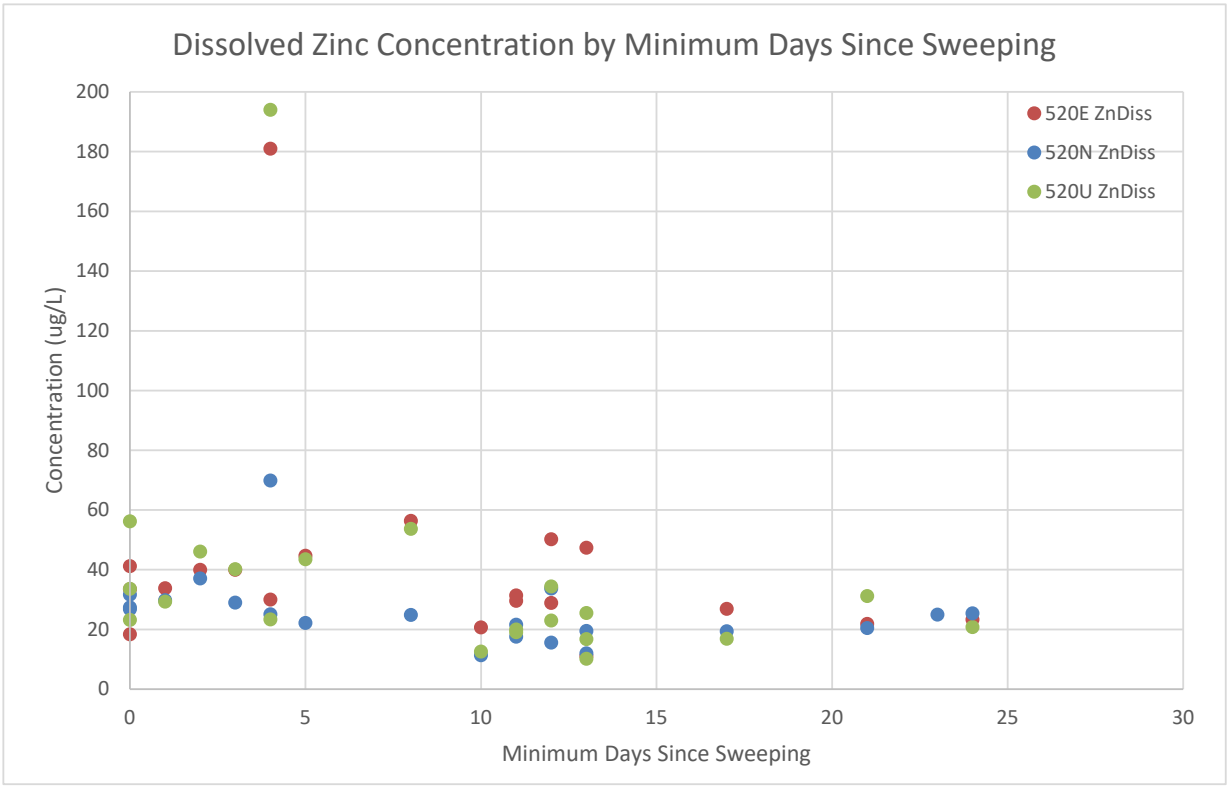

Dissolved Zinc Concentration by Rainfall Duration
Concentration (ug/L)
Rainfall Duration (hours)
520E ZnDiss
520N ZnDiss
520U ZnDiss
0
20
40
60
80
100
120
140
160
180
200
0
5
10
15
20
25
30
35

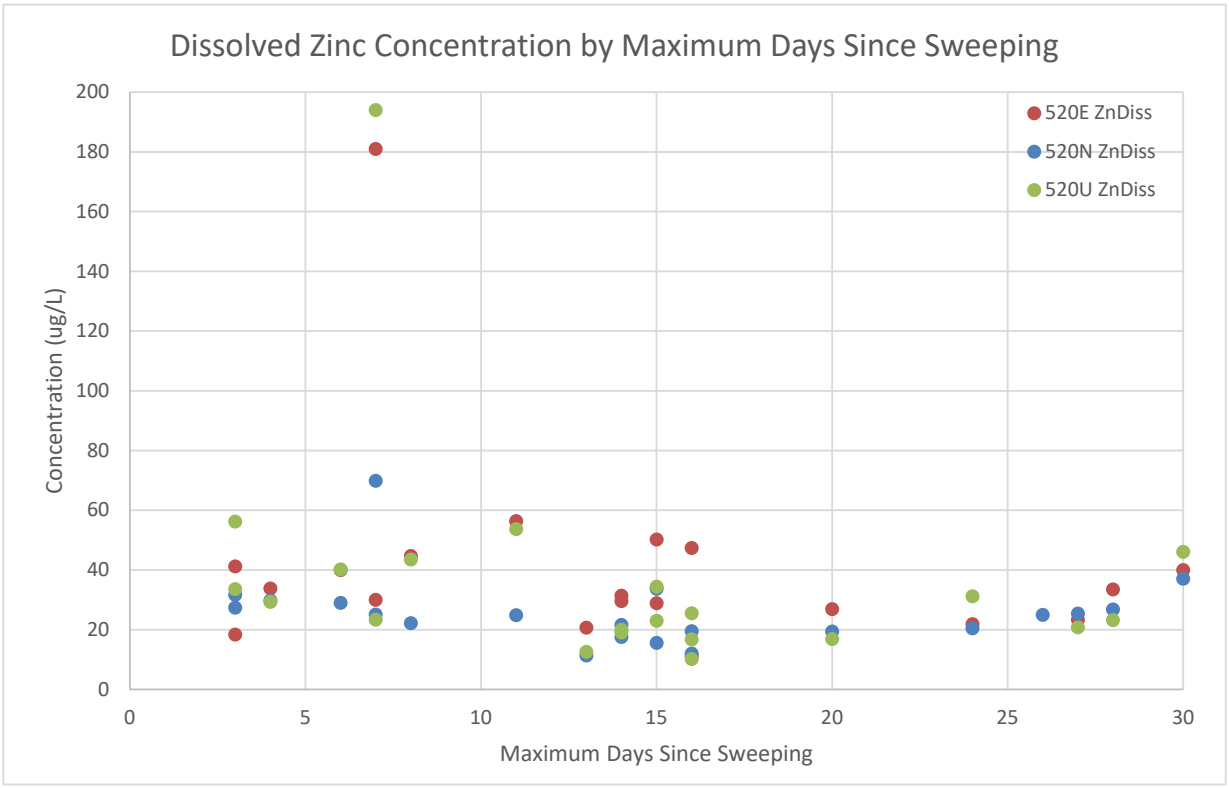

Dissolved Zinc Concentration by Rainfall Intensity
Concentration (ug/L)
Rainfall Intensity (cf/hr)
520E ZnDiss
520N ZnDiss
520U ZnDiss
0
20
40
60
80
100
120
140
160
180
200
0
50
100
150
200
250
300
350

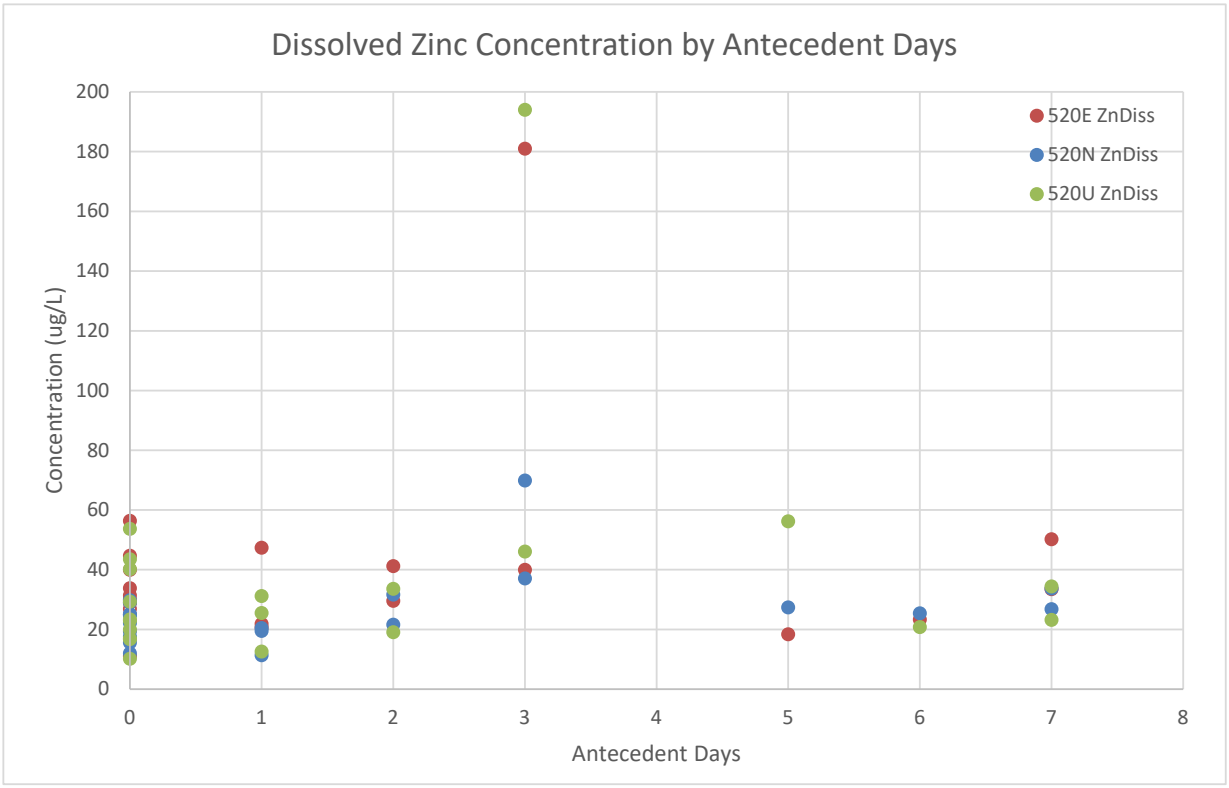

Dissolved Zinc Concentration by Runoff Intensity
Concentration (ug/L)
Runoff Intensity (cf/hr)
520E ZnDiss
520N ZnDiss
520U ZnDiss
0
20
40
60
80
100
120
140
160
180
200
0
50
100
150
200
250
300
350

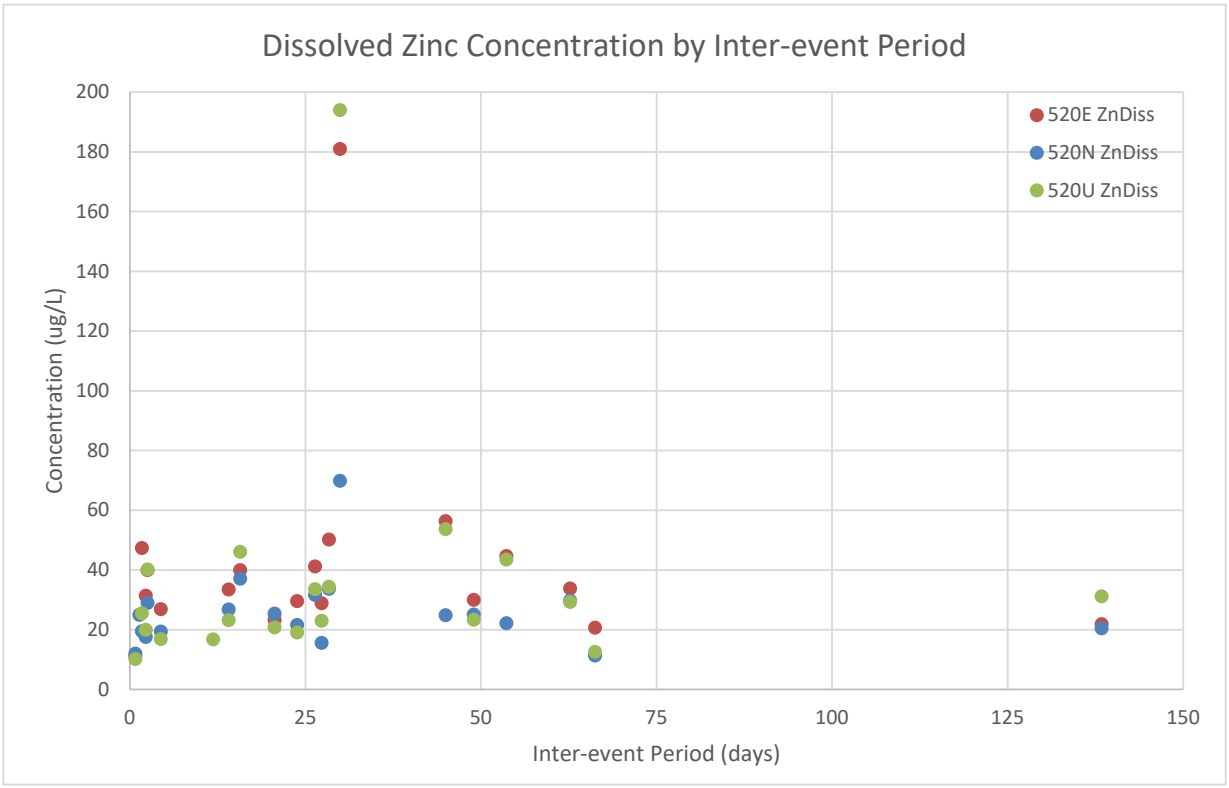

Dissolved Zinc Concentration by Runoff Volume
Concentration (ug/L)
Runoff Volume (cf)
520E ZnDiss
520N ZnDiss
520U ZnDiss
0
20
40
60
80
100
120
140
160
180
200
0
500
1000
1500
2000
2500
3000
3500

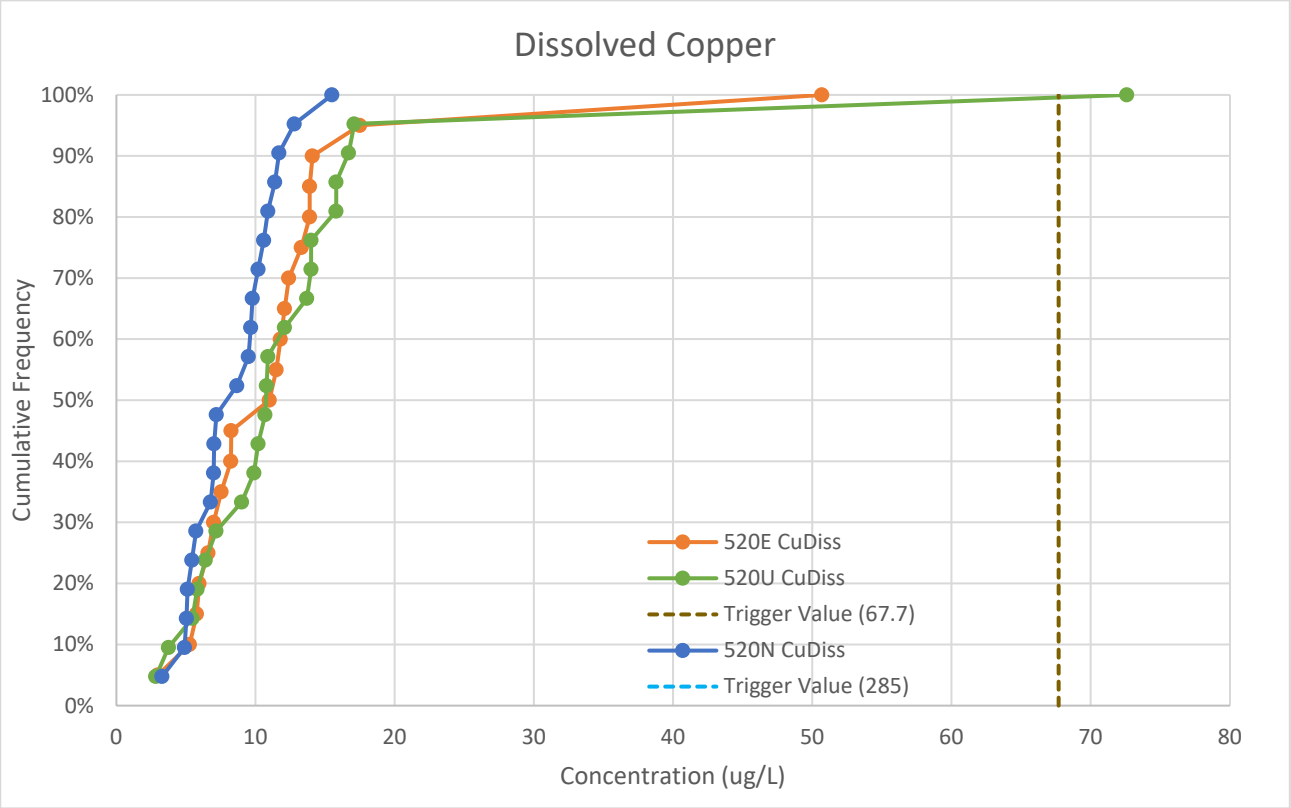

Dissolved Zinc Concentration by Minimum Days Since Cleanout
Concentration (ug/L)
Minimum Days Since Cleanout
520E ZnDiss
520N ZnDiss
520U ZnDiss
0
20
40
60
80
100
120
140
160
180
200
0
50
100
150
200
250
300
350

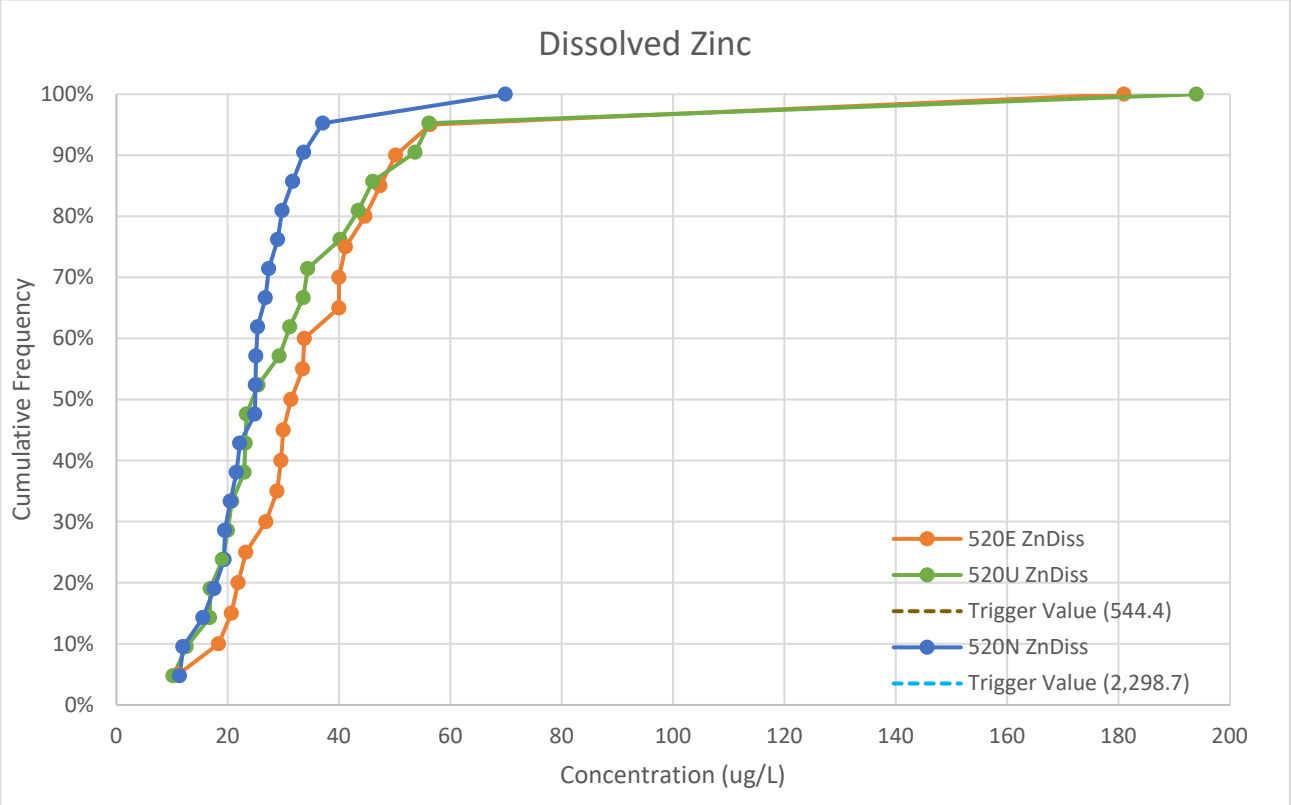

Dissolved Zinc Concentration by Minimum Days Since Sweeping
Concentration (ug/L)
Minimum Days Since Sweeping
520E ZnDiss
520N ZnDiss
520U ZnDiss
0
20
40
60
80
100
120
140
160
180
200
0
5
10
15
20
25
30

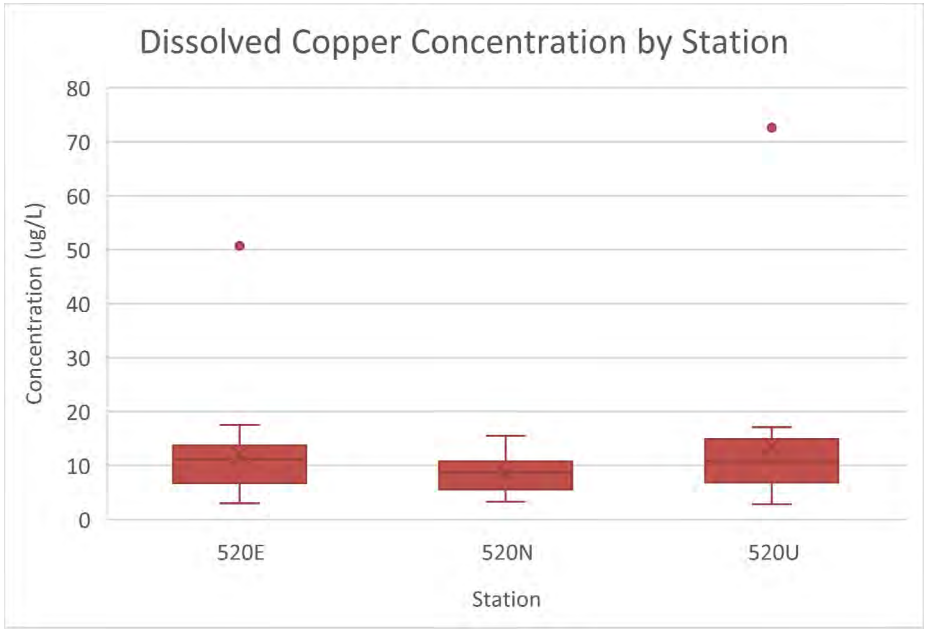

Dissolved Zinc Concentration by Maximum Days Since Sweeping
Concentration (ug/L)
Maximum Days Since Sweeping
520E ZnDiss
520N ZnDiss
520U ZnDiss
0
20
40
60
80
100
120
140
160
180
200
0
5
10
15
20
25
30

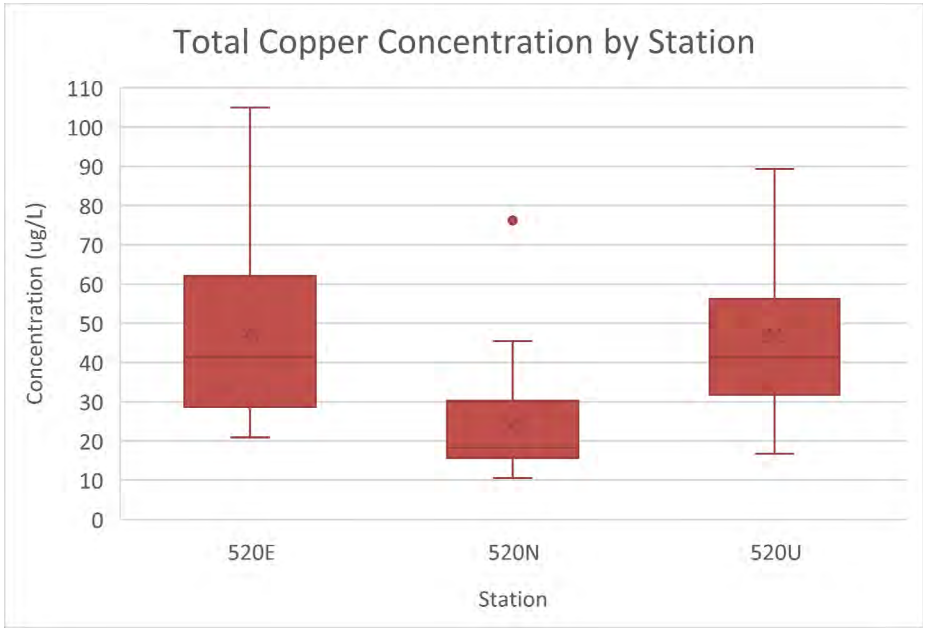

Dissolved Zinc Concentration by Antecedent Days
Concentration (ug/L)
Antecedent Days
520E ZnDiss
520N ZnDiss
520U ZnDiss
0
20
40
60
80
100
120
140
160
180
200
0
1
2
3
4
5
6
7
8

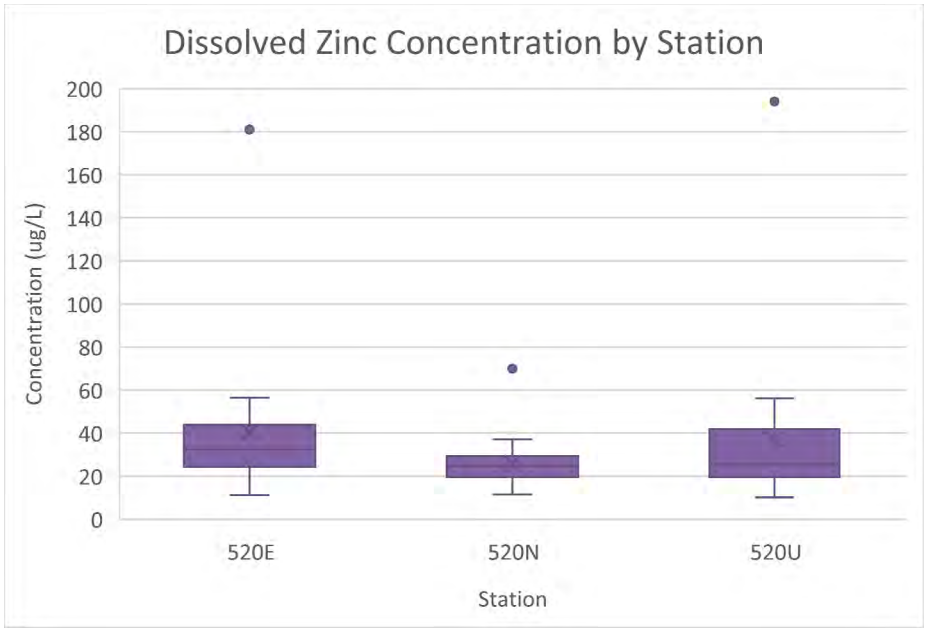

Dissolved Zinc Concentration by Inter-event Period
Concentration (ug/L)
Inter-event Period (days)
520E ZnDiss
520N ZnDiss
520U ZnDiss
0
20
40
60
80
100
120
140
160
180
200
0
25
50
75
100
125
150

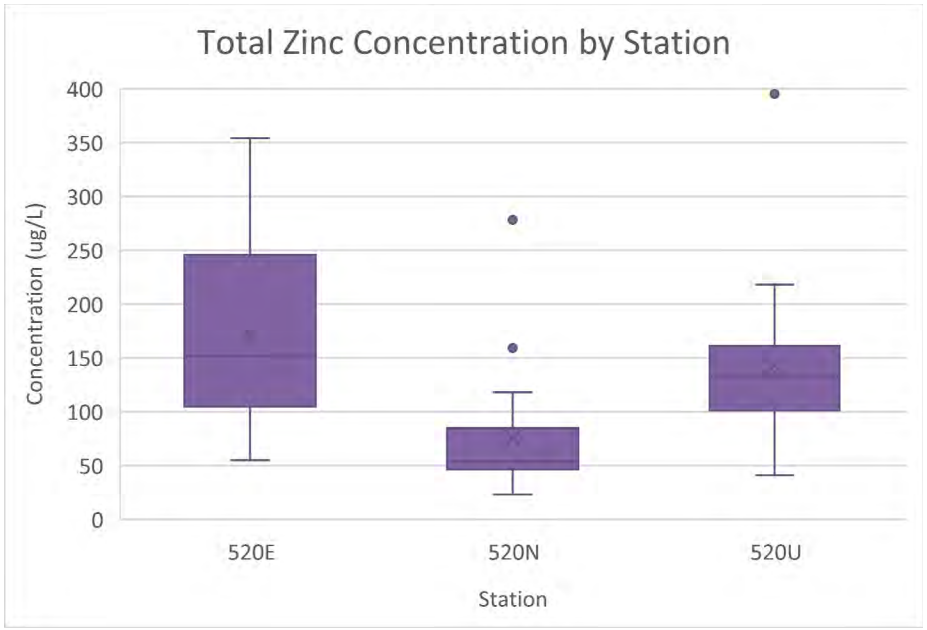

Dissolved Copper
Cumulative Frequency
100%
90%
80%
70%
60%
50%
40%
30%
20%
10%
0%
0
10
20
30
40
50
60
70
80
Concentration (ug/L)
520E CuDiss
520U CuDiss
Trigger Value (67.7)
520N CuDiss
Trigger Value (285)

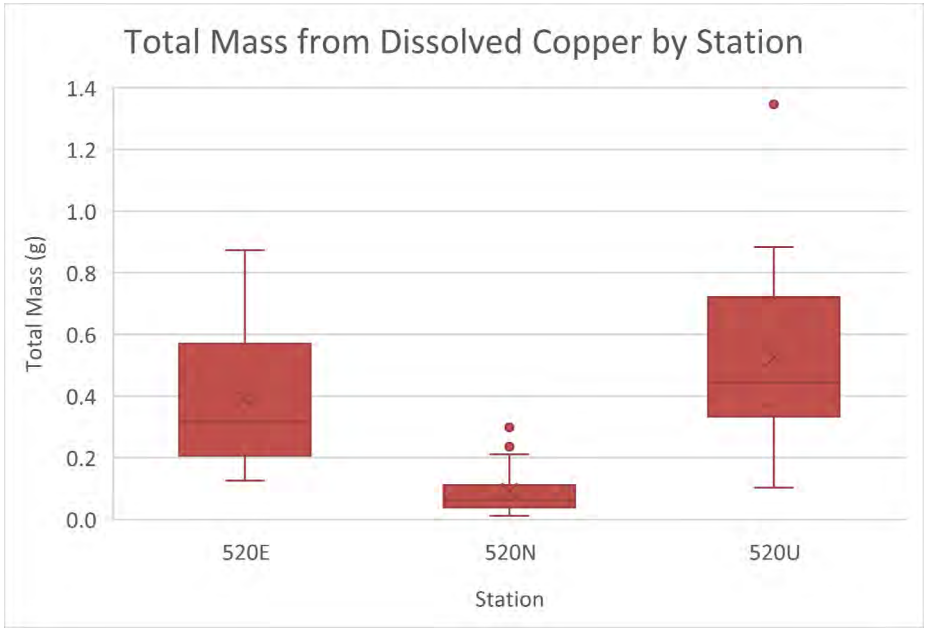

Dissolved Zinc
Cumulative Frequency
100%
90%
80%
70%
60%
50%
40%
30%
20%
10%
0%
0
20
40
60
80
100
120
140
160
180
200
Concentration (ug/L)
520E ZnDiss
520U ZnDiss
Trigger Value (544.4)
520N ZnDiss
Trigger Value (2,298.7)

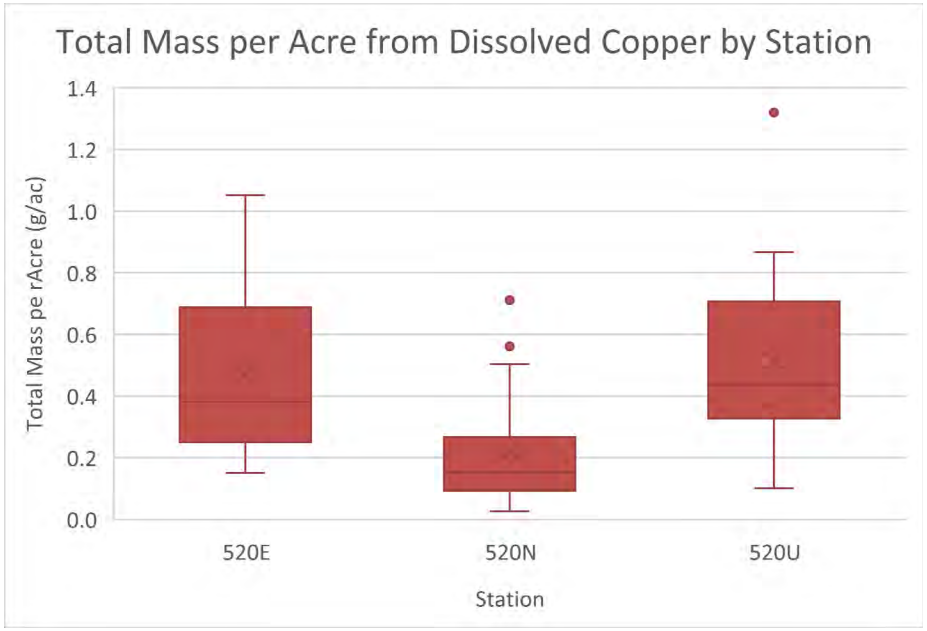

Dissolved Copper Concentration by Station
Concentration (ug/L)
80
70
60
50
40
30
20
10
0
520E
520N
520U
Station

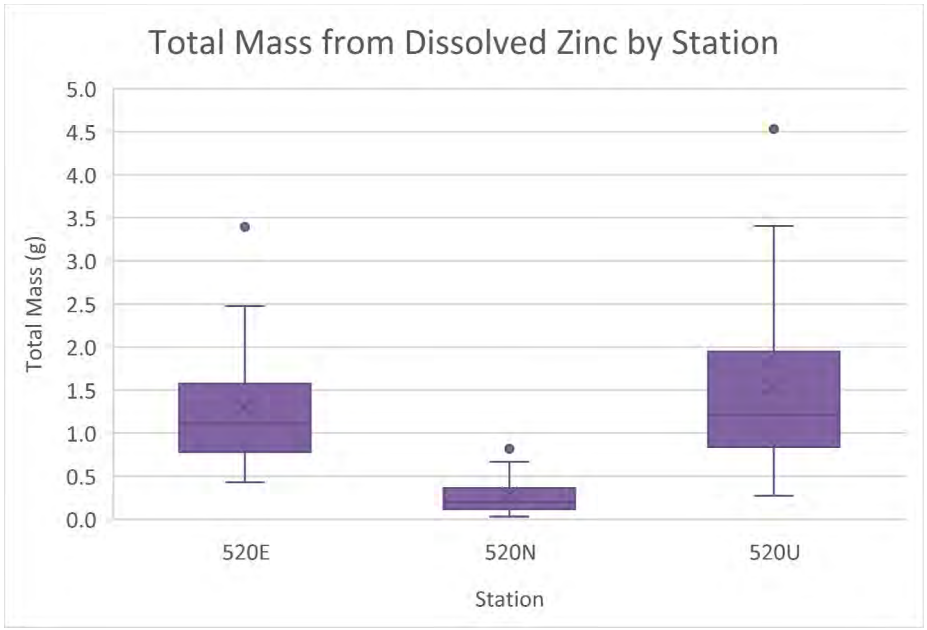

Total Copper Concentration by Station
Concentration (ug/L)
110
100
90
80
70
60
50
40
30
20
10
0
520E
520N
520U
Station

