3.16. AQUATIC BIOLOGY

The proposed Project area (the MOP Application Boundary of approximately 1,888 acres) encompasses part of the Sheep Creek drainage. Waterbodies in the proposed aquatic assessment area include Sheep Creek and its tributaries, Little Sheep Creek, Brush Creek, and Coon Creek, which provide a variety of habitats for fish and aquatic macroinvertebrates. This section describes the existing conditions of the fish, aquatic macroinvertebrate, and periphyton communities associated with waterbodies found in the Sheep Creek watershed, and the potential environmental consequences of the Proposed Action.

Sheep Creek is a high-quality fifth order stream and a tributary to the Smith River (Tintina 2017). Sheep Creek is approximately 36 miles long and has a total watershed area of roughly 194 square miles. The aquatic baseline assessment area near the Project is within the Sheep Creek drainage basin and approximately 19 river miles above the confluence with the Smith River, which is a popular destination for recreational anglers, rafters, and boaters. The Sheep Creek watershed upstream from the Project area drains approximately 78 square miles and is located approximately 15 miles north of White Sulphur Springs, Montana.

3.16.1. Analysis Methods

Baseline sampling reaches were established in the Sheep Creek and Little Sheep Creek basins upstream and downstream of the proposed mine activity drainage corridor (Project area) from 2014 to 2017 (see **Figure 3.16-1**) (Stagliano 2018a). The survey locations are arranged in consideration of a Before, After, Control (upstream and offsite reference), and Impact (within and downstream) (BACI) sampling design (see **Table 3.16-1**) in relation to proposed mine activity. This could allow the data to be analyzed using both univariate and multivariate statistical methods between years, streams, treatments, and stations. Tenderfoot Creek, located north of the Project area and Sheep Creek watershed, was chosen as the offsite control reach; the creek is a 40-mile-long tributary to the Smith River that has a total watershed area of 108 square miles.

The watershed areas upstream of the Sheep Creek assessment area and Tenderfoot Creek reference reaches are nearly identical in size, approximately 78 square miles each (see **Figure 3.16-1**). Eight mainstem reaches in Sheep and Tenderfoot creeks, and three tributary reaches in Little Sheep Creek (two reaches) and Coon Creek (one reach) were visited seasonally (see **Figure 3.16-1** and **Table 3.16-1**). Moose Creek, an 11-mile-long tributary to Sheep Creek, was added to the monitoring plan in 2017, and fish population estimates and redd counts were performed in fall 2017. In spring and summer of 2017, Brush Creek, a tributary to Little Sheep Creek, was sampled approximately 40 meters upstream and downstream of the proposed mine access road in the spring and summer.

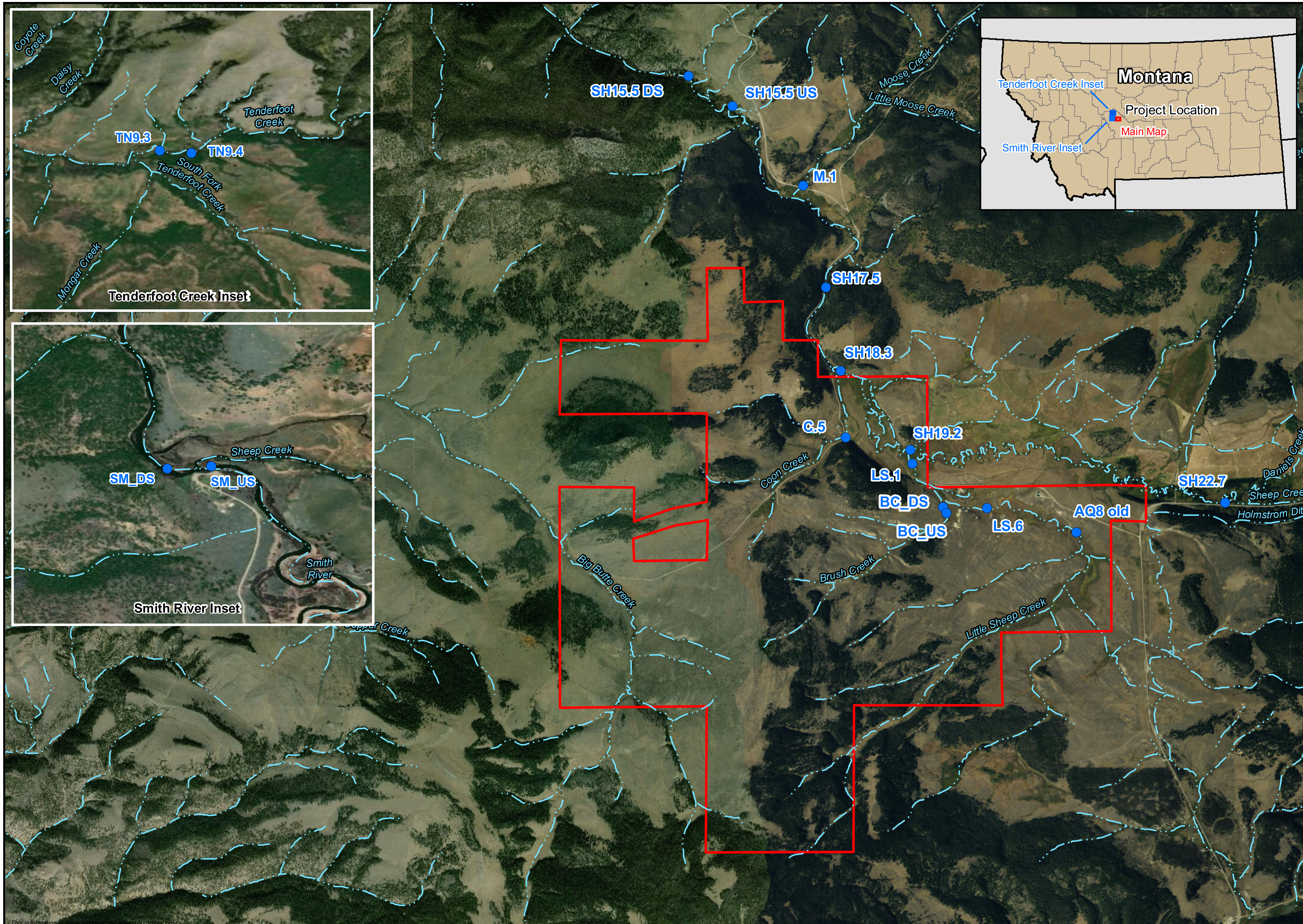

Figure 3.16-1
Black Butte
Copper Project
Aquatic Monitoring Stations
Meagher County, Montana

- Aquatic Monitoring Station
- Aquatic Assessment Area
- Stream

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Table 3.16-1
Aquatic Monitoring Station Locations at the Downstream and Upstream Ends of the Assessment Reach

Site RM Code [a]	Old Site Code [a]	Station Name [b]	BACI Type	Avg WW (m) [c]	Reach Length (m)	Latitude	Longitude	Elev. (m)	Location Comment
SH22.7	SHEEP AQ2	Sheep Cr. @ SW2 (D/S) Sheep Cr. @ SW2 (U/S)	Control	8.2	320	46.771973 46.771977	-110.853445 -110.851741	1,743	Upstream of Castle Mtn Ranch off U.S. 89
SH19.2	SHEEP AQ3	Sheep Cr. (D/S) Sheep Cr. (U/S)	Control	9.0	360	46.777247 46.777667	-110.898818 -110.898003	1,716	Hansen Meadow Reach U/S of L. Sheep Cr.
SH18.3	SHEEP AQ4	Sheep Cr. (D/S) Sheep Cr. (U/S)	Impact	8.0	320	46.785116 46.784465	-110.908826 -110.906504	1,706	Lower Meadow Reach on the Forest Service boundary
SH17.5	SHEEP AQ1	Sheep Cr. @ SW1 (D/S) Sheep Cr. @ SW1 (U/S)	Impact	15.0	600	46.795122 46.793008	-110.910367 -110.911062	1,697	Downstream Canyon Reach on Forest Service land
SH15.5 DS SH15.5 US	SHEEP AQ10, 11	Sheep Cr. (D/S) Sheep Cr. (U/S)	Impact	15.7	~1,000	46.81598 46.81112	-110.94058 -110.92398	1,652	Fishing access site (2 miles D/S of AQ1) D/S to the Davis Ranch
SH.1	NA	Sheep Cr. (D/S) Sheep Cr. (U/S)	Impact	16.0	150	46.804281 46.804404	-111.182992 -111.180809	1,320	New monitoring reach 0.1 mile U/S confluence
MO.1	NA	Moose Creek (D/S) Moose Creek (U/S)	Control/ Reference	5.2	210	46.803451 46.804935	-110.914155 -110.91313	1,661	New monitoring reach 0.1 mile U/S confluence
TN9.3	TEND AQ5	Tenderfoot Cr. (D/S) Tenderfoot Cr. (U/S)	Control/ Reference	10.0	400	46.95049 46.95077	-111.14739 -111.14447	1,435	Lower reach at South Fork Tenderfoot confluence
TN9.4	TEND AQ6	Tenderfoot Cr. (D/S) Tenderfoot Cr. (U/S)	Control/ Reference	10.2	410	46.95018 46.95032	-111.14362 -111.14365	1,438	Upper reach U/S of Forest Service boundary
LS.1	LSHEEP AQ7	Little Sheep Cr. (D/S) Little Sheep Cr. (U/S)	Impact	2.1	150	46.775038 46.775897	-110.89779 -110.89849	1,718	500 meters D/S of County Road culvert and proposed mine access road

Site RM Code [a]	Old Site Code [a]	Station Name [b]	BACI Type	Avg WW (m) [c]	Reach Length (m)	Latitude	Longitude	Elev. (m)	Location Comment
LS.6	LSHEEP AQ8	L. Sheep Cr. D/S SW8 (D/S) L. Sheep Cr. D/S SW8 (U/S)	Control	1.5	150	46.77145 46.77147	-110.88644 -110.8878	1,728	100 meters U/S of the future proposed mine access road culvert
C.5	COON AQ9	Coon Cr. @ SW3 (D/S)	Impact	0.5	150	46.77871	-110.90834	1,708	Upstream of County Road culvert at SW3 site
SM_DS SM_US	SMITH	Smith River D/S Sheep Cr. Smith River U/S Sheep Cr.	Impact Control	20.0	150	46.804 46.8041	-111.1841 -111.1824	1,316	D/S and U/S of the Sheep Cr. confluence
BC_DS BC_US	NA	Brush Creek	Impact	NR	80	46.77159 46.770987	-110.894071 -110.893572	NR	Spot-sampling upstream and downstream of the proposed haul road culvert

Source: Stagliano 2018a

Avg = average; BACI = Before, After, Control (upstream and offsite reference), and Impact (within and downstream); Cr. = Creek; D/S = downstream; L = Little; m = meter; Mtn = mountain; NA = not applicable; NR = not reported; RM = river mile; U/S = upstream; WW = wetted width

Notes:

[a] Site codes are based on river miles. Old Site Codes are used in Stagliano (2015, 2017a) and are included for reference.

[b] Station names denoted with SW are associated with Hydrometrics surface water monitoring sites.

[c] Average channel wetted width (WW) was measured at four reaches during summer base flows.

Seasonal baseline surveys of fish, macroinvertebrates, periphyton, and stream habitat were conducted on similar dates along the same designated reaches of Sheep, Little Sheep, and Tenderfoot creeks from 2014 to 2017, and are summarized below as referenced from Stagliano (2015, 2017a, 2018a). No fish were captured at Coon Creek in 2014 or 2015, so this tributary was only sampled for macroinvertebrates in 2016 and 2017.

Seventy-three seasonal fish survey events, 96 macroinvertebrate survey events, and 30 periphyton survey events occurred from 12 established monitoring stream reaches from 2014 to 2017.

Prior to the baseline surveys, no standardized biological sampling or monitoring had been conducted within the assessment area of Sheep Creek (Stagliano 2018a). These baseline aquatic surveys (Stagliano 2015, 2017a, 2018a), which are summarized below, were the primary sources used to determine the fish, macroinvertebrate, and periphyton distribution in the assessment area; however, literature and database searches were also conducted (see Section 3.16.1.1, Literature and Database Surveys). After submittal of the Draft EIS, additional baseline data for 2018 became available (Stagliano 2019), some of which has been incorporated into this Final EIS as Appendix K.

Methods for the habitat assessments and aquatic community surveys used in the baseline surveys are summarized below. Refer to Stagliano (2015, 2017a, 2018a) for more specific methodology.

3.16.1.1. Literature and Database Surveys

The FWP Fisheries Information System Database (FWP 2014), the MTNHP database (MTNHP and FWP 2017), and the Montana DEQ's ecological database application (DEQ 2017a) were the primary sources used to determine the potential presence and distribution of aquatic species in the analysis area. Additionally, information pertaining to federally listed threatened and endangered aquatic species was obtained from the U.S. Fish and Wildlife Service county list (USFWS 2017).

3.16.1.2. Habitat Data

Baseline sampling reaches were established in the Sheep Creek and Little Sheep Creek basins upstream and downstream of the proposed mine activity drainage corridor (Project area) in 2014, 2015, 2016, and 2017. During the 2014 to 2017 baseline surveys, biological community integrity was calculated using impairment metrics known to be affected by water and habitat quality. Physical habitat was evaluated by dividing the stream biological assessment reach into ten equally spaced transects according to Environmental Monitoring and Assessment Protocols followed by DEQ (Lazorchak et al. 1998; DEQ 2012). Stream gradients were estimated using the difference in the upper and lower Global Positioning System elevations of individual reaches and dividing by the reach length. Onsite habitat assessments were conducted using the rapid assessment protocol developed for the Bureau of Land Management by the National Aquatic Assessment Team (scores 0 to 24) (BLM 2008). The process for determining Proper Functioning Condition (PFC) followed Pritchard et al. (1993). Basic water quality parameters (temperature, total dissolved solids, pH, and conductivity) were recorded prior to biological sampling. Water quality of the streams and creeks in the Project area are discussed in Section 3.5, Surface Water Hydrology). Sites ranking higher using these protocols were determined to have higher quality habitat at the local reach scale.

3.16.1.3. Fish Population Data

Only two previous trout population estimates from 1973 and 1992 are available for the assessment area at the upstream Sheep Creek control site (SH22.7; FWP 2014). During the 2014 to 2017 baseline surveys, six reaches of Sheep Creek, two reaches on Little Sheep Creek, and two reaches of Tenderfoot Creek were sampled using backpack electrofishing equipment. In fall 2017, Moose Creek was also sampled using this method. In 2014 and 2015, each reach was divided into two 60- or 90-meter sections separated by shallow riffles and block seines. In 2016 and 2017, these reach lengths were extended to at least 150 meters (Little Sheep) and 300 to 400 meters (Sheep and Tenderfoot creeks).

Each fish collected was identified to species, weighed (grams), and measured (total length in millimeters [mm]), and random trout in the study were fin-clipped on the upper caudal fin to establish a section recapture percentage for reach fidelity. Young-of-the-year fish less than 30 mm were noted on the field sheet if species could be determined, and then immediately released to prevent mortality. All salmonids captured during the 2016 and 2017 surveys were scanned for passive integrated transponders (PIT tags) that are part of a Montana State University and Montana FWP fish movement study, and tag numbers were recorded with the other biometric data of the fish. Fish population estimates for 2016 and 2017 were calculated using an iterative process (Two Pass depletion estimates) to incorporate a maximum likelihood population estimate (Stagliano 2018a).

3.16.1.4. Metals in Fish Tissue

Metals analyses of Rocky Mountain sculpin and juvenile salmonid tissue collected from two sites downstream and two sites upstream of the assessment area were conducted in 2016, 2017, and 2018. In 2016 and 2017, the homogenized whole-fish tissue samples were analyzed to determine cadmium, copper, iron, lead, manganese, mercury, selenium, and zinc concentrations (reported as milligrams per kilogram) (Stagliano 2018a). In 2018, the tissue samples were also analyzed to determine aluminum concentrations (Stagliano 2019).

3.16.1.5. Redd Counts

During the 2016 to 2018 aquatic baseline surveys, redd count surveys were completed in the fall for fall-spawning brown trout and brook trout for all Sheep Creek and Little Sheep Creek reaches during the last week of October using methods outlined in Thurow et al. (2012). In 2017 and 2018, a redd count survey was also conducted at the Moose Creek station (MO.1). Within the assessment area, approximately 4,500 meters of stream channel in 2016 and 4,900 meters in 2017 were evaluated for the presence of trout spawning redds during the last week in October. Different salmonid species’ redds were identified based on size, visibly identifying fish on redds, or habitat selection preferences between brown and brook trout. Brook trout prefer redd sites in areas of groundwater seepage typically where mean stream velocities are approximately

18 centimeters per second. Average geometric mean sediment size of brook trout redds is significantly smaller than that of brown trout redds (5.7 mm versus 6.9 mm; $P < 0.02$), but less well sorted. Brown trout favor faster water velocities (mean 46.7 centimeters per second) and coarser substrates (Witzel and Maccrimmon 1983).

3.16.1.6. Freshwater Mussel Data

In 2014, surveys were conducted at all eight original monitoring sites for the western pearlshell mussel (*Margaritifera falcata*), a Montana SOC and Forest Service sensitive species. No evidence of current or historical presence was observed (Stagliano 2015). In the summer of 2016, the two newly added Sheep Creek reaches (SH15.5U and SH15.5D) were surveyed using the same longitudinal transect survey techniques as in 2014. No evidence of current or historical presence was observed (Stagliano 2018a).

3.16.1.7. Macroinvertebrate Population Data

In 2016, quantitative macroinvertebrate Hess sampling was conducted within the DEQ-recommended range for the DEQ sampling time frame (June 21 to September 30) at one riffle reach from all monitoring sites and processed according to DEQ protocols (DEQ 2012; see **Figure 3.16-1**). Three Hess samples were taken at each reach. Macroinvertebrate communities were also sampled with a dip net from each of the ten equally spaced transects within the assessment reach using the Environmental Monitoring and Assessment Protocol’s, Reach-Wide protocol (BLM 2008; Lazorchak et al. 1998). Sorting, identification, and data analysis of the samples was conducted at the Montana Biological Survey laboratory in Helena, Montana.

