Annual Report for Monitoring of Suspended Sediment Concentrations and Turbidity During the 2025 Water Year in McCloud Creek, Humboldt County, California

Pursuant to:
Monitoring and Reporting Program (MRP)
Order No. R1-2020-0001

Prepared By:
Green Diamond Resource Company
Korbel, CA

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1 Introduction

Elk River is listed as an impaired water body under Section 303(d) of the Federal Clean Water Act (USEPA, 1999) due to high instream sediment loads and associated adverse impacts to the beneficial uses of water. In response to this, the North Coast Regional Water Quality Control Board (NCRWQCB) developed a Total Maximum Daily Load (TMDL) for sediment in Elk River. In May 2016 the NCRWQCB adopted the Action Plan for the Upper Elk River Sediment TMDL as an amendment to the Water Quality Control Plan for the North Coast. The TMDL Action Plan was approved by the State Water Resources Control Board in August 2017, the Office of Administrative Law in March 2018, and the US Environmental Protection Agency in April 2018.

To address the Elk River sediment impairment, the NCRWQCB has adopted and revised multiple Waste Discharge Requirements (WDRs) with Green Diamond Resource Company (GDRCo) over the years. These Orders have included Monitoring and Reporting Programs (MRPs), that include the monitoring activities that GDRCo has been conducting in Elk River beginning in 2006. The current Order (R1-2020-0001) supersedes those portions of GDRCo's Forest Management WDR (Order R1-2012-0087) that apply to certain activities conducted by GDRCo on our timberlands in the Upper Elk River Watershed.

As part of the MRP in Order No. R1-2020-0001, GDRCo has agreed to continue to conduct water-quality trend monitoring in McCloud Creek, a tributary of South Fork Elk River. Using Turbidity Threshold Sampling (TTS), GDRCo measured stage, water velocity, turbidity and suspended sediment concentrations in McCloud Creek during the 2025 Water Year (WY2025). This annual report covers the period from October 1, 2024 to July 1, 2025, during which TTS monitoring occurred.

2 Data Collection and Analysis Activities

Data collection and analysis have been conducted as outlined in the MRP (Order No. R1-2020-0001), Standard Operating Procedures, and the Turbidity Threshold Sampling Quality Assurance Project Plan for McCloud Creek. See this document for further details on the monitoring parameters, protocols, and frequencies.

2.1 Station Installation and Adjustments

Equipment was installed on September 19, 2024 at the McCloud Creek TTS station for WY2025. The surface hydrology was disconnected at this time and the monitoring unit was an isolated pool. The station was turned online beginning October 28, 2024 when continuous flow was observed, at which time stage and turbidity were monitored and the station remained online for the remainder of the water year.

2.2 Continuous Measurement Station

WY2025 concluded the 19th year of monitoring at the McCloud Creek TTS station. The TTS station was established in McCloud Creek in 2007 on BLM property, approximately 400 feet upstream from the confluence with South Fork Elk River (Figure 1). The watershed area above the McCloud TTS monitoring site is approximately 1,482 acres (6.0 km^2). The specifications for the construction and operation of the TTS station are based on procedures developed by the United States Forest Service Redwood Science Laboratory (Lewis and Eads, 2009). The station automatically records stage height and turbidity at 10-minute intervals and collects and stores automated grab samples of creek water, which are later transported to the lab and analyzed to quantify turbidity and suspended sediment concentration. Table 1 displays all the parameters and frequency of measurements collected at the McCloud Creek TTS station.

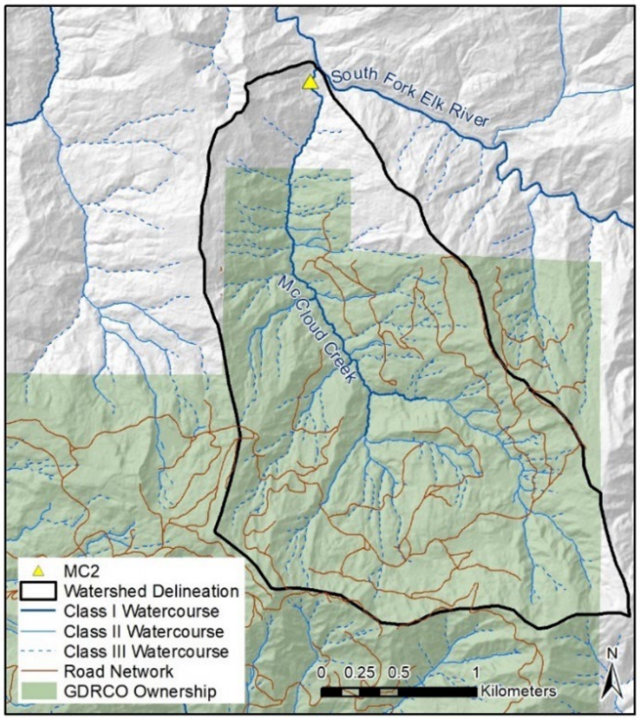

Figure 1. Location of the McCloud Creek Turbidity Threshold Sampling station (MC2) with monitored watershed extent and road network.

Table 1. McCloud Creek TTS station parameters and specifications.

Parameter	Units	Sampling Method	Sampling Frequency
Turbidity	FNU	DTS-12 (turbidimeter, in situ measurement)	Continuous (10-minute interval)
Turbidity	NTRU	Manual grab sample, ISCO water sampler	When FNU > 30 during visit
Suspended sediment	mg/L	Manual grab sample, ISCO water sampler	When FNU > 30 during visit
Suspended sediment	mg/L	Automated grab sample, ISCO water sampler	Event driven, based on turbidity thresholds
Discharge	cfs	Direct measurement	Weekly[1] and as needed for stage-discharge relationship
Stage	ft	Druck (pressure transducer, in situ measurement)	Continuous (10-minute interval)
Stage	ft	Stage plate	Weekly

[1] May vary due to low-flow conditions where velocity is below minimum required for current meters.

2.3 Field Visits-Summary of Logs

A total of 41 field visits (about one or more times a week) were conducted during WY2025. Visits were conducted to exchange sample bottles and batteries, download data, take streamflow measurements, or perform other storm-related maintenance activities. A summary of the activities conducted during WY2025 is provided in Table 2.

*Table 2. Summary of field activities at the McCloud Creek TTS station during the 2025 Water Year. *Type: SI = Site installation, CO = Construction, MO = Monitoring (flow measurements, and grab samples), MA = Maintenance (sensor cleanings and site adjustments), G/C = grab and control samples were collected.*

Date	Type*	Comments
9/19/2024	SI, CO	Monitoring equipment installed, station offline due to hydrologically disconnected monitoring unit
9/20/2024	SI	Monitoring equipment installed, station offline due to hydrologically disconnected monitoring unit
10/16/2024	SI, CO	Monitoring equipment installed, station offline due to hydrologically disconnected monitoring unit
10/28/2024	SI, MO	Station online for stage and turbidity, monitoring unit is not hydrologically connected
10/31/2024	MA	Adjusted DTS
11/4/2024	MA	Desiccant change
11/11/2024	MO, MA	Measured discharge, adjusted DTS
11/14/2024	MO, MA	Measured discharge, adjusted DTS, G/C
11/18/2024	MO, MA	Measured discharge, adjusted DTS, re-calibrated ISCO volume, advanced data dump, G/C
11/21/2024	MO, MA	Measured discharge twice, adjusted DTS, advanced data dump twice, G/C
11/25/2024	MO, MA	Measured discharge, adjusted DTS, advanced data dump, G/C
12/6/2024	MO, MA	Measured discharge, adjusted DTS, advanced data dump
12/9/2024	MA	Cleaned sediment from druck and re-calculated stage offset
12/17/2024	MO, MA	Measured discharge, adjusted DTS, desiccant change, advanced data dump
12/23/2024	MA	Adjusted DTS
12/25/2024	MA	Adjusted DTS, advanced data dump, G/C
12/31/2024	MA	Adjusted DTS, advanced data dump, G/C
1/6/2025	MO, MA	Measured discharge, adjusted DTS, advanced data dump, G/C
1/13/2025	MO, MA	Measured discharge, adjusted DTS, advanced data dump
1/21/2025	MO, MA	Measured discharge, desiccant change, replaced wiper blade on DTS
1/27/2025	MO	Measured discharge
2/4/2025	MO, MA	Measured discharge, adjusted DTS, advanced data dump, G/C
2/7/2025	MO, MA	Measured discharge, adjusted DTS, advanced data dump, G/C

Date	Type*	Comments
2/11/2025	MO, MA	Measured discharge, adjusted DTS, re-calibrated ISCO volume, advanced data dump
2/17/2023	MO	Grab & control collected, advanced data dump, G/C
2/25/2025	MO, MA	Measured discharge, adjusted DTS, advanced data dump
3/3/2025	MO, MA	Measured discharge, adjusted DTS, advanced data dump, G/C
3/13/2025	MO, MA	Measured discharge, adjusted DTS, advanced data dump, G/C
3/17/2025	MO, MA	Measured discharge, adjusted DTS, advanced data dump, G/C
3/21/2025	MO, MA	Measured discharge, adjusted DTS, advanced data dump
3/25/2025	MO	Measured discharge, advanced data dump
3/31/2025	MO, MA	Measured discharge, adjusted DTS, advanced data dump
4/2/2025	MO, MA	Measured discharge, adjusted DTS, advanced data dump, G/C
4/8/2025	MO, MA	Measured discharge, adjusted DTS, advanced data dump
4/15/2025	MO, MA	Measured discharge, adjusted DTS, cleaned druck and re-calculated stage offset
4/24/2025	MO, MA	Measured discharge, adjusted DTS
4/29/2025	MO	Measured discharge
5/5/2025	MO	Measured discharge
5/13/2025	MO, MA	Measured discharge, adjusted DTS, advanced data dump
5/20/2025	MO	Measured discharge
5/27/2025	MO	Measured discharge
6/3/2025	MO	Measured discharge
6/10/2025	MO, MA	Measured discharge, adjusted DTS
6/18/2025	MO	Measured discharge
6/24/2025	MO	Measured discharge
7/1/2025	MO	Site dismantle, monitoring equipment removed for cleaning and calibration. End of 2025 water year.

