Seasonal Progress Report #16
SR431 Treatment Vault Effectiveness Monitoring

Agreement Number: P367-18-018

Submitted by: Tahoe Resource Conservation District

Submitted to: Nevada Department of Transportation

Water Year: 2021

Period: Spring Season, Mar 1, 2021 –May 31, 2021

Submission Date: June 30, 2021

Two stormwater cartridge filter vaults, a Contech Media Filtration System (MFS) and a Jellyfish Filter, were installed by the Nevada Department of Transportation (NDOT) on State Highway 431 (SR431) above Incline Village, Nevada in 2013. Monitoring equipment was installed at the inflows and outflows of these two vaults. The Tahoe Resource Conservation District (Tahoe RCD) continued the effectiveness monitoring efforts of the Desert Research Institute (DRI) at the four monitoring stations on May 1, 2015 and will continue to monitor through the spring of water year 2023 (May 31, 2023) and beyond if funding allows. A new contract is soon to be executed for July 1, 2021 - June 30, 2023 to allow for this. Tahoe RCD follows sampling protocols outlined in the Regional Stormwater Monitoring Program Framework and Implementation Guidance document (RSWMP FIG Update, Tahoe RCD et al 2017). Tahoe RCD appreciates the opportunity to provide these water quality monitoring services for NDOT and looks forward to continuing the partnership.

Tasks and subtasks associated with this project and a summary of work completed to date are described below. Table 1 provides a summary of tasks, due dates and percent completion to date for the current agreement. ASWMR refers to the Annual Stormwater Monitoring Report submitted each year to the Nevada Division of Environmental Protection (NDEP) on March 31st as part of the IMP partnership.

Table 1: Summary of tasks, due dates, and percent completion to date.

Task	Description	Due Date	% Of Work Complete	Date Submitted
1	Project Administration			
1.1	Quarterly Invoices	4/30/19, 10/31/19, 1/31/20, 4/30/20, 7/31/20, 10/31/20, 1/31/21, 4/30/21	ongoing	6/19/19, 11/15/19, 3/31/20, 6/2/20, 7/31/20, 10/31/20, 1/31/21, 4/30/21
1.2	Seasonal Progress Reports	3/31/19, 6/30/19, 10/31/19, 3/31/20, 6/30/20, 10/31/20, 3/31/21, 6/30/21	ongoing	3/31/19, 7/10/19, 11/15/19, 3/31/20, 6/30/20, 10/31/20, 3/31/21, 6/30/21
2	Stormwater Monitoring			
2.1	Collect continuous flow and turbidity data at four monitoring stations	5/31/2021	ongoing	Available on Acuity
2.2	Collect stormwater runoff samples during eight events per year	5/31/2021	ongoing	NA
2.3	Collect three diurnal non-event snowmelt events if conditions allow	5/31/2021	NA	NA
2.4	Collect flow bypass data in both vaults	5/31/2021	ongoing	11/15/19, 3/31/20, 6/30/20, 10/31/20, 3/31/21, 6/30/21
2.5	Provide precipitation data to date	5/31/2021	ongoing	3/31/19, 7/10/19, 11/15/19, 3/31/20, 6/30/20, 10/31/20, 3/31/21, 6/30/21
2.6	Provide hydrograph, turbidity, and sample distribution graphs to date	5/31/2021	ongoing	3/31/19, 7/10/19, 11/15/19, 3/31/20, 6/30/20, 10/31/20, 3/31/21, 6/30/21
3	Condition Assessments			
3.1	Estimate Road RAM score prior to eight sampled events	5/31/2021	ongoing	3/31/19, 7/10/19, 11/15/19, 3/31/20, 6/30/20, 10/31/20, 3/31/21
3.2	Measure depth of sediment in both vaults after sampled events	5/31/2021	ongoing	

				3/31/19, 7/10/19, 11/15/19, 3/31/20, 6/30/20, 10/31/20, 3/31/21, 6/30/21
4	Final Report			
4.1	Provide raw data	3/31/2021	ongoing	ASWMR 3/31/21
4.2	Provide treatment effectiveness analysis	3/31/2021	ongoing	ASWMR 3/31/21
4.3	Correlate Road RAM score to pollutant concentration and load	3/15/2020	ongoing	ASWMR 3/15/20
4.4	Provide mass loading v. volume calculations for select events	6/30/2016	100%	3/31/16, 6/30/16

Task 1: Project Administration

1. Invoices

Quarterly invoices will be submitted for this project covering the following periods:

#1: January 1, 2019 - March 31, 2019 (due April 30, 2019)
#2: April 1, 2019 - June 30, 2019 (due July 31, 2019)
#3: July 1, 2019 - September 30, 2019 (due October 31, 2019)
#4: October 1, 2019 - December 31, 2019 (due January 31, 2020)
#5: January 1, 2020 - March 31, 2020 (due April 30, 2020)
#6: April 1, 2020 - June 30, 2020 (due July 31, 2020)
#7: July 1, 2020 - September 30, 2020 (due October 31, 2020)
#8: October 1, 2020 - December 31, 2020 (due January 31, 2021)
#9: January 1, 2021 - March 31, 2021 (due April 30, 2021)
#10: April 1, 2021 - June 30, 2021 (due July 31, 2021)

2. Progress Reports

Progress reports are not concurrent with quarterly invoices. Seasonal progress reports will be submitted for this project covering the following periods (report number is consistent with prior agreement's reports beginning May 2015):

#9: Fall/winter: - October 1, 2018 - February 28, 2019 (due March 31, 2019)
#10: Spring: March 1, 2019 - May 31, 2019 (due June 30, 2019)
#11: Summer: June 1, 2019 - September 30, 2019 (due October 31, 2019)
#12: Fall/winter: October 1, 2019 - February 29, 2020 (due March 31, 2020)
#13: Spring: March 1, 2020 - May 31, 2020 (due June 30, 2020)
#14: Summer: June 1, 2020 - September 30, 2020 (due October 31, 2020)
#15: Fall/winter: October 1, 2020 - February 29, 2021 (due March 31, 2021)
#16: Spring: March 1, 2021 - May 31, 2021 (due June 30, 2021)

Please accept this report as seasonal progress report #16 for the spring season of water year 2021.

Task 2: Stormwater Monitoring

1. Maintain four stormwater monitoring stations to collect continous flow and turbidity data

The spring season of WY21 began on March 1, 2021 and ended May 31, 2021. Continuous flow and turbidity were successfully monitored for the spring season at all sites.

2. Collect stormwater runoff samples at four monitoring sites during eight runoff events per year

There was very little runoff during spring of WY21. For the March 18, 2021 rain on snow event, samples were taken at Contech Inflow, Contech Outflow, and Jellyfish Inflow. Samples were not successful at Jellyfish Outflow due to low flow. For the April 13, 2021 event snowmelt, May 16, 2021 thunderstorm, and May 21, 2021 event snowfall, samples were succesful at all sites. Typically 6-12 samples should be taken per event at each site, however due to low flow and brief events this was not possible for any event to date (see Appendix A, Figures 8-23 at the end of this report for hydrographs, continous turbidity, and sample distributions for the events sampled). The successful samples were composited and sent to the lab for analysis, results are pending. This brings the water year total to five sampled events for Jellyfish Inflow and Contech Inflow, and four sampled events for Jellyfish Outflow and Contech Outflow.

3. If conditions allow for non-event snowmelt sampling, analyze a rising and a falling limb composite during three diurnals (counts as one of the eight events)

The spring snowmelt did not produce sufficient flows for sampling this season.

4. Install a pressure transducer in each treatment vault to identify when there is bypass flow

New pressure transducers were installed in June 2016 and linked to the remote access data management system currently used at the SR431 monitoring site. Data indicate that during the spring of WY21 both the Contech MFS cartridge filters and the Jellyfish filters were bypassed zero times (Figures 1 & 2).

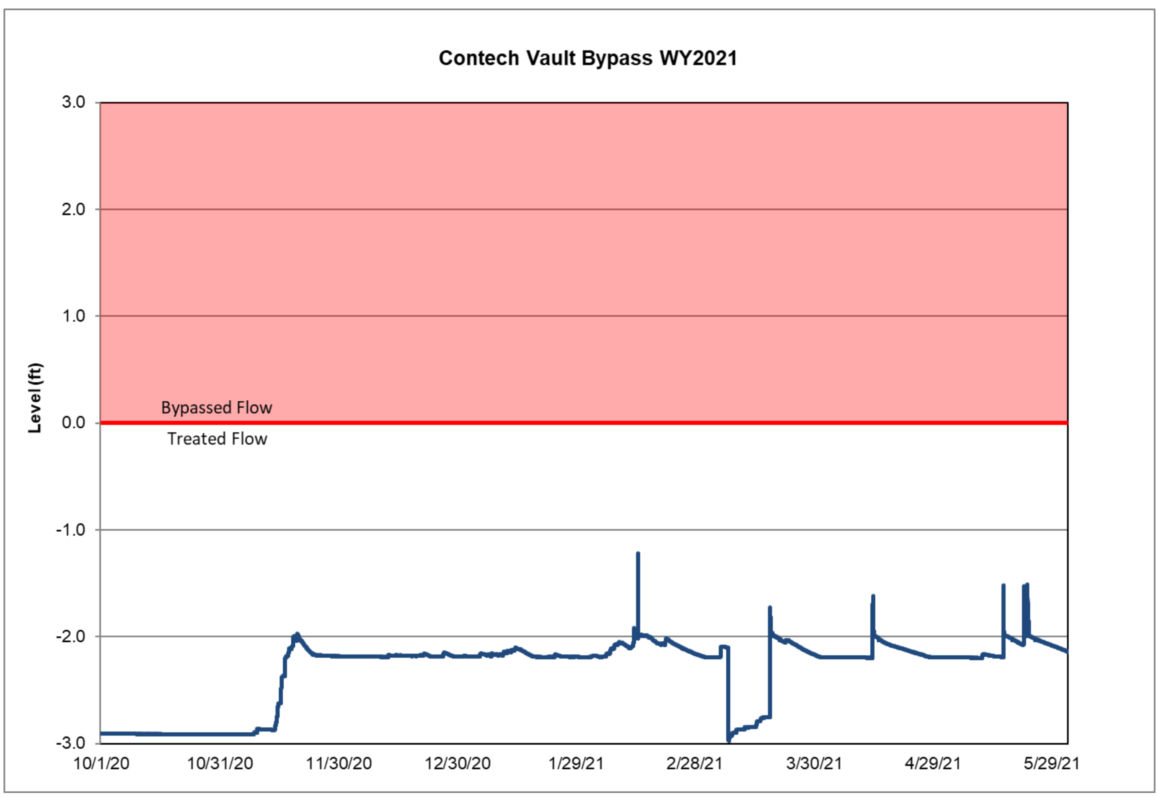

Figure 1: Bypassed flow in the Contech MFS vault for WY21 to date.