Macroinvertebrates were identified to the lowest taxonomic level (DEQ 2012), counted, and imported into the Ecological Data Application System, which provides metric values that are used to infer the health of the macroinvertebrate community. The biological metrics were calculated from the Ecological Data Application System data using DEQ’s multi-metric indices (MMI) protocols (Feldman 2006; DEQ 2012). Metric results were scored using the DEQ bioassessment criteria and each sample categorized as nonimpaired or impaired according to threshold values. The impairment threshold set by the DEQ’s MMI protocols is 63 on a 100-point scale for the Mountain Stream Index; thus, any scores above this threshold are considered unimpaired (DEQ 2012; Feldman 2006).

The Hilsenhoff Biotic Index (HBI), which measures the pollution tolerance for various benthic macroinvertebrate families, was also analyzed. HBI tolerance values are based on a 0 to 10 scale, where 0-ranked taxa are most sensitive and 10-ranked taxa are most tolerant to pollutants. For Montana surface waters, an HBI score of 4.0 should be used as the threshold (i.e., maximum allowable value) to prevent impacts on fish and associated aquatic life uses (DEQ 2016; DEQ 2012). HBI values of 0 to 3.0 in mountain streams indicate no organic pollution (excellent conditions), and values of 3.0 to 4.0 indicate slight organic pollution (very good) (Stagliano 2018a). Increased sedimentation also results in higher HBI values (DEQ 2012).

In 2016, the Upper Missouri Watershed Alliance (UMOWA) began the Smith River Baseline Macroinvertebrate Monitoring program. This study established eight monitoring sites along the

Smith River, two of which (SM_DS and SM_US) are proposed aquatic monitoring locations for the Project (Stagliano 2017c) for sampling benthic macroinvertebrates between Fort Logan and Eden Bridge. The sampling methods were consistent with those outlined above and relevant monitoring data from 2016 and 2017 (Stagliano 2017d, Stagliano 2018b) was included in Section 3.16.2.5, Macroinvertebrate Communities.

3.16.1.8. Periphyton Population Data

During the 2014 to 2017 aquatic baseline surveys, periphyton communities were sampled semi-quantitatively from each of the ten transects within the assessment reach using the Sample Collection and Laboratory Analysis of Chlorophyll-*a* Standard Operation Procedure (DEQ 2011a) and using the Periphyton Standard Operating Procedure (DEQ 2011b). Summer periphyton samples were collected within the DEQ-recommended range for the DEQ sampling time frame (June 21 to September 30) (DEQ 2012). The periphyton samples were processed by Rhithron Associates, Inc. in Missoula, Montana. Periphyton biointegrity metrics were generated and interpreted according to Teply and Bahls (2006).

3.16.2. Affected Environment

Twelve stream reaches in the assessment area were evaluated between 2014 and 2017. Aquatic Ecological Systems (AESs) are stream systems within a drainage area that have similar geomorphology and environmental processes (e.g., hydrologic, geologic, nutrient, and temperature regimes) (Groves et al. 2002). Standard attributes used to classify AESs are defined in Higgins et al. (2005) and include stream size, gradient, connectivity to other waterbodies and underlying lithology. Using this system, eight mainstem stream reaches on Sheep Creek (six sites) and Tenderfoot Creek (two sites) were classified as Mountain Streams (C003), Moose Creek was classified as a Small Forested Mountain Stream (D003), and two tributary reaches on Little Sheep and the reach on Coon Creek were classified as Headwater Stream (D001) systems (see **Table 3.16-1**) (Stagliano 2018a). Upstream of the Coon Creek sampling location (C.5), Coon Creek is currently diverted into a ditch from its original stream channel as it enters the Sheep Creek alluvial valley. Coon Creek flows through the ditch for approximately 2,586 feet before returning to its natural channel approximately 650 feet upstream of its confluence with Sheep Creek (Hydrometrics, Inc. 2018b, Sheet 1).

Stream flows at most Sheep Creek sites during the spring sampling periods of 2015, 2016, and 2017 have been above optimal levels for efficient electrofishing, so population estimates during these periods are considered qualitative estimates of salmonid abundance. There are no USGS streamflow gages on any streams in or near the Project area to consult; however, stream flow data was collected by Hydrometrics (Hydrometrics, Inc. 2017; see **Table 3.16-2**). The study is included as Appendix V-1 of the MOP Application (Tintina 2017). According to the study, from 2015 to 2017, spring runoff began10 to 14 days earlier than the 30-year historical flow average, and the runoff conditions persist until mid-June. Flows recorded at Sheep, Little Sheep, and Coon creeks during the dates closest to the seasonal sampling events are presented in **Table 3.16-2**. Annual average stream flows for Sheep Creek have declined since the high flows of 2014 (Stagliano 2018a). For additional information on stream hydrology, see Section 3.5, Surface Water Hydrology.

Table 3.16-2
Stream Discharge Reported at Four Surface Water Quality Stations and Associated Aquatic Monitoring Reaches in the Project Area, 2014–2017

		2014 (cfs)		2015 (cfs)		2016 (cfs)				2017 (cfs)			
		Summer	Fall	Spring	Summer	Spring	Summer	Fall	Fall	Spring	Summer	Fall	Fall
Site	Stream	8/21/14	9/3/14	4/29/15	6/25/15	4/29/16	7/14/16	9/20/16	10/22/16	4/23/17	7/17/17	9/11/17	10/17/17
SH17.5/SW1	Sheep Creek	25	22	103	47	84.2	17.2	19.7	22.2	40.6	18.9	10.7	17.5
SH22.7/SW2	Sheep Creek	19.3	17	82.2	36	68	9.2	16.7	18.5	31.3	14.6	6.8	13.7
LS.6/SW8	Little Sheep	0.5	0.6	1	0.7	0.7	0.5	0.2	0.2	0.8	0.5	0.1	0.1
C.5/SW3	Coon Creek	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.2	<0.1	0.2	0.2

Source: Stagliano 2018a

C = Coon Creek; cfs = cubic feet per second; LS = Little Sheep Creek; SH = Sheep Creek

3.16.2.1. Aquatic Special Status Species

No federally or state-listed threatened or endangered aquatic special status species were found in the Project area during surveys. According to available data, two state-listed SOC are known to occur in the general vicinity of the assessment area. The western pearlshell mussel (*Margaritifera falcate*), which is also a Forest Service sensitive species, was not observed during the 2014 or 2016 surveys performed in the assessment area. The last documented live mussel of this species in the Smith River basin was reported at Fort Logan bridge (Highway 360) in 2011 (Stagliano 2018a).

The westslope cutthroat trout (*Oncorhynchus clarkii lewisi*) is reported to occur in the Project area in Sheep Creek (MTNHP and FWP 2017), but there are no documented occurrences. Pure westslope cutthroat trout have been documented in Daniels Creek and Jumping Creek, upstream tributaries to Sheep Creek (FWP 2014), so pure westslope cutthroat trout could potentially be in the Project area at low densities. While no westslope cutthroat trout were documented during any of the Sheep Creek surveys between 2014 and 2017, a fish was collected from Tenderfoot Creek in 2017 that had characteristics/genetics indicating it was greater than 90 percent pure westslope cutthroat trout. Westslope cutthroat trout (>90 percent pure) are documented to occur about 6.8 miles upstream of the Tenderfoot Creek reference reach, TN9.4, and in the South Fork Tenderfoot Creek, which enters the Tenderfoot near reach TN9.3 (FWP 2014). Only rainbow/cutthroat hybrids were collected at the Sheep Creek sites during the 2014 to 2017 baseline surveys. Genetic testing to determine if any of the rainbow/cutthroat hybrids in Sheep Creek are at least 90 percent pure was not conducted (Stagliano 2018a).

3.16.2.2. Habitat Evaluations

During the 2014 to 2017 baseline surveys, six of the 12 sampling reaches evaluated in the assessment area were found to be in PFC with a stable trend and 6 were Functional at Risk. The sites ranked Functional at Risk had riparian habitat altered recently or historically by cattle (LS.1, LS.6, SH22.7, SH15.5U, MO.1, and TN9.3), or by human stream encroachment or manipulation (SH17.5 and SH22.7). The highest site integrity scores using both the Bureau of Land Management Habitat and PFC assessment methods were recorded at the Sheep Creek meadow reaches (SH19.2 and SH18.3), SH15.5DS, and the Tenderfoot Creek site (TN9.4). Lower habitat scores were reported for sites that were structurally degraded by cattle and had high associated livestock use indices (LS.6, SH22.7, and TN9.3) (see **Table 3.16-3**) (Stagliano 2018a).

Table 3.16-3
Site Aquatic Ecological Community Integrity Ranks

Site RM Code	BACI Type	AES Code b	Fish	Macro-invertebrates	Algae	Habitat	Overall Rank	Integrity Comment
SH22.7	C	C003	3	2	3	5	3	Stream manipulation from road and cattle trampling
SH19.2	C	C003	1	5	5	3	3	Upper reach affected by a partial beaver dam
SH18.3	I	C003	2	5	5	2	3	Lower reach with some loss of riparian vegetation
SH17.5	I	C003	5	3	4	5	5	Stream manipulation from roadside stabilization
SH15.5U/S	I	C003	3	3	4	5	4	Mass trampling of some stream banks by cattle
SH15.5D/S	I	C003	5	5	4	5	5	Lower Reach with some streambank impairment
TN9.3	R	C003	3	2	2	4	2	Mass trampling of some stream banks by cattle
TN9.4	R	C003	3	1	1	1	1	Upper Reach with no streambank impairment
MO.1	R	D003	2	NA	NA	3	2	Great fish populations, but streambank impairments.
LS.1	I	D001	1	2	2	2	1	Mass wasting of some of the stream banks
LS.6	C	D001	2	3	1	3	3	Mass wasting of some of the stream banks
CN.5	I	D001	NA	2	NA	1	2	Fenced, not grazed

Stagliano 2018a

AES = Aquatic Ecological Systems; BACI = Before, After, Control (upstream and offsite reference), and Impact (within and downstream); D/S = downstream; C = Control; I = Impact; LS = Little Sheep Creek; NA = not analyzed; R = Reference; RM = River mile; SH = Sheep Creek; TN = Tenderfoot Creek; U/S = upstream

Notes:

[a] Community integrity ranks were scored 1 (highest) through 5 (lowest).

[b] AES types include Mountain Streams (C003), Small Forested Mountain Stream (D003), and Headwater Stream (D001).

The stream reach habitat features mapping performed in 2014 found that Sheep Creek and Tenderfoot Creek can be classified broadly as Rosgen Type C, based on reach gradient, stream geomorphology, and bottom substrate characteristics. Little Sheep Creek has characteristics of Type E and F classes, being moderately entrenched at LS.6 and some sections of LS.1. Coon Creek has morphologic characteristics of a Type F channel (Rosgen 1996).

Type C channels are characterized as moderately sinuous (meandering), having a mild slope and a well-developed floodplain, and being fairly shallow relative to their width. Type E channels are similar to Type C, except they tend to be more sinuous and deeper relative to their width. Type F channels are also similar to Type C, except they are more entrenched with very high channel width to depth ratios at the bankfull stage. Type F channels can have high bank erosion rates and are often a failed or failing Type C channel. Stream habitat morphology is dominated by riffles and runs at all sites and Tenderfoot Creek sites had slightly more pool area than the Sheep Creek sites overall.

3.16.2.3. Fish Communities

Nine fish species and one hybrid were identified from more than 14,000 fish collected and handled during the 73 seasonal stream reach surveys conducted between 2014 and 2017. In 2016 and 2017, 5,031 and 6,177 individuals were collected, respectively. The higher number in 2017 (over 1,100 more individuals than in 2016) was attributed to the addition of the new Moose Creek site and lengthened fish sampling reaches. In 2014 and 2015, each reach was divided into two 60- or 90-meter sections separated by shallow riffles and block seines. In 2016 and 2017, the reach lengths were extended to at least 150 meters (Little Sheep) and 300 to 400 meters (Sheep and Tenderfoot Creeks). The Moose Creek reach length was 210 meters (Stagliano 2018a). Abundance and diversity of taxa among the 2014 to 2017 aquatic monitoring sampling locations were indicative of mountain streams populated by typical species, including mountain whitefish, Rocky Mountain sculpin, and longnose dace, in addition to gamefish such as brook trout, brown trout, and rainbow trout (see **Table 3.16-4**). The presence of two or more sensitive or intermediate species in each of these monitoring locations is one indication that quality habitat is present at these sites (see **Table 3.16-4**).

Rocky Mountain sculpin were present at all sites (100 percent site occupancy), comprised the highest proportion of total individuals collected (74 percent), and usually were the most abundant fish species captured (see **Figure 3.16-2**, **Figure 3.16-3**, **Figure 3.16-4,** and **Figure 3.16-5**). Tenderfoot Creek had the highest percentage of Rocky Mountain sculpin comprising the catch (80 percent) due to their high abundance. The other native species, mountain whitefish, longnose dace, white sucker, and mountain sucker had site occupancy rates of 52, 12, 12, and 1 percent, respectively (Stagliano 2018a). Rainbow trout was usually the most abundant salmonid present (see **Figure 3.16-6**) and the average densities in the Sheep Creek downstream impact sites (n=4) was higher (168 per mile ± 60 standard error) than the control sites (n=2) (85 per mile ± 35 standard error). In 2017, Sheep Creek monitoring locations SH19.2 and SH15.5DS had the highest species diversity with eight species recorded at each location (see **Table 3.16-4**).

Approximately 10 percent of the brook trout and rainbow trout documented in Little Sheep Creek in 2016 were affected by opercula erosion, a condition that can be caused by bacterial gill disease and results in swollen gills and the gill cover eroding away. While a definitive cause of opercula erosion has not been determined, when found in wild fish it is often an indication of organic loading into streams (Stagliano 2018a). The number of brook trout affected at LS.1 increased to approximately 17 percent in 2017. Based on macroinvertebrate and periphyton metrics (see Section 3.16.2.5, Macroinvertebrate Communities, and Section 3.16.2.6, Periphyton Communities), nutrient loading is still occurring in Little Sheep Creek although conditions may be improving (Stagliano 2018a).

During spot sampling of Brush Creek in spring 2017, three brook trout were collected within approximately 131 feet (40 meters) upstream of the proposed mine access road culvert. No fish were collected from this reach in the summer although water was present (Stagliano 2018a). During sampling of Little Sheep Creek (LS.6) in spring 2017, 6 brook trout and 30 sculpin were collected. No brook trout and 67 sculpin were collected in this reach in the summer. Because this reach had extremely low flows, warm water temperatures (21.5°C), and aquatic vegetation filling the channel, it is likely that the brook trout migrated out of the reach to more suitable habitat.

In fall 2017, the Moose Creek station (MO.1) was sampled for the first time and five fish species were captured (see **Table 3.16-4**). Salmonid population estimates for Moose Creek were 1,004 trout per mile, which is approximately three times more abundant than adjacent Sheep Creek estimates (Stagliano 2018a). As described above, in 2017 the reach lengths in Sheep Creek were between 300 to 400 meters and the reach length of Moose Creek was 210 meters. Fish population estimates were reported as numbers per unit distance (per section or per stream mile) based on Two Pass depletion estimates averaged between the two sampled section units per reach (Stagliano 2018a).

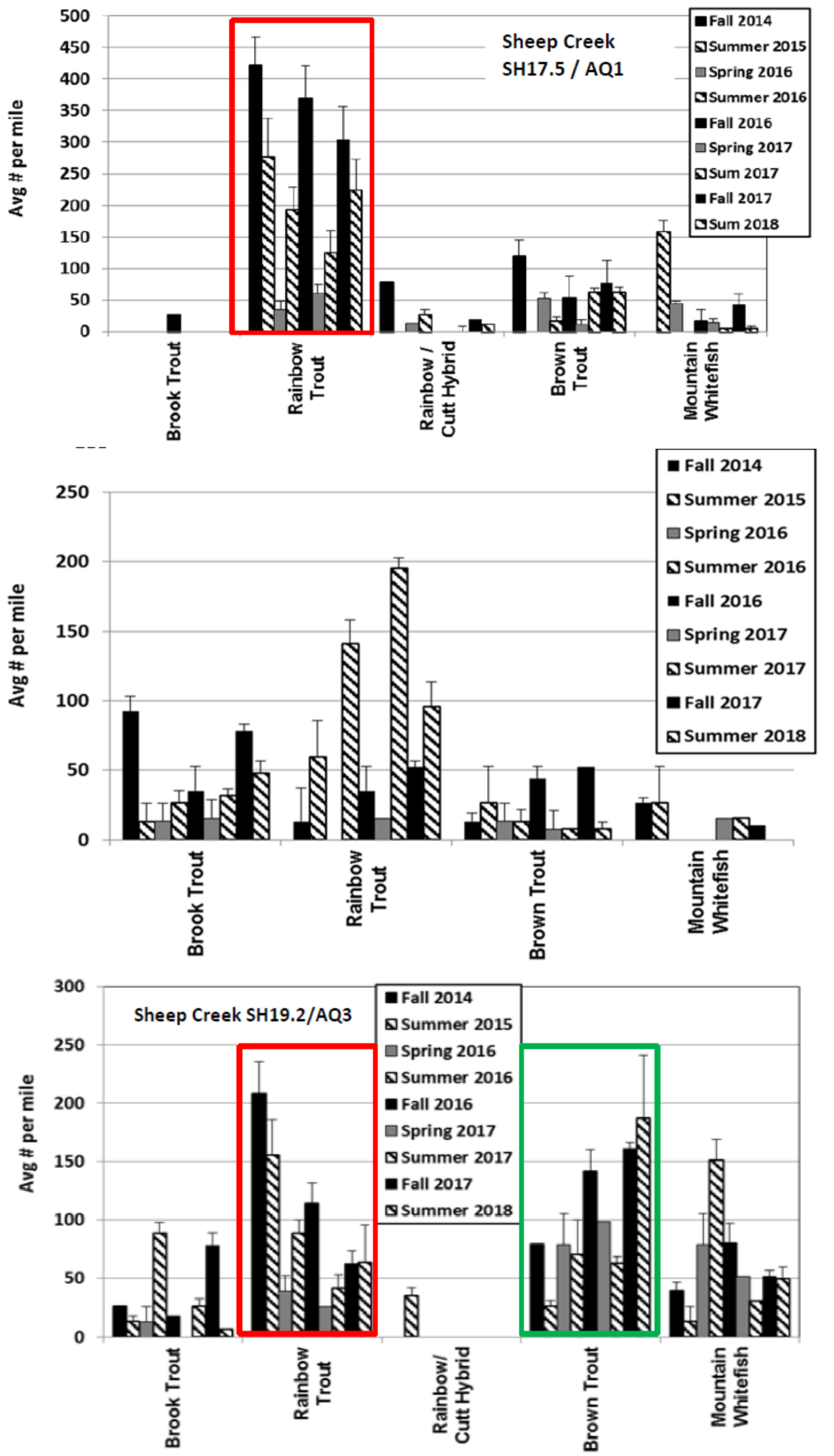
Trout and mountain whitefish were also tagged in the area of the Sheep Creek and Moose Creek confluence. These fish have been detected throughout the Smith River drainage, including in Benton Creek, Birch Creek, Camas Creek, Newlan Creek, Rock Creek, Tenderfoot Creek, and the Smith River from as far upstream as Canyon Ranch (RM 108.7) and as far downstream as Truly Bridge (RM 9.1). These points are the most upstream and most downstream points within the Smith River drainage where attempts have been made to detect fish movements. These data illustrate trout and mountain whitefish throughout the Smith River drainage use Sheep Creek in the vicinity of Moose Creek, and that fish from this area disperse throughout the entire Smith River drainage (DEQ, Pers. Comm., June 21, 2018).