2.4 Site Observations

A summary of site observations was compiled for WY2025 (Table 3). These site visit observations included notable items relating to the station status and site conditions. Observations for this water year included station status, hydrologic conditions and discharge measurement quality.

Table 3. Summary of station observations collected at the McCloud Creek TTS station during the 2025 Water Year.

Date	Observation	Personnel
9/19/2024	Monitoring unit is an isolated pool and hydrologically disconnected. Station offline.	RCH
9/19/2024	Monitoring equipment installed and tested. (EXCEPT DTS)	RCH
9/20/2024	Monitoring unit is an isolated pool and hydrologically disconnected. Station offline.	SRB
10/16/2024	Monitoring unit is an isolated pool and hydrologically disconnected. Station offline.	SRB
10/16/2024	DTS installed and tested	SRB
10/28/2024	Station is fully online for stage and turbidity due to druck being submerged. Monitoring unit is an isolated pool and hydrologically disconnected. Control is wetted and looks like stream came up and was flowing previously but has now dropped out again. Site was put online, due to druck being fully submerged, ahead of rain forecasted for 10/30/24-11/1/24, which should result in the unit becoming hydrologically connected	ERM
10/31/2025	Stage data suggested that the monitoring unit became hydrologically connected at approximately 08:00	MRR
2/4/2025	Discharge measurement had six verticals >10% of total flow; graded as poor data in TTS.	ERM
3/21/2025	Channel control still caused by debris jam downstream with tributary closest to unit constituting ~20-30% of flow through the unit.	SRB
3/21/2025	As a result of log jam and at request of MRR, measured discharge upstream of low water cross section and DTS in between the 2 small tribs. flowing upstream of our unit: measurement had two verticals >10% of total flow; graded as fair data in TTS	SRB
3/25/2025	Discharge measured approximately 25 feet upstream of normal cross-section due to channel control debris(logjam) potentially causing shift in the rating curve for the site.	ERM
3/31/2025	Discharge measured approximately 25 feet upstream of normal cross-section due to channel control debris(logjam) potentially causing shift in the rating curve for the site.	SRB
6/18/2025	Discharge measurement had six verticals >10% of total flow; graded as poor data in TTS.	SRB
6/24/2025	Discharge measurement had five verticals >10% of total flow; graded as poor data in TTS.	SRB
7/1/2025	Monitoring equipment removed from station. Station offline. Water season has concluded, turned off station for disassembly. Monitoring unit is still flowing/connected	SRB/RCH

2.5 Data Download Summary

The data stored on the data logger at the TTS station was downloaded to a field tablet at least weekly when the station was online. The files were then transferred to the GDRCo server and compiled into a proprietary SQL database. Editing and analysis were performed using this database, Aquatic Informatics' AQUARIUS Time-Series© (hereafter referred to as Aquarius; Aquatic Informatics Inc., 2025), and Microsoft Excel. The electronic data file for this report is labeled as "Appendix_A_MC2_All_Data_WY2025.xlsx" and was submitted with this annual report in accordance with the NCRWQCB 2014 electronic document submission guidelines (Appendix A).

3 Monitoring Results for WY2025

3.1 Data Summary

Hydrological monitoring at the McCloud Creek TTS station for WY2025 was continuous from October 28, 2024 through July 1, 2025 when the monitoring unit was hydrologically connected. Key observations during this period: maximum recorded stage = 5.22 ft (February 3,2025), estimated annual peak discharge ≈ 288 cfs (February 3, 2025), maximum recorded turbidity = 1,559 FNU (December 29, 2024), maximum estimated instantaneous SSC = 2,998 mg/L (December 29, 2024), and estimated annual suspended sediment load = 2,412 Mg (2,411,799 kg). The WY2025 annual sediment yield at MC2 was 401.1 Mg km^{-2} yr^{-1}, approximately 60% higher than the median value. Approximately 25% of the WY2025 sediment load was delivered during the February 3rd storm. A total of 251 water samples were collected during WY2025 (223 automated, 28 manual) and 34 discharge measurements were made for stage-discharge rating curve development. Temporal comparisons (WY2007–2025) are presented in Figure 2 to illustrate how WY2025 fits within the longer monitoring record.

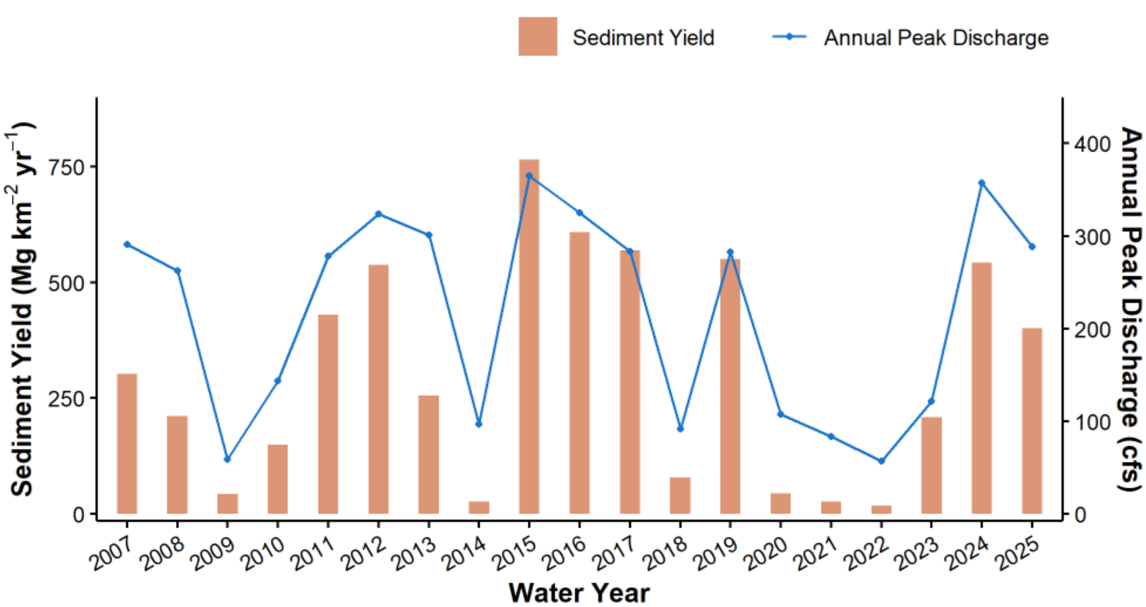

Figure 2. Annual sediment yield (Mg km^{-2} yr^{-1}) and annual peak discharge (cfs) estimates for the McCloud TTS monitoring site for Water Years 2007 through 2025.

WY2025 occurred under wetter-than-normal conditions in the region, with accumulated precipitation at nearby Eureka area rain gauges approximately 120% of normal (Figure 3). These conditions contributed to above-median peak flows and sediment yield this water year. Data capture was high, with 98.1% of stage values falling within the empirical range of measured discharges used in the rating. Where short gaps or sensor issues occurred, turbidity–SSC relationships and documented estimation methods were applied as described in Appendix C. All estimated values are flagged in the station dataset (Appendix A), and calibration records are available upon request.

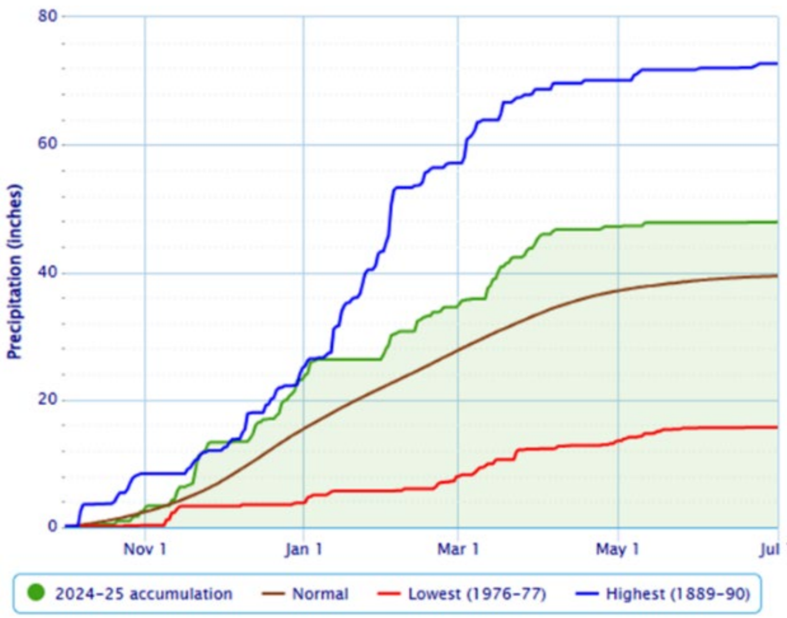

Figure 3. Accumulated precipitation at NOAA rain gauges in the Eureka area for Water Year 2025 (October 1 to July 1). Data source: NOAA, 2025.

