Government of Northwest Territories Gouvernement des Territoires du Nord-Ouest

Cindy Robinson
Senior Supervisor, Environment and Permitting
Teck Resources Limited, Legacy Properties

Re: Water License MV2017L2-0007
Quality Assurance and Quality Control Plan V2.0

Submitted: November 21, 2024
Reviewed: November 25, 2024

Thank you for the revised submission of the Quality Assurance and Quality Control Plan prepared for Teck Resources Ltd. The revised Pine Point Tailings Impoundment Area QA/QC plan has been reviewed and updates found to be acceptable.

If you have any questions or require further information, please do not hesitate to contact me at (867) 767-9235 x53162 or via email at Bradley_Koswan@gov.nt.ca.

Sincerely,

Bradley Koswan
Quality Assurance Officer
Analyst under the Northwest Territories Waters Act

Teck Metals Ltd. Pine Point Tailings Impoundment Area

Quality Assurance and Quality Control (QA/QC) Plan for the Surveillance Network Program - V2.0

Water Licence: MV2017L2-0007

Effective Date: June 19, 2019

Revised Date: November 15, 2024

Legacy Properties / Teck

Plain Language Summary

The Teck Metals Ltd. (Teck) Pine Point Tailings Impoundment Area (TIA) is located approximately 50 km southwest of Fort Resolution, NT and approximately 75 km east of Hay River, NT. The TIA is associated with the former Pine Point lead-zinc mine that operated from 1964 to 1988. In 1996, most of the lands leased to Teck's predecessor, Cominco, were released back to the Government of Northwest Territories (GNWT). The remaining lease (#85B/16-9-11) at closure includes the north portion of the TIA and some surrounding area. In 2020, an additional surface lease was acquired (L-2000009T) that incorporates the southern portion of the TIA for purposes of dyke inspection and maintenance and reclamation research and implementation.

Current activities on site are those associated with the "Closure Active Care Phase" of the TIA, which includes active treatment of water that collects in the TIA according to Water Licence MV2017L2-0007 and Land Use Permit MV2019X0006. Surface water runoff from the tailings area is collected and treated onsite with lime to precipitate zinc before discharge to the environment from June to October (approximately).

This quality control and quality assurance plan (QAQC) addresses the techniques used to collect and analyze samples collected for the Surveillance Network Program (SNP). The purpose of the SNP is to monitor water quality at the Pine Point TIA and downstream of the water treatment discharge point. This document describes the following:

- Where samples must be collected in accordance with the water licence
- Procedures used for sample collection
- On-site laboratory equipment, calibration and maintenance
- External laboratory provider analysis methods and how Teck determines if the data meet data quality objectives
- Data review and reporting

Version History Table

Revision No.	Date Created / Revised (yyyy-mmm-dd)	Revision(s) Made
1.0	2019-June-19	• Original document
2.0	2024-Nov-15	• Updated roles and responsibilities to reflect changes in the team structure. • Included more detailed procedures for laboratory tests. • Removed turbidity measurements and replaced with total suspended solids analysis • Updated QAQC sample approach • Added related Teck procedures • Updated ALS laboratory accreditation certificate, scope, qualifications, QA manual and detection limits (Appendices E, F, G, H and I)

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Abbreviations

APHA	American Public Health Association
CALA	Canadian Association for Laboratory Accreditation
CCME	Canadian Council of Ministers of the Environment
EQC	Effluent Quality Criteria
GPS	Global Positioning System
mg/L	Milligrams per litre
MVLWB	Mackenzie Valley Land and Water Board
N	Nitrogen
NT	Northwest Territories
NTU	Nephelometric Turbidity Units
QAQC	Quality Assurance and Quality Control
RPD	Relative Percent Difference
SNP	Surveillance Network Program
TIA	Tailings Impoundment Area
TSS	Total Suspended Solids
US EPA	United States Environmental Protection Agency
µg/L	Micrograms per litre

1.0 Introduction

This Quality Assurance and Quality Control (QAQC) Plan has been developed to meet Part A: Reporting Requirements, requirement 6 identified in Annex A Type B Water Licence MV2017L2-0007 (Water Licence) for the Teck Metals Ltd. (Teck) Pine Point Tailings Impoundment Area (TIA). In addition, the plan was developed according to guidelines published by the Department of Indian and Northern Affairs Canada, currently Crown-Indigenous Relations and Northern Affairs Canada (INAC 1996) . This QAQC Plan addresses the techniques used to collect and analyze samples collected for the Surveillance Network Program (SNP), for the purposes of quality assurance and quality control. The purpose of the SNP is to monitor water quality at the Pine Point TIA and downstream of the water treatment discharge point.

1.1 Site History

The Pine Point TIA is located on the south side of Great Slave Lake, between Hay River and Fort Resolution, Northwest Territories (NT) (Figure 1). The Pine Point mine was a lead-zinc mine operated by Cominco from 1964 to 1988. The site has operated under a Water Licence since 1975. A Closure and Abandonment Plan was implemented when the mine closed in 1988, Following initial implementation of the closure and reclamation activities surface leases were surrendered back to the Crown during the mid to late 1990s, with the exception of one surface lease. The remaining lease (#85B/16-9-9) at closure includes the north portion of the TIA and some surrounding area. In 2020, an additional surface lease was acquired (L-2000009) that incorporates the southern portion of the TIA for purposes of dyke inspection and maintenance and reclamation research and implementation. All mining claims were surrendered to the Crown.

A Type B Licence N1L3-0035 was first issued on April 1, 1975, which was renewed until it was replaced by Type B Licence N1L2-0035, issued on July 1, 1997, for a ten-year term. In July 2001, Cominco and Teck Metals merged. Since the merger, Teck Metals has managed the site. In June 2009, Teck Cominco Metals Ltd. changed its name to Teck Metals Ltd. (Teck). The current Type B Licence MV2007L2-0007 was issued on October 25, 2017 and is valid until October 24, 2027.

1.2 Company Name and Contact

Teck Metals Ltd.
601 Knighton Road, Bag 2000
Kimberley, BC
V1A 3E1

Contact: Michelle Unger, Manager Environmental Performance
Pine Point Coordinates (associated with decant area at TIA):
60^{o}53’41.3"N 114^{o}25’30.7"W

1.3 Document Review

The Manager, Environmental Performance is responsible for reviewing the manual annually and updating as required. Teck uses an Environmental Management System called SiteLine, which allows tasks, such as annual reviews, to be assigned to task or document owners. If revisions to the document are required, the contingency manual shall be submitted to the MVLWB for approval at least 60 days prior to implementing any proposed changes in accordance with the Water Licence.

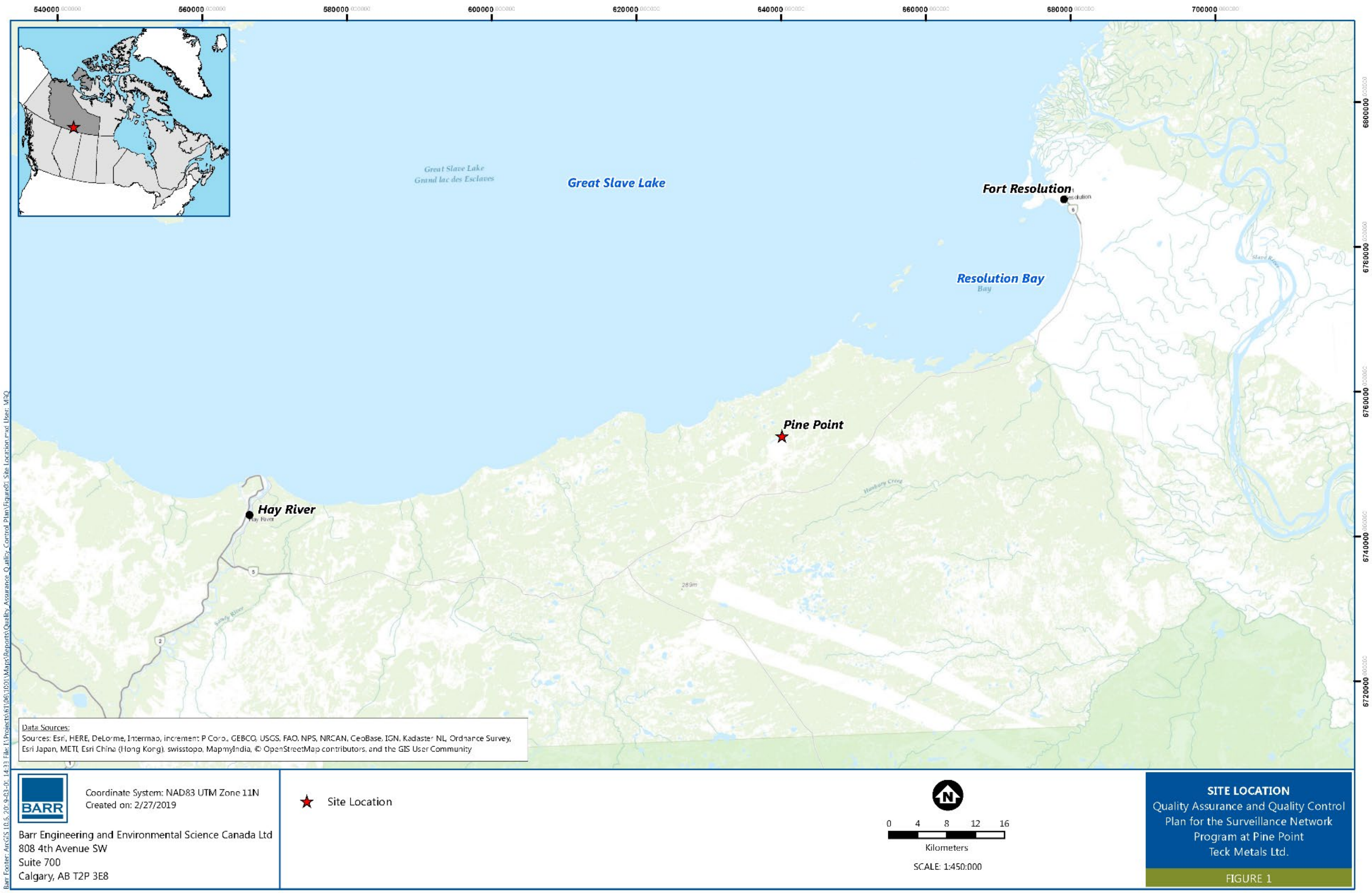

Figure 1.1 Site Location

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2.0 Surveillance Network Program

A condition of the Water Licence is to undertake a water quality monitoring program at nine surface water locations. The SNP station locations include two monitoring stations measure water quality prior to discharge with one sample from the Main Pond water (SNP station 35-1a) and one sample of post treatment effluent discharge (35-1b). There are seven downstream stations (SNP stations 35-4, 35-5, 35-6, 35-9, 35-10, 35-12, 35-13) between the TIA and Great Slake Lake. All SNP stations are presented on Figure 2. The sample station descriptions, parameters and sampling frequencies are presented in Table 1 and Table 2, for the pre-discharge and downstream sample stations, respectively. The parameters sampled include those that are required as documented in the licence and those that are included by Teck for site information.

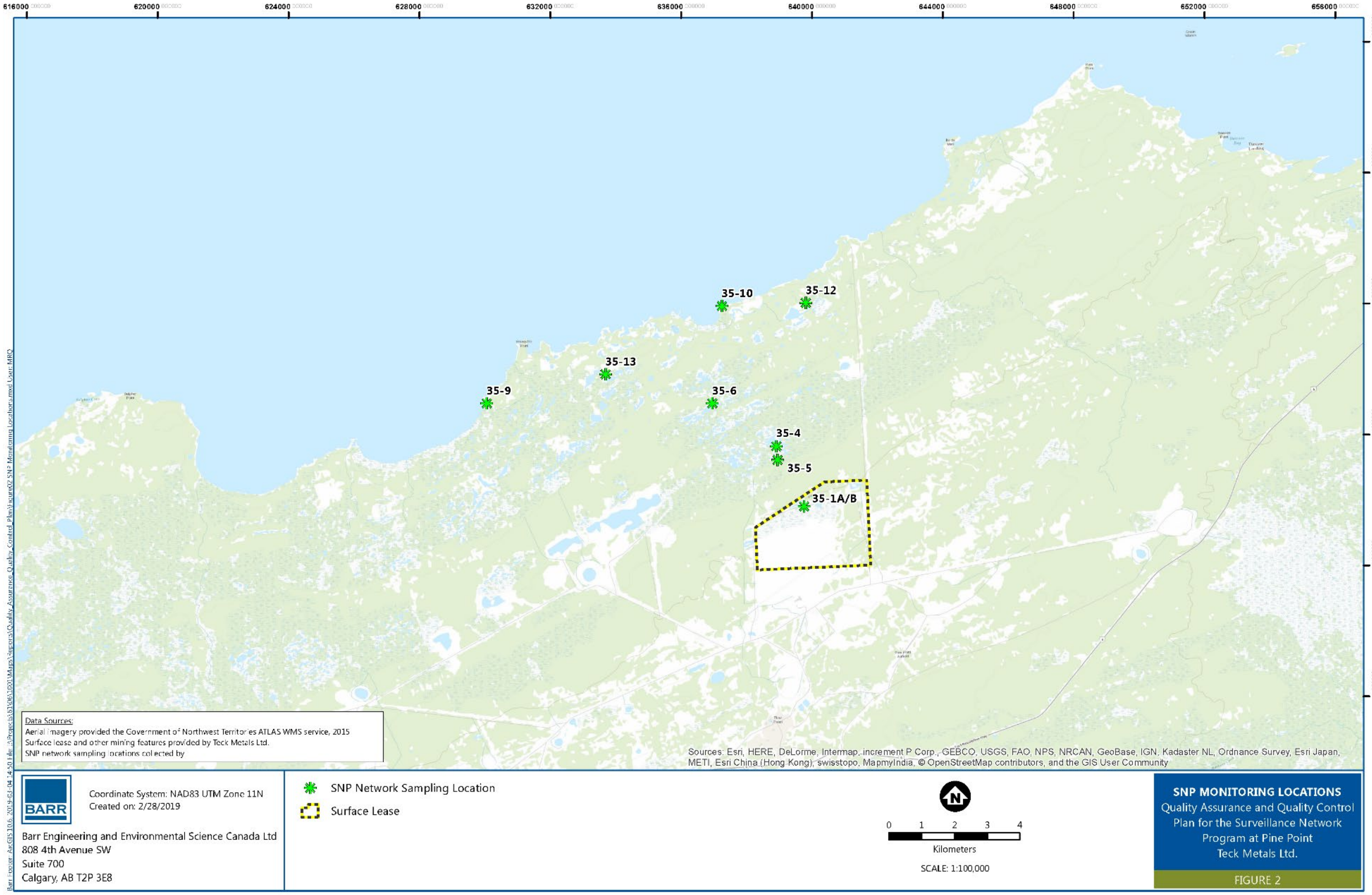


Figure 2.1 Surveillance Network Program Monitoring Locations

Table 2.1 Surveillance Network Program Stations Prior to Discharge and Sampling Parameters

Surveillance Network Program Station	Descriptions	Location	Parameters	Frequency
35-1a: Main Pond	Main pond prior to discharge to the serpentine channel (water treatment area/settling pond)	60°53’41.3"N 114°25’30.7"W	Total Arsenic Total Copper Total Lead Total Zinc pH Total Suspended Solids[a] Ammonia[a] Total Cyanide[a]	Weekly during discharge
			Water level	3 times per year, once in Spring, Summer, and Fall; during periods of open water
35-1b: Post-Treatment Effluent Discharge	Post-treatment effluent discharge at the decant structure	60°53’41.3"N 114°25’30.7"W	Volume, measured and recorded in cubic metres.	Weekly during discharge
			Total Arsenic Total Copper Total Lead Total Zinc pH Total Suspended Solids Ammonia Total Cyanide	

(a) Test parameters specified in the Effluent Quality Criteria and so are measured in addition to the parameters required for the SNP.

Table 2.2 Surveillance Network Program Stations Downstream of the Treatment Pond and Sampling Parameters

Surveillance Network Program Station	Descriptions	Location	Parameters	Frequency
SNP Station 35-4	Pond surface water north of SNP station 35-1, 4.0 km from Great Slave Lake.	60°54’41.8"N 114°26’17.2"W	Total and Dissolved Metals, Total Suspended Solids and pH	Annually; in fall following discharge
SNP Station 35-5	Pond surface water 1.6 km south of Great Slave Lake.	60°54’27.7"N 114°26’17.2"W		
SNP Station 35-6	Pond surface water 2.4 km due south of SNP station 35-5.	60°55’26.6"N 114°28’25.4"W		
SNP Station 35-9	Great Slave Lake, 2.4 km southwest of Presquile Point.	60°55’35.0"N 114°36’04.1"W		
SNP Station 35-10	Great Slave Lake, 4.8 km east of Presquile Point.	60°57’00.2"N 114°27’56.6"W		
SNP Station 35-12	Pond surface water 4.8 km north of Tailings area decant structures, 0.8 km south of Great Slave Lake shoreline.	60°57’02.1"N 114°25’06.6"W		
SNP Station 35-13	Pond surface water, 4.0 km east of SNP Station 35-9, and 0.8 km south of Great Slave Lake shoreline.	60°55’59.1"N 114°31’59.0"W		

2.1 Surveillance Network Program Criteria

Effluent quality criteria (EQC) for treated water discharge at SNP Station 35-1b are defined in the Water Licence Part F, Item 10 and are presented in Table 3. The maximum average concentration is defined in the Water Licence as the discrete average of four consecutive analytical results, or if less than four, the analytical results collected during a batch of decant and as submitted to the MVLWB in accordance with the sampling and analysis requirements specified in the SNP. A Maximum Grab concentration is the concentration of a parameter listed in the licence that cannot be exceeded in any one grab sample.

Table 2.3 SNP Station 35-1b Effluent Quality Criteria

Parameter	Maximum Average Concentration (in mg/L)	Maximum Grab Concentration (in mg/L)
Total Arsenic	0.50	1.00
Total Copper	0.15	0.30
Total Cyanide	0.10	0.20
Total Lead	0.20	0.40
Total Zinc	0.50	1.00
Ammonia as N	2.00	4.00
Total Suspended Solids	25.00	50.00
pH	shall have a pH between 6.5 and 9.5	

mg/L = milligram per litre

2.2 Roles and Responsibilities

The roles and responsibilities of those involved in the SNP are as follows:

- Teck Manager, Environmental Performance– is responsible for submitting an annual report to the MVLWB.
- Teck Supervisor, Water Treatment and Monitoring (Teck Supervisor) – is responsible for reviewing data as it is received, maintain field and laboratory data according to Teck's document management procedures, and must be included in correspondence with the analytical laboratory.
- Water Treatment Operators – are responsible for completion of daily inspections and logs, conducting on-site laboratory calibrations and analyses, and planning monitoring events according to the frequency identified in the Water Licence. The Water Treatment Operator is also responsible for immediately notifying the Teck Supervisor if on-site analyses indicate that Action Levels have been reached, as well as, if there has been any discharge at instance when water quality did not meet the conditions of the Water Licence.
- Sample Collector – is the person who will be carrying out the sampling program, which may be a Water Treatment Operator or an external party hired to conduct the sampling. The

Sample Collector is responsible for collecting, handling, and submitting the samples in adherence to this plan and the Water Treatment Manual.

- Laboratory Provider – is responsible for conducting chemical analyses according to the agreed upon analytical detection limits and methods. The laboratory provider shall also maintain its accreditation with the CALA and notify Teck if the accreditation is no longer valid. All laboratory QAQC records, including calibrations, shall be available to Teck upon request.

2.3 Training

A water treatment kick-off meeting is held every spring prior to the initiation of the water treatment season. During that kick-off meeting, training is conducted to include a review of the on-site laboratory methods, calibration procedures, sampling procedures and confirmation of the required supplies to carry out the SNP sampling. Expectations regarding communication and documentation of results and observations are also discussed at that meeting. Meeting participation is recorded and procedure documents are signed by samplers and laboratory staff (i.e., water treatment operators) to acknowledge that the information was received and understood.

3.0 Sample Collection Methods

3.1 General Water Sample Collection Procedures and Handling

The general methods for sample collection and handling are presented below. Specific considerations related to the site-specific program are provided in the next sections.

3.1.1 Sample Containers

For samples to be submitted to a Laboratory Provider (e.g., ALS), the Laboratory Provider will provide all certified sample containers to Teck. Sample bottles are inspected by Sample Collector prior to sample collection to make sure that they appear to be in good condition. Sample bottles found without caps, or are otherwise not in good condition, are discarded and not used for sample collection.

For samples that are analyzed at the on-site laboratory, samples are collected in plastic bottles and are cleaned with an acid/water solution and rinsed with deionized water.

3.1.2 Sample Labelling

All samples obtained for internal determinations must be labeled with the sample location at a minimum. Since the samples are collected and analyzed on the same day, other information such as date, are not required on the bottle, but must be recorded in the sample records.

For samples being submitted to an external laboratory, waterproof labels are completed with permanent ink so that sample information cannot be erased or altered. These labels are then placed directly on the sample bottle when dry for proper adhesion. The following information is recorded on all water quality samples bottles:

- Client name (Teck)
- Project or Teck-specific program code
- Date and time
- Sample identifier (SNP Station #)
- Location identifier
- Preservative added
- Analysis requested

3.1.3 Sample Nomenclature

Samples shall be uniquely identified using the following Sample Identification (sample ID) nomenclature:

- Sample IDs will have the following name structure: SITE (2 letters)_SNP LOCATION ID_YEAR(4 numbers)MONTH(2 numbers)DAY(2numbers)

  For example: PP_35-1B_2023-07-25

- Field duplicate samples will be submitted for laboratory analysis “blind” (e.g. the true sample location ID will be hidden from the lab) using the following name structure: SITE(2 letters)_DUP followed by a sequential number YEAR(4 numbers)-MONTH-(2 numbers)-DAY(2numbers)

  For example: PP_DUP1_2023-07-25

- Field blank samples will be submitted for laboratory analysis and have the following name structure: SITE(2 letters)_FB followed by a sequential number_YEAR(4 numbers)-MONTH(2 numbers)-DAY(2numbers)

  For example: PP_FB1_2023-07-25

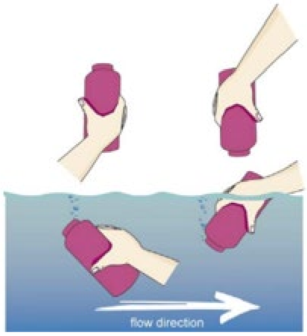
3.1.4 Sampling Procedure

Water samples must be sampled in accordance with protocols published by the Canadian Council of Ministers of the Environment (CCME 2011). Samples are typically collected from the shore using a swing sampler (at downstream SNP locations) or by crouching to the water surface from the shoreline (at 35-1B) or from the sampling platform at 35-1A.

The following protocols are summarized from CCME (2011):

- Sample bottle shall not be allowed to come into contact with any surface that may contaminate the sample.
- With a gloved hand (new gloves for each sample), the sample bottle will be lowered slowly into the water until it is entirely submerged with the bottle opening facing toward the flow direction (upstream or up-current).

- Each bottle is rinsed three times before collecting the sample



From CCME 2011

- Water samples will be collected in such a way as to avoid sediment contamination or contamination from particles in the water. Filled bottles will be lifted clear from the water and capped, excluding air if specified.
- The samples will be transported to the on-site laboratory in a plastic carrier to minimize the change in sample temperature and to prevent sample integrity loss should the samples be dropped.
- At the on-site laboratory, the samples will either be analyzed using the on-site equipment or temporarily stored in advance of shipment to an external Laboratory Provider.

For samples specified for dissolved metals or dissolved nutrients analyses, field filtering of samples may be required and should be confirmed with the laboratory prior to the sampling campaign. If required, filtering equipment should be provided by the laboratory and discarded between each sample.

For filtered samples, water must be collected in new, clean, laboratory-provided bottles that do not contain preservative (bottles are often pre-charged with preservative by the laboratory). The sampled water is drawn into a clean syringe. Just prior to use, the 45-µm filter should be removed from its packaging and placed on the syringe or in the filter cup. Push the plunger down to push sample through filter and discard the first 5 to 10 mL prior to filling the sample bottle. Push the remaining water in the syringe through the filter into the laboratory-provided sample bottle (with preservative if required). More than one filter may be required per sample depending on suspended material in the water column.

3.1.5 Preservatives

Some samples submitted to the external Laboratory Provider must be preserved prior to submission. The laboratory provides pre-charged sample bottles for all analyses requiring preservation, except for dissolved organic carbon. For dissolved organic carbon, the laboratory will provide the preservative to add to the sample after the water has been filtered. Appendix A provides preservation requirements.

3.1.6 Chain of Custody

A Chain of Custody (COC) form (Appendix B) must be completed for all samples submitted to an external Laboratory Provider. A photo of the COC should be taken prior to sending the samples. The paper copy is to be shipped with the sample(s).

The COC is a legal document that provides the information required to track sample custody and document sample information that the laboratory requires. In addition, correct and complete entries enable the lab to successfully upload data to Teck's EQuIS database. The important information includes sample identification, sample date, field matrix, confirmation of filtering and or preservative addition, and instruction for distribution of reports.

3.1.7 Sample Storage

The samples are kept in the laboratory refrigerator until they are ready to be shipped. Daily samples are to be shipped every 1 to3 days until the Teck Supervisor decides that daily samples are no longer needed. Weekly samples are to be shipped within 24 hours. Once ready to be shipped, the samples are packed in a cooler, along with ice packs and newspaper or bubble wrap to maintain temperatures at 4 degrees Celsius (°C) or below and to protect the samples from damage during shipment. The samples are shipped to an accredited laboratory for analyses.

3.1.8 Quality Assurance/Quality Control Samples

QAQC samples are collected to determine sample integrity and sample precision at the laboratory. Two types of QAQC samples will be included in the SNP; field blanks and duplicate samples.

Field blanks are used to determine whether there is a source of contamination in the field procedures and are indicative of sample integrity. New, lab-provided sample bottles are filled with deionized water in the field and preserved using the same approach as the other samples.

Duplicate samples are second aliquots of a surface water sample that are treated the same as the original sample and are used to determine precision in the laboratory procedures. The sample identification is typically kept blind (masked) from the laboratory. The true identity of the field duplicate sample location is recorded in the sample records.

QAQC samples will be collected as part of all sample events and are described in more detail in the following sections describing the specific sample programs.

3.1.9 Sample Receipt Confirmation

The analytical laboratory shall provide a Sample Receipt Confirmation after the samples are logged into the Laboratory Provider's system upon arrival. The Sample Receipt Confirmation is sent to the recipients identified on the Chain of Custody. The Teck Supervisor will confirm that the Laboratory Provider has received all intended samples and has correctly identified the requested analyses. Discrepancies will be identified and communicated to the Laboratory Provider immediately to allow for correction before the sample hold period has expired. Timely review of SRCs will also aid in identification of needs for resampling in the event of missing or mislabelled bottles or missing containers.