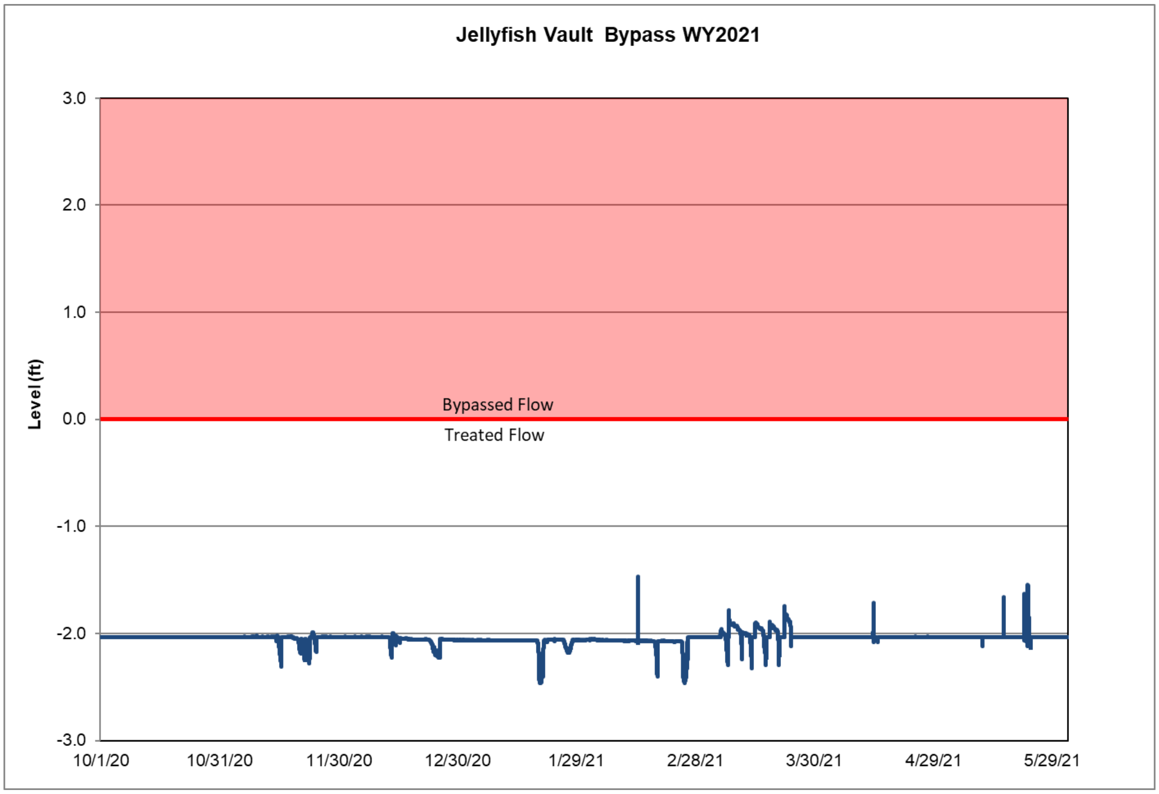

Figure 2: Bypassed flow in the Jellyfish vault for WY21 to date.

5. Provide precipitation data to date

Table 2 provides summary data for all 28 fall/winter and spring WY21 precipitation events recorded at the NDOT meteorological stations including event start and end dates, total precipitation, peak precipitation, minimum and maximum temperature, and precipitation type. Events highlighted in pink were sampled for water quality. Because of its high elevation, precipitation often falls in the form of snow during fall/winter and spring and thus does not always generate sufficient runoff for sampling. In general, events consisting of less than 0.5 inches of rain do not produce sufficient runoff for sampling. However, some events less than 0.5 inches can be successfully sampled.

Table 2: Summary of fall/winter precipitation and spring events at SR431 for WY21. Highlighted rows indicate events that were sampled.

Station ID	Precip Event (#)	Precipitation event start (PST)	Event end (PST)	Event duration (days)	Interevent duration (days)	Event precipitation (inches)	Event peak precipitation (inch/5min)	Event minimum temp (°C)	Event maximum temp (°C)	Type of Precipitation
NDOT	--	--	9/18/2020 7:35	--	--	--	--	--	--	--
NDOT	NDOT-21-01	11/7/2020 15:50	11/8/2020 23:40	1.326	50.3	0.2240	0.016	-10	-4	Rain, Snow
NDOT	NDOT-21-02	11/13/2020 13:10	11/13/2020 18:50	0.236	4.6	0.4320	0.016	-1	-1	Snow, Rain
NDOT	NDOT-21-03	11/17/2020 19:50	11/18/2020 22:15	1.101	4.0	1.5390	0.023	-2	1	Rain, Snow
NDOT/TERC	NDOT-21-04	12/13/2020 6:10	12/14/2020 10:50	1.194	24.3	0.8880	0.020	-6	0	Rain/Snow
NDOT/TERC	NDOT-21-05	12/17/2020 2:45	12/17/2020 11:45	0.375	2.7	0.3240	0.016	-3	-1	Snow
NDOT/TERC	NDOT-21-06	12/25/2020 16:05	12/26/2020 11:20	0.802	8.2	0.2120	0.012	-5	-1	Rain, Snow
NDOT/TERC	NDOT-21-07	12/31/2020 0:35	12/31/2020 3:50	0.135	4.6	0.0200	0.004	-4	-3	Snow
NDOT/TERC	NDOT-21-08	1/4/2021 4:30	1/4/2021 16:55	0.517	4.0	0.2000	0.016	-3	2	Rain, Snow
NDOT/TERC	NDOT-21-09	1/23/2021 6:20	1/23/2021 7:45	0.059	18.6	0.0240	0.004	-7	-7	Snow
NDOT/TERC	NDOT-21-10	1/25/2021 4:05	1/25/2021 4:25	0.014	1.8	0.0120	0.004	-8	-7	Snow
NDOT/TERC	NDOT-21-11	1/26/2021 22:50	1/29/2021 8:55	2.420	1.8	1.4680	0.012	-8	-3	Snow
NDOT/TERC	NDOT-21-12	2/2/2021 15:10	2/3/2021 2:35	0.476	4.3	0.0080	0.004	-5	-1	Snow
NDOT	NDOT-21-13	2/9/2021 6:30	2/9/2021 6:30	0.000	6.2	0.0040	0.004	-2	-2	Snow
NDOT	NDOT-21-14	2/11/2021 15:00	2/13/2021 11:00	1.833	2.4	1.0510	0.023	-6	3	Rain, Snow
NDOT	NDOT-21-15	2/14/2021 11:50	2/15/2021 21:55	1.420	1.0	0.0560	0.008	-3	3	Rain/Snow
NDOT	NDOT-21-16	2/18/2021 13:10	2/20/2021 8:45	1.816	2.6	0.1720	0.016	-8	4	Rain, Snow
NDOT	NDOT-21-17	3/6/2021 3:20	3/6/2021 5:30	0.090	13.8	0.1400	0.012	-5	-3	Snow
NDOT	NDOT-21-18	3/8/2021 23:45	3/10/2021 12:40	1.538	2.8	0.1200	0.012	-9	-1	Snow
NDOT	NDOT-21-19	3/11/2021 17:30	3/12/2021 3:00	0.396	1.2	0.0800	0.008	-6	-5	Snow
NDOT	NDOT-21-20	3/14/2021 23:30	3/15/2021 15:45	0.677	2.9	0.1080	0.012	-10	-3	Snow
NDOT	NDOT-21-21	3/18/2021 16:05	3/20/2021 18:35	2.104	3.0	0.4150	0.019	-7	4	Rain, Snow
NDOT	NDOT-21-22	3/22/2021 9:05	3/23/2021 1:35	0.688	1.6	0.0720	0.004	-5	3	Snow
NDOT	NDOT-21-23	4/5/2021 7:50	4/5/2021 10:05	0.094	13.3	0.012	0.004	-1	5	Snow
NDOT	NDOT-21-24	4/13/2021 16:35	4/14/2021 18:05	1.063	8.3	0.292	0.016	-5	4	Snow
NDOT	NDOT-21-25	4/20/2021 21:05	4/20/2021 21:25	0.014	6.1	0.016	0.004	3	4	Snow
NDOT	NDOT-21-26	4/25/2021 19:00	4/26/2021 17:35	0.941	4.9	0.0240	0.004	-8	1	Snow
NDOT	NDOT-21-27	5/16/2021 17:55	5/16/2021 19:30	0.066	20.0	0.0980	0.039	7	11	Thunderstorm
NDOT	NDOT-21-28	5/20/2021 12:10	5/23/2021 6:25	2.760	3.7	0.4870	0.019	-5	5	Snow

6. Provide hydrograph, continuous turbidity, and sample distribution graphs for each sampled event

See Appendix A, Figures 8-23 at the end of this report for hydrographs, continous turbidity, and sample distributions for the events sampled in the spring season of WY21.