Discharge and load estimates above the maximum measured rating stage (4.3 ft, ≈200 cfs) carry increased uncertainty because channel geometry and flow paths change above that level. Extrapolated values, including portions of the February 3rd peak, should be interpreted with caution. Continued collection of high-stage discharge measurements will help reduce uncertainty in future years.

3.1.1 Continuous Stage

A Druck pressure transducer (Druck Inc.) was used to measure continuous stage height (feet) at 10-minute intervals throughout WY2025 (Figure 4). The maximum recorded stage was 5.22 feet and occurred on February 3, 2025. Stage plate observation (accuracy +/- 0.02 feet) was used to validate the stage readings during each site visit. Where recorded stage values were erroneous or missing due to stage drift, stage offset, or equipment failure, values were estimated using time-interpolated drift corrections, offset corrections, or interpolated using adjacent valid data in Aquarius. The type of estimates used for missing or erroneous data was noted and can be found in the 'Data Management' tab of the electronic data file (Appendix A).

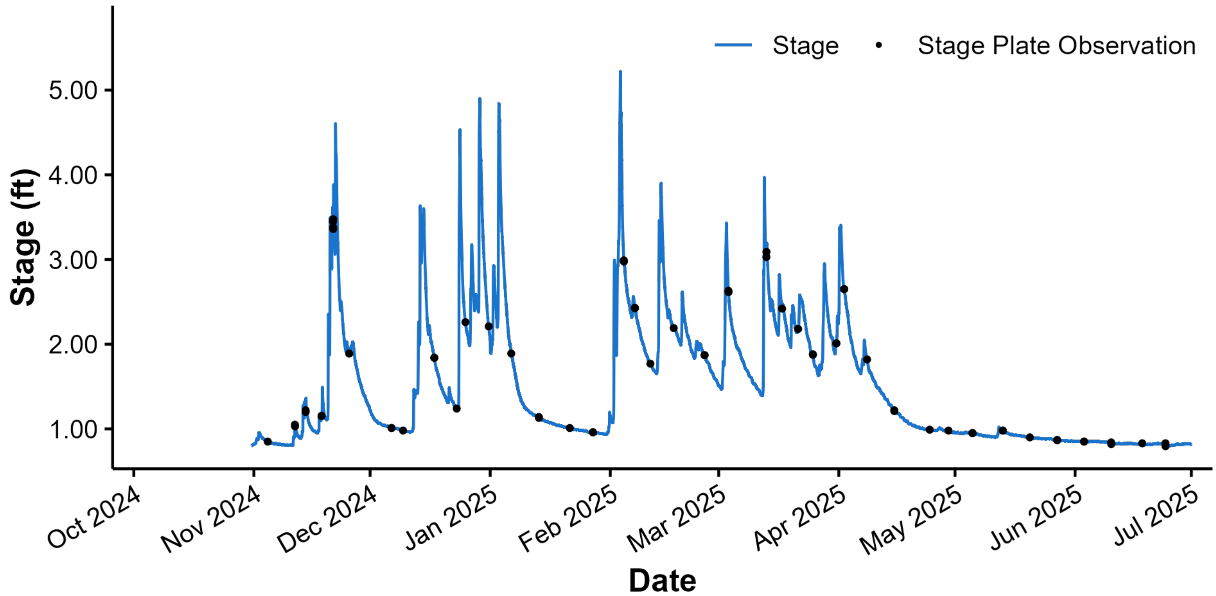

Figure 4. Continuous time-series of stage collected by the instream pressure transducer sensor and stage plate observations at the McCloud Creek TTS station during the 2025 Water Year.

3.1.2 Stage-Discharge Relationship

During WY2025, GDRCo personnel collected 34 discharge measurements using USGS Price AA or pygmy current meter. Using Aquatic Informatics' Rating Review Tool (Aquarius, 2025), coincidental stages were taken with discharge measurements and plotted to create a rating curve for WY2025 (Figure 5). One effective rating period was used during WY2025, and the same relationship has been applied since the storm event on January 13, 2024, as there have been no major physical changes to the channel controlling the monitoring unit since then. Three shifts were applied to the base rating during WY2025 due to physical changes of the section control in the monitoring unit.

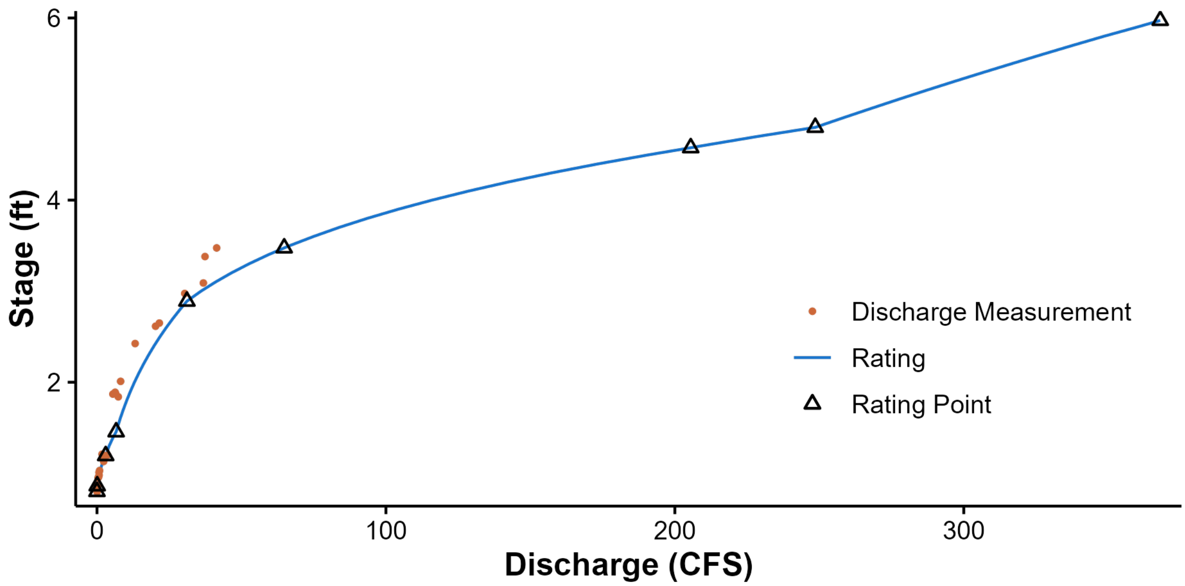

Figure 5. Discharge–stage rating, associated rating points, and measurements for the 2025 water year (shifts not shown).

3.1.3 Continuous Discharge

Continuous discharge for WY2025 (Figure 6) was derived using one discharge-stage rating model and the continuous stage time series data in Aquarius. The estimated peak discharge for McCloud Creek during WY2025 occurred on February 3, 2025, and was about 288 cfs (stage = 5.22 ft). The extrapolated discharge values that exceed the range of empirical values have a high uncertainty given the lack of discharge measurements for stages greater than 4.3 ft (about 200 cfs). Despite this limitation, 98.1% of the stage measurements recorded during WY2025 were within the range of measured discharges used in the rating. A general rule of thumb is to not estimate over two times the max measured discharge stage value as it becomes exceedingly difficult to estimate as this is where floodplain controls take effect.

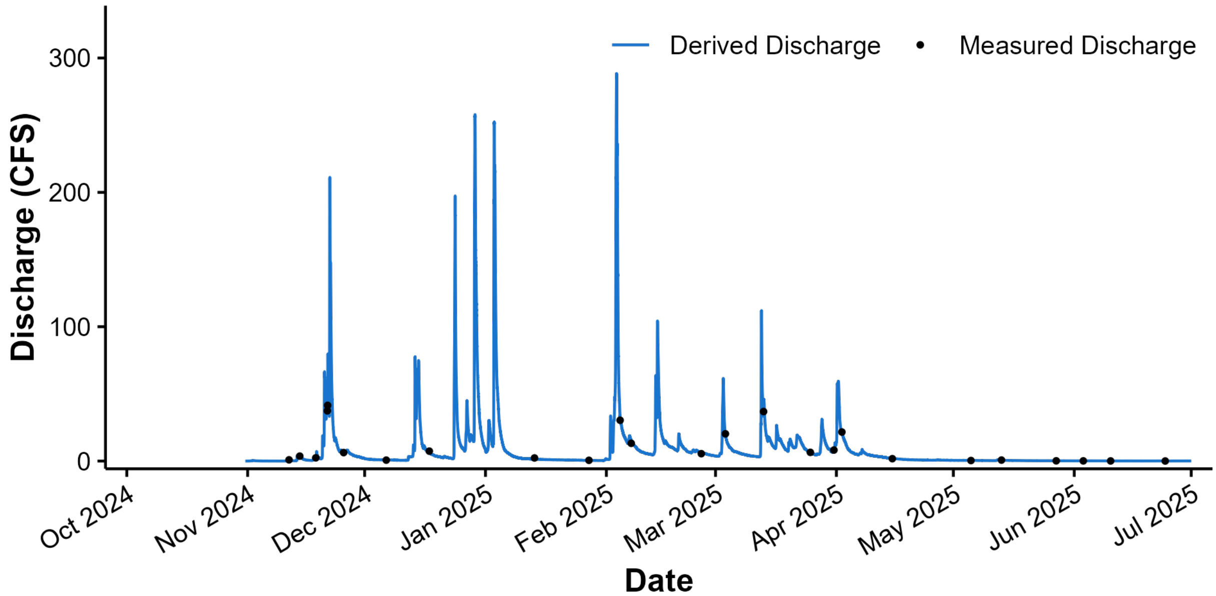

Figure 6. Continuous estimated discharge and measured discharge at the McCloud Creek TTS station during the 2025 Water Year.

