Seasonal Progress Report #5
SR431 Treatment Vault Effectiveness Monitoring

Agreement Number: P423-13-019

Submitted by: Tahoe Resource Conservation District

Submitted to: Nevada Department of Transportation

Water Year: 2017

Period: Spring Season, March 1, 2017 – May 31, 2017

Submission Date: June 30, 2017

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. 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 end of water year 2017 (September 30, 2017). Tahoe RCD follows sampling protocols outlined in the Regional Stormwater Monitoring Program Framework and Implementation Guidance document (RSWMP FIG, Tahoe RCD et al 2015).

An amendment to the original agreement between NDOT and Tahoe RCD to extend the end date to June 30, 2018, augment the budget to monitor for water 2017, and complete the annual monitoring report was fully executed in December 2016.

The 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.

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

Task	Description	Due Date	% Of Work Complete	Date (s) Submitted
1	Project Administration			
1.1	Twelve Quarterly Invoices	10/31/15, 1/31/16, 4/30/16, 7/31/16, 10/31/16, 1/31/17, 4/30/17, 7/31/17, 10/31/17, 1/31/18, 4/30/18, 7/31/18	58%	10/31/15, 1/31/16, 4/30/16, 7/31/16, 10/31/16, 1/31/17, 4/30/17
1.2	Six Seasonal Progress Reports	3/31/16, 6/30/16, 10/31/16, 3/31/17, 6/30/17, 10/31/17,	88%	3/31/2016, 6/30/16, 10/31/16, 3/31/17, 6/30/17
2	Stormwater Monitoring			
2.1	Collect continuous flow and turbidity data at four monitoring stations	9/30/2017	88%	ongoing
2.2	Collect stormwater runoff samples during eight events per year	9/30/2017	88%	ongoing
2.3	Collect three diurnal non-event snowmelt events if conditions allow	5/31/2017	NA	ongoing
2.4	Collect flow bypass data in both vaults	9/30/2017	88%	ongoing
2.5	Provide precipitation data to date	9/30/2017	88%	3/31/16, 6/30/16, 10/31/16, 3/31/17, 6/30/17
2.6	Provide hydrograph, turbidity, and sample distribution graphs to date	9/30/2017	88%	3/31/16, 6/30/16, 10/31/16, 3/31/17, 6/30/17
3	Condition Assessments			
3.1	Estimate Road RAM score prior to eight sampled events	9/30/2017	88%	3/31/16, 6/30/16, 3/31/17, 6/30/17
3.2	Measure depth of sediment in both vaults after sampled events	9/30/2017	88%	3/31/16, 6/30/16, 3/31/17, 6/30/17
4	Final Report			
4.1	Provide raw data	3/15/2018	66%	3/31/17
4.2	Provide treatment effectiveness analysis	3/15/2018	66%	3/31/17
4.3	Correlate Road RAM score to pollutant concentration and load	3/15/2018	50%	3/31/17
4.4	Provide mass loading v. volume calculations for select events	3/15/2018	50%	3/31/16, 6/30/16

Task 1: Project Administration

1. Invoices

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

#1: May 1, 2015 –September 30, 2015
#2: October 1, 2015 –December 31, 2015
#3: January 1, 2016 –March 31, 2016
#4: April 1, 2016 –June 30, 2016
#5: July 1, 2016 –September 30, 2016
#6: October 1, 2016 –December 31, 2016
#7: January 1, 2017 –March 31, 2017
#8: April 1, 2017 –June 30, 2017
#9: July 1, 2017 –September 30, 2017
#10: October 1, 2017 –December 31, 2017
#11: January 1, 2018 –March 31, 2018
#12: April 1, 2018 –June 30, 2018

2. Progress Reports

Progress reports will not be concurrent with quarterly invoices. Three seasonal progress reports each for water years 2016 and 2017 will be submitted for this project covering the following periods:

#1: Fall/winter: –October 1, 2015 - February 29, 2016
#2: Spring: March 1, 2016 - May 31, 2016
#3: Summer: June 1, 2016 - September 30, 2016
#4: Fall/winter: October 1, 2016 - February 29, 2017
#5: Spring: March 1, 2017 - May 31, 2017
#6: Summer: June 1, 2017 - September 30, 2017

Please accept this report as seasonal progress report #5.

Task 2: Stormwater Monitoring

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

The spring season began on March 1, 2017 and ended May 31, 2017. Continuous turbidity was successful for the majority of the season, but the sensors were occasionally buried in sediment at the inflows. When available, turbidity data was interpolated from turbidity measurements taken on single samples in the lab for periods when sensors were covered and turbidity data was unreliable. Sediment was removed from sensors by hand regularly. Continuous flow was successfully sampled for the duration of the season. Overland snowmelt was observed flowing into the CO manhole cover, causing more flow at the CO as compared to CI during this time period. Sediment filled the splitter vault once during this time period, and the splitter vault, along with the Jellyfish and Contech MFS vaults were cleaned on April 20, 2017. There continues to be an ample source of sediment along the roadside and in the pullout above the monitoring station (Figure 2-4).

Figure 1: May 1, 2017, overland snowmelt flowing into CO manhole cover.

Figure 2: May 12, 2017 sediment on pullout and road. Snowmelt flowing into drop inlet.

Figure 3: May 12, 2017 sediment on road.

Figure 4: May 22, 2017 sediment on road.

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

Four events were successfully sampled during spring season of WY17 –two rain on snow events (April 6, 2017 and May 5-6, 2017), one rain event (April 16, 2017), and one non-event snowmelt (May 19-21, 2017) –bringing the water year total to seven events (out of eight requisite events for the year).

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).

Although non-event snowmelt occurred during this period, flow was not high enough to collect enough samples for rising and falling limb composites during the three diurnals. One composite was made per diurnal.

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 WY17 the Contech MFS cartridge filters were bypassed six times (March 21-22, 2016; March 30, 2017; April 13, 2017; May 6-7, 2017; May 9-22, 2017 and May 23-24, 2017). During the second to last bypass event May 9-22, 2017 the system was in bypass continuously for 13 days. Figure 5). The Jellyfish filters were bypassed on seven times (March 21, 2017; March 22, 2017; March 30, 2017; April 6. 2017; April 13, 2017; May 6-7, 2017; May 23-24, 2017; Figure 6).

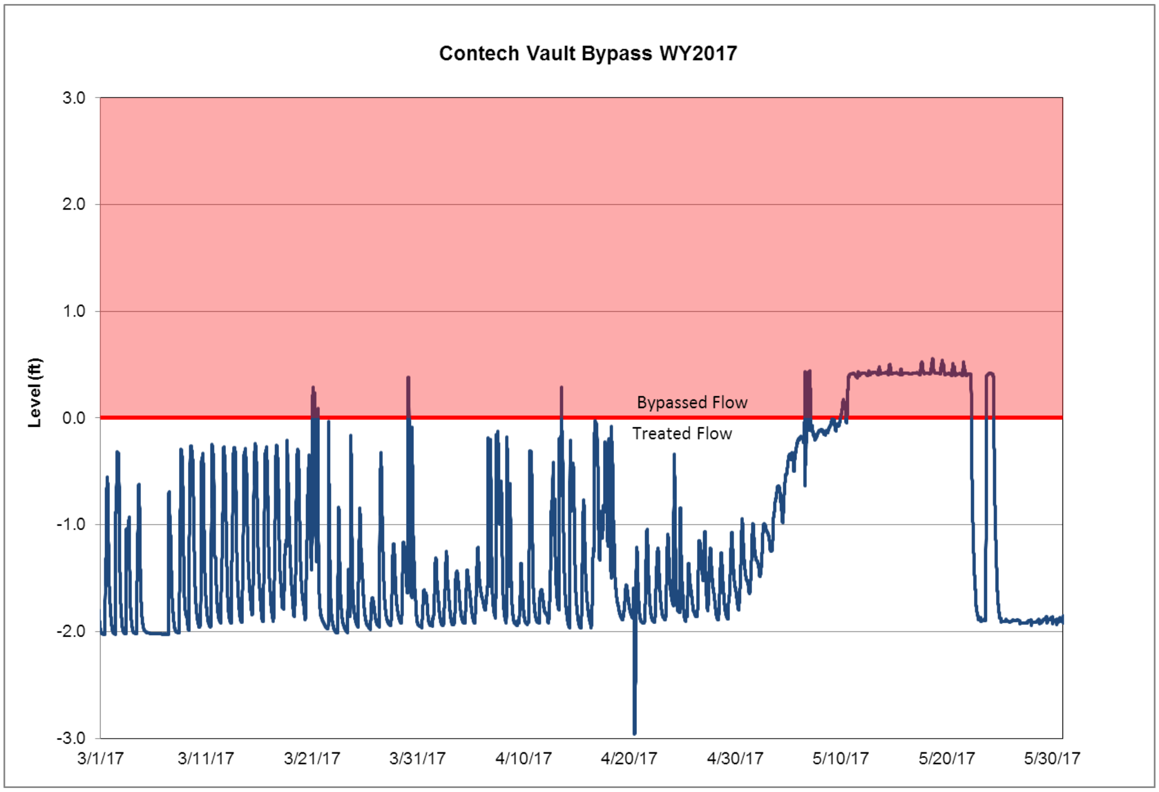

Figure 5: Bypassed flow in Contech MFS vault, spring WY17

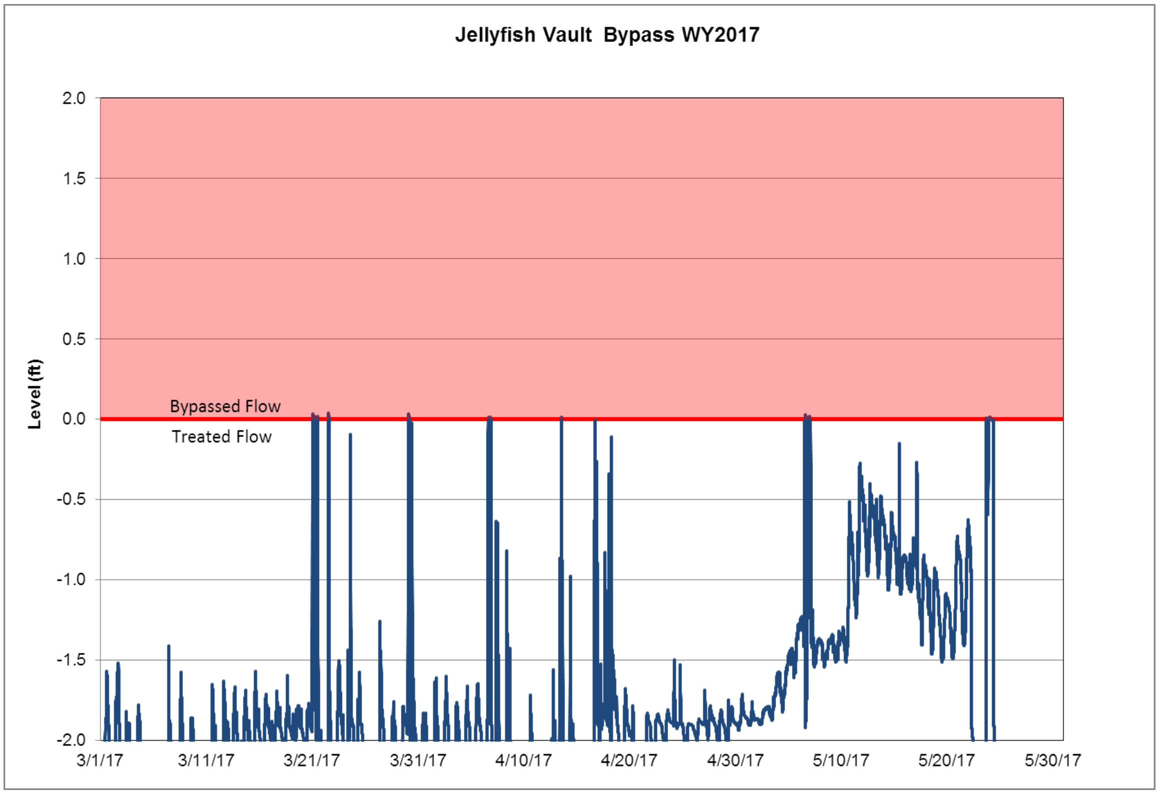

Figure 6: Bypassed flow in Jellyfish vault, spring WY17.

