Seasonal Progress Report #4
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: Fall Winter Season, October 1, 2016 – February 28, 2017

Submission Date: March 31, 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	50%	10/31/15, 1/31/16, 4/30/16, 7/31/16, 10/31/16, 1/31/17,
1.2	Six Seasonal Progress Reports	3/31/16, 6/30/16, 10/31/16, 3/31/17, 6/30/17, 10/31/17,	66%	3/31/2016, 6/30/16, 10/31/16, 3/31/17
2	Stormwater Monitoring			
2.1	Collect continuous flow and turbidity data at four monitoring stations	9/30/2017	66%	ongoing
2.2	Collect stormwater runoff samples during eight events per year	9/30/2017	66%	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	66%	ongoing
2.5	Provide precipitation data to date	9/30/2017	66%	3/31/16, 6/30/16, 10/31/16, 3/31/17
2.6	Provide hydrograph, turbidity, and sample distribution graphs to date	9/30/2017	66%	3/31/16, 6/30/16, 10/31/16, 3/31/17
3	Condition Assessments			
3.1	Estimate Road RAM score prior to eight sampled events	9/30/2017	66%	3/31/16, 6/30/16, 3/31/17
3.2	Measure depth of sediment in both vaults after sampled events	9/30/2017	66%	3/31/16, 6/30/16
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 #4.

Task 2: Stormwater Monitoring

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

The fall/winter season began on October 1, 2016, concurrent with the beginning of water year 2017 (WY17) and ended February 28, 2017. Continuous flow and turbidity measurements were taken between October 1 and October 20, 2016, however the measurements have been deemed unreliable because monitoring equipment was affected by sediment accumulation on the sensors (Figure 1). During this three week period, no event sampling could take place. On October 20, 2016 the filtration system was cleaned, including complete flushing and vactoring of accumulated sediment from the splitter vault, both cartridge filter vaults, the inflow and outflow flumes (Figure 2), and the pipes connecting all components of the system. In addition, the Jellyfish filters were removed and cleaned with high pressure water (Figure 3). The Contech MFS filters had been replaced on August 3, 2016 (Figure 4). Within a couple days after maintenance was performed, the instrumentation was checked and recalibrated, and event sampling resumed.

By mid-January 2017 sediment had again accumulated on sensors at all four monitoring stations causing unreliable measurements. However, maintenance could not be performed immediately due to snow berms covering the manholes that provide access to the monitoring equipment. On February 15, 2017 Tahoe RCD staff was temporarily able to access the inflow flumes only and cleared accumulated sediment from monitoring equipment; access manholes to the outflow flumes remained buried under several feet of snow. The access

issue was resolved on March 28, 2017 when NDOT road crews removed the snow covering all four manholes. During the equipment maintenance that occurred on the same day, it was discovered that the inflow turbidimeters at both the Jellyfish and Contech were buried in sediment, and that the outflow turbidimeters were covered in a film of fine sediment. These conditions appear to have impacted the validity of February and March turbidity data.

Figure 1: Sediment covering sensors in an inflow flume.

Figure 2: Clean flume after flushing and vactoring.

Figure 3: Pressure washing the Jellyfish filters.

Figure 4: New Contech MFS filters.

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

Three events were sampled during the fall/winter season of WY17. The first was a rain event that occurred on October 28, 2016, about a week after the system was cleaned. The second and third events were multi-day rain on snow events that began December 8, 2016 and January 7, 2017 respectively. No further sampling could continue for the fall/winter season after mid-January due to the presence of large snow berms covering the manholes that provide access to the monitoring equipment. This issue was resolved on March 28, 2017 when road crews removed the snow covering the manholes. The Tahoe RCD will attempt to sample three spring events (as opposed to the requisite two) to make up for missing one of the four requisite fall/winter events.

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).**

It is expected that there will be enough snowmelt during the spring of WY17 to successfully complete this task.

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 fall/winter of WY17 the Contech MFS cartridge filters were bypassed on two dates (10/16/16 and 2/8/16; Figure 5) and the Jellyfish filters were bypassed on six dates (10/14/16, 10/15/16, 10/16/16, 1/8/17, 2/7/16, and 2/8/16; Figure 6).

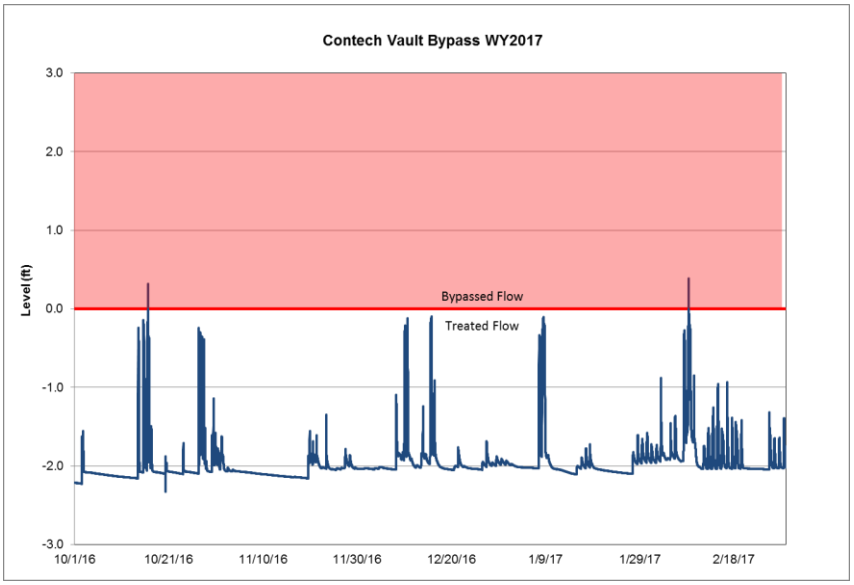

Figure 5: Bypassed flow in Contech MFS vault, fall/winter WY17

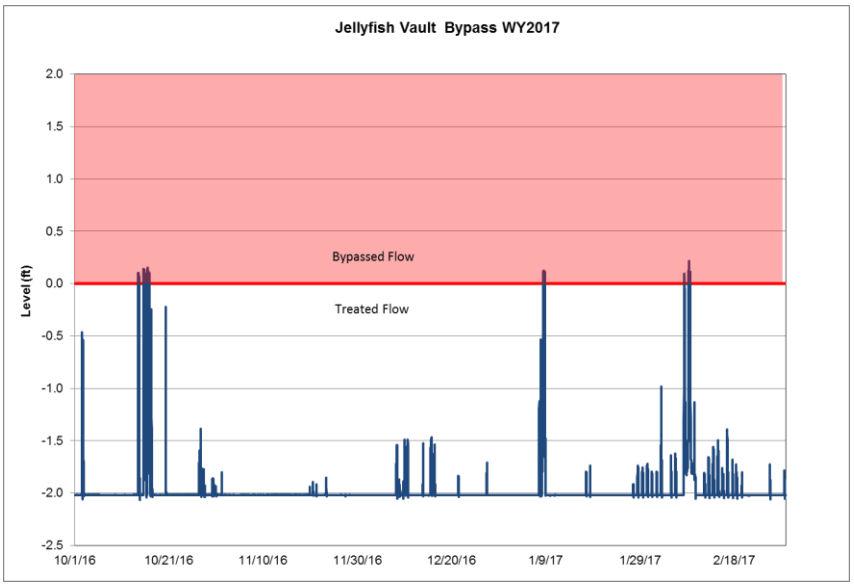

Figure 6: Bypassed flow in Jellyfish vault, fall/winter WY17.