Table 3.16-4
Fish Species Documented in the Black Butte Copper Project Area, 2014–2017

Species	**Scientific Name**	**Trophic**	**General Tolerance**	**Origin**	**Total Length 3 years (mm)**	**LS.1**	**LS.6**	**SH22.7**	**SH19.2**	**SH18.3**	**SH17.5**	**SH15.5 U/S**	**SH15.5 D/S**	**MO.1**	**TN 9.3/ TN9.4**
White sucker	*Catostomus commersonii*	OM	TOL	N	229	X	X	NR	X	X	NR	NR	NR	NR	NR
Mountain sucker	*Catostomus platyrhynchus*	INV	INT	N	102	NR	NR	NR	NR	NR	NR	NR	X	NR	NR
Rocky Mountain sculpin	*Cottus bondii*	INV	INT	N	86	X	X	X	X	X	X	X	X	X	X
Longnose dace	*Rhinichthys cataractae*	INV	INT	N	71	NR	NR	NR	X	X	NR	NR	X	NR	NR
Brook trout	*Salvelinus fontinalis*	INV	S	I	240	X	X	X	X	X	X	X	X	X	X
Brown trout	*Salmo trutta*	INV/C	TOL	I	269	X	NR	X	X	X	X	X	X	X	NR
Rainbow trout	*Oncorhynchus mykiss*	INV	S	I	260	X	NR	X	X	X	X	X	X	X	X
Rainbow trout x westslope cutthroat hybrid	*Oncorhynchus mykiss x clarkii lewisi*	INV	S	I	266	NR	NR	NR	X	NR	X	NR	X	X	X
Westslope cutthroat trout	*Oncorhynchus clarkii lewisi*	INV	S	N	266	NR	NR	NR	NR	NR	NR	NR	NR	NR	X
Mountain whitefish	*Prosopium williamsoni*	INV	INT	N	190	X	NR	X	X	X	X	X	X	NR	NR
Study year						2015-2017	2014-2017	2014-2017	2014, 2016, 2017	2014-2017	2014-2017	2016, 2017	2016, 2017	2017	2014-2017
Number of species observed						6	3	5	8	7	6	5	8	5	5

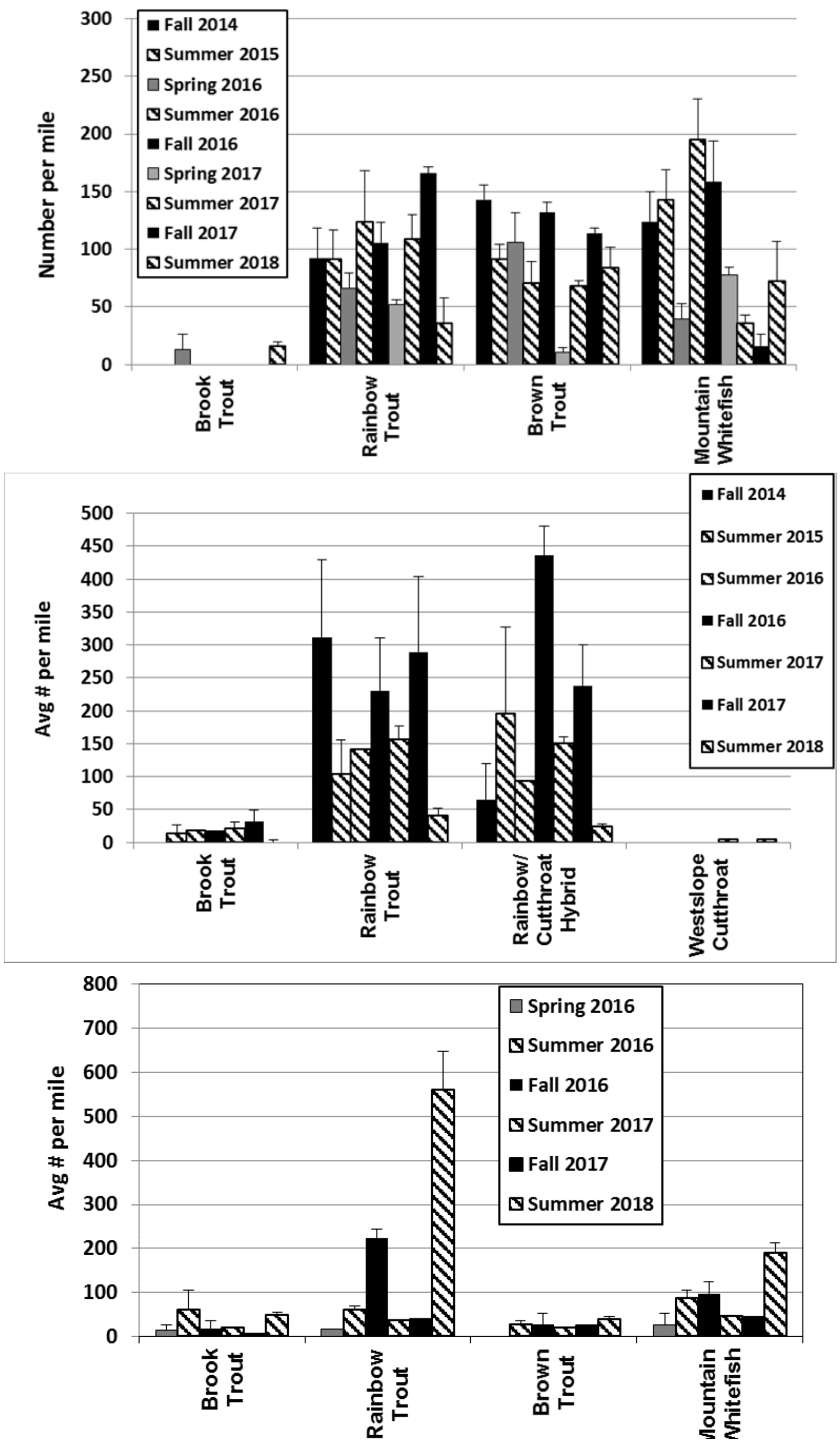
Source: Stagliano 2015, 2017a, 2018a

C = carnivore; D/S = downstream; I=introduced; INT = intermediate; INV = invertivore; LS = Little Sheep Creek; mm = millimeters; N = native; NR = not recorded; OM = omnivore; S = sensitive; SH = Sheep Creek; TOL = tolerant; TN = Tenderfoot Creek; U/S = upstream; X = documented in reach during 2014 to 2017 baseline surveys



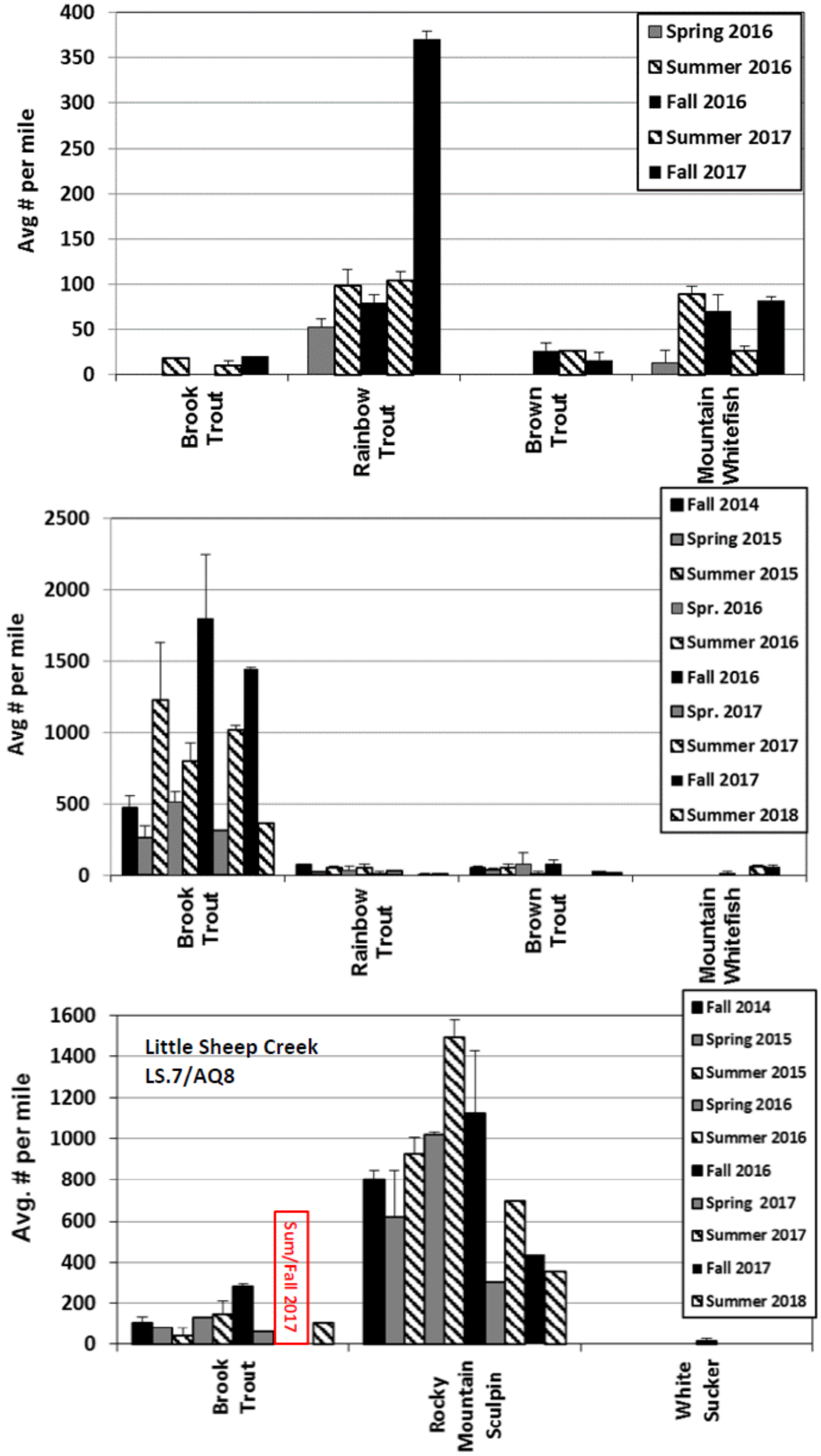
Source: Stagliano 2019

Figure 3.16-2
Seasonal Average Fish Abundance per Mile with Standard Deviation Error Bars for Project Aquatic Sampling Locations on Sheep Creek SH17.5 (top), SH22.7 (middle), and SH19.2 (bottom)



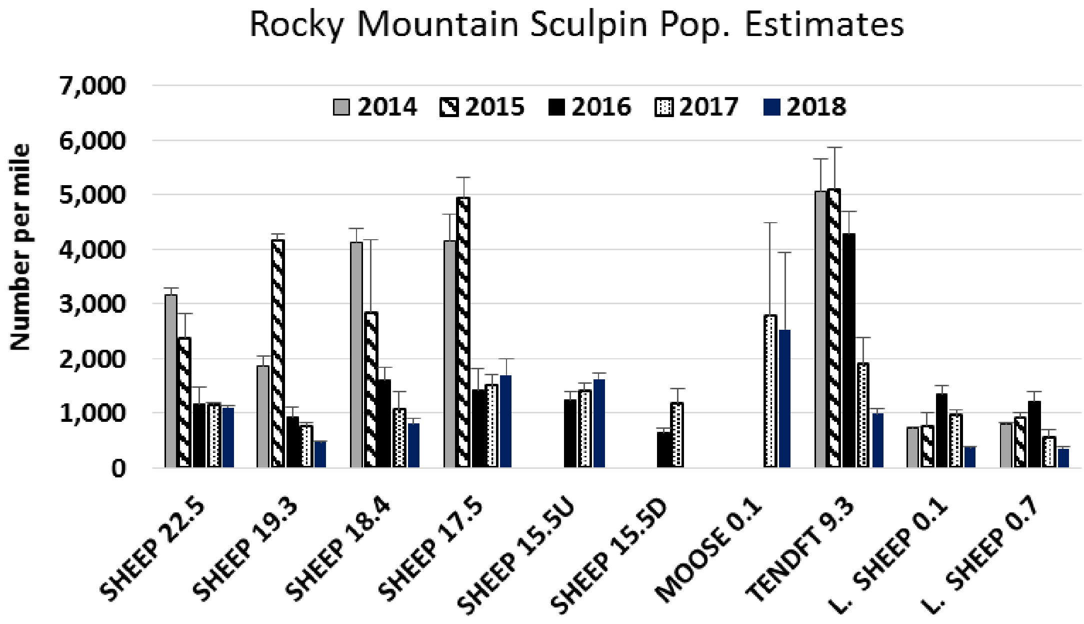
Source: Stagliano 2019

Figure 3.16-3
Seasonal Average Fish Abundance per Mile with Standard Deviation Error Bars for Project Aquatic Sampling Locations on Sheep Creek SH18.3 (top), Tenderfoot Creek TN9.3 (middle), and Sheep Creek SH15.5US (bottom)



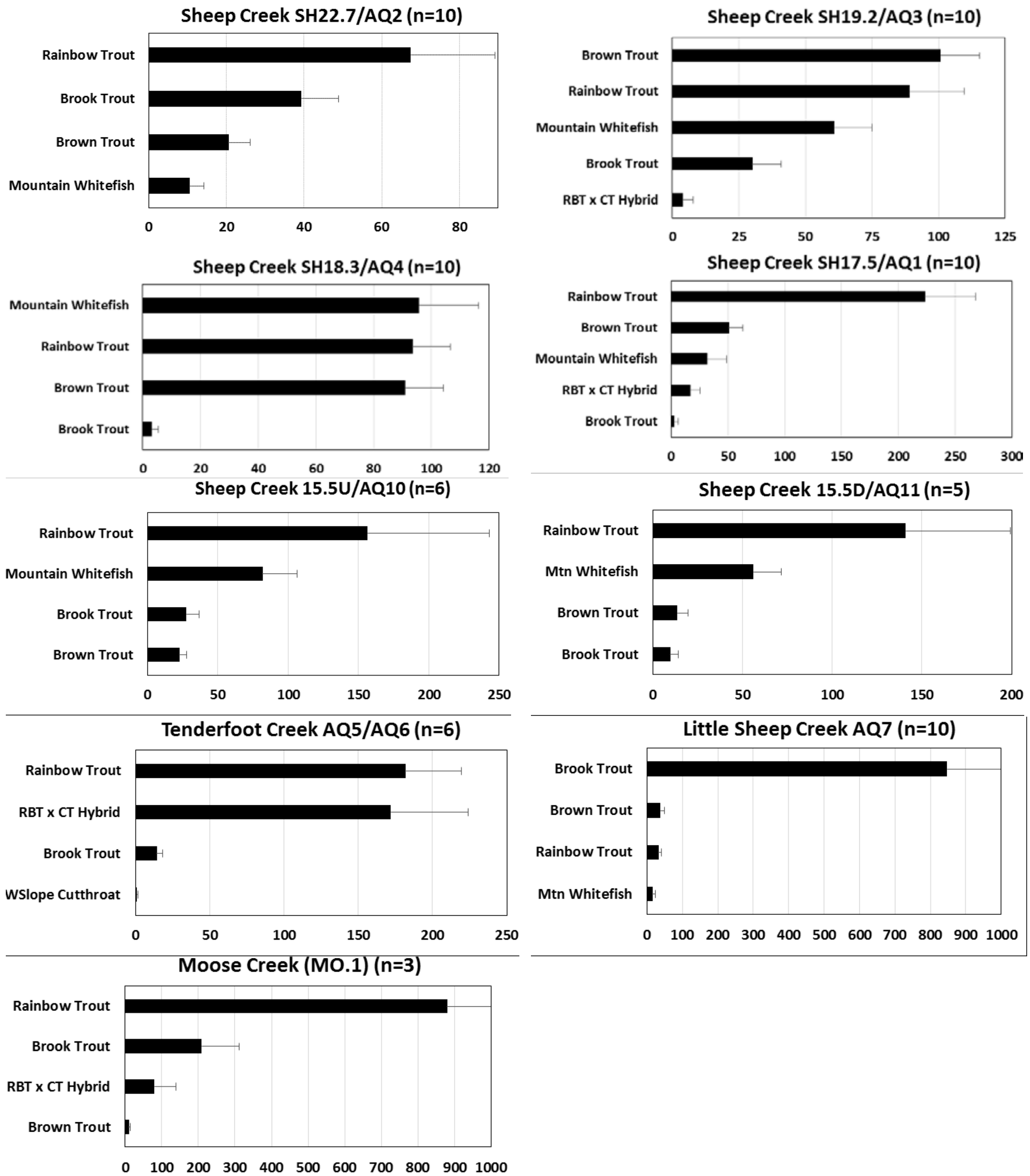
Source: Stagliano 2019
Note: The bottom figure is mislabeled as LS.7/AQ8 instead of LS.6.