5. Provide precipitation data to date.

Table 2 provides summary data for all 15 spring precipitation events that occurred during WY17 at the SR431 monitoring site including event start and end dates, total precipitation, peak precipitation, minimum and maximum temperature, and preciptation type. Events highlighted in pink were sampled for water quality (one non-event snowmelt was sampled May 19-21, 2017 during a period with no preciptiation).

Table 2: Summary of spring precipitation events at SR431. Highlighted rows indicate events that were sampled.

Station ID	Precip Event (#)	Precipitation event start (PST)	Event end (PST)	Event duration (hr:mm)	Interevent duration (hr:mm)	Event precipitation (inches)	Event peak precipitation (inch/10min)	Event minimum temp (°C)	Event maximum temp (°C)	Type of Precipitation
NDOT	NDOT-17-21	3/4/2017 22:30	3/7/2017 10:10	59:40	130:20	1.568	0.039	-9.9	-0.4	snow
NDOT	NDOT-17-22	3/18/2017 15:35	3/18/2017 15:45	0:10	269:25	0.02	0.008	2.2	2.7	rain
NDOT	NDOT-17-23	3/20/2017 23:50	3/22/2017 12:45	36:55	56:05	1.262	0.027	-3.5	1.9	rain/snow
NDOT	NDOT-17-24	3/24/2017 07:10	3/25/2017 14:35	31:25	42:25	0.384	0.012	-2.9	5.2	snow, rain
NDOT	NDOT-17-25	3/26/2017 19:55	3/27/2017 01:55	6:00	29:20	0.244	0.016	-2.5	-0.8	snow
NDOT	NDOT-17-26	3/30/2017 01:25	3/30/2017 21:05	19:40	71:30	0.621	0.023	-5.6	2.2	rain, snow
NDOT	NDOT-17-27	4/6/2017 14:50	4/8/2017 16:45	49:55	161:45	1.784	0.023	-7.3	2.9	rain, snow
NDOT	NDOT-17-28	4/12/2017 00:50	4/14/2017 00:05	47:15	80:05	0.749	0.019	-6.4	7.0	rain, snow
NDOT	NDOT-17-29	4/16/2017 15:50	4/18/2017 09:05	41:15	63:45	0.931	0.019	-1.2	6.2	rain
NDOT	NDOT-17-30	4/20/2017 02:40	4/20/2017 06:30	3:50	41:35	0.008	0.004	-2.6	-1.5	snow
NDOT	NDOT-17-31	4/24/2017 03:10	4/24/2017 23:25	20:15	92:40	0.096	0.008	-2.2	1.4	snow
NDOT	NDOT-17-32	4/26/2017 11:15	4/27/2017 22:30	35:15	35:50	0.055	0.027	-0.7	7.9	light rain
NDOT	NDOT-17-33	5/6/2017 12:20	5/7/2017 06:15	17:55	205:50	0.875	0.027	-1.0	3.8	rain, snow, rain
NDOT	NDOT-17-34	5/15/2017 12:05	5/17/2017 04:20	40:15	197:50	0.052	0.008	-1.3	9.7	snow
NDOT	NDOT-17-35	5/31/2017 08:15	5/31/2017 09:55	1:40	339:55	0.024	0.008	5.6	6.8	rain

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

See Figures 7-22 at the end of this report for hydrographs, continous turbidity, and sample distributions for each of the four events sampled in the spring season.

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 the Tahoe RCD and NDOT where it was decided that determining a Road RAM score prior to runoff events was valuable. This procedure is expected to help establish a site-specific relationship between road condition and FSP concentration in runoff.

Since November 2015, fourteen Road RAM scores have been determined. 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 (2NDNATURE et al 2015). Road RAM was not conducted during the months of January and February 2017 because the road surfaces were too wet (Road RAM is not possible on wet roads). 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 2015). Efforts were made to take Road RAM scores close to the beginning of sampled runoff events but this did not always occur.

Observed Road RAM scores thus far nearly cover 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). Between 12/2/15 and 12/8/15, there was an improvement in Road RAM scores from 1.6 to 2.1, which may either be a result of sediment washing away from the road surface in the 12/5/2015 rain event or from road sweeping activities, but this has not been verified. The lowest score of 0.4 was determined on 4/8/16. Though no events were sampled immediately afterwards, Tahoe RCD staff observed excessively dirty roads during this time and decided that determining a score was prudent. This exceptionally low score may be the reason the splitter vault, inflow flumes, and treatment vaults were inundated with excessive amounts of sediment which necessitated splitter vault and inflow pipe flushing in mid and late April 2016, the clean-out of the Contech MFS vault and cartridge replacement in early August 2016, and the full clean-out of the entire system and the Jellyfish on October 20, 2016. Relatively high scores were determined on 10/11/16 and 10/12/16 and FSP concentrations were correspondingly low in runoff two weeks later on 10/27/16. Relatively low scores were determined during spring of 2017. Turbidimeters at the inflows were occasionally inundated with sediment during this time, sediment in the splitter vault quickly accumulated, and a there was a large amount of sediment (about 2-3 inches deep) visible on the road and SR431 pullout. Vactor trucks removed sediment from the splitter vault, Contech MFS vault, and Jellyfish vault on April 20, 2017. There was an improvement in RAM score between the 5/1/17 RAM and the 5/5/2017 from 0.8 to 1.8, possibly due to sweeping operations. For spring 2017, FSP concentrations were with the expected range for the corresponding RAM score for the 4/6/17 and 5/6/17 events, and below range for the 4/16/17 and 5/12/17 events. It is important to note that the 5/12/17 event was a snowmelt event, with thus there was limited washoff from the road as compared to a rain event. Table 3 summarizes the Road RAM scores, days between RAM determination and runoff event, range of expected FSP concentrations associated with that score, 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 the average inflow EMC was above the highest expected FSP concentration.

Table 3: Summary of Road RAM scores and FSP concentrations WY16 and WY17.

Road RAM date	Runoff event date	Days between RAM and runoff event	Road RAM Score	Expected FSP concentration range* (mg/L)	Average JI+CI inflow FSP EMC (mg/L)	% above highest expected FSP concentration
12/2/15	12/10/15	8	1.6	291-679	722	6%
12/8/15	12/10/15	2	2.1	124-290	722	149%
1/28/15	1/29/16	1	1.7	291-679	1,118	65%
2/24/16	3/4/16	8	1.5	291-679	2,955	335%
4/8/16	5/5/16	27	0.4	680-1592	387	-76%
5/4/16	5/5/16	1	2.7	124-290	387	34%
10/11/16	10/27/16	16	4.6	23-52	34	-35%
10/12/16	10/27/16	15	3.1	53-123	34	-73%
12/7/16	12/8/16	1	1.9	291-679	774	14%
3/15/17	4/6/17	23	0.7	680-1592	746	-53%
4/11/17	4/16/17	6	0.7	680-1592	612	-62%
5/1/17	5/6/17	6	0.8	680-1592	352	-78%
5/5/17	5/6/17	2	1.8	291-679	352	-48%
5/12/17	5/19/17	7	1.3	291-679	13	-98%

*Range of FSP concentrations expected with particular RAM score (from Road RAM Technical Document, 2015)

According to the Road RAM Technical Document scores between 0 and 1.0 are considered "poor" and FSP concentrations in runoff from roads in this category should range from 680-1,592 mg/L. The RAM score of 0.4 determined on 4/8/16 occurred nearly a month before the 5/5/16 event and it is evident by the 5/4/16 RAM score and the resulting FSP EMC for the 5/5/16 event that road condition improved, perhaps due to sweeping or the 2.2 inches of rain that fell between 4/8/16 and 5/5/16. Road RAM scores of poor were determined in March, April, and the beginning of May 2017. Improvement in score was observed after the 5/1/2017 RAM for the spring 2017 season.

Road RAM scores greater than 1.0 and less than or equal to 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 event mean FSP concentrations from runoff events within this score range were higher than the Road RAM predictions in all cases for this category. The 335% increase in actual concentration over predicted concentration may indicate that the road condition worsened significantly between the 2/24/16 score determination and the 3/4/16 runoff event. It is unknown if road abrasives were applied, but there was no precipitation or very cold temperatures that would indicate the need for large amounts of road abrasives during this time.

Road RAM scores greater than 2.0 and less than or equal to 3.0 fall into the "fair" category where the range of expected FSP concentrations in runoff is 124-290 mg/L. FSP concentrations that low were not measured during the 12/10/15 event so it is possible that the 12/8/15 score was overestimated slightly. Event mean FSP concentration for the 5/5/16 event were only 34% higher than predicted by the 5/4/16 RAM score.

Road RAM scores greater than 3.0 and less than or equal to 4.0 are considered "acceptable" and FSP concentrations should range from 53-123 mg/L. The RAM score taken on 10/12/16 predicts an FSP concentration higher than what was measured nearly two weeks later during the 10/27/16 event, indicating that road conditions likely returned to the "desirable" condition that was measured on 10/11/16. (RAM scores between 4.0 and 5.0 are considered "desirable" and FSP concentrations should range between 23-52 mg/L).

