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# Cullaton Lake Mine Closed Site Aquatic Monitoring Report

## 2018 open-water season

***PECG Project #***
140052

***Prepared For***
Barrick Gold Inc.

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# Executive Summary

This report describes the results of sampling conducted in 2018 on the aquatic receiving environment at the Cullaton Lake Mine Site, which consisted of water quality, sediment quality, and benthic invertebrates. The purpose of this sampling was to support the adaptive management plan for the closed site.

Water, sediment and benthic invertebrate sampling was conducted between September 11th and 12th, 2018. Water was collected from three sites, one located on Shear Creek, downstream of the waste rock pile (SW9) and two within the tailings pond area (940-2 and SW33). The natural pond that is located upstream of the tailings ponds (SW18) was dry at the time of the assessment. Sediment was only collected from SW9 as the substrate was too compact at SW33 at the time of the assessment; all other sites were dry. The water and sediment samples were analyzed for general chemistry (physical tests and anions/nutrients) and metal concentrations.

Water samples collected from SW9 showed exceedances of Canadian Council of Ministers of the Environment (CCME) Water Quality Guidelines for copper. Site SW33 had no CCME exceedances in 2018.

Sediment samples collected in Shear Creek downstream of the waste rock pile (SW9) showed elevated levels of metals, with exceedances of CCME Interim Sediment Quality Guidelines (ISQG) for arsenic, chromium and copper. No metals exceeded the CCME Probable Effects Levels (PEL).

Benthic samples were collected on Shear Creek downstream of the waste rock pile (SW9) and the drainage channel located downstream of the tailings ponds (SW33), the only two sites with flowing water during the 2018 field program. The benthic invertebrate samples collected from SW9 and SW33 were heavily dominated by the order diptera. Taxa richness, EPT richness, %EPT and diversity at both sites were low. While total abundance was lower in 2018, taxonomic richness, including EPT richness and Chironomidae richness was comparable among years and sites.

The results from the samples collected provide no indication that aquatic conditions have deteriorated since 2016, and water quality results continue to point more to improved or stable conditions. It is recommended that sampling of water quality be completed in 2 years (2020) and sediment quality and benthic invertebrate community in 4 years (2022), as described in the 2018 Closure and Reclamation Plan for the Cullaton Lake Mine.

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# 1. Introduction

The Cullaton Lake Mine site is a closed mine site that is monitored by Barrick Gold Inc. (Barrick) with a post-closure water monitoring program, as required under the existing Water Licence as well as the ñCullaton Lake Mine Closure and Reclamation Planò (CRP) dated August 10, 2018 as approved by the Nunavut Water Board (NWB). This CRP closely follows the specific requirements pertaining to the content of a closure and reclamation plan as outlined in Mackenzie Valley Land and Water Board / Aboriginal Affairs and Northern Development Canada (MVLWB/AANDC; 2013)

The updated CRP laid out a post-closure aquatic monitoring program that has taken the form of an Adaptive Monitoring Plan. This plan has been designed to have sufficient spatial and temporal resolution to identify any trends indicating a change in ecological risk at the site, as well as ensuring early detection of any changes.

Monitoring of the Cullaton Lake Mine Site during the 2018 open water season consisted of surface water, sediment, and benthic invertebrate sampling. In addition to the aquatics monitoring program, a fisheries survey was completed in July 2018 within the Cullaton Lake Mine Site. The fisheries survey was primarily focused on an unnamed creek that flows out of Tailings Pond #2 to determine if fish are present, and if so, obtain a profile of the species inhabiting this creek. Fisheries results have been summarized by PECG and are presented in Appendix A.

This report outlines the methods and results of the 2018 aquatics sampling program as part of the post-closure monitoring plan for the Cullaton Lake Mine.

# 2. Methods

## 2.1 Study Area

The Cullaton Lake property is located in Nunavut, Canada approximately 230km west of Arviat, Nunavut. The mine site is situated between Cullaton Lake and the Kognak River (Figure 2-1). The property consists of a gravel airstrip and road, encapsulated waste rock pile, covered dry tailings, and a flooded tailings pond.

The design of the 2018 aquatic monitoring program was based on previous sampling programs conducted at the Project site, allowing for the assessment of temporal and spatial trends. The sampling locations included in the 2018 program include a subset of sites used in 2008 as component of a monitoring program to support a screening level risk assessment (AECOM, 2009) as well as the 2016 monitoring program completed by PECG (PECG, 2017). All sampling locations are within the previously defined Shear Lake study area and Tailings Impoundment study area (PECG, 2017). Both study areas flow into the Kognak River, however they have no influence on each other and are not hydrologically connected.

The CRP (PECG, 2018) outlines several modifications to the aquatics monitoring program, including the reduction of sampling sites from nine to the four shown in Table 2-1. On Sheer Creek, SW9 has been selected for ongoing sampling because this site has gravel and cobble substrate, which is suitable for benthic sampling, and is immediately downstream from the waste rock pile.

***Table 2-1. Sampling sites included in the 2018 post-closure monitoring plan for the Cullaton Lake Mine Site.***

| Waterbody | Site Name | UTM (Zone 14V) | | Site Description |
|---|---|---|---|---|
| | | Easting | Northing | |
| Shear Creek | SW9 | 526735 | 6796688 | Shear Lake outlet; Shear Creek downstream of waste rock pile. |
| Unnamed Creek | SW18 | 526743 | 6793024 | 100m upstream of Site SW18u. Upstream reference for Tailings Pond #1. |
| Tailings Pond #1 outlet | 940-2 | 526542 | 6796812 | Tailings Pond #1 discharge |
| Tailings Pond #2 Drainage Channel | SW33 (940-3) | 528273 | 6792794 | Drainage channel downstream of Tailings Pond #2. |

Site SW18u has been sampled by AECOM (2009) and PECG (2017) as a reference location. Due to confounding factors such as the access road and anthropogenic influences from the past mining activities, the sampling location for this site during 2018 surveys was to shift 100 m upstream from its historic location (SW18u).

From the Water License, Site 940-2 was carried forward into the monitoring plan.

Site SW33 is at the same location as station 940-3 from the past Water License. In 2018, this site was intended to move downstream of the diversion channel so that it captures water from both the Tailings Pond #2 outlet and the diversion channel. Assessment of the new site during the July and September field visits found that the channel was undefined, and no flowing water was evident. Therefore, Site SW33 remains at the same location as previous years, at the outlet of Tailings Pond #2.

## 2.2 Field and Lab Methods

On September 11th to September 12th, 2018, Maria Sotiropoulos and Andrew Wesley-James of PECG travelled to the closed Cullaton Lake Mine Site in southeastern Nunavut. Site level descriptions, photographs and field notes for each sampling location are provided in Appendix B.

### 2.2.1 Surface Water Quality

As outlined in the CRP (PECG, 2018), several modifications were made to the previous water quality program (as per the Water License) that took place in 2016 (PECG, 2017). This includes the reduction of sampling sites from nine to the four shown in Table 2-1. Unlike past monitoring programs that prescribed the analysis of parameters based on Metal Mining Effluent Regulations under the Fisheries Act, the CRP will focus on assessing parameters that help support assessment of water quality effects to the receiving environment. Parameters that will be analyzed include:

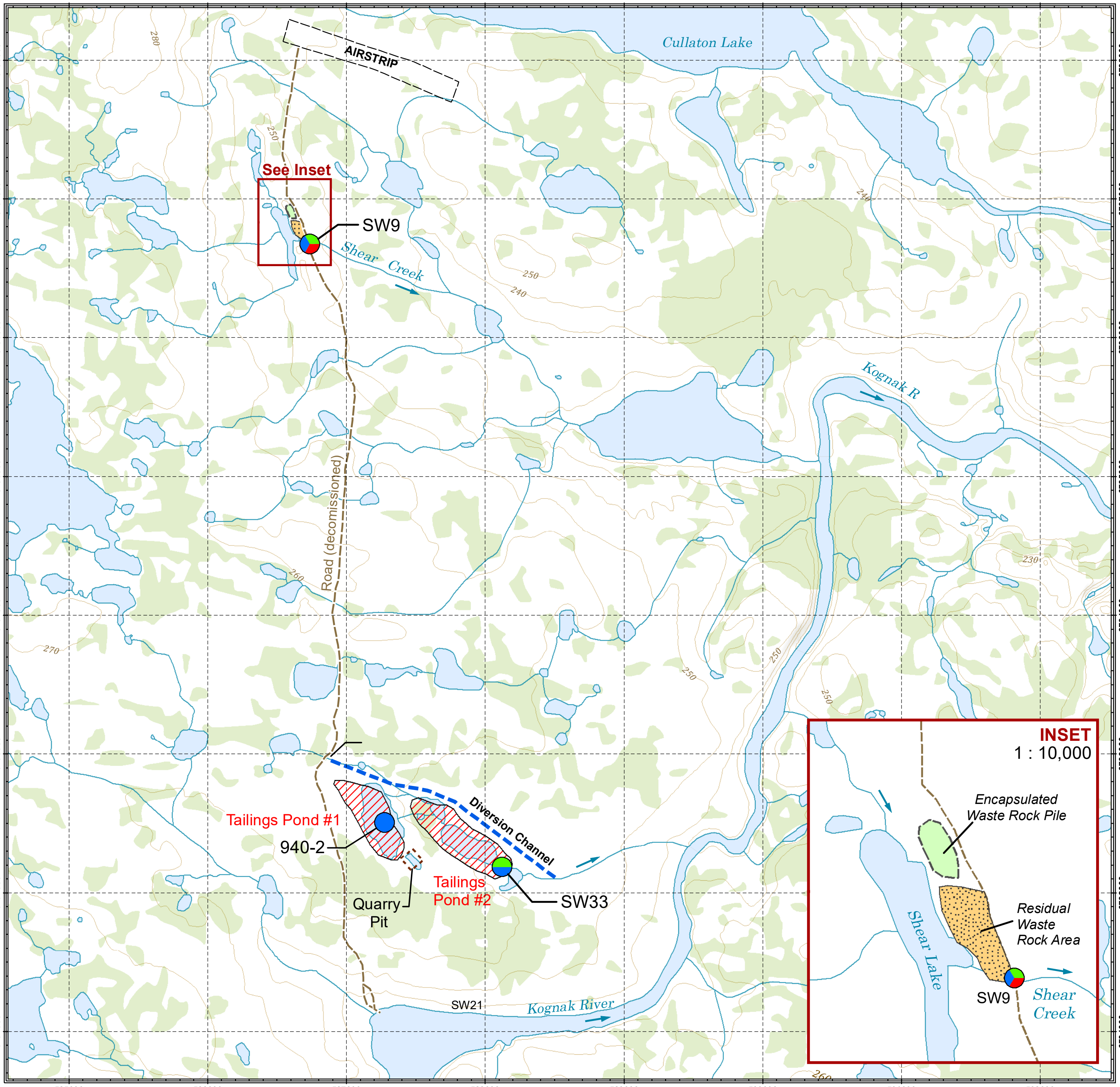
- Physical parameters: pH, conductivity, total dissolved solids (TDS), total suspended solids (TSS), hardness, acidity and ion balance;
- Anions and nutrients: alkalinity, chloride, sulphate, total organic carbon (TOC); and
- Total Metals: Al, Sb, As, Cd, Cr, Co, Cu, Fe, Pb, Li, Mn, Hg, Mo, Ni, Se, As, Th, U, V, Zn (Parameters of interest are Al, As, Cd, Cu, Co, Fe, Hg and Zn).

Field collection of water samples followed the BC Field Sampling Manual (Clarke, 2002). Surface water sampling was conducted in September of 2018, at three sites (Table 2-2). For Site 940-2 (outlet of Tailings Pond #1), the water sample was collected from within Tailings Pond #1 near the outlet location as the outlet was dry at the time of sampling. Site SW18 was not sampled as the channel was dry; only stagnant pooling was observed immediately upstream of the road crossing.

***Table 2-2. Sampling sites and samples collected in 2018, Cullaton Lake Mine Site.***

| Waterbody | Site Name | Sample Type Collected |
|---|---|---|
| Shear Creek | SW9 | • Surface water<br>• Sediment quality<br>• Benthic community |
| Unnamed Creek | SW18 | • Dry, not sampled |
| Tailings Pond #1 outlet | 940-2 | • Surface water* |
| Tailings Pond #2 Drainage Channel | SW33 (940-3) | • Surface water<br>• Benthic community |

*Note: *The outlet was dry at the time of sampling, therefore, the surface water sample was collected from within the Tailings Pond.*




**LEGEND**

*Samples Taken*

- Water quality
- Sediment
- Benthic Invertebrates

*Map Features*

- Diversion Channel
- Watercourse
- Direction of Flow
- Contour (10 m interval)
- Road (decomissioned)
- Vegetation
- Encapsulated Rock Pile
- Residual Waste Rock Area
- Tailings Pond
- Quarry Pit

**Site Descriptions**

| | |
|---|---|
| SW9 | Shear Creek downstream of Waste Rock Pile |
| SW33 | Drainage Channel downstream from Tailings Pond #2 |
| 940-2 | Tailings Pond #1 discharge |

N

0 0.5 1 1.5

Kilometers

COORDINATE SYSTEM: NAD 1983 UTM ZONE 14 N

SCALE: 1:40,000

NOTES

1. Base data supplied by Natural Resources Canada (Canvec, CDED) and contains information licensed under the Open Government Licence – Canada, 2016.
2. Tailings, Waste Rock Piles, Quarry, Airstrip, Road redrawn from "Cullaton Lake Project: 2008 Sampling Locations" ©2009 AECOM Canada Ltd.

**Client:** Barrick Gold
**Project:** Cullaton Lake 2018

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UPDATED: Mar 12, 2019

**Study Area and Site Locations**

**FIGURE 2.1**

Document Path: C:\Egnyte\Shared\Projects\Active\14005 - Barrick Gold\140054 - 2018 Cullaton Lake\Mapping\mxd\140054_Aquatics_Sites.mxd

Water quality samples for general chemical parameters were collected in pre-cleaned 1 L plastic bottles supplied by ALS Environmental (ALS) in Burnaby, BC. Samples for total metals were collected in 120 mL acid-washed plastic bottles supplied by the laboratory and preserved in the field with laboratory-supplied nitric acid. Samples for anions and total organic carbon (TOC) were collected in 120 mL bottles and preserved in the field with laboratory-supplied sulphuric acid. A complete list of parameters analyzed, and their detection limits can be found in Appendix C.

Nitrile gloves were worn throughout water quality sampling. Once samples were collected and labeled, they were immediately stored in coolers with ice packs. Samples were stored at temperatures Ò5  C throughout sample collection and shipping to the lab. Chain of custody were included with each shipment.

In addition, field parameters were measured *in situ* and were taken at each station using a YSI Pro pH/conductivity handheld meter. Measurements included pH, temperature, dissolved oxygen and specific electrical conductivity. All field parameters and relevant notes were recorded in a field log book on waterproof paper.

#### *2.2.1.1 Data Analysis*

Water quality data were compared to the Canadian Environmental Quality Guidelines (CCME) Water Quality Guidelines for the Protection of Aquatic Life (CCME, 2001).

### 2.2.2 Sediment

Sediment analysis is an important environmental monitoring component as sediments provide habitat for algae, plants, microorganisms, and macro-invertebrates, which in turn support higher trophic communities such as fish. Sediment analysis may provide more insight into long-term contaminant levels in comparison to water quality testing, as contaminants are integrated into sediments over time, and are more likely to capture periodic or storm-based contamination events.

Field sampling for sediment quality was conducted in accordance with ENV (2016) procedures. Only one sediment sample, from Site SW9, was collected in 2018 (Table 2-2). No sediment was collected from Site SW18 due to the dry creek conditions. As per the CRP, sediment was not to be sampled from Site 940-2. At Site SW33, flow was present, but the substrate was too compact and could not be sampled.

At Site SW9, fine-grained sediment was targeted from the top 3 to 5 cm of depositional areas. Sediment samples were collected using a plastic scoop utensil and transferred into 250 mL glass jars provided by ALS (Burnaby, BC). Samples were collected immediately downstream of water quality and benthic sampling locations to prevent disturbance of these sites. Nitrile gloves were worn while collecting the sediment, and a depth measurement and photo were taken at each sampling location.

Sediment sample was analyzed for moisture, pH and metals by ALS (Burnaby, BC). In the laboratory, samples were manually disaggregated (homogenized) with a wooden mallet, dried at 60ÁC, sieved through a 63 Õm mesh and then tested for metals using inductively coupled plasma mass spectrometry (ICP/MS). Lower size fractions (< 63 Õm) are generally analyzed for metals because they are more bioavailable to benthic invertebrates and generally have higher concentrations of metals compared to coarse sediment (ENV 2016).

Sediment sample was analyzed for metals, total organic carbon, total sulphur and nutrients by ALS. Full laboratory data, including detection limits and parameters sampled are shown in Appendix C.

#### *2.2.2.1 Data Analysis*

Sediments collected the Project area were compared to federal quality guidelines: CCME Interim Sediment Quality Guidelines for inorganic metals (CCME 2001). Guidelines are only available for a limited number of metal concentrations (total metals) in sediments. Currently, ISQGs and PELs are recommended for 7 metals: arsenic, cadmium, chromium, copper, lead, mercury and zinc. Definitions of these numerical guidelines for the protection of aquatic life are as follows (CCME 1999):

- Interim Sediment Quality Guidelines (ISQG): generally reflective of threshold effect levels (TELs), which are the concentrations below which there are unlikely to be any adverse biological effects.
- Probable Effects Level (PEL): concentration above which adverse effects are expected to frequently occur.

### 2.2.3 Benthic Invertebrates

Biomonitoring of benthic invertebrates provide insight into the long-term health of aquatic ecosystems, due to their sedentary nature, relatively long life-cycles, and high community diversity. In 2018, benthic invertebrate samples were only collected at two sites, Site SW9 and Site SW33 (Figure 2-1; Table 2-2). Both sites have been identified as sites that are potentially mine-influenced. All other sites were dry and therefore could not be sampled.

The Canadian Aquatic Biomonitoring Network (CABIN, ECCC 2012) field sampling protocol was performed at the two sites within the Cullaton Lake Mine Site. At each site, a CABIN field sheet was completed, and kick-net sampling was conducted, with a target of five 3-minute kick-net samples per site. Due to low water conditions and lack of suitable riffle area, only two replicate samples were collected at each site sampled. The CABIN method entails kick-net sampling for benthic invertebrates in the erosional zone (riffle, straight run, or rapid) of a representative watercourse reach. Habitat parameters such as stream substrate, channel dimensions (widths and depths), velocity measurements, and *in situ* water quality measurements were collected at each site in the vicinity of the benthic invertebrate kick-net area. *In situ* water quality measurements were taken with a YSI digital handheld meter. Other observations such as macrophyte coverage, streamside vegetation, and slope were evaluated within the entire reach (ECCC 2012). These data are included in raw format (field datasheets) in Appendix D.