Task 3: Condition Assessments

1. Estimate Road RAM score prior to monitored runoff events

This task was initiated in November 2015 following a meeting between Tahoe RCD and NDOT where it was decided that determining a Road RAM score prior to runoff events was valuable. Road RAM scores assess road condition and are expressed on a scale from 0 to 5. A score of 0 indicates road conditions that present a high risk to downslope water quality, while a score of 5 indicates road conditions with minimal risk to downslope water quality. Road RAM scores correspond to an estimated FSP concentration range that can be expected in runoff events as outlined in the Road RAM Technical Document (2NDNATURE et al 2010). This task is expected to help establish a *site-specific* relationship between road condition and inflow FSP concentration in runoff at SR431.

See figures 4-7 for road conditions on February 22, 2021.

Figure 3: SR431 on March 17, 2021.

Figure 4: SR431 on March 17, 2021.

Figure 5: SR431 on March 17, 2021.

Figure 6: SR431 on March 17, 2021.

Table 3 summarizes the 51 Road RAM measurements taken since November 2015. It shows the date the measurement was taken, date of the next runoff event after the measurement was taken, the date of the next runoff event that was sampled after the measurement was taken, the season of the next runoff event, the Road RAM score, the expected FSP concentrations associated with that score (2NDNATURE et al 2010), actual inflow FSP concentrations (an average of the event mean concentrations (EMCs) measured at the Contech MFS inflow and the Jellyfish inflow), and the percent difference between the expected FSP based on RAM score and the measured FSP concentration. Observed Road RAM scores thus far cover nearly the full range of possible measurements (0.4 to 4.6); however, the majority of scores indicate that the roads were relatively dirty prior to most runoff events (Table 3 - sorted from dirtiest to cleanest Road RAM scores.) The worst scores tend to occur in the spring (March - May), and the best scores tend to occur in the fall (October - November).

Table 3: Summary of Road RAM scores and FSP concentrations WY16, WY17, WY18, WY19, WY20, and WY21 to date. Table divisions correspond to poor (0-1.0), degraded (1.1-2.0), fair (2.1-3.0), acceptable (3.1-4.0), and desirable (4.1-5.0) scores. Rows highlighted in green indicate data used to investigate a site-specific relationship between expected and actual average inflow EMC (mg/L).

Road RAM date	Next runoff event date	Next sampled runoff event date	Season (based on runoff date)	Road RAM Score	Expected FSP concentration* (mg/L)	Average JI&CI inflow FSP EMC (mg/L)	FSP Percent Difference (%)
4/8/2016	4/9/2016	5/5/2016	spring	0.4	1133	387	-98%
5/6/2019	5/15/2019	5/15/2019	spring	0.6	977	791	-21%
4/11/2017	4/12/2017	4/16/2017	spring	0.7	872	612	-35%
3/15/2017	3/18/2017	4/6/2017	spring	0.7	847	746	-13%
5/1/2017	5/6/2017	5/6/2017	spring	0.8	802	352	-78%
5/12/2017	5/19/2017	5/19/2017	spring	1.3	537	13	-191%
4/20/2018	5/12/2018	5/16/2018	spring	1.3	516	177	-98%
4/18/2019	5/15/2019	5/15/2019	spring	1.5	463	791	52%
2/24/2016	2/25/2016	3/4/2016	fall/winter	1.5	445	2,955	148%
1/7/2020	1/7/2020	3/13/2020	fall/winter	1.5	435	1,415	106%
12/27/2017	1/4/2018	3/20/2018	fall/winter	1.6	415	783	62%
12/2/2015	12/2/2015	12/10/2015	fall/winter	1.6	409	722	55%
3/29/2018	4/6/2018	4/6/2018	spring	1.7	388	1,639	123%
1/28/2016	1/29/2016	1/29/2016	fall/winter	1.7	375	1,118	99%
2/22/2021	3/18/2021	3/18/2021	fall/winter	1.7	375	pending	pending
7/5/2017	8/15/2017	8/19/2017	summer	1.7	367	186	-65%
7/20/2017	8/15/2017	8/19/2017	summer	1.7	367	186	-65%
2/20/2020	2/29/2020	3/13/2020	fall/winter	1.7	364	1,415	118%
6/5/2017	6/9/2017	8/19/2017	summer	1.7	363	186	-64%
5/5/2017	5/6/2017	5/6/2017	spring	1.8	343	352	3%
12/7/2016	12/8/2016	12/8/2016	fall/winter	1.9	317	774	84%
5/13/2019	5/15/2019	5/15/2019	spring	1.9	316	791	86%
8/7/2017	8/15/2017	8/19/2017	summer	2.0	281	186	-41%
8/25/2017	9/5/2017	9/21/2017	summer	2.0	281	167	-51%
10/5/2017	10/20/2017	11/15/2017	fall/winter	2.0	281	201	-33%
12/8/2015	12/10/2015	12/10/2015	fall/winter	2.1	267	722	92%
5/6/2020	5/12/2020	5/17/2020	spring	2.1	267	337	23%
5/30/2018	6/17/2018	7/22/2018	summer	2.2	252	114	-75%
1/13/2018	1/19/2018	3/20/2018	fall/winter	2.2	248	783	104%
10/25/2019	11/20/2019	1/1/2020	fall/winter	2.2	244	1,360	139%
6/16/2020	6/16/2020	7/20/2020	summer	2.4	200	587	98%
9/18/2018	10/3/2018	10/3/2018	fall/winter	2.5	195	82	-81%
10/19/2017	10/20/2017	11/15/2017	fall/winter	2.5	195	201	3%
11/1/2017	11/4/2017	11/15/2017	fall/winter	2.5	195	201	3%
12/14/2017	1/4/2018	3/20/2018	fall/winter	2.5	195	783	120%
5/4/2016	5/5/2016	5/5/2016	spring	2.7	160	387	83%
11/16/2018	11/22/2018	11/23/2018	fall/winter	2.8	152	192	23%
6/20/2018	7/12/2018	7/22/2018	summer	2.8	147	114	-25%
7/26/2018	10/3/2018	10/3/2018	fall/winter	2.9	134	82	-48%
11/11/2017	11/13/2017	11/15/2017	fall/winter	2.9	130	201	43%
10/9/2020	2/13/2021	2/13/2021	fall/winter	3.0	127	1,177	161%
7/30/2020	8/17/2020	8/24/2020	summer	3.0	126	1	-197%
9/3/2020	2/13/2021	2/13/2021	fall/winter	3.0	125	1,177	162%
10/12/2018	11/22/2018	11/23/2018	fall/winter	3.0	124	192	43%
10/12/2016	10/14/2016	10/27/2016	fall/winter	3.1	114	34	-109%
4/7/2021	4/13/2021	4/13/2021	spring	3.1	114	1,700	175%
8/16/2018	10/3/2018	10/3/2018	fall/winter	3.2	107	82	-26%
10/28/2020	2/13/2021	2/13/2021	fall/winter	3.2	105	1,177	167%
12/3/2020	2/13/2021	2/13/2021	fall/winter	3.4	88	1,177	172%
12/22/2020	2/13/2021	2/13/2021	fall/winter	3.4	88	1,177	172%
3/17/2021	3/18/2021	3/18/2021	spring	3.4	88	pending	pending
11/3/2019	11/20/2019	1/1/2020	fall/winter	3.6	77	1,360	178%
10/11/2016	10/14/2016	10/27/2016	fall/winter	4.6	32	34	6%

*FSP concentration expected with a particular Road RAM score (2NDNATURE et al 2010).

The large percent differences in the last column of Table 3 would indicate that the FSP concentrations predicted for runoff based on Road RAM score from 2NDNATURE et al 2010 are not often accurate at SR431. However, many of the sampled runoff events occurred days or even weeks after the Road RAM measurement was taken and therefore this assessment cannot be made with any certainty. In order to investigate the possibility that a site-specific relationship between road condition and inflow FSP concentration in runoff at SR431 exists, only expected concentrations and average inflow FSP concentrations where the next runoff event date and next sampled runoff event date are the same were used in the correlation in Figure 8. These are highlighted in green in Table 3. However, the low R^2 value in Figure 6 indicates that no significant relationship can be established with the data collected to date. Due to the fact that no significant relationship has yet been found, this task was terminated after the spring of WY21.