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. These sediment depths indicate a gradual accumulation in the

Contech in the spring and summer of 2016 (with a small decrease between 4/15/16 and 4/22/16 following the system flush on 4/15/16 after the 4/15/16 measurement was taken) and a large increase in sediment accumulation between 4/22/16 and 6/3/16. The roads were relatively clean on 5/4/16 as indicated by a Road RAM score of 2.7, but a snow storm on 5/20/16-5/21/16 likely required road abrasive application that was later washed off in the thunderstorms that followed between 5/23/16 and 5/25/16. This could explain the 0.19 foot (2.28 inch) increase in sediment in the Contech MFS. Over a foot of sediment accumulated in the Jellyfish during spring 2016. The small decrease in sediment between 6/3/16 and 8/3/16 may have been due to indirect flushing during the August 3, 2016 cleanout of the Contech MFS. Sediment depth prior to Contech MFS clean-out on August 3, 2016 was 1.10 feet. Sediment depth prior to Jellyfish clean-out on October 20, 2016 was 1.92 feet. Both the Contech MFS and the Jellyfish vaults were vactored out April 20, 2017 (along with the splitter vault); sediment depth prior to this cleanout was 1.9 feet and 2.85 feet, respectively. All clean-outs restored sediment depth in the respective vaults to near zero.

Table 4: Average depth of sediment in vaults.

Date Time	Contech MFS (ft)	Jellyfish (ft)
12/30/2015 10:30	0.33	0.92
3/16/2016 11:45	0.58	1.14
4/15/2016 10:00	0.61	na
4/22/2016 09:30	0.56	na
6/3/2016 10:00	0.75	2.17
8/3/2016 10:00	1.10	2.05
10/20/2016 09:30	na	1.92
12/30/2016 11:00	0.10	0.05
4/3/2016 14:00	1.00	2.30
4/20/2017 10:30	1.90	2.85
5/1/2017 10:00	0.10	0.43
5/18/2017 15:19	0.08	0.37
5/22/2017 10:00	0.10	0.46
6/19/2017 09:00	0.12	0.38

Task 4: Final Report

1. Provide raw data.

Final reporting for each water year is provided as part of the Regional Stormwater Monitoring Program (RSWMP) Implementers' Monitoring Program (IMP) Annual Stormwater Monitoring Report (due March 15th of each year), but raw data can be provided at any time upon request.

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

Final reporting for each water year is provided as part of the Regional Stormwater Monitoring Program (RSWMP) Implementers' Monitoring Program (IMP) Annual Stormwater Monitoring Report (due March 15th of each year) which includes treatment effectiveness evaluations on a seasonal and annual basis. However, treatment effectiveness is provided on an event by event basis for spring of WY17 for the Contech MFS in Table 5 and the Jellyfish in Table 6. Removal efficiencies highlighted in pink indicate that FSP was flushed from the system. The very high positive percentages indicate that turbidity sensors are inundated with accumulated sediment. During the month of March the Contech MFS sensors were covered in sediment while the Jellyfish sensors remained comparatively free of sediment accumulation. Due to snow storage blocking access to the equipment between January 2017 and March 28, 2017 the Contech MFS sensors could not be cleaned and returned to proper function until the end of March. The removal efficiencies of the Jellyfish tend to be better than the Contech MFS when all sensors are functioning properly.

Table 5: Contech MFS FSP removal efficiency for each event of the spring WY17.

CONTECH MFS WY17 Spring: March 1, 2017 - May 31, 2017							
Runoff Start Date Time	Runoff End Date Time	Runoff Type	Event Duration	Influent Volume (cf)	Influent FSP (lbs)	Effluent FSP (lbs)	Removal Efficiency
3/1/2017 11:15	3/1/2017 19:00	snowmelt	7:45	203	0.001	4	325609%
3/2/2017 9:55	3/2/2017 20:00	snowmelt	10:05	532	0.003	7	212588%
3/3/2017 9:50	3/3/2017 18:05	snowmelt	8:15	73	0.000	1	117791%
3/4/2017 12:35	3/4/2017 18:00	snowmelt	5:25	90	0.001	1	135140%
3/7/2017 11:00	3/7/2017 16:00	snowmelt	5:00	81	0.001	1	172874%
3/8/2017 12:45	3/8/2017 20:55	snowmelt	8:10	379	0.003	5	172253%
3/9/2017 9:00	3/9/2017 21:20	snowmelt	12:20	579	0.004	6	137533%
3/10/2017 12:20	3/10/2017 20:10	snowmelt	7:50	177	0.001	2	123326%
3/11/2017 11:35	3/11/2017 19:15	snowmelt	7:40	416	0.003	4	140685%
3/12/2017 12:15	3/12/2017 23:05	snowmelt	10:50	499	0.004	5	118531%
3/13/2017 8:55	3/13/2017 22:00	snowmelt	13:05	553	0.004	4	97534%
3/14/2017 11:50	3/14/2017 23:25	snowmelt	11:35	514	0.004	3	79812%
3/15/2017 11:15	3/15/2017 22:15	snowmelt	11:00	547	0.004	3	76542%
3/16/2017 10:45	3/16/2017 22:00	snowmelt	11:15	423	0.003	2	65904%
3/17/2017 11:25	3/17/2017 22:15	snowmelt	10:50	366	0.003	2	62697%
3/18/2017 13:20	3/18/2017 20:40	snowmelt	7:20	102	0.001	1	62663%
3/19/2017 12:20	3/19/2017 20:50	snowmelt	8:30	143	0.001	1	59483%
3/20/2017 13:15	3/21/2017 14:30	rain	25:15	1,093	0.008	3	37189%
3/22/2017 13:15	3/22/2017 15:55	snow	2:40	130	0.001	0	30282%
3/23/2017 11:30	3/23/2017 13:20	snowmelt	1:50	8	0.000	0	3860%
3/24/2017 15:10	3/24/2017 18:30	snow	3:20	133	0.001	0	23231%
3/27/2017 9:30	3/27/2017 14:50	snow	5:20	85	0.001	0	13832%
3/30/2017 1:35	3/30/2017 13:15	snow	11:40	840	24.552	36	46%
4/3/2017 13:45	4/4/2017 3:40	snowmelt	13:55	72	0.646	0	-44%
4/4/2017 11:05	4/8/2017 0:50	rain, snow	85:45	1,458	76.358	30	-61%
4/8/2017 9:05	4/8/2017 21:00	snowmelt	11:55	377	4.881	9	82%
4/12/2017 10:30	4/14/2017 21:50	rain	59:20	1,365	141.304	43	-70%
4/15/2017 11:55	4/18/2017 23:30	rain	83:35	2,561	54.740	31	-44%
4/20/2017 12:40	5/24/2017 10:05	snowmelt	813:25	50,179	37.610	48	28%

Table 6: Jellyfish FSP removal efficiency for each event of the spring WY17.

JELLYFISH WY17 Spring: March 1, 2017 - May 31, 2017							
Runoff Start Date Time	Runoff End Date Time	Runoff Type	Event Duration	Influent Volume (cf)	Influent FSP (lbs)	Effluent FSP (lbs)	Removal Efficiency
3/1/2017 13:20	3/1/2017 17:50	snowmelt	4:30	87	7.653	2	-78%
3/2/2017 9:55	3/2/2017 18:40	snowmelt	8:45	142	7.699	3	-60%
3/4/2017 14:40	3/4/2017 16:25	snowmelt	1:45	2	0.105	0	-58%
3/7/2017 11:05	3/7/2017 11:55	snowmelt	0:50	18	1.427	0	-87%
3/8/2017 13:25	3/8/2017 17:15	snowmelt	3:50	48	3.040	1	-69%
3/11/2017 13:10	3/11/2017 16:25	snowmelt	3:15	20	0.870	0	-62%
3/12/2017 15:05	3/12/2017 18:15	snowmelt	3:10	7	0.303	0	-77%
3/13/2017 15:50	3/13/2017 18:30	snowmelt	2:40	3	0.126	0	-67%
3/14/2017 16:15	3/14/2017 19:45	snowmelt	3:30	0	0.016	0	220%
3/15/2017 14:40	3/15/2017 17:10	snowmelt	2:30	8	0.275	0	-68%
3/18/2017 15:45	3/18/2017 16:15	snowmelt	0:30	4	0.138	0	-67%
3/21/2017 0:35	3/21/2017 14:05	rain	13:30	1,499	54.275	34	-37%
3/22/2017 13:05	3/22/2017 17:35	snow	4:30	330	11.037	9	-18%
3/23/2017 9:55	3/23/2017 17:55	snowmelt	8:00	184	6.628	4	-35%
3/24/2017 9:15	3/24/2017 17:05	snow	7:50	189	6.778	5	-26%
3/25/2017 8:20	3/25/2017 13:50	snowmelt	5:30	74	2.718	2	-33%
3/27/2017 9:30	3/27/2017 14:55	snow	5:25	155	5.504	4	-33%
3/30/2017 1:35	3/30/2017 15:40	snow	14:05	965	28.952	45	55%
3/31/2017 12:00	3/31/2017 17:25	snowmelt	5:25	2	0.007	0	-10%
4/1/2017 13:50	4/1/2017 18:35	snowmelt	4:45	44	0.143	1	279%
4/2/2017 14:00	4/2/2017 18:45	snowmelt	4:45	52	0.304	0	36%
4/3/2017 13:50	4/3/2017 19:55	snowmelt	6:05	117	1.480	1	-7%
4/4/2017 12:35	4/4/2017 19:45	snowmelt	7:10	119	1.013	1	-6%
4/5/2017 11:20	4/5/2017 20:45	snowmelt	9:25	217	2.181	2	-15%
4/6/2017 13:00	4/7/2017 4:05	rain	15:05	1,233	33.380	28	-16%
4/7/2017 8:35	4/7/2017 21:10	snow	12:35	426	10.402	14	33%
4/8/2017 9:45	4/8/2017 18:15	snowmelt	8:30	142	2.131	2	11%
4/10/2017 14:35	4/11/2017 5:00	snowmelt	14:25	75	0.960	0	-97%
4/12/2017 10:15	4/12/2017 23:55	rain	13:40	71	0.768	0	-93%
4/13/2017 9:00	4/13/2017 17:10	snow	8:10	404	5.987	11	85%
4/14/2017 9:05	4/14/2017 11:30	snowmelt	2:25	108	1.207	2	60%
4/16/2017 16:05	4/18/2017 4:40	rain	36:35	1,606	32.539	11	-68%
4/18/2017 7:05	4/18/2017 22:15	rain, snow	15:10	640	8.313	4	-55%
4/19/2017 12:35	4/19/2017 20:25	snowmelt	7:50	150	1.644	0	-84%
4/20/2017 7:40	4/20/2017 10:15	snowmelt	2:35	9	0.091	0	-90%
4/21/2017 12:00	4/21/2017 19:00	snowmelt	7:00	80	0.435	0	-84%
4/22/2017 12:30	4/22/2017 18:55	snowmelt	6:25	43	0.222	0	-93%
4/23/2017 11:55	4/23/2017 18:30	snowmelt	6:35	56	0.304	0	-84%
4/24/2017 3:30	4/24/2017 20:25	rain, snow	16:55	232	4.134	0	-91%
4/27/2017 2:25	4/27/2017 23:05	rain	20:40	107	0.565	0	-90%
4/28/2017 13:30	4/28/2017 17:55	snowmelt	4:25	32	0.122	0	-91%
4/29/2017 8:50	4/29/2017 18:15	snowmelt	9:25	34	0.179	0	-93%
4/30/2017 12:50	4/30/2017 21:25	snowmelt	8:35	52	0.153	0	-81%
5/1/2017 12:45	5/2/2017 5:30	snowmelt	16:45	104	0.525	0	-88%
5/2/2017 12:20	5/22/2017 10:50	snowmelt	478:30	36,677	21.923	9	-57%
5/23/2017 16:10	5/24/2017 10:05	snowmelt	17:55	2,108	1.584	1	-34%

3. Correlate Road RAM score to pollutant concentration and load.

This task has been initiated, see task 3.1.