5. Provide precipitation data to date.

Table 2 provides summary data for all 20 fall/winter 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. It is important to note that meteorological data from the SR431 station was subsituted with data collected at an adjacent meteorological station located at the Tahoe Environmental Research Center from February 19, 2017 to March 1, 2017 due to the SR431 meteorological station being completely covered with snow.

Table 2: Summary of fall/winter 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			9/22/2016 18:35							--
NDOT	NDOT-17-01	10/2/2016 14:55	10/3/2016 14:00	23:05	236:20	0.20	0.02	-5	2	rain
NDOT	NDOT-17-02	10/10/2016 11:25	10/10/2016 11:25	0:00	165:25	0.02	0.02	14	14	rain
NDOT	NDOT-17-03	10/14/2016 7:45	10/17/2016 8:25	72:40	92:20	3.60	0.04	-2	10	rain
NDOT	NDOT-17-04	10/24/2016 1:20	10/24/2016 3:35	2:15	160:55	0.04	0.02	5	6	rain
NDOT	NDOT-17-05	10/27/2016 9:35	10/28/2016 23:05	37:30	78:00	1.37	0.03	3	14	rain
NDOT	NDOT-17-06	10/30/2016 5:05	11/1/2016 10:10	53:05	30:00	0.71	0.02	-3	6	rain
NDOT	NDOT-17-07	11/15/2016 19:20	11/16/2016 15:50	20:30	345:10	0.04	0.00	-5	4	snow
NDOT	NDOT-17-08	11/19/2016 14:45	11/21/2016 3:10	36:25	70:55	1.01	0.02	-2	1	rain,snow
NDOT	NDOT-17-09	11/23/2016 1:40	11/23/2016 14:00	12:20	46:30	0.16	0.01	-5	0	snow
NDOT	NDOT-17-10	11/26/2016 18:40	11/27/2016 22:55	28:15	76:40	0.60	0.02	-7	-1	snow
NDOT	NDOT-17-11	12/7/2016 17:50	12/10/2016 22:20	76:30	234:55	3.91	0.04	-5	6	snow, rain
NDOT	NDOT-17-12	12/13/2016 13:10	12/14/2016 1:50	12:40	62:50	0.14	0.01	0	2	rain
NDOT	NDOT-17-13	12/15/2016 12:30	12/16/2016 17:55	29:25	34:40	2.28	0.03	-7	4	rain, snow
NDOT	NDOT-17-14	12/21/2016 6:40	12/21/2016 14:15	7:35	108:45	0.08	0.01	-2	2	snow
NDOT	NDOT-17-15	12/23/2016 7:15	12/24/2016 10:35	27:20	41:00	0.59	0.02	-10	-1	snow
TERC	NDOT-17-16	1/2/2017 1:30	1/5/2017 4:00	74:30	206:55	3.17	0.06	-6	3	snow, rain
TERC	NDOT-17-17	1/7/2017 7:20	1/12/2017 22:30	135:10	51:20	7.02	0.06	-4	7	rain, snow
TERC	NDOT-17-18	1/18/2017 12:00	1/24/2017 11:00	143:00	133:30	2.98	0.04	-11	2	snow
NDOT	NDOT-17-19	1/31/2017 18:15	2/10/2017 20:20	242:05	175:15	7.72	0.07	-4	7	snow, rain
NDOT	NDOT-17-19	2/16/2017 6:25	2/23/2017 11:10	172:45	130:05	2.40	0.02	-11	4	rain, snow
NDOT	NDOT-17-20	2/27/2017 2:10	2/27/2017 12:10	10:00	87:00	0.01	0.00	-6	0	snow

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

See Figures 7-18 at the end of this report for hydrographs, continous turbidity and sample distributions for each of the three events sampled in the fall/winter season. Hydrographs at this site generally display rapidly increasing and decreasing flows likely due to the steepness and high percentage of impervious area in the catchment. The high imperviousness causes sites to respond quickly to rapidly fluctuating precipitation intensity which causes the spikes in the flow data. In general, turbidity stays high for the duration of the event, closely mirroring flow, but may peak slightly at the beginning of the event. The consistently high turbidity is likely due to the fact that the dominant land use is primary road, which may provide a constant source of sediment during runoff events. Accumulated sediment that could not be removed due to lack of access to the monitoring equipment fouled the turbidity sensors and caused erroneous turbidity readings during the months of February and March.

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, nine 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.

The scores below indicate that the roads were relatively dirty prior to most runoff events, falling within a range of 0.4 to 4.6. 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. 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 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	680-1,592	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%

*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 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 clean-outs restored sediment depth 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 9:30	0.56	na
6/3/2016 10:00	0.75	2.17
8/3/2016 10:00	1.10	2.05
10/20/2016 9:30	na	1.92

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 WY17 for the Contech MFS in Table 5 and the Jellyfish in Table 6. The two events that occurred prior to the clean-out on October 20, 2016 were not included. The removal efficiencies of the Jellyfish tend to be better than the Contech MFS. 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. However, due to snow storage blocking access to the equipment between January 2017 and March 28, 2017 the sensor could not be cleaned and returned to proper function during that time. Many of the 100% removal efficiencies occurred during events with very small volumes.

Table 5: Contech MFS FSP removal efficiency for each event of the fall/winter WY17.

CONTECH MFS WY17 Fall Winter: October 1, 2016 - February 28, 2017							
Runoff Start Date Time	Runoff End Date Time	Runoff Type	Event Duration	Influent Volume (cf)	Influent FSP (lbs)	Effluent FSP (lbs)	Removal Efficiency
10/24/2016 3:25	10/24/2016 4:05	rain	0:40	45	0.242	0.088	-63%
10/27/2016 9:45	10/28/2016 19:05	rain	33:20	3,086	5.552	2.502	-55%
10/30/2016 5:25	11/1/2016 10:05	rain	52:40	476	1.320	0.494	-63%
11/19/2016 15:30	11/21/2016 10:45	rain,snow	43:15	181	0.357	0.426	19%
11/23/2016 11:40	11/23/2016 12:45	snow	1:05	59	0.264	0.278	5%
11/27/2016 12:25	11/27/2016 14:35	snow	2:10	16	0.001	0.000	-100%
12/8/2016 6:45	12/10/2016 22:05	snow,rain	63:20	3,279	20.000	28.340	42%
12/13/2016 22:20	12/14/2016 1:45	rain	3:25	113	0.405	0.761	88%
12/15/2016 13:10	12/16/2016 14:05	rain	24:55	4,140	16.614	16.747	1%
12/21/2016 11:05	12/21/2016 12:15	rain	1:10	4	0.004	0.000	-100%
12/27/2016 12:30	12/27/2016 13:55	snowmelt	1:25	21	0.024	0.000	-100%
1/7/2017 14:00	1/9/2017 0:35	rain,snow	34:35	5,474	33.110	0.019	-100%
1/18/2017 11:35	1/18/2017 12:00	snow	0:25	2	0.052	0.000	-100%
2/2/2017 11:55	2/2/2017 16:30	rain	4:35	88	5.097	0.000	-100%
2/4/2017 14:10	2/4/2017 15:40	rain, snow	1:30	13	0.863	4.137	379%
2/5/2017 11:05	2/5/2017 16:40	rain, snow	5:35	58	2.976	0.285	-90%
2/7/2017 8:35	2/9/2017 14:50	rain, snow	54:15	6,040	168.066	2.019	-99%
2/12/2017 12:05	2/12/2017 17:20	snowmelt	5:15	54	0.941	33.728	3484%
2/13/2017 10:20	2/13/2017 17:30	snowmelt	7:10	111	1.992	0.614	-69%
2/14/2017 10:25	2/14/2017 18:15	snowmelt	7:50	171	3.091	1.707	-45%
2/15/2017 10:15	2/15/2017 12:45	snowmelt	2:30	10	0.060	2.316	3749%
2/16/2017 13:15	2/16/2017 16:20	snowmelt	3:05	59	0.224	1.367	510%
2/17/2017 14:45	2/17/2017 16:25	snowmelt	1:40	6	0.001	0.000	-100%
2/18/2017 9:50	2/18/2017 10:25	snowmelt	0:35	6	0.001	0.000	-100%
2/25/2017 12:40	2/25/2017 14:25	snowmelt	1:45	8	0.000	0.086	247612%
2/28/2017 15:40	2/28/2017 16:45	snowmelt	1:05	1	0.000	0.032	658823%