For benthic invertebrate sampling, a triangular kick-net sampler with 400 micron mesh and detachable collection cup was employed. To collect a sample the collector walked backward in the upstream direction, tracing a zig zag pattern, and dragging the net along the bottom. The collector kicked the substrate in front of the net while moving upstream. Sampling was timed for 3 minutes. Two non-overlapping areas were sampled within each site. The samples were collected moving upstream, and sample areas were chosen to include erosional habitat, where present. Each sample was distributed into sampling jars, preserved using 85% ethanol and submitted to Cordillera Consulting (Summerland, BC) for taxonomic analysis. Benthic invertebrates were identified to the lowest possible taxonomic group.

#### *2.2.3.1 Data Analysis*

CABIN field sheets were used to collect all the data required for input into the CABIN database, and are provided in Appendix D. These data include general site and location information, reach data (*i.e.* habitat types, canopy coverage, periphyton coverage, etc.), basic water chemistry, slope, widths, depth, velocity, and substrate data. Analysis of the benthic invertebrate data using the Reference Condition Approach (RCA) as adopted from Environment Canada's Canadian Aquatic Biomonitoring Network (CABIN) protocols cannot be performed at time of writing as a reference model for Nunavut has not yet been developed by Environment Canada. However, the use of CABIN method ensures a standardized sampling protocol and the associated dataset provides context for the taxonomic data which would be more difficult to interpret in isolation. Environment Canada are in the process of developing a reference model for Nunavut, and once available, the RCA can be applied to the data to further assess aquatic ecosystem condition.

The following traditional benthic community descriptors are presented for the 2018 data:

- Abundance, calculated as the mean number of individuals across the replicate samples, per site;
- Taxa richness, calculated as the mean number of families across the replicate samples, per site;
- EPT taxa richness, defined as the mean number of mayfly (Ephemeroptera), stonefly (Plecoptera) and caddisfly (Trichoptera) families per site. These three orders of aquatic insects are typically most sensitive to habitat disturbance;
- Percentage EPT, calculated as the mean percentage of individuals in the EPT families at each site; and
- Shannon-Wiener diversity index $H'$, defined as:

$$H' = -\sum_{i=1}^{R} p_i (\ln p_i),$$

Where R is taxa richness, and $p_i$ is the total number of individuals in the i$^{th}$ species divided by the total number of organisms in the sample. The index presented is the mean value across the two samples.

Benthic invertebrate abundance and community metrics are reported for each site as the mean of the two samples collected. Percentage composition was calculated by dividing the biomass (number of individuals) of dominant taxa groups by the total biomass.

## 2.3 Quality Assurance and Quality Control

All field sampling was completed by two experienced field technicians, with the same methods employed at each site for consistency. All field data were transcribed into excel spreadsheets, plotted where appropriate, and used to calculate metrics that aided data interpretation. Original field notes were consulted where necessary to identify transcription errors or potential field equipment errors.

### 2.3.1 Surface Water Quality

Appropriate measures were taken to reduce the potential for water sample contamination. Samples were collected mid-stream, where practical, in pre-cleaned and labelled sample bottles provided by ALS. Nitrile gloves were worn during sample collection, and sample bottles were rinsed before filling. The samples were maintained at or below 5 degrees Celsius between collection and delivery to the laboratory. The samples were shipped to ALS in Burnaby, BC. Recommended holding times were met for all samples. Chain of Custody forms accompanied all samples. Laboratory procedures followed ENV guidelines for analytical laboratories (ENV 2015).

### 2.3.2 Sediment Quality

Appropriate measures were taken to reduce the potential for sediment sample contamination. Field staff wore nitrile gloves when sampling and used pre-cleaned sample bottles supplied by ALS. Care was taken to prevent the inner portion of the sample container and caps touching anything other than the sample itself. Samples were maintained at about 5 degrees Celsius between collection and delivery to ALS in Burnaby, BC. Chain of Custody forms accompanied all samples.

The ALS Groupôs Environmental Division is a full-service, testing, research, and consulting laboratory specializing in environmental chemistry, and has over thirty yearsô experience providing analytical services to the environmental consulting industry. The analyses they conduct routinely involve trace level determinations in a variety of sample matrices and require stringent quality control. ALS Environmental laboratories use a Quality Management System that is subject to periodic audits by local accreditation bodies. Accreditations are based on the requirements of ISO/IEC 17025:2005.

### 2.3.3 Benthic Invertebrates

To minimize the potential for contamination, the kick-net and collection cap were examined prior to and following sampling for any insects that remained, and thoroughly rinsed in the creek.

Cordillera Consulting has over ten yearsô experience in taxonomic analysis of benthic invertebrates from streams, rivers and lakes of western Canada. The following QA/QC procedures are followed by Cordillera Consulting:

- Sorting efficiency: 10% of the whole sample number was resorted with an expectation of >90% efficiency in the sorting process;
- Taxonomic efficiency: 10% of the identified sample vials were re-identified and re-enumerated by a second certified taxonomist. The two results were compared with simple statistics and the taxonomists discussed how best to correct their differences and make appropriate changes to the results; and
- Taxonomic precision: An externally verified reference collection is maintained by Cordillera Consulting. Any new specimens are sent away to experts of that taxon and the collection is reviewed every five years.

All sample errors were within the acceptable limits for CABIN Laboratory methods (less than 5% error) and passed testing according to the CABIN misidentification protocols. Full results from the taxonomic QC Audit are available in the Methods and QC Report prepared by Cordillera Consulting for the Cullaton Lake benthic invertebrate samples included in Appendix E.

# 3. Results and Discussion

## 3.1 Surface Water Quality

Table 3-1 shows select water quality parameters compared with CCME guidelines for sites SW9, S33, and 940-2 for both 2018 and 2016. Because of dry creek conditions in September 2018, water samples were not collected at Site SW18 and water samples were collected from within Tailings Pond #1 for Site 940-2. It should be noted that similarly dry conditions were observed in July 2018, immediately post-freshet, indicating 2018 was a dry year in general.

At Site SW9 in Shear Creek, downstream of the waste rock pile, copper was the only exceedance that occurred in 2018 samples (0.00275 mg/L compared to a Cu guideline value of 0.002 mg/L; Table 3-1). At the alternate to Site 940-2, total aluminum, arsenic, copper, iron and lead all exceeded CCME guidelines. This is likely due to the water samples being collected directly from within Tailings Pond #1 due to the outlet being dry at the time of sampling. This water was not discharging the environment. At Site SW33, no exceedances occurred directly below Tailings Pond #2 in 2018. Site SW33 is also downstream of Site 940-2, indicating no significant contaminant loading from Tailings Pond #1.

## 3.2 Sediment Quality

Only one sediment sample was collected in the 2018 field season. Dry creek conditions and compact substrate prevented sampling at sites SW18 and SW33, respectively. Table 3-2 shows the sediment quality parameters compared with CCME guidelines. Results that are bolded exceed the ISQG and those that are bolded and underlined exceed the PEL. Only parameters for which there are CCME guidelines are shown in Table 3-2, results for the full suite of parameters are provided in Appendix C.

In 2018, Site SW9, which is downstream of the waste rock pile showed elevated levels of metals. Arsenic, chromium and copper levels exceeded the ISQG in 2018, which is consistent with 2016 data. No metals exceeded the PEL in 2018. Overall, sediment collected in 2018 showed decreased levels of all metals (except for lead) compared to samples collected in 2016.

Similar to 2016, there appears to be a detectable level of mercury at Site SW9 (Table 3-2), but well below the ISQG. As sediment quality upstream of the waste rock pile (Shear Creak background site) revealed elevated mercury levels (0.182 mg/kg) in 2016, the source of this mercury is likely not related to the waste rock pile (PECG, 2017).

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## *Table 3-1. Comparison of 2018 and 2016 water quality sampling results with CCME guidelines, Cullaton Lake.*

| Parameter | MRL | CCME Guideline | Units | 2018 | | | 2016 | |
|---|---|---|---|---|---|---|---|---|
| | | | | SW9 | SW33 | 940-2* | SW9 | SW33 |
| **Physical Tests (Water)** | | | | | | | | |
| Conductivity | 2 | - | uS/cm | 44.4 | 425 | 311 | 47 | 344 |
| Hardness (as CaCO3) | 0.5 | - | mg/L | 17.6 | 190 | 134 | 20 | 156 |
| pH | 0.1 | - | pH | 6.97 | 8.28 | 7.97 | 7.2 | 8.3 |
| Total Suspended Solids | 1 | - | mg/L | 4 | 2.2 | 87.3 | 2.2 | 4.6 |
| TDS (Calculated) | 1 | - | mg/L | 30.4 | 274 | 197 | 45 | 235 |
| **Anions and Nutrients (Water)** | | | | | | | | |
| Alkalinity, Total (as CaCO3) | 1 | - | mg/L | 7.2 | 139 | 55.4 | 12 | 115 |
| Chloride (Cl) | 0.5 | 120 | mg/L | <0.50 | 3.39 | 1.3 | <0.50 | 1.9 |
| Sulfate (SO4) | 0.3 | - | mg/L | 10.6 | 85.3 | 97 | 7.9 | 71 |
| Anion Sum | | - | meq/L | 0.37 | 4.64 | 3.16 | NA | NA |
| Cation Sum | | - | meq/L | 0.45 | 4.79 | 3.45 | NA | NA |
| Cation - Anion Balance | | - | % | 10.8 | 1.6 | 4.3 | NA | NA |
| **Organic / Inorganic Carbon (Water)** | | | | | | | | |
| Total Organic Carbon | 0.5 | - | mg/L | 6.88 | 15.2 | 2.54 | 9.5 | 13 |
| **Total Metals (Water)** | | | | | | | | |
| Aluminum (Al)-Total | 0.003 | 0.1 | mg/L | 0.0925 | 0.027 | **0.413** | **0.13** | **0.11** |
| Antimony (Sb)-Total | 0.0001 | - | mg/L | <0.00010 | 0.00015 | 0.00045 | <0.00020 | <0.00020 |
| Arsenic (As)-Total | 0.0001 | 0.005 | mg/L | 0.00039 | 0.00315 | **0.0502** | 0.00046 | 0.0031 |
| Barium (Ba)-Total | 0.0001 | - | mg/L | 0.0116 | 0.0248 | 0.0384 | NA | NA |
| Beryllium (Be)-Total | 0.00002 | - | mg/L | <0.000020 | <0.000020 | 0.000024 | NA | NA |
| Bismuth (Bi)-Total | 0.00005 | - | mg/L | <0.000050 | <0.000050 | 0.000187 | NA | NA |
| Boron (B)-Total | 0.01 | 1.5 | mg/L | <0.010 | <0.010 | <0.010 | NA | NA |
| Cadmium (Cd)-Total | 0.000005 | Variable[1] | mg/L | 0.0000102 | <0.0000050 | 0.0000172 | 0.00002 | <0.000010 |
| Calcium (Ca)-Total | 0.05 | - | mg/L | 4.7 | 43.6 | 34.5 | NA | NA |
| Chromium (Cr)-Total | 0.0001 | 0.0089 | mg/L | 0.00034 | 0.00018 | 0.00314 | 0.00048 | 0.00036 |
| Cobalt (Co)-Total | 0.0001 | - | mg/L | 0.00073 | 0.0005 | 0.00326 | 0.00093 | 0.00052 |
| Copper (Cu)-Total | 0.0005 | Variable[2] | mg/L | **0.00275** | 0.00236 | **0.00378** | **0.0031** | **0.0027** |
| Iron (Fe)-Total | 0.01 | 0.3 | mg/L | 0.535 | 0.117 | **3.9** | **0.43** | 0.27 |
| Lead (Pb)-Total | 0.00005 | Variable[3] | mg/L | 0.00005 | <0.000050 | **0.0165** | <0.000090 | <0.000090 |
| Lithium (Li)-Total | 0.001 | - | mg/L | <0.0010 | 0.0017 | <0.0010 | <0.0020 | <0.0020 |
| Magnesium (Mg)-Total | 0.1 | - | mg/L | 1.43 | 19.7 | 11.6 | NA | NA |
| Manganese (Mn)-Total | 0.0001 | - | mg/L | 0.0324 | 0.0253 | 0.106 | 0.029 | 0.034 |

| Parameter | MRL | CCME Guideline | Units | 2018 | | | 2016 | |
|---|---|---|---|---|---|---|---|---|
| | | | | SW9 | SW33 | 940-2* | SW9 | SW33 |
| Mercury (Hg)-Total | 0.000005 | 0.000026 | mg/L | <0.0000050 | <0.0000050 | <0.0000050 | 0.0000052 | <0.000005 |
| Molybdenum (Mo)-Total | 0.00005 | 0.073 | mg/L | <0.000050 | 0.000815 | 0.0019 | <0.00020 | 0.00056 |
| Nickel (Ni)-Total | 0.0005 | Variable[4] | mg/L | 0.00266 | 0.0036 | 0.00488 | 0.0037 | 0.0033 |
| Phosphorus (P)-Total | 0.05 | - | mg/L | <0.050 | <0.050 | <0.050 | NA | NA |
| Potassium (K)-Total | 0.1 | - | mg/L | 0.82 | 2.54 | 1.94 | NA | NA |
| Selenium (Se)-Total | 0.00005 | 0.001 | mg/L | <0.000050 | 0.0001 | 0.000158 | <0.00010 | <0.000100 |
| Silicon (Si)-Total | 0.1 | - | mg/L | 0.37 | 0.12 | 1.59 | NA | NA |
| Silver (Ag)-Total | 0.00001 | 0.00025 | mg/L | <0.000010 | 0.000013 | 0.000035 | <0.000010 | 0.000017 |
| Sodium (Na)-Total | 0.05 | - | mg/L | 0.937 | 21.3 | 10.6 | NA | NA |
| Strontium (Sr)-Total | 0.0002 | - | mg/L | 0.017 | 0.227 | 0.168 | NA | |
| Sulfur (S)-Total | 0.5 | - | mg/L | 3.45 | 31.8 | 36.3 | NA | NA |
| Thallium (Tl)-Total | 0.00001 | 0.0008 | mg/L | <0.000010 | <0.000010 | <0.000010 | <0.00010 | <0.00010 |
| Tin (Sn)-Total | 0.0001 | - | mg/L | <0.00010 | <0.00010 | <0.00010 | NA | NA |
| Titanium (Ti)-Total | 0.0003 | - | mg/L | 0.00091 | 0.00067 | 0.0062 | NA | NA |
| Uranium (U)-Total | 0.00001 | 0.015 | mg/L | 0.000099 | 0.00248 | 0.000882 | 0.00012 | 0.0013 |
| Vanadium (V)-Total | 0.0005 | - | mg/L | <0.00050 | <0.00050 | 0.00115 | <0.00020 | 0.00041 |
| Zinc (Zn)-Total | 0.003 | - | mg/L | <0.0030 | <0.0030 | 0.007 | 0.0024 | 0.0012 |
| Zirconium (Zr)-Total | 0.0003 | - | mg/L | <0.00030 | <0.00030 | 0.00032 | NA | NA |

Note:
*The sample location for 940-2 was dry. This sample was collected from within the tailings pond. There was no discharge to the environment.
All units are mg/L unless otherwise specified.
Values bolded and highlighted as red text exceed CCME guidelines.
**Note 1:** The CCME guideline for cadmium is hardness dependent:

- When the water hardness is > 0 to < 17 mg/L, the guideline is 0.00004 mg/L.
- At hardness Ó17 to Ò280 mg/L, the CCME is calculated using this equation: guideline (εg/L) = 10{0.83(log[hardness]) ï 2.46 }.
- At hardness > 280 mg/L, the is 0.00037 mg/L.

**Note 2:** The CCME guideline for copper is hardness dependent:

- When the water hardness is 0 to < 82 mg/L, the guideline is 0.002 mg/L.
- At hardness Ó82 to Ò180 mg/L the guideline is calculated using this equation: guideline (Õg/L) = 0.2 * e{0.8545[ln(hardness)]-1.465}.
- At hardness >180 mg/L, the guideline is 0.004 mg/L.

**Note 3:** The CCME guideline for lead is hardness dependent:

- When the hardness is 0 to Ò60 mg/L, the guideline is 0.001 mg/L.
- At hardness >60 to Ò180 mg/L the CCME is calculated using this equation: guideline (Õg/L) = e{1.273[ln(hardness)]-4.705}.
- At hardness >180 mg/L, the guideline is 0.007 mg/L.

**Note 4:** The CCME guideline for nickel is hardness dependent:

- When the water hardness is 0 to Ò60 mg/L, the guideline is 0.025 mg/L.
- At hardness > 60 to Ò180 mg/L the guideline is calculated using this equation: guideline (Õg/L) = e{0.76[ln(hardness)]+1.06}.
- At hardness >180 mg/L, the CWQG is 150 Õg/L (= 0.150 mg/L).

***Table 3-2. Comparison of 2018 and 2016 sediment quality results, Cullaton Lake Mine Site.***

| Parameter | Units | ISQG | <u>**PEL**</u> | 2018 | 2016 |
|---|---|---|---|---|---|
| | | | | SW9 | SW9 |
| Arsenic (As) | mg/kg | 5.9 | 17 | **14** | <u>**18.6**</u> |
| Cadmium (Cd) | mg/kg | 0.6 | 3.5 | 0.107 | **1.05** |
| Chromium (Cr) | mg/kg | 37.3 | 90 | **54.7** | **57.1** |
| Copper (Cu) | mg/kg | 35.7 | 197 | **42.4** | **72.6** |
| Lead (Pb) | mg/kg | 35 | 91.3 | 9.26 | 8.3 |
| Mercury (Hg) | mg/kg | 0.17 | 0.486 | 0.0466 | 0.098 |
| Zinc (Zn) | mg/kg | 123 | 315 | 64.5 | 86 |

*Note:*
*ISQG = interim sediment quality guideline; exceedances* ***bolded***
*PEL = probable effects levels; exceedances* ***bolded*** *and* *<u>underlined</u>*

## 3.3 Benthic Invertebrates

The benthic invertebrate community descriptor results for total abundance, taxa richness, EPT (Ephemeroptera, Plecoptera, Trichoptera) taxa richness, Chironomidae Richness, % EPT, and the Shannon-Wiener biodiversity index are provided in Table 3-3. Note that stream conditions only allowed for two samples to be taken at each site in the 2018 field season; the lack of replication restricted interpretation of data. Benthic invertebrate samples were not collected from sites SW18 and 940-2 due to dry creek conditions.