3.2 Sampling Procedures at 35-1a and 35-1b

The Main Pond (Stations 35-1a) and treated discharge water SNP stations (Station 35-1b) are located at the TIA facility (Figure 2). Station 35-1a is upstream of the water treatment system; therefore, water quality represents the pre-treatment conditions and does not reflect the performance of the treatment system. Station 35-1b is a monitoring location for the treated discharge outfall (Figure 2). Both stations 35-1a and 35-1b are sampled by the Water Treatment Operator as per the general water sample procedures and analyzed at the on-site laboratory for pH, Total zinc, TSS, and temperature.

At the beginning of the season, water samples from 35-1b are also collected on a daily basis for submission to a Laboratory Provider to determine congruity between site-based analyses of Total zinc and TSS with the laboratory results. Once the Teck Supervisor has determined congruity, the frequency of laboratory submissions may decrease to weekly, as per the Water Licence. The weekly samples are analysed for pH, total suspended solids, total cyanide, ammonia as N, total and dissolved metals, total and dissolved mercury, by the Laboratory Provider. The results will be compared for precision following the program data quality objectives described in Section 5.2 of this QAQC plan.

3.2.1 Field Observations and Documentation

The Water Treatment Operator will complete the Daily Operating Log and the Treated Water Discharge Volume Log as provided in Appendix C on each sampling day. The logs include the following records:

- Sample specifics (date, name of sampler, time and weather conditions)
- pH of water in culvert from Main Pond and at the discharge point (Figure 3)
- Flow rates (SNP location 35-1b) and daily discharge volume
- Total Zinc and TSS concentrations (SNP location 35-1b)
- Water temperature at the point of discharge (Figure 3) (SNP location 35-1b)

- Main Pond water height and change in height since previous day
- Any visible substance or presence of sheen
- Indicators of erosion at treatment pond spillway and discharge location

3.2.2 QA/QC Samples

For samples that are analyzed at the on-site laboratory, a duplicate sample is collected and measured daily. One on-site duplicate sample is collected at 35-1b at approximately 12 pm and is analyzed by the Water Treatment Operator for pH, total zinc and TSS to evaluate precision. Results of both measurements are documented and provided to the Teck Supervisor daily for review. Results that are greater than 20% difference will result in a recalibration of equipment and resampled.

For samples collected weekly for external laboratory analyses, a duplicate sample and field blank will be submitted each week. This weekly sample will be obtained during one of the normal daily sampling events, typically each Monday. Upon receipt of the analytical data, the data are reviewed including precision of duplicate samples in accordance with the approach described in Section 5.2.1.1.

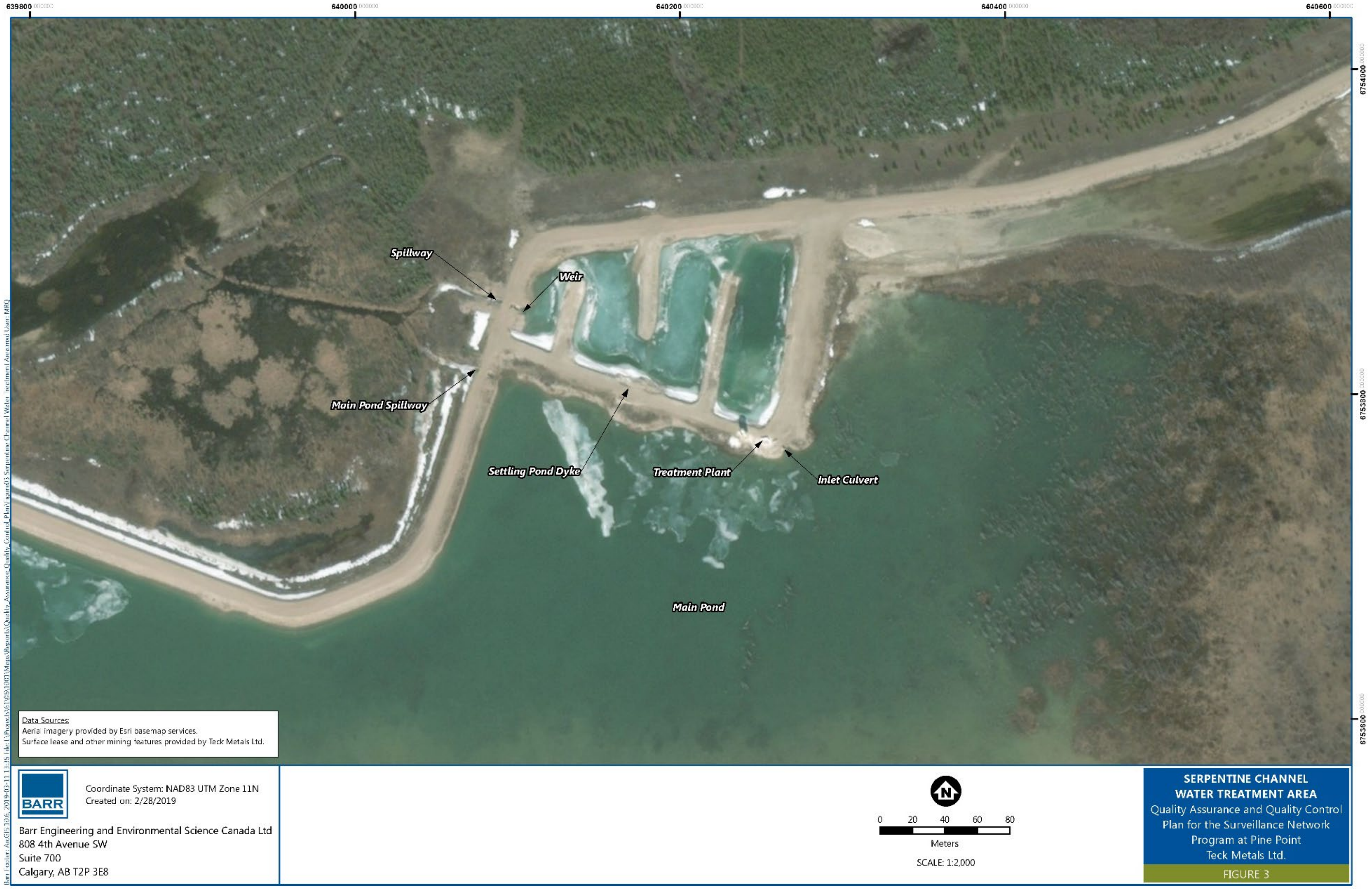


Figure 3.1 Treatment Pond

3.3 Downstream Surface Water SNP Sampling

The downstream surface water SNP stations (35-4, -5, -6, -9, -10, -12, and -13) are located between the TIA and Great Slave Lake (Figure 2). These downstream surface water locations are sampled once per year in the fall, after the annual treatment campaign has concluded, for pH, total suspended solids, total and dissolved metals analyses by an external laboratory provider. Samples may also be analysed for supporting parameters such as dissolved organic carbon so that the appropriate CCME guideline is used for comparison with the site data. The downstream sample locations are accessible by UTV or helicopter. These previously determined sample stations will be located using: (1) GPS, and (2) the triangular placards installed near each monitoring location on the ground surface.

Sample procedures and handling are consistent with instructions above. If a sample cannot be collected (e.g., safety reasons or pond is dry), then detailed notes will be documented.

3.3.1 QA/QC Samples

One field blank will be collected during the downstream sampling annual event. In addition, one field duplicate will be collected arbitrarily from one of the downstream surface water SNP stations (35-4, -5, -6, -9, -10, -12, and -13). Locations that are shallower than 15 cm and/or with observed turbidity will not be considered as suitable locations for duplicate sampling.

4.0 On-Site Laboratory

4.1 Equipment Specifications

The on-site laboratory equipment has been carefully selected for its suitability to the type of sample matrices and working conditions at the TIA. The on-site laboratory equipment is listed in Table 4.1 with their respective detection limits and measurement range. All components of the on-site laboratory equipment are kept in good working condition between uses.

Table 4.1 On-site Laboratory Equipment

Manufacturer	Model	Detection Limit	Measurement Range
Oakton	pH Meter 6+	0.01 pH units	0.01 to 14.00 pH units
HACH	DR3900 Spectrophotometer	0.01 mg/L	0.01 to 3.00 mg/L zinc
Ohaus Balance	PR 224	0.0001 g	0.0001 to 220 g

4.2 Equipment Calibration, Maintenance and Storage

The Water Treatment Operator checks the calibration of the on-site laboratory equipment at the beginning of each day. All meters are operated and calibrated according to the manufacturers' manuals, a summary of which is provided in Appendix D.

Oakton pH 6+ meter calibration check is performed prior to the first use of the day and throughout the day, results are recorded on the pH calibration form. pH buffers 7 and 10 are used if a recalibration is required. When not in use store pH probes in pH storage solution.

The HACH DR3900 spectrophotometer calibration occurs during the self-check each time the instrument is powered on. The test program takes two minutes to complete and checks the system, lamp, filter adjustment, wavelength calibration, and voltage. A 0.50 mg/L Zinc standard is run daily to determine spectrophotometer accuracy results are recorded on daily calibration check form. If the on-site results are substantially different from the off-site laboratory results, a lab spike calibration method will be conducted according to manufacturer protocols and summarized in Appendix D.

4.3 Laboratory Procedures

Samples are taken in 3-500ml bottles at the 35-1b (point of discharge). Each bottle is rinsed in the water 3 times, with minimal disturbance, filled to the top and placed into a plastic carrier (to minimize the change in sample temperature). Samples are taken back to the lab for analysis.

One bottle is used to measure the temperature and pH. The second bottle is used for the total zinc analysis. The third bottle is used for TSS analysis. A site TSS analysis must always be performed at the same time that samples are collected for submission to the analytical laboratory, for accuracy comparison of field to lab results.

4.4 Equipment Troubleshooting

Refer to equipment operating manuals as they all have an in-depth troubleshooting section.

Calibration errors on Oakton pH6+ meter can be mostly resolved by recalibrating with new pH buffer solution. The lab is supplied with several meters that can be used to verify readings. However, if pH is found to drift during use, meter may require maintenance (e.g., sensor replacement). If this is the case, contact the supervisor to exchange the meter and document expected drift in the laboratory notes.

When operating the DR3900 spectrophotometer, if the field measured zinc concentration is above the testing range (0 – 3.00 mg/L) then the sample must be diluted and measured again. Analysis of the 0.50 mg/L Zinc standard as outlined in Section 4.2 will assist in assessing accuracy.

5.0 External Laboratory Provider

Samples for the SNP will be submitted to an accredited laboratory (Canadian Association for Laboratory Accreditation (CALA) or Standards Council of Canada) who use CCME recognized methods to conduct laboratory analyses.

ALS Global (ALS) (Edmonton Laboratory) currently conducts all water quality analyses required by Water Licence MV2017L2-0007. ALS is accredited by CALA for the environmental tests listed in Appendix E and Appendix F. Accreditations are location and parameter specific and a complete listing of parameters is available from www.alsglobal.com and www.cala.ca. ALS's statement of qualifications details its company profile, services and capabilities, quality management systems, along with corporate responsibilities. This statement can be found in Appendix G.

Additionally, ALS (i.e., Laboratory Provider) has provided an overview of their QAQC (Appendix H) describing their corporate policy for their analytical work, facilities, services, accreditation, analytical capabilities, and detection limits. The detection limits for the water quality samples are provided in Appendix I, meet the requirements for Water Licence MV2017L2-0007, and are included in the analytical reports.

The Laboratory Provider will conduct routine internal QAQC tests, which include method blanks, laboratory control spike samples, certified reference material standards, matrix spikes, and instrument blanks.

5.1 Methods of Analysis

As noted in Annex A, Part A, Item 4 of the Water Licence: "*All sampling, sample preservation, and analyses shall be conducted in accordance with methods prescribed in the current edition of American Public Health Association's (APHA) Standard Methods for the Examination of Water and Wastewater at the time of analysis, or by other such methods approved by an Analyst*."

The Laboratory Provider performs its services in accordance with commonly accepted professional standards such as the APHA or United States Environmental Protection Agency (US EPA), and where applicable, accredited testing methodologies and procedures deemed scientifically appropriate in the Laboratory Provider's judgement. The Laboratory Provider's Operating Procedures for laboratory analyses of pH, total suspended solids, total and dissolved metals, total cyanide and ammonia as N analyses are included in Appendix D.

5.2 Program Data Quality Objectives

All laboratory analyses will adhere to QAQC criteria outlined in the Laboratory Provider’s Operating Procedures included in Appendix D and in US EPA published test method and other methods as stated on the analytical reports. Field instrumentation measurements will adhere to manufacturer calibration and operating guidelines.

Standard instrument QAQC criteria will include initial and continuing calibration blanks and initial and continuing calibration verifications. Interference checks, outside source standards and other method specific instrument QAQC requirements will be performed as directed in the methods stated on the analytical reports. The instruments will be calibrated as outlined in the stated methods.

Standard batch QAQC criteria will include method blanks, laboratory control samples, matrix spikes, matrix spike duplicates. Internal standards will be employed as required. Batch QAQC will be evaluated as outlined in the various methods. Summaries of batch QAQC results will include data qualifiers as appropriate.

5.2.1 Precision, Accuracy, Representativeness, Comparability, Completeness and Sensitivity Objectives

Data quality objectives (DQO) for are described below. The purpose of defining these DQO is to document the methods to be used to evaluate the acceptability of data for purposes of data evaluation for annual reporting. The objectives for precision, accuracy, representativeness, comparability, completeness, and sensitivity were based on guidance published by the US EPA (2023).

5.2.1.1 Precision

Precision measures the reproducibility of repetitive measurements. Precision is evaluated by calculating the relative percent difference (RPD) between duplicate spikes, duplicate sample analyses or field replicate samples and comparing it with appropriate precision objectives established by the laboratory.

Precision measures the reproducibility of measurements under a given set of conditions. Precision of analytical laboratory data may be assessed by comparing the analytical results between field duplicate. The relative percent difference (%RPD) will be calculated using the equation below for each pair of duplicate analysis.

$$RPD = \frac{|S - D|}{(S + D)/2} x\, 100$$

Where: RPD = relative percent difference
S = original sample result
D = duplicate sample result

5.2.1.2 Accuracy

Accuracy is the degree of agreement between an observed value and an accepted reference value. Accuracy measures the bias in a measurement system. Accuracy of laboratory results may be assessed using the analytical results of field blanks and laboratory control samples. Accuracy calculations are expressed as percentage of the known value and are evaluated by control limits established in the methods. The percent recovery (%R) for laboratory control samples will be calculated using the following equation.

$$\%R = \frac{SSR - SR}{SA} \times 100$$

Where: %R = % recovery
SSR = spiked sample result
SR = sample result (0 for laboratory control samples)
SA = spike added to native sample

5.2.1.3 Representativeness

Representativeness is obtained by using standard sampling and analytical procedures to generate data that yield an accurate description of the body of water being analysed. For the SNP, this is done by collecting water samples in the same locations year to year (sample locations are marked with signage and accessed using GPS coordinates) and by consistently sampling shallow surface water representative of water discharge from the water treatment pond.

5.2.1.4 Comparability

The comparability of data produced by and for this program is predetermined by the commitment of its staff and contracted laboratories to use standardized methods, where possible, including US EPA-approved analytical methods, or documented modifications thereof, which provide equal or better results. These methods have specified units in which the results are to be reported. Measurements are made according to standard procedure, or documented modifications thereof, which provide equal or better results, using common units such as Celsius, metres, metres/sec, mg/L, µg/L, mg/kg, etc.

5.2.1.5 Completeness

Completeness is a measure of the amount of valid data obtained from a measurement system compared to the amount that was expected to be obtained under normal conditions. Rejected data, or sampling points that do not yield a usable sample, count against the percent completeness. Field completeness goals for each project will be greater than 90 percent. It is expected that the laboratory will provide data meeting QC acceptance criteria for 90 percent or more of all samples tested.

5.2.1.6 Sensitivity

The sensitivity objective corresponds with the laboratory's ability to report concentrations at or below the applicable criteria, which in this case is the EQC and the CCME Water Quality Guidelines for the Protection of Aquatic Life. Laboratory sensitivity will be assessed by comparing the analytical reporting limits to the applicable criteria. Current laboratory reporting limits (included in Appendix I) are less than or equal to applicable criteria.

6.0 Reporting

6.1 Data Review

The Laboratory Provider submits the analytical results to the Teck Supervisor in electronic format and is uploaded directly into Teck’s EQuIS database. Upon receipt of the analytical data, the results are reviewed by Teck Supervisor to identify report completeness, any potential licence exceedances or obvious water quality anomalies. Analytical accuracy will be evaluated by reviewing laboratory control sample data for metals, cyanide, and ammonia as N analyses against laboratory specified limits stated in the laboratory reports.

Analytical precision will be evaluated by reviewing the field blank, field duplicate samples, laboratory duplicate sample relative percent difference (RPD) results for field measurements and laboratory analyses. Established RPD acceptance limits will be used for laboratory analyses. Field measurement RPDs will follow manufacturer recommendations for precision and are anticipated not to exceed 20%.

6.2 SNP Reporting

All reporting requirements for the Teck Metals Ltd. Pine Point TIA are outlined in Part 3.10 of the Water Licence (MV2017L2-0007). The annual SNP report is prepared by the Teck Supervisor and reviewed by the Manager, Environmental Performance (or designate). The SNP Report includes but is not limited to the following:

- A summary of the calibration, maintenance and status of the meters and devices used to measure pH, zinc and TSS
- Rationale for unattainable samples at SNP stations in instances when samples were not collected.
- Results and interpretation of QAQC procedures
- Graphical summaries and interpretation of the analytical results compared with the previous two years and with Water Licence EQC
- Analytical results
- Results of the duplicate samples, blanks and the laboratory QAQC submitted by the Laboratory Provider
- Description of site activities
- Discharge water volumes; and
- Flow rates

All data and information are submitted in an electronic format as required by the SNP and according to the MVLWB document submission standards (MVLWB 2023). The annual report is due to the MVLWB on or before March 31 each year.

6.4 Record Retention

Calibration records, field and laboratory data will be retained in Teck's EQuIS database indefinitely. Annual reports and certificates of analysis are stored on Teck's network.

7.0 Related Procedures

The following Teck related procedures are required for review and acknowledgement by all Teck employees and contractors working at Pine Point.

- Pine Point Tailings Impoundment Area Water Treatment Manual - PP-EP-001
- Pine Point Waste Management Plan – PP-EP-003
- Pine Point Mine Emergency Response Plan - PP-ERP-002
- Pine Point Contingency Plan – PP-EP-005
- Pine Point Operations, Maintenance and Surveillance Manual – PP-OMS-001

8.0 References

Canadian Council of Ministers of the Environment (CCME). (2011). *Protocols Manual for Water Quality Sampling in Canada.* Winnipeg: CCME.

Department of Indian and Northern Affairs Canada and the Northwest Territories Water Board (INAC). (1996). *Quality Assurance (QA) and Quality Control (QC) Guidelines for Use by Class "A" Licensees in Meeting SNP Requirements and for Submission of a QAQC Plan.* Yellowknife: Department of Indian and Northern Affairs Canada (Water Resources Division) and the Northwest Territories Water Board.

Mackenzie Valley Land and Water Board (MVLWB). (2023). Document Submission Standards. Yellowknife, NWT.

United States Environmental Protection Agency (US EPA). (2023). *Quality Assurance Project Plan Development Tool, Guidance on Preparing a QA Project Plan.* Retrieved from https://www.epa.gov/quality/module-1-quality-assurance-project-plan-development-tool-guidance-preparing-qa-project-plan

APPENDIX A
LABORATORY HOLD TIME AND SAMPLE HANDLING

Parameter	Sample Container	Sample Preservation	Holding Time
pH	250 mL HDPE	Chill to ≤10˚C	15 min.(a)
Total and Dissolved Metals	60 mL HDPE	Field filtered for dissolved metals Laboratory preserved	180 days
Total Cyanide	60 mL opaque HDPE	Chill to ≤10˚C Sodium hydroxide	14 days
Ammonia as N	250 mL HDPE (same bottle as pH)	Chill to ≤10˚C Sulfuric acid	3 days
Total Suspended Solids	500 mL HDPE	Chill to ≤10˚C	7 days
Dissolved Organic Carbon	100 mL amber glass	Field Filter Sulfuric acid Chill to ≤10˚C	28 days

(a) Laboratory hold times for pH cannot be achieved. Therefore, field pH must be measured at the same time.

APPENDIX B
CHAINS OF CUSTODY

Chain of Custody (COC) / Analytical Request Form

Canada Toll Free: 1 800 668 9878

www.alsglobal.com

Affix ALS barcode label here
(lab use only)

COC Number: 14 -

Page 1 of 1

Report To	**Stephen Parris**	
Company:	Teck Metals Ltd.	
Contact:	Dana Haggar	
Address:	Bag 2000, Kimberley, BC V1A 3E1	
Phone:	250-427-8403	

Report Format / Distribution

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

Quality Control (QC) Report with Report ☑ Yes ☐ No

☐ Criteria on Report - provide details below if box checked

Select Distribution: ☑ EMAIL ☐ MAIL ☐ FAX

Email 1 or Fax dana.haggar@teck.com

Email 2 teckkimb@equisonline.com

Select Service Level Below (Rush Turnaround Time (TAT) is not available for all tests)

- **R** ☐ Regular (Standard TAT if received by 3 pm - business days)
- **P** ☐ Priority (2-4 bus. days if received by 3pm) 50% surcharge - contact ALS to confirm TAT
- **E** ☑ Emergency (1-2 bus. days if received by 3pm) 100% surcharge - contact ALS to confirm TAT
- **E2** ☐ Same day or weekend emergency - contact ALS to confirm TAT and surcharge

Specify Date Required for E2,E or P: Saturday 5:00

Invoice To	Same as Report To	☐ Yes ☐ No
	Copy of Invoice with Report	☑ Yes ☐ No
Company:	Teck Metals Ltd.	
Contact:	Roxanne Menear	

Invoice Distribution

Select Invoice Distribution: ☑ EMAIL ☐ MAIL ☐ FAX

Email 1 or Fax roxanne.menear@teck.com

Email 2

Project Information

ALS Quote #:	Teck Metals Ltd.
Job #:	Pine Point
PO / AFE:	
LSD:	

Oil and Gas Required Fields (client use)

Approver ID:	Cost Center:
GL Account:	Routing Code:
Activity Code:	
Location:	

ALS Lab Work Order # (lab use only)

ALS Contact: Taryn **Sampler:** Clell

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	Total Arsenic, copper, lead, zinc		TSS	pH										Number of Containers
	PP_35-1A_201YYMMDD			Water	E		E	E										
	PP_35-1B_201YYMMDD			Water	E		E	E										

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 (client Use)

SAMPLE CONDITION AS RECEIVED (lab use only)

Frozen ☐ SIF Observations Yes ☐ No ☐

Ice packs Yes ☐ No ☐ Custody seal intact Yes ☐ No ☐

Cooling Initiated ☐

INIITIAL COOLER TEMPERATURES °C			FINAL COOLER TEMPERATURES °C		

SHIPMENT RELEASE (client use)			INITIAL SHIPMENT RECEPTION (lab use only)			FINAL SHIPMENT RECEPTION (lab use only)		
Released by: Clell	Date:	Time:	Received by:	Date:	Time:	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**.

ALS Environmental
www.alsglobal.com

Chain of Custody (COC) / Analytical Request Form

Canada Toll Free: 1 800 668 9878

Affix ALS barcode label here
(lab use only)

COC Number: 19 -

Page 1 of 1

Report To	**Stephen Parris**	
Company:	Teck Metals Ltd.	
Contact:	Dana Haggar	
Address:	Bag 2000, Kimberley, BC V1A 3E1	
Phone:	250-427-8403	

Report Format / Distribution

Select Report Format: ☑ PDF ☐ EXCEL ☑ EDD (DIGITAL)
Quality Control (QC) Report with Report ☑ Yes ☐ No
☐ Criteria on Report - provide details below if box checked
Select Distribution: ☑ EMAIL ☐ MAIL ☐ FAX
Email 1 or Fax dana.haggar@teck.com
Email 2 teckkimb@equisonline.com

Select Service Level Below (Rush Turnaround Time (TAT) is not available for all tests)

R	☑	Regular (Standard TAT if received by 3 pm - business days)
P	☐	Priority (2-4 bus. days if received by 3pm) 50% surcharge - contact ALS to confirm TAT
E	☐	Emergency (1-2 bus. days if received by 3pm) 100% surcharge - contact ALS to confirm TAT
E2	☐	Same day or weekend emergency - contact ALS to confirm TAT and surcharge

Specify Date Required for E2,E or P: Saturday 5:00

Invoice To Same as Report To ☐ Yes ☐ No
Copy of Invoice with Report ☑ Yes ☐ No
Company: Teck Metals Ltd.
Contact: Roxanne Menear

Invoice Distribution

Select Invoice Distribution: ☑ EMAIL ☐ MAIL ☐ FAX
Email 1 or Fax roxanne.menear@teck.com
Email 2

Project Information

ALS Quote #: Teck Metals Ltd.
Job #: Pine Point
PO / AFE:
LSD:

Oil and Gas Required Fields (client use)

Approver ID:	Cost Center:
GL Account:	Routing Code:
Activity Code:	
Location:	

ALS Lab Work Order # (lab use only)

ALS Contact: Taryn **Sampler:** Clell

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**	Total and Dissolved metals		TSS	pH	Ammonia as N	Total Cyanide								Number of Containers
	PP_35-1A_20YYMMDD			Water	R		R	R	R	R								
	PP_35-1B_20YYMMDD			Water	R		R	R	R	R								
	PP_DUP #_20YYMMDD (req'd once per month, cross out if not require			Water	R		R	R	R	R								
	PP_FB #_20YYMMDD (req'd once per month, cross out if not requir			Water	R		R	R	R	R								

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 (client Use)

SAMPLE CONDITION AS RECEIVED (lab use only)

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

INIITIAL COOLER TEMPERATURES °C			FINAL COOLER TEMPERATURES °C		

SHIPMENT RELEASE (client use)			INITIAL SHIPMENT RECEPTION (lab use only)			FINAL SHIPMENT RECEPTION (lab use only)		
Released by:	Date:	Time:	Received by:	Date:	Time:	Received by:	Date:	Time:

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

NA-FM-0326e v09 Front/04 January 2014

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

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

APPENDIX C
OPERATIONS LOGS

Pine Point Water Treatment Year:
NWT Licence Site 35-1
Daily Operating Log

Date: Operator: Sample Tech:

Time	Culvert (1E) pH	Weir (1B) pH	Weir Head inches	Weir Flowrate m^3/min	Lime Flow L/min	Samp. Taken ✓	Hach Zn mg/L	Turb NTU	Remarks
6: am									
6: am									
7: am									
7: am									
8: am									
8: am									
9: am									
9: am									
10: am									
10: am									
11: am									
11: am									
12: am									
12: am									
1: pm									
1: pm									
2: pm									
2: pm									
3: pm									
3: pm									
4: pm									
4: pm									
5: pm									
5: pm									
6: pm									
6: pm									
7: pm									
7: pm									
8: pm									
8: pm									

Water Temp (°C) at Weir: (35-1B)	am:		Weather:	pm:
	pm:		Air Temp.:	pm:
			Wind:	pm:
Lime Slurry Strength (%)				
Main Pond Height (m) (35-1A)	am: pm:		Height change since last day (m):	
Volume Discharged Today (m^3)				

Comments:

Pine Point Water Treatment Year:
NWT Licence Site 35-1
Treated Water Discharge Volumes

Operating Date	Daily Discharge Volume (cubic metres)	Total Cumulative Discharge Volume (cubic metres)	Pond Elevaton (meters)

Note: Pond Elevation is reported at the end of the day.