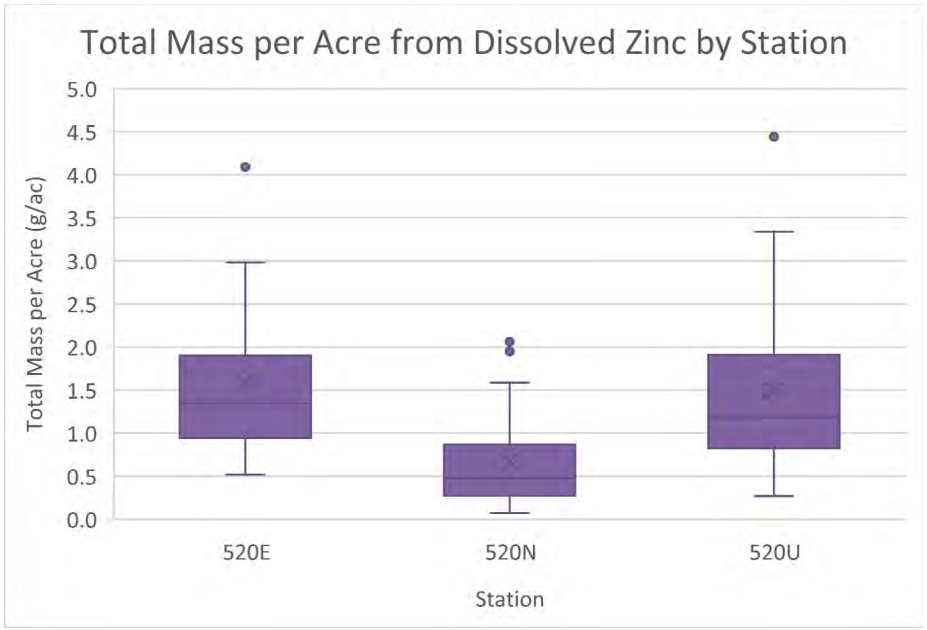

Dissolved Zinc Concentration by Station
Concentration (ug/L)
200
180
160
140
120
100
80
60
40
20
0
520E
520N
520U
Station

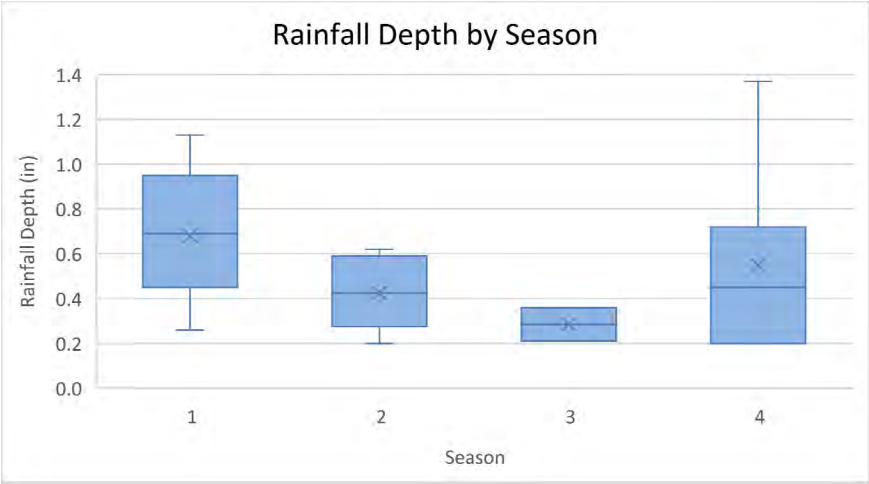

Total Zinc Concentration by Station
Concentration (ug/L)
400
350
300
250
200
150
100
50
0
520E
520N
520U
Station

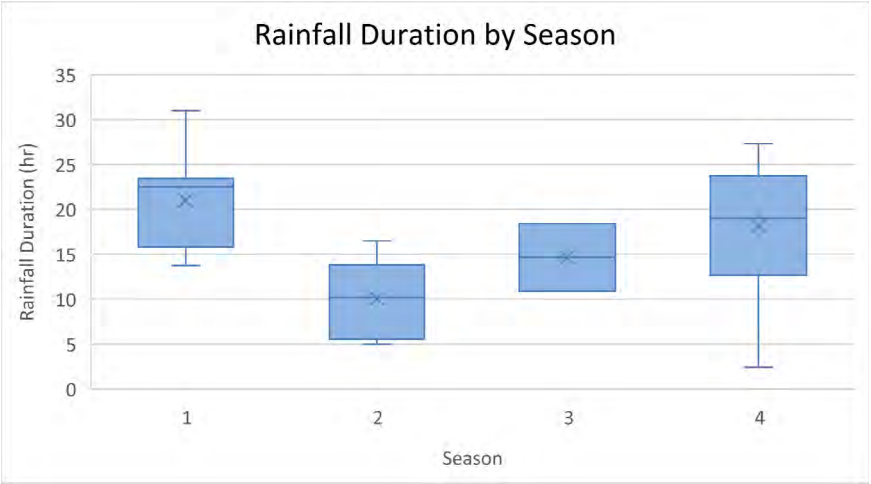

Total Mass from Dissolved Copper by Station
Total Mass (g)
1.4
1.2
1.0
0.8
0.6
0.4
0.2
0.0
520E
520N
520U
Station

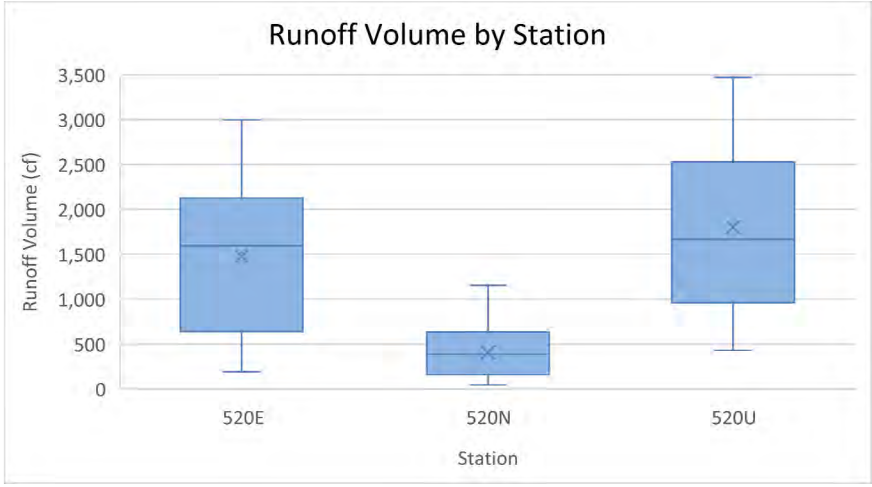

Total Mass per Acre from Dissolved Copper by Station
Total Mass pe rAcre (g/ac)
1.4
1.2
1.0
0.8
0.6
0.4
0.2
0.0
520E
520N
520U
Station

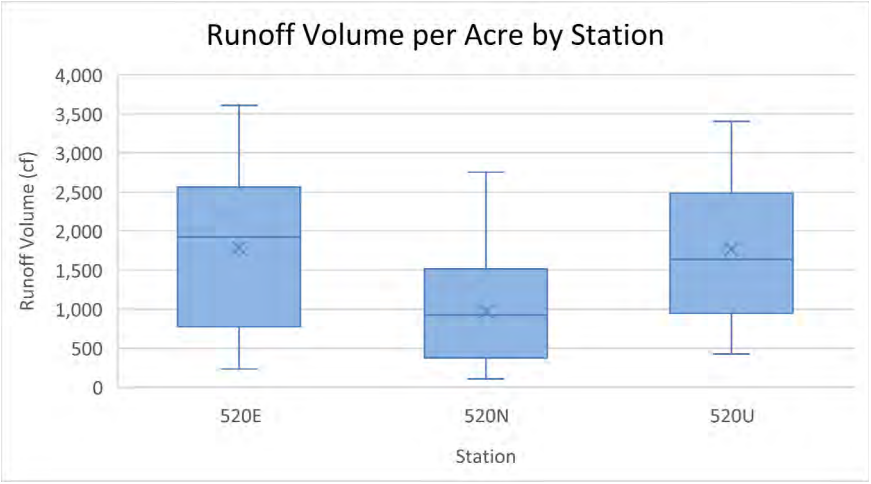

Total Mass from Dissolved Zinc by Station
Total Mass (g)
5.0
4.5
4.0
3.5
3.0
2.5
2.0
1.5
1.0
0.5
0.0
520E
520N
520U
Station

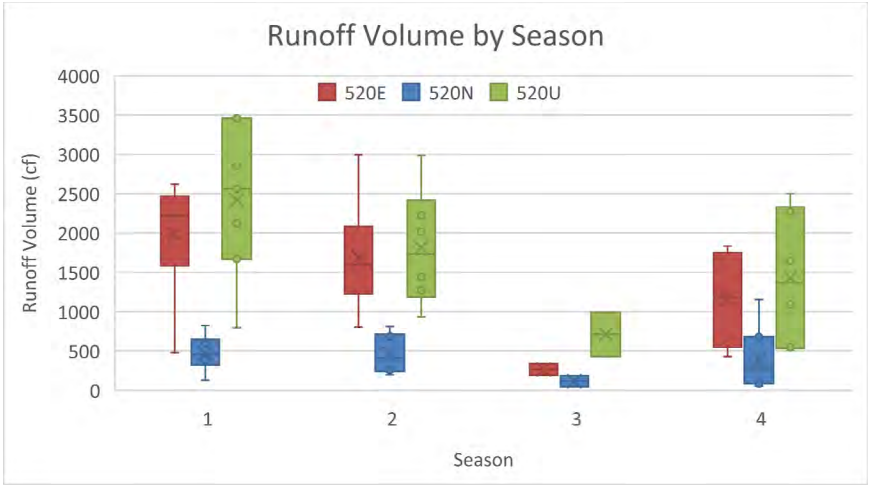

Total Mass per Acre from Dissolved Zinc by Station
Total Mass per Acre (g/ac)
5.0
4.5
4.0
3.5
3.0
2.5
2.0
1.5
1.0
0.5
0.0
520E
520N
520U
Station

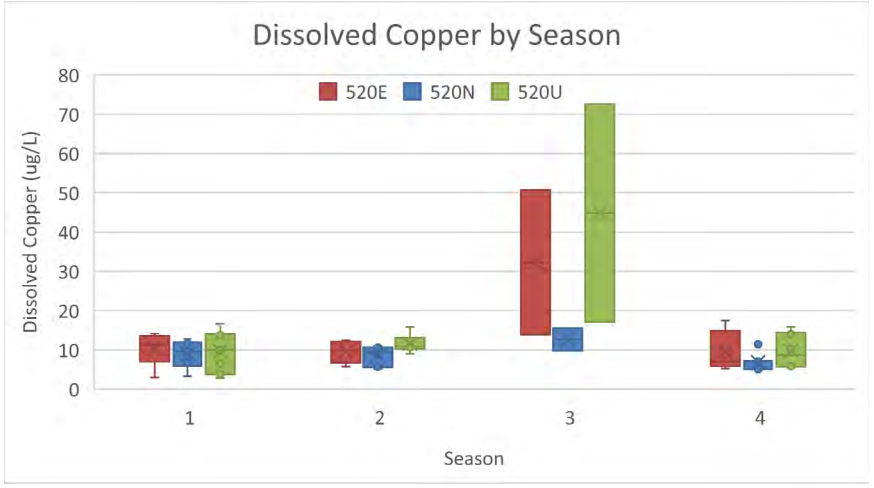

Rainfall Depth by Season
Rainfall Depth (in)
1.4
1.2
1.0
0.8
0.6
0.4
0.2
0.0
1
2
3
4
Season

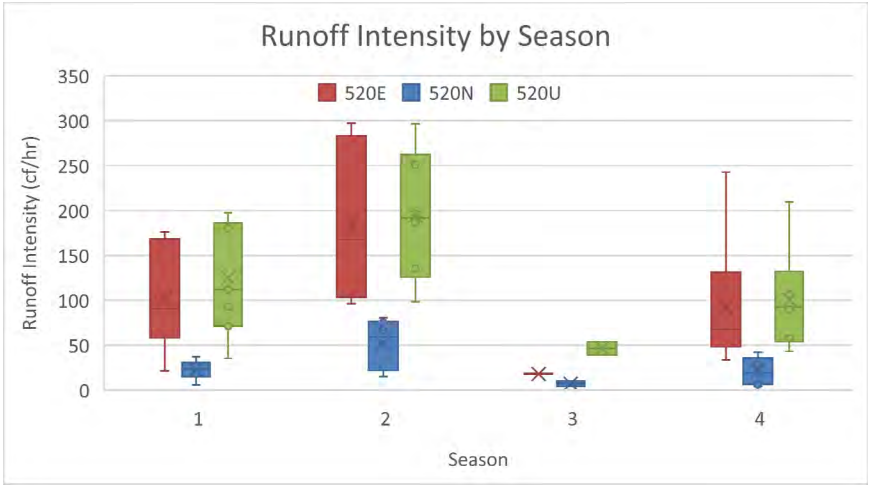

Rainfall Duration by Season
Rainfall Duration (hr)
35
30
25
20
15
10
5
0
1
2
3
4
Season

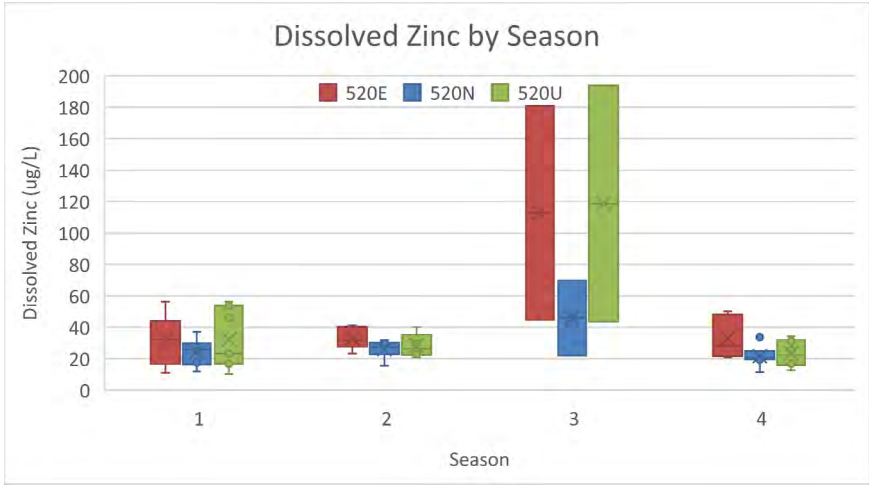

Runoff Volume by Station
Runoff Volume (cf)
3,500
3,000
2,500
2,000
1,500
1,000
500
0
520E
520N
520U
Station

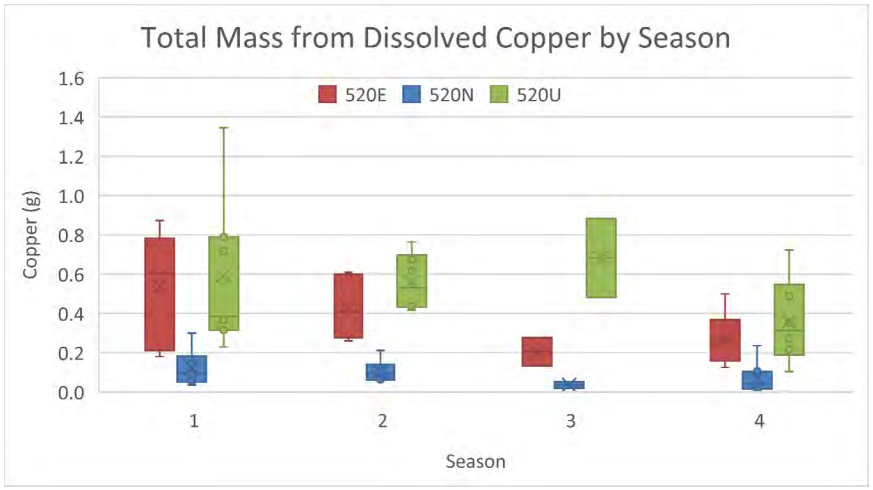

Runoff Volume per Acre by Station
Runoff Volume (cf)
4,000
3,500
3,000
2,500
2,000
1,500
1,000
500
0
520E
520N
520U
Station

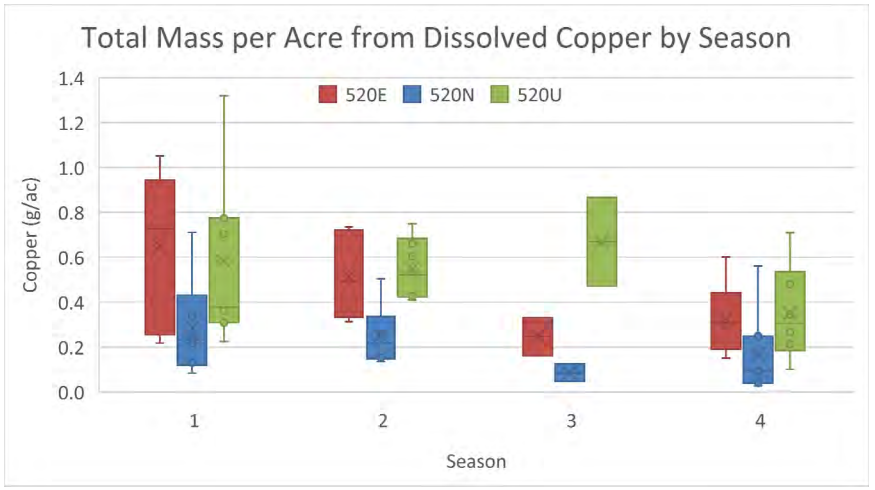

Runoff Volume by Season
520E
520N
520U
Runoff Volume (cf)
4000
3500
3000
2500
2000
1500
1000
500
0
1
2
3
4
Season

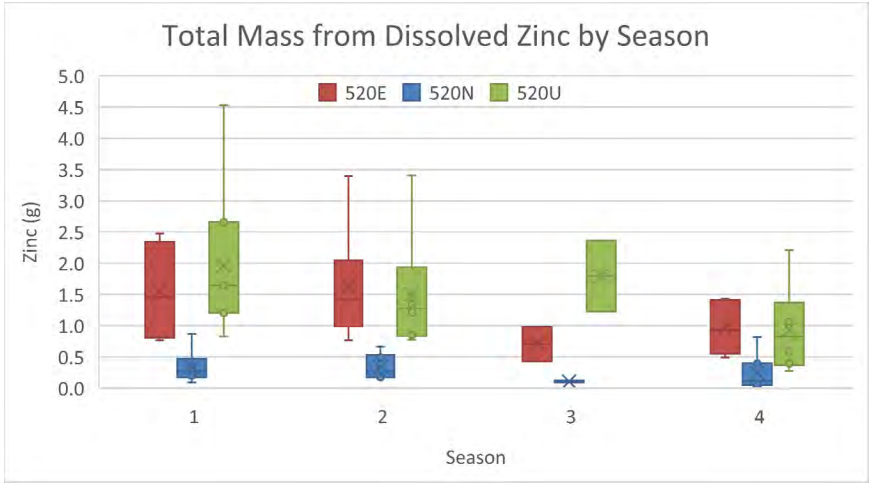

Dissolved Copper by Season
520E
520N
520U
Dissolved Copper (ug/L)
80
70
60
50
40
30
20
10
0
1
2
3
4
Season

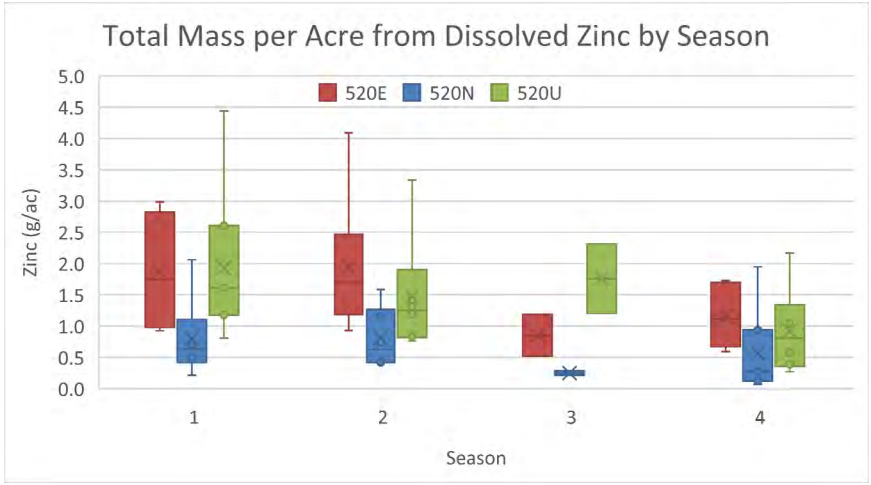

Runoff Intensity by Season
520E
520N
520U
Runoff Intensity (cf/hr)
350
300
250
200
150
100
50
0
1
2
3
4
Season

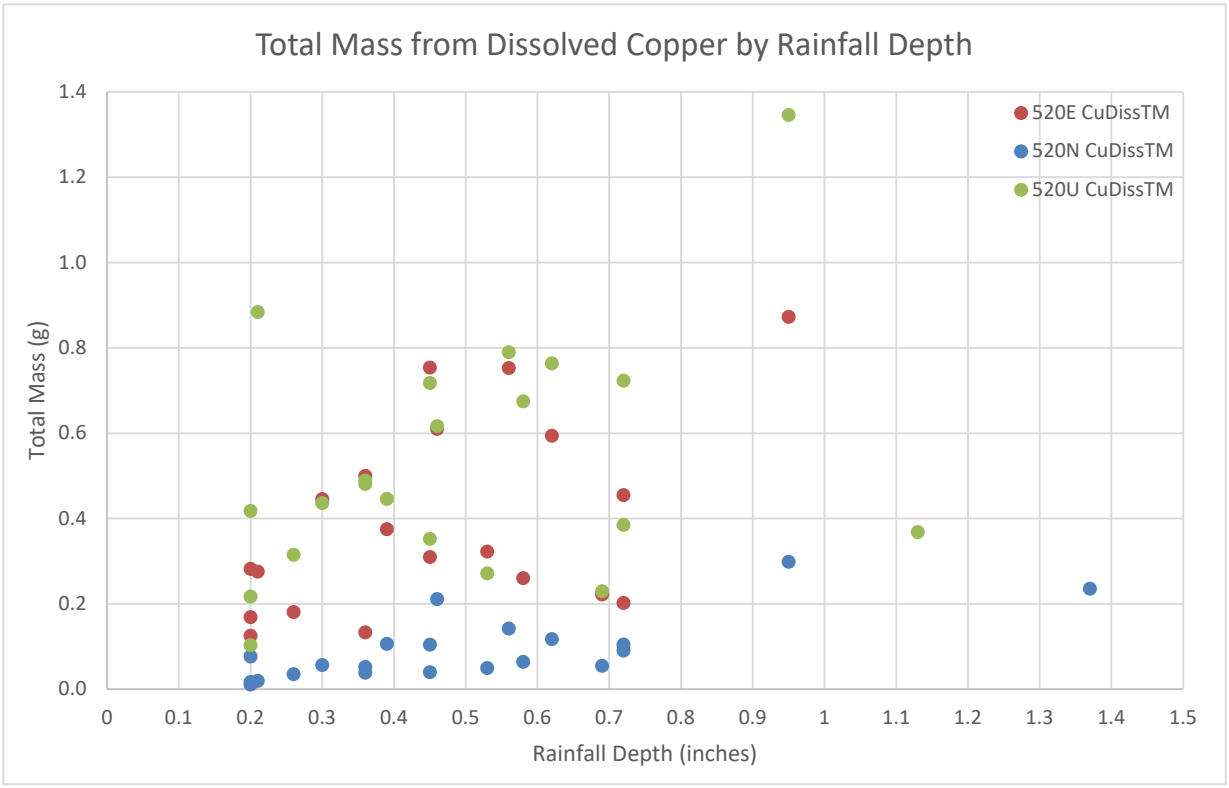

Dissolved Zinc by Season
520E
520N
520U
Dissolved Zinc (ug/L)
200
180
160
140
120
100
80
60
40
20
0
1
2
3
4
Season

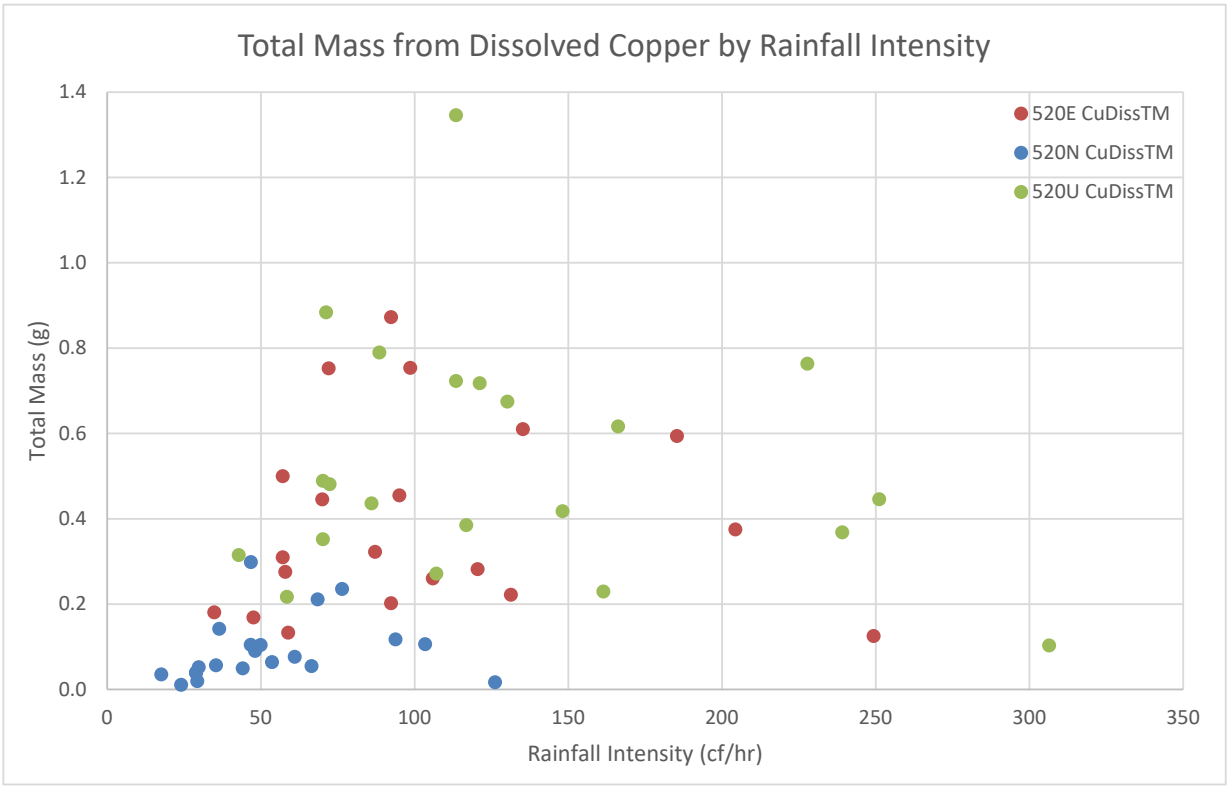

Total Mass from Dissolved Copper by Season
520E
520N
520U
Copper (g)
1.6
1.4
1.2
1.0
0.8
0.6
0.4
0.2
0.0
1
2
3
4
Season

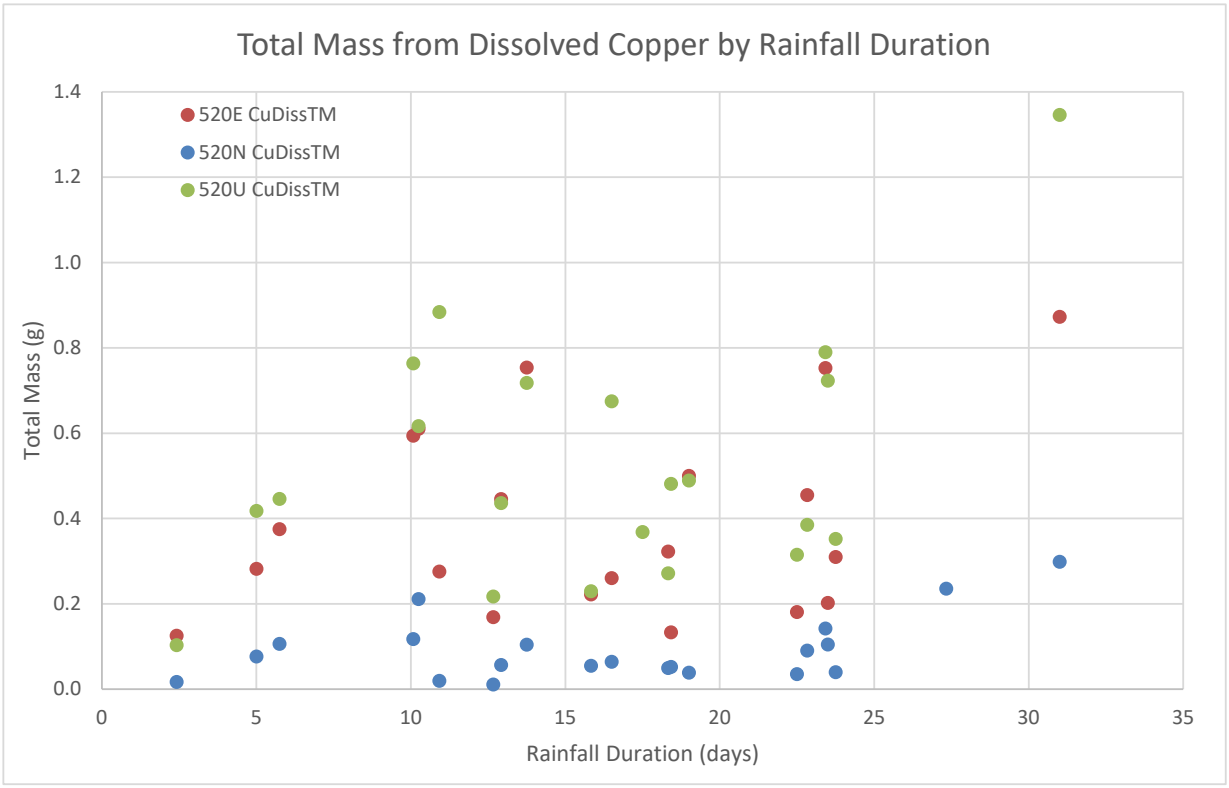

Total Mass per Acre from Dissolved Copper by Season
520E
520N
520U
Copper (g/ac)
1.4
1.2
1.0
0.8
0.6
0.4
0.2
0.0
1
2
3
4
Season

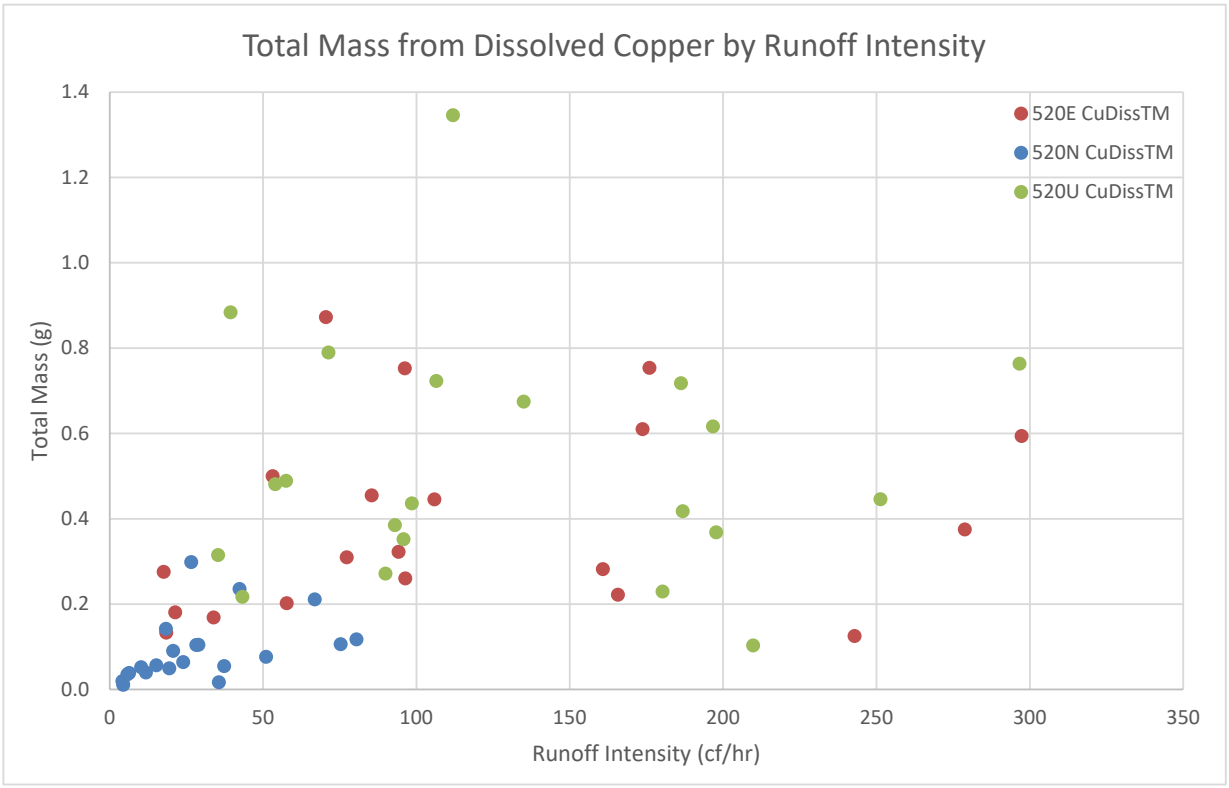

Total Mass from Dissolved Zinc by Season
520E
520N
520U
Zinc (g)
5.0
4.5
4.0
3.5
3.0
2.5
2.0
1.5
1.0
0.5
0.0
1
2
3
4
Season