***Table 3-3. Benthic community metrics results, Cullaton Lake, 2018.***

| **Year** | **2018** | | **2016** | |
|---|---|---|---|---|
| **Site** | **SW9** | **SW33** | **SW9** | **SW33** |
| Sample number (n) | 2 | 2 | 5 | 5 |
| Mean abundance | 1333 | 654 | 3915 Ñ1859 | 1953 Ñ1290 |
| Taxa richness | 31.5 | 33.5 | 22.4 Ñ2.3 | 35 Ñ2.3 |
| EPT taxa richness | 5 | 2 | 4.0 Ñ1.6 | 2.2 Ñ1.1 |
| Chironomidae richness | 15.5 | 12 | 11.6 Ñ1.3 | 18.8 Ñ4.4 |
| % EPT | 6.99% | 0.86% | 5.17% Ñ2.09% | 1.48% Ñ1.22% |
| Shannon-wiener H' (log 10) | 1.09 | 1.03 | 0.77 Ñ0.07 | 1.09 Ñ0.09 |

*Note: 2016 values are mean ± standard deviation*

Figure 3-1 to Figure 3-6 show plots of the benthic invertebrate community descriptors at sites SW9 and SW33 for 2018 and 2016 sampling. Both the Shear Creek site (SW9) and the tailings area site (SW33) showed similar tends in total abundance between 2016 and 2018. Overall, total abundance across both sites was lower in 2018 compared to 2016 (Figure 3-1). Taxonomic richness, including EPT richness and Chironomidae richness was comparable among years and sites (Figure 3-2, Figure 3-3, Figure 3-4). Figure 3-7 shows the relative abundance of taxa groups (*i.e.* community composition) by site and year. Diptera was the dominant order at both sites for both 2018 (>75% of individuals) and 2016 (>60% of individuals). The percentage of orders Ephemeroptera, Plecoptera and Trichoptera was low at both sites. These three orders of aquatic insects are typically most sensitive to pollution and are used as an indicator of aquatic ecosystem health.

In general, values for taxa richness, EPT richness, %EPT and diversity at both sites were low. This is attributable to the northern conditions at the sites. Northern aquatic environments tend to have lower diversity than southern aquatic systems due to the long periods of ice cover and generally low nutrient status. Bed roughness, substrate, and flow velocities influence benthic community structure, with slow flow areas supporting decomposer communities that tolerate lower dissolved oxygen levels and higher organic matter and sedimentation (e.g. silt-tolerant oligochaetes, chironomids). Riffle-dwelling communities are more sensitive to increasing pollution than communities in the pools or slow flowing areas in the same stream. Coarse substrate (cobble and gravel) is preferred by many EPT species, while finer substrate (sand, silt and organics) generally supports more Diptera and Oligochaeta.

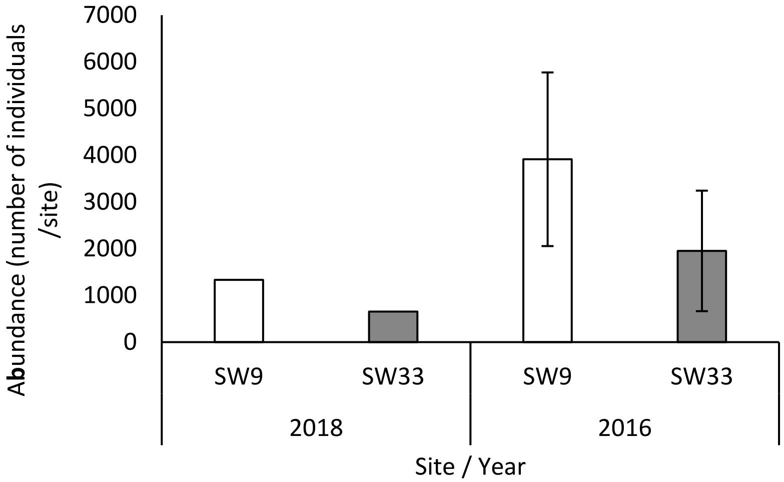


***Figure 3-1. Benthic invertebrate community abundance***

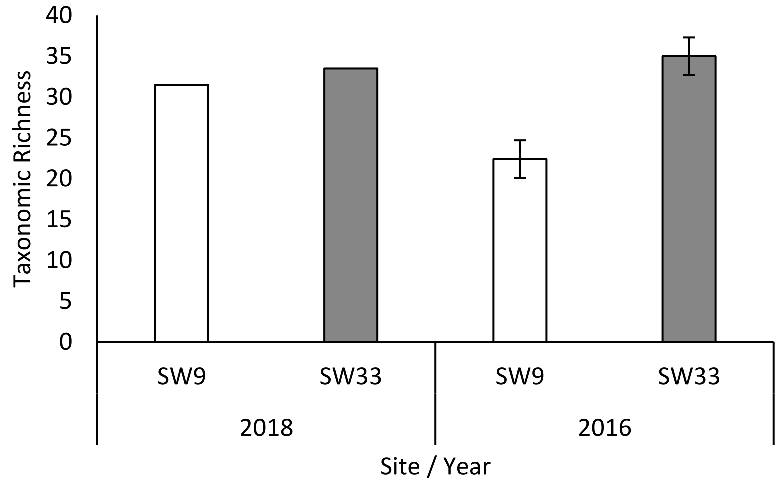


***Figure 3-2. Benthic invertebrate community taxonomic richness***

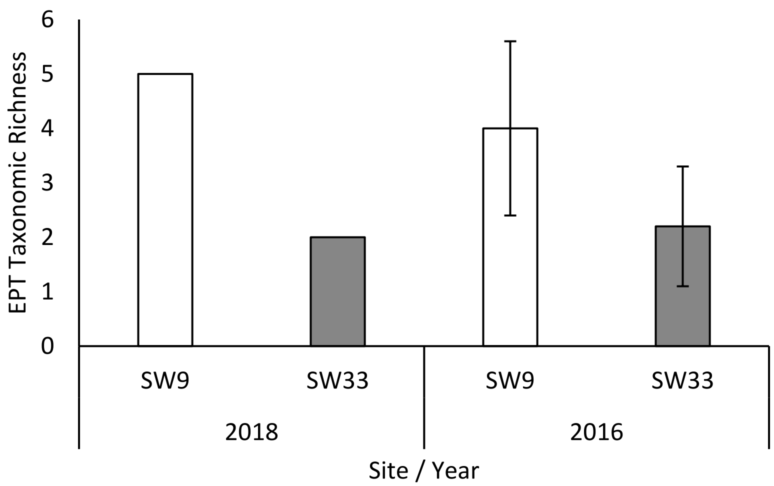


***Figure 3-3. Benthic invertebrate community EPT taxonomic richness***

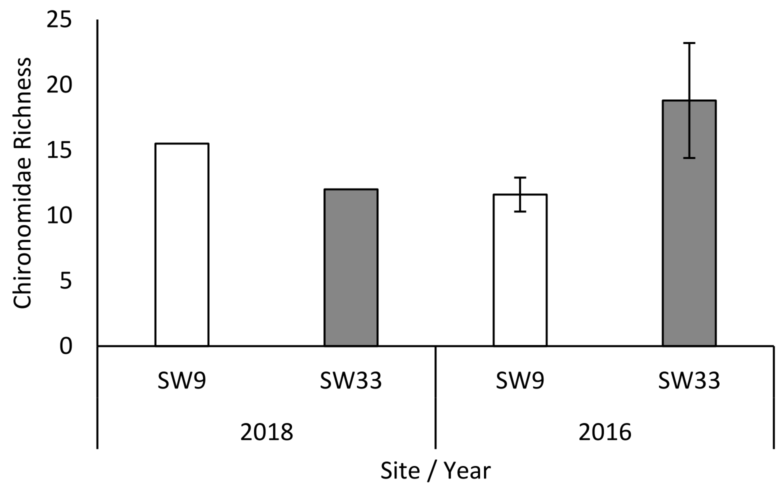


***Figure 3-4. Benthic invertebrate community chironomidae richness***

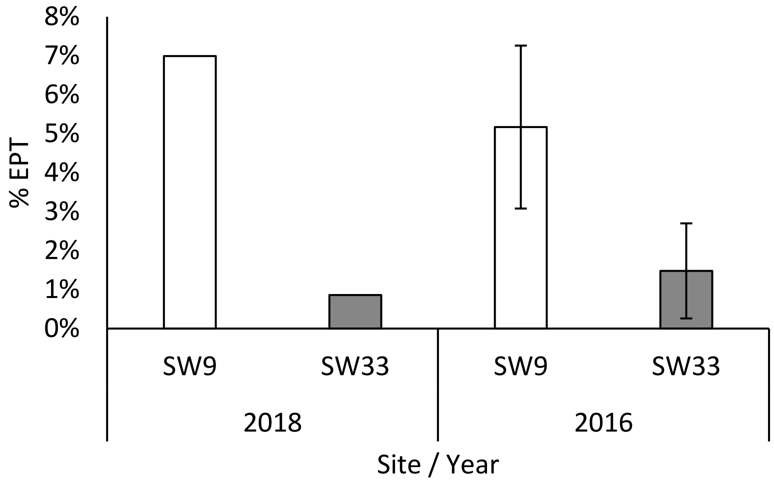


**_Figure 3-5. Benthic invertebrate community % EPT_**


**_Figure 3-6. Benthic invertebrate community Shannon-Wiener indices_**

*Notes for Figures 3-1 to 3-6:*

- *Shaded bars on plots indicate the sites on the tailings area.*
- *Sample numbers for 2018 data are n =2*
- *Sample numbers for 2016 data are n =5*
- *Error bars denote the standard deviation from the mean.*

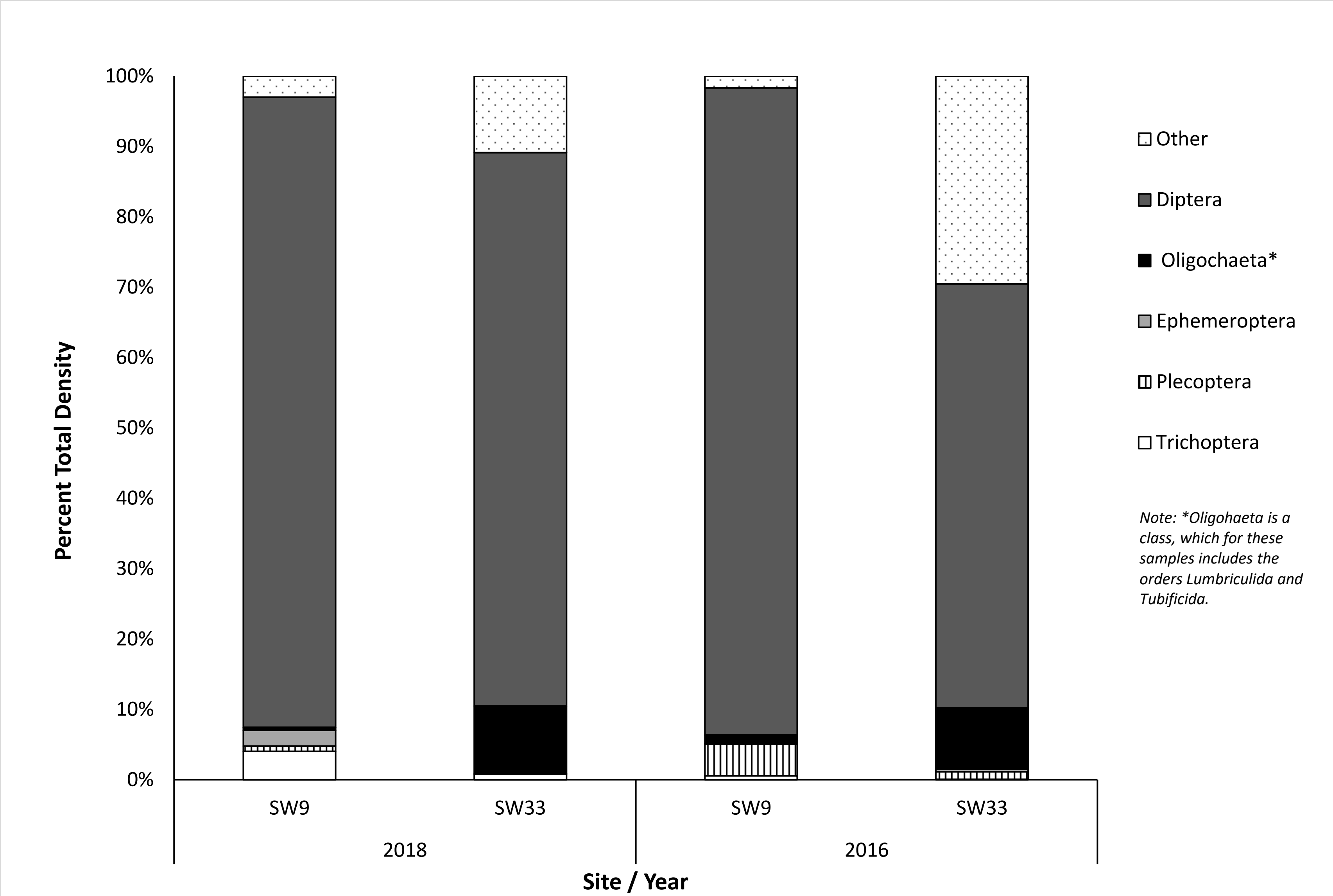


***Figure 3-7. Benthic invertebrate community composition by site and year, Cullaton Lake.***

# 4. Summary and Conclusions

The purpose of the 2018 water, sediment, and benthic invertebrate sampling was to support the 2018 Closure and Reclamation Plan (PECG, 2018). As outlined in the CRP, water quality sampling is to be completed every two years. In conjunction with the surface water quality program in 2018, sampling of the sediment and benthic invertebrate community were to be completed.

Water, sediment, and benthic community sampling completed in 2018 as part of the CRP were restricted due to the low flow and/or dry conditions throughout the Cullaton Lake Mine Site. Only two sites, Site SW9 and SW33, had flowing water at the time of the assessment. Water quality, sediment quality, and benthic community composition showed similar trends to those observed in 2016. This includes Shear Creek immediately downstream of the waste rock, at Site SW9, and the outlet to Tailings Pond #2, at Site SW33.

The results from samples collected provide no indication that aquatic conditions have deteriorated since 2016, and water quality results continue to point more towards improved or stable conditions. It is recommended that sampling of water quality be completed again in 2 years (2020) and sediment quality and benthic invertebrate community in 4 years (2022), as described in the 2018 Closure and Reclamation Plan for the Cullaton Lake Mine.

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# 5. Certification

This report was prepared, reviewed and approved by the undersigned:

**Prepared By:**

Crisostomo Gomez, M.Sc.
Aquatic Biologist

**Prepared By:**

Maria Sotiropoulos, M.Sc.
Fisheries Biologist

**Reviewed By:**

Rob Marsland, M.Sc., P.Eng.
Senior Environmental Engineer

**Approved By:**

Rick Palmer, M.Sc., R.P.Bio
President, Fisheries Biologist

# 6. References

AECOM. 2009. Screening Level Aquatic Ecological Risk Assessment for the Cullaton Lake Mine Site. Report prepared for Barrick Gold Inc. July 9, 2009

CCME, Canadian Council of Ministers of the Environment. 1999. Protocol for the derivation of Canadian Sediment Quality Guidelines for the Protection of Aquatic Life. Environment Canada. Ottawa Ontario.

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PECG, Palmer Environmental Consulting Group Inc. 2018. Cullaton Lake Mine Closure and Reclamation Plan. Report prepared for Barrick Gold Inc. August 10, 2018.

PECG, Palmer Environmental Consulting Group Inc. 2017. Cullaton Lake Mine Closed Site Aquatic Monitoring Report. 2016 open-water season. Report prepared for Barrick Gold Inc. January 23, 2017.

PALMER ENVIRONMENTAL CONSULTING GROUP INC.

# Appendix A

## Fisheries Surveys for Cullaton Lake – July 2018 Trip Report, PECG

PALMER ENVIRONMENTAL CONSULTING GROUP INC.

470 Granville Street, Suite 630, Vancouver, BC V6C 1V5
Tel: 604-629-9075 | www.pecg.ca

# Memorandum

Date: July 20, 2018

Project #: 14054 Cullaton Lake

To: Paul Brugger, Barrick Gold Corporation

From: Alexandra Crichton, Palmer Environmental Consulting Group

cc: May Mason, Palmer Environmental Consulting Group

Re: Cullaton Lake July 2018 Trip Report
Fisheries Investigation Downstream of Tailings Pond #2

## 1. Field Visit

### 1.1 Overview

As a component of the ongoing mine closure monitoring program, Alexandra Crichton of Palmer Environmental Consulting Group (PECG) accompanied Paul Brugger on a two-day site visit to the Cullaton Lake mine site between July 9th and 12th, 2018 (including travel days). The objective of the trip was to conduct a fisheries survey on an unnamed creek that flows out of Tailings Pond #2 within the Cullaton Lake Mine Site in Nunavut. This survey was conducted to determine if fish are present, and if so, obtain a profile of the species inhabiting this creek.

Table 1 summarizes the schedule and tasks completed by PECG staff during this field visit completed.

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***Table 1. Summary of work completed by PECG at the Cullaton Lake Mine Site, July, 2018.***

| Date | Weather | Work Completed |
|---|---|---|
| July 9, 2018 | - | - Travel Day (Vancouver to Winnipeg to Thompson) |
| July 10, 2018 | Sunny >30°C | - Alexandra, contractors and Barrick staff traveled to Cullaton Lake mine site from Thompson, MB<br>- Arrived on site at approximately 1145<br>- Unloaded plane, set up camp<br>- Traveled to outflow of Tailings Pond 2 by ATV at 1330<br>- Assessed stream at outflow and followed channel for approximately 1km<br>- Returned to camp at 2000 |
| July 11, 2018 | Sunny >30°C | - Traveled to outflow of Tailings Pond 2 by ATV at 0630<br>- Assessed area downstream of outflow; no defined channel was found.<br>- Assessed shoreline of Kognak River for channel outflow.<br>- Returned to camp at 1400 and packed up<br>- Traveled back to Thompson, MB |
| July 12, 2018 | - | - Travel day (Thompson to Winnipeg to Vancouver) |

## 1.2 Details of Field Visit

Alexandra met Paul in Thompson, MB on July 9, 2018. On July 10, the team traveled to site along with two local workers contracted to carry out maintenance work on the airstrip located at the Cullaton Lake mine site. The group travelled to site on a Cessna 208 Grand Caravan operated by Wings Over Kississing. All supplies, including food, water, maintenance equipment (brushers, weed whackers, etc) and fisheries sampling gear (backpack electrofisher, minnow traps, etc), fit onto the aircraft without issue. The flight from Thompson to the Cullaton Lake site took approximately 2.5 hours.

Once at site and camp was set up, Alexandra and Paul traveled by ATV to the outflow of Tailing Pond #2 (approximately distance from camp 6.5 km). The outflow creek was dry, with no visible flow present (Figure 1, Figure 2). The team followed the dry creek bed downstream, where it met a large meadow/wetland (Figure 3) approximately 40 m from the outflow. The diversion channel, which drains the upstream areas and bypassed Tailings Ponds #1 and #2, was located and followed to its terminus, where it drains into the same wetland as the unnamed outflow creek (Figure 4, Figure 5). The team followed the wetland area for approximately 1 km, however a channel was never identified. The following day, Alexandra and Paul returned to the site for an additional attempt to locate the unnamed creek. The pair traveled to the Kognak River and attempted to locate any channel draining into the River. A boulder field (Figure 6) was identified as a potential inlet to the unnamed creek; areas of open water were present upstream of this boulder field, however the flowing water originated from the hillside and quickly disappeared underground. The open water sections consisted of shallow pools (Figure 7, Figure 8) which were sampled for fish presence using a Smith-Root LR-20B backpack electrofishing unit; no fish were caught. No additional areas of open water were identified, apart from small pools dominated by boulders throughout the wetland area immediately downstream of the diversion channel/Tailings Pond #2 outflow creek. An additional area was located approximately 100m upstream from the boulder field on the Kognak River which could potentially act as a creek outlet during periods of higher flows. This area was characterized by sand and grasses, and contained two small creeks with no visible flow present (Figure 9, Figure 10).

