Technical Report No. 17-11

Glacier Creek Aquatic Studies, 2017

by

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and

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December 2017

Alaska Department of Fish and Game **Division of Habitat**

Symbols and Abbreviations

The following symbols and abbreviations, and others approved for the Système International d'Unités (SI), are used without definition in reports by the Divisions of Habitat, Sport Fish, and Commercial Fisheries. All others, including deviations from definitions listed below, are noted in the text at first mention, as well as in the titles or footnotes of tables, and in figures or figure captions.

Weights and measures (metric)

centimeter	cm
deciliter	dL
gram	g
hectare	ha
kilogram	kg
kilometer	km
liter	L
meter	m
milliliter	mL
millimeter	mm

Weights and measures (English)

cubic feet per second	ft^3/s
foot	ft
gallon	gal
inch	in
mile	mi
nautical mile	nmi
ounce	oz
pound	lb
quart	qt
yard	yd

Time and temperature

day	d
degrees Celsius	°C
degrees Fahrenheit	°F
degrees kelvin	K
hour	h
minute	min
second	s

Physics and chemistry

all atomic symbols	
alternating current	AC
ampere	A
calorie	cal
direct current	DC
hertz	Hz
horsepower	hp
hydrogen ion activity (negative log of)	pH
parts per million	ppm
parts per thousand	ppt, ‰
volts	V
watts	W

General

Alaska Administrative Code	AAC
all commonly accepted abbreviations	e.g., Mr., Mrs., AM, PM, etc.
all commonly accepted professional titles	e.g., Dr., Ph.D., R.N., etc.
at	@
compass directions:	
east	E
north	N
south	S
west	W
copyright	©
corporate suffixes:	
Company	Co.
Corporation	Corp.
Incorporated	Inc.
Limited	Ltd.
District of Columbia	D.C.
et alii (and others)	et al.
et cetera (and so forth)	etc.
exempli gratia (for example)	e.g.
Federal Information Code	FIC
id est (that is)	i.e.
latitude or longitude	lat. or long.
monetary symbols (U.S.)	$, ¢
months (tables and figures): first three letters	Jan,...,Dec
registered trademark	®
trademark	™
United States (adjective)	U.S.
United States of America (noun)	USA
U.S.C.	United States Code
U.S. state	use two-letter abbreviations (e.g., AK, WA)

Measures (fisheries)

fork length	FL
mideye-to-fork	MEF
mideye-to-tail fork	METF
standard length	SL
total length	TL

Mathematics, statistics

all standard mathematical signs, symbols and abbreviations	
alternate hypothesis	H_A
base of natural logarithm	*e*
catch per unit effort	CPUE
coefficient of variation	CV
common test statistics	(F, t, χ^2, etc.)
confidence interval	CI
correlation coefficient (multiple)	R
correlation coefficient (simple)	r
covariance	cov
degree (angular)	°
degrees of freedom	df
expected value	*E*
greater than	>
greater than or equal to	≥
harvest per unit effort	HPUE
less than	<
less than or equal to	≤
logarithm (natural)	ln
logarithm (base 10)	log
logarithm (specify base)	$\log_2$, etc.
minute (angular)	'
not detected	N
no data	ND
not significant	NS
null hypothesis	H_O
percent	%
probability	P
probability of a type I error (rejection of the null hypothesis when true)	α
probability of a type II error (acceptance of the null hypothesis when false)	β
second (angular)	"
standard deviation	SD
standard error	SE
variance	
population	Var
sample	var

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GLACIER CREEK AQUATIC STUDIES, 2017

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This investigation was fully financed by Constantine North, Inc.

Cover: Dolly Varden char captured in Christmas Creek.

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ACKNOWLEDGEMENTS

Constantine North, Inc. provided financial support for this project. Environmental Manager Allegra Cairns and Camp Manager Darsie Culbeck provided logistical support. Ms. Cairns assisted with sampling sediment and provided Glacier Creek water quality and discharge data. Vice President of Exploration Darwin Green and Acting Environmental Manager Maria Egerton reviewed the draft report. Chilkoot Indian Association staff Ted Hart and Luke Williams joined us while sampling Lower Glacier Creek.

Many Division of Habitat staff contributed to this project. Southeast Regional Supervisor Jackie Timothy collaborated on study design, Habitat Biologist Dylan Krull and Fish and Wildlife Technician Ben Landes assisted with sampling fish, Habitat Biologists Greg Albrecht and Johnny Zutz processed the periphyton samples, Mr. Albrecht, Mr. Krull, and Habitat Biologist Evan Fritz identified the benthic macroinvertebrates, and Mr. Zutz prepared the report for publication. Division of Habitat Operations Manager Dr. Al Ott and Ms. Timothy reviewed and edited the report.

Thank you all for your contribution.

EXECUTIVE SUMMARY

Constantine North, Inc. (CNI) began exploratory drilling at the Palmer Prospect in 2006 and has identified barite, copper, gold, silver, and zinc deposits within the volcanogenic massive sulfide deposit that may support a hard rock mine. CNI contracted with the Alaska Department of Fish and Game (ADF&G) Division of Habitat to study aquatic resources in Glacier Creek, a glacial water body draining the area. With CNI, Division of Habitat biologists developed a plan to study periphyton, benthic macroinvertebrates, fish, and sediment at two sites in Glacier Creek in spring 2016 and 2017 to document baseline aquatic productivity and sediment conditions.

We sampled the lower and middle reaches of Glacier Creek on June 8 and 9, 2017. Mean periphyton density was greater among the Lower Glacier Creek samples. Mean benthic macroinvertebrate density was greater among the Middle Glacier Creek samples, and both benthic macroinvertebrate communities were dominated by Diptera: Chironomidae, aquatic insects that are generally fast colonizers, easily adapt to changing habitats, and can exercise more than one feeding strategy (Entrekin et al. 2007).

We captured 12 Dolly Varden char *Salvelinus malma* in Lower Glacier Creek and 6 in Middle Glacier Creek; despite extensively fishing, we were unable to capture 4 more Dolly Varden char to achieve 10 samples from Middle Glacier Creek. All fish were in good condition, and we did not capture other fish species. Most median whole body Dolly Varden char concentrations of analyzed elements were greater among the Lower Glacier Creek samples, while arsenic and silver concentrations were often not detected at both sites. All concentrations were reasonable when compared with samples collected from reference and exploration sites elsewhere in Alaska (Legere and Timothy 2016).

We sampled fine sediment at each site for aluminum, arsenic, cadmium, copper, iron, lead, mercury, silver, selenium, and zinc and found the range of element concentrations similar among sites. The baseline cadmium, copper, and zinc concentrations were above the freshwater sediment guidelines suggested by Buchman (2008). While we find the sediment guidelines useful for evaluating the data, we also recognize organisms can respond differently in nature.

INTRODUCTION

The Palmer Exploration Project is located in the Porcupine Mining District about 55 km north of Haines by air in the southeastern extent of the Saint Elias Mountains near the U.S./Canada border (Figure 1). At the site, placer gold mining in Glacier Creek and its tributaries occurred during the 20th century, and in 1969 local prospector Merrill Palmer discovered base-metal sulfides and barite that initiated exploration drill programs by several different companies in the following years, including CNI beginning in 2006 (CNI 2015). The project is located on the same volcanogenic massive sulfide belt as the Greens Creek Mine[a], and CNI has identified barite, copper (Cu), gold, silver (Ag), and zinc (Zn) as potential mineable resources (CNI 2015).

[a] Owned and operated by Hecla Greens Creek Mining Company on Admiralty Island in Southeast Alaska.

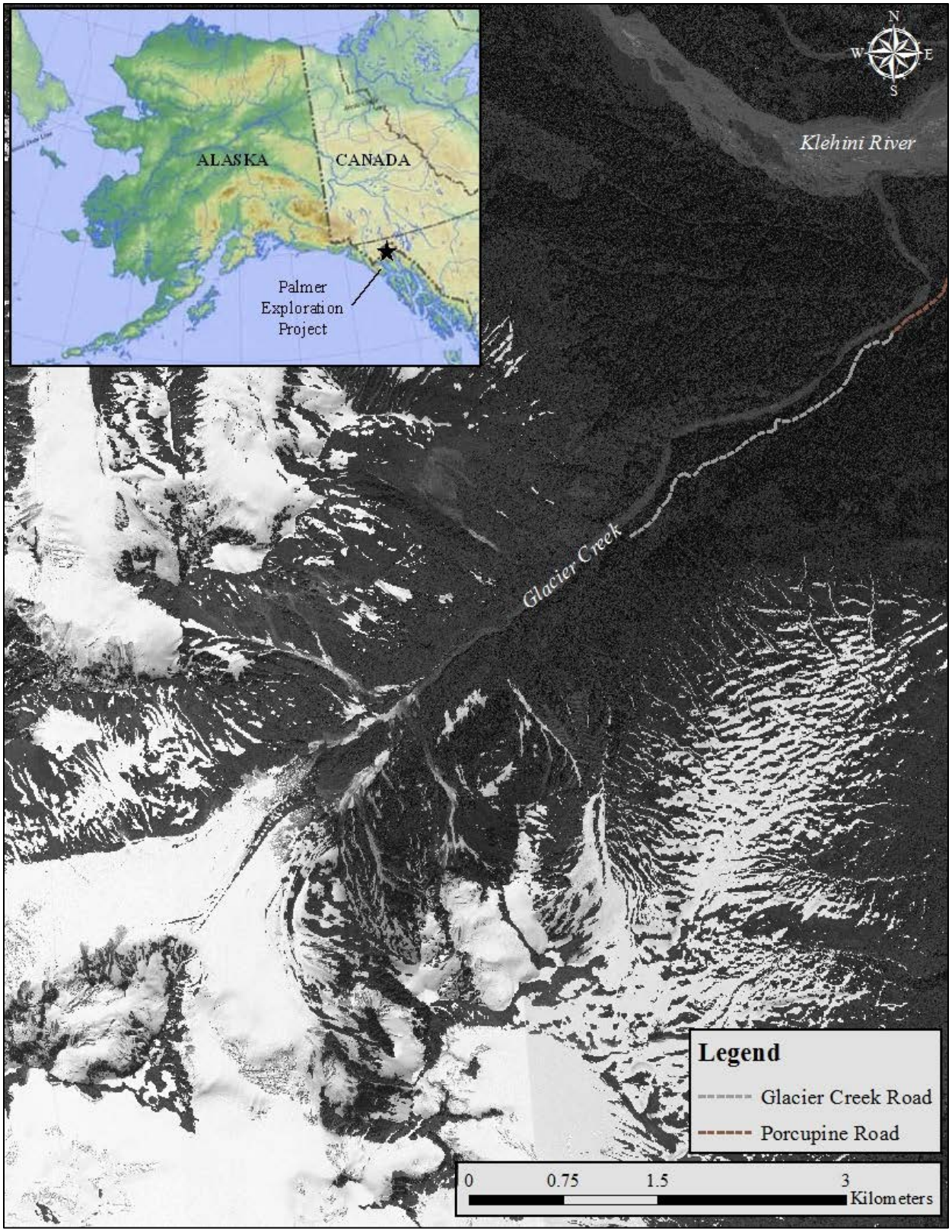

Figure 1.–Palmer Exploration Project area map.

Tetra Tech (2013) and ADF&G biologists documented[b] Dolly Varden char in Glacier Creek and three tributaries. In 2016 and 2017, CNI contracted with the ADF&G Division of Habitat to begin baseline studies in Glacier Creek. Following review of CNI's water quality sample data, Division of Habitat biologists developed a study plan to investigate and document aquatic resources in Glacier Creek, similar to aquatic sampling programs at the Greens Creek Mine and Kensington Gold Mine (Timothy and Kanouse 2014, Zutz 2017), underground hard rock mines in Southeast Alaska. The study plan included sampling periphyton, benthic macroinvertebrates, and fish, aquatic resources influenced by water and sediment quality through natural processes and development, to provide baseline information on aquatic productivity in Glacier Creek.

PURPOSE

The purpose of this investigation and technical report is to document the condition, abundance, and composition of biological communities and sediments in Glacier Creek.

AQUATIC STUDIES

We completed the following studies in Glacier Creek:

- chlorophyll *a* density and community composition;
- benthic macroinvertebrate density and community composition;
- Dolly Varden char condition and whole body element concentrations; and
- sediment composition and element concentrations.

STUDY AREA

Glacier Creek is about 7 km long, drains a 39 km^2 watershed between its headwaters at the Saksaia Glacier and its confluence with the Klehini River, and contributes about 5% of the total Klehini River drainage area measured from the U.S. Geological Survey gage at the Klehini River bridge–about 20 km downstream of the project.[c]

Continuous discharge data do not exist for Glacier Creek. Based on the relative size of the Glacier Creek and Klehini River drainage areas, Integral Consulting, Inc.[d] estimates average Glacier Creek discharge between May and September at 150 ft^3/s, less than the discharges measured in June 2015, August 2015, and June 2016, which ranged 225–272 ft^3/s. In June and July 2017, water levels were too high to measure discharge; on September 3, 2017, discharge at the Lower Glacier Creek sample site was 146 ft^3/s (A. Cairns, Environmental Manager, Constantine North Inc., Vancouver, personal communication).

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[b] Matthew Kern, Habitat Biologist, to Jackie Timothy, Southeast Regional Supervisor, ADF&G Division of Habitat. Memorandum: Glacier Creek investigation trip report; dated 6/26/2014. Unpublished document, can be obtained from the Southeast Regional Supervisor, ADF&G Division of Habitat, 802 3rd St, Douglas, AK.

[c] Marcia Greenblatt and Alice Conovitz, Integral Consulting, to Darwin Green, Constantine North. Memorandum: Klehini River and Glacier Creek Hydrologic Data Summary; dated 2/24/2016. Unpublished document, can be obtained from Constantine North, Inc., 800 W. Pender St. Ste. 320, Vancouver, BC, Canada.

[d] Marcia Greenblatt and Alice Conovitz, Integral Consulting, to Darwin Green and Allegra Cairns, Constantine North. Memorandum: Klehini River and Glacier Creek Hydrologic Data Summary–Fall 2016 Update; dated 12/19/2016. Unpublished document, can be obtained from Constantine North, Inc., 800 W. Pender St. Ste. 320, Vancouver, BC, Canada.

CNI's 2008–2014 and 2017 Glacier Creek basic water quality data documents total suspended solids ranging 9–2,470 mg/L, turbidity ranging 18–2,760 nephelometric turbidity units (NTU), and pH ranging 6.59–8.33 standard units (USDI 2016). Nutrients, arsenic (As), and other elements were generally below detection limits, except total aluminum (Al), which usually exceeded the 2008 Alaska acute aquatic life criteria (ADEC 2008).

The lower 1 km of Glacier Creek (Stream No. 115-32-10250-2077-3151) provides habitat for coho salmon *Oncorhynchus kisutch*, cutthroat trout *O. clarkii*, and Dolly Varden char (Johnson and Blossom 2017).[e] On June 9, 2017, we captured Dolly Varden char 0.6 km upstream of the Christmas Creek confluence, a nonglacial tributary located 4.5 km upstream of the Glacier Creek confluence with the Klehini River;[f] previously, Tetra Tech (2013) and ADF&G documented the upper extent of Dolly Varden char below the Christmas Creek confluence. We sampled two locations in Glacier Creek: Lower Glacier Creek and Middle Glacier Creek (Figure 2).

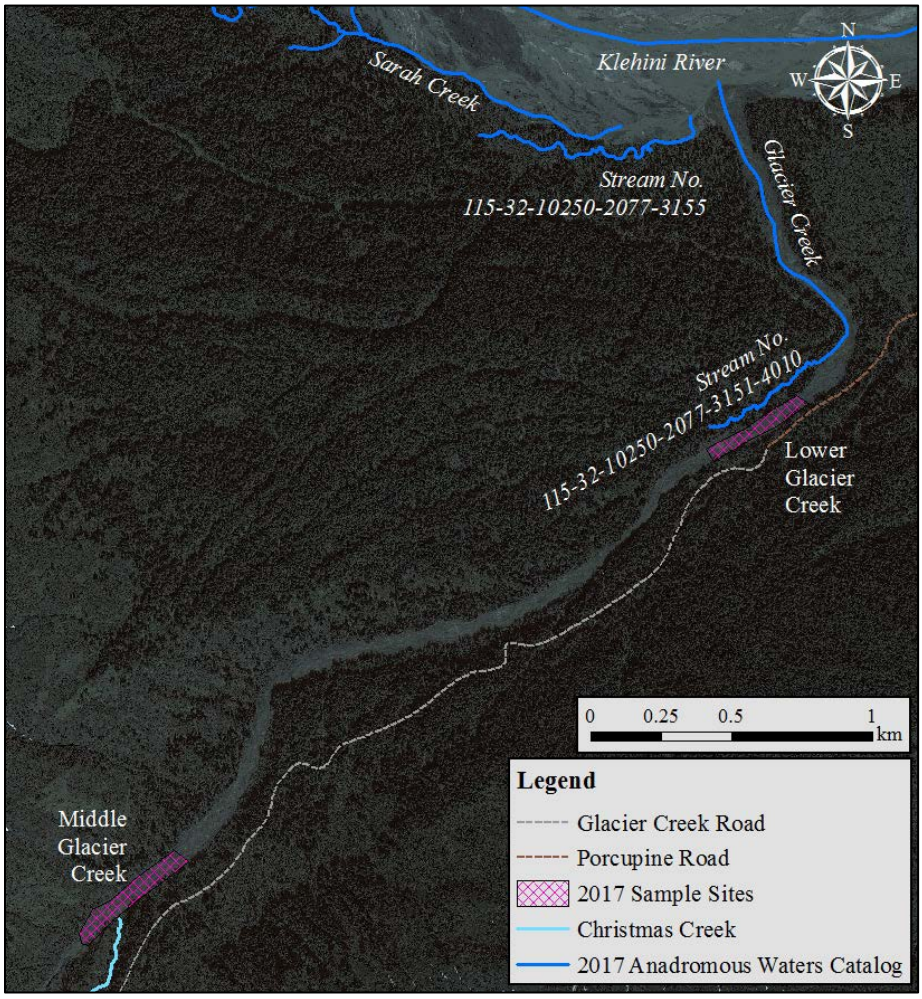

Figure 2.–Glacier Creek sample sites.

[e] We sampled fish within the upper 300 m of this reach on June 8, 2017, and captured several Dolly Varden char, no other fish species.

[f] Kate Kanouse, Habitat Biologist, to Jackie Timothy, Southeast Regional Supervisor, ADF&G Division of Habitat. Memorandum: 2017 Palmer Project Glacier Creek sampling; dated 8/9/2017. Unpublished document, can be obtained from the Southeast Regional Supervisor, ADF&G Division of Habitat, 802 3rd St, Douglas, AK.

Lower Glacier Creek

The Lower Glacier Creek sample site is located at the former Glacier Creek bridge near 230 m elevation, about 1.5 km upstream of the Klehini River (Table 1, Figure 3). We accessed the site from the old bridge crossing at the end of Porcupine Road.

Lower Glacier Creek is a medium glacial outwash channel (Paustian 2010). Streambed gradient ranges 2–4% and the substrate is composed of gravel and cobble underlain with sand and silt. In 2017, we sampled a 400 m reach, about twice as long as the 2016 sample reach[g], collecting periphyton, benthic macroinvertebrate, and sediment samples in channel braids and along the main channel margin upstream of the old crossing, and fish throughout the sample reach. We could not measure stream discharge because flows prevented us from safely crossing the creek.

Comparing stream characteristics at the Lower Glacier Creek sample site between years, we observed fewer channel braids upstream of the old crossing in 2017, which were more incised than in 2016, and the side channel present downstream of the old crossing within the 2016 sample area had washed-out and was dry in 2017. The main channel generally flowed a similar course both years.

Table 1.–2017 Lower Glacier Creek sample site location data.

	Latitude	Longitude
Upper extent	59.41642	-136.30415
Lower extent	59.41835	-136.29903

Note: WGS84 datum.

Figure 3.–Lower Glacier Creek, looking upstream.

[g] Higher water limited sampling areas so we sampled a larger reach.

Middle Glacier Creek

The Middle Glacier Creek sample site is located near 350 m elevation, about 4.5 km upstream of the Klehini River (Table 2; Figure 4), and in 2017 we accessed the site by helicopter.

Middle Glacier Creek is also characterized as a medium glacial outwash channel (Paustian 2010). Streambed gradient ranges 4–6% and the substrate is composed of cobble, gravel, sand, and silt. We sampled a 450 m reach upstream and downstream of the Christmas Creek confluence, about twice as long as the 2016 sample reach[h]. We collected periphyton, benthic macroinvertebrate, and sediment samples in channel braids, and fish throughout the sample reach. We did not sample the main channel margin and could not measure stream discharge because flows prevented us from safely crossing the creek.

Comparing stream characteristics at the Middle Glacier Creek sample site between years, we observed many channel braids both years, though the 2017 channels were shallower and many were not incised. The main channel shifted from river left to river right, preventing Christmas Creek from flowing within the Glacier Creek floodplain as we observed in 2016.

Table 2.–2017 Middle Glacier Creek sample site location data.

	Latitude	Longitude
Upper extent	59.40272	-136.33965
Lower extent	59.40371	-136.33735

Note: WGS84 datum.

Figure 4.–Middle Glacier Creek and Christmas Creek confluence (yellow arrow), looking downstream.

[h] Ibid.

METHODS

WATER QUALITY

We collected basic water quality data with a YSI Pro 2030, a Hach 2100P Portable Turbidimeter, and Hanna Instrument model HI98108 pH meter, and calibrated the YSI and the Hach instruments on site per the manufacturer's instructions before sampling. We present the data by site in a table.

PERIPHYTON: CHLOROPHYLL DENSITY AND COMPOSITION

Periphyton is composed of primary producing organisms, such as algae, cyanobacteria, and heterotrophic microbes, and detritus attached to the submerged surfaces of aquatic ecosystems. Algal density and community structure are influenced by water and sediment quality through physical, chemical, and biological disturbances that change throughout the year (Barbour et al. 1999). We sampled periphyton in Lower Glacier Creek and Middle Glacier Creek to estimate algal density and community composition at each site, using concentrations of chlorophylls *a*, *b*, and *c*. Chlorophyll *a* pigment is produced by algae and provides an estimate of active algal density. Chlorophyll *b* and *c* pigments provide an estimate of the composition of algal organisms present, such as green algae that produces chlorophyll *b*, and diatoms and brown algae that produce chlorophyll *c*. We use the periphyton data to document baseline primary productivity.

Sample Collection and Analysis

We collected 10 smooth, flat, undisturbed, and perennially wetted rocks from submerged cobble in riffle habitats in less than 0.45 m water depth at each sample site. We placed a 5 × 5 cm square of high-density foam on each rock and scrubbed the area around the foam with a toothbrush to remove algae and other organisms outside the covered area, then rinsed the rock by dipping it with foam intact in the stream.

We removed the foam square and scrubbed the sample area with a rinsed toothbrush over a 1 µm, 47 mm glass fiber filter attached to a vacuum pump. We used stream water in a wash bottle to rinse the loosened periphyton from the rock, the toothbrush, and the inside of the vacuum pump onto the filter. We pumped most of the water through the filter and added a few drops[i] of saturated magnesium carbonate solution ($MgCO_3$) to the filter to prevent acidification and conversion of chlorophyll to phaeophytin, before we pumped the sample dry. We removed the dry glass fiber filter, folded it in half with the sample on the inside, and wrapped it in a white coffee filter to absorb additional water. We placed the samples in a sealed, labeled plastic bag with desiccant and stored the samples in a light-proof cooler containing frozen icepacks during transportation, in a camp freezer while onsite, and in a –20°C freezer until we processed them in an ADF&G laboratory.

We followed U.S. Environmental Protection Agency (1997) protocol for chlorophyll extraction and measurement, determining instrument and estimated detection limits, and data analysis.[j] We removed the samples from the freezer, cut them into small pieces, and placed the filter pieces for

[i] This measurement is not exact as the amount of water used to saturate the magnesium carbonate solution is not exact and fixes the sample regardless of the concentration and without affecting sample integrity.

[j] Except, we store the samples longer than 3.5 weeks and we cut the sample filters, rather than homogenize them, to reduce staff risk of acetone exposure.

each sample into individual centrifuge tubes containing 10 mL of 90% buffered acetone. We cap the centrifuge tubes, placed them in a rack, covered them with aluminum foil, and stored them in a refrigerator for less than 24 h to extract the chlorophyll. We centrifuged the samples for 20 min at 1,600 rpm and measured each sample absorbance at wavelengths 664 nm, 647 nm, 630 nm, and 750 nm using a Shimadzu UV-1800 Spectrophotometer. We used a 90% acetone stock solution to correct for absorbance of the solvent. We treated each sample with 80 µL of 0.1 N hydrochloric acid to convert the chlorophyll to phaeophytin, and measured absorbance at wavelengths 665 nm and 750 nm.

We used trichromatic equations to estimate chlorophylls *a*, *b*, and *c* concentration, and corrected chlorophyll *a* concentrations when phaeophytin was detected. When chlorophyll *a* was not detected in a sample, we report the concentration at the estimated detection limit and do not report values for chlorophylls *b* or *c*. The 2017 chlorophyll *a* concentration estimated detection limit was 0.19 mg/m^2.

Data Presentation

For each site and by year, we present mean density of chlorophylls *a*, *b*, and *c* in a table, mean chlorophyll *a* density in a figure, mean proportions of chlorophylls *a*, *b*, and *c* in a figure, and provide the 2016 and 2017 data in Appendix A.

BENTHIC MACROINVERTEBRATE DENSITY AND COMMUNITY COMPOSITION

Benthic macroinvertebrates classified in the orders Ephemeroptera (mayflies), Plecoptera (stoneflies), and Trichoptera (caddisflies), collectively known as EPT taxa, have complex and short life cycles, and many genera are sensitive to changes in water and sediment quality (Barbour et al. 1999). These organisms are secondary producers, feed upon periphyton and other macroinvertebrates, and provide a food source for fish. We sampled benthic macroinvertebrates in Lower Glacier Creek and Middle Glacier Creek to estimate density and community composition at each site and document baseline conditions.

Sample Collection and Analysis

We opportunistically sampled benthic macroinvertebrates using a Surber stream bottom sampler in riffle and run habitats with cobble substrate and different flow velocities (Barbour et al. 1999), collecting six samples at each site. Sampling only riffles and runs, habitats that support greater benthic macroinvertebrate densities and number of taxa, reduces variability in the data.

The Surber stream bottom sampler has a 0.093 m^2 sample area and a 0.3 mm mesh net and cod end. After securing the frame on the substrate, we scrubbed rocks within the sample area with a brush and disturbed gravels, sand, and silt to about 10 cm depth to dislodge macroinvertebrates into the net. We rinsed the net in the stream to ensure all organisms floated into the cod end of the Surber sampler, transferred each sample from the cod end to a labeled 500 mL plastic bottle, and preserved the samples in 95% ethanol at a ratio of three parts ethanol to one part sample.