Table 6: Jellyfish FSP removal efficiency for each event of the fall/winter WY17.

JELLYFISH WY17 Fall Winter: October 1, 2016 - February 28, 2017							
Runoff Start Date Time	Runoff End Date Time	Runoff Type	Event Duration	Influent Volume (cf)	Influent FSP (lbs)	Effluent FSP (lbs)	Removal Efficiency
10/24/2016 3:25	10/24/2016 4:05	rain	0:40	45	0.164	0.009	-94%
10/27/2016 9:45	10/28/2016 19:35	rain	33:50	3,212	5.992	0.825	-86%
10/30/2016 5:25	11/1/2016 9:55	rain	52:30	665	2.035	0.347	-83%
11/19/2016 15:30	11/21/2016 11:40	rain,snow	44:10	138	1.956	0.138	-93%
11/23/2016 11:40	11/23/2016 13:55	snow	2:15	71	1.057	0.086	-92%
11/27/2016 13:05	11/27/2016 14:35	snow	1:30	3	0.001	0.000	-100%
12/8/2016 6:45	12/10/2016 22:15	snow,rain	63:30	3,566	29.898	12.578	-58%
12/13/2016 22:20	12/14/2016 2:40	rain	4:20	106	0.707	0.396	-44%
12/15/2016 13:10	12/16/2016 14:35	rain	25:25	4,165	25.216	13.652	-46%
12/27/2016 12:30	12/27/2016 14:55	snowmelt	2:25	33	1.025	0.147	-86%
1/7/2017 13:50	1/9/2017 0:15	rain,snow	34:25	5,588	42.869	69.123	61%
1/18/2017 11:30	1/18/2017 12:10	snow	0:40	4	0.346	0.020	-94%
1/28/2017 13:15	1/28/2017 16:40	snowmelt	3:25	16	0.609	0.257	-58%
1/30/2017 13:20	1/30/2017 17:05	snowmelt	3:45	23	0.996	0.644	-35%
2/2/2017 11:50	2/2/2017 16:25	snowmelt	4:35	112	5.041	4.588	-9%
2/4/2017 14:10	2/4/2017 16:30	snowmelt	2:20	20	0.917	0.206	-78%
2/5/2017 10:55	2/5/2017 16:55	rain,snow	6:00	97	3.408	2.574	-24%
2/7/2017 8:35	2/9/2017 13:55	rain,snow	53:20	6,694	36.507	73.107	100%
2/12/2017 13:15	2/12/2017 17:20	snowmelt	4:05	12	0.012	0.099	755%
2/13/2017 12:20	2/13/2017 17:35	snowmelt	5:15	55	0.131	0.674	416%
2/14/2017 12:10	2/14/2017 17:35	snowmelt	5:25	78	0.188	1.130	502%
2/16/2017 13:15	2/16/2017 16:25	snowmelt	3:10	78	5.188	0.876	-83%
2/17/2017 14:45	2/17/2017 16:45	snowmelt	2:00	20	0.505	0.103	-80%
2/18/2017 9:50	2/18/2017 10:35	snowmelt	0:45	6	0.154	0.022	-85%

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 consistenly 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.

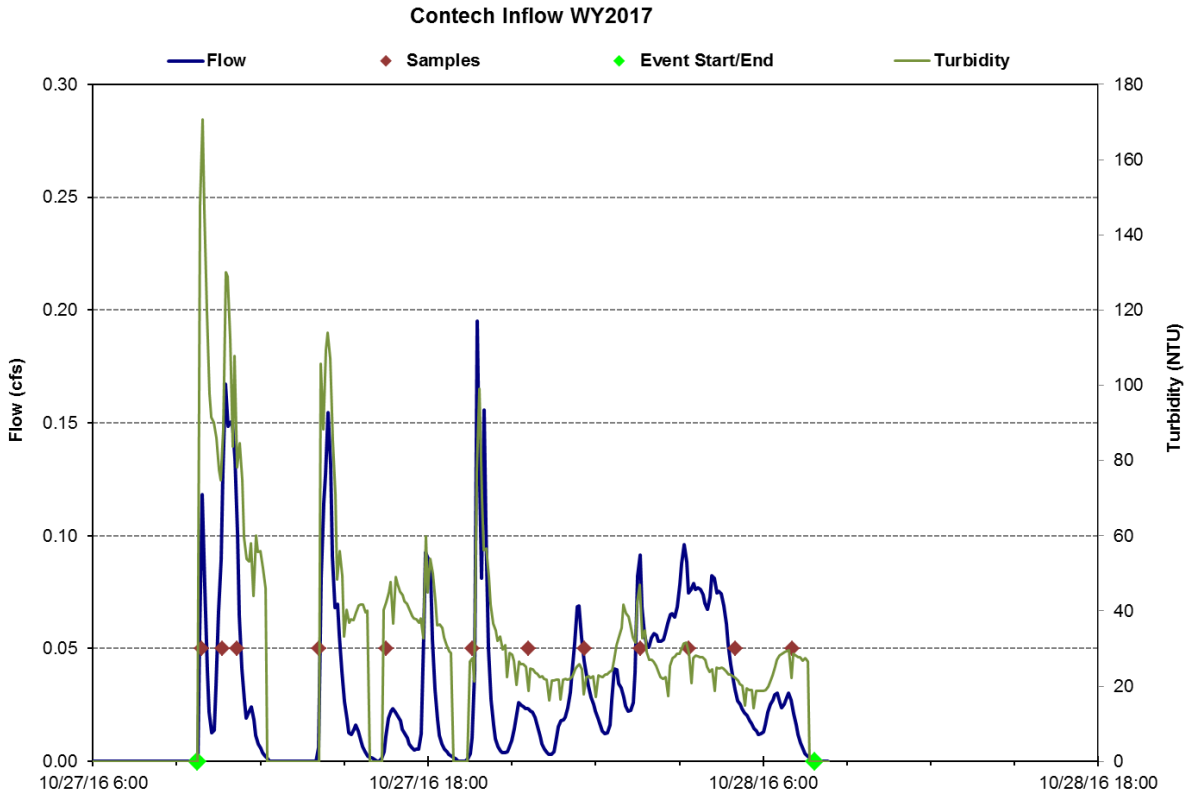

Figure 7: Hydrograph, continuous turbidity and sample distribution at the Contech Inflow for the 10/27/16 rain event.