The team then traveled back to camp, where they met up with the two additional workers on site. Gear was packed and brought down to the airstrip for pickup. The airplane was scheduled to arrive at 1530, however due to unforeseen delays it arrived at Cullaton Lake Mine Site at 1900. The charter departed site at 1930 and arrived in Thompson at 2215.

***Table 2. Various sites identified within assessed area of Cullaton Lake Mine Site.***

| Site | UTM Coordinates Zone 14V | | Description |
|---|---|---|---|
| | Easting | Northing | |
| Outflow at Tailings Pond #2 | 528152 | 6792329 | The creek at the outflow of the tailings pond was dry at the time of the visit. |
| Terminus of Drainage Ditch | 529516 | 6792428 | Drainage ditch end abruptly and continues to flow through a large wetland. No open water or defined creek was identified further downstream. |
| Potential Inlet at Kognak R. #1 | 529403 | 6792202 | Located within a flat area adjacent to the Kognak River dominated by sand and grasses. One of two small potential streams within the area. No visible flow, however pools were present. |
| Potential Inlet at Kognak R. #2 | 529398 | 6792200 | Located within a flat area adjacent to the Kognak River dominated by sand and grasses. One of two small potential streams within the area. No visible flow, however pools were present. |
| Boulder Field at Kognak R. | 529433 | 6792339 | Large boulder field and potential outflow of water seeping underground from diversion channel and downstream wetland area. |
| Hillside Seep with Pools | 529281 | 6792425 | Localized area of water seeping from hill, forming pools deep enough to conduct electrofishing for fish presence. |

## 2. Summary of Field Findings

The team was unable to locate the unnamed creek downstream of Tailings Pond #2. The outflow out of the tailings pond was dry, and therefore no in situ water quality data was collected at this location. Stagnant water was identified in the diversion channel located to the North of outflow location and ended abruptly at a large meadow/wetland. Small pools were identified within the wetland, which were dominated by boulders. An open creek channel was never located downstream of this wetland. At the Kognak River, no streams were located, and therefore it was concluded that the water in the unnamed creek/wetland downstream of Tailings Pond #2 travels underground and slowly seeps into the Kognak River. This trip coincided with a period of high air temperatures and low water flow compared to previous years (personal communication with Paul Brugger), and therefore conditions may vary from what was observed during this trip.

# 3. Photo Log

***Figure 1. Tailings Pond #2 outflow creek looking upstream. No visible flow present. Photo taken on July 10$^{th}$, 2018.***

***Figure 2. Tailings Pond #2 outflow creek looking downstream. No visible flow present. Photo taken on July 10$^{th}$, 2018.***

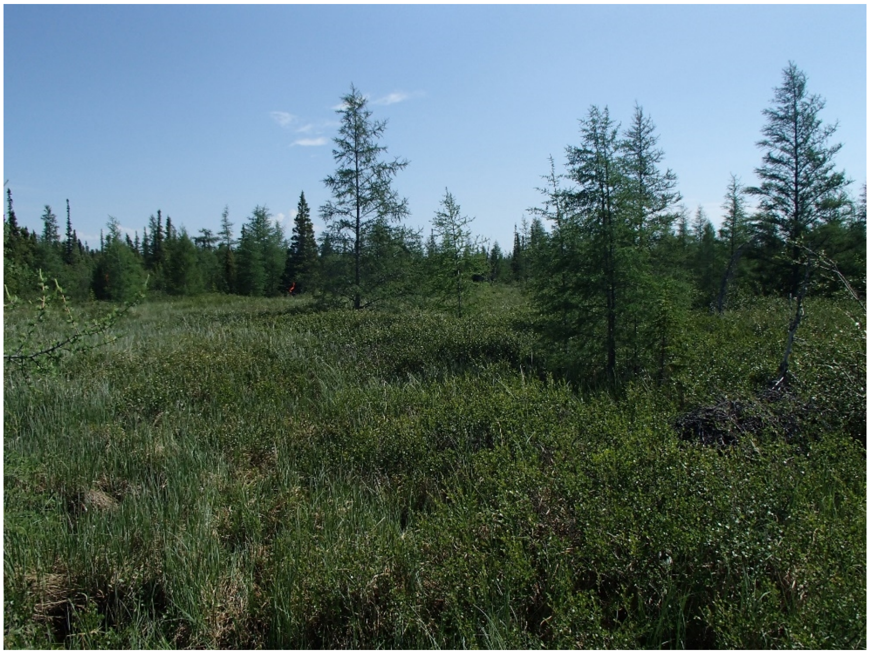

***Figure 3. Meadow/wetland downstream of Tailings Pond #2 outflow creek looking downstream (towards Kognak River). Photo taken on July 11, 2018.***

***Figure 4. Diversion channel looking downstream. Photo taken on July 10, 2018.***

***Figure 5. Diversion channel terminus at wetland/meadow looking upstream. Photo taken on July 10, 2018.***

***Figure 6. Boulder field at the Kognak River. Photo taken on July 11, 2018.***

***Figure 7. Water flowing from hillside upstream of boulder field at Kognak River. Photo taken on July 11, 2018.***

***Figure 8. Water flowing from hillside upstream of boulder field at Kognak River. Photo taken on July 11, 2018.***

***Figure 9. Area with potential creeks at confluence with the Kognak River, looking downstream. Photo taken July 11, 2018.***

***Figure 10. Area with potential creeks at confluence with the Kognak River, looking upstream. Photo taken July 11, 2018.***

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**Prepared By:**

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**Reviewed By:**

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Fisheries Biologist

**Approved By:**

May Mason, M.Sc., R.P.Bio.
Vice-President, Senior Aquatic Ecologist

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# Appendix B

## Field Sampling Locations and Photolog

**SW9 – CABIN**

| | |
|---|---|
| Project | 14054 - Cullaton Lake 2018 |
| Site Name | SW9 CABIN |
| Date | 11/09/2018 |
| Time | 1330 |
| UTM | 14 V 0526735 6796688 |
| Observations | Shear Creek just below road crossing. Water levels very low. Open, wide channel with riffle habitat at ford; channel tapering downstream and densely covered by shrubs. CABIN completed on 11/09/2018; 2 replicate kick samples completed at site (SW9-1 and SW9-2). Sediment and water samples collected on 12/09/2018. |

Photos

Looking downstream from SW9-2 reach


Looking upstream at SW9-2 reach


Looking downstream at SW9-1 reach


Looking across, from right to left bank at SW9

Fish captured in SW9-1 kick sample

**940-2**

| | |
|---|---|
| Project | 14054 – Cullaton Lake 2018 |
| Site Name | 940-2 |
| Date | 12/09/2018 |
| Time | 1015 |
| UTM | 14 V 0527353  6792562 |
| Observations | Outflow channel dry.  CABIN not completed. Water samples were collected from within tailings pond. |

Photos

Looking upstream at Tailings Pond #1 from centre of dry outflow channel

Looking at dry channel downstream of Tailings Pond #1 outflow


Water and shoreline of Tailings Pond #1 at the time water samples were collected

**SW33 - CABIN**

| | |
|---|---|
| Project | 14054 - Cullaton Lake 2018 |
| Site Name | SW33 |
| Date | 12/09/2018 |
| Time | 1330 |
| UTM | 14 V 0528273 6792294 |
| Observations | Creek flowing out of Tailings Pond #2. Straight, narrow riffle with cobble/gravel substrate. Channel flows into grassy area. Sampling location was not moved to the confluence of this creek with the diversion channel as no channel was observed at this new location. CABIN completed; 2 replicate kick samples completed at this site (SW331 and SW33-2). Water samples were collected immediately upstream of where the berm of the tailings pond intersects the channel. Substrate was compact therefore substrate samples were not collected at this site. |

Photos

Looking upstream towards Tailings Pond #2

Looking downstream


Looking downstream of reach where channel enters grassy area

**SW18**

| | |
|---|---|
| Project | 14054 - Cullaton Lake 2018 |
| Site Name | SW18 |
| Date | 11/09/2018 |
| Time | 1600 UTM 14 V 0526923  6793185 |
| Observations | Dry channel at original road crossing site (SW18u) and at new site located 150 m upstream of road crossing (SW18). Wet grassy area and pooling of water immediately upstream of road crossing.  CABIN and water samples were not completed at this site. |

Photos

Dry channel at 150m upstream of SW18u road crossing

Wet grassy area upstream of SW18u road crossing


Isolated pooling of water located immediately upstream of SW18u road crossing

Dry channel at SW18u road crossing

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# Appendix C

## ALS Laboratories Datasheets

PALMER ENVIRONMENTAL CONSULTING GROUP
ATTN: May Mason
470 Granville Street
Suite 630
Vancouver BC V6C 1V5

Date Received: 14-SEP-18
Report Date: 01-OCT-18 15:09 (MT)
Version: FINAL

Client Phone: 604-629-9075

# Certificate of Analysis

Lab Work Order #: L2164519

Project P.O. #: NOT SUBMITTED

Job Reference:

C of C Numbers:

Legal Site Desc:

Shane Stack
Account Manager

# ALS ENVIRONMENTAL ANALYTICAL REPORT

| | | | | | | |
|---|---|---|---|---|---|---|
| | **Sample ID** | L2164519-1 | | | | |
| | **Description** | Water.Sed | | | | |
| | **Sampled Date** | 12-SEP-18 | | | | |
| | **Sampled Time** | 09:05 | | | | |
| | **Client ID** | SW9 | | | | |
| **Grouping** | **Analyte** | | | | | |
| **SOIL** | | | | | | |
| **Physical Tests** | pH (1:2 soil:water) (pH) | 6.19 | | | | |
| **Metals** | Aluminum (Al) (mg/kg) | 16100 | | | | |
| | Antimony (Sb) (mg/kg) | 0.88 | | | | |
| | Arsenic (As) (mg/kg) | 14.0 | | | | |
| | Barium (Ba) (mg/kg) | 100 | | | | |
| | Beryllium (Be) (mg/kg) | 0.85 | | | | |
| | Bismuth (Bi) (mg/kg) | 0.77 | | | | |
| | Boron (B) (mg/kg) | <10 | | | | |
| | Cadmium (Cd) (mg/kg) | 0.107 | | | | |
| | Calcium (Ca) (mg/kg) | 1890 | | | | |
| | Chromium (Cr) (mg/kg) | 54.7 | | | | |
| | Cobalt (Co) (mg/kg) | 37.2 | | | | |
| | Copper (Cu) (mg/kg) | 42.4 | | | | |
| | Iron (Fe) (mg/kg) | 56500 | | | | |
| | Lead (Pb) (mg/kg) | 9.26 | | | | |
| | Lithium (Li) (mg/kg) | 14.5 | | | | |
| | Magnesium (Mg) (mg/kg) | 8370 | | | | |
| | Manganese (Mn) (mg/kg) | 873 | | | | |
| | Mercury (Hg) (mg/kg) | 0.0466 | | | | |
| | Molybdenum (Mo) (mg/kg) | 1.32 | | | | |
| | Nickel (Ni) (mg/kg) | 46.2 | | | | |
| | Phosphorus (P) (mg/kg) | 372 | | | | |
| | Potassium (K) (mg/kg) | 6770 | | | | |
| | Selenium (Se) (mg/kg) | 0.47 | | | | |
| | Silver (Ag) (mg/kg) | 0.387 | | | | |
| | Sodium (Na) (mg/kg) | 109 | | | | |
| | Strontium (Sr) (mg/kg) | 10.5 | | | | |
| | Thallium (Tl) (mg/kg) | 0.376 | | | | |
| | Tin (Sn) (mg/kg) | 1.04 | | | | |
| | Titanium (Ti) (mg/kg) | 993 | | | | |
| | Uranium (U) (mg/kg) | 2.44 | | | | |
| | Vanadium (V) (mg/kg) | 45.4 | | | | |
| | Zinc (Zn) (mg/kg) | 64.5 | | | | |

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

# ALS ENVIRONMENTAL ANALYTICAL REPORT

| | Sample ID | L2164519-1 | L2164519-2 | L2164519-3 | | |
|---|---|---|---|---|---|---|
| | Description | Water.Sed | Water | Water | | |
| | Sampled Date | 12-SEP-18 | 12-SEP-18 | 12-SEP-18 | | |
| | Sampled Time | 09:05 | 13:05 | 10:15 | | |
| | Client ID | SW9 | SW33 (940-3) | 940-2 | | |
| **Grouping** | **Analyte** | | | | | |
| **WATER** | | | | | | |
| **Physical Tests** | Conductivity (uS/cm) | 44.4 | 425 | 311 | | |
| | Hardness (as CaCO3) (mg/L) | 17.6 HTC | 190 HTC | 134 HTC | | |
| | pH (pH) | 6.97 | 8.28 | 7.97 | | |
| | Total Suspended Solids (mg/L) | 4.0 | 2.2 | 87.3 | | |
| | TDS (Calculated) (mg/L) | 30.4 | 274 | 197 | | |
| **Anions and Nutrients** | Alkalinity, Total (as CaCO3) (mg/L) | 7.2 | 139 | 55.4 | | |
| | Chloride (Cl) (mg/L) | <0.50 | 3.39 | 1.30 | | |
| | Sulfate (SO4) (mg/L) | 10.6 | 85.3 | 97.0 | | |
| | Anion Sum (meq/L) | 0.37 | 4.64 | 3.16 | | |
| | Cation Sum (meq/L) | 0.45 | 4.79 | 3.45 | | |
| | Cation - Anion Balance (%) | 10.8 | 1.6 | 4.3 | | |
| **Organic / Inorganic Carbon** | Total Organic Carbon (mg/L) | 6.88 | 15.2 | 2.54 | | |
| **Total Metals** | Aluminum (Al)-Total (mg/L) | 0.0925 | 0.0270 | 0.413 | | |
| | Antimony (Sb)-Total (mg/L) | <0.00010 | 0.00015 | 0.00045 | | |
| | Arsenic (As)-Total (mg/L) | 0.00039 | 0.00315 | 0.0502 | | |
| | Barium (Ba)-Total (mg/L) | 0.0116 | 0.0248 | 0.0384 | | |
| | Beryllium (Be)-Total (mg/L) | <0.000020 | <0.000020 | 0.000024 | | |
| | Bismuth (Bi)-Total (mg/L) | <0.000050 | <0.000050 | 0.000187 | | |
| | Boron (B)-Total (mg/L) | <0.010 | <0.010 | <0.010 | | |
| | Cadmium (Cd)-Total (mg/L) | 0.0000102 | <0.0000050 | 0.0000172 | | |
| | Calcium (Ca)-Total (mg/L) | 4.70 | 43.6 | 34.5 | | |
| | Chromium (Cr)-Total (mg/L) | 0.00034 | 0.00018 | 0.00314 | | |
| | Cobalt (Co)-Total (mg/L) | 0.00073 | 0.00050 | 0.00326 | | |
| | Copper (Cu)-Total (mg/L) | 0.00275 | 0.00236 | 0.00378 | | |
| | Iron (Fe)-Total (mg/L) | 0.535 | 0.117 | 3.90 | | |
| | Lead (Pb)-Total (mg/L) | 0.000050 | <0.000050 | 0.0165 | | |
| | Lithium (Li)-Total (mg/L) | <0.0010 | 0.0017 | <0.0010 | | |
| | Magnesium (Mg)-Total (mg/L) | 1.43 | 19.7 | 11.6 | | |
| | Manganese (Mn)-Total (mg/L) | 0.0324 | 0.0253 | 0.106 | | |
| | Mercury (Hg)-Total (mg/L) | <0.0000050 | <0.0000050 | <0.0000050 | | |
| | Molybdenum (Mo)-Total (mg/L) | <0.000050 | 0.000815 | 0.00190 | | |
| | Nickel (Ni)-Total (mg/L) | 0.00266 | 0.00360 | 0.00488 | | |
| | Phosphorus (P)-Total (mg/L) | <0.050 | <0.050 | <0.050 | | |
| | Potassium (K)-Total (mg/L) | 0.82 | 2.54 | 1.94 | | |
| | Selenium (Se)-Total (mg/L) | <0.000050 | 0.000100 | 0.000158 | | |
| | Silicon (Si)-Total (mg/L) | 0.37 | 0.12 | 1.59 | | |

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

# ALS ENVIRONMENTAL ANALYTICAL REPORT

| | Sample ID | L2164519-1 | L2164519-2 | L2164519-3 | | |
|---|---|---|---|---|---|---|
| | Description | Water.Sed | Water | Water | | |
| | Sampled Date | 12-SEP-18 | 12-SEP-18 | 12-SEP-18 | | |
| | Sampled Time | 09:05 | 13:05 | 10:15 | | |
| | Client ID | SW9 | SW33 (940-3) | 940-2 | | |
| **Grouping** | **Analyte** | | | | | |
| **WATER** | | | | | | |
| **Total Metals** | Silver (Ag)-Total (mg/L) | <0.000010 | 0.000013 | 0.000035 | | |
| | Sodium (Na)-Total (mg/L) | 0.937 | 21.3 | 10.6 | | |
| | Strontium (Sr)-Total (mg/L) | 0.0170 | 0.227 | 0.168 | | |
| | Sulfur (S)-Total (mg/L) | 3.45 | 31.8 | 36.3 | | |
| | Thallium (Tl)-Total (mg/L) | <0.000010 | <0.000010 | <0.000010 | | |
| | Tin (Sn)-Total (mg/L) | <0.00010 | <0.00010 | <0.00010 | | |
| | Titanium (Ti)-Total (mg/L) | 0.00091 | 0.00067 | 0.00620 | | |
| | Uranium (U)-Total (mg/L) | 0.000099 | 0.00248 | 0.000882 | | |
| | Vanadium (V)-Total (mg/L) | <0.00050 | <0.00050 | 0.00115 | | |
| | Zinc (Zn)-Total (mg/L) | <0.0030 | <0.0030 | 0.0070 | | |
| | Zirconium (Zr)-Total (mg/L) | <0.00030 | <0.00030 | 0.00032 | | |

* 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 | Antimony (Sb) | DUP-H | L2164519-1 |
| Matrix Spike | Total Organic Carbon | MS-B | L2164519-1, -2, -3 |
| Matrix Spike | Calcium (Ca)-Total | MS-B | L2164519-1, -2, -3 |
| Matrix Spike | Cobalt (Co)-Total | MS-B | L2164519-1, -2, -3 |
| Matrix Spike | Magnesium (Mg)-Total | MS-B | L2164519-1, -2, -3 |
| Matrix Spike | Manganese (Mn)-Total | MS-B | L2164519-1, -2, -3 |
| Matrix Spike | Nickel (Ni)-Total | MS-B | L2164519-1, -2, -3 |
| Matrix Spike | Sodium (Na)-Total | MS-B | L2164519-1, -2, -3 |
| Matrix Spike | Strontium (Sr)-Total | MS-B | L2164519-1, -2, -3 |
| Matrix Spike | Sulfur (S)-Total | MS-B | L2164519-1, -2, -3 |