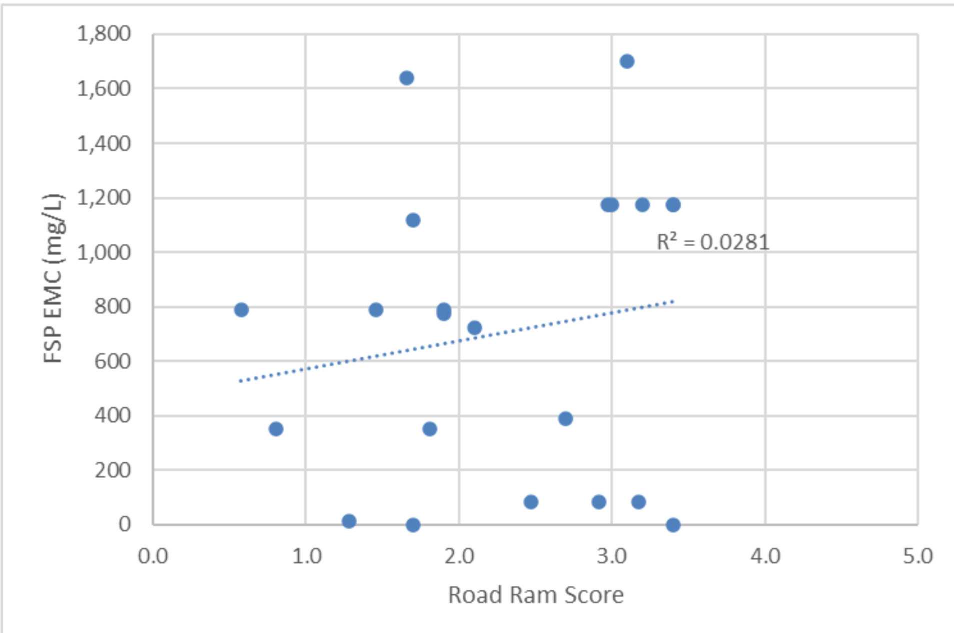

Figure 7: Relationship between Road Ram Score and inflow FSP EMC; very low R2 indicates no significant relationship.

According to the Road RAM Technical Document scores between 0 and 1.0 are considered “poor” and expected FSP concentrations in runoff from roads in this category range from 680-1,592 mg/L. Actual average inflow FSP EMCs were less than expected FSP concentrations in all cases for poor scores. Poor scores constitute 9% of scores determined to date and all occurred in the spring. Snowbanks full of sediment accumulated over a winter of snow removal operations may deposit a significant amount of sediment on the road as they melt and recede in the spring. Sweeping operations may not have removed the sediment before the next runoff event.

Road RAM scores between 1.1 and 2.0 fall into the “degraded” category. The range of FSP concentrations that can be expected in runoff from roads in this condition is 291-679 mg/L. However, the actual average inflow FSP EMCs from runoff events within this score range tended to be higher than the expected FSP concentrations for Road RAM estimations made in the fall/winter and spring seasons and lower for estimations made in the summer season for this category of scores. This may indicate a seasonal influence on the dependability of Road RAM to predict actual concentrations. It may also indicate that roads are generally cleaner than expected in the summer. Degraded scores constitute 38% of scores determined to date.

Road RAM scores between 2.1 and 3.0 fall into the “fair” category where the range of expected FSP concentrations in runoff is 124-290 mg/L. The actual average inflow FSP EMCs from runoff events within this score range tended to fall above that range in the fall/winter, and below that range in the summer. Fair scores constitute 36% of scores determined to date.

Road RAM scores between 3.1 and 4.0 are considered “acceptable” and expected FSP concentrations range from 53-123 mg/L. To date, three measurements had a score between 3.0 and 4.0; for these measurements two of the average inflow FSP EMCs from runoff events fell within the estimated FSP concentration range, and one was less than 53mg/L. Acceptable scores constitute 15% of scores determined to date and occurred between August and November. Late summer and fall road conditions may be better due to the lack of traction abrasives applied in the summer, road sweeping operations having removed sediment from the prior winter, and/or summer thunderstorms washing the roads clean.

Road RAM scores between 4.1 and 5.0 are considered “desired” and expected FSP concentrations range from 23-53mg/L. Only one measurement fell in this range, and the actual average inflow FSP EMC fell within the estimated FSP concentration range. Desired scores constitute 2% of scores determined to date and occurred in October.

2. Measure depth of sediment in vaults after eight monitored runoff events

This task was initiated November 2015 following the meeting between Tahoe RCD and NDOT mentioned above where it was determined that post event sediment depth was valuable information. The depths shown in Table 4 represent the average depth in each vault in feet. All clean-outs restored sediment depth in the respective vaults to near zero. Summer and fall of WY18 were dry and minimal sediment accumulation occurred by January of 2019 (~0.1 feet for both the Contech MFS and the Jellyfish). No sediment accumulation measurements were conducted during the lapse of funding that occurred July 2018-December 2018. February 2019 was the snowiest month on record for many areas in the Tahoe basin, and therefore it was not possible to conduct sediment accumulation until May 2019 due to lack of access to the vaults. By May 2019 substantial sediment had entered the system and a cleanout was performed in June 2019, restoring the sediment depth to zero. A small amount of sediment accumulation occurred by the end of summer WY19 due to a series of thunderstorms in September. Little to no sediment accumulation occurred during the fall/winter of WY20. Some sediment accumulation was observed during the spring of WY20. Both vaults were vactored on May 12, 2020. Little to no sediment accumulation was observed at the Contech vault over the summer of WY20, possibly due to the fact that sediment accumulation in the splitter chamber was preferentially routing flow to the Jellyfish. The Jellyfish vault saw 0.13 feet of summertime sediment accumulation (from 0.11 feet in June 2020 to 0.24 feet in September 2020). Little to no sediment accumulation occurred during the fall/winter of WY21 in either vault. Both the Contech and the Jellyfish vaults were vactored on March 8, 2021. Sediment accumulation was 0.10 ft and 0.11 ft in the Contech MFS and Jellyfish respectively during the spring of WY21. The pipes between the splitter vault and the inflow flumes were cleaned with a pressure washer by Tahoe RCD on May 11, 2021.

Table 4: Average depth of sediment in vaults.

Date Time	Contech MFS (ft)	Jellyfish (ft)
12/30/2015	0.33	0.92
3/16/2016	0.58	1.14
4/15/2016	0.61	na
4/22/2016	0.56	na
6/3/2016	0.75	2.17
8/3/2016	1.10	2.05
10/20/2016	na	1.92
12/30/2016	0.10	0.05
4/3/2016	1.00	2.30
4/20/2017	1.90	2.85
5/1/2017	0.10	0.43
5/18/2017	0.08	0.37
5/22/2017	0.10	0.46
6/19/2017	0.12	0.38
8/19/2017	0.00	0.00
9/21/2017	0.01	0.10
10/5/2017	0.03	0.15
10/24/2017	0.00	0.04

Table 4: Continued.

Date Time	Contech MFS (ft)	Jellyfish (ft)
11/14/2017	0.10	1.19
11/17/2017	0.00	0.10
2/2/2018	0.17	0.30
4/7/2018	0.00	0.05
5/17/2018	0.08	0.36
1/2/2019	0.10	0.09
5/8/2019	0.25	0.38
6/25/2019	0.00	0.00
10/21/2019	0.10	0.09
2/26/2020	0.10	0.12
4/22/2020	0.19	0.38
6/17/2020	0.10	0.11
8/7/2020	0.10	0.13
9/3/2020	0.10	0.24
11/4/2020	0.08	0.22
2/16/2021	0.06	0.22
3/22/2021	0.06	0.09
5/11/2021	0.10	0.11

Task 4: Final Report

1. Provide raw data

Final reporting for each water year is provided as part of the Annual Stormwater Monitoring Report (due March 31st of each year), but raw data can be viewed at any time on Acuity.

2. Provide treatment effectiveness analysis following formats outlined in the RSWMP FIG

Final reporting for each water year is provided as part of the Annual Stormwater Monitoring Report (due March 31st of each year) which includes treatment effectiveness evaluations for FSP, TN, and TP on a seasonal and annual basis as well as for sampled events. The data for FSP in the Annual Stormwater Monitoring Report is based on water quality samples. However, treatment effectiveness for FSP for WY21 is provided for all events for the Contech MFS in Table 5 and the Jellyfish in Table 6 based on continuous turbidity, a proxy measurement for FSP (2NDNATURE et al 2014). Removal efficiencies in red indicate that FSP was flushed from the system or that outflow turbidity sensors were inundated with accumulated sediment. A removal efficiency of 100% indicates no outflow from the Contech MFS vault, which occurs when influent volumes are less than 3,000 cubic feet (the approximate storage capacity of the Contech MFS vault) and the vault can accommodate the new flow. Sometimes the vault is full from a previous event and even small inflow volumes will result in outflow. The holding capacity of the Contech MFS is likely what allows it to generally be more efficient than the Jellyfish; not only because it often doesn't outflow, but also because sediment has the opportunity to settle out during the longer residence time in the vault.

There was only one event during the fall/winter season of WY21, occurring on February 12-13, 2021. Both the Contech MFS and the Jellyfish performed similarly, reducing FSP by 71% and 73% respectively. There were four events during the spring season of WY21. Both vaults were vactored on March 8, 2021, and likely contributed to the very high removal efficiency by the Jellyfish during the 3/18/21 event. The Contech MFS does not show the same removal efficiency after the clean-out. Generally, the Contech MFS is more effective than the Jellyfish over time due to the longer holding time in the vault, but this was not observed during the spring of WY21. Both vaults performed similarly during the very low flow conditions of WY21.

Table 5: Contech MFS FSP removal efficiency for each event of fall/winter and spring WY21.

CONTECH MFS WY21 Fall/Winter and Spring: October 1, 2020 - May 31, 2021								
Runoff Start Date Time	Runoff End Date Time	Runoff Type	Event Duration	Influent Volume (cf)	Effluent Volume (cf)	Influent FSP (lbs)	Effluent FSP (lbs)	FSP Removal Efficiency
2/13/21 13:55	2/13/21 15:00	Rain on Snow	1:05	136	66	7.86	2.29	71%
3/18/21 19:05	3/19/21 1:00	Rain on Snow	5:55	84	56	4.80	2.22	54%
4/13/21 18:00	4/13/21 21:50	Event Snowmelt	3:50	67	57	2.91	1.03	65%
5/16/21 19:25	5/16/21 20:05	Thunderstorm	0:40	55	44	3.11	1.20	61%
5/21/21 20:55	5/23/21 1:45	Event Snowmelt	28:50	337	224	2.99	1.67	44%

Table 6: Jellyfish FSP removal efficiency for each event of fall/winter and spring WY21.

