CHAPTER IX

FISH AND AQUATIC RESOURCES

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1.0 INTRODUCTION

During the summer and early fall of 1988, Dames & Moore conducted an aquatic baseline survey of Moose and Buffalo creeks. The purpose of this survey was to develop a data baseline, which could be used for evaluating potential impacts from the construction and operation of the Wishbone Hill Coal Development Project. Baseline data, that were identified as necessary by the ADF&G, were collected concerning fish habitat, water quality, juvenile fish distribution and abundance, spawner escapement, and benthic invertebrates. This report describes the results of these surveys and includes supplemental information from the ADF&G.

In late September and early October, 2008, WHPacific conducted another aquatic biological resources study on Moose and Buffalo creeks. This study attempted to replicate the surveys and protocols that were implemented in 1988 and were conducted to provide comparative long term monitoring data. The report that was completed for this study is contained in Addendum 1.

A technical report was completed by WHPacific in November 2009 that provided environmental background of the Wishbone Hill Resource Area and the specific Moose Creek and Buffalo Mine Creek study area. A copy of the WHPacific report dated November 23, 2009 is contained in Addendum 2.

A discharge measurement and fish sampling study was completed for Buffalo Creek by WHPacific in July 2012. WHPacific concluded in their study that in general spawning habitat for large salmonids is limited in Buffalo Creek. Sediment particle size in much of the lower stream segments (between the bluff and Moose Creek) is small with sand and silt dominating. Upstream of the bluff the particle size significantly increases, but water flows are diminished, suitable depth for spawning is absent, and several large natural barriers are found impeding potential upstream movement by fish. Potential rearing habitat for juvenile salmon occurs only below the relict beaver dam on lower Buffalo Creek. A copy of the WHPacific Technical Memorandum of the study dated August 16, 2012 is contained in Addendum 3.

A synopsis of the fisheries resource changes since the 2008 stream restorations work on Moose Creek was provided by ADF&G on February 7, 2013. The ADF&G synopsis was received in an email on February 7, 2013 from Samuel Ivey, Area Management Biologist, Northern & West Cook Inlet, ADF&G Sport Fish Division. The synopsis is contained in Addendum 4.

2.0 METHODS

2.1 Survey Design

This survey was designed to obtain baseline data of the aquatic environment and to establish a network of sample stations, which could be used to monitor aquatic conditions over the life of the coal development project. In order to accomplish this goal, a reconnaissance survey was conducted during June 22 to 24 and a systematic survey was conducted during September 19 to 23, 1988. Information gathered during the reconnaissance survey was used to determine sample locations and to plan the sample methods used for the systematic survey. Data gathered during the reconnaissance survey were also used to describe the general habitat characteristics and fish species distribution within Moose and Buffalo Creeks.

Five sample stations were selected for the systematic survey and future aquatic monitoring program (Figure 1 and Plate IX-1). One station was located downstream of the project area at river mile (RM) 0.8 in order to provide a site for detecting the downstream extent of potential impacts from the project. This site was also chosen because it is the only station, among the five stations, that is accessible to anadromous salmonids. Station two is representative of aquatic conditions in the lower end of the project area (i.e., RM 3.9) and is influenced by activities in upper Moose Creek and Buffalo Creek. Station three is representative of the upper portion of the project area (i.e.,RM 4.9) but exclusive of any potential impacts in Buffalo Creek. Station four is located upstream of the project area (i.e., RM 6.8) in order to provide a record of environmental conditions that cannot be influenced by any potential impacts from the project. Station five is located near the mouth of Buffalo Creek in order to provide a measure of aquatic conditions in the only stream which will be temporarily altered by the proposed project.

2.2 Fish Habitat

Fish habitat was characterized by measurements of stream width, depth, gradient, substrate composition, substrate embeddeness, and photographs. These data were collected at each of the five stations during the September field survey. Gradient, spawning habitat and substrate composition data were also collected along 19 segments of Moose Creek (Figure 1 and Plate IX-1) during the June reconnaissance survey.

2.2.1 Width, Depth, and Gradient

Stream width and depth were measured along transects located at 30-foot intervals within a 240 to 300-foot long stream reach at each sample station. Width measurements were taken at the water's edge and depth was measured at 3- to 5-foot intervals, depending on stream width in each transect. Mean width, mean depth, and surface area of the sample reach were computed from these data. Stream discharge was also computed from measurements of depth and velocity along one transect at each station. Stream gradient was measured with a hand-held clinometer.

2.2.2 Substrate Size Composition

Substrate size composition was visually determined for each 3- to 5-foot interval along each transect. Size composition was partitioned according to the following size categories:

Size (Inches)	Description	Code
< ¼	Silt and Sand	1
¼ - 3	Gravel	2
3 – 6	Small Cobble	3
6 – 12	Large Cobble	4
12	Boulder	5
---	Log, Roots, & Stems	6

Estimates of substrate size composition were coded according to the percentage composition of the two most dominant size fractions. For example, an area composed of 70 percent gravel and 30 percent small cobbles is coded as 23.7. The first number is the code for the most dominant size fraction, the second number is the code for the second most dominant size fraction, and the decimal indicates the percentage composition of the most dominant size fraction.

Substrate size composition results are plotted in a bar graph according to the relative occurrence of each size category within a sample reach. The percentage composition of each size category were summed for all observations and each sum was normalized to a scale of 0 to 1.

2.2.3 Substrate Embeddedness

Embeddedness is a measure of how much of the surface area of the larger size particles is covered by fine sediment (i.e., particles <1/8 inch). It was determined from visual estimates taken at each 3- to 5-foot interval along each transect. Estimates were assigned to one category of five potential embeddedness rating categories. The categories are an index of the percentage of the substrate covered by sediment: <5 percent, 5 to 25 percent, 25 to 50 percent, 50 to 75 percent, and >75 percent (Armour et al. 1983). The results are expressed as the frequency of observations within each embeddedness category.

2.3 Fish Inventory

2.3.1 Fish Distribution and Relative Abundance

Fish distribution and relative abundance were determined from reconnaissance surveys conducted during June and September, and from a population inventory conducted during September. A backpack electroshocker was used to sample fish habitat during all surveys. During the June reconnaissance survey, a field crew walked Moose Creek from the Glenn Highway bridge to the Premier Creek bridge (RM 3.8) and walked Buffalo Creek from the mouth to Wishbone Lake. During the September survey, the field crew conducted a second survey of Buffalo Creek from the mouth to the base of the bluffs. Stream pools, side channels, and backwaters were sampled to determine species occurrence and distribution. Fish captured during these surveys were counted, identified, and released alive.

The population inventory was conducted in the 240- to 300-foot long reaches at the five sample stations. Two or three passes through a reach were made with the electroshocker in orderto remove as many salmonids as possible. Non-salmonids (e.g., sculpins) were not included in the population inventory. All captured fish were held alive in 5-gallon buckets. Fish were returned to the stream after being anesthetized, identified, and fork length measured.

Fish population estimates were determined by either the removal method (Armour et al.1983) or by summing the catches from each pass with the electroshocker. The latter method was only used when the catch data failed to meet the declining catch assumption of the removal method. Population estimates and 95 percent confidence intervals were calculated for each species and species size/age group. Species size/age groups were determined from length frequency analysis. Fish densities (number/square yard) were determined from the population data and stream surface

area.

2.3.2 Spawner Surveys

Adult spawner surveys were conducted for chinook salmon by ADF&G and for coho salmon by Dames & Moore. The ADF&G has conducted annual spawner surveys for chinook salmon in Moose Creek since 1970. These surveys are conducted on foot from the stream mouth to the Premier Creek bridge (Figure 1). ADF&G normally does not conduct coho surveys. Therefore, Dames & Moore conducted two surveys (i.e., 9/26 and 10/10/88) of Moose Creek from the Glenn Highway bridge to the Premier Creek Bridge.

2.4 Benthic Invertebrates

Benthic invertebrate sampling was conducted with a Hess-type sampler fitted with a 504-micron net and plankton cup. Three replicate samples were collected from gravel and cobble substrate areas at each of the sample stations. Samples were collected by embedding the sampler 5 cm into the substrate. All large rocks within the sample area (i.e., 1,000 square cm) were individually cleaned with a scrub brush and were removed from the sample area. Then, the substrate inside the sampler was disturbed to a depth of approximately 10 centimeters using a large screw driver. The sampler was removed from the water and all material was washed from the net into a one-pint jar and preserved with 75 percent denatured ethanol (ETOH).

Benthic invertebrate samples were analyzed at the Dames & Moore laboratory in Seattle. Samples were washed into a white enamel tray to dislodge organisms from the substrate and debris. The decant water and floating organic material was poured through a 500-micron sieve to concentrate the sample. The residue in the enamel tray was inspected under an illuminated magnifier and any remaining organisms (e.g., Tricoptera) were removed. Samples were sorted into taxonomic orders under a dissecting microscope. Counts and wet weights were recorded for each taxonomic group. After processing, the organisms were placed into a labeled vial with 70 percent ETOH and were returned to McKinley Mining Consultants for storage. Subsamples of 1/8 to 1/2 were taken from some samples that were too large for processing in an efficient manner. Counts and weights of these samples were adjusted to a whole sample by the appropriate multiplication factor.

2.5 Water Quality

Water quality was determined at the five sample stations during June and September. Parameters measured in-situ were: dissolved oxygen with a YSI Model 518 D.O. meter; conductivity and temperature with a YSI Model 33 S-C-T meter; and pH with an Orion Research Model SA 230 pH meter. A 2-liter water sample was also collected for the analysis of total suspended solids. These samples were analyzed by Northern Testing Laboratory in Anchorage.

3.0 RESULTS AND DISCUSSION

3.1 Reconnaissance Survey

3.1.1 Moose Creek

On June 23, a reconnaissance survey of Moose Creek was conducted from the Glenn Highway Bridge upstream to the bridge near Premier Creek. The measured streamflow was 261 cfs and the stream level was just below bankfull. Many side channels and backwater areas were connected to the main channel. The survey was conducted only along the western edge of the channel because the high flow prevented the survey crew from crossing the stream. Water clarity was good as the stream bottom was visible in all but the deepest pools.

Habitat in Moose Creek is characteristically composed of long cascading reaches separated by relatively short glide type pools. Stream gradient averages 3 percent and ranged 2 to 4 percent (Table 1). Stream substrate was composed predominantly of large cobble (6 to 12 inches) with small cobble (3 to 6 inches), and boulders (>12 inches) being subdominant. Salmon spawning habitat (i.e., 0.5 to 5 inch gravel) was not abundant and generally occurred in small patches at the tailout of pools. Most of the spawning habitat occurred in stream segments 8 to 13 (Table 1). Rearing habitat was predominantly composed of small pocket water areas created by the abundance of large cobble and boulders along the stream margin. Habitat associated with large woody debris was rare. The stream banks were mostly non-erosive and were composed of rocks or bedrocks. Several exposed cutbanks were observed and one large landslide was noted along segment 11. This landslide is a large source of sediment and spawning gravel for the stream. The riparian environment was mostly composed of alder, willow, cottonwood, and aspen. A 10-foot waterfalls (measured from water surface to water surface) was identified at R.M. 3.2. This waterfalls had no

obstruction at the top and dropped vertically into a pool, which was 3 to 5 feet deep.

Juvenile and adult salmon were observed during the survey. Juvenile coho (35 to 42 mm) occurred along the stream margins, in backwaters, and side-channels. One side-channel in stream segment 12 had a school of at least 1,000 juvenile coho. These fish were probably stranded during the summer because the upper end of the side-channel was disconnected and the lower end was becoming dewatered. No juvenile coho were found above the waterfalls and no juvenile chinook were observed. The absence of juvenile chinook suggests that chinook probably do not rear in Moose Creek and most likely migrate out as fry during early spring. Low numbers of chinook spawners were observed in areas downstream of the waterfalls with the majority occurring between segments 8 and 13 (Table 1).

Dolly Varden char, ranging from 59 to 124 mm long, were the only salmonid species observed above the waterfalls on Moose Creek. Locations upstream of the waterfalls checked for fish during the June reconnaissance survey included: segments 17 to 19, a side-channel just upstream of Premier Creek, and another one located at RM 5.2.

3.1.2 Buffalo Creek

Buffalo Creek was surveyed on June 22 from the mouth upstream to the outlet of Wishbone Lake (Figure 1). The stream is small, approximately 2 to 3 feet wide, and the discharge was about 2 cfs. The stream runs through a thickly wooded area and the channel disappears under the brush in some locations. The substrate is mostly composed of silt, sand, and small gravel except in a steep reach near the Moose Creek valley bluffs, where it runs over cobble and rock. Two inactive beaver ponds occur .1 and .25 miles upstream from the mouth. The outlet from the lower pond goes around the beaver dam and passes through very heavy brush and only a portion of the flow seems to return to the main channel downstream. The outlet of the upper beaver pond passes through a notch in the dam creating a 5-foot waterfall. Access by adult salmon above the beaver dams is highly unlikely as a result of the large number of obstacles and small size of the stream.

Salmonids were present but not very abundant in Buffalo Creek. Several small rainbow trout (i.e., 30 to 50 mm) were caught in the reach below the bluff and one larger rainbow (i.e., >150 mm) was caught about .75 miles downstream of Wishbone Lake. A second survey conducted during September between the stream mouth and the bluffs indicated that Dolly Varden were also present

in the reach below the beaver ponds (see Section 3.4). No juvenile or adult salmon were observed during the surveys of Buffalo Creek. The occurrence of rainbow trout is assumed to be a result of the ADF&G fish planting of Wishbone Lake. Over time, mature rainbow spawners have most likely moved down into Buffalo Creek and have seeded the stream. The low abundance of these fish, however, suggests the habitat for salmonids is very limited, probably as a result of low stream flow and winter freeze up.

3.2 Systematic Survey

The systematic survey was conducted during September 19 to 23, 1988. Data collected from the five sample stations included habitat characteristics, discharge, water quality, fish abundance, and benthic invertebrate density. Weather during this 5-day survey was clear on the first and last day, with heavy rain on the second to fourth days. The rain hindered field work on one day as a result of high stream flow and turbid water.

3.2.1 Fish Habitat

Habitat characteristics of the four stations in Moose Creek (i.e., 1-4) were typical of a swift, cascading stream (Table 2). Average depths ranged from 0.7 to 1.1 feet and average velocity was ≥2.0 ft/s. Only small pools occur as the majority of the habitat was less than 1.5 feet deep at all stations except Station 3 (Figure 2). The substrate was predominantly composed of large rocks ranging from small cobble to boulders (Figure 3). Gravel-size material occurred in small patches at the tailout of pools. Sand and silt was rare and only occurred along the stream margin. The streambed and banks at all stations were relatively stable as a result of the cobble-boulder substrate. Substrate embeddedness was typically less than 5 percent at all stations (Figure 4) and typically occurs along the stream margins and in eddies behind large boulders. The availability of interstitial spaces among the cobble substrate and the low substrate embeddedness creates excellent cover and refuge habitat for salmonids.

Buffalo Creek (i.e., Station 5) was typical of a small creek with shallow water and low velocity habitat. The substrate was very different from Moose Creek and was dominated by sand and gravel. A portion of the bottom of Buffalo Creek also had extensive roots and stems from willows growing in the channel. Root wads from these trees created a braided stream with many small channels and islands. Substrate embeddedness was relatively high as a result of the predominance of sandy substrate. Refuge habitat in Buffalo Creek is provided by the abundant root masses and overhanging vegetation that occurs in and along the stream.

3.2.2 Water Quality

The water quality conditions of Moose and Buffalo Creeks reflect the near natural conditions of the basin (Table 3). Water temperature ranged from 5.3 to 8.2°C during the two surveys, which is typical for a stream draining snow fields at this latitude. The pH was near neutral or slightly above, which suggests that acid inputs are minor or non-existent. Dissolved oxygen concentrations were relatively high and were within the range suitable for salmonids. Conductivity was relatively low, but varied over time. High conductivities were associated with the storm flow in September. Total suspended solids were also low and varied as a result of stream flow. These low levels, however, are not indicative of the background levels during peak freshet conditions. High turbidity was observed by the field crew during a freshet in September indicating that suspended sediment levels are much higher than the data indicate. High turbidities were noticed coming from the east fork of

Moose Creek upstream of the project area.

3.2.3 Fish Distribution and Relative Abundance

The population inventory conducted during September confirmed the results of the reconnaissance survey concerning species distribution. Juvenile coho only occurred at Station 1 below the waterfalls, Dolly Varden occur at all stations in Moose and Buffalo creeks, and rainbow trout occur in only Buffalo Creek. Juvenile chinook were not found at any station. These results suggest that chinook and coho salmon are currently not utilizing stream habitat above the waterfalls. No other data is available concerning juvenile fish distribution in Moose Creek. Therefore, it is unknown whether or not the habitat above the waterfalls has historically been utilized by juvenile salmon.

The size/age groups of juvenile salmonids were determined from the length frequency analyses shown in Figures 5 to 7. The juvenile coho caught at Station 1 were designated age 0 because they ranged in length from 49 to 83 mm (Figure 5). The size of age 1+ coho from the Little Susitna River range from 95 to 108 mm (Larry Engle, ADF&G, personal communication). We assume growth rates would be similar between the two streams; therefore, the juvenile coho caught in Moose Creek were most likely young-of-the-year.

The absence of 1+ coho from the September survey and from the June reconnaissance survey suggests these fish are not rearing in Moose Creek. Since juvenile coho in Alaska generally spend two years in freshwater prior to smolting, the older coho must be moving out of Moose Creek to seek more suitable rearing habitat. This outmigration from Moose Creek would most likely occur during the fall in order to avoid harsh winter conditions. Research on coho in the Pacific Northwest and southeast Alaska has found that juvenile coho will vacate their summer habitat during declining temperatures in fall and will seek winter refuge in beaver ponds and sloughs downstream (Peterson 1982, Tschaplinski and Hartman 1983, Swales et al. 1986). Research on the Susitna River also found that juvenile coho overwinter in large sloughs adjacent to the river (Stratton 1986).

The Dolly Varden char were separated into three size/age groups (Figure 6). Fish less than 70 mm were designated age 0, fish >70 to 160 mm were designated 1+, and fish >160 mm were designated adults. The actual ages of the 1+ and adult groups are unknown. The presence of all size groups of Dolly Varden indicates the population is self-sustaining and that reproduction is at least maintained by resident adults.

The rainbow trout were separated into two age groups. Fish <50 mm were designated as age 0 and fish >50 mm were designated age 1+ (Figure 7). The absence of adult rainbow trout in lower Buffalo Creek (i.e., Station 5) and the absence of trout in Moose Creek suggests recruitment to the population must be derived from upper Buffalo Creek and perhaps from Wishbone Lake.

The results of the population inventory are shown in Table 4. Juvenile coho at Station 1 were the most abundant salmonid and had the highest density among the five stations. Dolly Varden were the most abundant at Stations 2, 3, and 4. Dolly Varden were least abundant at Stations 1 and 5 in association with coho and rainbow trout, respectively. Age 0 Dolly Varden were found in low velocity areas along the stream margin, which is similar to habitat utilized by juvenile coho. Downstream of the waterfalls, juvenile coho would have an advantage over juvenile Dolly Varden because coho emerge earlier in spring. This enables coho to outcompete Dolly Varden because of their greater size. The low abundance of Dolly Varden in Buffalo Creek is probably a reflection of the habitat not being suitable for this species.

Densities of salmonids in Moose and Buffalo Creeks are very low compared to other streams in Alaska. For example, the density of coho in the Chuitna River drainage ranged from 0.1 to 3.3 fish/square meter (ERT 1985) and densities in small streams of Southeast Alaska range 0.32 to 1.82 fish/square meter Bryant 1984). The density of coho in Moose Creek (i.e., 0.06/square yd) is an order of magnitude lower than any density reported in the literature. The densities of all age groups of Dolly Varden combined are also lower than other streams. Dolly Varden densities ranged 0.03 to 0.93/square m (ERT 195) and densities in Southeast Alaska streams ranged 0.07 to 0.36 fish/square m (Bryant 1984). These results suggest the productivity of Moose and Buffalo Creeks for coho salmon and Dolly Varden char is relatively poor compared to other streams in Alaska.

3.3 Spawner Survey

Spawner surveys were conducted on Moose Creek for chinook salmon by ADF&G on July 27th and two surveys for coho spawners were conducted by Dames & Moore on September 26 and October 10, 1988. The number of chinook spawners counted in 1988 was the highest number ever recorded for Moose Creek (Table 5). No adult chinook were observed above the waterfalls and of the 1,072 counted, 356 were observed in the stream reach downstream of the Glenn Highway Bridge (Larry Engle, ADF&G, personal communication). Counts of adult coho in 1988 were lower

than in 1987, but are similar to counts in previous years (Table 5). Most of the coho spawners in 1988 were observed in stream segments 8 to 16 and no coho were observed above the waterfalls (Table 6). The large number of coho carcasses counted during the 1988 surveys indicates the coho escapement was probably more than 100 fish. Chum salmon were not observed during any of the spawner surveys. The one record of chum salmon in Moose Creek (Table 5) is from an observation by ADF&G of chum salmon holding at the mouth of the creek. Chum salmon are not known to spawn in Moose creek but have been seen holding in the stream's mouth during their migration up the Matanuska River (Larry Engle, ADF&G, personal communication).

The results from this survey and information from ADF&G indicates the waterfall at R.M. 3.2 is a barrier to adult spawners during most years. ADF&G personnel have rarely seen spawners above the falls during the past 18 years of conducting spawner surveys on Moose Creek (Larry Engle, ADF&G, personal communication). Since no salmon were observed above the falls during the past two years of large escapements, it is assumed that flow conditions at the falls are more important for passage than the number of fish available.

3.4 Benthic Macroinvertebrates

The density and biomass of benthic macroinvertebrates was highly variable among the sample stations (Table 7). Stations 1 and 4 had the highest and lowest total densities, respectively. However, the large standard deviations (i.e., relative to the mean) associated with the densities indicates no detectable difference exists among the stations. These large standard deviations, especially at the Moose Creek stations (i.e., 1 to 4), are reflective of the heterogeneous nature of the macroinvertebrate density and biomass. The cobble and boulder substrate in Moose Creek creates a variable environment (i.e., depth, velocity, substrate size) resulting in a patchy distribution of the macroinvertebrate community. The standard deviations for density and biomass at the Buffalo Creek Station (i.e., Station 5) are relatively small because the samples were collected from a riffle with uniform depth, velocity, and gravel substrate.

Macroinvertebrate taxonomic composition was variable among the stations. In terms of density, Plecoptera and Diptera were most abundant at Stations 1 and 5; Plecoptera and Ephemeroptera were most abundant at Stations 2 and 4; and Tricoptera and Diptera were most abundant at Station 3 (Table 7). Ephemeroptera had the greatest biomass at all stations in Moose Creek and Tricoptera the greatest biomass in Buffalo Creek.

The Ephemeroptera at all stations were mostly composed of Heptageniidae, which has a flattened shape and is well adapted for high velocity environments like Moose Creek. The Plecoptera were composed of a variety of taxa with Chloroperlidae being the most obvious. The Tricoptera were dominated by Glossosomatidae, which were often found attached to the cobble and boulders. The Diptera were exclusively composed of Chironomidae.

4.0 HUMAN USES OF MOOSE AND BUFFALO CREEK

Information concerning fishing on Moose and Buffalo Creeks is not documented. Formal creel surveys have never been conducted (Larry Engle, ADF&G, personal communication) and neither stream is listed in the Annual Alaska Sport Fish Report. Fishing for chinook salmon is prohibited in Moose Creek and the numbers of the other salmon species are too low to provide significant fishing opportunity. ADF&G biologists have observed people fishing for salmon (i.e., coho, sockeye, and chum) at the confluence of Moose Creek and the Matanuska River. Most of this fishing occurs because salmon tend to congregate in the clear water plume created by Moose Creek. Fishing in Moose Creek is primarily limited to catches of Dolly Varden Char. Most of this fishing occurs downstream of the waterfall and is concentrated around the small campground near the Glenn Highway Bridge (Larry Engle, ADF&G, personal communication). No fishing has been observed in Buffalo Creek; however, a popular rainbow trout fishery exists on Wishbone Lake. The lake is stocked annually with fingerling rainbow trout and, beginning in 1989, Wishbone Lake will be regulated as a catch-and-release, fly fishing only area. The intent is to establish a high quality trophy fish area for use by a particular segment of the angling community.

In recent years Moose Creek has supported a small, but significant, population of chinook salmon which can be expected to contribute to commercial salmon fisheries in upper Cook Inlet. Proportionally, the Moose Creek run represents a small fraction of the total chinooks in upper Cook Inlet. The Susitna River drainage alone has an annual escapement of 120,000-200,000 chinooks (Larry Engle, ADF&G, personal communication). Therefore, Moose Creek with escapements of less than 1000 fish contributes less than 1 percent of the total chinooks available to the fishery.

5.0 THREATENED AND ENDANGERED SPECIES

No threatened or endangered fish species were captured or observed during the baseline survey of

Moose and Buffalo Creeks. The ADF&G is not aware of any threatened and endangered fish in either stream (Larry Engle, ADF&G, personal communication).

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7.0 RESPONSIBLE PARTIES

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TABLES

Table 1
Observations of fish habitat and fish occurance during reconnaissance survey of Moose Creek on June 23, 1988

Stream Segment No.(a)	Gradient (%)	Dominant Substrate Composition(b)	Spawning Habitat(c)	Fish Occurence(d)	
				Juvenile	Adult
1	3-4	34.6	fair	--	--
2	3	34.5	poor	3-CO	2-CH
3	2-3	45.5	fair	--	--
4	3	45.6	good	--	--
5	2	45.6	poor	5-CO	--
6	3	34.5	poor	--	--
7	2	43.7	poor	--	--
8	3	24.5	good	--	4-CH
9	2-3	34.5	fair	--	1-CH
10	3	45.8	poor	--	--
11	4	45.6	good	--	2-CH
12	3	43.8	fair	>1000-CO	--
13	3	43.7	good	--	1-CH
14	3	54.7	poor	2-CO	1-CH
15	4	43.7	poor	--	--
16	3	54.6	poor	--	--
17	---	--	poor	1-DV	--
18	---	--	poor	--	--
19	---	--	poor	1-DV	--

Notes: a - See map (Figure 1) for locations
b - See methods for explanation of code
c - poor - No suitable habitat observed
fair - Few small patches
good - Some large and small patches
d - Species codes: CO - Coho
CH - Chinook
DV - Dolly Varden
RB - Rainbow

Table 2
Habitat characteristics of Moose and Buffalo Creeks during September, 1988

Station	Date	Reach Length (ft)	Mean Width (ft)	Mean Depth (ft)	Surface Area (yd^2)	Gradient (%)	Mean Velocity (ft/s)	Discharge (cfs)
1	09/19/88	270	42.2	0.8	1,266	1.0	2.0	81.9
2	09/19/88	300	34.2	1.0	1,140	2.0	2.2	97.8
3	09/21/88	270	49.3	1.1	1,479	2.0	2.3	112.7
4	09/22/88	270	36.5	0.7	1,095	3.0	2.2	68.6
5	09/23/88	240	11.7	0.3	312	2.0	0.7	2.6

Table 3
Water quality of Moose and Buffalo Creeks during 1988

Station	Date	Temperature (°C)	pH	Dissolved Oxygen (ppm)	Conductivity (µmhos/cm)	Total Suspended Solids (mg/l)
1	06/24/88	8.2	8.7	11.9	48	---
	09/19/88	6.5	7.2	7.5	195	2.4
	09/22/88	---	---	---	---	11.0
	09/26/88	6.1	---	11.8	105	---
2	06/24/88	6.1	7.9	9.8	132	---
	09/19/88	6.5	7.4	8.3	---	< 1
	09/26/88	6.5	---	12.2	110	---
3	06/24/88(a)	5.6	7.6	9.8	43	---
	09/20/88	---	---	---	---	3.4
	09/21/88	6.8	6.3	11.8	1,820	---
	09/22/88	---	---	---	---	12.0
4	06/24/88(b)	4.8	8.3	8.4	59	---
	09/22/88	5.3	6.3	10.8	900	5.0
5	06/24/88	7.0	8.6	10.1	35	---
	09/21/88	---	---	---	---	19.0
	09/22/88	6.4	7.4	12.5	1,250	---

Notes: a - Sample taken just below mouth of Buffalo Creek, 0.1 mile downstream of station 3.
b - Sample taken approximately 1 mile downstream of station 4.

Table 4
Fish catch data, population estimates, and density by species and age group for the study reaches in Moose and Buffalo Creeks during September, 1988

Station	Species	Age	Catch per Sample Run			Population Estimate Method	Population Estimate	95% Confidence Interval	Density (no./yd²)
			1	2	3				
	Coho	0	25	26	30	Sum	> 81	--	> 0.06
1	Dolly Varden	0	0	0	1	Sum	> 1	--	> 0.0008
	Dolly Varden	adult	1	0	0	Sum	1	--	0.0008
	Dolly Varden	total							0.0016
	Dolly Varden	0	3	1	-	Removal	5	4-8	0.0044
2	Dolly Varden	1+	5	2	-	Removal	8	7-14	0.007
	Dolly Varden	total							0.0114
	Dolly Varden	0	4	1	1	Removal	7	6-10	0.0047
3	Dolly Varden	1+	1	6	4	Sum	> 11	--	0.0074
	Dolly Varden	total							0.0121
	Dolly Varden	0	2	2	0	Removal	4	4-6	0.0037
4	Dolly Varden	1+	4	7	3	Sum	> 14	--	0.0128
	Dolly Varden	adult	0	0	1	Sum	> 1	--	0.0009
	Dolly Varden	total							0.0174
	Dolly Varden	0	1	0	-	Sum	1	--	0.0032
	Dolly Varden	1+	0	1	-	Sum	> 1	--	0.0032
	Dolly Varden	total							0.0064
5									
	Rainbow	0	9	4	-	Removal	16	13-26	0.0513
	Rainbow	1+	1	1	-	Sum	> 2	--	0.0064
	Rainbow	total							0.0577

Notes: Sum - Population estimate computed by sum of catch.
Removal - Population estimate computed by removal method.

Table 5
Moose Creek spawner survey records

(All data are from ADF&G except the 1988 coho survey)

Chinook		Coho		Chum	
Date	Count	Date	Count	Date	Count
07/24/70	126	10/05/78	23	10/05/78	118
07/28/71	22	10/03/83	11		
07/29/71	40	10/01/87	73		
07/28/72	15	09/26/88	30 *		
07/31/72	6	10/10/88	12 *		
08/01/73	36				
08/01/74	32				
08/01/75	55				
07/28/76	101				
07/25/77	153				
07/17/78	245				
07/23/79	253				
07/27/81	238				
07/20/82	406				
07/19/83	452				
07/30/84	541				
08/02/85	475				
07/19/86	419				
07/21/87	957				
07/27/88	1072				

* From Dames & Moore survey between Glenn Highway and bridge at Premier Creek.

