1.0 INTRODUCTION

A notice of violation and compliance order (NOV/CO) was issued to the North Utah County Water Conservancy District (NUCWCD) by the Utah Division of Water Quality (UDWQ) as a result of the large sediment discharge into the American Fork River on August 20, 2016, from the Tibble Fork Dam construction site. Under the subject NOV/CO, NUCWCD was ordered to submit a comprehensive monitoring plan for the sediment and water in the affected portion of the American Fork River drainage.

2.0 MONITORING SAMPLING LOCATIONS

Water and sediment samples will be collected at five locations within the American Fork River watershed, one of which is located upstream of the Tibble Fork Reservoir. The other four locations are downstream of the Tibble Fork Reservoir and represent areas impacted by the sediment discharge. The sampling locations are summarized in Table 1 and illustrated in Figure 1. District sampling personnel will consult with DWQ staff prior to the initial round of sampling to confirm detailed sample locations.

These sampling locations correspond to sampling locations used by UDWQ in their post-discharge sampling effort from August 23 through 30, 2016. Location #1 is considered to be a reference location because it was not impacted by the sediment discharge event. The UDWQ sampling location on the South Fork of the American Fork River (South Fork) (UDWQ Location ID 4994983) is included for a single reference sampling event in August 2017 only. While this location was sampled by UDWQ during the initial post-discharge sampling, NUCWCD does not believe it is suitable for use as a reference location. The size (width and flow regime), gradient, upstream mineralogy and substrate of the South Fork are not comparable to the North Fork, which limit the relevance of the location as a reference location for purposes of this study. As noted by DWQ, for purposes of determining the overall recovery of the North Fork and the American Fork River, data from the South Fork will not apply.