Figure 3.16-4
Seasonal Average Fish Abundance per Mile with Standard Deviation Error Bars for Project Aquatic Sampling Locations on Sheep Creek SH15.5 DS (top), Little Sheep Creek LS.1 (middle), and Little Sheep Creek LS.6 (bottom)



Source: Stagliano 2019

Figure 3.16-5
Average Total Annual Sculpin Population Estimates for Sheep Creek Sites (SH22.7 and SH19.2) and the First Impact Site (SH18.3), 2014-2018



Source: Stagliano 2019

Figure 3.16-6
Overall Average Salmonid Abundance per Mile with Standard Deviation Error Bars for Sheep, Little Sheep, and Tenderfoot Creek Sampling Locations 2014-2018

The downstream Sheep Creek impact sites, SH15.5U and SH15.5D, added in 2016, had overall fish communities similar to SH18.3, SH19.2 and SH22.7, respectively (see **Figure 3.16-6** and **Table 3.16-4**). These sites, which qualitatively have similar pool habitat, also reported fewer catchable-sized fish (greater than 200 mm) than found in the Sheep Creek meadow reaches SH19.2 and SH18.3 (see Appendix K). Similar patterns were observed at the upper Sheep Creek site SH22.7, which has roadside fishing access and likely higher fishing pressure. Rainbow trout size-frequency numbers indicate the presence of four dominant size classes (age classes) in most Sheep Creek reaches, except those with abundant large brown trout where the first and second year classes (less than 100 mm) are missing (see Appendix K), likely due to predation (Stagliano 2018a, 2019). Brown trout size classes are eschewed toward larger fish across most Sheep Creek sites, especially at SH15.5U, which is the fishing access site (see Appendix K). Stagliano (2019) stated that Moose Creek is a salmonid production area with the highest densities of salmonids reported (approximately 1,000 and 2,400 per mile in 2017 and 2018, respectively [see Appendix K]). The high frequency of small size classes (less than 150 mm), including brook and rainbow trout juveniles (approximately 50 to 75 mm), in Moose Creek indicate that many fish are likely spawned and reared in this creek. The rainbow trout reared in Moose Creek are out-migrating and augmenting populations at the Sheep Creek sites downstream (SH15.5U/D) (Stagliano 2019).

During the 2016 aquatic baseline studies, eleven PIT-tagged fish (two recaptures) from the Montana State University/FWP study were captured and released. These were found in Sheep Creek (SH17.5, SH18.3, SH19.2, and SH15.5US) and included five rainbow trout, six mountain whitefish, and one brown trout. The furthest upstream detection of any tagged fish into the Project area was a mountain whitefish captured at Sheep Creek SH19.2 in the summer of 2016. Tagged fish captured at Sheep Creek SH17.5 during the summer 2016 sampling were recently tagged at that location and showed signs of handling stress (i.e., missing scales, poor condition). No PIT-tagged fish were identified at any site during any season in 2017. No PIT-tagged rainbow trout were detected near the Project area during any season; however, given the densities of young year-class rainbow trout and cut-bow hybrids collected in the fall of 2017 (approximately 80 percent were less than 200 mm in length), they are likely using Moose Creek for the majority of spring spawning (Stagliano 2018a).

Trout that enter tributaries in the Project vicinity to spawn usually arrive in April and leave in May (Grisak 2013; FWP 2001).

Metals in Fish

Currently there are no state-wide fish consumption advisories for Montana. However, the FWP, DEQ, and Montana Department of Health and Human Services (2014) have published sport fish consumption guidelines with specific guidelines for some waterbodies. No waterbodies in the Project vicinity, or the Smith River, currently have consumption advisories or specific guidelines. Results of the baseline whole body metal analysis performed on Rocky Mountain sculpin and juvenile salmonids in 2016, 2017, and 2018 are presented in **Table 3.16-5**. The reported values for all metals in the fish tissue are below the impairment threshold for Aquatic

Life Standards (DEQ 2017b). Arsenic, cadmium, lead, mercury, and nickel were not reported at any site at detectable levels in 2016, 2017, or 2018.

Fall Redd Counts

During the last week of October in 2016, 2017, and 2018, approximately 2.8, 3.1, and 3.2 miles, respectively, of stream channel encompassing the Sheep Creek and Little Sheep Creek monitoring sections were surveyed for brook and brown trout redds (see **Figures 3.16-7, 3.16-8, and 3.16-9**). **Figure 3.16-10** shows the average number of redds per 100 meters at sites within the assessment area. The highest number of brown trout redds were reported in 2016 at Sheep Creek sites SH19.2 and SH18.3, and averaged 3.5 and 2.8 redds per 100 meters, respectively. Redd counts at these same sites in 2017 and 2018 were less than one half of those densities reported in 2016 (see **Figure 3.16-8** and **Figure 3.16-9**). The highest number of brook trout redds were reported at Little Sheep Creek site LS.1 in 2016 and 2018 and averaged 3.3 redds and 1 redd per 100 meters, respectively.

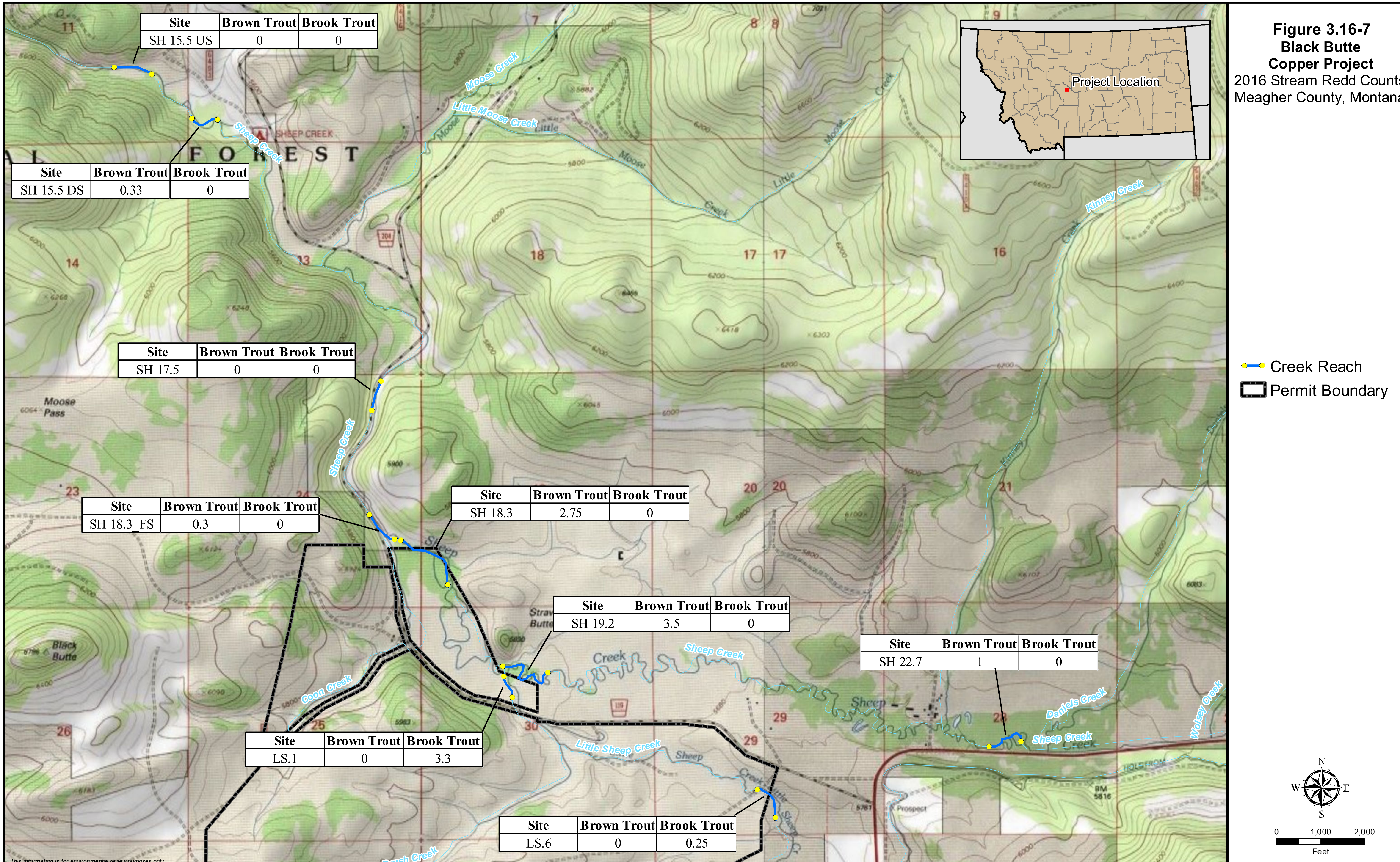
Table 3.16-5
Baseline Whole Body Metal Values Downstream and Upstream of the Project Area

Stream Site	Al (mg/kg)	Cu (mg/kg)			Fe (mg/kg)		Mn (mg/kg)		Se (mg/kg)			Zn (mg/kg)		
	2018	**2016**	**2017**	**2018**	**2016**	**2017**	**2016**	**2017**	**2016**	**2017**	**2018**	**2016**	**2017**	**2018**
Sheep SH17.5 (D/S)	29 15	2	1	N/D	204	53	8	9	1	N/D	N/D	25	20	21
Sheep SH18.3 (D/S)		1	1	N/D	177	43	4	11	3	N/D	N/D	18	27	17
Average	22.0	**1.5**	**1.0**		**190.5**	**48.0**	**6.0**	**10.0**	**2.0**	**N/D**	**N/D**	**21.5**	**23.5**	**19.0**
Sheep SH22.7 (U/S)	25 23	1	1	N/D	171	24	7	6	2	N/D	N/D	22	20	16
L. Sheep LS.1 (U/S)		1	N/D	N/D	275	155	8	5	2	1	2	24	23	21
L. Sheep LS.1 (EBT)	NR	NR	1		NR	23	NR	3	NR	N/D	N/D	NR	22	22
Average	24.0	**1.0**	**0.7**		**223.0**	**67.3**	**7.5**	**4.7**	**2.0**	**0.5**	**0.5**	**23.0**	**21.7**	**19.7**
F-test, p-value (C x I)	0.4	**0.2**	**0.3**		**0.3**	**0.4**	**0.3**	**<0.1**	**0.5**	**0.3**	**0.3**	**0.4**	**0.3**	**0.4**
F-test, p-value (year)	NR	**0.1**	NR		**<0.1**	NR	**0.5**	NR	**0.1**	NR		**0.5**	0.1	0.1

Source: Stagliano 2018a

Al = aluminum; C = control; Cu = copper; D/S = downstream; EBT = juvenile brook trout; Fe = iron; I = impact; L. = Little; mg/kg = milligrams per kilogram; Mn = manganese; N/D = nondetectable at reporting limits; NR = not reported; Se = selenium; U/S = upstream; Zn = zinc

Figure 3.16-7
Black Butte
Copper Project
2016 Stream Redd Counts
Meagher County, Montana



Site	Brown Trout	Brook Trout
SH 15.5 US	0	0
SH 15.5 DS	0.33	0
SH 17.5	0	0
SH 18.3_FS	0.3	0
SH 18.3	2.75	0
SH 19.2	3.5	0
SH 22.7	1	0
LS.1	0	3.3
LS.6	0	0.25

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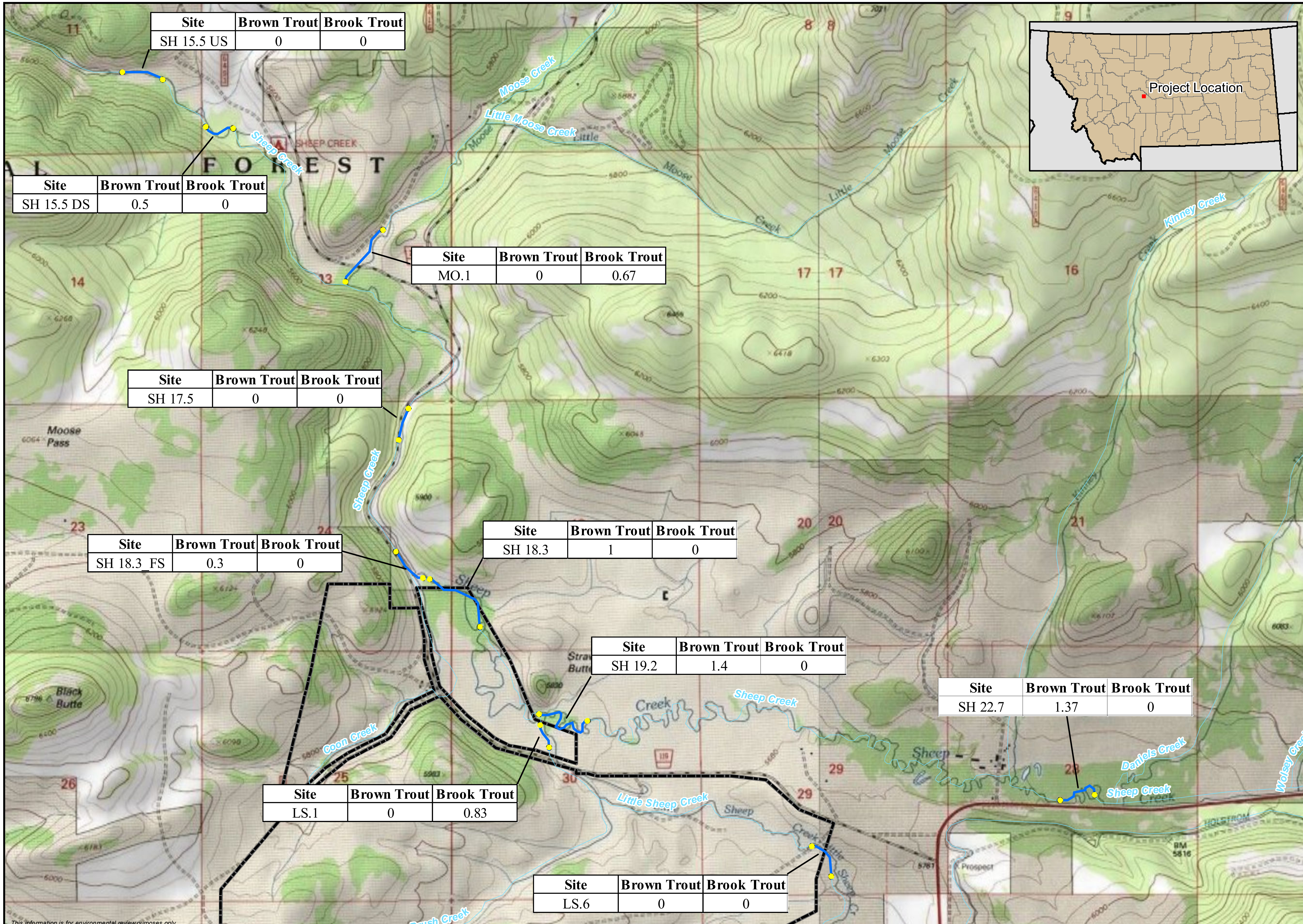
Figure 3.16-8
Black Butte Copper Project
2017 Stream Redd Counts
Meagher County, Montana



Site	Brown Trout	Brook Trout
SH 15.5 US	0	0
SH 15.5 DS	0.5	0
MO.1	0	0.67
SH 17.5	0	0
SH 18.3_FS	0.3	0
SH 18.3	1	0
SH 19.2	1.4	0
SH 22.7	1.37	0
LS.1	0	0.83
LS.6	0	0

Creek Reach
Permit Boundary

All values of Redd Counts per 100 meters of Stream

N W E S

0 1,000 2,000
Feet

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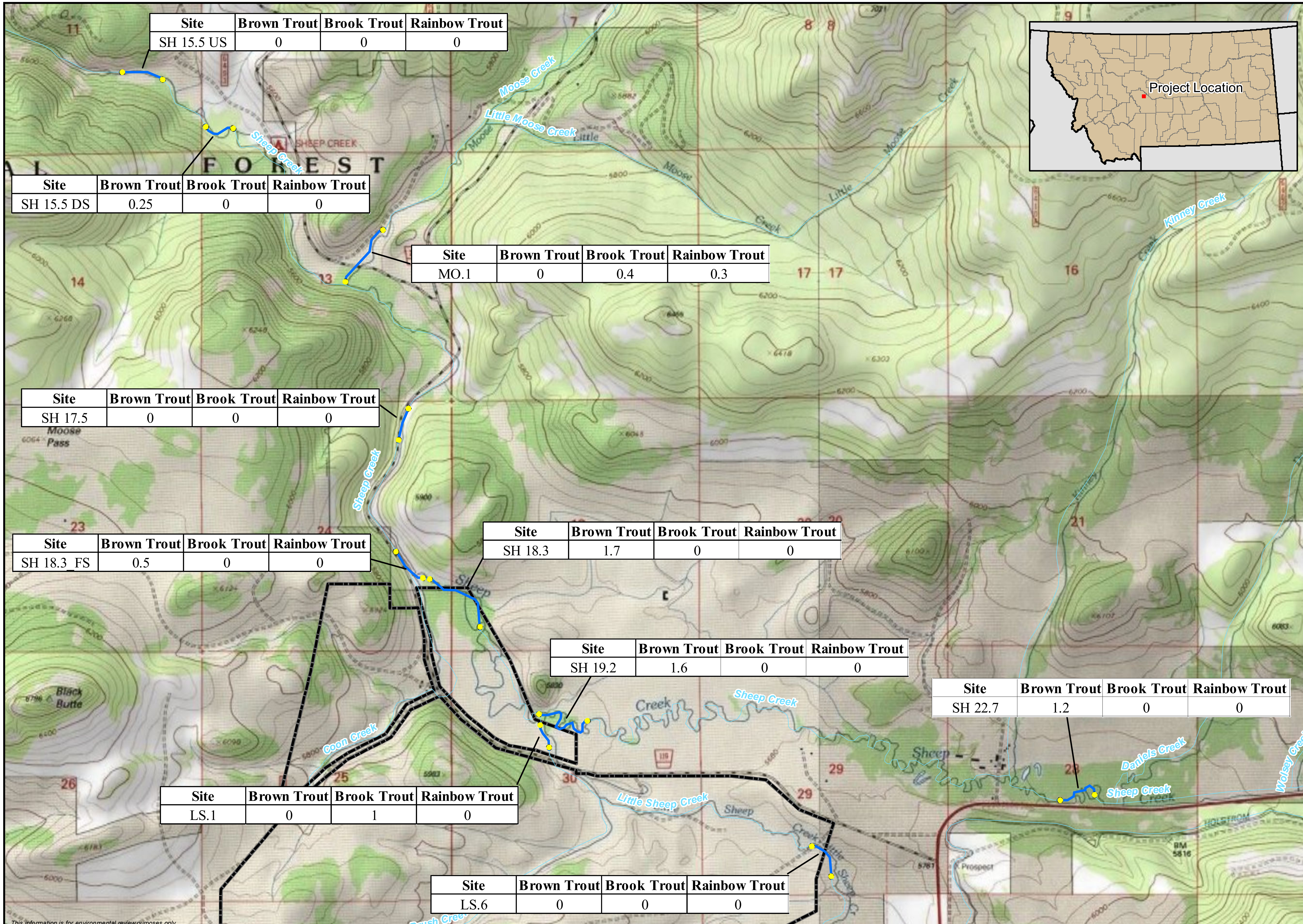