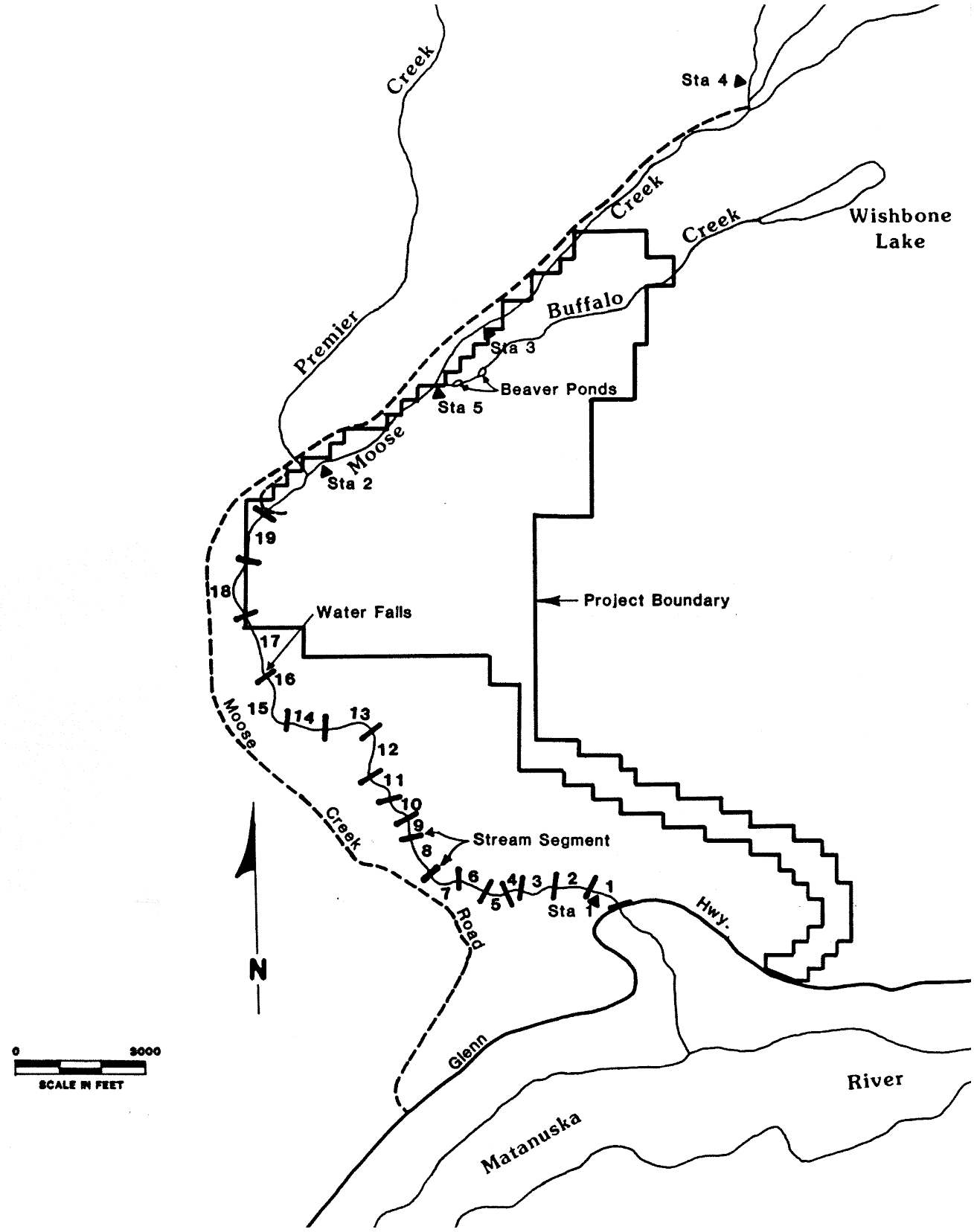
Table 6
Counts of live and dead salmon spawners in Moose Creek during 1988

Stream Segment	Location	Survey (9/26)		Survey (10/10)	
		Live Coho	Carcass Count	Live Coho	Carcass Count
1		0	11	0	38
2		2	5	0	11
3		0	0	0	5
4		0	6	0	8
5		2	4	0	3
6	Above	0	1	0	5
7		0	9	0	4
8	Glenn	7	8	0	13
9		1	8	0	4
10	Hwy.	3	0	0	18
11		1	1	2	0
12		1	1	2	0
13		4	2	3	0
14		0	0	2	1
15		3	1	2	1
16		6	0	1	0
17	Above falls	0	0	0	0
18	Above falls	0	0	0	0
19	Above falls	0	0	0	0
Total		30	57	12	111

Table 7
Density and biomass (wet weight) of benthic macroinvertebrates in Moose and Buffalo Creeks during September, 1988

Station	Taxa	Density (no./m²)		Biomass (g/m²)	
		Mean	StdDev	Mean	StdDev
1	Ephemeroptera	1,120	1,106	9.48	7.84
	Plecoptera	1,636	1,668	2.09	2.08
	Tricoptera	233	130	1.91	0.69
	Diptera	1,633	1,031	2.19	1.42
	Total	4,623	3,625	15.68	11.43
2	Ephemeroptera	706	333	3.86	1.76
	Plecoptera	783	515	1.24	0.68
	Tricoptera	616	153	1.22	0.40
	Diptera	676	209	1.58	1.02
	Total	2,783	1,161	7.89	2.90
3	Ephemeroptera	460	380	2.17	2.35
	Plecoptera	553	517	0.63	0.61
	Tricoptera	1,313	898	1.86	1.56
	Diptera	1,046	1,085	1.93	2.02
	Total	3,373	2,842	6.58	6.39
4	Ephemeroptera	240	138	1.81	1.09
	Plecoptera	390	310	0.85	0.80
	Tricoptera	93	40	0.36	0.17
	Diptera	140	60	0.33	0.31
	Total	863	544	3.34	2.32
5	Ephemeroptera	13	11	0.05	0.05
	Plecoptera	783	290	0.81	0.36
	Tricoptera	246	175	3.47	1.04
	Diptera	346	170	0.98	0.68
	Total	1,390	614	5.31	1.75

FIGURES



DESIGN BY:	LOCATIONS OF SURVEY SITES ON MOOSE & BUFFALO CREEKS	WISHBONE HILL MINE — PERMIT No. 01-89-796
DRAWN BY:		
CHECK BY:		
DWG FILE:	USIBELLI COAL MINE, INC. P.O. BOX 1000, HEALY, ALASKA 99743 (907) 683-2226	FIGURE No. 1 — REV. 0
DATE DRAWN:		SCALE:

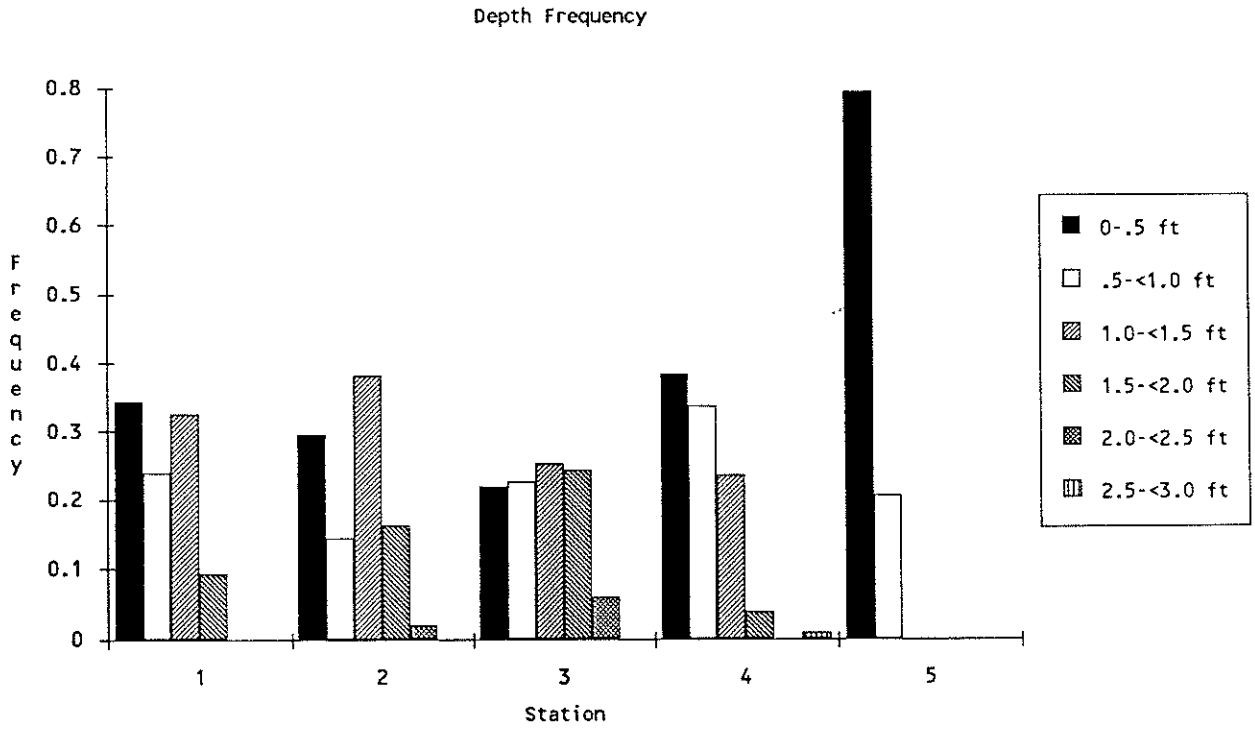


Figure 2

Water Depth Distribution by 0.5' Intervals for Moose and Buffalo Creeks during September, 1988

Dames & Moore

Job No. 11998-001

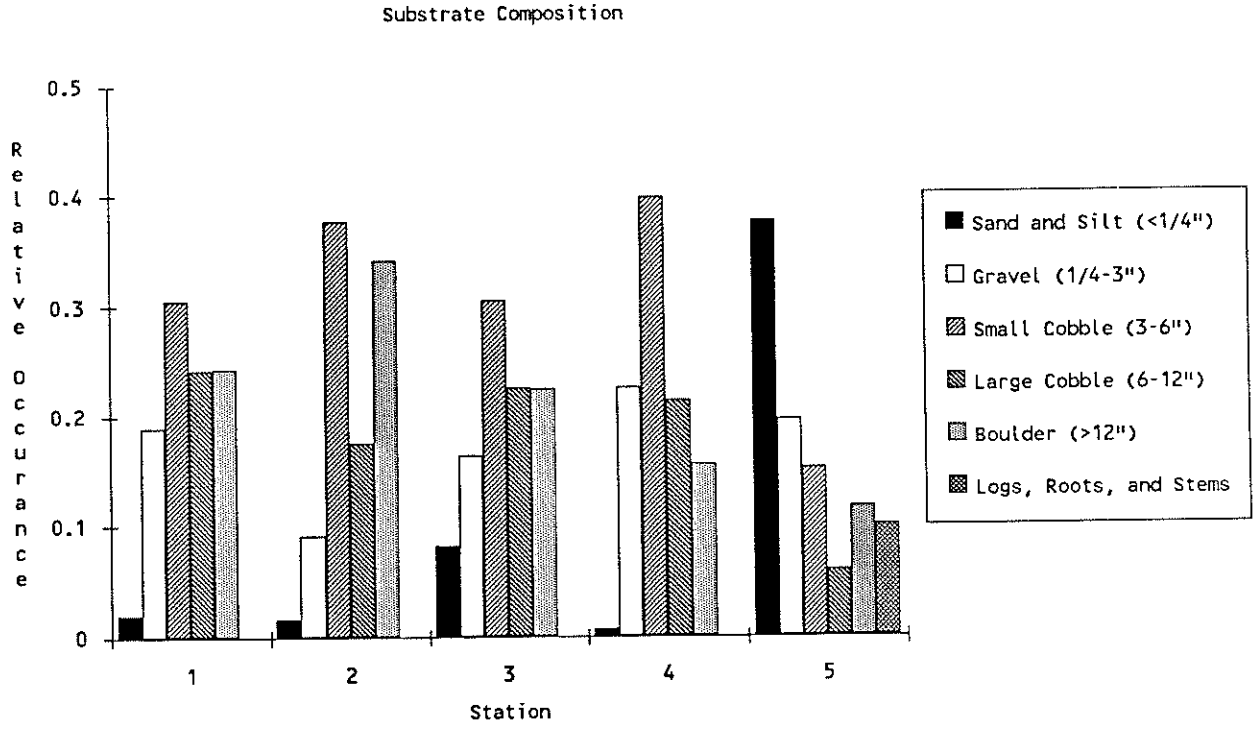


Figure 3

Substrate Composition of Moose and Buffalo Creeks during September, 1988

Dames & Moore

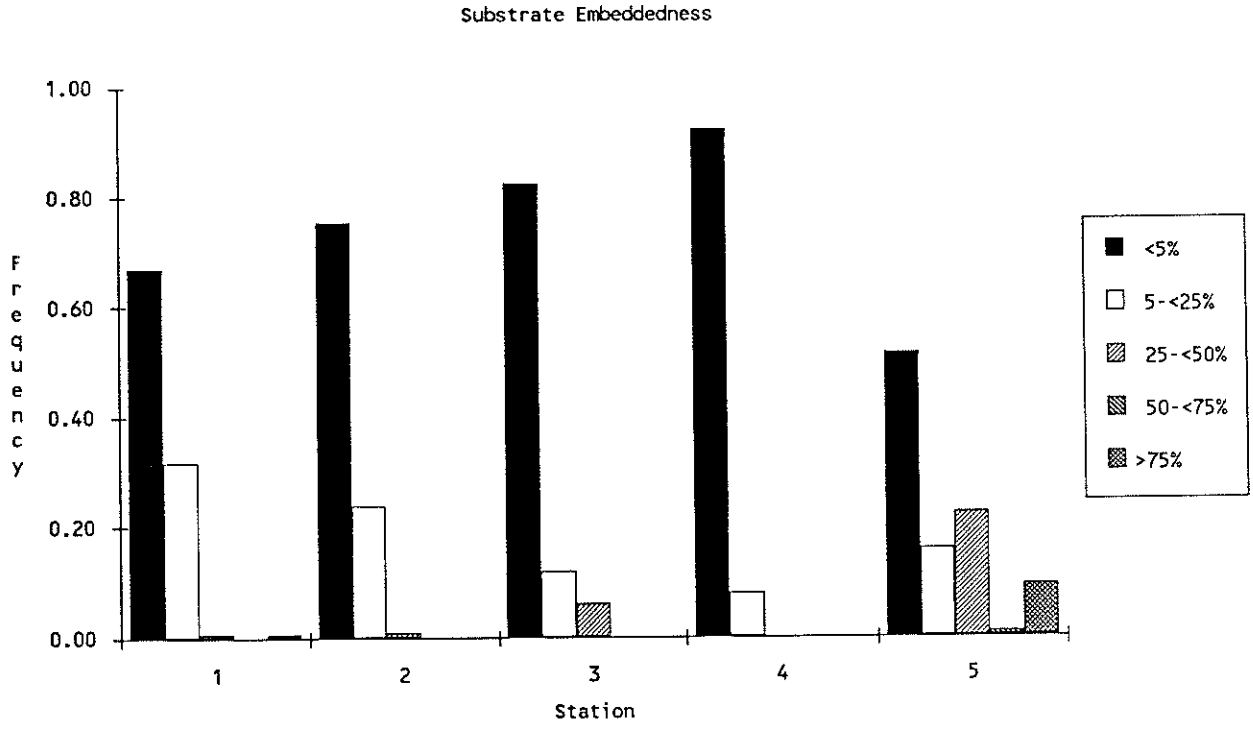


Figure 4
Substrate Embeddedness of
Moose and Buffalo Creeks during September, 1988
Dames & Moore

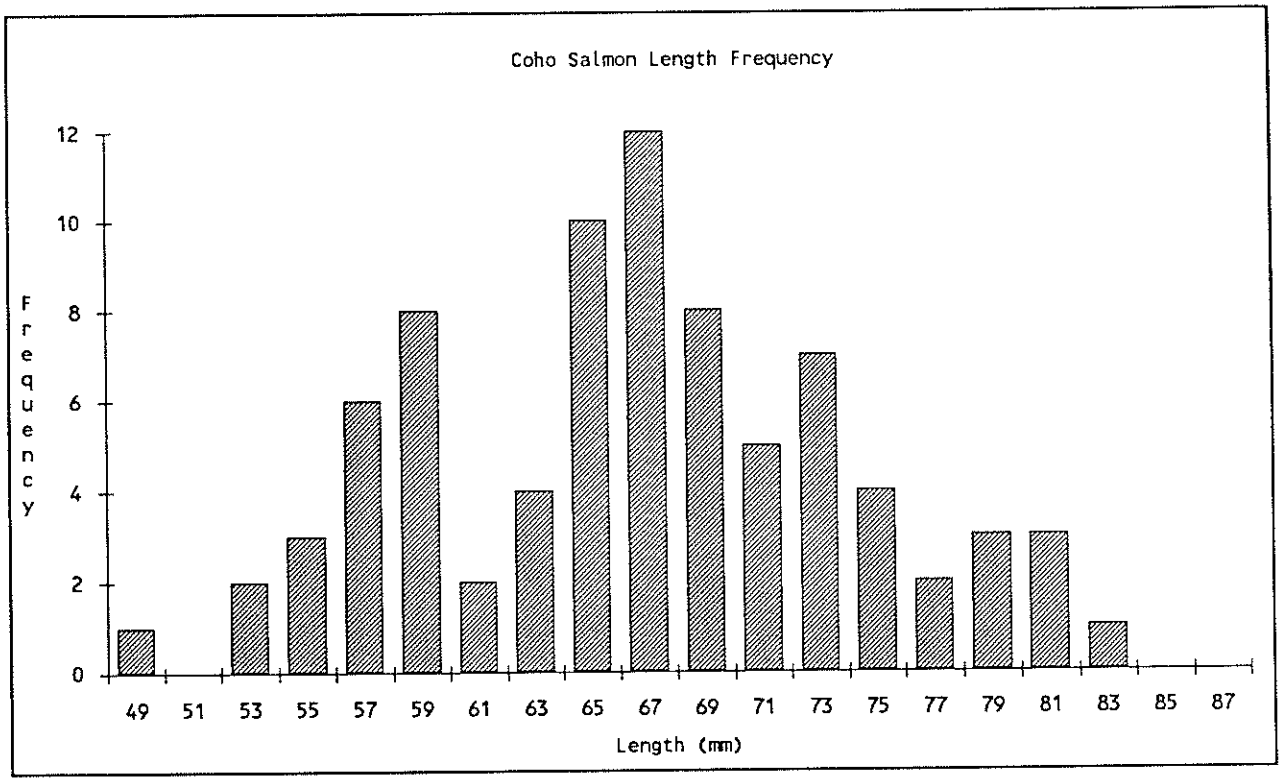


Figure 5
Length Frequency of Juvenile Coho Salmon
Caught at Station 1 in
Moose Creeks during September, 1988
Dames & Moore

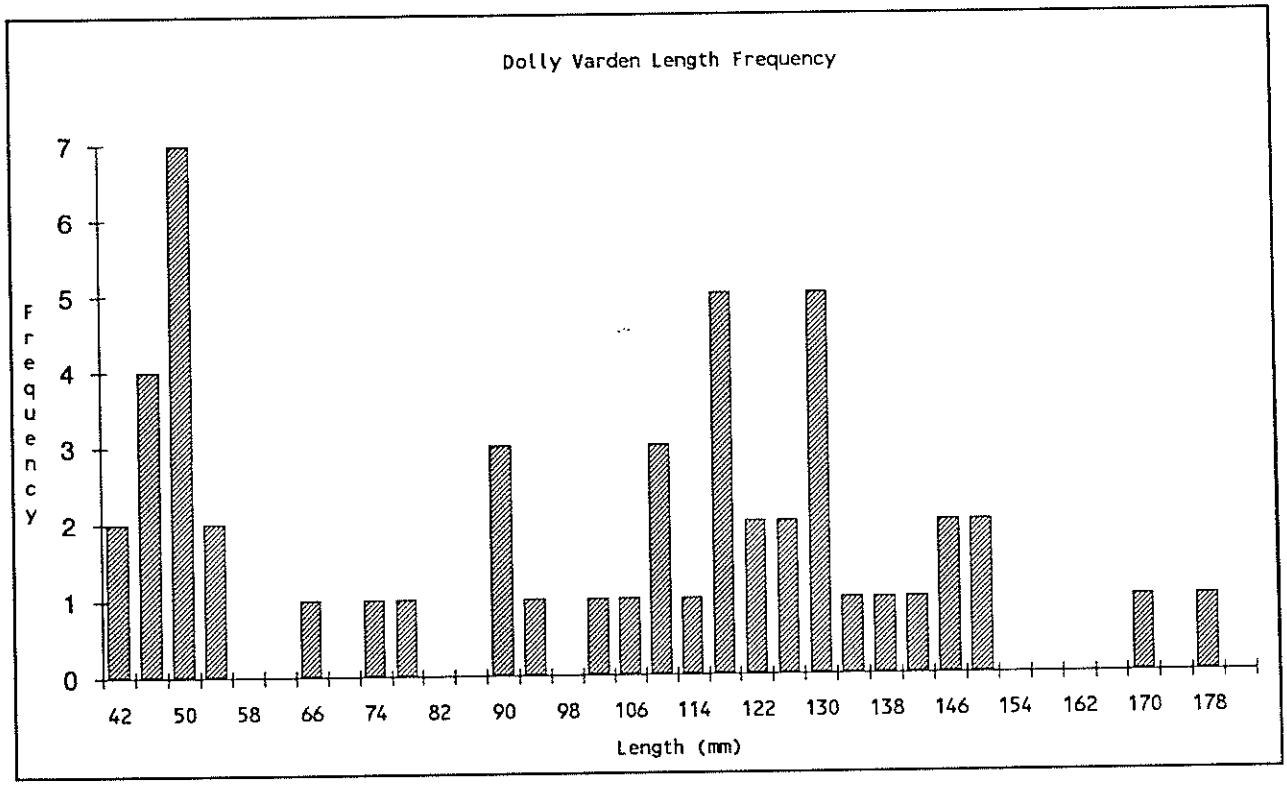


Figure 6

Length Frequency of Dolly Varden Char from Moose Creek during September, 1988

Dames & Moore

Job No. 11998-001

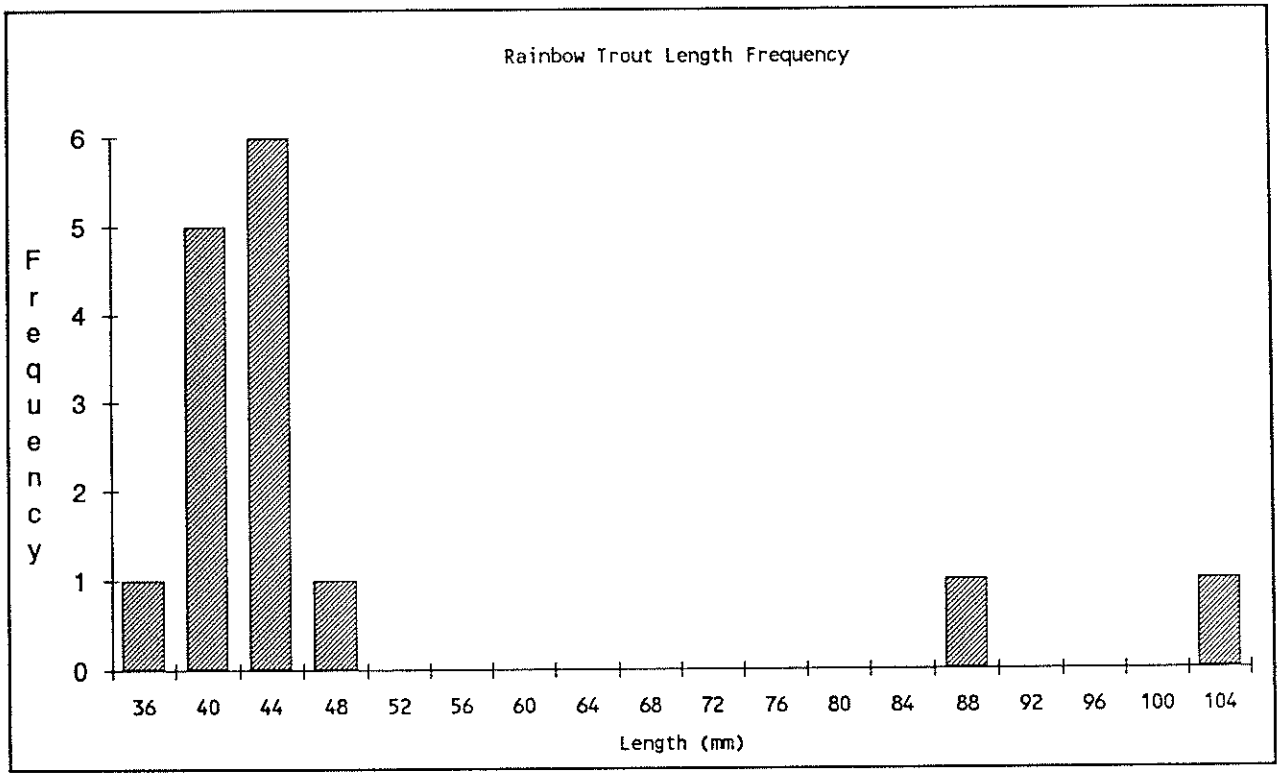


Figure 7

Length Frequency of Juvenile Rainbow Trout from Buffalo Creek during September, 1988

Dames & Moore

PLATES

R 2 E

Sta 4
Sta 3
Sta 5
Sta 2
Sta 1
Wishbone Lake
Moose Creek
Buffalo Creek
Elk's Lake
Water Fall
T 19 N
T 18 N

The core map area was photogrammetricaly mapped from photography of 5/8/84, 5/8/83, 6/22/85 by Air Photo Tech, Inc. of Anchorage, Alaska.
The core map area meets National Map Accuracy Standards at 1"=200' and smaller scales. Topographic and Planimetric features outside of the core area were taken from a photo enlarged 1" = 1mile USGS Anchorage C-6 quad map of 1987.
Horizontal datum is Alaska State Plane, zone 4.
Vertical datum is based on USC & GS monumentation.

CERTIFICATE

I hereby certify that this drawing has been prepared under my direction and is correct to the best of my knowledge and belief.

David E. Herman

SAMPLING STATION

2 STUDY SEGMENT

Map Area

R 2 E R 3 E

T 19 N

T 18 N

Sutton

Palmer

North

500 250 0 500 1000 1500

SCALE IN FEET
1"= 500'
CONTOUR INTERVAL
5 FEET

SUBJECT REVISIONS			
REV.	DATE:	BY:	DESCRIPTION
1	2009	JEH	MINOR REVISIONS

DESIGN BY:	
DRAWN BY:	
CHECK BY:	
DWG FILE:	
DATE DRAWN:	

WISHBONE HILL MINE — PERMIT NUMBER 01-89-796

LOCATION OF SURVEY SITES ON MOOSE AND BUFFALO CREEKS

WISHBONE HILL MINE

USIBELLI COAL MINE, INC.
P.O. BOX 1000, HEALY, ALASKA 99743
(907) 683-2226

PLATE No. IX-1 — REV. 1

SHEET No. 1 OF 1

APPENDICES

Appendix Table A.

Habitat Inventory Data.

Station	Transect	Interval (ft)	Embeddedness	Depth (ft)	Velocity (ft/sec)	Wetted width (ft)	Substrate
1	0	0	0	0.0	0.0	44.0	24.6
1	0	3	0	0.2	0.1	44.0	24.8
1	0	6	0	0.5	0.9	44.0	24.8
1	0	9	0	0.8	0.7	44.0	53.8
1	0	12	0	0.7	2.2	44.0	42.7
1	0	15	0	0.6	1.9	44.0	34.7
1	0	18	0	1.1	3.1	44.0	43.6
1	0	21	0	1.4	2.7	44.0	24.8
1	0	24	0	1.2	3.3	44.0	23.7
1	0	27	0	1.0	3.3	44.0	32.6
1	0	30	0	1.0	3.4	44.0	23.6
1	0	33	0	1.2	1.4	44.0	32.8
1	0	36	0	1.0	1.5	44.0	52.9
1	0	39	0	0.6	0.9	44.0	32.8
1	0	42	0	0.2	0.0	44.0	42.7
1	0	44	5	0.0	0.0	44.0	41.6
1	30	0	0	0.1	0.0	45.0	51.9
1	30	3	5	0.9	0.0	45.0	31.8
1	30	6	5	0.8	0.0	45.0	24.8
1	30	9	0	1.1	0.0	45.0	42.9
1	30	12	5	1.3	0.0	45.0	24.7
1	30	15	5	1.3	0.0	45.0	52.7
1	30	18	0	1.2	0.0	45.0	35.7
1	30	21	0	1.3	0.0	45.0	53.8
1	30	24	0	1.1	0.0	45.0	43.7
1	30	27	5	1.3	0.0	45.0	24.8
1	30	30	0	1.2	0.0	45.0	25.8
1	30	33	0	1.3	0.0	45.0	32.9
1	30	36	0	0.8	0.0	45.0	34.6
1	30	39	0	0.5	0.0	45.0	42.7
1	30	42	5	0.5	0.0	45.0	42.6
1	30	45	5	0.1	0.0	45.0	42.6
1	60	0	0	0.0	0.0	44.0	51.9
1	60	3	0	0.9	0.0	44.0	51.9
1	60	6	0	1.6	0.0	44.0	41.9
1	60	9	0	1.2	0.0	44.0	43.9
1	60	12	0	1.6	0.0	44.0	53.9
1	60	15	5	1.6	0.0	44.0	52.9
1	60	18	5	1.1	0.0	44.0	43.7
1	60	21	0	0.5	0.0	44.0	43.6
1	60	24	0	0.6	0.0	44.0	32.9

Appendix Table A.

Continued.