Habitat biologists used an elutriator system and 0.5 mm and 0.3 mm sieves to sort macroinvertebrates from debris,[k,l] and identified organisms to the lowest practical taxonomic

[k] Gordon Willson-Naranjo and Greg Albrecht, Habitat Biologists, to Jackie Timothy, Southeast Regional Supervisor, ADF&G Division of Habitat. Memorandum: Benthic macroinvertebrate elutriation trials amendment; dated 12/17/2013. Unpublished document can be obtained from the Southeast Regional Supervisor, ADF&G Division of Habitat, 802 3rd St, Douglas, AK.

level[m] using Merritt and Cummins (1996) and Stewart and Oswood (2006). Habitat biologists provided quality assurance and control by verifying macroinvertebrate identification of two samples.

We calculated benthic macroinvertebrate density (per m^2) for each sample by dividing the number of macroinvertebrates by 0.093 m^2, the Surber sampling area. We estimated mean benthic macroinvertebrate density for each site by calculating the mean density among the six samples. We report taxa richness as the number of taxonomic groups identified to the lowest practical level, excluding terrestrial organisms from all calculations.

Data Presentation

For each site and by year we present mean benthic macroinvertebrate data by site in a table, illustrate mean density and community composition in a figure, and provide the raw data for each 2017 sample and a summary of the 2016 and 2017 data for each site in Appendix B.

FISH CONDITION

Age, sex, season, maturation, diet, gut contents, fat reserve, and muscular development affect fish condition. We measured and weighed fish captured in Lower Glacier Creek and Middle Glacier Creek for element concentrations analyses to estimate fish condition.

Sample Collection and Analysis

We measured FL and weight of resident Dolly Varden char, recording FL to the nearest 1 mm and weight to the nearest 0.1 g. We used the FL and weight data to calculate Fulton's condition factor (K) for each fish using the equation given in Anderson and Neumann (1996), where the fish weight (W) is divided by the cubed length (L), and the product multiplied by 100,000:

$$K = \frac{W}{L^3} \times 100{,}000$$

Data Presentation

We present the mean fish condition factor of Dolly Varden char for each site, and provide the raw data in Appendix C.

RESIDENT FISH ELEMENT CONCENTRATIONS

Heavy metals bioavailability and bioaccumulation depends on physical and chemical factors and interactions among biological communities (Tchounwou et al. 2012). Similar to other studies in Alaska (Legere and Timothy 2016), we sampled resident Dolly Varden char in Lower Glacier Creek and Middle Glacier Creek and measured whole body concentrations of Ag, As, cadmium (Cd), Cu, lead (Pb), mercury (Hg), selenium (Se), and Zn to document baseline concentrations and variability. We selected these elements based on CNI's Glacier Creek water sample data and potential target metals identified in the ore body.

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[l] Katrina Lee, Administrative Assistant, to Jackie Timothy, Southeast Regional Supervisor, ADF&G Division of Habitat. Memorandum: Benthic macroinvertebrate sample enumeration procedures; dated 6/28/2016. Unpublished document can be obtained from the Southeast Regional Supervisor, ADF&G Division of Habitat, 802 3rd St, Douglas, AK.

[m] Insects of the orders Ephemeroptera, Plecoptera, Trichoptera, and Diptera to genus, except nonbiting midges to family Chironomidae, and all others to class or order.

Sample Collection and Analysis

We captured fish using a Smithroot LR-24 backpack electrofisher.[n] We attempted to capture Dolly Varden char measuring 90–130 mm FL, as other Southeast Alaska Dolly Varden char sampling programs require (Legere and Timothy 2016, Timothy and Kanouse 2014, Zutz 2017), though we retained all fish captured regardless of size due to few fish captures. A 90 mm fish provides the minimum weight requirement for laboratory testing, while a 130 mm fish is 2–3 years old and young enough to reasonably conclude it is resident and nonanadromous. We retained fish as they were captured, some outside the size criteria, assuming all fish were resident based on headwater location–about 60 km upriver from Chilkat Inlet. We processed samples as a composite of 2 fish if there was uncertainty whether 1 fish would meet the minimum weight requirement for laboratory testing.

We wore latex gloves when handling fish and placed each fish in an individually labeled plastic bag. We placed all samples from each site in a larger plastic bag labeled with the sample location. We stored the samples in a cooler with frozen icepacks during transport, in a camp freezer while onsite, and in a –20 ºC freezer in the ADF&G Douglas lab. Upon returning to the lab, we measured FL and weight of each fish in the sample bag, and corrected for bag weight.

We shipped the samples to ALS Environmental in Kelso, WA in a cooler with frozen icepacks via overnight air freight, and maintained written chain of custody documentation. ALS Environmental measured total concentrations of Ag, As, Cd, Cu, Pb, Hg, Se, and Zn in each sample on a dry-weight basis, following EPA method 1631E (Mercury in Water by Oxidation, Purge and Trap, and Cold Vapor Atomic Fluorescence Spectrometry) for Hg, and EPA method 6020A[o] for the other elements. The laboratory provided Tier II quality assurance/quality information including results for matrix spikes, standard reference materials, sample blanks, and sample duplicates.

Data Presentation

For each site and by year, we present Dolly Varden char whole body median element concentrations in a table, and we present minimum, median, and maximum concentrations in a figure. A table with the raw data and the laboratory report are in Appendix C.

SEDIMENT ELEMENT CONCENTRATIONS

Sediment element concentrations are influenced by a variety of factors, such as geochemical composition and weathering within the watershed, sediment grain size, organic content, and development (Tchounwou et al. 2012). Subsequently, sediment element concentrations influence benthic aquatic productivity. We sampled Lower Glacier Creek and Middle Glacier Creek fine sediments for total organic carbon, acid volatile sulfide, and total concentrations of Ag, Al, As, Cd, Cu, iron (Fe), Hg, Pb, Se, and Zn to document baseline conditions. We selected these elements based on CNI's Glacier Creek water sample data and potential target metals identified in the ore body.

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[n] In 2016, we used minnow traps baited with disinfected salmon eggs to capture fish in Lower Glacier Creek, and we used the same electrofisher in Middle Glacier Creek.

[o] The same lab processed the 2016 fish samples using EPA method 200.8.

Sample Collection and Analysis

Wearing latex gloves, we opportunistically collected one sample each from sand/silt bars about 3–5 m length and retained a total of five replicate samples in glass jars for element analyses and plastic bags for particle size analyses. We stored the samples in a camp refrigerator while onsite, and on June 12, 2017, CNI staff transported the sediment samples in coolers with ice packs to the ALS Environmental lab in Whitehorse, BC.

ALS Environmental measured total organic carbon, acid volatile sulfide, and total concentrations of Ag, Al, As, Cd, Cu, Fe, Hg, Pb, Se, and Zn, on a dry-weight basis using Canadian methods listed in Table 3.[p] The laboratory provided quality control results for sample duplicates.

Table 3.–2017 sediment tests, analytes, and methods.

Test Description	Analyte	Method
Particle size distribution	Particle size determination	CSSS (1993) 47.2
Total inorganic carbon in soil	Total inorganic carbon	CSSS (2008) P216-217
Total organic carbon calculation	Total organic carbon	CSSS (2008) 21.2
Total Carbon by combustion method	Total carbon	CSSS (2008) 21.2
Mercury in soil by CVAFS	Hg	EPA 200.2 / 1631E (mod)
Inorganic carbon as CaCO3 equivalent	Inorganic carbon	Calculation
Metals in soil by CRC ICPMS	Ag, Al, As, Cd, Cu, Fe, Pb, Se, and Zn	EPA 200.2/6020A (mod)
Sulfide, acid volatile	Acid volatile sulfides	APHA 4500S2J

Data Presentation

For each site and by year, we present sediment composition data in a table and element concentrations in a figure, and compare the element concentrations data with the Screening Quick Reference Tables for inorganics in freshwater sediment guidelines developed by the National Oceanic and Atmospheric Administration (Buchman 2008), specifically the threshold effects concentrations (TEC) and the probable effects concentrations (PEC). The guidelines are based on results of controlled laboratory bioassays, wherein element concentrations below the TECs rarely affect aquatic life survival and growth, and element concentrations above the PECs can affect aquatic life survival and growth. Appendix D contains the laboratory report.

[p] The 2016 Glacier Creek sediment samples were processed by an ALS Environmental lab in Kelso, WA. The methods each lab used were different, but the results are comparable, though Al and Fe concentrations were greater in the 2017 samples. The parameters analyzed were different between labs; we present and compare data between years where applicable.

RESULTS

LOWER GLACIER CREEK

We sampled Lower Glacier Creek on June 8, 2017, and measured basic water quality at 1310 (Table 4).

Table 4.–2017 Lower Glacier Creek water quality data.

Temperature (°C)	Dissolved Oxygen (mg/L)	Conductivity (µS/cm)	Turbidity (NTU)	pH (SU)
6.5	13.6	129	306	8.32

Periphyton: Chlorophyll Density and Composition

Among the 2017 Lower Glacier Creek periphyton samples, mean chlorophyll *a* density was 1.73 mg/m^2, less than the 2016 mean density (Table 5; Figure 5). The 2016 and 2017 samples contained about 85% chlorophyll *a* and 15% chlorophyll *c*, and we did not observe chlorophyll *b* (Figure 6).

Table 5.–Lower Glacier Creek mean chlorophylls *a*, *b*, and *c* densities.

Sample Date	Chlorophyll *a* (mg/m^2)	Chlorophyll *b* (mg/m^2)	Chlorophyll *c* (mg/m^2)
6/7/2016	2.27 ± 1.07	0.00	0.35
6/8/2017	1.73 ± 0.89	0.00	0.26

Note: Chlorophyll *a* mean density ± 1 SD.

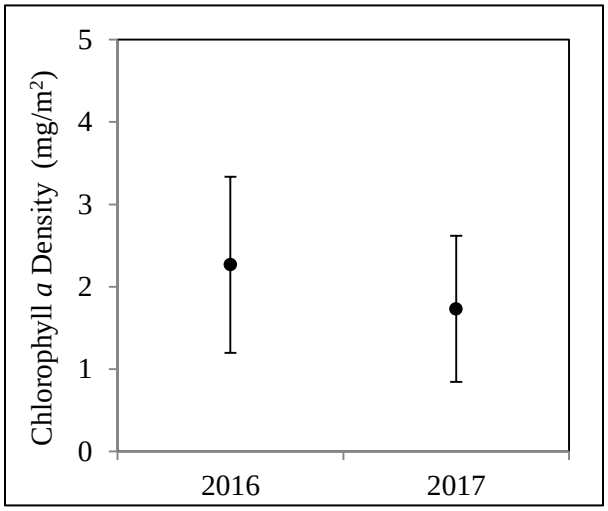

Figure 5.–Lower Glacier Creek mean chlorophyll *a* densities ± 1 SD.

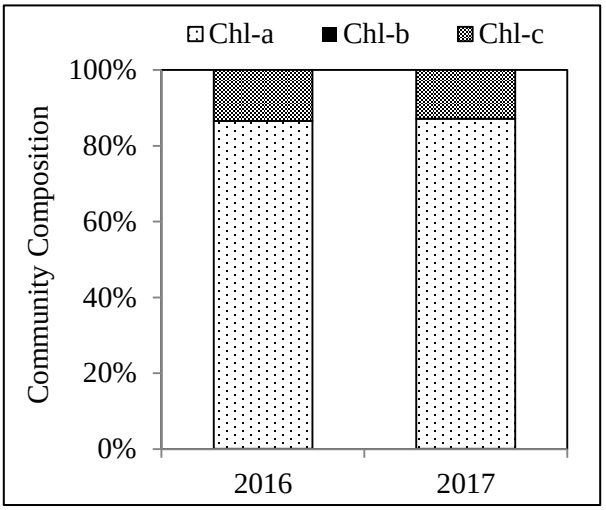

Figure 6.–Lower Glacier Creek mean proportions of chlorophylls *a*, *b*, and *c*.

Benthic Macroinvertebrate Density and Community Composition

Mean benthic macroinvertebrate density and number of taxa among the 2017 Lower Glacier Creek samples were greater than in 2016, and the dominant taxon remained Diptera: Chironomidae (Table 6; Figures 7, 8). We observed about double the number of EPT insects among the 2017 samples compared to the 2016 samples, nearly doubling the proportion of EPT insects.

Table 6.–Lower Glacier Creek benthic macroinvertebrate data summaries.

	6/7/2016	6/8/2017
Mean benthic macroinvertebrates per m^2	995 ± 373	2,136 ± 1,015
Number of taxa	17	30
Proportion of EPT insects	10%	17%
Proportion of dominant taxon, Chironomidae	85%	78%

Note: Mean benthic macroinvertebrate density data ± 1 SD.

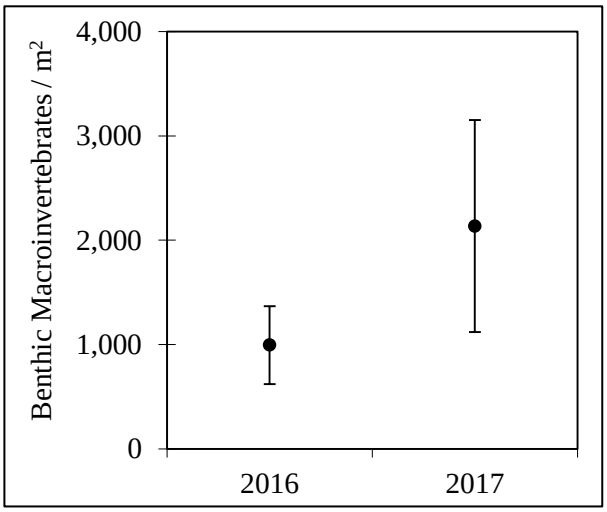

Figure 7.–Lower Glacier Creek mean benthic macroinvertebrate densities ± 1 SD.

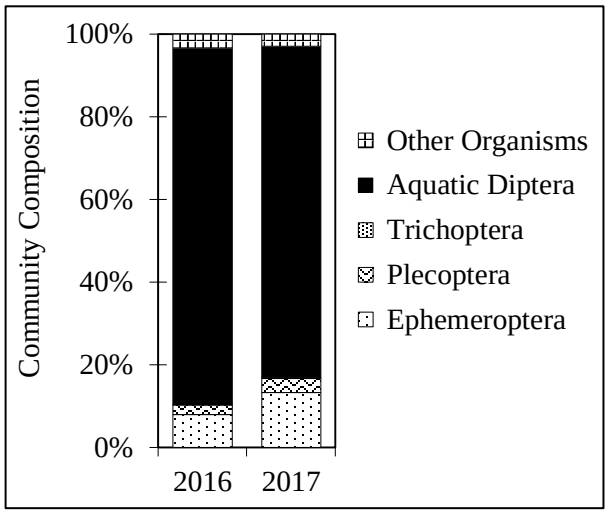

Figure 8.–Lower Glacier Creek mean benthic macroinvertebrate community compositions.

Fish Condition and Element Concentrations

Mean fish condition of the 8 Dolly Varden char we captured and retained (75–175 mm) in 2017 was 1.2.[q] We did not capture other fish species while sampling Lower Glacier Creek. Median whole body Dolly Varden char element concentrations among samples collected in 2016 and 2017 are presented in Table 7 and Figure 9.

[q] Not including 4 Dolly Varden char processed as 2 composite samples.

Table 7.–Lower Glacier Creek Dolly Varden char median element concentrations.

Sample Date	Ag (mg/kg)	As (mg/kg)	Cd (mg/kg)	Cu (mg/kg)	Hg (mg/kg)	Pb (mg/kg)	Se (mg/kg)	Zn (mg/kg)
6/7/2016	0.020	0.50	0.613	3.67	0.0414	0.180	6.75	154
6/8/2017	0.020	< 0.50	0.604	4.28	0.0514	0.107	7.46	151

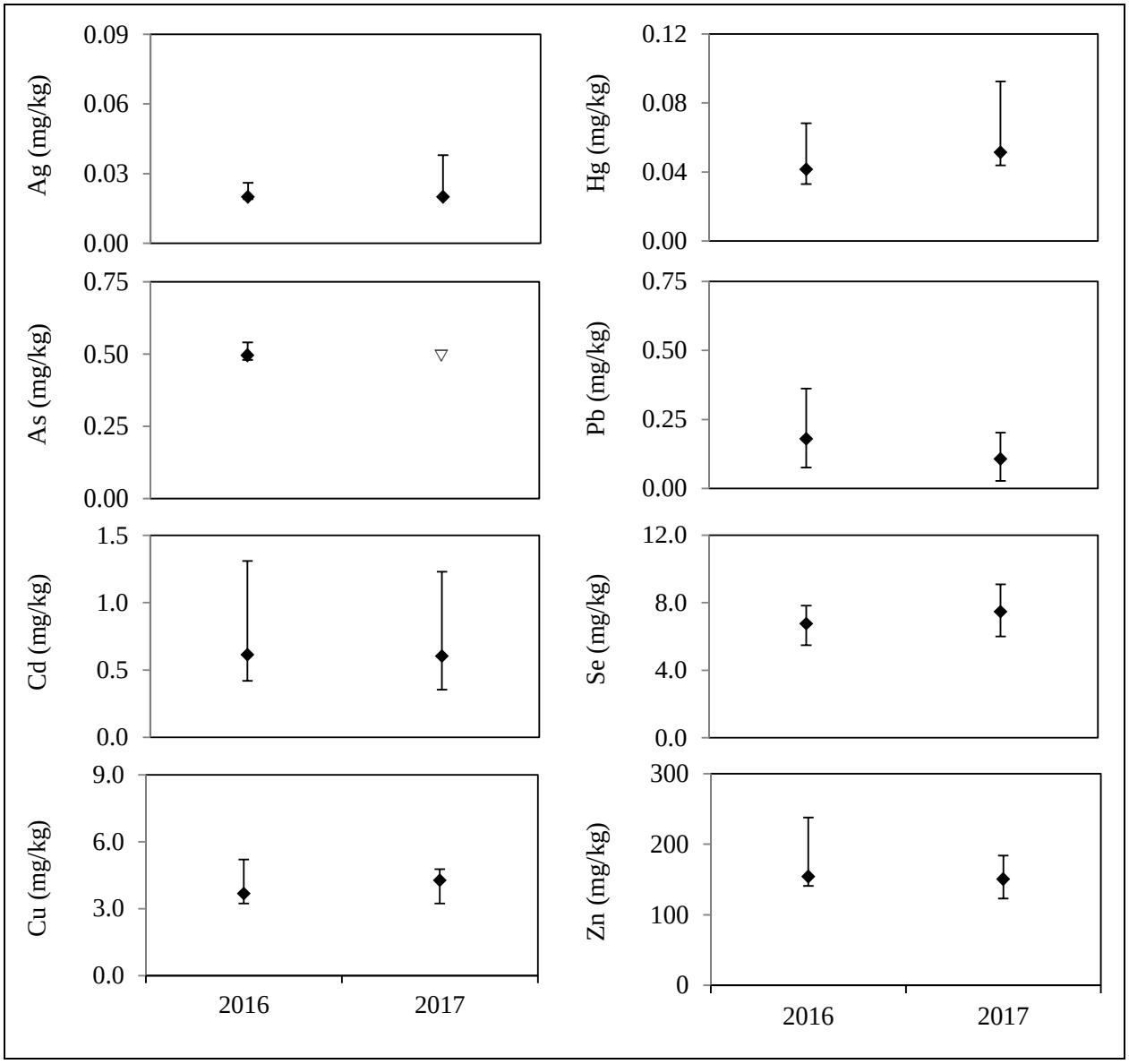

Figure 9.–Lower Glacier Creek whole body Dolly Varden char element concentrations.
Note: Median (♦), minimum, and maximum concentrations presented; elements undetected (▽) are presented at the method reporting limit.

Sediment Composition and Element Concentrations

The 2017 Lower Glacier Creek sediment samples were composed of particles less than 2 mm. Total organic carbon ranged less than 0.16% to 0.25% and acid volatile sulfide was not detected.

Element concentrations for the Lower Glacier Creek sediment samples are presented in Table 8. The predominant elements were Al and Fe, which made up 99.6% of the 10 elements presented, similar to the 2016 results.

Table 8.–Lower Glacier Creek sediment element concentrations.

Sample Date	Ag (mg/kg)	Al (mg/kg)	As (mg/kg)	Cd (mg/kg)	Cu (mg/kg)	Fe (mg/kg)	Hg (mg/kg)	Pb (mg/kg)	Se (mg/kg)	Zn (mg/kg)
6/7/2016	0.190	9,460	4.98	1.170	51.1	35,700	< 0.020	9.06	1.69	193
6/9/2017	0.14	15,500	3.91	0.510	37.0	47,300	0.012	7.90	1.22	133
6/9/2017	0.25	16,300	5.68	0.910	58.5	57,800	0.019	20.60	1.35	202
6/9/2017	0.26	14,700	5.49	1.010	53.6	51,100	0.020	8.49	1.67	186
6/9/2017	0.21	14,900	4.66	0.821	60.1	53,600	0.014	20.10	1.39	173
6/9/2017	0.17	13,300	3.94	0.818	48.9	51,400	0.014	7.03	1.54	186

MIDDLE GLACIER CREEK

We sampled Middle Glacier Creek on June 9, 2017, and measured basic water quality at 1110 (Table 9).

Table 9.–2017 Middle Glacier Creek water quality data.

Temperature (°C)	Dissolved Oxygen (mg/L)	Conductivity (µS/cm)	Turbidity (NTU)	pH (SU)
3.1	16.7	113.5	> 1000	8.38

Periphyton: Chlorophyll Density and Composition

Among the 2017 Middle Glacier Creek periphyton samples, mean chlorophyll *a* density was 0.81 mg/m^2, less than the 2016 mean density (Table 10; Figure 10). The 2016 and 2017 samples contained about 85% chlorophyll *a* and 15% chlorophyll *c*, and we did not observe chlorophyll *b* (Figure 11).

Table 10.–Middle Glacier Creek mean chlorophylls *a*, *b*, and *c* densities.

Sample Date	Chlorophyll *a* (mg/m^2)	Chlorophyll *b* (mg/m^2)	Chlorophyll *c* (mg/m^2)
6/8/2016	1.50 ± 1.18	0.00	0.25
6/9/2017	0.81 ± 0.45	0.00	0.10

Note: Chlorophyll *a* mean density ± 1 SD.

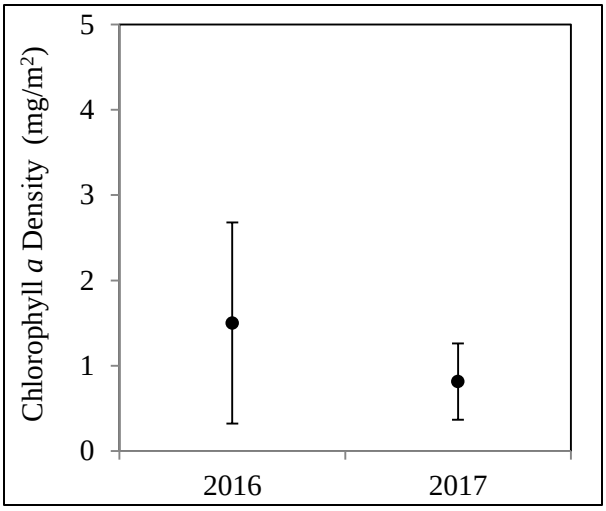

Figure 10.–Middle Glacier Creek mean chlorophyll *a* densities ± 1 SD.

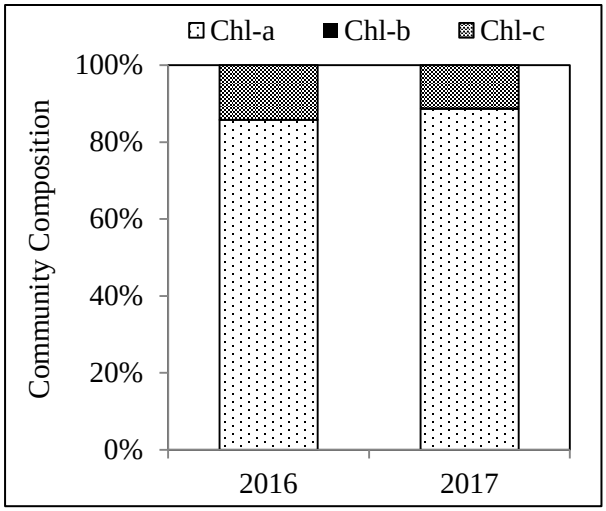

Figure 11.–Middle Glacier Creek mean proportions of chlorophylls *a*, *b*, and *c*.

Benthic Macroinvertebrate Density and Community Composition

Mean benthic macroinvertebrate density and number of taxa among the 2017 Middle Glacier Creek samples were lower than in 2016, and the dominant taxon remained Diptera: Chironomidae (Table 11; Figures 12, 13). We observed four times fewer EPT and Diptera insects among the 2017 samples compared to the 2016 samples, and a similar proportion of EPT and Chironomidae.

Table 11.–Middle Glacier Creek benthic macroinvertebrate data summaries.

	6/8/2016	6/9/2017
Benthic Macroinvertebrates per m^2	2,299 ± 976	593 ± 392
Number of taxa	22	14
Proportion of EPT insects	13%	12%
Proportion of dominant taxon, Chironomidae	85%	82%

Note: Mean benthic macroinvertebrate density data ± 1 SD.

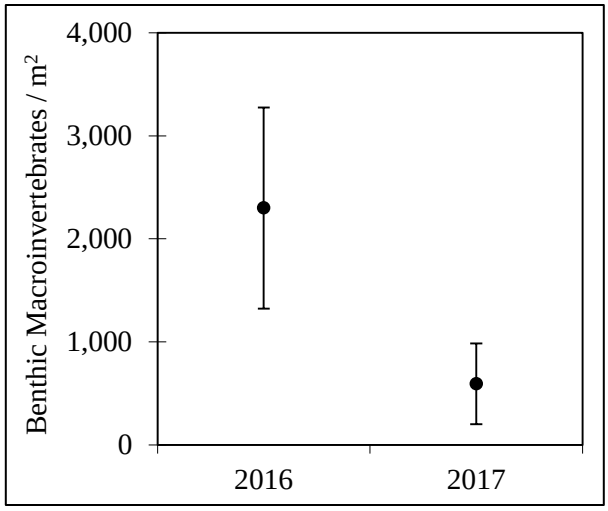

Figure 12.–Middle Glacier Creek mean benthic macroinvertebrate densities ± 1 SD.

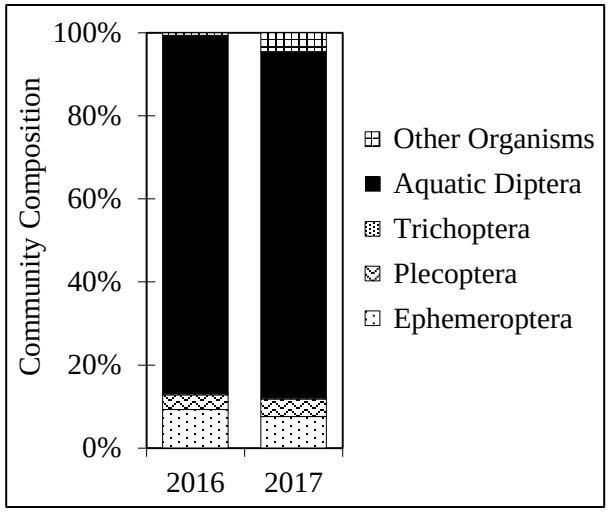

Figure 13.–Middle Glacier Creek mean benthic macroinvertebrate community compositions.