Site	Brown Trout	Brook Trout	Rainbow Trout
SH 15.5 US	0	0	0

Site	Brown Trout	Brook Trout	Rainbow Trout
SH 15.5 DS	0.25	0	0

Site	Brown Trout	Brook Trout	Rainbow Trout
MO.1	0	0.4	0.3

Site	Brown Trout	Brook Trout	Rainbow Trout
SH 17.5	0	0	0

Site	Brown Trout	Brook Trout	Rainbow Trout
SH 18.3_FS	0.5	0	0

Site	Brown Trout	Brook Trout	Rainbow Trout
SH 18.3	1.7	0	0

Site	Brown Trout	Brook Trout	Rainbow Trout
SH 19.2	1.6	0	0

Site	Brown Trout	Brook Trout	Rainbow Trout
SH 22.7	1.2	0	0

Site	Brown Trout	Brook Trout	Rainbow Trout
LS.1	0	1	0

Site	Brown Trout	Brook Trout	Rainbow Trout
LS.6	0	0	0

Figure 3.16-9
Black Butte Copper Project
2018 Stream Redd Counts
Meagher County, Montana

Creek Reach
Permit Boundary

All values of Redd Counts per 100 meters of Stream

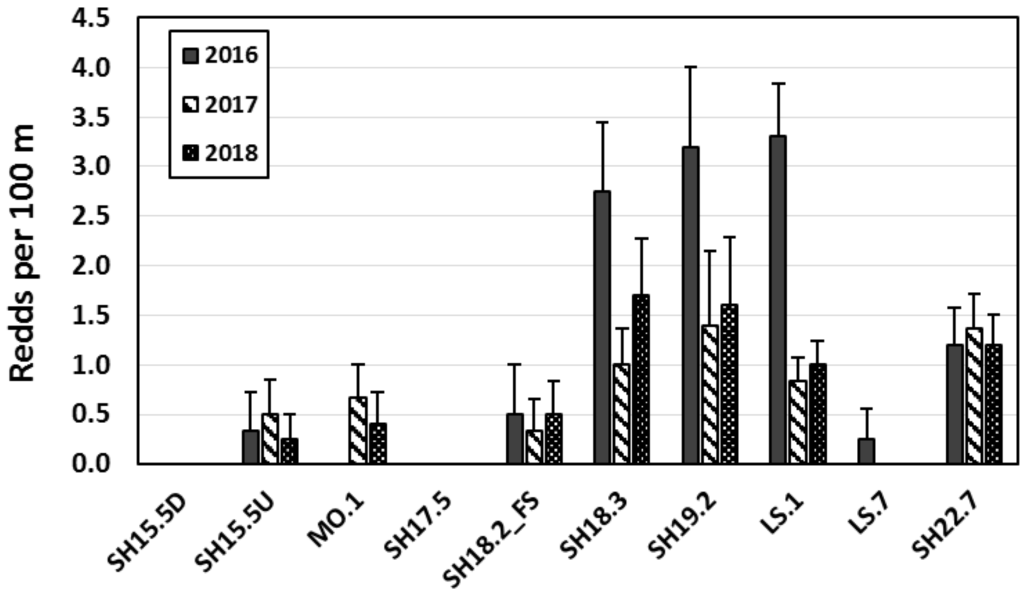
N W E S

0 1,000 2,000
Feet

FILE: M:\Clients\M-O\MTDEQ\BlackBute_Copper_ArcGIS\2018\06\BBC_Aquatics_Figure_BBC_Aquatics_2018counts.mxd | REVISED: 09/06/2019 | SCALE: 1:24,000 when printed at 11x17

DRAWN BY: SDB

Brook trout redds were identified in areas with lower stream velocity and smaller substrate sizes and averaged 3.3 and 0.25 per 100 meters in 2016 at Little Sheep Creek LS.1 and LS.6, respectively (see **Figure 3.16-10**). In 2017, brook trout redds at LS.1 were less than 1/3 those densities and no redds were observed in LS.6 (see **Figure 3.16-10**). Redd counts of Moose Creek were added in 2017 and contained brook trout redds at densities of 0.67 per 100 meters (see **Figure 3.16-7**).



Source: Stagliano 2019

Notes:
[a] Sites are arranged from further downstream to upstream of the Project area.
[b] Number of redds includes brook, brown, and rainbow trout.

Figure 3.16-10
Average Number of Redds per 100 Meters within the Project Area

3.16.2.4. Freshwater Mussel Surveys

During the 2014 and 2016 surveys of Sheep Creek, Little Sheep Creek, and Tenderfoot Creek reaches, no evidence of the western pearlshell mussel was reported. As stated in Section 3.16.2.1, Aquatic Special Status Species, this species is considered extirpated in the Smith River basin (Stagliano 2018a). No further analysis will be done for this species in this EIS.

3.16.2.5. Macroinvertebrate Communities

The 2014 to 2018 aquatic baseline surveys reported 146 macroinvertebrate taxa in the assessment area. No Montana invertebrate SOCs were collected. Average macroinvertebrate richness across all sites over the 4 years surveyed was 50 taxa, while Ephemeroptera (mayflies), Plecoptera (stoneflies), and Trichoptera (caddisflies) (EPT) taxa averaged 20 per site. The highest taxa richness (64 species) was reported at SH18.3 (in 2016), while SH15.5US had the highest number of combined EPT (30 species in 2016). The results of the baseline analysis indicate that habitats for macroinvertebrate assemblages at the SH22.7 Sheep Creek study sites are comparable to the reference condition mountain stream (Tenderfoot Creek) as the percent of EPT taxa (% EPT) at SH22.7 was similar to the Tenderfoot Creek sites. However, the SH19.2 Sheep Creek and LS.6 Little Sheep Creek control sites reported much lower macroinvertebrate MMI scores than the Tenderfoot Creek reference sites (see **Table 3.16-6**).

Streamflow inputs from Sheep Creek and other tributaries in the use-permit canyon affect the Smith River water quantity, quality, and temperatures. Increased densities and diversity of insect communities, especially EPT taxa, have been documented in the Smith River below the tributaries. The Smith River downstream of the Sheep Creek confluence maintains a more cool-water macroinvertebrate community because of the colder water influx. Smith River sites upstream of the Sheep Creek confluence reported lower diversity, biological integrity, and sensitivity of macroinvertebrates than downstream of the confluence (Stagliano 2018b).

Smith River macroinvertebrate data were collected from upstream and downstream of Sheep Creek in 2016 and 2017 (Stagliano 2018b) and in lower Sheep Creek (RM 0.1) in 2018 (Stagliano 2019). In 2016, Smith River locations SM_US and SM_DS reported 20 and 23 EPT, respectively. The 2016 to 2017 cumulative EPT richness for SM_DS was 32 species, which was the second highest reported of all sites in the UMOWA study. The highest average densities were documented in the Smith River downstream of the confluence with Sheep Creek (15,260 individuals per square meter at SM_DS) in 2016. These are high densities of macroinvertebrates, rivaling nutrient-rich aquatic environments, such as spring creeks or the Missouri River below Holter Dam (Stagliano 2017d). In 2016, the macroinvertebrate densities averaged 3,442 individuals per square meter in Sheep Creek approximately 16 miles upstream from the Smith River (see **Table 3.16-6** and **Figure 3.16-1**). Macroinvertebrate abundance at SM_DS was lower in 2017 and 2018 than in 2016; this may correspond to the higher stream flows in 2017 and 2018. The lower abundance, combined with lower total taxa richness and EPT taxa, has decreased these metrics to below the optimal levels (see **Figure 3.16-11**) (Stagliano 2019).

Tenderfoot Creek reported the highest integrity scores ranked by the DEQ MMI (averages above 70 all 4 years), while the Sheep Creek sites averaged 63.2, 63, 61.5 and 57.4 in 2014, 2016, 2017, and 2018, respectively, which is ranked slightly impaired by DEQ thresholds (impairment threshold of the Low Valley MMI is 63) (Stagliano 2018a). Both Little Sheep Creek sites, Sheep Creek SH19.2, and Coon Creek were ranked impaired by the DEQ MMI with scores below 63 in all years of the baseline studies. DEQ MMI scores from the Hess samples were typically lower than reach-wide samples, exceptions being the impact sites SH15.5U/S and 15.5D/S in 2016/2017 and LS.1 in 2018 (see **Figure 3.16-12**) (Stagliano 2019).

The HBI scores across all sites averaged 4.1, 3.4, 3.6, and 3.9 in 2014, 2016, 2017, and 2018, respectively. These scores are slightly impaired for mountain streams (>3 to 4), indicating probable nutrient, sedimentation, or other organic impairment to all sites (Stagliano 2018a; Stagliano 2019; DEQ 2016; DEQ 2012). However, from 2014 to 2017, the HBI scores have decreased at four sites, including SH17.5, SH22.7, TN9.3, TN9.4, and a steady improvement at site SH19.2 (see **Figure 3.16-13**). Little Sheep Creek sites LS.1 and LS.6 were the only sites reporting moderate organic pollution with HBI scores of greater than 4 during three of the surveys (2014, 2017, and 2018) (see **Figure 3.16-13**). Annual average stream flows for Sheep Creek have been declining since the high flows of 2014 (see **Table 3.16-2**) (Stagliano 2018a), and this could be contributing to organic impairments.

Low numbers of the mayfly family, Heptageniidae, were present across the Sheep Creek sites between 2014 and 2018. Tenderfoot Creek TN9.3 and Little Sheep LS.1 reported the highest percentages of Heptageniidae in 2017 (see **Figure 3.16-13**). One of the factors that influence the absence or decreased abundance of Heptageniidae has been shown to be a measure of a community's sensitivity to heavy metal impacts (Winner et al. 1980; Clements 1991; Nelson and Roline 1993), since these taxa are considered the most sensitive to metals.

Table 3.16-6 contains macroinvertebrate metrics that were scored using the DEQ bioassessment criteria, and each sample was categorized as impaired or non-impaired according to threshold values (Stagliano 2019); these values are described in the table notes below.

Table 3.16-6
Macroinvertebrate Sample Characteristics and Metrics

Site RM Code	Date Collected	Ind/m^2	Mtn MMI Index [a]	Total Taxa [b]	EPT Taxa [c]	% EPT [d]	% Hept [e]	% NonIns [f]	HBI [g]
SH22.7	7/6–7/9 2018	3,320	69.2	57	24.2	**65.3**	**4.0**	8.2	3.2
SH19.2	7/6–7/9 2018	15,910	**48.9**	48	**17.8**	**43.4**	**0.8**	3.3	**4.0**
	Control avg.	9,615	59.1	52.5	21.0	54.3	2.4	5.7	3.6
SH17.5	7/6–7/9 2018	5,673	**45.7**	42	**16.7**	**32.4**	**1.4**	3.0	3.8
SH18.3	7/6–7/9 2018	4,776	**51.7**	46	21.4	**34.0**	**1.2**	2.4	**4.1**
SH15.5DS	7/6–7/9 2018	2,857	**62.4**	55	22.0	**59.3**	**0.9**	2.8	3.4
SH15.5US	7/6–7/9 2018	4,290	63.6	52	**18.5**	**40.9**	**1.1**	6.0	3.6
SH0.1	7/6–7/9 2018	3,340	63.8	43	24.6	**61.2**	**3.2**	2.0	3.6
	Impact avg.	4,187	57.4	47.6	20.6	45.6	1.6	3.3	3.7
TN9.3	7/6–7/9 2018	950	64.3	52	21.3	**67.3**	**4.3**	0.5	3.4
TN9.4	7/6–7/9 2018	1,110	73.2	50	22.0	70.0	**4.1**	0.3	3.2
	Reference avg.	1,030	68.7	51.0	21.6	68.6	4.2	0.4	3.3
LS0.1	7/6–7/9 2018	4,880	**42.4**	44	**11.0**	**17.0**	**1.8**	**22.8**	**5.1**
LS0.6	7/6–7/9 2018	1,008	**37.2**	43	**9.0**	**9.4**	**0.0**	**48.2**	**6.5**
	avg.	2,944	39.8	43.5	10.0	13.2	0.9	35.5	5.8
C0.5	7/6–7/9 2018	2,040	**43.3**	**39**	**12.0**	**22.9**	**0.8**	**13.4**	**4.1**
SH22.7	7/19–7/20 2017	2,392	64.6	57	29	**56.7**	**0.3**	5.0	3.0
SH19.2	7/19–7/20 2017	2,216	**55.1**	42	**17**	**42.4**	**<0.1**	1.6	3.5
	Control avg.	2,304	59.9	49.5	23.0	49.6	0.2	3.3	3.3
SH17.5	7/19-7/20 2017	4,288	**60.7**	42	21	**64.0**	**0.9**	2.6	3.0
SH18.3	7/19-7/20 2017	2,364	**61.9**	46	22	**47.2**	**1.0**	0.5	3.7
SH15.5DS	7/19-7/20 2017	3,256	65.1	47	27	**52.4**	**0.7**	1.0	3.7

Site RM Code	Date Collected	Ind/m²	Mtn MMI Index [a]	Total Taxa [b]	EPT Taxa [c]	% EPT [d]	% Hept [e]	% NonIns [f]	HBI [g]
SH15.5US	7/19-7/20 2017	4,808	**58.2**	55	22	**62.1**	**0.5**	2.0	3.4
	Impact avg.	3,679	61.5	47.5	23.0	56.4	0.8	1.5	3.5
TN9.3	7/19-7/20 2017	3,880	67.5	47	25	**51.4**	5.5	0.0	2.9
TN9.4	7/19-7/20 2017	3,515	72.8	48	23	**55.0**	5.1	0.1	2.8
	Reference avg.	3,698	70.1	47.5	24.0	53.2	5.3	0.1	2.9
LS0.1	7/19-7/20 2017	4,080	**47.4**	53	22	**37.6**	14.9	**18.1**	**4.5**
LS0.6	7/19-7/20 2017	1,152	**30.1**	45	**11**	**22.0**	**0.2**	**47.0**	**5.2**
	avg.	2,616	38.8	49.0	16.5	29.8	7.6	32.5	4.9
C0.5	7/19-7/20 2017	1,412	**56.0**	**39**	**14.0**	**47.6**	**0.0**	4.3	3.5
SH22.7	7/12/2016	5,632	70.1	59	27	**63.6**	**0.6**	0.6	2.8
SH19.2	7/12/2016	3,940	**53.7**	**35**	**16**	**36.8**	**0.0**	1.3	3.8
	Control avg.	4,786	61.9	47.0	21.5	50.2	0.3	0.9	3.3
SH17.5	7/14/2016	4,335	65.5	58	29	**65.2**	**0.4**	2.3	2.8
SH18.3	7/11/2016	4,630	**60.8**	64	24	**25.5**	**0.3**	4.1	**4.3**
SH15.5DS	7/12/2016	2,760	65.8	55	23	**53.9**	**0.3**	4.8	3.2
SH15.5US	7/12/2016	2,044	**65.8**	45	30	**51.6**	**0.6**	0.9	3.2
	Impact avg.	3,442	63.0	55.5	26.5	49.1	0.4	3.0	3.4
TN9.3	7/12/2016	2,224	68.1	46	24	**67.7**	**0.4**	0.2	3.2
TN9.4	7/12/2016	2,515	72.8	42	22	**62.6**	**0.6**	0.3	3.0
	Reference avg.	2,369.5	70.4	44.0	23	65.2	0.5	0.3	3.1
LS0.1	7/11/2016	2,612	**61.1**	45	21	**52.7**	**1.4**	5.2	3.1
LS0.6	7/12/2016	1,136	**39.7**	**29**	**9**	**9.9**	**0.0**	9.9	3.7
	avg.	1,874	50.4	37.0	15	31.3	0.7	7.5	3.4
C0.5	7/12/2016	1,992	**51.0**	**35**	**12**	**15.5**	**0.4**	3.4	3.9
SH22.7	8/15/2014	3,260	63.3	47	**19**	**60.0**	**0.0**	3.4	3.4
SH19.2	8/16/2014	3,158	**55.8**	**39**	**16**	**26.9**	**0.3**	0.5	3.9
	Control avg.	3,209	59.5	43.0	17.5	43.5	0.2	2.0	3.7
SH17.5	8/16/2014	2,952	63.7	44	21	**48.8**	**0.0**	1.9	**4.0**
SH18.3	8/16/2014	5,872	**62.7**	60	21	**47.0**	**0.3**	3.1	3.8
	Impact avg.	4,412	63.2	52.0	21	47.9	0.2	2.5	3.9
TN9.3	8/16/2014	6,080	68.6	53	23	**33.8**	**0.3**	1.1	**4.7**
TN9.4	8/16/2014	7,424	71.4	43	22	**48.4**	**0.5**	1.0	3.6
	avg.	6,752.0	70.0	48.0	22.5	41.1	0.4	1.1	4.1
LS0.1	8/16/2014	3,040	**39.7**	**35**	**9**	**12.1**	**1.3**	9.8	**4.9**
LS0.6	8/15/2014	1,132	**46.9**	**37**	**10**	**24.7**	**0.5**	**19.4**	**4.7**
	avg.	2,086.0	43.3	36.0	10	18.4	0.9	14.6	4.8
C0.5	7/8/2015	2,520	**48.5**	**36**	**14**	**35.5**	**0.0**	**17.0**	3.4

Source: Stagliano 2015, 2017b, 2019, 2020

avg. = average; EPT = Ephemeroptera (mayflies), Plecoptera (stoneflies), and Trichoptera (caddisflies), see note d; Hept = Heptageniidae (mayflies); HBI = Hilsenhoff Biotic Index, see note g; Ind/m^2 = individuals per square meter; MMI = multi-metric indices; Mtn = mountain; NonIns = non-insects; RM = river mile

Notes:

[a] The impairment threshold set by DEQ is 63 for the Mountain Stream Index, thus any scores above this threshold are considered unimpaired (DEQ 2017b). Values below this threshold (impaired) are bold and underlined.