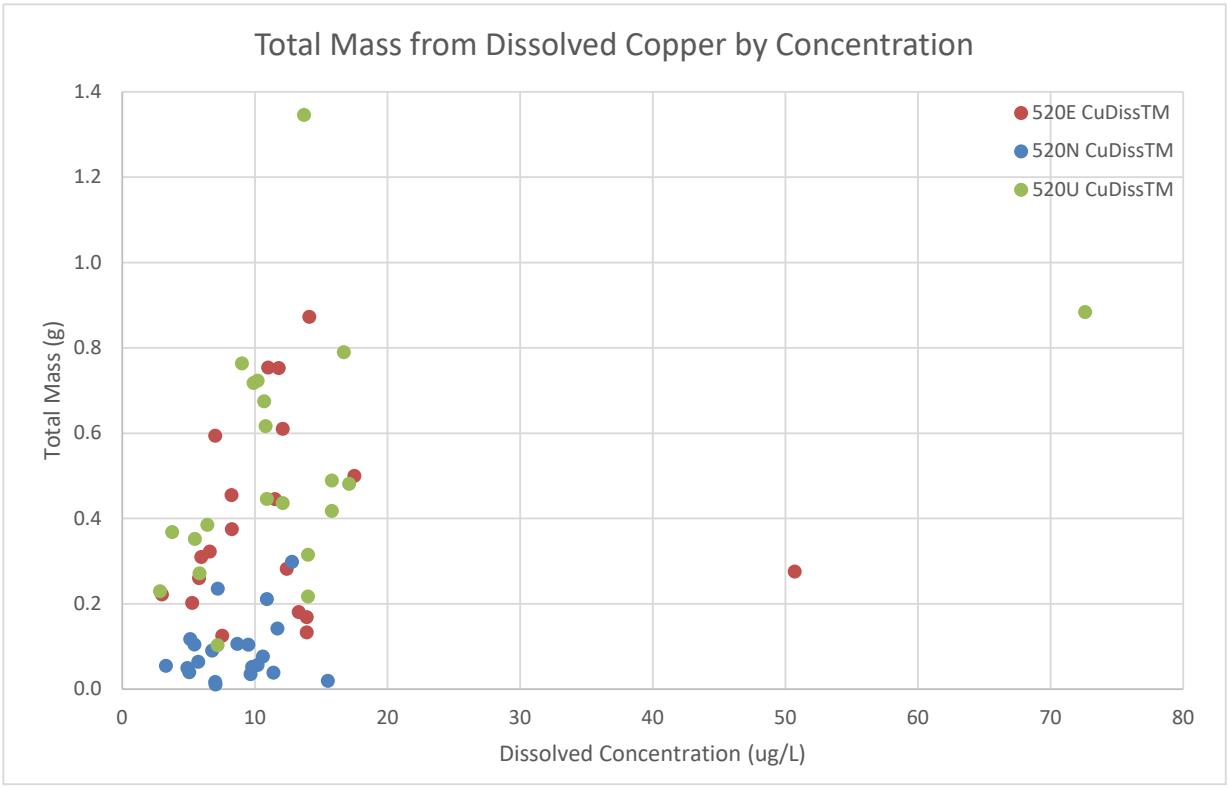

Total Mass per Acre from Dissolved Zinc by Season
520E
520N
520U
Zinc (g/ac)
5.0
4.5
4.0
3.5
3.0
2.5
2.0
1.5
1.0
0.5
0.0
1
2
3
4
Season

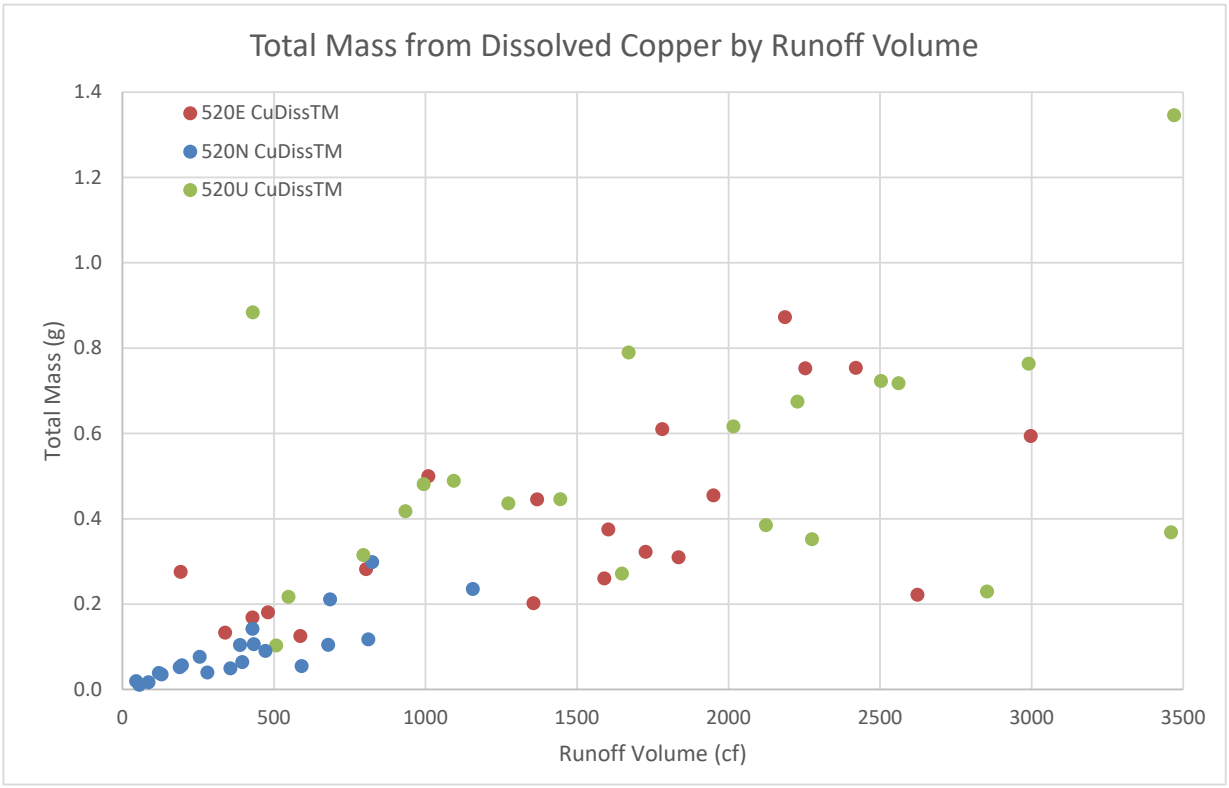

Total Mass from Dissolved Copper by Rainfall Depth
Total Mass (g)
Rainfall Depth (inches)
520E CuDissTM
520N CuDissTM
520U CuDissTM
0.0
0.2
0.4
0.6
0.8
1.0
1.2
1.4
0
0.1
0.2
0.3
0.4
0.5
0.6
0.7
0.8
0.9
1
1.1
1.2
1.3
1.4
1.5

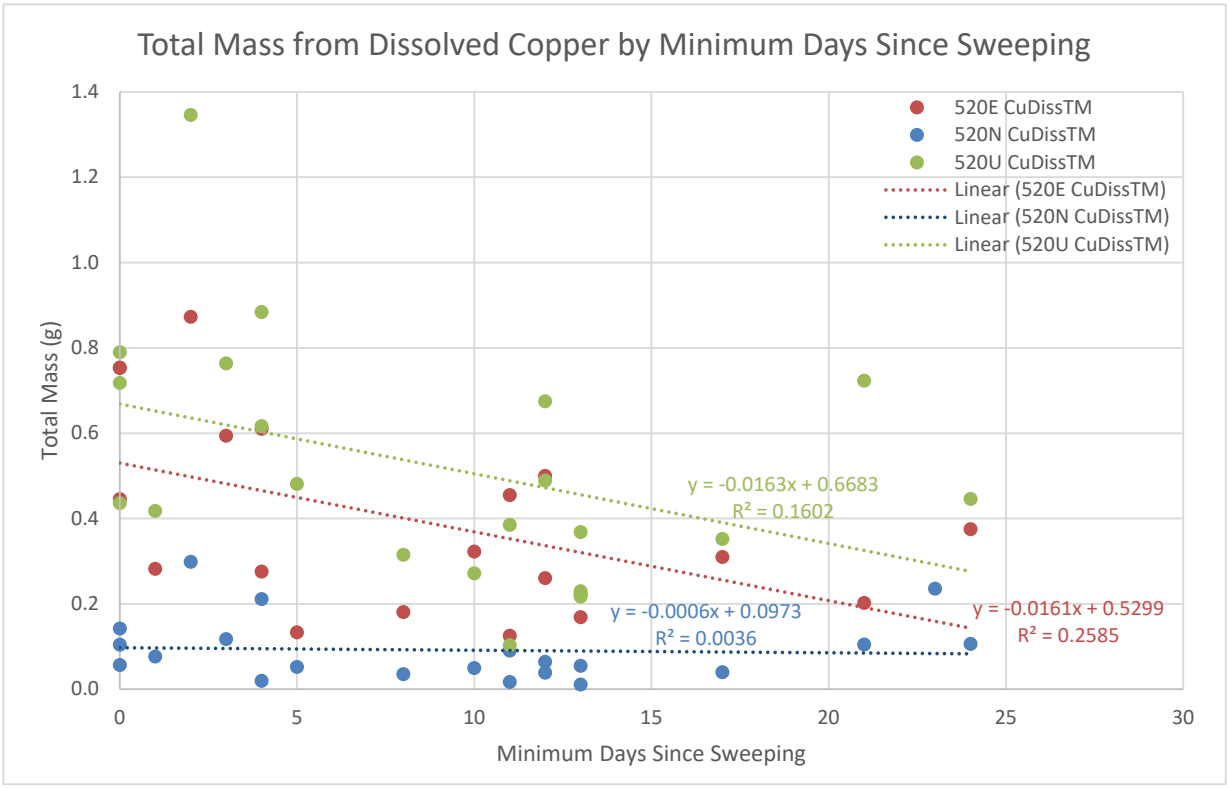

Total Mass from Dissolved Copper by Rainfall Intensity
Total Mass (g)
Rainfall Intensity (cf/hr)
520E CuDissTM
520N CuDissTM
520U CuDissTM
0.0
0.2
0.4
0.6
0.8
1.0
1.2
1.4
0
50
100
150
200
250
300
350

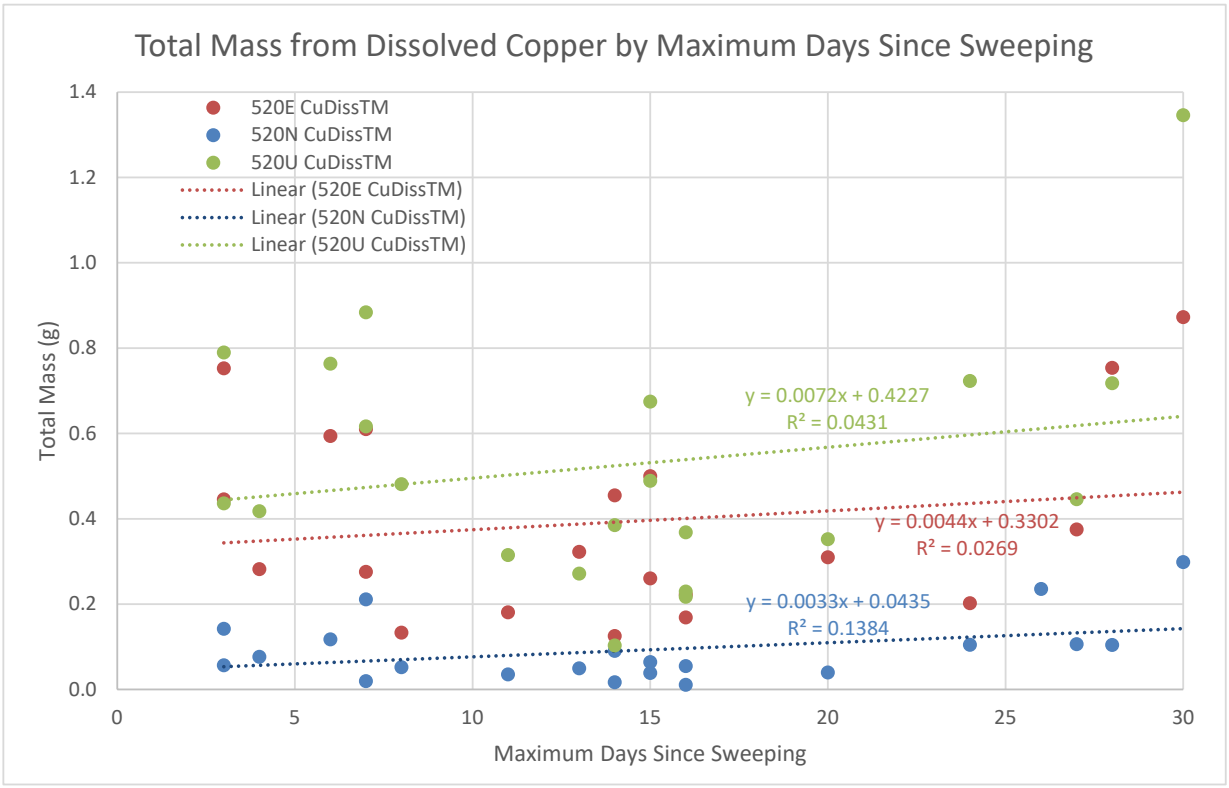

Total Mass from Dissolved Copper by Rainfall Duration
520E CuDissTM
520N CuDissTM
520U CuDissTM
Total Mass (g)
Rainfall Duration (days)
0.0
0.2
0.4
0.6
0.8
1.0
1.2
1.4
0
5
10
15
20
25
30
35

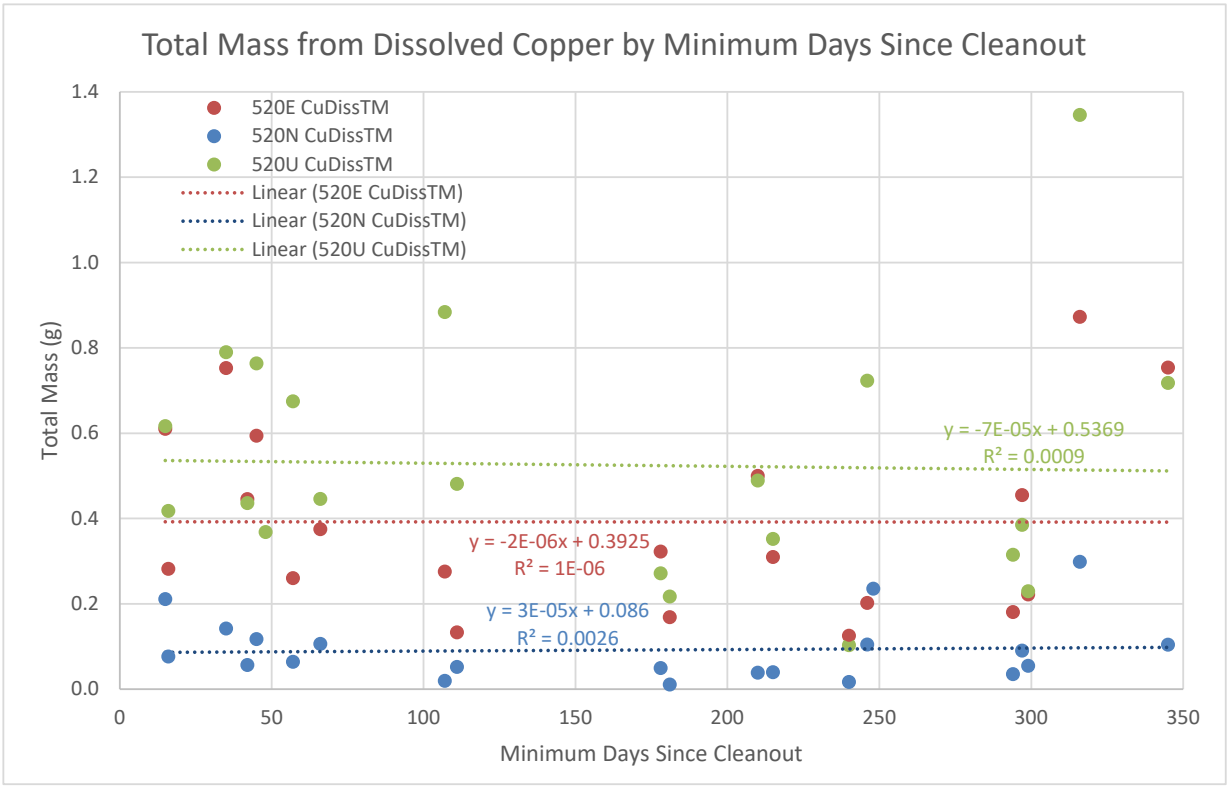

Total Mass from Dissolved Copper by Runoff Intensity
520E CuDissTM
520N CuDissTM
520U CuDissTM
Total Mass (g)
Runoff Intensity (cf/hr)
0.0
0.2
0.4
0.6
0.8
1.0
1.2
1.4
0
50
100
150
200
250
300
350

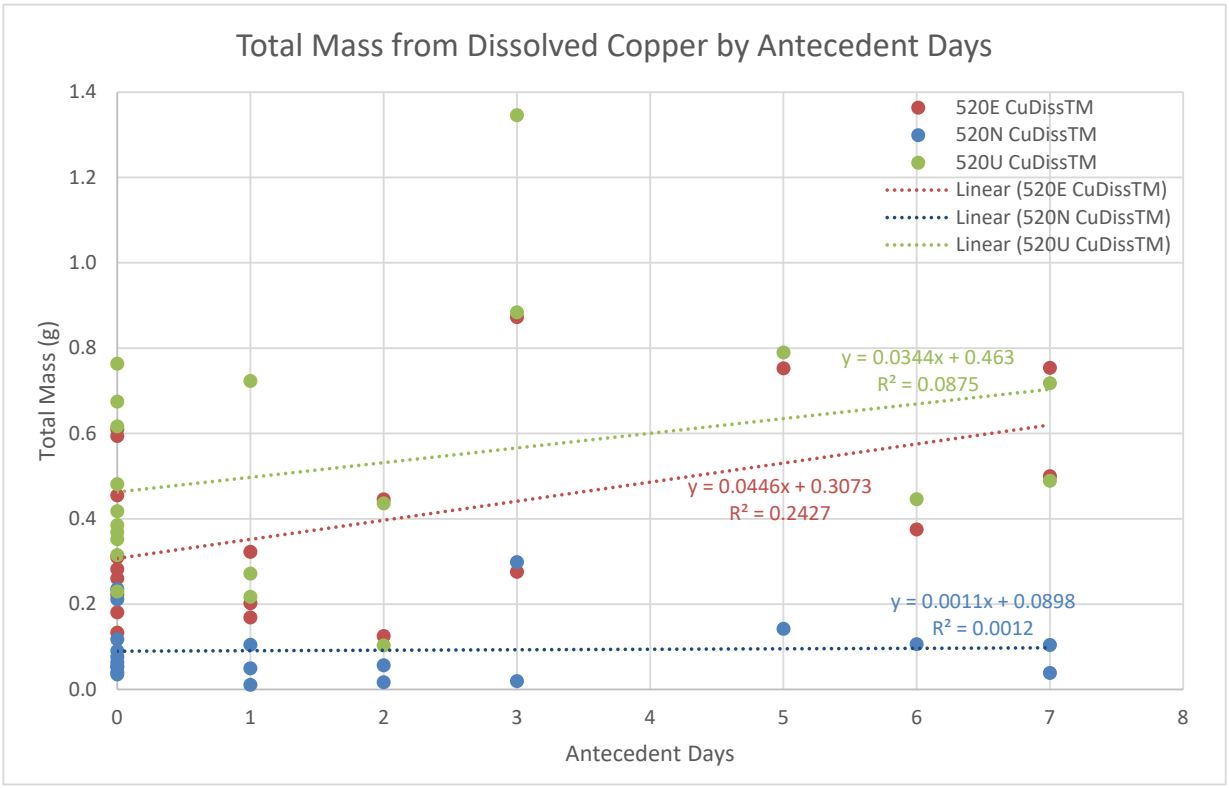

Total Mass from Dissolved Copper by Concentration
Total Mass (g)
Dissolved Concentration (ug/L)
520E CuDissTM
520N CuDissTM
520U CuDissTM
0.0
0.2
0.4
0.6
0.8
1.0
1.2
1.4
0
10
20
30
40
50
60
70
80

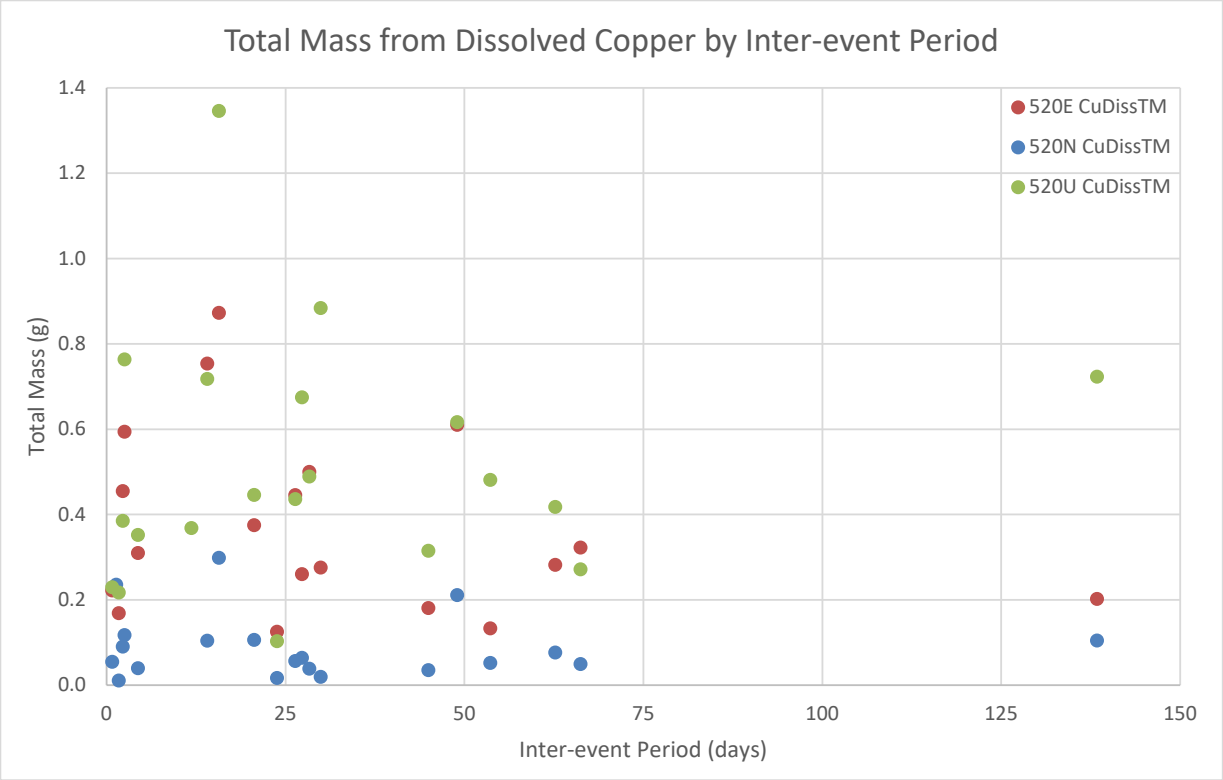

Total Mass from Dissolved Copper by Runoff Volume
Total Mass (g)
Runoff Volume (cf)
520E CuDissTM
520N CuDissTM
520U CuDissTM
0.0
0.2
0.4
0.6
0.8
1.0
1.2
1.4
0
500
1000
1500
2000
2500
3000
3500

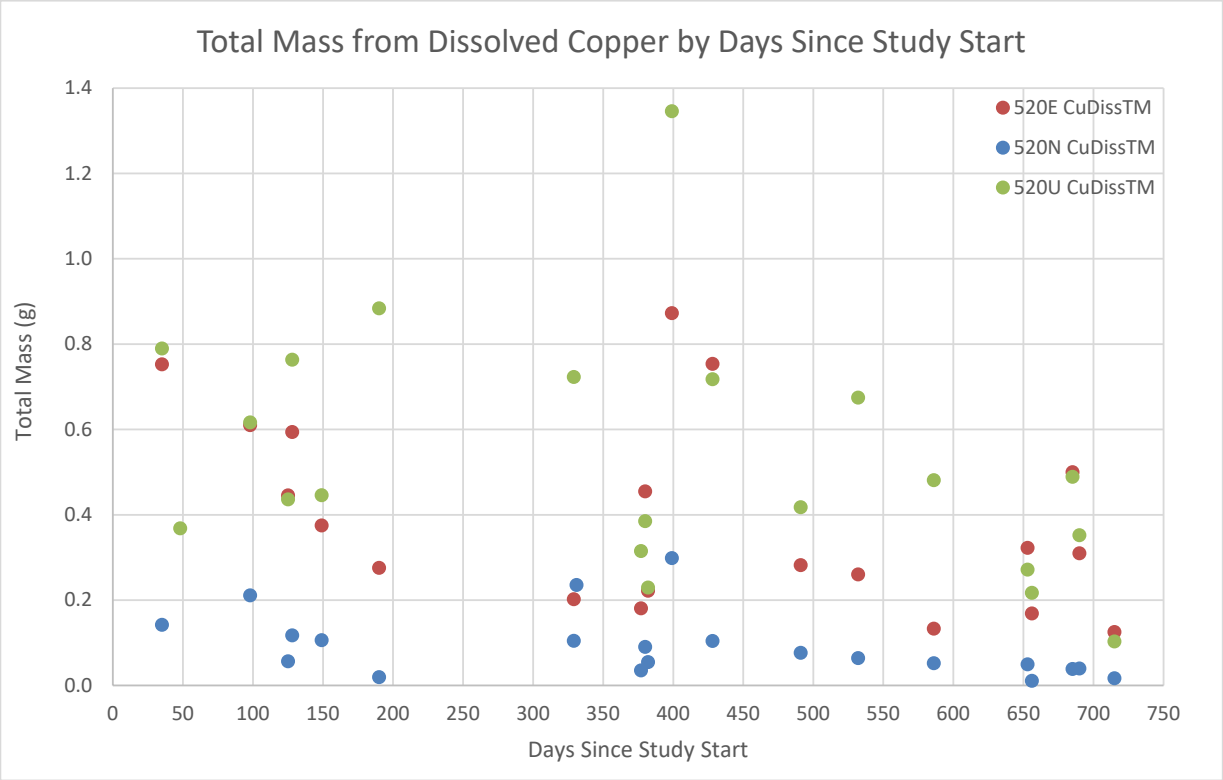

Total Mass from Dissolved Copper by Minimum Days Since Sweeping
Total Mass (g)
Minimum Days Since Sweeping
520E CuDissTM
520N CuDissTM
520U CuDissTM
Linear (520E CuDissTM)
Linear (520N CuDissTM)
Linear (520U CuDissTM)
y = -0.0163x + 0.6683
R² = 0.1602
y = -0.0006x + 0.0973
R² = 0.0036
y = -0.0161x + 0.5299
R² = 0.2585

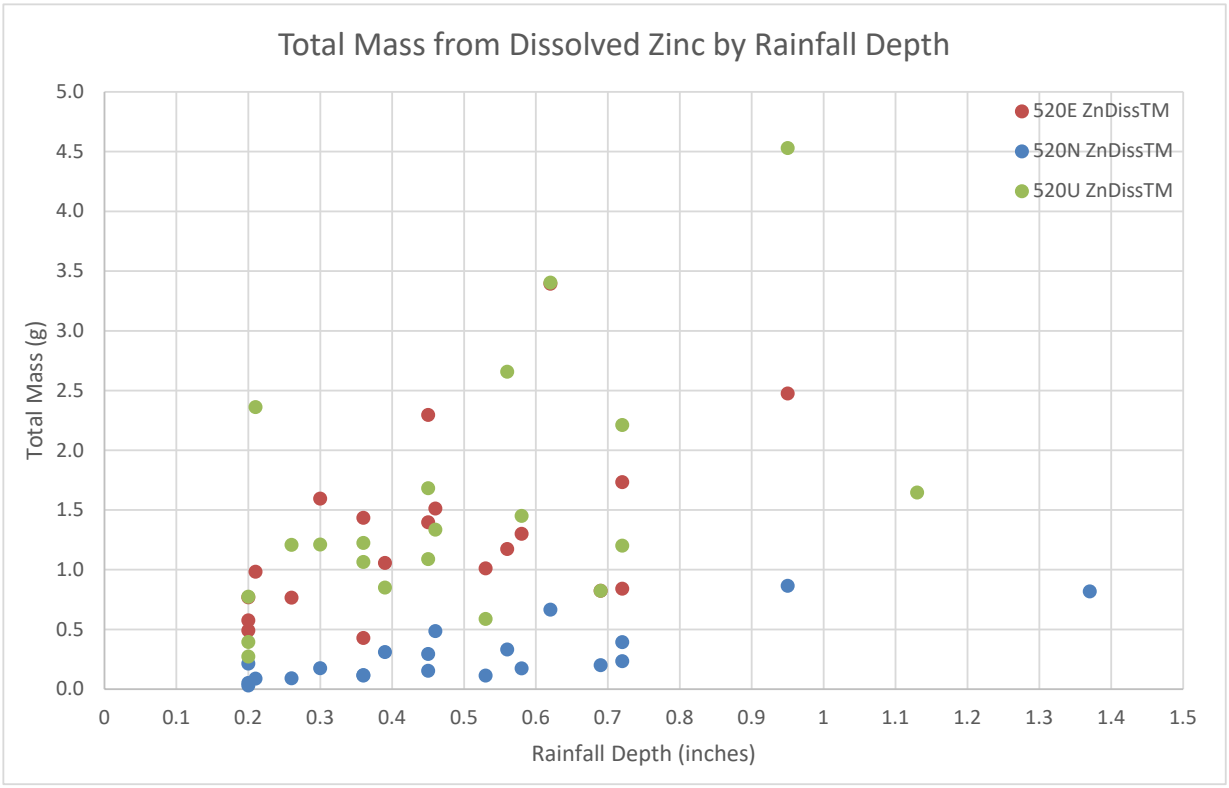

Total Mass from Dissolved Copper by Maximum Days Since Sweeping
Total Mass (g)
Maximum Days Since Sweeping
520E CuDissTM
520N CuDissTM
520U CuDissTM
Linear (520E CuDissTM)
Linear (520N CuDissTM)
Linear (520U CuDissTM)
y = 0.0072x + 0.4227
R² = 0.0431
y = 0.0044x + 0.3302
R² = 0.0269
y = 0.0033x + 0.0435
R² = 0.1384

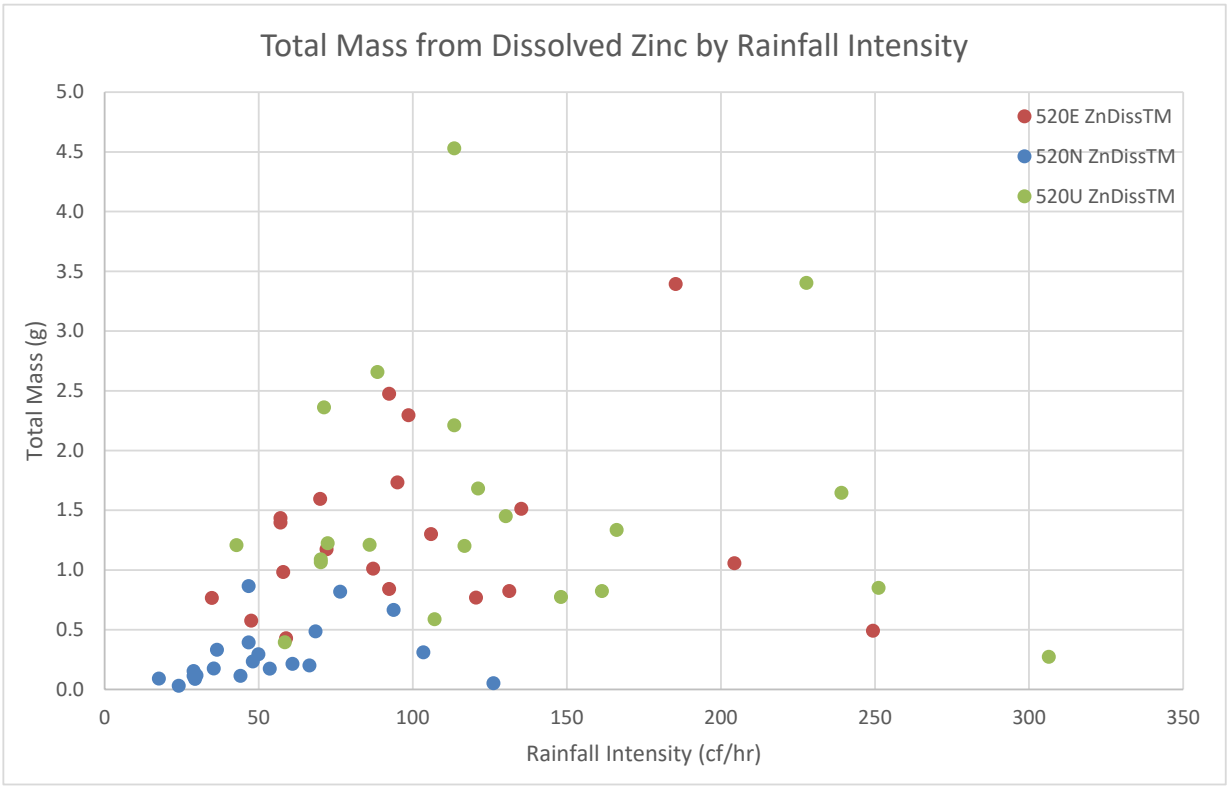

Total Mass from Dissolved Copper by Minimum Days Since Cleanout
520E CuDissTM
520N CuDissTM
520U CuDissTM
Linear (520E CuDissTM)
Linear (520N CuDissTM)
Linear (520U CuDissTM)
y = -7E-05x + 0.5369
R² = 0.0009
y = -2E-06x + 0.3925
R² = 1E-06
y = 3E-05x + 0.086
R² = 0.0026
Total Mass (g)
Minimum Days Since Cleanout
0.0
0.2
0.4
0.6
0.8
1.0
1.2
1.4
0
50
100
150
200
250
300
350