Fish Condition and Element Concentrations

Mean fish condition of the 6 Dolly Varden char we captured and retained (90–210 mm) in 2017 was 1.2.[r] We did not capture other fish species while sampling Middle Glacier Creek. Median whole body Dolly Varden char element concentrations among samples collected in 2016 and 2017 are presented in Table 12 and Figure 14.

Table 12.–Middle Glacier Creek Dolly Varden char median element concentrations.

Sample Date	Ag (mg/kg)	As (mg/kg)	Cd (mg/kg)	Cu (mg/kg)	Hg (mg/kg)	Pb (mg/kg)	Se (mg/kg)	Zn (mg/kg)
6/8/2016	0.020	< 0.50	0.328	3.45	0.0300	0.099	5.41	133
6/9/2017	< 0.020	< 0.50	0.316	3.28	0.0375	0.037	6.60	121

[r] Despite extensively fishing, we were unable to capture 4 more Dolly Varden char to achieve 10 samples.

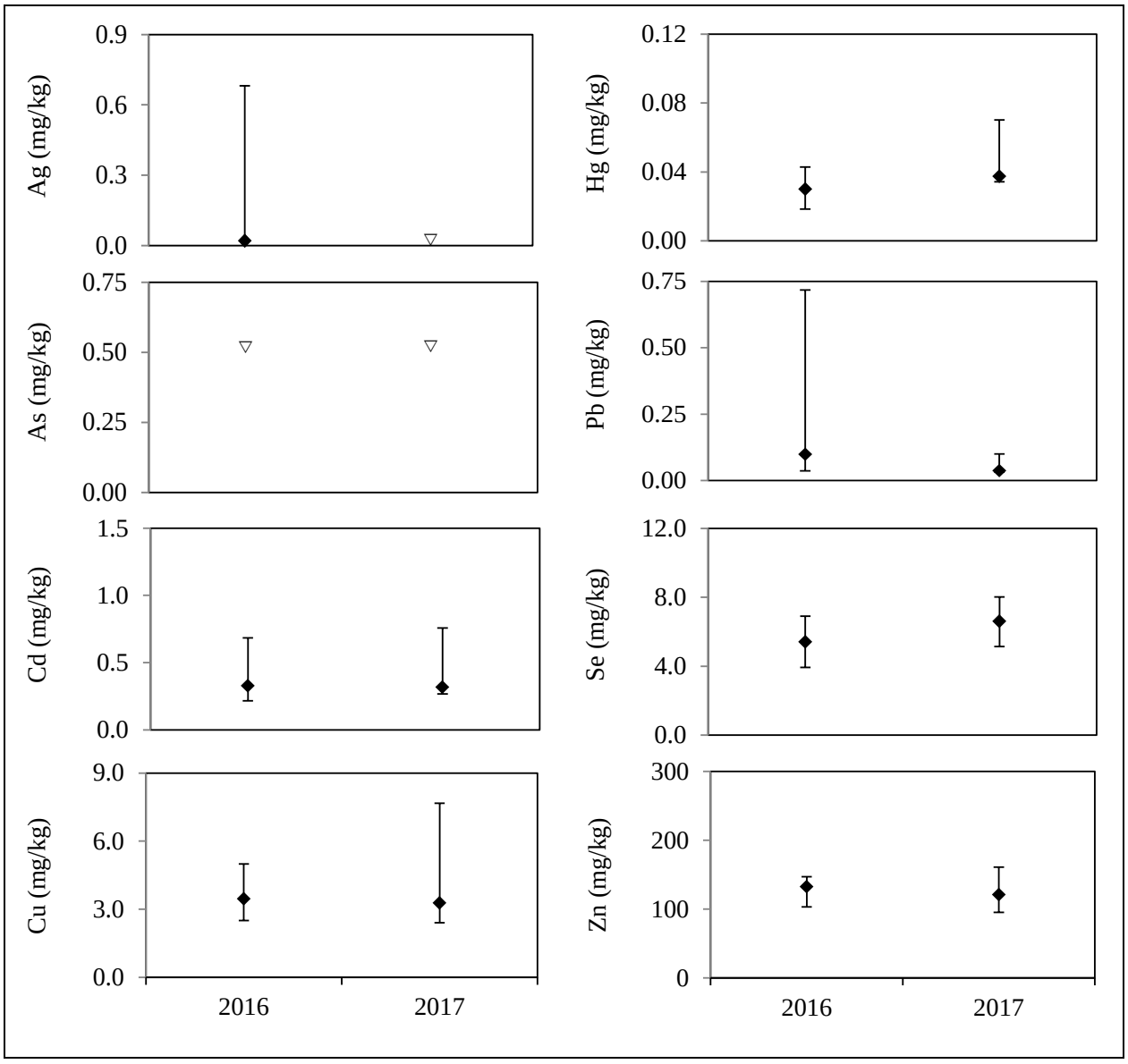

Figure 14.–Middle Glacier Creek whole body Dolly Varden char element concentrations.
Note: Median (♦), minimum, and maximum concentrations presented; elements undetected (▽) are presented at the method reporting limit.

Sediment Composition and Element Concentrations

The 2017 Middle Glacier Creek sediment samples were composed of particles less than 2 mm. Total organic carbon ranged less than 0.16% to 0.27% and acid volatile sulfide ranged less than 0.2 mg/kg to 0.3 mg/kg.

Element concentrations for the Middle Glacier Creek sediment samples are presented in Table 13. The predominant elements were Al and Fe, which made up 99.6% of the 10 elements presented, similar to 2016 results.

Table 13.–Middle Glacier Creek sediment element concentrations.

Sample Date	Ag (mg/kg)	Al (mg/kg)	As (mg/kg)	Cd (mg/kg)	Cu (mg/kg)	Fe (mg/kg)	Hg (mg/kg)	Pb (mg/kg)	Se (mg/kg)	Zn (mg/kg)
6/8/2016	0.156	7,650	4.33	0.87	55.8	32,400	< 0.020	12.00	1.14	170
6/9/2017	0.140	15,700	3.68	0.76	48.1	49,400	0.009	8.67	0.90	190
6/9/2017	0.150	13,800	4.76	0.90	45.5	53,400	0.018	14.80	0.93	203
6/9/2017	0.330	14,700	4.88	1.11	75.6	54,500	0.016	12.50	2.05	189
6/9/2017	0.180	16,000	4.47	1.14	55.7	47,500	0.021	12.30	1.30	205
6/9/2017	0.210	15,600	4.73	1.07	62.1	50,800	0.018	11.90	1.42	199

COMPARISON AMONG SITES

Periphyton: Chlorophyll Density and Composition

Similar to the 2016 results, mean chlorophyll *a* density was greater among the 2017 Lower Glacier Creek samples than the Middle Glacier Creek samples, and most samples contained about 85% chlorophyll *a* and 15% chlorophyll *c* (Figures 15, 16). We did not observe chlorophyll *b* in samples from either site.

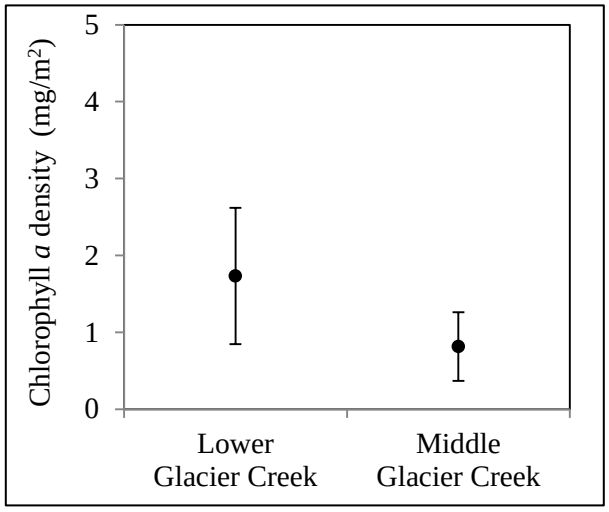

Figure 15.–2017 Glacier Creek mean chlorophyll *a* densities ± 1 SD.

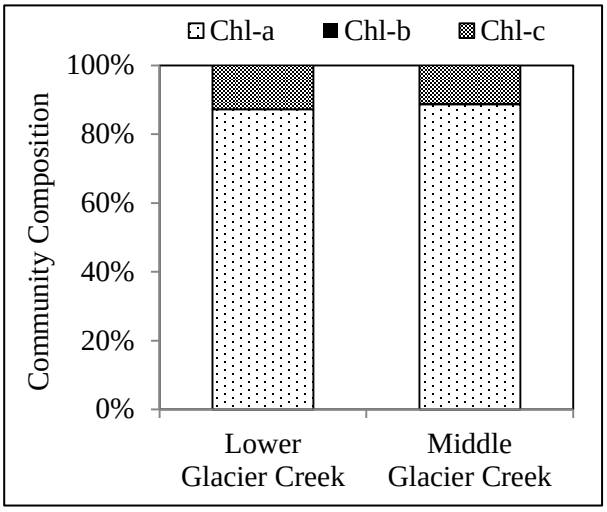

Figure 16.–2017 Glacier Creek mean proportions of chlorophylls *a*, *b*, and *c*.

Benthic Macroinvertebrate Density and Community Composition

Opposite of the 2016 results, mean benthic macroinvertebrate density and number of taxa were greater among the 2017 Lower Glacier Creek samples than the Middle Glacier Creek samples. The proportions of EPT insects and dominant taxon, Diptera: Chironomidae, were similar among sites (Figures 17, 18).

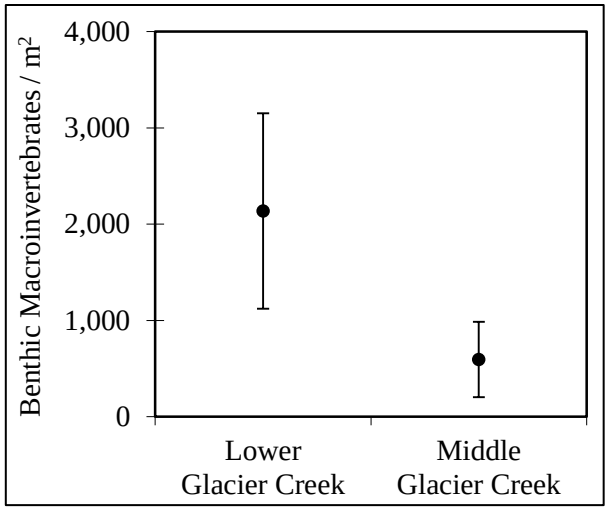

Figure 17.–2017 Glacier Creek mean benthic macroinvertebrate densities ± 1 SD.

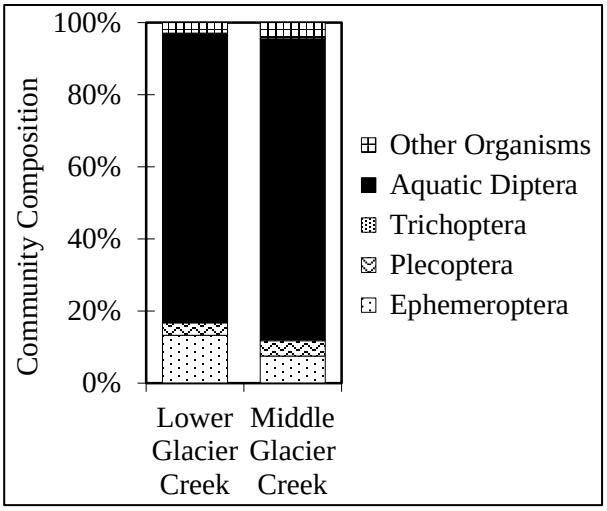

Figure 18.–2017 Glacier Creek mean benthic macroinvertebrate community compositions.

Fish Condition and Element Concentrations

Mean fish condition among the 2017 Lower and Middle Glacier Creek Dolly Varden char samples were the same, and similar to Dolly Varden char condition data collected in Southeast Alaska (Kanouse and Zutz 2017, Zutz 2017).

When we pooled the 2016 and 2017 concentration data by site, most median whole body Dolly Varden char element concentrations were greater among the Lower Glacier Creek samples, while Ag and As concentrations were often not detected (Figure 19). All concentrations were reasonable when compared with samples collected from reference and exploration sites elsewhere in Alaska (Legere and Timothy 2016).

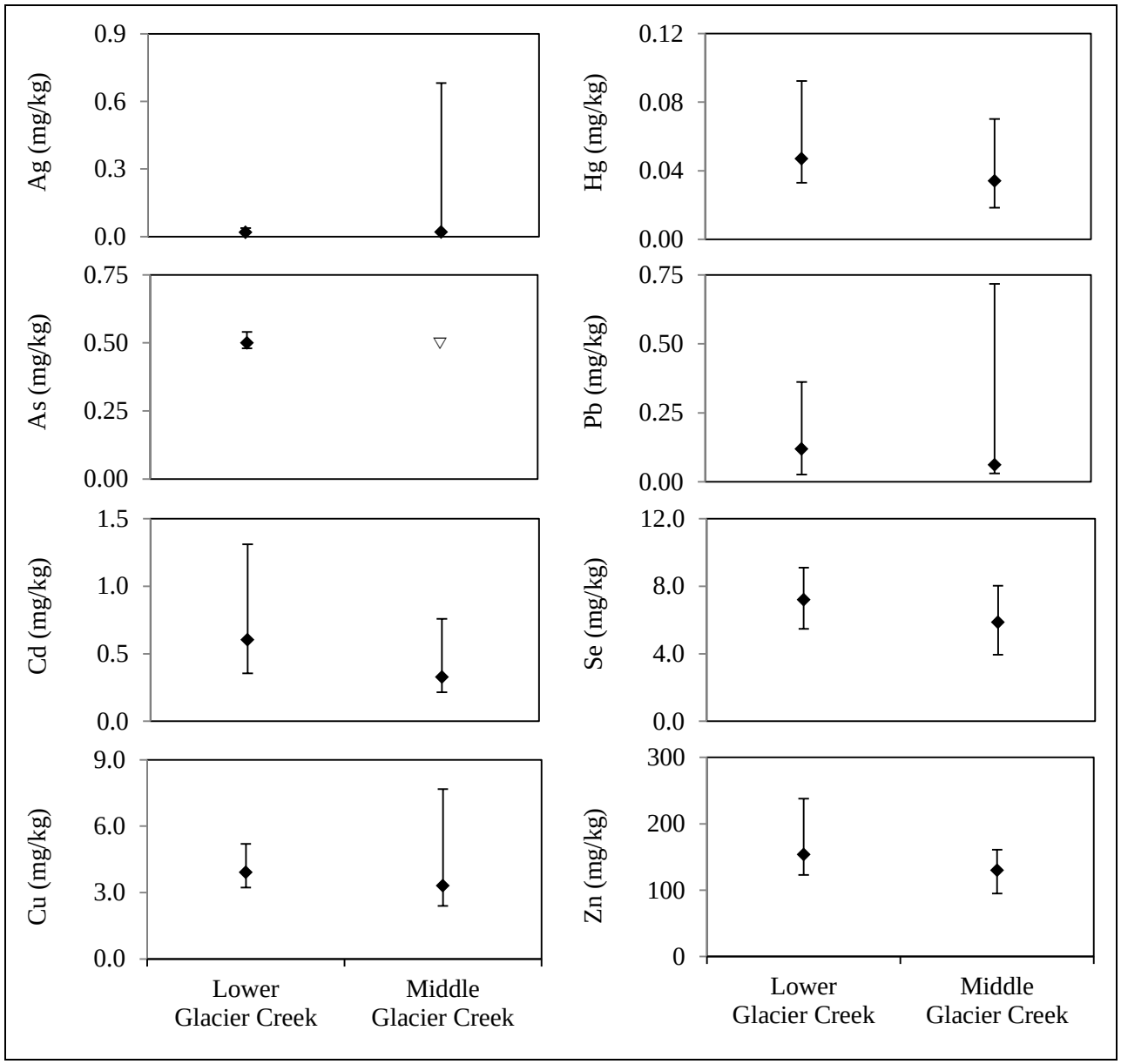

Figure 19.–Glacier Creek whole body Dolly Varden char element concentrations, 2016–2017.

Note: Median (♦), minimum, and maximum concentrations presented; elements undetected (▽) are presented at the method reporting limit.

Sediment Composition and Element Concentrations

The 2017 Lower and Middle Glacier Creek sediment samples were generally composed of sand and silt, and total organic carbon and acid volatile sulfide were low or not detected (Table 14).

We evaluated the element concentration data against the guidelines for freshwater sediments published in Buchman (2008), and similar to the 2016 results found Cd, Cu, and Zn

Table 14.–2017 Glacier Creek sediment sample compositions.

	Particle Size Distribution (% weight)					
Location	Clay	Silt	Sand	Coarse material (> 2 mm)	% Total Organic Carbon	Acid Volatile Sulfide (mg/kg)
Lower Glacier Creek	2.0	26.4	71.3	0.3	< 0.16	< 0.20
Lower Glacier Creek	1.6	38.8	59.5	0.1	< 0.17	< 0.20
Lower Glacier Creek	0.7	18.0	81.3	0.0	0.20	< 0.20
Lower Glacier Creek	1.3	27.4	70.7	0.6	0.25	< 0.20
Lower Glacier Creek	0.4	3.1	95.6	0.9	< 0.16	< 0.20
Middle Glacier Creek	0.7	10.9	84.1	4.3	< 0.16	< 0.20
Middle Glacier Creek	0.6	15.8	81.1	2.5	< 0.17	< 0.20
Middle Glacier Creek	1.2	28.0	70.8	0.1	< 0.19	0.30
Middle Glacier Creek	2.3	48.1	49.6	0.0	0.27	< 0.20
Middle Glacier Creek	2.6	45.0	52.4	0.0	< 0.19	< 0.20

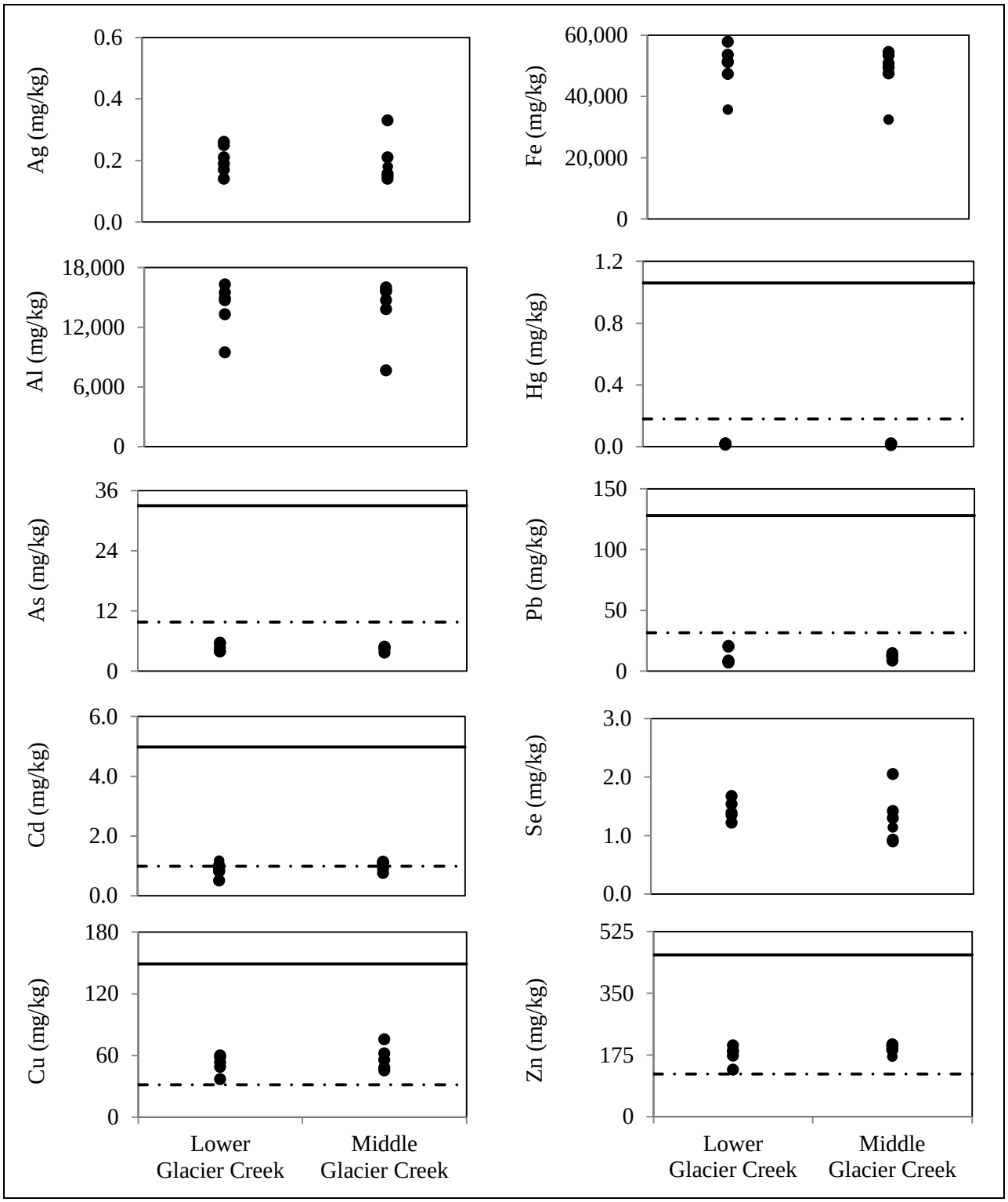

Figure 20.–Glacier Creek sediment element concentrations, 2016–2017.

Note: The dashed line represents the TEC and the solid line represents the PEC for freshwater sediments (Buchman 2008); guidelines are not published for Ag, Al, Fe, or Se.

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APPENDIX A: CHLOROPHYLL DATA

Appendix A.1.–Lower Glacier Creek chlorophylls *a*, *b*, and *c* densities.

	2016			2017		
mg/m²	Chl-*a*	Chl-*b*	Chl-*c*	Chl-*a*	Chl-*b*	Chl-*c*
	3.35	0.00	0.47	1.50	0.00	0.17
	3.31	0.00	0.51	1.28	0.00	0.25
	2.56	0.00	0.45	2.89	0.00	0.30
	1.28	0.00	0.29	1.82	0.00	0.20
	3.10	0.00	0.38	1.92	0.00	0.25
	1.97	0.00	0.29	3.31	0.00	0.46
	0.53	0.00	0.11	1.92	0.00	0.24
	2.03	0.00	0.30	**0.19**	ND	ND
	3.52	0.00	0.63	1.39	0.00	0.21
	1.01	0.00	0.09	1.09	0.00	0.22
Mean	2.27	0.00	0.35	1.73	0.00	0.26
Median	2.30	0.00	0.34	1.66	0.00	0.24
Maximum	3.52	0.00	0.63	3.31	0.00	0.46
Minimum	0.53	0.00	0.09	0.19	0.00	0.17

Note: Bold value is the instrument detection limit, chlorophyll *a* was not detected in the sample.

Appendix A.2.–Middle Glacier Creek chlorophylls *a*, *b*, and *c* densities.

	2016			2017		
mg/m²	Chl-*a*	Chl-*b*	Chl-*c*	Chl-*a*	Chl-*b*	Chl-*c*
	1.82	0.00	0.30	0.96	0.00	0.15
	4.38	0.00	0.75	0.75	0.00	0.15
	0.96	0.00	0.10	1.38	0.00	0.08
	1.60	0.00	0.26	1.56	0.00	0.22
	0.19	ND	ND	0.43	0.00	0.00
	1.17	0.00	0.13	0.75	0.00	0.05
	0.96	0.00	0.15	0.50	0.00	0.03
	1.82	0.00	0.27	1.17	0.00	0.23
	0.28	0.00	0.00	0.21	0.02	0.10
	1.82	0.00	0.27	0.43	0.00	0.02
Mean	1.50	0.00	0.25	0.81	0.00	0.10
Median	1.39	0.00	0.26	0.75	0.00	0.09
Maximum	4.38	0.00	0.75	1.56	0.02	0.23
Minimum	0.19	0.00	0.00	0.21	0.00	0.00

Note: Bold value is the instrument detection limit, chlorophyll *a* was not detected in the sample.

APPENDIX B: BENTHIC MACROINVERTEBRATE DATA

Appendix B.1.–2017 Lower Glacier Creek benthic macroinvertebrate sample data.

				Sample Number						
Phyllum/Class	Order	Family	*Genus*	1	2	3	4	5	6	**Total**
Insecta	Ephemeroptera	Amelitidae	*Ameletus*		1					**1**
		Baetidae	*Baetis*	16	20	46	22	24	18	**146**
		Heptageniidae	*Cinygmula*				1	1		**2**
			Epeorus			2		2	2	**6**
			Rhithrogena	1				1	1	**3**
	Plecoptera	Capniidae	*Capnia*		1	3				**4**
			Isocapnia		1					**1**
		Chloroperlidae	*Suwallia*	7	3		5	3	5	**23**
			Unidentified			2		3	2	**7**
		Nemouridae	*Podmosta*	2						**2**
			Zapada	1			1	2		**4**
	Trichoptera	Glossosomatida	*Glossosoma*					1		**1**
		Rhyacophilidae	*Rhyacophila*	1	1					**2**
	Diptera	Chironomidae	*Unidentified*	168	105	135	77	330	120	**935**
		Dolichopodidae	*Unidentified*						1	**1**
		Empididae	*Clinocera*				1	1		**2**
			Unidentified							**0**
		Limoniidae	*Gonomyodes*	3		2	1	2		**8**
		Simuliidae	*Prosimulium*			3		1		**4**
		Tipulidae	*Dicranota*	1						**1**
			Limonia			1				**1**
			Pedicia						1	**1**
			Unidentified			1				**1**
		Psychodidae	*Pericoma*				1			**1**
	Hemiptera	Unidentified	*Unidentified*	1				1		**2**
	Coleoptera	Gyrinidae	*Spanglerogyrus*					1		**1**
		Staphylinidae	*Unidentified*			1		1	1	**3**
		Unidentified	*Unidentified*		2			1		**3**
Entognatha	Collembola	Unidentified	*Unidentified*		2	1	4	1	2	**10**
Nematoda	Unidentified	Unidentified	*Unidentified*		1					**1**
Oligochaeta	Unidentified	Unidentified	*Unidentified*	2	3	1	1	2	2	**11**
Ostracoda	Unidentified	Unidentified	*Unidentified*	1		2	1			**4**
			Total	**204**	**140**	**200**	**115**	**378**	**155**	**1,192**

Appendix B.2.–Lower Glacier Creek benthic macroinvertebrate data summaries.