Table 1. Monitoring Sampling Locations on the American Fork River

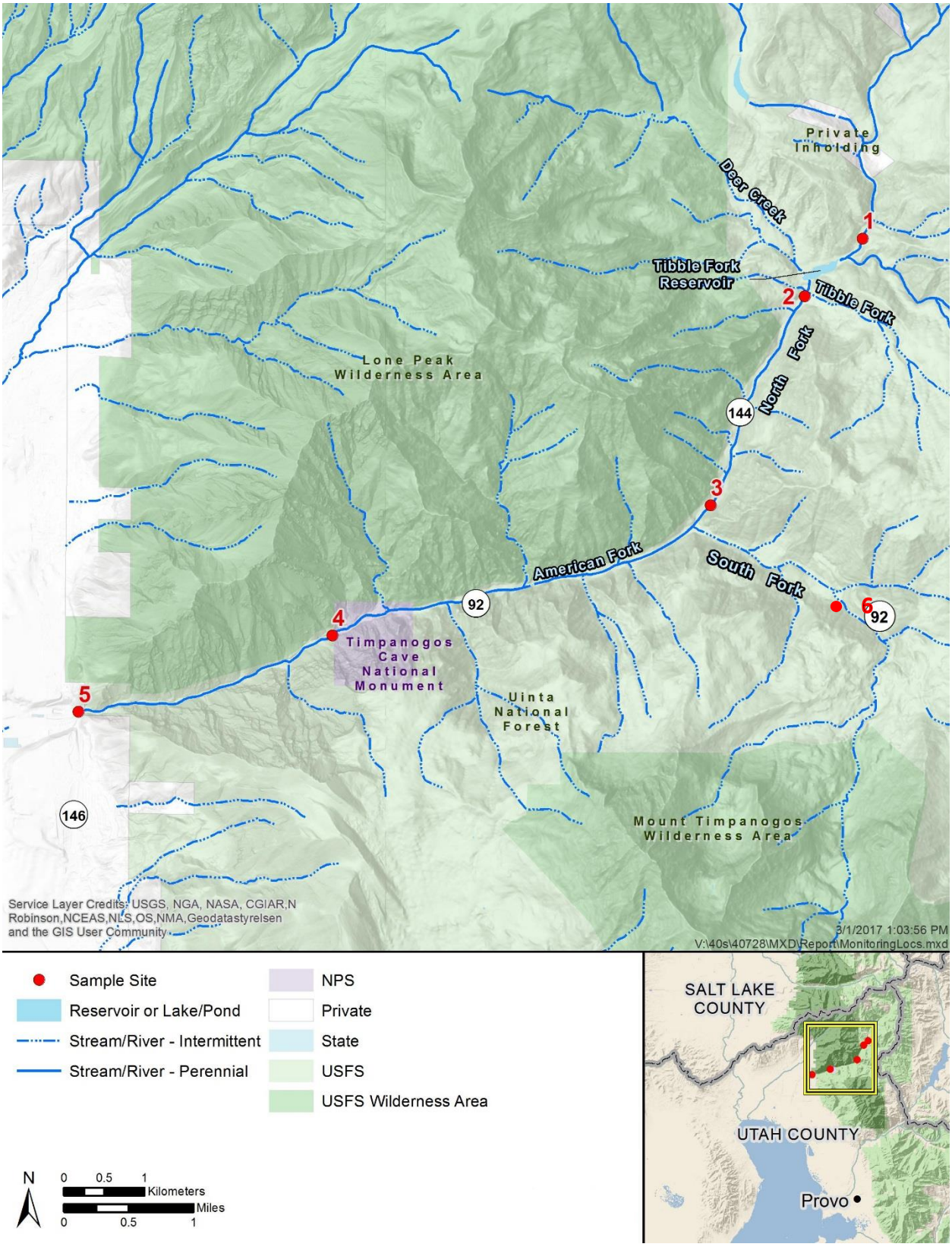
Site ID	UDWQ Location ID	Location Name and Description	Latitude	Longitude
1	5912840	N FK American Fork above Tibble Fork Reservoir, above foot bridge	40.48384	-111.640474
2	5912810	N FK American Fork below Tibble Fork Reservoir, upstream of Mile Rock	40.479396	-111.647428
3	4994990	N FK American Fork above confluence with S FK American Fork	40.456062	-111.661863
4	4994984	American Fork below Timpanogos Cave Natl. Monument Visitor's Center	40.441851	-111.714216
5	4994980	American Fork at mouth of American Fork Canyon	40.431898	-111.750767
6*	4994983	S FK American Fork ½ mile AB Mutual Dell	40.444401	-111.640064

Notes:

Global positioning system (GPS) coordinates are approximate and may be updated after first sampling event.

Site ID 6 included for reference comparison with DWQ August 2016 sampling event and will be sampled only one time, in August 2017.

Figure 1. Monitoring sampling locations of the American Fork River



In addition, downstream sediment deposits and soils potentially irrigated during or shortly after the August 2016 release will be sampled at the locations identified in Table 2. These locations have been selected to evaluate potential downstream transport of elevated metals via irrigation water. The Lehi and Pleasant Grove ditches were reported to receive irrigation water during or shortly after the August 2016 release; one public park, school, or other municipal property will be selected on each of these two irrigation ditches for a soil sample.

Sampling and management of sediment that accumulates at the mouth of American Fork Canyon (i.e., in the Highland City Irrigation Basin, American Fork Irrigation Basin, American Fork Weir, etc.) is addressed under a separate Sediment Remediation Plan. Note that an initial sample for irrigation system sediments and downstream soils will be taken before spring 2017 irrigation begins. This will not represent a pre-release baseline for portions of the irrigation system that received water during the August 2016 release; but will provide an initial "as-found" data set prior to the 2017 irrigation season.