Station	Transect	Interval (ft)	Embeddedness	Depth (ft)	Velocity (ft/sec)	Wetted width (ft)	Substrate
1	60	27	0	0.4	0.0	44.0	52.8
1	60	30	5	0.3	0.0	44.0	25.8
1	60	33	0	0.4	0.0	44.0	43.7
1	60	36	0	0.2	0.0	44.0	51.8
1	60	39	0	0.4	0.0	44.0	52.9
1	60	42	0	0.5	0.0	44.0	54.7
1	60	44	5	0.0	0.0	44.0	32.7
1	90	0	0	0.1	0.0	45.0	53.9
1	90	3	5	0.9	0.0	45.0	51.9
1	90	6	0	1.7	0.0	45.0	53.9
1	90	9	5	2.0	0.0	45.0	43.6
1	90	12	5	1.8	0.0	45.0	34.7
1	90	15	5	1.6	0.0	45.0	54.6
1	90	18	5	1.5	0.0	45.0	52.8
1	90	21	0	1.2	0.0	45.0	53.6
1	90	24	0	0.9	0.0	45.0	43.6
1	90	27	0	0.6	0.0	45.0	34.6
1	90	30	5	0.2	0.0	45.0	32.7
1	90	33	0		0.0	45.0	32.7
1	90	36	75	0.4	0.0	45.0	13.9
1	90	39	25	0.6	0.0	45.0	53.8
1	90	42	5	0.6	0.0	45.0	32.6
1	90	45	5		0.0	45.0	42.6
1	120	0	5		0.0	41.0	32.7
1	120	3	0	0.2	0.0	41.0	23.7
1	120	6	0	0.9	0.0	41.0	32.6
1	120	9	0	1.3	0.0	41.0	43.7
1	120	12	0	1.8	0.0	41.0	34.7
1	120	15	5	1.5	0.0	41.0	52.9
1	120	18	5	1.5	0.0	41.0	34.6
1	120	21	5	1.3	0.0	41.0	34.8
1	120	24	0	1.0	0.0	41.0	23.7
1	120	27	5	0.7	0.0	41.0	23.6
1	120	30	5	0.5	0.0	41.0	41.9
1	120	33	5	0.4	0.0	41.0	53.7
1	120	36	0	0.4	0.0	41.0	53.7
1	120	39	0	0.1	0.0	41.0	34.6
1	120	41	5	0.0	0.0	41.0	34.6
1	150	0	5		0.0	39.0	34.6
1	150	3	5	0.5	0.0	39.0	52.7
1	150	6	0	1.0	0.0	39.0	42.8

Appendix Table A.

Continued.

Station	Transect	Interval (ft)	Embeddedness	Depth (ft)	Velocity (ft/sec)	Wetted width (ft)	Substrate
1	150	9	0	1.2	0.0	39.0	34.7
1	150	12	0	1.2	0.0	39.0	53.8
1	150	15	5	1.5	0.0	39.0	53.6
1	150	18	0	2.0	0.0	39.0	53.6
1	150	21	0	1.4	0.0	39.0	43.8
1	150	24	0	1.1	0.0	39.0	34.8
1	150	27	0	0.7	0.0	39.0	34.7
1	150	30	0	0.2	0.0	39.0	52.8
1	150	33	0	0.1	0.0	39.0	52.9
1	150	36	0	0.1	0.0	39.0	24.7
1	150	39	5		0.0	39.0	23.7
1	180	0	0		0.0	39.0	35.8
1	180	3	5	0.5	0.0	39.0	42.8
1	180	6	0	0.9	0.0	39.0	24.8
1	180	9	0	0.9	0.0	39.0	52.6
1	180	12	0	1.2	0.0	39.0	42.8
1	180	15	0	1.1	0.0	39.0	34.8
1	180	18	0	1.2	0.0	39.0	53.8
1	180	21	0	1.7	0.0	39.0	53.6
1	180	24	0	1.9	0.0	39.0	53.6
1	180	27	5	1.5	0.0	39.0	51.9
1	180	30	5	1.8	0.0	39.0	51.9
1	180	33	0	0.7	0.0	39.0	45.7
1	180	36	0	0.2	0.0	39.0	42.9
1	180	39	0		0.0	39.0	23.6
1	210	0	5		0.0	42.0	21.8
1	210	3	0	0.2	0.0	42.0	23.8
1	210	6	0	0.1	0.0	42.0	32.6
1	210	9	5	0.4	0.0	42.0	52.8
1	210	12	0	0.8	0.0	42.0	34.7
1	210	15	0	1.1	0.0	42.0	35.8
1	210	18	5	0.9	0.0	42.0	52.6
1	210	21	5	0.8	0.0	42.0	34.6
1	210	24	5	1.2	0.0	42.0	34.7
1	210	27	0	1.1	0.0	42.0	42.8
1	210	30	0	1.3	0.0	42.0	42.7
1	210	33	0	1.1	0.0	42.0	35.8
1	210	36	5	1.4	0.0	42.0	34.7
1	210	39	5	1.2	0.0	42.0	42.7
1	210	42	5	0.2	0.0	42.0	35.6
1	240	0	5		0.0	41.0	25.7

Appendix Table A.

Continued.

Station	Transect	Interval (ft)	Embeddedness	Depth (ft)	Velocity (ft/sec)	Wetted width (ft)	Substrate
1	240	3	5	0.6	0.0	41.0	24.7
1	240	6	0	0.6	0.0	41.0	32.7
1	240	9	0	0.8	0.0	41.0	34.8
1	240	12	0	1.2	0.0	41.0	53.8
1	240	15	0	1.3	0.0	41.0	32.7
1	240	18	0	1.6	0.0	41.0	34.8
1	240	21	0	1.4	0.0	41.0	43.7
1	240	24	0	1.3	0.0	41.0	23.7
1	240	27	5	1.3	0.0	41.0	34.8
1	240	30	5	1.0	0.0	41.0	34.6
1	240	33	0	0.9	0.0	41.0	42.7
1	240	36	0	0.4	0.0	41.0	42.7
1	240	39	0	0.5	0.0	41.0	24.6
1	240	41	0		0.0	41.0	35.6
1	270	0	0	0.1	0.0	41.0	51.9
1	270	3	5	1.1	0.0	41.0	51.8
1	270	6	0	1.6	0.0	41.0	43.8
1	270	9	0	1.4	0.0	41.0	32.7
1	270	12	0	1.5	0.0	41.0	43.6
1	270	15	0	1.4	0.0	41.0	35.6
1	270	18	0	1.3	0.0	41.0	34.6
1	270	21	0	1.3	0.0	41.0	45.6
1	270	24	0	0.9	0.0	41.0	34.8
1	270	27	0	0.9	0.0	41.0	54.8
1	270	30	0	1.2	0.0	41.0	35.7
1	270	33	0	0.8	0.0	41.0	53.7
1	270	36	0	0.5	0.0	41.0	34.6
1	270	37	0	0.0	0.0	41.0	43.6
2	0	0	0	0.0	0.0	44.0	34.6
2	0	4	0	1.1	1.9	44.0	35.6
2	0	8	0	1.3	3.1	44.0	35.6
2	0	12	0	1.3	3.8	44.0	53.6
2	0	16	0	1.1	3.7	44.0	52.7
2	0	20	0	1.0	2.3	44.0	53.8
2	0	24	0	1.4	3.3	44.0	53.8
2	0	28	0	1.1	0.9	44.0	53.8
2	0	32	0	0.7	0.5	44.0	45.7
2	0	36	0	0.6	1.4	44.0	53.7
2	0	40	0	0.3	0.7	44.0	45.7
2	0	44	0	0.1	0.0	44.0	52.8
2	30	0	25	0.0	0.0	44.0	13.9

Appendix Table A.

Continued.

Station	Transect	Interval (ft)	Embeddedness	Depth (ft)	Velocity (ft/sec)	Wetted width (ft)	Substrate
2	30	4	0	0.1	0.0	44.0	23.9
2	30	8	0	0.7	0.0	44.0	53.6
2	30	12	0	1.2	0.0	44.0	35.8
2	30	16	0	1.3	0.0	44.0	43.7
2	30	20	5	1.6	0.0	44.0	35.6
2	30	24	0	1.4	0.0	44.0	32.7
2	30	28	0	1.2	0.0	44.0	35.6
2	30	32	0	1.1	0.0	44.0	45.7
2	30	36	5	1.2	0.0	44.0	35.6
2	30	40	0	1.2	0.0	44.0	35.7
2	30	44	0	0.1	0.0	44.0	35.6
2	60	0	5	0.1	0.0	34.0	24.8
2	60	4	0	0.7	0.0	34.0	34.6
2	60	8	0	1.1	0.0	34.0	32.8
2	60	12	0	1.2	0.0	34.0	34.7
2	60	16	0	1.3	0.0	34.0	35.6
2	60	20	0	1.5	0.0	34.0	34.7
2	60	24	0	2.2	0.0	34.0	43.7
2	60	28	0	1.2	0.0	34.0	34.8
2	60	32	5	0.6	0.0	34.0	53.6
2	60	34	5	0.0	0.0	34.0	43.7
2	90	0	5	0.0	0.0	36.0	23.8
2	90	4	5	0.2	0.0	36.0	34.8
2	90	8	0	0.1	0.0	36.0	52.9
2	90	12	5	1.3	0.0	36.0	35.7
2	90	16	0	1.5	0.0	36.0	34.7
2	90	20	5	1.9	0.0	36.0	34.7
2	90	24	0	1.4	0.0	36.0	35.7
2	90	28	0	1.5	0.0	36.0	43.7
2	90	32	0	0.6	0.0	36.0	45.7
2	90	36	5	0.0	0.0	36.0	35.6
2	120	0	5	0.1	0.0	35.0	34.8
2	120	4	5	0.8	0.0	35.0	34.8
2	120	8	0	1.0	0.0	35.0	53.7
2	120	12	0	1.1	0.0	35.0	53.8
2	120	16	0	1.7	0.0	35.0	35.7
2	120	20	0	1.6	0.0	35.0	54.7
2	120	24	0	1.8	0.0	35.0	34.7
2	120	28	5	1.0	0.0	35.0	42.8
2	120	32	0	0.4	0.0	35.0	43.8
2	120	35	5	0.1	0.0	35.0	53.8

Appendix Table A.

Continued.

Station	Transect	Interval (ft)	Embeddedness	Depth (ft)	Velocity (ft/sec)	Wetted width (ft)	Substrate
2	150	0	0	0.2	0.0	31.0	32.6
2	150	4	0	0.3	0.0	31.0	53.8
2	150	8	0	1.8	0.0	31.0	53.6
2	150	12	0	1.5	0.0	31.0	35.6
2	150	16	0	2.0	0.0	31.0	32.7
2	150	20	0	1.6	0.0	31.0	53.7
2	150	24	5	1.5	0.0	31.0	43.8
2	150	28	5	0.5	0.0	31.0	43.8
2	150	31	5	0.1	0.0	31.0	34.6
2	180	0	0	0.1	0.0	27.0	52.9
2	180	4	5	1.2	0.0	27.0	23.8
2	180	8	0	2.0	0.0	27.0	35.8
2	180	12	0	1.7	0.0	27.0	53.7
2	180	16	0	1.6	0.0	27.0	35.9
2	180	20	0	1.6	0.0	27.0	35.8
2	180	24	0	0.8	0.0	27.0	34.7
2	180	27	0	0.0	0.0	27.0	53.8
2	210	0	0	0.0	0.0	31.0	52.9
2	210	4	0	0.0	0.0	31.0	52.9
2	210	8	0	1.5	0.0	31.0	35.7
2	210	12	0	1.5	0.0	31.0	53.6
2	210	16	0	1.6	0.0	31.0	53.9
2	210	20	0	1.3	0.0	31.0	43.7
2	210	24	0	1.1	0.0	31.0	35.6
2	210	28	0	0.6	0.0	31.0	35.6
2	210	31	0	0.1	0.0	31.0	53.7
2	240	0	5	0.2	0.0	30.0	24.7
2	240	4	0	1.0	0.0	30.0	34.8
2	240	8	0	1.2	0.0	30.0	52.9
2	240	12	0	1.5	0.0	30.0	42.6
2	240	16	0	1.5	0.0	30.0	43.7
2	240	20	0	1.7	0.0	30.0	32.7
2	240	24	0	1.6	0.0	30.0	34.8
2	240	28	5	0.9	0.0	30.0	53.7
2	240	30	0	0.2	0.0	30.0	52.8
2	270	0	5	0.0	0.0	28.0	14.8
2	270	4	5	0.8	0.0	28.0	34.6
2	270	8	0	1.3	0.0	28.0	32.7
2	270	12	0	1.4	0.0	28.0	35.6
2	270	16	5	1.5	0.0	28.0	52.8
2	270	20	5	2.1	0.0	28.0	52.7

Appendix Table A.

Continued.

Station	Transect	Interval (ft)	Embeddedness	Depth (ft)	Velocity (ft/sec)	Wetted width (ft)	Substrate
2	270	24	0	1.5	0.0	28.0	43.8
2	270	28	5	0.3	0.0	28.0	52.7
2	300	0	0	0.2	0.0	27.0	24.6
2	300	4	0	1.3	0.0	27.0	53.6
2	300	8	0	1.2	0.0	27.0	52.7
2	300	12	0	1.8	0.0	27.0	53.8
2	300	16	0	1.8	0.0	27.0	43.8
2	300	20	0	1.1	0.0	27.0	53.9
2	300	24	0	0.4	0.0	27.0	35.6
2	300	27	0	0.2	0.0	27.0	52.8
3	0	0	25	0.0	0.0	52.0	14.9
3	0	4	5	0.3	0.3	52.0	52.8
3	0	8	5	0.3	0.3	52.0	52.5
3	0	12	0	1.0	1.0	52.0	34.7
3	0	16	0	1.1	1.1	52.0	24.8
3	0	20	0	0.8	0.8	52.0	24.8
3	0	24	0	1.1	1.1	52.0	35.6
3	0	28	0	1.1	1.1	52.0	35.6
3	0	32	0	1.5	1.5	52.0	53.8
3	0	36	0	0.9	0.9	52.0	34.6
3	0	40	0	1.4	1.4	52.0	43.6
3	0	44	0	1.2	1.2	52.0	35.6
3	0	48	0	0.7	0.7	52.0	24.8
3	0	52	25	0.0	0.0	52.0	14.9
3	30	0	0	0.0	0.0	52.0	51.9
3	30	4	0	0.9	0.0	52.0	43.8
3	30	8	0	0.7	0.0	52.0	52.9
3	30	12	0	1.1	0.0	52.0	45.8
3	30	16	5	1.7	0.0	52.0	51.6
3	30	20	5	1.9	0.0	52.0	52.7
3	30	24	0	1.4	0.0	52.0	54.7
3	30	28	0	1.9	0.0	52.0	43.8
3	30	32	0	1.8	0.0	52.0	43.7
3	30	36	0	1.5	0.0	52.0	34.7
3	30	40	0	1.5	0.0	52.0	53.9
3	30	44	0	1.4	0.0	52.0	24.7
3	30	48	0	0.9	0.0	52.0	23.7
3	30	52	0	0.0	0.0	52.0	24.7
3	60	0	0	0.0	0.0	50.0	15.8
3	60	4	25	0.1	0.0	50.0	14.9
3	60	8	5	0.7	0.0	50.0	51.8

Appendix Table A.

Continued.

Station	Transect	Interval (ft)	Embeddedness	Depth (ft)	Velocity (ft/sec)	Wetted width (ft)	Substrate
3	60	12	0	1.2	0.0	50.0	25.8
3	60	16	0	1.0	0.0	50.0	45.6
3	60	20	0	1.5	0.0	50.0	24.6
3	60	24	0	1.6	0.0	50.0	35.7
3	60	28	0	1.7	0.0	50.0	35.6
3	60	32	0	1.6	0.0	50.0	43.7
3	60	36	0	2.1	0.0	50.0	53.8
3	60	40	0	1.8	0.0	50.0	53.7
3	60	44	0	1.8	0.0	50.0	43.7
3	60	48	5	0.8	0.0	50.0	14.9
3	60	50	5	0.0	0.0	50.0	35.7
3	90	0	5	0.0	0.0	49.0	14.8
3	90	5	5	0.2	0.0	49.0	14.7
3	90	10	0	0.2	0.0	49.0	35.9
3	90	15	5	0.9	0.0	49.0	14.8
3	90	20	0	1.1	0.0	49.0	25.9
3	90	25	0	1.5	0.0	49.0	34.7
3	90	30	0	1.5	0.0	49.0	35.6
3	90	35	0	2.0	0.0	49.0	43.6
3	90	40	0	2.1	0.0	49.0	34.8
3	90	45	0	0.8	0.0	49.0	42.8
3	90	49	0	0.0	0.0	49.0	25.7
3	120	0	5	0.0	0.0	48.0	24.8
3	120	5	0	0.6	0.0	48.0	25.8
3	120	10	0	0.9	0.0	48.0	23.8
3	120	15	0	0.7	0.0	48.0	53.9
3	120	20	0	0.9	0.0	48.0	53.9
3	120	25	0	1.2	0.0	48.0	35.7
3	120	30	0	1.9	0.0	48.0	34.7
3	120	35	0	1.6	0.0	48.0	48.7
3	120	40	0	2.0	0.0	48.0	53.7
3	120	45	0	1.6	0.0	48.0	53.7
3	120	48	0	0.3	0.0	48.0	24.7
3	150	0	25	0.0	0.0	48.0	15.6
3	150	5	0	0.4	0.0	48.0	32.8
3	150	10	0	1.2	0.0	48.0	25.8
3	150	15	0	1.3	0.0	48.0	35.7
3	150	20	0	1.2	0.0	48.0	24.7
3	150	25	0	1.7	0.0	48.0	35.8
3	150	30	0	1.4	0.0	48.0	42.7
3	150	35	0	2.1	0.0	48.0	53.8

Appendix Table A.

Continued.

Station	Transect	Interval (ft)	Embeddedness	Depth (ft)	Velocity (ft/sec)	Wetted width (ft)	Substrate
3	150	40	0	2.1	0.0	48.0	34.8
3	150	45	0	1.5	0.0	48.0	43.6
3	150	48	0	0.8	0.0	48.0	24.6
3	180	0	5	0.0	0.0	52.0	43.7
3	180	5	0	0.2	0.0	52.0	43.8
3	180	10	0	1.3	0.0	52.0	53.9
3	180	15	0	0.7	0.0	52.0	53.7
3	180	20	0	1.1	0.0	52.0	35.8
3	180	25	0	0.9	0.0	52.0	35.7
3	180	30	0	1.4	0.0	52.0	34.6
3	180	35	0	1.3	0.0	52.0	32.7
3	180	40	0	2.2	0.0	52.0	35.6
3	180	45	0	1.7	0.0	52.0	53.7
3	180	50	0	1.0	0.0	52.0	42.7
3	180	52	5	0.7	0.0	52.0	23.7
3	210	0	25	0.0	0.0	53.0	14.8
3	210	5	5	0.9	0.0	53.0	43.8
3	210	10	0	1.3	0.0	53.0	35.8
3	210	15	0	1.6	0.0	53.0	24.8
3	210	20	0	1.4	0.0	53.0	53.8
3	210	25	0	1.6	0.0	53.0	43.8
3	210	30	0	1.9	0.0	53.0	42.8
3	210	35	0	1.6	0.0	53.0	35.8
3	210	40	0	2.2	0.0	53.0	32.7
3	210	45	0	1.7	0.0	53.0	35.7
3	210	50	0	0.7	0.0	53.0	34.7
3	210	53	0	0.0	0.0	53.0	32.7
3	240	0	25	0.0	0.0	47.0	52.8
3	240	5	25	0.9	0.0	47.0	15.9
3	240	10	0	0.7	0.0	47.0	43.9
3	240	15	0	1.6	0.0	47.0	35.8
3	240	20	0	1.9	0.0	47.0	42.8
3	240	25	0	1.3	0.0	47.0	43.8
3	240	30	0	1.9	0.0	47.0	43.7
3	240	35	0	2.1	0.0	47.0	43.8
3	240	40	0	1.4	0.0	47.0	32.8
3	240	45	0	0.2	0.0	47.0	34.7
3	240	47	0	0.0	0.0	47.0	34.9
3	270	0	0	0.0	0.0	38.0	34.7
3	270	5	0	0.9	0.0	38.0	34.7
3	270	10	0	1.6	0.0	38.0	52.9

Appendix Table A.

Continued.

Station	Transect	Interval (ft)	Embeddedness	Depth (ft)	Velocity (ft/sec)	Wetted width (ft)	Substrate
3	270	15	0	1.8	0.0	38.0	35.8
3	270	20	0	2.0	0.0	38.0	32.7
3	270	25	0	2.0	0.0	38.0	53.7
3	270	30	0	1.7	0.0	38.0	34.8
3	270	35	0	0.9	0.0	38.0	23.7
3	270	38	0	0.1	0.0	38.0	42.7
4	0	0	0	0.0	0.0	28.0	32.6
4	0	3	0	0.5	1.3	28.0	32.7
4	0	6	0	1.0	2.2	28.0	34.7
4	0	9	0	1.5	2.9	28.0	43.7
4	0	12	0	1.5	3.2	28.0	34.7
4	0	15	0	1.0	3.9	28.0	43.7
4	0	18	0	1.3	2.4	28.0	34.8
4	0	21	0	1.0	3.5	28.0	35.9
4	0	24	0	0.4	0.7	28.0	34.7
4	0	27	5	0.4	0.2	28.0	43.6
4	0	28	0	0.3	0.0	28.0	43.9
4	30	0	0	0.0	0.0	23.0	42.7
4	30	3	0	0.7	0.0	23.0	34.8
4	30	6	0	0.8	0.0	23.0	32.7
4	30	9	0	1.3	0.0	23.0	34.8
4	30	12	0	1.5	0.0	23.0	35.7
4	30	15	0	1.3	0.0	23.0	43.8
4	30	18	0	1.2	0.0	23.0	34.8
4	30	21	5	1.0	0.0	23.0	35.6
4	30	23	0	0.0	0.0	23.0	23.7
4	60	0	0	0.0	0.0	24.0	42.6
4	60	3	0	0.8	0.0	24.0	24.7
4	60	6	0	1.6	0.0	24.0	43.8
4	60	9	0	1.7	0.0	24.0	53.8
4	60	12	0	1.2	0.0	24.0	52.8
4	60	15	5	2.0	0.0	24.0	15.7
4	60	18	0	1.0	0.0	24.0	34.6
4	60	21	0	0.9	0.0	24.0	24.8
4	60	24	0	0.0	0.0	24.0	23.7
4	90	0	0	0.0	0.0	35.0	52.7
4	90	3	0	0.6	0.0	35.0	25.7
4	90	6	0	1.2	0.0	35.0	25.8
4	90	9	0	1.2	0.0	35.0	35.8
4	90	12	0	1.3	0.0	35.0	34.7
4	90	15	0	0.6	0.0	35.0	34.7

Appendix Table A.

Continued.

Station	Transect	Interval (ft)	Embeddedness	Depth (ft)	Velocity (ft/sec)	Wetted width (ft)	Substrate
4	90	18	0	0.2	0.0	35.0	34.7
4	90	21	0	0.1	0.0	35.0	42.7
4	90	24	0	0.2	0.0	35.0	24.8
4	90	27	0	0.6	0.0	35.0	34.6
4	90	30	0	1.1	0.0	35.0	43.6
4	90	33	0	0.6	0.0	35.0	32.8
4	90	35	0	0.0	0.0	35.0	34.8
4	120	0	0	0.0	0.0	44.0	35.7
4	120	3	0	0.9	0.0	44.0	42.7
4	120	6	0	0.6	0.0	44.0	45.8
4	120	9	0	1.2	0.0	44.0	52.8
4	120	12	0	1.1	0.0	44.0	52.9
4	120	15	0	1.1	0.0	44.0	43.8
4	120	18	0	0.6	0.0	44.0	35.7
4	120	21	0	0.6	0.0	44.0	25.9
4	120	24	0	0.2	0.0	44.0	45.8
4	120	27	0	0.3	0.0	44.0	43.8
4	120	30	0	0.5	0.0	44.0	25.7
4	120	33	0	0.5	0.0	44.0	35.7
4	120	36	0	0.6	0.0	44.0	53.9
4	120	39	0	0.7	0.0	44.0	34.7
4	120	42	0	0.3	0.0	44.0	32.7
4	120	44	0	0.3	0.0	44.0	52.8
4	150	0	0	0.0	0.0	45.0	34.6
4	150	3	0	0.4	0.0	45.0	42.7
4	150	6	0	0.7	0.0	45.0	35.8
4	150	9	0	0.4	0.0	45.0	53.9
4	150	12	0	0.6	0.0	45.0	43.6
4	150	15	0	0.5	0.0	45.0	43.7
4	150	18	0	0.9	0.0	45.0	53.9
4	150	21	0	0.6	0.0	45.0	35.7
4	150	24	0	0.8	0.0	45.0	34.8
4	150	27	0	0.9	0.0	45.0	34.7
4	150	30	0	1.1	0.0	45.0	34.7
4	150	33	0	1.1	0.0	45.0	35.8
4	150	36	0	0.9	0.0	45.0	32.7
4	150	39	0	0.7	0.0	45.0	34.8
4	150	42	0	0.8	0.0	45.0	24.8
4	150	45	0	0.0	0.0	45.0	42.8
4	180	0	5	0.0	0.0	42.0	32.7
4	180	3	0	0.3	0.0	42.0	25.8

Appendix Table A.

Continued.

Station	Transect	Interval (ft)	Embeddedness	Depth (ft)	Velocity (ft/sec)	Wetted width (ft)	Substrate
4	180	6	5	1.5	0.0	42.0	23.9
4	180	9	5	0.8	0.0	42.0	25.8
4	180	12	0	0.2	0.0	42.0	24.9
4	180	15	0	0.3	0.0	42.0	35.9
4	180	18	0	0.3	0.0	42.0	25.9
4	180	21	0	0.7	0.0	42.0	23.9
4	180	24	0	1.1	0.0	42.0	34.7
4	180	27	0	1.2	0.0	42.0	34.7
4	180	30	0	1.3	0.0	42.0	34.7
4	180	33	0	1.6	0.0	42.0	35.7
4	180	36	0	1.2	0.0	42.0	23.7
4	180	39	5	0.6	0.0	42.0	24.9
4	180	42	0	0.0	0.0	42.0	24.9
4	210	0	0	0.0	0.0	33.0	45.8
4	210	3	0	0.5	0.0	33.0	34.7
4	210	6	0	0.6	0.0	33.0	53.8
4	210	9	0	0.4	0.0	33.0	53.9
4	210	12	0	0.3	0.0	33.0	53.8
4	210	15	0	0.6	0.0	33.0	53.9
4	210	18	0	1.0	0.0	33.0	43.8
4	210	21	0	1.6	0.0	33.0	34.7
4	210	24	0	1.3	0.0	33.0	34.7
4	210	27	0	1.5	0.0	33.0	35.8
4	210	30	0	1.2	0.0	33.0	53.8
4	210	33	0	0.0	0.0	33.0	53.8
4	240	0	0	0.0	0.0	33.0	34.7
4	240	3	0	0.5	0.0	33.0	35.6
4	240	6	0	0.8	0.0	33.0	53.9
4	240	9	0	2.8	0.0	33.0	34.7
4	240	12	0	1.5	0.0	33.0	43.7
4	240	15	0	1.2	0.0	33.0	34.8
4	240	18	0	0.9	0.0	33.0	23.8
4	240	21	0	0.4	0.0	33.0	23.7
4	240	24	0	0.6	0.0	33.0	24.7
4	240	27	0	0.7	0.0	33.0	24.8
4	240	30	0	0.8	0.0	33.0	24.9
4	240	33	0	0.1	0.0	33.0	23.6
4	270	0	5	0.0	0.0	43.0	23.9
4	270	3	0	0.4	0.0	43.0	21.8
4	270	9	0	0.6	0.0	43.0	34.8
4	270	12	0	0.6	0.0	43.0	34.9

Appendix Table A.

Continued.

Station	Transect	Interval (ft)	Embeddedness	Depth (ft)	Velocity (ft/sec)	Wetted width (ft)	Substrate
4	270	15	0	0.9	0.0	43.0	34.9
4	270	18	0	0.8	0.0	43.0	34.8
4	270	21	0	1.2	0.0	43.0	35.8
4	270	24	0	1.5	0.0	43.0	34.8
4	270	27	5	1.2	0.0	43.0	25.9
4	270	30	0	0.5	0.0	43.0	34.9
4	270	33	0	0.4	0.0	43.0	35.9
4	270	36	5	0.2	0.0	43.0	24.8
4	270	39	0	0.4	0.0	43.0	35.8
4	270	42	0	0.3	0.0	43.0	34.7
4	270	43	0	0.0	0.0	43.0	24.8
5	0	0	0	0.0	0.0	5.0	23.6
5	0	1	0	1.0	0.0	5.0	25.8
5	0	2	0	0.8	0.0	5.0	25.9
5	0	3	0	0.7	0.0	5.0	23.8
5	0	4	0	0.5	0.0	5.0	24.9
5	0	5	0	0.1	0.0	5.0	12.9
5	30	0	75	0.0	0.0	9.0	12.9
5	30	1	75	0.2	0.0	9.0	12.9
5	30	2	75	0.5	1.3	9.0	12.9
5	30	3	75	0.5	1.1	9.0	12.9
5	30	4	75	0.5	1.0	9.0	12.9
5	30	5	75	0.4	1.0	9.0	12.9
5	30	6	75	0.4	0.7	9.0	12.9
5	30	7	75	0.3	0.6	9.0	12.9
5	30	8	75	0.3	0.0	9.0	12.9
5	30	9	75	0.0	0.0	9.0	12.9
5	60	0	0	0.0	0.0	12.0	23.8
5	60	1	0	0.4	0.0	12.0	23.8
5	60	2	0	0.3	0.0	12.0	23.9
5	60	3	0	0.0	0.0	12.0	52.9
5	60	4	0	0.0	0.0	12.0	52.9
5	60	5	0	0.0	0.0	12.0	52.9
5	60	6	0	0.0	0.0	12.0	52.9
5	60	7	0	0.0	0.0	12.0	52.9
5	60	8	0	0.0	0.0	12.0	52.9
5	60	9	0	0.4	0.0	12.0	32.7
5	60	10	0	0.6	0.0	12.0	32.8
5	60	11	0	0.4	0.0	12.0	23.8
5	60	12	0	0.0	0.0	12.0	12.9
5	90	0	0	0.0	0.0	8.0	12.9

Appendix Table A.

Continued.