	2016	2017
Total benthic macroinvertebrate taxa counted	17	30
Number of Ephemeroptera	44	158
Number of Plecoptera	13	41
Number of Trichoptera	1	3
Number of aquatic Diptera	478	955
Number of other organisms	19	35
% Ephemeroptera	8%	13%
% Plecoptera	2%	3%
% Trichoptera	0%	0%
% Aquatic Diptera	86%	80%
% Other organisms	3%	3%
% EPT	10%	17%
% Chironomidae	85%	79%
Number of terrestrial organisms	17	18
Number of benthic macroinvertebrates	555	1,192
Total terrestrial and macroinvertebrates counted	572	1,210
% Sample aquatic	97%	99%
% Sample terrestrial	3%	1%
Total Sample Area (m^2)	0.558	0.558
Mean benthic macroinvertebrate density per m^2	995	2,136
± 1 standard deviation	373	1,015

Appendix B.3.–2017 Middle Glacier Creek benthic macroinvertebrate sample data.

				Sample Number						
Phyllum/Class	Order	Family	Genus	1	2	3	4	5	6	**Total**
Insecta	Ephemeroptera	Baetidae	*Baetis*	6	0	4	12	1	2	**25**
	Plecoptera	Capniidae	*Capnia*	1	0	1	0	0	2	**4**
		Chloroperlidae	*Suwallia*	1	0	0	2	0	4	**7**
			Unidentified	0	0	1	0	0	0	**1**
		Nemouridae	*Podmosta*	0	0	0	1	0	0	**1**
			Shipsa	0	0	0	1	0	0	**1**
	Trichoptera	Rhyacophilidae	*Rhyacophila*	0	1	0	0	0	0	**1**
	Diptera	Chironomidae	*Unidentified*	88	17	42	76	11	39	**273**
		Limoniidae	*Gonomyodes*	0	0	0	2	0	0	**2**
		Tanyderidae	*Unidentified*	0	1	0	0	0	0	**1**
Arachnida	Unidentified	Unidentified	*Unidentified*	0	0	1	0	0	0	**1**
Entognatha	Collembola	Unidentified	*Unidentified*	0	0	0	0	0	1	**1**
Gastropoda	Unidentified	Unidentified	*Unidentified*	1	0	0	0	0	0	**1**
Nematoda	Unidentified	Unidentified	*Unidentified*	0	1	0	0	0	0	**1**
Oligochaeta	Unidentified	Unidentified	*Unidentified*	3	0	4	0	0	4	**11**
			Total	**100**	**20**	**53**	**94**	**12**	**52**	**331**

Appendix B.4.–Middle Glacier Creek benthic macroinvertebrate data summaries.

	2016	2017
Total benthic macroinvertebrate taxa counted	22	14
Number of Ephemeroptera	119	25
Number of Plecoptera	45	14
Number of Trichoptera	4	1
Number of aquatic Diptera	1,107	276
Number of other organisms	8	15
% Ephemeroptera	9%	8%
% Plecoptera	4%	4%
% Trichoptera	0%	0%
% Aquatic Diptera	86%	83%
% Other organisms	1%	5%
% EPT	13%	12%
% Chironomidae	85%	82%
Number of terrestrial organisms	19	8
Number of benthic macroinvertebrates	1,283	331
Total terrestrial and macroinvertebrates counted	1,302	339
% Sample aquatic	99%	98%
% Sample terrestrial	1%	2%
Total Sample Area (m^2)	0.558	0.558
Mean benthic macroinvertebrate density per m^2	2,299	593
± 1 standard deviation	976	392

APPENDIX C: RESIDENT FISH ELEMENT CONCENTRATIONS AND LABORATORY REPORT

Appendix C.1.–Lower Glacier Creek whole body Dolly Varden char element concentrations data.

Sample Date	Length (mm)	Weight (g)	Condition (*K*)	Ag (mg/kg)	As (mg/kg)	Cd (mg/kg)	Cu (mg/kg)	Hg (mg/kg)	Pb (mg/kg)	Se (mg/kg)	Zn (mg/kg)
6/7/2016	108	12.7	1.0	<0.019	<0.48	0.429	3.55	0.0466	0.076	7.23	153
6/7/2016	68	4.8	1.5	<0.020	<0.50	0.501	3.75	0.0330	0.182	7.60	173
6/7/2016	112	17.7	1.3	0.025	<0.48	1.310	3.63	0.0567	0.230	5.48	145
6/7/2016	105	15.9	1.4	<0.019	<0.48	0.585	3.23	0.0509	0.078	7.56	150
6/7/2016	113	14.3	1.0	<0.020	0.50	0.420	3.42	0.0427	0.177	6.21	154
6/7/2016	94	10.8	1.3	<0.019	0.52	0.441	4.35	0.0381	0.195	7.83	167
6/7/2016	109	14.6	1.1	0.026	<0.50	1.250	5.20	0.0683	0.362	6.46	238
6/7/2016	97	11.2	1.2	<0.019	<0.49	0.641	3.71	0.0401	0.172	6.11	154
6/8/2016	93	9.5	1.2	<0.020	<0.49	0.960	3.32	0.0349	0.091	7.04	141
6/8/2016	73	4.7	1.2	0.025	0.54	0.730	4.67	0.0353	0.360	6.31	168
6/8/2017	133	29.1	1.2	0.023	<0.50	0.727	4.47	0.0599	0.109	6.00	184
6/8/2017	113	15.7	1.1	<0.020	<0.50	0.426	3.69	0.0505	0.027	7.01	148
6/8/2017	105	12.6	1.1	<0.020	<0.50	0.601	3.23	0.0523	0.038	7.16	134
6/8/2017	90	9.2	1.3	0.038	<0.50	1.230	3.24	0.0473	0.088	8.33	123
6/8/2017	106	12.8	1.1	<0.020	<0.50	0.606	4.06	0.0532	0.104	9.09	153
6/8/2017	175	60.5	1.1	<0.020	<0.50	0.355	4.71	0.0924	0.119	6.90	162
6/8/2017	75	5.7	1.4	<0.020	<0.50	0.429	4.77	0.0438	0.202	7.86	157
6/8/2017	110	17.3	1.3	0.025	<0.50	0.736	4.35	0.0446	0.074	9.03	126
6/8/2017	59, 118[a]	20.2	ND	<0.020	<0.50	0.472	4.20	0.0456	0.119	7.30	160
6/8/2017	102, 70[a]	15.6	ND	<0.020	<0.50	0.865	4.55	0.0642	0.196	7.62	130

[a] Composite sample of two fish.

Appendix C.2.–Middle Glacier Creek whole body Dolly Varden char element concentrations data.

Sample Date	Length (mm)	Weight (g)	Condition (*K*)	Ag (mg/kg)	As (mg/kg)	Cd (mg/kg)	Cu (mg/kg)	Hg (mg/kg)	Pb (mg/kg)	Se (mg/kg)	Zn (mg/kg)
6/8/2016	150	36.0	1.1	0.031	<0.48	0.605	3.37	0.0429	0.069	5.66	143
6/8/2016	108	15.9	1.3	<0.020	<0.50	0.327	4.33	0.0337	0.183	6.91	147
6/8/2016	123	26.5	1.4	<0.020	<0.50	0.683	3.83	0.0301	0.717	5.64	117
6/8/2016	73	5.2	1.3	<0.020	<0.49	0.288	4.99	0.0260	0.128	3.94	128
6/8/2016	180	66.7	1.1	<0.020	<0.50	0.329	3.11	0.0376	0.061	5.17	132
6/8/2016	77	6.0	1.3	<0.020	<0.50	0.215	3.53	0.0259	0.259	4.80	146
6/8/2016	83	7.8	1.4	<0.020	<0.50	0.280	3.75	0.0247	0.182	6.05	132
6/8/2016	146	31.5	1.0	<0.020	<0.50	0.521	2.50	0.0299	0.062	4.90	103
6/8/2016	83	7.0	1.2	<0.020	<0.50	0.678	2.56	0.0328	0.046	4.66	139
6/8/2016	70	5.0	1.5	0.682	<0.50	0.257	2.63	0.0184	0.036	6.29	133
6/9/2017	154	45.5	1.2	<0.020	<0.50	0.267	3.29	0.0364	0.036	5.14	116
6/9/2017	130	24.3	1.1	<0.020	<0.50	0.333	3.23	0.0343	0.056	6.86	95
6/9/2017	210	115	1.2	<0.020	<0.50	0.758	7.67	0.0701	0.031	6.34	161
6/9/2017	141	34.7	1.2	<0.020	<0.50	0.291	3.33	0.0430	0.037	8.02	126
6/9/2017	131	24.3	1.1	<0.020	<0.50	0.299	3.26	0.0385	0.100	6.10	128
6/9/2017	90	7.4	1.0	<0.020	<0.50	0.343	2.40	0.0361	0.034	6.86	101

ALS Environmental
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August 28, 2017 **Analytical Report for Service Request No:** K1707899

Kate Kanouse
Alaska Department of Fish and Game
Division of Habitat
802 3rd Street
P.O. Box 110024
Douglas, AK 99811-0024

RE: 2017 Palmer Project Biomonitoring / 160004158

Dear Kate,

Enclosed are the results of the sample(s) submitted to our laboratory July 27, 2017
For your reference, these analyses have been assigned our service request number **K1707899.**

Analyses were performed according to our laboratory's NELAP-approved quality assurance program. The test results meet requirements of the current NELAP standards, where applicable, and except as noted in the laboratory case narrative provided. For a specific list of NELAP-accredited analytes, refer to the certifications section at www.alsglobal.com. All results are intended to be considered in their entirety, and ALS Group USA Corp. dba ALS Environmental (ALS) is not responsible for use of less than the complete report. Results apply only to the items submitted to the laboratory for analysis and individual items (samples) analyzed, as listed in the report.

Please contact me if you have any questions. My extension is 3293. You may also contact me via email at Shar.Samy@alsglobal.com.

Respectfully submitted,

ALS Group USA, Corp. dba ALS Environmental

Shar Samy, Ph.D.
Project Manager

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Table of Contents

Acronyms

ASTM	American Society for Testing and Materials
A2LA	American Association for Laboratory Accreditation
CARB	California Air Resources Board
CAS Number	Chemical Abstract Service registry Number
CFC	Chlorofluorocarbon
CFU	Colony-Forming Unit
DEC	Department of Environmental Conservation
DEQ	Department of Environmental Quality
DHS	Department of Health Services
DOE	Department of Ecology
DOH	Department of Health
EPA	U. S. Environmental Protection Agency
ELAP	Environmental Laboratory Accreditation Program
GC	Gas Chromatography
GC/MS	Gas Chromatography/Mass Spectrometry
LOD	Limit of Detection
LOQ	Limit of Quantitation
LUFT	Leaking Underground Fuel Tank
M	Modified
MCL	Maximum Contaminant Level is the highest permissible concentration of a substance allowed in drinking water as established by the USEPA.
MDL	Method Detection Limit
MPN	Most Probable Number
MRL	Method Reporting Limit
NA	Not Applicable
NC	Not Calculated
NCASI	National Council of the Paper Industry for Air and Stream Improvement
ND	Not Detected
NIOSH	National Institute for Occupational Safety and Health
PQL	Practical Quantitation Limit
RCRA	Resource Conservation and Recovery Act
SIM	Selected Ion Monitoring
TPH	Total Petroleum Hydrocarbons
tr	Trace level is the concentration of an analyte that is less than the PQL but greater than or equal to the MDL.

Inorganic Data Qualifiers

*	The result is an outlier. See case narrative.
#	The control limit criteria is not applicable. See case narrative.
B	The analyte was found in the associated method blank at a level that is significant relative to the sample result as defined by the DOD or NELAC standards.
E	The result is an estimate amount because the value exceeded the instrument calibration range.
J	The result is an estimated value.
U	The analyte was analyzed for, but was not detected ("Non-detect") at or above the MRL/MDL. *DOD-QSM 4.2 definition* : Analyte was not detected and is reported as less than the LOD or as defined by the project. The detection limit is adjusted for dilution.
i	The MRL/MDL or LOQ/LOD is elevated due to a matrix interference.
X	See case narrative.
Q	See case narrative. One or more quality control criteria was outside the limits.
H	The holding time for this test is immediately following sample collection. The samples were analyzed as soon as possible after receipt by the laboratory.

Metals Data Qualifiers

#	The control limit criteria is not applicable. See case narrative.
J	The result is an estimated value.
E	The percent difference for the serial dilution was greater than 10%, indicating a possible matrix interference in the sample.
M	The duplicate injection precision was not met.
N	The Matrix Spike sample recovery is not within control limits. See case narrative.
S	The reported value was determined by the Method of Standard Additions (MSA).
U	The analyte was analyzed for, but was not detected ("Non-detect") at or above the MRL/MDL. *DOD-QSM 4.2 definition* : Analyte was not detected and is reported as less than the LOD or as defined by the project. The detection limit is adjusted for dilution.
W	The post-digestion spike for furnace AA analysis is out of control limits, while sample absorbance is less than 50% of spike absorbance.
i	The MRL/MDL or LOQ/LOD is elevated due to a matrix interference.
X	See case narrative.
+	The correlation coefficient for the MSA is less than 0.995.
Q	See case narrative. One or more quality control criteria was outside the limits.

Organic Data Qualifiers

*	The result is an outlier. See case narrative.
#	The control limit criteria is not applicable. See case narrative.
A	A tentatively identified compound, a suspected aldol-condensation product.
B	The analyte was found in the associated method blank at a level that is significant relative to the sample result as defined by the DOD or NELAC standards.
C	The analyte was qualitatively confirmed using GC/MS techniques, pattern recognition, or by comparing to historical data.
D	The reported result is from a dilution.
E	The result is an estimated value.
J	The result is an estimated value.
N	The result is presumptive. The analyte was tentatively identified, but a confirmation analysis was not performed.
P	The GC or HPLC confirmation criteria was exceeded. The relative percent difference is greater than 40% between the two analytical results.
U	The analyte was analyzed for, but was not detected ("Non-detect") at or above the MRL/MDL. *DOD-QSM 4.2 definition* : Analyte was not detected and is reported as less than the LOD or as defined by the project. The detection limit is adjusted for dilution.
i	The MRL/MDL or LOQ/LOD is elevated due to a chromatographic interference.
X	See case narrative.
Q	See case narrative. One or more quality control criteria was outside the limits.

Additional Petroleum Hydrocarbon Specific Qualifiers

F	The chromatographic fingerprint of the sample matches the elution pattern of the calibration standard.
L	The chromatographic fingerprint of the sample resembles a petroleum product, but the elution pattern indicates the presence of a greater amount of lighter molecular weight constituents than the calibration standard.
H	The chromatographic fingerprint of the sample resembles a petroleum product, but the elution pattern indicates the presence of a greater amount of heavier molecular weight constituents than the calibration standard.
O	The chromatographic fingerprint of the sample resembles an oil, but does not match the calibration standard.
Y	The chromatographic fingerprint of the sample resembles a petroleum product eluting in approximately the correct carbon range, but the elution pattern does not match the calibration standard.
Z	The chromatographic fingerprint does not resemble a petroleum product.

ALS Group USA Corp. dba ALS Environmental (ALS) - Kelso
State Certifications, Accreditations, and Licenses

Agency	Web Site	Number
Alaska DEH	http://dec.alaska.gov/eh/lab/cs/csapproval.htm	UST-040
Arizona DHS	http://www.azdhs.gov/lab/license/env.htm	AZ0339
Arkansas - DEQ	http://www.adeq.state.ar.us/techsvs/labcert.htm	88-0637
California DHS (ELAP)	http://www.cdph.ca.gov/certlic/labs/Pages/ELAP.aspx	2795
DOD ELAP	http://www.denix.osd.mil/edqw/Accreditation/AccreditedLabs.cfm	L14-51
Florida DOH	http://www.doh.state.fl.us/lab/EnvLabCert/WaterCert.htm	E87412
Hawaii DOH	http://health.hawaii.gov/	-
ISO 17025	http://www.pjlabs.com/	L16-57
Louisiana DEQ	http://www.deq.louisiana.gov/page/la-lab-accreditation	03016
Maine DHS	http://www.maine.gov/dhhs/	WA01276
Minnesota DOH	http://www.health.state.mn.us/accreditation	053-999-457
Nevada DEP	http://ndep.nv.gov/bsdw/labservice.htm	WA01276
New Jersey DEP	http://www.nj.gov/dep/enforcement/oqa.html	WA005
New York - DOH	https://www.wadsworth.org/regulatory/elap	12060
North Carolina DEQ	https://deq.nc.gov/about/divisions/water-resources/water-resources-data/water-sciences-home-page/laboratory-certification-branch/non-field-lab-certification	605
Oklahoma DEQ	http://www.deq.state.ok.us/CSDnew/labcert.htm	9801
Oregon – DEQ (NELAP)	http://public.health.oregon.gov/LaboratoryServices/EnvironmentalLaboratoryAccreditation/Pages/index.aspx	WA100010
South Carolina DHEC	http://www.scdhec.gov/environment/EnvironmentalLabCertification/	61002
Texas CEQ	http://www.tceq.texas.gov/field/qa/env_lab_accreditation.html	T104704427
Washington DOE	http://www.ecy.wa.gov/programs/eap/labs/lab-accreditation.html	C544
Wyoming (EPA Region 8)	https://www.epa.gov/region8-waterops/epa-region-8-certified-drinking-water-	-
Kelso Laboratory Website	www.alsglobal.com	NA

Analyses were performed according to our laboratory's NELAP-approved quality assurance program. A complete listing of specific NELAP-certified analytes, can be found in the certification section at www.ALSGlobal.com or at the accreditation bodies web site.
Please refer to the certification and/or accreditation body's web site if samples are submitted for compliance purposes. The states highlighted above, require the analysis be listed on the state certification if used for compliance purposes and if the method/anlayte is offered by that state.

Case Narrative

ALS Environmental—Kelso Laboratory
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Phone (360)577-7222 Fax (360)636-1068
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ALS ENVIRONMENTAL

Client:	Alaska Department of Fish and Game	**Service Request No.:**	K1707899
Project:	2017 Palmer Project Biomonitoring/160004185	**Date Received:**	07/27/17
Sample Matrix:	Animal Tissue		

Case Narrative

All analyses were performed consistent with the quality assurance program of ALS Environmental. This report contains analytical results for samples designated for Tier II data deliverables. When appropriate to the method, method blank results have been reported with each analytical test. Additional quality control analyses reported herein include: Laboratory Duplicate (DUP), Matrix Spike (MS), and Matrix/Duplicate Matrix Spike (MS/DMS).

Sample Receipt

Sixteen tissue samples were received for analysis at ALS Environmental on 07/27/17. The samples were received in good condition and consistent with the accompanying chain of custody form. The samples were stored in frozen at –20ºC upon receipt at the laboratory.

Total Metals

Matrix Spike Recovery Exceptions:
The matrix spike recovery of Selenium for sample 2017 LGCDV1 was outside control criteria (126% recover versus an upper control limit of 125%). Recovery in the Laboratory Control Sample (LCS) was acceptable, which indicated the analytical batch was in control. No further corrective action was appropriate.

No other anomalies associated with the analysis of these samples were observed.

Approved by_____

Chain of Custody

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CHAIN OF CUSTODY

ALS Environmental

SR# K1709899

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PAGE 1 OF 2 COC#

PROJECT NAME: 2017 Palmer Project Biomonitoring
PROJECT NUMBER:
PROJECT MANAGER: Kate Kanouse
COMPANY NAME: Alaska Dept. of Fish & Game
ADDRESS: 802 3rd St.
CITY/STATE/ZIP: Douglas, AK 99824
E-MAIL ADDRESS: Kate.Kanouse@alaska.gov
PHONE #: (907) 465-4290 FAX #:
SAMPLER'S SIGNATURE: Kate Kanouse

SAMPLE I.D.	DATE	TIME	LAB I.D.	MATRIX	NUMBER OF CONTAINERS	Semivolatile Organics by GC/MS 625☐ 8270☐ SIM PAH☐	Volatile Organics 624☐ 8270LL☐ 8260☐ 8021☐ BTEX☐	Hydrocarbons (*see below) Gas☐ Diesel☐ Oil☐	Oil & Grease/TRPH 1664 HEM☐ 1664 SGT☐	PCBs Aroclors☐ Congeners☐	Pesticides/Herbicides 608☐ 8081☐ 8141☐ 8151☐	Chlorophenolics - 8151M Tri☐ Tetra☐ PCP☐	Metals, Total or Dissolved (See List below)	Cyanide☐ Hex-Chrom☐	(circle) pH, Cond., Cl, SO_4, PO_4, F, NO_2, NO_3, BOD, TSS, TDS, Turb.	(circle) NH_3-N, COD, TKN, TOC, DOC, NO_2+NO_3, T-Phos	TOX 9020☐ AOX 1650☐ 506☐	Alkalinity ☐ CO_3☐ HCO_3☐	Dioxins/Furans 1613☐ 8290☐	Dissolved Gases RSK 175☐ Methane☐ Ethane☐ Ethene☐ CO_2☐	REMARKS
see attachment 1 of 1 of whole body juvenile fish Individual samples					16								X								

REPORT REQUIREMENTS

- ___ I. Routine Report: Method Blank, Surrogate, as required
- ✓ II. Report Dup., MS, MSD as required
- ___ III. CLP Like Summary (no raw data)
- ___ IV. Data Validation Report
- ___ V. EDD

INVOICE INFORMATION

P.O. # Darwin Green
Bill To: Constantine
darwin@constantinemetals.com

TURNAROUND REQUIREMENTS

___ 24 hr. ___ 48 hr.
___ 5 day
✓ Standard (15 working days)
___ Provide FAX Results
___ Requested Report Date

Circle which metals are to be analyzed:

Total Metals: Al (As) Sb Ba Be B Ca (Cd) Co Cr (Cu) Fe (Pb) Mg Mn Mo Ni K (Ag) Na (Se) Sr Tl Sn V (Zn) (Hg)

Dissolved Metals: Al As Sb Ba Be B Ca Cd Co Cr Cu Fe Pb Mg Mn Mo Ni K Ag Na Se Sr Tl Sn V Zn Hg

*INDICATE STATE HYDROCARBON PROCEDURE: AK CA WI NORTHWEST OTHER: ___ (CIRCLE ONE)

SPECIAL INSTRUCTIONS/COMMENTS:

please send report to Kate Kanouse, and to Allegra Cairns: allegra@constantinemetals.com

Container Supply Number 79921

☐ Sample Shipment contains USDA regulated soil samples (check box if applicable)

RELINQUISHED BY:	RECEIVED BY:	RELINQUISHED BY:	RECEIVED BY:
Signature: Kate Kanouse	Signature: R. Wrzesinski	Signature:	Signature:
Date/Time: 7/25/17	Date/Time: 07/27/17 0940	Date/Time:	Date/Time:
Printed Name: Kate Kanouse	Printed Name: R. Wrzesinski	Printed Name:	Printed Name:
Firm: ADFG 0800	Firm: ALS	Firm:	Firm:

Project Name:	2017 Palmer Project Biomonitoring
Project Manager:	Kate Kanouse
Company Name:	Alaska Department of Fish and Game
Contact Information:	kate.kanouse@alaska.gov; (907) 465-4290
Sample Type:	Whole body juvenile Dolly Varden char
Analysis:	Total metals, dry weight basis, report percent solids

IC170 899

Matrix	Sample Date	Sample Name	Sample ID	Total Metals	Fork Length (mm)	Weight (g)
Whole Body	6/8/2017	Lower Glacier Creek DV Metals Fish #1	2017LGCDV1	Ag, As, Cd, Cu, Hg, Pb, Se, Zn	133	29.1
Whole Body	6/8/2017	Lower Glacier Creek DV Metals Fish #2	2017LGCDV2	Ag, As, Cd, Cu, Hg, Pb, Se, Zn	113	15.7
Whole Body	6/8/2017	Lower Glacier Creek DV Metals Fish #3	2017LGCDV3	Ag, As, Cd, Cu, Hg, Pb, Se, Zn	105	12.6
Whole Body	6/8/2017	Lower Glacier Creek DV Metals Fish #4	2017LGCDV4	Ag, As, Cd, Cu, Hg, Pb, Se, Zn	90	9.2
Whole Body	6/8/2017	Lower Glacier Creek DV Metals Fish #5	2017LGCDV5	Ag, As, Cd, Cu, Hg, Pb, Se, Zn	106	12.8
Whole Body	6/8/2017	Lower Glacier Creek DV Metals Fish #6	2017LGCDV6	Ag, As, Cd, Cu, Hg, Pb, Se, Zn	175	60.5
Whole Body	6/8/2017	Lower Glacier Creek DV Metals Fish #7	2017LGCDV7	Ag, As, Cd, Cu, Hg, Pb, Se, Zn	75	5.7
Whole Body	6/8/2017	Lower Glacier Creek DV Metals Fish #8	2017LGCDV8	Ag, As, Cd, Cu, Hg, Pb, Se, Zn	110	17.3
Whole Body	6/8/2017	Lower Glacier Creek DV Metals Fish #9	2017LGCDV9	Ag, As, Cd, Cu, Hg, Pb, Se, Zn	59, 118[a]	20.2
Whole Body	6/8/2017	Lower Glacier Creek DV Metals Fish #10	2017LGCDV10	Ag, As, Cd, Cu, Hg, Pb, Se, Zn	102, 70[a]	15.6
Whole Body	6/9/2017	Middle Glacier Creek DV Metals Fish #4	2017MGCDV4	Ag, As, Cd, Cu, Hg, Pb, Se, Zn	154	45.5
Whole Body	6/9/2017	Middle Glacier Creek DV Metals Fish #5	2017MGCDV5	Ag, As, Cd, Cu, Hg, Pb, Se, Zn	130	24.3
Whole Body	6/9/2017	Middle Glacier Creek DV Metals Fish #7	2017MGCDV7	Ag, As, Cd, Cu, Hg, Pb, Se, Zn	210	115.0
Whole Body	6/9/2017	Middle Glacier Creek DV Metals Fish #8	2017MGCDV8	Ag, As, Cd, Cu, Hg, Pb, Se, Zn	141	34.7
Whole Body	6/9/2017	Middle Glacier Creek DV Metals Fish #9	2017MGCDV9	Ag, As, Cd, Cu, Hg, Pb, Se, Zn	131	24.3
Whole Body	6/9/2017	Middle Glacier Creek DV Metals Fish #10	2017MGCDV10	Ag, As, Cd, Cu, Hg, Pb, Se, Zn	90	7.4

[a] Composite sample of two fish.