Table 2. Downstream Sediment and Soil Sampling Locations

Location Name and Description	Number of Samples	Sample Type
Highland Glen Park Reservoir inlet	1	Grab
Manila Park Reservoir inlet	1	Grab
Public location TBD on Lehi ditch	1	Grab
Public location TBD on Pleasant Grove ditch	1	Grab

3.0 MONITORING SCHEDULE AND PARAMETERS

Annual monitoring times, media, and locations are summarized in Table 3 below. The temporal extent of monitoring is not explicitly defined, but rather will continue until water and sediment concentrations meet estimated pre-release conditions as demonstrated by NUCWCD and accepted by UDWQ. The criteria to be utilized to define the recovered condition will include UDWQ numeric criteria for recreational, cold water aquatic wildlife, and agricultural beneficial uses in addition to concentrations at the reference location (site #1), which will serve as the baseline condition. Concentrations below the UDWQ numeric criteria are the desired condition for monitoring locations; however, this may not be realistic given the influence of mining activities throughout the watershed. Sampling results should satisfy the criteria described above for a full year of monitoring before monitoring activities may be terminated. Additionally, the frequency, number of sampling locations, and/or number of sample replicates may be reduced with DWQ concurrence based on prior sampling results.

Note that the monitoring parameters and methods vary between river sediment and irrigation ditch sediment samples. This is due to the different applications for the data. River sediment data will be compared with background (sample location 5912840, taken above Tibble Fork Reservoir) as well as human health and aquatic life screening values consistent with the evaluations performed in DWQ, 2016[1]. Irrigation ditch data will be compared with irrigation basin and background data to evaluate potential spread of contamination downstream.

As recommended by DWQ, NUCWCD is consulting with the Utah Division of Wildlife Resources (DWR) to determine how best to quantify pre-release ecological conditions in the river and the appropriate method to evaluate current status against those conditions. A plan will be developed and approved by DWR prior to the initial river sampling event tentatively scheduled for August 2017. At a

[1] Utah Division of Water Quality (UDWQ). September 9, 2016. *Evaluation of UDEQ Water Quality Data following the Tibble Fork Reservoir Sediment Release*. Utah Department of Environmental Quality.

minimum in order to provide quantification of the river's biological health, NUCWCD proposes to perform a macroinvertebrate survey as detailed in Section 4.5 below.

Table 3. Monitoring Schedule

Date	Environmental Media	Location	Monitoring Parameters	Total Number of Samples
April 15	Irrigation water	Pleasant Grove ditch, American Fork ditch, and Lehi ditch downstream of the American Fork Weir	Table 4 (total and dissolved metals)	3
Late August	River water and sediment	Table 1	Table 4 (water) Table 5 (sediment)	6 (water) 6 (sediment)
Before April 15	Irrigation ditch sediment/soil	Table 2	Table 6	4
Late August	Aquatic life	Table 1	Macroinvertebrate taxa	6
Low flow (October /November)	River water and sediment Irrigation ditch sediment/soil	Table 1 Table 2	Table 7	5 (water) 5 (sediment) 4 (irrigation system sediment/soil)

Note: Dates provide a seasonal target and may be adjusted based on river conditions or irrigation usage.

Table 4. Monitoring Parameters for Irrigation Water (from DWQ, *Evaluation of UDEQ Water Quality Data following the Tibble Fork Reservoir Sediment Release*, September 9, 2016, Table 2)