APPENDIX D
PINE POINT LABORATORY PROCEDURES

Laboratory Glassware Cleaning Procedure

PURPOSE

To provide directions on cleaning glassware in a laboratory setting.

SCOPE

In Scope	Out of Scope
• Cleaning glassware in a laboratory setting	• Cleaning outside of a laboratory setting.

APPLIES TO

Teck employees and contractors who clean glassware in a laboratory-setting established at a Legacy property.

ROLES AND RESPONSIBILITIES

Understand and follow the procedures when cleaning glassware and request clarification if steps are unclear.

PROCEDURE

Step	Action
1.	Initial Rinse: • Rinse the glassware with tap water to remove any loose debris or residues.
2.	Detergent Wash: • Fill a tub with a laboratory detergent solution (e.g., Alconox, Fisherbrand Versa-Clean) and add glassware to the detergent solution. • Use a brush to scrub the interior and exterior surfaces thoroughly. • Rinse the glassware several times with tap water to remove all traces of detergent.
3.	Deionized Water Rinse: • Rinse the glassware with deionized water to remove any remaining impurities from the tap water.
4.	Acid Rinse: • Prepare a dilute acid solution (e.g., 1% HCl) in a separate tub. • Carefully lower the glassware into the acid solution allowing it to be completely submerged (i.e., filled) and let it sit for a few minutes. • Pour out the acid solution and rinse the glassware several times with deionized water to remove all traces of acid. • Dispose of acid solution by neutralizing the acid with a basic solution (pH should be approximately 7).

	5. Drying: • Allow the glassware to air dry on a clean drying rack. • Inspect the glassware for any remaining residues or spots. If necessary, repeat the cleaning process.
SAFETY PRECAUTIONS	• Always wear appropriate personal protective equipment (PPE) such as gloves, goggles, and a lab coat. • Handle acids with care and use them in a well-ventilated area or under a fume hood. • Discard any glassware that is cracked, chipped or otherwise in poor condition.

All copies of this document are uncontrolled when printed.

WARNING:

- *Handle acids and bases with caution.*
- *Never add water to acid/bases, only add acid/base to an excess of water.*
- *Always wear appropriate PPE.*
- *Do not dispose of solutions with pH less than 6.5 or greater than 9.5.*

DEFINITIONS

Acid – An acid is a substance that forms hydrogen ions H^+ when dissolved in water and has a pH of less than 7.

Base – An acid is a substance that forms hydroxide ions OH^- when dissolved in water and has a pH of greater than 7.

Neutralize – A chemical reaction in which acid and a base react with an equivalent quantity of each other. In a reaction in water, neutralization results in there being no excess of hydrogen or hydroxide ions present in the solution.

REFERENCES

- None

Hach DR3900 Spectrophotometer Operating Procedure For Measuring Zinc Concentrations

PURPOSE

This Standard Operating Procedure (SOP) provides operating guidelines and instructions for the calibration and use of the Hach DR3900 Spectrophotometer.

OBJECTIVE

- provide instructions for calibration and use of the meter
- provide instructions to measure zinc concentrations in water using the Hach DR3900 Spectrophotometer

SCOPE

In Scope	Out of Scope
• Calibration and use of the Hach DR3900 Spectrophotometer for analysis of zinc in surface water.	• Repairs of any type for the Hach DR3900 Spectrophotometer. • Analyses other than zinc.

ROLES & RESPONSIBILITIES

Teck employees and contractors who are required to use a Hach DR3900 Spectrophotometer to measure zinc concentrations.

TRAINING

Field technicians shall review and understand the Instruction Manual for the Hach DR3900 Spectrophotometer.

PERSONAL PROTECTIVE EQUIPMENT

- Safety goggles or glasses with side protection
- Face shield
- Nitrile black gloves
- Lab coat
- All tests must be conducted under a fume hood.

SUMMARY OF METHOD

Zinc and other metals in the sample are complexed with cyanide. Adding cyclohexanone causes a selective release of zinc. The zinc reacts with 2-carboxy-2'-hydroxy-5'-sulfoformazyl benzene (zincon) indicator to form a blue-colored species. The blue color is masked by the brown color from the excess indicator. The intensity of the blue color is proportional to the amount of zinc present. The measurement wavelength is 620 nm for spectrophotometers or 610 nm for colorimeters.

CALIBRATION

The Hach DR3900 Spectrophotometer does a self-calibration each time the unit is turned on. However, once per month or when spectrophotometer results are not congruent with analytical laboratory results, an accuracy check should be done using the Optical check or Accuracy Check with Standard Solution.

Annually, and typically at the end of the water treatment season, the unit is sent to Hach Service Canada for service and calibration.

OPTICAL CHECK

Step	Action
1.	The DR3900 has an “Optical Check” program for checking wavelength accuracy, stray light, and photometric accuracy. The “Optical Check” can be found in the “System Check” menu. In order to run the check, the user requires the optional test filter set (Verification Kit) containing six precision glass filters, target values, and instructions. If any results exceed allowable tolerances, contact the manufacturer.

ACCURACY CHECK WITH STANDARD SOLUTION

Step	Action
1.	Prepare a 0.50 mg/L zinc standard solution as follows.
2.	Pipette 2.5 mL of 100 mg/L zinc standard solution into a 500-mL volumetric flask.
3.	Pour deionized water into the flask to the 500-mL mark and mix well.
4.	Measure the concentration of the prepared standard solution using the zinc analysis procedure below.
5.	Compare the actual result with the expected result (i.e., 0.50 mg/L) and record data on the calibration record form.
6.	Calibration record forms to be saved on Legacy SharePoint: Pine Point>Monitoring>Environmental>Water Quality>Instruments>Calibration Records

ZINC ANALYSIS

SAMPLE DIGESTION

Step	Action
1.	Shake the 500-mL container containing sample water
2.	Decant 100 mL into a clean 100-mL glass graduated cylinder. Add one vial (5 mL) of concentrated nitric acid.
3.	Pour the 100-mL sample into a clean 250-mL glass beaker.
4.	Turn on hot plate to medium (95˚C or 203˚F).
5.	Add one vial (5 mL) of 1:1 hydrocholoric acid to the 100 mL sample in the glass beaker.

6.	Place beaker on hot plate until 15 to 20 mL of the sample remains. **Make sure that the sample does not boil.**
7.	Using tongs, remove and place beaker in a water bath (beaker will be very hot).
8.	Allow the sample to cool and filter the sample using a 0.45 µm filter to remove any insoluble material.
9.	Wash off the watch glass cover into the beaker using deionized water.
10.	The sample pH will be between 1 and 2. Adjust sample pH to between pH 4 to 5 using **10N and 1N Sodium Hydroxide** solutions stored in 100 mL burets. Add 10N sodium hydroxide dropwise until a pH of around 3 is observed. Add 1N sodium hydroxide dropwise until a pH between 4 to 5 is observed. The pH must not be greater than 5. If the sodium hydroxide adjustment results in a pH greater than 5, use one vial of nitric acid to reduce the pH and then increase the pH with 10N or 1N sodium hydroxide as per the steps above.
11.	Transfer sample from beaker into a 100-mL glass graduated cylinder add deionized water until the total volume is 100 mL. Pour sample back and forth three times between beaker and cylinder to mix.

SAMPLE ANALYSIS

The sample analysis method described below applies to all types of water samples, the Standard Solution and the blank sample (deionized water).

Step	Action
1.	Start program 780 Zinc on the Hach 3900 Spectrophotometer.
2.	Fill a 25-mL graduated cylinder with 20 mL of sample.
3.	Add the contents of one ZincoVer 5 Reagent Powder Pillow to the cylinder. Close the cylinder with a glass stopper.
4.	Shake the cylinder vigorously to dissolve the powder completely. Inconsistent readings can result if all the particles are not dissolved. The sample should be orange. If the sample is brown or blue, the zinc concentration is too high or an interfering metal is present. Dilute the sample and repeat the test.
5.	Use a plastic dropper to add 0.5 mL of cyclohexanone to the solution in the mixing cylinder.
6.	Start the instrument timer. A 30-second reaction time starts.
7.	During the reaction period, close the mixing cylinder and vigorously shake the prepared sample. The sample becomes reddish-orange,

	brown or blue, depending on the zinc concentration.
8.	Start the instrument timer. A 3-minute reaction time starts. During the reaction period, complete the next step.
9.	Pour the prepared sample solution from the mixing cylinder into a second sample cell.
10.	When the timer expires, clean the blank sample cell.
11.	Insert the blank into the cell holder.
12.	Push **ZERO**. The display shows 0.00 mg/L Zn.
13.	Clean the prepared sample cell.
14.	Insert the prepared sample into the cell holder.
15.	Push **READ**. Results show in mg/L Zn. Record the result in the sample analysis form.

DISPOSAL OF TEST MATERIALS

Collect final product of the zinc assay into a labelled container stored under the fume hood or otherwise ventilated space. At the end of the water treatment season or when the container is full, dispose of the container at a licensed hazardous waste facility.

CLEANING

Step	Action
1.	Clean glassware in accordance with the Laboratory Glassware Cleaning Procedure (TLP-EP-008)

MAINTENANCE OF LOGS

When the Hach DR3900 Spectrophotometer requires maintenance or manufacturer calibration, save all records on SharePoint according to the following pathway:

SITE>Monitoring>Environmental>Water Quality>Instruments>Maintenance Records

WARNING:

- *All tests must be completed under a fume hood.*
- *Handle acids and bases with caution.*
- *Read and understand SDS prior to beginning tests.*
- *The reagents that are used in the sample analysis contain potassium cyanide.*
- *Keep cyanide solutions at pH > 11 to prevent exposure to hydrogen cyanide gas.*
- *Ensure acids are properly stored before starting the Zinc Powder Pillow part of the test.*

DEFINITIONS

Calibration – the action of adjusting the readings of an instrument with those of a standard to check the instrument's accuracy.

REFERENCES

- Water Treatment Manual – PP -EP-001
- User Manual https://cdn.brandfolder.io/7FYZVWYB/as/844jtw567rtx7mfct36b36f/DR_3900_User_Manual_DOC0225390323.pdf
- Safety Data Sheets for all reagents

Oakton pH Meter Operating Procedure

PURPOSE

This Standard Operating Procedure (SOP) provides operating guidelines and instructions for the storage, cleaning, calibration and use of the Oakton pH meter.

OBJECTIVE

- describe storage requirements
- describe cleaning requirements
- provide instructions for calibration and use of the meter

SCOPE

In Scope	Out of Scope
• Storage, cleaning, calibration and use of the Oakton pH meter.	• Repairs of any type for any probe. • Storage, cleaning, and calibration of probes other than the Oakton pH meter. • Calibration of sensors other than the pH sensor.

ROLES & RESPONSIBILITIES

Teck employees and contractors who are required to use an Oakton pH meter at the Pine Point water treatment facility.

TRAINING

Field technicians shall review and understand the Instruction Manual for the Oakton Meter.

CALIBRATION

CALIBRATION – FREQUENCY AND RECORD KEEPING

Step	Action
1.	The pH meter must be calibrated once daily prior to use. The meter is calibrated using pH 7.00 and 10.00 buffer solutions. Always begin with pH 7.00 calibration.
2.	Use fresh calibration standards. The shelf life of calibration solution is one month after being opened; therefore, when opening a new bottle, write the date on the bottle with indelible ink (e.g., Sharpie).
3.	Make note of date and time of calibration and personnel on the calibration form, as well as pre and post calibration values.
4.	Proceed to calibrating the Oakton pH meter following the instructions below and save the calibration records to Pine Point>Monitoring>Environmental>Water Quality>Instruments>Calibration Records

CALIBRATION GENERAL INSTRUCTIONS

Step	Action
1.	Pour a known pH buffer standard solution into a clean, dry container. Turn on the meter and it will automatically enter measurement mode. Select pH mode by pressing MODE key.
2.	Dip both pH electrode and temperature probe into the buffer solution. Swirl gently and wait for reading to stabilize (approximately 30 seconds depending on electrode's condition).
3.	Press CAL key to enter pH calibration mode. A "CA" displays momentarily, and the display shows the current uncalibrated reading flashing.
4.	To abort or cancel calibration without accepting new value, press CAL key. The meter then reverts to pH measurement mode.
5.	To proceed with calibration, allow reading to stabilize. The meter automatically recognizes pH 7.00, or 10.01 buffers. Press ENTER key to confirm calibration and the LCD displays "CO" momentarily. The meter reverts to measurement mode.
6.	Rinse the probe and calibration cup with deionized water.
7.	Repeat steps 3 with pH 10.01 buffer for higher accuracy.

ANALYSIS PROCEDURE

Step	Action
1.	To conduct analysis of water samplers, insert the probe into the water sample bottle
2.	Record the temperature and pH reading from the meter in the field notes.

3.	Confirm that pH is within the target range for the sample location in accordance with the water treatment manual (TLP-EP-001).

CLEANING AND STORAGE

Step	Action
1.	Rinse probe using deionized water prior to calibration and between samples.
2.	Conduct a thorough clean of the probe for the following situations: • when lime deposits or contamination is apparent on the sensor • when the sensor does not calibrate properly • when the sensor response time is noticeably slow • when parameter readings appear to be drifting higher or lower than expected • before long-term storage (more than 4 weeks)
3.	Use mild detergent and warm water to clean the probe. If there is noticeable build-up of lime, the pH meter probes can be soaked for 10 minutes in 1% hydrochloric acid and then rinsed with deionized water. Do not touch the probe with your fingers. Recalibrate after cleaning.
4.	When not in use, place the probe in pH storage solution. Never use deionized water for storage.

MAINTENANCE OF LOGS

When the Oakton meter requires maintenance or manufacturer calibration, save all records on SharePoint according to the following pathway:

Pine Point>Monitoring>Environmental>Water Quality>Instruments>Maintenance Records

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WARNING:

Risks associated with the calibration standards and cleaning products. Read the Safety Data Sheet (SDS) before using.

DEFINITIONS

Calibration – the action of adjusting the readings of an instrument with those of a standard to check the instrument's accuracy.

REFERENCE DOCUMENTS

- Water Treatment Manual – TLP -EP-001
- https://www.manualslib.com/manual/1183737/Oakton-Ph-5Plus.html
- Safety Data Sheets for calibration solutions

Total Suspended Solids Analysis Procedure

PURPOSE

This Standard Operating Procedure (SOP) provides instructions for analysis of Total Suspended Solids in a water column.

OBJECTIVE

- describe equipment and supplies
- describe sample preparation and determination of TSS water concentration
- quality control measures

SCOPE

In Scope	Out of Scope
• Determination of Total Suspended Solids in a water column	• Turbidity or other water quality analyses

ROLES & RESPONSIBILITIES

Teck employees and contractors who are required to measure TSS concentrations in surface water samples.

TRAINING

Field technicians. Must be familiar with vacuum apparatus, drying oven, desiccator and weight balance.

PERSONAL PROTECTIVE EQUIPMENT

- Nitrile gloves
- Safety glasses

SUMMARY OF METHOD

Total Suspended Solids are defined as the solid particles in water that are retained by a filter and dried at 103 to 105°C to a constant weight.

SUPPLIES

- GE Healthcare Whatman grade 934-AH RTU- glass microfibre filters. Filters are ready to use – pre-washed and pre-weighed
- Vacuum flask
- Vacuum funnel and support
- Vacuum pump
- Drying oven, set at 103° C to 105°C
- 100-mL volumetric flask
- Desiccator
- Analytical balance

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- Analytical precision weight (100 mg)
- 500 mL graduated cylinder
- Tweezers
- Aluminum dish
- Deionized water

FILTER PAPER PREPARATION

Step	Action
1.	Place ten 0.45-micron filter papers in deionized water and leave overnight.
2.	Remove with tweezers and place each filter paper in an aluminum dish
3.	Dry in the oven at 103°C for two hours.
4.	Place dish with filter paper in desiccator to cool.
5.	Record weight of dried filter paper.

SAMPLE ANALYSIS

Step	Action
1.	Collect 700 to 900 mL water sample in a clean 1-L lidded plastic sample container.
2.	Shake sample well, pour 300 mL into a clean 500-mL graduated glass cylinder.
3.	Assemble filtration apparatus.
4.	Turn on vacuum pump and wet filter with approximately 15 mL of deionized water.
5.	Pour sample from graduated cylinder into filtering flask, and do not to let the filter paper go dry until all of the sample has been filtered.
6.	Rinse graduated cylinder with deionized water to remove all solids and filter.
7.	Rinse down sides of filtration apparatus with deionized water.
8.	Allow filter paper to vacuum dry.
9.	Turn off vacuum pump.
10.	Using tweezers, carefully remove glass filter and place in aluminum dish.
11.	Place dish and filter in drying oven set at 103°C to 105°C for at least 1 hour.
12.	Using tweezers, remove the filter and place in the desiccator to cool. (30 min).
13.	Weigh and record weight of glass filter.
14.	Rinse out the 500-mL glass graduated cylinder and the filtration apparatus with deionized water and allow to air dry.

CONCENTRATION CALCULATION

Total Suspended Solids (TSS) mg/L = [(A-B) X 1000] / C
Where:
A = Final weight of filter in grams
B = Tare weight of filter in grams
C = Volume of sample in litres

Record sample concentration on the daily samples log sheet.

QUALITY CONTROL

- Balance accuracy should be checked daily by weighing and recording weight of an analytical precision weight. (100 mg or 0.01 g).
- Duplicate sample shall be analyzed weekly.
- Blank sample (deionized water) shall be processed weekly.

CLEANING

Step	Action
1.	Clean glassware in accordance with the Laboratory Glassware Cleaning Procedure (TLP-EP-008)
2.	Used filter papers may be disposed of in standard garbage to be removed from site.

WARNING:

- *Handle heated items with care.*
- *Cracked or chipped glassware must be discarded.*

DEFINITIONS

Duplicate Sample - A second TSS analysis run with the same water sample. The intention of a duplicate sample is to measure the accuracy of the analytical technique.

REFERENCE DOCUMENTS

- Laboratory Glassware Cleaning Procedure – TLP-EP-008

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APPENDIX E
ALS CALA ACCREDITATION CERTIFICATE

Canadian Association for Laboratory Accreditation Inc.

CALA

Certificate of Accreditation

ALS Environmental (Edmonton)
ALS Canada Ltd.
9450-17th Ave. NW
Edmonton, Alberta

This laboratory is accredited in accordance with the recognized International Standard ISO/IEC 17025:2017. This accreditation demonstrates technical competence for a defined scope and the operation of a laboratory quality management system (refer to joint ISO-ILAC-IAF Communiqué dated April 2017).

Accreditation No.: 1001352
Issued On: 11/15/2022
Accreditation Date: 1/3/2005
Expiry Date: 5/15/2025

KMcKinley

President and CEO

CALA

This certificate is the property of the Canadian Association for Laboratory Accreditation Inc. and must be returned on request; reproduction must follow policy in place at date of issue.
For the specific tests to which this accreditation applies, please refer to the laboratory's scope of accreditation at www.cala.ca.

APPENDIX F
ALS CALA ACCREDITATION SCOPE

CALA Scope of Accreditation

Laboratory Name: ALS Environmental (Edmonton)

Client ID: 1001352

Parent Institution: ALS Canada Ltd.

Address: 9450-17th Ave. NW, Edmonton, Alberta, T6N 1M9

Contact: Ms. Sarah Stilson

Email: alsed.quality@alsglobal.com; David.Gurdibaniuk@alsglobal.com

Phone: (780) 413-5226

Fax: (780) 437-2311

Standard: Conforms with requirements of ISO/IEC 17025:2017

Clients Served: All Interested Parties

Revised On: 02/01/2023

Valid To: 05/15/2025

002 - Polychlorinated Biphenyls (PCB)

Field of Accreditation: Environmental

Matrix: Oil

Analytical Method: GC/ECD

Preparation Method: EXTRACTION

Lab Method ID(s): ED-TM-1104, ED-TM-1116

Method Reference	Modified From	Analytical Method	Preparation Method
ASTM D4059	Yes	Yes	No
EPA 8082	Yes	Yes	No

Parameter
Aroclor 1016
Aroclor 1221
Aroclor 1232
Aroclor 1242
Aroclor 1248
Aroclor 1254
Aroclor 1260
Aroclor 1262
Aroclor 1268
Total PCB

004 - Alkalinity

Field of Accreditation: Environmental

Matrix: Water

Analytical Method: TITRIMETRIC

Preparation Method:

Lab Method ID(s): ED-TM-1026

Method Reference	Modified From	Analytical Method	Preparation Method
SM 2320 B	Yes	Yes	No

Parameter
Alkalinity (pH 4.5)
Alkalinity (pH 8.3) (Phenolphthalein Alkalinity)

005 - Anions

Field of Accreditation: Environmental

Matrix: Water

Analytical Method: ION CHROMATOGRAPHY (IC)

Preparation Method:

Lab Method ID(s): NA-TM-1001

Method Reference	Modified From	Analytical Method	Preparation Method
EPA 300.1	Yes	Yes	No

Parameter
Bromide
Chloride
Fluoride
Nitrate
Nitrite
Sulfate

006 - Conductivity

Field of Accreditation: Environmental

Matrix: Water

Analytical Method: CONDUCTIVITY METER

Preparation Method:

Lab Method ID(s): ED-TM-1026

Method Reference	Modified From	Analytical Method	Preparation Method
SM 2510 B	Yes	Yes	No

Parameter
Conductivity (25C)

007 - Dissolved Metals

Field of Accreditation: Environmental

Matrix: Water

Analytical Method: ICP/MS

Preparation Method:

Lab Method ID(s): NA-TM-1002, NA-TP-2002

Method Reference	Modified From	Analytical Method	Preparation Method
EPA 6020B	Yes	Yes	No

Parameter
Aluminum
Antimony
Arsenic
Barium
Beryllium
Bismuth
Boron
Cadmium
Calcium
Cesium
Chromium
Cobalt
Copper
Iron
Lead
Lithium
Magnesium
Manganese
Molybdenum
Nickel
Phosphorus
Potassium
Rubidium
Selenium
Silicon
Silver
Sodium
Strontium
Sulphur (Sulfur)
Tellurium
Thallium
Thorium
Tin
Titanium
Tungsten
Uranium
Vanadium
Zinc
Zirconium

012 - Solids

Field of Accreditation: Environmental

Matrix: Water

Analytical Method: GRAVIMETRIC

Preparation Method:

Lab Method ID(s): NA-TM-1004, NA-TM-1008

Method Reference	Modified From	Analytical Method	Preparation Method
SM 2540 A	Yes	Yes	No
SM 2540 B	Yes	Yes	No
SM 2540 C	Yes	Yes	No
SM 2540 D	Yes	Yes	No
SM 2540 E	Yes	Yes	No

Parameter
Total Dissolved Solids
Total Suspended Solids

013 - Biochemical Oxygen Demand (BOD)

Field of Accreditation: Environmental

Matrix: Water

Analytical Method: DISSOLVED OXYGEN METER (DO)

Preparation Method:

Lab Method ID(s): ED-TM-1007, ED-TM-1037

Method Reference	Modified From	Analytical Method	Preparation Method
SM 5210 B	Yes	Yes	No

Parameter

BOD (5 day)
CBOD (5 day)
Ultimate Biochemical Oxygen Demand (BOD) (180 day)

015 - pH

Field of Accreditation: Environmental

Matrix: Water

Analytical Method: PH METER

Preparation Method:

Lab Method ID(s): ED-TM-1026

Method Reference	Modified From	Analytical Method	Preparation Method
SM 4500-H+ A	Yes	Yes	No
SM 4500-H+ B	Yes	Yes	No

Parameter

pH

023 - Metals

Field of Accreditation: Environmental

Matrix: Solids [Soil]

Analytical Method: ICP/MS

Preparation Method: DIGESTION

Lab Method ID(s): NA-TM-1002, NA-TP-2004

Method Reference	Modified From	Analytical Method	Preparation Method
EPA 200.2	Yes	Yes	No
EPA 6020B	Yes	Yes	No

Parameter

Aluminum
Antimony
Arsenic
Barium
Beryllium
Bismuth
Boron
Cadmium
Calcium
Chromium
Cobalt
Copper
Iron
Lead
Lithium
Magnesium
Manganese
Molybdenum
Nickel
Phosphorus
Potassium
Selenium
Silver
Sodium
Strontium
Sulphur (Sulfur)
Thallium
Tin
Titanium
Tungsten
Uranium
Vanadium
Zinc
Zirconium

028 - Grain Size

Field of Accreditation: Environmental

Matrix: Solids [Soil]

Analytical Method: GRAVIMETRIC

Preparation Method: SIEVE

Lab Method ID(s): ED-TM-1014

Method Reference	Modified From	Analytical Method	Preparation Method
ASTM D422-63	Yes	Yes	No

Parameter
Particle Size (>75um)

029 - Oil and Grease

Field of Accreditation: Environmental

Matrix: Solids [Soil]

Analytical Method: GRAVIMETRIC

Preparation Method: EXTRACTION

Lab Method ID(s): NA-TM-1100

Method Reference	Modified From	Analytical Method	Preparation Method
SM 5520	Yes	Yes	No

Parameter
Total Oil and Grease

035 - Hexavalent Chromium

Field of Accreditation: Environmental

Matrix: Water

Analytical Method: ION CHROMATOGRAPHY (IC)

Preparation Method:

Lab Method ID(s): ED-TM-1023

Method Reference	Modified From	Analytical Method	Preparation Method
SM 3500-CR C	Yes	Yes	No

Parameter
Hexavalent Chromium

051 - Chemical Oxygen Demand (COD)

Field of Accreditation: Environmental

Matrix: Water

Analytical Method: COLORIMETRIC

Preparation Method: DIGESTION

Lab Method ID(s): NA-TM-1201

Method Reference	Modified From	Analytical Method	Preparation Method
SM 5220 D	Yes	Yes	No

Parameter
COD

055 - Flashpoint

Field of Accreditation: Environmental

Matrix: Waste

Analytical Method: PENSKY-MARTENS CLOSED CUP

Preparation Method:

Lab Method ID(s): ED-TM-1012

Method Reference	Modified From	Analytical Method	Preparation Method
ASTM 93-D	Yes	Yes	No

Parameter
Flashpoint

075 - Petroleum Hydrocarbons (PHC)

Field of Accreditation: Environmental

Matrix: Water

Analytical Method: GC/FID

Preparation Method: EXTRACTION

Lab Method ID(s): NA-TM-1112

Method Reference	Modified From	Analytical Method	Preparation Method
EPA 3511	Yes	Yes	No

Parameter
F2: C10-C16
F3: C16-C34
F4: C34-C50
Total Extractable Hydrocarbons (TEH): C11-C30

078 - Turbidity

Field of Accreditation: Environmental

Matrix: Water

Analytical Method: TURBIDIMETRIC

Preparation Method:

Lab Method ID(s): NA-TM-1007

Method Reference	Modified From	Analytical Method	Preparation Method
SM 2130 A	Yes	Yes	No
SM 2130 B	Yes	Yes	No

Parameter
Turbidity

082 - Total Metals

Field of Accreditation: Environmental

Matrix: Water

Analytical Method: ICP/MS

Preparation Method: DIGESTION

Lab Method ID(s): NA-TM-1002, NA-TP-2001

Method Reference	Modified From	Analytical Method	Preparation Method
SM 3030 E	Yes	Yes	No
EPA 6020B	Yes	Yes	No

Parameter
Aluminum
Antimony
Arsenic
Barium
Beryllium
Bismuth
Boron
Cadmium
Calcium
Cesium
Chromium
Cobalt
Copper
Iron
Lead
Lithium
Magnesium
Manganese
Molybdenum
Nickel
Phosphorus
Potassium
Rubidium
Selenium
Silicon
Silver
Sodium
Strontium
Sulphur (Sulfur)
Tellurium
Thallium
Thorium
Tin
Titanium
Tungsten
Uranium
Vanadium
Zinc
Zirconium

097 - Polychlorinated Biphenyls (PCB)

Field of Accreditation: Environmental

Matrix: Solids [Soil]

Analytical Method: GC/ECD

Preparation Method: EXTRACTION

Lab Method ID(s): ED-TM-1102, ED-TM-1116

Method Reference	Modified From	Analytical Method	Preparation Method
EPA 3550	Yes	Yes	No
EPA 8082	Yes	Yes	No

Parameter
Aroclor 1016
Aroclor 1221
Aroclor 1232
Aroclor 1242
Aroclor 1248
Aroclor 1254
Aroclor 1260
Aroclor 1262
Aroclor 1268
Total PCB

099 - pH

Field of Accreditation: Environmental

Matrix: Solids [Soil]

Analytical Method: METER

Preparation Method: SATURATED PASTE

Lab Method ID(s): ED-TM-1003, NA-TP-2008

Method Reference	Modified From	Analytical Method	Preparation Method
SOIL SAMPLING & METHODS OF ANALYSIS, CARTER 15.2.1	Yes	Yes	No
SOIL SAMPLING & METHODS OF ANALYSIS, CARTER16.2	Yes	Yes	No

Parameter

pH

100 - pH

Field of Accreditation: Environmental

Matrix: Solids [Soil]

Analytical Method: PH METER

Preparation Method: EXTRACTION

Lab Method ID(s): ED-TM-1003

Method Reference	Modified From	Analytical Method	Preparation Method
SOIL SAMPLING & METHODS OF ANALYSIS, CARTER 16.2	Yes	Yes	No

Parameter

pH (1:1) soil:water
pH (1:2) soil:water

110 - Particle Size Analysis (PSA)

Field of Accreditation: Environmental

Matrix: Solids [Soil]

Analytical Method: PARTICLE SIZE

Preparation Method:

Lab Method ID(s): ED-TM-1010

Method Reference	Modified From	Analytical Method	Preparation Method
SOIL SAMPLING & METHODS OF ANALYSIS, CARTER 55.3	Yes	Yes	No

Parameter

Percent Clay
Percent Sand
Percent Silt

120 - Dustfall

Field of Accreditation: Environmental

Matrix: Air [Dustfall]

Analytical Method: GRAVIMETRIC

Preparation Method:

Lab Method ID(s): ED-TM-1030

Method Reference	Modified From	Analytical Method	Preparation Method
ALBERTA ENVIRONMENT 32020	Yes	Yes	No

Parameter

Fixed Dustfall
Total Dustfall

123 - Chlorine

Field of Accreditation: Environmental

Matrix: Water

Analytical Method: COLORIMETRIC

Preparation Method:

Lab Method ID(s): ED-TM-1036

Method Reference	Modified From	Analytical Method	Preparation Method
SM 4500-CL A	Yes	Yes	No
SM 4500-CL F	Yes	Yes	No
SM 4500-CL G	Yes	Yes	No

Parameter

Free Chlorine
Total Chlorine

135 - BTEX

Field of Accreditation: Environmental

Matrix: Waste

Analytical Method: GC/MS

Preparation Method: TCLP

Lab Method ID(s): ED-TP-2005, NA-TM-1102

Method Reference	Modified From	Analytical Method	Preparation Method
EPA 1311	Yes	No	Yes
EPA 8260B	Yes	Yes	No

Parameter
Benzene
Ethylbenzene
m,p-Xylene
o-Xylene
Toluene

141 - Metals

Field of Accreditation: Environmental

Matrix: Waste

Analytical Method: ICP/MS

Preparation Method: TCLP

Lab Method ID(s): NA-TM-1002, NA-TM-1700, NA-TP-2001

Method Reference	Modified From	Analytical Method	Preparation Method
EPA 1311	No	No	Yes
EPA 6020B	Yes	Yes	No

Parameter
Antimony
Arsenic
Barium
Beryllium
Boron
Cadmium
Chromium
Cobalt
Copper
Iron
Lead
Nickel
Selenium
Silver
Thallium
Uranium
Vanadium
Zinc
Zirconium

148 - Hexavalent Chromium

Field of Accreditation: Environmental

Matrix: Solids [Soil]

Analytical Method: ION CHROMATOGRAPHY (IC)

Preparation Method: DIGESTION

Lab Method ID(s): ED-TM-1023

Method Reference	Modified From	Analytical Method	Preparation Method
EPA 3060A	Yes	Yes	No

Parameter
Hexavalent Chromium

149 - Mercury

Field of Accreditation: Environmental

Matrix: Water

Analytical Method: COLD VAPOUR ATOMIC ABSORPTION (CVAA)

Preparation Method: COLD OXIDATION

Lab Method ID(s): NA-TM-1005

Method Reference	Modified From	Analytical Method	Preparation Method
EPA 1631E	Yes	Yes	No
EPA 245.7	Yes	Yes	No

Parameter
Mercury

152 - Colour

Field of Accreditation: Environmental

Matrix: Water

Analytical Method: SPECTROPHOTOMETRIC

Preparation Method:

Lab Method ID(s): ED-TM-1038

Method Reference	Modified From	Analytical Method	Preparation Method
SM 2120 A	Yes	Yes	No
SM 2120 C	Yes	Yes	No

Parameter
True Colour

154 - Volatile Organic Compounds (VOC)

Field of Accreditation: Environmental

Matrix: Solids [Soil]

Analytical Method: GC/MS-HEADSPACE

Preparation Method:

Lab Method ID(s): NA-TM-1102, NA-TP-2102

Method Reference	Modified From	Analytical Method	Preparation Method
EPA 8260	No	Yes	No

Parameter
Benzene
Ethylbenzene
m,p-Xylene
o-Xylene
Toluene

155 - Petroleum Hydrocarbons (PHC)

Field of Accreditation: Environmental

Matrix: Solids [Soil]

Analytical Method: GC/FID-HEADSPACE

Preparation Method:

Lab Method ID(s): NA-TM-1102, NA-TP-2102

Method Reference	Modified From	Analytical Method	Preparation Method
CCME CWS PETROLEUM HYDROCARBONS IN SOIL - TIER 1 METHOD	No	Yes	No
BC MOE LABORATORY MANUAL	No	Yes	No

Parameter
F1: C6-C10

156 - Conductivity

Field of Accreditation: Environmental

Matrix: Solids [Soil]

Analytical Method: METER

Preparation Method: SATURATED PASTE

Lab Method ID(s): ED-TM-1004, NA-TP-2008

Method Reference	Modified From	Analytical Method	Preparation Method
SOIL SAMPLING & METHODS OF ANALYSIS, CARTER 15.2.1	Yes	Yes	No
SOIL SAMPLING & METHODS OF ANALYSIS, CARTER 15.3	Yes	Yes	No

Parameter
Conductivity

158 - Petroleum Hydrocarbons (PHC)

Field of Accreditation: Environmental

Matrix: Solids [Soil]

Analytical Method: GC/FID

Preparation Method: TUMBLER EXTRACTION

Lab Method ID(s): NA-TM-1100, NA-TP-2100

Method Reference	Modified From	Analytical Method	Preparation Method
CCME CWS PETROLEUM HYDROCARBONS IN SOIL - TIER 1 METHOD	No	Yes	No

Parameter
F2: C10-C16
F3: C16-C34
F4: C34-C50

159 - Oil and Grease

Field of Accreditation: Environmental

Matrix: Water

Analytical Method: INFRARED SPECTROSCOPY (IR)

Preparation Method:

Lab Method ID(s): NA-TM-1111

Method Reference	Modified From	Analytical Method	Preparation Method
SM 5520 C	Yes	Yes	No
SM 5520 F	Yes	Yes	No

Parameter
Mineral Oil and Grease
Total Oil and Grease

160 - Metals

Field of Accreditation: Environmental

Matrix: Solids [Soil]

Analytical Method: ICP

Preparation Method: SATURATED PASTE

Lab Method ID(s): ED-TM-1021, NA-TP-2008

Method Reference	Modified From	Analytical Method	Preparation Method
EPA 200.7	Yes	Yes	No
SOIL SAMPLING & METHODS OF ANALYSIS, CARTER 15.2.1	Yes	Yes	No

Parameter
Boron
Calcium
Magnesium
Potassium
Sodium
Sulphate
Sulphur (Sulfur)

162 - Mercury

Field of Accreditation: Environmental

Matrix: Waste

Analytical Method: COLD VAPOUR ATOMIC ABSORPTION (CVAA)

Preparation Method: DIGESTION, TCLP

Lab Method ID(s): NA-TM-1005, NA-TM-1700

Method Reference	Modified From	Analytical Method	Preparation Method
EPA 1311	No	No	Yes
EPA 245.1	Yes	Yes	No
EPA 245.7	Yes	Yes	No

Parameter
Mercury

163 - pH

Field of Accreditation: Environmental

Matrix: Solids [Soil]

Analytical Method: PH METER

Preparation Method: 1:2 CACL2 EXTRACTION

Lab Method ID(s): ED-TM-1015

Method Reference	Modified From	Analytical Method	Preparation Method
SOIL SAMPLING & METHODS OF ANALYSIS, CARTER 16.3	Yes	Yes	No

Parameter
pH (1:2) soil:CaCl2

164 - Mercury

Field of Accreditation: Environmental

Matrix: Solids [Soil]

Analytical Method: COLD VAPOUR ATOMIC ABSORPTION (CVAA)

Preparation Method: DIGESTION

Lab Method ID(s): NA-TM-1005, NA-TP-2004

Method Reference	Modified From	Analytical Method	Preparation Method
EPA 1631E	Yes	Yes	No
EPA 200.2	Yes	Yes	No

Parameter
Mercury

165 - Petroleum Hydrocarbons (PHC)

Field of Accreditation: Environmental

Matrix: Water

Analytical Method: GC/FID-HEADSPACE

Preparation Method:

Lab Method ID(s): NA-TM-1102

Method Reference	Modified From	Analytical Method	Preparation Method
BC MOE LABORATORY MANUAL	Yes	Yes	No
CCME CWS PETROLEUM HYDROCARBONS IN SOIL - TIER 1 METHOD	Yes	Yes	No
EPA 5021A	Yes	No	Yes

Parameter
F1: C6-C10
VH: C6-C10

166 - Volatile Organic Compounds (VOC)

Field of Accreditation: Environmental

Matrix: Water

Analytical Method: GC/MS-HEADSPACE

Preparation Method:

Lab Method ID(s): NA-TM-1102

Method Reference	Modified From	Analytical Method	Preparation Method
EPA 5021	Yes	Yes	No
EPA 8260	Yes	Yes	No

Parameter
1,1,1,2-Tetrachloroethane
1,1,1-Trichloroethane
1,1,2,2-Tetrachloroethane

Parameter
1,1,2-Trichloroethane
1,1-Dichloroethane
1,1-Dichloroethylene
1,1-Dichloropropene
1,2,3-Trichlorobenzene
1,2,3-Trichloropropane
1,2,4-Trichlorobenzene
1,2,4-Trimethylbenzene
1,2-Dibromo-3-chloropropane (DBCP)
1,2-Dichlorobenzene
1,2-Dichloroethane
1,2-Dichloropropane
1,3,5-Trimethylbenzene
1,3-Dichlorobenzene
1,3-Dichloropropane
1,4-Dichlorobenzene
2,2-Dichloropropane
2-Chlorotoluene
2-Hexanone (Methyl butyl ketone, MBK)
4-Chlorotoluene (p-Chlorotoluene)
4-Isopropyltoluene (p-Cymene)
Acetone (2-Propanone)
Acrylonitrile
Benzene
Bromobenzene
Bromochloromethane
Bromodichloromethane
Bromoform
Bromomethane
Butylbenzene (n-Butylbenzene)
Carbon disulfide
Carbon tetrachloride
Chlorobenzene
Chlorodibromomethane
Chloroethane (Ethyl chloride)
Chloroform
Chloromethane (Methyl chloride)
cis-1,2-Dichloroethylene
cis-1,3-Dichloropropene
cis-1,4-Dichloro-2-butene
Dibromomethane
Dichlorodifluoromethane (CFC-12, Freon 12)
Dichloromethane
Ethanol
Ethyl methacrylate (Ethyl-2-Methyl-2-Propenoate)
Ethylbenzene
Ethylene Dibromide
Hexachlorobutadiene (1,1,2,3,4,4-Hexachloro-1,3-butadiene)
Isopropylbenzene (Cumene)
m,p-Xylene
Methyl ethyl ketone
Methyl iodide
Methyl isobutyl ketone (MIBK)
Naphthalene
n-Propylbenzene
o-Xylene
sec-Butylbenzene ((1-Methylpropyl)benzene)
Styrene
tert-Butylbenzene
Tetrachloroethylene
Toluene
trans-1,2-Dichloroethylene
trans-1,3-Dichloropropene
trans-1,4-Dichloro-2-butene
Trichloroethylene
Trichlorofluoromethane
Vinyl chloride

167 - Volatile Organic Compounds (VOC)

Field of Accreditation: Environmental

Matrix: Solids [Soil]

Analytical Method: GC/MS-HEADSPACE

Preparation Method: EXTRACTION

Lab Method ID(s): NA-TM-1102, NA-TP-2102

Method Reference	Modified From	Analytical Method	Preparation Method
EPA 5021	Yes	Yes	No
EPA 8260	Yes	Yes	No

Parameter

1,1,1,2-Tetrachloroethane
1,1,1-Trichloroethane
1,1,2,2-Tetrachloroethane
1,1,2-Trichloroethane
1,1-Dichloroethane
1,1-Dichloroethylene
1,1-Dichloropropene
1,2,3-Trichlorobenzene
1,2,3-Trichloropropane
1,2,4-Trichlorobenzene
1,2,4-Trimethylbenzene
1,2-Dibromo-3-chloropropane (DBCP)
1,2-Dichlorobenzene
1,2-Dichloroethane
1,2-Dichloropropane
1,3,5-Trichlorobenzene
1,3,5-Trimethylbenzene
1,3-Dichlorobenzene
1,3-Dichloropropane
1,4-Dichlorobenzene
2,2-Dichloropropane
2-Chlorotoluene
2-Hexanone (Methyl butyl ketone, MBK)
4-Chlorotoluene (p-Chlorotoluene)
4-Isopropyltoluene (p-Cymene)
Acetone (2-Propanone)
Acrylonitrile
Benzene
Bromobenzene
Bromochloromethane
Bromodichloromethane
Bromoform
Bromomethane
Butylbenzene (n-Butylbenzene)
Carbon disulfide
Carbon tetrachloride
Chlorobenzene
Chlorodibromomethane
Chloroethane (Ethyl chloride)
Chloroethene (Vinyl chloride)
Chloroform
Chloromethane (Methyl chloride)
cis-1,2-Dichloroethylene
cis-1,3-Dichloropropene
cis-1,4-Dichloro-2-butene
Dibromomethane
Dichlorodifluoromethane (CFC-12, Freon 12)
Dichloromethane
Ethanol
Ethyl methacrylate (Ethyl-2-Methyl-2-Propenoate)
Ethylbenzene
Ethylene Dibromide
Hexachlorobutadiene (1,1,2,3,4,4-Hexachloro-1,3-butadiene)
Isopropylbenzene (Cumene)
m,p-Xylene
Methyl ethyl ketone
Methyl iodide
Methyl isobutyl ketone (MIBK)
Methyl t-butyl ether
n-Propylbenzene
o-Xylene
sec-Butylbenzene ((1-Methylpropyl)benzene)
Styrene
tert-Butylbenzene
Tetrachloroethylene
Toluene
trans-1,2-Dichloroethylene
trans-1,3-Dichloropropene
trans-1,4-Dichloro-2-butene
Trichloroethylene
Trichlorofluoromethane

168 - Chloride

Field of Accreditation: Environmental

Matrix: Solids [Saturated Paste, Soil]

Analytical Method: COLORIMETRIC

Preparation Method:

Lab Method ID(s): ED-TM-1032, NA-TP-2008

Method Reference	Modified From	Analytical Method	Preparation Method
SM 4500-CL- E	Yes	Yes	No
SOIL SAMPLING & METHODS OF ANALYSIS, CARTER 15.2.1	Yes	Yes	No

Parameter
Chloride

169 - Percent Saturation

Field of Accreditation: Environmental

Matrix: Solids [Soil]

Analytical Method: GRAVIMETRIC

Preparation Method:

Lab Method ID(s): NA-TP-2008

Method Reference	Modified From	Analytical Method	Preparation Method
SOIL SAMPLING & METHODS OF ANALYSIS, CARTER 15.2.1	Yes	Yes	No

Parameter
Percent Saturation

170 - Density

Field of Accreditation: Environmental

Matrix: Solids [Soil]

Analytical Method: GRAVIMETRIC

Preparation Method:

Lab Method ID(s): ED-TM-1025

Method Reference	Modified From	Analytical Method	Preparation Method
ASTM D5057	Yes	Yes	No

Parameter
Density

171 - Petroleum Hydrocarbons (PHC)

Field of Accreditation: Environmental

Matrix: Solids [Soil]

Analytical Method: GRAVIMETRIC

Preparation Method: TUMBLER EXTRACTION

Lab Method ID(s): NA-TM-1100, NA-TP-2100

Method Reference	Modified From	Analytical Method	Preparation Method
CCME CWS PETROLEUM HYDROCARBONS IN SOIL - TIER 1 METHOD	No	Yes	No

Parameter
F4: Gravimetric

172 - Barium

Field of Accreditation: Environmental

Matrix: Solids [Soil]

Analytical Method: ICP

Preparation Method: FUSION

Lab Method ID(s): ED-TM-1021, ED-TM-1055

Method Reference	Modified From	Analytical Method	Preparation Method
EPA 200.7	Yes	Yes	No
SSSA PART 3, 1996, PG 202	Yes	Yes	No

Parameter
Barium

173 - Sulphate (Sulfate)

Field of Accreditation: Environmental

Matrix: Solids

Analytical Method: ION CHROMATOGRAPHY (IC)

Preparation Method: DIGESTION

Lab Method ID(s): ED-TM-1046, NA-TM-1001

Method Reference	Modified From	Analytical Method	Preparation Method
CSA A23.2	Yes	Yes	No

Parameter
Sulphate (Sulfate)

174 - Specific Gravity

Field of Accreditation: Environmental

Matrix: Waste

Analytical Method: GRAVIMETRIC **Preparation Method**:

Lab Method ID(s): ED-TM-1025

Method Reference	Modified From	Analytical Method	Preparation Method
ASTM D5057	Yes	Yes	No

Parameter
Specific Gravity

176 - Anions

Field of Accreditation: Environmental **Matrix**: Solids [Soil]

Analytical Method: ION CHROMATOGRAPHY (IC) **Preparation Method**: SATURATED PASTE

Lab Method ID(s): NA-TM-1001, NA-TP-2008

Method Reference	Modified From	Analytical Method	Preparation Method
EPA 300.1	Yes	Yes	No
SOIL SAMPLING & METHODS OF ANALYSIS, CARTER 15.2.1	Yes	Yes	No

Parameter
Chloride
Nitrate-N
Nitrite (NO2)
Sulphate

179 - Percent Moisture

Field of Accreditation: Environmental **Matrix**: Solids [Soil]

Analytical Method: GRAVIMETRIC **Preparation Method**:

Lab Method ID(s): NA-TM-1200

Method Reference	Modified From	Analytical Method	Preparation Method
CCME CWS PETROLEUM HYDROCARBONS IN SOIL - TIER 1 METHOD	No	Yes	Yes

Parameter
Percent Moisture

182 - Extractable Barium

Field of Accreditation: Environmental **Matrix**: Solids [Soil]

Analytical Method: ICP **Preparation Method**: EXTRACTION

Lab Method ID(s): ED-TM-1021, ED-TM-1051

Method Reference	Modified From	Analytical Method	Preparation Method
BARITE WASTE GUIDELINES	Yes	Yes	No

Parameter
Barium

183 - Phosphate

Field of Accreditation: Environmental **Matrix**: Water

Analytical Method: COLORIMETRIC **Preparation Method**:

Lab Method ID(s): ED-TM-1041

Method Reference	Modified From	Analytical Method	Preparation Method
SM 4500-P	Yes	Yes	No

Parameter
Phosphate

184 - Phosphorus

Field of Accreditation: Environmental **Matrix**: Water

Analytical Method: COLORIMETRIC **Preparation Method**:

Lab Method ID(s): ED-TM-1041

Method Reference	Modified From	Analytical Method	Preparation Method
SM 4500-P B	Yes	Yes	No
SM 4500-P E	Yes	Yes	No

Parameter
Total Dissolved Phosphorus
Total Phosphorus

188 - Fluoride

Field of Accreditation: Environmental **Matrix**: Air

Analytical Method: ION SELECTIVE ELECTRODE (ISE) **Preparation Method**:

Lab Method ID(s): ED-TM-1028

Method Reference	Modified From	Analytical Method	Preparation Method
ALBERTA ENVIRONMENT	Yes	Yes	No
SM 4500-F- C	Yes	Yes	No

Parameter
Fluoride

196 - Coliforms

Field of Accreditation: Environmental **Matrix**: Water

Analytical Method: QUANTI-TRAY (COLILERT) **Preparation Method**:

Lab Method ID(s): NA-TM-1300

Method Reference	Modified From	Analytical Method	Preparation Method
SM 9223 B	Yes	Yes	No

Parameter
Escherichia coli
Total Coliforms

197 - Fecal (Thermotolerant) Coliforms

Field of Accreditation: Environmental **Matrix**: Water

Analytical Method: QUANTI-TRAY (COLILERT) **Preparation Method**:

Lab Method ID(s): NA-TM-1300

Method Reference	Modified From	Analytical Method	Preparation Method
SM 9223 B	Yes	Yes	No

Parameter
Fecal (Thermotolerant) Coliforms

198 - Heterotrophic Plate Count (HPC)

Field of Accreditation: Environmental **Matrix**: Water

Analytical Method: QUANTI-TRAY (COLILERT) **Preparation Method**:

Lab Method ID(s): NA-TM-1300

Method Reference	Modified From	Analytical Method	Preparation Method
SM 9215 E	Yes	Yes	No

Parameter
Heterotrophic Plate Count (HPC)

202 - Polychlorinated Biphenyls (PCB)

Field of Accreditation: Environmental **Matrix**: Solids [Swab]

Analytical Method: GC/ECD **Preparation Method**: EXTRACTION

Lab Method ID(s): ED-TM-1102, ED-TM-1116

Method Reference	Modified From	Analytical Method	Preparation Method
EPA 3550	Yes	Yes	No
EPA 8082	Yes	Yes	No

Parameter
Aroclor 1016
Aroclor 1221
Aroclor 1232
Aroclor 1242
Aroclor 1248
Aroclor 1254
Aroclor 1260
Aroclor 1262
Aroclor 1268
Total PCBs (Total Polychlorinated Biphenyls)

216 - Volatile Organic Compounds (VOC)

Field of Accreditation: Environmental **Matrix**: Air

Analytical Method: GC/FID **Preparation Method**:

Lab Method ID(s): ED-TM-1142

Method Reference	Modified From	Analytical Method	Preparation Method
EPA 018	Yes	Yes	No

Method Reference	Modified From	Analytical Method	Preparation Method
EPA 25C	Yes	Yes	No

Parameter
Benzene
Ethylbenzene
Non-methane Organic Carbons
Toluene
Xylenes

217 - Hydrocarbons

Field of Accreditation: Environmental

Matrix: Air

Analytical Method: GC/FID

Preparation Method:

Lab Method ID(s): ED-TM-1142, ED-TM-1144

Method Reference	Modified From	Analytical Method	Preparation Method
CSA Z180	No	Yes	No
EPA 18	Yes	Yes	No

Parameter
Carbon dioxide (CO2)
Carbon monoxide (CO)
Ethane
Methane
Total Volatile Hydrocarbons (TVH): C1-C16

218 - Gas

Field of Accreditation: Environmental

Matrix: Air [Compressed Breathing Air]

Analytical Method: GC/TCD

Preparation Method:

Lab Method ID(s): ED-TM-1144

Method Reference	Modified From	Analytical Method	Preparation Method
ASTM D1946	Yes	Yes	No
CSA 180	No	Yes	No
EPA 3C	No	Yes	No

Parameter
Carbon dioxide (CO2)
Nitrogen
Oxygen

221 - Formaldehyde

Field of Accreditation: Environmental

Matrix: Air

Analytical Method: HPLC/UV

Preparation Method: EXTRACTION

Lab Method ID(s): ED-TM-1151

Method Reference	Modified From	Analytical Method	Preparation Method
EPA TO-11A	Yes	Yes	No
NIOSH 2016	Yes	Yes	No

Parameter
Formaldehyde

224 - Phosphorus

Field of Accreditation: Environmental

Matrix: Water

Analytical Method: COLORIMETRIC

Preparation Method:

Lab Method ID(s): ED-TM-1041

Method Reference	Modified From	Analytical Method	Preparation Method
SM 4500-P	No	Yes	No

Parameter
Inorganic Phosphorus

226 - Polyaromatic Hydrocarbons (PAH)

Field of Accreditation: Environmental

Matrix: Water

Analytical Method: GC/MS

Preparation Method: MICROEXTRACTION

Lab Method ID(s): NA-TM-1112, NA-TP-2019

Method Reference	Modified From	Analytical Method	Preparation Method
EPA 3511	Yes	Yes	No
EPA 8270D	Yes	Yes	No

Parameter
1-Methylnaphthalene
2-Methylnaphthalene
Acenaphthene
Acenaphthylene
Acridine
Anthracene
Benzo(a)anthracene
Benzo(a)pyrene
Benzo(b,j)fluoranthene
Benzo(e)pyrene
Benzo(g,h,i)perylene
Benzo(k)fluoranthene
Chrysene
Dibenzo(a,h)anthracene
Fluoranthene
Fluorene
Indeno(1,2,3 - cd)pyrene
Naphthalene
Perylene
Phenanthrene
Pyrene
Quinoline

227 - Polycyclic Aromatic Hydrocarbons (PAH)

Field of Accreditation: Environmental

Matrix: Solids

Analytical Method: GC/MS

Preparation Method: EXTRACTION

Lab Method ID(s): NA-TM-1105, NA-TP-2103

Method Reference	Modified From	Analytical Method	Preparation Method
EPA 3570	Yes	Yes	No
EPA 8270	Yes	Yes	No