Station	Transect	Interval (ft)	Embeddedness	Depth (ft)	Velocity (ft/sec)	Wetted width (ft)	Substrate
5	90	1	25	0.6	0.0	8.0	13.9
5	90	2	5	0.7	0.0	8.0	23.8
5	90	3	0	0.8	0.0	8.0	32.8
5	90	4	0	0.5	0.0	8.0	32.8
5	90	5	0	0.4	0.0	8.0	42.8
5	90	6	0	0.5	0.0	8.0	42.8
5	90	7	25	0.5	0.0	8.0	15.9
5	90	8	0	0.2	0.0	8.0	15.9
5	120	0	0	0.0	0.0	15.0	32.9
5	120	1	5	0.5	0.0	15.0	34.8
5	120	2	0	0.2	0.0	15.0	24.9
5	120	3	0	0.6	0.0	15.0	32.9
5	120	4	0	0.5	0.0	15.0	42.9
5	120	5	0	0.6	0.0	15.0	24.8
5	120	6	0	0.4	0.0	15.0	62.7
5	120	7	0	0.3	0.0	15.0	45.8
5	120	8	0	0.0	0.0	15.0	51.9
5	120	9	0	0.0	0.0	15.0	0
5	120	10	0	0.0	0.0	15.0	0
5	120	11	0	0.0	0.0	15.0	0
5	120	12	0	0.0	0.0	15.0	0
5	120	13	0	0.4	0.0	15.0	36.7
5	120	14	0	0.4	0.0	15.0	36.8
5	120	15	0	0.1	0.0	15.0	56.8
5	150	0	5	0.0	0.0	10.0	12.9
5	150	1	5	0.1	0.0	10.0	12.9
5	150	2	5	0.4	0.0	10.0	12.9
5	150	3	5	0.5	0.0	10.0	14.9
5	150	4	5	0.3	0.0	10.0	34.7
5	150	5	0	0.6	0.0	10.0	34.8
5	150	6	0	0.6	0.0	10.0	43.8
5	150	7	0	0.7	0.0	10.0	34.8
5	150	8	5	0.7	0.0	10.0	24.8
5	150	9	5	0.5	0.0	10.0	24.8
5	150	10	5	0.2	0.0	10.0	13.9
5	180	0	25	0.0	0.0	11.0	12.9
5	180	1	25	0.2	0.0	11.0	13.9
5	180	2	25	0.4	0.0	11.0	13.9
5	180	3	25	0.5	0.0	11.0	13.9
5	180	4	25	0.5	0.0	11.0	13.8
5	180	5	0	0.0	0.0	11.0	51.9

Appendix Table A.

Continued.

Station	Transect	Interval (ft)	Embeddedness	Depth (ft)	Velocity (ft/sec)	Wetted width (ft)	Substrate
5	180	6	0	0.0	0.0	11.0	51.9
5	180	7	0	0.6	0.0	11.0	32.8
5	180	8	0	0.6	0.0	11.0	34.8
5	180	9	0	0.4	0.0	11.0	53.9
5	180	10	5	0.2	0.0	11.0	51.8
5	180	11	0	0.0	0.0	11.0	56.7
5	210	0	50	0.0	0.0	13.0	13.9
5	210	1	25	0.3	0.0	13.0	13.9
5	210	2	5	0.4	0.0	13.0	13.9
5	210	3	5	0.3	0.0	13.0	13.9
5	210	4	5	0.4	0.0	13.0	21.8
5	210	5	0	0.4	0.0	13.0	32.8
5	210	6	0	0.6	0.0	13.0	62.8
5	210	7	5	0.6	0.0	13.0	62.8
5	210	8	5	0.6	0.0	13.0	32.8
5	210	9	5	0.6	0.0	13.0	21.6
5	210	10	25	0.6	0.0	13.0	21.7
5	210	11	25	0.5	0.0	13.0	16.9
5	210	12	25	0.3	0.0	13.0	16.7
5	210	13	25	0.2	0.0	13.0	16.8
5	240	0	25	0.0	0.0	15.0	16.7
5	240	1	25	0.3	0.0	15.0	16.8
5	240	2	25	0.5	0.0	15.0	12.9
5	240	3	25	0.5	0.0	15.0	16.8
5	240	4	25	0.5	0.0	15.0	16.9
5	240	5	25	0.5	0.0	15.0	16.9
5	240	6	25	0.4	0.0	15.0	16.8
5	240	7	25	0.4	0.0	15.0	16.6
5	240	8	25	0.3	0.0	15.0	16.6
5	240	9	25	0.1	0.0	15.0	61.6
5	240	10	25	0.3	0.0	15.0	61.7
5	240	11	25	0.1	0.0	15.0	61.9
5	240	12	0	0.4	0.0	15.0	61.9
5	240	13	0	0.6	0.0	15.0	26.8
5	240	14	0	0.6	0.0	15.0	26.6
5	240	15	0	0.1	0.0	15.0	61.8

Appendix Table B.

Fish Population Inventory Data.

Date	Station	Pass	Shocking Duration (min)	Species	Length (mm)
9/20/88	1	1	53	coho salmon	68
9/20/88	1	1	53	coho salmon	82
9/20/88	1	1	53	coho salmon	69
9/20/88	1	1	53	coho salmon	74
9/20/88	1	1	53	coho salmon	75
9/20/88	1	1	53	coho salmon	73
9/20/88	1	1	53	coho salmon	71
9/20/88	1	1	53	coho salmon	72
9/20/88	1	1	53	coho salmon	68
9/20/88	1	1	53	coho salmon	54
9/20/88	1	1	53	coho salmon	59
9/20/88	1	1	53	coho salmon	78
9/20/88	1	1	53	coho salmon	60
9/20/88	1	1	53	coho salmon	82
9/20/88	1	1	53	coho salmon	78
9/20/88	1	1	53	coho salmon	79
9/20/88	1	1	53	coho salmon	68
9/20/88	1	1	53	coho salmon	72
9/20/88	1	1	53	coho salmon	57
9/20/88	1	1	53	coho salmon	55
9/20/88	1	1	53	coho salmon	68
9/20/88	1	1	53	coho salmon	68
9/20/88	1	1	53	coho salmon	72
9/20/88	1	1	53	coho salmon	63
9/20/88	1	1	53	coho salmon	57
9/20/88	1	1	53	Dolly Varden	169
9/20/88	1	2	53	coho salmon	74
9/20/88	1	2	53	coho salmon	65
9/20/88	1	2	53	coho salmon	67
9/20/88	1	2	53	coho salmon	63
9/20/88	1	2	53	coho salmon	60
9/20/88	1	2	53	coho salmon	67
9/20/88	1	2	53	coho salmon	66
9/20/88	1	2	53	coho salmon	65
9/20/88	1	2	53	coho salmon	66
9/20/88	1	2	53	coho salmon	80
9/20/88	1	2	53	coho salmon	81
9/20/88	1	2	53	coho salmon	65
9/20/88	1	2	53	coho salmon	70

Appendix Table B.

Continued.

Date	Station	Pass	Shocking Duration (min)	Species	Length (mm)
9/20/88	1	2	53	coho salmon	66
9/20/88	1	2	53	coho salmon	62
9/20/88	1	2	53	coho salmon	50
9/20/88	1	2	53	coho salmon	69
9/20/88	1	2	53	coho salmon	70
9/20/88	1	2	53	coho salmon	68
9/20/88	1	2	53	coho salmon	59
9/20/88	1	2	53	coho salmon	66
9/20/88	1	2	53	coho salmon	59
9/20/88	1	2	53	coho salmon	67
9/20/88	1	2	53	coho salmon	57
9/20/88	1	2	53	coho salmon	71
9/20/88	1	2	53	coho salmon	59
9/20/88	1	3	34	coho salmon	70
9/20/88	1	3	34	coho salmon	69
9/20/88	1	3	34	coho salmon	69
9/20/88	1	3	34	coho salmon	61
9/20/88	1	3	34	coho salmon	66
9/20/88	1	3	34	coho salmon	59
9/20/88	1	3	34	coho salmon	67
9/20/88	1	3	34	coho salmon	57
9/20/88	1	3	34	coho salmon	63
9/20/88	1	3	34	coho salmon	65
9/20/88	1	3	34	coho salmon	57
9/20/88	1	3	34	coho salmon	53
9/20/88	1	3	34	coho salmon	55
9/20/88	1	3	34	coho salmon	65
9/20/88	1	3	34	coho salmon	80
9/20/88	1	3	34	coho salmon	70
9/20/88	1	3	34	coho salmon	73
9/20/88	1	3	34	coho salmon	84
9/20/88	1	3	34	coho salmon	63
9/20/88	1	3	34	coho salmon	74
9/20/88	1	3	34	coho salmon	76
9/20/88	1	3	34	coho salmon	67
9/20/88	1	3	34	coho salmon	58
9/20/88	1	3	34	coho salmon	75
9/20/88	1	3	34	coho salmon	60
9/20/88	1	3	34	coho salmon	56
9/20/88	1	3	34	coho salmon	74

Appendix Table B.

Continued.

Date	Station	Pass	Shocking Duration (min)	Species	Length (mm)
9/20/88	1	3	34	coho salmon	67
9/20/88	1	3	34	coho salmon	74
9/20/88	1	3	34	coho salmon	75
9/20/88	1	3	34	Dolly Varden	65
9/20/88	2	1	52	Dolly Varden	151
9/20/88	2	1	52	Dolly Varden	130
9/20/88	2	1	52	Dolly Varden	130
9/20/88	2	1	52	Dolly Varden	89
9/20/88	2	1	52	Dolly Varden	55
9/20/88	2	1	52	Dolly Varden	147
9/20/88	2	1	52	Dolly Varden	49
9/20/88	2	1	52	Dolly Varden	43
9/20/88	2	2	46	Dolly Varden	80
9/20/88	2	2	46	Dolly Varden	49
9/20/88	2	2	46	Dolly Varden	131
9/21/88	3	1	59	Dolly Varden	106
9/21/88	3	1	59	Dolly Varden	46
9/21/88	3	1	59	Dolly Varden	50
9/21/88	3	1	59	Dolly Varden	49
9/21/88	3	1	59	Dolly Varden	47
9/21/88	3	2	60	Dolly Varden	117
9/21/88	3	2	60	Dolly Varden	95
9/21/88	3	2	60	Dolly Varden	101
9/21/88	3	2	60	Dolly Varden	111
9/21/88	3	2	60	Dolly Varden	54
9/21/88	3	2	60	Dolly Varden	112
9/21/88	3	2	60	Dolly Varden	127
9/21/88	3	3	55	Dolly Varden	117
9/21/88	3	3	55	Dolly Varden	124
9/21/88	3	3	55	Dolly Varden	139
9/21/88	3	3	55	Dolly Varden	74
9/21/88	3	3	55	Dolly Varden	50
9/23/88	4	1	61	Dolly Varden	120
9/23/88	4	1	61	Dolly Varden	144
9/23/88	4	1	61	Dolly Varden	129
9/23/88	4	1	61	Dolly Varden	44
9/23/88	4	1	61	Dolly Varden	89
9/23/88	4	1	61	Dolly Varden	45
9/23/88	4	2	40	Dolly Varden	114
9/23/88	4	2	40	Dolly Varden	126

Appendix Table B.

Continued.

Date	Station	Pass	Shocking Duration (min)	Species	Length (mm)
9/23/88	4	2	40	Dolly Varden	145
9/23/88	4	2	40	Dolly Varden	119
9/23/88	4	2	40	Dolly Varden	120
9/23/88	4	2	40	Dolly Varden	130
9/23/88	4	2	40	Dolly Varden	123
9/23/88	4	2	40	Dolly Varden	51
9/23/88	4	2	40	Dolly Varden	48
9/23/88	4	3	41	Dolly Varden	180
9/23/88	4	3	41	Dolly Varden	134
9/23/88	4	3	41	Dolly Varden	109
9/23/88	4	3	41	Dolly Varden	90
9/21/88	5	1	40	Dolly Varden	50
9/21/88	5	1	40	rainbow trout	47
9/21/88	5	1	40	rainbow trout	45
9/21/88	5	1	40	rainbow trout	46
9/21/88	5	1	40	rainbow trout	42
9/21/88	5	1	40	rainbow trout	42
9/21/88	5	1	40	rainbow trout	41
9/21/88	5	1	40	rainbow trout	90
9/21/88	5	1	40	rainbow trout	44
9/21/88	5	1	40	rainbow trout	40
9/21/88	5	1	40	rainbow trout	46
9/21/88	5	2	32	Dolly Varden	151
9/21/88	5	2	32	rainbow trout	103
9/21/88	5	2	32	rainbow trout	44
9/21/88	5	2	32	rainbow trout	40
9/21/88	5	2	32	rainbow trout	36
9/21/88	5	2	32	rainbow trout	45

Appendix Table C.

Benthic Macroinvertebrate Laboratory Data.

Station	Replicate	Taxonomic Group	Count	Wet Weight (gm)	Multiplier
1	1	Ephemeroptera	39	0.2876	6
1	1	Plecoptera	58	0.0732	6
1	1	Trichoptera	6	0.0406	6
1	1	Diptera/Chironomid	34	0.0579	6
1	2	Ephemeroptera	14	0.1603	6
1	2	Plecoptera	20	0.0255	6
1	2	Trichoptera	4	0.0189	6
1	2	Diptera	40	0.0406	6
1	2	Ephemeroptera	18	0.1579	1
1	2	Plecoptera	23	0.0346	1
1	2	Trichoptera	10	0.2165	1
1	2	Diptera	46	0.0669	1
2	1	Ephemeroptera	20	0.1601	3
2	1	Plecoptera	30	0.0551	3
2	1	Trichoptera	24	0.0254	3
2	1	Diptera	25	0.0917	3
2	2	Ephemeroptera	36	0.1645	3
2	2	Plecoptera	41	0.0536	3
2	2	Trichoptera	23	0.0495	3
2	2	Diptera	28	0.0364	3
2	3	Ephemeroptera	22	0.0915	2
2	3	Plecoptera	11	0.0231	2
2	3	Trichoptera	22	0.0701	2
2	3	Diptera	22	0.0443	2
3	1	Ephemeroptera	22	0.0719	2
3	1	Plecoptera	14	0.0079	2
3	1	Trichoptera	38	0.0296	2
3	1	Diptera	21	0.0499	2
3	2	Ephemeroptera	9	0.0272	1
3	2	Plecoptera	23	0.0413	1
3	2	Trichoptera	83	0.1390	1
3	2	Diptera	42	0.0538	1
3	3	Ephemeroptera	17	0.0959	5
3	3	Plecoptera	23	0.0262	5
3	3	Trichoptera	47	0.0720	5
3	3	Diptera	46	0.0849	5
4	1	Ephemeroptera	17	0.1243	1
4	1	Plecoptera	28	0.0721	1
4	1	Trichoptera	10	0.0215	1

Appendix Table C.

Continued.

Station	Replicate	Taxonomic Group	Count	Wet Weight (gm)	Multiplier
4	1	Diptera	11	0.0101	1
4	2	Ephemeroptera	15	0.1106	1
4	2	Plecoptera	15	0.0124	1
4	2	Trichoptera	5	0.0312	1
4	2	Diptera	10	0.0198	1
4	3	Ephemeroptera	40	0.3067	1
4	3	Plecoptera	74	0.1706	1
4	3	Trichoptera	13	0.0554	1
4	3	Diptera	21	0.0677	1
5	1	Ephemeroptera	0	0.0000	1
5	1	Plecoptera	45	0.0547	1
5	1	Trichoptera	7	0.2569	1
5	1	Diptera	18	0.0502	1
5	2	Ephemeroptera	2	0.0078	1
5	2	Plecoptera	98	0.1215	1
5	2	Trichoptera	25	0.3217	1
5	2	Diptera	34	0.0682	1
5	3	Ephemeroptera	1	0.0039	2
5	3	Plecoptera	46	0.0335	2
5	3	Trichoptera	21	0.2306	2
5	3	Diptera	26	0.0879	2

ADDENDA

ADDENDUM 1

AQUATIC BIOLOGICAL RESOURCES REPORT FOR MOOSE AND BUFFALO CREEKS

Technical Report

Aquatic Biological Resources
Moose Creek and Buffalo Creek
Wishbone Hill Resource Area

Prepared for

Usibelli Coal Mine, Inc.

November 19, 2008

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APPENDICES

1.0 Introduction

This report presents the results of recent fisheries and macroinvertebrate sampling conducted in the Moose Creek watershed in the Matanuska basin, Alaska. Sampling efforts and surveys were conducted to provide long term monitoring data from previously established sampling stations and protocols designed and implemented in 1988. An effort was made to repeat general sampling efforts and locales to provide comparative data. Some techniques and sampling methods were adjusted to meet existing environmental conditions and newly accepted protocols. In addition, recent stream channel restoration efforts necessitated additional analysis to account for increased salmon passage within the sampled watershed.

2.0 Background

The following provides environmental background of the Wishbone Hill Resource Area and the specific Moose Creek and Buffalo Creek study area.

2.1 Study area

The study area is located in the Matanuska basin near the town of Palmer, AK. The study area includes segments of Moose Creek and the entirety of Buffalo Creek.

Moose Creek is a tributary to the Matanuska River and enters the River approximately 6 miles northeast of Palmer. Moose Creek is crossed by the Glenn Highway (Highway 1) approximately 0.8 miles upstream from its confluence with the River. Buffalo Mine Road runs parallel to Moose Creek for approximately 6.7 miles before it splits into private roadways. The study area on Moose Creek includes the reach between the Glenn Highway Crossing and the upper extent of Buffalo Mine Road.

Buffalo Creek is a tributary to Moose Creek and enters on the left bank of the stream (facing downstream). Buffalo Creek is approximately 2 miles long and originates at the outlet of Wishbone Lake, located 10 air miles northeast of Palmer. The study area of Buffalo Creek includes the entirety of Buffalo Creek.

2.1.1 General Environment Conditions

Moose Creek

Moose Creek is a large stream that originates in the Talkeetna Mountains. Moose Creek has a total drainage area of approximately 47.3 square miles and receives several tributaries, including Premier Creek, Buffalo Mine Creek, and several unnamed creeks and two forks of Moose Creek at the upper end of the study area. Gauging data is recorded by the US Geological Survey (USGS) near the Glenn Highway Bridge. The

highest discharge indicated by the USGS at the gauging area indicates a flow of 1075 cfs. Average flow indicated during the late September to early October study period is between approximately 90 and 100 cfs, for three years of recorded values (USGS 2008).

Most of study area reach of Moose Creek is characterized by cascades and high velocity riffles. Pools and slow water habitats are limited to stream bank margins, plunge pools, pocket pools behind large boulders, and side channels. Side channels are found throughout the stream study reach and are typically low in gradient, but not abundant. Approximately 3 miles of Moose Creek flow through Tsadaka Canyon. This canyon is a narrow U-shaped canyon that confines the stream. Upstream of the canyon the creek occupies a relatively narrow valley with an old railroad bed following the majority of the study area reach. The width of Moose Creek within the study area ranges from 25-50 feet with the depth averaging about 2 feet. Substrate is composed of primarily cobbles and boulders, with gravel and sand in margins and side channels.

Buffalo Creek
Buffalo Creek is a small stream and tributary of Moose Creek. Buffalo Mine Creek ranges from 1- 6 feet wide and averages 0.5 feet deep. We estimated the flow of Buffalo Creek at 2-3 cfs. Buffalo Creek originates at the western end of Wishbone Lake on a plateau at about 1500 feet elevation. This creek flows in a westerly direction before it enters Moose Creek. Buffalo Creek flows through a series of conglomerate bluffs approximately 1000 feet downstream of Wishbone Lake and descends steeply to a relatively flat bench above Moose Creek. Flatter segments of the stream are highly sinuous with substrate dominated by sand, silt, gravel, and cobble. Stream segments that intersect the conglomerate bluffs form substantial alcove undercuts within the rock and several waterfalls and chutes over 7' in height are interspersed within these reaches.

2.1.2 Riparian Habitat

Moose Creek
Riparian habitat along the majority of Moose Creek is dominated by an over story of black cottonwood (*Populus trichocarpa*), paper birch (*Betula neoalaskana*), quaking aspen (*Populus tremuloides*), and spruce (*Picea sp.*). The understory is comprised of devils club (*Oplopanax horridus*), currant (*Ribes sp.*), alder (*Alnus sp.*), prickly rose (*Rosa acicularis*), and willows (*Salix sp.*). Most segments of stream bank are heavily vegetated and stable. However, several large slumps and slides exist including a large slide near a power line crossing, a large bank failure in the upper reaches of the study area at the base of Buffalo Mine Road, and smaller natural slides associated with geologic features, including a number near the confluences of Premier, and Buffalo Mine Creek.

2.1.3 Topography and Geology

The study area is located at the southern foot of the Talkeetna Mountains. Moose Creek arises in a valley between Arkose Peak and Eska Mountain. Just south (downstream) of

the confluence with Buffalo Mine Creek and Premier Creek, Moose Creek enters into Tsadaka Canyon.

2.1.4 Climate

The study area experiences weather similar to communities in the Cook Inlet area. Data from the Alaska Climate Research Center for years 1971 - 2000 puts the average annual temperature at 36 degrees with 62.9 inches of snowfall and 15.8 inches of accumulated precipitation (water equivalent) annually (Alaska Climate Research Center 2008).

2.3 Aquatic Biological Resources

The following section presents known records and data previously collected in the study area related to aquatic biological resources.

2.3.1 Historic Fisheries and Previous Results

Previous Methods and Analysis

As part of environmental monitoring associated with previous mine permitting, Dames and Moore completed an analysis of aquatic habitat, fisheries, and macroinvertebrate communities in 1988. During this analysis Dames and Moore conducted general habitat surveys, salmon spawning counts, systematic fisheries sampling at 5 stations, macroinvertebrate sampling at 5 stations, water quality sampling, and reconnaissance fish sampling throughout the study area. The 5 stations were intended as long-term monitoring sites and are located throughout the watershed to capture potential changes at significant confluences and points of potential accumulated effects. Stations were established at the following locations:

Station 1 - Moose Creek, immediately upstream of Glenn Highway crossing

Station 2 – Moose Creek, immediately upstream of Premier Creek confluence.

Station 3 – Moose Creek, at rivermile 4.9

Station 4 – Moose Creek, at rivermile 6.8, upstream of bridge at fork.

Station 5 – Buffalo Creek, immediately upstream of confluence with Moose Creek

All sample stations were 240 to 300 feet in length, with widths and general habitat varying.

Dames and Moore utilized a backpack electrofisher and dip nets to collect fisheries population data at all stations. Multiple pass/removal was used to estimate fish populations. General and exploratory sampling by Dames and Moore in Moose and

Buffalo Creek was also conducted with a backpack electrofisher and dip nets. During this sampling, collected fish were measured and released and a population estimate was not produced. General presence and absence of fish species was the primary objective of the exploratory sampling.

The collection of benthic macroinvertebrates was made with the use of a Hess sampler. This sampler was embedded in the substrate while all substrate was scrubbed with a brush and the bed sediment disturbed with a long screwdriver. Three replicate samples were made with the Hess sampler at all stations and a subset of each replicate was utilized for taxa identification and density estimates.

Spawning surveys were also conducted by Dames and Moore on Moose Creek from the Glenn Highway crossing (RM 0.8) to the Premier Creek Bridge (since removed) at RM (3.9). Dames and Moore focused their spawning surveys on coho salmon and conducted surveys on September 26 and October 10th, 1988.

Dames and Moore 1988 Fish Community Results

Reconnaissance Survey

The general reconnaissance survey by Dames and Moore documented the presence of juvenile and adult coho salmon (*Oncorhynchus kisutch*) throughout the lower reach (RM .08 – RM 3.2) and downstream of a large waterfall at RM 3.2 (since removed). During the reconnaissance survey several spawning Chinook salmon (*Oncorhynchus tshwaytscha*) were also observed in the reach of Moose Creek below the waterfall. Dolly Varden (*Salvelinus malma*) were noted in spot sampling upstream of the waterfall on Moose Creek at several locations and as far upstream as RM 5.2. Reconnaissance sampling in Buffalo Mine Creek found that rainbow trout (*Oncorhynchus mykiss*) occurred in proximity to the confluence with Moose Creek and closer to Wishbone Lake (within ¾ of a mile of the lake outlet). Dolly Varden were collected in Buffalo Creek in the lower reach near the confluence with Moose Creek.

Spawning Survey

Dames and Moore conducted spawning surveys for coho salmon only. ADF&G conducted spawning surveys for Chinook salmon on July 27th, 1988. ADF&G recorded the highest number of spawning Chinook salmon during that year with 1,072 individuals counted in the entire stream reach (mouth to waterfall) and 716 were counted upstream of the Glenn Highway Bridge (Dames and Moore report, Appendix C). Results of the two Dames and Moore spawning surveys identified 87 fish (live and carcasses) during the September 26 count and 123 fish during the October 10th count. Dames and Moore estimated escapement at more than 100 fish. No adult coho were identified during spawning counts above the waterfall.

Station Sampling

Station sampling resulted in the collection of coho salmon and Dolly Varden at Station 1, Dolly Varden alone at Stations 2, 3, and 4, and Dolly Varden and rainbow trout at Station 5. Densities were estimated by age class for rainbow trout and Dolly Varden and were only measured for juvenile coho. Estimated densities for all species across all stations ranged from 0.0016 to 0.06 fish/square yard. The highest species density measured was for juvenile coho salmon at Station 1 with a density of 0.06 fish/square yard and the lowest density measured for a species and a station was for Dolly Varden at Station 2 with an estimated density of 0.0016 fish/square yard.

Dames and Moore 1988 Macroinvertebrate Results

Hess derived macroinvertebrate samples were analyzed by Dames and Moore. Samples were sorted into taxonomic groups before counts and wet weights were recorded. Results indicated that no significant difference in macroinvertebrate densities between the sample stations was found. The taxonomic composition of the samples found that Plecoptera (stoneflies) and Diptera (true flies) were most common at Stations 1 and 5, stoneflies and Ephemeroptera (mayflies) were most common at Stations 2 and 4, and Trichoptera (caddisflies) and true flies were most common at Station 3.

The most frequently occurring family for each order collected is listed in Table 1.

TABLE 1. Most commonly occurring family by order. Dames and Moore Study 1988

Order	Family	Common Name
Ephemeroptera	*Heptageniidae*	Flat-headed mayflies
Plecoptera	*Chloroperlidae*	Green stoneflies
Trichoptera	*Glossosomatidae*	Little black caddisfly
Diptera	*Chironomidae*	Non-biting midges

2.4 Hydrologic Alterations

In recent history the stream channel and riparian area associated with Moose Creek has experienced alteration due to the construction and operation of the Moose Creek railroad spur. Evidence of the spur still exists on site with noticeable segments of constructed rail bed, several small trestles, rail segments and other railroad related hardware located throughout the study area.

Channel straightening and additional stream bank confinement likely created features within Moose Creek that prevented, or greatly hindered fish passage beyond. Such is suspected with the case of the waterfall at RM 3.2 indicated in the Dames and Moore report. ADF&G collection records sited by Dames and Moore and results of fish sampling and spawning surveys indicated that adult salmon passage above this waterfall

rarely occurred. Furthermore, the Chickaloon Village Corporation website (2008) indicates that the waterfall was a hindrance to the passage of salmon that historically utilized upstream areas. Additionally, the Tribe indicates the loss of channel meanders and habitat diversity from this and other channel alterations caused by previous mining and railroad use and development.

2.4.1 Restoration Project

In 2005 the Chickaloon Village Corporation undertook a stream realignment project to create a meandering stream reach around the site of the impassible waterfall. The Tribe and project partners excavated a new channel, removed trees and obstructions, and filled in the channel leading to the waterfall. At the conclusion of the project, flows were restored around the waterfall escarpment and the upstream reach of the project area became passable for salmon.

Following the completion of the channel reroute around the large waterfall, a second phase of the restoration was completed. Phase II included additional reroute of a stream channel segment of Moose Creek that bypassed three small waterfalls that were expected to impede upstream fish passage. The Phase II project was completed in the summer of 2006.

In August of 2005, after the completion of the Phase I component of the project, Chickaloon Village Corporation personnel conducted a spawning census of Chinook salmon upstream of the waterfall site. During the survey 174 live Chinook and 41 carcasses were counted (Chickaloon Village Corporation 2008) demonstrating the increased accessibility and passage provided through the project.

2.5 Water Quality

This section presents general water quality, current and historic, gathered for Moose and Buffalo Creeks.

2.5.1 General Water Quality

Dames and Moore collected water quality data during the 1988 assessment. Parameters analyzed included dissolved oxygen, conductivity, temperature, pH, and suspended solids. Water quality results were typical for a relatively undeveloped watershed. Water temperatures ranged from 5.3 to 8.2 degrees Celsius, pH ranged from 6.3 to 8.7, dissolved oxygen from 7.5-12.5 ppm, conductivity from 35 to 1,820, and total suspended solids ranged from < 1.0 to 19.0 mg/L. The highest conductivity values were derived from samples taken during a large storm event and from samples on both streams.

The US Geological Survey (USGS) maintains a stream gauge on Moose Creek near the Glenn Highway crossing. The gauging station has been established since 2005. The gauge monitors gauge height, discharge, and water temperature. In addition, periodic analysis of dissolved metals, dissolved oxygen, nitrate/nitrite, total nitrogen, turbidity,

conductivity, ammonia, and other parameters have been periodically sampled for on Moose Creek with data ranging from 1998 to 2001 (USGS 2008).

Dissolved oxygen, conductivity, pH, and water temperature data from 10 samples taken during the data range (1998-2001) do not significantly differ from the range recorded during the Dames and Moore study.

3.0 2008 Aquatic Biological Resources

3.1 Aquatic Resource Sampling Methods

WHPacific conducted the majority of aquatic biological resource sampling on September 21 to 24, 2008 and limited sampling and field observations on October 6 to 9, 2008 on Moose and Buffalo Mine Creek. The 2008 study area attempted to replicate that established by Dames and Moore in 1988, ranging from the Glenn Highway Bridge (RM 0.8) to RM 6.8 near the old railroad crossing. WHPacific personnel conducted a spawning survey through the entirety of the study area on Moose Creek, including above the site of the Premier Creek Bridge, station sampling for fish and macroinvertebrates, spot sampling and general field observations.

The spawning survey was conducted during two days, because of the substantial length of the salmon accessible stream reach. WHPacific personnel walked upstream on Moose Creek, starting at the Glenn Highway crossing and identified and tallied live salmon and carcasses while working upstream to the end of the study area at RM 6.8. In some instances, due to extensive decomposition, carcasses could not be identified to species and were simply tallied as unidentified carcasses.