Analyte	CAS #	Units	Utah WQ Standards (R317-2-14) for American Fork River Uses [Dissolved metals]			Recreational Screening Values [Total Metals]	Agricultural Screening Values [Dissolved Metals]			Analyte
			3A (cold water fish) [1-hour]	3A (cold water fish) [4-day]	4 (agriculture)		Livestock Water (ug/L)	Long-Term Irrigation Waters (ug/L) [NAS, 1972]	Short-Term Irrigation Waters (ug/L) [NAS, 1972]	
Hardness	-	mg/L					180 mg/L (UA)			Hardness
Aluminum	7429-90-5	µg/L	750	87		1,579,090.7	5,000 (NAS)	5,000	20,000	Aluminum
Antimony	7440-36-0	µg/L				631.6	No Data Available	No Data Available	No Data Available	Antimony
Arsenic	7440-38-2	µg/L	340	150	100	7,895.5	200 (NAS)	100	2,000	Arsenic
Barium	7440-39-3	µg/L				315,818.1	No Data Available	No Data Available	No Data Available	Barium
Beryllium	7440-41-7	µg/L				3,158.2	No Data Available	No Data Available	No Data Available	Beryllium
Cadmium	7440-43-9	µg/L	2	0.25	10	789.5	50 (NAS)	10	50	Cadmium
Calcium	7440-70-2	µg/L					500,000 (UA)	No Data Available	No Data Available	Calcium
Chromium	7440-47-3	µg/L	16 (VI); 570 (III)	11 (VI); 74 (III)	100	1,786,865.7	1,000 (NAS)	100	1,000	Chromium
Cobalt	7440-48-4	µg/L				39,477.3	1,000 (NAS)	50	5,000	Cobalt
Copper	7440-50-8	µg/L	13	9	200	15,790.9	500 (NAS)	200	5,000	Copper
Iron	7439-89-6	µg/L	1000	1000			Limit Not Considered Necessary (NAS)	5,000	20,000	Iron
Lead	7439-92-1	µg/L	65	2.5	100	14,796.1	100 (NAS)	5,000	10,000	Lead
Magnesium	7439-95-4	µg/L					250,000 (UA)	No Data Available	No Data Available	Magnesium
Manganese	7439-96-5	µg/L				74,217.3	Limit Not Considered Necessary (NAS)	200	10,000	Manganese
Mercury	7439-97-6	µg/L	-	0.012		11,053.6	10 (NAS)	No Data Available	No Data Available	Mercury
Molybdenum	7439-98-7	µg/L				7,895.5	No Data Available	10	50	Molyebdenum
Nickel	7440-02-0	µg/L	468	52		157,909.1	No Data Available	200	2,000	Nickel
Potassium	7440-22-4	µg/L					No Data Available	No Data Available	No Data Available	Potassium
Selenium	7782-49-2	µg/L	18.4	4.6	50	7,895.5	50 (NAS)	20	20	Selenium
Silver	7440-22-4	µg/L	1.6	-		13,159.1	No Data Available	No Data Available	No Data Available	Silver
Sodium	7440-23-5	µg/L					1,000,000 (UA)	No Data Available	No Data Available	Sodium
Thallium	7440-28-0	µg/L				63.2	No Data Available	No Data Available	No Data Available	Thallium
Vanadium	7440-62-2	µg/L				15,790.9	100 (NAS)	100	1,000	Vanadium
Zinc	7440-66-6	µg/L	120	120		789,545.3	25,000 (NAS)	2,000	10,000	Zinc
TDS		mg/L					1200 (Utah)	500,000-1,000,000 (NAS)		
pH							6.5-9 (Utah)	4.5-9 (NAS)		
Boron	7440-42-8	µg/L			750	315,818.1				
Tin	7440-31-5	µg/L				473,727.2				

RMEG: ATSDR Reference Dose Media Evaluation Guide
EMEG: ATSDR Environmental Media Evaluation Guide
RSL: EPA Regional Screening Level

Note: Table 4 parameters will also include Total Suspended Solids (TSS) and Turbidity. EPA methods 200.7 or 200.8 (metals), 160.1 (TDS), 160.2 (TSS), and 180.1(turbidity).

Table 5. Monitoring Parameters for River Sediment (total metals)

Analyte	Units	Human Health Screening Value	Aquatic Life Screening Value
Aluminum	mg/kg	165,428	none
Antimony	mg/kg	66	none
Arsenic	mg/kg	753	9.8
Barium	mg/kg	33,086	none
Beryllium	mg/kg	331	none
Cadmium	mg/kg	87	1.0
Chromium	mg/kg	213,402	43.4
Cobalt	mg/kg	1,654	50.0
Copper	mg/kg	1,654	31.6
Iron	mg/kg	115,799	20,000.0
Lead	mg/kg	400	35.8
Manganese	mg/kg	7,775	460.0
Mercury	mg/kg	1,158	0.2
Nickel	mg/kg	3,309	22.7
Selenium	mg/kg	827	2.0
Silver	mg/kg	827	1.0
Vanadium	mg/kg	1,654	none
Zinc	mg/kg	49,628	121.0
Molybdenum	mg/kg	827	none