Parameter
1-Methylnaphthalene
2-Methylnaphthalene
Acenaphthene
Acenaphthylene
Anthracene
Benzo(a)anthracene
Benzo(a)pyrene
Benzo(b,j)fluoranthene
Benzo(g,h,i)perylene
Benzo(k)fluoranthene
Chrysene
Dibenzo(a,h)anthracene
Fluoranthene
Fluorene
Indeno(1,2,3 - cd)pyrene
Naphthalene
Perylene
Phenanthrene
Pyrene
Quinoline

228 - Phenols

Field of Accreditation: Environmental

Matrix: Water

Analytical Method: COLORIMETRIC

Preparation Method:

Lab Method ID(s): ED-TM-1057

Method Reference	Modified From	Analytical Method	Preparation Method
EPA 9066	Yes	Yes	No

Parameter
Total Phenolics

229 - Acidity

Field of Accreditation: Environmental

Matrix: Water

Analytical Method: TITRIMETRIC

Preparation Method:

Lab Method ID(s): ED-TM-1026

Method Reference	Modified From	Analytical Method	Preparation Method
SM 2310	Yes	Yes	No

Parameter
Acidity

230 - UV Absorbance and Transmittance

Field of Accreditation: Environmental

Matrix: Water

Analytical Method: SPECTROPHOTOMETRIC

Preparation Method:

Lab Method ID(s): ED-TM-1058

Method Reference	Modified From	Analytical Method	Preparation Method
SM 5910 B	Yes	Yes	No

Parameter
UV Absorbance
UV Transmittance

231 - Paint Filter

Field of Accreditation: Environmental

Matrix: Solids [Paint, Soil]

Analytical Method:

Preparation Method: FILTRATION

Lab Method ID(s): ED-TM-1042

Method Reference	Modified From	Analytical Method	Preparation Method
EPA 9095A	No	Yes	No

Parameter
Paint Filter (Free Liquid)

232 - Ammonia

Field of Accreditation: Environmental

Matrix: Water

Analytical Method: FLUOROMETRIC

Preparation Method:

Lab Method ID(s): ED-TM-1039

Method Reference	Modified From	Analytical Method	Preparation Method
JOURNAL OF ENVIRONMENTAL MONITORING (2005) SECTION 7, P. 37-42	Yes	Yes	No

Parameter
Ammonia

233 - Total Kjeldahl Nitrogen (TKN)

Field of Accreditation: Environmental

Matrix: Water

Analytical Method: FLUOROMETRIC

Preparation Method:

Lab Method ID(s): ED-TM-1043, NA-TM-1006

Method Reference	Modified From	Analytical Method	Preparation Method
JOURNAL OF ENVIRONMENTAL MONITORING (2005) SECTION 7, P. 37-42	Yes	Yes	No
SM 4500-NORG B	Yes	Yes	No

Parameter
Total Kjeldahl Nitrogen

234 - Naphthenic Acids

Field of Accreditation: Environmental

Matrix: Water

Analytical Method: FTIR

Preparation Method: EXTRACTION

Lab Method ID(s): ED-TM-1107

Method Reference	Modified From	Analytical Method	Preparation Method
NAPHTHENIC ACIDS BY FTIR, SYNCRUDE, 1994	Yes	Yes	No

Parameter
Naphthenic Acids

235 - Ammonia

Field of Accreditation: Environmental

Matrix: Solids [Soil]

Analytical Method: FLUOROMETRIC

Preparation Method: SATURATED PASTE

Lab Method ID(s): NA-TM-1009, NA-TP-2008

Method Reference	Modified From	Analytical Method	Preparation Method
SOIL SAMPLING & METHODS OF ANALYSIS, CARTER 15.2.1	Yes	No	Yes

Parameter
Ammonia (NH3)

236 - Carbon

Field of Accreditation: Environmental

Matrix: Water

Analytical Method: INFRARED SPECTROSCOPY (IR)

Preparation Method: COMBUSTION

Lab Method ID(s): ED-TM-1002, NA-TM-1203

Method Reference	Modified From	Analytical Method	Preparation Method
SM 5310 B	Yes	Yes	Yes

Parameter
Organic Carbon

237 - Metals

Field of Accreditation: Environmental

Matrix: Solids [Soil]

Analytical Method: ICP/MS

Preparation Method: SATURATED PASTE

Lab Method ID(s): NA-TM-1002, NA-TP-2008

Method Reference	Modified From	Analytical Method	Preparation Method
EPA 6020B	Yes	Yes	No
SOIL SAMPLING & METHODS OF ANALYSIS, CARTER 15.2.1	Yes	No	Yes

Parameter
Boron
Calcium
Magnesium
Potassium
Sodium
Sulphur (Sulfur)

† “OSDWA” indicates the appendix is used for the analysis of Ontario drinking water samples, which is subject to the rules and related regulations under the Ontario “Safe Drinking Water Act” (2002).

The list of tests and measurement capabilities for which a laboratory is accredited can change at any time due to circumstances such as scope extensions, voluntary withdrawal of tests by the laboratory and suspension. Scopes are published by the CALA via the Internet at http://www.cala.ca/cala_directories.html

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APPENDIX G
ALS STATEMENT OF QUALIFICATIONS

STATEMENT OF QUALIFICATIONS

Environmental Testing • Canada

Right Solutions • Right Partner

www.alsglobal.com

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ALS IS THE **GLOBAL** BENCHMARK FOR **QUALITY** AND **INTEGRITY**

By the numbers

13,000	350+	55
Experienced and dedicated staff globally	Laboratories and offices across the world	**Countries covered by the ALS global network**

Corporate Profile

As one of the world's largest and most diverse testing services providers, ALS has sites strategically located around the world to provide accurate and timely services. We have operations in more than 350 locations in 55 countries across six continents. We have teams of experts around the world available to provide specialized business solutions that align with client needs.

ALS Limited's international testing services business is focused on delivering superior services through four main divisions and 12 business groups. These include: Minerals (Geochemistry, Metallurgy, Mine Site, Inspection); Life Sciences (Environmental, Food, Animal Health, Consumer Products, and Electronics); Energy (Coal, Oil & Gas); and Industrial (Asset Care, Tribology). With these groups, we are able to offer a broad range of technical services to our clients – unrivaled in the industry.

ALS is the global benchmark for quality and integrity, and we have built our reputation on these two principles along with client service, innovation, and technical excellence. Our commitment to systemization and standardization allows our people to focus on what is important.

Life Sciences Division

ALS Life Sciences is comprised of five primary analytical testing areas: Environmental, Food, Electronics, Consumer Products, and Animal Health. With our expansive worldwide footprint, ALS Life Sciences is the leader in global, comprehensive analytical testing services. We are experts in microbiological, physical and chemical testing services. Our industry-leading technical expertise, performance excellence and dedication to customer service make us the most reliable and trusted analytical service in the world.

At ALS Life Sciences, we work closely with you to understand your current analytical testing and service requirements, as well as those of the future. Our philosophy is to provide you with more than just reliable test results. We offer our clients all the advantages that an integrated laboratory network provides: regulatory compliance across six continents, excessive capacity, redundant certifications, and program management flexibility not possible with other laboratories.

SAFETY AS A PRIORITY

> “OUR GLOBAL MINIMUM STANDARD ASSISTS IN MANAGING HEALTH, SAFETY, AND ENVIRONMENTAL ISSUES.”

ALS is committed to a safe work culture. Our global minimum standard assists in managing health, safety and environmental issues. On a national basis, policy and procedures are designed to comply with the requirements of relevant legislation. ALS employs a team of Health and Safety professionals at both a regional and corporate level to support continual improvement and best practice.

ALS believes that meeting its safety and environmental obligations is essential to its long-term success. ALS imparts its safety and environmental values from the first day the employee commences work with the company and throughout their term as a valued employee.

We do this by:
- Comprehensive safety training upon hire
- Ongoing training, including formal training on core topics and personalized training based on risk assessments
- Integration with our day-to-day operations through our “Safety First” program and quality management system
- Auditing, reporting and review at all levels of the organization

ALS has a core value of “Safety as a Priority”. Being an employee of ALS is about putting safety first. This approach is identical for staff working across the globe.

As part of this global approach, the minimum standard is driven by an ethic to deliver a consistently friendly and safe approach to work, regardless of differences in local laws.

The ALS HSE Minimum Standard requires each business to manage risks by adopting the following:
- Ensuring health, safety and environmental resources are available
- Ensuring managers are aware of their responsibilities
- Implementing a plan for managing injuries and site emergencies
- Ensuring contractors work safely
- Ensuring that key safety information is available for all staff to view
- Providing training on key safety risks
- Ensuring that all staff have an opportunity to provide feedback
- Ensuring that work areas are designed and maintained in a safe manner
- Ensuring that all incidents are reported so we can learn from our experiences
- Completing a review of health and safety issues on a regular basis
- Ensuring that a monthly site audit of Safety issues is conducted

Fixed schedules are in place for auditing, reporting and review of the HSE management system by staff, supervisors and management.

THE **LEADER IN** COMPREHENSIVE ANALYTICAL **TESTING SERVICES**

North America Headquarters: 10450 Stancliff Rd, Ste 210 • Houston, Texas 77099 USA • +1 877 793 5656

AIR WATER WASTEWATER SOIL SLUDGE
SOLIDS WASTE OIL HAZARDOUS WASTE
SOLVENTS SEDIMENTS TISSUES

The World’s Largest Environmental Laboratory Network

ALS provides a full range of environmental analytical testing services, specializing in the analysis of air, water (raw, waste, drinking, catchment, recycled, saline, and product), soil, sludge, solids, waste oil, solvents, hazardous waste, sediments and tissues. Analytical laboratory testing services for these matrices includes routine, trace and ultra-trace level organics (volatile and semi volatile, herbicides, pesticides, PCBs and disinfection byproducts), metals and nutrients, inorganic non-metallics, microbiological, biological, toxicological parameters, particle sizing and radionuclides. We have expertise in many specialty testing areas in addition to the routine services.

As the largest and most diverse global environmental laboratory network, ALS has the experience, resources, and expertise needed to ensure we exceed expectations for all your environmental projects.

Benefits of using ALS for environmental testing

ALS, through the depth of technical and management expertise, consistently provides high-level service. Our commitment to good science and personal service is backed by a sound quality program. Each laboratory within the ALS network maintains accreditations to satisfy target market demands. To obtain copies of Scopes of Accreditation, visit alsglobal.com, refer to the accrediting bodies, or contact the local ALS laboratory location. When working with ALS, clients can expect:

- Rapid turnaround to keep projects on schedule
- Project mobilization assistance to cover the scope of services required
- Technical resources to help solve problems
- Extensive experience working with a wide range of clients and programs
- Customized EDD formats with direct database uploads
- Interaction with trained professionals and problem solvers
- Regular participation in Proficiency Test evaluations to ensure that the accuracy of results is continuously monitored and improved


AGRICULTURE


WATER TREATMENT


PULP & PAPER


INDUSTRIAL


CONSTRUCTION


OIL & GAS


HEALTH & SAFETY


MINING


GOVERNMENT

EXPERIENCE AND EXPERTISE WITH MANY INDUSTRIES

> "ALS HELPED US WITH A NON-STANDARD, TIME-SENSITIVE PROJECT AND DELIVERED! THEY ARE EXPERTS IN THEIR FIELDS, AND CAN DEVELOP AND MODIFY ANALYTICAL PROTOCOLS TO SUIT OUR NEEDS. ALS WENT ABOVE AND BEYOND."
>
> **NATIONAL ENGINEERING FIRM**

Our staff consists of more than 800 employees, including chemists, biologists, computer scientists, technicians and support personnel. The diverse educational backgrounds and experience of our employees provide ALS the comprehensive skills required by a modern analytical laboratory network. We take pride in our experience and professional dedication and are committed to providing the necessary resources to maintain and further develop our expertise to meet our customers' needs. ALS provides analytical services to many different industries, including:

- Aerospace
- Agriculture
- Automotive
- Chemical
- Commercial/Solid Waste
- Construction
- Electronics
- Environmental & Construction Engineering
- Federal Government Agencies (DoD, EPA, NOAA)
- Forest Products
- Health & Safety
- Industrial
- Manufacturers
- Microelectronics, Semiconductor
- Mining
- Municipalities
- Nutraceutical
- Petrochemical
- Petroleum, Oil, Gas, Coal
- Pharmaceutical
- Ports and Harbors
- Pulp and Paper
- Transportation
- Utilities
- Waste Management
- Water Industries
- Water Treatment

COMPREHENSIVE RANGE OF **CAPABILITIES** AND **SERVICES**

> "ALS IS INCREDIBLY HELPFUL WITH TECHNICAL AND BASIC QUESTIONS. I FEEL THEY REALLY GO OUT OF THEIR WAY TO MAKE MY FIELD SAMPLING ACTIVITIES A SUCCESS BY PROVIDING SOUND ADVICE. THEY PROVIDE FAST AND ACCURATE SERVICE."
>
> **STATE GOVERNMENT AGENCY**

Organic Capabilities

- Air Testing (ambient)
- CAL LUFT, CAL WET
- Chemical Agent Breakdown Products by LC/MS
- Dioxins/Furans
- Endocrine Disruptors
- Ethene, Ethane, Methane
- Explosives by LC/UV and LC/MS/MS
- Formaldehyde
- GC Semi-VOAs-PCBs
- GC Semi-VOAs-Pesticides and Herbicides
- GC Volatiles-BTEX
- GC/MS VOAs, Semi-VOAs, PAHs
- GC/MS/MS Pesticides
- GC/MS/SIM/LVI (various applications)
- GRO/DRO/ORO
- Incremental Sampling
- LC/MS and LC/MS/MS (various applications)
- NDMA
- Nitrocellulose
- Nitroglycerine, PETN
- Nitroguanidine,
- Oxyanions and Perchlorate
- PCB Congeners
- Petroleum Biomarkers
- Pharmaceutical and Personal Care Products (PPCP)
- Polybrominated Diphenyl Ethers by GC/MS/LVI/SIM
- Sediment/Tissue Chemistry
- Speciated Hydrocarbons
- TCLP/SPLP Organics
- TPH
- Vapor Intrusion
- White Phosphorus (7580)

Inorganic Capabilities

- Chemical Separations
- Chemistry
- Clean Room Chemistry
- Clean Sampling Equipment
- Elutriations - SET, EET, DRET, etc.
- General Wet
- Hydride Techniques
- ICP/MS Metals
- Low-level Mercury
- Mercury by CV
- Metals Speciation
- Organometallics
- Physical Tests (Grain Size, Atterberg, etc.)
- Sediment/Tissue Chemistry
- Selective Sequential Extractions
- TCLP/SPLP Metals
- Ultra-trace Metals


ALS

COMPREHENSIVE RANGE OF **CAPABILITIES** AND **SERVICES**

> "ALS IS EASY TO WORK WITH AND ALTHOUGH THEY HAVE THE FULL EXPERIENCE AND SUPPORT OF A GREAT BIG NATIONWIDE LAB, IT'S NICE TO FEEL LIKE YOU ARE DEALING WITH YOUR LOCAL LAB."
>
> **ECOTOXICOLOGY COMPANY**

Air Quality and Industrial Hygiene

- Air Toxics Methods
- Aldehydes and Amines
- Amines
- Antineoplastic / Chemo Drugs
- Beryllium
- Carboxylic Acids
- Diacetyl/Acetoin
- Diesel Particulates
- Dietary Supplements
- Fixed/Permanent Gases
- Formaldehyde/Aldehydes
- GC/MS Screens
- LEEDs Testing
- Loaner Pumps and Media
- Metals
- Methamphetamine
- NIOSH 0600 Respirable Dust
- NIOSH 0500 Total Dust
- Organics
- Passive Sampling for VOCs
- Pesticides and Herbicides
- PM-10/PM-2.5 (47 mm ptfe)
- Radiochemistry
- Silica
- Siloxanes
- Source & Stack Testing
- TO-14, 15 , 17
- TSP/PM10 (8x10 filters) on glass fiber/quartz filters
- Wet Chemistry

COMPREHENSIVE RANGE OF **CAPABILITIES** AND **SERVICES**

> “I NEEDED ANALYTICS WITH A SHORT DEADLINE MEET. ALS TOOK EXCELLENT AND PROMPT CARE OF MY REQUIREMENTS WITH CHEERFUL AND PROFESSIONAL SERVICE.”
>
> **FEDERAL GOVERNMENT AGENCY**

Asbestos/Microscopy Capabilities

At ALS, our Microscopy department utilizes PCM, PLM, and TEM to identify fibers (primarily asbestos) in air, bulk, dust, and water samples.

Our wide range of prep methods, instrumentation, and expertise, allow us to customize analyses such as fiber and particle characterization and identification to individual client needs.

- Low Level Radioactively Contaminated Asbestos analysis
- Nanoparticles
- Other Fiber Identification
- Particle Sizing & Identification
- Soil (OH VAP Certified)
- Vermiculite

PCM Analysis
- Airborne Fibers by PCM
- Particle Characterization by PCM
- Airborne Fibers by PCM - Mines and Quarries
- Vitreous Fibers by PCM

PLM Analysis
- Asbestos by PLM
- Asbestos by PLM in soil
- Asbestos Point Count by PLM
- Asbestos in Vermiculite by PLM
- Friable Material by PLM
- Nonfriable Organic Binder by PLM
- Particle Characterization by PLM
- Refractory Ceramic Fibers by PLM

TEM Analysis
- Asbestos in Settled Dust via Ghost Wipe by TEM
- Asbestos in Settled Dust via MicroVac by TEM
- Airborne Asbestos (>0.5 μm) by TEM
- Airborne Asbestos (>5 μm) by TEM
- Asbestos in Friable Bulk by TEM
- Asbestos in Nonfriable Bulk by TEM
- Asbestos in Soil by TEM
- Asbestos in Vermiculite by TEM
- Asbestos in Water by TEM
- Particle Characterization by TEM

COMPREHENSIVE RANGE OF **CAPABILITIES** AND **SERVICES**

> "ALS HAS ALWAYS PROVIDED EXCELLENT CUSTOMER SERVICE. THEY GO OUT OF THEIR WAY, AFTER WORKING HOURS, TO SHIP SAMPLE CONTAINERS OVERNIGHT TO MY OFFICE."
>
> **NATIONAL ENVIRONMENTAL CONSULTING FIRM**

Dietary Supplements

- Heavy Metals
- Minerals Analysis
- Pesticides Screens
- Vitamin Analysis

Microbiology/Mycology

- Coliforms and E. coli 0157:H7
- Endotoxins/Mycotoxins
- Microbial Identification
- Non-Viable Fungal Spore Analysis
- Viable Fungal and Bacterial Analysis

Radiochemical Capabilities

- Alpha Isotopics
- Alpha Scintillation Methods
- Carbon-14
- Gamma Scans
- Gas Flow Proportional Counting
- Gross Alpha Beta
- Iodine-129
- Iron-55
- Lead-210
- Liquid Scintillation
- Nickel-63
- Plutonium-241
- Radium-226 and Radium-228
- Radon-222
- Strontium-89/90
- Technetium-99
- Tritium

COMPREHENSIVE RANGE OF CAPABILITIES AND SERVICES

> "THE PEOPLE AT ALS ARE ALWAYS VERY FRIENDLY AND ACCOMMODATING. THEY ARE QUICK TO RESPOND, THEY HAVE REASONABLE PRICING, AND QUICK TURNAROUND. ALS IS JUST ALL AROUND A GREAT COMPANY TO DEAL WITH!"
>
> **NATIONAL ENGINEERING FIRM**

Field Products

Passive Diffusion Bag (PDB) Samplers for the Collection of Groundwater Samples for Volatile Organics Analysis

ALS has been granted a license to manufacture, use and provide the bags by the US Geological Survey (USGS) and The General Electric Company (GE), both co-patent holders on the product (US #5,804,743). The downhole passive water sampler and method of sampling was invented by Don Vroblesky (USGS) and Thomas Hyde (GE).

PDB Samplers are made of low-density polyethylene (LDPE), which acts as a semipermeable membrane. Volatile Organic Compounds (VOCs), excluding certain ketones, ethers and alcohols diffuse readily through the membrane. Equilibrium is established between the VOCs in the bag and those in the groundwater. The PDB Sampler, in the shape of a long cylindrical tube, is filled with analyte-free water. It is available in both field-ready and field-filled versions. It is simple to deploy, eliminates the collection and disposal of purged water and significantly reduces the cost of sampling. Upon retrieval, usually 14 days after deployment, bags are opened to fill vials and returned to the laboratory for analysis.

Rigid Porous Polyethylene Samplers (RPPs) for the Collection of Groundwater Samples for Water Soluble Analyte Analysis

ALS also manufactures another passive sampler based on the design and research of Don Vroblesky of the USGS. The Rigid Porous Polyethylene sampler (RPPs) is made of thin sheets of foam-like porous polyethylene with pore sizes of 6-20 microns. When completely filled with water the pores allow a water-water interface, facilitating the equilibrium of water-soluble analytes in the aquifer adjacent to the well screen with the deionized water of the RPP.

Primary sampling applications for the RPPS are for all water soluble analytes, like inorganic anions and cations, metals, MEE parameters, 1,4-dioxane, MTBE, hexavalent chromium, explosives, perchlorate and dissolved gases. They are also very useful in deep wells where submersible pumps may not function or be economically feasible.

Like the PDB, the RPP is simple to deploy, eliminates the collection and disposal of purged water and significantly reduces the cost of sampling.

A **NETWORK** OF LABORATORIES TO MEET **ALL PROJECT NEEDS**

British Columbia / Yukon

Businesses and governments in British Columbia and the Yukon territory have access to a full service laboratory in Vancouver specializing in measurement of organic, inorganic, microbiological, and physical parameters in air, water, seawater, soils, sediments, and solids. The Vancouver laboratory has extensive capabilities for trace metals analysis and offers ultra trace metals analysis by High Resolution Inductively Coupled Plasma Mass Spectrometry (HR-ICPMS) for environmental matrices including biota, water, and seawater samples. The Fort St. John facility is a service centre for the Vancouver and Alberta laboratories.

The ALS facility in Whitehorse, Yukon delivers exceptional service and quality directly to the clients in Yukon and surrounding area. This location offers rapid turnaround times as a part of ALS's innovative "Quick" program. ALS Quick provides analysis in water for short holding time parameters.

Alberta

Located in Alberta are the full service laboratories in Calgary and Edmonton, as well as industry-specific laboratories located in Grande Prairie and Fort McMurray.

In addition to a full range of organic and inorganic testing in all sample types, the full service laboratory in Edmonton has unique capabilities in:

- Ultra trace metals and metals speciation analysis
- Industrial hygiene
- Air quality and air toxics

The Calgary laboratory services the environmental and oil and gas markets with a broad scope of organic, inorganic, and microbiological test services. The Fort McMurray lab provides specific analyses for the upstream energy sector and the Grande Prairie facility provides specific analyses for the forest products sector, as well as the upstream energy sector.

A **NETWORK** OF LABORATORIES TO MEET **ALL PROJECT NEEDS**

Saskatchewan

ALS has a full service agricultural and environmental analytical laboratory in Saskatoon. Agricultural services include water and plant analyses. The laboratory also carries out environmental testing services for the oil and gas, drinking water, and wastewater sectors.

Manitoba

Manitoba is serviced by a full service laboratory in Winnipeg that provides analyses of inorganic, organic, and biological parameters in water, soil, and air samples. Unique capabilities include bioassays (fish and biota), microbiological, mold/fungi, and asbestos testing.

Ontario

There are three ALS laboratories located in Ontario.

The Waterloo facility is a full-service laboratory providing:
- Environmental testing for organics, metals, general chemistry and microbiology
- Pharmaceutical and personal care product testing in environmental samples
- State of the art air quality testing capabilities

The Burlington laboratory is a specialty lab focused on High Resolution Mass Spectrometry (HRMS) in a variety of sources that include agriculture & food products and environmental samples (air, soil, sediment and water) and Air Toxics in samples derived primarily from stack and ambient air monitoring. The Lab is accredited to ISO 17025:2005 standards by the Standards Council of Canada (SCC) and by the US National Environmental Laboratory Accreditation Conference (NELAC) to NELAC: 2003 standards.

The Thunder Bay laboratory provides testing services and support in Northern Ontario. It is licensed to provide drinking water testing, as well as regulatory compliance monitoring for the pulp and paper, mining, forestry and municipal sectors.

The Ontario laboratories have depots in London, Mississauga and Richmond Hill to serve their respective geographic regions.

Northwest Territories

The laboratory in Yellowknife offers specific analytical services to the mining and municipal sectors, while operating as a service centre for the Northern Region.

COMPREHENSIVE RANGE OF **CAPABILITIES** AND **SERVICES**

Capability	Burlington, ON	Calgary, AB	Edmonton, AB	Fort McMurray, AB	Grande Prairie, AB	Kamloops, BC	Saskatoon, SK	Thunder Bay, ON	Vancouver, BC	Waterloo, ON	Whitehorse, YT	Winnipeg, MB	Yellowknife, NT
Organics													
Volatile Organic Compounds (VOCs)													
Alcohols		X								X		X	
BTEX		X	X		X		X		X	X		X	
1,4-Dioxane										X			
Hydrocarbon Gases (C1-C4, Ethene)		X	X						X	X			
Trihalomethanes			X				X		X	X		X	
VOCs, Full List, by GC/MS		X	X				X		X	X		X	
Volatile Fatty Acids										X		X	
Semi-Volatile Organic Compounds (SVOCs)													
Alkanolamines										X			
Caffeine										X			
Chlorinated Naphthalenes	X												
Formaldehyde			X							X			
Geosmin	X												
Glycols		X							X	X		X	
Haloacetic Acids										X		X	
Nonylphenols & Ethoxylates										X			
Organotin Compounds													
Polycyclic Aromatic Hydrocarbons (PAHs)	X	X	X		X				X	X		X	
PAHs, Alkylated	X	X											
PCB Aroclors	X		X						X	X		X	
PCB Congeners	X												
Perfluorinated Compounds (PFOS, PFOA, etc)										X			
Pesticides & Herbicides	X								X	X			
Phenols, Chlorinated & Non-Chlorinated	X	X	X						X	X			
Phthalate Esters			X							X			
Resin Acids & Fatty Acids			X						X				
Sulfolane			X										
Petroleum Hydrocarbons													
BC VH, EPH		X	X		X				X		X		
BC VPH, LEPH, HEPH		X	X		X				X				
CCME F1-F4, F4G		X	X		X		X		X	X		X	
Naphthenic Acids				X									
Oil & Grease, Mineral Oil & Grease		X	X	X	X		X		X	X			
Saskatchewan TEH		X					X						

Continued on next page...