PC Skas

Cooler Receipt and Preservation Form

Client Alaska Fish & Game Service Request *K17* 07899

Received: 07/27/17 Opened: 07/27/17 By: JW Unloaded: 07/27/17 By: JW

1. Samples were received via? *USPS* *Fed Ex* *UPS* *DHL* *PDX* *Courier* *Hand Delivered*
2. Samples were received in: (circle) *Cooler* *Box* *Envelope* *Other* _____ *NA*
3. Were custody seals on coolers? NA Y N If yes, how many and where? _____
   If present, were custody seals intact? Y N If present, were they signed and dated? Y N

Raw Cooler Temp	Corrected Cooler Temp	Raw Temp Blank	Corrected Temp Blank	Corr. Factor	Thermometer ID	Cooler/COC ID NA	Tracking Number NA	Filed
2.8	2.6	4.6	4.4	-0.2	375		787288953919	
-0.5	-0.7	3.0	2.8	-0.2	298			

4. Packing material: *Inserts* *Baggies* *Bubble Wrap* *Gel Packs* *Wet Ice* *Dry Ice* *Sleeves* _____
5. Were custody papers properly filled out (ink, signed, etc.)? NA Y N
6. Were samples received in good condition (temperature, unbroken)? *Indicate in the table below.* NA Y N
   If applicable, tissue samples were received: *Frozen* *Partially Thawed* *Thawed*
7. Were all sample labels complete (i.e analysis, preservation, etc.)? NA Y N
8. Did all sample labels and tags agree with custody papers? *Indicate major discrepancies in the table on page 2.* NA Y N
9. Were appropriate bottles/containers and volumes received for the tests indicated? NA Y N
10. Were the pH-preserved bottles (*see SMO GEN SOP*) received at the appropriate pH? *Indicate in the table below* NA Y N
11. Were VOA vials received without headspace? *Indicate in the table below.* NA Y N
12. Was C12/Res negative? NA Y N

Sample ID on Bottle	Sample ID on COC	Identified by:

Sample ID	Bottle Count Bottle Type	Out of Temp	Head-space	Broke	pH	Reagent	Volume added	Reagent Lot Number	Initials	Time

Notes, Discrepancies, & Resolutions: _____

Total Solids

ALS Environmental—Kelso Laboratory
1317 South 13th Avenue, Kelso, WA 98626
Phone (360)577-7222 Fax (360)636-1068
www.alsglobal.com

Analytical Report

Client:	Alaska Department of Fish and Game	**Service Request:**	K1707899
Project:	2017 Palmer Project Biomonitoring/160004158	**Date Collected:**	06/08/17 - 06/09/17
Sample Matrix:	Animal Tissue	**Date Received:**	07/27/17
Analysis Method:	Freeze Dry	**Units:**	Percent
Prep Method:	None	**Basis:**	Wet

Total Solids

Sample Name	Lab Code	Result	MRL	Dil.	Date Analyzed	Q
2017 LGCDV1	K1707899-001	**22.7**	-	1	08/08/17 17:10	
2017 LGCDV2	K1707899-002	**24.3**	-	1	08/08/17 17:10	
2017 LGCDV3	K1707899-003	**25.9**	-	1	08/08/17 17:10	
2017 LGCDV4	K1707899-004	**24.3**	-	1	08/08/17 17:10	
2017 LGCDV5	K1707899-005	**25.9**	-	1	08/08/17 17:10	
2017 LGCDV6	K1707899-006	**24.6**	-	1	08/08/17 17:10	
2017 LGCDV7	K1707899-007	**24.9**	-	1	08/08/17 17:10	
2017 LGCDV8	K1707899-008	**24.7**	-	1	08/08/17 17:10	
2017 LGCDV9	K1707899-009	**24.3**	-	1	08/08/17 17:10	
2017 LGCDV10	K1707899-010	**23.7**	-	1	08/08/17 17:10	
2017 MGCDV4	K1707899-011	**27.1**	-	1	08/08/17 17:10	
2017 MGCDV5	K1707899-012	**28.6**	-	1	08/08/17 17:10	
2017 MGCDV7	K1707899-013	**24.1**	-	1	08/08/17 17:10	
2017 MGCDV8	K1707899-014	**26.0**	-	1	08/08/17 17:10	
2017 MGCDV9	K1707899-015	**24.6**	-	1	08/08/17 17:10	
2017 MGCDV10	K1707899-016	**24.3**	-	1	08/08/17 17:10	

ALS Group USA, Corp.
dba ALS Environmental

QA/QC Report

Client:	Alaska Department of Fish and Game	**Service Request:**	K1707899
Project	2017 Palmer Project Biomonitoring/160004158	**Date Collected:**	06/08/17 - 06/09/17
Sample Matrix:	Animal Tissue	**Date Received:**	07/27/17
Analysis Method:	Freeze Dry	**Units:**	Percent
Prep Method:	None	**Basis:**	Wet

Replicate Sample Summary
Inorganic Parameters

Sample Name:	Lab Code:	MRL	Sample Result	Duplicate Result	Average	RPD	RPD Limit	Date Analyzed
2017 LGCDV6	K1707899-006DUP	-	24.6	24.9	24.8	1	20	08/08/17
2017 MGCDV7	K1707899-013DUP	-	24.1	24.8	24.5	3	20	08/08/17

Results flagged with an asterisk (*) indicate values outside control criteria.

Results flagged with a pound (#) indicate the control criteria is not applicable.

Percent recoveries and relative percent differences (RPD) are determined by the software using values in the calculation which have not been rounded.

Metals

ALS Environmental—Kelso Laboratory
1317 South 13th Avenue, Kelso, WA 98626
Phone (360)577-7222 Fax (360)636-1068
www.alsglobal.com

Client:	Alaska Department of Fish and Game	**Service Request:**	K1707899
Project:	2017 Palmer Project Biomonitoring/160004158	**Date Collected:**	06/08/17
Sample Matrix:	Animal tissue	**Date Received:**	07/27/17

Mercury, Total

Prep Method: METHOD
Analysis Method: 1631E
Test Notes:

Units: ng/g
Basis: Dry

Sample Name	Lab Code	MRL	Dilution Factor	Date Extracted	Date Analyzed	Result	Result Notes
2017 LGCDV1	K1707899-001	4.7	5	08/24/17	08/25/17	59.9	
2017 LGCDV2	K1707899-002	5.0	5	08/24/17	08/25/17	50.5	
2017 LGCDV3	K1707899-003	4.8	5	08/24/17	08/25/17	52.3	
2017 LGCDV4	K1707899-004	5.0	5	08/24/17	08/25/17	47.3	
2017 LGCDV5	K1707899-005	4.9	5	08/24/17	08/25/17	53.2	
2017 LGCDV6	K1707899-006	4.9	5	08/24/17	08/25/17	92.4	
2017 LGCDV7	K1707899-007	4.8	5	08/24/17	08/25/17	43.8	
2017 LGCDV8	K1707899-008	4.6	5	08/24/17	08/25/17	44.6	
2017 LGCDV9	K1707899-009	4.9	5	08/24/17	08/25/17	45.6	
2017 LGCDV10	K1707899-010	4.8	5	08/24/17	08/25/17	64.2	
2017 MGCDV4	K1707899-011	4.5	5	08/24/17	08/25/17	36.4	
2017 MGCDV5	K1707899-012	4.9	5	08/24/17	08/25/17	34.3	
2017 MGCDV7	K1707899-013	4.6	5	08/24/17	08/25/17	70.1	
2017 MGCDV8	K1707899-014	4.9	5	08/24/17	08/25/17	43.0	
2017 MGCDV9	K1707899-015	4.9	5	08/24/17	08/25/17	38.5	
2017 MGCDV10	K1707899-016	4.4	5	08/24/17	08/25/17	36.1	
Method Blank 1	K1707899-MB1	1.0	1	08/24/17	08/25/17	ND	
Method Blank 2	K1707899-MB2	1.0	1	08/24/17	08/25/17	ND	
Method Blank 3	K1707899-MB3	1.0	1	08/24/17	08/25/17	ND	

ALS Group USA, Corp.
dba ALS Environmental
QA/QC Report

Client:	Alaska Department of Fish and Game	**Service Request:**	K1707899
Project:	2017 Palmer Project Biomonitoring/160004158	**Date Collected:**	06/08/17
Sample Matrix:	Animal tissue	**Date Received:**	07/27/17
		Date Extracted:	08/24/17
		Date Analyzed:	08/25/17

Matrix Spike/Duplicate Matrix Spike Summary
Total Metals

Sample Name:	2017 LGCDV1	Units:	ng/g
Lab Code:	K1707899-001MS, K1707899-001MSD	Basis:	Dry
Test Notes:			

									Percent Recovery				
	Prep	Analysis		Spike Level		Sample	Spike Result				ALS Acceptance	Relative Percent	Result
Analyte	**Method**	**Method**	**MRL**	**MS**	**DMS**	**Result**	**MS**	**DMS**	**MS**	**DMS**	**Limits**	**Difference**	**Notes**
Mercury	METHOD	1631E	4.8	234	238	59.9	275	288	92	96	70-130	5	

ALS Group USA, Corp.
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QA/QC Report

Client:	Alaska Department of Fish and Game	**Service Request:**	K1707899
Project:	2017 Palmer Project Biomonitoring/160004158	**Date Collected:**	06/09/17
Sample Matrix:	Animal tissue	**Date Received:**	07/27/17
		Date Extracted:	08/24/17
		Date Analyzed:	08/25/17

Matrix Spike/Duplicate Matrix Spike Summary
Total Metals

Sample Name:	2017 MGCDV5	Units:	ng/g
Lab Code:	K1707899-001MS, K1707899-001MSD	Basis:	Dry
Test Notes:			

				Spike Level		Sample	Spike Result		Percent Recovery		ALS	Relative	
	Prep	Analysis									Acceptance	Percent	Result
Analyte	**Method**	**Method**	**MRL**	**MS**	**DMS**	**Result**	**MS**	**DMS**	**MS**	**DMS**	**Limits**	**Difference**	**Notes**
Mercury	METHOD	1631E	4.7	230	236	34.3	255	270	96	100	70-130	6	

ALS Group USA, Corp.
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QA/QC Report

Client:	Alaska Department of Fish and Game	**Service Request:**	K1707899
Project:	2017 Palmer Project Biomonitoring/160004158	**Date Collected:**	NA
LCS Matrix:	Water	**Date Received:**	NA
		Date Extracted:	NA
		Date Analyzed:	08/25/17

Ongoing Precision and Recovery (OPR) Sample Summary
Total Metals

Sample Name: Ongoing Precision and Recovery (Initial)

Units: ng/g
Basis: NA

Test Notes:

Analyte	Prep Method	Analysis Method	True Value	Result	Percent Recovery	ALS Percent Recovery Acceptance Limits	Result Notes
Mercury	METHOD	1631E	5.00	4.71	94	70-130	

ALS Group USA, Corp.
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QA/QC Report

Client:	Alaska Department of Fish and Game	**Service Request:**	K1707899
Project:	2017 Palmer Project Biomonitoring/160004158	**Date Collected:**	NA
LCS Matrix:	Water	**Date Received:**	NA
		Date Extracted:	NA
		Date Analyzed:	08/25/17

Ongoing Precision and Recovery (OPR) Sample Summary
Total Metals

Sample Name: Ongoing Precision and Recovery (Final)

Units: ng/g
Basis: NA

Test Notes:

Analyte	Prep Method	Analysis Method	True Value	Result	Percent Recovery	ALS Percent Recovery Acceptance Limits	Result Notes
Mercury	METHOD	1631E	5.00	4.98	100	70-130	

ALS Group USA, Corp.
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QA/QC Report

Client:	Alaska Department of Fish and Game	**Service Request:**	K1707899
Project:	2017 Palmer Project Biomonitoring/160004158	**Date Collected:**	NA
LCS Matrix:	Animal tissue	**Date Received:**	NA
		Date Extracted:	08/24/17
		Date Analyzed:	08/25/17

Quality Control Sample (QCS) Summary
Total Metals

Sample Name:	Quality Control Sample	Units:	ng/g
Lab Code:		Basis:	Dry
Test Notes:			

Source: TORT-3

Analyte	Prep Method	Analysis Method	True Value	Result	Percent Recovery	ALS Percent Recovery Acceptance Limits	Result Notes
Mercury	METHOD	1631E	292	277	95	70-130	

Analytical Report

Client:	Alaska Department of Fish and Game	**Service Request:**	K1707899
Project:	2017 Palmer Project Biomonitoring/160004158	**Date Collected:**	06/08/17
Sample Matrix:	Animal Tissue	**Date Received:**	07/27/17 09:40
Sample Name:	2017 LGCDV1	**Basis:**	Dry
Lab Code:	K1707899-001		

Total Metals

Analyte Name	Analysis Method	Result	Units	MRL	Dil.	Date Analyzed	Date Extracted	Q
Arsenic	6020A	ND U	mg/Kg	0.50	5	08/24/17 17:58	08/22/17	
Cadmium	6020A	**0.747**	mg/Kg	0.020	5	08/24/17 17:58	08/22/17	
Copper	6020A	**4.48**	mg/Kg	0.10	5	08/24/17 17:58	08/22/17	
Lead	6020A	**0.118**	mg/Kg	0.020	5	08/24/17 17:58	08/22/17	
Selenium	6020A	**6.1**	mg/Kg	1.0	5	08/24/17 17:58	08/22/17	
Silver	6020A	**0.025**	mg/Kg	0.020	5	08/24/17 17:58	08/22/17	
Zinc	6020A	**183**	mg/Kg	0.50	5	08/24/17 17:58	08/22/17	

Analytical Report

Client:	Alaska Department of Fish and Game	**Service Request:**	K1707899
Project:	2017 Palmer Project Biomonitoring/160004158	**Date Collected:**	06/08/17
Sample Matrix:	Animal Tissue	**Date Received:**	07/27/17 09:40
Sample Name:	2017 LGCDV2	**Basis:**	Dry
Lab Code:	K1707899-002		

Total Metals

Analyte Name	Analysis Method	Result	Units	MRL	Dil.	Date Analyzed	Date Extracted	Q
Arsenic	6020A	ND U	mg/Kg	0.50	5	08/24/17 18:13	08/22/17	
Cadmium	6020A	**0.426**	mg/Kg	0.020	5	08/24/17 18:13	08/22/17	
Copper	6020A	**3.69**	mg/Kg	0.099	5	08/24/17 18:13	08/22/17	
Lead	6020A	**0.027**	mg/Kg	0.020	5	08/24/17 18:13	08/22/17	
Selenium	6020A	**7.01**	mg/Kg	0.99	5	08/24/17 18:13	08/22/17	
Silver	6020A	ND U	mg/Kg	0.020	5	08/24/17 18:13	08/22/17	
Zinc	6020A	**148**	mg/Kg	0.50	5	08/24/17 18:13	08/22/17	

Analytical Report

Client:	Alaska Department of Fish and Game	**Service Request:**	K1707899
Project:	2017 Palmer Project Biomonitoring/160004158	**Date Collected:**	06/08/17
Sample Matrix:	Animal Tissue	**Date Received:**	07/27/17 09:40
Sample Name:	2017 LGCDV3	**Basis:**	Dry
Lab Code:	K1707899-003		

Total Metals

Analyte Name	Analysis Method	Result	Units	MRL	Dil.	Date Analyzed	Date Extracted	Q
Arsenic	6020A	ND U	mg/Kg	0.50	5	08/24/17 18:16	08/22/17	
Cadmium	6020A	**0.601**	mg/Kg	0.020	5	08/24/17 18:16	08/22/17	
Copper	6020A	**3.23**	mg/Kg	0.100	5	08/24/17 18:16	08/22/17	
Lead	6020A	**0.038**	mg/Kg	0.020	5	08/24/17 18:16	08/22/17	
Selenium	6020A	**7.16**	mg/Kg	1.00	5	08/24/17 18:16	08/22/17	
Silver	6020A	ND U	mg/Kg	0.020	5	08/24/17 18:16	08/22/17	
Zinc	6020A	**134**	mg/Kg	0.50	5	08/24/17 18:16	08/22/17	

Analytical Report

Client:	Alaska Department of Fish and Game	**Service Request:**	K1707899
Project:	2017 Palmer Project Biomonitoring/160004158	**Date Collected:**	06/08/17
Sample Matrix:	Animal Tissue	**Date Received:**	07/27/17 09:40
Sample Name:	2017 LGCDV4	**Basis:**	Dry
Lab Code:	K1707899-004		

Total Metals

Analyte Name	Analysis Method	Result	Units	MRL	Dil.	Date Analyzed	Date Extracted	Q
Arsenic	6020A	ND U	mg/Kg	0.50	5	08/24/17 18:18	08/22/17	
Cadmium	6020A	**1.23**	mg/Kg	0.020	5	08/24/17 18:18	08/22/17	
Copper	6020A	**3.24**	mg/Kg	0.099	5	08/24/17 18:18	08/22/17	
Lead	6020A	**0.088**	mg/Kg	0.020	5	08/24/17 18:18	08/22/17	
Selenium	6020A	**8.33**	mg/Kg	0.99	5	08/24/17 18:18	08/22/17	
Silver	6020A	**0.038**	mg/Kg	0.020	5	08/24/17 18:18	08/22/17	
Zinc	6020A	**123**	mg/Kg	0.50	5	08/24/17 18:18	08/22/17	

Analytical Report

Client:	Alaska Department of Fish and Game	**Service Request:**	K1707899
Project:	2017 Palmer Project Biomonitoring/160004158	**Date Collected:**	06/08/17
Sample Matrix:	Animal Tissue	**Date Received:**	07/27/17 09:40
Sample Name:	2017 LGCDV5	**Basis:**	Dry
Lab Code:	K1707899-005		

Total Metals

Analyte Name	Analysis Method	Result	Units	MRL	Dil.	Date Analyzed	Date Extracted	Q
Arsenic	6020A	ND U	mg/Kg	0.50	5	08/24/17 18:21	08/22/17	
Cadmium	6020A	**0.606**	mg/Kg	0.020	5	08/24/17 18:21	08/22/17	
Copper	6020A	**4.06**	mg/Kg	0.099	5	08/24/17 18:21	08/22/17	
Lead	6020A	**0.104**	mg/Kg	0.020	5	08/24/17 18:21	08/22/17	
Selenium	6020A	**9.09**	mg/Kg	0.99	5	08/24/17 18:21	08/22/17	
Silver	6020A	ND U	mg/Kg	0.020	5	08/24/17 18:21	08/22/17	
Zinc	6020A	**153**	mg/Kg	0.50	5	08/24/17 18:21	08/22/17	

Analytical Report

Client:	Alaska Department of Fish and Game	**Service Request:**	K1707899
Project:	2017 Palmer Project Biomonitoring/160004158	**Date Collected:**	06/08/17
Sample Matrix:	Animal Tissue	**Date Received:**	07/27/17 09:40
Sample Name:	2017 LGCDV6	**Basis:**	Dry
Lab Code:	K1707899-006		

Total Metals

Analyte Name	Analysis Method	Result	Units	MRL	Dil.	Date Analyzed	Date Extracted	Q
Arsenic	6020A	ND U	mg/Kg	0.50	5	08/24/17 18:36	08/22/17	
Cadmium	6020A	**0.355**	mg/Kg	0.020	5	08/24/17 18:36	08/22/17	
Copper	6020A	**4.71**	mg/Kg	0.10	5	08/24/17 18:36	08/22/17	
Lead	6020A	**0.119**	mg/Kg	0.020	5	08/24/17 18:36	08/22/17	
Selenium	6020A	**6.9**	mg/Kg	1.0	5	08/24/17 18:36	08/22/17	
Silver	6020A	ND U	mg/Kg	0.020	5	08/24/17 18:36	08/22/17	
Zinc	6020A	**162**	mg/Kg	0.50	5	08/24/17 18:36	08/22/17	

Analytical Report

Client:	Alaska Department of Fish and Game	**Service Request:**	K1707899
Project:	2017 Palmer Project Biomonitoring/160004158	**Date Collected:**	06/08/17
Sample Matrix:	Animal Tissue	**Date Received:**	07/27/17 09:40
Sample Name:	2017 LGCDV7	**Basis:**	Dry
Lab Code:	K1707899-007		

Total Metals

Analyte Name	Analysis Method	Result	Units	MRL	Dil.	Date Analyzed	Date Extracted	Q
Arsenic	6020A	ND U	mg/Kg	0.50	5	08/24/17 18:39	08/22/17	
Cadmium	6020A	**0.429**	mg/Kg	0.020	5	08/24/17 18:39	08/22/17	
Copper	6020A	**4.77**	mg/Kg	0.100	5	08/24/17 18:39	08/22/17	
Lead	6020A	**0.202**	mg/Kg	0.020	5	08/24/17 18:39	08/22/17	
Selenium	6020A	**7.86**	mg/Kg	1.00	5	08/24/17 18:39	08/22/17	
Silver	6020A	ND U	mg/Kg	0.020	5	08/24/17 18:39	08/22/17	
Zinc	6020A	**157**	mg/Kg	0.50	5	08/24/17 18:39	08/22/17	

Analytical Report

Client:	Alaska Department of Fish and Game	**Service Request:**	K1707899
Project:	2017 Palmer Project Biomonitoring/160004158	**Date Collected:**	06/08/17
Sample Matrix:	Animal Tissue	**Date Received:**	07/27/17 09:40
Sample Name:	2017 LGCDV8	**Basis:**	Dry
Lab Code:	K1707899-008		

Total Metals

Analyte Name	Analysis Method	Result	Units	MRL	Dil.	Date Analyzed	Date Extracted	Q
Arsenic	6020A	ND U	mg/Kg	0.50	5	08/24/17 18:42	08/22/17	
Cadmium	6020A	**0.736**	mg/Kg	0.020	5	08/24/17 18:42	08/22/17	
Copper	6020A	**4.35**	mg/Kg	0.100	5	08/24/17 18:42	08/22/17	
Lead	6020A	**0.074**	mg/Kg	0.020	5	08/24/17 18:42	08/22/17	
Selenium	6020A	**9.03**	mg/Kg	1.00	5	08/24/17 18:42	08/22/17	
Silver	6020A	**0.025**	mg/Kg	0.020	5	08/24/17 18:42	08/22/17	
Zinc	6020A	**126**	mg/Kg	0.50	5	08/24/17 18:42	08/22/17	

Analytical Report

Client:	Alaska Department of Fish and Game	**Service Request:**	K1707899
Project:	2017 Palmer Project Biomonitoring/160004158	**Date Collected:**	06/08/17
Sample Matrix:	Animal Tissue	**Date Received:**	07/27/17 09:40
Sample Name:	2017 LGCDV9	**Basis:**	Dry
Lab Code:	K1707899-009		

Total Metals

Analyte Name	Analysis Method	Result	Units	MRL	Dil.	Date Analyzed	Date Extracted	Q
Arsenic	6020A	ND U	mg/Kg	0.50	5	08/24/17 18:45	08/22/17	
Cadmium	6020A	**0.472**	mg/Kg	0.020	5	08/24/17 18:45	08/22/17	
Copper	6020A	**4.20**	mg/Kg	0.10	5	08/24/17 18:45	08/22/17	
Lead	6020A	**0.119**	mg/Kg	0.020	5	08/24/17 18:45	08/22/17	
Selenium	6020A	**7.3**	mg/Kg	1.0	5	08/24/17 18:45	08/22/17	
Silver	6020A	ND U	mg/Kg	0.020	5	08/24/17 18:45	08/22/17	
Zinc	6020A	**160**	mg/Kg	0.50	5	08/24/17 18:45	08/22/17	

Analytical Report

Client:	Alaska Department of Fish and Game	**Service Request:**	K1707899
Project:	2017 Palmer Project Biomonitoring/160004158	**Date Collected:**	06/08/17
Sample Matrix:	Animal Tissue	**Date Received:**	07/27/17 09:40
Sample Name:	2017 LGCDV10	**Basis:**	Dry
Lab Code:	K1707899-010		

Total Metals

Analyte Name	Analysis Method	Result	Units	MRL	Dil.	Date Analyzed	Date Extracted	Q
Arsenic	6020A	ND U	mg/Kg	0.50	5	08/24/17 18:48	08/22/17	
Cadmium	6020A	**0.865**	mg/Kg	0.020	5	08/24/17 18:48	08/22/17	
Copper	6020A	**4.55**	mg/Kg	0.100	5	08/24/17 18:48	08/22/17	
Lead	6020A	**0.196**	mg/Kg	0.020	5	08/24/17 18:48	08/22/17	
Selenium	6020A	**7.62**	mg/Kg	1.00	5	08/24/17 18:48	08/22/17	
Silver	6020A	ND U	mg/Kg	0.020	5	08/24/17 18:48	08/22/17	
Zinc	6020A	**130**	mg/Kg	0.50	5	08/24/17 18:48	08/22/17	

Analytical Report

Client:	Alaska Department of Fish and Game	**Service Request:**	K1707899
Project:	2017 Palmer Project Biomonitoring/160004158	**Date Collected:**	06/09/17
Sample Matrix:	Animal Tissue	**Date Received:**	07/27/17 09:40
Sample Name:	2017 MGCDV4	**Basis:**	Dry
Lab Code:	K1707899-011		

Total Metals

Analyte Name	Analysis Method	Result	Units	MRL	Dil.	Date Analyzed	Date Extracted	Q
Arsenic	6020A	ND U	mg/Kg	0.50	5	08/24/17 18:51	08/22/17	
Cadmium	6020A	**0.267**	mg/Kg	0.020	5	08/24/17 18:51	08/22/17	
Copper	6020A	**3.29**	mg/Kg	0.099	5	08/24/17 18:51	08/22/17	
Lead	6020A	**0.036**	mg/Kg	0.020	5	08/24/17 18:51	08/22/17	
Selenium	6020A	**5.14**	mg/Kg	0.99	5	08/24/17 18:51	08/22/17	
Silver	6020A	ND U	mg/Kg	0.020	5	08/24/17 18:51	08/22/17	
Zinc	6020A	**116**	mg/Kg	0.50	5	08/24/17 18:51	08/22/17	

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Analytical Report

Client:	Alaska Department of Fish and Game	**Service Request:**	K1707899
Project:	2017 Palmer Project Biomonitoring/160004158	**Date Collected:**	06/09/17
Sample Matrix:	Animal Tissue	**Date Received:**	07/27/17 09:40
Sample Name:	2017 MGCDV5	**Basis:**	Dry
Lab Code:	K1707899-012		

Total Metals

Analyte Name	Analysis Method	Result	Units	MRL	Dil.	Date Analyzed	Date Extracted	Q
Arsenic	6020A	ND U	mg/Kg	0.50	5	08/24/17 18:54	08/22/17	
Cadmium	6020A	**0.333**	mg/Kg	0.020	5	08/24/17 18:54	08/22/17	
Copper	6020A	**3.23**	mg/Kg	0.099	5	08/24/17 18:54	08/22/17	
Lead	6020A	**0.056**	mg/Kg	0.020	5	08/24/17 18:54	08/22/17	
Selenium	6020A	**6.86**	mg/Kg	0.99	5	08/24/17 18:54	08/22/17	
Silver	6020A	ND U	mg/Kg	0.020	5	08/24/17 18:54	08/22/17	
Zinc	6020A	**95.0**	mg/Kg	0.50	5	08/24/17 18:54	08/22/17	

Analytical Report

Client:	Alaska Department of Fish and Game	**Service Request:**	K1707899
Project:	2017 Palmer Project Biomonitoring/160004158	**Date Collected:**	06/09/17
Sample Matrix:	Animal Tissue	**Date Received:**	07/27/17 09:40
Sample Name:	2017 MGCDV7	**Basis:**	Dry
Lab Code:	K1707899-013		

Total Metals

Analyte Name	Analysis Method	Result	Units	MRL	Dil.	Date Analyzed	Date Extracted	Q
Arsenic	6020A	ND U	mg/Kg	0.50	5	08/24/17 18:57	08/22/17	
Cadmium	6020A	**0.758**	mg/Kg	0.020	5	08/24/17 18:57	08/22/17	
Copper	6020A	**7.67**	mg/Kg	0.100	5	08/24/17 18:57	08/22/17	
Lead	6020A	**0.031**	mg/Kg	0.020	5	08/24/17 18:57	08/22/17	
Selenium	6020A	**6.34**	mg/Kg	1.00	5	08/24/17 18:57	08/22/17	
Silver	6020A	ND U	mg/Kg	0.020	5	08/24/17 18:57	08/22/17	
Zinc	6020A	**161**	mg/Kg	0.50	5	08/24/17 18:57	08/22/17	