Note: EPA methods 200.7, 200.8, 6020B, or 6010D

Table 6. Monitoring Parameters for Irrigation System Sediment (total and TCLP metals)

Analyte	Regulatory Level (mg/L TCLP)	EPA Regional Screening Level (mg/kg)
Arsenic	5.0	3.0
Barium	100.0	225,000
Cadmium	1.0	980
Chromium (TCLP)	5.0	n/a
Chromium(III)	n/a	1,800,000
Chromium(VI)	n/a	6.3
Lead	5.0	800
Mercury	0.2	4.6
Selenium	1.0	5,800
Silver	5.0	5,800

Note: Regulatory Level taken from 40 CFR 261.24, Table 1. Regional Screening Level could exceed background as measured at sample location 1, DWQ location ID 5912840. EPA methods 200.7, 200.8, 6020B, or 6010D.

Table 7. Monitoring Parameters for Low Flow Sampling Event

Analyte	Units in Water (total and dissolved)	Units in Sediment (total metals)
Arsenic	mg/L and mg/kg	mg/kg
Cadmium	mg/L and mg/kg	mg/kg
Lead	mg/L and mg/kg	mg/kg
Zinc	mg/L and mg/kg	mg/kg
Total Dissolved Solids	mg/L	n/a
Total Suspended Solids	mg/L	n/a
Turbidity	NTU	n/a

EPA methods 200.7, 200.8, 6020B, or 6010D (metals), 160.1 (TDS), 160.2 (TSS), and 180.1(turbidity).

4.0 SAMPLING AND ANALYSIS PROCEDURES

Procedures for each type of sampling are summarized below.

4.1 Irrigation Water

The American Fork weir is the main diversion point used to direct irrigation water to one or more of three ditches, thus sampling each ditch just downstream of this point will provide a representative sample. Pre-cleaned water collection bottles attached to a sampling pole will be used to collect stream water from the center of the flow (thalweg) in the ditch, and then used to fill analytical laboratory-issued plastic bottles. Depending on water delivery schedules, the irrigation ditches may be sampled on different dates. Water sample bottles will be properly labeled and stored in an ice-filled cooler prior to delivery to the analytical laboratory. Water quality data will be reviewed and compared to state agricultural screening values (the four columns on the right side of Table 4).

4.2 River Water

At each sample location, pre-cleaned water collection bottles attached to a sampling pole will be used to collect stream water from the center of the flow (thalweg) and subsequently to fill analytical laboratory-issued plastic bottles. Water sample bottles will be properly labeled and stored in an ice-filled cooler prior to delivery to the analytical laboratory. Water quality data will be reviewed and compared to state water quality standards (Utah Administrative Code R317-2-13.5) based on designated beneficial uses for the American Fork River (beneficial uses 2B-primary contact, 3A-aquatic life, 4-irrigation; Utah Administrative Code R317-2-13.5(c)). Additionally, water quality will be compared to the reference site upstream of Tibble Fork Reservoir.

All water samples obtained by DWQ between August 23, 2016 and August 31, 2016 were found to be below screening levels for agricultural, recreational, and aquatic life uses; although several parameters were found to be above background levels with concentrations generally reducing with time. Water sample data will be analyzed both against the screening levels and for temporal trends.

4.3 River Sediment

A sediment sample will be collected from three different sediment cores taken from each monitoring location during each sampling event. If sediments visually consistent with those released from Tibble Fork Reservoir in August 2016 are observed, these materials will be preferentially included in the sample. The fine sediment layer in each core will be homogenized and composited into a single sample per location for analysis of metals concentrations. Sediment monitoring data collected from this effort will be compared against human health and aquatic screening levels provided in Table 5, consistent with the analysis performed by DWQ in September 2016 (DWQ, 2016). Analysis will also compare the data with background levels as determined by sample location 1, upstream of Tibble Fork Reservoir. Time series analysis will be done to evaluate the change in sediment metal concentrations over time.