[b] The impairment threshold for total taxa is 40, thus any scores below this threshold are impaired and bold and underlined.

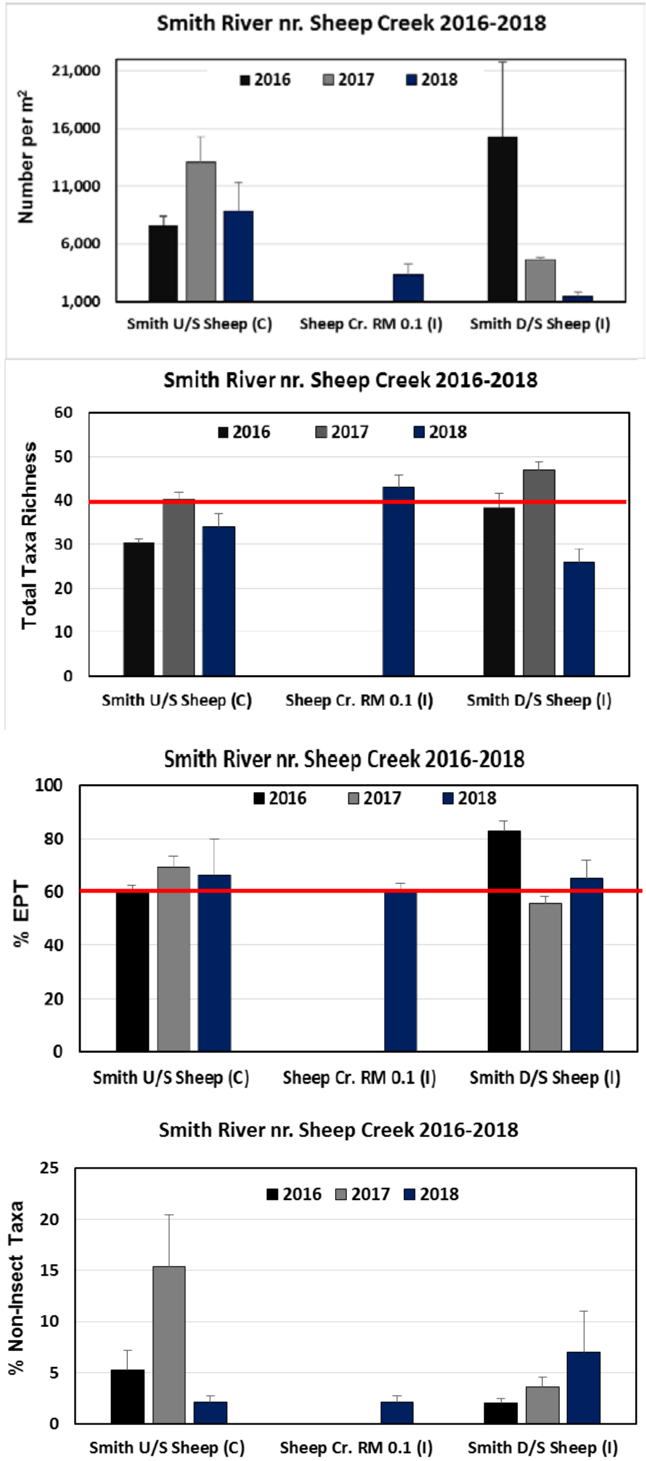
[c] The impairment threshold for EPT taxa is 20, thus any scores below this threshold are impaired and bold and underlined.

[d] % EPT indicates the percentage of mayflies, stoneflies, and caddisflies within the macroinvertebrate sample. High EPT percentages of the population typically indicate that degraded habitat conditions are not present, and scores above 70 percent are considered healthy communities. Thus, any scores below 70 percent are not considered healthy and are bold and underlined.

[e] % Hept indicates the average percentage of Heptageniidae per macroinvertebrate sample. Scores above 5 percent indicate healthy mountain stream communities. Thus, any scores below 5 percent are not considered healthy and are bold and underlined.

[f] % NonIns indicates the average percentage of non-insects per macroinvertebrate sample. Scores above 10 percent are considered impaired mountain stream communities, and are bold and underlined.

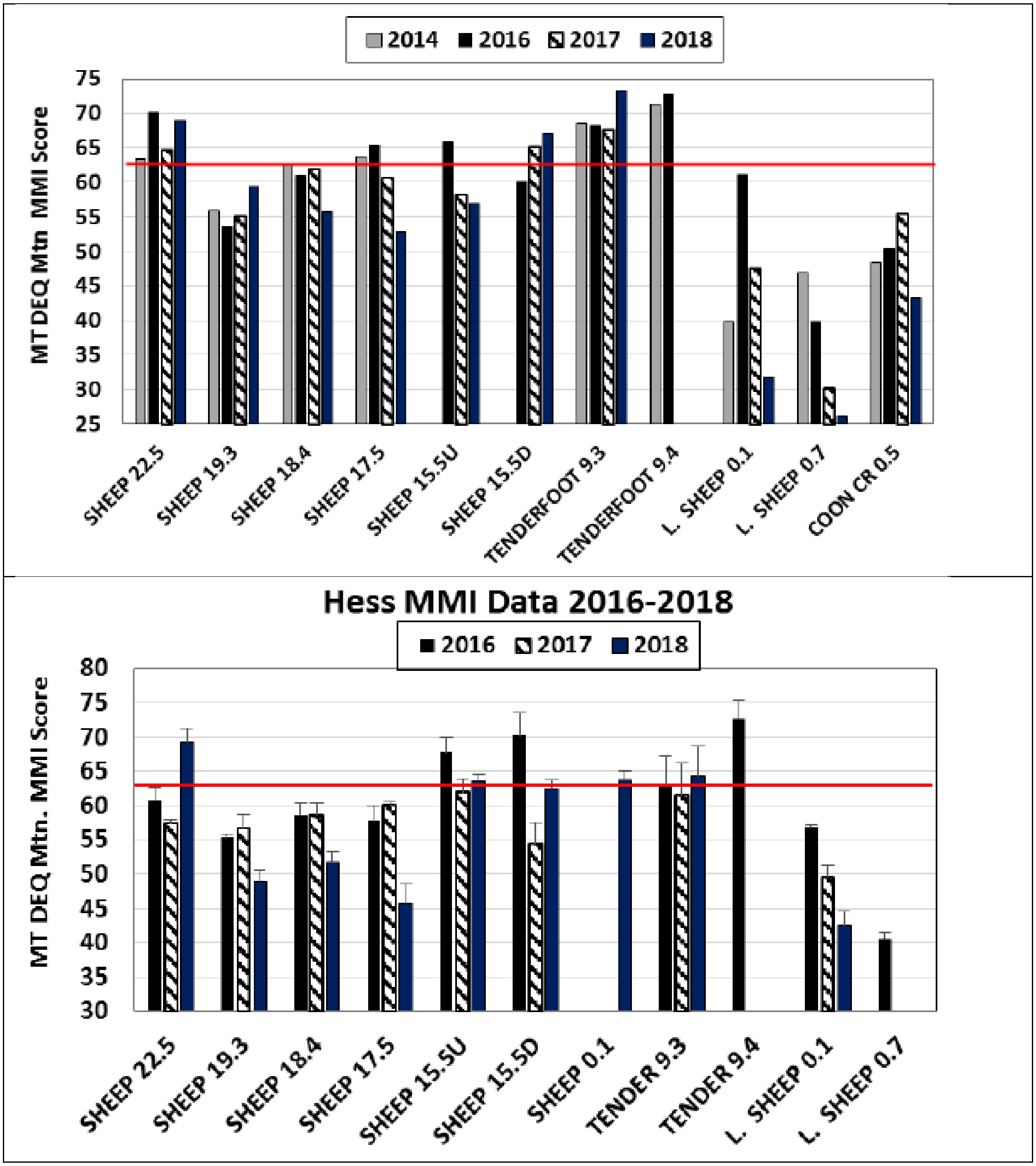
[g] HBI is the measure of macroinvertebrate assemblage's tolerance toward organic (nutrient) enrichment. HBI tolerance values are based on a 0 to 10 scale, where 0-ranked taxa are most sensitive and 10-ranked taxa are most tolerant to pollutants. HBI values of 0 to 3.0 in mountain streams indicate no organic pollution (excellent conditions), and values of 3.0 to 4.0 indicate slight organic pollution (very good). Scores above 4.0 are considered moderately impaired communities and are bolded and underlined.



Source: Stagliano 2019

C = Control; I = Impact
Notes: Macroinvertebrate metrics calculated from Hess samples. Values above red line are optimal.

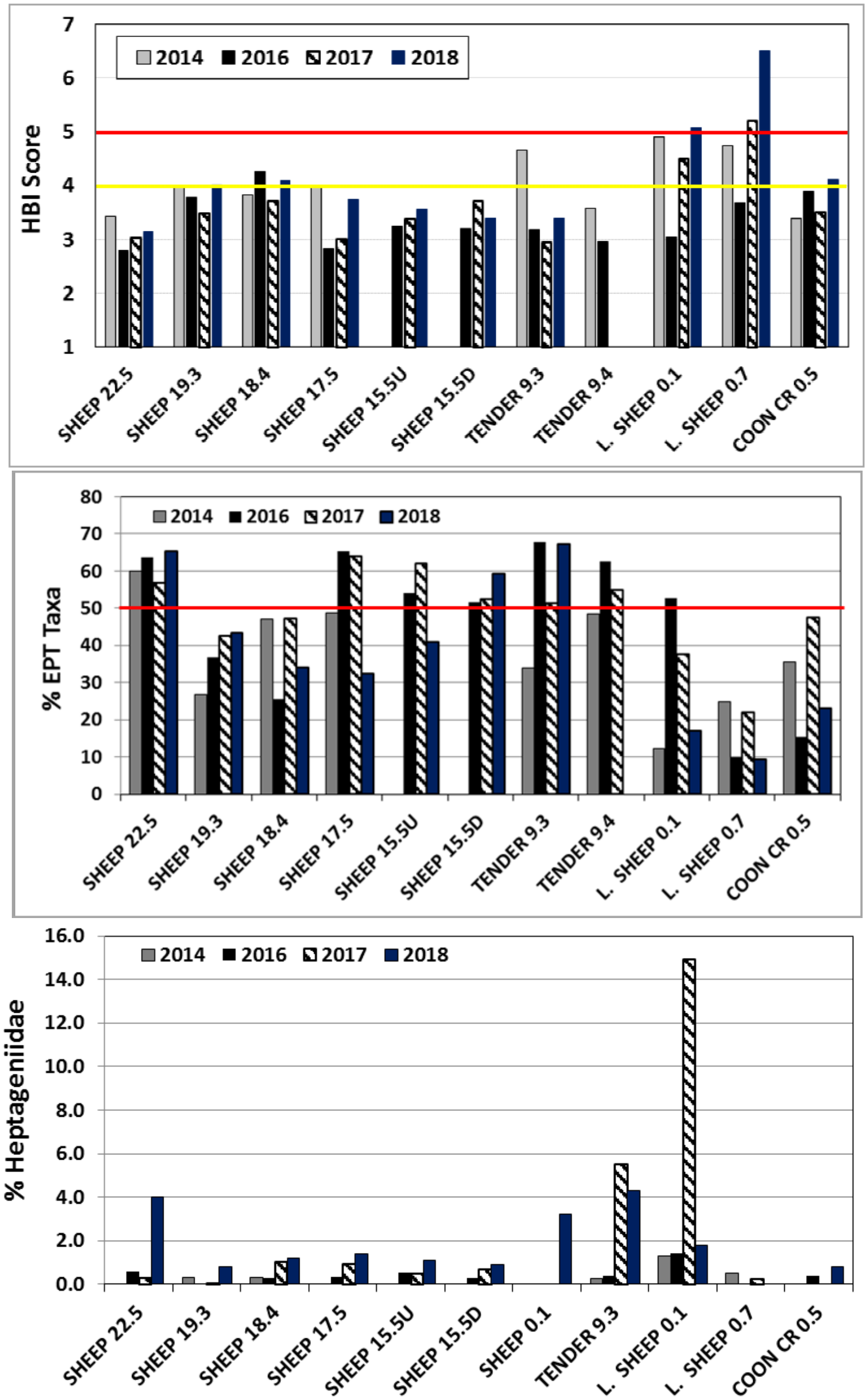
Figure 3.16-11
Macroinvertebrate Metrics in the Smith River Upstream to Downstream of Sheep Creek



Source: Stagliano 2019

MMI = multi-metric indices; Mtn = mountain
Notes: Red line represents the impairment threshold (63), below this indicates impairment.

Figure 3.16-12
Macroinvertebrate Reach-wide (top) and Hess (bottom) DEQ Mountain MMI Scores Upstream to Downstream



Source: Stagliano 2019

Notes:
[a] Red to yellow lines bracket the moderate organic impairment range (4.0 to 5.0); below 4.0 indicates slight impairment.
[b] Monitoring location SH19.2 is mislabeled as SH19.3 on the figure above from Stagliano 2019.

Figure 3.16-13
Macroinvertebrate Metrics in the Project Area Arranged Upstream to Downstream

Chlorophyll-*a* levels from Sheep and Moose Creek sites sampled by DEQ in 2015 were well below the nuisance levels of 150 milligrams per square meter (mg/m^2) with the highest value in the assessment area recorded at SH17.5 (65.2 mg/m^2) (see **Table 3.16-7**). In 2017, underwater photographs of the substrate were taken instead of collecting chlorophyll-*a* samples since benthic algal levels reported during the previous years were low (<50 mg/m^2, one-third the nuisance level of 150 mg/m^2) at all transects of the stream reaches (Stagliano 2018a). In August 2018, chlorophyll-*a* levels were sampled in Sheep Creek sites upstream (C) and downstream (I) of the Project area by the Montana Biological Survey. Although only the weighted average at the upstream control site (SH22.7) exceeded the threshold level (120 mg/m^2), chlorophyll-*a* levels exceeded the nuisance levels of 150 mg/m^2 at two transects of the site (see **Table 3.16-8**). In addition, other impact transects downstream of the Project area, SH18.3 and SH17.5, also exhibited levels above the threshold (Stagliano 2019).

Table 3.16-7
Chlorophyll-*a* Levels Reported from 2015

Site RM Code (BACI Type)	Collection Date	Chlorophyll-*a* densities (mg/m^2)
SH15.5U (I)	8/19/2015	23.5
SH17.5 (I)	8/19/2015	65.2
SH18.3 (I)	8/19/2015	31.4
Moose 0.5 (R)	8/19/2015	53.7

Source: Stagliano 2019

BACI = Before, After, Control (upstream and offsite reference), and Impact (within and downstream); I = impact; mg/m^2 = milligrams per square meter; R = reference; RM = river mile
Note: Levels reported using the weighted average for 11 transect templates.

Table 3.16-8
Chlorophyll-*a* Levels Reported from 2018

Site RM Code (BACI Type)	Collection Date	Transect 1 Chl-*a* densities (mg/m^2)	Transect 2 Chl-*a* densities (mg/m^2)	Transect 3 Chl-*a* densities (mg/m^2)	Transect 4 Chl-*a* densities (mg/m^2)	Transect 5 Chl-*a* densities (mg/m^2)	Average Chl-*a* densities (mg/m^2)
SH22.7 (C)	8/22/2018	75.6	<u>132.5</u>	95.8	<u>157.0</u>	<u>161.6</u>	<u>124.5</u>
SH19.2 (C)	8/22/2018	102.1	54.8	<u>122.6</u>	95.7	<u>148.2</u>	104.7
SH18.3 (I)	8/22/2018	68.5	<u>135.3</u>	47.7	110.8	49.0	82.3
SH17.5 (I)	8/22/2018	<u>130.0</u>	107.0	91.4	118.4	NR	111.7
SH15.5U (I)	8/22/2018	58.6	53.8	110.8	78.6	96.8	79.7

Source: Stagliano 2019

BACI = Before, After, Control (upstream and offsite reference), and Impact (within and downstream); C= Control; Chl-*a* = Chlorophyll-*a*; I = impact; mg/m^2 = milligrams per square meter; RM = river mile
Note: Underlined values are above the threshold levels.

3.16.2.6. Periphyton Communities

The 2016 to 2018 aquatic baseline surveys reported 167 unique diatom and algae taxa from the 38 periphyton assessment samples collected in the assessment area. The average periphyton richness per site in both 2016 and 2017 was 68.6 taxa, which is approximately10 taxa higher than in 2014 (57 taxa). Sheep Creek survey location SH19.2 reported the highest periphyton taxa richness (86 species in 2016), while Little Sheep Creek LS.1 reported the lowest (43 species in 2017) (see **Table 3.16-9**). Abundant filamentous algae outbreaks were visually observed at the lower Sheep Creek sites (SH15.5U and SH15.5D) in 2015 and 2016, but not in 2017. The outbreaks were confirmed with *Cladophora* being the dominant periphyton taxa at both sites in 2016 (Stagliano 2018a).