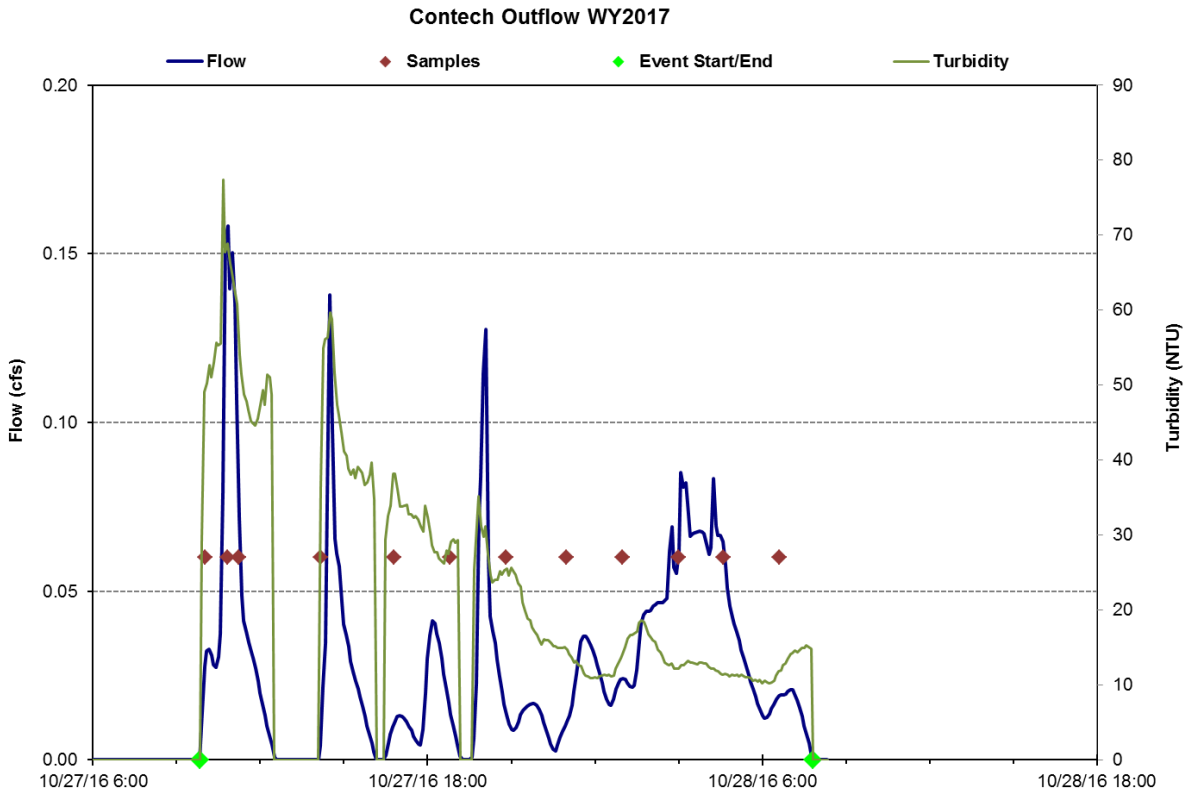

Figure 8: Hydrograph, continuous turbidity and sample distribution at the Contech Outflow for the 10/27/16 rain event.

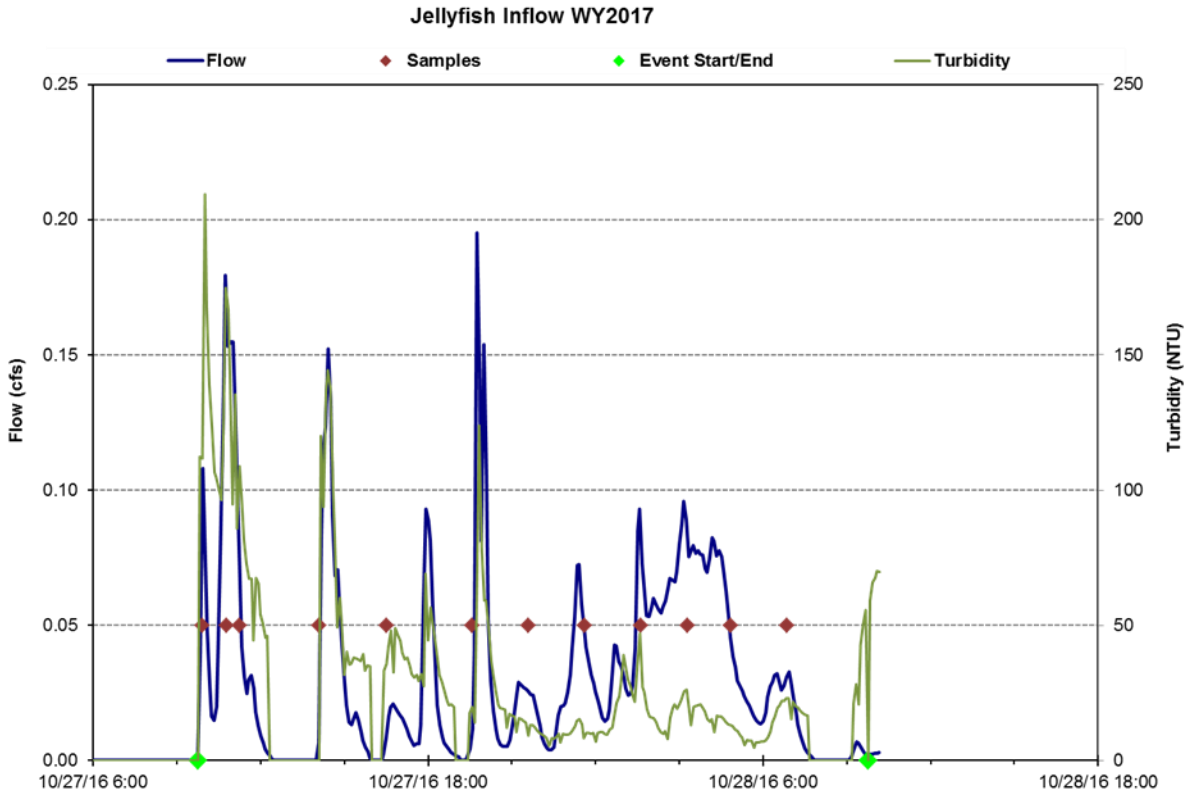

Figure 9: Hydrograph, continuous turbidity and sample distribution at the Jellyfish Inflow for the 10/27/16 rain event.