JELLYFISH WY21 Fall/Winter and Spring: October 1, 2020 - May 31, 2021								
Runoff Start Date Time	Runoff End Date Time	Runoff Type	Event Duration	Influent Volume (cf)	Effluent Volume (cf)	Influent FSP (lbs)	Effluent FSP (lbs)	Removal Efficiency
2/12/21 11:15	2/13/21 15:50	Rain on Snow	28:35	193	78	7.71	2.06	73%
3/18/21 19:05	3/19/21 1:05	Rain on Snow	6:00	163	2	4.17	0.02	99%
4/13/21 17:55	4/14/21 1:40	Event Snowmelt	7:45	141	120	1.78	0.86	52%
5/16/21 19:25	5/16/21 20:20	Thunderstorm	0:55	66	60	3.43	0.91	74%
5/21/21 20:55	5/23/21 1:55	Event Snowmelt	29:00	335	235	3.75	1.61	57%

3. Provide mass loading v. volume calculations for select events

Seasonal Progress Report #3 provides this analysis for events that occurred in the fall/winter and spring of water year 2016. Seasonal Progress Report #1 included a similar study based on four events that occurred in the late spring and early summer of water year 2015. Analyses have consistently shown that in general, turbidities (and thus FSP) mirror the flow and therefore no first flush phenomenon exists at SR431 with respect to FSP. This may indicate that the primary road serves as a constant source of sediment. Due to consistent results this analysis has not been repeated since Seasonal Progress Report #3. This analysis can be repeated upon request.

Appendix A

Hydrographs, continuous turbidity, and sample distribution for all sampled events.

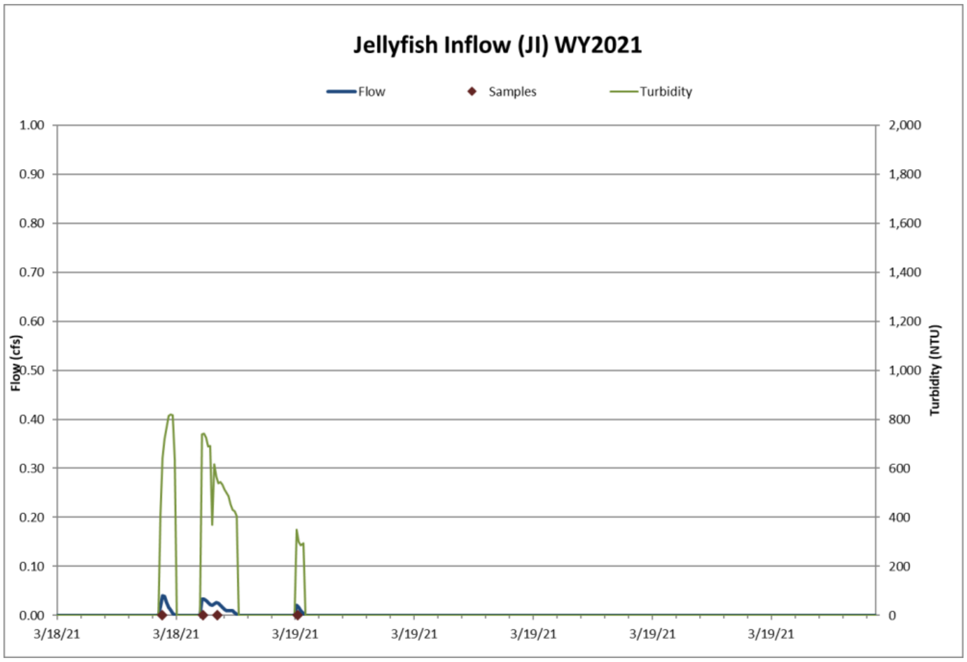

Figure 8: Hydrograph, continuous turbidity, and sample distribution at the Jellyfish Inflow for the 3/18/2021 rain on snow event.

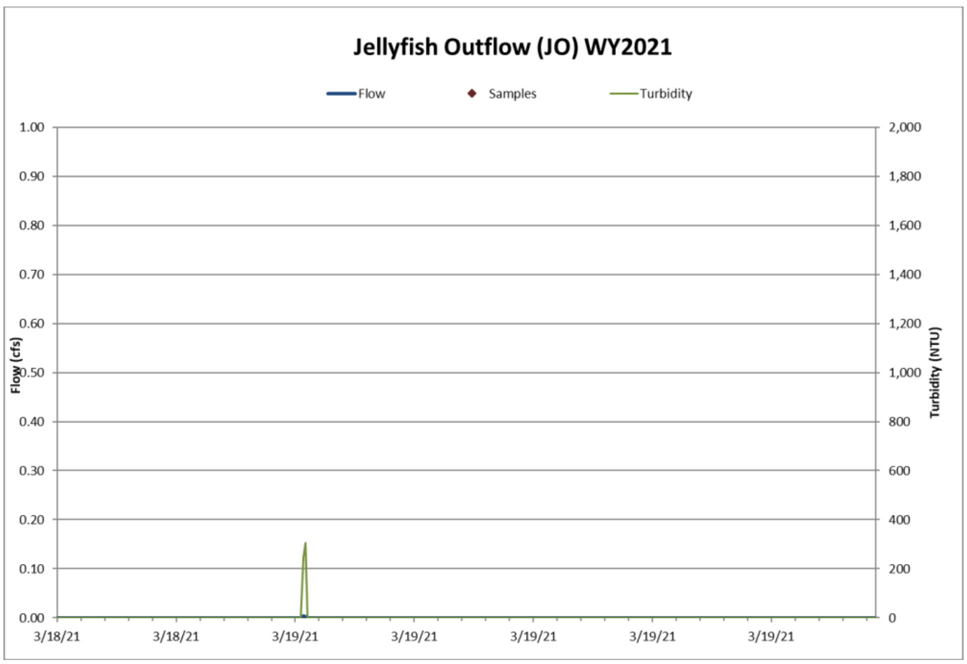

Figure 9: Hydrograph and continuous turbidity at the Jellyfish Outflow for the 3/18/2021 rain on snow event. No samples were taken at Jellyfish Outflow during this event because there was not enough flow.

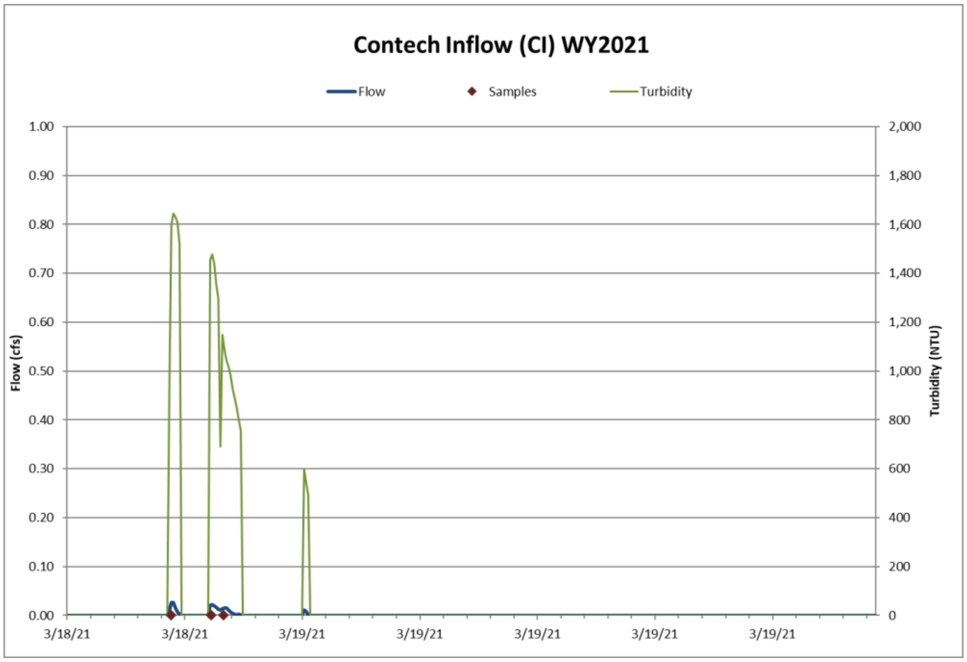

Figure 10: Hydrograph, continuous turbidity, and sample distribution at the Contech Inflow for the 3/18/2021 rain on snow event.