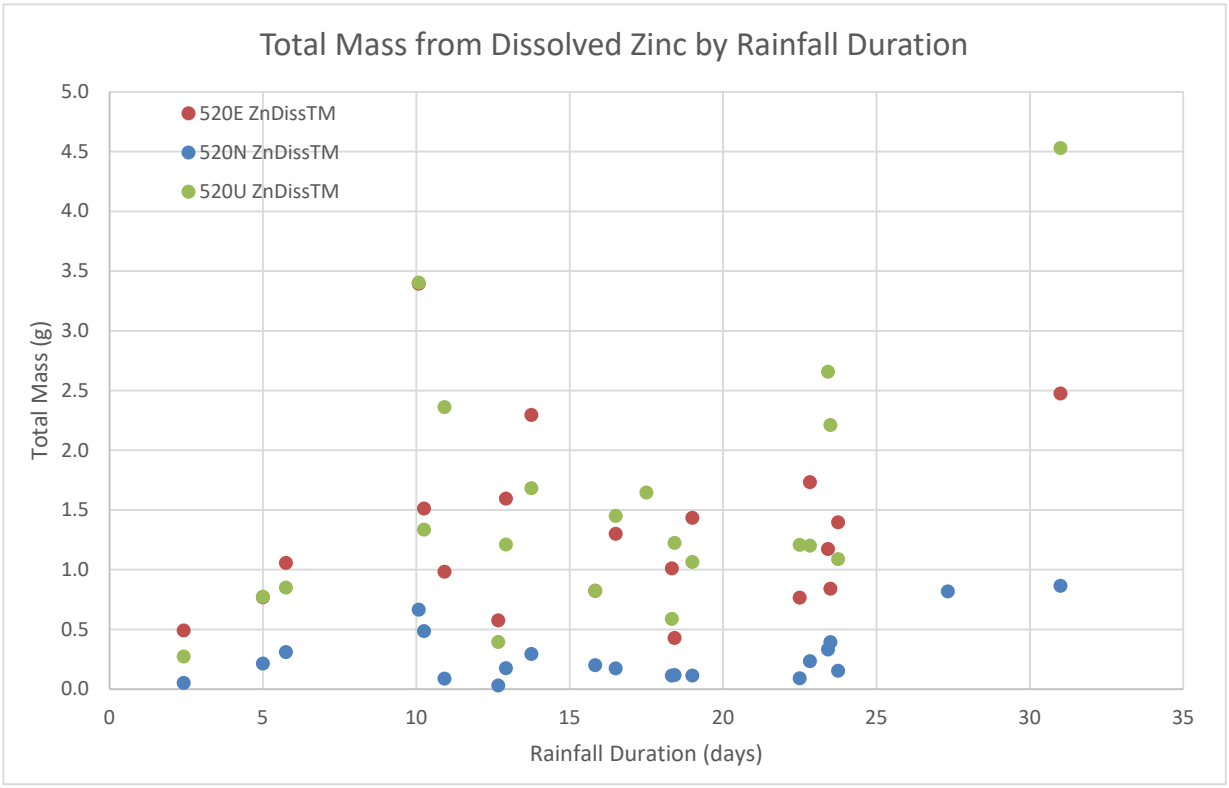

Total Mass from Dissolved Copper by Antecedent Days
520E CuDissTM
520N CuDissTM
520U CuDissTM
Linear (520E CuDissTM)
Linear (520N CuDissTM)
Linear (520U CuDissTM)
y = 0.0344x + 0.463
R² = 0.0875
y = 0.0446x + 0.3073
R² = 0.2427
y = 0.0011x + 0.0898
R² = 0.0012
Total Mass (g)
Antecedent Days
0.0
0.2
0.4
0.6
0.8
1.0
1.2
1.4
0
1
2
3
4
5
6
7
8

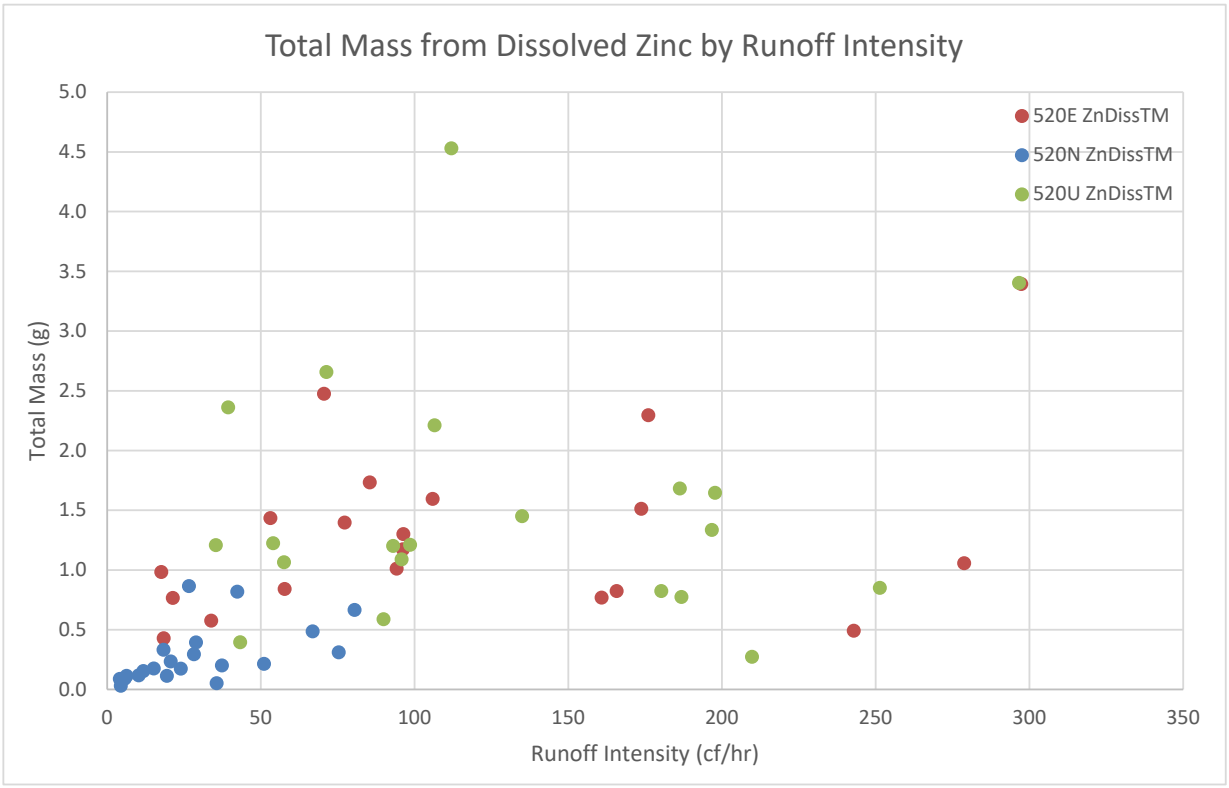

Total Mass from Dissolved Copper by Inter-event Period
Total Mass (g)
Inter-event Period (days)
520E CuDissTM
520N CuDissTM
520U CuDissTM
0.0
0.2
0.4
0.6
0.8
1.0
1.2
1.4
0
25
50
75
100
125
150

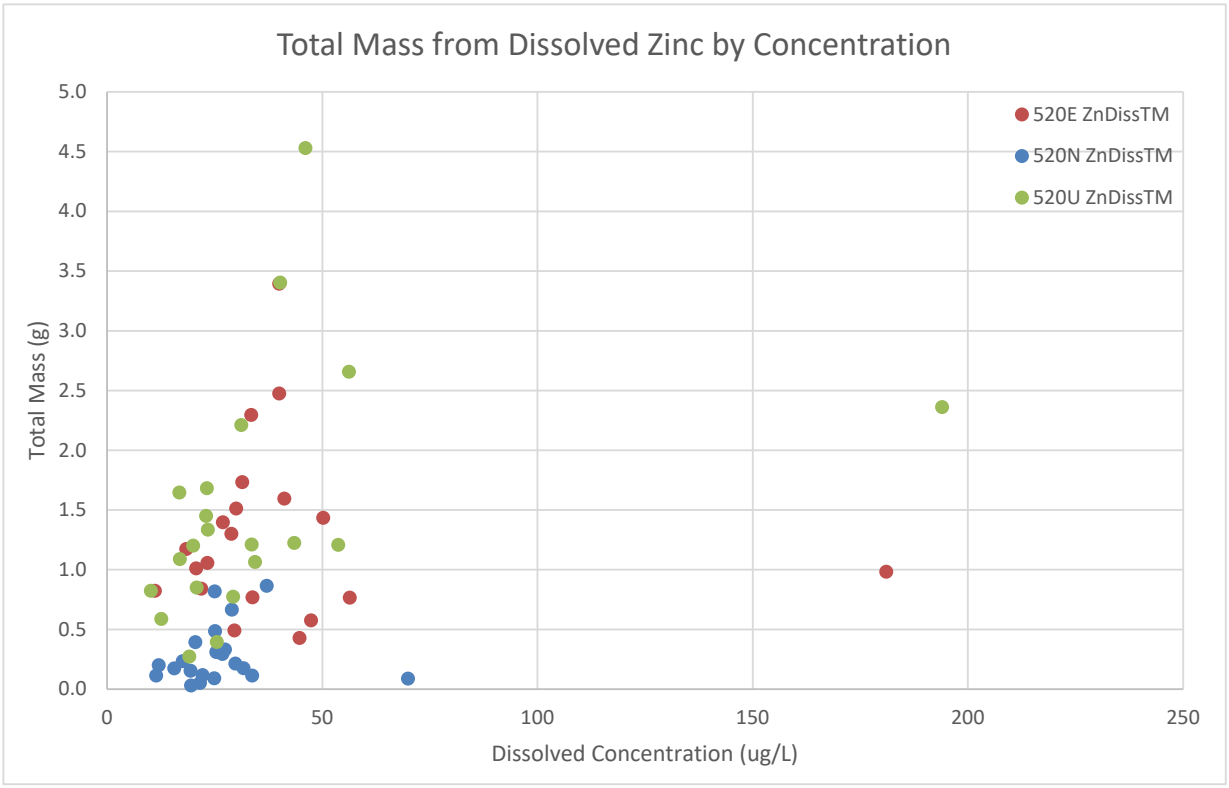

Total Mass from Dissolved Copper by Days Since Study Start
Total Mass (g)
Days Since Study Start
520E CuDissTM
520N CuDissTM
520U CuDissTM
0.0
0.2
0.4
0.6
0.8
1.0
1.2
1.4
0
50
100
150
200
250
300
350
400
450
500
550
600
650
700
750

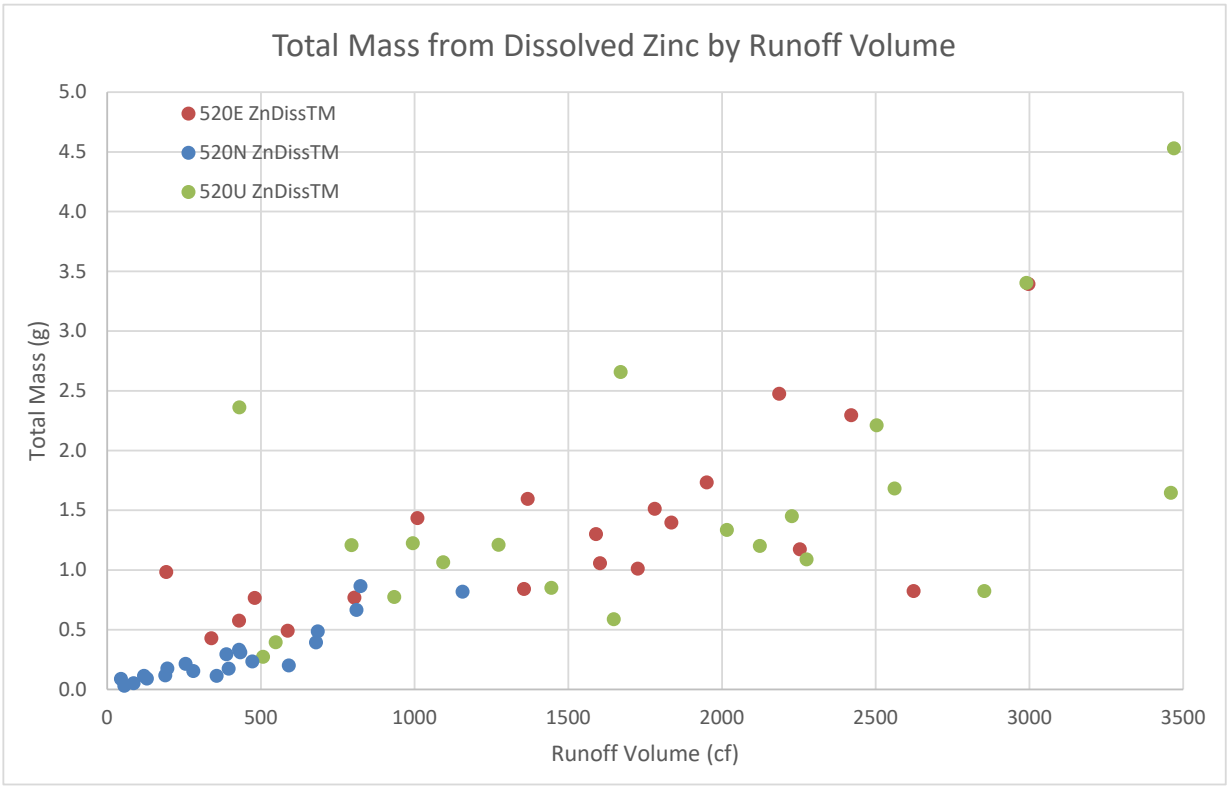

Total Mass from Dissolved Zinc by Rainfall Depth
Total Mass (g)
Rainfall Depth (inches)
520E ZnDissTM
520N ZnDissTM
520U ZnDissTM
0.0
0.5
1.0
1.5
2.0
2.5
3.0
3.5
4.0
4.5
5.0
0
0.1
0.2
0.3
0.4
0.5
0.6
0.7
0.8
0.9
1
1.1
1.2
1.3
1.4
1.5

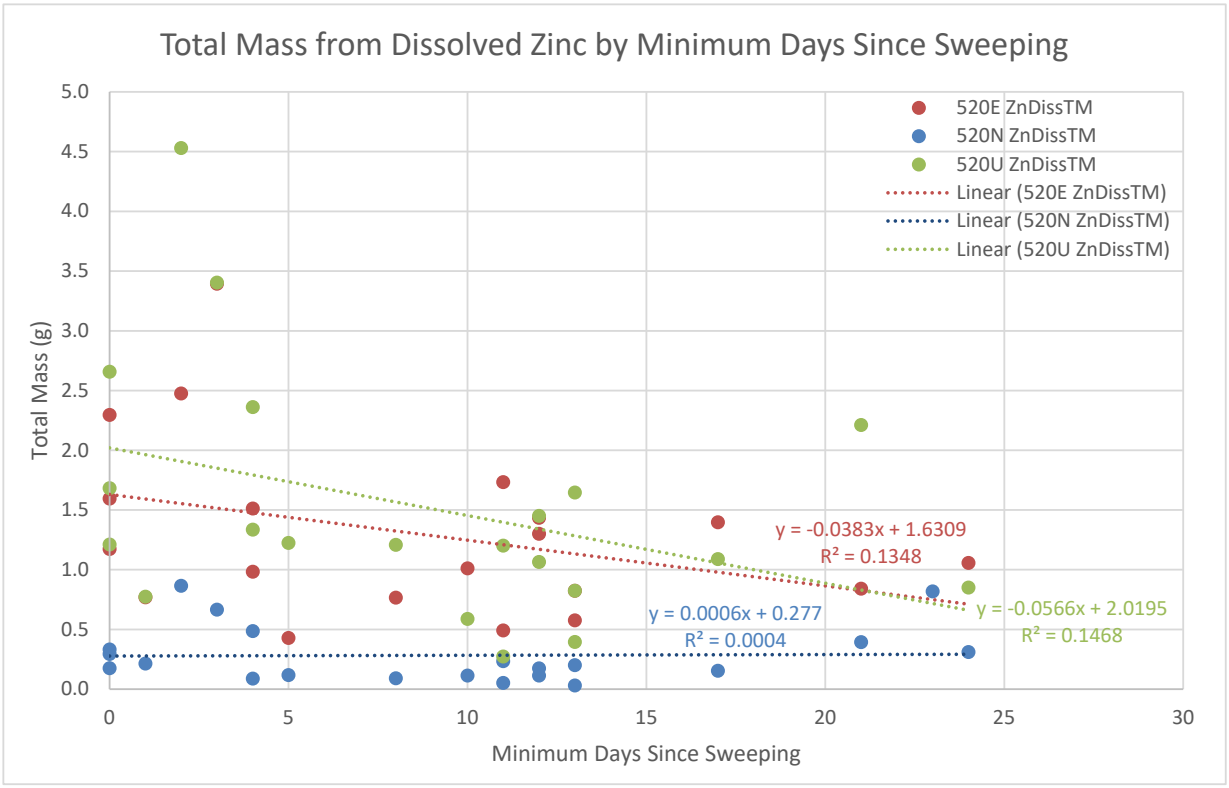

Total Mass from Dissolved Zinc by Rainfall Intensity
Total Mass (g)
Rainfall Intensity (cf/hr)
520E ZnDissTM
520N ZnDissTM
520U ZnDissTM
0.0
0.5
1.0
1.5
2.0
2.5
3.0
3.5
4.0
4.5
5.0
0
50
100
150
200
250
300
350

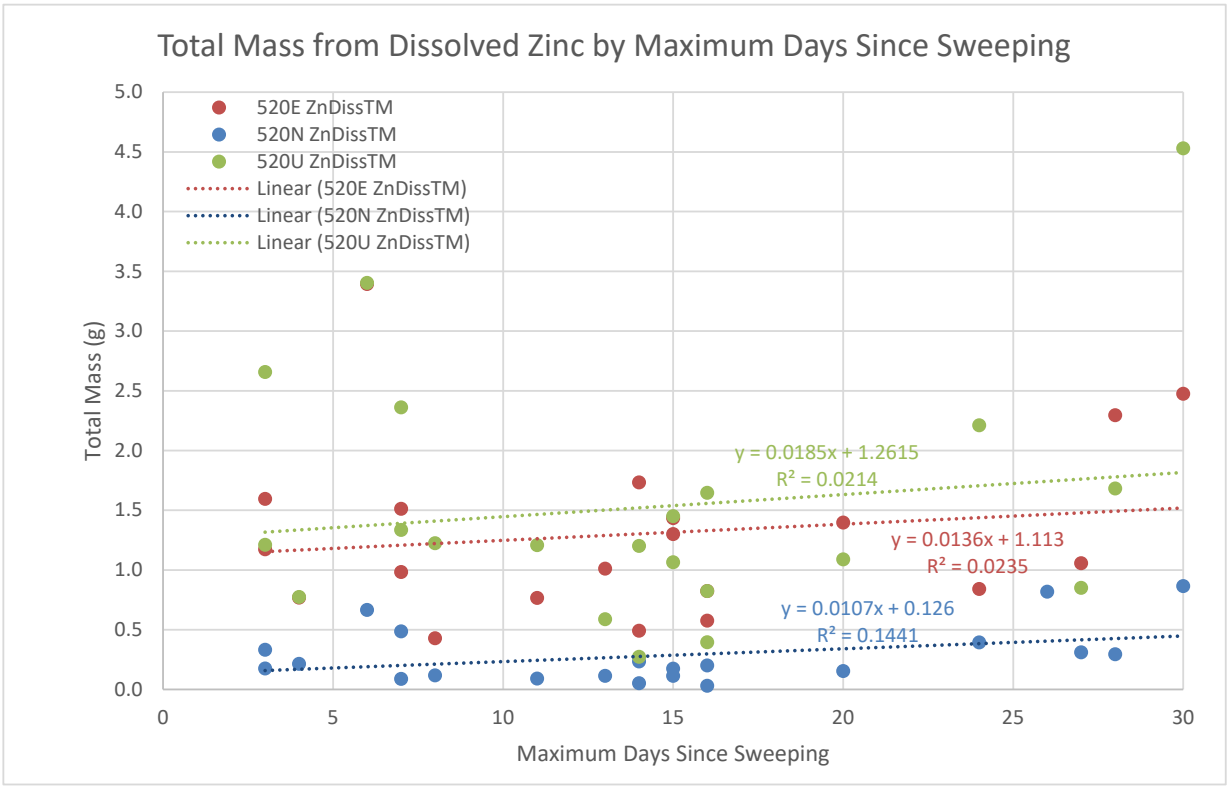

Total Mass from Dissolved Zinc by Rainfall Duration
520E ZnDissTM
520N ZnDissTM
520U ZnDissTM
Total Mass (g)
Rainfall Duration (days)
0.0
0.5
1.0
1.5
2.0
2.5
3.0
3.5
4.0
4.5
5.0
0
5
10
15
20
25
30
35

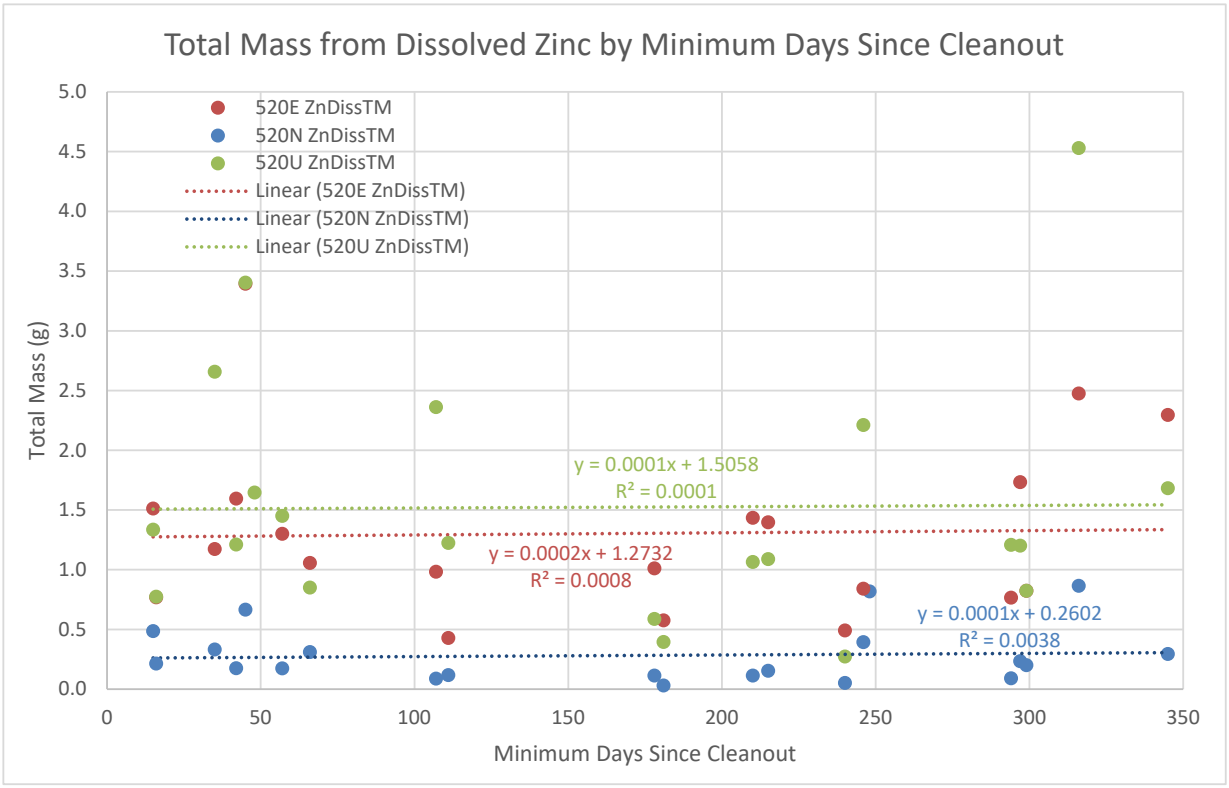

Total Mass from Dissolved Zinc by Runoff Intensity
520E ZnDissTM
520N ZnDissTM
520U ZnDissTM
Total Mass (g)
Runoff Intensity (cf/hr)
0.0
0.5
1.0
1.5
2.0
2.5
3.0
3.5
4.0
4.5
5.0
0
50
100
150
200
250
300
350

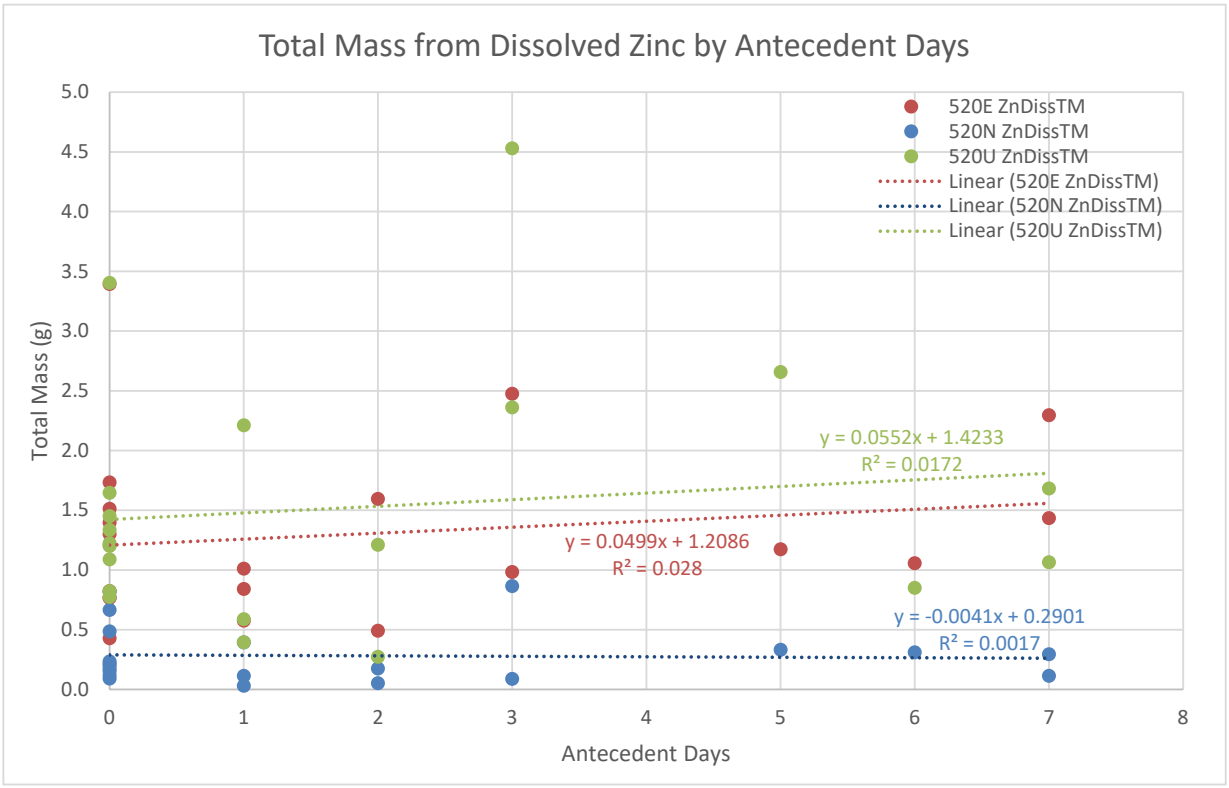

Total Mass from Dissolved Zinc by Concentration
Total Mass (g)
Dissolved Concentration (ug/L)
520E ZnDissTM
520N ZnDissTM
520U ZnDissTM
0.0
0.5
1.0
1.5
2.0
2.5
3.0
3.5
4.0
4.5
5.0
0
50
100
150
200
250

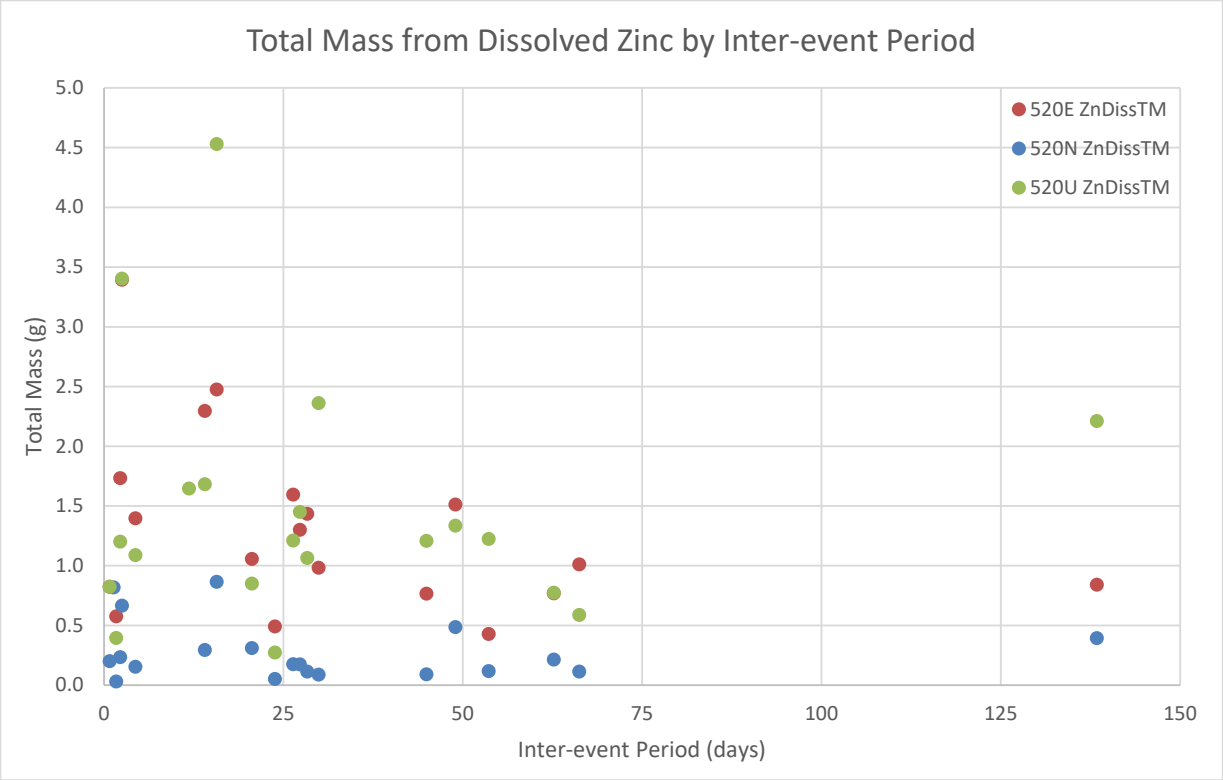

Total Mass from Dissolved Zinc by Runoff Volume
Total Mass (g)
Runoff Volume (cf)
520E ZnDissTM
520N ZnDissTM
520U ZnDissTM
0.0
0.5
1.0
1.5
2.0
2.5
3.0
3.5
4.0
4.5
5.0
0
500
1000
1500
2000
2500
3000
3500

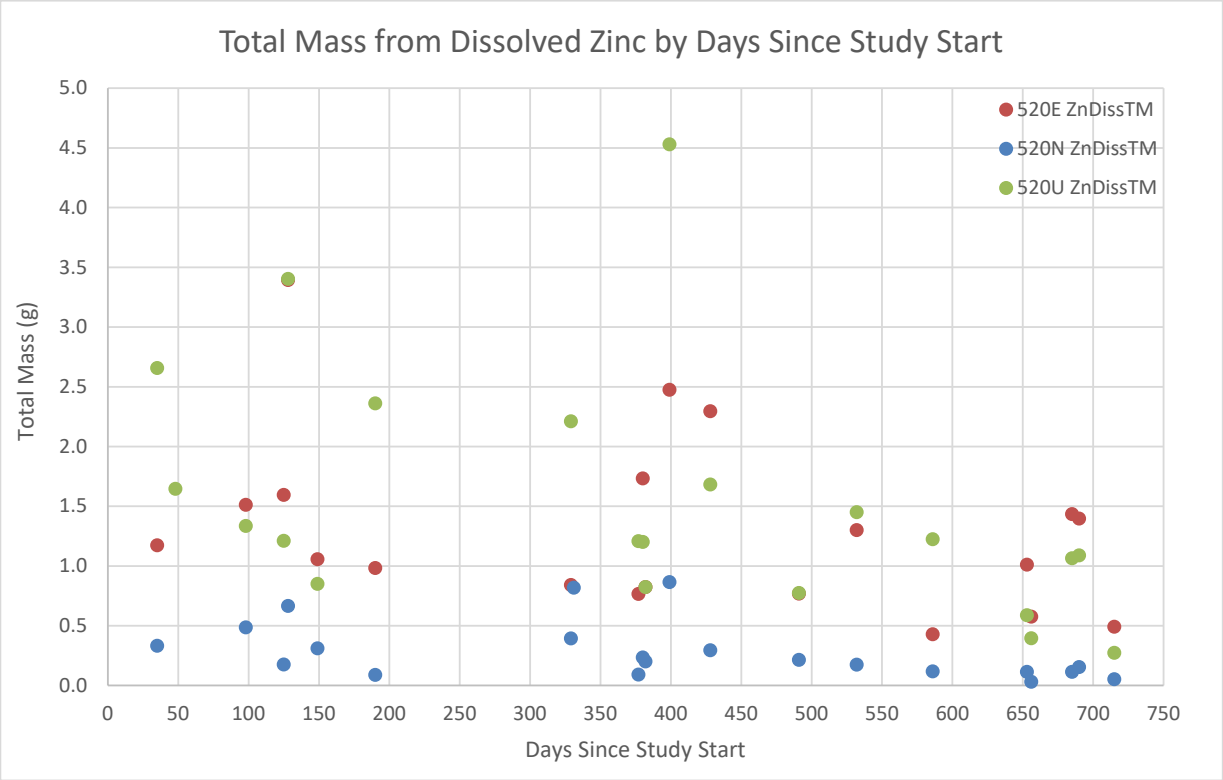

Total Mass from Dissolved Zinc by Minimum Days Since Sweeping
Total Mass (g)
Minimum Days Since Sweeping
520E ZnDissTM
520N ZnDissTM
520U ZnDissTM
Linear (520E ZnDissTM)
Linear (520N ZnDissTM)
Linear (520U ZnDissTM)
y = -0.0383x + 1.6309
R² = 0.1348
y = 0.0006x + 0.277
R² = 0.0004
y = -0.0566x + 2.0195
R² = 0.1468