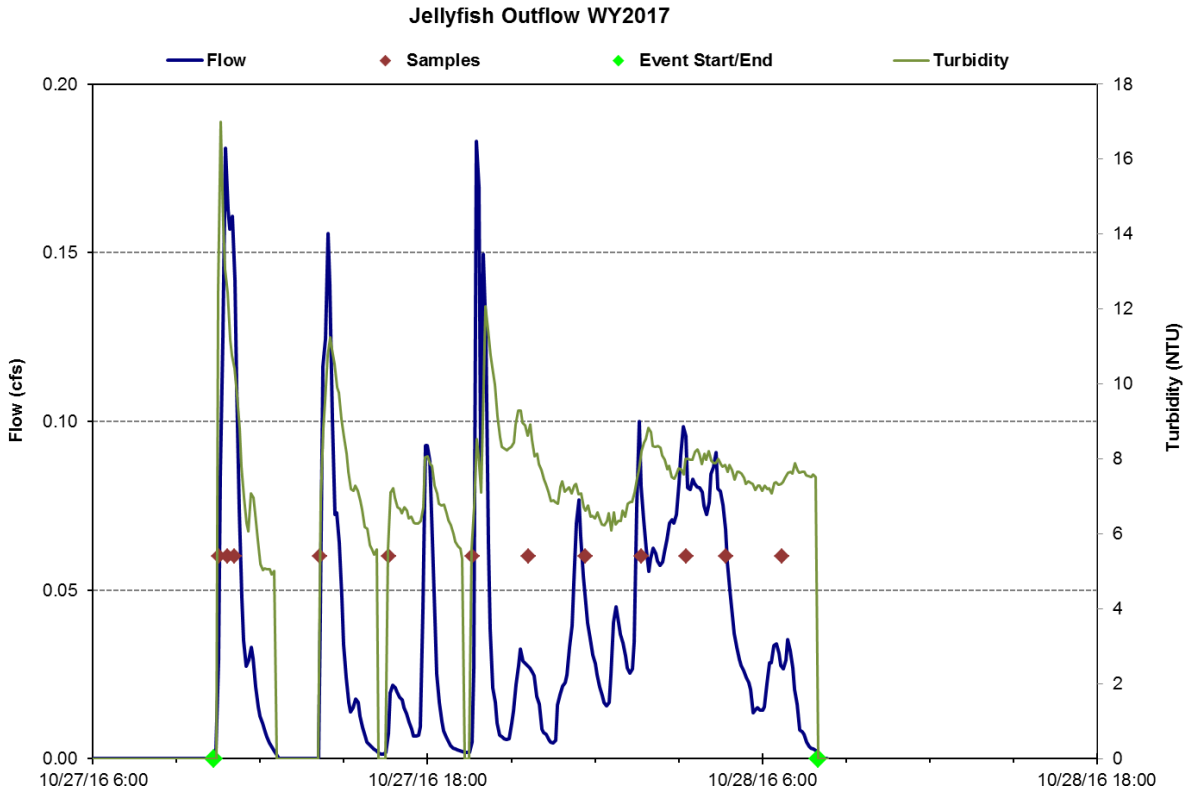

Figure 10: Hydrograph, continuous turbidity and sample distribution at the Jellyfish Outflow for the 10/27/16 rain event.

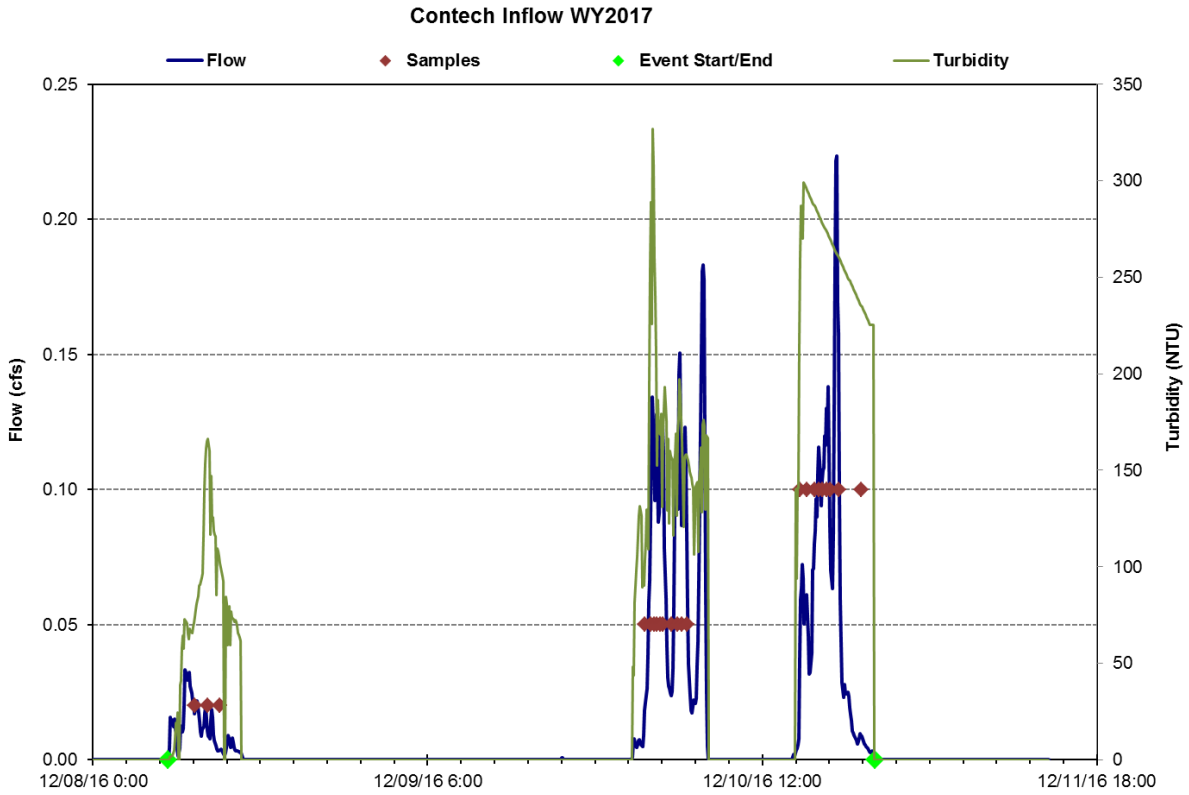

Figure 11: Hydrograph, continuous turbidity and sample distribution at the Contech Inflow for the 12/8/16 mixed snow and rain event.