4. 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.

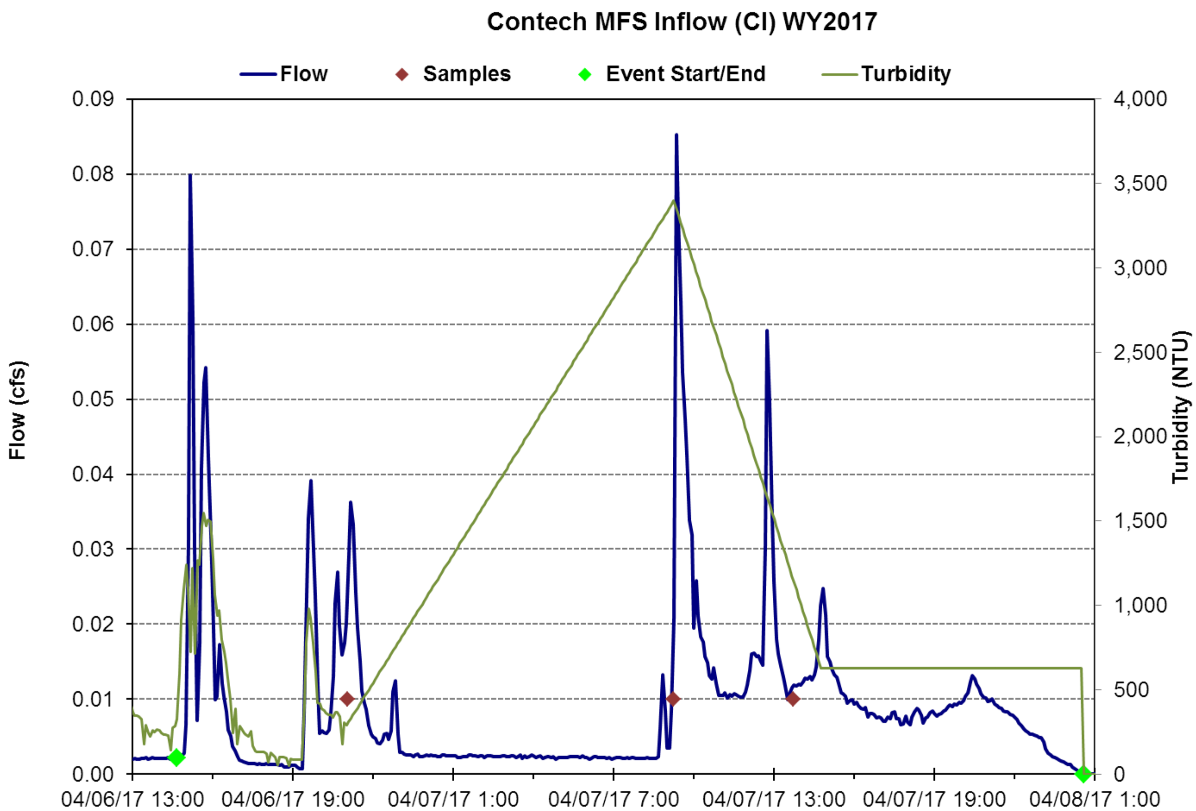

Figure 7: Hydrograph, continuous turbidity and sample distribution at the Contech MFS Inflow for the 4/06/17 rain and snow event. The turbidimeter was buried so turbidity is interpolated between single samples.

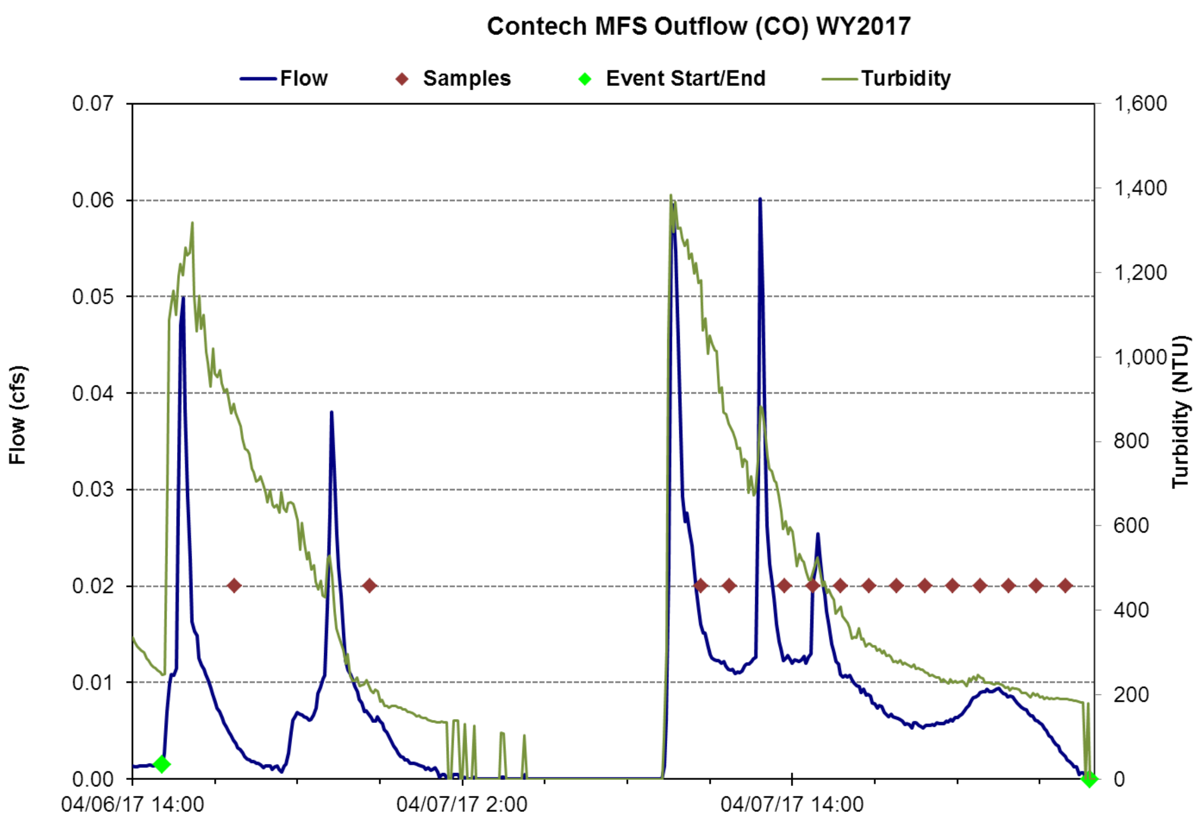

Figure 8: Hydrograph, continuous turbidity and sample distribution at the Contech MFS Outflow for the 4/06/17 rain and snow event.

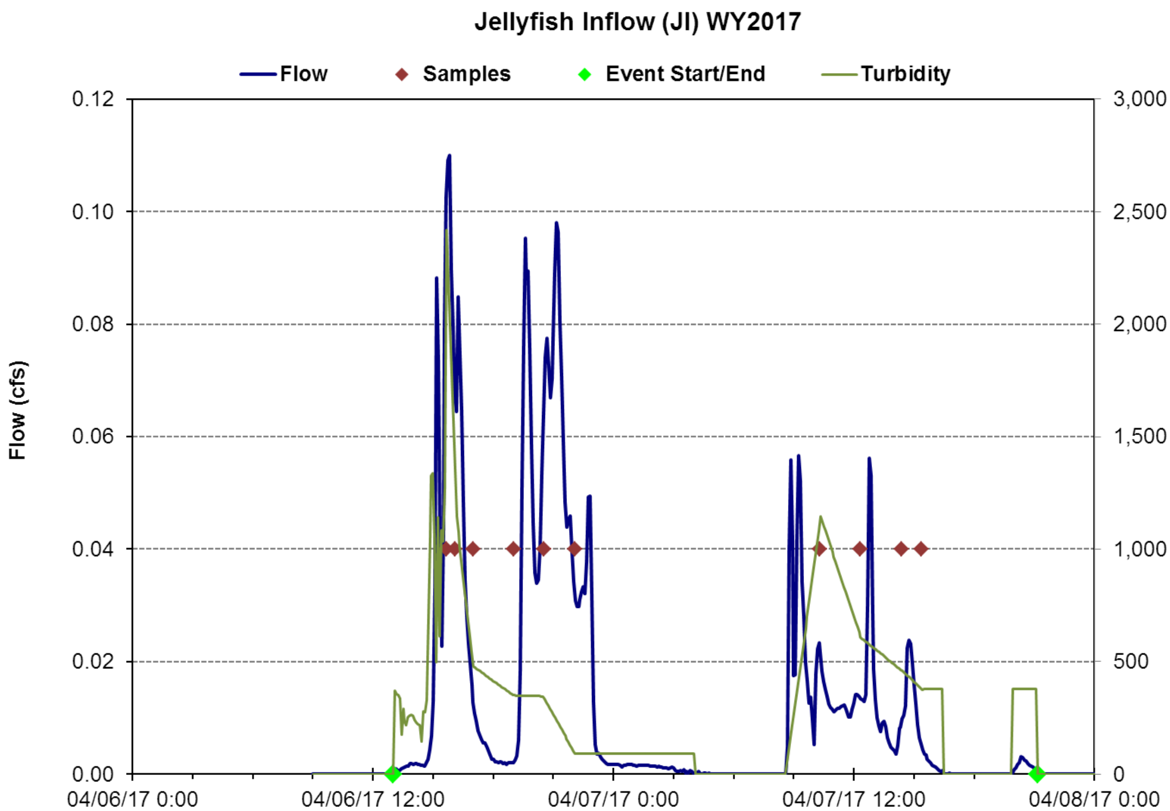

Figure 9: Hydrograph, continuous turbidity and sample distribution at the Jellyfish Inflow for the 4/06/17 rain and snow event. The turbidimeter was buried so turbidity is interpolated between single samples.