Analytical Report

Client:	Alaska Department of Fish and Game	**Service Request:**	K1707899
Project:	2017 Palmer Project Biomonitoring/160004158	**Date Collected:**	06/09/17
Sample Matrix:	Animal Tissue	**Date Received:**	07/27/17 09:40
Sample Name:	2017 MGCDV8	**Basis:**	Dry
Lab Code:	K1707899-014		

Total Metals

Analyte Name	Analysis Method	Result	Units	MRL	Dil.	Date Analyzed	Date Extracted	Q
Arsenic	6020A	ND U	mg/Kg	0.50	5	08/24/17 18:59	08/22/17	
Cadmium	6020A	**0.291**	mg/Kg	0.020	5	08/24/17 18:59	08/22/17	
Copper	6020A	**3.33**	mg/Kg	0.099	5	08/24/17 18:59	08/22/17	
Lead	6020A	**0.037**	mg/Kg	0.020	5	08/24/17 18:59	08/22/17	
Selenium	6020A	**8.02**	mg/Kg	0.99	5	08/24/17 18:59	08/22/17	
Silver	6020A	ND U	mg/Kg	0.020	5	08/24/17 18:59	08/22/17	
Zinc	6020A	**126**	mg/Kg	0.50	5	08/24/17 18:59	08/22/17	

Analytical Report

Client:	Alaska Department of Fish and Game	**Service Request:**	K1707899
Project:	2017 Palmer Project Biomonitoring/160004158	**Date Collected:**	06/09/17
Sample Matrix:	Animal Tissue	**Date Received:**	07/27/17 09:40
Sample Name:	2017 MGCDV9	**Basis:**	Dry
Lab Code:	K1707899-015		

Total Metals

Analyte Name	Analysis Method	Result	Units	MRL	Dil.	Date Analyzed	Date Extracted	Q
Arsenic	6020A	ND U	mg/Kg	0.50	5	08/24/17 19:02	08/22/17	
Cadmium	6020A	**0.299**	mg/Kg	0.020	5	08/24/17 19:02	08/22/17	
Copper	6020A	**3.26**	mg/Kg	0.10	5	08/24/17 19:02	08/22/17	
Lead	6020A	**0.100**	mg/Kg	0.020	5	08/24/17 19:02	08/22/17	
Selenium	6020A	**6.1**	mg/Kg	1.0	5	08/24/17 19:02	08/22/17	
Silver	6020A	ND U	mg/Kg	0.020	5	08/24/17 19:02	08/22/17	
Zinc	6020A	**128**	mg/Kg	0.50	5	08/24/17 19:02	08/22/17	

Analytical Report

Client:	Alaska Department of Fish and Game	**Service Request:**	K1707899
Project:	2017 Palmer Project Biomonitoring/160004158	**Date Collected:**	06/09/17
Sample Matrix:	Animal Tissue	**Date Received:**	07/27/17 09:40
Sample Name:	2017 MGCDV10	**Basis:**	Dry
Lab Code:	K1707899-016		

Total Metals

Analyte Name	Analysis Method	Result	Units	MRL	Dil.	Date Analyzed	Date Extracted	Q
Arsenic	6020A	ND U	mg/Kg	0.50	5	08/24/17 19:14	08/22/17	
Cadmium	6020A	**0.343**	mg/Kg	0.020	5	08/24/17 19:14	08/22/17	
Copper	6020A	**2.40**	mg/Kg	0.099	5	08/24/17 19:14	08/22/17	
Lead	6020A	**0.034**	mg/Kg	0.020	5	08/24/17 19:14	08/22/17	
Selenium	6020A	**6.86**	mg/Kg	0.99	5	08/24/17 19:14	08/22/17	
Silver	6020A	ND U	mg/Kg	0.020	5	08/24/17 19:14	08/22/17	
Zinc	6020A	**101**	mg/Kg	0.50	5	08/24/17 19:14	08/22/17	

Analytical Report

Client:	Alaska Department of Fish and Game	**Service Request:**	K1707899
Project:	2017 Palmer Project Biomonitoring/160004158	**Date Collected:**	NA
Sample Matrix:	Animal Tissue	**Date Received:**	NA
Sample Name:	Method Blank	**Basis:**	Dry
Lab Code:	KQ1711848-01		

Total Metals

Analyte Name	Analysis Method	Result	Units	MRL	Dil.	Date Analyzed	Date Extracted	Q
Arsenic	6020A	ND U	mg/Kg	0.50	5	08/24/17 17:41	08/22/17	
Cadmium	6020A	ND U	mg/Kg	0.020	5	08/24/17 17:41	08/22/17	
Copper	6020A	ND U	mg/Kg	0.10	5	08/24/17 17:41	08/22/17	
Lead	6020A	ND U	mg/Kg	0.020	5	08/24/17 17:41	08/22/17	
Selenium	6020A	ND U	mg/Kg	1.0	5	08/24/17 17:41	08/22/17	
Silver	6020A	ND U	mg/Kg	0.020	5	08/24/17 17:41	08/22/17	
Zinc	6020A	ND U	mg/Kg	0.50	5	08/24/17 17:41	08/22/17	

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QA/QC Report

Client:	Alaska Department of Fish and Game	**Service Request:**	K1707899
Project	2017 Palmer Project Biomonitoring/160004158	**Date Collected:**	06/08/17
Sample Matrix:	Animal Tissue	**Date Received:**	07/27/17
		Date Analyzed:	08/24/17

Replicate Sample Summary

Total Metals

Sample Name:	2017 LGCDV1	**Units:**	mg/Kg
Lab Code:	K1707899-001	**Basis:**	Dry

Analyte Name	Analysis Method	MRL	Sample Result	Duplicate Sample KQ1711848-05 Result	Average	RPD	RPD Limit
Arsenic	6020A	0.50	ND U	ND U	ND	-	20
Cadmium	6020A	0.020	0.747	0.707	0.727	5	20
Copper	6020A	0.100	4.48	4.46	4.47	<1	20
Lead	6020A	0.020	0.118	0.100	0.109	17	20
Selenium	6020A	1.00	6.1	5.9	6.01	3	20
Silver	6020A	0.020	0.025	0.021	0.023	19	20
Zinc	6020A	0.50	183	185	184	1	20

Results flagged with an asterisk (*) indicate values outside control criteria.

Results flagged with a pound (#) indicate the control criteria is not applicable.

Percent recoveries and relative percent differences (RPD) are determined by the software using values in the calculation which have not been rounded.

Printed 8/28/2017 2:16:39 PM Superset Reference:

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QA/QC Report

Client:	Alaska Department of Fish and Game	**Service Request:**	K1707899
Project:	2017 Palmer Project Biomonitoring/160004158	**Date Collected:**	06/08/17
Sample Matrix:	Animal Tissue	**Date Received:**	07/27/17
		Date Analyzed:	08/24/17
		Date Extracted:	08/22/17

Matrix Spike Summary
Total Metals

Sample Name:	2017 LGCDV1	**Units:**	mg/Kg
Lab Code:	K1707899-001	**Basis:**	Dry
Analysis Method:	6020A		
Prep Method:	PSEP Metals		

Matrix Spike
KQ1711848-06

Analyte Name	Sample Result	Result	Spike Amount	% Rec	% Rec Limits
Arsenic	ND U	19.7	16.7	118	75-125
Cadmium	0.747	6.12	5.00	107	75-125
Copper	4.48	28.6	25.0	96	75-125
Lead	0.118	48.3	50.0	96	75-125
Selenium	6.1	27.1	16.7	126 N	75-125
Silver	0.025	5.02	5.00	100	75-125
Zinc	183	235	50.0	104	75-125

Results flagged with an asterisk (*) indicate values outside control criteria.

Results flagged with a pound (#) indicate the control criteria is not applicable.

Percent recoveries and relative percent differences (RPD) are determined by the software using values in the calculation which have not been rounded.

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QA/QC Report

Client: Alaska Department of Fish and Game
Project: 2017 Palmer Project Biomonitoring/160004158
Sample Matrix: Animal Tissue

Service Request: K1707899
Date Analyzed: 08/24/17

Lab Control Sample Summary
Total Metals

Units:mg/Kg
Basis: Dry

Lab Control Sample
KQ1711848-02

Analyte Name	Analytical Method	Result	Spike Amount	% Rec	% Rec Limits
Arsenic	6020A	17.7	16.7	106	80-120
Cadmium	6020A	5.05	5.00	101	80-120
Copper	6020A	24.9	25.0	100	80-120
Lead	6020A	51.5	50.0	103	80-120
Selenium	6020A	19.1	16.7	114	80-120
Silver	6020A	4.92	5.00	98	80-120
Zinc	6020A	51.6	50.0	103	80-120

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QA/QC Report

Client:	Alaska Department of Fish and Game	**Service Request:**	K1707899
Project:	2017 Palmer Project Biomonitoring/160004158	**Date Collected:**	NA
LCS Matrix:	Tissue	**Date Received:**	NA
		Date Extracted:	08/22/17
		Date Analyzed:	08/24/17

Standard Reference Material Summary
Total Metals

Sample Name:	Standard Reference Material	Units:	mg/Kg (ppm)
Lab Code:	KQ1711848-03SRM1	Basis:	Dry
Test Notes:	Dorm-4 Solids = 94.5%		

Source: N.R.C.C. Dorm-4

Analyte	Prep Method	Analysis Method	True Value	Result	Percent Recovery	Control Limits	Result Notes
Arsenic	PSEP Tissue	6020A	6.8	7.6	112	4.93-8.93	
Cadmium	PSEP Tissue	6020A	0.306	0.319	104	0.233 - 0.385	
Copper	PSEP Tissue	6020A	15.9	14.8	93	12.0 - 20.2	
Lead	PSEP Tissue	6020A	0.416	0.379	91	0.290 - 0.563	
Selenium	PSEP Tissue	6020A	3.56	4.12	116	2.58 - 4.68	
Zinc	PSEP Tissue	6020A	52.20	51.1	98	39.2 - 66.5	

ALS Group USA, Corp.
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QA/QC Report

Client:	Alaska Department of Fish and Game	**Service Request:**	K1707899
Project:	2017 Palmer Project Biomonitoring/160004158	**Date Collected:**	NA
LCS Matrix:	Tissue	**Date Received:**	NA
		Date Extracted:	08/22/17
		Date Analyzed:	08/24/17

Standard Reference Material Summary
Total Metals

Sample Name:	Standard Reference Material	Units:	mg/Kg (ppm)
Lab Code:	KQ1711848-04SRM2	Basis:	Dry
Test Notes:	Tort-3 Solids = 99.1%		

Source: N.R.C.C. Tort-3

Analyte	Prep Method	Analysis Method	True Value	Result	Percent Recovery	Control Limits	Result Notes
Arsenic	PSEP Tissue	6020A	59.5	70.3	118	44.6-76.0	
Cadmium	PSEP Tissue	6020A	42.3	41.7	99	32.4-52.9	
Copper	PSEP Tissue	6020A	497	432	87	380-623	
Lead	PSEP Tissue	6020A	0.225	0.205	91	0.166-0.292	
Selenium	PSEP Tissue	6020A	10.9	11.9	109	7.9-14.3	
Zinc	PSEP Tissue	6020A	136	135	99	104-170	

APPENDIX D: SEDIMENT LABORATORY REPORT

Constantine North Inc.
ATTN: Allegra Cairns
Suite 320 - 800 West Pender St.
Vancouver BC V6C 2V6

Date Received: 12-JUN-17
Report Date: 23-JUN-17 13:16 (MT)
Version: FINAL

Client Phone: 604-329-5982

Certificate of Analysis

Lab Work Order #: L1941345

Project P.O. #: NOT SUBMITTED
Job Reference:
C of C Numbers: 14-470894
Legal Site Desc:

Elwin Ko
Account Manager

ALS ENVIRONMENTAL ANALYTICAL REPORT

Grouping	Analyte	Sample ID Description Sampled Date Sampled Time Client ID	L1941345-1 Soil 09-JUN-17 14:00 LOWER GLACIER CK 1	L1941345-2 Soil 09-JUN-17 14:00 LOWER GLACIER CK 2	L1941345-3 Soil 09-JUN-17 14:00 LOWER GLACIER CK 3	L1941345-4 Soil 09-JUN-17 14:00 LOWER GLACIER CK 4	L1941345-5 Soil 09-JUN-17 14:00 LOWER GLACIER CK 5
MISC.							
Miscellaneous	Special Request		See Attached	See Attached	See Attached	See Attached	See Attached

* Please refer to the Reference Information section for an explanation of any qualifiers detected.

ALS ENVIRONMENTAL ANALYTICAL REPORT

Grouping	Analyte	Sample ID Description Sampled Date Sampled Time Client ID	L1941345-6 Soil 09-JUN-17 12:00 MIDDLE GLACIER CK 1	L1941345-7 Soil 09-JUN-17 12:00 MIDDLE GLACIER CK 2	L1941345-8 Soil 09-JUN-17 12:00 MIDDLE GLACIER CK 3	L1941345-9 Soil 09-JUN-17 12:00 MIDDLE GLACIER CK 4	L1941345-10 Soil 09-JUN-17 12:00 MIDDLE GLACIER CK 5
MISC.							
Miscellaneous	Special Request		See Attached	See Attached	See Attached	See Attached	See Attached

* Please refer to the Reference Information section for an explanation of any qualifiers detected.

ALS ENVIRONMENTAL ANALYTICAL REPORT

Grouping	Analyte	L1941345-1 Soil 09-JUN-17 14:00 LOWER GLACIER CK 1	L1941345-2 Soil 09-JUN-17 14:00 LOWER GLACIER CK 2	L1941345-3 Soil 09-JUN-17 14:00 LOWER GLACIER CK 3	L1941345-4 Soil 09-JUN-17 14:00 LOWER GLACIER CK 4	L1941345-5 Soil 09-JUN-17 14:00 LOWER GLACIER CK 5
SOIL						
Physical Tests	Loss on Ignition @ 550 C (%)	<1	<1	1	1	1
	Moisture (%)	17.7	26.7	26.1	22.2	23.7
	pH (1:2 soil:water) (pH)	8.60	8.37	8.32	8.45	8.55
Organic / Inorganic Carbon	Total Organic Carbon (%)	<0.16	<0.17	0.20	0.25	<0.16
Inorganic Parameters	Acid Volatile Sulphides (mg/kg)	<0.20	<0.20	<0.20	<0.20	<0.20
Metals	Aluminum (Al) (mg/kg)	15500	16300	14700	14900	13300
	Antimony (Sb) (mg/kg)	0.36	0.52	0.60	0.51	0.56
	Arsenic (As) (mg/kg)	3.91	5.68	5.49	4.66	3.94
	Barium (Ba) (mg/kg)	131	183	168	165	79.9
	Beryllium (Be) (mg/kg)	0.20	0.24	0.24	0.22	0.20
	Bismuth (Bi) (mg/kg)	<0.20	<0.20	<0.20	<0.20	<0.20
	Boron (B) (mg/kg)	<5.0	<5.0	<5.0	<5.0	<5.0
	Cadmium (Cd) (mg/kg)	0.510	0.910	1.01	0.821	0.818
	Calcium (Ca) (mg/kg)	24400	28800	27300	26600	22800
	Chromium (Cr) (mg/kg)	28.6	29.2	30.7	28.9	22.5
	Cobalt (Co) (mg/kg)	22.9	30.5	25.4	27.3	26.2
	Copper (Cu) (mg/kg)	37.0	58.5	53.6	60.1	48.9
	Iron (Fe) (mg/kg)	47300	57800	51100	53600	51400
	Lead (Pb) (mg/kg)	7.90	20.6	8.49	20.1	7.03
	Lithium (Li) (mg/kg)	6.8	7.2	6.9	6.8	6.5
	Magnesium (Mg) (mg/kg)	12500	12800	11800	12000	11200
	Manganese (Mn) (mg/kg)	706	820	724	715	662
	Mercury (Hg) (mg/kg)	0.0120	0.0194	0.0204	0.0144	0.0135
	Molybdenum (Mo) (mg/kg)	1.19	1.45	2.03	1.66	4.95
	Nickel (Ni) (mg/kg)	18.5	21.5	23.5	21.0	17.0
	Phosphorus (P) (mg/kg)	981	1080	896	940	854
	Potassium (K) (mg/kg)	1260	1490	1200	1310	1280
	Selenium (Se) (mg/kg)	1.22	1.35	1.67	1.39	1.54
	Silver (Ag) (mg/kg)	0.14	0.25	0.26	0.21	0.17
	Sodium (Na) (mg/kg)	148	192	170	185	114
	Strontium (Sr) (mg/kg)	62.6	75.4	71.4	68.9	54.4
	Sulfur (S) (mg/kg)	3900	6200	4700	5600	6200
	Thallium (Tl) (mg/kg)	0.064	0.098	0.079	0.083	0.067
	Tin (Sn) (mg/kg)	<2.0	<2.0	<2.0	<2.0	<2.0
	Titanium (Ti) (mg/kg)	1760	1980	1750	1790	1090
	Tungsten (W) (mg/kg)	<0.50	<0.50	<0.50	<0.50	<0.50

* Please refer to the Reference Information section for an explanation of any qualifiers detected.

ALS ENVIRONMENTAL ANALYTICAL REPORT

Grouping	Analyte	L1941345-6 Soil 09-JUN-17 12:00 MIDDLE GLACIER CK 1	L1941345-7 Soil 09-JUN-17 12:00 MIDDLE GLACIER CK 2	L1941345-8 Soil 09-JUN-17 12:00 MIDDLE GLACIER CK 3	L1941345-9 Soil 09-JUN-17 12:00 MIDDLE GLACIER CK 4	L1941345-10 Soil 09-JUN-17 12:00 MIDDLE GLACIER CK 5
Sample ID						
Description						
Sampled Date						
Sampled Time						
Client ID						
SOIL						
Physical Tests	Loss on Ignition @ 550 C (%)	1	1	1	2	1
	Moisture (%)	17.5	19.7	23.9	25.2	25.3
	pH (1:2 soil:water) (pH)	8.59	8.69	8.50	8.47	8.49
Organic / Inorganic Carbon	Total Organic Carbon (%)	<0.16	<0.17	<0.19	0.27	<0.19
Inorganic Parameters	Acid Volatile Sulphides (mg/kg)	<0.20	<0.20	0.30	<0.20	<0.20
Metals	Aluminum (Al) (mg/kg)	15700	13800	14700	16000	15600
	Antimony (Sb) (mg/kg)	0.33	0.39	0.51	0.49	0.46
	Arsenic (As) (mg/kg)	3.68	4.76	4.88	4.47	4.73
	Barium (Ba) (mg/kg)	158	100	162	196	194
	Beryllium (Be) (mg/kg)	0.23	0.22	0.22	0.22	0.22
	Bismuth (Bi) (mg/kg)	<0.20	<0.20	<0.20	<0.20	<0.20
	Boron (B) (mg/kg)	<5.0	<5.0	<5.0	<5.0	<5.0
	Cadmium (Cd) (mg/kg)	0.758	0.902	1.11	1.14	1.07
	Calcium (Ca) (mg/kg)	24400	23200	28200	32100	28800
	Chromium (Cr) (mg/kg)	27.6	22.7	33.1	33.0	33.0
	Cobalt (Co) (mg/kg)	23.4	27.9	24.9	23.0	24.9
	Copper (Cu) (mg/kg)	48.1	45.5	75.6	55.7	62.1
	Iron (Fe) (mg/kg)	49400	53400	54500	47500	50800
	Lead (Pb) (mg/kg)	8.67	14.8	12.5	12.3	11.9
	Lithium (Li) (mg/kg)	7.3	6.7	7.2	7.4	7.2
	Magnesium (Mg) (mg/kg)	13000	11800	12100	13100	12600
	Manganese (Mn) (mg/kg)	755	691	711	867	794
	Mercury (Hg) (mg/kg)	0.0094	0.0179	0.0161	0.0210	0.0181
	Molybdenum (Mo) (mg/kg)	1.20	1.00	2.76	2.20	2.19
	Nickel (Ni) (mg/kg)	19.2	16.4	26.0	24.6	24.7
	Phosphorus (P) (mg/kg)	967	879	912	1080	1080
	Potassium (K) (mg/kg)	1410	1490	1240	1320	1360
	Selenium (Se) (mg/kg)	0.90	0.93	2.05	1.30	1.42
	Silver (Ag) (mg/kg)	0.14	0.15	0.33	0.18	0.21
	Sodium (Na) (mg/kg)	178	140	148	158	161
	Strontium (Sr) (mg/kg)	64.4	54.3	71.2	79.6	69.9
	Sulfur (S) (mg/kg)	2800	6700	4800	2900	3200
	Thallium (Tl) (mg/kg)	0.083	0.077	0.084	0.083	0.093
	Tin (Sn) (mg/kg)	<2.0	<2.0	<2.0	<2.0	<2.0
	Titanium (Ti) (mg/kg)	1520	1390	1590	1680	1420
	Tungsten (W) (mg/kg)	<0.50	<0.50	<0.50	<0.50	<0.50

* Please refer to the Reference Information section for an explanation of any qualifiers detected.

ALS ENVIRONMENTAL ANALYTICAL REPORT

Grouping	Analyte	L1941345-1 Soil 09-JUN-17 14:00 LOWER GLACIER CK 1	L1941345-2 Soil 09-JUN-17 14:00 LOWER GLACIER CK 2	L1941345-3 Soil 09-JUN-17 14:00 LOWER GLACIER CK 3	L1941345-4 Soil 09-JUN-17 14:00 LOWER GLACIER CK 4	L1941345-5 Soil 09-JUN-17 14:00 LOWER GLACIER CK 5
Sample ID **Description** **Sampled Date** **Sampled Time** **Client ID**						
SOIL						
Metals	Uranium (U) (mg/kg)	0.274	0.339	0.426	0.344	0.277
	Vanadium (V) (mg/kg)	112	125	116	122	108
	Zinc (Zn) (mg/kg)	133	202	186	173	186
	Zirconium (Zr) (mg/kg)	1.7	2.2	1.6	2.1	1.2

* Please refer to the Reference Information section for an explanation of any qualifiers detected.

ALS ENVIRONMENTAL ANALYTICAL REPORT

	Sample ID	L1941345-6	L1941345-7	L1941345-8	L1941345-9	L1941345-10
	Description	Soil	Soil	Soil	Soil	Soil
	Sampled Date	09-JUN-17	09-JUN-17	09-JUN-17	09-JUN-17	09-JUN-17
	Sampled Time	12:00	12:00	12:00	12:00	12:00
	Client ID	MIDDLE GLACIER CK 1	MIDDLE GLACIER CK 2	MIDDLE GLACIER CK 3	MIDDLE GLACIER CK 4	MIDDLE GLACIER CK 5
Grouping	**Analyte**					
SOIL						
Metals	Uranium (U) (mg/kg)	0.321	0.224	0.487	0.377	0.363
	Vanadium (V) (mg/kg)	115	116	120	107	111
	Zinc (Zn) (mg/kg)	190	203	189	205	199
	Zirconium (Zr) (mg/kg)	1.5	1.5	1.8	1.6	1.4

* Please refer to the Reference Information section for an explanation of any qualifiers detected.

Reference Information

QC Samples with Qualifiers & Comments:

QC Type Description	Parameter	Qualifier	Applies to Sample Number(s)
Duplicate	Copper (Cu)	DUP-H	L1941345-1, -10, -2, -9
Duplicate	Molybdenum (Mo)	DUP-H	L1941345-1, -10, -2, -9

Qualifiers for Individual Parameters Listed:

Qualifier	Description
DUP-H	Duplicate results outside ALS DQO, due to sample heterogeneity.

Test Method References:

ALS Test Code	Matrix	Test Description	Method Reference**
C-TIC-PCT-SK	Soil	Total Inorganic Carbon in Soil	CSSS (2008) P216-217
A known quantity of acetic acid is consumed by reaction with carbonates in the soil. The pH of the resulting solution is measured and compared against a standard curve relating pH to weight of carbonate.			
C-TOC-CALC-SK	Soil	Total Organic Carbon Calculation	CSSS (2008) 21.2
Total Organic Carbon (TOC) is calculated by the difference between total carbon (TC) and total inorganic carbon. (TIC)			
C-TOT-LECO-SK	Soil	Total Carbon by combustion method	CSSS (2008) 21.2
The sample is ignited in a combustion analyzer where carbon in the reduced CO2 gas is determined using a thermal conductivity detector.			
HG-200.2-CVAF-VA	Soil	Mercury in Soil by CVAFS	EPA 200.2/1631E (mod)
Soil samples are digested with nitric and hydrochloric acids, followed by analysis by CVAFS.			
IC-CACO3-CALC-SK	Soil	Inorganic Carbon as CaCO3 Equivalent	Calculation
LOI-550-SK	Soil	Loss on Ignition @ 550 C	CSSS (1993) p.461-462
The sample is air dried at 40C overnight, then ground to < 2mm in particle size using a flail grinder. A portion of the dried and ground sample is dried at 105C overnight, then ignited at 550C for 16-20 hours. Loss on ignition at 550C is reported on a dry sample basis.			
Loss on Ignition at 550C can be used as an estimation of Organic Matter (CSSS 2008)			
MET-200.2-CCMS-VA	Soil	Metals in Soil by CRC ICPMS	EPA 200.2/6020A (mod)
This method uses a heated strong acid digestion with HNO3 and HCl and is intended to liberate metals that may be environmentally available. Silicate minerals are not solubilized. Dependent on sample matrix, some metals may be only partially recovered, including Al, Ba, Be, Cr, Sr, Ti, Tl, V, W, and Zr. Volatile forms of sulfur (including sulfide) may not be captured, as they may be lost during sampling, storage, or digestion. Analysis is by Collision/Reaction Cell ICPMS.			
MOISTURE-VA	Soil	Moisture content	CWS for PHC in Soil - Tier 1
This analysis is carried out gravimetrically by drying the sample at 105 C for a minimum of six hours.			
PH-1:2-VA	Soil	pH in Soil (1:2 Soil:Water Extraction)	BC WLAP METHOD: PH, ELECTROMETRIC, SOIL
This analysis is carried out in accordance with procedures described in the pH, Electrometric in Soil and Sediment method - Section B Physical/Inorganic and Misc. Constituents, BC Environmental Laboratory Manual 2007. The procedure involves mixing the dried (at <60°C) and sieved (No. 10 / 2mm) sample with deionized/distilled water at a 1:2 ratio of sediment to water. The pH of the solution is then measured using a standard pH probe.			
SPECIAL REQUEST-SK	Misc.	Special Request Sask Lab	SEE SUBLET LAB RESULTS
SULPHIDE-WT	Soil	Sulphide, Acid Volatile	APHA 4500S2J
This analysis is carried out in accordance with the method described in APHA 4500 S2-J. Hydrochloric acid is added to sediment samples within a purge and trap system. The evolved hydrogen sulphide (H2S) is carried into a basic solution by inert gas. The acid volatile sulfide is then determined colourimetrically.			