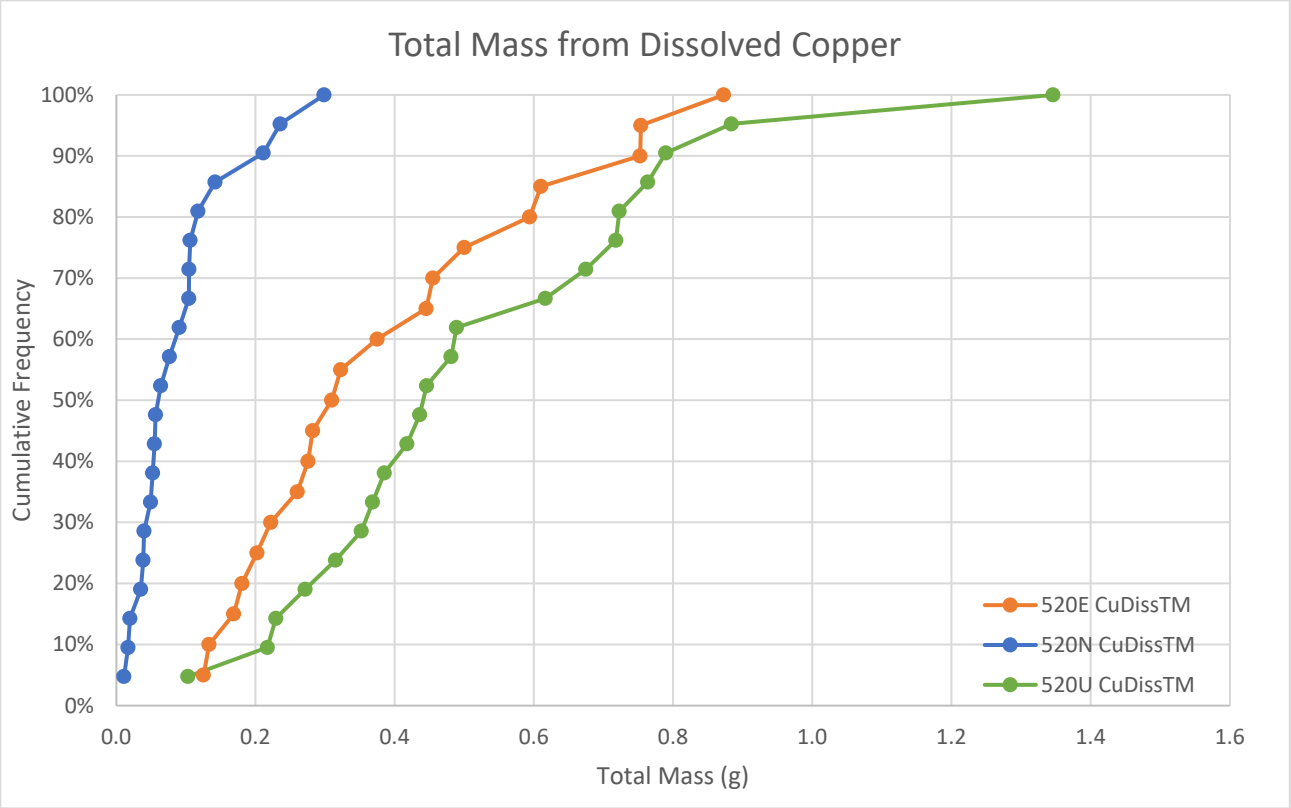

Total Mass from Dissolved Zinc by Maximum Days Since Sweeping
Total Mass (g)
Maximum Days Since Sweeping
520E ZnDissTM
520N ZnDissTM
520U ZnDissTM
Linear (520E ZnDissTM)
Linear (520N ZnDissTM)
Linear (520U ZnDissTM)
y = 0.0185x + 1.2615
R² = 0.0214
y = 0.0136x + 1.113
R² = 0.0235
y = 0.0107x + 0.126
R² = 0.1441

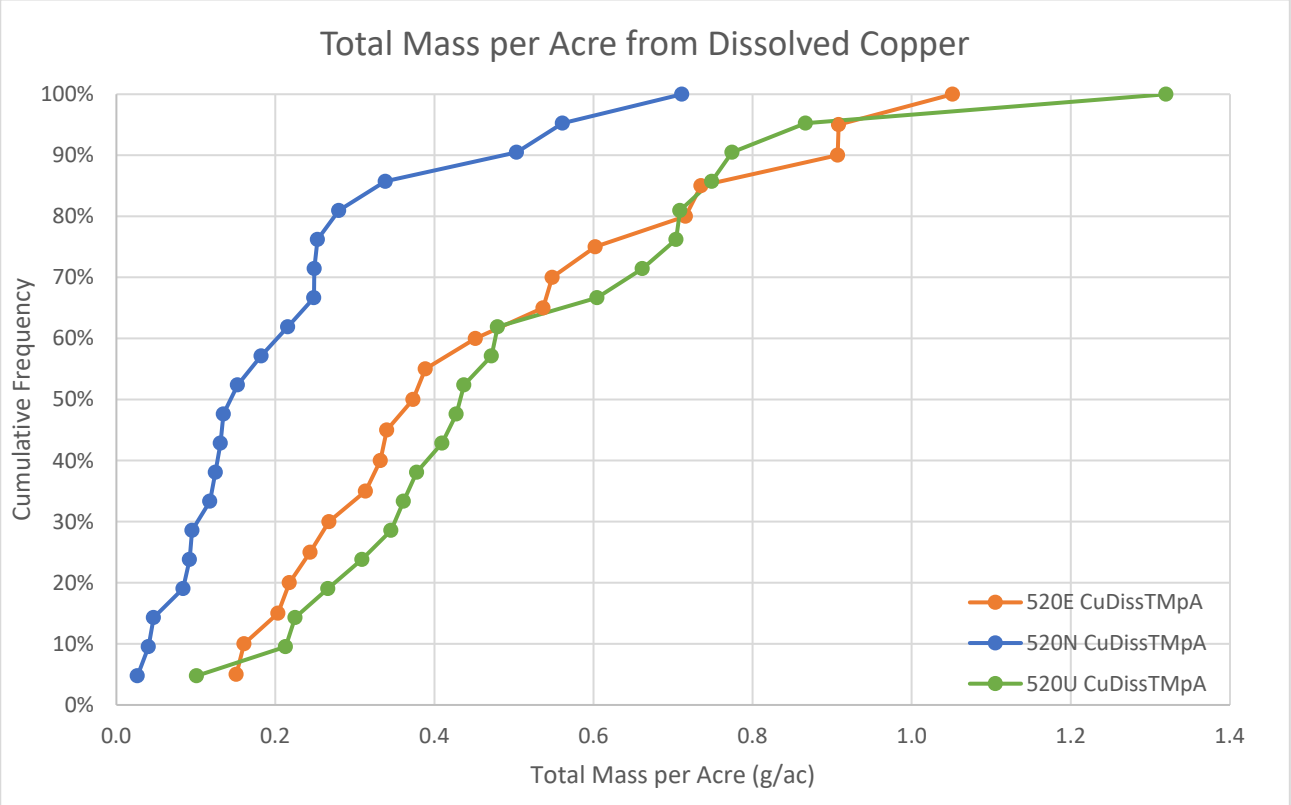

Total Mass from Dissolved Zinc by Minimum Days Since Cleanout
520E ZnDissTM
520N ZnDissTM
520U ZnDissTM
Linear (520E ZnDissTM)
Linear (520N ZnDissTM)
Linear (520U ZnDissTM)
y = 0.0001x + 1.5058
R² = 0.0001
y = 0.0002x + 1.2732
R² = 0.0008
y = 0.0001x + 0.2602
R² = 0.0038
Total Mass (g)
Minimum Days Since Cleanout
0.0
0.5
1.0
1.5
2.0
2.5
3.0
3.5
4.0
4.5
5.0
0
50
100
150
200
250
300
350

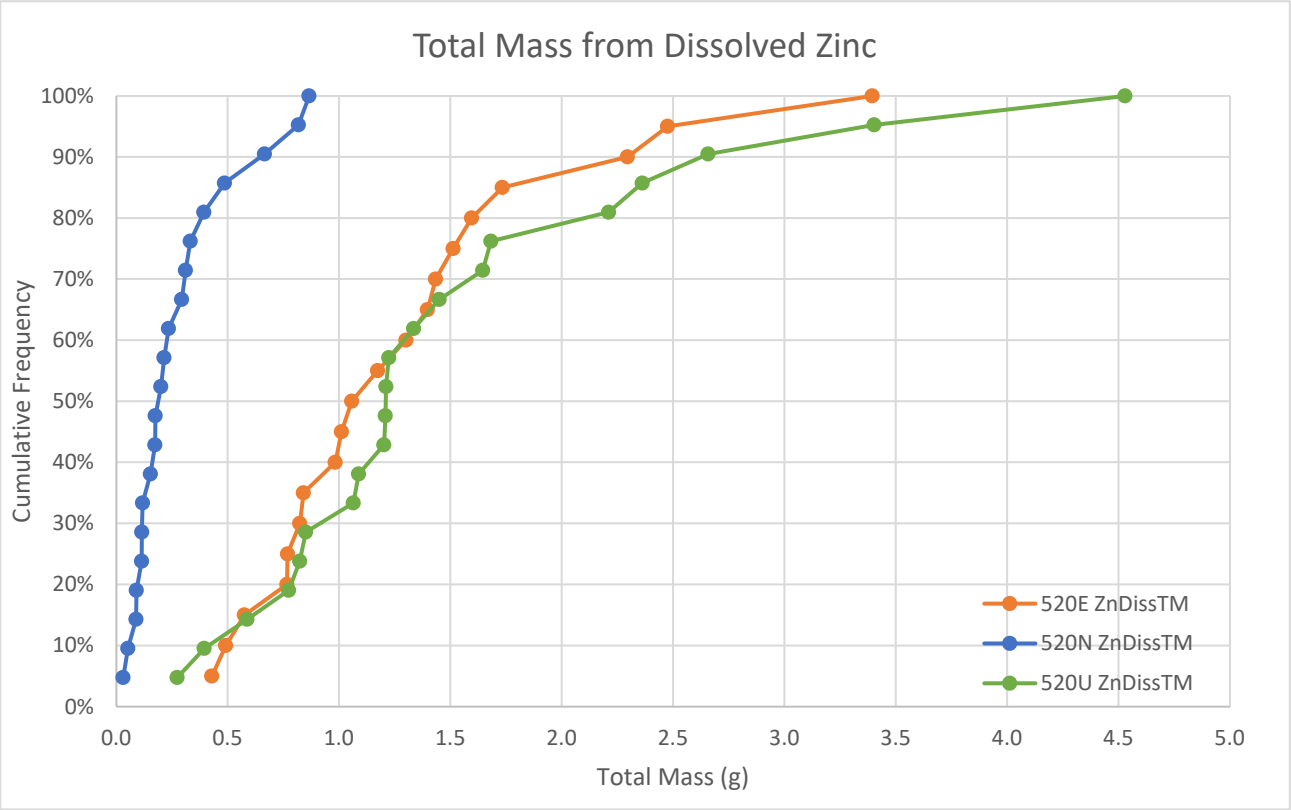

Total Mass from Dissolved Zinc by Antecedent Days
520E ZnDissTM
520N ZnDissTM
520U ZnDissTM
Linear (520E ZnDissTM)
Linear (520N ZnDissTM)
Linear (520U ZnDissTM)
y = 0.0552x + 1.4233
R² = 0.0172
y = 0.0499x + 1.2086
R² = 0.028
y = -0.0041x + 0.2901
R² = 0.0017
Total Mass (g)
Antecedent Days
0.0
0.5
1.0
1.5
2.0
2.5
3.0
3.5
4.0
4.5
5.0
0
1
2
3
4
5
6
7
8

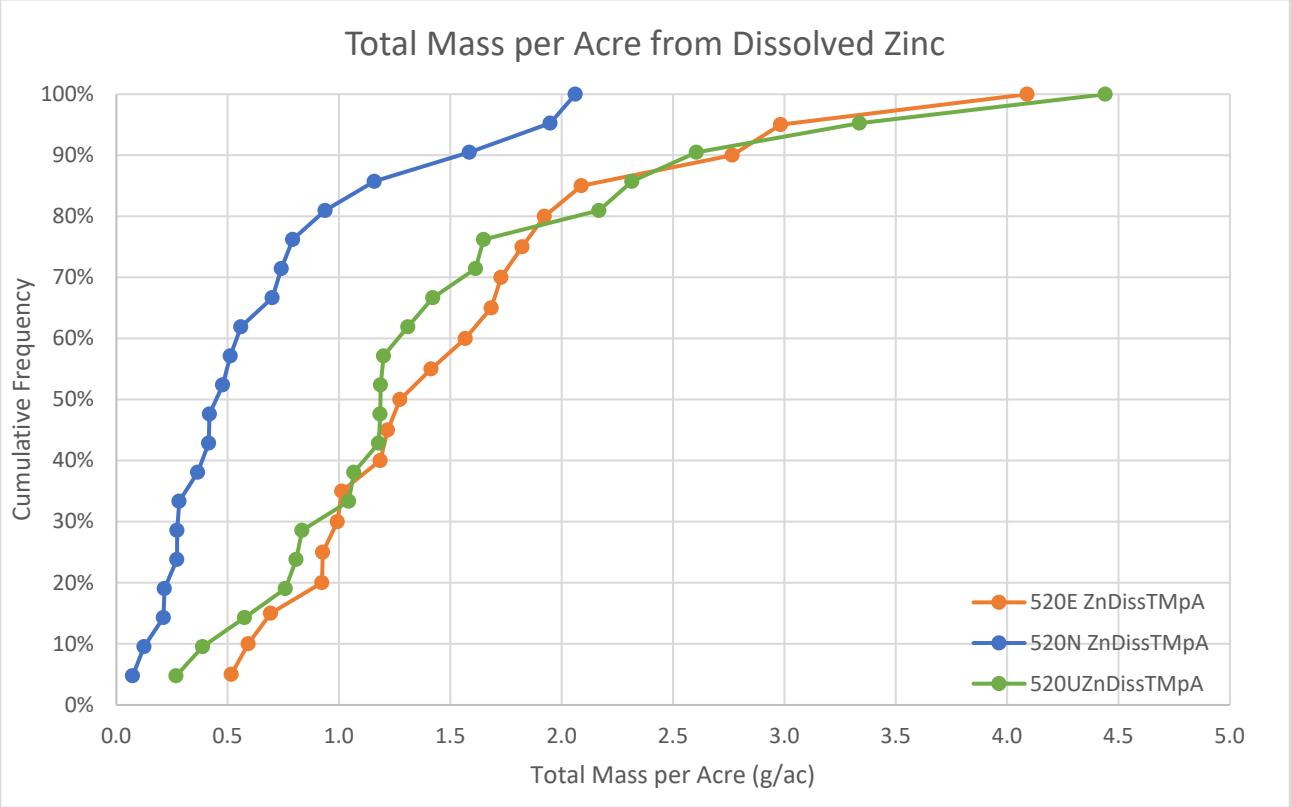

Total Mass from Dissolved Zinc by Inter-event Period
Total Mass (g)
Inter-event Period (days)
520E ZnDissTM
520N ZnDissTM
520U ZnDissTM
0.0
0.5
1.0
1.5
2.0
2.5
3.0
3.5
4.0
4.5
5.0
0
25
50
75
100
125
150

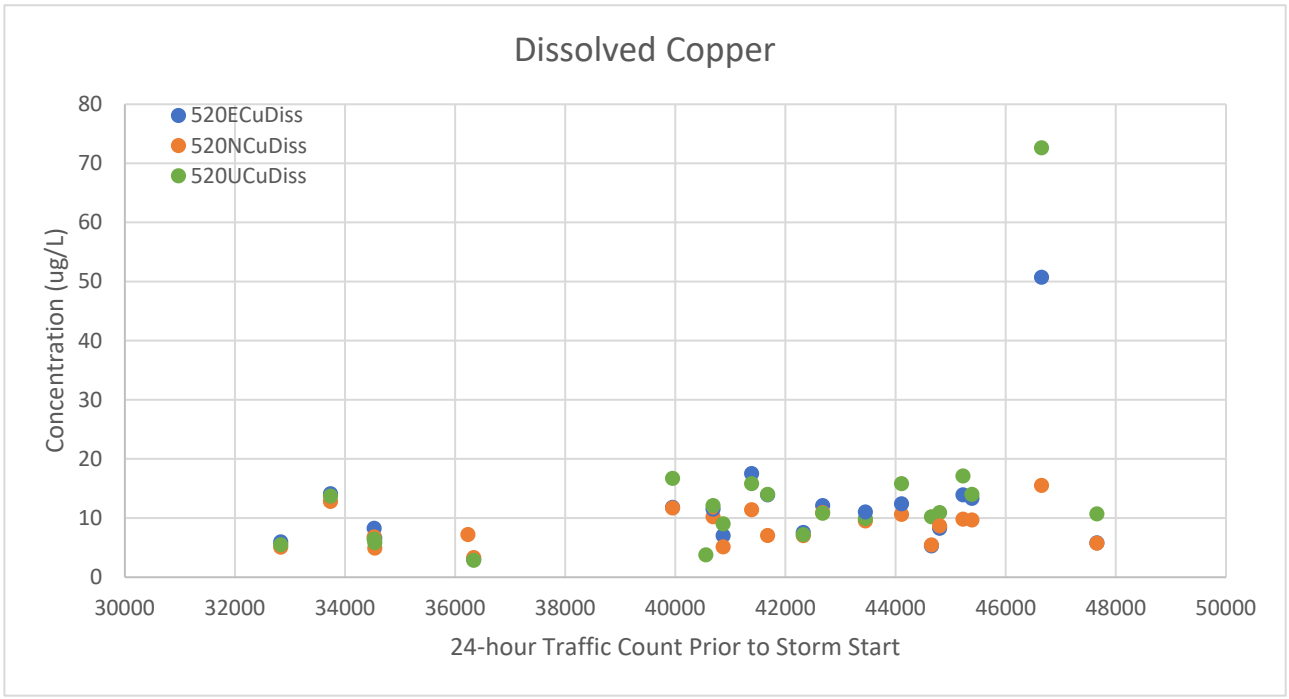

Total Mass from Dissolved Zinc by Days Since Study Start
Total Mass (g)
Days Since Study Start
520E ZnDissTM
520N ZnDissTM
520U ZnDissTM
0.0
0.5
1.0
1.5
2.0
2.5
3.0
3.5
4.0
4.5
5.0
0
50
100
150
200
250
300
350
400
450
500
550
600
650
700
750

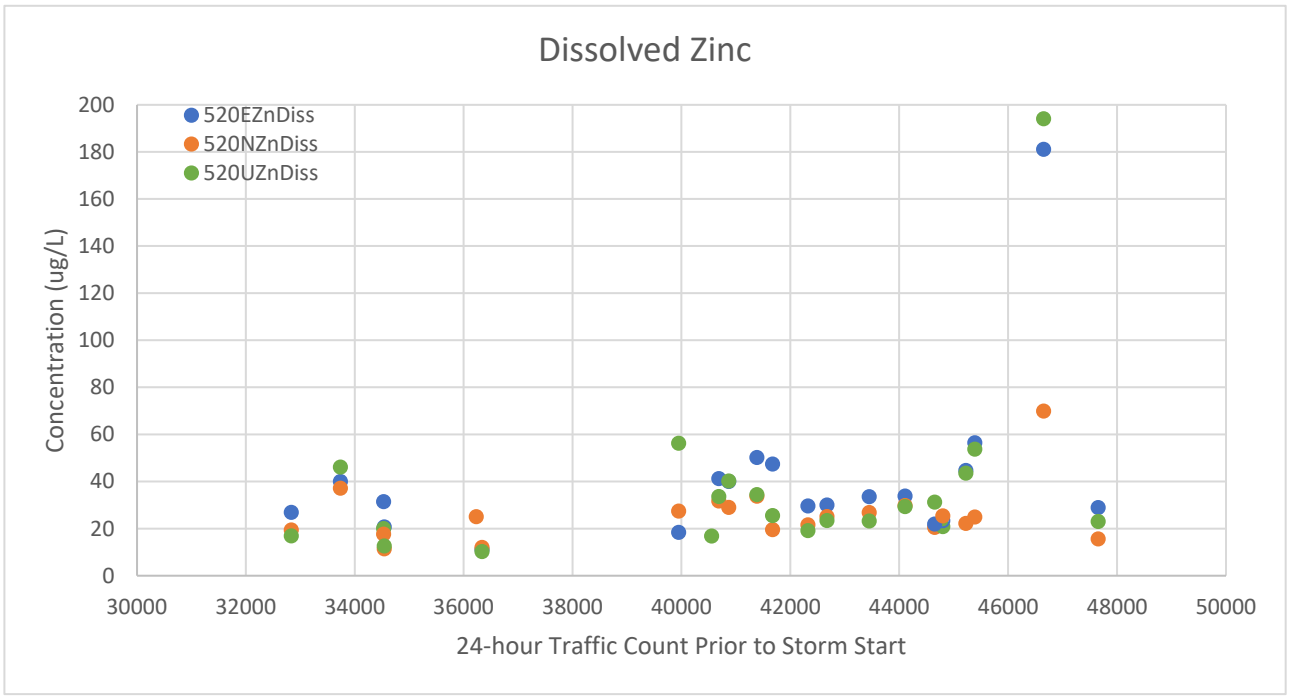

Total Mass from Dissolved Copper
Cumulative Frequency
100%
90%
80%
70%
60%
50%
40%
30%
20%
10%
0%
0.0
0.2
0.4
0.6
0.8
1.0
1.2
1.4
1.6
Total Mass (g)
520E CuDissTM
520N CuDissTM
520U CuDissTM

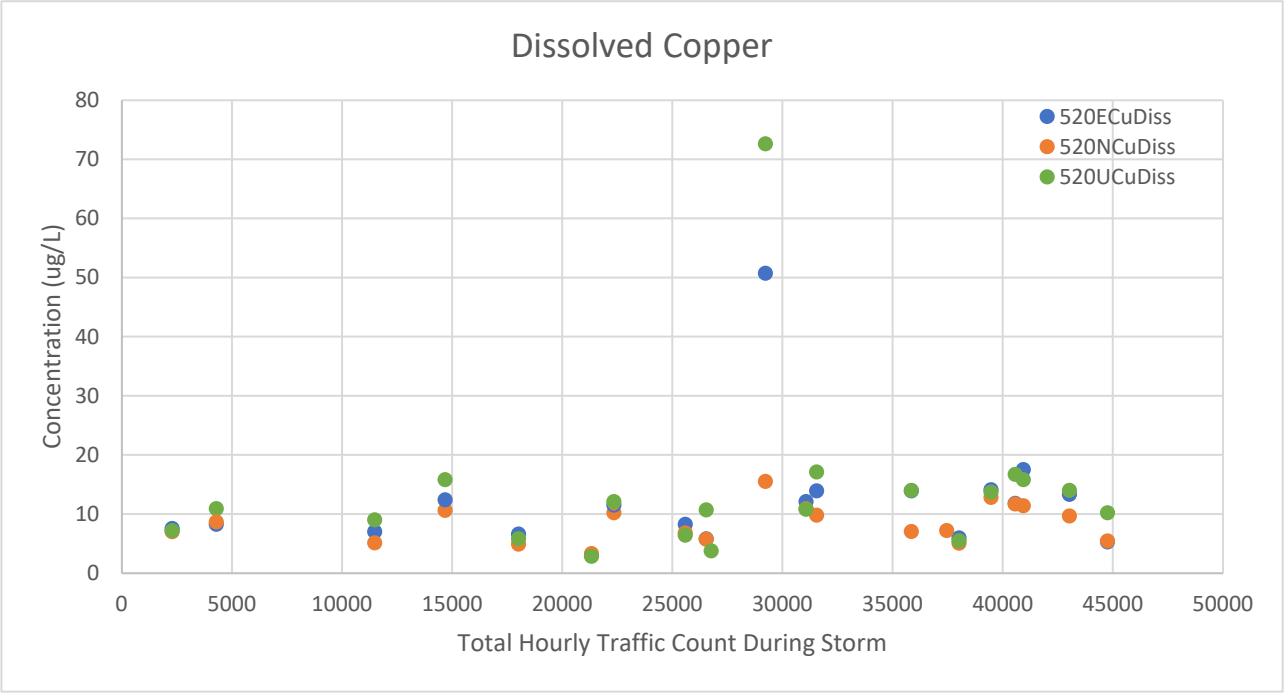

Total Mass per Acre from Dissolved Copper
Cumulative Frequency
100%
90%
80%
70%
60%
50%
40%
30%
20%
10%
0%
0.0
0.2
0.4
0.6
0.8
1.0
1.2
1.4
Total Mass per Acre (g/ac)
520E CuDissTMpA
520N CuDissTMpA
520U CuDissTMpA

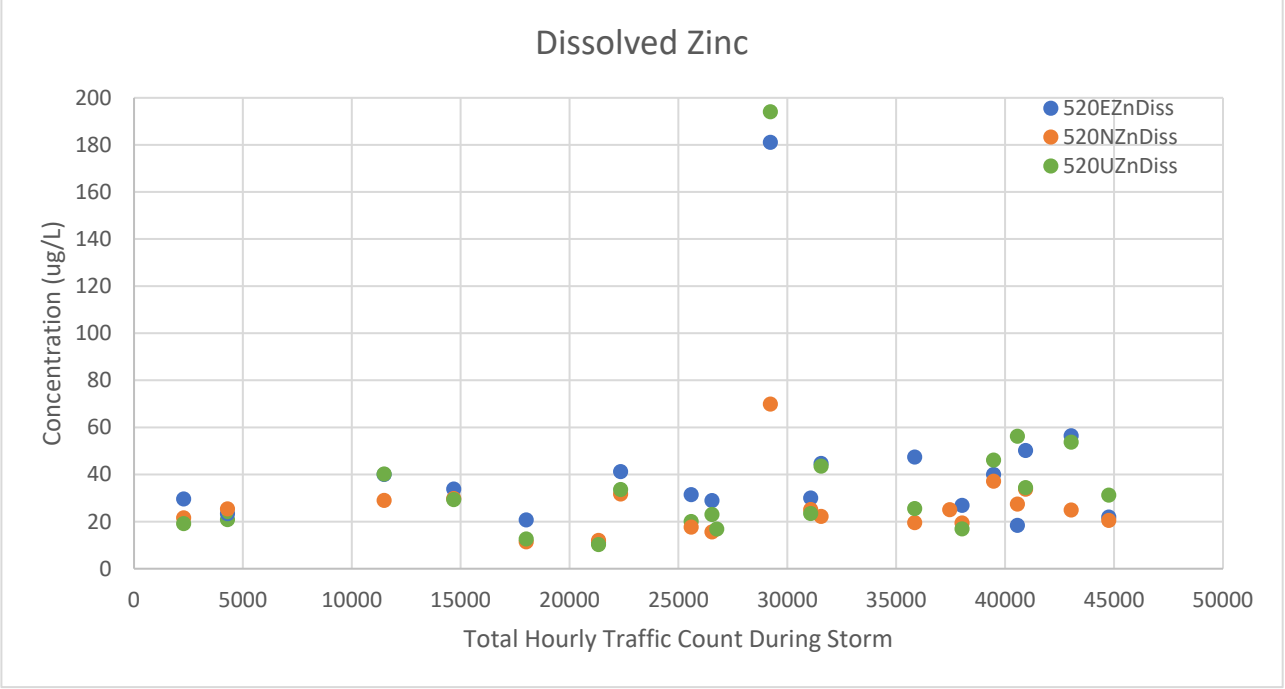

Total Mass from Dissolved Zinc
Cumulative Frequency
100%
90%
80%
70%
60%
50%
40%
30%
20%
10%
0%
0.0
0.5
1.0
1.5
2.0
2.5
3.0
3.5
4.0
4.5
5.0
Total Mass (g)
520E ZnDissTM
520N ZnDissTM
520U ZnDissTM

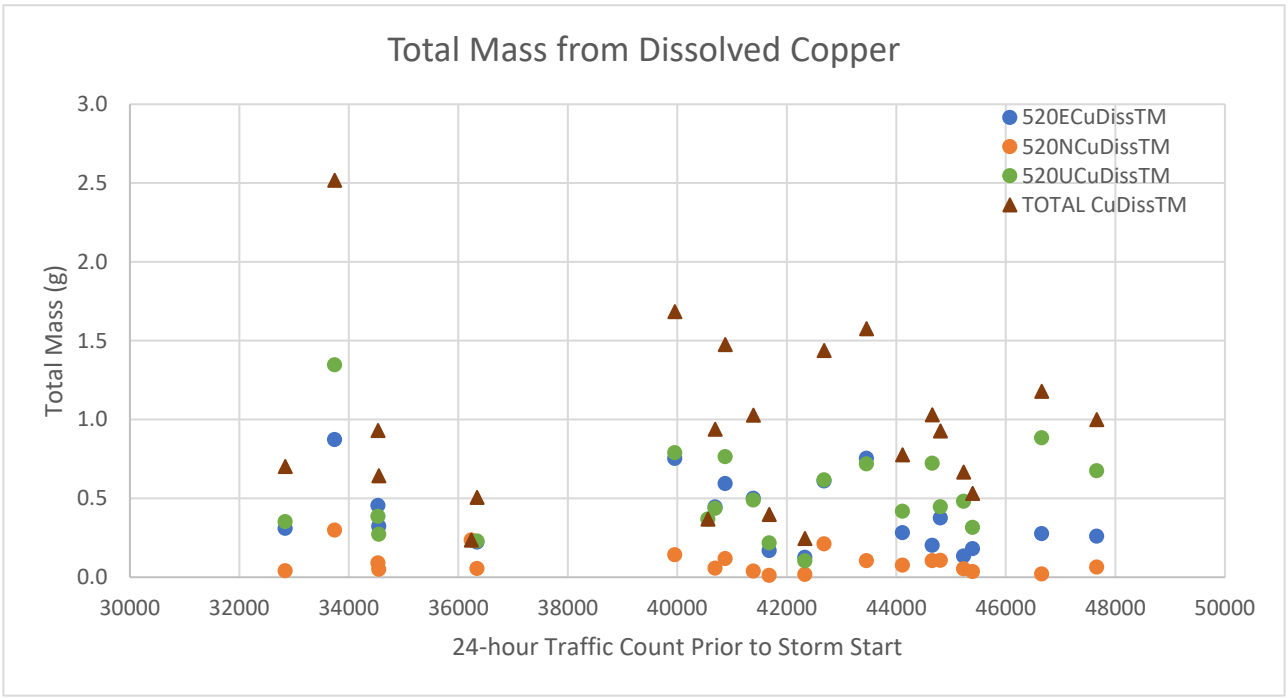

Total Mass per Acre from Dissolved Zinc
Cumulative Frequency
100%
90%
80%
70%
60%
50%
40%
30%
20%
10%
0%
0.0
0.5
1.0
1.5
2.0
2.5
3.0
3.5
4.0
4.5
5.0
Total Mass per Acre (g/ac)
520E ZnDissTMpA
520N ZnDissTMpA
520UZnDissTMpA

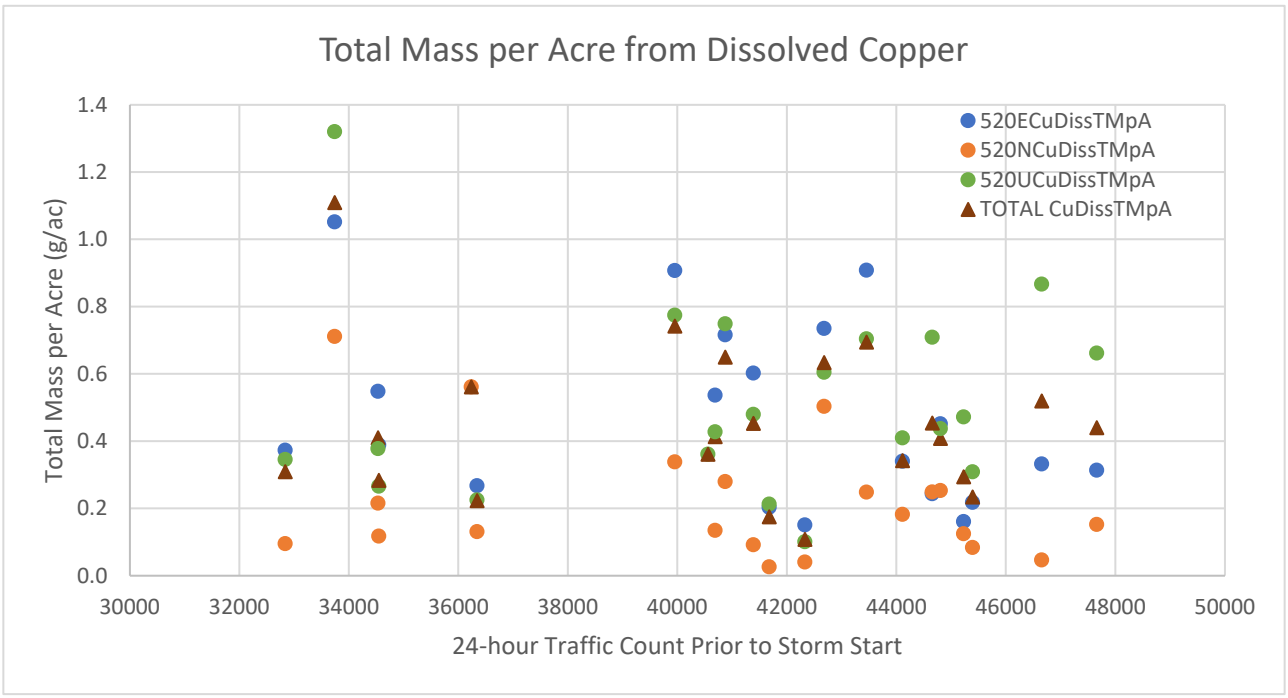

Dissolved Copper
520ECuDiss
520NCuDiss
520UCuDiss
Concentration (ug/L)
0
10
20
30
40
50
60
70
80
30000
32000
34000
36000
38000
40000
42000
44000
46000
48000
50000
24-hour Traffic Count Prior to Storm Start

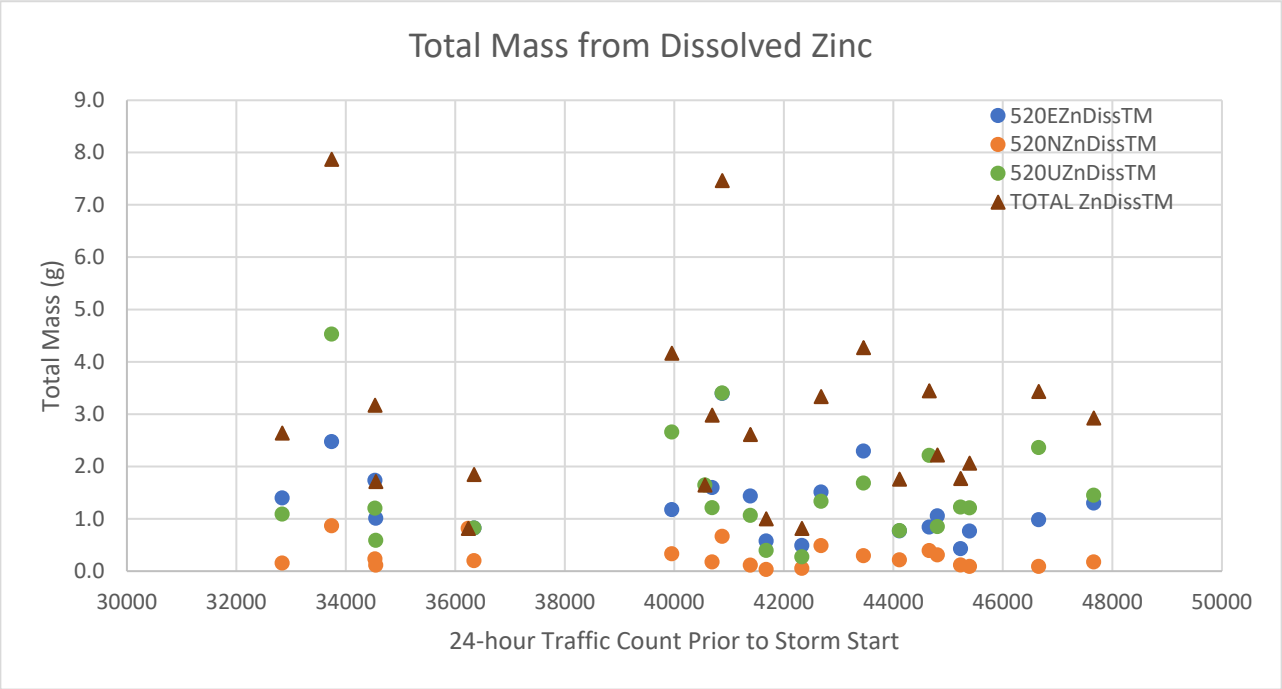

Dissolved Zinc
520EZnDiss
520NZnDiss
520UZnDiss
Concentration (ug/L)
0
20
40
60
80
100
120
140
160
180
200
30000
32000
34000
36000
38000
40000
42000
44000
46000
48000
50000
24-hour Traffic Count Prior to Storm Start