Station locations were placed as close to the locations established by Dames and Moore in 1988 as possible from location data. The location of Station 1 was moved upstream of the bridge to avoid numerous spawning salmon and visible redds. Stations 2, 3, and 5 were located as close to the described stations as noted by Dames and Moore. Station 4 was located on the left side fork (looking downstream) of Moose Creek immediately upstream of the old railroad bridge and confluence. This was determined to be the primary fork of Moose Creek, but may differ from the exact locality sampled by Dames and Moore. The specific locations of sampled stations are as follows:

Station 1 – Moose Creek from USGS gauging station upstream 270 feet.

Station 2 – Moose Creek from the Premier Creek confluence upstream 270 feet.

Station 3 – Moose Creek at approximate RM 4.9 upstream 300 feet. Station is located at major bank failure and immediately below Buffalo Mine Road.

Station 4 – Moose Creek on left fork immediately upstream of fork confluence and old railroad bridge. Station includes 420 foot long side channel and 270 foot long main stem segment.

Station 5 – Buffalo Creek from 25 feet upstream of confluence with Moose Creek to an end point 240 feet upstream.

Macroinvertebrate sampling was conducted with a Hess sampler, with three replicates made at each station. A scrub brush was used to clean all large substrate (large gravel to large cobble) before removal from the sampler. After all large substrate was cleaned and removed a large metal spike was used to disturb remaining substrate and bed sediment to a depth of approximately 10 centimeters. Samples were removed from the Hess sampler collection cup and placed in a plastic tub. Once in the tub the sample was repeatedly washed and sent through a fine mesh sieve. Once all coarse sediment and debris had been removed from the sample, the entirety of the remaining collected material was placed on 70 percent isopropyl alcohol. Samples were submitted to Aquatic Biology Associates, Inc. for sorting and identification. A subset of the composite of replicates was identified and specimens were sorted to family. Blot dry wet weights were made of each family identified at each station.

During the October 6 – 9th site visit, general field observations of Moose and Buffalo mine creek were made during a stream morphology study of Buffalo Creek. In addition, to field observations, seine hauls, seine sets and minnow traps were utilized in Buffalo Creek to document fish distributions throughout the length of the stream.

4.0 Results

4.1 Fisheries Results

The following section presents the results of the WHPacific fisheries sampling in Moose and Buffalo Mine Creeks in 2008.

4.1.1 Spawning Survey

Spawning surveys were conducted on Moose Creek on September 21 and September 22. The spawning survey on September 22 was continued from the point where the survey ended on September 21. Surveys identified 100 live coho, 30 unidentified salmon carcasses, and 3 positively identified coho carcasses. Live coho salmon were observed throughout the sample reach with fish being identified immediately upstream of the Glenn Highway crossing and several hundred feet downstream of the upstream end of the study area. Fifty (50) of the live coho identified during the survey were observed between the Glenn Highway Bridge and the former location of the Premier Creek Bridge.

Concentrations of spawning salmon were highest between the Glenn Highway Bridge and the site of the former large waterfall (approximate RM 3.2) and between the Buffalo Creek confluence and last fork or tributary of Moose Creek downstream of the railroad bridge. Live salmon were most often identified in the tails of pools, lower velocity riffles and runs, and side channels where they were abundant. A single side channel contained over 20 spawning salmon and averaged only 4-6 feet in width.

Unidentified carcasses were generally highly decayed and were found throughout the study area with the majority (26) being identified between the Glenn Highway Bridge and the Buffalo Creek confluence. Due to the high level of decomposition of these carcasses and the large size of most of the carcasses, it is assumed that they are Chinook salmon.

A single male coho salmon was observed in Premier Creek, approximately 100 feet upstream of the confluence with Moose Creek on September 21st.

Observations were made of at least two spawning coho salmon in Moose Creek at the former location of the Premier Creek Bridge on October 5th. These salmon and the Premier Creek individual were not included in the total spawning salmon count.

4.1.2 Station Sampling

Station 1

Station 1 was sampled on September 23, 2008. Spawning coho salmon were identified immediately downstream of the station start point. Station 1 is dominated by high velocity riffle habitat with few eddies and pools to provide resting and foraging habitat for small salmonids. Due to the high velocity and depth of the station, most of the habitat that was sampled was found along the margins and behind large boulders within the channel. The average width of the sample area was 42 feet and the length of the sample reach was 270 feet. Sampling was conducted in an upstream manner.

A total of 52 juvenile coho salmon and 3 slimy sculpins (*Cottus cognatus*) were collected during sampling. The size range for coho salmon (fork length) was 37-70 mm and for slimy sculpins the size ranged from 37-66 mm (standard length). Using a 2 pass depletion method for calculating population density (Armour et al. 1983) puts the coho density at approximately 0.08/square yard, but with significant standard error in the calculation (See Table 1 - Appendix A). Estimating a minimum population density based on a basic sum of catch data puts the coho density at > 0.041/square yard. Due to the difficulty in efficient collection of slimy sculpin, a population estimate was not obtained.

Station 2

Station 2 was sampled on September 24, 2008. The station extends from the mouth of Premier Creek, upstream 270 feet. The average wetted width of the sample reach was 30 feet at the time of sampling. The study reach was dominated by cobble and boulder substrate with high velocity riffles as the dominant habitat type. Several pocket pools, undercut banks, and wood debris provided limited refuge habitat. Depletion sampling yielded six (6) coho, five (5) Dolly Varden, one rainbow trout (*Oncorhynchus mykiss*), and one slimy sculpin. The size range for coho salmon was 54-60 mm, 95 – 190 mm for Dolly Varden, and the individual sculpin and rainbow trout were 54 and 73 mm respectively. A population estimate based on a 2-pass depletion calculation is 0.007 fish/square yard for coho and 0.01/square yard for Dolly Varden. A summation population estimate for both species is > 0.0067 fish/square yard for coho and 0.006 fish/square yards for Dolly Varden. Due to the small sample size for all other collected species, additional species estimates were not made.

Station 3

Station 3 was sampled on September 23, 2008. The station is found at the base of a large river right bank failure at approximate river mile 4.9. The station extends upstream from this bank failure 300 feet. The channel in the sample reach is wide with an average width of 50 feet. Habitat is characterized by riffles, with a short (~50') moderate velocity side channel on the right bank, and extensive shallow and low velocity margins along the left bank in the upper half of the sample reach. Several pocket pools occur along the left bank associated with large substrate and woody debris, as well as main channel pocket pools behind large boulders. Several salmon carcasses were observed in the reach and on September 22nd a single live adult coho was observed in the side channel during the spawning survey.

Two-pass sampling in the study area yielded eighteen (18) coho, eight (8) Dolly Varden, and five (5) slimy sculpins. The size range for coho salmon was 45-68 mm, 73-135mm for Dolly Varden, and 30-71mm for sculpins. Two-pass depletion population calculations for coho and Dolly Varden resulted in an estimate of approximately 0.03 coho/square yard and 0.008 Dolly Varden/square yard. Summation population estimates put the minimum density for coho at > 0.01 fish/square yard and for Dolly Varden at > 0.0046 fish/square yard. The density of slimy sculpins was not estimated for the study reach.

Station 4

Station 4 was sampled on September 22, at the conclusion of the spawning survey. This station begins at the upstream side of the old railroad bridge at approximate river mile 6.8. Upstream from the bridge the sample reach follows the right side fork (looking upstream) of Moose Creek and extends 270 feet upstream. The sample reach also includes a 420 foot length of river right side channel that enters near the confluence of the two forks. Sampling this side channel was deemed important due to the abundance of still water, woody debris, and other refuge habitats not found to be abundant in the main channel. The main channel habitat consisted primarily of a swift cascading torrent with

few small pocket pools. Several areas of undercut banks and overhanging vegetation provided additional fish habitat.

Two-pass sampling yielded eleven (11) Dolly Varden, with sizes ranging from 50-153mm. A 2-pass depletion estimate of Dolly Varden density results in 0.0293 fish/square yard. The standard error associated with the depletion estimate was substantial. A summation estimate results in an estimate of > 0.009 fish/square yard.

Station 5

Station 5 was sampled on September 24. This station is located on Buffalo Mine Creek and begins approximately twenty feet upstream of the confluence with Moose Creek and extends upstream 240 feet from this point. The average width of this stream reach is approximately four and a half feet. Habitat consists of shallow runs, pools, and low velocity riffles. Undercut banks, overhanging vegetation, and woody debris provide important habitat elements. An abundance of age 0 rainbow trout were collected within the sample reach and were the only fish species and age class collected.

Two-pass sampling yielded 41 rainbow trout all under 20mm in length. Catch efficiency was low given the small size of the specimens collected (< 20mm), abundant vegetation, and small habitat size (increasing the difficulty of collection). Two-pass depletion calculations place the estimate of rainbow trout densities at 3.50 fish/square yard and a minimum density based on summation of catch data is > .342 fish/square yard. The standard error for the 2-pass depletion calculation is significant (Table 1 – Appendix A). The more conservative summation density is a more reliable minimum estimate.

4.1.3 Spot Sampling

Limited spot sampling was conducted on October 8, 2008 in Buffalo Creek using a beach seine and baited minnow traps. Baited minnow traps were deployed approximately 500 feet upstream from the Moose Creek confluence and kick-seining was used in habitat within the first 1000 feet downstream of Wishbone Lake. While juvenile salmonids estimated at less than 20mm were observed in the lower reach, no fish were collected in the minnow traps. Kick seining and seine hauls in the upper reach of Buffalo Creek did not yield fish and no fish were observed during the Rosgen survey effort or fish sampling.

4.2 Macroinvertebrate Results

General observations of macroinvertebrates during collection of samples found all major aquatic insect orders represented at all stations. Stoneflies, mayflies, true flies, and caddisflies were all identified in composite samples and during general field observations.

The analysis of each station composite identified all organisms in the composite (0.3 m^2 total area sampled). The total number of each taxa identified was converted to a square

meter basis. Wet weight biomass calculations were determined by blot dry of all invertebrates in sample and converted to a square meter basis as well.
As with the Dames and Moore study, taxonomic composition was variable between the sites. Chironomidae, mayflies, and stoneflies comprised three of the four most common taxa identified at each site except at Station 2, where stoneflies are much less abundant. Despite these similarities, total densities, taxa richness and genera/species composition is highly variable across all stations.

Taxa richness for the study area ranged from 21 at Station 5 to a high of 30 at Stations 1 and 3. Invertebrate abundance ranged from a low of 847 organisms per square meter at Station 2 to a high of 2518 at Station 5. Biomass was highest at Station 1 with a total weight of 2.138 grams and lowest at Station 2 with a weight of 0.39 grams.

The Hilsenhoff index (Hilsenhoff 1982), a biotic index that provides a rating of stream health, was calculated for all stations. Furthermore, a richness of taxa intolerant of environmental perturbations was calculated for each station. These calculations and the total richness of the taxa from the orders Ephemeroptera, Plecoptera, and Trichoptera (EPT) are useful for determining watershed and sample area health. These analytical components can be used to formulate comparisons for long term watershed monitoring.

All macroinvertebrate laboratory results are presented in Appendix A.

4.2.1 Station Sampling

Results of macroinvertebrate station sampling are presented below.

Station 1

The total invertebrate abundance at the station was 1208, with a total biomass of 2.138 grams. Station 1 yielded a total of 30 taxa, with 20 EPT. The richness of intolerant taxa identified at the station was 8. The Hilsenhoff index score for this station is 3.58 and indicates a "very good" water quality and slight organic pollution (Hilsenhoff 1987).

The three most common taxa represented in the sample are in order of abundance, a black stonefly (*Zapada cinctipes*), Chironomidae, and the green drake mayfly (*Drunella doddsi*). These three taxa comprise nearly 51 percent of the total sample. Other common taxa represented are other mayflies, stoneflies, caddisflies, and Oligochaete worms.

Station 2

The total invertebrate abundance at the station was 847 and represents the lowest abundance of all sampled stations. The calculated biomass for the station was 0.39g. The station yielded a total of 23 taxa, including 14 EPT. The richness of intolerant taxa identified at the station was 7. The Hilsenhoff index score for this station is 3.65 and indicates "very good" water quality with slight organic pollution.

The four most common taxa represented in the sample comprise 65.5 percent of the total. In order of abundance, these taxa are the blue winged olive mayfly (*Baetis bicaudatus*), Chironomidae, the green drake mayfly, and the dark red quill mayfly genus, *Cinygmula*. Oligochaete worms, a caddisfly genus, *Glossoma*, and a stonefly, the Oregon forest fly (*Zapada oregonensis*).

Station 3

The total invertebrate abundance at the station was 2137, with a biomass of 1.249g. Along with Station 1, this station yielded the highest taxa richness with 30, and total EPT richness of 19. The richness of intolerant taxa identified at the station was 9. The Hilsenhoff index for the site is 4.05, indicating "very good" water quality and only slight organic pollution.

The two most abundant taxa, Chironomidae and blue winged olive mayflies comprise over 50 percent of the sample. Other common taxa include a number of mayfly genera, forest flies, and black stoneflies.

Station 4

The total invertebrate abundance at this station was 1535, with a biomass of 1.509g. Taxa richness was 24 with an EPT richness of 18. The richness of intolerant taxa identified at the station was 8. The Hilsenhoff index for the station is 3.2 and falls within the highest rating category possible for the index (Hilsenhoff 1987), indicating "excellent" water quality and no apparent organic pollution.

The three most common taxa collected at the site represent over 54 percent of the sample. These taxa include, blue winged olive mayfly, Chironomidae, and dark red quill mayfly. Other common taxa in the sample include a caddisfly (*Rhyacophila vofixa*), little yellow stoneflies (*Suwallia sp.*), and small winter stoneflies (Capniidae).

Station 5

The total invertebrate abundance at this station was 2518 and is the highest abundance of organisms for any station. The biomass for this station was 0.779g. Total taxa richness for the site was 21 and the EPT richness was 12. Intolerant taxa richness at the site was just 4. The Hilsenhoff score for the station was 5.25, the highest for any of the stations. Such a score indicates "good" water quality and some organic pollution.

Chironomidae, the most abundant taxa in the sample, represent over 50 percent of the total sample (57.6 percent). Other common taxa include black stoneflies, blue winged olives, and little yellow stoneflies from the genus *Isoperla*.

5.0 Discussion

Results of the 2008 fisheries sampling and monitoring effort show many changes since the prior sampling effort conducted in 1988. Salmon access and habitat utilization has greatly expanded throughout the study reach above the former waterfall at rivermile 3.2.

Salmon, live and dead were observed throughout the study area (RM 0.8 – 6.8) and the upstream extent of salmon utilization is assumed to continue above the study area. Adult Chinook salmon carcasses were found throughout the study reach and adult spawning coho were observed almost to the end of the study reach. Habitat and substrate for salmon spawning is limited throughout Moose Creek, due to the high velocity, large substrate size, and confined channel of the stream in the study area. Side channels were not abundant within the study area, but when examined were found to be heavily utilized by salmon and Dolly Varden. As observed in 1988, juvenile Chinook salmon were not collected in the study area, indicating that these fish migrate out of the Moose Creek watershed to rear in downstream areas within the Matanuska River system. However, the collection of juvenile Chinook salmon has been made by biologists with the Chickaloon Village Corporation (Chickaloon Village Corporation 2008) and may warrant additional sampling throughout the study area.

Dolly Varden were collected at Stations 2, 3, and 4 and are expected to be found in segments of Buffalo Creek, despite the negative collection results. One Dolly Varden larger than 300 mm was observed during electrofishing at Station 2, but not collected. In addition, Dolly Varden were observed and abundant in a side channel-tributary mosaic found on the right bank in the upper ¼ of the study area.

Sculpins were expected to be found throughout the study area stream reach and abundances are generally not known due to the difficultly in efficient sampling of habitat preferred by the genera.

Rainbow trout were previously only collected in the lower and extreme upper reaches of Buffalo Creek. Sampling in 2008 found evidence of rainbow trout in Moose Creek with the collection of one juvenile (73 mm). Rainbow trout were also found in Buffalo Creek once again, with the collection of relatively large numbers of age 0 rainbows in the lower reach of the creek. Unlike the previous sampling effort in Buffalo Creek, age 1+ rainbow trout were not collected during the 2008 survey. This may be attributed to changes in the habitat sampled or exact position of the sampling station in the stream. Downstream dispersal of juvenile rainbow to Moose Creek is expected due to the small size and potential freeze up of Buffalo Creek. Additional sampling within Moose Creek would likely yield rainbow trout throughout the system.

General habitat conditions within the Moose Creek and Buffalo Creek study area are not presumed to have greatly changed during the last twenty years. However, recent restoration and habitat improvement efforts in the past 3 years by the Chickaloon Tribe have undoubtedly produced greater habitat access and availability to salmon, trout, Dolly Varden, and other resident fish. The restoration reaches associated with the Phase I and II projects have created lower velocity habitat and resting areas that are in short supply in Moose Creek. In addition, greater access to upstream reaches by salmon has likely increase food availability and nutrients to upstream resident fish. Juvenile salmon,

salmon eggs, and carcasses are all forage, community, and nutrient components previously excluded from the upper reach segment of the study area.

The lower reach of Buffalo Mine Creek no longer has the two beaver ponds previously documented. This translates to a reduction in potential rearing habitat, but an increase in access as the second beaver pond had created a substantial barrier to upstream access by migrating fishes.

Macroinvertebrate results indicate that water quality in Moose Creek is very good to excellent, with little to no organic or chemical pollutants affecting the macroinvertebrate community. Stations 1 and 3 have the highest diversity of organisms, while Station 4 at the upstream end of the study area scores highest in the Hilsenhoff index.

Variation in taxa richness, biomass, and abundance across the Moose Creek stations (1-4) can likely be attributed to subtle differences in habitat found at each station, the position of each station in the watershed, and subtle differences in substrate embeddedness and substrate size between each. For example, the sampling of Station 1 was conducted in a shallow margin with cobble, gravel, and sand dominating the substrate. Such substrate was easily scrubbed and disturbed and significant surface area exposed to sampling techniques. Sampling at Station 2 on the other hand, was conducted in swift habitat, dominated by large and more embedded substrate. While some cobbles and gravels were moved and sampled at this station, the total surface area sampled was likely smaller and the organisms collected likely reflect the habitat conditions.

Macroinvertebrate sampling results from Buffalo Creek reflect the distinct habitat differences between it and Moose Creek. The abundance of Chironomidae, the lower Hilsenhoff rating, lower taxa richness, and the small number of intolerant and EPT taxa are a likely result of a sand dominated habitat, limited water quality associated with the small stream size, and potential effects associated with amplified wildlife use within the Buffalo Creek watershed.

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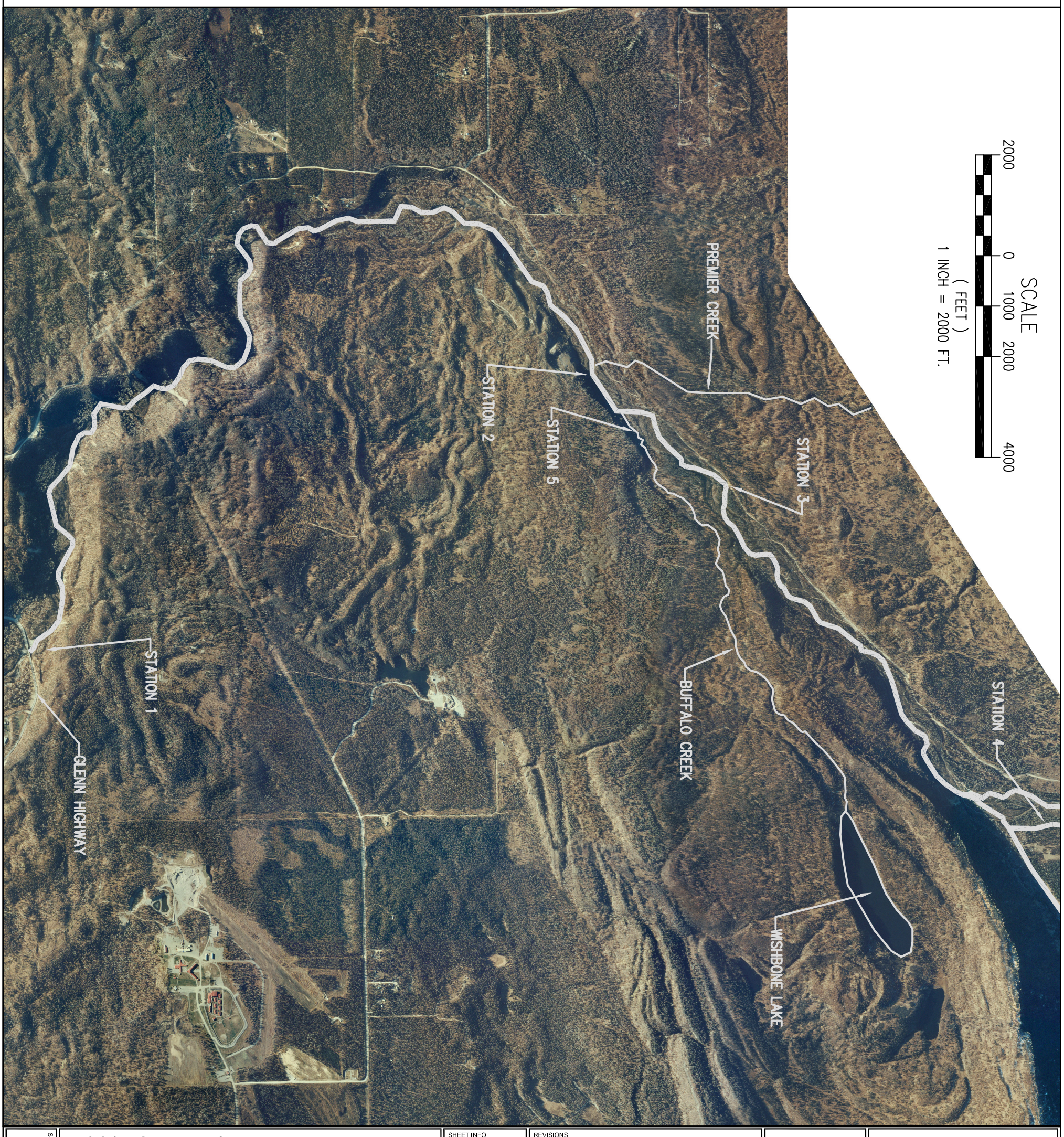
Appendix A – Fish and Aquatic Macroinvertebrate Data and Station Locations Figure

XREF INDEX:

N

SCALE
2000 0 1000 2000 4000
(FEET)
1 INCH = 2000 FT.



SHEET NUMBER 1 of 1

MOOSE CREEK VICINITY
USIBELLI COAL MINE
MOOSE CREEK
FISH HABITAT STUDY

PROJECT NUMBER	DRAWING FILE NAME	SCALE
34272	MOOSE CREEK TOPO	1=2000

SHEET INFO	
DRAWN	JCO
CHECKED	
APPROVED	
LAST EDIT	11/20/2008
PLOT DATE	11-14-2008
SUBMITTAL	

REVISIONS			
NO.	BY	DATE	REMARKS

WHPacific
515 7th Avenue, Sulte 310
Fairbanks, AK 99701
907-458-2142 Fax 907-458-2143
www.whpacific.com

Fisheries Data

Table 1. Summary of Fisheries Results

Station	Species	Pass 1 Catch	Pass 2 Catch	Population Estimate Sum	Population Estimate 2 Pass Depletion	95% Confidence Interval 2-pass depletion	Accepted Population Estimate	Sampling Area (square feet)	Density No/sq.yd
1	Coho Salmon	31	21	>52	96	96-199	Sum	11,340	>0.041
2	Coho Salmon	5	1	>6	6	6 - 8	Depletion	8,100	0.0066
2	Dolly Varden	3	2	>5	9	5 - 318	Sum	8,100	>0.0055
3	Coho Salmon	10	8	>18	50	18 - 14,450	Sum	15,000	>0.0104
3	Dolly Varden	5	3	>8	13	8 - 238	Sum	15,000	>0.0046
4	Dolly Varden	6	5	>11	36	11 - 1,945	Sum	11,040	>0.009
5	Rainbow Trout	21	20	>41	420	41 – 6 million +	Sum	1,080	>0.342

Station 1 : Moose Creek at USGS Monitoring Station Upstream of Glen Highway Bridge
Sampled Date: 9/23/2008
Reach Length: 270 feet Average Width: 42 feet

Shock Seconds
Pass 1 1075
Pass 2 911

Pass 1 Catch Data

Genus	Species	Common Name	SL	FL
Oncorynchus	*kisutch*	Coho salmon	40	45
Oncorynchus	*kisutch*	Coho salmon	57	64
Oncorynchus	*kisutch*	Coho salmon	54	58
Oncorynchus	*kisutch*	Coho salmon	40	45
Oncorynchus	*kisutch*	Coho salmon	52	58
Oncorynchus	*kisutch*	Coho salmon	40	45
Oncorynchus	*kisutch*	Coho salmon	44	48
Oncorynchus	*kisutch*	Coho salmon	48	53
Oncorynchus	*kisutch*	Coho salmon	46	53
Oncorynchus	*kisutch*	Coho salmon	53	59
Oncorynchus	*kisutch*	Coho salmon	53	57
Oncorynchus	*kisutch*	Coho salmon	50	55
Oncorynchus	*kisutch*	Coho salmon	46	50
Oncorynchus	*kisutch*	Coho salmon	61	70
Oncorynchus	*kisutch*	Coho salmon	54	62
Oncorynchus	*kisutch*	Coho salmon	50	57
Oncorynchus	*kisutch*	Coho salmon	45	48
Oncorynchus	*kisutch*	Coho salmon	49	55
Oncorynchus	*kisutch*	Coho salmon	43	46
Oncorynchus	*kisutch*	Coho salmon	47	50
Oncorynchus	*kisutch*	Coho salmon	48	55
Oncorynchus	*kisutch*	Coho salmon	47	53
Oncorynchus	*kisutch*	Coho salmon	56	62
Oncorynchus	*kisutch*	Coho salmon	49	53
Oncorynchus	*kisutch*	Coho salmon	52	58
Oncorynchus	*kisutch*	Coho salmon	45	48
Oncorynchus	*kisutch*	Coho salmon	57	63
Oncorynchus	*kisutch*	Coho salmon	32	34
Oncorynchus	*kisutch*	Coho salmon	34	37
Oncorynchus	*kisutch*	Coho salmon	53	57
Oncorynchus	*kisutch*	Coho salmon	46	51
Cottus	*cognatus*	Slimy sculpin	66	NA

Pass 2 Catch Data

Genus	Species	Common Name	SL	FL
Oncorynchus	*kisutch*	Coho salmon	62	68
Oncorynchus	*kisutch*	Coho salmon	57	63
Oncorynchus	*kisutch*	Coho salmon	57	62
Oncorynchus	*kisutch*	Coho salmon	48	53
Oncorynchus	*kisutch*	Coho salmon	51	55
Oncorynchus	*kisutch*	Coho salmon	62	68
Oncorynchus	*kisutch*	Coho salmon	59	64
Oncorynchus	*kisutch*	Coho salmon	55	60
Oncorynchus	*kisutch*	Coho salmon	50	55
Oncorynchus	*kisutch*	Coho salmon	46	52
Oncorynchus	*kisutch*	Coho salmon	48	53
Oncorynchus	*kisutch*	Coho salmon	56	59
Oncorynchus	*kisutch*	Coho salmon	54	60
Oncorynchus	*kisutch*	Coho salmon	58	65
Oncorynchus	*kisutch*	Coho salmon	46	51
Oncorynchus	*kisutch*	Coho salmon	47	51
Oncorynchus	*kisutch*	Coho salmon	44	48
Oncorynchus	*kisutch*	Coho salmon	53	57
Oncorynchus	*kisutch*	Coho salmon	54	58
Oncorynchus	*kisutch*	Coho salmon	55	60
Oncorynchus	*kisutch*	Coho salmon	43	48
Cottus	*cognatus*	Slimy sculpin	67	
Cottus	*cognatus*	Slimy sculpin	37	

Station 2 : Moose Creek at Premier Creek

Sampled Date: 9/24/2008

Reach Length: 270 feet Average Width: 30 feet

Shock Seconds

Pass 1	543
Pass 2	497

Pass 1 Catch Data

Genus	Species	Common Name	SL	FL
Salvelinus	*malma*	Dolly Varden	135	145
Salvelinus	*malma*	Dolly Varden	170	190
Salvelinus	*malma*	Dolly Varden	94	102
Oncorynchus	*kisutch*	Coho salmon	48	54
Oncorynchus	*kisutch*	Coho salmon	56	60
Oncorynchus	*kisutch*	Coho salmon	53	60
Oncorynchus	*kisutch*	Coho salmon	49	55
Oncorynchus	*kisutch*	Coho salmon	54	60

Pass 2 Catch Data

Genus	Species	Common Name	SL	FL
Salvelinus	*malma*	Dolly Varden	150	165
Salvelinus	*malma*	Dolly Varden	85	95
Oncorynchus	*kisutch*	Coho salmon	56	60
Oncorynchus	*mykiss*	Rainbow trout	65	73
Cottus	*cognatus*	Slimy sculpin	54	NA

Station 3 : Moose Creek Upstream of Confluence of Buffalo Mine Creek
Sampled Date: 9/23/2008
Reach Length: 300 feet Average Width:50 feet

Shock Seconds
Pass 1 915
Pass 2 733

Pass 1 Catch Data

Genus	Species	Common Name	SL	FL
Salvelinus	*malma*	Dolly Varden	104	114
Salvelinus	*malma*	Dolly Varden	67	72
Salvelinus	*malma*	Dolly Varden	75	81
Salvelinus	*malma*	Dolly Varden	75	83
Salvelinus	*malma*	Dolly Varden	73	82
Oncorynchus	*kisutch*	Coho salmon	62	68
Oncorynchus	*kisutch*	Coho salmon	53	58
Oncorynchus	*kisutch*	Coho salmon	49	55
Oncorynchus	*kisutch*	Coho salmon	46	50
Oncorynchus	*kisutch*	Coho salmon	50	53
Oncorynchus	*kisutch*	Coho salmon	41	45
Oncorynchus	*kisutch*	Coho salmon	48	53
Oncorynchus	*kisutch*	Coho salmon	59	68
Oncorynchus	*kisutch*	Coho salmon	50	55
Oncorynchus	*kisutch*	Coho salmon	50	54
Cottus	*cognatus*	Slimy sculpin	60	NA
Cottus	*cognatus*	Slimy sculpin	71	NA
Cottus	*cognatus*	Slimy sculpin	30	NA