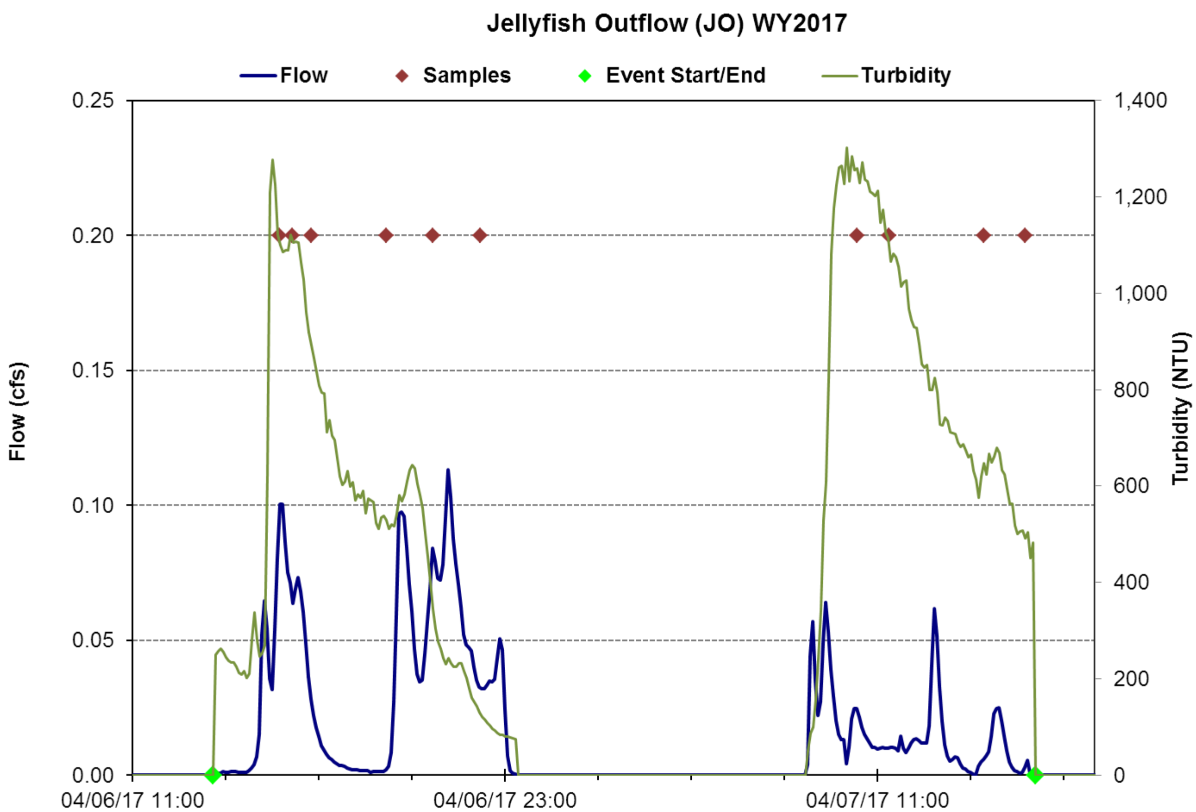

Figure 10: Hydrograph, continuous turbidity and sample distribution at the Jellyfish Outflow for the 4/06/17 rain and snow event.

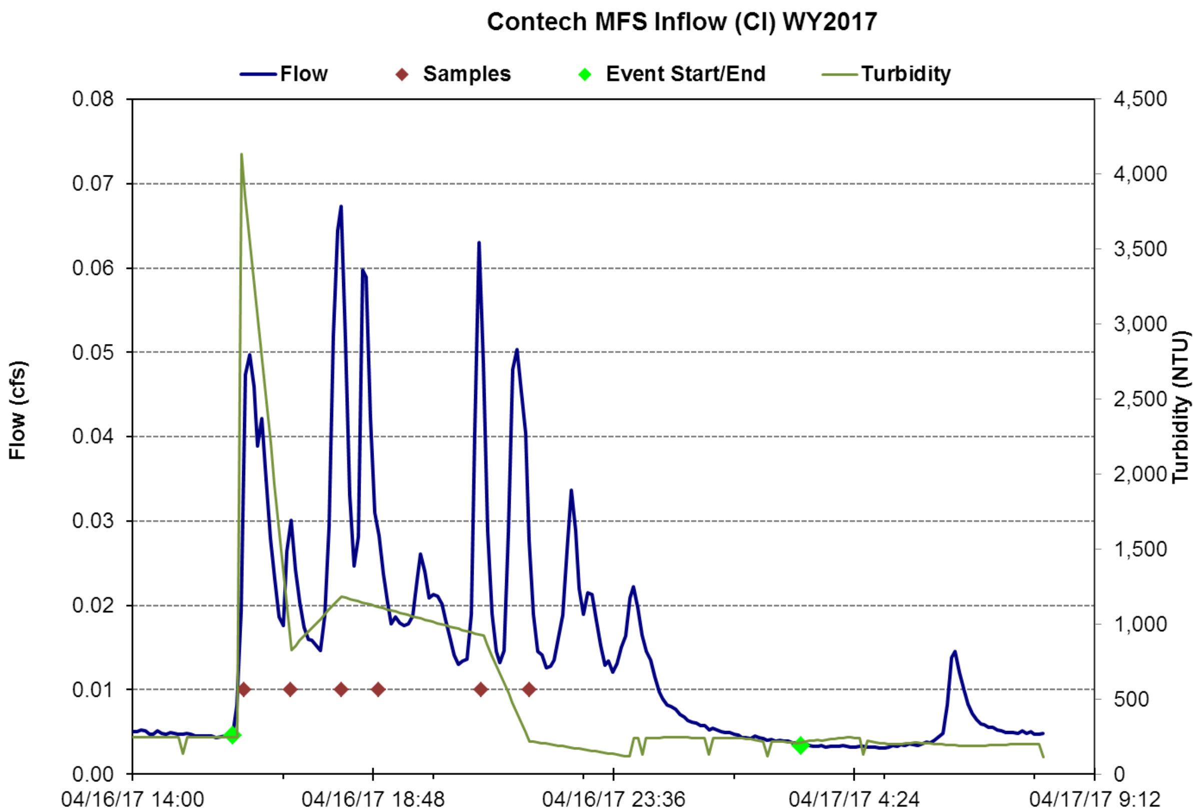

Figure 11: Hydrograph, continuous turbidity and sample distribution at the Contech MFS Inflow for the 4/16/17 rain event. The turbidimeter was buried so turbidity is interpolated between single samples.

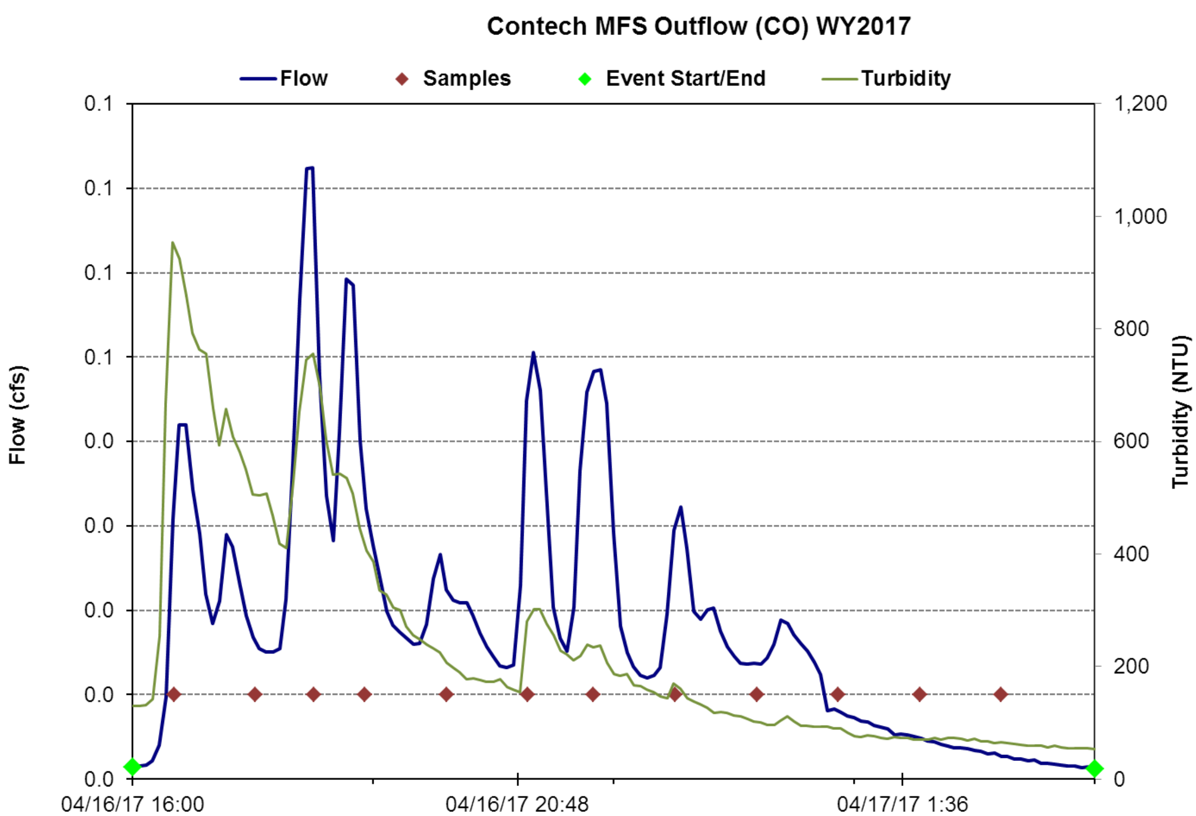

Figure 12: Hydrograph, continuous turbidity and sample distribution at the Contech MFS Outflow for the 4/16/17 rain event.