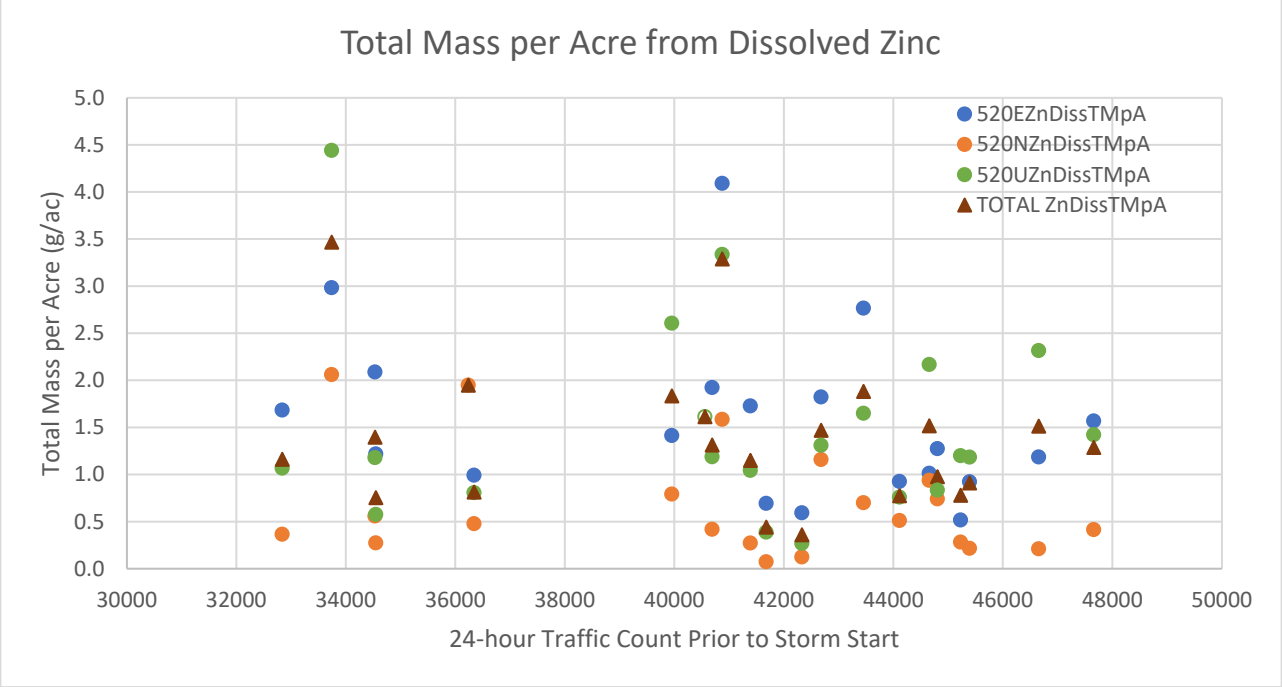

Dissolved Copper
Concentration (ug/L)
Total Hourly Traffic Count During Storm
520ECuDiss
520NCuDiss
520UCuDiss
0
10
20
30
40
50
60
70
80
0
5000
10000
15000
20000
25000
30000
35000
40000
45000
50000

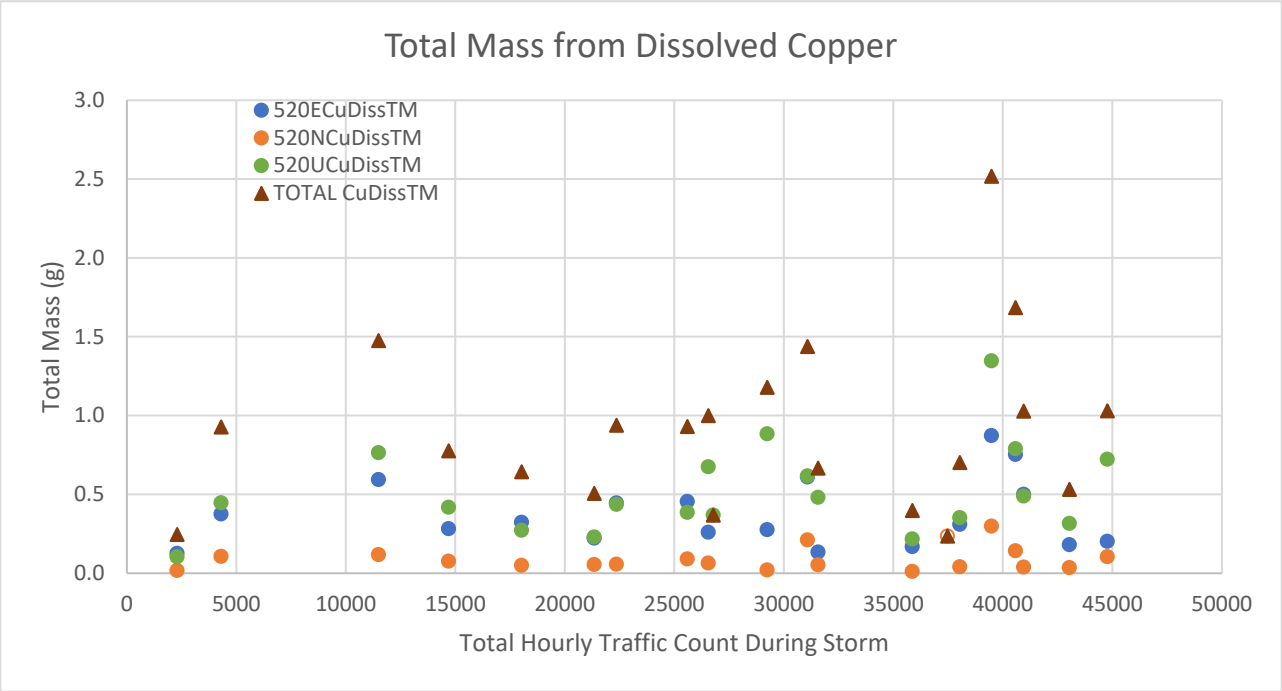

Dissolved Zinc
Concentration (ug/L)
Total Hourly Traffic Count During Storm
520EZnDiss
520NZnDiss
520UZnDiss
0
20
40
60
80
100
120
140
160
180
200
0
5000
10000
15000
20000
25000
30000
35000
40000
45000
50000

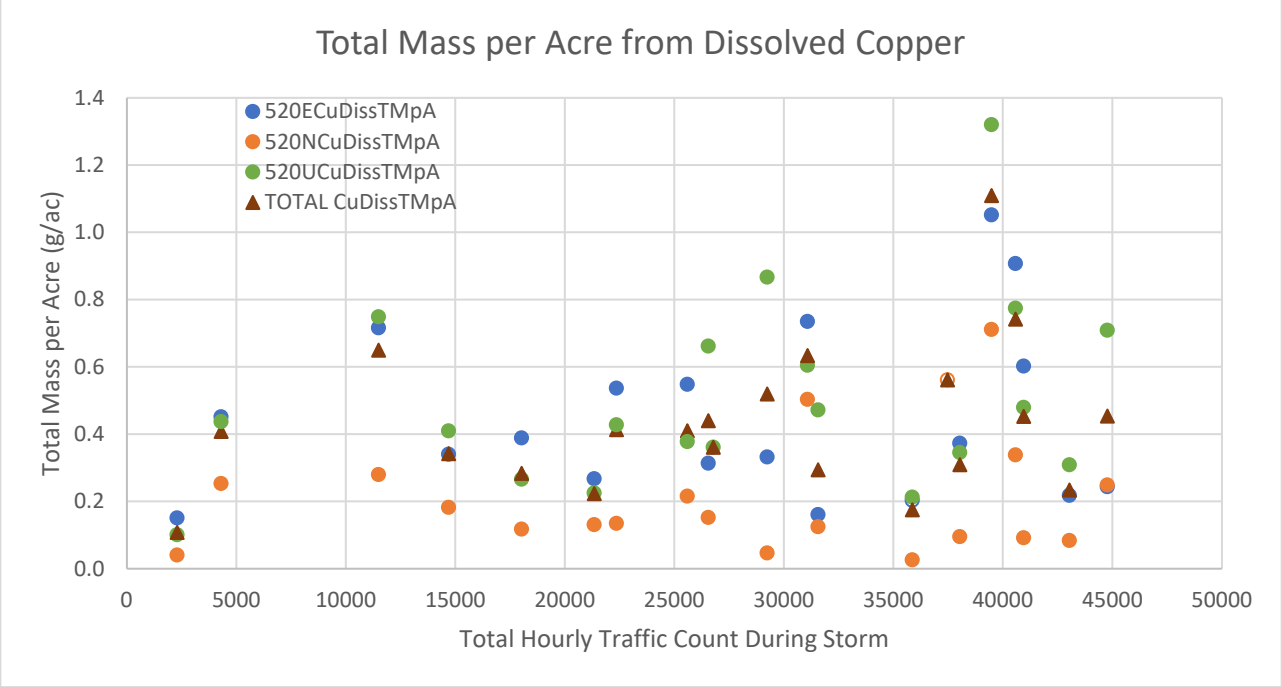

Total Mass from Dissolved Copper
Total Mass (g)
3.0
2.5
2.0
1.5
1.0
0.5
0.0
30000
32000
34000
36000
38000
40000
42000
44000
46000
48000
50000
24-hour Traffic Count Prior to Storm Start
520ECuDissTM
520NCuDissTM
520UCuDissTM
TOTAL CuDissTM

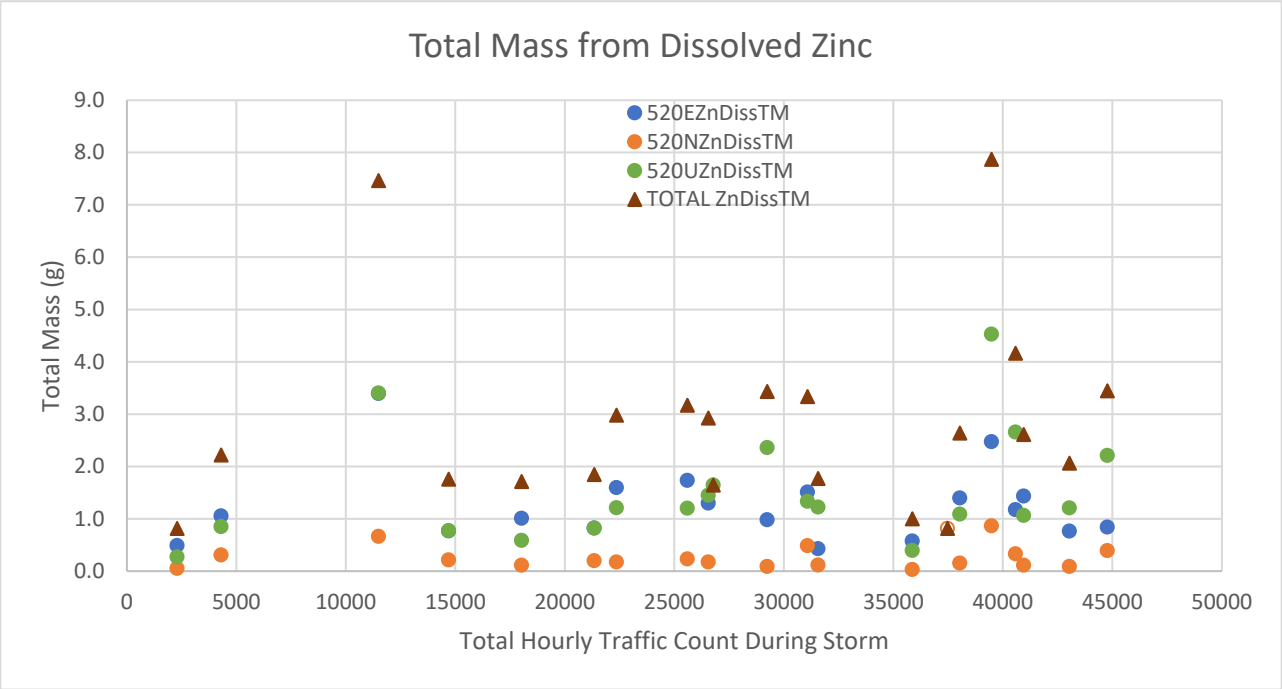

Total Mass per Acre from Dissolved Copper
Total Mass per Acre (g/ac)
1.4
1.2
1.0
0.8
0.6
0.4
0.2
0.0
30000
32000
34000
36000
38000
40000
42000
44000
46000
48000
50000
24-hour Traffic Count Prior to Storm Start
520ECuDissTMpA
520NCuDissTMpA
520UCuDissTMpA
TOTAL CuDissTMpA

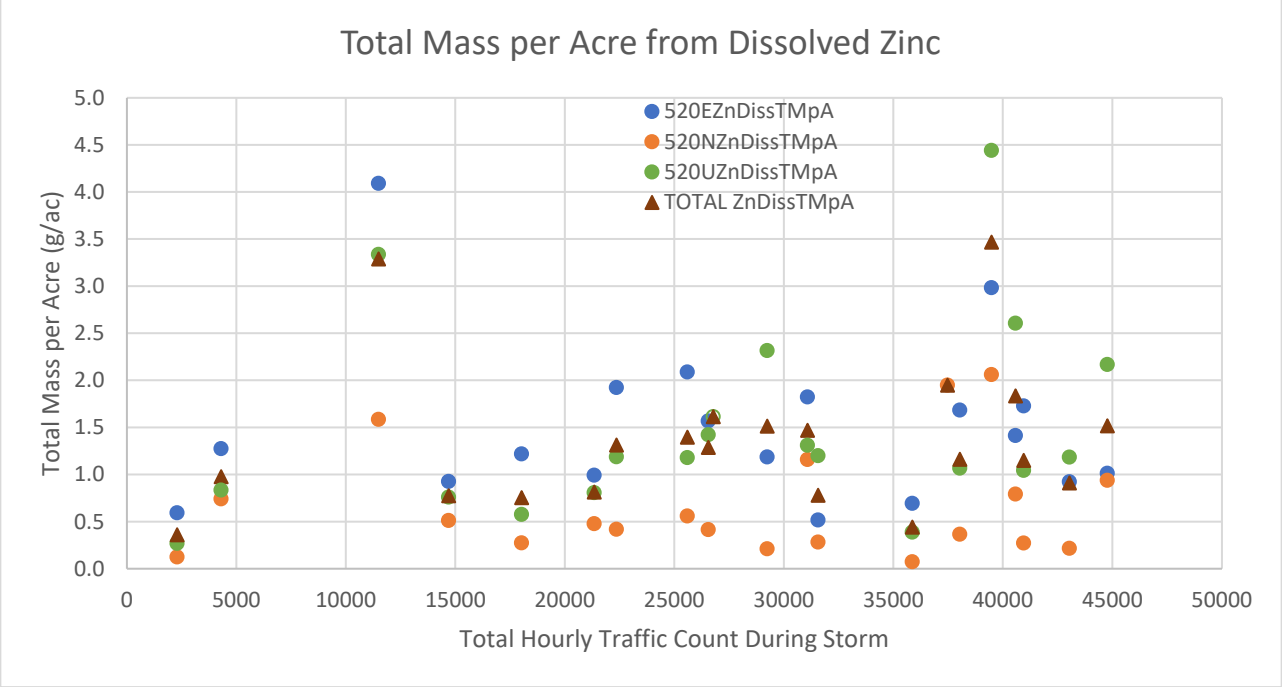

Total Mass from Dissolved Zinc
Total Mass (g)
9.0
8.0
7.0
6.0
5.0
4.0
3.0
2.0
1.0
0.0
30000
32000
34000
36000
38000
40000
42000
44000
46000
48000
50000
24-hour Traffic Count Prior to Storm Start
520EZnDissTM
520NZnDissTM
520UZnDissTM
TOTAL ZnDissTM


Total Mass per Acre from Dissolved Zinc
Total Mass per Acre (g/ac)
5.0
4.5
4.0
3.5
3.0
2.5
2.0
1.5
1.0
0.5
0.0
30000
32000
34000
36000
38000
40000
42000
44000
46000
48000
50000
24-hour Traffic Count Prior to Storm Start
520EZnDissTMpA
520NZnDissTMpA
520UZnDissTMpA
TOTAL ZnDissTMpA


Total Mass from Dissolved Copper
520ECuDissTM
520NCuDissTM
520UCuDissTM
TOTAL CuDissTM
Total Mass (g)
3.0
2.5
2.0
1.5
1.0
0.5
0.0
0
5000
10000
15000
20000
25000
30000
35000
40000
45000
50000
Total Hourly Traffic Count During Storm


Total Mass per Acre from Dissolved Copper
520ECuDissTMpA
520NCuDissTMpA
520UCuDissTMpA
TOTAL CuDissTMpA
Total Mass per Acre (g/ac)
1.4
1.2
1.0
0.8
0.6
0.4
0.2
0.0
0
5000
10000
15000
20000
25000
30000
35000
40000
45000
50000
Total Hourly Traffic Count During Storm


Total Mass from Dissolved Zinc
520EZnDissTM
520NZnDissTM
520UZnDissTM
TOTAL ZnDissTM
Total Mass (g)
9.0
8.0
7.0
6.0
5.0
4.0
3.0
2.0
1.0
0.0
0
5000
10000
15000
20000
25000
30000
35000
40000
45000
50000
Total Hourly Traffic Count During Storm


Total Mass per Acre from Dissolved Zinc
520EZnDissTMpA
520NZnDissTMpA
520UZnDissTMpA
TOTAL ZnDissTMpA
Total Mass per Acre (g/ac)
5.0
4.5
4.0
3.5
3.0
2.5
2.0
1.5
1.0
0.5
0.0
0
5000
10000
15000
20000
25000
30000
35000
40000
45000
50000
Total Hourly Traffic Count During Storm

Attachment 8

Suggested Maintenance Activities Improvement Addendum

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Washington State Department of Transportation

SR 520 Bridge Replacement and HOV Program

I-5 to Medina: Bridge Replacement and HOV Project

SR520 Floating Bridge and Landings Project AKART Monitoring Final Report

Suggested Maintenance Activities Improvement Addendum

Prepared for:

Washington State Department of Transportation
SR 520 Bridge Replacement and HOV Program
Floating Bridge and Landings Project
999 3rd Avenue, Suite 900
Seattle, WA 98104

Prepared by:

Parametrix
719 2nd Avenue, Suite 200, Seattle, WA 98104

and

Aspect CONSULTING
401 Second Ave S, Suite 201, Seattle, WA 98104

May 2020

PURPOSE

The Final Report involved analysis of bridge stormwater conveyance and treatment structural elements, specifically the Modified Catch Basins and the sumps which provide for settling and removal of sediments. After reviewing the SR 520 Floating Bridge and Landings Project as-built stormwater plans and through discussions with WSDOT about the maintenance schedule for these features, we identified some uncertainties related to removal of sediments from several features. The concern is that any drainage structure that has a solid locking lid over the sump area, rather than a vaned grate, may not have been part of the maintenance routine. These structures may be accumulating silt and sediments which could be trapping pollutants because they were not cleaned during the regular maintenance schedule. At the request of WSDOT, this addendum provides a list of actionable steps and identifies the relevant structures on design plans for reference by the maintenance crew. As the study resulted in no need for adaptive management strategies to BMP frequency or design, this addendum is intended to provide reference for discussion among WSDOT Area 5 Maintenance crews about BMP maintenance.

SUGGESTED MAINTENANCE IMPROVEMENTS

The following are suggested improvements to the current maintenance activities:

Modular Expansion Joints:

- Inspect the modular expansion joints to verify that the high-efficiency sweeping is effectively removing the silt and sediments.
- Vactor out the silt remaining between the modular expansion joint center beams and above the neoprene strip seals that is left behind after the sweeping operation. (Refer to Modular Expansion Joint Detail- Sheet T.421)

Drainage Structures (other than modified catch basins-locking lids, rectangular or round):

- Inspect the stormwater structures that have solid, locking covers for silt and sediment. Refer to Table 1.
- Vactor out sediment from the sump storage basins of the stormwater structures. Refer to Table 1 for complete reference of drainage structure locations and structure design details.

Table 1 identifies the structures and flow splitters which may benefit from additional maintenance. Detailed plan set drawings have been annotated in the attached figures to aid WSDOT maintenance practices for the modified catch basin BMPs.

Table 1. Drainage and Roadway Structures Identified for Additional Maintenance.

Drainage Structures				
Structure # [1]	Station [2]	Offset (ft) [3]	Receiving SSP	Plan Sheets [4,5]
West High-Rise Modular Expansion Joints	ML 237+13.00 ML 139+03.00 MR 239+03.00 MR 237+13.00	0.0 ft Lt 0.0 ft Lt 0.0 ft Rt 0.0 ft Rt	N/A	T1.3 T4.21
East High-Rise Modular Expansion Joints	ML 215+37.00 ML 217+28.00 MR 217+28.00 MR 215+37.00	0.0 ft Lt 0.0 ft Lt 0.0 ft Rt 0.0 ft Rt	N/A	T1.4 T4.21
FS1	ML 209+07.92	43.25 Lt	TNY/UNW	DR1.58 DD1.07 DD1.09
FS2	ML 211+04.97	43.25 Lt	UNE/UNW/TNE	DR1.58 DD1.09 DD1.10
FS3	MR 211+05.03	31.25 Rt	USE/USW	DR1.58 DD1.09 DD1.12
79	ML 215+30.29	39.07 Lt	UNE/UNW/TNE	DR1.61 DD1.16 DD1.17
179	MR 215+31.05	25.86 Rt	USE	DR1.61 DD1.16 DD1.17

1. FS = flow splitter.
2. ML = North side bridge lanes MR = South side bridge lanes.
3. Lt = Left Rt = Right.
4. Source: SR 520 Evergreen Point Bridge Floating Bridge and Landings Bridge Drainage As-Builts (Vol. 14a, 2012).
5. Source: SR 520 Evergreen Point Bridge Floating Bridge and Landings Transition Span Plan As-Builts (Vol. 4, 2012).

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Figures

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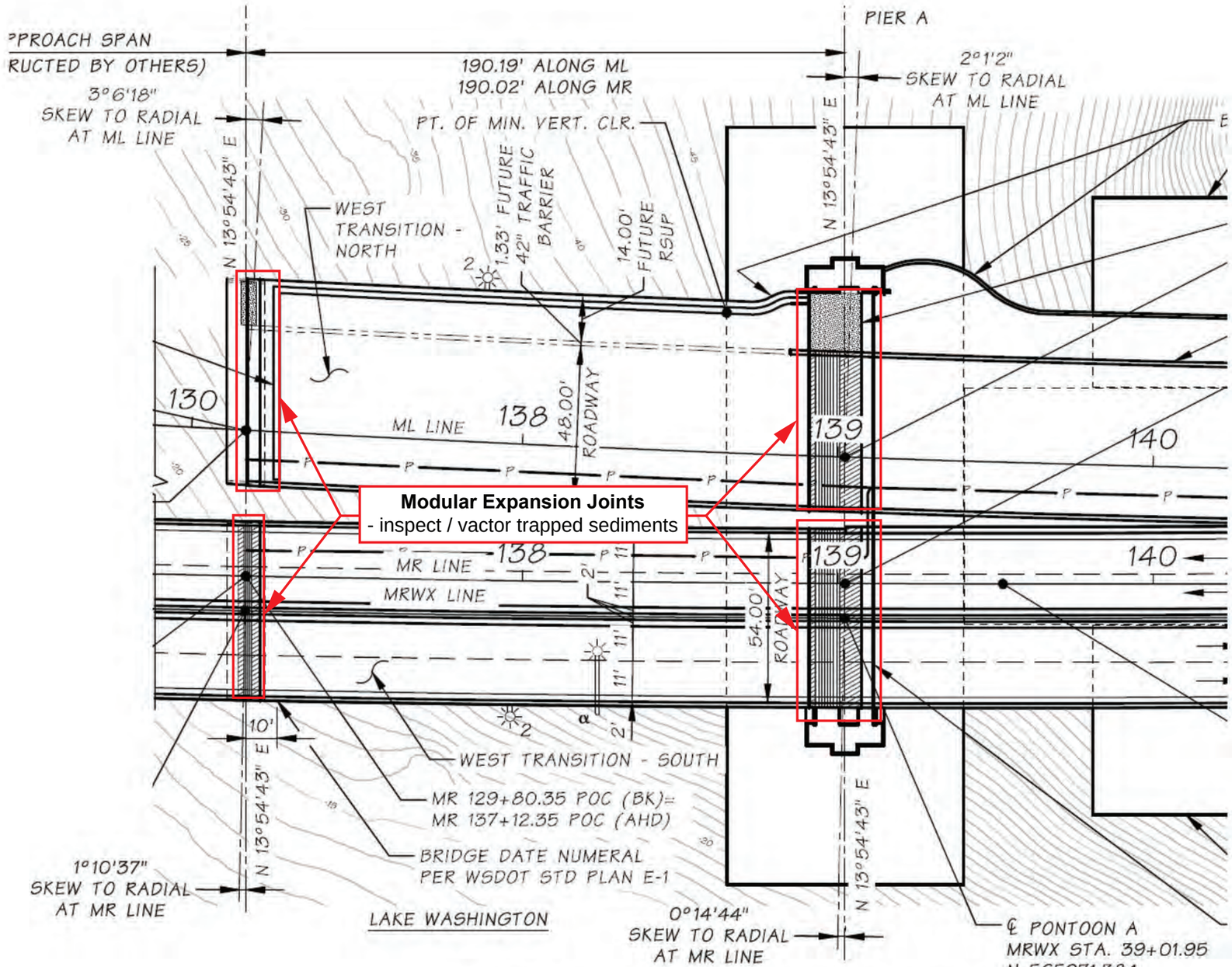

PLAN - WEST TRANSITION SPANS

Washington State Department of Transportation

KGM Kiewit/General/Manson, A Joint Venture

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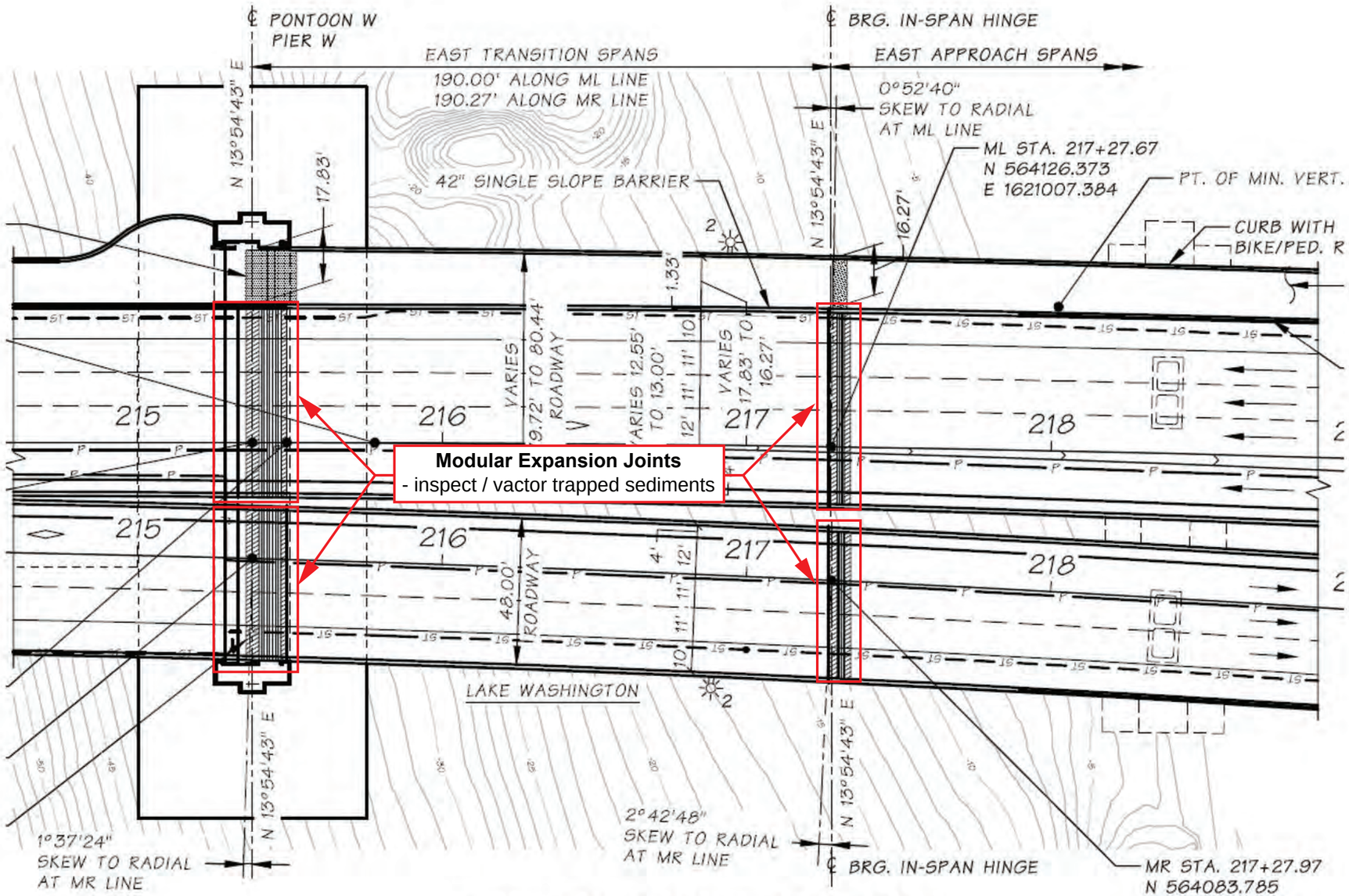
SR 520
I-5 TO MEDINA - STG. 1 EVERGREEN PT
FLOATING BRIDGE AND LANDINGS
Transition Span Plan, Volume 4 As Built

SHEET T1.3



PLAN - EAST TRANSITION SPANS

Washington State Department of Transportation

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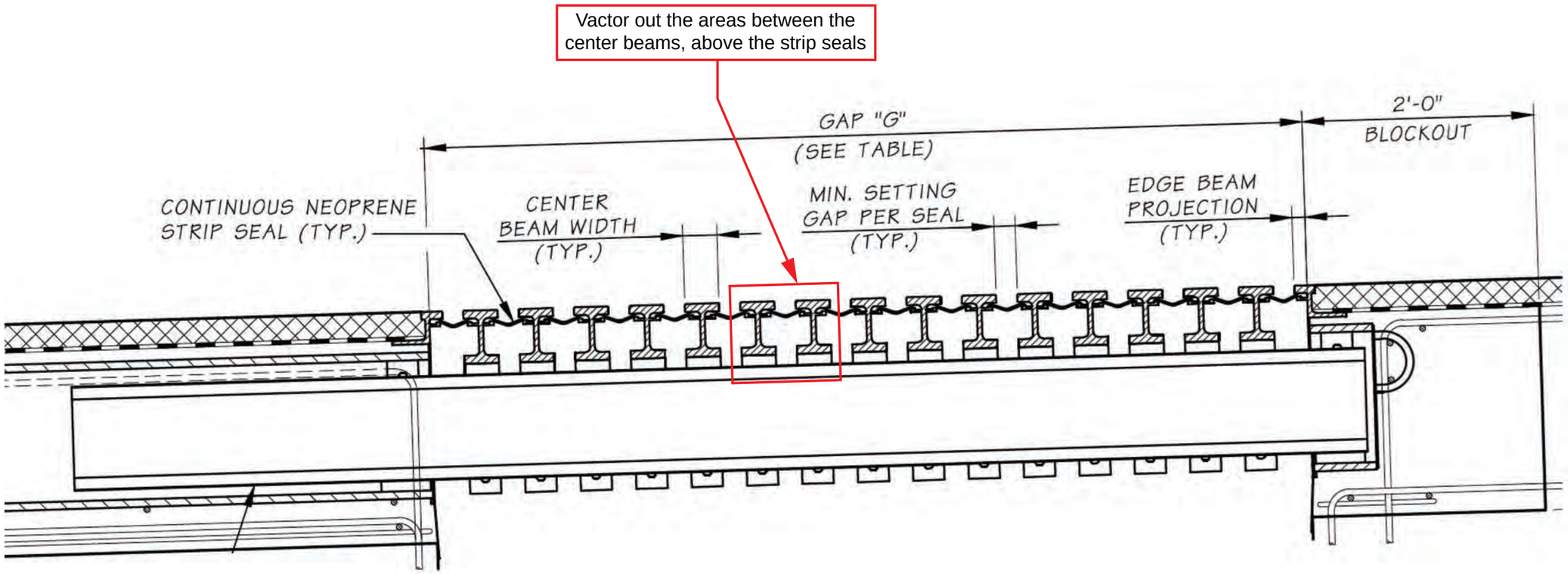
SR 520
I-5 TO MEDINA - STG. 1 EVERGREEN PT
FLOATING BRIDGE AND LANDINGS
Transition Span Plan, Volume 4 As Built

SHEET T1.4

Vactor out the areas between the center beams, above the strip seals



SECTION - MODULAR EXPANSION JOINT (A / T4.21)