**Qualifiers for Individual Parameters Listed:**

| Qualifier | Description |
|---|---|
| DUP-H | Duplicate results outside ALS DQO, due to sample heterogeneity. |
| HTC | Hardness was calculated from Total Ca and/or Mg concentrations and may be biased high (dissolved Ca/Mg results unavailable). |
| MS-B | Matrix Spike recovery could not be accurately calculated due to high analyte background in sample. |

## Test Method References:

| ALS Test Code | Matrix | Test Description | Method Reference** |
|---|---|---|---|
| **ALK-TITR-VA** | Water | Alkalinity Species by Titration | APHA 2320 Alkalinity |

This analysis is carried out using procedures adapted from APHA Method 2320 "Alkalinity". Total alkalinity is determined by potentiometric titration to a pH 4.5 endpoint. Bicarbonate, carbonate and hydroxide alkalinity are calculated from phenolphthalein alkalinity and total alkalinity values.

| | | | |
|---|---|---|---|
| **BE-T-L-CCMS-VA** | Water | Total Be (Low) in Water by CRC ICPMS | EPA 200.2/6020A (mod) |

Water samples are digested with nitric and hydrochloric acids, and analyzed by CRC ICPMS.

| | | | |
|---|---|---|---|
| **CARBONS-TOC-VA** | Water | Total organic carbon by combustion | APHA 5310B TOTAL ORGANIC CARBON (TOC) |

This analysis is carried out using procedures adapted from APHA Method 5310 "Total Organic Carbon (TOC)".

| | | | |
|---|---|---|---|
| **CL-IC-N-VA** | Water | Chloride in Water by IC | EPA 300.1 (mod) |

Inorganic anions are analyzed by Ion Chromatography with conductivity and/or UV detection.

| | | | |
|---|---|---|---|
| **EC-PCT-VA** | Water | Conductivity (Automated) | APHA 2510 Auto. Conduc. |

This analysis is carried out using procedures adapted from APHA Method 2510 "Conductivity". Conductivity is determined using a conductivity electrode.

| | | | |
|---|---|---|---|
| **EC-SCREEN-VA** | Water | Conductivity Screen (Internal Use Only) | APHA 2510 |

Qualitative analysis of conductivity where required during preparation of other tests - e.g. TDS, metals, etc.

| | | | |
|---|---|---|---|
| **HARDNESS-CALC-VA** | Water | Hardness | APHA 2340B |

Hardness (also known as Total Hardness) is calculated from the sum of Calcium and Magnesium concentrations, expressed in $CaCO_3$ equivalents. Dissolved Calcium and Magnesium concentrations are preferentially used for the hardness calculation.

| | | | |
|---|---|---|---|
| **HG-63UM-CVAF-VA** | Soil | Hg in Soil by CVAAS | EPA 200.2/245.7 |

This analysis is carried out using procedures from CSR Analytical Method: "Strong Acid Leachable Metals (SALM) in Soil", BC Ministry of Environment, 26 June 2009, and procedures adapted from EPA Method 200.2. The sample is manually homogenized, dried at 60 degrees Celsius, sieved through a 63 um (230 mesh) sieve, and a representative subsample of the dry material is weighed. The sample is then digested at 95 degrees Celsius for 2 hours by block digester using concentrated nitric and hydrochloric acids. Instrumental analysis is by atomic absorption spectrophotometry (EPA Method 245.7).

Method Limitation: This method is not a total digestion technique. It is a very strong acid digestion that is intended to dissolve those metals that may be environmentally available. By design, elements bound in silicate structures are not normally dissolved by this procedure as they are not usually mobile in the environment.

Deviation from Reference Method: This procedure deviates from the BC CSR SALM method, which specifies sieving to 2 mm (10 mesh).

| | | | |
|---|---|---|---|
| **HG-T-CVAA-VA** | Water | Total Mercury in Water by CVAAS or CVAFS | EPA 1631E (mod) |

Water samples undergo a cold-oxidation using bromine monochloride prior to reduction with stannous chloride, and analyzed by CVAAS or CVAFS.

| | | | |
|---|---|---|---|
| **IONBALANCE-VA** | Water | Ion Balance Calculation | APHA 1030E |

# Reference Information

Cation Sum, Anion Sum, and Ion Balance (as % difference) are calculated based on guidance from APHA Standard Methods (1030E Checking Correctness of Analysis). Because all aqueous solutions are electrically neutral, the calculated ion balance (% difference of cations minus anions) should be near-zero.

Cation and Anion Sums are the total meq/L concentration of major cations and anions. Dissolved species are used where available. Minor ions are included where data is present. Ion Balance is calculated as:

Ion Balance (%) = [Cation Sum-Anion Sum] / [Cation Sum+Anion Sum]

| | | | |
|---|---|---|---|
| **MET-63UM-CCMS-VA** | Soil | Metals in Soil by CRC ICPMS (63um) | EPA 200.2/6020A |

Samples are passed through a 63um sieve and digested with HNO3 and HCl. Analysis is by Collision/Reaction Cell ICPMS.

Method Limitation: This method is not a total digestion technique. It is a very strong acid digestion that is intended to dissolve those metals that may be environmentally available. By design, elements bound in silicate structures are not normally dissolved by this procedure as they are not usually mobile in the environment.

| | | | |
|---|---|---|---|
| **MET-T-CCMS-VA** | Water | Total Metals in Water by CRC ICPMS | EPA 200.2/6020A (mod) |

Water samples are digested with nitric and hydrochloric acids, and analyzed by CRC ICPMS.

Method Limitation (re: Sulfur): Sulfide and volatile sulfur species may not be recovered by this method.

| | | | |
|---|---|---|---|
| **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.

| | | | |
|---|---|---|---|
| **PH-PCT-VA** | Water | pH by Meter (Automated) | APHA 4500-H pH Value |

This analysis is carried out using procedures adapted from APHA Method 4500-H "pH Value". The pH is determined in the laboratory using a pH electrode

It is recommended that this analysis be conducted in the field.

| | | | |
|---|---|---|---|
| **SO4-IC-N-VA** | Water | Sulfate in Water by IC | EPA 300.1 (mod) |

Inorganic anions are analyzed by Ion Chromatography with conductivity and/or UV detection.

| | | | |
|---|---|---|---|
| **TDS-CALC-VA** | Water | TDS (Calculated) | APHA 1030E (20TH EDITION) |

This analysis is carried out using procedures adapted from APHA 1030E "Checking Correctness of Analyses".
The Total Dissolved Solids result is calculated from measured concentrations of anions and cations in the sample.

| | | | |
|---|---|---|---|
| **TSS-LOW-VA** | Water | Total Suspended Solids by Grav. (1 mg/L) | APHA 2540D |

This analysis is carried out using procedures adapted from APHA Method 2540 "Solids". Solids are determined gravimetrically. Total suspended solids (TSS) are determined by filtering a sample through a glass fibre filter, TSS is determined by drying the filter at 104 degrees celsius.
Samples containing very high dissolved solid content (i.e. seawaters, brackish waters) may produce a positive bias by this method. Alternate analysis methods are available for these types of samples.

** 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 |
|---|---|
| VA | ALS ENVIRONMENTAL - VANCOUVER, BRITISH COLUMBIA, CANADA |

**Chain of Custody Numbers:**

# Reference Information

**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.*

# Chain of Custody (COC) / Analytical Request Form

ALS Environmental
www.alsglobal.com

Canada Toll Free: 1 800 668 9878

L2164519-COFC

COC Number: 15 -

Page of

| Report To | Contact and company name below will appear on the final report |
|---|---|
| Company: | Palmer Environmental Consulting Group Inc |
| Contact: | May Mason |
| Phone: | |
| | Company address below will appear on the final report |
| Street: | 470 Granville Street, Suite 630 |
| City/Province: | Vancouver, BC |
| Postal Code: | V6C 1V5 |
| Invoice To | Same as Report To ☑ YES ☐ NO |
| | Copy of Invoice with Report ☑ YES ☐ NO |
| Company: | |
| Contact: | |

**Report Format / Distribution**

Select Report Format: ☑ PDF ☑ EXCEL ☐ EDD (DIGITAL)

Quality Control (QC) Report with Report ☐ YES ☐ NO

☐ Compare Results to Criteria on Report - provide details below if box checked

Select Distribution: ☐ EMAIL ☐ MAIL ☐ FAX

Email 1 or Fax maria@pecg.ca

Email 2

Email 3

**Invoice Distribution**

Select Invoice Distribution: ☐ EMAIL ☐ MAIL ☐ FAX

Email 1 or Fax

Email 2

**Select Service Level Below - Please confirm all E&P TATs with your AM - surcharges will apply**

Regular [R] ☐ Standard TAT if received by 3 pm - business days - no surcharges apply

PRIORITY (Business Days): 4 day [P4] ☐ 3 day [P3] ☐ 2 day [P2] ☐

EMERGENCY: 1 Business day [E1] ☐ Same Day, Weekend or Statutory holiday [E0] ☐

Date and Time Required for all E&P TATs:

For tests that can not be performed according to the service level selected, you will be contacted.

**Project Information**

ALS Account # / Quote #: Q56339

Job #:

PO / AFE:

LSD:

**Oil and Gas Required Fields (client use)**

AFE/Cost Center: PO#

Major/Minor Code: Routing Code:

Requisitioner:

Location:

ALS Lab Work Order # (lab use only) L2164504

ALS Contact:

Sampler: Maria

**Analysis Request**

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

| 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 | ALK-TITR-TOT-ONLY-VA | CARBONS-TOC-VA | CL-IC-N-VA | EC-PCT-VA | HARDNESS-CALC-VA | IONBALANCE-VA | MET-T-BCMDG-VA | PH-PCT-VA | SO4-IC-N-VA | TDS-CALC-VA | TSS-LOW-VA | | MET-63UM-SED-VA | Number of Containers |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 1 | SW9 | 17/09/18 | 0905 | Water Sed | ✓ | ✓ | ✓ | ✓ | ✓ | ✓ | ✓ | ✓ | ✓ | ✓ | ✓ | | ✓ | |
| | SW18 Dry - no sample | — | | | | | | | | | | | | | | | | |
| 2 | SW33 (940-3) | 12/09/18 | 1305 | Water | ✓ | ✓ | ✓ | ✓ | ✓ | ✓ | ✓ | ✓ | ✓ | ✓ | ✓ | | | |
| 3 | 940-2 | 12/09/18 | 1015 | Water | ✓ | ✓ | ✓ | ✓ | ✓ | ✓ | ✓ | ✓ | ✓ | ✓ | ✓ | | | |
| | Duplicate | — | | | | | | | | | | | | | | | | |
| | Field Blank - no DI - not taken | — | | | | | | | | | | | | | | | | |

**Drinking Water (DW) Samples[1] (client use)**

Are samples taken from a Regulated DW System? ☐ YES ☑ NO

Are samples for human drinking water use? ☐ YES ☑ NO

Special Instructions / Specify Criteria to add on report by clicking on the drop-down list below (electronic COC only)

**SAMPLE CONDITION AS RECEIVED (lab use only)**

Frozen ☐ SIF Observations Yes ☐ No ☐

Ice Packs ☐ Ice Cubes ☐ Custody seal intact Yes ☐ No ☐

Cooling Initiated ☐

INITIAL COOLER TEMPERATURES °C: 17.9

FINAL COOLER TEMPERATURES °C:

| SHIPMENT RELEASE (client use) | | | INITIAL SHIPMENT RECEPTION (lab use only) | | | FINAL SHIPMENT RECEPTION (lab use only) | | |
|---|---|---|---|---|---|---|---|---|
| Released by: [signature] | Date: 13/09/18 | Time: 0900 | Received by: [signature] | Date: 09/14/18 | Time: 11:30 | Received by: | Date: | Time: |

REFER TO BACK PAGE FOR ALS LOCATIONS AND SAMPLING INFORMATION WHITE - LABORATORY COPY YELLOW - CLIENT COPY



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.

# Appendix D

## CABIN Datasheets

Field Crew: ____________________ Site Code: SW33 (original site)

Sampling Date: (DD/MM/YYYY) 12/09/18

☐ **Occupational Health & Safety: Site Inspection Sheet completed**

## PRIMARY SITE DATA

CABIN Study Name: ____________________ Local Basin Name: ____________________

River/Stream Name: SW33 @ TSP#2 Stream Order: (map scale 1:50,000) ____________

Select one: ☐ Test Site ☐ Potential Reference Site

**Geographical Description/Notes:**
land ~75m to S on TBP#2 and walked North to strm xing

Surrounding Land Use: (check those present) Information Source: ____________

☐ Forest ☐ Field/Pasture ☐ Agriculture ☐ Residential/Urban
☐ Logging ☑ Mining ☐ Commercial/Industrial ☐ Other ________

Dominant Surrounding Land Use: (check one) Information Source: ____________

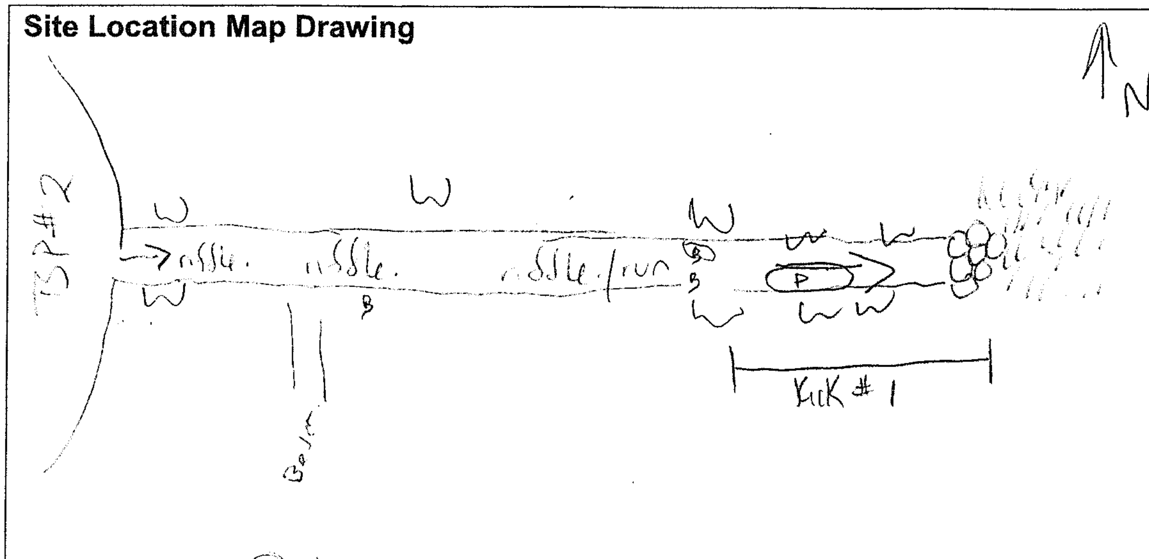
☐ Forest ☐ Field/Pasture ☐ Agriculture ☐ Residential/Urban
☐ Logging ☑ Mining ☐ Commercial/Industrial ☐ Other ________

**Location Data** 14V 0528273 6792194 (wpt. 018)

Latitude: ________N Longitude: - ________W (DMS or DD)

Elevation: 258m. (fasl *or* masl) GPS Datum: ☐ GRS80 (NAD83/WGS84) ☐ Other: ________

**Site Location Map Drawing**




Note: Indicate north ⊗ heli

Field Crew: ______________________________ Site Code: ______________

Sampling Date: (DD/MM/YYYY) ______________________

**Photos**

- [x] 1 Field Sheet  - [x] 2 Upstream  - [x] 3 Downstream  - [x] 4 RB-713 Across Site  - [ ] Aerial View
- [ ] Substrate (exposed)  - [x] 5 Substrate (aquatic)  - [ ] Other ____________

6 - @ extreme d/s end where SU33-1 started Waypt.

7 looking u/s @ u/s end Waypt.

## REACH DATA *(represents 6 times bankfull width)*

1. Habitat Types: *(check those present)*
   - [x] Riffle  - [ ] Rapids  - [x] Straight run  - [x] Pool/Back Eddy
2. Canopy Coverage: *(stand in middle of stream and look up, check one)*
   - [ ] 0 %  - [ ] 1-25 %  - [ ] 26-50 %  - [x] 51-75 %  - [ ] 76-100 %
3. Macrophyte Coverage: *(not algae or moss, check one)*
   - [x] 0 %  - [ ] 1-25 %  - [ ] 26-50 %  - [ ] 51-75 %  - [ ] 76-100 %
4. Streamside Vegetation: *(check those present)*
   - [x] ferns/grasses  - [x] shrubs  - [ ] deciduous trees  - [ ] coniferous trees
5. Dominant Streamside Vegetation: *(check one)*
   - [ ] ferns/grasses  - [x] shrubs  - [ ] deciduous trees  - [ ] coniferous trees
6. Periphyton Coverage on Substrate: *(benthic algae, not moss, check one)*
   - [x] **1** - Rocks are not slippery, no obvious colour (thin layer < 0.5 mm thick)
   - [ ] **2** - Rocks are slightly slippery, yellow-brown to light green colour (0.5-1 mm thick)
   - [ ] **3** - Rocks have a noticeable slippery feel (footing is slippery), with patches of thicker green to brown algae (1-5 mm thick)
   - [ ] **4** - Rocks are very slippery (algae can be removed with thumbnail), numerous large clumps of green to dark brown algae (5 mm -20 mm thick)
   - [ ] **5** - Rocks are mostly obscured by algal mat, extensive green, brown to black algal mass may have long strands (> 20 mm thick)

Note: 1 through 5 represent categories entered into the CABIN database.

## BENTHIC MACROINVERTEBRATE DATA

Habitat sampled: *(check one)* - [x] riffle - [ ] rapids - [ ] straight run

| **400 µm mesh Kick Net** | |
|---|---|
| Person sampling | Mona |
| Sampling time (i.e. 3 min.) | 3 x-5 min |
| No. of sample jars | 3 |
| Typical depth in kick area (cm) | ~7 cm |

Preservative used: Ethanol.

Sampled sieved on site using "Bucket Swirling Method": - [ ] YES - [ ] NO

If YES, debris collected for QAQC - [ ]

Note: Indicate if a sampling method other than the recommended 400 µm mesh kick net is used.

pool 28cm - 33 deepest.