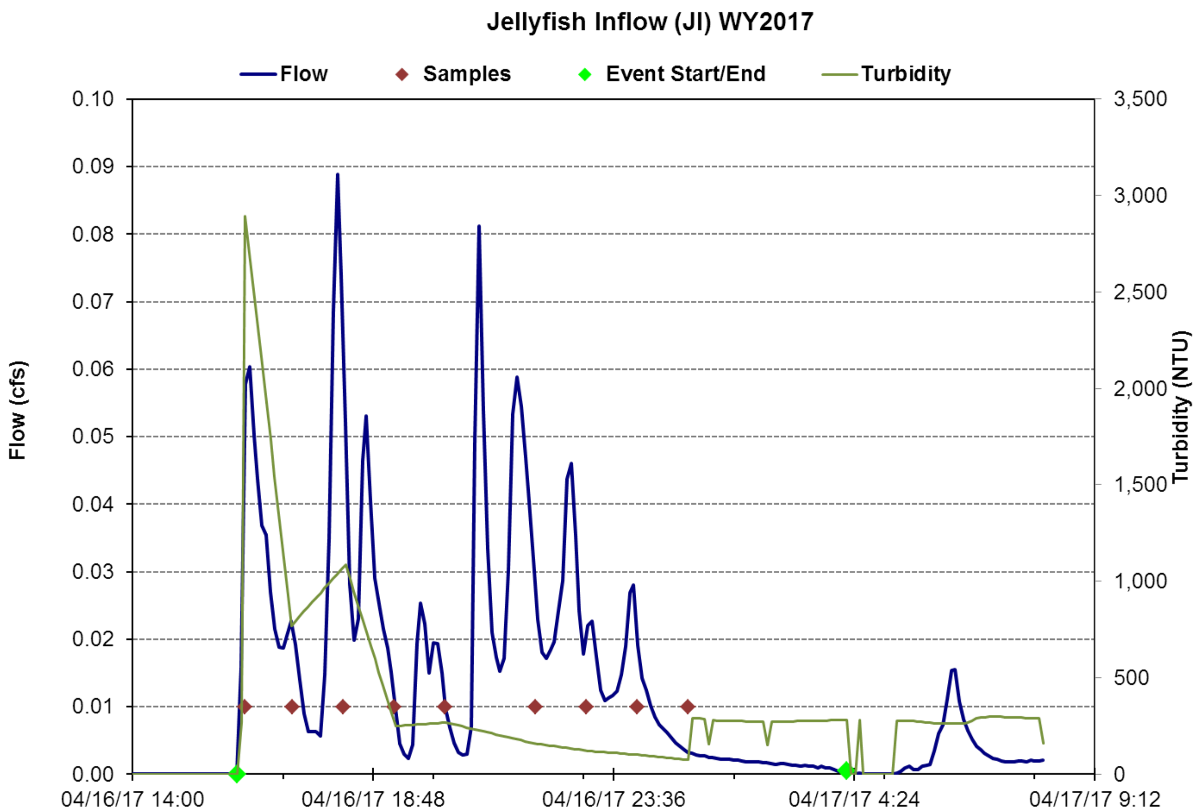

Figure 13: Hydrograph, continuous turbidity and sample distribution at the Jellyfish Inflow for the 4/16/17 rain event. The turbidimeter was buried so turbidity is interpolated between single samples.

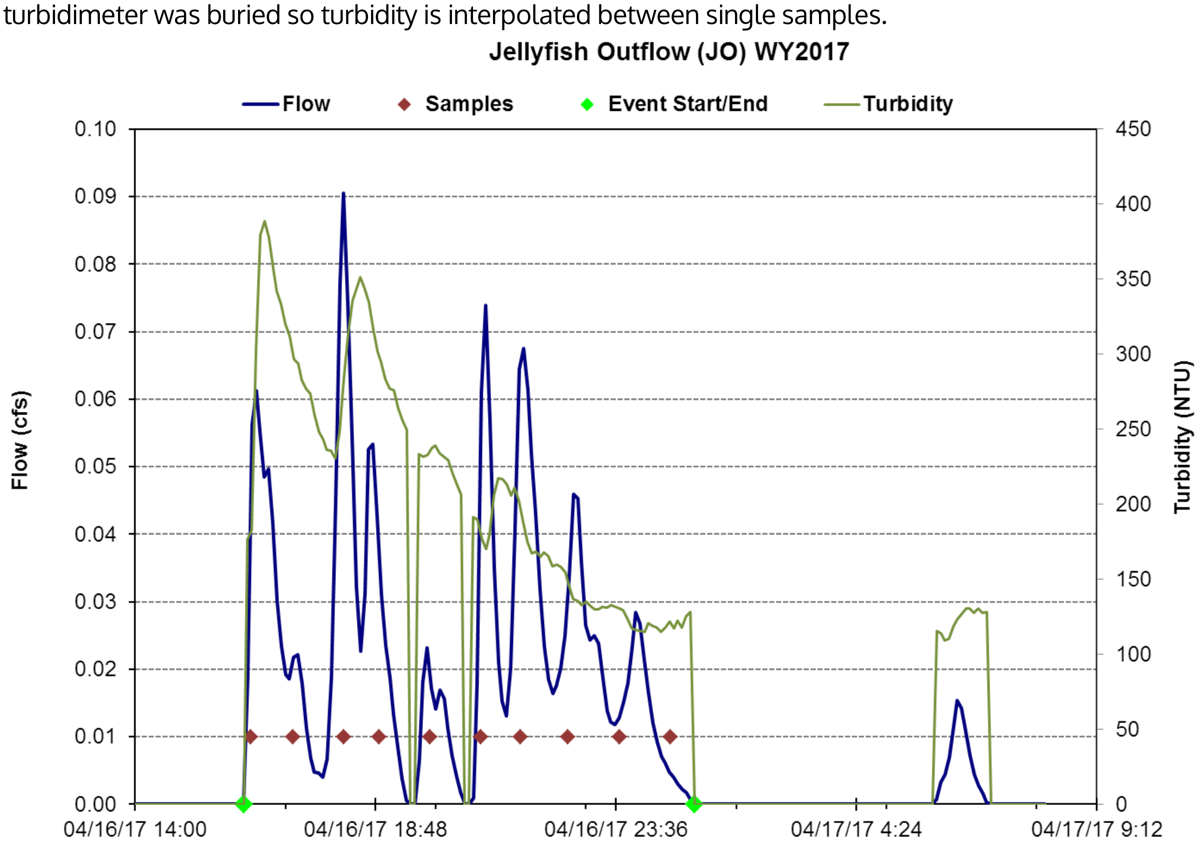

Figure 14: Hydrograph, continuous turbidity and sample distribution at the Jellyfish Outflow for the 4/16/17 rain event.

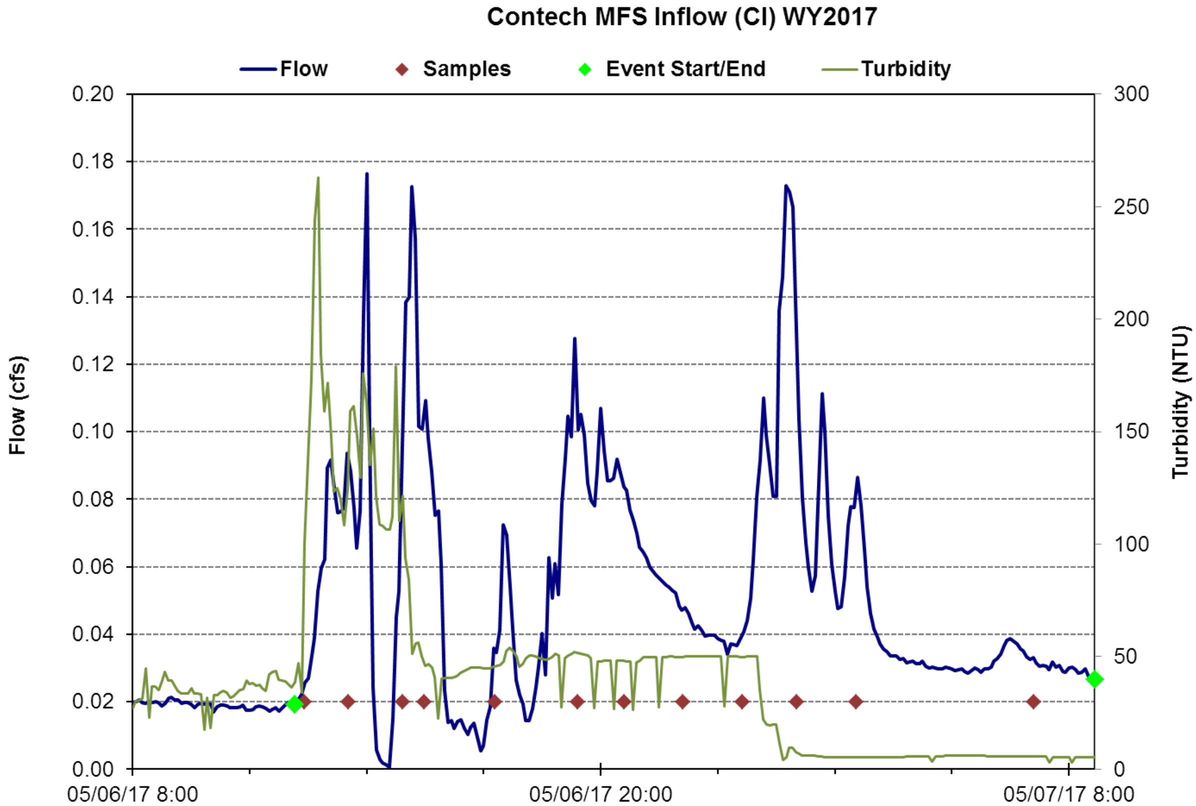

Figure 15: Hydrograph, continuous turbidity and sample distribution at the Contech MFS Inflow for the 5/6/17 mixed rain and snow event.