While the CWA and subsequent regulations set forth national goals and minimum standards for ambient water quality, individual states have the responsibility to monitor water quality and to set and enforce standards. The trophic diatom index (TDI) is a relatively new index that was developed to monitor the trophic status of waterways. Biocriteria are particularly useful for assessing impairment from sediment and nutrients. Teply and Bahls (2006) developed biocriteria for using the composition and structure of periphyton communities to assess biological integrity and impairment of aquatic life in Montana streams specific to USEPA Ecoregion 17 (Middle Rockies). The study classified impaired streams as those where aquatic life use support was listed as partial or none and where the cause of impairment was sediment, nutrients, or metals. Nonimpaired streams were classified as those where support for aquatic life use was full or where the cause of impairment was other than sediment, nutrients, or metals (Teply and Bahls 2006). The 50 percent probability of impairment occurs at about 17.9 percent relative abundance of an increaser taxa; this is the threshold for sediment impairment reported by Teply (2010).

Based on Teply's interpretation of the TDI (2010), Sheep Creek site SH17.5 had the highest probability (61 percent) of sediment impairment in 2014; however, in 2017 this probability was reduced to 28 percent. The 2016 and 2017 analyses reported that Sheep Creek site SH18.3 had the highest probability of impairment (82 percent) followed by the Sheep Creek site SH19.2 at 62 percent (see **Table 3.16-9** and **Figure 3.16-14**). Based on the index, other Sheep Creek and Little Sheep Creek sites were below the impairment threshold (50 percent probability of impairment) and were less likely to be impaired. During all 4 years, the Tenderfoot Creek sites were the least likely to be impaired; however, the dominance of *Nostoc* indicates there is likely some nutrient loading from cattle use in the watershed.

Table 3.16-9
Periphyton Sample Metrics

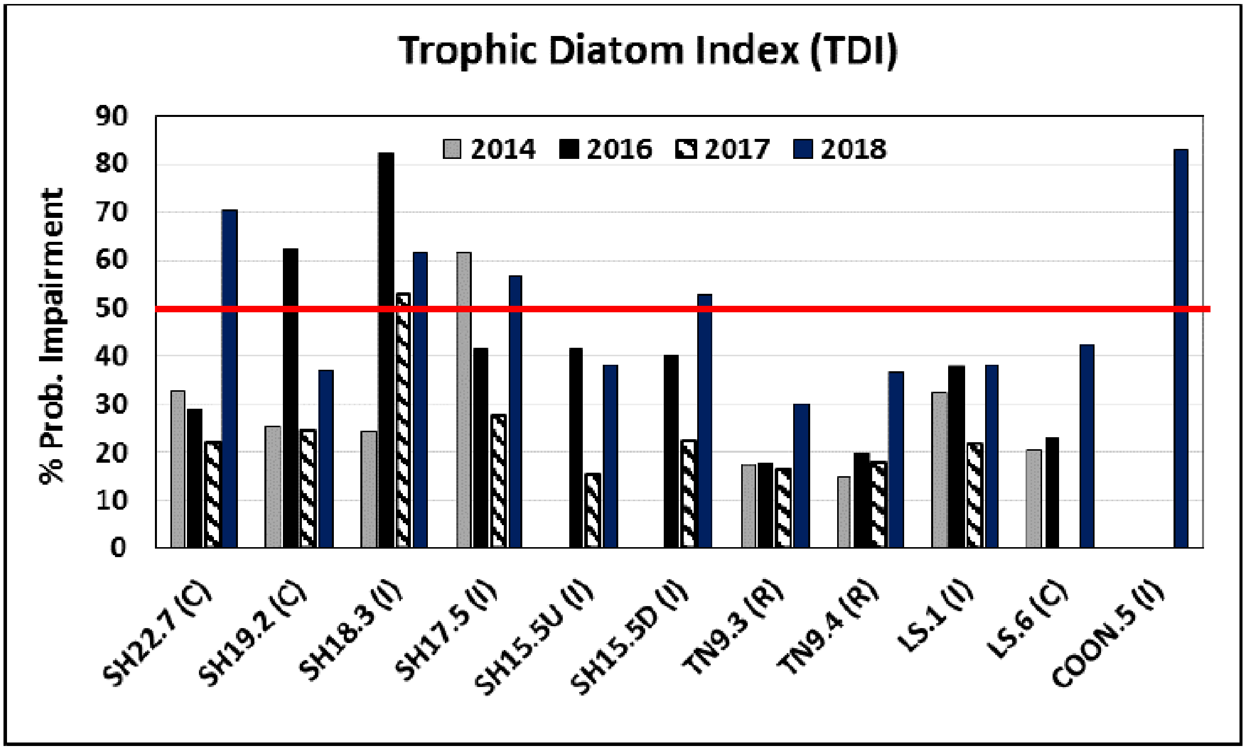
Site RM Code (BACI Type)	2014			2016			2017			2014		2016		2017	
	Total Taxa	% RA	% PI [a]	Total Taxa	% RA	% PI [a]	Total Taxa	% RA	% PI [a]	Dominant Taxa 1	Dominant Taxa 2	Dominant Taxa 1	Dominant Taxa 2	Dominant Taxa 1	Dominant Taxa 2
SH22.7 (C)	68	9.8	33	44	8.4	29	59	5.6	22	Diatoms	*Draparnaldia*	*Tolypothrix*	Diatoms	*Calothrix*	Diatoms
SH19.2 (C)	71	6.9	25	86	19.6	62	54	6.5	24	*Cladophora*	*Tolypothrix*	Diatoms	*Phormidium*	*Phormidium*	Diatoms
SH18.3 (I)	57	6.5	24	82	27.5	82	69	16.7	53	Diatoms	*Homeothrix*	Diatoms	*Phormidium*	*Phormidium*	Diatoms
SH17.5 (I)	62	19.3	61	57	12.8	41	53	7.9	28	Diatoms	*Cladophora*	Diatoms	*Phormidium*	*Closteridium*	Diatoms
SH15.5U (I)	NR	NR	NR	82	12.7	41	55	2.4	15	NR	NR	*Cladophora*	Diatoms	Diatoms	*Nostoc*
SH15.5D (I)	NR	NR	NR	84	12.1	40	63	5.7	22	NR	NR	*Cladophora*	Diatoms	Diatoms	*Nostoc*
TN9.3 (R)	44	3.3	18	61	3.4	18	43	2.7	16	Diatoms	*Zygnema*	Diatoms	*Nostoc*	Diatoms	*Nostoc*
TN9.4 (R)	42	2.0	15	60	4.3	20	48	3.5	18	Diatoms	*Zygnema*	Diatoms	*Nostoc*	*Nostoc*	Diatoms
LS.1 (I)	53	9.6	32	56	11.7	38	41	5.4	22	*Spirogyra*	Diatoms	Diatoms	*Phormidium*	*Phormidium*	Diatoms
LS.6 (C)	59	4.8	20	74	5.9	23	NR	NR	NR	Diatoms	*Anabaena*	Diatoms	*Cladophora*	NR	NR

Source: Stagliano 2015, 2018a

% PI = percent probability of impairment; % RA = percent relative abundance of dominant taxa; BACI = Before, After, Control (upstream and offsite reference), and Impact (within and downstream); C = control; I = impact; NR = not reported; R = reference; RM = river mile

Note:

[a] Probable impairment values greater than 50 percent and based on the trophic diatom index (TDI) are underlined.



Source: Stagliano 2019

C = control site; I = impact site; R = reference site
Note: Above red line indicates impairment (50 percent probability of impairment).

Figure 3.16-14
TDI Calculated from the Peri-MOD Samples Arranged Upstream to Downstream

3.16.3. Environmental Consequences

This section describes the potential impacts of the Project on aquatic biological resources. Impacts on aquatic resources would be associated with potential impacts on groundwater and surface water as described in Sections 3.4, Groundwater Hydrology, and 3.5, Surface Water Hydrology, respectively. Water quantity, local stream habitat, and water quality have the potential to affect fish, mussels, amphibians, and other aquatic organisms because of their dependence on the aquatic environment. Impacts previously described in those sections are not repeated in detail here except to explain how changes would potentially affect aquatic resources.

3.16.3.1. No Action Alternative

Under the No Action Alternative, the Project as described in Section 2.2, Proposed Action, would not occur. No underground mine or associated infrastructure would be built. The No Action Alternative (or No Mine Alternative) would not change the existing landscape or result in changes to groundwater or surface water hydrology. The No Action Alternative would not alter baseline conditions discussed in Section 3.16.2, Affected Environment, and the existing land uses of cattle ranching, hay production, and recreational use (i.e., hunting and fishing) would continue to occur.

3.16.3.2. Proposed Action

This section describes the potential environmental consequences of the Proposed Action to aquatic resources, including the potential direct and secondary impacts.

Stream Crossings and Sedimentation

The Proposed Action would disturb 0.84 acre of wetlands and 1,551 feet of streams during construction. The only impact on riparian wetland Waters of the United States would be from the mine access road crossings of Brush Creek and Little Sheep Creek. The sites for the two stream crossings were selected specifically to minimize impacts on wetlands, which also minimizes impacts on aquatic life that use that habitat since wetlands provide them with food, shelter, and nursery areas. At each creek crossing, a 9.8-foot-diameter, bottomless pipe arch, and two 5.9-foot-diameter, round culverts would be installed, one on each side of the bottomless pipe arch. In general, stream crossings are designed using structures capable of passing mean annual flood discharge without compromising existing channel width. The use of a bottomless pipe arch would preserve the natural creek substrate as the streambed would not be disturbed. The MOP Application stated that any storm flow not accommodated by the stream crossing would potentially overtop or damage the road requiring occasional repairs.

Along the roadway, drainage control would be established. To control erosion, cut and fill slopes and culverts would be installed as necessary. Revegetation of the cut and fill slopes would occur as soon as practicable (Tintina 2017). The two stream crossings would permanently alter two wetlands, Brush Creek and Little Sheep Creek. The eastern crossing would affect 0.05 acre of riparian wetlands (W-LS-05) and 85 feet of Little Sheep Creek (S-LS-O4). The western crossing would affect 0.05 acre of wetlands (W-LST1-02) and 69 feet of the Brush Creek tributary to Little Sheep Creek (S-LST-001). Construction of the stream crossings would potentially introduce sediment into the two creeks and could impact fish that are resident or spawn in the area, particularly brook trout, which were identified during fall surveys as having redds in the lower stream velocity area of Little Sheep Creek. If redd quality is reduced due to sedimentation, the mortality rates of the fish eggs may be affected.

Increased sedimentation may also result in changes to the benthic invertebrate community. Suspended sediments affect benthic invertebrates through abrasive action of particles, interference in food gathering, and clogging of respiratory surfaces, all of which may induce organisms to drift downstream. Species type, richness, and diversity may change as excess sediment inputs convert the dominant substrate from larger sizes (pebbles, cobble) to small particles (sand, silt, clay). Aquatic communities that were dominated by EPT taxa may become dominated by burrowing invertebrates such as segmented worms (Oligochaeta) and midges (Chironomidae) as a result of sedimentation (Herbst et al. 2011). These changes would have cascading impacts on the food web, particularly for fish.

Erosion control methods and BMPs, such as silt fencing, sediment traps, vegetation management and revegetation, and rolled erosion control products, would be implemented during the construction, operations, and closure phases. These methods and BMPs would minimize the potential for negative impacts on stream habitat and aquatic life from introduced sediment from increased turbidity and deposition. During construction, silt fencing would be used and maintained to control sediment from disturbed areas and natural drainage patterns would be retained whenever possible. During construction and operations, reclamation efforts would take place to stabilize disturbed areas on a simultaneous schedule. At the end of mine life, permanent reclamation and closure would occur.

The main access road to the mine site (including bridges), construction access roads, and service access roads to various facilities on private property would not be open to the public. They would either be completely reclaimed or left open with a reduced footprint at the landowner's request. Disturbed areas within the Project area would either be reclaimed or recontoured to premining topography and revegetated, in accordance with § 82-4-336, MCA. Impacts on aquatic habitat from soil erosion or sedimentation from culvert installations, any storm events that overtop the road, or culvert removals in closure, would be short term, would be fairly likely to occur, and could be reduced by limiting or avoiding in-stream construction activities during fall spawning when redds are likely to be found nearby. Based on these factors, the impacts on aquatic life from the stream crossings would be minor with the use of BMPs, such as appropriate soil erosion and sediment controls during road construction and maintenance activities.

Changes in Water Quantity (Streamflow)

Section 3.4, Groundwater Hydrology, and Section 3.5, Surface Water Hydrology, describe the impacts the Proposed Action would have on water quantity in the nearby creeks. Model simulations show no measurable change in streamflow to Moose Creek. However, the model predicts that Coon Creek (defined as AES type D001-Headwater Stream system) would be reduced by approximately 70 percent of the steady state base flow observed in the stream (0.2 cfs at the confluence with Sheep Creek) during operations due to mine dewatering (see Section 3.4, Groundwater Hydrology, and Section 3.5, Surface Water Hydrology). To mitigate this predicted impact, water from the NCWR would be pumped into the headwaters of Coon Creek to augment flows within 15 percent of the average monthly flow (Hydrometrics, Inc. 2018c).

As previously stated, Coon Creek is often fully diverted during the irrigation season and frozen during the winter months; therefore, it does not provide ideal fish habitat. After baseline surveys in 2015, it was determined to be fishless upstream of the county road near SW3; however, near its confluence with Sheep Creek, Coon Creek provides a refuge for young-of-the-year brown trout (Tintina 2017). Other aquatic life was documented in Coon Creek during the baseline surveys. Coon Creek was sampled for macroinvertebrates and determined to have an MMI score below the threshold of 63 set by DEQ, which is indicative of an impaired waterbody (see **Table 3.16-5**) (DEQ 2012). The total reduction in Coon Creek from mine dewatering is estimated at approximately 70 percent of the steady state base flow observed in the stream. This 70 percent reduction is considered a conservative estimate, as there is evidence that the headwaters of that creek are not connected to the deeper bedrock system subject to dewatering (Hydrometrics, Inc. 2016, 2018c).

The depletion of base flow from mine dewatering in other creeks near the Project area is estimated to be much smaller or not detectable. Reduction in Black Butte Creek would be approximately 0.1 cfs, or 3 to 4 percent of the steady-state base flow (3.2 cfs) in the stream, while reduction of base flow in the Sheep Creek SW-1 station would be on the order of 2 percent, or approximately 0.35 cfs from the 15.3 cfs steady state base flow at this station. This reduction in Sheep Creek would be comparable in magnitude to the Project's estimated consumptive water use (210 gpm) (Hydrometrics, Inc. 2016). The water discharged to the environment via the UIG within the alluvial plain of Sheep Creek would offset the surface water flow reduction from mine dewatering above the consumptive use rate. The water infiltration would commence before the cone of depression from mine dewatering and the associated reduction of creek base flow would reach its maximum extent.

The Proponent plans to augment flows to the surface water system with water stored in the NCWR, should impacts on wetlands or streams develop over the relatively short period of mining (13 years). After the mine ceases its production and dewatering, groundwater levels would start recovering, with water levels in wells completed in Ynl A recovering to within 1 to 2 feet of the premining simulation after 3 to 4 years post-mining. The analysis showed similar results in wells completed in the USZ and UCZ. The model simulations indicated that the Project would not result in any long-term residual impacts regarding groundwater levels and base flows in creeks (see Section 3.4, Groundwater Hydrology). Based on these factors, the changes in water quantity would have a minor impact on aquatic life in the area with most of the impacts limited to the aquatic life in Coon Creek, including the young-of-the-year brown trout that are known to take refuge near the Coon Creek confluence with Sheep Creek (Tintina 2017). Changes in water quantity may cause some aquatic biota to move to areas with more favorable habitat conditions.

Non-Contact Water Reservoir's Wet Well and Pipeline

The purpose of the design and operation of the NCWR is to address depletion of surface water flow in the affected watersheds associated with consumptive use of groundwater during operations. The conceptual plan (pending review and approval from the DNRC) outlines that water to fill the NCWR could be pumped from a diversion point based on existing leased water rights along Sheep Creek. Existing surface water rights would allow the NCWR to be filled during the 5-month irrigation period of the year. The NCWR would be filled using a wet well with the diversion point approximately 60 feet west of the private road in the hay meadow adjacent to Sheep Creek, depicted on **Figure 2.2-1** (Hydrometrics, Inc. 2018a).

The diversion point would consist of a wet well with an 8-foot concrete manhole connecting to Sheep Creek through a 22-inch HDPE DR 21 intake pipe. The intake pipe would extend approximately 6.5 feet into Sheep Creek placed on the streambed. The pipe would be equipped with a fish screen over the intake section. The remainder of the intake pipeline would be solid pipe buried beneath the ground surface at an elevation equal to or slightly below the streambed elevation. Water from the wet well would be pumped to the NCWR when flow in Sheep Creek exceeds 84 cfs.

Potential impacts due to the diversion of stream flow to fill the NCWR would be nominal, as the majority of the diversion would occur via a new water right limited to May through July and only when stream flow is in excess of all existing water rights and instream flow requirements (see Section 3.5.3.1, Surface Water Quantity). Therefore, impacts on aquatic biota due to changes in water quantity from the water diversion are not anticipated. However, aquatic biota would be impacted during the intake pipe installation, which would have short-term impacts likely to affect aquatic biota, including increased turbidity and sedimentation near the installation, degraded water quality, and substrate alteration. Longer-term impacts from the installation could potentially include changes in the substrate and sediments, habitat quality, and hydrology (Johnson et al. 2008). The NCWR would be used for mitigation of depletion in surface waters during operations and for approximately 20 years after the end of mine dewatering (Hydrometrics, Inc. 2018a). Once the flow mitigation system is unnecessary, the wet well, intake pipeline, and transfer pipeline to the NCWR would be removed and reclaimed. Reclamation would include removal of all non-native materials (pipelines, concrete structure, and fill material). Excavations would be filled with sand and gravel material to within 1 foot below grade (Tintina 2018b). Reclamation activities would have short-term impacts on aquatic biota similar to construction impacts, including increased turbidity near the intake pipe removal, degraded water quality, and substrate alteration. Following reclamation activities, the aquatic habitat should gradually recover until it is similar to pre-construction activities.