3.1.4 Turbidity and Water Samples

Turbidity was measured using two methodologies at the McCloud Creek TTS station during WY2025. First, a DTS-12 turbidity sensor (Forest Technology Systems, LTD., Victoria, B.C., Canada) was used to measure continuous turbidity (Formazin Nephelometric Units [FNU]) in situ in McCloud Creek. Second, turbidity was also measured in the laboratory using a HACH TL2300 turbidimeter (Hach Company, Loveland, Colorado), which analyzes turbidity in Nephelometric Turbidity Ratio Units (NTRU) from collected water samples.

Water samples were collected concurrently using an ISCO 3700C water sampler (Teledyne ISCO, Lincoln, Nebraska). Samples were triggered either automatically based on predefined turbidity thresholds or manually during field visits when the in-situ turbidity reading was 30 FNU or greater.

A total of 251 water samples were collected during WY2025. Of these, 223 samples were collected automatically through turbidity threshold sampling, while 28 samples were collected manually during field visits, representing 14 paired field samples. The primary purpose of the paired samples was to support laboratory quality control.

Low-level turbidity samples (FNU < 30 FNU) comprised a disproportionate share of the total collected, which can introduce bias in the low end of the FNU–NTRU relationship. To reduce this potential bias, a systematic subsampling protocol was implemented wherein only 50% of the low-turbidity samples were processed in the lab. In total, 122 automated samples and 20 manual samples were processed for turbidity analysis using the HACH TL2300 turbidimeter.

A regression relationship was developed between the lab-based (NTRU) and field-based (FNU) turbidity measurements. This regression equation (Figure 7) was then applied to lab turbidity values to assist in reconstructing missing field turbidity data, smoothing erratic in situ measurements, and verifying turbidity spikes.

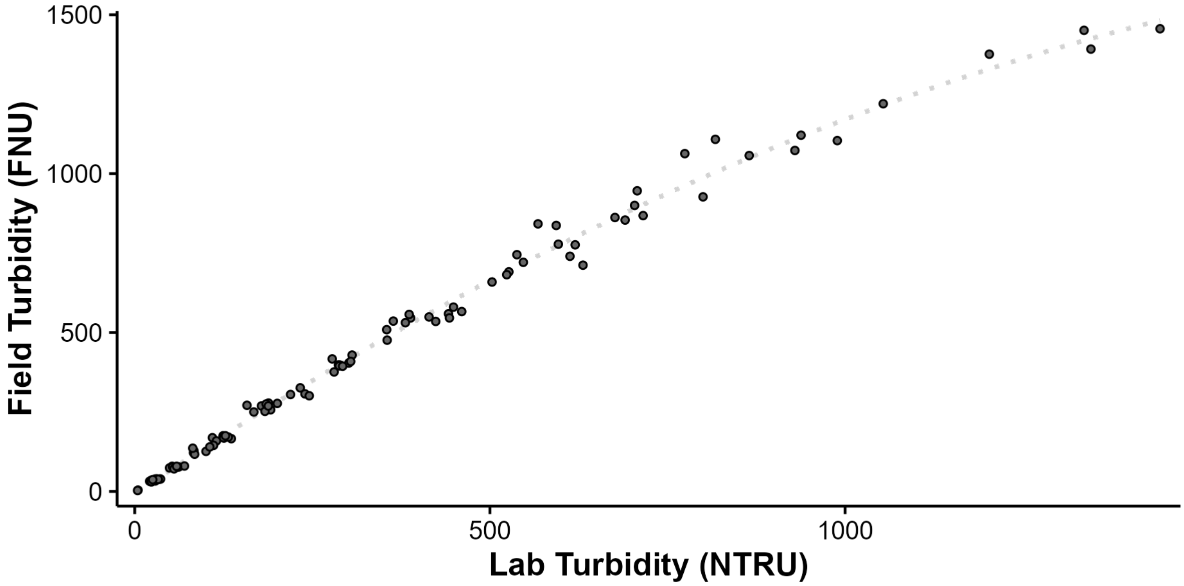

Figure 7. Relationship between coincident lab turbidity measurements (NTRU) and field turbidity measurements (FNU) collected at the McCloud Creek TTS station during the 2025 Water Year.

3.1.5 Continuous Turbidity

A DTS-12 sensor recorded continuous turbidity measurements (in FNU) at 10-minute intervals throughout WY2025. The timestamps of automated grab samples, triggered by turbidity threshold exceedances, were compiled and overlaid on the continuous turbidity time series for WY2025 (Figure 8). The maximum turbidity recorded was 1,559 FNU and occurred on December 29, 2024. Periods with missing or erroneous turbidity data, due to equipment malfunction or exceedance of the sensor's measurable range, were addressed using a combination of estimation methods. These included stage-based regression models, values derived from corresponding grab samples when available, or interpolation from surrounding valid data points. The method used for each estimated value is documented in the 'Data Management' tab of the electronic data file (Appendix A).

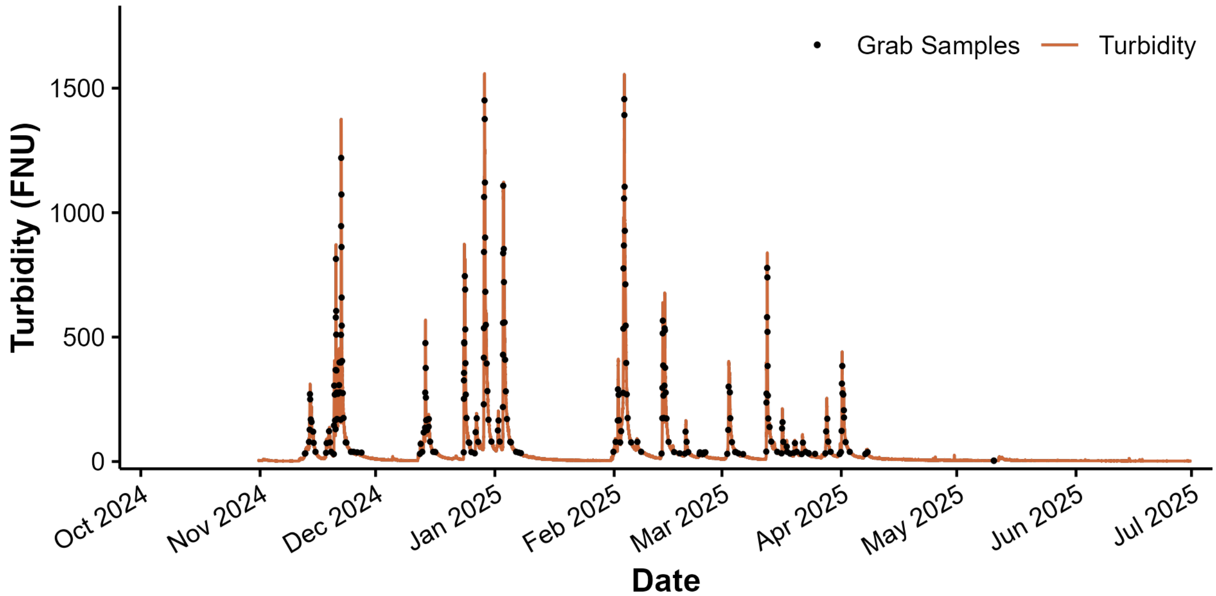

Figure 8. Continuous Time-Series of turbidity collected by the instream DTS-12 sensor and timing of turbidity threshold grab samples at the McCloud Creek TTS station during the 2025 Water Year.

3.1.6 Comparative Analysis of Continuous Stage and turbidity

Continuous stage and turbidity data were visually compared to identify any turbidity increases not associated with rising stage, which could indicate additional sediment inputs from sources such as localized landslides, upstream tributaries, or nearby roads. As expected, most turbidity increases at the McCloud Creek TTS site during WY2025 coincided with rising stage, suggesting that turbidity was primarily driven by discharge (Figure 9). One major exception occurred on December 24, 2024 during the rising limb of a storm event, when a turbidity event lasting about an hour peaked at 874 FNU, exceeding the peak turbidity of the storm event itself. Several smaller turbidity events were also observed between mid-March and early April on the falling limb of storm events. Overall, the two largest turbidity increases of the year aligned with the two highest peak stage events, on December 29, 2024, and February 3, 2025.