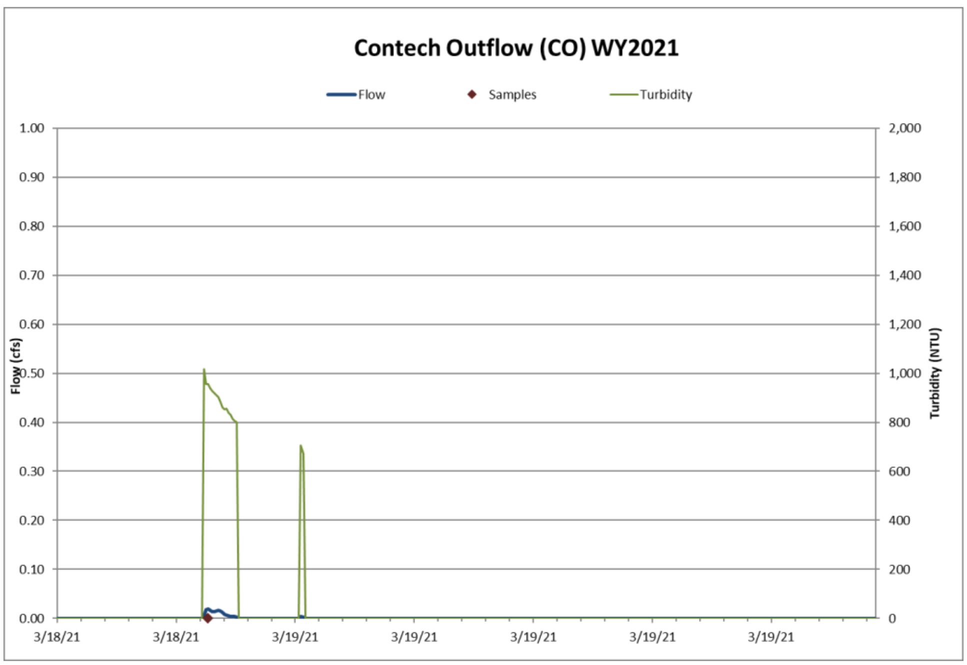

Figure 11: Hydrograph, continuous turbidity, and sample distribution at the Contech Outflow for the 3/18/2021 rain on snow event.

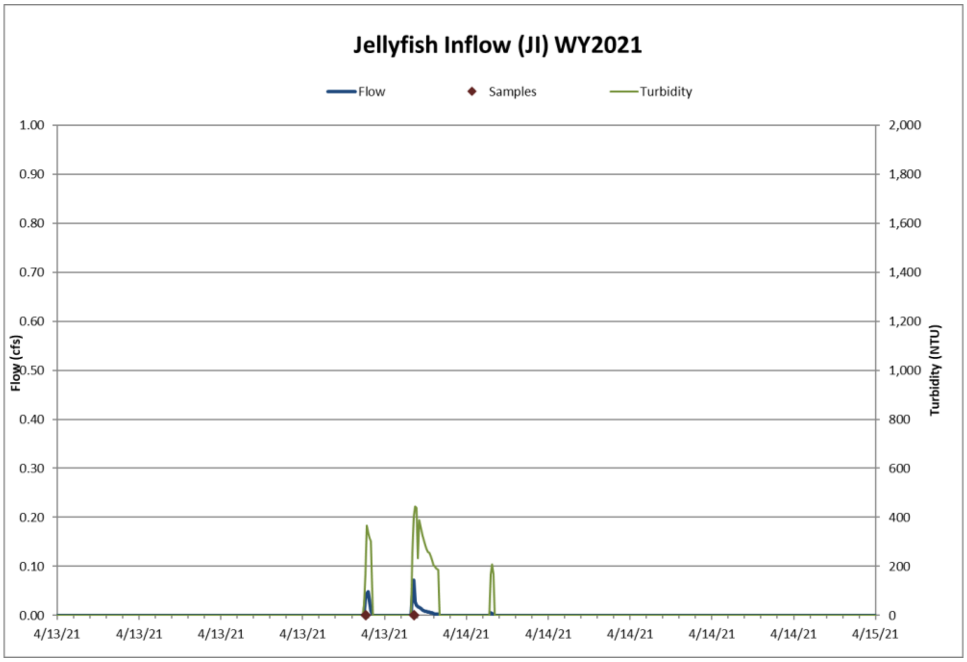

Figure 12: Hydrograph, continuous turbidity, and sample distribution at the Jellyfish Inflow for the 4/13/2021 event snowmelt.

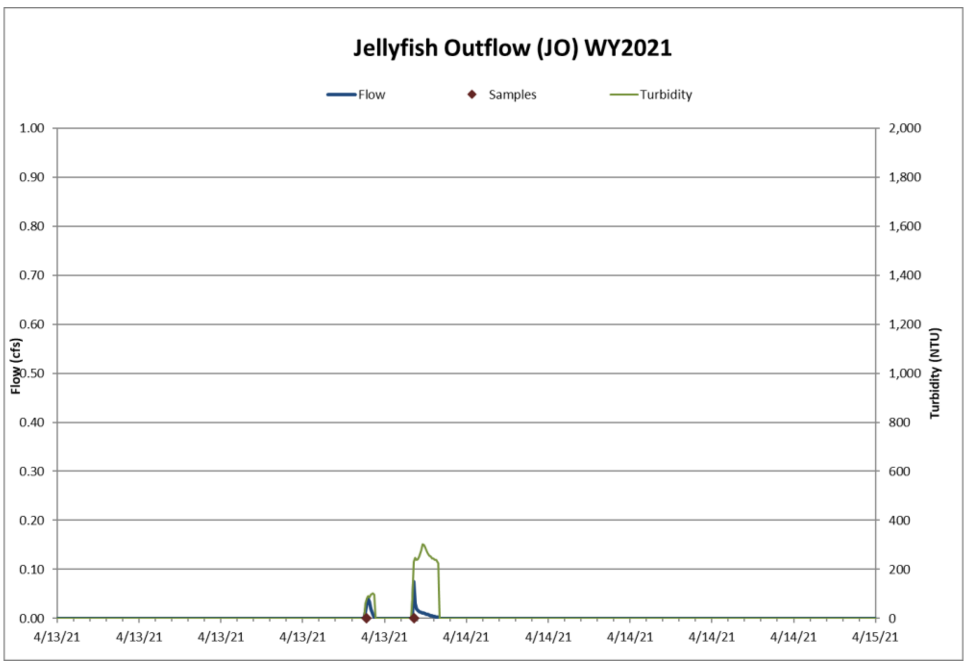

Figure 13: Hydrograph, continuous turbidity, and sample distribution at the Jellyfish Outflow for the 4/13/2021 event snowmelt.

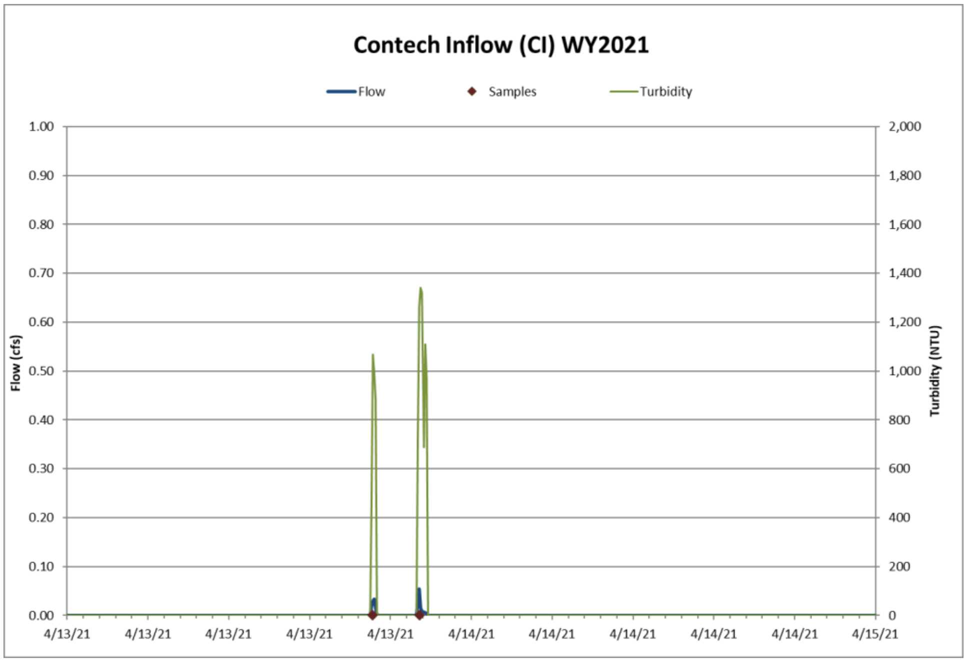

Figure 14: Hydrograph, continuous turbidity, and sample distribution at the Contech Inflow for the 4/13/2021 event snowmelt.

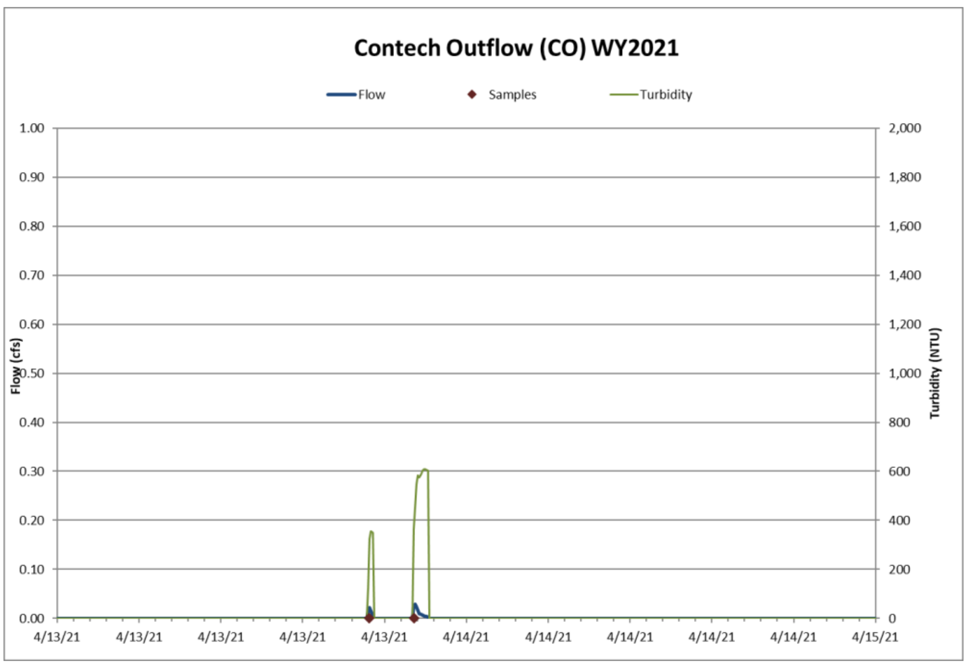

Figure 15: Hydrograph, continuous turbidity, and sample distribution at the Contech Outflow for the 4/13/2021 event snowmelt.