CABIN

Field Crew: ______________________ Site Code: SW33 - orig. site

Sampling Date: (DD/MM/YYYY) 12/09/18

**WATER CHEMISTRY DATA** **Time:** 1326 (24 hr clock) **Time zone:** ________

Air Temp: 4 (°C) Water Temp: 3.4 (°C) pH: 8.20

Specific Conductance: 427.1 (μs/cm) DO: 14.21 (mg/L) Turbidity: — (NTU)

107.1 % DO

Check if water samples were collected for the following analyses:

- ☐ TSS (Total Suspended Solids)
- ☐ Nitrogen (i.e. Total, Nitrate, Nitrite, Dissolved, and/or Ammonia)
- ☐ Phosphorus (Total, Ortho, and/or Dissolved)
- ☐ Major Ions (i.e. Alkalinity, Hardness, Chloride, and/or Sulphate)
- ☐ Other ________

✓ ALS.

Note: Determining alkalinity is recommended, as are other analyses, but not required for CABIN assessments.

## CHANNEL DATA

**Slope -** Indicate how slope was measured: (check one)

☐ **Calculated from map**

Scale: ________ (Note: small scale map recommended if field measurement is not possible - i.e. 1:20,000).
contour interval (vertical distance) ________ (m),
distance between contour intervals (horizontal distance) ________ (m)
slope = vertical distance/horizontal distance = ________

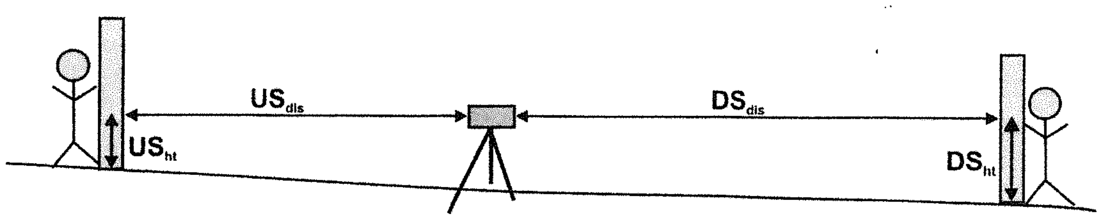
**OR**

☑ **Measured in field**

Circle device used and fill out table according to device:
a. Survey Equipment b. Hand Level & Measuring Tape

6% over 5.5m
Clarometer

| Measurements | Upstream (U/S) | Downstream(D/S) | Calculation |
|---|---|---|---|
| [a]Top Hairline (T) | | | |
| [a]Mid Hairline (ht) OR [b]Height of rod | | | |
| [a]Bottom Hairline (B) | | | |
| [b]Distance (dis) OR [a]T-B x 100 | [a]$US_{dis}$=T-B | [a]$DS_{dis}$=T-B | $US_{dis}+DS_{dis}$= |
| Change in height (Δht) | | | $DS_{ht}-US_{ht}$= |
| Slope (Δht/total dis) | | | |






CABIN

Field Crew: ______________________ Site Code: SL133

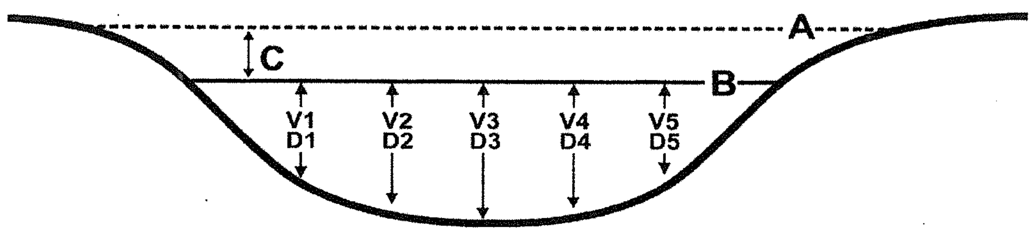
Sampling Date: (DD/MM/YYYY) ______________________

## Widths and Depth

Location at site: SL133 (Indicate where in sample reach, ex. d/s of kick area)

A - Bankfull Width: 1.1 (m) B - Wetted Stream Width: 0.9 (m)

C - Bankfull–Wetted Depth (height from water surface to Bankfull): 5 (cm)




Note:
Wetted widths > 5 m, measure a minimum of 5-6 equidistant locations;
Wetted widths < 5 m, measure 3-4 equidistant locations.

## Velocity and Depth

Check appropriate velocity measuring device and fill out the appropriate section in chart below. Distance from shore and depth are required regardless of method:

☐ **Velocity Head Rod (or ruler)**: Velocity Equation (m/s) = $\sqrt{[2(\Delta D/100) * 9.81]}$

☐ **Rotary meters**: Gurley/Price/Mini-Price/Propeller (Refer to specific meter conversion chart for calculation)

☐ **Direct velocity measurements**: ☐ Marsh-McBirney ☐ Sontek or ☐ Other________

| | 1 | 2 | 3 | 4 | 5 | 6 | AVG |
|---|---|---|---|---|---|---|---|
| Distance from Shore (m) ~~RB~~ | ~~0.25~~ | | | 0.2 | 0.4 | 0.8 | |
| Depth (D) (cm) | ~~7.4~~ | ~~6.3~~ | RB | 7.8 | 8.3 | 6.3 | LB |
| **Velocity Head Rod (ruler)** | | | | | | | |
| Flowing water Depth ($D_1$) (cm) | | | | | | | |
| Depth of Stagnation ($D_2$) (cm) | ~~7.7~~ | ~~6.3~~ | | 8.2 | 8.6 | 6.5 | |
| Change in depth ($\Delta D = D_2 - D_1$) (cm) | | | | | | | |
| **Rotary meter** | | | | | | | |
| Revolutions | | | | | | | |
| Time (minimum 40 seconds) | | | | | | | |
| **Direct Measurement or calculation** | | | | | | | |
| Velocity (V) (m/s) | | | | | | | |



CABIN

Field Crew: ______________________________ Site Code: SL33- orig. site

Sampling Date: (DD/MM/YYYY) 12/09/18

## SUBSTRATE DATA

### Surrounding/Interstitial Material

Circle the substrate size category for the surrounding material.

| Substrate Size Class | Category |
|---|---|
| Organic Cover | 0 |
| < 0.1 cm (fine sand, silt or clay) | 1 |
| 0.1-0.2 cm (coarse sand) | 2 |
| 0.2-1.6 cm (gravel) | 3 — hard to measure b/c [illegible] |
| 1.6-3.2 cm (small pebble) | 4 |
| 3.2-6.4 cm (large pebble) | 5 |
| 6.4-12.8 cm (small cobble) | 6 |
| 12.8-25.6 cm (cobble) | 7 |
| > 25.6 cm (boulder) | 8 |
| Bedrock | 9 |

### 100 Pebble Count & Substrate Embeddedness

- Measure the intermediate axis (100 rocks) and embeddedness (10 rocks) of substrate in the stream bed.
- Indicate B for bedrock, S for sand/silt/clay (particles < 0.2 cm) and O for organic material.
- Embededness categories (E): Completely embedded = 1, 3/4 embedded, 1/2 embedded, 1/4 embedded, unembedded = 0

| | Diameter (cm) | E | | Diameter (cm) | E | | Diameter (cm) | E | | Diameter (cm) | E |
|---|---|---|---|---|---|---|---|---|---|---|---|
| 1 | 1.9 | | 26 | 1.1 | | 51 | 2.0 | | 76 | 1.3 | |
| 2 | 2.5 | | 27 | 3.0 | | 52 | 2.2 | | 77 | 1.1 | |
| 3 | 1.1 | | 28 | 4.5 | | 53 | 3.6 | | 78 | 6.8 | |
| 4 | 6.0 | | 29 | 5.5 | | 54 | [illegible].0 | | 79 | 14.4 | |
| 5 | 0.4 | | 30 | 5.8 | 0 | 55 | [illegible].8 | | 80 | 5.3 | |
| 6 | 4.7 | | 31 | 6.9 | | 56 | 2.5 | | 81 | 1.6 | 0 |
| 7 | 3.5 | | 32 | 16.9 | | 57 | 2.0 | | 82 | 2.0 | |
| 8 | 2.4 | | 33 | 5.5 | | 58 | 1.3 | | 83 | 2.0 | |
| 9 | 3.[illegible] | | 34 | 4.0 | | 59 | 1.1 | | 84 | 3.6 | |
| 10 | 4.5 | 0 | 35 | 7.0 | | 60 | 3.0 | 0 | 85 | 4.0 | |
| 11 | 2.5 | | 36 | 5.6 | | 61 | 6.6 | | 86 | 4.5 | |
| 12 | 3.9 | | 37 | 6.4 | | 62 | 5.4 | | 87 | 3.0 | |
| 13 | 2.8 | | 38 | 2.5 | | 63 | 2.5 | | 88 | 3.6 | |
| 14 | 2.4 | | 39 | 3.9 | | 64 | 0.8 | | 89 | 16 | |
| 15 | 3.3 | | 40 | 3.0 | 1/4 | 65 | 4.3 | | 90 | 5.5 | |
| 16 | 6.1 | | 41 | 3.6 | | 66 | 6.6 | | 91 | 9.0 | |
| 17 | ~~12~~ 13.5 | | 42 | 3.1 | | 67 | 5.4 | | 92 | 2.6 | |
| 18 | ~~[illegible]~~ 8.6 | | 43 | 5.5 | | 68 | 4.3 | | 93 | 3.0 | 0 |
| 19 | ~~[illegible]~~ 4.6 | | 44 | 1.4 | | 69 | 6.0 | | 94 | 2.1 | 0 |
| 20 | 7.8 | 0 | 45 | 8.2 | | 70 | 5.3 | 1/4 | 95 | 4.6 | |
| 21 | 6.4 | | 46 | 7.4 | | 71 | 10.8 | | 96 | 4.7 | |
| 22 | 2.2 | | 47 | 2.6 | | 72 | 5.8 | | 97 | 7.1 | |
| 23 | B | | 48 | 5.4 | | 73 | 1.7 | | 98 | 16.4 | |
| 24 | 7.9 | | 49 | 7.9 | | 74 | 9.5 | | 99 | 1.8 | |
| 25 | 6.6 | | 50 | 3.1 | 0 | 75 | 0.9 | | 100 | 4.1 | 1/4 |

***Note:*** The Wolman D50 (i.e. median diameter), Wolman Dg (i.e. geometric mean diameter) and the % composition of the substrate classes will be calculated automatically in the CABIN database using the 100 pebble data. All 100 pebbles must be measured in order for the CABIN database tool to perform substrate calculations.



CABIN

Field Crew: ______________________________ Site Code: __________

Sampling Date: (DD/MM/YYYY) ____________________

# SITE INSPECTION

Site Inspected by: ______________________________

**Communication Information**

☐ Itinerary left with contact person (include contact numbers)

Contact Person: ________________________ Time checked-in: ________

Form of communication: ☐ radio ☐ cell ☐ satellite ☐ hotel/pay phone ☐ SPOT

Phone number: (    ) __________

**Vehicle Safety**

☐ Safety equipment (first aid, fire extinguisher, blanket, emergency kit in vehicle)

☐ Equipment and chemicals safely secured for transport

☐ Vehicle parked in safe location; pylons, hazard light, reflective vests if necessary

Notes:

**Shore & Wading Safety**

☐ Wading Task Hazard Analysis read by all field staff

☐ Wading Safe Work Procedures read by all field staff

☐ Instream hazards identified (i.e. log jams, deep pools, slippery rocks)

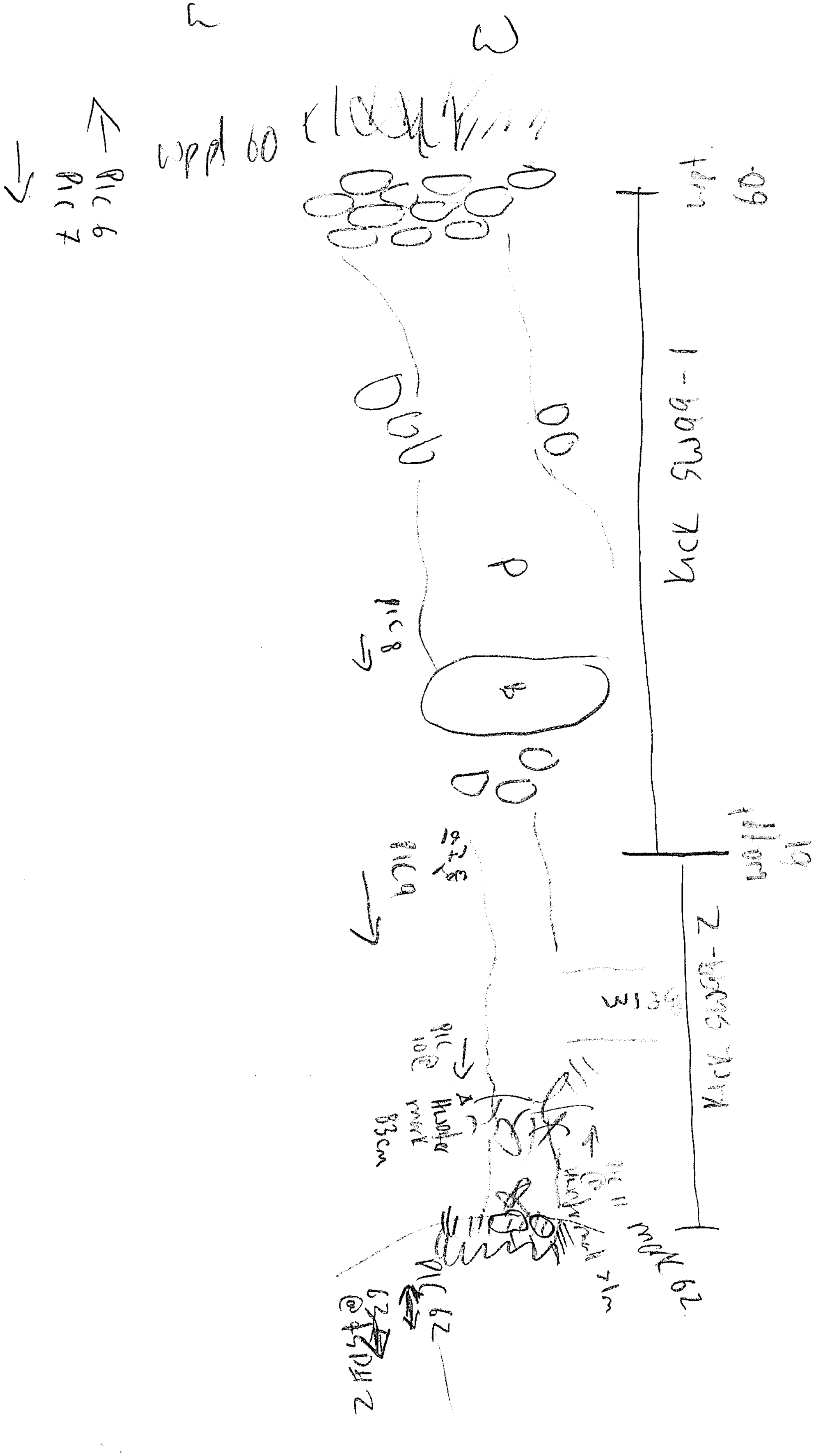
☐ PFD worn

☐ Appropriate footwear, waders, wading belt

☐ Belay used

Notes:

SW33
12/09/18



W
E
wpt 60
Kick Swag-1
Kick Swag-2
Pic 6
Pic 7
P
B
Pic 8
Pic 9
W134
83cm
mark 62
Pic 62

Field Crew: Maria S + Andrew Site Code: SW9

Sampling Date: (DD/MM/YYYY) 11/09/2018

☐ **Occupational Health & Safety: Site Inspection Sheet completed**

## PRIMARY SITE DATA

CABIN Study Name: ______________ Local Basin Name: ______________

River/Stream Name: SW9 Stream Order: (map scale 1:50,000) ______________

Select one: ☑ Test Site ☐ Potential Reference Site

**Geographical Description/Notes:**
d/s of road crossing @ shear lake outflow

Surrounding Land Use: (check those present) Information Source: ______________

☐ Forest ☐ Field/Pasture ☐ Agriculture ☐ Residential/Urban
☐ Logging ☑ Mining ☐ Commercial/Industrial ☐ Other ______________

Dominant Surrounding Land Use: (check one) Information Source: ______________

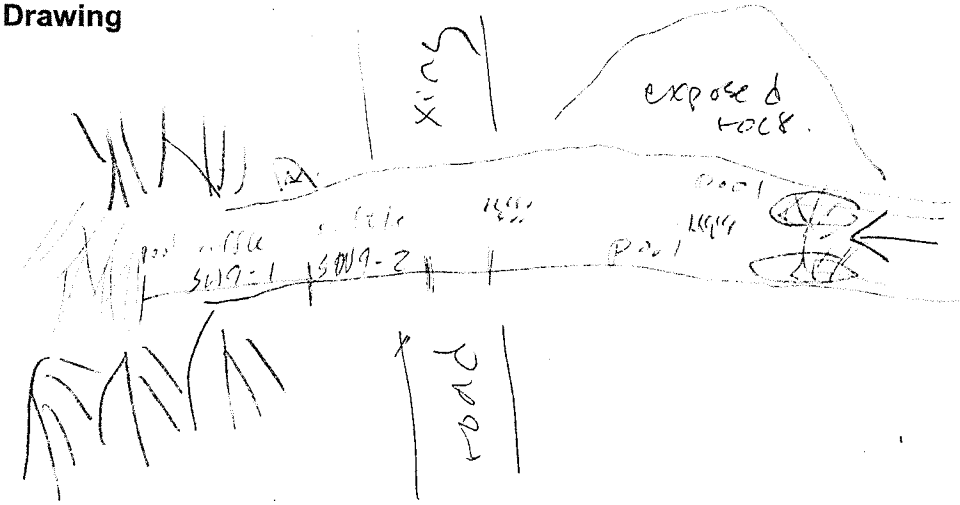
☐ Forest ☐ Field/Pasture ☐ Agriculture ☐ Residential/Urban
☐ Logging ☑ Mining ☐ Commercial/Industrial ☐ Other ______________

**Location Data** 14V 0526735 6796688

Latitude: ______________N Longitude: - ______________W (DMS or DD)

Elevation: 246 m (fasl *or* masl) GPS Datum: ☐ GRS80 (NAD83/WGS84) ☐ Other: ______________

**Site Location Map Drawing**




Note: Indicate north

Field Crew: ______________________ Site Code: SW9

Sampling Date: (DD/MM/YYYY) ______________________

**Photos** PIC#2 = fish in SW9-1 kick sample

☑ Field Sheet ☑ Upstream ☑ Downstream ☑ Across Site ☐ Aerial View

☐ Substrate (exposed) ☑ Substrate (aquatic) ☐ Other ______________________

## REACH DATA *(represents 6 times bankfull width)*

7 looking d/s from Rock wpt 46
8 looking u/s from rock @ road crossi

1. Habitat Types: *(check those present)*
   ☑ Riffle ☐ Rapids ☐ Straight run ☑ Pool/Back Eddy

2. Canopy Coverage: *(stand in middle of stream and look up, check one)*
   ☑ 0 % ☑ 1-25 % ☐ 26-50 % ☐ 51-75 % ☐ 76-100 %

   * only @ extreme d/s end where willows cover stream

3. Macrophyte Coverage: *(not algae or moss, check one)*
   ☐ 0 % ☑ 1-25 % ☐ 26-50 % ☐ 51-75 % ☐ 76-100 %

4. Streamside Vegetation: *(check those present)*
   ☑ ferns/grasses ☑ shrubs ☐ deciduous trees ☐ coniferous trees

5. Dominant Streamside Vegetation: *(check one)*
   ☑ ferns/grasses ☐ shrubs ☐ deciduous trees ☐ coniferous trees

6. Periphyton Coverage on Substrate: *(benthic algae, not moss, check one)*

   ☐ **1** - Rocks are not slippery, no obvious colour (thin layer < 0.5 mm thick)
   ☐ **2** - Rocks are slightly slippery, yellow-brown to light green colour (0.5-1 mm thick)
   ☐ **3** - Rocks have a noticeable slippery feel (footing is slippery), with patches of thicker green to brown algae (1-5 mm thick)
   ☐ **4** - Rocks are very slippery (algae can be removed with thumbnail), numerous large clumps of green to dark brown algae (5 mm -20 mm thick)
   ☐ **5** - Rocks are mostly obscured by algal mat, extensive green, brown to black algal mass may have long strands (> 20 mm thick)

Note: 1 through 5 represent categories entered into the CABIN database.