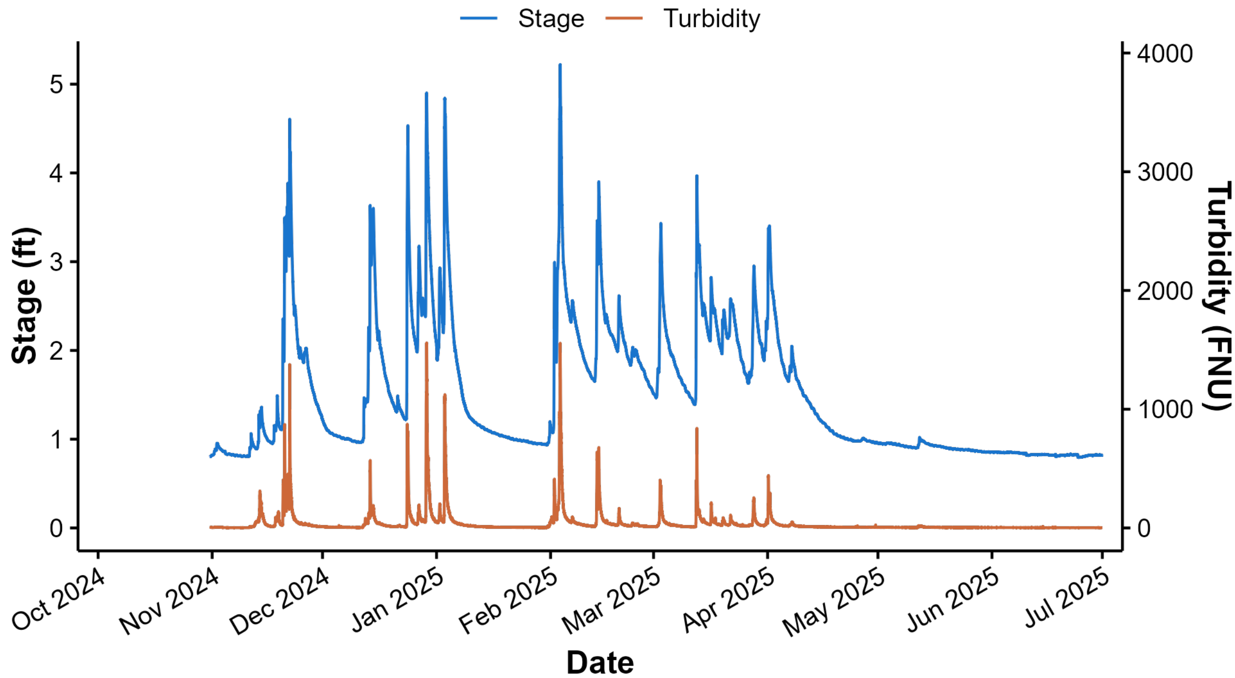

Figure 9. Continuous time-series of stage and turbidity at the McCloud Creek TTS station during the 2025 Water Year.

3.1.7 Suspended Sediment Concentration

The relationship between suspended sediment concentration (SSC, in mg/L) of the grab samples and the coincident field turbidity (FNU) for WY2025 is shown in Figure 10. There was a total of 220 automated samples processed for suspended sediment concentration during WY2025. The initial assessment of this relationship is relatively simplistic, and a better fit of these data is possible through an assessment of storm-specific relationships.

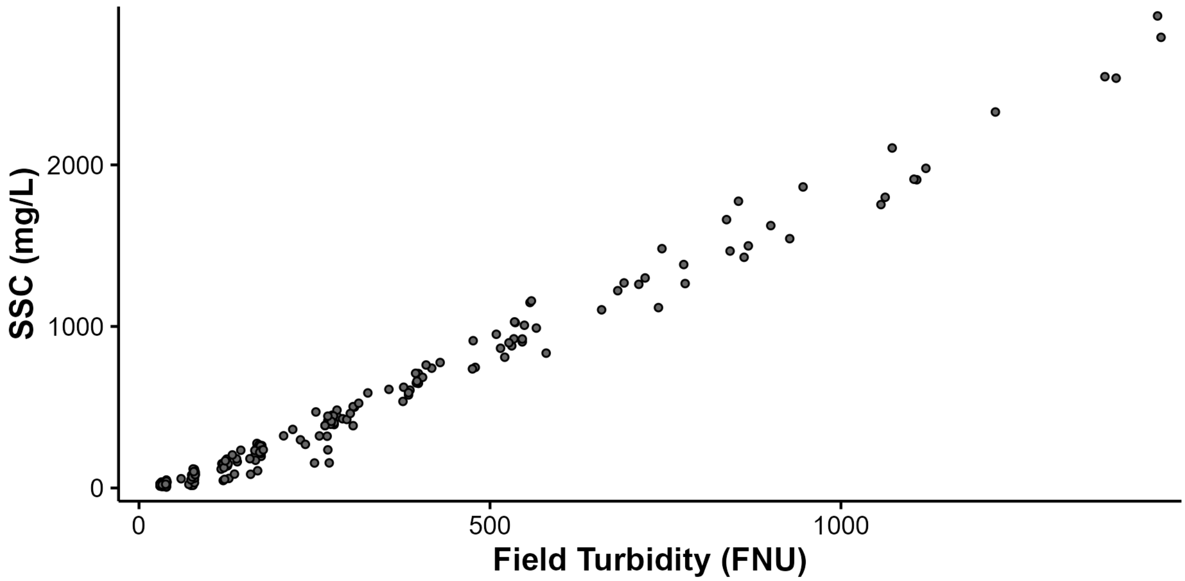

Figure 10. Relationship between turbidity and SSC for the McCloud Creek TTS station during the 2025 Water Year.

The relationship between SSC and turbidity can change over the course of the year either between or within storm events (Lewis, 1996). Individual storm events were analyzed to establish stronger relationships, and, where sample size permitted, the rising and falling limbs of the corresponding hydrographs were also examined. SSC data was then paired with corresponding turbidity measurements following the methods described by Lewis and Eads (2009), implemented in R, a free statistical software package (R Core Team, 2025). This method allows for the construction of turbidity-sediment rating curves where relationships between SSC and turbidity can be established on an event-by-event basis. Storm periods were defined for rising and falling turbidity with at least four samples and, where sample size permitted, were further subdivided into rising and falling limbs. For periods with fewer than four samples, data were combined with samples from adjacent storms. The best-fit relationship for each storm period was determined by reviewing graphics, R-squared values, and residual standard error. The relationship was selected as either linear, square-root, power, or log-transformed. Once established, the software produces a derived SSC time series using the turbidity time series as input (Figure 11). The maximum estimated instantaneous SSC for WY2025 was 2,998 mg/L and occurred on December 29, 2024. The derived SSC data set is then multiplied by the derived discharge data produced by a standard stage-discharge rating curve. The resulting data set provides instantaneous Suspended Sediment Load (iSSL) estimates at 10-minute intervals throughout the water year.

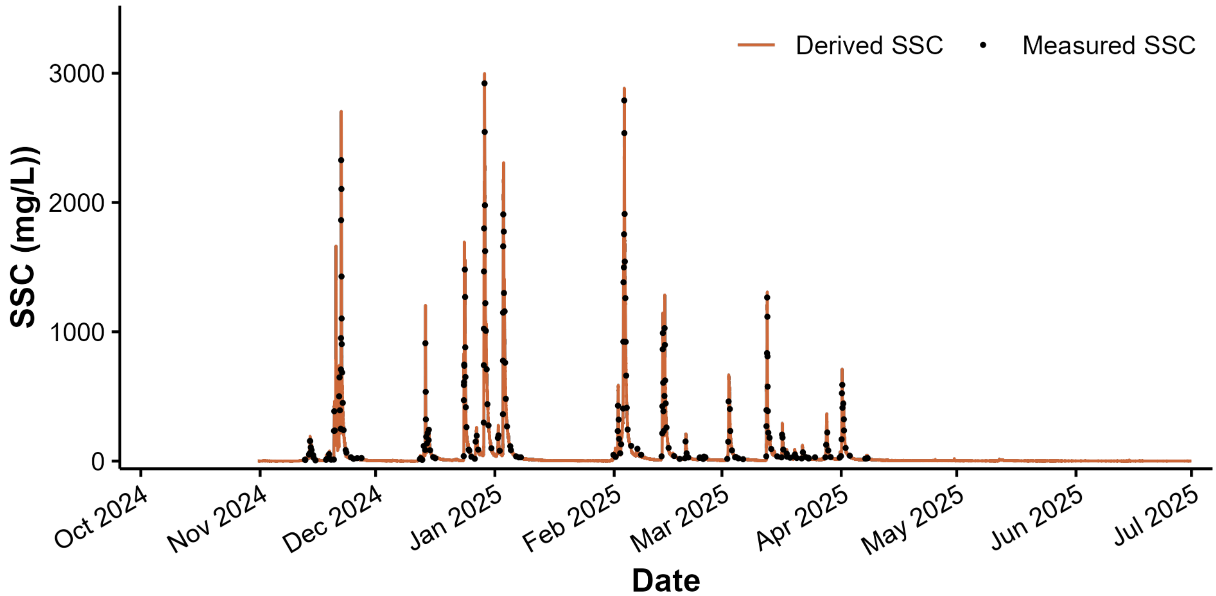

Figure 11. Derived Suspended Sediment Concentration (SSC) based on individual storm event's best-fit relationships during the 2025 Water Year. Black points indicate the measured SSC of automated water samples.