** ALS test methods may incorporate modifications from specified reference methods to improve performance.

The last two letters of the above test code(s) indicate the laboratory that performed analytical analysis for that test. Refer to the list below:

Laboratory Definition Code	Laboratory Location
SK	ALS ENVIRONMENTAL - SASKATOON, SASKATCHEWAN, CANADA
WT	ALS ENVIRONMENTAL - WATERLOO, ONTARIO, CANADA
VA	ALS ENVIRONMENTAL - VANCOUVER, BRITISH COLUMBIA, CANADA

Chain of Custody Numbers:

Reference Information

14-470894

GLOSSARY OF REPORT TERMS

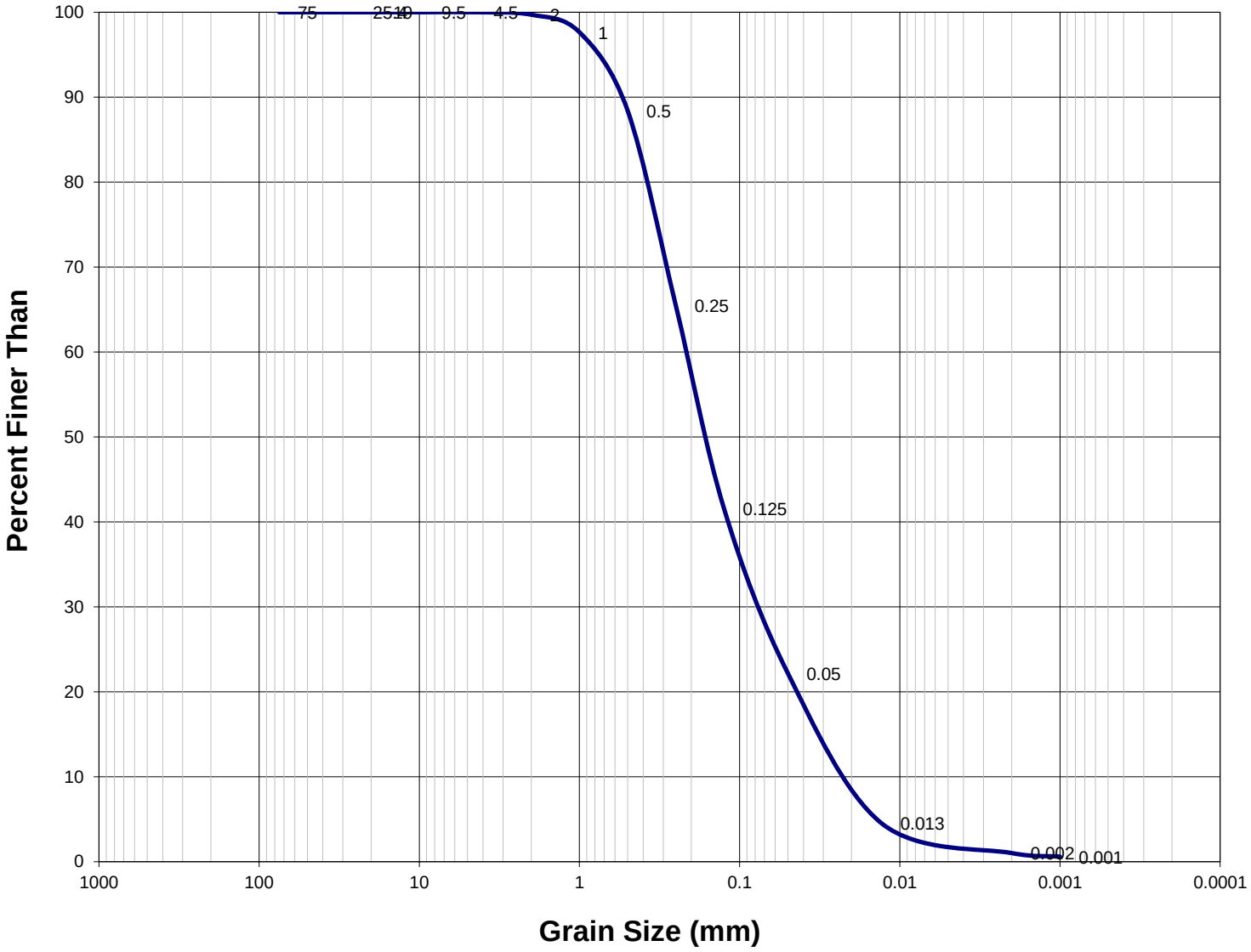
Surrogate - A compound that is similar in behaviour to target analyte(s), but that does not occur naturally in environmental samples. For applicable tests, surrogates are added to samples prior to analysis as a check on recovery.
mg/kg - milligrams per kilogram based on dry weight of sample.
mg/kg wwt - milligrams per kilogram based on wet weight of sample.
mg/kg lwt - milligrams per kilogram based on lipid-adjusted weight of sample.
mg/L - milligrams per litre.
< - Less than.
D.L. - The reported Detection Limit, also known as the Limit of Reporting (LOR).
N/A - Result not available. Refer to qualifier code and definition for explanation.

Test results reported relate only to the samples as received by the laboratory.
UNLESS OTHERWISE STATED, ALL SAMPLES WERE RECEIVED IN ACCEPTABLE CONDITION.
Analytical results in unsigned test reports with the DRAFT watermark are subject to change, pending final QC review.

ALS Laboratory Group
ANALYTICAL CHEMISTRY & TESTING SERVICES
Environmental Division
819-58th Street, Saskatoon, SK S7K 6X5

Client Name: Constantine North Inc.
Project:
Sample ID: LOWER GLACIER CK 1
Lab ID: L1941345-1

Particle Size Distribution Curve



Particle Size Distribution

Size Class	Range (mm)	Wt. (%)
Gravel	> 75	0.00
Gravel	75 - 19	0.00
Gravel	19 - 9.5	0.00
Gravel, Medium	9.5 - 4.75	0.00
Gravel, Fine	4.75 - 2	0.29
Sand, Very Coarse	2 - 0.85	4.83
Sand, Coarse	0.85 - 0.425	13.35

Particle Size Distribution

Size Class	Range (mm)	Wt. (%)
Sand, Medium	0.425 - 0.25	16.08
Sand, Fine	0.25 - 0.106	28.81
Sand, Very Fine	0.106 - 0.075	8.00
Silt and Clay	0.075 - 0.074	0.26
Silt and Clay	0.074 - 0.005	26.41
Silt and Clay	0.005 - 0.001	1.28
Clay	<0.001	0.70

Method Reference: Can. Soc. Soil Sci. (1993) Method 47.2

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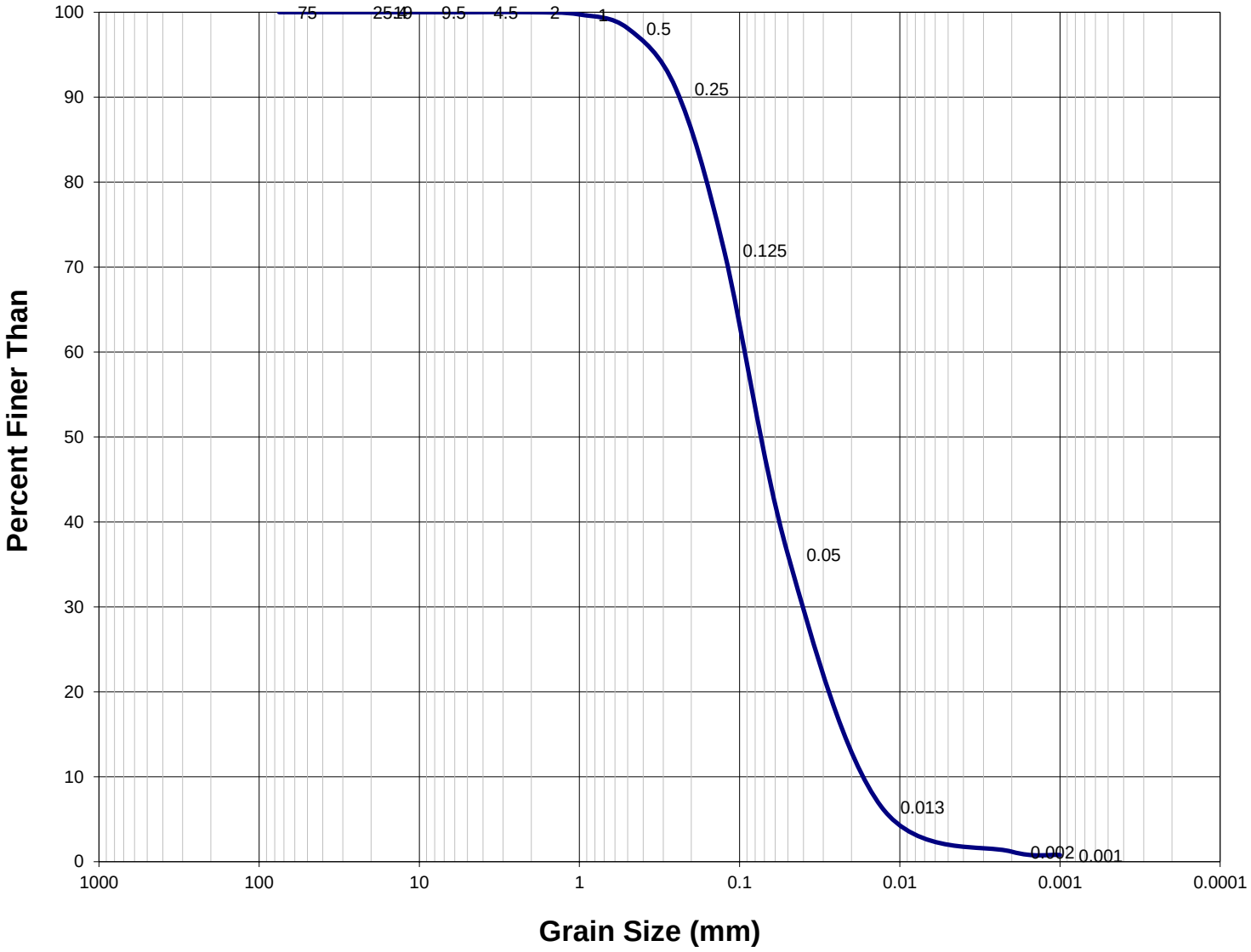
Environmental Division
819-58th Street, Saskatoon, SK S7K 6X5

Client Name: Constantine North Inc.
Project:
Sample ID: MIDDLE GLACIER CK 5
Lab ID: L1941345-10

Particle Size Distribution Curve



Particle Size Distribution

Size Class	Range (mm)	Wt. (%)
Gravel	> 75	0.00
Gravel	75 - 19	0.00
Gravel	19 - 9.5	0.00
Gravel, Medium	9.5 - 4.75	0.00
Gravel, Fine	4.75 - 2	0.00
Sand, Very Coarse	2 - 0.85	0.75
Sand, Coarse	0.85 - 0.425	3.27

Particle Size Distribution

Size Class	Range (mm)	Wt. (%)
Sand, Medium	0.425 - 0.25	4.98
Sand, Fine	0.25 - 0.106	28.10
Sand, Very Fine	0.106 - 0.075	14.79
Silt and Clay	0.075 - 0.074	0.48
Silt and Clay	0.074 - 0.005	45.03
Silt and Clay	0.005 - 0.001	1.91
Clay	<0.001	0.71

Method Reference: Can. Soc. Soil Sci. (1993) Method 47.2

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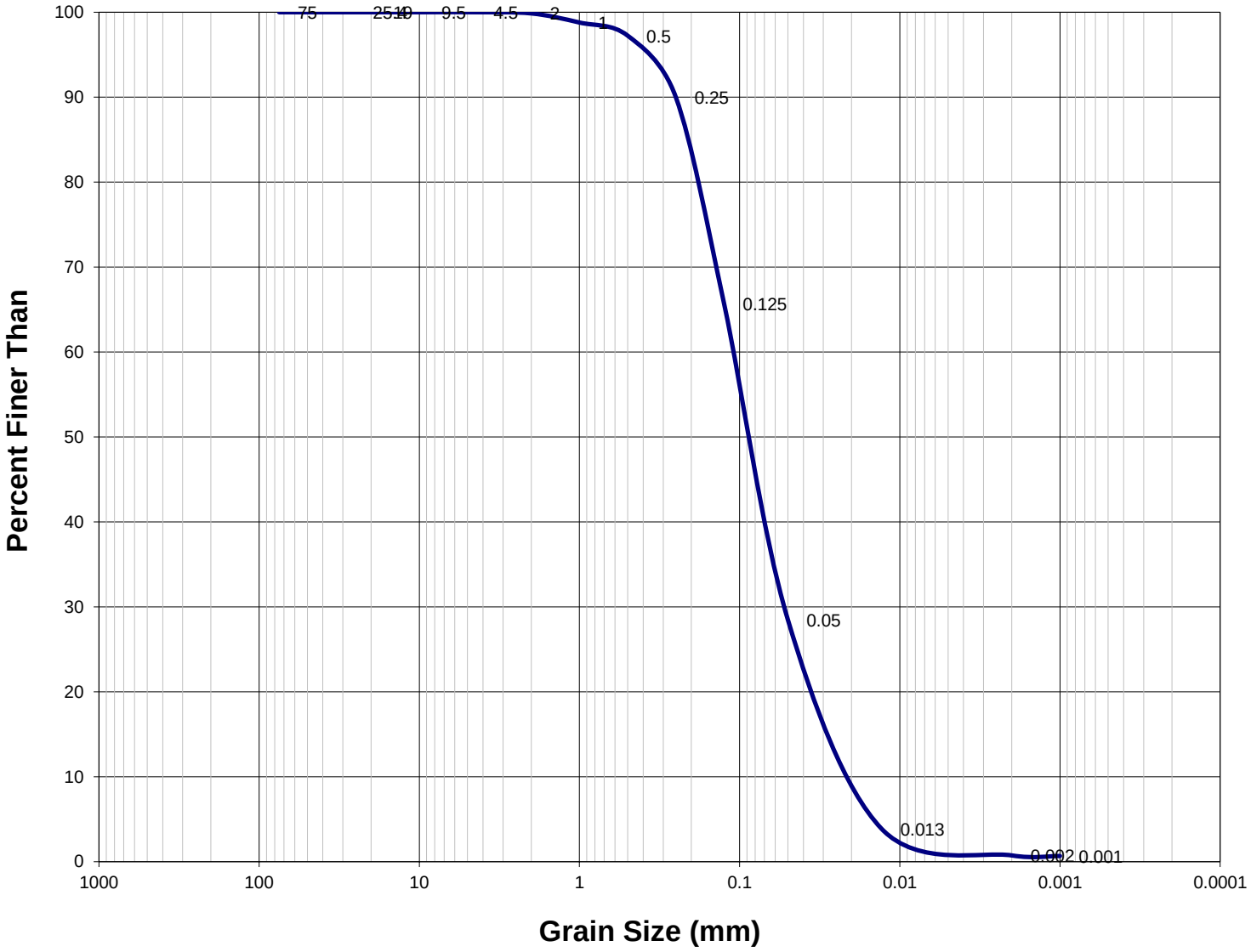
Environmental Division
819-58th Street, Saskatoon, SK S7K 6X5

Client Name: Constantine North Inc.
Project:
Sample ID: LOWER GLACIER CK 2
Lab ID: L1941345-2

Particle Size Distribution Curve



Particle Size Distribution

Size Class	Range (mm)	Wt. (%)
Gravel	> 75	0.00
Gravel	75 - 19	0.00
Gravel	19 - 9.5	0.00
Gravel, Medium	9.5 - 4.75	0.00
Gravel, Fine	4.75 - 2	0.14
Sand, Very Coarse	2 - 0.85	1.54
Sand, Coarse	0.85 - 0.425	3.26

Particle Size Distribution

Size Class	Range (mm)	Wt. (%)
Sand, Medium	0.425 - 0.25	5.08
Sand, Fine	0.25 - 0.106	33.72
Sand, Very Fine	0.106 - 0.075	15.37
Silt and Clay	0.075 - 0.074	0.50
Silt and Clay	0.074 - 0.005	38.81
Silt and Clay	0.005 - 0.001	1.14
Clay	<0.001	0.46

Method Reference: Can. Soc. Soil Sci. (1993) Method 47.2

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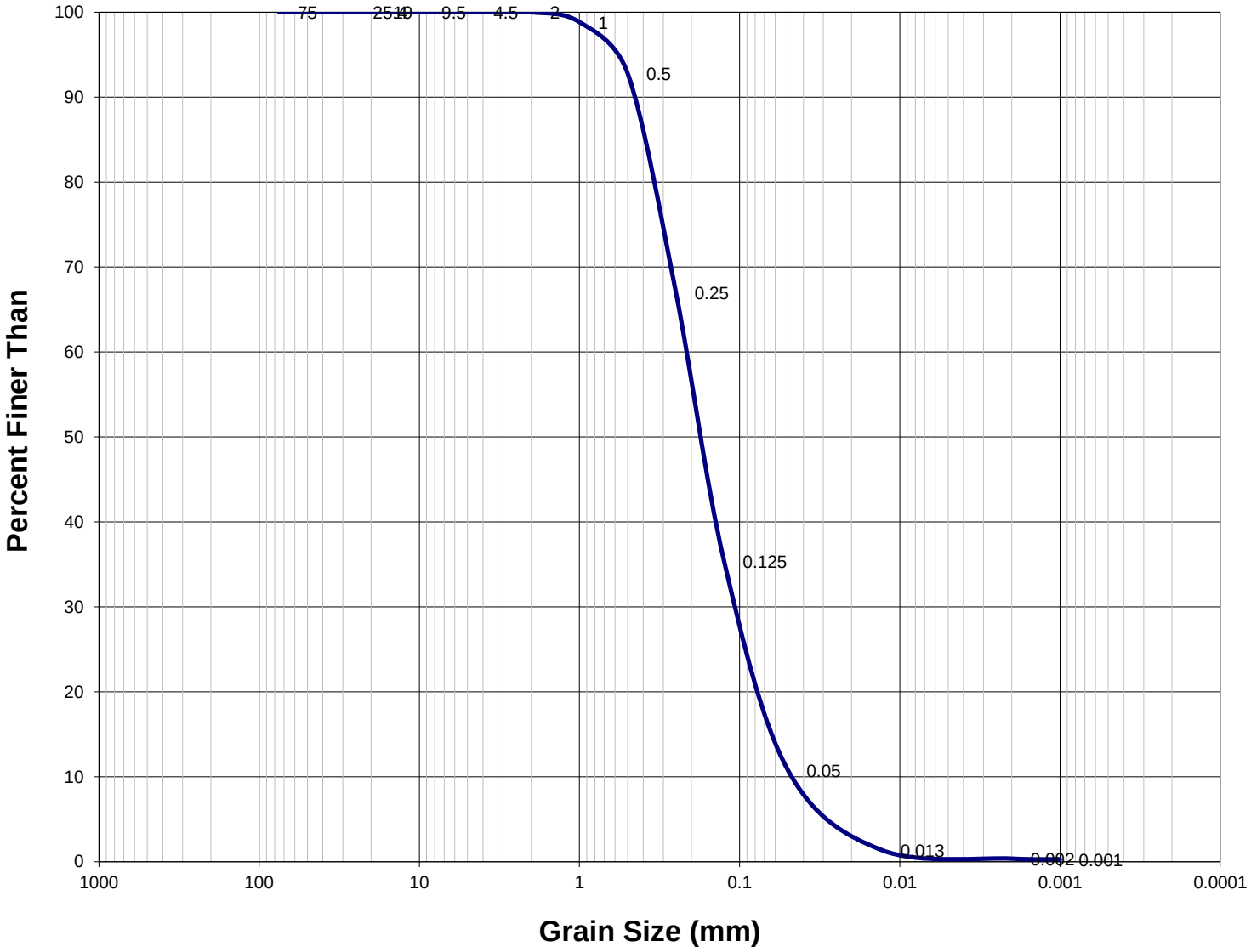
Client Name: Constantine North Inc.
Project:
Sample ID: LOWER GLACIER CK 3
Lab ID: L1941345-3

Particle Size Distribution Curve



Particle Size Distribution

Size Class	Range (mm)	Wt. (%)
Gravel	> 75	0.00
Gravel	75 - 19	0.00
Gravel	19 - 9.5	0.00
Gravel, Medium	9.5 - 4.75	0.00
Gravel, Fine	4.75 - 2	0.00
Sand, Very Coarse	2 - 0.85	2.97
Sand, Coarse	0.85 - 0.425	11.96

Particle Size Distribution

Size Class	Range (mm)	Wt. (%)
Sand, Medium	0.425 - 0.25	18.05
Sand, Fine	0.25 - 0.106	37.87
Sand, Very Fine	0.106 - 0.075	10.16
Silt and Clay	0.075 - 0.074	0.33
Silt and Clay	0.074 - 0.005	18.02
Silt and Clay	0.005 - 0.001	0.37
Clay	<0.001	0.28

Method Reference: Can. Soc. Soil Sci. (1993) Method 47.2

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Environmental Division
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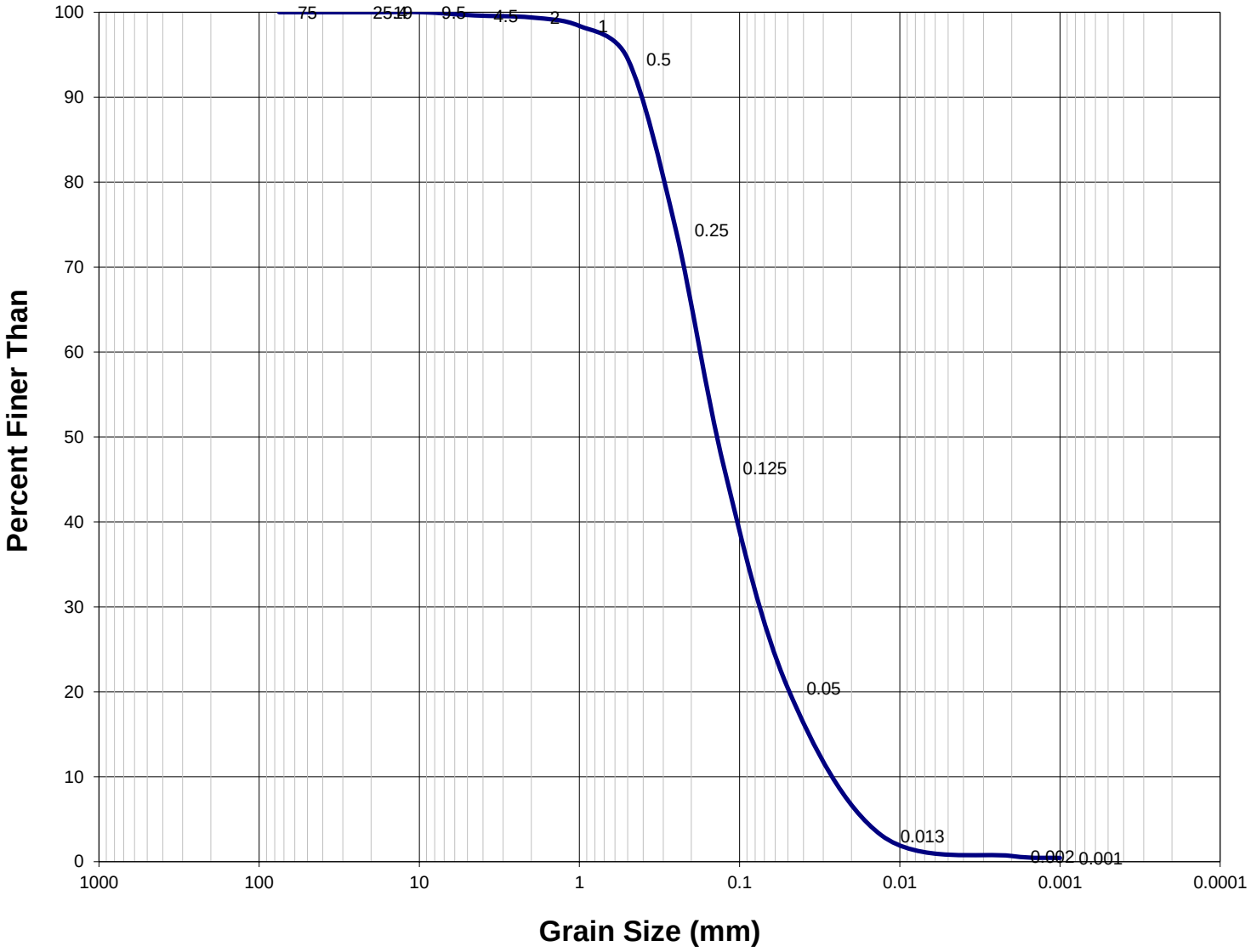
Client Name: Constantine North Inc.
Project:
Sample ID: LOWER GLACIER CK 4
Lab ID: L1941345-4

Particle Size Distribution Curve



Particle Size Distribution

Size Class	Range (mm)	Wt. (%)
Gravel	> 75	0.00
Gravel	75 - 19	0.00
Gravel	19 - 9.5	0.00
Gravel, Medium	9.5 - 4.75	0.36
Gravel, Fine	4.75 - 2	0.26
Sand, Very Coarse	2 - 0.85	2.16
Sand, Coarse	0.85 - 0.425	8.75

Particle Size Distribution

Size Class	Range (mm)	Wt. (%)
Sand, Medium	0.425 - 0.25	14.11
Sand, Fine	0.25 - 0.106	34.57
Sand, Very Fine	0.106 - 0.075	10.72
Silt and Clay	0.075 - 0.074	0.35
Silt and Clay	0.074 - 0.005	27.40
Silt and Clay	0.005 - 0.001	0.88
Clay	<0.001	0.45