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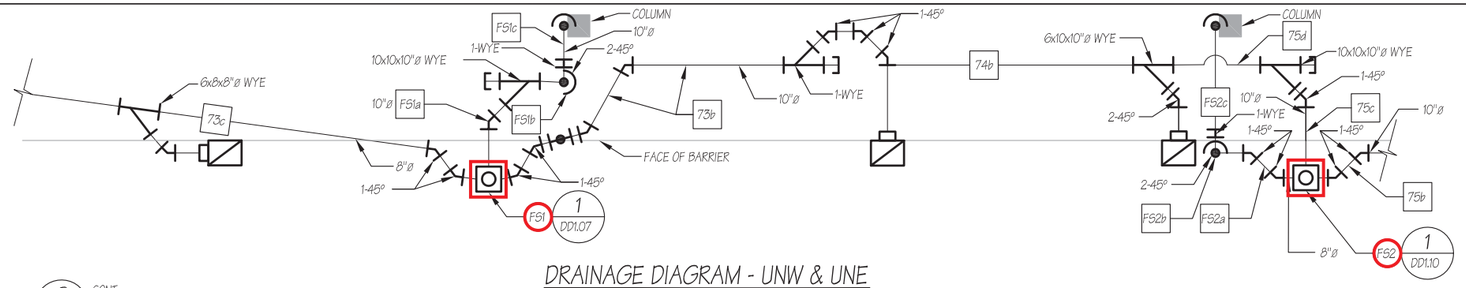
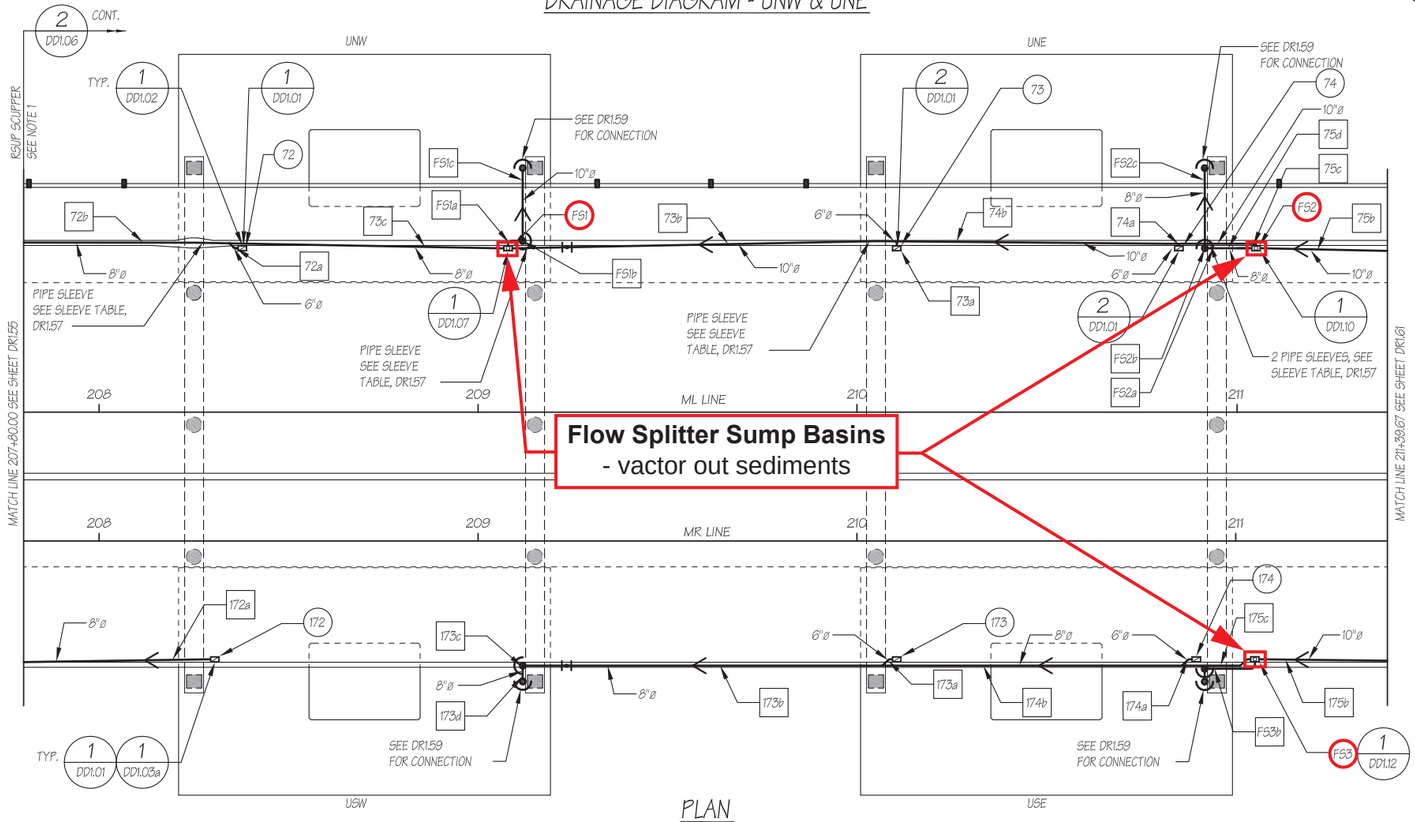
SR 520
I-5 TO MEDINA - STG. 1 EVERGREEN PT
FLOATING BRIDGE AND LANDINGS
Transition Span Plan, Volume 4 As Built

MODULAR EXPANSION JOINT DETAIL - SHEET T4.21

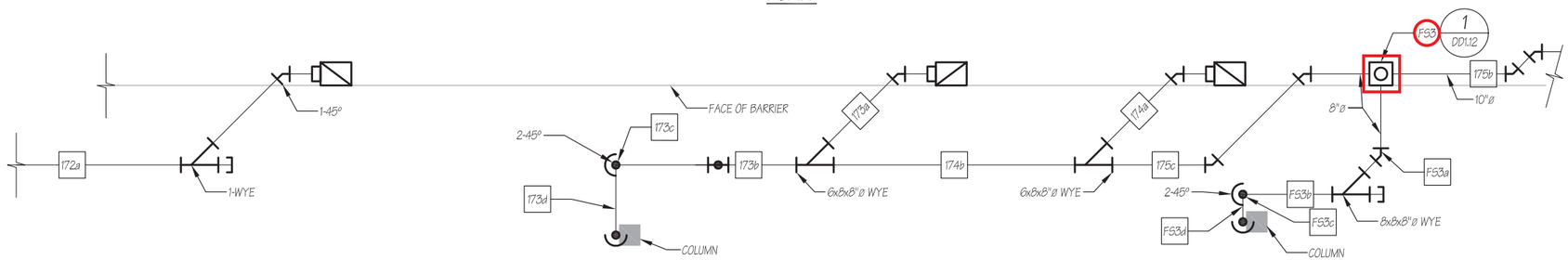


DRAINAGE DIAGRAM - UNW & UNE



Flow Splitter Sump Basins
- vactor out sediments

PLAN



DRAINAGE DIAGRAM - USW & USE

LEGEND

- MODIFIED CATCH BASIN
- FLOW SPLITTER
- STORM DRAIN PIPE
- VERTICAL PIPE
- EXPANSION JOINT
- FLOW DIRECTION
- XXa PIPE SECTION
- STRUCTURAL COLUMN
- ACCESS HATCH
- WYE
- 45° BEND
- CAP
- FLEX COUPLING
- PIPE SECTION
- REDUCER
- SCUPPER
- REMOVABLE PIPE
- BALL JOINT
- TEE

NOTES

1. SEE DR1.05 FOR RSUP SCUPPER LOCATIONS.
2. SEE STRUCTURAL PLANS FOR HANGAR SUPPORTS.
3. SEE ANCILLARY PLANS FOR SUPPORTS ON PONTOONS.
4. SEE STRUCTURAL PLANS, VOL. 8 FOR PIPE SLEEVES AND REINFORCING DETAILS AT DIAPHRAGM.

AS-BUILT

Bridge Design Engr.	
Supervisor	Oates, D
Designed By	Seethoff, A
Checked By	Rhodes, J
Detailed By	Rasile, C
Bridge Projects Engr.	
Prelim. Plan By	
Architect/Specialist	

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REGION NO.	STATE	FED AID PROJ NO
10	WASH	BR-0520(050)
JOB NUMBER 8066		

BRIDGE AND STRUCTURES OFFICE

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BRIDGE STORMWATER

BRIDGE DRAINAGE PLAN - U

BRIDGE SHEET NO. DR1.58

SHEET 62 OF 99 SHEETS

VOLUME 14a - BRIDGE DRAINAGE - RELEASED FOR CONSTRUCTION - OCTOBER 10, 2012

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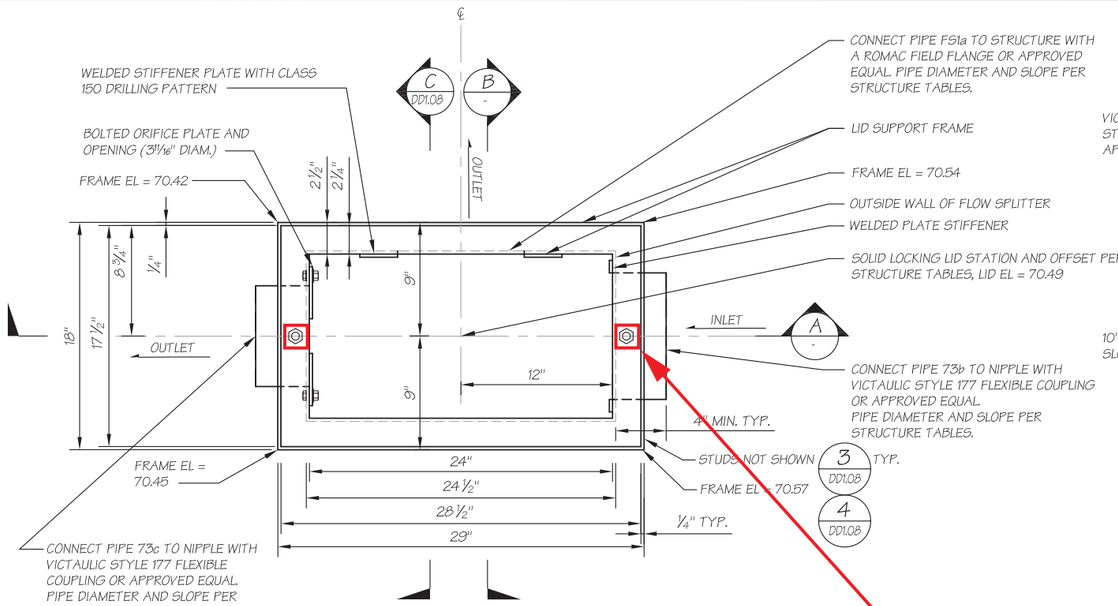
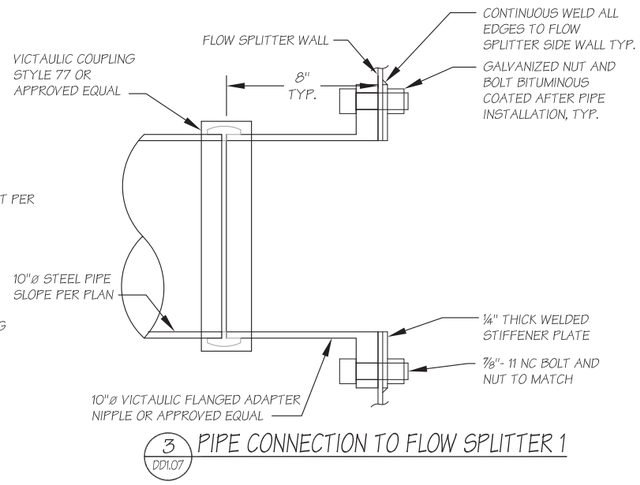




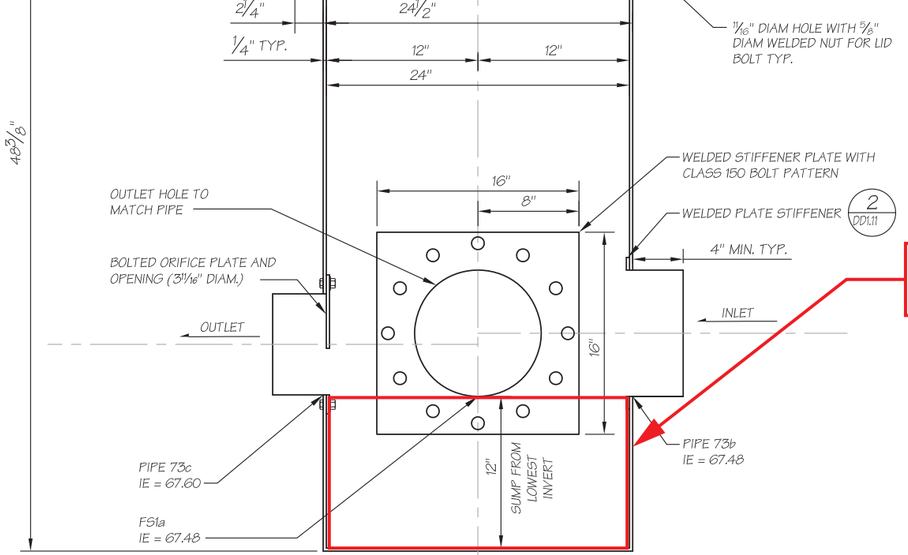
3 DD1.07 PIPE CONNECTION TO FLOW SPLITTER 1

FLOW SPLITTER

1. FLOW SPLITTERS SHALL BE LOCATED PER PLANS. UNLESS OTHERWISE NOTED, ALL PORTIONS OF THE STRUCTURE SHALL BE CONSTRUCTED OF 1/4" THICK STEEL.
2. THE FRAME SHALL BE CONSTRUCTED OF 1/4" THICK STEEL PLATE AND/OR ANGLE IRON. FRAME WELDS SHALL NOT CAUSE THE LID TO BIND OR ROCK IN THE FRAME.
3. THE FLOW SPLITTER BOX AND FRAME SHALL BE HOT DIP GALVANIZED INSIDE AND OUT. THE EXTERIOR GALVANIZING SHALL BE COATED WITH PAINT PER MANUFACTURERS SPECIFICATIONS. THE INTERIOR GALVANIZING SHALL BE COATED WITH A BITUMINOUS COATING, TYPE 1, 2, OR 5 PER WSDOT STD. SPECIFICATION 9-05.4(3).
4. THE LID SHALL BE CONSTRUCTED WITH STAINLESS STEEL METAL WITH NO COATINGS. THE LID SHALL BE CONSTRUCTED TO SUPPORT HS-25 LOAD CONDITIONS.
5. THE LID SHALL BE BOLT DOWN/LOCKING AS INDICATED IN THE DETAILS.
6. PLATE STIFFENERS SHALL BE BOLTED AND/OR WELDED AS INDICATED IN THE DETAILS.
7. WELDED STIFFENERS PLATES SHALL BE WELDED CONTINUOUSLY TO THE INSIDE OF THE FLOW SPLITTER AND SHALL BE WATER TIGHT.
8. BOLTED ORIFICE PLATES SHALL BE ADJUSTED TO THE INVERT AS INDICATED IN THE DETAILS AND SEALED WITH A BITUMINOUS COATING.
9. WELDED STEEL NIPPLES SHALL BE GALVANIZED INSIDE AND OUT AND BITUMINOUS COATED ON THE INSIDE. THE OUTSIDE GALVANIZING SHALL BE PREPARED AND PAINTED ACCORDING TO THE MANUFACTURER'S RECOMMENDATIONS.
10. THE FLOW SPLITTERS SHALL BE HUNG PLUMB AND FLUSH WITH FINISHED GRADE.
11. NELSON STUDS SHALL HAVE 1½" SEPARATION FROM REBAR REINFORCING TYP.

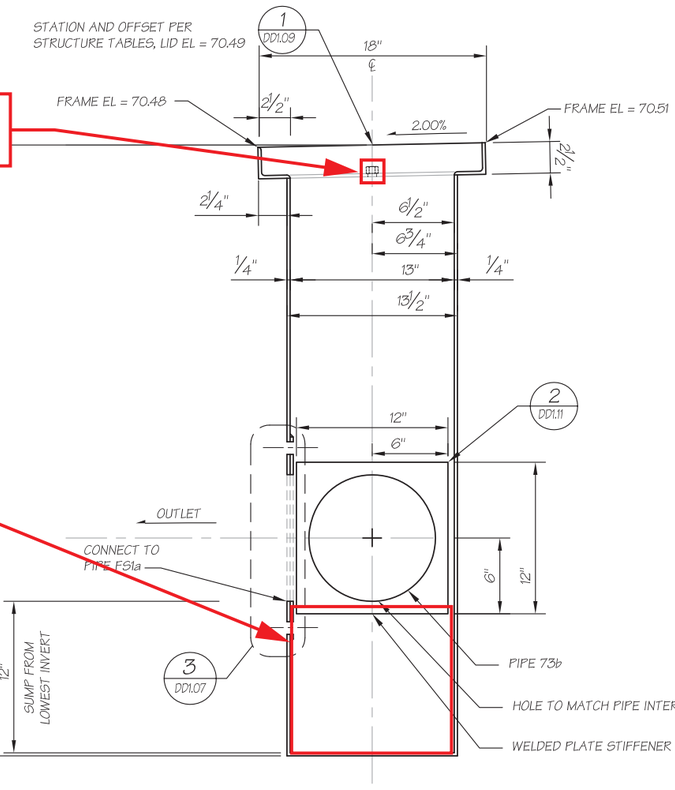
Locking Mechanisms
- may require tools

Flow Splitter Sump Basins
- vactor out sediments



A - SECTION

1 DR1.58 FLOW SPLITTER FS1



B - SECTION

AS-BUILT

Bridge Design Engr.	
Supervisor	Oates, D
Designed By	Seethoff, A
Checked By	Rhodes, J
Detailed By	Rasile, C
Bridge Projects Engr.	
Prelim. Plan By	
Architect/Specialist	

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REGION NO.	STATE	FED AID PROJ NO
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JOB NUMBER 8066		

BRIDGE AND STRUCTURES OFFICE

Washington State Department of Transportation

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BRIDGE STORMWATER

DRAINAGE DETAILS

BRIDGE SHEET NO. DD1.07

SHEET 78 OF 99 SHEETS

VOLUME 14a - BRIDGE DRAINAGE - RELEASED FOR CONSTRUCTION - OCTOBER 10, 2012

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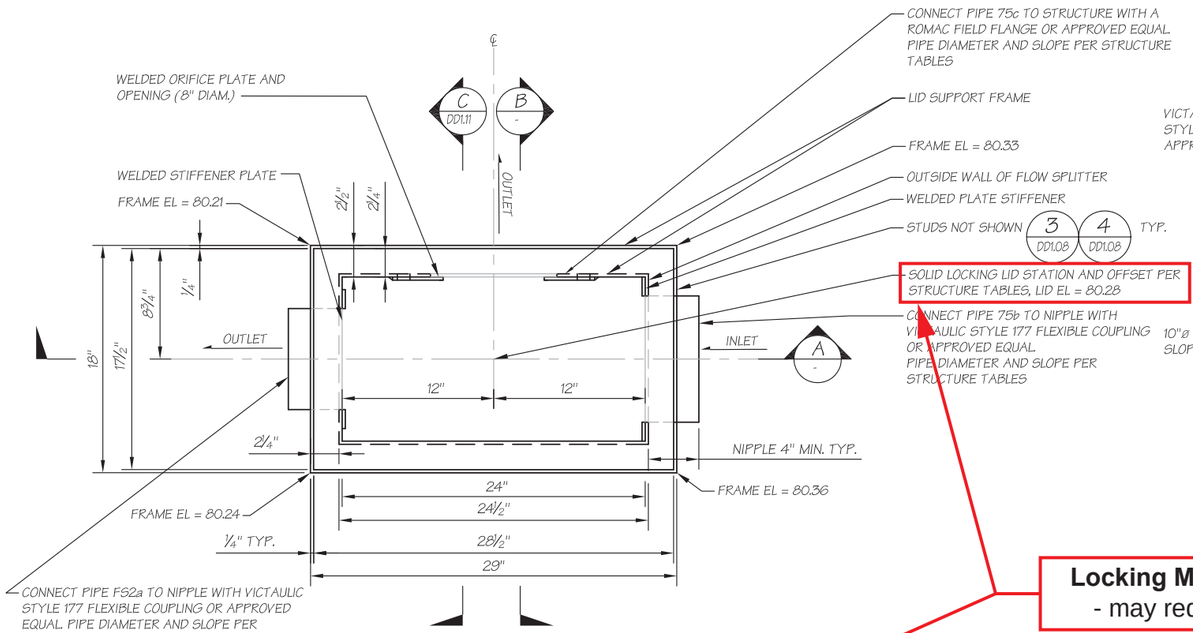
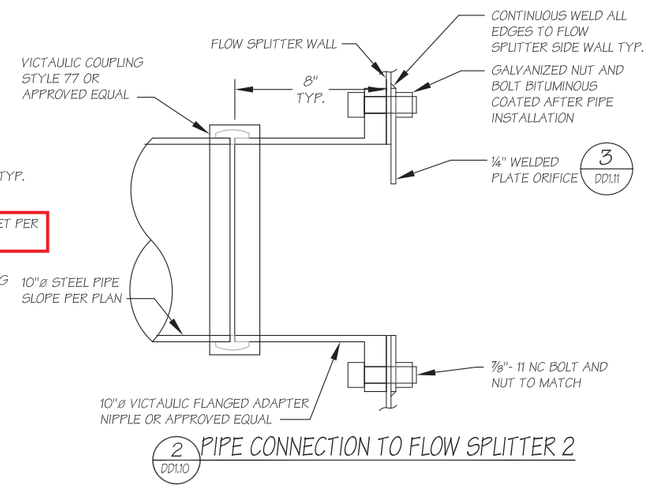


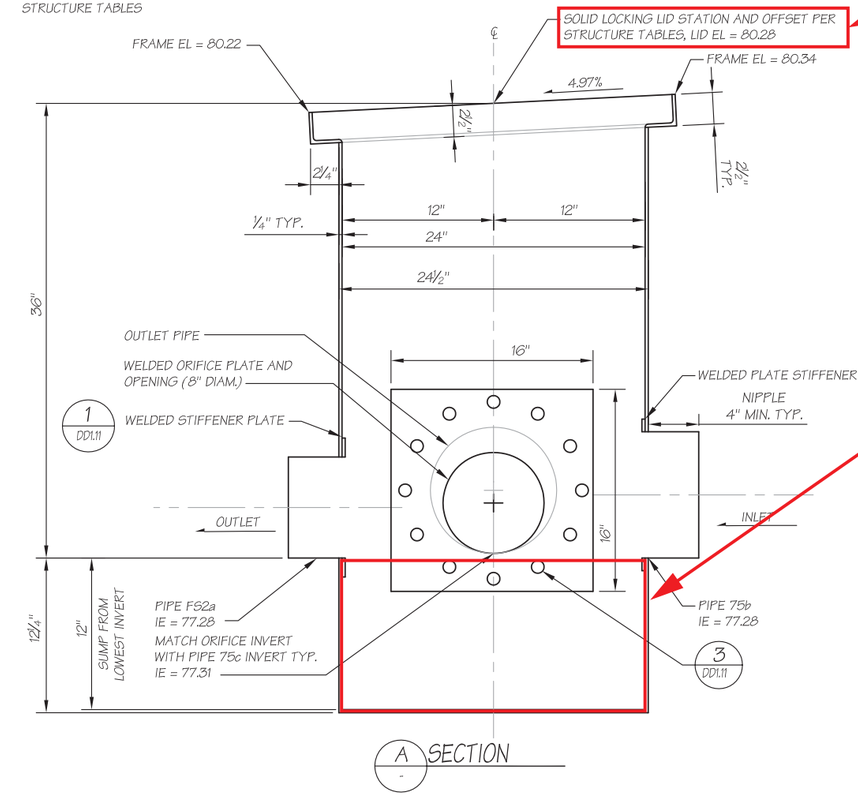


2 DD1.10 PIPE CONNECTION TO FLOW SPLITTER 2

FLOW SPLITTER

1. FLOW SPLITTERS SHALL BE LOCATED PER PLANS. UNLESS OTHERWISE NOTED, ALL PORTIONS OF THE STRUCTURE SHALL BE CONSTRUCTED OF ¼" STEEL.
2. THE FRAME SHALL BE CONSTRUCTED OF ¼" STEEL PLATE AND/OR ANGLE IRON. FRAME WELDS SHALL NOT CAUSE THE LID TO BIND OR ROCK IN THE FRAME.
3. THE FLOW SPLITTER BOX AND FRAME SHALL BE HOT DIP GALVANIZED INSIDE AND OUT. THE EXTERIOR GALVANIZING SHALL BE COATED WITH PAINT PER MANUFACTURERS SPECIFICATIONS. THE INTERIOR GALVANIZING SHALL BE COATED WITH A BITUMINOUS COATING, TYPE 1, 2, OR 5 PER WSDOT STD. SPECIFICATION 9-05.4(3).
4. THE LID SHALL BE CONSTRUCTED WITH STAINLESS STEEL METAL WITH NO COATINGS. THE RIM SHALL BE CONSTRUCTED TO SUPPORT HS-25 LOAD CONDITIONS.
5. THE LID SHALL BE BOLT DOWN/LOCKING AS INDICATED IN THE DETAILS.
6. PLATE STIFFENERS SHALL BE BOLTED AND/OR WELDED AS INDICATED IN THE DETAILS.
7. WELDED PLATE STIFFENERS/ORIFICE PLATES SHALL BE WELDED CONTINUOUSLY TO THE INSIDE OF THE FLOW SPLITTER AND SHALL BE WATER TIGHT.
8. BOLTED PLATE STIFFENERS/ORIFICE PLATES SHALL BE ADJUSTED TO THE INVERT AS INDICATED IN THE DETAILS AND SEALED WITH A BITUMINOUS COATING.
9. WELDED STEEL NIPPLES SHALL BE GALVANIZED INSIDE AND OUT AND BITUMINOUS COATED ON THE INSIDE. THE OUTSIDE GALVANIZING SHALL BE PREPARED AND PAINTED ACCORDING TO THE MANUFACTURER'S RECOMMENDATIONS.
10. THE FLOW SPLITTERS SHALL BE HUNG PLUMB AND FLUSH WITH FINISHED GRADE.
11. NELSON STUDS SHALL HAVE 1½" SEPARATION FROM REBAR REINFORCING TYP.

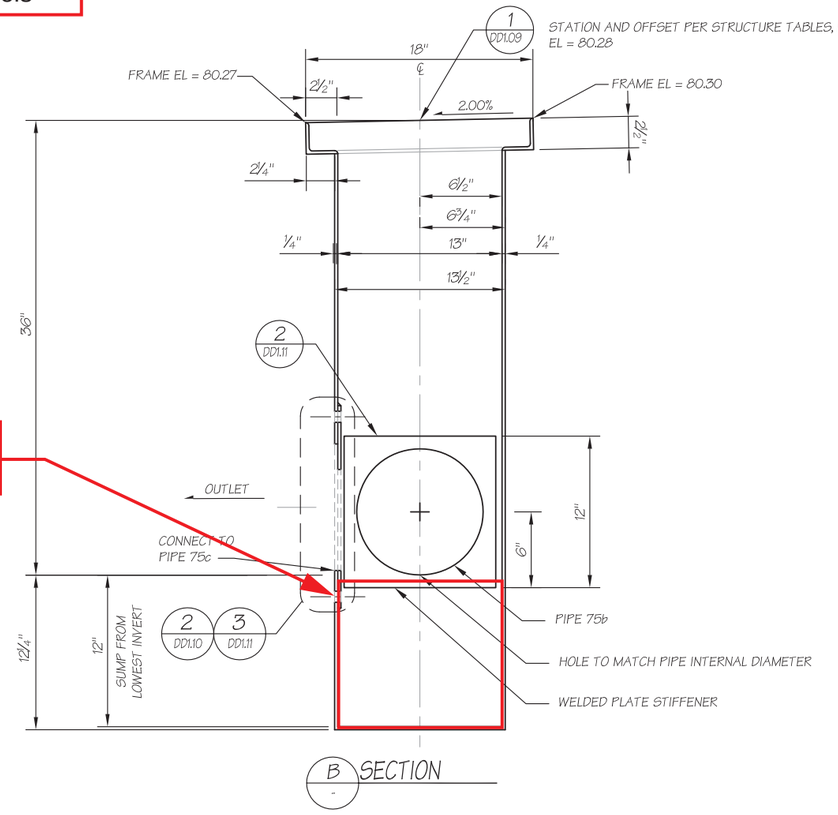
Locking Mechanisms
- may require tools



A - SECTION

1 DR1.58 FLOW SPLITTER FS2

Flow Splitter Sump Basins
- vactor out sediments



B - SECTION

AS-BUILT

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Supervisor	Oates, D
Designed By	Seethoff, A
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Bridge Projects Engr.	
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REGION NO	STATE
10	WASH

JOB NUMBER 8066

FED AID PROJ NO: BR-0520(050)

BRIDGE AND STRUCTURES OFFICE

Washington State Department of Transportation

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BRIDGE STORMWATER
DRAINAGE DETAILS

BRIDGE SHEET NO. DD1.10

SHEET 81 OF 99 SHEETS

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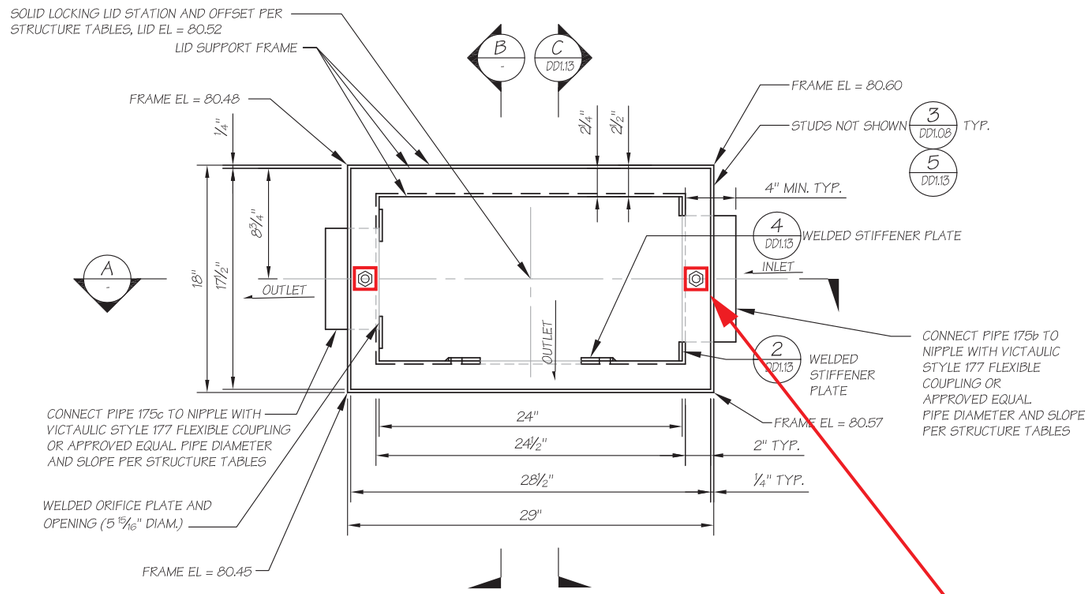

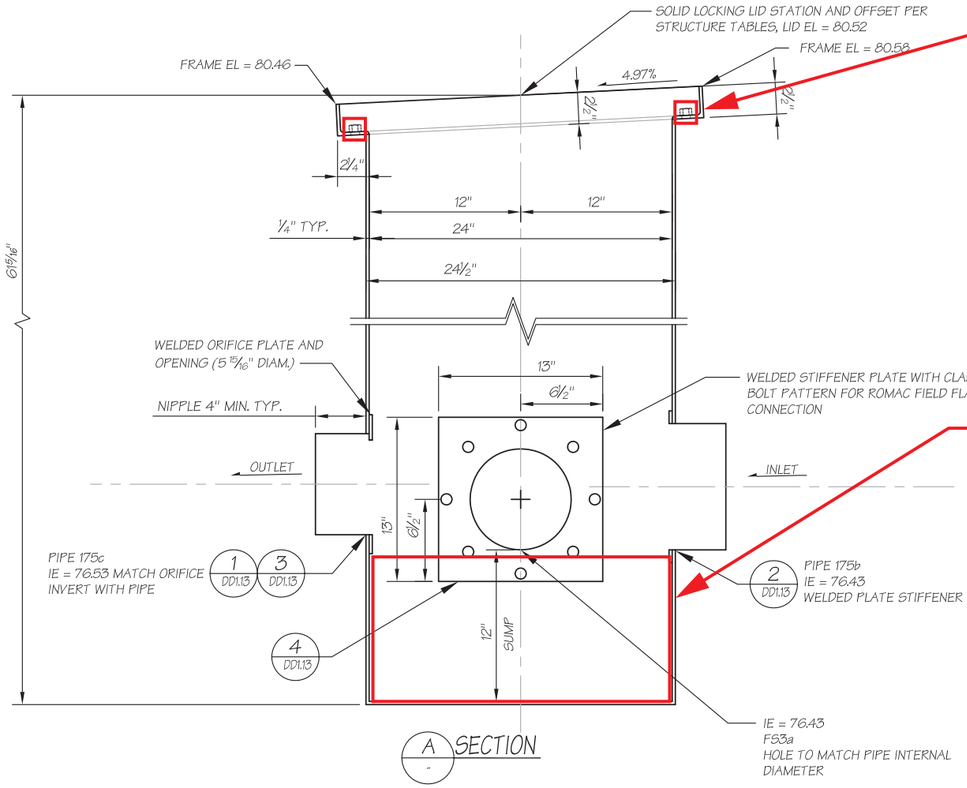

A SECTION

1 FLOW SPLITTER FS3 (DR1.58)

Locking Mechanisms
- may require tools

Flow Splitter Sump Basins
- vactor out sediments

FLOW SPLITTER

1. FLOW SPLITTERS SHALL BE LOCATED PER PLANS. UNLESS OTHERWISE NOTED, ALL PORTIONS OF THE STRUCTURE SHALL BE CONSTRUCTED OF ¼" STEEL.
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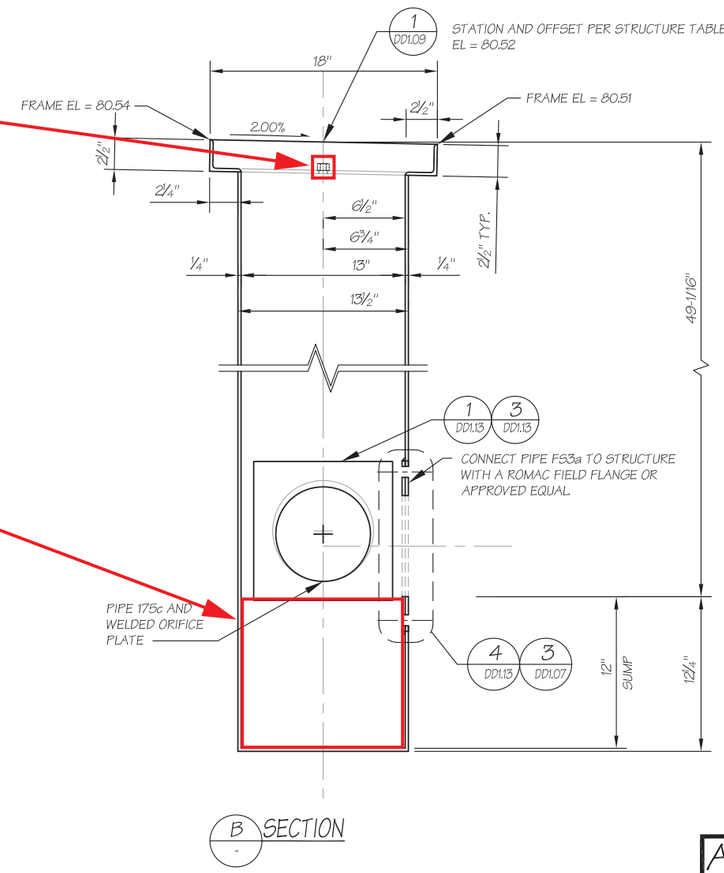
3. THE FLOW SPLITTER BOX AND FRAME SHALL BE HOT DIP GALVANIZED INSIDE AND OUT. THE EXTERIOR GALVANIZING SHALL BE COATED WITH PAINT PER MANUFACTURERS SPECIFICATIONS. THE INTERIOR GALVANIZING SHALL BE COATED WITH A BITUMINOUS COATING, TYPE 1, 2, OR 5 PER STANDARD SPECIFICATION 9-05.4(3).
4. THE RIM SHALL BE CONSTRUCTED WITH STAINLESS STEEL METAL WITH NO COATINGS. THE RIM SHALL BE CONSTRUCTED TO SUPPORT HS-25 LOAD CONDITIONS.
5. THE LID SHALL BE BOLT DOWN/LOCKING AS INDICATED IN THE DETAILS.
6. PLATE STIFFENERS SHALL BE BOLTED AND/OR WELDED AS INDICATED IN THE DETAILS.
7. WELDED PLATE STIFFENERS/ORIFICE PLATES SHALL BE WELDED CONTINUOUSLY TO THE INSIDE OF THE FLOW SPLITTER AND SHALL BE WATER TIGHT.
8. BOLTED PLATE STIFFENERS/ORIFICE PLATES SHALL BE ADJUSTED TO THE INVERT AS INDICATED IN THE DETAILS AND SEALED WITH A BITUMINOUS COATING.
9. WELDED STEEL NIPPLES SHALL BE GALVANIZED INSIDE AND OUT AND BITUMINOUS COATED ON THE INSIDE. THE OUTSIDE GALVANIZING SHALL BE PREPARED AND PAINTED ACCORDING TO THE MANUFACTURER'S RECOMMENDATIONS.
10. THE FLOW SPLITTERS SHALL BE HUNG PLUMB AND FLUSH WITH FINISHED GRADE.
11. NELSON STUDS SHALL HAVE 1½" SEPARATION FROM REBAR REINFORCING TYP.