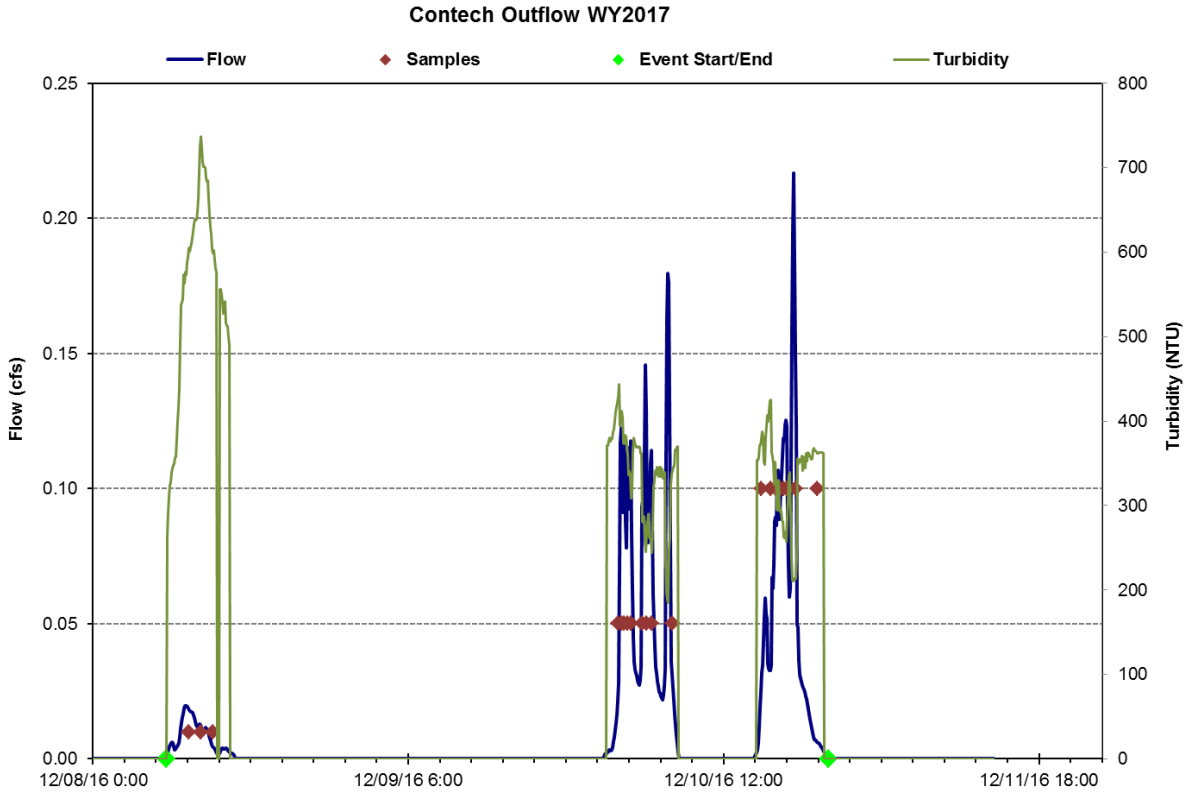

Figure 12: Hydrograph, continuous turbidity and sample distribution at the Contech Outflow for the 12/8/16 mixed snow and rain event.

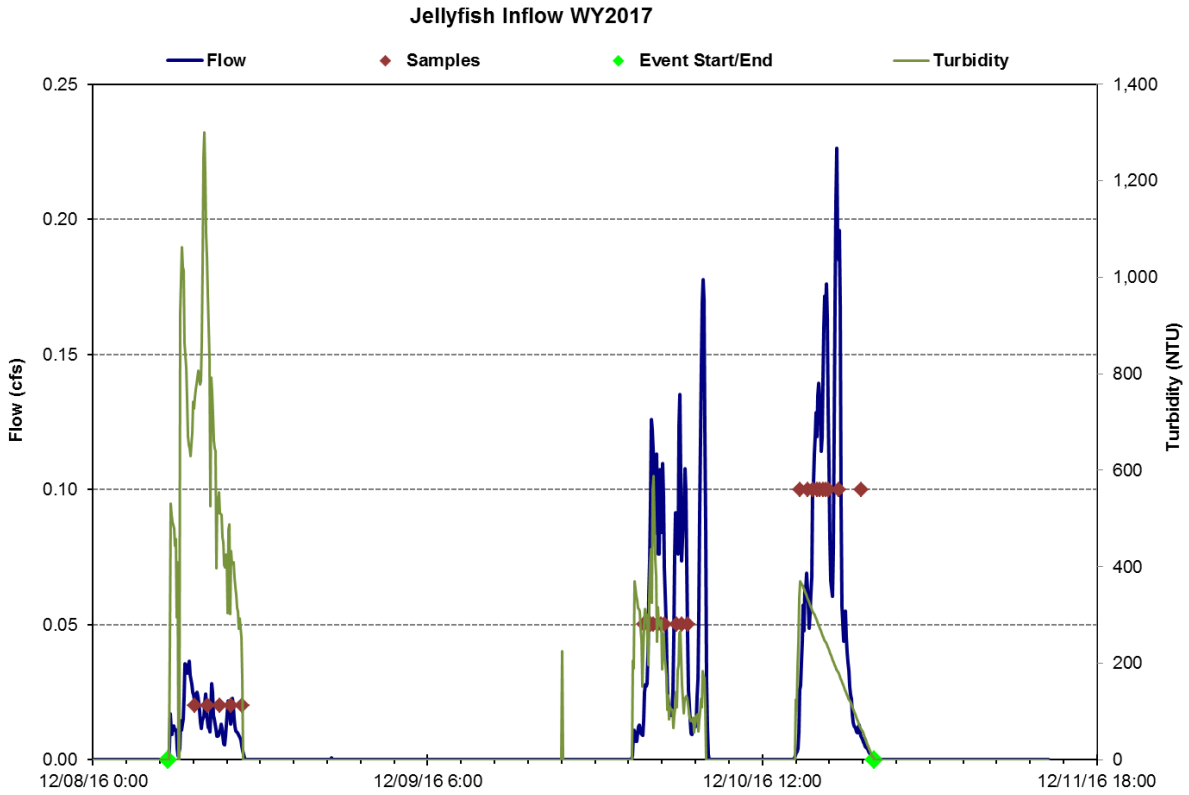

Figure 13: Hydrograph, continuous turbidity and sample distribution at the Jellyfish Inflow for the 12/8/16 mixed snow and rain event.