Pass 2 Catch Data

Genus	Species	Common Name	SL	FL
Salvelinus	*malma*	Dolly Varden	**126**	**135**
Salvelinus	*malma*	Dolly Varden	**77**	**84**
Salvelinus	*malma*	Dolly Varden	**67**	**73**
Oncorynchus	*kisutch*	Coho salmon	**59**	**65**
Oncorynchus	*kisutch*	Coho salmon	**57**	**61**
Oncorynchus	*kisutch*	Coho salmon	**60**	**66**
Oncorynchus	*kisutch*	Coho salmon	**44**	**48**
Oncorynchus	*kisutch*	Coho salmon	**54**	**59**
Oncorynchus	*kisutch*	Coho salmon	**56**	**59**
Oncorynchus	*kisutch*	Coho salmon	**50**	**53**
Oncorynchus	*kisutch*	Coho salmon	**51**	**55**
Cottus	*cognatus*	Slimy sculpin	**63**	**NA**
Cottus	*cognatus*	Slimy sculpin	**62**	**NA**

Station 4 : Moose Creek Upstream of Confluence of Buffalo Mine Creek

Sampled Date: 9/22/2008

Reach Length: 270' Average Width:30 feet wide

Side Channel: 420 Average Width:7

Shock Seconds

Pass 1 711

Pass 2 637

Pass 1 Catch Data

Genus	Species	Common Name	SL	FL
Salvelinus	***malma***	**Dolly Varden**	89	100
Salvelinus	***malma***	**Dolly Varden**	57	63
Salvelinus	***malma***	**Dolly Varden**	84	95
Salvelinus	***malma***	**Dolly Varden**	130	145
Salvelinus	***malma***	**Dolly Varden**	43	50
Salvelinus	***malma***	**Dolly Varden**	62	68

Pass 2 Catch Data

Genus	Species	Common Name	SL	FL
Salvelinus	***malma***	**Dolly Varden**	135	153
Salvelinus	***malma***	**Dolly Varden**	110	130
Salvelinus	***malma***	**Dolly Varden**	73	81
Salvelinus	***malma***	**Dolly Varden**	59	64
Salvelinus	***malma***	**Dolly Varden**	54	58

Station 5 : Buffalo Mine Creek Upstream of Moose Creek Confluence
Sampled Date: 9/24/2008
Reach Length: 240' Average Width: 4.5 feet wide

Shock Seconds

Pass 1	337
Pass 2	308

Pass 1 Catch Data

Genus	Species	Common Name	SL	FL
Oncorynchus	***mykiss***	Rainbow trout	NA	<20
Oncorynchus	***mykiss***	Rainbow trout	NA	<20
Oncorynchus	***mykiss***	Rainbow trout	NA	<20
Oncorynchus	***mykiss***	Rainbow trout	NA	<20
Oncorynchus	***mykiss***	Rainbow trout	NA	<20
Oncorynchus	***mykiss***	Rainbow trout	NA	<20
Oncorynchus	***mykiss***	Rainbow trout	NA	<20
Oncorynchus	***mykiss***	Rainbow trout	NA	<20
Oncorynchus	***mykiss***	Rainbow trout	NA	<20
Oncorynchus	***mykiss***	Rainbow trout	NA	<20
Oncorynchus	***mykiss***	Rainbow trout	NA	<20
Oncorynchus	***mykiss***	Rainbow trout	NA	<20
Oncorynchus	***mykiss***	Rainbow trout	NA	<20
Oncorynchus	***mykiss***	Rainbow trout	NA	<20
Oncorynchus	***mykiss***	Rainbow trout	NA	<20
Oncorynchus	***mykiss***	Rainbow trout	NA	<20
Oncorynchus	***mykiss***	Rainbow trout	NA	<20
Oncorynchus	***mykiss***	Rainbow trout	NA	<20
Oncorynchus	***mykiss***	Rainbow trout	NA	<20
Oncorynchus	***mykiss***	Rainbow trout	NA	<20
Oncorynchus	***mykiss***	Rainbow trout	NA	<20
Oncorynchus	***mykiss***	Rainbow trout	NA	<20
Oncorynchus	***mykiss***	Rainbow trout	NA	<20

Pass 2 Catch Data

Genus	Species	Common Name	SL	FL
Oncorynchus	***mykiss***	Rainbow trout	NA	<20
Oncorynchus	***mykiss***	Rainbow trout	NA	<20
Oncorynchus	***mykiss***	Rainbow trout	NA	<20
Oncorynchus	***mykiss***	Rainbow trout	NA	<20
Oncorynchus	***mykiss***	Rainbow trout	NA	<20
Oncorynchus	***mykiss***	Rainbow trout	NA	<20
Oncorynchus	***mykiss***	Rainbow trout	NA	<20
Oncorynchus	***mykiss***	Rainbow trout	NA	<20
Oncorynchus	***mykiss***	Rainbow trout	NA	<20
Oncorynchus	***mykiss***	Rainbow trout	NA	<20
Oncorynchus	***mykiss***	Rainbow trout	NA	<20
Oncorynchus	***mykiss***	Rainbow trout	NA	<20
Oncorynchus	***mykiss***	Rainbow trout	NA	<20
Oncorynchus	***mykiss***	Rainbow trout	NA	<20
Oncorynchus	***mykiss***	Rainbow trout	NA	<20
Oncorynchus	***mykiss***	Rainbow trout	NA	<20
Oncorynchus	***mykiss***	Rainbow trout	NA	<20
Oncorynchus	***mykiss***	Rainbow trout	NA	<20
Oncorynchus	***mykiss***	Rainbow trout	NA	<20
Oncorynchus	***mykiss***	Rainbow trout	NA	<20
Oncorynchus	***mykiss***	Rainbow trout	NA	<20
Oncorynchus	***mykiss***	Rainbow trout	NA	<20
Oncorynchus	***mykiss***	Rainbow trout	NA	<20
Oncorynchus	***mykiss***	Rainbow trout	NA	<20

Macroinvertebrate Data

Moose Creek Basin, September 2008, Benthic Macroinvertebrates

Alaska: For WH Pacific, Inc. Portland, Oregon
Analysis by Aquatic Biology Associates, Inc., Corvallis, Oregon.
Riffle habitat, Hess sampler, composite of 3 replicates, 0.3 square meter area total, 500 micron mesh.
Entire sample processed, abundances converted to a square meter basis, Chironomidae (midges identified to family).
Wet weights are blot dry of all invertebrates in sample, with weights converted to a square meter basis.

Site	**1**	**2**	**3**	**4**	**5**
Creek	**Moose**	**Moose**	**Moose**	**Moose**	**Buffalo**
Location	**@ gauge**	**u/s Premier**	**u/s Buffalo**		**@ mouth**
Total invertebrate abundance (m^2)	1208	847	2137	1535	2518
Total wet weight (grams/m^2)	2.138	0.39	1.249	1.509	0.779
Total taxa richness	30	23	30	24	21
EPT taxa richness	20	14	19	18	12
Hilsenhoff Biotic Index	3.58	3.65	4.07	3.2	5.25
Shannon Diversity Index (loge)	2.55	2.35	2.36	2.49	1.67
Taxa richness					
Non-insects	4	5	4	3	4
Ephemeroptera	7	5	6	6	3
Plecoptera	8	7	9	9	4
Trichoptera	5	2	4	3	5
Diptera	6	4	7	3	5
% Contribution					
Non-insects	5.52	11.76	4.52	6.29	6.47
Ephemeroptera	34.17	50.98	34.44	46.86	8.19
Plecoptera	32.51	10.58	18.84	22.14	18.75
Trichoptera	7.72	7.06	4.21	6.95	2.38
Diptera	20.13	19.6	38.02	17.79	64.2
Feeding Groups (%)					
Predator	3.59	3.13	4.83	16.06	6.99
Parasite	1.38	1.96	0.47	2.39	2.64
Collector-filterer	27.02	49.41	30.38	33.19	12.02
Collector-gatherer	0.28	0.39	0.94	0	2.51
Scraper	17.09	17.25	12.16	19.53	1.32
Shredder	29.75	9.02	14.79	11.07	14.66
Omnivore	1.38	0	0.16	0	2.25
Unknown	19.56	18.82	36.3	17.79	57.6
Chironomidae identified to family level only and designated as unknown feeding group.					
Cold water biota richness (intolerai	8	7	9	8	4
% Cold water biota (intolerant)	28.39	39.6	26.65	41.66	8.46
Warm water biota	none	none	none	none	none

Site 1, Moose Cr. @ gauge, Sept. 23, 2008

AK: For WHPacific, Inc. Analysis by Aquatic Biology Associates, Inc.
Riffle habitat, Hess sampler, 3 reps, 0.3 m2 total area, 500 micron mes
Full sample analysis.Abundances=square meter basis.FILE:08WH01

IDENTIFICATION CODE	08WH01
CORRECTION FACTOR	3.33

Taxon	Abundance	%
Nematoda	3	0.28
Oligochaeta	47	3.86
Ostracoda	3	0.28
Acari	13	1.10
TOTAL: NON INSECTS	67	5.51
Ameletus	10	0.83
Baetis bicaudatus	103	8.54
Drunella doddsi	157	12.95
Ephemerella excrusians	3	0.28
Cinygmula	100	8.26
Epeorus albertae	3	0.28
Epeorus grandis	37	3.03
TOTAL: EPHEMEROPTERA	413	34.16
Capniidae	27	2.20
Chloroperlidae	7	0.55
Zapada cinctipes	240	19.83
Zapada columbiana	10	0.83
Zapada Oregonensis Group	83	6.89
Isoperla	10	0.83
Doddsia occidentalis	3.33	0.28
Taenionema	13.32	1.10
TOTAL: PLECOPTERA	393	32.51
Brachycentrus americanus	3	0.28
Glossosoma	47	3.86
Limnephilidae	13	1.10
Ecclisomyia	17	1.38
Rhyacophila Vofixa Group	13	1.10
TOTAL: TRICHOPTERA	93	7.71
Chelifera/Metachela	10	0.83
Pericoma	3	0.28
Simulium	3	0.28
Dicranota	3	0.28
Hesperoconopa	3	0.28
TOTAL: DIPTERA	23	1.93
Chironomidae	220	18.18
TOTAL: CHIRONOMIDAE	220	18.18
GRAND TOTAL	1209	100.00

Site 1, Moose Cr. @ gauge, Sept. 23, 2008
AK: For WHPacific, Inc. Analysis by Aquatic Biology Associates, Inc.
Riffle habitat, Hess sampler, 3 reps, 0.3 m2 total area, 500 micron mesh.
Full sample analysis.Abundances=square meter basis.FILE:08WH01

Total invertebrate abundance=	1207.7	EPT abundance	= 899.6
Total number of taxa	= 30	Number EPT taxa	= 20
Hilsenhoff Biotic Index	= 3.58	Brillouin H	= 2.48

TAXONOMIC GROUP	#TAXA	ABUNDANCE	PERCENT
Non-insects	4	66.0	5.52
Odonata	0	0.0	0.00
Ephemeroptera	7	413.0	34.17
Plecoptera	8	393.6	32.51
Hemiptera	0	0.0	0.00
Megaloptera	0	0.0	0.00
Trichoptera	5	93.0	7.72
Lepidoptera	0	0.0	0.00
Coleoptera	0	0.0	0.00
Misc. Diptera	5	22.0	1.95
Chironomidae	1	220.0	18.18

FEEDING GROUP	#TAXA	ABUNDANCE	PERCENT
Predator	5	43.0	3.59
Parasite	2	16.0	1.38
Collector-gatherer	7	326.0	27.02
Collector-filterer	1	3.0	0.28
Macrophyte-herbivore	0	0.0	0.00
Piercer-herbivore	0	0.0	0.00
Scraper	7	206.7	17.09
Shredder	4	360.0	29.75
Xylophage	0	0.0	0.00
Omnivore	1	17.0	1.38
Unknown	3	236.0	19.56

DOMINANT TAXON	ABUNDANCE	PERCENT
Zapada cinctipes	240.0	19.83
Chironomidae	220.0	18.18
Drunella doddsi	157.0	12.95
Baetis bicaudatus	103.0	8.54
Cinygmula	100.0	8.26
SUBTOTAL 5 DOMINANTS	820.0	67.76
Zapada Oregonensis Group	83.0	6.89
Oligochaeta	47.0	3.86
Glossosoma	47.0	3.86
Epeorus grandis	37.0	3.03
Capniidae	27.0	2.20
TOTAL 10 DOMINANTS	1061.0	87.60

INDICATOR ASSEMBLAGE	#TAXA	ABUNDANCE	PERCENT
A Tolerant misc.	0	0.0	0.00
B Tolerant mayflies	0	0.0	0.00
C Intolerant mayflies	3	297.0	24.52
D Intolerant stoneflies	2	13.3	1.11
E Tolerant caddisflies	0	0.0	0.00
F Intolerant caddisflies	2	30.0	2.48
G Tolerant beetles	0	0.0	0.00
H Intolerant flies	1	3.0	0.28
I Tolerant flies	0	0.0	0.00
J Intolerant midges	0	0.0	0.00
K Tolerant midges	0	0.0	0.00
L	0	0.0	0.00
M	0	0.0	0.00
N	0	0.0	0.00

Site 1, Moose Cr. @ gauge, Sept. 23, 2008
AK: For WHPacific, Inc. Analysis by Aquatic Biology Associates, Inc.
Riffle habitat, Hess sampler, 3 reps, 0.3 m2 total area, 500 micron mesh.
Full sample analysis.Abundances=square meter basis.FILE:08WH01

RATIOS OF TAX. GROUP ABUNDANCES

EPT/Chironomidae	= 4.09
Hydropsychidae/Total Trichoptera	= 0.00
Baetidae/Total Ephemeroptera	= 0.25

RATIOS OF FFG ABUNDANCES

Scraper/Collector-filter	= 68.88
Scraper/(Scraper + C.-filterer)	= 0.99
Shredder/Total organisms	= 0.30

Biotic Condition Index

Community Tolerance Quotient (a)	= 53.07
Community Tolerance Quotient (d)	= 50.42

DIVERSITY MEASURES

Shannon H (loge)	= 2.55
Shannon H (log2)	= 3.67
Evenness	= 0.75
Simpson D	= 0.11

COMMUNITY VOLTINISM ANALYSIS

TYPE	ABUNDANCE	PERCENT
Multivoltine	262.8	21.76
Univoltine	911.9	75.51
Semivoltine	33.0	2.73

Site 2, Moose Cr. u/s Premier Cr., Sept. 23, 2008

AK: For WHPacific, Inc. Analysis by Aquatic Biology Associates, Inc.
Riffle habitat, Hess sampler, 3 reps, 0.3 m2 total area, 500 micron mesh.
Full sample analysis.Abundances=square meter basis.FILE:08WH02

IDENTIFICATION CODE	08WH02
CORRECTION FACTOR	3.33

Taxon	Abundance	%
Turbellaria	7	0.78
Nematoda	3	0.39
Oligochaeta	73	8.63
Ostracoda	3	0.39
Acari	13	1.57
TOTAL: NON INSECTS	100	11.76
Ameletus	30	3.53
Baetis bicaudatus	193	22.75
Drunella doddsi	113	13.33
Cinygmula	93	10.98
Epeorus grandis	3	0.39
TOTAL: EPHEMEROPTERA	433	50.98
Capniidae	10	1.18
Chloroperlidae	7	0.78
Suwallia	3	0.39
Zapada cinctipes	27	3.14
Zapada columbiana	7	0.78
Zapada Oregonensis Group	33	3.92
Doddsia occidentalis	3.33	0.39
TOTAL: PLECOPTERA	90	10.59
Glossosoma	47	5.49
Rhyacophila Vofixa Group	13	1.57
TOTAL: TRICHOPTERA	60	7.06
Simulium	3	0.39
Dicranota	3	0.39
Hesperoconopa	3	0.39
TOTAL: DIPTERA	10	1.18
Chironomidae	157	18.43
TOTAL: CHIRONOMIDAE	157	18.43
GRAND TOTAL	849	100.00

Site 2, Moose Cr. u/s Premier Cr., Sept. 23, 2008
AK: For WHPacific, Inc. Analysis by Aquatic Biology Associates, Inc.
Riffle habitat, Hess sampler, 3 reps, 0.3 m2 total area, 500 micron mesh.
Full sample analysis.Abundances=square meter basis.FILE:08WH02

Total invertebrate abundance=	847.3	EPT abundance	= 582.3
Total number of taxa	= 23	Number EPT taxa	= 14
Hilsenhoff Biotic Index	= 3.65	Brillouin H	= 2.29

TAXONOMIC GROUP	#TAXA	ABUNDANCE	PERCENT
Non-insects	5	99.0	11.76
Odonata	0	0.0	0.00
Ephemeroptera	5	432.0	50.98
Plecoptera	7	90.3	10.58
Hemiptera	0	0.0	0.00
Megaloptera	0	0.0	0.00
Trichoptera	2	60.0	7.06
Lepidoptera	0	0.0	0.00
Coleoptera	0	0.0	0.00
Misc. Diptera	3	9.0	1.17
Chironomidae	1	157.0	18.43

FEEDING GROUP	#TAXA	ABUNDANCE	PERCENT
Predator	4	26.0	3.13
Parasite	2	16.0	1.96
Collector-gatherer	6	419.0	49.41
Collector-filterer	1	3.0	0.39
Macrophyte-herbivore	0	0.0	0.00
Piercer-herbivore	0	0.0	0.00
Scraper	4	146.3	17.25
Shredder	4	77.0	9.02
Xylophage	0	0.0	0.00
Omnivore	0	0.0	0.00
Unknown	2	160.0	18.82

DOMINANT TAXON	ABUNDANCE	PERCENT
Baetis bicaudatus	193.0	22.75
Chironomidae	157.0	18.43
Drunella doddsi	113.0	13.33
Cinygmula	93.0	10.98
Oligochaeta	73.0	8.63
SUBTOTAL 5 DOMINANTS	629.0	74.12
Glossosoma	47.0	5.49
Zapada Oregonensis Group	33.0	3.92
Ameletus	30.0	3.53
Zapada cinctipes	27.0	3.14
Acari	13.0	1.57
TOTAL 10 DOMINANTS	779.0	91.77

INDICATOR ASSEMBLAGE	#TAXA	ABUNDANCE	PERCENT
A Tolerant misc.	0	0.0	0.00
B Tolerant mayflies	0	0.0	0.00
C Intolerant mayflies	3	309.0	36.47
D Intolerant stoneflies	2	10.3	1.17
E Tolerant caddisflies	0	0.0	0.00
F Intolerant caddisflies	1	13.0	1.57
G Tolerant beetles	0	0.0	0.00
H Intolerant flies	1	3.0	0.39
I Tolerant flies	0	0.0	0.00
J Intolerant midges	0	0.0	0.00
K Tolerant midges	0	0.0	0.00
L	0	0.0	0.00
M	0	0.0	0.00
N	0	0.0	0.00

Site 2, Moose Cr. u/s Premier Cr., Sept. 23, 2008
AK: For WHPacific, Inc. Analysis by Aquatic Biology Associates, Inc.
Riffle habitat, Hess sampler, 3 reps, 0.3 m2 total area, 500 micron mesh.
Full sample analysis.Abundances=square meter basis.FILE:08WH02

RATIOS OF TAX. GROUP ABUNDANCES

EPT/Chironomidae	= 3.71
Hydropsychidae/Total Trichoptera	= 0.00
Baetidae/Total Ephemeroptera	= 0.45

RATIOS OF FFG ABUNDANCES

Scraper/Collector-filter	= 48.78
Scraper/(Scraper + C.-filterer)	= 0.98
Shredder/Total organisms	= 0.09

Biotic Condition Index

Community Tolerance Quotient (a)	= 52.70
Community Tolerance Quotient (d)	= 51.46

DIVERSITY MEASURES

Shannon H (loge)	= 2.35
Shannon H (log2)	= 3.40
Evenness	= 0.75
Simpson D	= 0.13

COMMUNITY VOLTINISM ANALYSIS

TYPE	ABUNDANCE	PERCENT
Multivoltine	288.5	34.05
Univoltine	515.8	60.88
Semivoltine	43.0	5.07

Site 3, Moose Cr. u/s Buffalo Cr., Sept. 23, 2008

AK: For WHPacific, Inc. Analysis by Aquatic Biology Associates, Inc.
Riffle habitat, Hess sampler, 3 reps, 0.3 m2 total area, 500 micron mesh.
Full sample analysis.Abundances=square meter basis.FILE:08WH03

IDENTIFICATION CODE	08WH03
CORRECTION FACTOR	3.33

Taxon	Abundance	%
Turbellaria	7	0.31
Oligochaeta	67	3.12
Ostracoda	13	0.62
Acari	10	0.47
TOTAL: NON INSECTS	97	4.52
Ameletus	103	4.83
Baetis bicaudatus	356	16.67
Drunella doddsi	97	4.52
Cinygmula	173	8.10
Epeorus albertae	3	0.16
Epeorus grandis	3	0.16
TOTAL: EPHEMEROPTERA	736	34.42
Capniidae	123	5.76
Chloroperlidae	23	1.09
Suwallia	23	1.09
Zapada cinctipes	130	6.07
Zapada columbiana	13	0.62
Zapada Oregonensis Group	50	2.34
Isoperla	7	0.31
Doddsia occidentalis	29.97	1.40
Taenionema	3.33	0.16
TOTAL: PLECOPTERA	403	18.85
Glossosoma	47	2.18
Limnephilidae	10	0.47
Ecclisomyia	3	0.16
Rhyacophila Vofixa Group	30	1.40
TOTAL: TRICHOPTERA	90	4.21
Chelifera/Metachela	3	0.16
Pericoma	7	0.31
Prosimulium	3	0.16
Simulium	17	0.78
Dicranota	17	0.78
Hesperoconopa	33	1.56
TOTAL: DIPTERA	80	3.74
Chironomidae	733	34.27
TOTAL: CHIRONOMIDAE	733	34.27
GRAND TOTAL	2138	100.00

Site 3, Moose Cr. u/s Buffalo Cr., Sept. 23, 2008
AK: For WHPacific, Inc. Analysis by Aquatic Biology Associates, Inc.
Riffle habitat, Hess sampler, 3 reps, 0.3 m2 total area, 500 micron mesh.
Full sample analysis.Abundances=square meter basis.FILE:08WH03

Total invertebrate abundance=	2137.3	EPT abundance	= 1227.3
Total number of taxa	= 30	Number EPT taxa	= 19
Hilsenhoff Biotic Index	= 4.07	Brillouin H	= 2.32

TAXONOMIC GROUP	#TAXA	ABUNDANCE	PERCENT
Non-insects	4	97.0	4.52
Odonata	0	0.0	0.00
Ephemeroptera	6	735.0	34.44
Plecoptera	9	402.3	18.84
Hemiptera	0	0.0	0.00
Megaloptera	0	0.0	0.00
Trichoptera	4	90.0	4.21
Lepidoptera	0	0.0	0.00
Coleoptera	0	0.0	0.00
Misc. Diptera	6	80.0	3.75
Chironomidae	1	733.0	34.27

FEEDING GROUP	#TAXA	ABUNDANCE	PERCENT
Predator	6	103.0	4.83
Parasite	1	10.0	0.47
Collector-gatherer	7	650.0	30.38
Collector-filterer	2	20.0	0.94
Macrophyte-herbivore	0	0.0	0.00
Piercer-herbivore	0	0.0	0.00
Scraper	6	259.3	12.16
Shredder	4	316.0	14.79
Xylophage	0	0.0	0.00
Omnivore	1	3.0	0.16
Unknown	3	776.0	36.30

DOMINANT TAXON	ABUNDANCE	PERCENT
Chironomidae	733.0	34.27
Baetis bicaudatus	356.0	16.67
Cinygmula	173.0	8.10
Zapada cinctipes	130.0	6.07
Capniidae	123.0	5.76
SUBTOTAL 5 DOMINANTS	1515.0	70.87
Ameletus	103.0	4.83
Drunella doddsi	97.0	4.52
Oligochaeta	67.0	3.12
Zapada Oregonensis Group	50.0	2.34
Glossosoma	47.0	2.18
TOTAL 10 DOMINANTS	1879.0	87.86

INDICATOR ASSEMBLAGE	#TAXA	ABUNDANCE	PERCENT
A Tolerant misc.	0	0.0	0.00
B Tolerant mayflies	0	0.0	0.00
C Intolerant mayflies	3	456.0	21.35
D Intolerant stoneflies	2	43.0	2.02
E Tolerant caddisflies	0	0.0	0.00
F Intolerant caddisflies	2	33.0	1.56
G Tolerant beetles	0	0.0	0.00
H Intolerant flies	2	36.0	1.72
I Tolerant flies	0	0.0	0.00
J Intolerant midges	0	0.0	0.00
K Tolerant midges	0	0.0	0.00
L	0	0.0	0.00
M	0	0.0	0.00
N	0	0.0	0.00

Site 3, Moose Cr. u/s Buffalo Cr., Sept. 23, 2008
AK: For WHPacific, Inc. Analysis by Aquatic Biology Associates, Inc.
Riffle habitat, Hess sampler, 3 reps, 0.3 m2 total area, 500 micron mesh.
Full sample analysis.Abundances=square meter basis.FILE:08WH03

RATIOS OF TAX. GROUP ABUNDANCES

EPT/Chironomidae	= 1.67
Hydropsychidae/Total Trichoptera	= 0.00
Baetidae/Total Ephemeroptera	= 0.48

RATIOS OF FFG ABUNDANCES

Scraper/Collector-filter	= 12.96
Scraper/(Scraper + C.-filterer)	= 0.93
Shredder/Total organisms	= 0.15

Biotic Condition Index

Community Tolerance Quotient (a)	= 55.07
Community Tolerance Quotient (d)	= 51.97

DIVERSITY MEASURES

Shannon H (loge)	= 2.36
Shannon H (log2)	= 3.40
Evenness	= 0.69
Simpson D	= 0.17

COMMUNITY VOLTINISM ANALYSIS

TYPE	ABUNDANCE	PERCENT
Multivoltine	846.8	39.62
Univoltine	1242.0	58.11
Semivoltine	48.5	2.27

Site 4, Moose Creek, Sept. 22, 2008

AK: For WHPacific, Inc. Analysis by Aquatic Biology Associates, Inc.
Riffle habitat, Hess sampler, 3 reps, 0.3 m2 total area, 500 micron mesh.
Full sample analysis.Abundances=square meter basis.FILE:08WH04

IDENTIFICATION CODE	08WH04
CORRECTION FACTOR	3.33

Taxon	Abundance	%
Turbellaria	17	1.08
Oligochaeta	43	2.82
Acari	37	2.39
TOTAL: NON INSECTS	97	6.29
Ameletus	37	2.39
Baetis bicaudatus	370	24.08
Drunella doddsi	43	2.82
Cinygmula	200	13.02
Epeorus albertae	20	1.30
Epeorus grandis	50	3.25
TOTAL: EPHEMEROPTERA	719	46.85
Capniidae	83	5.42
Chloroperlidae	37	2.39
Suwallia	97	6.29
Leuctridae	3	0.22
Zapada cinctipes	27	1.74
Zapada columbiana	43	2.82
Zapada Oregonensis Group	13	0.87
Isoperla	10	0.65
Doddsia occidentalis	26.64	1.74
TOTAL: PLECOPTERA	340	22.13
Glossosoma	3	0.22
Limnephilidae	3	0.22
Rhyacophila Vofixa Group	100	6.51
TOTAL: TRICHOPTERA	107	6.94
Dicranota	3	0.22
Hesperoconopa	3	0.22
TOTAL: DIPTERA	7	0.43
Chironomidae	266	17.35
TOTAL: CHIRONOMIDAE	266	17.35
GRAND TOTAL	1535	100.00

Site 4, Moose Creek, Sept. 22, 2008
AK: For WHPacific, Inc. Analysis by Aquatic Biology Associates, Inc.
Riffle habitat, Hess sampler, 3 reps, 0.3 m2 total area, 500 micron mesh.
Full sample analysis.Abundances=square meter basis.FILE:08WH04

Total invertebrate abundance	= 1534.6	EPT abundance	= 1165.6
Total number of taxa	= 24	Number EPT taxa	= 18
Hilsenhoff Biotic Index	= 3.20	Brillouin H	= 2.45

TAXONOMIC GROUP	#TAXA	ABUNDANCE	PERCENT
Non-insects	3	97.0	6.29
Odonata	0	0.0	0.00
Ephemeroptera	6	720.0	46.86
Plecoptera	9	339.6	22.14
Hemiptera	0	0.0	0.00
Megaloptera	0	0.0	0.00
Trichoptera	3	106.0	6.95
Lepidoptera	0	0.0	0.00
Coleoptera	0	0.0	0.00
Misc. Diptera	2	6.0	0.44
Chironomidae	1	266.0	17.35

FEEDING GROUP	#TAXA	ABUNDANCE	PERCENT
Predator	5	247.0	16.06
Parasite	1	37.0	2.39
Collector-gatherer	5	510.0	33.19
Collector-filterer	0	0.0	0.00
Macrophyte-herbivore	0	0.0	0.00
Piercer-herbivore	0	0.0	0.00
Scraper	5	299.6	19.53
Shredder	5	169.0	11.07
Xylophage	0	0.0	0.00
Omnivore	0	0.0	0.00
Unknown	3	272.0	17.79

DOMINANT TAXON	ABUNDANCE	PERCENT
Baetis bicaudatus	370.0	24.08
Chironomidae	266.0	17.35
Cinygmula	200.0	13.02
Rhyacophila Vofixa Group	100.0	6.51
Suwallia	97.0	6.29
SUBTOTAL 5 DOMINANTS	1033.0	67.25
Capniidae	83.0	5.42
Epeorus grandis	50.0	3.25
Oligochaeta	43.0	2.82
Drunella doddsi	43.0	2.82
Zapada columbiana	43.0	2.82
TOTAL 10 DOMINANTS	1295.0	84.38

INDICATOR ASSEMBLAGE	#TAXA	ABUNDANCE	PERCENT
A Tolerant misc.	0	0.0	0.00
B Tolerant mayflies	0	0.0	0.00
C Intolerant mayflies	3	463.0	30.15
D Intolerant stoneflies	3	72.6	4.78
E Tolerant caddisflies	0	0.0	0.00
F Intolerant caddisflies	1	100.0	6.51
G Tolerant beetles	0	0.0	0.00
H Intolerant flies	1	3.0	0.22
I Tolerant flies	0	0.0	0.00
J Intolerant midges	0	0.0	0.00
K Tolerant midges	0	0.0	0.00
L	0	0.0	0.00
M	0	0.0	0.00
N	0	0.0	0.00