Even with fish screens, water intake structures could result in adverse impacts on aquatic resources by entrainment and impingement of fishes and invertebrates; alteration of natural flow rates; degradation of downstream shoreline and riparian habitats during construction and potentially longer, depending on if or how water flow rates and direction is modified by the intake structure; and potential alteration of aquatic community structure and diversity as a result of the aforementioned impacts over time by adding another source of mortality to the early life-stage, which affects recruitment and year-class strength. Water diversion projects are known to cause injury and mortality when organisms too large to pass through screening devices become stuck or impinged against the screen and as a result, increased predation may occur near intake pipes. Eggs and larval stages of aquatic organisms are more susceptible to injury and mortality from intake pipes (Johnson et al. 2008). It is generally assumed that for an aquatic organism to enter an intake structure, it must (1) be within the area where the structure influences the stream flow, (2) not receive a cue to trigger an avoidance response, and (3) be unable to swim faster than the intake velocity (Taft et al. 2007).

Changes in Water Quality

The Proposed Action would affect surface water quality in the Project area during mine construction and operations either directly through surface water runoff or secondarily through water discharged via the UIG. Based on the small percentage of disturbed area, changes in surface runoff would not be expected to have an adverse impact on surface water quality to Sheep Creek. However, the smaller drainages in the immediate Project vicinity, including Brush Creek, Coon Creek, and Little Sheep Creek, would potentially be affected by surface runoff, but impacts on water quality would not extend outside the immediate area (see Section 3.5, Surface Water Hydrology). This may cause some aquatic biota, such as fish, to move to areas with more favorable habitat conditions. As stated above, erosion control methods and BMPs would be implemented during the construction, operations, and closure phases, minimizing impacts on aquatic life. Therefore, impacts on aquatic organisms from surface runoff would be minor.

There could potentially be secondary Project impacts on the water quality of Sheep Creek. Water from the facilities would be collected and treated by the reverse osmosis treatment plant prior to discharge via the alluvial UIG in non-wetland areas beneath the floodplain of Sheep Creek southwest of Strawberry Butte. No impacts on Sheep Creek water quality are anticipated during the construction and operations phases since modeling has shown that the solute concentrations of infiltrated water would be low and meet both the surface and groundwater non-degradation standards prior to discharge to the alluvial UIG (see Section 3.4, Groundwater Hydrology, and Section 3.5, Surface Water Hydrology).

The quality of the groundwater reporting to Sheep Creek would be the same if not better than baseline conditions (see Section 3.4, Groundwater Hydrology, and Section 3.5, Surface Water Hydrology). However, groundwater from the underground workings would not be treated after the final closure (i.e., once non-degradation criteria are met). At least 2 to 4 years after the end of operations, up to an estimated ten rinsing cycles of the underground workings are proposed to ensure that water quality meets the groundwater non-degradation criteria. Groundwater quality modeling showed that after the post-closure rinsing, only thallium would be dissolved in contact groundwater (i.e., water within flooded underground mine workings) at concentrations exceeding DEQ Groundwater Standards by a factor of two. However, thallium would be at concentrations below the estimated groundwater non-degradation criteria (Enviromin 2017, see Table 4-5) (see Section 3.4, Groundwater Hydrology; Section 3.5, Surface Water Hydrology; and the MOP Application Section 4.2.3.1, Underground Mine).

As stated in Section 3.4.3.2, Post-closure Groundwater Quality, the combined flow rate of potential chemical sources (i.e., contact groundwater) from the Proposed Action is expected to be less than about 3 gpm. Referring to **Figure 3.4-8**, the groundwater flow rate in Ynl A within the mine area is estimated to be about 90 gpm. If 3 gpm of contact groundwater were to completely mix with Ynl A groundwater, and the Ynl A water does not have significant concentrations of the same solutes found in the contact groundwater, one would expect a 30:1 dilution of the solutes existing in the contact groundwater.

Affected water in the Ynl A would eventually flow into the Sheep Creek alluvium, which has an estimated groundwater flow rate of 200 gpm. Complete mixing of the chemical source water with the alluvial groundwater would be expected to dilute the original COCs by a factor of 67.

The alluvial groundwater eventually becomes groundwater discharge to Sheep Creek, which has a minimum flow rate of 6,700 gpm. Complete mixing of the chemical source water with Sheep Creek surface water would dilute the original COC concentrations by a factor of 2,200 or more.

Regardless of the above dilution analysis, all parameters in underground mine water post-closure are predicted to remain within non-degradation limits (i.e., comparable to existing groundwater quality). Therefore, water of similar quality already flows from the aquifer to adjacent streams and no changes to surface water quality are projected.

While the above statements are based on general index values, they provide evidence that chemically affected water from the mine workings or surface facilities (if any) is unlikely to cause significant impacts on ambient groundwater in the Ynl A, Sheep Creek Alluvium, or Sheep Creek surface water. Given the large mixing and retardation factors, concentrations would most likely be decreased to below the standards far before discharging to Sheep Creek.

Any elevation in nitrate in surface waters in the Project area may cause more blooms of nuisance algae, which can reduce water quality for other aquatic organisms, and may adversely affect fish or other aquatic life. These impacts would be limited to the immediate area near the source and most mobile aquatic life would move to areas with more favorable habitat conditions. Less mobile aquatic organisms could experience minor impacts in the short term. As a part of the MPDES permitting process it was identified that during maximum discharge to the UIG the concentration of total nitrogen in the ditched portion of Coon Creek and Sheep Creek may exceed the non-degradation criteria. To avoid such exceedances, a Treated Water Storage Pond (TWSP) would be in place to store Water Treatment Plant (WTP) effluent during periods when total nitrogen exceeds effluent limits, which is applicable from July 1 to September 30. Treated water from the WTP would be pumped through a 6-inch diameter HDPE pipeline to the TWSP. During the rest of the calendar year, water stored in the TWSP would be pumped back to the WTP via a 6-inch diameter HDPE pipeline, where it would be mixed with the WTP effluent and allow for the blended water to be sampled prior to being discharged per the MPDES permit (Zieg 2018). Based on the surface water quality changes that could potentially affect aquatic biota in the Project Area, overall impacts on aquatic organisms from potential pollutants in the discharge water would be minor.

Thermal Impacts

As part of mine operations, the Proponent anticipates discharging water seasonally from the WTP and/or TWSP via the UIG, which would discharge to the alluvial groundwater system associated with Sheep Creek prior to the water entering Sheep Creek itself. The discharge would be governed by an MPDES permit. Therefore, the Proponent has developed predictions regarding potential thermal effects resulting from the UIG discharge on Sheep Creek. Montana administrative rules applicable to B1 classified streams such as Sheep Creek restrict temperature changes to a 1 °F maximum increase above naturally occurring water temperatures, and a 2 °F decrease below naturally occurring water temperatures. A summary of conservative thermal analyses conducted by the Proponent indicating the absence of significant temperature effects on creeks is outlined in detail in Section 3.5.3.2, Surface Water Quality and Temperature (Water Temperature Thermal Analysis Methods and Results). The WTP discharge point would be sampled for water quality, including temperature. In addition, temperature would be monitored during the spring, summer, and fall at all surface water and aquatic monitoring stations.

Water stored in the NCWR would be allowed to seep from the reservoir floor to the downstream catchment to offset a portion of mine site consumptive use of groundwater. Analyses indicate that the seepage rate is expected to vary seasonally between 5 and 26 gpm (Zieg 2019). The predicted rate of seepage from the NCWR is not of sufficient volume to fully drain the reservoir within a single year. Therefore, both a floating pump system and a system that pumps from the reservoir bottom would be in place to dewater the NCWR. This would allow water to be discharged at a suitable rate to offset the mine site's consumptive use on a monthly basis.

Results of the thermal analyses indicate that water temperature in the NCWR would be greater than in Sheep Creek during the following 5 months: May (Mean Creek temperature 41.6 °F vs. NCWR water temperature 41.8 °F), June (Mean Creek temperature 49.6 °F vs. NCWR water temperature 49.7 °F), August (Mean Creek temperature 53.2 °F vs. NCWR water temperature 54.7 °F), September (Mean Creek temperature 46.9 °F vs. NCWR water temperature 51.9 °F) and October (Mean Creek temperature 39.7 °F vs. NCWR water temperature 51 °F). Of these 5 months, the Proponent only proposes to transfer water from the NCWR to Sheep Creek via the wet well during the month of October. Planned discharges to Sheep Creek via the wet well during October are estimated to represent a 1 to 2 percent increase in stream flow as measured at SW-1. Therefore, effects on stream temperatures during October are expected to be less than the 1 degree change allowed for per ARM 17.30.623(2)(e). Direct discharges from the NCWR to Sheep Creek during May to September are not proposed. Seepage from the reservoir (estimated to range from 22 to 26 gpm during summer months) would migrate to Little Sheep Creek via subsurface (groundwater) flow and is expected to equilibrate with ground temperatures prior to entering surface water; therefore, this seepage is not expected to have a detectable influence on the creek's water temperature. Water transfers from the NCWR to Coon Creek and Black Butte Creek are expected to equilibrate with groundwater temperatures as a result of (1) flow through buried pipelines, and (2) equilibration with subsurface temperatures following discharge to UIGs (Zieg 2019). Per the discussion above, discharge of water from the NCWR into the environment would not cause an increase in the creeks' water temperature, and impacts on aquatic life are not anticipated. If stream flow were to be augmented via direct discharge from the NCWR, the temperature would be monitored, and discharges limited as necessary to prevent impacts to aquatic life.

Studies have shown that heat can be used as a natural tracer of groundwater movement near streams (Constantz 2008), so any change in the groundwater temperature could also result in stream temperature changes near the Project, which would be observed during monitoring. Any change in surface water temperature could result in residual impacts to the resident fish species or other aquatic life, as well as those fish species or other aquatic life that migrate to the Project area or immediately below. As noted above for elevated levels of nitrates, an extended elevation in water temperature may indirectly cause blooms of nuisance algae, which can reduce water quality in the Project area and result in low dissolved oxygen and corresponding impacts on fish. Abundant filamentous algae outbreaks have already been observed at the lower Sheep Creek sites (SH15.5U and SH15.5D) and confirmed with *Cladophora* being the dominant periphyton taxa at both sites in 2016. Temperature is one of the factors that limits *Cladophora* growth. Impacts on aquatic habitat from thermal impacts related to discharge of water to the UIG would be of medium duration and have a low likelihood of occurring. This means the impacts on aquatic life from thermal impacts would be minor.

Required Monitoring

Adequate monitoring is necessary to verify whether the required mitigations are effective or ineffective in reducing environmental impacts to acceptable levels. Aquatic monitoring is outlined in the "Final Aquatic Monitoring Plan for the Black Butte Copper Project in Upper Sheep Creek Basin in Meagher County, Montana" (Stagliano 2017c), which is a finalized version of the Draft Plan of Study included as Appendix G-1 (Stagliano 2017e) of the MOP Application (Tintina 2017). Monitoring would occur annually at 15 established sites, including five stations on Sheep Creek and one each on Little Sheep and Coon creeks that are within or downstream of the Project disturbance boundary lines (see **Figure 3.16-1, Table 3.16-1**, and **Table 3.16-10**). Two sites on the Smith River, upstream and downstream of the Sheep Creek confluence (see **Figure 3.16-1**), would be quantitatively sampled for macroinvertebrates to detect any future changes in these communities during Project operations; these sites have previously been sampled in 2016 and 2017 by the UMOWA (Stagliano 2017d).

Table 3.16-10
Summary of Annual Aquatic Monitoring

Survey Type	Sampling Activity	Season Performed			Monitoring Locations (see Figure 3.16-1 and Table 3.16-1)
		Spring	Summer	Fall	
Habitat Survey	Channel bed morphology and fish habitat survey		X		All aquatic sampling locations, except C.5, SH.1, and Smith River sites
Substrate Analysis	Substrate size distribution, surface fines, benthic sediment		X		Conducted at Sheep Creek impact sites and control site SH19.3
Fish	Population sampling		X		All aquatic sampling locations, except C.5, SH.1, and Smith River sites
	Tissue analysis - metals		X		Aquatic sampling locations SH22.7, SH18.3, SH17.5, SH15.5, and LS.1
	Redd counts	X		X	Conducted only on Sheep Creek, Little Sheep Creek, Moose Creek
Macroinvertebrates	Hess sample		X		All aquatic sampling locations, except C.5
	Reach-wide dipnet		X		All aquatic sampling locations
Periphyton	Chlorophyll-*a* and Peri-Mod1		X		All aquatic sampling locations, except C.5, SH.1, and Smith River sites
Water Quality	Air & H_2O temperature (°C) pH, TDS, conductivity	X	X	X	All aquatic sampling locations, except C.5, SH.1, and Smith River sites and only in summer

Source: Stagliano 2017c

Two Sheep Creek stations and one Little Sheep Creek station are upstream of potential impacts from the Project and would serve as control stations. Two Tenderfoot Creek stations and a Moose Creek station are outside the Project sub-basin and would serve as reference control streams (see **Figure 3.16-1** and **Table 3.16-1**). Results would be compared to the cumulative monitoring record. Monitoring methods to detect potential impacts are described in Stagliano (2017c).

Assessment of impacts would be based on data collected before, during, and after mine construction and operations by comparison to two reference reaches in Tenderfoot Creek and one reference reach in Moose Creek, and comparison to DEQ biotic indices for similar streams in Montana. The objective of the biological monitoring plan is to confirm that aquatic beneficial uses and fisheries are being protected in the Sheep Creek drainage during construction, operations, and closure. Surface water quality samples, temperature, and discharge data would be collected adjacent to four of the aquatic biological monitoring plan stations during the biological monitoring plan sample periods (within 5 days), to provide information for the interpretation of the biological data. Fisheries population surveys, habitat assessments, macroinvertebrate and periphyton sampling, and redd counts would be conducted to support the biological monitoring plan and provide the field data necessary to assess the influence of the Proposed Action on stream biota. Redd counts for fall-spawning brown and brook trout and spring-spawning rainbow trout would be completed for all Sheep and Little Sheep Creek reaches. Fish tissue and sediments would be analyzed for metal concentrations (Stagliano 2017c).

Smith River Assessment

The Smith River is located approximately 19 river miles downstream of the Project and is the receiving water for Sheep Creek. As discussed in Section 3.4, Groundwater Hydrology, and Section 3.5, Surface Water Hydrology, significant impacts are not expected on surface water quantity or water quality in Sheep Creek, or the receiving waters of the Smith River, due to the Proposed Action. **Figure 3.4-8** (Section 3.4, Groundwater Hydrology) provides an indication of the magnitude of mixing the contact water with other waters (the rates of groundwater flow within the mine footprint: 0.4 gpm contact water, 90 gpm shallow bedrock groundwater, 200 gpm alluvial aquifer groundwater, and 6,700 gpm Sheep Creek base flow). Given the large mixing and retardation factors, analyte concentrations would most likely be decreased to below the standards before discharging to Sheep Creek and are unlikely to contribute to water quality impairments currently observed in the Smith River. Therefore, the Project would not likely have any direct or secondary impacts on aquatic life in the Smith River. However, as stated above in Section 3.16.2.3, Fish Communities, studies have confirmed that trout from the Smith River basin migrate to Sheep Creek where some of the trout from the Smith River spawn (Grisak 2012 and 2013; Grisak et al. 2012). These studies did not track any fish to the Project area, but did track several trout to the confluence of Sheep Creek and Moose Creek approximately 2 miles downstream from the Project area.

In 2016, four tagged mountain whitefish were documented during the baseline surveys in the Project area at Sheep Creek sites SH19.2 and SH18.3. Any fish or other aquatic species that travel into the Project area from the Smith River would be affected by the Proposed Action as described in Section 3.16.3.2, Proposed Action. Specifically, fish that migrate into the Project area could be affected by changes in water quality or quantity. These impacts may be limited to the immediate area near the source and the fish would move to areas with more favorable habitat conditions. Construction of the stream crossings for the access roads would potentially introduce sediment into Brush Creek and Little Sheep Creek and could affect fish that spawn in the area. If redds fill in due to sedimentation, the mortality rates of the fish eggs would increase.

As stated in Section 3.16.3.2, Proposed Action, impacts on aquatic habitat from the Proposed Action would likely be short term, have a medium likelihood of occurring, and could be reduced by limiting in-stream construction activities during the fall when spawning occurs and redds are likely to be found nearby. Based on these factors, the impacts on Smith River aquatic life that migrates into the Project area would be minor with the use of BMPs and appropriate soil erosion and sediment controls.

As stated in Section 3.16.3.2, in the Required Monitoring section, two sites on the Smith River (one upstream and one downstream of the Sheep Creek confluence) (see **Figure 3.16-1**), would be quantitatively sampled for macroinvertebrates to detect any future changes in these communities during Project operations; these sites were previously sampled in 2016 and 2017 by the UMOWA (Stagliano 2017d). In addition, all salmonids captured during the monitoring surveys in Sheep Creek (SH15.5, SH17.5, SH18.3, SH19.2, SH22.7), Little Sheep Creek (LS.1 and LS.6), Moose Creek (M.1), and Tenderfoot Creek (TN9.3 and TN9.4) would be scanned to document fish that may have been tagged in the Montana State University and Montana FWP fish movement study on the Smith River.

3.16.3.3. Agency Modified Alternative

The modifications identified in the AMA would result in impacts similar to those described for the Proposed Action Alternative. Modifications to the Proposed Action include an additional backfill of mine workings component. This project alternative proposes to backfill additional mine workings with a low hydraulic conductivity material consisting of cemented paste tailings generated from mill processing of the stockpiled ore and/or waste rock at the end of operations. This would help prevent air and groundwater flow within certain mine workings, preventing further surface oxidation and potential groundwater contamination. Impacts of the underground mine facilities on surface water quality during post-closure under the AMA would be less than expected under the Proposed Action. Therefore, impacts on aquatic biota under the AMA due to changes in water quality would be reduced with the use of required BMPs and appropriate soil erosion and sediment controls, such as silt fencing, sediment traps, vegetation management and revegetation, and rolled erosion control products (Tintina 2017).

Smith River Assessment

The AMA modifications would result in impacts on aquatic biota in the Smith River similar to those described for the Proposed Action. Therefore, impacts on Smith River aquatic life that migrate into the Project area from the AMA would be minor with the use of required BMPs and appropriate soil erosion and sediment controls.