Capability	Burlington, ON	Calgary, AB	Edmonton, AB	Fort McMurray, AB	Grande Prairie, AB	Kamloops, BC	Saskatoon, SK	Thunder Bay, ON	Vancouver, BC	Waterloo, ON	Whitehorse, YT	Winnipeg, MB	Yellowknife, NT
Organics													
GC - High Resolution MS (GC-HRMS)													
Chlorinated Dioxins / Furans	X												
n-Nitrosodimethylamine (NDMA)	X												
PCB Congeners	X												
Polybrominated Diphenyl Ethers (PBDEs)	X												
Metals													
Acid Volatile Sulfide & Simultaneously Extracted Metals									X				
Arsenic by GFAAS													X
Chromium, Hexavalent			X							X			
ICP/MS Metals	X	X	X				X	X	X	X		X	
ICP/OES Metals		X	X		X		X		X	X			
Mercury by CVAFS (Ultra-Trace)									X			X	
Mercury by CVAFS or CVAAS	X	X	X		X		X	X	X	X		X	
Methyl Mercury (Ultra-Trace)									X				
Speciated Arsenic & Selenium													
Inorganics													
Acidity			X					X	X		X	X	
Alkalinity		X	X				X	X	X	X	X	X	
Anions (Cl, Br, F, NO2, NO3, SO4)		X	X		X		X	X	X	X	X	X	
Biochemical Oxygen Demand (BOD)		X	X	X	X		X	X	X	X	X	X	
Carbon (TOC/DOC/TIC)		X	X				X	X	X	X		X	
Chemical Oxygen Demand (COD)		X	X	X	X		X	X	X	X		X	
Colour		X	X		X		X	X	X	X	X	X	
Cyanide					X			X	X	X		X	X
Elemental Sulfur		X											
Nitrogen, Total		X	X				X		X			X	
Nitrogen, Total Kjeldahl (TKN) & Organic		X	X				X	X	X	X		X	
Nutrients (Nitrogen & Phosphorus)		X	X				X	X	X	X	X	X	
Oxyanions (Chlorate, Chlorite, Bromate)			X										
Oxygen, Dissolved		X	X							X		X	
Perchlorate										X			
Phenols, Total (4AAP Method)			X					X		X			

Continued on next page...

Capability	Burlington, ON	Calgary, AB	Edmonton, AB	Fort McMurray, AB	Grande Prairie, AB	Kamloops, BC	Saskatoon, SK	Thunder Bay, ON	Vancouver, BC	Waterloo, ON	Whitehorse, YT	Winnipeg, MB	Yellowknife, NT
Inorganics													
Solids - TDS / TS		X	X	X	X		X	X	X	X		X	X
Solids - TSS		X	X	X	X		X	X	X	X	X	X	X
Sulfide			X						X	X			
Thiocyanate								X	X	X			
Turbidity		X	X	X	X		X	X	X	X	X	X	X
Physical Tests - Soils													
Atterberg Limits		X	X		X		X						
Bulk Density		X	X		X		X						
Cation Exchange Capacity							X						
Electrical Conductivity (EC)		X	X	X	X		X		X	X			
Hydraulic Conductivity							X						
Particle Size by Hydrometer		X	X		X		X			X			
Particle Size by Sieve		X	X		X		X			X			
pH		X	X	X	X		X		X	X			X
Porosity							X						
Specific Gravity		X	X		X		X						
Agricultural Soil & Plant Testing													
DTPA Extractable Metals							X						
Sodium Adsorption Ratio (SAR)		X	X		X		X		X				
Soil Fertility (NPKS)							X						
Soil Salinity Testing		X	X		X		X		X				
Waste Characterization													
BC Modified Leachate Extraction Procedure (MLEP)		X			X				X				
Corrosivity		X	X							X		X	
Drilling Waste Testing		X	X		X								
Flammability		X					X			X			
Flashpoint		X	X		X		X			X			
Paint Filter Liquids Test		X	X		X								
Synthetic Precipitation Leachate Procedure (SPLP)									X	X			
Toxicity Characteristic Leachate Procedure (TCLP)		X	X		X				X	X		X	
Microbiology / Mycology / Limnology													
Bacterial Identification (PCR / Ribotyping)												X	
Benthic Invertebrate Identification & Enumeration												X	
Chlorophyll-a & Pheophytin									X			X	X
Coliforms (Total, Fecal, & E. coli)		X	X			X	X	X	X	X		X	X
Endotoxins / Mycotoxins												X	
Giardia & Cryptosporidium												X	
Heterotrophic Plate Count		X	X					X	X	X		X	X
Iron & Sulfur Reducing Bacteria		X										X	
Legionella												X	

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Capability	Burlington, ON	Calgary, AB	Edmonton, AB	Fort McMurray, AB	Grande Prairie, AB	Kamloops, BC	Saskatoon, SK	Thunder Bay, ON	Vancouver, BC	Waterloo, ON	Whitehorse, YT	Winnipeg, MB	Yellowknife, NT
Microbiology / Mycology / Limnology													
Limnological Examination												X	
Mold Identification & Count												X	
Non-Viable Fungal Spores												X	
Phytoplankton Enumeration												X	
Viable Fungi & Bacteria												X	
Toxicity Testing													
Daphnia												X	
Microtox		X	X		X							X	
Trout Bioassay												X	
Radiochemistry													
Radon												X	
Air / Vapour													
Amines			X										
Ammonia	X		X										
Anions (Cl, Br, F, NO2, NO3, SO4)	X		X										
Charcoal Tube Testing			X										
Dioxins / Furans	X												
Fixed / Permanent Gases			X							X			
Formaldehyde / Aldehydes	X		X										
Industrial Hygiene Air Testing			X										
Landfill Gas / Biogas Testing			X							X			
Metals	X		X						X				
Odour Testing			X							X			
PAHs	X		X						X				
Particulate Matter - PM-10 / PM-2.5	X		X						X	X			
Passive Samplers / Badges			X										
PCBs	X		X										
Pesticides & Herbicides	X												
Reduced Sulfur Compounds, Total Reduced Sulfur			X										
Sampling Pumps									X				
Silica			X										
Siloxanes			X							X			
Source & Stack Testing			X										
TO-13A PAHs	X		X										
TO-14A, TO-15 VOCs by Summa Canisters			X							X			
TO-17 VOCs by Thermal Desorption			X							X			
VOST	X		X										

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Capability	Burlington, ON	Calgary, AB	Edmonton, AB	Fort McMurray, AB	Grande Prairie, AB	Kamloops, BC	Saskatoon, SK	Thunder Bay, ON	Vancouver, BC	Waterloo, ON	Whitehorse, YT	Winnipeg, MB	Yellowknife, NT
Asbestos / Microscopy													
Asbestos in Air			X									X	
Asbestos in Bulk Materials			X									X	
Asbestos in Vermiculite			X									X	
Particle Sizing & Identification			X										
Phase Contrast Microscopy (PCM)			X									X	
Polarized Light Microscopy (PLM)			X									X	
Other Specialty Testing													
Antibiotics										X			
Biomonitoring													
Environmental Forensics													
GLP Pesticide Analysis													
Humidity Cell / Kinetic Cell Testing									X				
LC/MS										X			
LC/MS/MS										X			
Personal Care Products										X			
Steroids										X			

HIGH-TECH **INSTRUMENTATION** WITH **CAPACITY** FOR LARGE PROJECTS

Instrument quantity at each ALS laboratory:

Instrument	Burlington, ON	Calgary, AB	Edmonton, AB	Fort McMurray, AB	Fort St John, BC	Grande Prairie, AB	Kamloops, BC	Saskatoon, SK	Thunder Bay, ON	Vancouver, BC	Waterloo, ON	Whitehorse, YT	Winnipeg, MB	Yellowknife, NT	ALS Canada Network
Metals															
CVAFS / CVAAS	1	1	2			1		1	1	3	2		1		13
GFAAS / DFAAS														1	1
Gold Trap Ultra Trace Hg Analyzer										1			1		2
ICPMS – Collision/Reaction Cell		1	3					1		5	2				12
ICPMS – High Resolution										1					1
ICPMS – Standard	2								1		1		2		6
ICPOES		1	2			2		2		2	1				10
Microwave Digestion System	2														2
Non-Metallic Inorganics															
AOX / EOX Analyzer									1						1
Automated BOD Analyzer		1	1					1	1	1	1		1		7
Automated Cyanide Analyzer (CFA)									1	1	2				4
Auto-Titrator		1	2					1	1	2			1		8
Colourimetric Autoanalyzer – Discrete		1	2						1	3	2		1		10
Colourimetric Autoanalyzer – FIA/CFA		1	6					14	1	2			1		25
Combustion Analyzer (CNS – Soils)								2							2
Combustion Analyzer (TOC – Waters)		2	2						1	4	2		1		12
Ion Chromatograph	2	2	3			2			1	5	2	1	2		20
Turbidity Meter		1	2	1		1		2	1	2	1	1	1	1	14
Organics															
Automated Solid Phase Extractor															3
Automated Soxhlet Extractor													2		2
Fourier Transform IR (FTIR)			1	1											2
GC – High Resolution MS	4														6
GC-ECD			3							2			2		8
GC-FID		5	3					1		7	3	1	5		26
GC-FID/ECD											2				2
GC-FID/TCD			1								1				2

Instrument quantity at each ALS laboratory:

Instrument	Burlington, ON	Calgary, AB	Edmonton, AB	Fort McMurray, AB	Fort St John, BC	Grande Prairie, AB	Kamloops, BC	Saskatoon, SK	Thunder Bay, ON	Vancouver, BC	Waterloo, ON	Whitehorse, YT	Winnipeg, MB	Yellowknife, NT	ALS Canada Network
Inorganics															
GCMS – Air Analysis / IH			4							1	3				8
GCMS – SVOC	2	2	3			2				7	7		1		30
GCMS – VOC	1	7	5			1		2		4	8		1		29
GC-PID/FID			2			2									4
Gel Permeation Chromatograph	1														3
HPLC-Fluorescence															2
HPLC-UV			1												2
LC/MS/MS Triple Quadrupole											2				9
Microbiology															
Autoclave		1	2		2		1	1	1	1	1		2	1	13
Incubator		1	2		1		1	1	3	3	3		3	1	19
Miscellaneous Equipment															
Automated Flashpoint Analyzer		1	1			1		1							4
Microtox Analyzer		1	3			3							1		8

QUALITY ASSURANCE PROGRAM BUILT FOR **CLIENT NEEDS**

> "IF I EVER HAVE QUESTIONS ABOUT SAMPLING OR ANALYSIS, I GO DIRECTLY TO ALS ENVIRONMENTAL. THE ALS STAFF IS EXTREMELY KNOWLEDGEABLE AND HELPFUL."
>
> **MINING COMPANY**

Quality Management System

The ALS Quality Management System (QMS) is structured to include the needs of clients and ALS corporate policies, as well as accreditation, licensing, and certification requirements. Our exemplary QMS focuses on the generation of high-quality data that is delivered on time, and meets client and regulatory requirements. The ALS QMS documented in the Quality Assurance Manual (QAM) is designed to meet federal, state and local regulatory guidelines, as well as all available quality standards. Extensive training and monitoring at all facilities by quality assurance staff ensures effective implementation.

ALS policy:

- Generate scientifically sound and legally defensible data
- Comply with requirements of NELAC and other accrediting bodies
- Provide high quality testing services in compliance with all federal, state and agency regulatory requirements

All analytical methods used at ALS undergo validation prior to their approval for use in the laboratory. The approved methods contain criteria for quality control and performance criteria that provides information on each preparation and analytical stage of analysis. Data generated are compared to data quality objectives.

Scheduled internal audits are performed on all quality management system elements. System audits are qualitative evaluations of all components of the laboratory systems. They determine if the measurement systems are being used appropriately. Such audits typically involve a comparison of the activities given in the QA Manual with those actually scheduled or performed and are conducted by a Quality Assurance Manager at each facility. Audit findings are used by ALS to improve process performance. Accreditation, certification, and licensing bodies also perform audits to ensure conformity to the applicable standards or regulations. In addition, clients may wish to perform audits to verify compliance with their project requirements. Each ALS facility participates in the Performance Testing programs semiannually for each certified area of testing. Proficiency Testing programs are used to monitor testing activities. Results are reported to accreditation bodies when applicable and are used to measure performance while meeting accreditation and license requirements.

QUALITY ASSURANCE PROGRAM BUILT FOR **CLIENT NEEDS**

> “ALS STAFF ARE VERY PATIENT AND RESPONSIVE WITH OUR INITIAL QUESTIONS. WE WILL CERTAINLY USE ALS WHEN WE NEED MORE TESTING. THEY ARE A VERY EFFICIENT TEAM AND HAVE GOOD TURNAROUND TIME.”
>
> **MEDICAL TECHNOLOGY MANUFACTURER**

Accreditations, Recognitions and Licenses

ALS is committed to utilizing performance testing samples to ensure that all analyses are compliant with industry standards. ALS laboratories are routinely involved with various performance programs over the past several years.

These programs include, but are not limited to:

- American Water Works Association (AWWA)
- American Public Health Association (APHA)
- BC Ministry of Environment EDQA
- BC Provincial Health Officer EWQA
- Canadian Association for Laboratory Accreditation Inc. (CALA)
- EPA and OECD Good Laboratory Practices (GLP)
- Health Canada Good Manufacturing Practices
- National Environmental Laboratory Accreditation Program (NELAP)
- Ontario Ministry of the Environment Drinking Water License
- Standards Council of Canada (SCC)
- US Environmental Protection Agency (USEPA)
- US Army Corps of Engineers (USACE)
- US Department of Defense (DoD)
- US Department of Energy Mixed-Analyte Performance Evaluation Program (MAPEP)
- National Oceanic and Atmospheric Administration (NOAA)
- North American Proficiency Testing Program (NAPT)
- National Voluntary Laboratory Accreditation Program (NVLAP)

PERFORMING **EFFICIENTLY** AND **ETHICALLY** AT ALL TIMES

> “THE CUSTOMER SERVICE IS ABOVE EXCEPTIONAL, THEY GO OUT OF THEIR WAY TO GET YOU WHAT YOU NEED WHEN YOU NEED IT WITHOUT ANY PROBLEMS. THE BEST AND MOST PROFESSIONAL BUSINESS I WORK WITH!”
>
> **ENVIRONMENTAL CONSULTING FIRM**

ALS is committed at all times to performing duties in efficient and ethical ways, while meeting and often exceeding standards that govern the operations of the company and complying with the all applicable laws.

Compliance

ALS believes that meeting compliance obligations is a responsibility essential to its long-term success. The company is committed to adhering to all legislation relating to ALS operations.

All ALS employees are responsible for complying with policies and procedures established to ensure that ALS fulfills requisite legislative requirements. Every employee, contractor, or agent of the company is held accountable to conform to the law and act ethically at all times.

Health and Safety

ALS is committed to achieving the highest levels of occupational health and safety performance in all of its laboratories through the reduction of risk of workplace injuries and illness. The company has a comprehensive health and safety program that protects staff, contractors, visitors, property, and the public. Compliance with health and safety legislation, development of safe operating procedures, employee training programs, regular site inspections, and annual audits ensure that employees at every level are responsible and accountable for the company’s health and safety performance.

Environment

ALS is committed to minimizing its environmental footprint. To support this goal, each laboratory adheres to relevant legislation in their jurisdiction for waste storage and disposal. Samples and wastes are recycled or disposed in an environmentally responsible manner. Containers and packaging are recycled wherever possible.

Confidentiality

ALS employees understand the importance of confidentiality and have implemented policies that ensure the protection of client information. Employees are required to sign and follow ethics, conflict of interest, and confidentiality policies. These agreements are required to ensure that all employees are aware of the following items:

- Laboratory policy regarding ethics and the standards of integrity that are expected of them
- The notion that they are free from any undue pressures that might affect the quality of their work

Client confidentiality ensures that procedures for sending test results by mail, facsimile, email, or electronically meet client requirements. Requests for records made by a third party must be accompanied by written consent from the client. All employees assure clients that confidentiality is observed at all times when presenting records.

System Integrity

- Secure, virus-free system, including a firewall to protect data
- Back-up of all data
- Redundancy of major equipment and services
- Professionally managed and maintained

DEDICATED MANAGEMENT AND **TECHNICAL** STAFF

> "THE CERTIFICATES OF ANALYSIS ARE ALWAYS CLEAR AND PRECISE. THE TIME FRAMES TO GET PRICE QUOTES AND SAMPLES ANALYZED ARE EXCELLENT."
>
> **NATIONAL CHEMICAL COMPANY**

Management and Professional Staff

ALS employs the most dedicated management and technical staff in the business. A focus on staff retention and career development has always been a priority. This loyalty translates into a technical resource with a very high level of expertise and experience.

ALS is managed within a regional structure with the autonomy to deliver services that meet local needs. Since the majority of staff, including senior management, are chemists, testing requirements of clients are well known. The resume of key technical professionals are available upon request. Key positions include:

- **Managers** - responsible for resource management and efficient delivery of services
- **Technical Specialists** - responsible for maintaining the leadership at ALS in the analytical testing market. Technical specialists are knowledgeable about emerging technologies, and are often consulted by industry and regulatory bodies to provide expert assistance on a wide range of unique projects
- **Account/Project Managers** - provide the routine interaction between the laboratory and the client as it relates to the analytical project requirements for which ALS is renowned. Each client is assigned a Project/Account Manager that develops an understanding of service requirements
- **Chemists and Technical Staff** - are highly skilled professionals trained in modern analytical procedures
- **Support Staff** – ensure that services are available to provide clients with timely and secure data delivery

What This Means to Our Clients

The depth of technical and management expertise of ALS allows the company to deliver a consistently high level of service to clients. A commitment to having the highest level of technical expertise and knowledge provides the assurance that data are supported by a quality program using only modern instrumentation and procedures. The personal and comprehensive service delivered by ALS professionals translates to peace of mind and successful partnerships.


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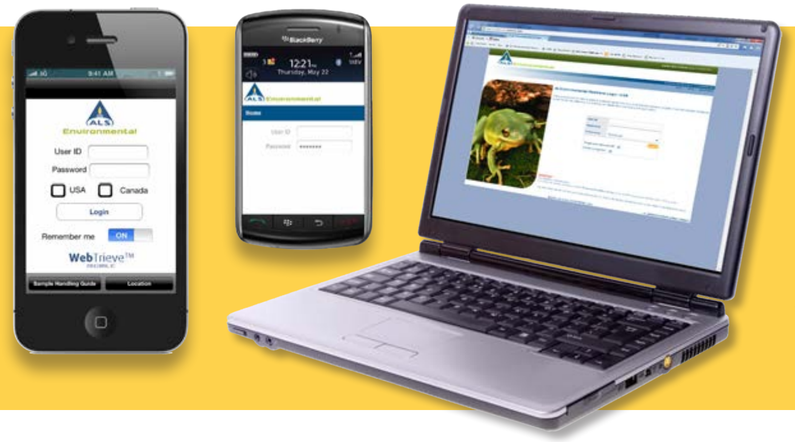
WEBTRIEVE™ ONLINE DATA ACCESS AND WEBTRIEVE™ **MOBILE** APPS



OFFICE
AT HOME
ON-THE-GO

Real-Time Results to Save You Time and Money

Webtrieve™ is a secure, internet-based application that provides real-time access to your laboratory data with the following convenient features:

- Internet access to view validated results
- Exclusive, complimentary service to our clients
- Export results to MS-Excel
- Security protection against unauthorized users
- Reports emailed directly to your address
- Multiple levels of access available
- Compare results to guidelines
- Data access 24 hrs/day, 7 days/wk, 365 days/yr
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Do you need access to your data on-the-go? Use your Webtrieve™ login on our mobile application and mobile website to access:

- Work order status
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Search "ALS Enviro" in the Apple App Store and download the FREE iPhone application.

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40+

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20+

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CANADA

Laboratories

- Burlington, ON
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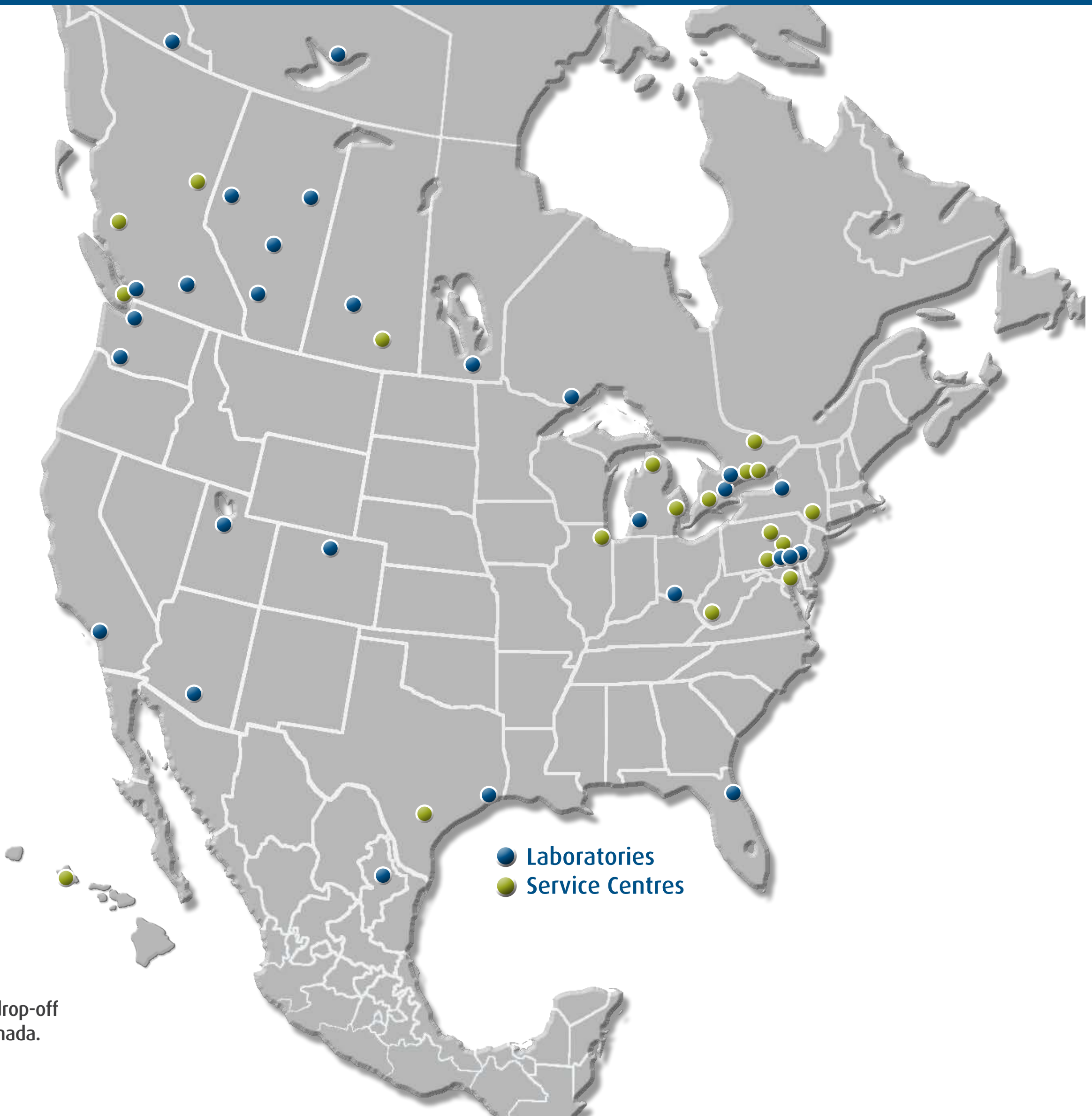
- Edmonton, AB
- Fort McMurray, AB
- Grande Prairie, AB
- Kamloops, BC
- Saskatoon, SK
- Thunder Bay, ON
- Vancouver, BC
- Waterloo, ON
- Whitehorse, YT
- Winnipeg, MB
- Yellowknife, NT

Service Centres

- Fort St. John, BC
- London, ON
- Mississauga, ON
- Ottawa, ON
- Regina, SK
- Richmond Hill, ON
- Terrace, BC
- Victoria, BC

Also several sample drop-off points throughout Canada.



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CALGARY, AB

WINNIPEG, MB

WATERLOO, ON

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THUNDER BAY, ON

VANCOUVER, BC

SASKATOON, SK

BURLINGTON, ON

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Canada Laboratories

Burlington, ON	+1 905 331 3111
Calgary, AB	+1 403 291 9897
Edmonton, AB	+1 780 413 5227
Fort McMurray, AB	+1 780 791 1524
Grande Prairie, AB	+1 780 539 5196
Kamloops, BC	+1 250 372 3588
Saskatoon, SK	+1 306 668 8370
Thunder Bay, ON	+1 807 623 6463
Vancouver, BC	+1 604 253 4188
Waterloo, ON	+1 519 886 6910
Whitehorse, YT	+1 867 668 6689
Winnipeg, MB	+1 204 255 9720
Yellowknife, NT	+1 867 873 5593

Canada Service Centres

Fort St. John, BC	+1 250 261 5517
London, ON	+1 519 652 6044
Mississauga, ON	+1 905 507 6910
Ottawa, ON	+1 613 225 8279
Regina, SK	+1 306 525 0970
Richmond Hill, ON	+1 905 887 9887
Terrace, BC	+1 250 635 3309
Victoria, BC	+1 250 413 3243

Sample Drop-off Sites

Bonneyville, AB	+1 780 913 2299
Drayton Valley, AB	+1 877 894 7666
Lethbridge, AB	+1 403 329 8444
Medicine Hat, AB	+1 403 527 8504
Red Deer, AB	+1 403 343 7443

ALS

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APPENDIX H
ALS QUALITY ASSURANCE MANUAL

ALS Canada Environmental
Life Sciences Division
National Quality Manual

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National Authorizations

Authorized By:	David Gurdibaniuk National Quality Manager, Canada	Date:	June 3, 2021
Authorized By:	Mark Hugdahl Technical Director, Canada	Date:	June 3, 2021

Local Authorization

____
Laboratory Location

Authorized By: ______________________ Effective Date: ______________
Laboratory Manager

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1.0 SCOPE

This Quality Manual describes the Quality Management System operated by the ALS Canada Environmental locations. Where appropriate, it refers to other documents for additional information. Throughout this manual, whenever ALS is used alone, it refers to the ALS Environmental locations in Canada.

The policies and procedures described in this manual comply with the ALS Limited Quality Management Policy CAR-GL-GRP-POL-012, the requirements of clients, and of the current and applicable accreditation bodies and recognition agencies.

In addition, these policies and procedures comply with ISO/IEC 17025:2017 and ISO/IEC 17025:2005. Maintaining compliance to both versions of the Standard is necessary until all ALS locations and their Accrediting Bodies have transitioned to the 2017 version.

2.0 LOCATIONS, ACCREDITATIONS AND RECOGNITIONS

ALS operates several environmental testing laboratories across Canada. Addresses and contact information are available by following the location links at our website: www.alsglobal.com.

Locations within the ALS Canada network hold accreditations for all routinely offered tests from various agencies as listed on their scopes of accreditation, and/or hold certifications or licenses provided by regional regulators, as appropriate to their fields of testing, client requirements, and geographic sectors. For example, the requirements of the following agencies and programs are currently relevant to specific locations and tests offered by ALS Canada.

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- The Canadian Association for Laboratory Accreditation (CALA).
- Perry Johnson Laboratory Accreditation (PJLA).
- Quebec Accreditation Program for Analytical Laboratories (PALA).
- The NELAC Institute (TNI).
- The USA Department of Defense (DOD).
- British Columbia Enhanced Water Quality Assurance Program (EWQA).
- Ontario Safe Drinking Water ACT (OSDWA).