Method Reference: Can. Soc. Soil Sci. (1993) Method 47.2

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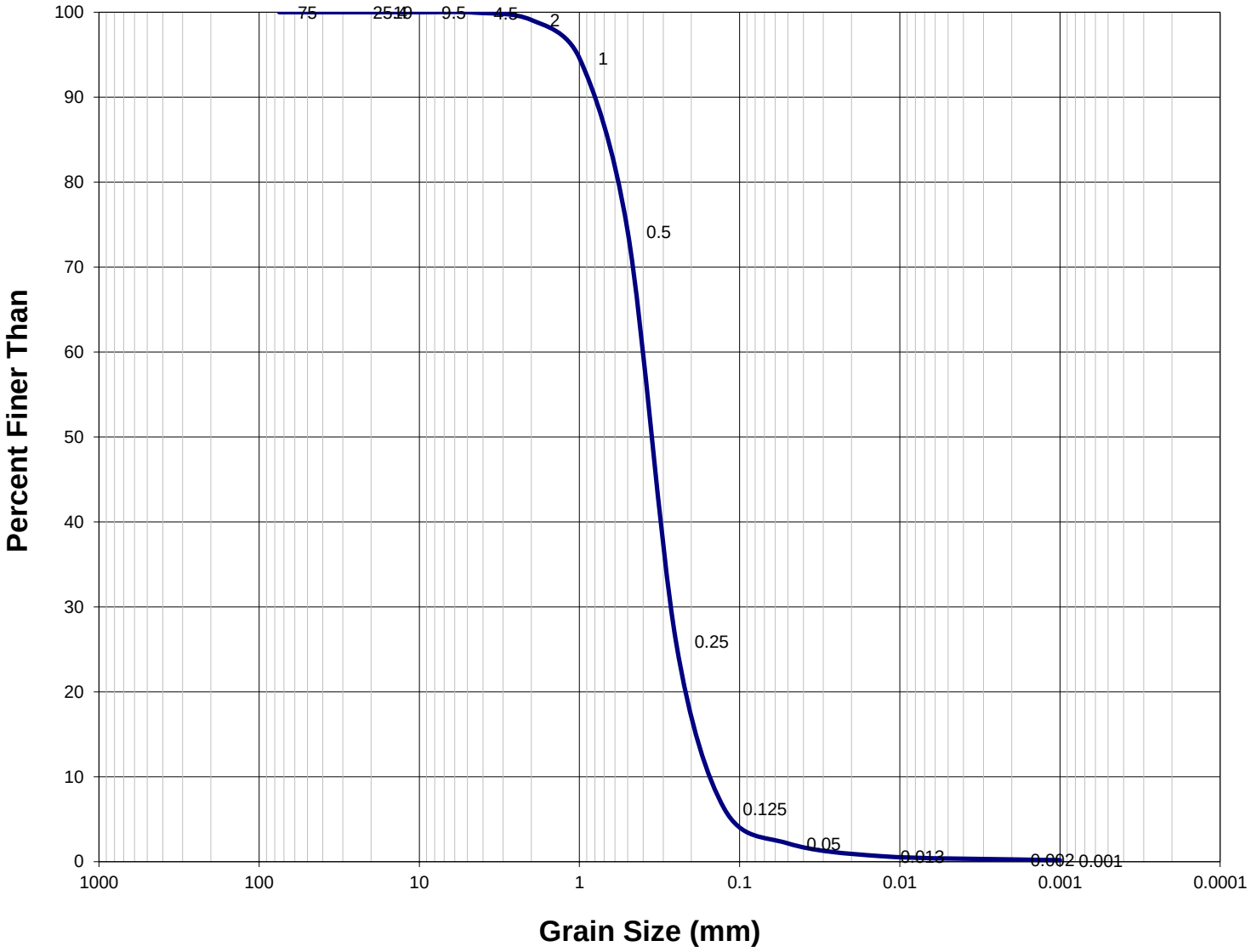
819-58th Street, Saskatoon, SK S7K 6X5

Client Name: Constantine North Inc.
Project:
Sample ID: LOWER GLACIER CK 5
Lab ID: L1941345-5

Particle Size Distribution Curve



Particle Size Distribution

Size Class	Range (mm)	Wt. (%)
Gravel	> 75	0.00
Gravel	75 - 19	0.00
Gravel	19 - 9.5	0.00
Gravel, Medium	9.5 - 4.75	0.05
Gravel, Fine	4.75 - 2	0.86
Sand, Very Coarse	2 - 0.85	10.62
Sand, Coarse	0.85 - 0.425	28.73

Particle Size Distribution

Size Class	Range (mm)	Wt. (%)
Sand, Medium	0.425 - 0.25	33.77
Sand, Fine	0.25 - 0.106	20.74
Sand, Very Fine	0.106 - 0.075	1.71
Silt and Clay	0.075 - 0.074	0.06
Silt and Clay	0.074 - 0.005	3.10
Silt and Clay	0.005 - 0.001	0.14
Clay	<0.001	0.24

Method Reference: Can. Soc. Soil Sci. (1993) Method 47.2

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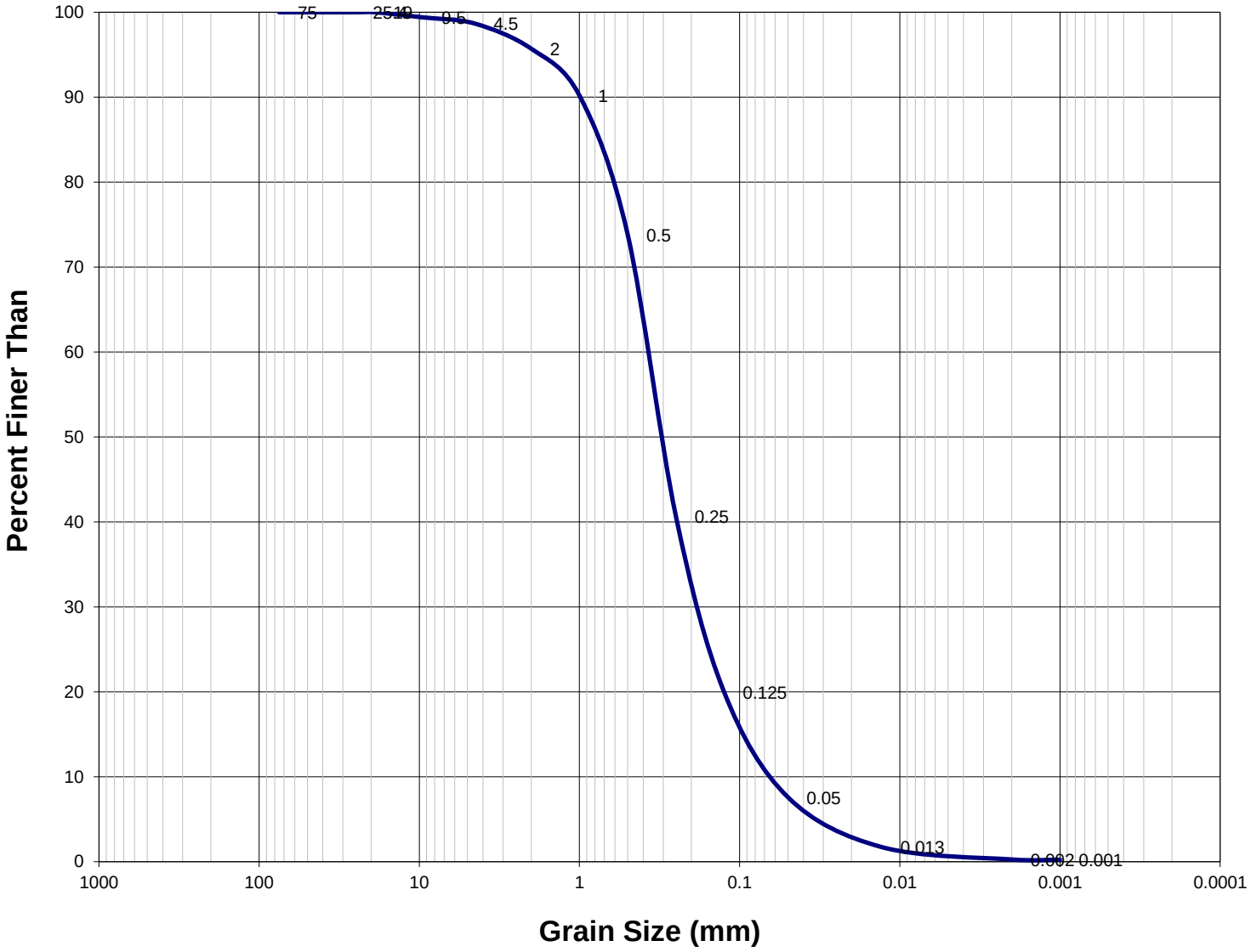
Environmental Division
819-58th Street, Saskatoon, SK S7K 6X5

Client Name: Constantine North Inc.
Project:
Sample ID: MIDDLE GLACIER CK 1
Lab ID: L1941345-6

Particle Size Distribution Curve



Particle Size Distribution

Size Class	Range (mm)	Wt. (%)
Gravel	> 75	0.00
Gravel	75 - 19	0.00
Gravel	19 - 9.5	0.61
Gravel, Medium	9.5 - 4.75	0.69
Gravel, Fine	4.75 - 2	3.00
Sand, Very Coarse	2 - 0.85	10.41
Sand, Coarse	0.85 - 0.425	21.39

Particle Size Distribution

Size Class	Range (mm)	Wt. (%)
Sand, Medium	0.425 - 0.25	23.21
Sand, Fine	0.25 - 0.106	23.84
Sand, Very Fine	0.106 - 0.075	5.12
Silt and Clay	0.075 - 0.074	0.17
Silt and Clay	0.074 - 0.005	10.90
Silt and Clay	0.005 - 0.001	0.53
Clay	<0.001	0.13

Method Reference: Can. Soc. Soil Sci. (1993) Method 47.2

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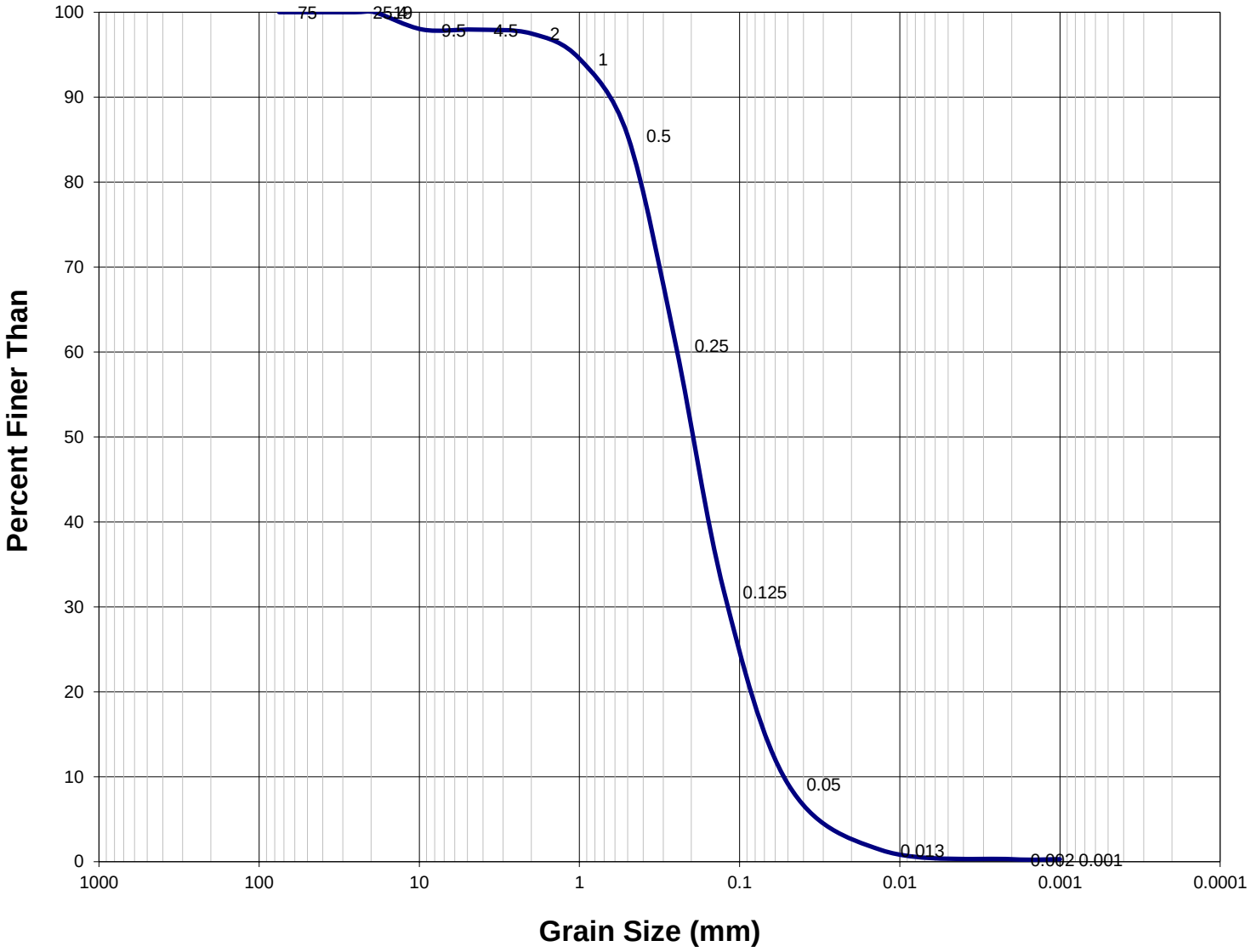
Environmental Division
819-58th Street, Saskatoon, SK S7K 6X5

Client Name: Constantine North Inc.
Project:
Sample ID: MIDDLE GLACIER CK 2
Lab ID: L1941345-7

Particle Size Distribution Curve



Particle Size Distribution

Size Class	Range (mm)	Wt. (%)
Gravel	> 75	0.00
Gravel	75 - 19	0.00
Gravel	19 - 9.5	2.05
Gravel, Medium	9.5 - 4.75	0.00
Gravel, Fine	4.75 - 2	0.46
Sand, Very Coarse	2 - 0.85	5.68
Sand, Coarse	0.85 - 0.425	13.75

Particle Size Distribution

Size Class	Range (mm)	Wt. (%)
Sand, Medium	0.425 - 0.25	17.28
Sand, Fine	0.25 - 0.106	34.75
Sand, Very Fine	0.106 - 0.075	9.33
Silt and Clay	0.075 - 0.074	0.30
Silt and Clay	0.074 - 0.005	15.82
Silt and Clay	0.005 - 0.001	0.39
Clay	<0.001	0.20

Method Reference: Can. Soc. Soil Sci. (1993) Method 47.2

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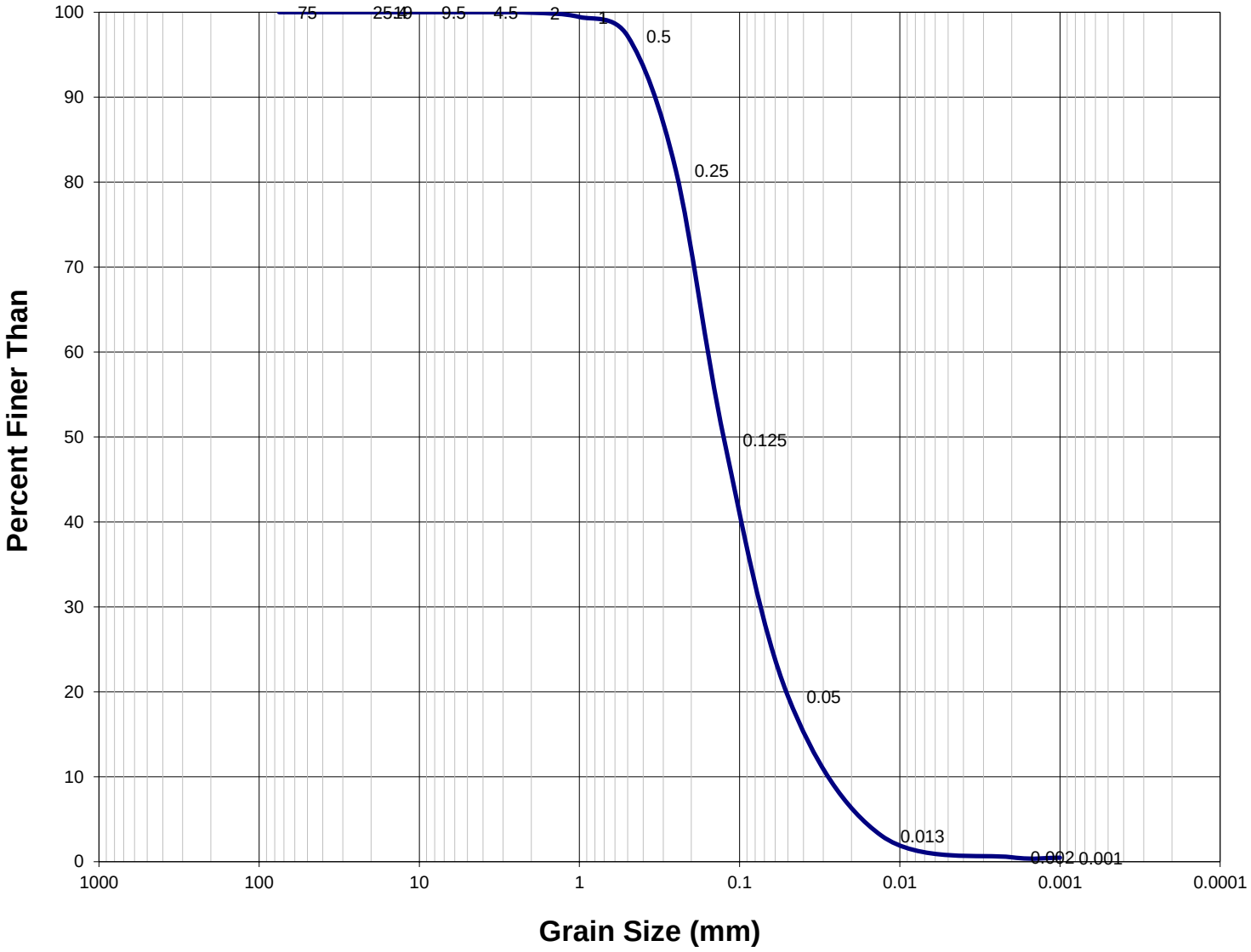
Environmental Division
819-58th Street, Saskatoon, SK S7K 6X5

Client Name: Constantine North Inc.
Project:
Sample ID: MIDDLE GLACIER CK 3
Lab ID: L1941345-8

Particle Size Distribution Curve



Particle Size Distribution

Size Class	Range (mm)	Wt. (%)
Gravel	> 75	0.00
Gravel	75 - 19	0.00
Gravel	19 - 9.5	0.00
Gravel, Medium	9.5 - 4.75	0.00
Gravel, Fine	4.75 - 2	0.05
Sand, Very Coarse	2 - 0.85	1.18
Sand, Coarse	0.85 - 0.425	6.32

Particle Size Distribution

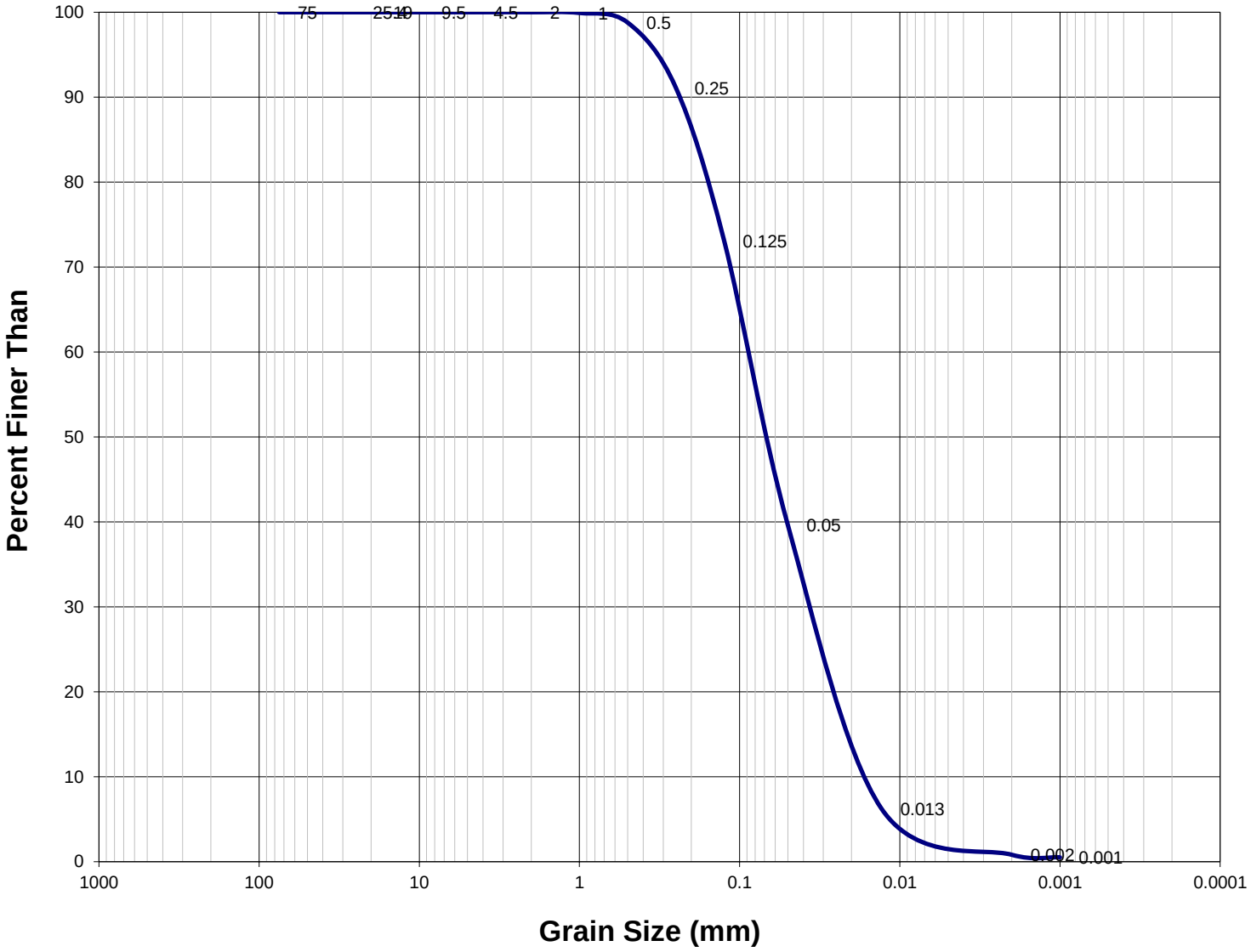
Size Class	Range (mm)	Wt. (%)
Sand, Medium	0.425 - 0.25	11.07
Sand, Fine	0.25 - 0.106	39.31
Sand, Very Fine	0.106 - 0.075	12.48
Silt and Clay	0.075 - 0.074	0.40
Silt and Clay	0.074 - 0.005	27.97
Silt and Clay	0.005 - 0.001	0.92
Clay	<0.001	0.29

Method Reference: Can. Soc. Soil Sci. (1993) Method 47.2

ALS Laboratory Group
ANALYTICAL CHEMISTRY & TESTING SERVICES
Environmental Division
819-58th Street, Saskatoon, SK S7K 6X5

Client Name: Constantine North Inc.
Project:
Sample ID: MIDDLE GLACIER CK 4
Lab ID: L1941345-9

Particle Size Distribution Curve



Particle Size Distribution

Size Class	Range (mm)	Wt. (%)
Gravel	> 75	0.00
Gravel	75 - 19	0.00
Gravel	19 - 9.5	0.00
Gravel, Medium	9.5 - 4.75	0.00
Gravel, Fine	4.75 - 2	0.00
Sand, Very Coarse	2 - 0.85	0.42
Sand, Coarse	0.85 - 0.425	3.10

Particle Size Distribution

Size Class	Range (mm)	Wt. (%)
Sand, Medium	0.425 - 0.25	5.37
Sand, Fine	0.25 - 0.106	26.46
Sand, Very Fine	0.106 - 0.075	13.84
Silt and Clay	0.075 - 0.074	0.45
Silt and Clay	0.074 - 0.005	48.06
Silt and Clay	0.005 - 0.001	1.97
Clay	<0.001	0.33

Method Reference: Can. Soc. Soil Sci. (1993) Method 47.2

Chain of Custody (COC) / Analytical Request Form

ALS Environmental
www.alsglobal.com

Canada Toll Free: 1 800 668 9878

L1941345-COFC

COC Number: 14 - 470894

Page 1 of 1

Report To		Report Format		Turnaround Time (TAT) Below (Rush Turnaround Time (TAT) is not available for all tests)	
Company:	ADFG Habitat	Select Report Format:	☑ PDF ☑ EXCEL ☐ EDD (DIGITAL)	R ☑	Regular (Standard TAT if received by 3pm)
Contact:	Kate Kanouse	Quality Control (QC) Report with Report	☑ Yes ☐ No	P ☐	Priority (2-4 business days if received by 3pm)
Address:	PO Box 110024 + 1000 A Juneau, AK 99811-0024	☐ Criteria on Report - provide details below if box checked		E ☐	Emergency (1-2 business days if received by 3pm)
Phone:	(907) 465-4290	Select Distribution:	☑ EMAIL ☐ MAIL ☐ FAX	E2 ☐	Same day or weekend emergency if received by 10am – contact ALS for surcharge.
		Email 1 or Fax	kate.kanouse@alaska.gov	Specify Date Required for E2,E or P:	
		Email 2	allegra@constantinemetals.com		

Invoice To		Invoice Distribution	
	Same as Report To ☐ Yes ☑ No	Select Invoice Distribution:	☑ EMAIL ☐ MAIL ☐ FAX
	Copy of Invoice with Report ☐ Yes ☑ No	Email 1 or Fax	allegra@constantinemetals.com
Company:	Constantine Metal Resources	Email 2	aris@constantinemetals.com
Contact:		Oil and Gas Required Fields (client use)	

Project Information			
ALS Quote #:	Q62329	Approver ID:	Cost Center:
Job #:		GL Account:	Routing Code:
PO / AFE:		Activity Code:	
LSD:		Location:	
ALS Lab Work Order # (lab use only)		ALS Contact:	Sampler:

Analysis Request — Indicate Filtered (F), Preserved (P) or Filtered and Preserved (F/P) below

per quote

ALS Sample # (lab use only)	Sample Identification and/or Coordinates (This description will appear on the report)	Date (dd-mmm-yy)	Time (hh:mm)	Sample Type	Number of Containers
	Lower Glacier Ck 1	6/9/17	1400	soil	3
	2				3
	3				3
	4				3
	5				3
	Middle Glacier Ck 1	6/9/17	1200	soil	3
	2				3
	3				3
	4				3
	5				3

Drinking Water (DW) Samples[1] (client use)	Special Instructions / Specify Criteria to add on report (client Use)
Are samples taken from a Regulated DW System? ☐ Yes ☐ No	
Are samples for human drinking water use? ☐ Yes ☐ No	

SAMPLE CONDITION AS RECEIVED (lab use only)

Frozen	☐	SIF Observations	Yes ☐	No ☐	
Ice packs	Yes ☑	No ☐	Custody seal Intact	Yes ☐	No ☐
Cooling Initiated	☑				

INITIAL COOLER TEMPERATURES °C		FINAL COOLER TEMPERATURES °C		
8.0				5°C

SHIPMENT RELEASE (client use)			INITIAL SHIPMENT RECEPTION (lab use only)			FINAL SHIPMENT RECEPTION (lab use only)		
Released by:	Date:	Time:	Received by:	Date:	Time:	Received by:	Date:	Time:
Kate Kanouse	6/9/17	1500	LHF	12 June 2017	13:30	Icky	June 14	4:15PM

REFER TO BACK PAGE FOR ALS LOCATIONS AND SAMPLING INFORMATION

WHITE - LABORATORY COPY YELLOW - CLIENT COPY

ALS FM-0326a v09 Front/04 January 2014

Failure to complete all portions of this form may delay analysis. Please fill in this form LEGIBLY. By the use of this form the user acknowledges and agrees with the Terms and Conditions as specified on the back page of the white - report copy.

1. If any water samples are taken from a Regulated Drinking Water (DW) System, please submit using an Authorized DW COC form.