Site 4, Moose Creek, Sept. 22, 2008
AK: For WHPacific, Inc. Analysis by Aquatic Biology Associates, Inc.
Riffle habitat, Hess sampler, 3 reps, 0.3 m2 total area, 500 micron mesh.
Full sample analysis.Abundances=square meter basis.FILE:08WH04

RATIOS OF TAX. GROUP ABUNDANCES
EPT/Chironomidae = 4.38
Hydropsychidae/Total Trichoptera = 0.00
Baetidae/Total Ephemeroptera = 0.51

RATIOS OF FFG ABUNDANCES
Scraper/Collector-filter undefined - Coll.-Filt.=0
Scraper/(Scraper + C.-filterer) = 1.00
Shredder/Total organisms = 0.11

Biotic Condition Index
Community Tolerance Quotient (a) = 44.12
Community Tolerance Quotient (d) = 44.89

DIVERSITY MEASURES
Shannon H (loge) = 2.49
Shannon H (log2) = 3.59
Evenness = 0.78
Simpson D = 0.12

COMMUNITY VOLTINISM ANALYSIS

TYPE	ABUNDANCE	PERCENT
Multivoltine	531.0	34.60
Univoltine	932.1	60.74
Semivoltine	71.5	4.66

Site 5, Buffalo Cr. @ mouth, Sept. 24, 2008

AK: For WHPacific, Inc. Analysis by Aquatic Biology Associates, Inc.
Riffle habitat, Hess sampler, 3 reps, 0.3 m2 total area, 500 micron mesh.
Full sample analysis.Abundances=square meter basis.FILE:08WH05

IDENTIFICATION CODE	08WH05
CORRECTION FACTOR	3.33

Taxon	Abundance	%
Nematoda	63	2.51
Oligochaeta	90	3.57
Ostracoda	7	0.26
Acari	3	0.13
TOTAL: NON INSECTS	163	6.47
Ameletus	13	0.53
Baetis bicaudatus	160	6.34
Cinygmula	33	1.32
TOTAL: EPHEMEROPTERA	206	8.19
Capniidae	53	2.11
Chloroperlidae	3	0.13
Zapada cinctipes	316	12.55
Isoperla	100	3.96
TOTAL: PLECOPTERA	473	18.76
Chyranda centralis	30	1.19
Ecclisomyia	10	0.40
Psychoglypha	13	0.53
Psychoglypha subborealis	3	0.13
Rhyacophila	3	0.13
TOTAL: TRICHOPTERA	60	2.38
Chelifera/Metachela	3	0.13
Pericoma	33	1.32
Simulium	63	2.51
Dicranota	67	2.64
TOTAL: DIPTERA	167	6.61
Chironomidae	1452	57.60
TOTAL: CHIRONOMIDAE	1452	57.60
GRAND TOTAL	2521	100.00

Site 5, Buffalo Cr. @ mouth, Sept. 24, 2008
AK: For WHPacific, Inc. Analysis by Aquatic Biology Associates, Inc.
Riffle habitat, Hess sampler, 3 reps, 0.3 m2 total area, 500 micron mesh.
Full sample analysis.Abundances=square meter basis.FILE:08WH05

Total invertebrate abundance=	2518.0	EPT abundance	= 737.0
Total number of taxa	= 21	Number EPT taxa	= 12
Hilsenhoff Biotic Index	= 5.25	Brillouin H	= 1.64

TAXONOMIC GROUP	#TAXA	ABUNDANCE	PERCENT
Non-insects	4	163.0	6.47
Odonata	0	0.0	0.00
Ephemeroptera	3	206.0	8.19
Plecoptera	4	472.0	18.75
Hemiptera	0	0.0	0.00
Megaloptera	0	0.0	0.00
Trichoptera	5	59.0	2.38
Lepidoptera	0	0.0	0.00
Coleoptera	0	0.0	0.00
Misc. Diptera	4	166.0	6.60
Chironomidae	1	1452.0	57.60

FEEDING GROUP	#TAXA	ABUNDANCE	PERCENT
Predator	5	176.0	6.99
Parasite	2	66.0	2.64
Collector-gatherer	5	303.0	12.02
Collector-filterer	1	63.0	2.51
Macrophyte-herbivore	0	0.0	0.00
Piercer-herbivore	0	0.0	0.00
Scraper	1	33.0	1.32
Shredder	2	369.0	14.66
Xylophage	0	0.0	0.00
Omnivore	4	56.0	2.25
Unknown	1	1452.0	57.60

DOMINANT TAXON	ABUNDANCE	PERCENT
Chironomidae	1452.0	57.60
Zapada cinctipes	316.0	12.55
Baetis bicaudatus	160.0	6.34
Isoperla	100.0	3.96
Oligochaeta	90.0	3.57
SUBTOTAL 5 DOMINANTS	2118.0	84.02
Dicranota	67.0	2.64
Nematoda	63.0	2.51
Simulium	63.0	2.51
Capniidae	53.0	2.11
Cinygmula	33.0	1.32
TOTAL 10 DOMINANTS	2397.0	95.11

INDICATOR ASSEMBLAGE	#TAXA	ABUNDANCE	PERCENT
A Tolerant misc.	0	0.0	0.00
B Tolerant mayflies	0	0.0	0.00
C Intolerant mayflies	1	160.0	6.34
D Intolerant stoneflies	0	0.0	0.00
E Tolerant caddisflies	0	0.0	0.00
F Intolerant caddisflies	3	53.0	2.12
G Tolerant beetles	0	0.0	0.00
H Intolerant flies	0	0.0	0.00
I Tolerant flies	0	0.0	0.00
J Intolerant midges	0	0.0	0.00
K Tolerant midges	0	0.0	0.00
L	0	0.0	0.00
M	0	0.0	0.00
N	0	0.0	0.00

Site 5, Buffalo Cr. @ mouth, Sept. 24, 2008
AK: For WHPacific, Inc. Analysis by Aquatic Biology Associates, Inc.
Riffle habitat, Hess sampler, 3 reps, 0.3 m2 total area, 500 micron mesh.
Full sample analysis.Abundances=square meter basis.FILE:08WH05

RATIOS OF TAX. GROUP ABUNDANCES

EPT/Chironomidae	= 0.51
Hydropsychidae/Total Trichoptera	= 0.00
Baetidae/Total Ephemeroptera	= 0.78

RATIOS OF FFG ABUNDANCES

Scraper/Collector-filter	= 0.52
Scraper/(Scraper + C.-filterer)	= 0.34
Shredder/Total organisms	= 0.15

Biotic Condition Index

Community Tolerance Quotient (a)	= 58.95
Community Tolerance Quotient (d)	= 60.68

DIVERSITY MEASURES

Shannon H (loge)	= 1.67
Shannon H (log2)	= 2.40
Evenness	= 0.55
Simpson D	= 0.36

COMMUNITY VOLTINISM ANALYSIS

TYPE	ABUNDANCE	PERCENT
Multivoltine	1282.0	50.91
Univoltine	1159.5	46.05
Semivoltine	76.5	3.04

Appendix B - Photographs

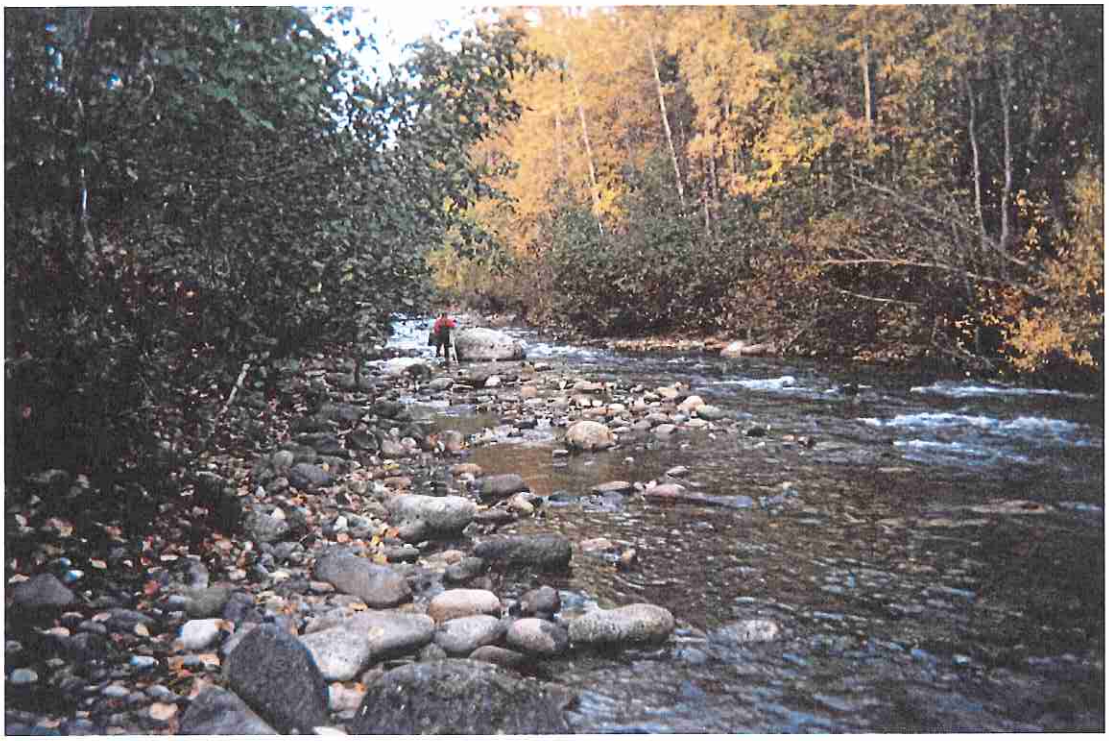


Photo 1. Looking upstream at Station 1 at USGS gauging station.

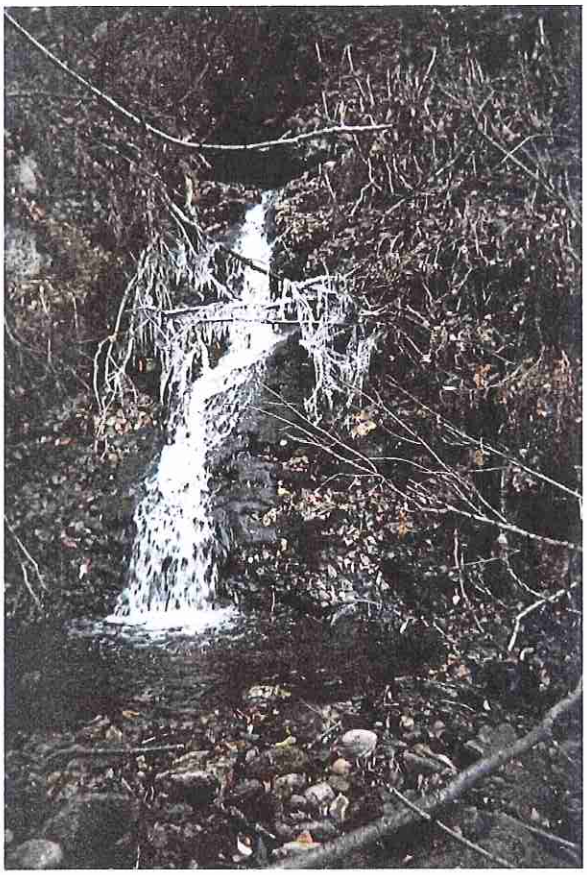
Photo 2. Looking upstream at Station 2 immediately upstream of Premier Creek confluence.

Photo 3. Upstream railway bridge and downstream extent of Station 4.

Photo 4. Looking upstream at Station 4 and Moose Creek forks upstream of bridge (Photo 3).

Photo 5. Buffalo Mine Creek in proximity to Station 5.

Photo 6. Wishbone Lake at beginning of Buffalo Mine Creek (extreme right of photo)




Photos 7 and 8. Waterfalls on Buffalo Mine Creek at bluffs area.

Photo 9. Former main channel waterfall on Moose Creek.

Photo 10. Salmon spawning redds.

Photo 11. Spawning coho salmon utilizing one of few side channels.

ADDENDUM 2

Environmental background of the Wishbone Hill Resource Area and the specific Moose Creek and Buffalo Mine Creek study area.

Fisheries Resources – Moose and Buffalo Mine Creeks: Wishbone Hill Resource Area, Summer 2009. Technical Report by WHPacific, Inc. November 23, 2009

Technical Report

Fisheries Resources – Moose and Buffalo Creeks: Wishbone Hill Resource Area Summer 2009

Prepared for

Usibelli Coal Mine, Inc.

November 23, 2009

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APPENDICES

1.0 Introduction

This report presents the results of recent fisheries sampling conducted in the Moose Creek watershed in the Matanuska basin, Alaska. Sampling efforts were conducted to supplement previous sampling efforts made by WHPacific in the fall of 2008.

The following provides environmental background of the Wishbone Hill Resource Area and the specific Moose Creek and Buffalo Mine Creek study area.

1.1 Study area

The study area is located in the Matanuska basin near the town of Palmer, AK. The study area includes segments of Moose Creek and Buffalo Creek.

Moose Creek is a tributary to the Matanuska River and enters the river approximately 6 miles northeast of Palmer. Moose Creek is crossed by the Glenn Highway (Highway 1) approximately 0.8 miles upstream from its confluence with the river. Buffalo Mine Road runs parallel to Moose Creek for approximately 6.7 miles before it splits into private roadways. The study area on Moose Creek includes the reach between the Glenn Highway Crossing and the upper extent of Buffalo Mine Road.

Buffalo Creek is a tributary to Moose Creek and enters on the left bank of the stream (facing downstream). Buffalo Creek is approximately 2 miles long and originates at the outlet of Wishbone Lake, located 10 air miles northeast of Palmer. The study area of Buffalo Mine Creek includes the entirety of Buffalo Creek.

1.1.1 General Environmental Conditions

Moose Creek

Moose Creek is a large stream that originates in the Talkeetna Mountains. Moose Creek has a total drainage area of approximately 47.3 square miles and receives several tributaries, including Premier Creek, Buffalo Mine Creek, and several unnamed creeks and two forks of Moose Creek at the upper end of the study area. Gauging data is recorded by the US Geological Survey (USGS) near the Glenn Highway Bridge.
Most of study area reach of Moose Creek is characterized by cascades and high velocity riffles. Pools and slow water habitats are limited to streambank margins, plunge pools, pocket pools behind large boulders, and side channels. Side channels are found throughout the stream study reach and are typically low in gradient, but not abundant. Approximately 3 miles of Moose Creek flow through Tsadaka Canyon. This canyon is a narrow U-shaped canyon that confines the stream. Upstream of the canyon the creek occupies a relatively narrow valley with an old railroad bed following the majority of the study area reach. The width of Moose Creek within the study area ranges from 25-50 feet with the depth averaging about 2 feet. Substrate is composed of primarily cobbles and boulders, with gravel and sand in margins and side channels.

Buffalo Creek
Buffalo Creek is a small stream and tributary of Moose Creek. Buffalo Creek ranges from 1- 6 feet wide and averages 0.5 feet deep. Buffalo Creek originates at the western end of Wishbone Lake on a plateau at about 1,500 feet elevation. This creek flows in a westerly direction before it enters Moose Creek. Buffalo Creek flows through a series of conglomerate bluffs approximately 1,000 feet downstream of Wishbone Lake and descends steeply to a relatively flat bench above Moose Creek. Flatter segments of the stream are highly sinuous with substrate dominated by sand, silt, gravel, and cobble. Stream segments that intersect the conglomerate bluffs form substantial alcove undercuts within the rock and several waterfalls and chutes over 10' in height are interspersed within these reaches.

1.1.2 Riparian Habitat

Moose Creek
Riparian habitat along the majority of Moose Creek is dominated by an overstory of black cottonwood (Populus trichocarpa), paper birch (Betula neoalaskana), quaking aspen (Populus tremuloides), and spruce (Picea sp.). The understory is composed of devils club (Oplopanax horridus), currant (Ribes sp.), alder (Alnus sp.), prickly rose (Rosa acicularis), and willows (Salix sp.). Most segments of streambank are heavily vegetated and stable. However, several large slumps and slides exist including a large slide near a powerline crossing, a large bank failure in the upper reaches of the study area at the base of Buffalo Mine Road, and smaller natural slides associated with geologic features, including a number near the confluences of Premier, and Buffalo Mine Creek.

1.1.3 Topography and Geology

The study area is located at the southern foot of the Talkeetna Mountains. Moose Creek arises in a valley between Arkose Peak and Eska Mountain. Just south (downstream) of the confluence with Buffalo Mine Creek, Moose Creek enters into Tsadaka Canyon.

1.1.4 Climate

The study area experiences weather similar to communities in the Cook Inlet area. Data from the National Climate Data Center for years 1971 - 2000 puts the average annual temperature at 36 degrees with 62.9 inches of snowfall and 15.8 inches of accumulated precipitation (water equivalent) annually.

2.0 Previous Survey Results - Fisheries

The following summarizes the results of fisheries sampling and surveys completed by WHPacific in the fall of 2008.

Previous Methods and Analysis
As part of long-term environmental monitoring, WHPacific completed an analysis of aquatic habitat, fisheries, and macroinvertebrates in 2008. WHPacific completed salmon

spawning counts, systematic fisheries sampling at 5 stations, macroinvertebrate sampling at 5 stations, and reconnaissance fish sampling throughout the study area. The 5 stations sampled are intended as long-term monitoring sites and are located throughout the watershed to capture potential changes at significant confluences and points of potential accumulated effects. The 5 stations occur at the following locations:

Station 1 - Moose Creek, immediately upstream of Glenn Highway crossing

Station 2 – Moose Creek, immediately upstream of Premier Creek confluence.

Station 3 – Moose Creek, at river mile (RM) 4.9

Station 4 – Moose Creek, at RM 6.8, upstream of bridge at fork.

Station 5 – Buffalo Mine Creek, immediately upstream of confluence with Moose Creek

All sample stations were 240 to 300 feet in length, with widths and general habitat varying.

Fisheries sampling methods included the use of a backpack electrofisher and dipnets to collect fisheries population data at all stations. Multiple pass/removal was used to estimate fish populations. General and exploratory fisheries sampling in Moose and Buffalo Creek was also conducted with a backpack electrofisher and dip nets. During this sampling, collected fish were measured and released and a population estimate was not produced. General presence and absence of the exploratory sampling was the primary objective.

Spawning surveys were conducted from the Glenn Highway crossing (RM 0.8) to the most upstream bridge crossing over Moose Creek. Spawning counts on coho salmon (Oncorhynchus kisutch) as the effort was completed during the timing of this run.

WHPacific Fish Community Results

Reconnaisance Survey

Limited spot sampling was conducted on October 8, 2008 in Buffalo Creek using a beach seine and baited minnow traps. Baited minnow traps were deployed approximately 500 feet upstream from the Moose Creek confluence and kick-seining was used in habitat within the first 1,000 feet downstream of Wishbone Lake. While juvenile salmonids estimated at less than 20mm were observed in the lower reach, no fish were collected in the minnow traps. Kick seining and seine hauls in the upper reach of Buffalo Mine Creek did not yield fish and no fish were observed during the Rosgen survey effort or fish sampling.

Spawning Survey

Spawning surveys were conducted on Moose Creek on September 21 and September 22, 2008. The spawning survey on September 22 was continued from the point where the survey ended on September 21. Surveys identified 100 live coho, 30 unidentified salmon carcasses, and 3 positively identified coho carcasses. Live coho salmon were observed throughout the sample reach with fish being identified immediately upstream of the Glenn Highway crossing and several hundred feet downstream of the upstream end of the study area. Fifty (50) of the live coho identified during the survey were observed between the Glenn Highway Bridge and the former location of the Premier Creek Bridge. Concentrations of spawning salmon were highest between the Glenn Highway Bridge and the site of the former large waterfall (approximate RM 3.2) and between the Buffalo Creek confluence and last fork or tributary of Moose Creek downstream of the railroad bridge. Live salmon were most often identified in the tails of pools, lower velocity riffles and runs, and side channels where they were abundant. A single side channel contained over 20 spawning salmon and averaged only 4 feet in width.

Station Sampling

Station 1

Station 1 was sampled on September 23, 2008. Spawning coho salmon were identified immediately downstream of the station start point. Station 1 is dominated by high velocity riffle habitat with few eddies and pools to provide resting and foraging habitat for small salmonids. A total of 52 juvenile coho salmon and 3 slimy sculpins (Cottus cognatus) were collected during sampling.

Station 2

Station 2 was sampled on September 24, 2008. The station extends from the mouth of Premier Creek, upstream 270 feet. The average wetted width of the sample reach was 30 feet at the time of sampling. The study reach was dominated by cobble and boulder substrate with high velocity riffles as the dominant habitat type. Several pocket pools, undercut banks, and wood debris provided limited refuge habitat. Depletion sampling yielded six (6) coho, five (5) Dolly Varden (Salvelinus malma), one rainbow trout (Oncorhynchus mykiss), and one slimy sculpin.

Station 3

Station 3 was sampled on September 23, 2008. The station is found at the base of a large river right bank failure at approximate RM 4.9. The station extends upstream from this bank failure 300 feet. The channel in the sample reach is wide with an average width of 50 feet. Habitat is characterized by riffles, with a short (~50') moderate velocity side channel on the right bank, and extensive shallow and low velocity margins along the left bank in the upper half of the sample reach. Several pocket pools occur along the left

bank associated with large substrate and woody debris, as well as main channel pocket pools behind large boulders

Two-pass sampling in the study area yielded eighteen (18) coho, eight (8) Dolly Varden, and five (5) slimy sculpins.

Station 4
Station 4 was sampled on September 22, 2008. This station begins at the upstream side of the old railroad bridge at approximate RM 6.8. Upstream from the bridge the sample reach follows the right side fork (looking upstream) of Moose Creek and extends 270 feet upstream. The sample reach also includes a 420 foot length of river right side channel that enters near the confluence of the two forks (the downstream end of an island).

Two-pass sampling yielded eleven (11) Dolly Varden, with sizes ranging from 50-153mm.

Station 5
Station 5 was sampled on September 24. This station is located on Buffalo Creek and begins approximately twenty feet upstream of the confluence with Moose Creek and extends upstream 240 feet from this point. The average width of this stream reach is approximately four and a half feet. Habitat consists of shallow runs, pools, and low velocity riffles. Undercut banks, overhanging vegetation, and woody debris provide important habitat elements. An abundance of age 0 rainbow trout were collected within the sample reach and were the only fish species and age class collected. Two-pass sampling yielded 41 rainbow trout all under 20mm in length.

3.0 WHPacific 2009 Summer Sampling

The following section presents the results of the WHPacific fisheries sampling in Moose and Buffalo Creeks in the summer of 2009. Previously sampled stations were not included in the sampled reaches, aside from sampled segments of Buffalo Creek.

Sampling was conducted in an effort to document species and life stages from habitat not sampled during the previous year's effort. In particular, an effort was made to focus sampling on those habitats that were potentially more productive and attractive to species or life stages not previously collected. In addition, a significant segment of Buffalo Creek was sampled to determine the extent of fisheries throughout the stream's length.

3.1 Methods

All sampling was conducted with either a backpack electrofisher and dipnet or a 6' X 8' seine. All habitat containing adult salmon (Chinook – Oncorhynchus tshawytscha) was avoided with the backpack electrofisher. All fish collected were identified to species, measured (fork length or standard length), and released.

Most stream reaches were selected in stream segments not previously sampled and in areas with a high density of backwaters, pools, side channels, and other sampleable habitats with the potential to support resident and migratory fish.

3.2 Sample Site (Reach) Descriptions

Sample site locations are provided below.

Site #1: Buffalo Creek from Mouth to First Dry Reach
Site includes approximately 4,700 linear feet of habitat and also includes the previously sampled reach from the fall 2008 fisheries study. Habitat consists of shallow water (< 0.5') riffles and runs with few, small pools. Adjacent riparian habitat consists of extremely dense herbaceous cover, cottonwood trees, and an abundance of fallen wood. Approximately 40 percent of the stream reach was sampled. All major pools, accessible riffles, undercut banks, and runs were sampled. Habitat avoided include significant portions of the stream reach too shallow to contain fish and/or unsampleable due to the density of vegetation.

Site #2: Buffalo Creek from Upstream End of Dry Reach to Wishbone Lake Site includes approximately 5,200 linear feet of stream habitat. Site reach includes several waterfalls, bluffs, and extensive marsh areas near Wishbone Lake. Habitat is deeper in this reach and includes more pools, larger substrate, and less woody debris. Herbaceous cover is less dense than Site 1, but includes an abundance of devils club.

Site #3: Moose Creek Approximately 100 Feet Upstream of USGS Gauging Station
Habitat includes an abundance of large plunge pools, large substrate (cobble to large boulder), and small quantities of low velocity water. Some large woody debris is present and provides in-channel habitat. Depths range from 1.0 – 4.0 feet. The width of the stream in this reach exceeds 25 feet in most places. Adjacent riparian habitat is dominated by willows, cottonwoods, and alders. The end of the site (sample reach) is downstream of the first major side channel upstream of the Glenn Highway. Sample reach length is approximately 1,400 feet.

Site #4: Moose Creek Upstream of Site #3
Habitat is primarily associated with a left bank side channel. Approximately 70 percent of the sample reach is composed of the side channel. Depth of this habitat is 0.5-1.0 feet on average and the side channel does not exceed 20 feet in width. Site 4 is approximately 1,200 feet in length.

Site #5: Moose Creek in Vicinity of Old Waterfall Pool (prior to channel reroute)
Habitat includes a large relict plunge pool below the old waterfall, a side channel pool upstream of the plunge pool (along the restored channel reach), a short side channel downstream of the pool, and cascading riffles with abundant large woody debris upstream of the old waterfall. Riparian habitat is dominated by cottonwoods with

currants and devils club in the understory. This sample reach is approximately 300 feet long.

Site #6: Moose Creek Tributary/Fork and Side Channel Mosaic
Habitat consists of step pools and shallow riffles (<0.5'). Undercut banks, large boulders, and plunge pools provide additional habitat components. Habitat is distinctly different from the main channel of Moose Creek. Velocities are reduced, total percent cover is much higher, emergent vegetation is common along the margins and the channel is approximately one tenth the size of the main channel. The sampled reach length is 300 feet.

Site #7: Moose Creek Upstream of Confluence with Tributary (Site #6) Habitat is primarily a cascading torrent with few small plunge pools behind large boulders and small pools and slow velocity habitat immediately next to the bank. Average depth in the sample reach is approximately 2.5 feet. The channel width in the sample reach is approximately 30 feet. Sample reach length is 350 feet.

Site #8: Moose Creek at Buffalo Creek Confluence
Habitat is similar to Site #7 although side margin habitat is more abundant and stream velocities are lower. Approximately 90% of the habitat is riffle. Substrate is composed of cobbles and small boulders. Sample reach length is approximately 400 feet.

Site #9: Moose Creek-Middle Reach – Downstream of site #5 and upstream of site #4
Sample reach includes main channel of Moose Creek at midpoint of island created by extensive side channel. Sampled habitat includes a large pool and an abundance of plunge pools and high velocity riffles. Areas of low velocity margin habitat are present along the right bank. Site 9 is approximately 425 feet in length.

Site #10: Moose Creek in Vicinity of Ford and Campground
Sample reach includes backwaters, a side channel, and the stream reach associated with the Wishbone Lake Road ford. Habitat is riffle dominated and approximately 2 feet deep on average. Backwaters are on river right and associated with side channels. A river left side channel downstream of the ford provides refuge habitat and is characterized by low velocity flows and small pools. Woody debris and in-stream vegetation is associated with this and the backwater habitats. The sampled reach is approximately 300 feet in length.

3.3 Sample Site Results

Site 1: Site 1 includes a stream segment of Buffalo Creek previously sampled in 2008. Juvenile rainbow trout were the only fish species collected in the stream reach in 2008. In 2009, no fish were collected in any portion of stream reach 1. All pools, runs, and accessible habitats were sampled with the backpack electrofisher without result.

Site 2: All accessible habitats in the second reach (Site 2) were sampled. Sampling did not yield any fish. Emergent and riparian vegetation almost completely enclosed most of the reach. Fish were expected from large plunge pools and near the outlet of Wishbone Lake, but these and all other habitats were devoid of fish.

Site 3: A total of eight (8) juvenile coho salmon were collected within the third reach and over thirty adult Chinook salmon were observed in the sample reach. Juvenile salmon were collected in waters along the streambank and in association with woody debris.

Site 4: A total of six (6) juvenile coho salmon were collected within the fourth reach. A single slimy sculpin was collected and 9 adult Chinook salmon were observed in the reach. The habitat associated with the side channel did not yield fish. Despite heavy utilization of the side channel by spawning adult coho as witnessed in 2008, Chinook salmon were not found to be utilizing this habitat for spawning. Redds were not observed.

Site 5: Thirty-five (35) juvenile coho salmon, two (2) Dolly Varden, and three slimy sculpin were collected within the fifth reach, 9 adult Chinook salmon were observed. Juvenile salmon were abundant in a small side channel at the downstream end of the reach and an isolated pool on the left bank at the upstream end of the reach. Most of the fish collected in this reach were collected with seine hauls.

Site 6: Four juvenile coho salmon (4) and eleven (11) Dolly Varden were collected in the sixth reach. Adult Chinook salmon were not present in the reach. The habitat associated with this reach is expected to be too small for use by adult Chinook salmon. Fish were common in most habitats, but most abundant in several of the large plunge pools in the reach.

Site 7: Seven (7) juvenile coho salmon were collected in the seventh reach. Adult Chinook salmon were not observed in the sample reach.

Site 8: Twenty-one (21) juvenile coho salmon were collected in the eighth reach. Most fish were collected with seine hauls. Approximately ten (10) adult Chinook salmon were observed in the sample reach.

Site 9: Thirty-two (32) juvenile coho salmon were collected in the ninth reach. Four (4) Dolly Varden were collected in this reach. Adult Chinook salmon (approximately four (4)) were observed at the upstream end of the sample reach in a large plunge pool.

Site 10: Forty-four (44) juvenile coho salmon and a single Dolly Varden were collected in the tenth reach. Large groups of juvenile coho were collected in seine hauls in a large river right backwater. Additionally, a large number of juvenile coho and the lone Dolly Varden were collected in a small side channel on river left.

4.0 Summary and Discussion

Consistent with results from 2009, we found that juvenile coho salmon are the most commonly collected fish in the Moose Creek study area. Coho were collected at all Moose Creek stations. Dolly Varden appear to be more abundant in upstream portions of the Moose Creek study area, although several were collected in the middle reaches (Sites 5, 9, and 10). Catch rates for slimy sculpins were inconsistent, but their distribution is assumed to be throughout the study reach. Adult Chinook salmon were observed throughout the study area. The highest abundance of Chinook adults was noted within a quarter mile of the Glenn Highway Bridge. However, individuals were noted well upstream of this, including the uppermost extent of the study area at the last bridge over Moose Creek.