The Quality Department maintains up-to-date scopes and certificates for each ALS Canada location on the ALS SharePoint site where they are available for viewing and downloading by ALS staff. The North America Marketing Team is automatically notified when changes are made to the SharePoint site and they update the ALS global website accordingly, to make the documents available for public viewing and downloading at www.alsglobal.com.

The scopes and certificates contain details on the accredited tests in each ALS locations as well as the Standard of compliance and expiry date.

3.0 TERMS AND DEFINITIONS

Refer to NA-FM-0001a Definitions of Key Terms for details.

The terms and definitions relevant to the national quality management system have been standardized and are described in a national document.

4.1 ORGANIZATION AND RESPONSIBLITIES

4.1.1 ALS is a global laboratory organization which is solely owned by the Australian publicly traded company ALS Limited. In Canada, ALS operates environmental testing laboratories under the legal name ALS Canada Ltd., and the general business name ALS Environmental.

ALS Canada provincial business registrations are maintained on the network at N:\Life Sciences\Environmental\QA\ALS Canada Business Registrations.

ALS offers the following testing services through our Environmental lab network:

- Inorganic Analysis including Metals.
- Organic Analysis.
- Pesticide and Herbicide Analysis.
- Dioxin Testing.
- Toxicological Testing.
- Biological Examination Analysis.
- Microbiological Testing.
- Industrial Hygiene Testing.

Matrices tested include drinking water, ground and surface water, effluent, soil, sediment, solid waste, air, food and biota, including vegetation, animal, and fish tissue.

ALS Canada clients include private individuals, consultants, government, and industry.

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4.1.2 ALS accepts the responsibility to carry out its testing activities in such a way as to meet the requirements of clients, regulatory authorities, ISO/IEC 17025:2005, ISO/IEC 17025:2017, and organizations providing accreditation and recognition relevant to each location, including the program requirements of CALA, PJLA, PALA, TNI, and the US DOD.

Cases of voluntary or involuntary loss of accreditation or needed recognitions are resolved by evaluating the impact to customers and taking appropriate action. Such actions may include subcontracting (refer to section 4.5), or analysis by another accredited test method.

To ensure the terms and conditions of accrediting body publicity policies are met, all publications or advertisements that refer to accreditation, proficiency testing performance, or compliance to regulations are reviewed prior to release by the Technical Director and/or the National Quality Manager.

4.1.3 This Quality Manual covers the laboratory management system for work carried out in the ALS Environmental permanent facilities and associated mobile facilities in Canada.

ALS locations do not differentiate between accredited and non-accredited testing activities. The Quality Management System described in this document applies to all testing activities performed by ALS.

4.1.4 The responsibilities of key corporate personnel that have an involvement and influence on testing activities have been defined to identify potential conflicts of interest. Refer to the Organization and Management Structure in section 4.1.5.

4.1.5 ALS has the following organizational practices:

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a) Managerial and technical personnel have the authority and resources needed to carry out the duties assigned to them. Such duties include the implementation, maintenance, and improvement of the management system, and where applicable, the identification of departures from the management system or procedures for conducting tests. Managerial personnel also have the ability to initiate actions to prevent or minimize such departures. Refer to Organization and Management Structure below.

b) Arrangements are in place to ensure management and personnel are free from undue internal and external commercial, financial, and other pressures and influences that may adversely affect the quality of their work. Refer to section 5.2.1 for details on the ALS Code of Conduct Policy.

c) Policies and procedures are in place to ensure the protection of customers' confidential information and proprietary rights. Refer to policy objectives in section 4.2 and section 5.2.1 for details on the Code of Conduct Policy.

d) Policies and procedures are in place to avoid involvement in activities that would diminish confidence in the competence, impartiality, judgment or operational integrity of an ALS Laboratory or its staff. Refer to section 5.2.1 for details of the Code of Conduct, the Data Integrity Policies, and the ALS Integrity and Compliance Helpline.

e) The organizational and management structure is well defined, including the relationships between quality management, technical operations and support services. Refer to Organization and Management Structure below. Organizational charts are available from the Human Resources Department on request.

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f) Responsibilities, authorities and interrelationships are specified for all personnel who manage, perform or verify work affecting the quality of tests. Refer to Organization and Management Structure below.

g) Adequate supervision is provided to all staff and trainees by persons familiar with test methods and procedures, the purposes of these tests and the assessment of test results. Refer to Organization and Management Structure below, and section 5.2.

h) Senior management has overall responsibility for the technical operations and provision of resources needed to ensure the quality of laboratory operations. Refer to Organization and Management Structure below.

i) The National Quality Manager has defined responsibility and authority for ensuring that the management system related to quality is maintained, implemented, improved, and followed at all times. This individual ensures that personnel understand their contribution to the quality system, quality system tools are evaluated objectively, and the effectiveness of the quality system is communicated to all levels of the organization. This individual is independent from laboratory operations and has direct access to the highest levels of ALS management. Refer to Organization and Management Structure below.

j) Personnel are appointed to substitute as needed in the absence of key managerial personnel. Such substitutions must be flexible due to the variety of demands on individuals. The Organization and Management Structure table below summarizes routine practices. Substitution details are available at each location where needed.

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k) Personnel are aware of the relevance and importance of their activities and how they contribute to the achievement of the objectives of the management system – refer to section 5.2 for additional information.

ORGANIZATION AND MANAGEMENT STRUCTURE

The management system in Canada is divided between laboratory specific, regional and national functions. An appropriate number of managerial positions support the management system. The responsibility, authority and interrelationships of key positions are defined and outlined in the table below.

Alternates are assigned by job-function and therefore staff in each location know who the alternate is during any absence. In addition, individuals are identified as alternates in email out-of-office messages for both internal and external emails, to ensure continuous availability of responsible staff.

Corporate cross-divisional roles (not specifically listed below) include human resources, finance, accounting, compliance and management of information technology.

KEY ENVIRONMENTAL DIVISION ROLES AND ALTERNATES

Title	Role and Alternate Where Applicable
General Manager, Life Sciences, Americas	Responsibility for and authority over operations at all locations within North and South America. Reports to the ALS CEO.
Regional Operations Directors	Responsibility for and authority over operations within designated regions (Western Canada, the Prairies, Eastern Canada). Reports to the General Manager. Fills other regional roles as needed during absences.
Regional Business Development Managers	Responsibility for oversight and management of the sales and marketing division within designated regions (Western Canada, the Prairies and Eastern Canada). Reports to the Regional Operations Directors.
North America Purchasing Department	Responsibility for oversight and operation of the purchasing system. Reports to the Director of Finance, North America.
Technical Director, Canada (TD)	Responsibility for managing a group of national technical specialists, for oversight and management of technology and best practices, and for ALS Canada nationally harmonized test methods and the ALS Canada Quality System. Reports to the General Manager. Fills NQM role as needed.
National Quality Manager, Canada (NQM)	Responsibility for managing the ALS Canada Quality Department staff and for overseeing the development, documentation, implementation, and oversight of the harmonized ALS Canada Quality System. Reports to the TD. Fills the TD role for quality issues as designated. Fills local QA roles as needed.
Laboratory Managers	Responsibility for and authority over operations for a single location, including the provision of resources needed to ensure the quality and compliance of laboratory operations. Reports to a Regional Operations Director. Fills other local managerial and supervisory roles as needed.
Laboratory Dept. Managers, Client Services Managers, Supervisors, and Team Leaders	Responsibility for and authority over selected operations and for providing adequate supervision of a department or section within a single location. Reports to the Laboratory Manager or Supervisor. Fills local management and supervisory roles as designated.
Quality Systems Coordinators (QA)	Responsibility for the organization, implementation, maintenance, and monitoring of the nationally defined quality management system in one or more locations. Reports to the NQM for quality-related duties. Fills the NQM role as designated.
Analysts, Support Staff, Administrative Staff, Sales and Marketing Staff	Responsibility for and authority over assigned work. Reports to Department Manager or Supervisor. May be designated to fill local Supervisor or Manager roles.

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4.1.6 Senior management communicates the ongoing effectiveness of the management system to all staff throughout the network. This is primarily accomplished through staff meetings and reports communicated as appropriate to all levels of the organization. Management system goals related to quality are developed by the management team and communicated to all affected division personnel. The status of management system is reported monthly to national, divisional and location management through National Quality Reports. National Quality Reports are posted on the ALS network and are accessible to all staff at: N:\Life Sciences\Environmental\QA\National Quality Reports and Template.

4.1.7 For TNI/DOD accreditations:

The individuals identified as technical managers in the program applications are members of staff that exercise day-to-day supervision of laboratory operations for the applicable fields of accreditation and reporting of results.

They are experienced in the applicable fields, and monitor the standards of performance and the validity of the analyses to ensure reliable data. They will not fill the technical manager role at more than one laboratory location without authorization from the primary Accreditation Body.

If an individual identified as a technical manager will be absent for a period of time exceeding fifteen consecutive calendar days, they will designate another staff member meeting the qualifications to temporarily perform their function. If their absence exceeds thirty-five consecutive calendar days, the primary Accreditation Body must be notified in writing.

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4.2 MANAGEMENT SYSTEM

4.2.1 The ALS management system is appropriate to the type, range, and volume of environmental testing activities undertaken at each location. Policies, systems, programs, procedures, and instructions are documented to the degree necessary to assure the quality of test results. ALS ensures all staff understands the quality management system and that all required documentation is available to and implemented by staff.

4.2.2 MANAGEMENT SYSTEM POLICIES, POLICY STATEMENT AND OBJECTIVES

ALS management is committed to good professional practice, and to providing a superior level of service and quality in its testing activities that exceeds the industry norm. Our management system is designed to comply with the requirements of ISO/IEC 17025:2005, ISO/IEC 17025:2017, the program requirements of all applicable accrediting bodies, ALS corporate goals, and to satisfy the needs of clients, regulatory authorities, and organizations providing recognition. All staff are required to be familiar with ALS quality system documentation and to implement its policies and procedures in their work. ALS management is committed to complying with these policies and to continually improve the effectiveness of the management system.

This policy statement and the entire Quality Manual are issued under the authority of senior management in Canada.

The policy objectives of the management system are listed below. Their implementation and effectiveness is evaluated during management reviews:

- ALS protects its customers' confidential information and proprietary rights. We require all employees to review and sign the Code of Conduct agreement that communicates the ALS expectations for employee conduct, including the confidentiality policy (refer to section 5.2.1). The electronic storage of information is protected by a national computer network protection system (refer to section 5.1). Test results are protected during communication and transmission by ensuring only the correct individual receives results, and by identifying transmissions as confidential (refer to section 5.10).
- ALS employees avoid involvement in activities that would diminish confidence in their competence, impartiality, judgement or operational integrity by complying with the ALS Code of Conduct agreement and the Data Integrity Policy (refer to section 5.2.1).
- The quality policy statement heading this section is issued under the authority of senior management. The policy statement includes measurable objectives that are monitored through operation of the quality management system, as identified in the following points.
- Involuntary loss of accreditation results in an evaluation of the impact to the customer and determination of appropriate action (refer to section 4.1.2).
- Procedures pertaining to the quality management system and testing activities are documented and controlled to ensure the most current work instructions are available to staff. Responsibilities are defined for monitoring documents of both internal and external origin for currency and continued suitability. Updates to external documents are reviewed to determine if changes to internal processes are needed (refer to section 4.3).
- Appropriate personnel are involved with the provision of quotations and contracts to the degree necessary to understand our clients' needs, to determine if a location can manage projected workloads, to identify the correct test methods to be used, and to maintain appropriate communications with the client during testing. Records of client communications are maintained and all changes to work plans are communicated to those involved (refer to section 4.4).
- Tests are subcontracted to laboratories that have demonstrated competency for the targeted test in a manner acceptable to the applicable accreditation and recognition agencies, and that meet the customers testing needs and ALS corporate compliance requirements (refer to section 4.5).
- Suppliers of goods and services are pre-approved using national protocols where they affect the quality of test results. The national purchasing system provides control over selection and purchasing of goods and services, while systems for reception, storage, and handling of supplies ensure we receive what was ordered, that appropriate storage is provided, and that records of verification are maintained where needed (refer to section 4.6).
- Complaints, whether received by direct communication or during survey activities, are managed and resolved. Records are maintained of the complaint, including discussions with the client, and its resolution (refer to section 4.8).
- When any of our services fail to conform to ALS policies or procedures or to the requirements of our customer, a nonconformance is recorded. Procedures define the responsibilities and authorities for handling nonconformances, including

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documentation, work stoppage, work resumption, and for evaluating the significance of the nonconformance. Correction, evaluation, and customer notification are initiated where applicable (refer to section 4.9).

- Cause analysis is performed where nonconforming work is identified and where corrective action is needed. Corrective actions that will prevent recurrence are selected and implemented as appropriate to the magnitude and risk of the problem. Procedures describe documentation requirements, national and local monitoring, and the provision of additional audits as needed (refer to section 4.11).
- New employees receive an orientation and job-specific training. Training needs are reviewed on an on-going and as-needed basis to ensure cross-training is provided and that work can be reassigned when needed. Longer term training plans are developed during annual performance evaluations. The effectiveness of training actions is evaluated using direct observation and monitoring of quality system tools. Additional training can be requested by anyone at any time for LIMS, quality systems or specific technical topics (refer to section 5.2).
- ALS Quality Control practices monitor the validity of tests performed by its laboratories. Technical records are maintained to allow evaluation and interpretation of original test conditions and test results. Technical records are organized to support test result, inter-parameter, and test report validation by qualified, authorized, and independent individuals (refer to section 5.9).

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4.2.3 Evidence of commitment to the development and implementation of the management system and to its continual improvement is available in the procedures and records referred to throughout this document, and include the approval and implementation of the systems described in this manual.

4.2.4 ALS senior management's communication of the importance of meeting customer, statutory and regulatory requirements is provided in various ways such as during staff meetings as described in section 4.1.6, through employment policies, business goals, and the training program (refer to section 5.2). In addition, goals set during management reviews (as described in section 4.15), and various planning meetings are communicated as appropriate.

4.2.5 This Quality Manual includes or references relevant support and technical procedures and outlines the structure of documentation used in the management system.

4.2.6 Roles and responsibilities of technical and quality management staff are summarized in section 4.1.5. Responsibilities for ensuring compliance with International Standards and the program requirements of accreditation and recognition agencies are defined as:

- The Technical Director is responsible for the direction and technical authorization of the national quality management system.
- The National Quality Manager is responsible for building a national quality management system in compliance with the current International Standards and the relevant program requirements of accrediting and recognition agencies, and for reporting on the status of national and local implementation to the management team.

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- Local quality staff are responsible for implementing the national quality management system under the direction of the NQM in the locations under their responsibility, and for reporting on the status to the local Lab Manager and National Quality Manager.
- Local Lab Managers are responsible for ensuring implementation of the national quality management system in their locations, and for addressing reported deficiencies.
- Regional Directors are responsible for supporting and enforcing compliance to the national quality management system.

4.2.7 Senior management ensures the integrity of the management system is maintained when changes to the system are planned and implemented. This is achieved by assigning the planning and implementation of changes to staff that have the appropriate knowledge, training, qualifications, and authority to manage the changes, and by ensuring planned changes have adequate review and oversight by personnel who understand the implications. Planned changes to the management system are reported to and discussed with the national management team as needed, prior to authorization and implementation.

4.2.8 In some regions, authorized/qualified signatories must hold professional chemist designations in the province where the laboratory is located. This is currently applicable to testing performed under the Quebec PALA program and testing performed under the Saskatchewan MOE regulatory agency. Local Laboratory Management is responsible for meeting requirements applicable to their work.

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4.3 DOCUMENT CONTROL

Refer to NA-SP-0425 Document Control for Internal and External Documents for details.

4.3.1 STRUCTURE OF MANAGEMENT SYSTEM DOCUMENTATION

ALS controls documents that form part of its quality system, including those of internal and external origins.

Internal documents are those originating within ALS Canada Environmental. Some internal documents are national in scope and are intended to be used at multiple locations. Others are local and are intended to be used at one specific location. The documentation structure is outlined below:

Document Type	Application	Origin
Quality Manual	Summary of high-level Policies	National
Support Procedure	Detailed Quality System Policies and	National or Local
Test Method	Testing Activity	National or Local
Test Procedure	Testing Activity	National or Local
Work Instruction	Testing Activity	National or Local
Form	Can Apply to Any Level of Document	National or Local
Variance	Can Apply to Any Level of Document	National or Local

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In the rare case where local and national documents both describe similar activities or information, the local document takes precedence only when the policies and/or protocols specified in the national document are fulfilled as intended.

Templates for the above documents are provided to ensure consistency of technical content and presentation across the ALS Canada locations.

External documents originate from sources external to ALS. External documents that are important to the operation of our laboratories include, for example, instrument manuals, software manuals, reference methods, regulations, standards, and accrediting body policies. In the rare cases where external documents are used directly to perform work, supplemental internal documents will relate the additional information required by the ALS document templates.

4.3.2 DOCUMENT APPROVAL AND ISSUE

4.3.2.1 Documents used in the laboratory as part of the management system are reviewed and approved for use by authorized personnel prior to issue. These authorities are personnel with knowledge appropriate to the content of the document.

Master lists are maintained for the authorization and distribution of national documents at: N:\Life Sciences\Environmental\QA\Documentation\National Documents.

Master Lists are also maintained for each location. They include documents from internal and external, and local and national origins that have been authorized for local use. Master Lists are available for viewing by all staff.

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4.3.2.2 Authorized documents are available at all work stations where essential to the effective functioning of the laboratory.

Internal documents and any related forms are reviewed on a cycle corresponding to the internal audit schedule to ensure continuing suitability and compliance with requirements. Refer to section 4.14 for additional information regarding internal audits.

External documents such as applicable regulations, reference methods, and documents issued by accrediting and recognition bodies are monitored by individuals responsible for the work. Changes to internal processes and documentation are identified and occur when needed to ensure continued suitability and compliance.

Invalid or obsolete documents are removed from use. The original electronic file and the original signed hard copy are transferred to clearly identified archive files and maintained as historical quality system records.

4.3.2.3 Documents generated by ALS Laboratories are uniquely identified, including:

- Document identification number and name.
- Version number.
- Header Date (date of the last change made to the version).
- Signing authorities and dates for Quality and Technical authorizations.

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- Local signing authority and effective date (date the documented procedure was authorized for implementation at the location).
- Page numbering and total number of pages.

Authorizations, page numbers, and date conventions are simplified for forms.

If it becomes necessary to amend an authorized national document for local use, procedures describe the editing process and the Technical authorization is provided by the national signing authority.

4.3.3 DOCUMENT CHANGES

4.3.3.1 Changes to internal documents are reviewed and approved by the same authorities as the original document, unless otherwise delegated. All involved in this process have access to pertinent information upon which to base their approval.

4.3.3.2 A summary of revisions is provided in each document to relate significant alterations or new text.

4.3.3.3 Where hand-written amendments are made pending re-issue of the documents, the following apply:

- Hand written amendments are authorized by both quality and technical staff, as per the original document.
- Amendments are clearly legible, initialed and dated.
- Formally re-issue the document no later than the next scheduled internal audit.

Hand written amendments are not made to national documents.

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4.3.3.4 Procedures are established to describe how changes to documents maintained in computerized systems are made and controlled.

4.4 REVIEW OF AGREEMENTS, QUOTATIONS AND CONTRACTS

Refer to NA-SP-0650 Quotes, Contracts, and Client Notifications and NA-SP-0651 Credit Policy and Procedure for details.

4.4.1 Agreements, quotations, and contracts are reviewed to ensure understanding of defined and documented requirements. The customer's status is evaluated and information is shared to ensure the location has the capability, resource availability, and the appropriate test methods to meet applicable requirements. Differences that occur between a quotation and the final contract are resolved prior to commencing work.

4.4.2 Records of reviews, including communications and significant changes to the customer's requirements or the laboratory's capabilities are maintained.

For routine and simple tasks, the date and initials of the laboratory staff responsible for reviewing the request is an adequate record of review, such as on a Chain of Custody (COC). For repetitive routine work, a review at the initial inquiry stage and provision of a quote is adequate, and subsequent changes to the requirements are monitored and resolved. For new or complex testing requirements, a more comprehensive record is maintained, such as a detailed proposal of services.

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Records are also maintained of all pertinent discussions with clients during the life span of the contracted work.

4.4.3 The reviews performed include reviews of tests subcontracted by ALS. Refer to section 4.5.

4.4.4 The customer is informed of any proposed deviation from the contract or agreement.

4.4.5 If changes are made during the contract, the new requirements are subject to the same review process as the original contract. Any amendments are communicated to all affected personnel. If, due to unforeseen circumstances, the laboratory is unable to comply with a condition of the contract (e.g. turnaround time, equipment failure), the client is notified as soon as possible and contingency plans are developed.

4.4.6 COCs and/or quotes and contracts contain the ALS Terms and Conditions that describe the services provided by ALS, including the decision rule. Refer to 5.10 for details on the rule applied.

4.5 SUBCONTRACTING TESTS

Refer to NA-SP-0052 Internal and External Subcontracting and Network Notifications of Test Status Changes for details.

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4.5.1 Testing is subcontracted to another ALS location or external organization when it cannot be carried out at the receiving location. ALS has policies and procedures that govern the qualification of subcontract labs and the handling and transfer of subcontracted samples. ALS selects subcontractors through a qualification process that includes an evaluation of the test method, detection limits, accreditation status, agreement to notify of status changes, and corporate insurance policy compliance.

When subcontracting samples for accredited tests, ALS chooses subcontract lab tests that are accredited to the same standard as the applicable accrediting body, and who also meet the client and corporate ALS criteria. Labs holding accreditation by a recognized accrediting body for the tests in question are also given first consideration when subcontracting non-accredited tests whenever the client and corporate ALS requirements are also fulfilled. If an accredited lab is unavailable, is impractical, or does not meet testing or corporate criteria, ALS will choose laboratories that at minimum fulfill the other components of the qualification process.

4.5.2 The client is notified in writing of subcontract arrangements. Client written approval is obtained whenever possible, and records of approval are kept. When notified of subcontracting by quote, or contract, or during sample receipt and login processes, the submission of samples is deemed as acceptance of the subcontract laboratory.

4.5.3 Clients or regulatory authorities sometimes specify the subcontractor to be used. The ALS qualification process is optional in these cases as described in the support procedure.

4.5.4 ALS laboratories maintain lists of pre-approved subcontract lab tests and records of the qualifications.

4.6 PURCHASING AND HANDLING SUPPLIES AND SERVICES

Refer to NA-SP-0050 Purchasing and Supplier Approval for details.

4.6.1 ALS controls the procurement of supplies and services where there is a potential impact to the quality of test results. Documented procedures exist for the purchasing, reception, and storage of materials relevant to the tests performed at each location.

4.6.2 Supplies that affect the quality of test results are not used until they are inspected to verify the received items conform to the specifications or requirements as ordered. Upon receipt, supplies are compared to the packing slip to establish the order was filled correctly. The packing slip is initialed and dated as a record of the receipt and verification.

Certificates of traceability and/or analysis are maintained for certified supplies such as certified reference materials and standards, stock cultures and other consumables where specifications are critical. When additional verification is needed such as testing, procedures describe the testing performed and records maintained.

Critical supplies and their storage conditions are specified in test methods wherever needed to protect the quality of test results.

4.6.3 Purchasing requisitions are reviewed for technical content at each location to ensure required specifications are met. Requisitions are further reviewed by purchasing staff to ensure correctness, and to determine the most appropriate supplier.

4.6.4 ALS works closely with vendors of critical supplies to ensure they understand our requirements and specifications, and can consistently meet them. The ALS Purchasing Department maintains the purchasing system that limits access to only approved supplies from approved vendors for North American ALS labs. A list of current approved vendors is available from the Purchasing Department upon request. Approved supplies and vendors are those that have been demonstrated through validations and through experience to be fit for specific usage. In cases where a supply or vendor fails to consistently meet our quality specifications, corrective action is taken that is relevant to the event (refer to section 4.11). Corrective action can include for example, national notification to user labs, identification of replacement supplies and blocking the supply in the purchasing system to prevent future orders, as appropriate.

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4.7 SERVICE TO THE CUSTOMER

4.7.1 ALS cooperates closely with its customers to ensure their testing needs are understood, and allows them reasonable access to relevant areas of the laboratories to audit the management system or to witness test work being undertaken on their behalf.

ALS assists customers to develop audit objectives when appropriate. An ALS staff member reviews the External Auditor Confidentiality Agreement with the client and invites them to sign it. An ALS staff member accompanies any client while on-site and ensures steps are taken to protect the confidentiality of other customers' information in accordance with the ALS ethics, confidentiality, and privacy policies (refer to 5.2.1). ALS records and addresses all customer audit findings. Also refer to section 4.14 regarding external audits.

ALS has assigned staff the task of ensuring good communication with customers regarding technical issues and the status of testing being conducted on their behalf. Customers are informed of delays or deviations in the conduct of their tests. Communications with customers are documented as needed to ensure continuity of service.

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4.7.2 Periodically, ALS prepares and distributes or commissions surveys to its customers. The purpose of these surveys is to evaluate services, to ensure ALS continues to meet clients' needs and to identify areas for improvement. Copies of survey results are maintained at: N:\Life Sciences\Environmental\QA\Client Surveys. The surveys are evaluated by national and regional management teams and are used to define initiatives for improvements. In addition to various senior management planning meetings, survey results are communicated during Management Reviews (refer to section 4.15).

4.7.3 The Technical Director and National Quality Manager maintain summaries of ALS Quality System and Quality Control Protocols to provide customers with an understanding of ALS practices. The summaries are provided in both Word and PDF format. The Word format text is intended to be copied into larger documents while the PDF file can be emailed directly to customers. Copies are accessed on SharePoint.

4.8 COMPLAINTS

Refer to NA-SP-0125 CARS and PARs for details.

ALS is committed to providing a superior level of service to its customers. As a result, every complaint received from customers or other parties, whether received by direct communication or during survey activities, is a risk to client services and the ALS reputation, and receives follow-up.

To ensure adequate oversight and resolution, all complaints received by ALS are initially recorded as nonconformances, and follow the usual investigation, resolution, and client notification processes.

Information on the ALS process for handling complaints is readily provided to interested parties on request.

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4.9 CONTROL OF NONCONFORMANCES

Refer to NA-SP-0125 CARS and PARs for details.

When any work conducted by ALS does not conform to a requirement, including noncompliance with ALS policies and procedures or the requirements of our customers, the nonconformance is recorded and reviewed by an appropriate authority.

Nonconformance procedures define responsibilities and authorities for:

- Halting work and withholding reports where appropriate.
- The evaluation of the significance (risk) of the nonconformance.
- Ensuring immediate correction / remedial actions.
- Customer notification where applicable.
- Authorizing the resumption of work.

Where the evaluation indicates it is appropriate to prevent recurrence, root cause analysis and corrective action are implemented – refer to section 4.11.

Single event data quality objective failures or other isolated occurrences during testing activities are initially recorded on a test method nonconformance record which includes corrective action, technical justification, and authorization. When recurrence is observed, the issue is transferred to the Corrective Action Report (CAR) system.