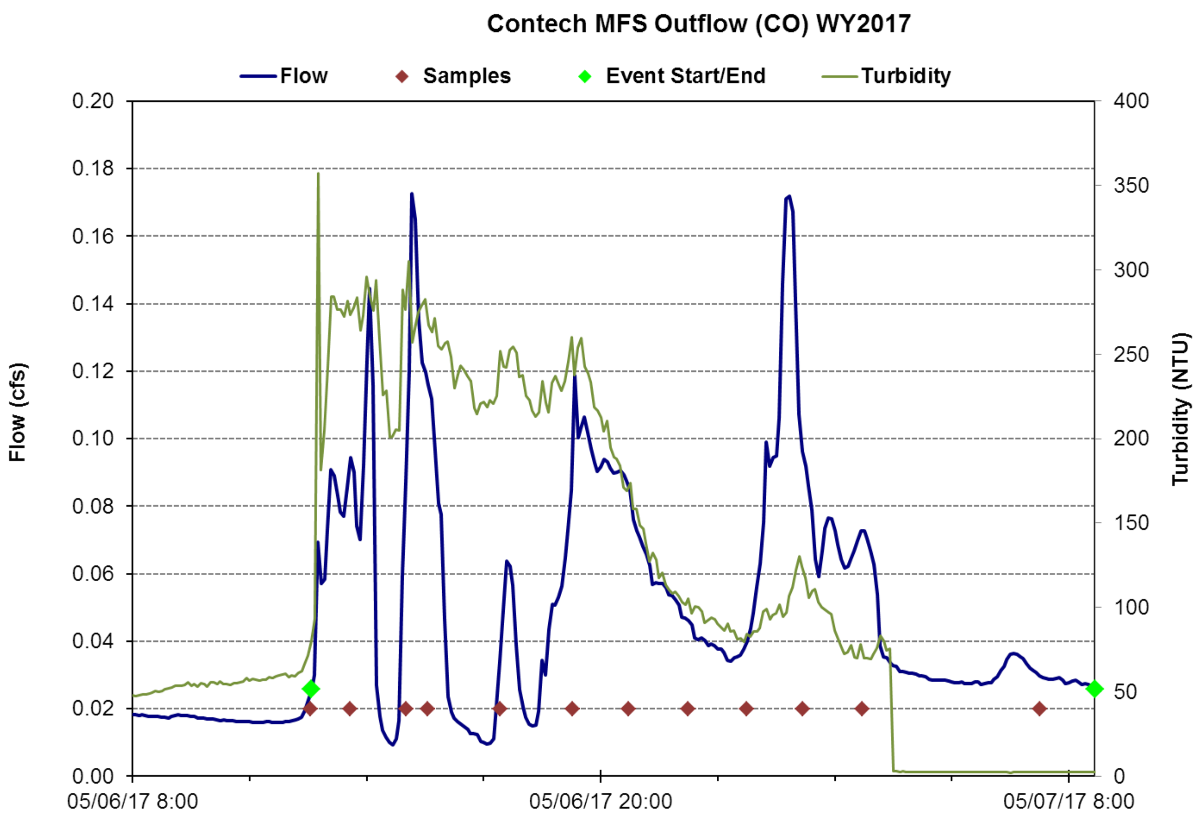

Figure 16: Hydrograph, continuous turbidity and sample distribution at the Contech MFS Outflow for the 5/6/17 mixed rain and snow event.

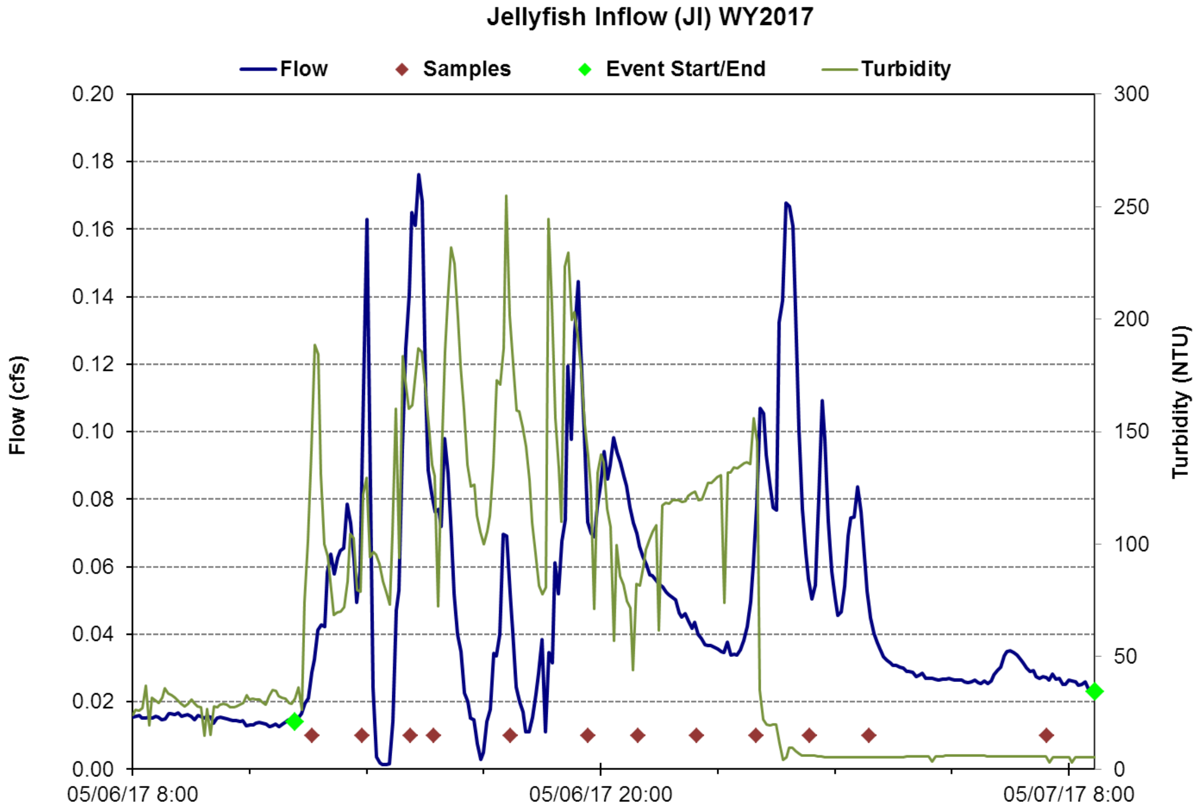

Figure 17: Hydrograph, continuous turbidity and sample distribution at the Jellyfish Inflow for the 5/6/17 mixed rain and snow event.

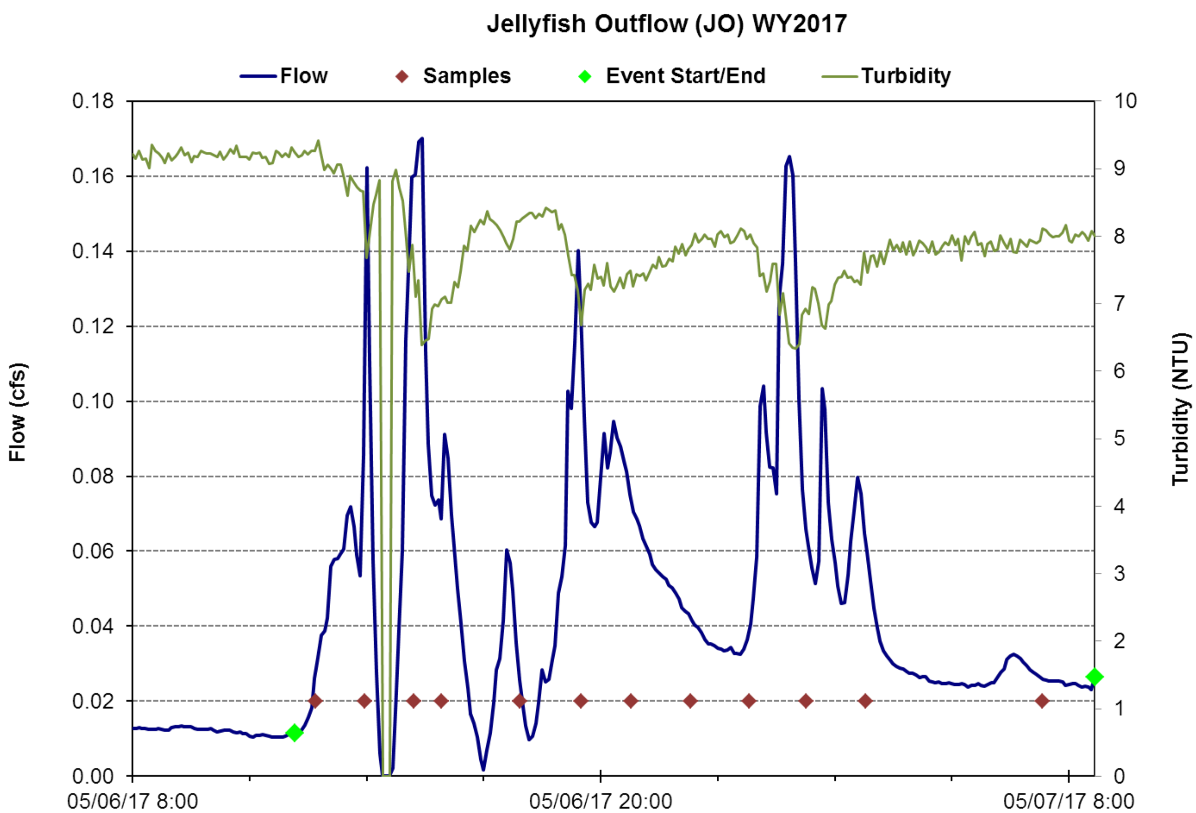

Figure 18: Hydrograph, continuous turbidity and sample distribution at the Jellyfish Outflow for the 5/6/17 mixed rain and snow event.

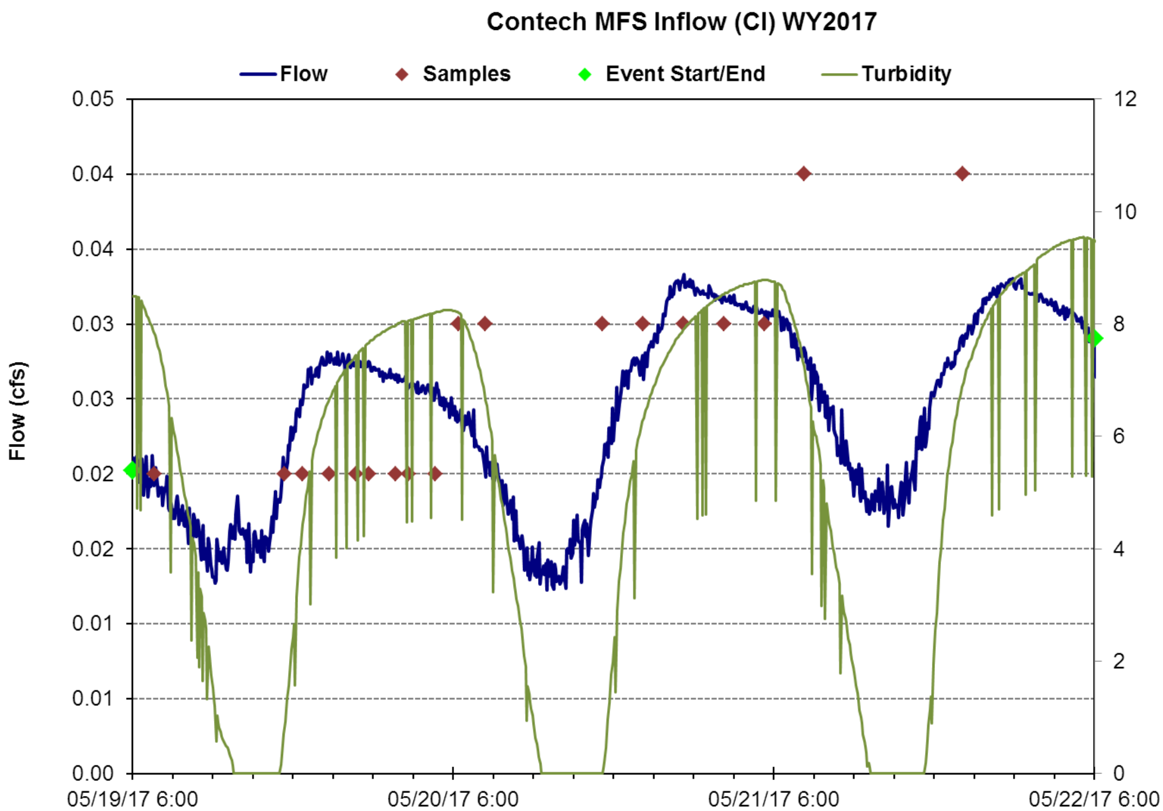

Figure 19: Hydrograph, continuous turbidity and sample distribution at the Contech MFS Inflow for the 5/19/17-5/22/2017 non-event snowmelt sampling. The turbidity sensor malfunctioned was buried during the event so turbidity from Jellyfish Inflow was used.