3.1.8 Sediment Load and Yield

Sediment load for WY2025 was estimated using methods developed by Jack Lewis (Lewis and Eads, 2009) and implemented in R (R Core Team, 2025). Load (kg) was calculated from continuous suspended sediment concentration (SSC, mg/L) estimates derived from turbidity multiplied with the derived continuous discharge derived from the stage-discharge rating. For WY2025, turbidity-SSC relationships were established for 19 periods, including 17 storm events and baseflow conditions in fall and spring (Table 4). Sediment yield, expressed in megagrams (1 megagram = 1,000 kg) per square kilometer per year ($Mg\ km^{-2}\ yr^{-1}$), was calculated by scaling the total sediment load by the upstream watershed area ($6.0\ km^2$).

The estimated sediment load for WY2025 was 2,411,799 kg (2,412 Mg). Nearly 25% of this load occurred during Storm 11 (February 03, 2025), which lasted approximately 2 days. The resulting annual sediment yield was 401.1 $Mg\ km^{-2}\ yr^{-1}$, about 60% greater than the median annual yield of 255.13 $Mg\ km^{-2}\ yr^{-1}$ for the monitoring period (WY2007–WY2025). Annual sediment load and annual peak discharge (cfs) over this period were strongly correlated ($\rho = 0.9$; refer to Figure 2).

Table 4. Summary of time periods and relationships used to estimate continuous suspended sediment concentration (mg/L) and sediment Loads (kg) for WY2025. (R = rising limb, F = falling limb, logxy = log-transformed turbidity and SSC, mvue = minimum-variance unbiased correction method, sqrt = square-root transformed turbidity and SSC, duan = bias correction method, n = sample size, CV% = coefficient of variation). Note: the same samples and regression were used for each period with the same superscript on relationship type.

Period	Start	End	Relationship	n	Sediment Load (kg)	CV %	Percent Annual Sediment Load
Storm 1	11/13/2024 18:50	11/15/2024 9:20	linear	8	774.91	4.52	<0.1%
Storm 2	11/20/2024 3:30	11/20/2024 14:10	linear	4	4252.51	15.29	0.2%
Storm 3 (R)	11/20/2024 14:20	11/20/2024 17:20	power[1]	4	14759.33	2.34	1.7%
Storm 3 (F)	11/20/2024 17:30	11/21/2024 3:10	power[2]	8	25364.00	4.93	
Storm 4	11/21/2024 12:10	11/21/2024 23:20	linear	4	29535.40	3.37	1.2%
Storm 5 (R)	11/21/2024 23:30	11/22/2024 1:40	power[1]	4	41333.22	1.49	8.7%
Storm 5 (F)	11/22/2024 1:50	11/23/2024 5:40	power[2]	8	168375.66	2.58	
Storm 6	12/13/2024 20:40	12/14/2024 7:10	power	5	25325.86	4.03	1.1%
Storm 7	12/23/2024 21:30	12/25/2024 21:50	power	15	160863.02	1.95	6.7%
Storm 8 (R)	12/29/2024 2:30	12/29/2024 7:40	linear	6	201361.74	3.57	22.4%
Storm 8 (F)	12/29/2024 7:50	12/31/2024 2:30	linear	9	338486.25	1.02	
Storm 9 (R)	1/3/2025 2:10	1/3/2025 4:30	sqrt:duan	5	46549.52	NA	17.9%
Storm 9 (F)	1/3/2025 4:40	1/7/2025 18:20	sqrt:duan	11	385568.88	NA	
Storm 10	2/1/2025 22:00	2/2/2025 15:30	linear	5	9235.28	6.53	0.4%
Storm 11	2/3/2025 7:40	2/5/2025 9:50	power	15	610480.60	1.14	25.3%
Storm 12	2/13/2025 11:50	2/13/2025 22:40	power	7	27031.35	0.61	1.1%
Storm 13	2/13/2025 22:50	2/15/2025 3:30	power	7	72860.54	2.64	3.0%
Storm 14	3/2/2025 9:00	3/6/2025 12:10	power	10	31688.77	0.97	1.3%
Storm 15	3/12/2025 12:10	3/13/2025 5:40	linear	10	54968.63	2.01	2.3%
Storm 16	3/27/2025 20:40	3/29/2025 6:00	power	5	8979.45	2.75	0.4%
Storm 17	4/1/2025 2:10	4/2/2025 3:20	linear	8	37126.19	2.44	1.5%
Fall Base	10/31/2024 9:50	11/13/2024 18:40	logxy:mvue	17	67.47	13.57	0.4%
	11/15/2024 9:30	11/20/2024 3:20			520.01	16.49	
	11/21/2024 3:20	11/21/2024 12:00			5742.88	52.87	
	11/23/2024 5:50	12/13/2024 20:30			2901.26	13.38	
Spring Base	12/14/2024 7:20	12/23/2024 21:20	power	57	23520.35	2.00	4.5%
	12/25/2024 22:00	12/29/2024 2:20			13177.29	2.16	
	12/31/2024 2:40	1/3/2025 2:00			9424.79	2.30	
	1/7/2025 18:30	2/1/2025 21:50			718.73	8.65	
	2/2/2025 15:40	2/3/2025 7:30			12421.11	2.80	
	2/5/2025 10:00	2/13/2025 11:40			7424.83	5.00	
	2/15/2025 3:40	3/2/2025 8:50			9724.45	5.11	
	3/6/2025 12:20	3/12/2025 12:00			583.97	10.80	
	3/13/2025 5:50	3/27/2025 20:30			23906.34	3.41	
	3/29/2025 6:10	4/1/2025 2:00			1707.97	6.71	
	4/2/2025 3:30	5/1/2025 0:00			4963.83	6.43	
	5/1/2025 0:10	6/1/2025 0:00			66.24	15.36	
	6/1/2025 0:10	6/30/2025 23:50			6.71	19.42	
			Total:	220	2411799		

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Appendix A. Electronic Data File

Electronic copy (file name = Appendix_A_MC2_All_Data_WY2025.xlsx) of data collected and data management notes for the McCloud TTS site during the 2025 Water Year. This file was submitted as an email attachment to the NCRQCB in accordance with the 2014 electronic document submission guidelines.

Appendix B. Summary of Field Problems Encountered and Resolutions

A summary of issues encountered at the McCloud Creek TTS monitoring station during WY2025, along with their resolutions, is provided in Table-B1. Common issues included electronic stage offset adjustments, turbidity sensor calibrations, discrepancies in stage readings, discharge measurement notes, and routine equipment maintenance.

Before WY2024, discharge values above the maximum measured stage of 2.12 ft were extrapolated using the Flow Transference Method (FTM; Cafferata et al., 2004), relying on data from the South Fork Elk River provided by Humboldt Redwood Company. High-flow discharge measurements at McCloud Creek were historically limited by unsafe conditions preventing technician access during peak flows. However, improved access since WY2022 has allowed discharge measurements during higher stage events.

On January 13, 2024, two high-flow discharge measurements were collected during a large and rising streamflow event. This data filled a longstanding gap, extending the valid discharge rating up to a stage of 4.3 ft. While this improves confidence in discharge estimates up to that point, data beyond 4.3 ft should still be interpreted with caution due to a lack of empirical support.

Above 4.3 ft, the channel geometry changes substantially and includes overland flow paths, likely altering the stage–discharge relationship. As large storm events are typically responsible for high sediment loads, sediment and discharge estimates at these stages rely on extrapolated relationships based on lower-flow data, introducing uncertainty. Continued efforts will focus on collecting additional high-stage discharge measurements to refine rating curves and improve the accuracy of sediment load estimates.

Table B-1. Summary of field problems encountered and resolutions at the McCloud Creek TTS station during the 2025 Water Year.

Start Date	End Date	Comment	Resolution	Resolution Date	Personnel
10/31/24	11/11/24	Station is hydrologically connected but streamflow is too low to obtain a discharge measurement.	Will monitor and measure discharge as streamflow increases.	11/11/24	SRB/RCH
10/31/24	10/31/24	DTS is sitting too low in the water column.	Raised DTS so that sensor is at standard 6/10 depth.	10/31/24	SRB
11/11/24	11/11/24	DTS is sitting too low in the water column	Raised DTS so that sensor is at standard 6/10 depth.	11/11/24	ERM
11/14/24	11/14/24	DTS is sitting too low in the water column.	Raised DTS so that sensor is at standard 6/10 depth.	11/14/24	RCH