B SECTION

AS-BUILT

Bridge Design Engr.	
Supervisor	Oates, D
Designed By	Seethoff, A
Checked By	Rhodes, J
Detailed By	Rasile, C
Bridge Projects Engr.	
Prelim. Plan By	
Architect/Specialist	

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REGION NO.	STATE	FED AID PROJ NO
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JOB NUMBER 8066		

BRIDGE AND STRUCTURES OFFICE

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SR 520
I-5 TO MEDINA - STG. 1 EVERGREEN PT FLOATING BRIDGE AND LANDINGS
BRIDGE STORMWATER

DRAINAGE DETAILS

BRIDGE SHEET NO. DD1.12

SHEET 83 OF 99 SHEETS

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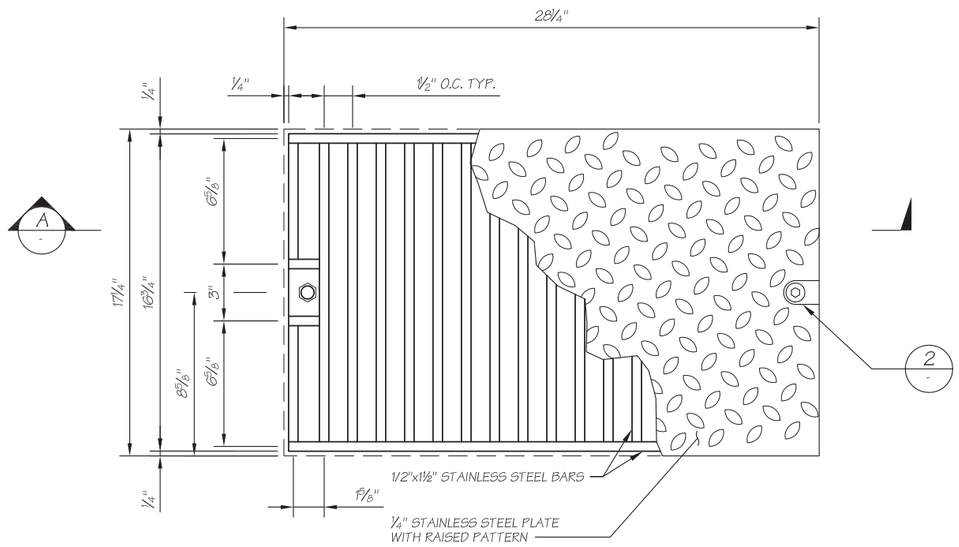
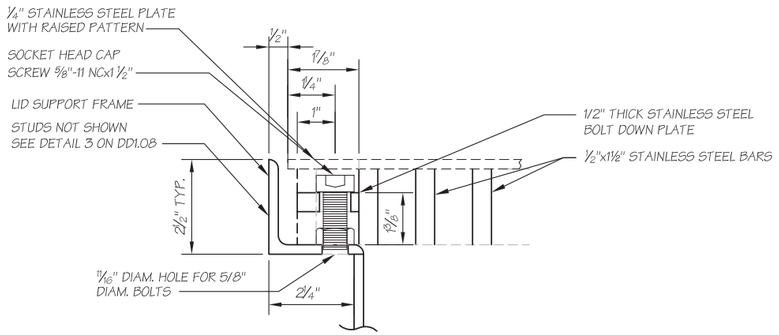
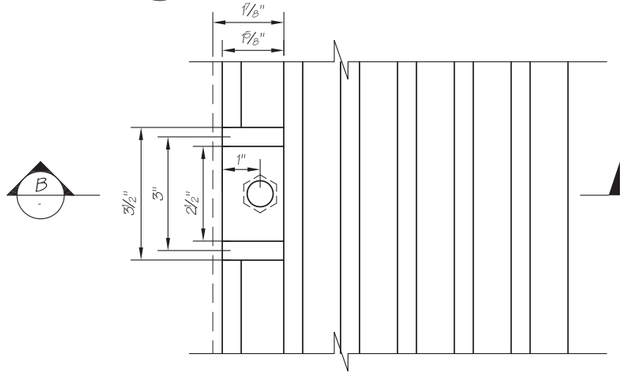


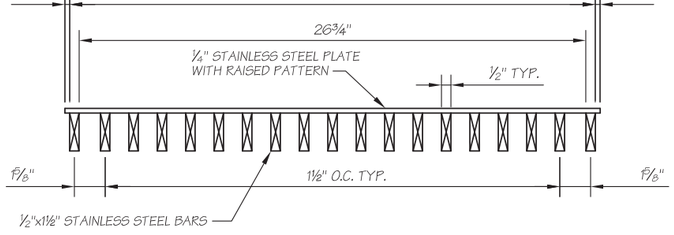
1 DD1.07 TYPICAL FLOW SPLITTER LID



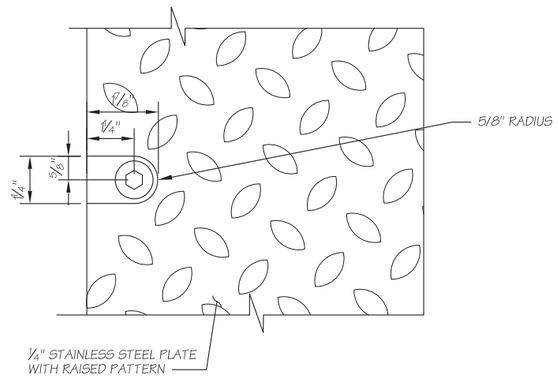
B - BOLT DOWN PLATE SECTION



BOLT DOWN FRAME PLAN



A - TYPICAL FLOW SPLITTER LID SECTION



2 - LOCKING/BOLT DOWN DETAIL

GENERAL NOTES

1. CONTRACTOR SHALL PREPARE SHOP DRAWINGS AND WELD DETAILS.
2. LID SHALL BE CAPABLE OF SUPPORTING AN HS-25 LOAD.
3. LID FINAL FABRICATION AND BOLTS/HOLES SHALL BE COORDINATED WITH FLOW SPLITTER FRAME.

AS-BUILT

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BRIDGE STORMWATER
DRAINAGE DETAILS

BRIDGE SHEET NO. DD1.09
SHEET 80 OF 99 SHEETS

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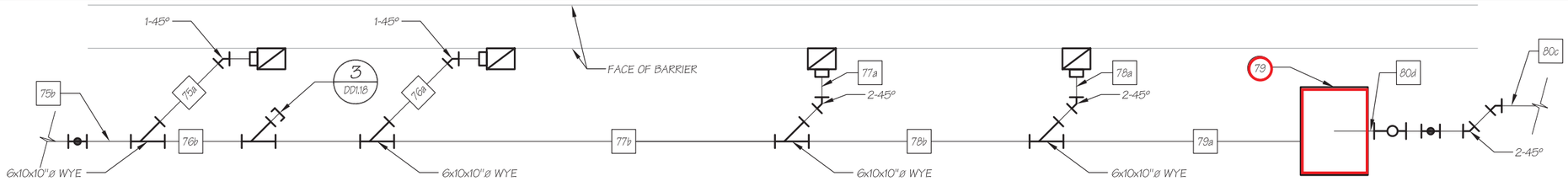
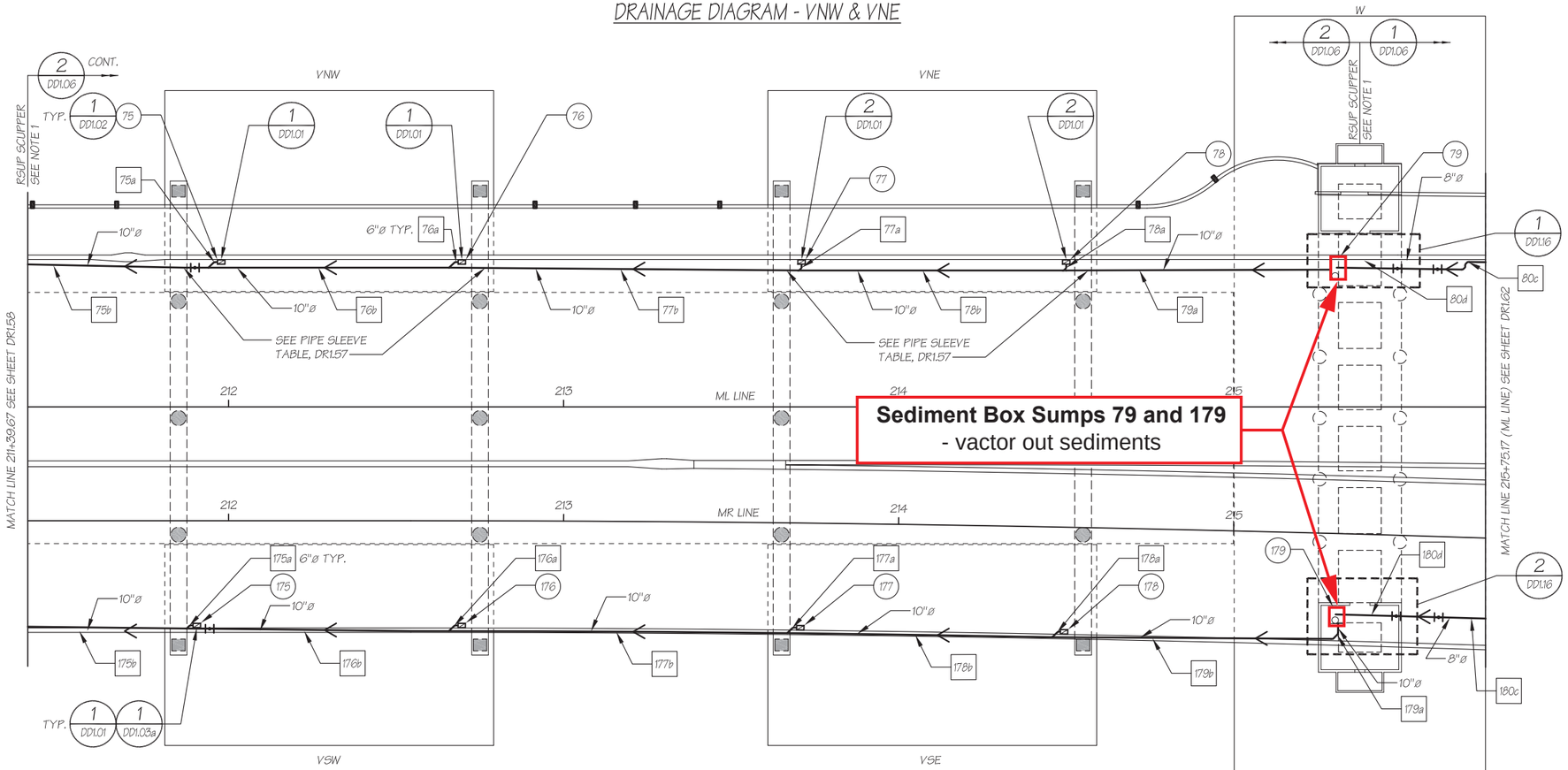
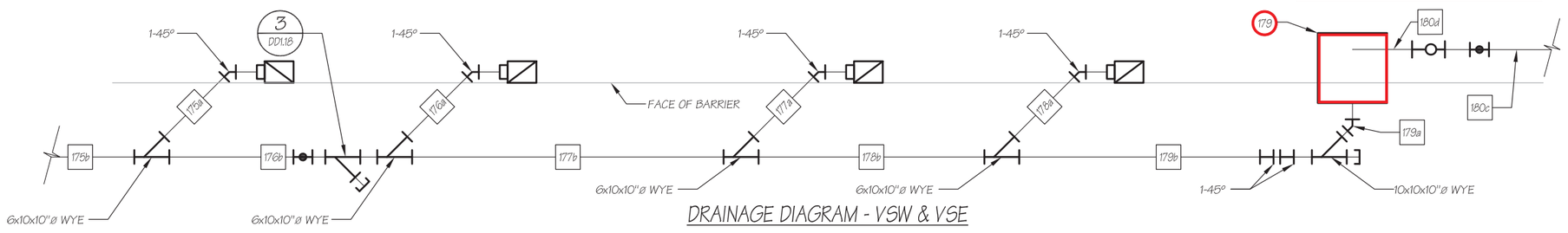


DRAINAGE DIAGRAM - VNW & VNE



PLAN



DRAINAGE DIAGRAM - VSW & VSE

NOTES

1. SEE DR1.05 FOR RSUP SCUPPER LOCATIONS.
2. SEE STRUCTURAL PLANS FOR HANGARS/SUPPORTS.
3. SEE STRUCTURAL PLANS, VOL. 8 FOR PIPE SLEEVE AND REINFORCING DETAIL AT DIAPHRAM.

LEGEND

- MODIFIED CATCH BASIN
- FLOW SPLITTER
- STORM DRAIN PIPE
- VERTICAL PIPE
- EXPANSION JOINT
- FLOW DIRECTION
- XXa PIPE SECTION
- STRUCTURAL COLUMN
- ACCESS HATCH
- WYE
- 45° BEND
- CAP
- FLEX COUPLING
- PIPE SECTION
- REDUCER
- SCUPPER
- REMOVABLE PIPE
- BALL JOINT
- TEE

AS-BUILT

Bridge Design Engr.	
Supervisor	Oates, D
Designed By	Seethoff, A
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Detailed By	Rasile, C
Bridge Projects Engr.	
Prelim. Plan By	
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BRIDGE STORMWATER

BRIDGE DRAINAGE PLAN - V & W

BRIDGE SHEET NO. DR1.61

SHEET 65 OF 99 SHEETS

VOLUME 14a - BRIDGE DRAINAGE - RELEASED FOR CONSTRUCTION - OCTOBER 10, 2012

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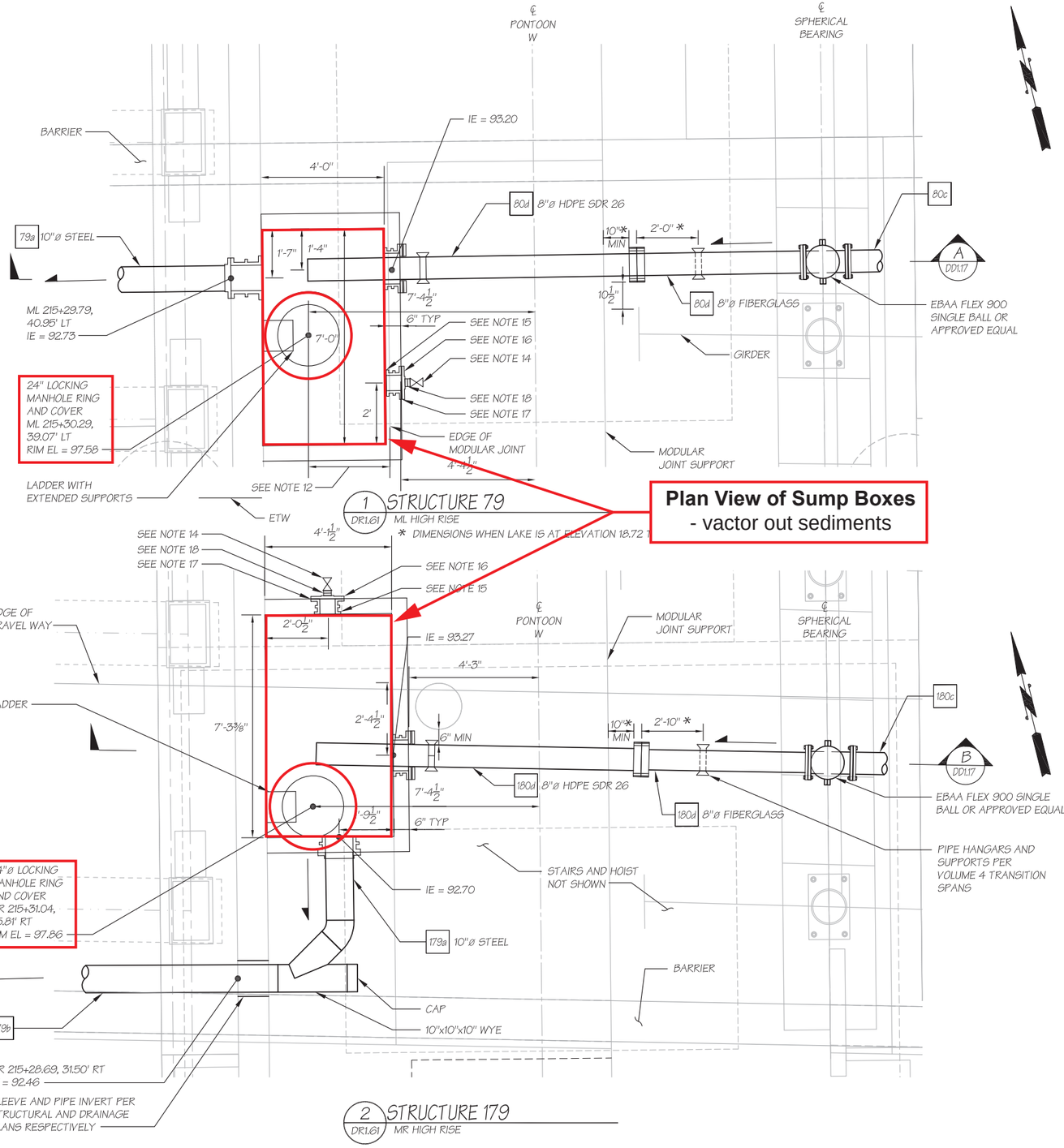

NOTES:

GENERAL CONSTRUCTION NOTES SEDIMENT BOXES AND SLIDING PIPES

1. THE SEDIMENT BOXES SHALL BE CONSTRUCTED OF WATERTIGHT REINFORCED CONCRETE WALLS CAST INTEGRAL WITH THE FLOOR, CEILING, AND SHARED WALL OF THE BRIDGE STRUCTURE.
2. JOINTS SHALL BE WATERTIGHT AND THE INTERIOR OF THE SEDIMENT BOXES SHALL BE COATED WITH A TWO PART THOROSEAL AND ACRYL 60 OR APPROVED EQUAL WITH A MINIMUM OF TWO COATS. THE COATING SHALL BE APPLIED TO A CLEAN DRY SURFACE AND ALLOWED TO CURE BEFORE EXPOSURE TO STORMWATER.
3. A MANHOLE CIRCULAR FRAME (RING) AND COVER SHALL BE INSTALLED IN THE SHOULDER WITH ACCESS TO THE SEDIMENT BOX. THE RING AND COVER SHALL BE FLUSH WITH THE FINISHED DECK GRADE AND POSITIONED AND COORDINATED WITH STRUCTURAL STEEL LAYOUT AND FORM FABRICATION. THE 24 INCH DIAMETER MANHOLE LID SHALL BE BOLT DOWN PER WSDOT STANDARD PLAN B-30.70-02 AND CONSTRUCTED OF MATERIALS IDENTIFIED IN THE STANDARD SPECIFICATIONS (9-05.15 METAL CASTINGS).
4. STEPS AND LADDERS SHALL MEET THE REQUIREMENTS OF AASHTO M199. SPACING AND LAYOUT SHALL BE ACCORDING TO WSDOT STANDARD PLAN B-30.90-01. THE 6 INCH LONG LADDER SUPPORTS SHALL BE EXTENDED AS NECESSARY TO BE FIXED TO THE VERTICAL WALLS. METAL STEPS AND LADDERS SHALL BE HOT DIPPED GALVANIZED AND EPOXY COATED.
5. THE INLET AND OUTLET SHALL BE CONSTRUCTED TO THE ELEVATIONS, LOCATIONS, AND SLOPES AS INDICATED IN THE PLANS.
6. WALL THIMBLES SHALL BE A SECTION E THIMBLE AND LOCATED TO ALLOW FOR PIPE CONNECTIONS AND INVERT ELEVATIONS AS INDICATED IN THE PLANS. THIMBLES SHALL BE DUCTILE CAST IRON (ASTM A536, CLASS B), CAST IRON WITH 2% NICKEL (ASTM A126, CLASS B), OR NIRESIST WITH THREADED FLANGE, OF ADEQUATE SECTION TO WITHSTAND ALL OPERATIONAL AND REASONABLE INSTALLATION STRESSES. WALL THIMBLES SHALL BE CLEAN AND INTERNALLY BRACED DURING CONCRETE PLACEMENT. A CENTER RING OR WATER STOP SHALL BE CAST AROUND THE PERIPHERY OF THE THIMBLE. THE FRONT FLANGE SHALL BE MACHINED AND HAVE TAPPED HOLES FOR MATING FIELD FLANGES, GASKETS, AND GASKET PLATES.
7. WALL THIMBLES SHALL BE COATED WITH A POTABLE EPOXY COATING PRIOR TO SHIPMENT. FIELD COATING REPAIRS SHALL BE PERFORMED ACCORDING TO THE MANUFACTURER'S RECOMMENDATIONS.
8. GASKETS BETWEEN THE FIELD FLANGE AND WALL THIMBLE SHALL BE A MINIMUM OF 1/8 INCH THICK MADE OF WHITE NITRILE GASKET MATERIAL THE FIELD FLANGE AND PIPE SHALL BE INSTALLED AND FITTED TO THE WALL THIMBLE TO ALLOW THE PIPE TO DISCHARGE AT THE SLOPE INDICATED ON THE PLANS.
9. THE SLIDING GASKET SEAL SHALL BE MADE OF (16) 1/32 INCHES THICK SHEETS OF UHMW. THE GASKET HOLE SHALL BE MACHINE CUT TO THE OUTER DIAMETER OF THE SLIDING PIPE (SEE DETAIL 1 ON DD1.17). THE SHEETS SHALL BE INSTALLED TO ALLOW FOR SLIDING OF THE PIPE WITHOUT BINDING OF THE GASKET. THE GASKET PLATES SHALL BE SNUG BUT NOT OVERTIGHT. THE BOLTS SHALL NOT BE SO TIGHT AS TO CAUSE WARPING OF THE GASKET PLATES. THE GASKET SEAL SHALL BE SUPPORTED ON BOTH SIDES WITH SOLID PLATES AND EXTEND A MINIMUM OF ½ INCH BEYOND THE SOLID SUPPORT PLATES. CONTRACTOR SHALL PROVIDE ONE TEMPLATE FOR THE GASKET.
10. THE SLIDING PIPE SHALL BE HDPE DR26 8 INCH DIAMETER WITH BUTT FUSE WELDED FLANGE CONNECTIONS TO THE STEEL FLANGE FITTINGS.
11. ROLLING PIPE SUPPORTS SHALL BE WITHIN 9 INCHES OF THE SLIDING GASKET SEAL. THE SUPPORT SHALL BE POSITIONED TOP AND BOTTOM TO PREVENT THE WEIGHT OF THE PIPE FROM RESTING ON THE GASKET SEAL SHEETS AND RUBBING. PIPE SUPPORTS SHALL BE ROLLER TYPE SUPPORTS AND SHALL BE POSITIONED TO PREVENT CONFLICT WITH FLANGES, BOLTS, AND/OR OTHER ASSEMBLY ITEMS.
12. CONTRACTOR SHALL FIELD MAXIMIZE DISTANCE OF MANHOLE RING AND COVER FROM MODULAR JOINT.
13. SEE STRUCTURAL PLANS FOR JOINTS, REINFORCING AND INTEGRATION WITH COLUMN, FLOOR, AND BEAM MEMBERS.

NOTES - CONTINUED:

14. DRAINAGE VALVE SHALL BE 2" DIAM. NON LUBRICATED PLUG VALVE. THE VALVE SHALL BE A THREADED VALVE WITH THREADS CONFORMING TO ANSI/ASME B1.20.1.
15. THE WALL THIMBLE SHALL BE A CAST IRON TYPE E THIMBLE WITH ROUND FRONT FLANGE ROUND OPENING STYLE. THIMBLE SIZE SHALL BE NO GREATER TAN 6" DIAM. AND NO LESS THAN 2" DIAM. OUTSIDE RING OF THIMBLE SHALL BE DRILLED AND TAPPED TO ACCEPT A CLASS 150 FLANGE OF LIKE DIAMETER.
16. THE WALL THIMBLE WITH REDUCING COMPANION FLANGE SHALL BE WATER TIGHT. THE COMPANION FLANGE SHALL BE THREADED TO ACCEPT A 2" DIAM. PIPE, THREADS SHALL CONFORM TO ANSI/ASME B1.20.1.
17. THE FULL FACED GASKET SHALL BE CONSTRUCTED OF NITRILE RUBBER SUITABLE FOR A CLASS 150 FLANGE AND INSTALLED PER THE GASKET MANUFACTURER'S INSTRUCTIONS..
18. TEFLON TAPE SHALL BE USED ON ALL THREADS AND SHALL BE INSTALLED IN A MANNER TO ENSURE A LEAK FREE SEAL AT ALL JOINTS.

AS-BUILT

Bridge Design Engr.	
Supervisor	Oates, D
Designed By	Seethoff, A
Checked By	Rhodes, J
Detailed By	Rasile, C
Bridge Projects Engr.	
Prelim. Plan By	
Architect/Specialist	

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SR 520
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BRIDGE STORMWATER

DRAINAGE DETAILS

BRIDGE SHEET NO. DD1.16

SHEET 87 OF 99 SHEETS

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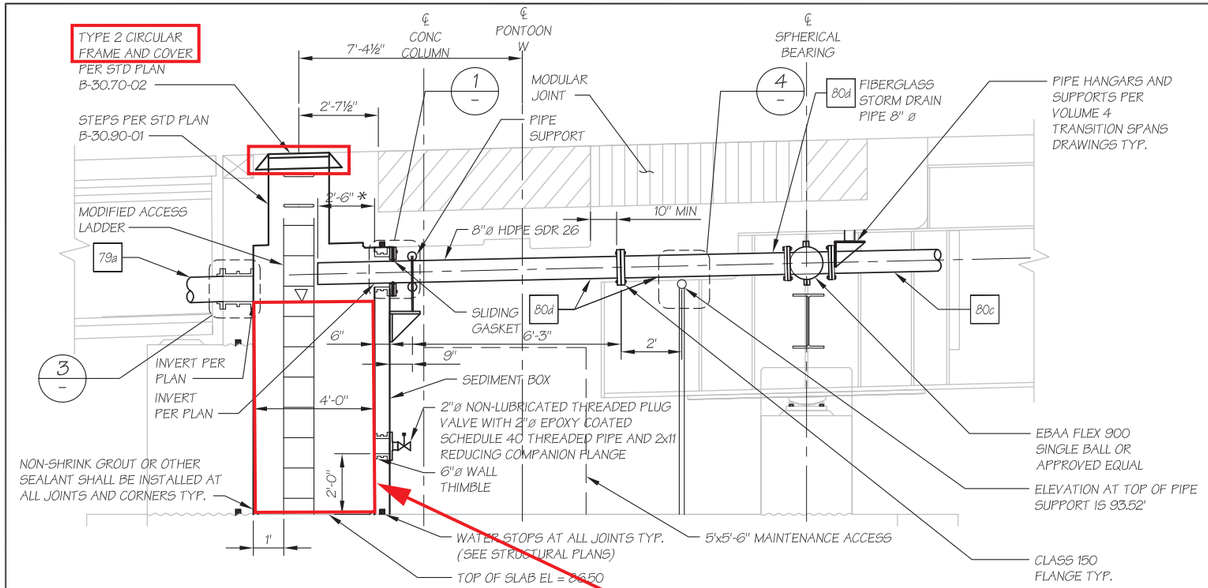
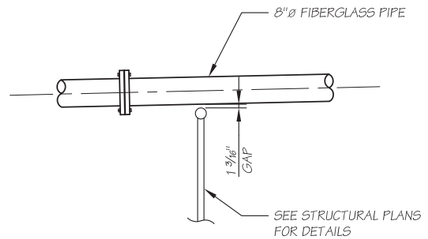


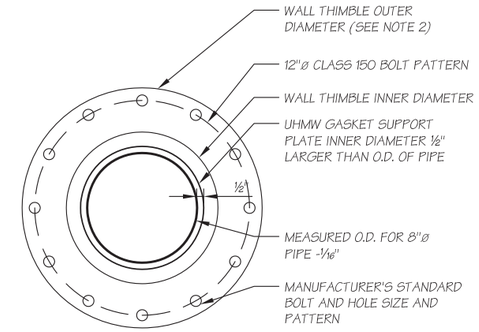
A DD1.16 **PIPE AT PIER W**
ML HIGH RISE

Elevation View of Sump Boxes
- vactor out sediments

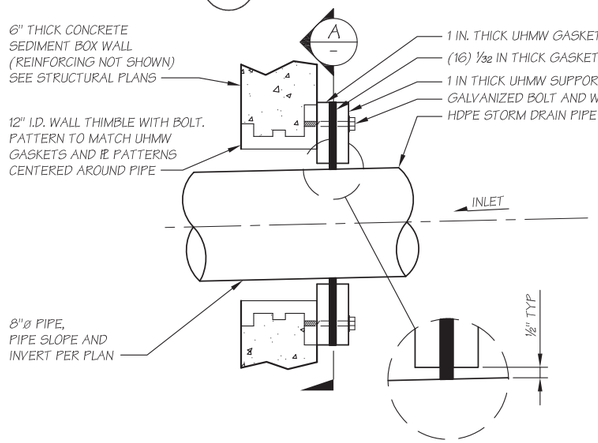
* DIMENSIONS WHEN LAKE IS AT ELEVATION 18.72 TYP.



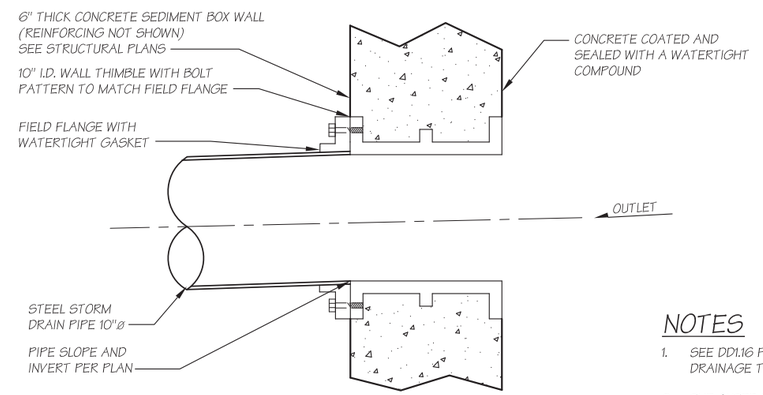
4 - **INTERMEDIATE PIPE SUPPORT IN W**
ML AND MR HIGH RISE



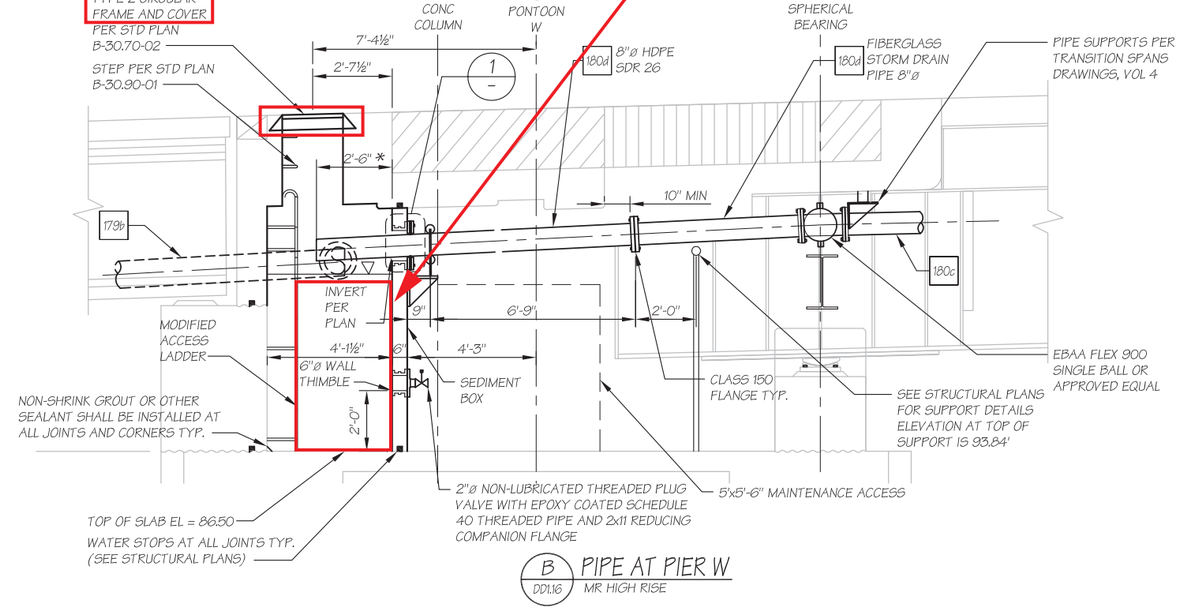
A - **SLIDING PIPE GASKET DETAIL**
ML AND MR HIGH RISE



1 - **SLIDING PIPE DETAIL**
DD1.16 ML AND MR HIGH RISE



3 - **PIPE OUTLET DETAIL**
ML AND MR HIGH RISE



B DD1.16 **PIPE AT PIER W**
MR HIGH RISE

NOTES

1. SEE DD1.16 FOR NOTES ON STORM DRAINAGE THROUGH PIER W.
2. THE OUTER DIAMETER OF THE UHMW GASKET SUPPORT PLATE SHALL BE WITHIN ½" OF THE OUTER DIAMETER OF THE WALL THIMBLE.

AS-BUILT

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BRIDGE SHEET NO. DD1.17

SHEET 88 OF 99 SHEETS

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