Fish of any species or life stage were not collected in Buffalo Creek. Habitat and connectivity in habitat are limited in this stream. A large segment in the central part of Buffalo Creek lacks surface water, providing a migration barrier between fish populations that could source from Moose Creek and Wishbone Lake. In addition, impassible waterfalls occur in Buffalo Creek downstream of Wishbone Lake. In-stream habitat capable of supporting resident fish is limited downstream of Wishbone Lake and upstream of the impassable falls. Much of the habitat is associated either with heavily-vegetated and incised channels or with small plunge pools associated with the conglomerate bluffs that form the waterfalls. All of these habitats were sampled with backpack shocker, seine, or both in 2009.

Downstream of the dry reach in Buffalo Creek habitat is primarily a meandering, incised channel associated with dense vegetation. Large pools and habitat deeper than 6 inches are rare. The previous collection (2008) of juvenile rainbow trout just upstream of the confluence of Buffalo Creek with Moose Creek was not repeated in 2009. We expect that lower segments of Buffalo Creek near the confluence serve as occasional rearing habitat for juvenile salmonids and may also serve as spawning habitat for resident Dolly Varden and rainbow trout.

Project sampling did not identify species not previously collected in 2008 or 1988 (Dames and Moore) in Moose or Buffalo Creeks. Of note, Dolly Varden exceeding 128 mm (fork length) were not observed or collected, while fish exceeding this size class were observed and collected in several reaches. This may indicate a spawning migration or a shift in seasonal dispersal patterns.

Combining the results of fisheries sampling from 2008 and 2009 a number of assumptions can be drawn on fish distributions in the study area. Generally, coho and Chinook salmon at a minimum occur throughout the study area, with overall abundances appearing to be higher in lower reaches. Based on survey results and field observations

by personnel from the Chickaloon Village Traditional Council, chum salmon (Oncorhynchus keta), and sockeye salmon (Oncorhynchus nerka) also occur in the lower reaches of the study area, although they were not observed during WHPacific's studies. Abundance of chum salmon within the lower reaches of the study area may be significant (Winstauffer, pers. comm. 2008).

Rearing of coho salmon juveniles occurs throughout the study area. Coho were commonly collected in almost all lower velocity habitats sampled. Even narrow streambank margins and small pocket pools adjacent to swift flowing torrents yielded coho during both summer and fall sampling efforts. A large abundance of coho salmon was collected in the few still water areas sampled during the studies.

Dolly Varden were generally more common in upstream reaches of the study area. This can likely be attributed to the relatively higher abundance of backwaters upstream of the old stream ford. Dolly Varden were not collected by WHPacific in reaches nearest the Glenn Highway.

Rainbow trout, while collected by WHPacific in small numbers in 2008, were not collected during sample efforts in 2009. General abundance of the species in the study area is not known, but can be assumed to be low.

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Alaska Climate Research Center. 2008. Climate data for Cook Inlet communities. retrieved on October 24, 2008 at: http://climate.gi.alaska.edu/

Chickaloon Village Traditional Council. 2008. Moose Creek fisheries and restoration project details retrieved on September 20th and October 23, 2008 at: http://www.chickaloon.org/Environmental/Environmental.html

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Appendix A – Fisheries Data by Site(Station) and Site Location Figure

Site 3 : Moose Creek Upstream from USGS Monitoring Station Upstream
Sampled Date: 7/29/09
Reach Length: 1400 feet

Shock Seconds 379

Catch Data

Genus	Species	Common Name	FL
Oncorynchus	kisutch	Coho salmon	55
Oncorynchus	kisutch	Coho salmon	38
Oncorynchus	kisutch	Coho salmon	53
Oncorynchus	kisutch	Coho salmon	44
Oncorynchus	kisutch	Coho salmon	44
Oncorynchus	kisutch	Coho salmon	40
Oncorynchus	kisutch	Coho salmon	30
Oncorynchus	kisutch	Coho salmon	33
Cottus	Cognatus	Slimy sculpin	obs

Site 4 : Moose Creek Upstream of Site 3
Sampled Date: 7/29/09
Reach Length: 1200 feet

Shock Seconds 658

Catch Data

Genus	Species	Common Name	FL
Oncorynchus	kisutch	Coho salmon	47
Oncorynchus	kisutch	Coho salmon	48
Oncorynchus	kisutch	Coho salmon	44
Oncorynchus	kisutch	Coho salmon	35
Oncorynchus	kisutch	Coho salmon	40
Oncorynchus	kisutch	Coho salmon	37
Cottus	Cognatus	Slimy sculpin	32

Site 5 : Moose Creek at Old Waterfall Pool
Sampled Date: 7/29/09
Reach Length: 300 feet

Shock Seconds 353
Seine Hauls: 5

Catch Data

Genus	Species	Common Name	FL
Oncorynchus	kisutch	Coho salmon	90
Oncorynchus	kisutch	Coho salmon	40
Oncorynchus	kisutch	Coho salmon	43
Oncorynchus	kisutch	Coho salmon	45
Oncorynchus	kisutch	Coho salmon	46
Oncorynchus	kisutch	Coho salmon	46
Oncorynchus	kisutch	Coho salmon	33
Oncorynchus	kisutch	Coho salmon	45
Oncorynchus	kisutch	Coho salmon	43
Oncorynchus	kisutch	Coho salmon	42
Oncorynchus	kisutch	Coho salmon	52
Oncorynchus	kisutch	Coho salmon	46
Oncorynchus	kisutch	Coho salmon	41
Oncorynchus	kisutch	Coho salmon	38
Oncorynchus	kisutch	Coho salmon	36
Oncorynchus	kisutch	Coho salmon	32
Oncorynchus	kisutch	Coho salmon	40
Oncorynchus	kisutch	Coho salmon	48
Oncorynchus	kisutch	Coho salmon	47
Oncorynchus	kisutch	Coho salmon	35
Oncorynchus	kisutch	Coho salmon	43
Oncorynchus	kisutch	Coho salmon	41
Oncorynchus	kisutch	Coho salmon	43
Oncorynchus	kisutch	Coho salmon	33
Oncorynchus	kisutch	Coho salmon	46
Oncorynchus	kisutch	Coho salmon	37
Oncorynchus	kisutch	Coho salmon	40
Oncorynchus	kisutch	Coho salmon	Est40
Oncorynchus	kisutch	Coho salmon	43
Oncorynchus	kisutch	Coho salmon	42
Oncorynchus	kisutch	Coho salmon	33
Oncorynchus	kisutch	Coho salmon	30
Oncorynchus	kisutch	Coho salmon	37
Oncorynchus	kisutch	Coho salmon	36
Oncorynchus	kisutch	Coho salmon	32
Salvelinus	malma	Dolly Varden	65
Salvelinus	malma	Dolly Varden	68
Cottus	Cognatus	Slimy sculpin	50
Cottus	Cognatus	Slimy sculpin	55
Cottus	Cognatus	Slimy sculpin	27

Site 6 : Moose Creek Upstream Fork (Tributary) at Confluence with Main Stem
Sampled Date: 7/30/09
Reach Length: 300 feet

Shock Seconds 280

Catch Data

Genus	Species	Common Name	FL
Oncorynchus	kisutch	Coho salmon	39
Oncorynchus	kisutch	Coho salmon	38
Oncorynchus	kisutch	Coho salmon	38
Oncorynchus	kisutch	Coho salmon	43
Salvelinus	malma	Dolly Varden	125
Salvelinus	malma	Dolly Varden	75
Salvelinus	malma	Dolly Varden	56
Salvelinus	malma	Dolly Varden	74
Salvelinus	malma	Dolly Varden	128
Salvelinus	malma	Dolly Varden	65
Salvelinus	malma	Dolly Varden	68
Salvelinus	malma	Dolly Varden	98
Salvelinus	malma	Dolly Varden	114
Salvelinus	malma	Dolly Varden	58
Salvelinus	malma	Dolly Varden	30

Site 7 : Moose Creek Immediately Upstream of Fork (Tributary) Confluence
Sampled Date: 7/30/09
Reach Length: 350 feet

Shock Seconds NA
Seine Hauls 10

Catch Data

Genus	Species	Common Name	FL
Oncorynchus	kisutch	Coho salmon	Est40
Oncorynchus	kisutch	Coho salmon	44
Oncorynchus	kisutch	Coho salmon	44
Oncorynchus	kisutch	Coho salmon	43
Oncorynchus	kisutch	Coho salmon	52
Oncorynchus	kisutch	Coho salmon	44
Oncorynchus	kisutch	Coho salmon	40
Oncorynchus	kisutch	Coho salmon	43
Oncorynchus	kisutch	Coho salmon	41
Oncorynchus	kisutch	Coho salmon	42

Site 8: Moose Creek at Buffalo Creek Confluence
Sampled Date: 7/30/09
Reach Length: 400 feet

Shock Seconds	240
Seine Hauls	10

Catch Data

Genus	Species	Common Name	FL
Oncorynchus	kisutch	Coho salmon	41
Oncorynchus	kisutch	Coho salmon	Est45
Oncorynchus	kisutch	Coho salmon	40
Oncorynchus	kisutch	Coho salmon	40
Oncorynchus	kisutch	Coho salmon	50
Oncorynchus	kisutch	Coho salmon	55
Oncorynchus	kisutch	Coho salmon	55
Oncorynchus	kisutch	Coho salmon	42
Oncorynchus	kisutch	Coho salmon	46
Oncorynchus	kisutch	Coho salmon	42
Oncorynchus	kisutch	Coho salmon	55
Oncorynchus	kisutch	Coho salmon	47
Oncorynchus	kisutch	Coho salmon	44
Oncorynchus	kisutch	Coho salmon	50
Oncorynchus	kisutch	Coho salmon	53
Oncorynchus	kisutch	Coho salmon	38
Oncorynchus	kisutch	Coho salmon	44
Oncorynchus	kisutch	Coho salmon	46
Oncorynchus	kisutch	Coho salmon	40
Oncorynchus	kisutch	Coho salmon	42
Oncorynchus	kisutch	Coho salmon	42

Site 9: Moose Creek (Between Site 4 and Site 5)
Sampled Date: 7/30/09
Reach Length: 425 feet

Shock Seconds 620
Seine Hauls 4

Catch Data

Genus	Species	Common Name	FL
Oncorynchus	kisutch	Coho salmon	55
Oncorynchus	kisutch	Coho salmon	48
Oncorynchus	kisutch	Coho salmon	62
Oncorynchus	kisutch	Coho salmon	45
Oncorynchus	kisutch	Coho salmon	40
Oncorynchus	kisutch	Coho salmon	41
Oncorynchus	kisutch	Coho salmon	38
Oncorynchus	kisutch	Coho salmon	Est45
Oncorynchus	kisutch	Coho salmon	42
Oncorynchus	kisutch	Coho salmon	40
Oncorynchus	kisutch	Coho salmon	43
Oncorynchus	kisutch	Coho salmon	42
Oncorynchus	kisutch	Coho salmon	Est45
Oncorynchus	kisutch	Coho salmon	46
Oncorynchus	kisutch	Coho salmon	38
Oncorynchus	kisutch	Coho salmon	52
Oncorynchus	kisutch	Coho salmon	48
Oncorynchus	kisutch	Coho salmon	44
Oncorynchus	kisutch	Coho salmon	55
Oncorynchus	kisutch	Coho salmon	56
Oncorynchus	kisutch	Coho salmon	45
Oncorynchus	kisutch	Coho salmon	45
Oncorynchus	kisutch	Coho salmon	40
Oncorynchus	kisutch	Coho salmon	42
Oncorynchus	kisutch	Coho salmon	43
Oncorynchus	kisutch	Coho salmon	46
Oncorynchus	kisutch	Coho salmon	41
Oncorynchus	kisutch	Coho salmon	41
Oncorynchus	kisutch	Coho salmon	44
Oncorynchus	kisutch	Coho salmon	43
Oncorynchus	kisutch	Coho salmon	45
Salvelinus	malma	Dolly Varden	58
Salvelinus	malma	Dolly Varden	110
Salvelinus	malma	Dolly Varden	68
Salvelinus	malma	Dolly Varden	46

Site 10: Moose Creek at Campsite and Ford (Old Bridge Crossing)
Sampled Date: 7/31/09
Reach Length: 300 feet

Shock Seconds 412
Seine Hauls 6

Catch Data

Genus	Species	Common Name	FL
Oncorynchus	kisutch	Coho salmon	43
Oncorynchus	kisutch	Coho salmon	38
Oncorynchus	kisutch	Coho salmon	47
Oncorynchus	kisutch	Coho salmon	Est40
Oncorynchus	kisutch	Coho salmon	39
Oncorynchus	kisutch	Coho salmon	38
Oncorynchus	kisutch	Coho salmon	37
Oncorynchus	kisutch	Coho salmon	34
Oncorynchus	kisutch	Coho salmon	35
Oncorynchus	kisutch	Coho salmon	35
Oncorynchus	kisutch	Coho salmon	36
Oncorynchus	kisutch	Coho salmon	36
Oncorynchus	kisutch	Coho salmon	Est40
Oncorynchus	kisutch	Coho salmon	Est40
Oncorynchus	kisutch	Coho salmon	Est40
Oncorynchus	kisutch	Coho salmon	Est40
Oncorynchus	kisutch	Coho salmon	Est40
Oncorynchus	kisutch	Coho salmon	38
Oncorynchus	kisutch	Coho salmon	38
Oncorynchus	kisutch	Coho salmon	42
Oncorynchus	kisutch	Coho salmon	38
Oncorynchus	kisutch	Coho salmon	39
Oncorynchus	kisutch	Coho salmon	41
Oncorynchus	kisutch	Coho salmon	45
Oncorynchus	kisutch	Coho salmon	42
Oncorynchus	kisutch	Coho salmon	33
Oncorynchus	kisutch	Coho salmon	38
Oncorynchus	kisutch	Coho salmon	43
Oncorynchus	kisutch	Coho salmon	42
Oncorynchus	kisutch	Coho salmon	40
Oncorynchus	kisutch	Coho salmon	44
Oncorynchus	kisutch	Coho salmon	34
Oncorynchus	kisutch	Coho salmon	34
Oncorynchus	kisutch	Coho salmon	41
Oncorynchus	kisutch	Coho salmon	36
Oncorynchus	kisutch	Coho salmon	36
Oncorynchus	kisutch	Coho salmon	38
Oncorynchus	kisutch	Coho salmon	32
Oncorynchus	kisutch	Coho salmon	38
Oncorynchus	kisutch	Coho salmon	41
Oncorynchus	kisutch	Coho salmon	44
Oncorynchus	kisutch	Coho salmon	35
Oncorynchus	kisutch	Coho salmon	38
Oncorynchus	kisutch	Coho salmon	32

Appendix B – Photographs

Photo 1: Wishbone Lake near the end of Site 2.

Photo 2: Downstream end of Site 3. Moose Creek upstream of Glenn Highway.

Photo 3: Mid-portion of Site 4. Photo taken from confluence of side channel.

Photo 4: Sampled side channel- Site 4.

Photo 5: Relict channel waterfall pool – Site 5

Photo 6: Side channel pool – Site 5.

Photo 7: Typical habitat {tributary) Site 6

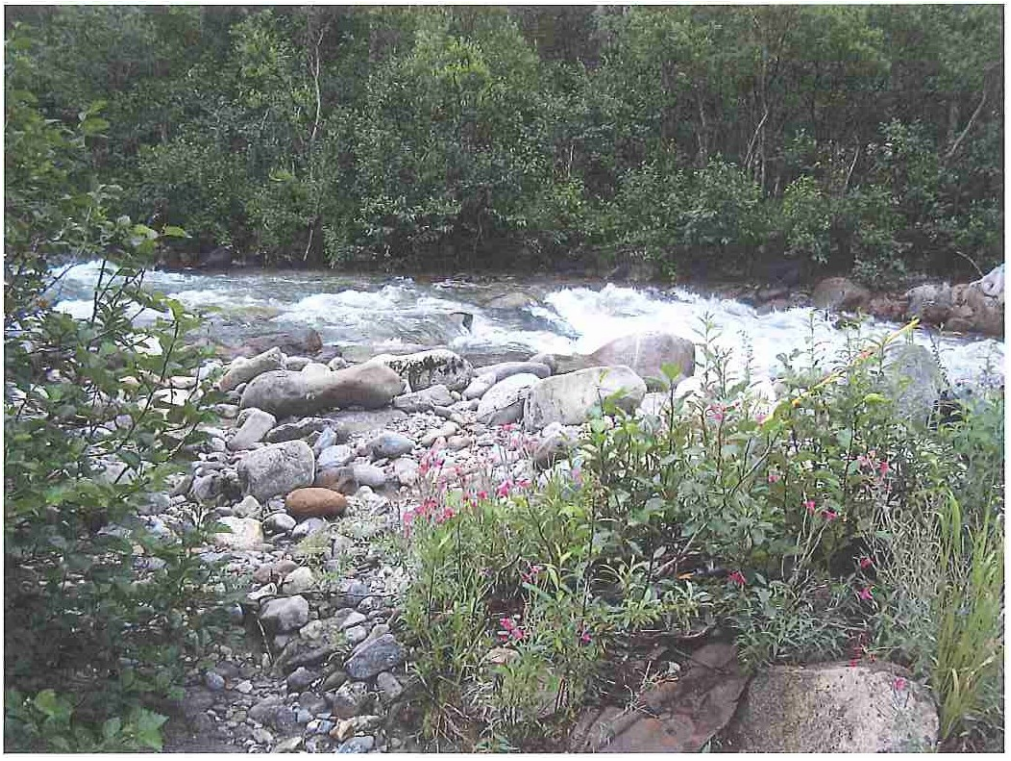


Photo 8: Downstream end of Site 7.

Photo 9: Site 8 -looking downstream from confluence of Buffalo Creek.

Photo 10: Downstream end of Site 9 -looking upstream.

Photo 11: Pool at upstream end of Site 9 – looking upstream.

Photo 9: Downstream end of Site 8.

ADDENDUM 3

Update of Fisheries Resources Since the 2008 Stream Restorations Work on Moose Creek and discharge measurements of lower Buffalo Creek.

Technical Memorandum by WHPacific, Inc. August 16, 2012.

WHPacific

9755 SW Barnes Road,
Portland, OR 97225
503-626-0455

Technical Memorandum

To: Rob Brown, Usibelli Coal Mine, Inc.

From: Casey Storey, WHPacific

Date: July 24, 2012 – Revised August 1, August 16, 2012

Re: **Recent discharge measurements and fisheries sampling**

This memorandum documents recent fisheries sampling and discharge measurements that were undertaken on behalf of Usibelli Coal Mine, Inc. on Buffalo Creek in the Wishbone Hill and Wishbone Lake vicinity approximately 10 miles Northeast of Palmer, AK.

Stream Discharge

On July 12th, WHPacific staff completed discharge measurements at Buffalo Creek at five locations. Weather during the time of sampling was overcast and in the 50s. No rain fell during the day of sampling. Staff utilized a Marsh Mcbirney Flo-Mate velocity meter with a top setting wading rod to measure water velocities and depths at chosen cross sections. At each cross section, the wetted width of the channel was measured and the width was evenly divided into no fewer than five segments for velocity measurements. Sites that were selected for discharge measurements were in straight channel segments with generally uniform substrate and even flows. Sites were also selected throughout Buffalo Creek to represent a range of hydrologic conditions and the potential addition of tributaries, ground water, or springs to base flow. Descriptions of site locations and the results of discharge measurements are listed in the table below. A map depicting the approximate location of each sample station is attached.

Station	Station Description	Preliminary Discharge Measurements
1.0	At Buffalo Creek weir – approximately 500 feet downstream of Wishbone Lake	**0.1455 cfs**
2.0	Downstream of Sample Station 1.0 approximately 300 feet – first slot canyon downstream of Wishbone Lake	**0.0977 cfs**
3.0	Approximately 25 feet upstream of confluence with Moose Creek	**0.171 cfs**
4.0	Approximately 1200 feet upstream of the confluence with Moose Creek and approximately 700 feet downstream of the notch in the bluff wall	**0.1955 cfs**
5.0	Approximately 100 feet upstream of Sample Station 3.0 and near the confluence of Buffalo and Moose Creeks	**0.242 cfs**

Fisheries

Previous fish resource sampling efforts in Buffalo Creek by WHPacific found juvenile rainbow trout (*Oncorhynchus mykiss*) in Buffalo Creek in proximity to the confluence with Moose Creek. To determine the extent of fisheries resources in Buffalo Creek following recent improvements in fish passage on Moose Creek – WHPacific staff sampled Buffalo Creek from the confluence with Moose Creek up to the first cascade at the break in the bluff of Wishbone Hill on July 13th, 2012. All habitats of Buffalo Creek were sampled with a backpack electrofisher up to two relict beaver ponds, approximately 500 feet upstream of the confluence. At the downstream end of the beaver ponds, one of the remaining dams has created a 4' drop. Habitat above the beaver dam drop was spot sampled as access and conditions allowed up to the break in the bluff (approximately 1200 feet total length). Habitat that was too shallow to sample or that was too heavily vegetated to be effectively sampled was passed over in favor of deeper and more accessible habitats. All habitat sampled above and below the relict beaver dam is depicted in the second figure attached to this memorandum. In addition, the approximate location of the relict beaver dam is noted.

Dolly Varden (*Salvelinus malma*) were observed and collected from the mouth of Buffalo Creek up to the beaver dam drop in Buffalo Creek. Four (4) individual Dolly Varden ranging in size from 62-70 mm (fork length) were collected in this segment of stream. An additional four (4) Dolly Varden were observed but not collected within the lower reach. Above the beaver dam drop – no fish were observed or collected in the entire segment to the bluff break. Shock seconds during sampling totaled 985.

In general, spawning habitat for large salmonids is limited in Buffalo Creek. Sediment particle size in much of the lower stream segments (between the bluff and Moose Creek) is small with sand and silt dominating. Upstream of the bluff – particle size significantly increases, but flows are diminished, suitable depth for spawning is absent, and several large natural barriers are found impeding potential upstream movement by fish. Potential rearing habitat for juvenile salmon occurs below the relict beaver dam, but observations and collections past and present do not indicate that juvenile or adult salmon enter Buffalo Creek from Moose Creek, despite the access to and use by Dolly Varden and rainbow trout.

Photo 1: Discharge Cross Section #1

Photo 2: Discharge Cross Section #2

Photo 3: Discharge Cross Section #3

Photo 4: Discharge Cross Section #4

Photo 5: Discharge Cross Section #5

Cross Section 1	Width	Depth	X-section area	Velocity	Discharge
2.08'	0.5	0.3	0.15	0.36	0.054
	0.5	0.3	0.15	0.36	0.054
	0.5	0.3	0.15	0.18	0.027
	0.5	0.3	0.15	0.07	0.0105
					0.1455

Cross Section 2	Width	Depth	X-section area	Velocity	Discharge
4.7'	0.5	0	0	0	0
	0.5	0.2	0.1	0.12	0.012
	0.5	0.25	0.125	-0.03	-0.00375
	0.5	0.2	0.1	0.09	0.009
	0.5	0.2	0.1	0.3	0.03
	0.5	0.3	0.15	0.37	0.0555
	0.5	0.2	0.1	-0.05	-0.005
	0.5	0.1	0.05	0	0
	0.5	0	0	0	0
					0.09775

Cross Section 3	Width	Depth	X-section area	Velocity	Discharge
2.7'	0.4	0.4	0.16	0.11	0.0176
	0.4	0.4	0.16	0.39	0.0624
	0.4	0.3	0.12	0.34	0.0408
	0.4	0.25	0.1	0.2	0.02
	0.4	0.25	0.1	0.19	0.019
	0.4	0.2	0.08	0.14	0.0112
					0.171

Cross Section 4	Width	Depth	X-section area	Velocity	Discharge
2.8'	0.5	0.3	0.15	0.2	0.03
	0.5	0.3	0.15	0.27	0.0405
	0.5	0.4	0.2	0.25	0.05
	0.5	0.4	0.2	0.33	0.066
	0.5	0.3	0.15	0.06	0.009
	0.3	0	0	0	0
					0.1955

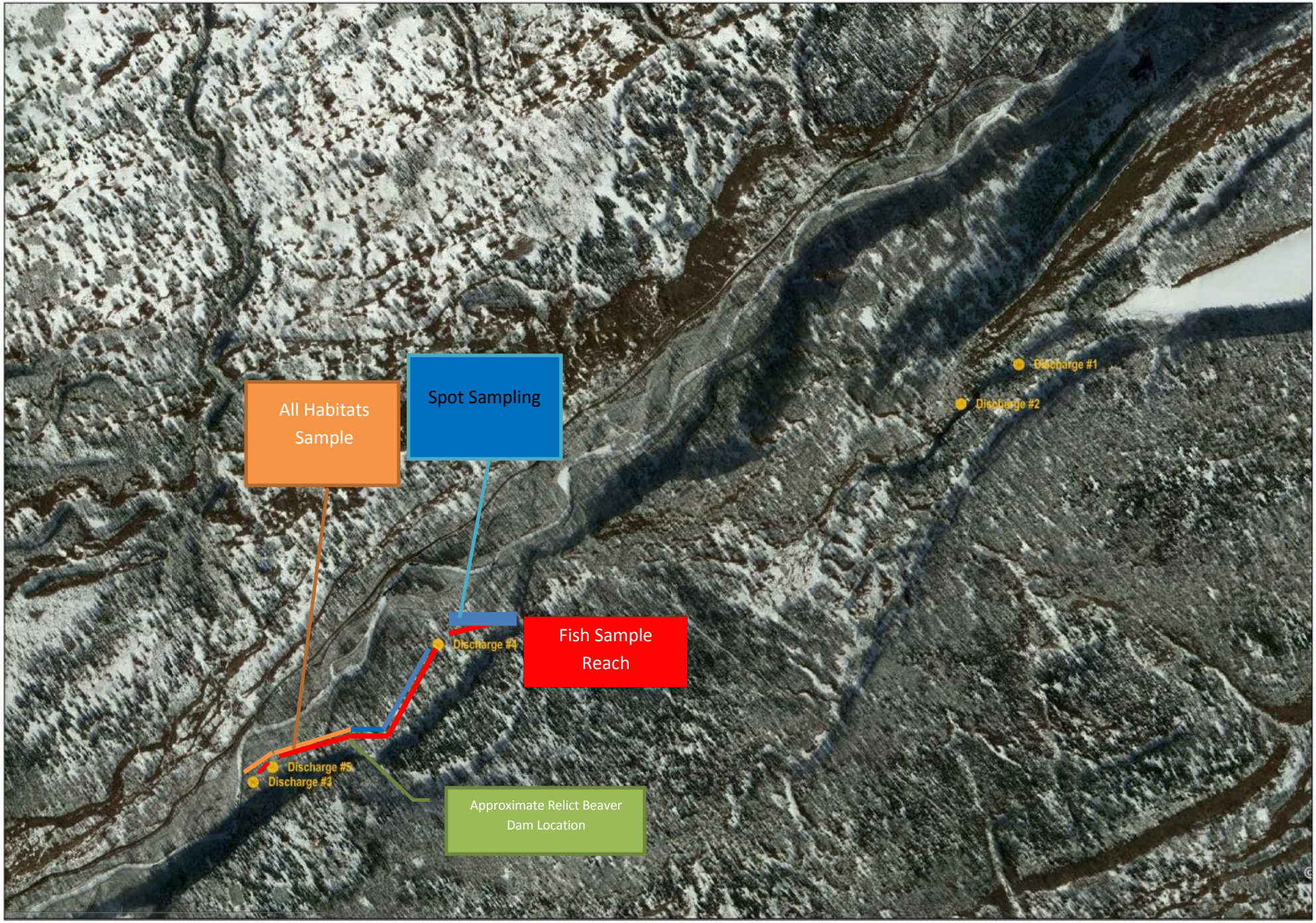
Cross Section 5	Width	Depth	X-section area	Velocity	Discharge
2.6	0.5	0.2	0.1	0.42	0.042
	0.5	0.2	0.1	0.62	0.062
	0.5	0.2	0.1	0.76	0.076
	0.5	0.2	0.1	0.44	0.044
	0.5	0.2	0.1	0.18	0.018
					0.242

034272-E-EP01.DWG

July 23, 2012

Buffalo Creek Discharge Locales

Wishbone Hill



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Buffalo Creek Fish Sample Reach – Wishbone Hill

ADDENDUM 4

A synopsis by ADF&G of the fisheries resource changes since the 2008 stream restorations work on Moose Creek.

Email dated February 7, 2013 by Samuel Ivey. Area Management Biologist, Northern and West Cook Inlet, ADF&G Sport Fish Division, Palmer.

UCM requested and received a synopsis of the aquatic resource changes since the 2008 stream restorations work on Moose Creek from ADF&G. The synopsis from ADF&G was received in an email on February 7, 2013 from Samuel Ivey, Area Management Biologist, Northern & West Cook Inlet, ADF&G Sport Fish Division. The synopsis from Samuel Ivey will be included in Chapter IX, and is quoted below:

> *"The Moose Creek watershed supports various fish species, including all five species of pacific salmon and resident rainbow trout and Dolly Varden. Chinook and coho salmon are the most prevalent salmonids. The Anadromous Waters Catalog (AWC) maintained by the Alaska Department of Fish and Game (ADF&G) lists the following species and life stage for Moose Creek: King salmon rearing and spawning, coho salmon rearing and spawning, and presence of sockeye, chum, and pink salmon. The abundance of Chinook salmon has been monitored by ADF&G since about 1979 by means of aerial index counts conducted by helicopter on an annual basis. The average all years count is 460 and range from 175-1,072 fish. In 2005 Chickaloon Village Traditional Council restored salmon passage to upper Moose Creek by returning the channel to its original state prior to construction of a railroad spur in the early 1920s that caused the formation of a waterfall. This project opened at least 5 additional miles of spawning habitat for salmon. As a result, Chinook salmon were found spawning further upstream and the departments index area for assessing Chinook abundance was extended from Buffalo Mine Road Bridge near the Superior Mine upstream to the point of entrance into the mountains, the current upstream limit of documented spawning in the AWC. In October, 2012, adult coho and juvenile Chinook were documented in Buffalo Creek, a small tributary upstream of the old barrier waterfall. During the October survey, 21 Dolly Varden and 1 rainbow trout were also noted in Buffalo Creek."*