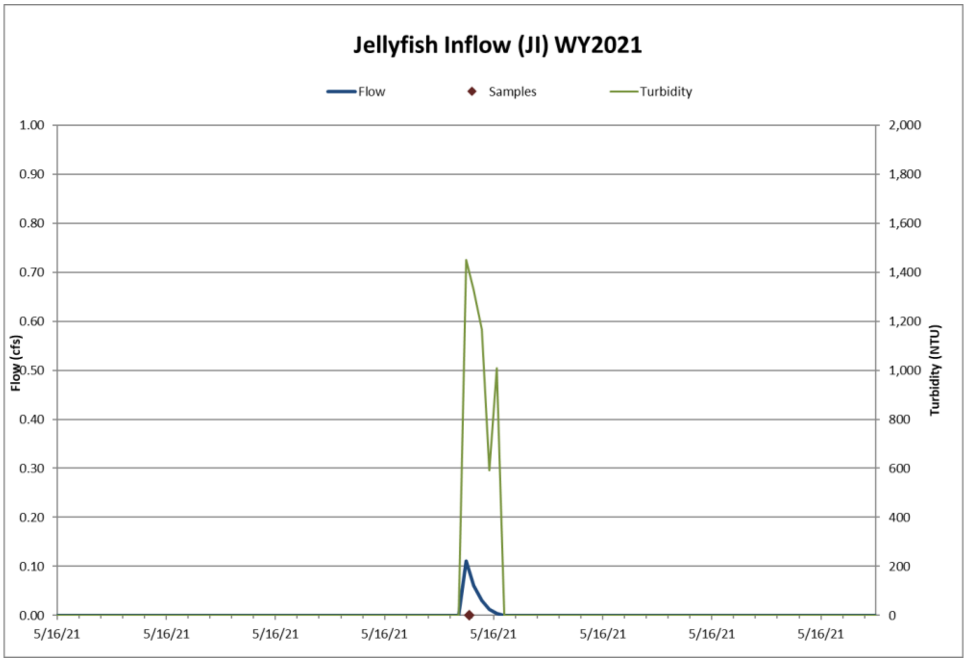

Figure 16: Hydrograph, continuous turbidity, and sample distribution at the Jellyfish Inflow for the 5/16/2021 thunderstorm event.

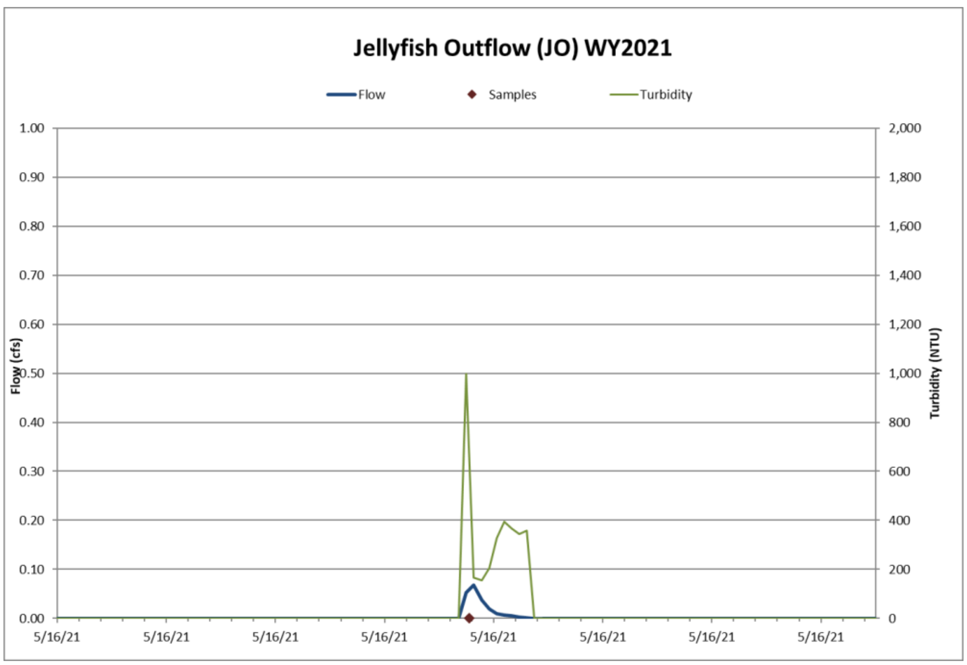

Figure 17: Hydrograph, continuous turbidity, and sample distribution at the Jellyfish Outflow for the 5/16/2021 thunderstorm event.

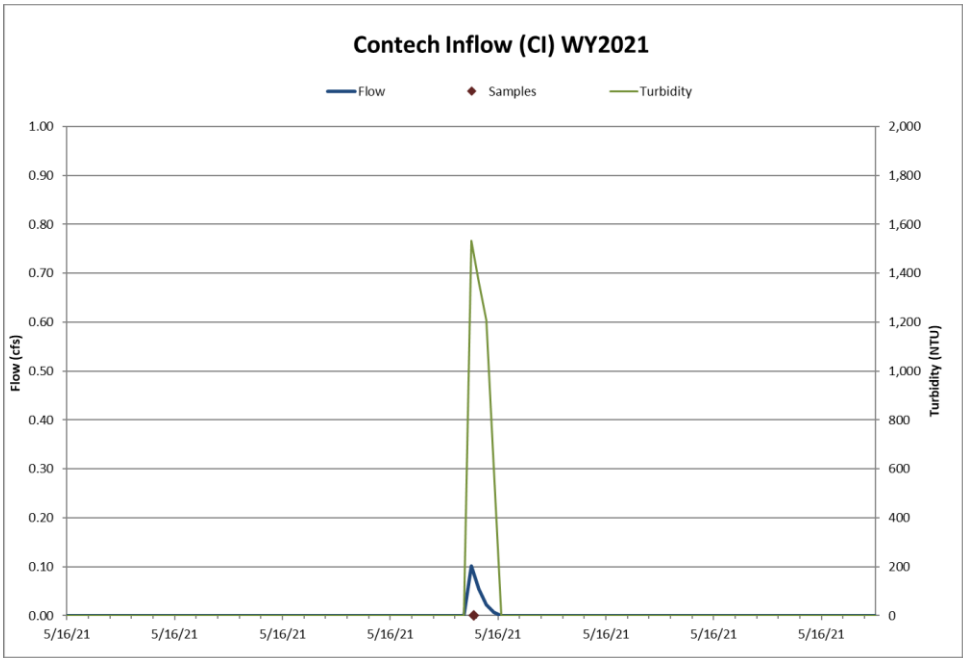

Figure 18: Hydrograph, continuous turbidity, and sample distribution at the Contech Inflow for the 5/16/2021 thunderstorm event.

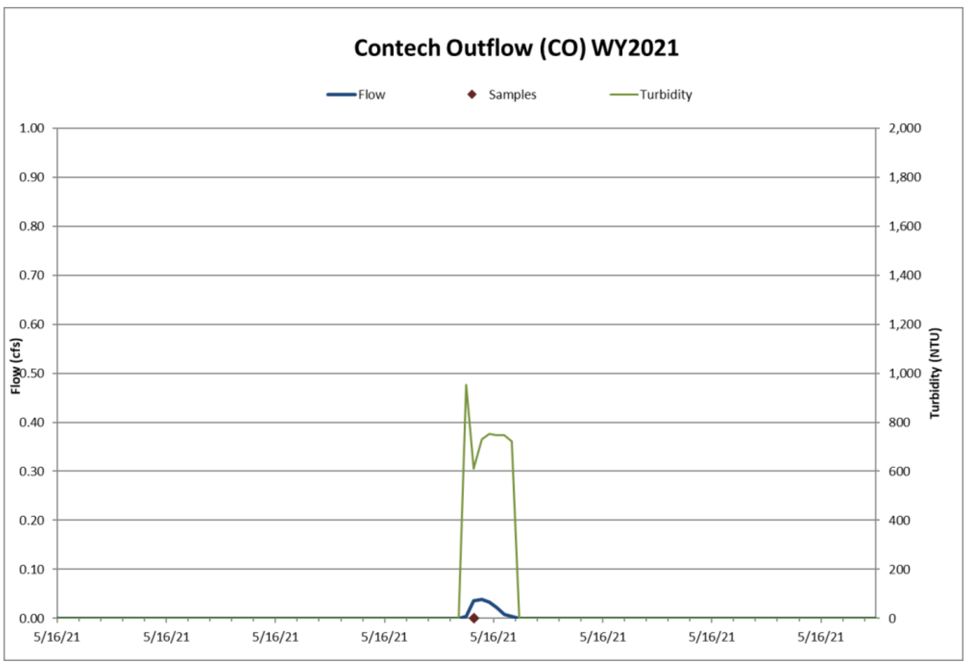

Figure 19: Hydrograph, continuous turbidity, and sample distribution at the Contech Outflow for the 5/16/2021 thunderstorm event.