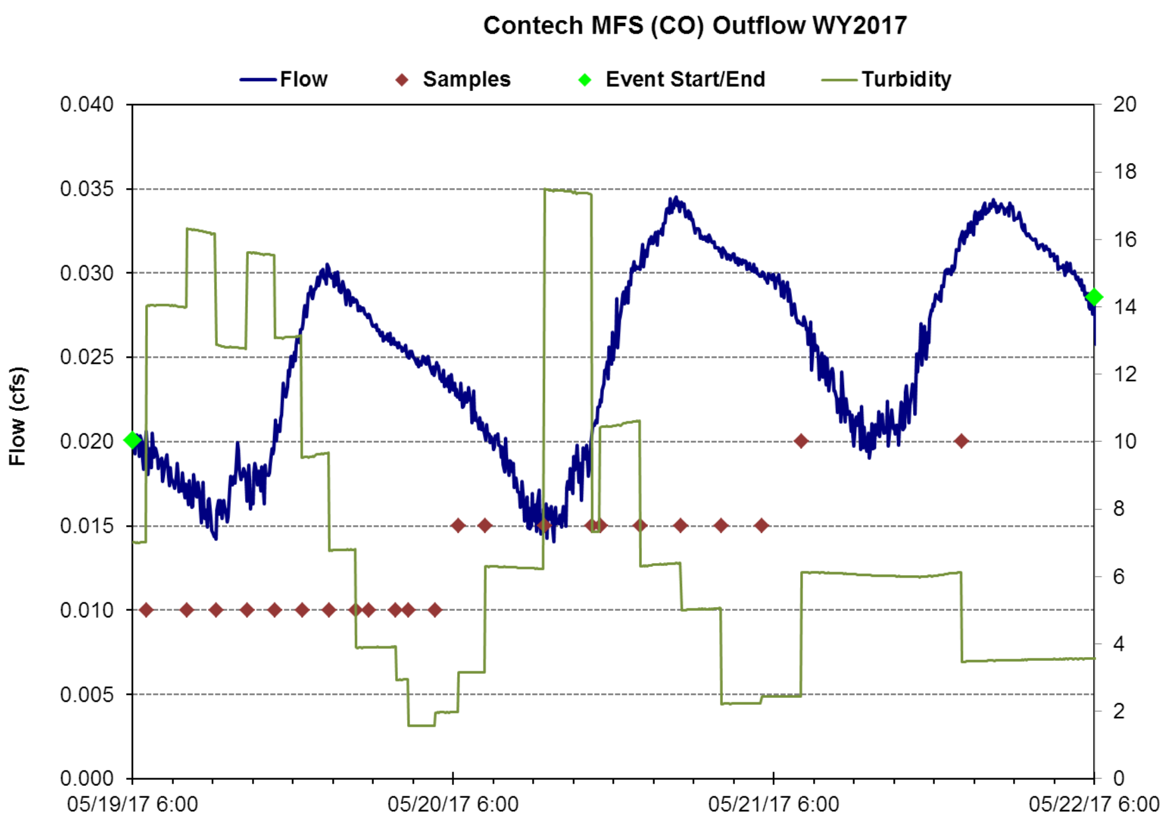

Figure 20: Hydrograph, continuous turbidity and sample distribution at the Contech MFS Outflow for the 5/19/17-5/22/2017 non-event snowmelt sampling. Turbidity was adjusted by multiplier based on single sample turbidity.

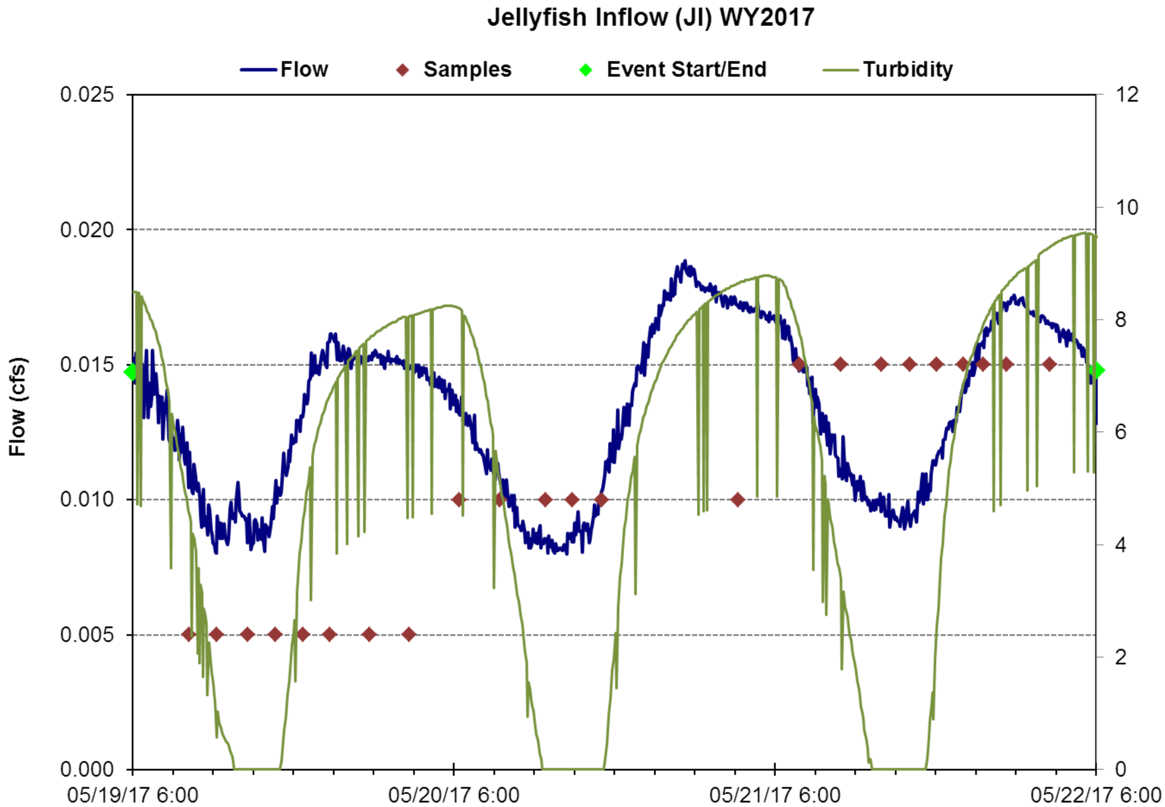

Figure 21: Hydrograph, continuous turbidity and sample distribution at the Jellyfish Inflow for the 5/19/17-5/22/2017 non-event snowmelt sampling.

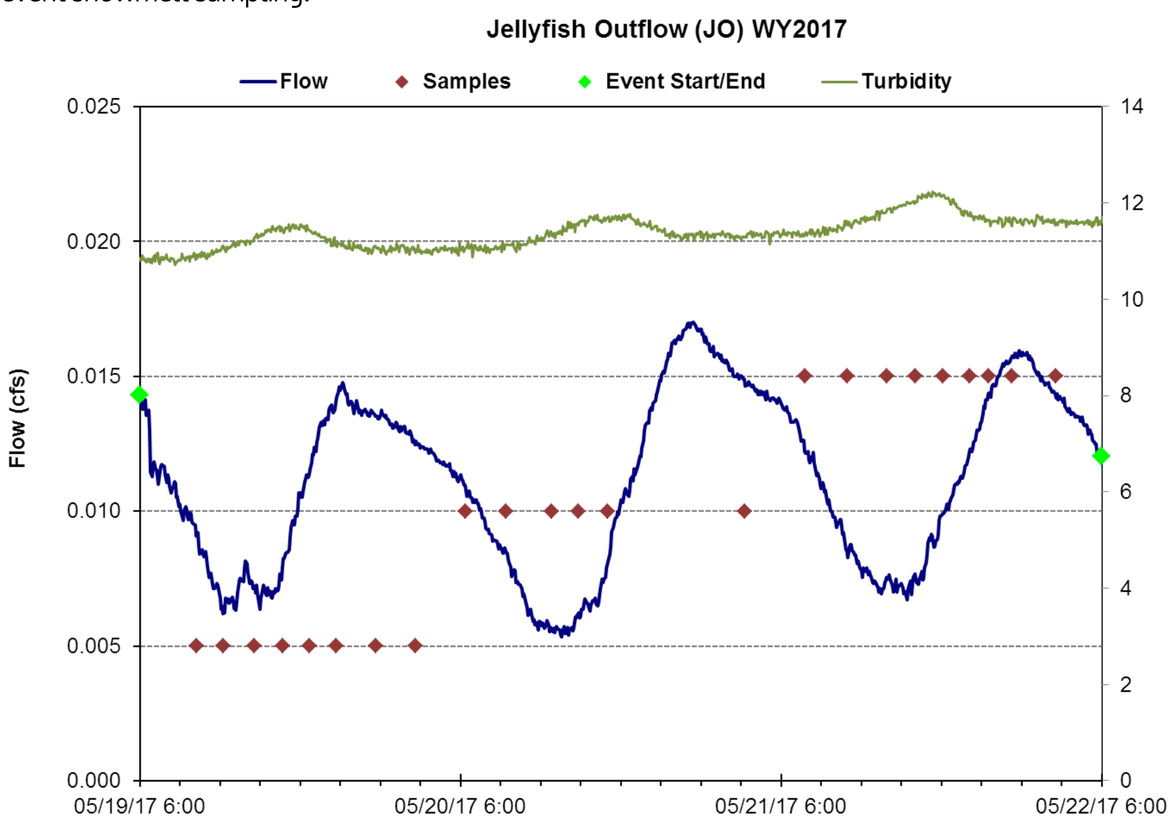

Figure 22: Hydrograph, continuous turbidity and sample distribution at the Jellyfish Outflow for the 5/19/17-5/22/2017 non-event snowmelt sampling.

References

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

2NDNATURE LLC, Northwest Hydraulic Consultants, Environmental Incentives, 2015. *Road Rapid Assessment Methodology (Road RAM) User Manual v2, Tahoe Basin. Final Document*. Prepared for the Nevada Division of Environmental Protection and Lahontan Regional Water Quality Control Board. May 2015.