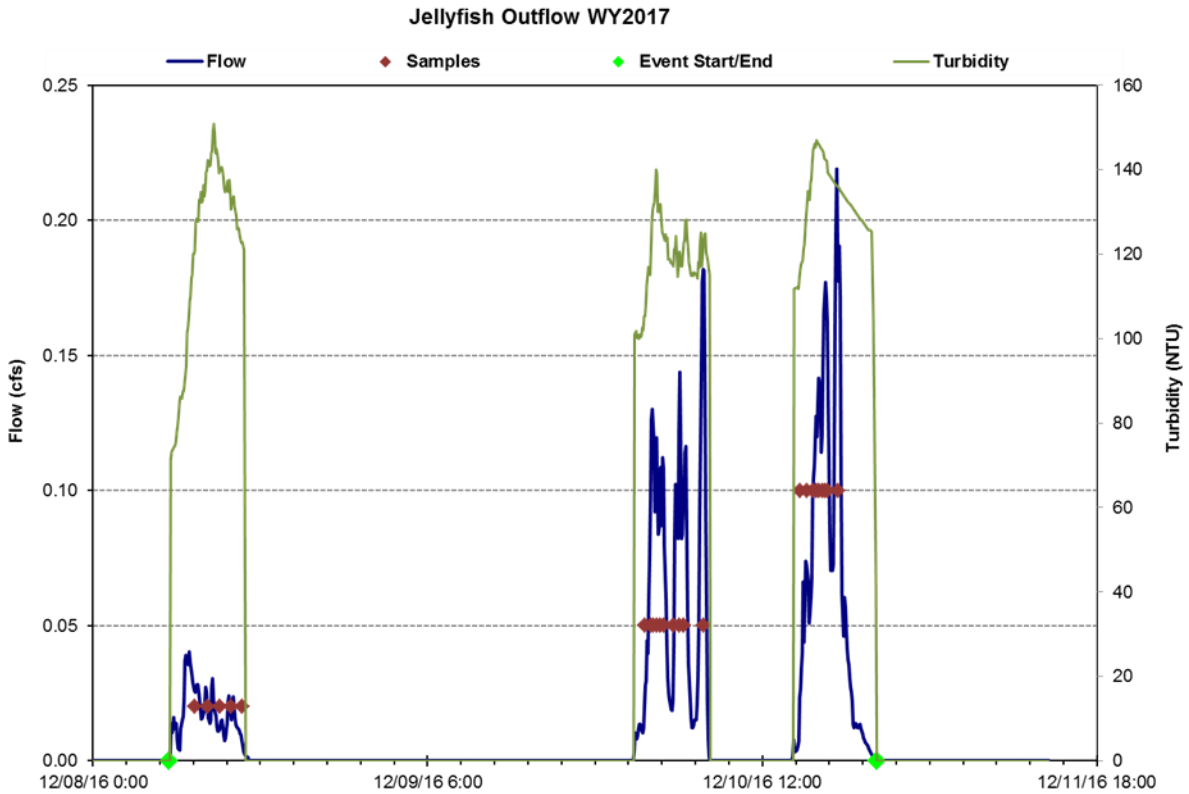

Figure 14: Hydrograph, continuous turbidity and sample distribution at the Jellyfish Outflow for the 12/8/16 mixed snow and rain event.

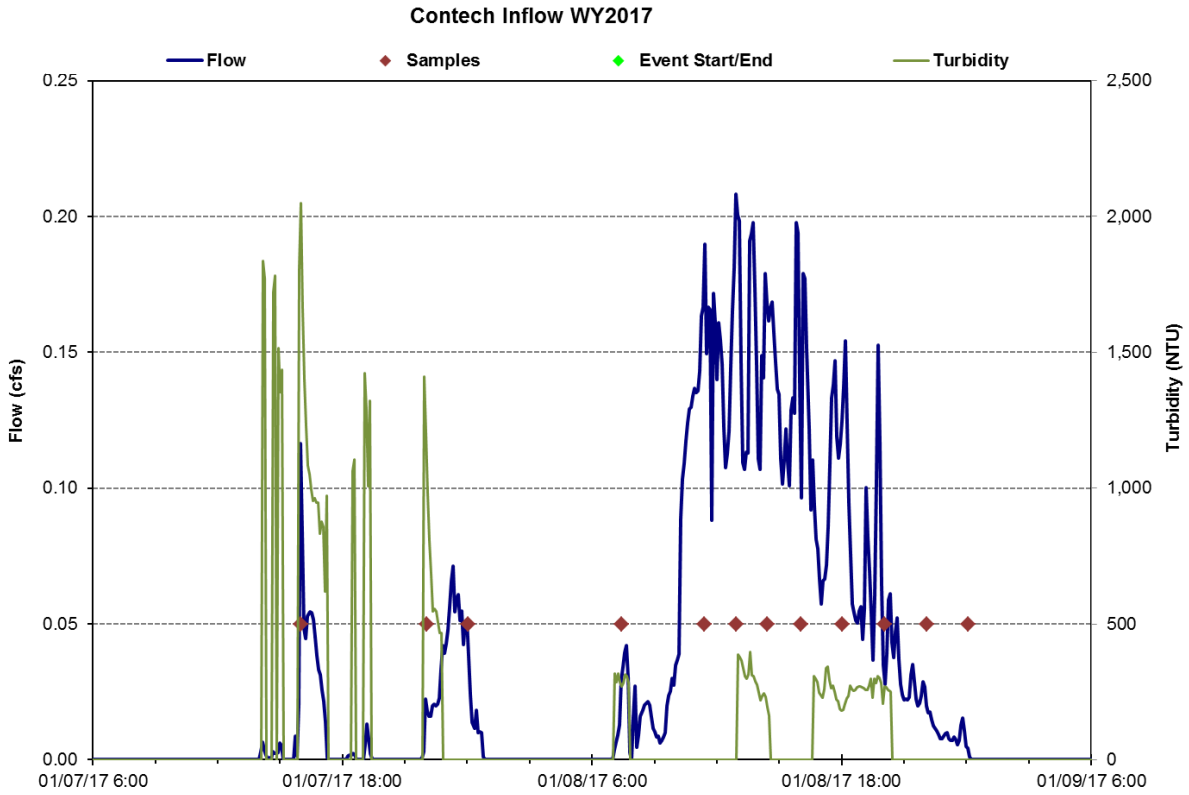

Figure 15: Hydrograph, continuous turbidity and sample distribution at the Contech Inflow for the 1/7/17 mixed rain and snow event.

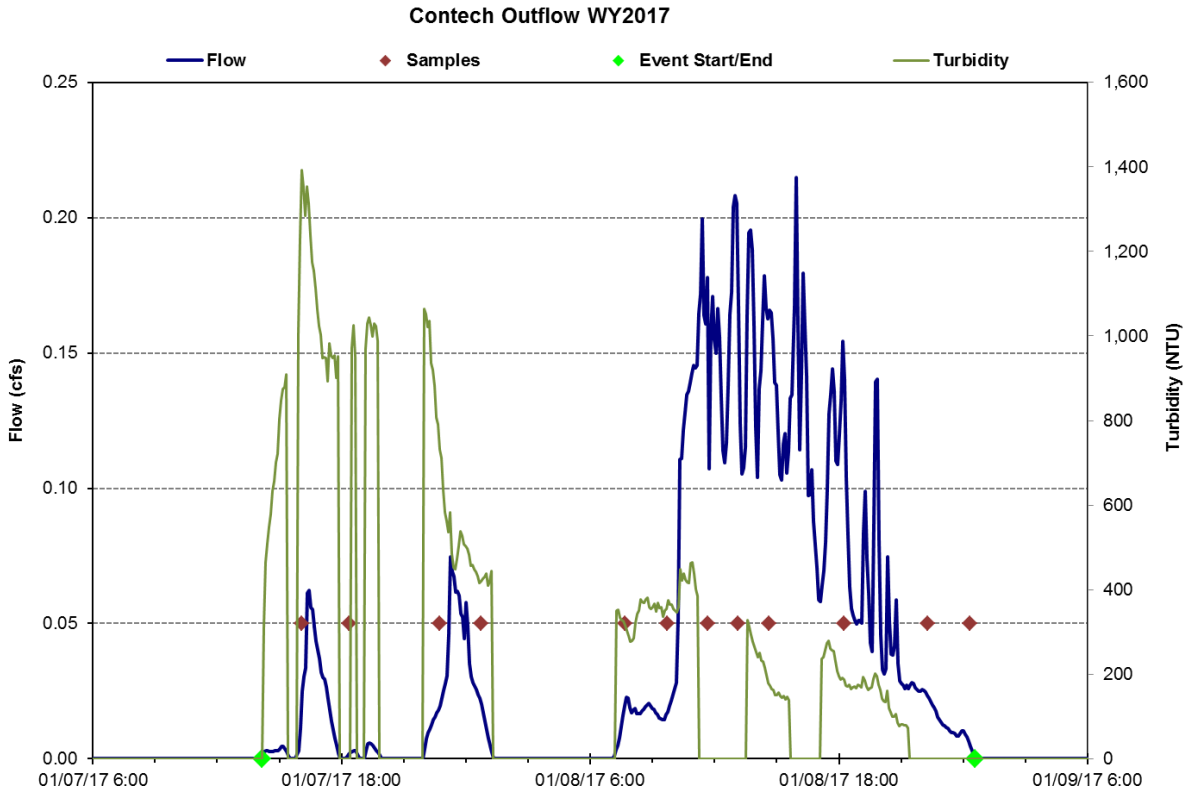

Figure 16: Hydrograph, continuous turbidity and sample distribution at the Contech Outflow for the 1/7/17 mixed rain and snow event.