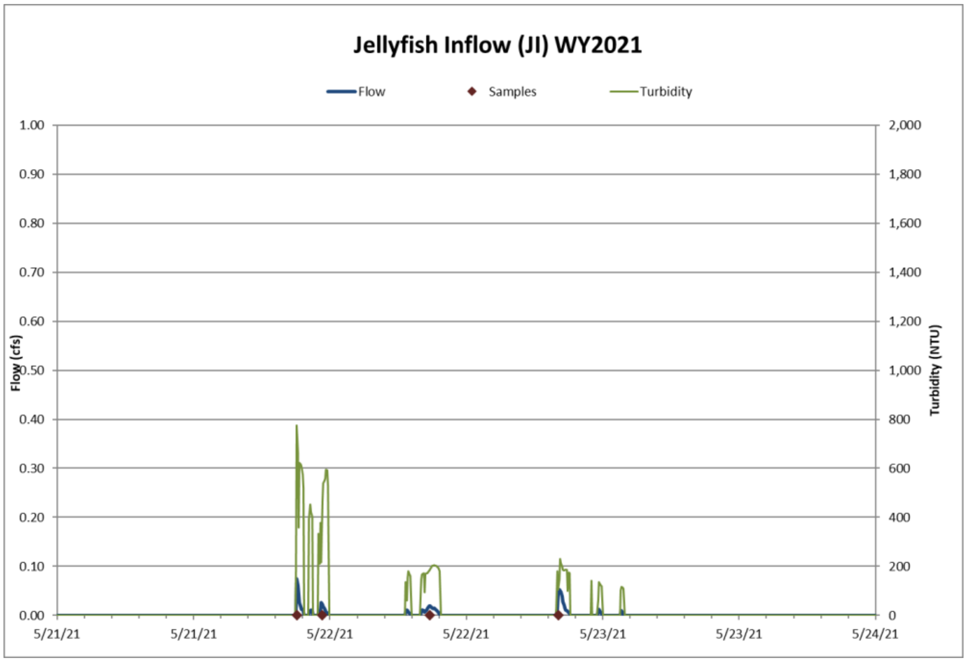

Figure 20: Hydrograph, continuous turbidity, and sample distribution at the Jellyfish Inflow for the 5/21/2021 event snowmelt.

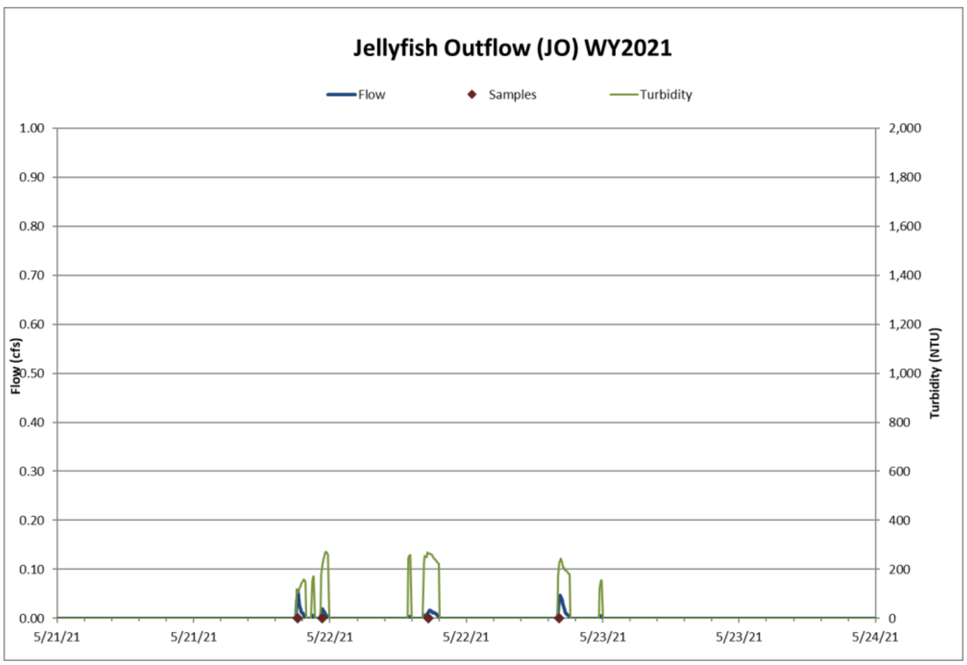

Figure 21: Hydrograph, continuous turbidity, and sample distribution at the Jellyfish Outflow for the 5/21/2021 event snowmelt.

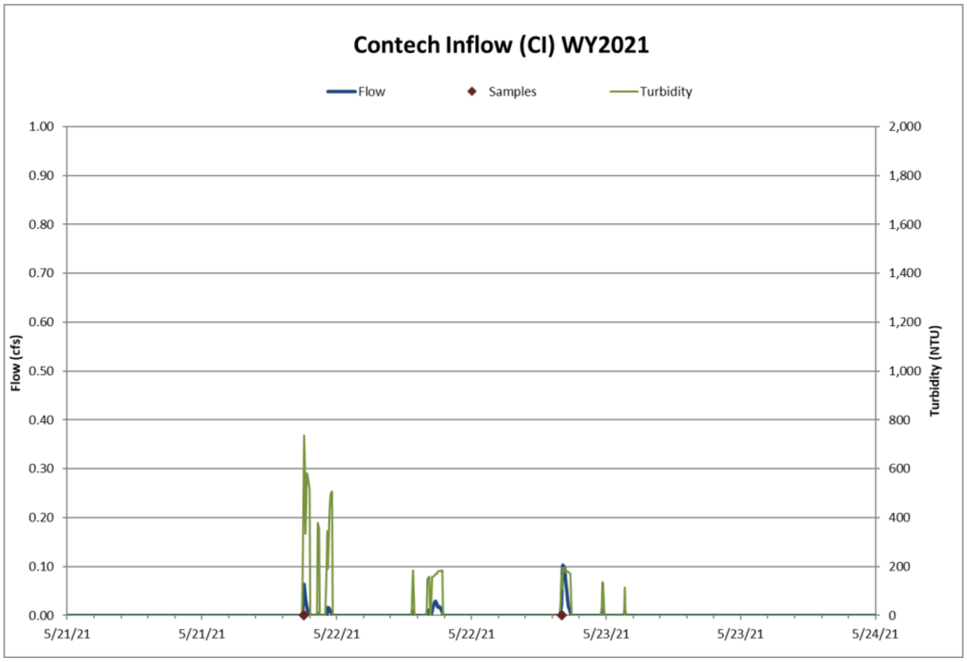

Figure 22: Hydrograph, continuous turbidity, and sample distribution at the Contech Inflow for the 5/21/2021 event snowmelt.

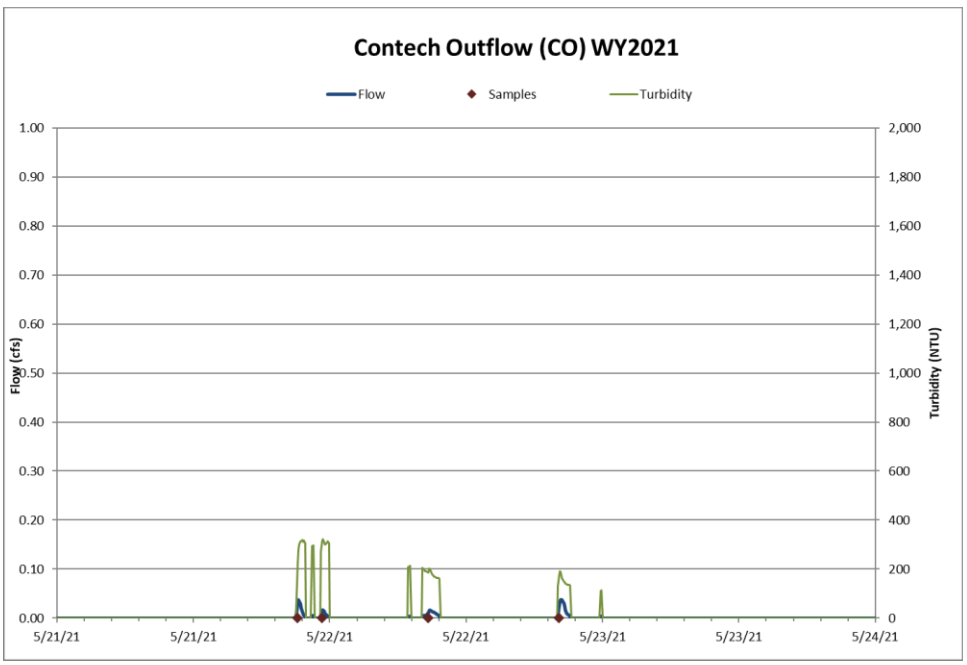

Figure 23: Hydrograph, continuous turbidity, and sample distribution at the Contech Outflow for the 5/21/2021 event snowmelt.

References

2NDNATURE, Desert Research Institute. 2014. Surrogate Indicators to Monitor Fine Sediment Particles in the Lake Tahoe Basin. March 2014.

2NDNATURE LLC, Northwest Hydraulic Consultants, Environmental Incentives, 2010. *Road RAM Technical Document.* Prepared for the Nevada Division of Environmental Protection and California Tahoe Conservancy. November 2010.

Tahoe Resource Conservation District, 2NDNATURE, Desert Research Institute, Northwest Hydraulic Consultants. 2017. *Updated RSWMP Framework and Implementation Guidance Document*. Submitted the California State Water Board. March 30, 2015. Updated October 31, 2017.