Start Date	End Date	Comment	Resolution	Resolution Date	Personnel
11/14/24	11/14/24	Organic debris (one tree branch) observed to be built up around DTS housing upon arrival to the site, not obscuring optics	Removed debris that had been built up around DTS housing.	11/14/24	RCH
11/18/24	11/18/24	ISCO sample volume was less than 250 mL	Re-calibrated ISCO sample volume back to 250 mL and verified with a manual sample.	11/18/24	ERM
11/18/24	11/18/24	DTS is sitting too low in the water column	Raised DTS so that sensor is at standard 6/10 depth.	11/18/24	ERM
11/21/24	11/21/24	Organic debris observed to be built up around DTS housing upon arrival to the site, possibly obscuring optics	Removed debris that had been built up around DTS housing.	11/21/24	RCH
11/21/24	11/21/24	DTS is sitting too low in the water column.	Raised DTS so that sensor is at standard 6/10 depth.	11/21/24	RCH
11/25/24	11/25/24	DTS backstay broken on arrival	Re-attached DTS backstay	11/25/24	ERM
11/25/24	11/25/24	Organic debris observed to be built up around DTS housing upon arrival to the site, possibly obscuring optics	Removed debris that had been built up around DTS housing.	11/25/24	ERM
11/25/24	11/25/24	DTS is sitting too high in the water column	Lowered DTS so that sensor is at standard 6/10 depth.	11/25/24	ERM
11/21-11/25/2024	04/24/25	Debris jam downstream of monitoring station is creating a control at stages between ~1.3 to 2.6'. See details in Comments tab.	Lower flows allowed the crew to break up the debris jam. The monitoring station is now operating under control conditions, as surveyed at the monitoring unit, for all recorded stage values.	04/24/25	MRR/SRB/RCH/ERM
12/06/24	12/06/24	DTS is sitting too high in the water column	Lowered DTS so that sensor is at standard 6/10 depth.	12/06/24	ERM

Start Date	End Date	Comment	Resolution	Resolution Date	Personnel
12/09/24	12/09/24	druck housing has been filled with sediment due to high flows	Cleaned and reset druck	12/09/24	ERM
12/17/24	12/17/24	Datalogger pelican case desiccant requires replacement.	Replaced datalogger pelican case desiccant.	12/17/24	RCH
12/17/24	12/17/24	Organic debris observed to be built up around DTS housing upon arrival to the site, possibly obscuring optics	Removed debris that had been built up around DTS housing.	12/17/24	RCH
12/17/24	12/17/24	DTS is sitting too low in the water column.	Raised DTS so that sensor is at standard 6/10 depth.	12/17/24	RCH
12/23/24	12/23/24	DTS is sitting too low in the water column.	Lowered DTS so that sensor is at standard 6/10 depth.	12/23/24	MRR
12/25/24	12/25/24	Backstay that stabilizes DTS downrigger not tight upon arrival to site.	Attached/Tightened backstay to DTS downrigger so that sensor is stabilized in flow.	12/25/24	MRR
12/25/24	12/25/24	DTS is sitting too low in the water column.	Lowered DTS so that sensor is at standard 6/10 depth.	12/25/24	MRR
12/31/24	12/31/24	Organic debris observed to be built up around DTS housing upon arrival to the site, possibly obscuring optics	Removed debris that had been built up around DTS housing.	12/31/24	SRB
12/31/24	12/31/24	DTS is sitting too low in the water column.	Raised DTS so that sensor is at standard 6/10 depth.	12/31/24	SRB
12/31/24	12/31/24	Slight amount of water (5-10 mL) observed in ISCO base.	OK sample volumes observed in ISCO slots 1-20. Checked tube in ISCO distributor arm and length was appropriate. Will monitor and adjust ISCO settings if necessary.	12/31/24	SRB
01/06/25	01/06/25	Organic debris observed to be built up around DTS housing upon	Removed debris that had been built up around DTS housing.	01/06/25	RCH

Start Date	End Date	Comment	Resolution	Resolution Date	Personnel
		arrival to the site, possibly obscuring optics			
01/06/25	01/06/25	DTS is sitting too high in the water column.	Lowered DTS so that sensor is at standard 6/10 depth.	01/06/25	RCH
01/13/25	01/13/25	DTS is sitting too high in the water column	Lowered DTS so that sensor is at standard 6/10 depth.	01/13/25	ERM
01/21/25	01/21/25	Datalogger pelican case desiccant required replacement.	Replaced datalogger pelican case desiccant.	01/21/25	SRB
01/21/25	01/21/25	Wiper blade on DTS optics required replacement.	Attached new wiper blade to DTS optics.	01/21/25	SRB
02/03/25	02/04/25	Was unable to access MC2 from Elk River Road as the road was flooded	Will attempt to access the site as flows drop	02/03/25	ERM
02/04/25	02/04/25	DTS is sitting too low in water column	Raised DTS so that sensor is at standard 6/10 depth	02/04/25	ERM
02/04/25	02/04/25	Upon arrival DTS has been pushed up onto left bank in higher flows. DTS sensor was still functioning correctly and still under water upon arrival.	Pulled DTS off of left bank and placed back into the thalweg.	02/04/25	ERM
02/04/25	02/04/25	Organic debris observed to be built up around DTS housing upon arrival to the site, possibly obscuring optics	Removed debris that had been built up around DTS housing.	02/04/25	ERM
02/07/25	02/07/25	DTS is sitting too high in the water column.	Lowered DTS so that sensor is at standard 6/10 depth.	02/07/25	ERM
02/11/25	02/11/25	DTS is sitting too low in the water column.	Raised DTS so that sensor is at standard 6/10 depth.	02/11/25	SRB
02/11/25	02/11/25	ISCO sample volume was less than 250 mL	Re-calibrated ISCO sample volume back to 250 mL.	02/11/25	SRB

Start Date	End Date	Comment	Resolution	Resolution Date	Personnel
02/11/25	02/11/25	druck housing has light debris built up around it from last flow event.	Removed debris from around druck.	02/11/25	SRB
02/17/25	02/17/25	Organic debris observed to be built up around DTS housing upon arrival to the site, sensor optics were not obscured.	Removed debris that had built up around DTS boom	02/17/25	RCH
02/25/25	02/25/25	DTS is sitting to high in the water column	Lowered DTS so that sensor is at standard 6/10 depth.	02/25/25	ERM
03/03/25	03/03/25	Organic debris observed to be built up around DTS housing upon arrival to the site, possibly obscuring optics	Removed debris that had been built up around DTS housing.	03/03/25	ERM
03/03/25	03/03/25	DTS is sitting too low in the water column.	Raised DTS so that sensor is at standard 6/10 depth.	03/03/25	ERM
03/03/25	03/03/25	Datalogger pelican case desiccant required replacement.	Replaced datalogger pelican case desiccant.	03/03/25	ERM
03/13/25	03/13/25	DTS is sitting to low in water column	Raised DTS so that sensor is at standard 6/10 depth.	03/13/25	ERM
03/17/25	03/17/25	Tree branch observed to be built up around DTS housing upon arrival to the site, sensor optics were not obscured.	Removed tree branch that had built up around DTS boom	03/17/25	RCH
03/17/25	03/17/25	DTS is sitting to high in the water column	Lowered DTS so that sensor is at standard 6/10 depth.	03/17/25	RCH
03/21/25	03/21/25	DTS is sitting too low in the water column	Raised DTS so that sensor is at standard 6/10 depth.	03/21/25	SRB
03/21/25	03/21/25	Light debris observed to be built up around DTS housing upon arrival to the site, sensor optics were not obscured.	Removed light debris that had built up around DTS boom	03/21/25	SRB

Start Date	End Date	Comment	Resolution	Resolution Date	Personnel
03/21/25	03/21/25	E-stage does not match observed stage measurement, is off by -0.02	Will monitor and re-calculate stage offset if necessary	03/21/25	SRB
03/31/25	03/31/25	Organic debris observed to be built up around DTS housing upon arrival to the site, sensor optics were not obscured.	Removed debris that had been built up around DTS housing.	03/31/25	SRB
03/31/25	03/31/25	DTS is sitting too low in the water column for anticipated flows.	Raised DTS so that sensor will be at standard 6/10 depth as stage rises.	03/31/25	SRB
04/02/25	04/02/25	DTS is sitting to high in the water column	Lowered DTS so that sensor is at standard 6/10 depth.	04/02/25	RCH
04/08/25	04/08/25	DTS is sitting to high in the water column	Lowered DTS so that sensor is at standard 6/10 depth.	04/08/25	ERM
04/15/25	04/15/25	DTS is sitting to high in the water column	Lowered DTS so that sensor is at standard 6/10 depth.	04/15/25	RCH
04/15/25	04/15/25	E-stage does not match observed stage measurement, is off by -0.03'.	Cleaned druck and recalculated stage offset so that e-stage matches observed stage measurement.	04/15/25	RCH
04/24/25	04/24/25	DTS is sitting too high in the water column	Lowered DTS so that sensor is at standard 6/10 depth.	04/24/25	SRB
04/29/25	04/29/25	E-stage does not match observed stage measurement, is off by -0.02	Will monitor and re-calculate stage offset if necessary	04/29/25	SRB
05/05/25	05/05/25	E-stage does not match observed stage measurement, is off by -0.03	Recalculated stage offset so that e-stage matches observed stage measurement.	05/05/25	SRB
05/13/25	05/13/25	DTS is sitting too high in the water column	Lowered DTS so that sensor is at standard 6/10 depth.	05/13/25	RCH
06/10/25	06/10/25	DTS is sitting too high in the water column	Lowered DTS so that sensor is at standard 6/10 depth.	06/10/25	RCH

Appendix C. Quality Assurance Summary

Special training is required for all GDRCo staff involved in the implementation of this project. During WY2025, seven individuals participated in some part of the implementation of field and lab standard operating procedures. All personnel were trained prior to performing assigned work tasks and responsibilities.