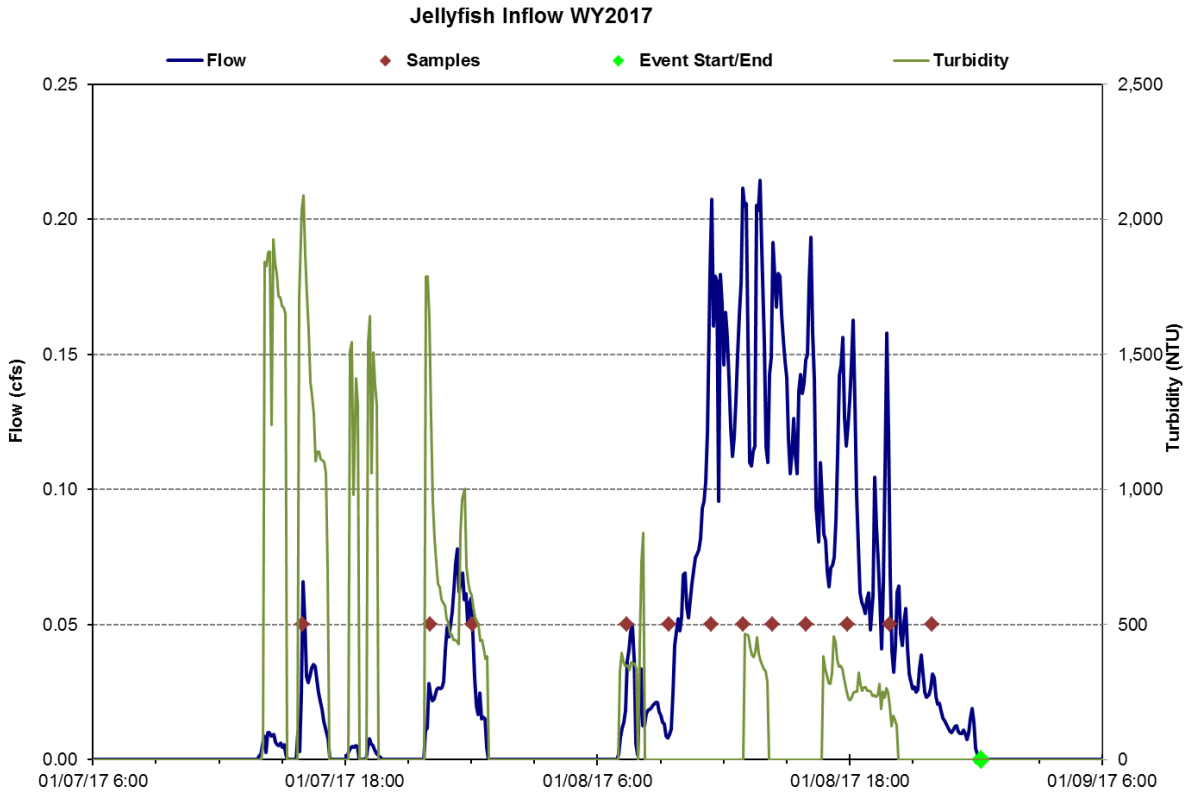

Figure 17: Hydrograph, continuous turbidity and sample distribution at the Jellyfish Inflow for the 1/7/17 mixed snow and rain event.

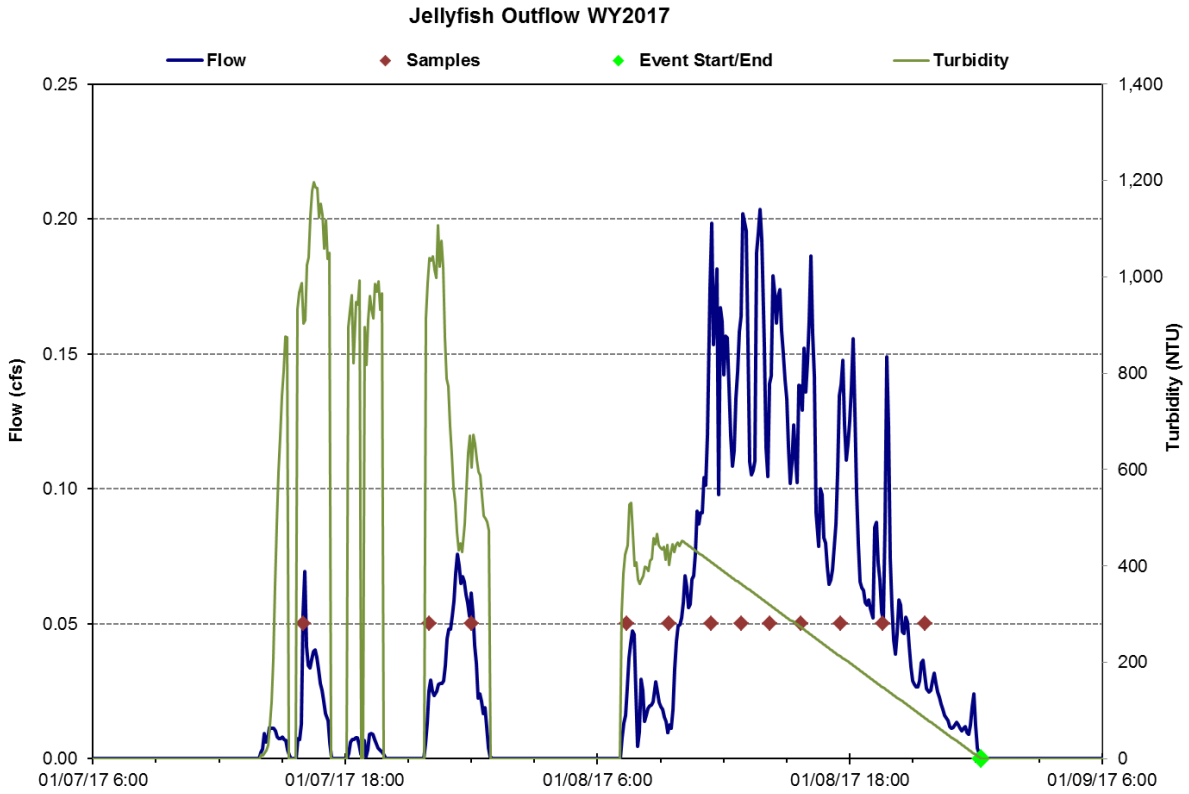

Figure 18: Hydrograph, continuous turbidity and sample distribution at the Jellyfish Outflow for the 1/7/17 mixed rain and snow event. The turbidity sensor malfunctioned from 1/8/17 10:05 through the end of the event.

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.