## BENTHIC MACROINVERTEBRATE DATA

Habitat sampled: (*check one*) ☐ riffle ☐ rapids ☐ straight run

| **400 µm mesh Kick Net** | 2 x 3 min |
|---|---|
| Person sampling | mcna |
| Sampling time (i.e. 3 min.) | 2 x 3 min |
| No. of sample jars | d/s 2 ; u/s 1 |
| Typical depth in kick area (cm) | 3cm |

Preservative used: Ethanol

Sampled sieved on site using "Bucket Swirling Method":
☐ YES ☑ NO

If YES, debris collected for QAQC ☐

Site SW9-2 strm crossing @ road → Wpt 47 → 246
Site SW9-01 d/s is Wpt 46 → 245

Note: Indicate if a sampling method other than the recommended 400 µm mesh kick net is used.



CABIN

Field Crew: ________________ Site Code: 9109

Sampling Date: (DD/MM/YYYY) 11|09|18

**WATER CHEMISTRY DATA** **Time:** 1430 (24 hr clock) **Time zone:** ________

Air Temp: ________ (°C) Water Temp: 6.7 (°C) pH: 6.80

Specific Conductance: 43.4 (µs/cm) DO: 12.23 (mg/L) 100.5% Turbidity: — (NTU)

Check if water samples were collected for the following analyses: √ ALS.

- ☐ TSS (Total Suspended Solids)
- ☐ Nitrogen (i.e. Total, Nitrate, Nitrite, Dissolved, and/or Ammonia)
- ☐ Phosphorus (Total, Ortho, and/or Dissolved)
- ☐ Major Ions (i.e. Alkalinity, Hardness, Chloride, and/or Sulphate) ☐ Other________

Note: Determining alkalinity is recommended, as are other analyses, but not required for CABIN assessments.

Ⓟ Taken again @ time WQ samples taken or 12/09/18 - see field book.

## CHANNEL DATA

**Slope -** Indicate how slope was measured: (check one)

☐ **Calculated from map**

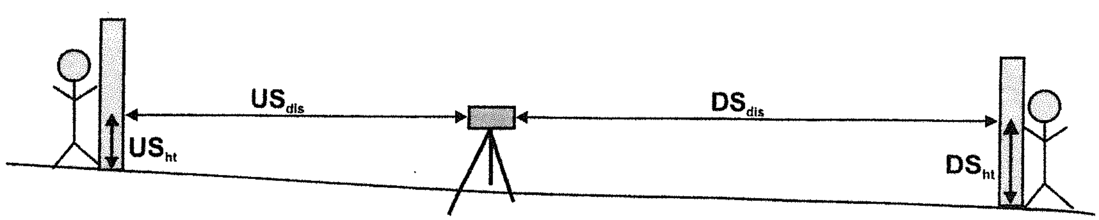
Scale: ________ (Note: small scale map recommended if field measurement is not possible - i.e. 1:20,000).
contour interval (vertical distance) ________ (m),
distance between contour intervals (horizontal distance) ________ (m)
slope = vertical distance/horizontal distance = ________

**OR**

☒ **Measured in field** Clinometer 3%

Circle device used and fill out table according to device:
a. Survey Equipment b. Hand Level & Measuring Tape

| Measurements | Upstream (U/S) | Downstream(D/S) | Calculation |
|---|---|---|---|
| [a]Top Hairline (T) | | | |
| [a]Mid Hairline (ht) OR [b]Height of rod | | | |
| [a]Bottom Hairline (B) | | | |
| [b]Distance (dis) OR [a]T-B x 100 | [a]$US_{dis}$=T-B | [a]$DS_{dis}$=T-B | $US_{dis}+DS_{dis}$= |
| Change in height (Δht) | | | $DS_{ht}-US_{ht}$= |
| Slope (Δht/total dis) | | | |



Field Crew: ______________________ Site Code: 51J9

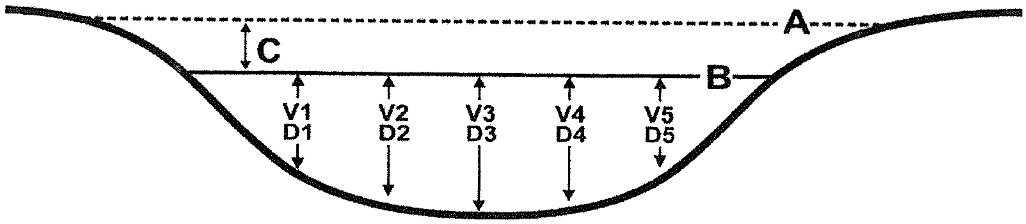
Sampling Date: (DD/MM/YYYY) ______________________

## Widths and Depth

Location at site: ______________________ (Indicate where in sample reach, ex. d/s of kick area)

A - Bankfull Width: 1.2 (m) B - Wetted Stream Width: 1.0 (m)

C - Bankfull–Wetted Depth (height from water surface to Bankfull): ______________ (cm)




Note:
Wetted widths > 5 m, measure a minimum of 5-6 equidistant locations;
Wetted widths < 5 m, measure 3-4 equidistant locations.

## Velocity and Depth

Check appropriate velocity measuring device and fill out the appropriate section in chart below. Distance from shore and depth are required regardless of method:

☐ **Velocity Head Rod (or ruler)**: Velocity Equation (m/s) = √ [ 2(ΔD/100) * 9.81]

☐ **Rotary meters**: Gurley/Price/Mini-Price/Propeller (Refer to specific meter conversion chart for calculation)

☐ **Direct velocity measurements**: ☐ Marsh-McBirney ☐ Sontek or ☐ Other______________

| | 1 | 2 | 3 | 4 | 5 | 6 | AVG |
|---|---|---|---|---|---|---|---|
| Distance from Shore (m) ~~RB~~ | ~~0.2~~ | ~~0.5~~ | RB | 0.20 | 0.5 | 0.75 | LB |
| Depth (**D**) (cm) | ~~4.5~~ | ~~3.5~~ | | 1.9 | 3.8 | 5.5 | |
| **Velocity Head Rod (ruler)** | | | | | | | |
| Flowing water Depth (**D₁**) (cm) | | | | | | | |
| Depth of Stagnation (**D₂**) (cm) | ~~4.5~~ | ~~4.0~~ | | 1.9 | 4.4 | 7.6 | |
| Change in depth (**ΔD=D₂-D₁**) (cm) | | | | | | | |
| **Rotary meter** | | | | | | | |
| Revolutions | | | | | | | |
| Time (minimum 40 seconds) | | | | | | | |
| **Direct Measurement or calculation** | | | | | | | |
| Velocity (**V**) (m/s) | | | | | | | |

Field Crew: ____________________ Site Code: 3W9.

Sampling Date: (DD/MM/YYYY) 11/09/18.

## SUBSTRATE DATA

### Surrounding/Interstitial Material

Circle the substrate size category for the surrounding material.

| Substrate Size Class | Category |
|---|---|
| Organic Cover | 0 |
| < 0.1 cm (fine sand, silt or clay) | 1 |
| 0.1-0.2 cm (coarse sand) | 2 |
| 0.2-1.6 cm (gravel) | 3 |
| 1.6-3.2 cm (small pebble) | 4 |
| 3.2-6.4 cm (large pebble) | 5 |
| 6.4-12.8 cm (small cobble) | 6 |
| 12.8-25.6 cm (cobble) | 7 |
| > 25.6 cm (boulder) | 8 |
| Bedrock | 9 |

### 100 Pebble Count & Substrate Embeddedness

- Measure the intermediate axis (100 rocks) and embeddedness (10 rocks) of substrate in the stream bed.
- Indicate B for bedrock, S for sand/silt/clay (particles < 0.2 cm) and O for organic material.
- Embededness categories (E): Completely embedded = 1, 3/4 embedded, 1/2 embedded, 1/4 embedded, unembedded = 0

| | Diameter (cm) | E | | Diameter (cm) | E | | Diameter (cm) | E | | Diameter (cm) | E |
|---|---|---|---|---|---|---|---|---|---|---|---|
| 1 | 4.5 | | 26 | 4.4 | | 51 | 4.1 | 0 | 76 | 2.0 | |
| 2 | 3.5 | | 27 | 2.1 | | 52 | 1.8 | | 77 | 4.1 | |
| 3 | 2.8 | | 28 | 2.2 | 0 | 53 | 3.6 | | 78 | 2.6 | |
| 4 | 3.7 | | 29 | 1.9 | 1/4 | 54 | 2.0 | | 79 | 12.3 | 1/4 |
| 5 | 2.7 | | 30 | 3.3 | | 55 | 3.0 | | 80 | 2.2 | 1/2 |
| 6 | 4.0 | | 31 | 4.0 | | 56 | 11.8 | | 81 | 4.2 | |
| 7 | 4.6 | | 32 | 1.6 | | 57 | 4.6 | | 82 | 6.0 | |
| 8 | 5.9 | | 33 | 6.9 | | 58 | 4.5 | | 83 | 2.8 | |
| 9 | 6.1 | | 34 | 3.1 | | 59 | 2.0 | | 84 | 5.3 | |
| 10 | 2.9 | | 35 | 1.3 | | 60 | 1.3 | 0 | 85 | 2.4 | |
| 11 | 2.6 | E | 36 | 2.8 | | 61 | 5.6 | | 86 | 6.3 | |
| 12 | 2.4 | | 37 | 10.6 | | 62 | 1.4 | | 87 | 4.0 | |
| 13 | 3.0 | | 38 | 2.9 | | 63 | 2.3 | | 88 | 2.0 | |
| 14 | 2.0 | | 39 | 6.2 | 1/4 | 64 | 2.8 | | 89 | 1.9 | |
| 15 | 2.8 | | 40 | 3.0 | | 65 | 4.2 | | 90 | 2.9 | 0 |
| 16 | 2.9 | | 41 | 3.3 | | 66 | 5.0 | | 91 | 0.6 | |
| 17 | 3.7 | | 42 | 2.8 | | 67 | 3.9 | | 92 | 3.2 | |
| 18 | 0.7 | | 43 | 6.5 | | 68 | 3.0 | | 93 | 6.0 | |
| 19 | 2.8 | | 44 | 4.0 | | 69 | 2.0 | | 94 | 6.3 | |
| 20 | 5.4 | | 45 | 2.6 | | 70 | 1.1 | 1/2 | 95 | [illegible] | |
| 21 | 4.0 | | 46 | 1.9 | | 71 | 5.0 | | 96 | [illegible] | |
| 22 | 5.0 | | 47 | 5.9 | | 72 | 1.3 | | 97 | [illegible] | |
| 23 | 2.6 | | 48 | 6.2 | | 73 | 5.0 | | 98 | 4.7 | |
| 24 | 2.3 | | 49 | [illegible] | | 74 | 3.0 | | 99 | 4.1 | |
| 25 | 2.0 | | 50 | 2.5 | | 75 | 2.9 | | 100 | 3.3 | 1/4 |

***Note:*** The Wolman D50 (i.e. median diameter), Wolman Dg (i.e. geometric mean diameter) and the % composition of the substrate classes will be calculated automatically in the CABIN database using the 100 pebble data. All 100 pebbles must be measured in order for the CABIN database tool to perform substrate calculations.



CABIN

Field Crew: ______________________________ Site Code: __________

Sampling Date: (DD/MM/YYYY) ____________________

## SITE INSPECTION

Site Inspected by: ____________________________

**Communication Information**

☐ Itinerary left with contact person (include contact numbers)

Contact Person: ______________________ Time checked-in: ________

Form of communication: ☐ radio ☐ cell ☐ satellite ☐ hotel/pay phone ☐ SPOT

Phone number: (     ) __________

**Vehicle Safety**

☐ Safety equipment (first aid, fire extinguisher, blanket, emergency kit in vehicle)

☐ Equipment and chemicals safely secured for transport

☐ Vehicle parked in safe location; pylons, hazard light, reflective vests if necessary

Notes:

**Shore & Wading Safety**

☐ Wading Task Hazard Analysis read by all field staff

☐ Wading Safe Work Procedures read by all field staff

☐ Instream hazards identified (i.e. log jams, deep pools, slippery rocks)

☐ PFD worn

☐ Appropriate footwear, waders, wading belt

☐ Belay used

Notes:

PALMER
ENVIRONMENTAL
CONSULTING
GROUP INC.

# Appendix E

## Cordillera Datasheets

# Methods and QC Report 2018

Project ID: Cullaton - 14054

Client: Palmer Environmental

**Prepared by:**
Scott Finlayson
Cordillera Consulting Inc.
Summerland, BC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Summerland, BC, V0H 1Z0
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## Sample Reception

On October 2, 2018, Cordillera Consulting received 4 CABIN samples from Palmer Environmental Group. When samples arrived to Cordillera Consulting, exterior packaging was initially inspected for damage or wet spots that would have indicated damage to the interior containers.

Next, samples were logged into a proprietary software database (INSTAR1) where the clients assigned sample name was recorded along with a Cordillera Consulting (CC) number for cross-reference. Each sample was checked to ensure that all sites and replicates recorded on field sheets or packing lists were delivered intact and with adequate preservative. Any missing, mislabelled or extra samples were reported to the client immediately to confirm the total numbers and correct names on the sample jars. The client representative was notified of the arrival of the shipment and provided a sample inventory once intake was completed.
See table below for sample inventory:

**Table 1: Summary of sample information including Cordillera Consulting (CC) number**

| Site | Sample | CC# | Date | Size | # of Jars |
|---|---|---|---|---|---|
| 2018 | SW9-1 | CC191667 | 9/11/2018 | 400µM | 2 |
| 2018 | SW9-2 | CC191668 | 9/11/2018 | 400µM | 1 |
| 2018 | SW33-1 | CC191669 | 9/12/2018 | 400µM | 1 |
| 2018 | SW33-2 | CC191670 | 9/12/2018 | 400µM | 2 |

## Sample Sorting

- Using a gridded Petri dish, fine forceps and a low power stereo-microscope (Olympus, Nikon, Leica) the sorting technicians removed the invertebrates and sorted them into family/orders.
- The sorting technician kept a running tally of total numbers excluding organisms from Porifera, Nemata, Platyhelminthes, Ostracoda, Copepoda, Cladocera and terrestrial drop-ins such as aphids. These organisms were marked for their presence (given a value of 1) only and left in the sample. They were not included towards the 300-organism subsample count.
- Where specimens are broken or damaged, only heads were counted.
- Subsampling was conducted with the use of a Marchant Box.
- When using the Marchant box, cells were extracted at the same time in the order indicated by a random number table. If the 300$^{th}$ organism was found part way into sorting a cell then the balance of that cell was sorted. If the organism count had not reached 300 by the 50$^{th}$ cell then the entire sample was sorted.
- The total number of cells sorted and the number of organisms removed were recorded manually on a bench sheet and then recorded into INSTAR1
- Organisms were stored in vials containing 80% ethanol and an interior label indicating the site names, date of sampling, site code numbers and portion subsampled. This information was also recorded on the laboratory bench sheet and on INSTAR1.
- The sorted portion of the debris was preserved and labeled separately from the unsorted portion and was tested for sorting efficiency (Sorting Quality Control – Sorting Efficiency). The unsorted portion was also labeled and preserved in separate jars.

Percent sub-sampled and total countable invertebrates pulled from the samples were summarized in the table below.

**Table 2: Percent sub-sample and invertebrate count for each sample**

| Site | Sample | Date | CC# | 400 micron fraction | |
|---|---|---|---|---|---|
| | | | | % Sampled | # Invertebrates |
| 2018 | SW9-1 | 11-Sep-18 | CC191667 | 23% | 318 |
| 2018 | SW9-2 | 11-Sep-18 | CC191668 | 25% | 326 |
| 2018 | SW33-1 | 12-Sep-18 | CC191669 | 100% | 477 |
| 2018 | SW33-2 | 12-Sep-18 | CC191670 | 33% | 334 |

## Sorting Quality Control - Sorting Efficiency

As a part of Cordillera's laboratory policy, all projects undergo sorting efficiency checks.

- As sorting progresses, 10% of samples were randomly chosen by senior members of the sorting team for resorting.
- All sorters working on a project had at least 1 sample resorted by another sorter.
- An efficiency of 90 % was expected (95% for CABIN samples).

- If 90/95% efficiency was not met, samples from that sorter were resorted.
- To calculated sorting efficiency the following formula was used:

$$\frac{\#OrganismsMissed}{TotalOrganismsFound} * 100 = \%OM$$

Table 3: Summary of sorting efficiency

| CC # | Number of Organisms Recovered (initial sort) | Number of Organisms in Re-sort | Percent Recovery |
|---|---|---|---|
| CC190974 | 318 | 6 | 98% |
| | | Average Recovery | 98% |

## Taxonomic Effort

The next procedure was the identification to genus-species level where possible of all the organisms in the sample.

- Identifications were made at the genus/species level for all insect organisms found including Chironomidae (Based on CABIN protocol).
- Non-insect organisms (except those not included in CABIN count) were identified to genus/species where possible and to a minimum of family level with intact and mature specimens.
- The Standard Taxonomic Effort lists compiled by the CABIN manual[1], SAFIT[2] , and PNAMP[3] were used as a guide line for what level of identification to achieve where the condition and maturity of the organism enabled.
- Organisms from the same families/order were kept in separate vials with 80% ethanol and an interior label of printed laser paper.
- Chironomidae was identified to genus/species level where possible and was aided by slide mounts. CMC-10 was used to clear and mount the slide.
- Oligochaetes was identified to family/genus level with the aid of slide mounts. CMC-10 was used to clear and mount the slide.
- Other Annelida (leeches, polychaetes) were identified to the family/genus/species level with undamaged, mature specimens.
- Mollusca was identified to family and genus/species where possible
- Decapoda, Amphipoda and Isopoda were identified at family/genus/species level where possible.
- Bryozoans and Nemata remained at the phylum level
- Hydrachnidae and Cnidaria were identified at the family/genus level where possible.
- When requested, reference collections were made containing at least one individual from each taxa listed. Organisms represented will have been identified to the lowest practical level.
- Reference collection specimens were stored in 55 mm glass vials with screw-cap lids with polyseal inserts (museum quality). They were labeled with taxa name, site code,

date identified and taxonomist name. The same information was applied to labels on the slide mounts.