4.4 Irrigation Ditches

A single grab sample of sediment will be collected from the just upstream of the inlet to each lake. If sediments visually consistent with those released from Tibble Fork Reservoir in August 2016 are observed, these materials will be preferentially included in the sample. A single grab sample of soil will be collected at each public location identified on Table 2 irrigated during or shortly after the August 2016 release. Public locations will be determined in coordination with the municipality.

Sediment monitoring data collected from this effort will be compared against human health and aquatic screening levels provided in Table 5, consistent with the analysis performed by DWQ in September 2016 (DWQ, 2016). Analysis will also compare the data with background levels as determined by sample location 1, upstream of Tibble Fork Reservoir. Time series analysis will be done to evaluate the change in sediment metal concentrations over time.

The design of the irrigation system minimizes the volume of sediment delivered with irrigation water, so it is unlikely that the downstream park locations (fed by the irrigation ditches) will demonstrate metals of concern above background as a result of the August 2016 release. In the unlikely event that background is exceeded at one or more park locations, NUCWCD will work with the municipal owner to request access for additional sampling as well as any soil metals data that the owner may possess. Additional sample locations may include park lake sediments, adjacent soils, or areas known to be watered using the irrigation water. A detailed assessment plan will be submitted to DWQ within 90 days of receiving analytical results above background.

4.5 Aquatic Life

Macroinvertebrates provide a critical food base for the fish populations of the American Fork River. The presence and/or absence of macroinvertebrate taxa in the river will provide an indication of the overall health of the ecosystem, as many macroinvertebrate taxa are sensitive to impacts.

A macroinvertebrate sample will be collected in riffle habitat near each of the sampling locations with Hess benthic samplers, which facilitate the collection of all macroinvertebrates within a 13-inch-diameter cylinder to a depth of 3 to 6 inches into the stream bed. The benthos (benthic substrate) within the sampler area will be agitated by hand to “clean” off all particulates from the substrate. Macroinvertebrates will be swept out of the sampler by the current, which passes through the upstream window and into the collection net where they are funneled into a trap. The contents of the

sample trap will be transferred into a labeled (site, date, and time) collection jar filled with 95% ethanol for preservation.

Samples will be submitted to the National Aquatic Monitoring Center (BugLab) at Utah State University for identification and enumeration to the genus level. Macroinvertebrate density will be expressed as number of taxa per square meter of stream bed, and bioassessment techniques will be used to characterize stream health based on the presence (and absence) and density of specific macroinvertebrate taxa.

Using a River Invertebrate Prediction and Classification System (RIVPACS) approach developed by the BugLab and UDWQ, the list of taxa that is observed (O) at a given site will be compared to the list of taxa that is expected (E) in the absence of human-caused stress. Predictions of E are obtained empirically from reference sites that together are assumed to encompass the range of ecological variability observed among streams in the region where the model was developed. O/E is easily interpreted because it simply represents the extent to which taxa have become locally extinct as a result of human activities. Based on the O/E score (UDWQ 2010) in addition to other bioassessment metrics such as EPT (Ephemeroptera, Plecoptera, Trichoptera) richness and abundance for each sample (collected from a given site), a description of stream health will be reported.

5.0 REPORTING

Within 30 days of receiving analytical data following each sampling event, a brief summary report will be submitted to DWQ. These summary reports will include a list of the samples taken along with any notable observations from the sampling event. Additionally, at the end of the year, an annual report summarizing sampling activities and laboratory results will be prepared and submitted to DWQ. The annual report will provide raw sampling data and also interpret findings to evaluate the recovery of the American Fork River ecosystem from the sediment release. Results from the previous years' sampling will be included in the analysis, to the extent that sampling extends beyond 2017.