The hydrology coordinator/lead was appointed by the GDRCo Aquatic Supervisor to perform the training and certification of the watershed staff during WY2025 (Table C-1). Training was performed on all aspects of field work including cleaning and adjusting equipment, downloading of data, collecting grab samples, replacing ISCO bottles, and taking discharge measurements. Training in the laboratory included: preparing filters, taking turbidity measurements, filtering and weighing of suspended sediment, and recording data. Data management training included: data entry, QA/QC, and updating files. The chain-of-custody for all phases of project implementation was tracked.

Table C-1. Summary of initial training dates for certifications completed by GDRCo staff involved in field and lab activities during the 2025 Water Year. Employees have annual refresher training before the beginning of each water year.

Personnel	Role	Field Methods Certification	Lab Certification	Data Management Certification
Matt Nannizzi	Aquatic Biologist - Supervisor	10/1/2021	12/15/2011	10/21/2021
Melissa Reneski	Hydrology Coordinator	10/1/2015	10/1/2015	10/1/2015
Simon Boycott	Hydrology Technician	11/15/2022	10/1/2022	10/1/2022
Reed Hamilton	Hydrology Technician	11/15/2022	10/1/2022	10/1/2022
Eli Martineau	Hydrology Technician	10/10/2022	12/14/2022	12/15/2022
Jordan Spence	Aquatics Technician	12/5/2022	NA	NA
Erin Philips	Aquatics Technician	NA	12/14/2023	NA

Among the turbidity samples collected and measured, no samples were excluded from the FNU-NTRU regression analysis due to unreliable field turbidity values. Potential outliers are identified empirically by graphing lab vs turbidity values. Generally, there is a tight relationship (R^2 > 95%) between the two measurements, so errors and outliers tend to stand out.

To evaluate the consistency of laboratory processing for turbidity and SSC, GDRCo performed a QA/QC test using paired grab and control water samples collected during site visits. Grabs are taken back to be immediately processed in the lab while controls are stored in a refrigerator until the end of the water year. Hydrochloric acid is added to each control sample that is placed in the refrigerator to help preserve it for later processing. At the end of the water year a random subsample of grabs and paired controls are processed for turbidity and SSC to assess lab repeatability. This subsample resulted in six of the 28 paired manual samples from McCloud to be selected. These samples were collected during routine site visits, using the ISCO pump sampler.

Paired grab and control samples for turbidity and SSC were compared using data from 11 TTS sites operated by GDRCo, including the McCloud Creek station (Figure C-1 and Figure C-2, respectively). Laboratory turbidity results demonstrated a strong linear relationship ($n = 31$, $R^2 > 0.99$) with no outliers, indicating consistency between paired samples. The 31 paired SSC samples also exhibited a strong linear relationship ($R^2 = 0.98$), although five discrepancies were identified. These discrepancies were associated with varying amounts of organic material retained on both the grab and control filters. Lab notes also indicated that differences in the removal of larger organic debris prior to weighing may have contributed to these discrepancies.

All equipment was maintained and calibrated within the frequency defined in Section B6 of the Turbidity Threshold Sampling Quality Assurance Project Plan submitted by GDRCo. The DTS-12 sensors were calibrated by FTS in August 2024 prior to deployment. The HACH TL2300 was calibrated every 3 months with Formazin StableCal® standards and weekly during the monitoring season using Gelex Secondary standards and receives yearly calibration and maintenance from HACH. The Druck pressure transducer was calibrated by the GDRCo watershed staff in August, 2024 to ensure proper operation prior to deployment. Finally, current meters used during the monitoring season received calibration at least weekly.

At times there can be complications regarding the DTS-12 turbidity sensor, resulting in missing, or “noisy”, data. When this happened, the data corrections was applied conservatively. In the case of missing data, values were generated using the methods described in Section 3.1.5 and are noted in the ‘Data Management’ tab in the electronic data file (Appendix A).

Two different approaches were used to address “noisy” turbidity data where there was no association with fluctuations in stage. If the turbidity recordings prompted an automated grab sample that verified there was no increase in SSC, that turbidity value was interpolated from adjacent values. If there was no associated grab sample, which can happen when the turbidity increases didn’t cross set thresholds, the value was left and no data corrections took place.

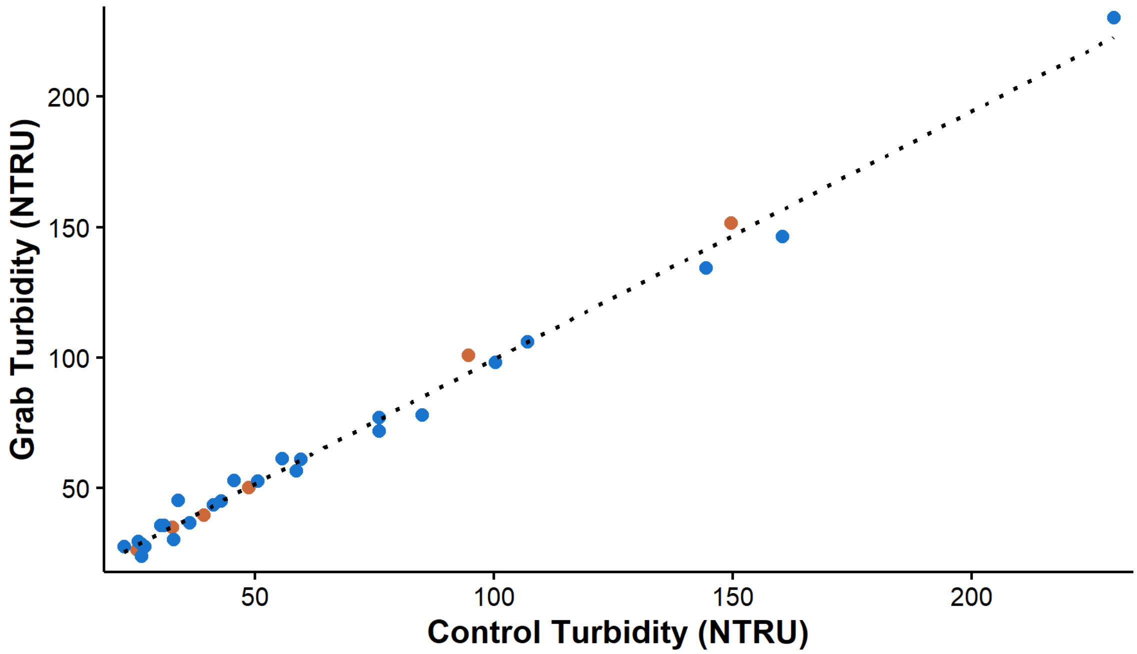

Figure C-1. Relationship between lab turbidity (NTRU) of paired control and grab samples collected across 11 TTS sites during the 2025 Water Year, with those samples collected at the McCloud Creek TTS station indicated by orange points.

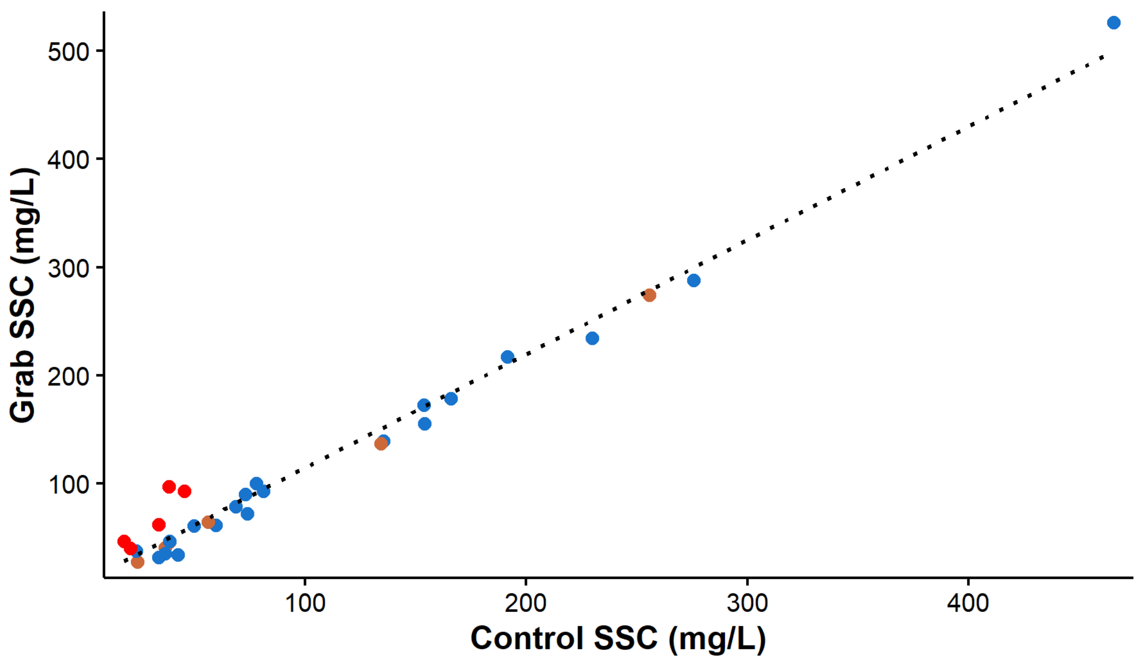

Figure C-2. Relationship between suspended sediment concentration (SSC, mg/L) of paired control and grab samples collected across 11 sites during the 2025 Water Year, with those samples collected at the McCloud Creek TTS station indicated by orange points and outliers indicated by red points.