## Taxonomic QC

The taxonomists for this project were certified by the Society of Freshwater Science (SFS) Taxonomic Certification Program at level 2 which is the required certification for CABIN projects:

**Scott Finlayson**: Group 1 General Arthropods (East/West); Group 2 EPT (East/West); Group 3 Chironomidae (East/West); Group 4 Oligochaeta

**Adam Bliss**: Group 1 General Arthropods (East/West); Group 2 EPT (East/West); Group 3 Chironomidae

**Rita Avery:** Group 1 General Arthropods (East/West); Group 2 EPT (East/West)

Taxonomic QC was performed in house by someone other than the original taxonomist.

- Quality control protocol involved complete, blind re-identification and re-enumeration of at least 10% of samples by a second SFS-certified taxonomist.
- Samples for taxonomic quality control were randomly selected and quality control procedures were conducted as the project progresses through the laboratories.

- The second (QC) taxonomist will calculate and record four types of errors:
    1. Misidentification error
    2. Enumeration error
    3. Questionable taxonomic resolution error
    4. Insufficient taxonomic resolution error

The QC coordinator then calculates the following estimates of taxonomic precision.

1. The percent total identification error rate is calculated as:

$$\frac{Sum\ of\ incorrect\ identifications}{total\ organisms\ counted\ in\ audit} * (100)$$

The average total identification error rate of audited samples did not exceed 5%. All samples that exceed a 5% error rate were re-evaluated to determine whether repeated errors or patterns in error contributed.

2. The percent difference in enumeration (PDE) to quantify the consistency of specimen counts.

$$PDE = \frac{|n_1 - n_2|}{n_1 + n_2} x100$$

3. The percent taxonomic disagreement (PTD) to quantify the shared precision between two sets of identifications.

$$PTD = \left(1 - \left[\frac{a}{N}\right]\right) x100$$

4. Bray Curtis dissimilarity Index to quantify the differences in identifications.

$$BC_{ij} = 1 - \frac{2C_{ij}}{S_j + S_i}$$

## Error Summary

The sample report errors are not within the acceptable limits for CABIN Laboratory methods (less than 5% error). The chironomid taxa were re-identified for all of the remaining samples. The new identifications were updated on the CABIN data base.

Table 4: Summary of taxonomic error following QC

| Site | Taxa Identified | % Error | PDE | PTD | Bray - Curtis Dissimilarity index |
|---|---|---|---|---|---|
| Site - 2018, Sample - SW33-1, CC# - CC191669, Percent sampled = 100%, Sieve size = 400 | 366 | 1.37 | 0.2739 | 2.459 | 0.0219 |

There will always be disagreements between taxonomists regarding the degree of taxonomic resolution in immature specimens and when laboratories make use of different keys for certain groups (Mollusks is an especially disputed group). It is always possible that some taxa found by the original taxonomist were overlooked in QC.

All of the Taxonomic QC samples that were observed passed testing according to the CABIN misidentification protocols. See the tables below for results from taxonomic QC audit.

## Error Rationale

| Site - 2018, Sample - SW33-1, CC# - CC191669, Percent sampled = 100%, Sieve size = 400 | Laboratory Count | QC Audit Count | Agreement | Misidentification | Questionable Taxonomic Resolution | Enumeration | Insufficent Taxonomic Resolution | Comments |
|---|---|---|---|---|---|---|---|---|
| Ablabesmyia | 61 | 61 | | | | | | |
| Arachnida | 1 | 1 | | | | | | |
| Bezzia/ Palpomyia | 25 | 25 | | | | | | |
| Chironomidae | 2 | 0 | No | 2 | | X | | |

| | | | | | | | | |
|---|---|---|---|---|---|---|---|---|
| Collembola | 1 | 1 | | | | | | |
| Corynoneura | 2 | 2 | | | | | | |
| Diplocladius cultriger | 4 | 5 | No | | | X | | |
| Diptera | 1 | 1 | | | | | | |
| Dixidae | 0 | 2 | No | | | X | | From Chironomidae |
| Dixella | 2 | 2 | | | | | | |
| Enchytraeus | 96 | 96 | | | | | | |
| Fossaria | 1 | 1 | | | | | | |
| Gastropoda | 1 | 1 | | | | | | |
| Hydrophilidae | 1 | 1 | | | | | | |
| Lebertia | 1 | 1 | | | | | | |
| Limnephilidae | 1 | 1 | | | | | | |
| Limnophyes | 62 | 59 | No | | | X | | |
| Lymnaeidae | 4 | 4 | | | | | | |
| Nemouridae | 2 | 2 | | | | | | |
| Orthocladius | 29 | 29 | | | | | | |
| Orthocladius complex | 8 | 11 | No | | | X | | |
| Paratanytarsus | 0 | 1 | No | 1 | | X | | From Tanytarsus |
| Physella | 1 | 1 | | | | | | |
| Physidae | 1 | 1 | | | | | | |
| Polypedilum | 1 | 1 | | | | | | |
| Simulium | 1 | 1 | | | | | | |
| Smittia | 0 | 1 | | 1 | | | | |
| Sperchon | 9 | 9 | | | | | | |
| Stempellinella | 0 | 1 | No | 1 | | X | | From Tanytarsus |
| Tanytarsini | 1 | 1 | | | | | | |
| Tanytarsus | 3 | 1 | No | | | X | | |
| Tipula | 1 | 1 | | | | | | |
| Tipulidae | 2 | 2 | | | | | | |
| Trombidiformes | 22 | 22 | | | | | | |
| Tubificinae with hair chaetae | 17 | 17 | | | | | | |
| | | | | | | | | |
| | | | | | | | | |
| | | | | | | | | |
| | | | | | | | | |
| | | | | | | | | |
| **Total:** | **364** | **366** | | | | | | |

| | | | | | | | | |
|---|---|---|---|---|---|---|---|---|
| | | | | | 0 | 8 | 0 | |
| % Total Misidentification Rate = | misidentifications | x100 = | 1.37 | **Pass** | | | | |
| | total number | | | | | | | |

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# Taxonomic Keys

Below is a reference list of taxonomic keys utilized by taxonomists at Cordillera Consulting. Cordillera taxonomists routinely seek out new literature to ensure the most accurate identification keys are being utilized. This is not reflective of the exhaustive list of resources that we use for identification. A more complete list of taxonomic resources can be found at Southwest Association of Freshwater Invertebrate Taxonomists. (2015).
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Cordillera Consulting

**Project: 14054 Cullaton Lake 2018**
Palmer Environmental Group, Alyssa Murdoch, May Mason Irene Mencke,
Taxonomist: Scott Finlayson
scoottfinlayson@cordilleraconsulting.ca
250-494-7553

| | | | | |
|---|---|---|---|---|
| **Site:** | 2018 | 2018 | 2018 | 2018 |
| **Sample:** | SW9-1 | SW9-2 | SW33-1 | SW33-2 |
| **Sample Collection Date:** | 11-Sep-18 | 11-Sep-18 | 12-Sep-18 | 12-Sep-18 |
| **CC#:** | CC191667 | CC191668 | CC191669 | CC191670 |
| **Phylum: Arthropoda** | 0 | 0 | 0 | 0 |
| **\| Order: Collembola** | 0 | 0 | 1 | 12 |
| **\| Family: Sminthuridae** | 0 | 0 | 0 | 6 |
| | | | | |
| **Subphylum: Hexapoda** | 0 | 0 | 0 | 0 |
| **\| Class: Insecta** | 0 | 0 | 0 | 0 |
| **\| Order: Ephemeroptera** | 0 | 0 | 0 | 0 |
| **\| Family: Baetidae** | 0 | 0 | 0 | 0 |
| *Baetis* | 39 | 16 | 0 | 0 |
| **\| Family: Leptophlebiidae** | 0 | 4 | 0 | 0 |
| | | | | |
| **\| Order: Plecoptera** | 0 | 0 | 0 | 0 |
| **\| Family: Chloroperlidae** | 0 | 0 | 0 | 0 |
| *Haploperla* | 0 | 4 | 0 | 0 |
| **\| Family: Nemouridae** | 0 | 12 | 2 | 0 |
| **\| Family: Peltoperlidae** | 0 | 0 | 0 | 0 |
| *Yoraperla* | 0 | 4 | 0 | 0 |
| | | | | |
| **\| Order: Trichoptera** | 0 | 0 | 0 | 0 |
| **\| Family: Hydroptilidae** | 0 | 0 | 0 | 0 |

| Site: | 2018 | 2018 | 2018 | 2018 |
|---|---|---|---|---|
| **Sample:** | SW9-1 | SW9-2 | SW33-1 | SW33-2 |
| **Sample Collection Date:** | 11-Sep-18 | 11-Sep-18 | 12-Sep-18 | 12-Sep-18 |
| **CC#:** | CC191667 | CC191668 | CC191669 | CC191670 |
| *Oxyethira* | 43 | 52 | 0 | 3 |
| **\| Family: Limnephilidae** | 0 | 4 | 1 | 6 |
| **\| Family: Molannidae** | 0 | 0 | 0 | 0 |
| *Molannodes tinctus* | 9 | 0 | 0 | 0 |
| | | | | |
| **\| Order: Coleoptera** | 0 | 0 | 0 | 0 |
| **\| Family: Hydrophilidae** | 0 | 0 | 1 | 0 |
| *Enochrus* | 0 | 0 | 0 | 3 |
| | | | | |
| **\| Order: Diptera** | 0 | 0 | 1 | 6 |
| **\| Family: Ceratopogonidae** | 0 | 0 | 0 | 0 |
| *Bezzia/ Palpomyia* | 170 | 256 | 25 | 58 |
| *Mallochohelea* | 9 | 0 | 0 | 0 |
| **\| Family: Chironomidae** | 0 | 0 | 0 | 0 |
| **\| Subfamily: Chironominae** | 0 | 0 | 0 | 0 |
| **\| Tribe: Chironomini** | 0 | 0 | 0 | 0 |
| *Chironomus* | 26 | 8 | 0 | 6 |
| *Cryptochironomus* | 4 | 8 | 0 | 0 |
| *Parachironomus* | 0 | 0 | 0 | 6 |
| *Phaenopsectra* | 0 | 0 | 0 | 3 |
| *Polypedilum* | 87 | 16 | 1 | 9 |
| **\| Tribe: Tanytarsini** | 109 | 152 | 1 | 0 |
| *Constempellina* | 30 | 32 | 0 | 3 |
| *Paratanytarsus* | 0 | 0 | 1 | 15 |
| *Rheotanytarsus* | 74 | 0 | 0 | 0 |
| *Stempellinella* | 4 | 0 | 1 | 0 |
| *Tanytarsus* | 261 | 504 | 1 | 18 |
| **\| Subfamily: Orthocladiinae** | 0 | 4 | 0 | 0 |
| *Corynoneura* | 0 | 0 | 2 | 42 |
| *Diplocladius cultriger* | 0 | 0 | 5 | 9 |

| Site: | 2018 | 2018 | 2018 | 2018 |
|---|---|---|---|---|
| **Sample:** | SW9-1 | SW9-2 | SW33-1 | SW33-2 |
| **Sample Collection Date:** | 11-Sep-18 | 11-Sep-18 | 12-Sep-18 | 12-Sep-18 |
| **CC#:** | CC191667 | CC191668 | CC191669 | CC191670 |
| *Limnophyes* | 91 | 0 | 59 | 291 |
| *Metriocnemus* | 0 | 4 | 0 | 0 |
| *Nanocladius* | 0 | 4 | 0 | 0 |
| *Orthocladius* | 100 | 88 | 29 | 248 |
| *Orthocladius complex* | 65 | 0 | 11 | 0 |
| *Psectrocladius* | 17 | 20 | 0 | 0 |
| *Smittia* | 0 | 0 | 1 | 0 |
| *Zalutschia* | 43 | 0 | 0 | 0 |
| **\| Subfamily: Tanypodinae** | 9 | 0 | 0 | 0 |
| *Ablabesmyia* | 9 | 4 | 61 | 100 |
| *Zavrelimyia* | 52 | 0 | 0 | 0 |
| **\| Tribe: Pentaneurini** | 0 | 0 | 0 | 0 |
| *Thienemannimyia group* | 0 | 20 | 0 | 0 |
| **\| Tribe: Procladiini** | 0 | 0 | 0 | 0 |
| *Procladius* | 4 | 12 | 0 | 0 |
| **\| Family: Dixidae** | 0 | 0 | 2 | 0 |
| *Dixa* | 0 | 4 | 0 | 0 |
| *Dixella* | 0 | 0 | 2 | 0 |
| **\| Family: Empididae** | 0 | 0 | 0 | 0 |
| *Hemerodromia* | 4 | 4 | 0 | 0 |
| **\| Family: Psychodidae** | 0 | 0 | 0 | 0 |
| *Pericoma/Telmatoscopus* | 0 | 0 | 0 | 3 |
| **\| Family: Simuliidae** | 0 | 0 | 0 | 0 |
| *Simulium* | 43 | 24 | 1 | 12 |
| **\| Family: Tipulidae** | 0 | 0 | 2 | 0 |
| *Antocha* | 9 | 0 | 0 | 0 |
| *Limnophila* | 4 | 0 | 0 | 0 |
| *Tipula* | 0 | 0 | 1 | 0 |
| | | | | |
| **\| Order: Lepidoptera** | 4 | 0 | 0 | 3 |

| Site: | 2018 | 2018 | 2018 | 2018 |
|---|---|---|---|---|
| **Sample:** | SW9-1 | SW9-2 | SW33-1 | SW33-2 |
| **Sample Collection Date:** | 11-Sep-18 | 11-Sep-18 | 12-Sep-18 | 12-Sep-18 |
| **CC#:** | CC191667 | CC191668 | CC191669 | CC191670 |
| **\| Order: Thysanoptera** | 4 | 0 | 0 | 3 |
| | | | | |
| **Subphylum: Chelicerata** | 0 | 0 | 0 | 0 |
| **\| Class: Arachnida** | 4 | 0 | 1 | 0 |
| **\| Order: Trombidiformes** | 13 | 0 | 22 | 24 |
| **\| Family: Arrenuridae** | 0 | 0 | 0 | 0 |
| *Arrenurus* | 0 | 0 | 0 | 3 |
| **\| Family: Lebertiidae** | 0 | 0 | 0 | 0 |
| *Lebertia* | 0 | 4 | 1 | 3 |
| **\| Family: Pionidae** | 0 | 0 | 0 | 6 |
| **\| Family: Sperchontidae** | 0 | 0 | 0 | 0 |
| *Sperchon* | 26 | 16 | 9 | 64 |
| *Sperchonopsis* | 9 | 12 | 0 | 0 |
| | | | | |
| **Phylum: Mollusca** | 0 | 0 | 0 | 0 |
| **\| Class: Bivalvia** | 0 | 0 | 0 | 0 |
| **\| Order: Veneroida** | 0 | 0 | 0 | 0 |
| **\| Family: Pisidiidae** | 4 | 0 | 0 | 0 |
| | | | | |
| **\| Class: Gastropoda** | 0 | 0 | 1 | 0 |
| **\| Order: Basommatophora** | 0 | 0 | 0 | 0 |
| **\| Family: Lymnaeidae** | 0 | 0 | 4 | 15 |
| *Fossaria* | 0 | 0 | 1 | 3 |
| **\| Family: Physidae** | 0 | 0 | 1 | 0 |
| *Physella* | 0 | 0 | 1 | 12 |
| **\| Family: Planorbidae** | 0 | 0 | 0 | 0 |
| *Gyraulus* | 0 | 0 | 0 | 3 |
| | | | | |
| **Phylum: Annelida** | 0 | 0 | 0 | 0 |
| **Subphylum: Clitellata** | 0 | 0 | 0 | 0 |

| Site: | 2018 | 2018 | 2018 | 2018 |
|---|---|---|---|---|
| **Sample:** | SW9-1 | SW9-2 | SW33-1 | SW33-2 |
| **Sample Collection Date:** | 11-Sep-18 | 11-Sep-18 | 12-Sep-18 | 12-Sep-18 |
| **CC#:** | CC191667 | CC191668 | CC191669 | CC191670 |
| **\| Class: Oligochaeta** | 0 | 0 | 0 | 0 |
| **\| Order: Tubificida** | 0 | 0 | 0 | 0 |
| **\| Family: Enchytraeidae** | 0 | 0 | 0 | 0 |
| *Enchytraeus* | 0 | 8 | 96 | 12 |
| **\| Family: Naididae** | 0 | 4 | 0 | 0 |
| **\| Subfamily: Tubificinae with ha** | 0 | 0 | 17 | 0 |
| **Totals:** | **1379** | **1304** | **366** | **1010** |

**Taxa present but not included:**

| | | | | |
|---|---|---|---|---|
| **Phylum: Arthropoda** | 0 | 0 | 0 | 0 |
| **Subphylum: Hexapoda** | 0 | 0 | 0 | 0 |
| **\| Class: Insecta** | 0 | 0 | 0 | 0 |
| **\| Order: Diptera** | 0 | 0 | 0 | 0 |
| **\| Family: Cecidomyiidae** | 0 | 0 | 4 | 3 |
| | | | | |
| **Subphylum: Crustacea** | 0 | 0 | 0 | 0 |
| **\| Class: Ostracoda** | 4 | 4 | 1 | 3 |
| **\| Class: Branchiopoda** | 0 | 0 | 0 | 0 |
| **\| Order: Cladocera** | 4 | 4 | 1 | 3 |
| | | | | |
| **\| Class: Maxillipoda** | 0 | 0 | 0 | 0 |
| **\| Class: Copepoda** | 4 | 4 | 1 | 3 |
| | | | | |
| **Phylum: Annelida** | 0 | 0 | 0 | 0 |
| **Subphylum: Clitellata** | 0 | 0 | 0 | 0 |
| **\| Class: Oligochaeta** | 0 | 0 | 0 | 0 |
| **\| Order: Tubificida** | 0 | 0 | 0 | 0 |
| **\| Family: Lumbricidae** | 0 | 4 | 0 | 0 |

| | | | | |
|---|---|---|---|---|
| **Site:** | 2018 | 2018 | 2018 | 2018 |
| **Sample:** | SW9-1 | SW9-2 | SW33-1 | SW33-2 |
| **Sample Collection Date:** | 11-Sep-18 | 11-Sep-18 | 12-Sep-18 | 12-Sep-18 |
| **CC#:** | CC191667 | CC191668 | CC191669 | CC191670 |
| **Phylum: Nemata** | 0 | 4 | 1 | 0 |
| **Totals:** | **12** | **20** | **8** | **12** |