Nonconformances identified during audits and assessments are recorded in reports that are used to track the issues through the steps listed above and to resolution. Any items that are potential data quality issues or that indicate systematic noncompliance with the quality system policies or procedures require immediate action and are entered into the CAR system – refer to section 4.14.

All other sources of nonconformance are recorded directly into the CAR system.

4.10 IMPROVEMENT

Management's commitment to continuously improving the effectiveness of the management system is demonstrated by the use of various management system tools to identify areas of needed improvement. Regular evaluations of each of the following are used to identify areas for improvement: internal and external audits, corrective and preventive action reports, management reviews, various management reports and meetings, client feedback, proficiency test results, reviews of test method performance and data quality objectives, client surveys, and input from personnel. Documentation and follow-up is defined in the Quality Manual sections specific to these functions and activities.

4.11 CORRECTIVE ACTION

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Refer to NA-SP-0125 CARs and PARs for details.

Appropriate corrective actions are evaluated whenever investigation of a nonconformance indicates prevention of recurrence is needed. Responsibilities and authorities are defined for implementing and documenting corrective actions based on an analysis of the causes and identification of the root cause where possible.

Corrective actions that are most likely to prevent recurrence of the nonconformance are initiated, as appropriate to the magnitude and risk of the problem. Actions taken are monitored for effectiveness where appropriate.

When a serious risk is identified, or when otherwise deemed appropriate, additional audits are performed when the nonconformance casts doubt on compliance with ALS policies and procedures or compliance with regulations or with accreditation requirements.

4.12 PREVENTIVE ACTION

Refer to NA-SP-0125 CARS and PARs for details.

Needed improvements and potential sources of nonconformance for technical and management systems are identified from various sources (see also section 4.10).

When improvement opportunities are identified or when preventive actions are needed, action plans are developed, implemented and monitored to reduce the likelihood of a nonconformance. The investigation and record keeping system is the same as for nonconformance and corrective action. Refer to sections 4.9 and 4.11.

4.13 CONTROL OF RECORDS

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Refer to NA-SP-0175 Data Validation of Test Data, NA-SP-0252 Protection and Storage of Sample Testing Records, and NA-SP-0850 Electronic Data Control and Security for details.

4.13.1 General

4.13.1.1 ALS controls records through defined procedures for identifying, collecting, indexing, accessing, filing, storing, maintaining and disposing of quality and technical records.

Quality records include but are not limited to reports from site assessments, customer audits, internal audits, management reviews, corrective actions, preventive actions, proficiency testing reports, initial method validations, and revalidations. Storage of quality records is described in the SOPs that describe these programs.

Refer to 4.13.2 for information regarding technical records.

4.13.1.2 All records are legible, readily retrievable, and stored in an environment that protects them from damage or deterioration for a minimum of five years, unless regulatory or contractual obligations dictate a longer retention period. Records may be recorded and stored on paper or using an electronic medium.

4.13.1.3 All records are held secure and in confidence, in compliance with policies for confidentiality and non-disclosure - refer to section 5.2.

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4.13.1.4 Procedures exist for the back-up and protection of records stored electronically, and to prevent unauthorized access to or amendment of these records.

4.13.1.5 For records related to TNI / DOD accreditation:

When accreditation is transferred in the case of new ownership or a change in legal status, quality and technical records pertaining to accreditation will be maintained for a minimum of five years and will be subject to inspection by the accrediting authority without prior notification to the lab.

Where required by the accrediting authority, and in the event of a transfer of ownership or closure, the lab will ensure records of analysis are maintained or transferred according to its customers instructions. This information will be collected from customers when needed. In cases of bankruptcy, all regulatory and legal requirements concerning laboratory records will be followed.

4.13.2 Technical Records

4.13.2.1 Technical records include all original observations and derived data recorded at the time they are made. Technical records include sufficient information to establish an audit trail, such as equipment records, calibration records, method validation records, reagent and standard preparation records, unique sample preparation and analysis instructions and records, staff records, copies of each test report issued, and the identities of the individuals responsible for performing each test and for checking results. Records for each test contain enough information to identify factors affecting uncertainty and to enable the test to be repeated under conditions as close as possible to the original.

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4.13.2.2 All observations, data and calculations are recorded at the time they are made in a manner identifiable to the specific task.

4.13.2.3 When a mistake is identified in a hard copy record, the original record is left legible with a line drawn through it, and hand-written corrections are recorded alongside, together with the date and initials of the person making the change. Where not intuitive, all reasons for corrections are documented in the pertinent analytical records. Data changes in LIMS are tracked using a function that includes the identity of the individual making the modification and the reason for the modification.

4.14 INTERNAL AUDITS

Refer to NA-SP-0400 Audits – Internal and External for details.

4.14.1 Internal audits are performed at each facility following pre-determined schedules and procedures to ensure operations comply with the requirements of the management system, the program requirements of all applicable accrediting and recognition bodies, ISO/IEC 17025:2005, and ISO/IEC17025:2017. Audits are managed by the Quality Department.

Management system audits are managed nationally and scheduled annually. Schedules and records are maintained in network folders. Technical audits of testing activities are coordinated locally. They are scheduled on a cycle that complies with accreditation program requirements. Test method revalidation and document review are part of the ALS audit protocol. Schedules and records are maintained for all audits.

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Audit schedules record the accreditation program relevant to each laboratory and test to ensure program-specific requirements are included in each audit.

Audits are coordinated and conducted by individuals who have received training on audit objectives and techniques and who are independent of the activity being audited wherever possible.

Technical audits can require a group effort to ensure a technical review is performed that will identify needed improvements and ensure implementation of best practices. Draft audit reports and supporting documents and data are reviewed and released by QA to ensure impartiality.

4.14.2 ALS takes timely corrective action when audit findings cast doubt on the effectiveness of operations or the validity of test results. ALS notifies customers in writing if investigations show test results may have been adversely affected, as soon as the scope and impact of the event is understood.

4.14.3 Records of internal audits performed, identified nonconformances, root cause analysis and where needed, selection of corrective actions that will prevent recurrence are recorded in audit reports. A CAR is issued for any nonconformances that require immediate action.

4.14.4 Follow-up audits verify the implementation and effectiveness of corrective actions taken due to audit findings.

4.15 MANAGEMENT REVIEWS

Refer to NA-SP-0401 Management Review for details.

4.15.1 At least annually, Management conducts a review to ensure the management system is effective, continues to be suitable for its operations, and to identify necessary changes or improvements. Senior management is included in the review process for all locations.

The review may be a series of events or meetings that percolate up through the management structure that are summarized at year-end, or may be an annual event or meeting. Determining the format and setting the schedule is the responsibility of the local Laboratory Manager. The schedule is maintained and the review facilitated by Quality staff.

The intent is to evaluate the status and adequacy of national and local policies and systems by examining the following items for the time period between reviews:

- Status of actions from previous management reviews.
- Changes in internal and external issues that are relevant to the laboratory.
- Fulfillment of objectives.
- Suitability of the Quality Policy Statement, policy objectives, and procedures.
- Reports from managers and supervisors, and feedback from personnel.
- Outcomes of internal and external audits and assessments.
- Corrective and preventive action reports.
- Proficiency testing results and other interlaboratory comparisons.
- Changes in the volume and type of work or in the range of laboratory activities.
- Adequacy of resources.
- Complaints and other client feedback from all sources including surveys.
- Effectiveness of any implemented improvements.
- Results of risk identification.
- Outcomes of the assurance of the validity of results.
- Recommendations for improvement.
- Other relevant topics such as management objectives related in lab metrics and key performance indicators or other monitoring activities, new tests under development, new recognition programs being sought, staff training, etc.

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4.15.2 Findings from the reviews and identified decisions and actions are recorded and carried out in an appropriate and agreed upon timeframe.

4.15.3 In addition, the Quality Department provides status reports each month to local and senior management. These reports include reviews of internal and external audits and assessments, proficiency testing programs, nonconformances, corrective and preventive actions, training initiatives, and any other information needed to inform management of the status of the quality system.

4.16 ACTIONS TO ADDRESS RISKS AND OPPORTUNITES

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Refer to ALS Limited Risk Management Policy and Framework CAR-GL-GRP-POL-007 and Risk Appetite and Tolerance Statement CAR-GL-GRP-POL-011 for details.

ALS views risk management as a key component of its corporate governance responsibilities and an essential process in achieving and mandating a viable organization. ALS is committed to enterprise-wide risk management to ensure its corporate governance responsibilities are met and its strategic goals are realized.

Risk is defined at ALS as the effect of uncertainty on objectives. Objectives for the organization have different attributes and aspects, such as financial, health and safety, and environmental goals, and are considered at different levels, such as enterprise-wide, operational, and project levels. ALS interprets risk as anything that could impact meeting its corporate strategic objectives, and believes risks can provide positive opportunities as well as having negative impacts. Business risks and opportunities are evaluated and managed at the senior management and corporate level, and are included in the annual reports available on the alsglobal.com website.

At the local laboratory level, the primary risks are actions and circumstances that compromise the quality of data reported to clients, compliance with accreditation polices, and the reputation of ALS. They include but are not limited to customer complaints, the release of unreliable test results, and noncompliance with authorized procedures. All such items are considered to be nonconformances requiring corrective action (refer to sections 4.9 and 4.11 for details), to ensure the appropriate oversight and attention occurs.

Whether corporate or local action is taken, the policies and procedures provide a framework for categorizing, assessing, analyzing, and addressing risk, as well as monitoring and reviewing actions taken. Roles and responsibilities are defined in the relevant procedures.

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5.0 TECHNICAL PROTOCOLS

5.1 COMPUTER SYSTEM MANAGEMENT

Refer to ALS Limited Information Management Policy IT-GL-GRP-POL-002, Data and IT Usage Policy IT-GL-GRP-POL-001, NA-SP-0850 Electronic Data Control and Security, NA-SP-0150 Creation and Validation of LIMS Products, and NA-SP-0152 GEL Method and Test Authorization and Verification for details.

A network of computers and information management systems interface specific workstations into Local Area Networks (LANs) that are coordinated and managed by the North American IT Group under the authority of the Chief Information Officer.

Security is achieved through a combination of passwords, permissions, firewalls and Virtual Private Network (VPN) systems.

System access and monitoring for system failures, data back-up, archival, protection and retrieval are strictly controlled.

Software development in North America is performed under the authority of the General Manager, Life Sciences. Development and changes to the Laboratory Information Management System (LIMS), is controlled by the LIMS Steering Committee and the GEL Support Group. Extensive testing is performed prior to introduction of changes to the operational modules of LIMS.

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Test data is managed in the ALS Laboratory Information Management System using EvoLIMS products and GEL methods that can only be created by specifically delegated individuals. Specifications for new product codes and methods, and changes to existing codes and methods are documented. Verification from sample login through to data reporting is required to confirm the correct functionality of all components including data calculations and data transfers.

5.2 PERSONNEL

Refer to the ALS Limited Code of Conduct HR-GL-GRP-POL-001, the ALS Whistleblower Policy CAR-GL-GRP-POL-005, the HR Orientation Training Record FRM-710, and NA-SP-0300 Quality System and Job-Specific Training Protocols for details.

5.2.1 ALS ensures the competence of all personnel who operate specific equipment, perform specific tests, evaluate procedures, sign test reports, supervise or manage lab operations, and evaluate the significance of deviations. Staff are qualified on the basis of education, training, experience, and/or demonstrated skills necessary for performing assigned functions. Job-specific training is provided and staff undergoing training are supervised by assigned trainers.

Position descriptions are used to communicate to personnel their duties, responsibilities, and authorities. Position descriptions specify the qualifications for each position, and are generally a combination of education and experience appropriate for the role. Records of educational backgrounds are maintained in personnel files.

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Upon hiring, all staff are provided an orientation to safety programs, employment policies, and management system policies. Each section of the orientation is managed by appropriate staff in each location, under the authority of the local Laboratory Manager.

ALS is committed to achieving the highest standards of ethical conduct. Acceptance of employment is an implicit commitment to observe the company’s standards of conduct and performance.

The Code of Conduct provides a framework for decisions and actions in relation to conduct in employment. It underpins commitment to a duty of care to all employees and to customers receiving our services. The agreement covers a wide range of topics including personal and professional behavior, conflicts of interest, gifts, confidentiality, legal compliance, and security of information, among others. The Code of Conduct is administered in Canada by the North American Human Resources Department as part of an orientation provided to newly hired staff. The orientation is provided locally under the responsibility of the local Laboratory Manager. Records are forwarded to the Human Resources (HR) Department for maintenance in secure personnel files.

The Data Integrity Policy expands on the Code of Conduct agreement regarding personal and professional behavior that directly impacts test results and information. Specific expectations are identified for ALS and its employees.

The Data Integrity Policy training program is administered by the National Quality Department as part of a Quality System orientation provided to newly hired staff. Quality staff ensures the original signed policies are forwarded to HR for maintenance. In addition, all employees are required to attend annual Data Integrity refresher sessions. Attendance records are maintained.

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Together, these agreements ensure freedom from undue internal and external commercial, financial, and other pressures or influences that could adversely affect the quality of work. They protect customers' confidential information and the proprietary rights of ALS. They ensure avoidance of activities that would diminish confidence in the competence, impartiality, judgement, or integrity of any ALS staff.

Any breach or suspected breach of the Code of Conduct or the Data Integrity Policy can be reported to any manager, or to any HR or QA representative. In addition, ALS provides an Integrity and Compliance Helpline on SharePoint as a confidential and independent guidance and reporting service that is accessible to all staff. Any cases of theft, fraud, dishonesty, risks to impartiality, harassment, unethical behavior, and/or workplace safety hazards can be confidentially and anonymously reported to an independent party. An investigation procedure details the process and notifications. In addition, the ALS Whistleblower Policy protects staff that make honest and genuine reports from all forms of retaliation.

For activities related to DOD accreditation, any instances of inappropriate and prohibited laboratory practices must be reported to the Accrediting Body within 15 business days of discovery. Discovery includes findings of such inappropriate practices by laboratory staff or customer stakeholders. Laboratories must submit records of associated corrections taken or proposed corrective actions to their Accrediting Body within 30 business days of discovery.

5.2.2 ALS generally identifies long term training needs and plans for the provision of training to personnel during annual performance reviews, based on present and anticipated future responsibilities. The effectiveness of training is evaluated during a six-month follow-up where applicable.

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Training is also undertaken at any time the need is identified, whether to ensure adequate cross-training so work can be reassigned if needed, or to update knowledge and skills. The effectiveness of as-needed training is evaluated by the assigned trainer or by the manager responsible for the work. Evaluation tools include direct observation, quality control samples, performance testing samples, technical audits, and corrective action reports.

Training is provided for every job function and may include but not be limited to quality systems, LIMS applications, management, leadership, customer service, safety, test method or equipment specific training, and issuing test reports. Staff may request additional training at any time.

The process for demonstrating analyst proficiency for specific tests is documented and complies with applicable accrediting body policies regarding training duration, content, and record keeping, where specified. On-going proficiency is monitored through using proficiency testing samples with additional training provided as needed. Analysts who predate current competency and training procedures are grandfathered into the current system.

5.2.3 Periodically, contract personnel may be hired to fulfill specific project requirements. Contract personnel are subject to the same qualifications, supervision, orientation, and training procedures as permanent staff.

5.2.4 The Human Resources Department maintains position descriptions for managerial, technical, and key support personnel. Position descriptions are used for job postings to ensure prospective employees are aware of position requirements prior to applying.

5.2.5 Records are maintained for all staff and include the relevant authorizations, educational and professional qualifications, training, skills and experience. Records include dates of authorization and confirmed competence.

5.2.5 For TNI / DOD Accreditations:

Individuals identified as Technical Managers must meet specific qualifications identified in the program documents.

5.3 ACCOMMODATIONS AND ENVIRONMENTAL CONDITIONS

ALS facilities and their environmental conditions, including energy sources, lighting, and temperatures are appropriate for the correct performance of tests conducted at each location.

All instrumentation and electrical equipment used within ALS facilities must meet or exceed the relevant Canadian Standards Association (CSA) or Underwriters Laboratory (UL) requirements. Any equipment or instrumentation containing a radioactive source must meet or exceed the safety and licensing requirements specified by the Canadian Nuclear Safety Commission.

Environmental requirements necessary for the performance of specific tests are site-specific and are documented, monitored, and recorded. When such requirements are out of compliance, appropriate action is taken that may include suspension of testing where applicable, in accordance with the local documents.

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Incompatible activities are separated and steps are taken to prevent cross-contamination. Refer to site-specific floor plans.

Each ALS location has procedures to ensure that access to laboratory and office areas is monitored and restricted to authorized individuals only.

Housekeeping is conducted to maintain appropriate environmental conditions within each facility.

SAFETY

ALS has an extensive safety program managed by the Corporate Compliance Department. The program is designed to meet corporate, federal, and regional regulations as applicable. The Safety Program includes task specific safety requirements, regular safety meetings and audits, and compliance and incident reporting mechanisms. Management and staff are responsible for implementing and adhering to the Safety Program, Safety Policies, and related procedures. Safety information is available on SharePoint.

All fire safety equipment within the ALS Environmental Division facilities meets or exceeds local fire safety regulations.

All shipments of supplies and samples are carried out in accordance with the appropriate local, regional, federal, or international ordinances, including the Transportation of Dangerous Goods (TDG) Regulation. Staff responsible for the shipment of Dangerous Goods have received TDG training.

WASTE MANAGEMENT

Waste management procedures are developed by each ALS location for all wastes designated as hazardous, and to ensure that all waste disposal practices meet local regulatory requirements. Refer to site-specific procedures.

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FUME HOODS

Fume hoods are available in all laboratory sections where required to meet safety needs. Fume hood face velocities are regularly monitored. Refer to site-specific procedures and/or records.

5.4 TEST METHODS AND METHOD VALIDATION

Refer to NA-SP-0100 Method Validation, NA-SP-0101 MU Principles and NA-SP-0102 Method Revalidation and MU for details. Local procedures apply to other disciplines where needed.

5.4.1 General

ALS locations use appropriate, documented methods for all tests performed. Templates for national and local test methods specify the minimum documentation requirements. Test method instructions and support information is kept current and accessible where the work is performed.

Deviations from test methods occur only if the deviation has been documented, technically justified, authorized, and accepted by the customer where applicable. Analytical department supervisors and managers have the authority to approve method deviations for the analysis of samples and to impose appropriate quality control into the analysis. If the deviation is judged to alter the outcome of a test, client acceptance of the deviation will be obtained prior to approval. These isolated occurrences can be documented using the record keeping system established for single event test method nonconformances. Refer to section 4.9.

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5.4.2 Selection of Methods

Customers rely on ALS to select test methods that are scientifically valid, defensible, and appropriate to meet their needs. Where possible, ALS uses the latest versions of published standard methods developed by organizations such as the American Public Health Association, the United States Environmental Protection Agency, the National Institute for Occupational Safety and Health, Environment Canada, and other international, regional, or regulatory organizations, or equipment manufacturers. When needed, standard methods are supplemented with additional instructions to ensure consistency of application and performance and to comply with the content requirements of ALS document templates. Where an appropriate standard method is not available, ALS may develop and validate an in-house test method, or may adopt a third-party validated method. ALS provides method information to clients on test reports and upon request.

For published reference methods, each ALS location confirms it can properly operate the standard method before introducing the test into the laboratory. If a future revision of the standard method causes it to change in a manner that may affect test results, the confirmation is repeated.

Unique circumstances may occur where a customer specifies the methodology to be used. The customer will be notified if ALS deems the recommended method to be inappropriate or out of date.

5.4.3 Laboratory Developed Methods

When in-house development of a test procedure is needed, qualified individuals are assigned to the planning and development stages of the project. The plan is updated as

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development progresses and all changes are effectively communicated to everyone involved to ensure that objectives are met.

5.4.4 Non-standard Methods

If it is necessary to use methods not covered by standard methods, customer agreement will be obtained. The test methods will include or reference clear specification of the requirements and the purpose of the test. The developed method will be appropriately validated before use.

5.4.5 Validation of Methods

Method validations are conducted to confirm that the developed methods are fit for their intended use. The validations are as extensive as necessary to meet the needs of the given application. The extent depends on the source of the method. For example, standard methods used for their intended application require a less extensive validation than non-standard methods or standard methods used outside of their intended scope.

All results relating to the validation of a given method, including the procedure used for validation and a statement of whether the method is fit for its intended use are retained in method validation records.

As appropriate, validation studies performed will verify the range and accuracy of the test method, including measurement uncertainty, detection limit, selectivity (i.e. sensitivity to interference), linearity, repeatability and/or reproducibility, and robustness. Measurement uncertainty values are reviewed to ensure they are sufficient to meet customers' needs.

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Chemistry test methods are revalidated periodically to ensure continued suitability and fitness for purpose. Revalidation is routinely scheduled as part of the internal audit process. Revalidation frequency is based on test method performance and the requirements of applicable accrediting bodies. Refer to section 4.14 for additional information regarding internal audit schedules. Revalidation may also occur at any time when the performance of a test method is under investigation. At minimum, revalidation includes an examination of precision and bias data, an evaluation of detection limits and limits of reporting and an estimation of measurement uncertainty.

5.4.6 Estimation of Measurement Uncertainty

The ALS procedure for estimating measurement uncertainty is based on accepted practices of identifying components contributing to uncertainty, compiling data that represents or includes these components, evaluating the data using appropriate statistical calculations, and reporting in a manner that prevents misunderstanding of the result.

In those cases where the nature of the test precludes calculation of uncertainty, ALS will at minimum identify the components of uncertainty and make a reasonable estimation where needed. This estimation will be based on available validation data and other sources of information about the test method's performance.

5.4.7 Control of Data

Refer to NA-SP-0850 Electronic Data Control and Security and NA-SP-0150 Creation and Validation of LIMS Products, and NA-SP-0152 GEL Method and Test Authorization and Verification for details.

Automated calculations and data transfer systems are checked in a systematic manner when first programmed and are re-verified appropriately when changes are made.

When computers and automated equipment are used for the acquisition, processing, recording, reporting, storage, or retrieval of test data, ALS ensures:

- In-house developed software is sufficiently documented and validated.
- Procedures are implemented for protecting data, including integrity and confidentiality of entry, collection, storage, transmission, and processing – refer to sections 4.13, 5.1 and 5.10.
- Computers and automated equipment are maintained to ensure proper functioning and adequate environmental conditions – refer to section 5.1.

5.5 EQUIPMENT

Refer to NA-SP-0051 Equipment Maintenance Contracts and NA-SP-0078 Equipment Inventory for details.

5.5.1 ALS laboratories use appropriate sampling and testing equipment and instrumentation to ensure test method performance meets client needs. If ALS locations use equipment that is outside of their permanent control, the laboratories are responsible for ensuring the equipment meets the requirements of this section.

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5.5.2 All equipment and its software needed for testing meets required performance specifications. Equipment is calibrated at the frequency stated in specific test methods and is confirmed to achieve required accuracy. Calibration and verification programs are established where appropriate.

5.5.3 Authorized staff use documented test methods and procedures to operate, calibrate and maintain equipment. Relevant operating manuals or other work instructions are available where needed.

All proposals for maintenance contracts are reviewed and authorized nationally by the TD.

5.5.4 Equipment and its software are uniquely identified where practical. Inventory lists are maintained of all equipment with a new or replacement value of greater than $750.00 CAD, excluding consumables, vehicles, and furniture.

5.5.5 Instrument logbooks and/or maintenance records contain the following information relating to instrumentation and software:

- Equipment and software identification.
- Manufacturer’s name, model and serial number.
- Performance check records.
- Current location where appropriate.
- Manufacturer instructions (alternatively referenced in test method).
- Calibration history, adjustments, acceptance criteria (alternatively referenced in test method), and due date of next calibration (except for equipment calibrated on an as-used basis).

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- Maintenance schedules (alternatively referenced in test methods), and records of maintenance.
- Records of damage, malfunction, repair, or modification.

5.5.6 Documented instructions describe the management of measuring equipment and instrumentation, including:

- Safe handling, transport where applicable, storage and use.
- Planned maintenance.
- Intermediate calibration checks.
- The application of correction factors and updating of software or other records, where applicable.

5.5.7 Any equipment known or suspected to be defective is removed from service, isolated where practical, and clearly labeled as being out of service. The equipment is not returned into use until it is examined, necessary repairs have been completed, and it has been verified to meet performance specifications. Records are maintained in equipment logbooks. Where the defect calls reported analytical results into question, corrective action will be implemented – refer to sections 4.9 and 4.11.

5.5.8 Where practical, equipment under the control of the laboratory will be labeled to identify its calibration status. The label will include the date last calibrated and the expiration criteria or other indication of when re-calibration is due. Labels are not practical when the equipment is calibrated on a daily basis or when labels will interfere with the operation of the equipment. In such cases, other tracking mechanisms are implemented.

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5.5.9 When it is necessary for equipment to go outside of the direct control of a laboratory, it will not be returned to service until it is demonstrated to meet performance specifications. Records are maintained in equipment logbooks or maintenance records.

5.5.10 When intermediary checks are needed to maintain confidence in the calibration status, the checks are carried out according to documented procedures. Refer to section 5.5.6.

5.5.11 Where calibrations result in correction factors, procedures for applying the corrections are documented. Refer to section 5.5.6.

5.5.12 Equipment is situated in the lab in a manner that will protect it from inadvertent adjustments. Specific equipment settings are documented where these settings can affect analytical results. Correct equipment adjustment is included in the training provided to individuals working with equipment.

5.6 MEASUREMENT TRACEABILITY

Refer to NA-SP-0075 Volumetric Device Calibration and Verification, NA-SP-0082 Balance and Weight Use, Calibration and Verification, and local procedures for details.

5.6.1 Wherever possible, ALS measurement and testing equipment that can have a significant effect on the accuracy or validity of test results is calibrated using established procedures. Calibration procedures ensure traceability through an unbroken chain of calibrations or by comparison to national measurement standards.

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When using external calibration services, traceability of measurement is assured where applicable by the use of laboratories that can demonstrate competence, measurement capability, and traceability through accreditation to ISO/IEC 17025:2005 or ISO/IEC 17025:2017 during the transition phase. The calibration certificates issued by these laboratories relate their accreditation status and contain the measurement results, measurement uncertainty, and a statement of compliance with an identified metrological specification.

5.6.2 Where traceability of measurements to SI units is not possible and/or not relevant, traceability is provided by the use certified reference materials and/or consensus standards.

5.6.3 Reference Standards and Reference Materials

5.6.3.1 Reference Standards

Reference standards such as reference thermometers are calibrated by service providers that have demonstrated competence by being accredited to ISO/IEC 17025:2005 (during the transition phase) or ISO/IEC 17025:2017 for the required calibrations. This equipment is used for no purpose other than demonstrating that equipment is within calibration specifications, unless it can be demonstrated that their performance is not invalidated by the other uses. Where adjustments are needed, re-calibration or replacement is performed.

5.6.3.2 Reference Materials

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Reference materials purchased by ALS are traceable to SI units where possible or to other certified reference materials. They are purchased from ISO/IEC 17034 accredited suppliers where available and where practical. Where not available or practical, purchasing from ISO/IEC 17025 accredited suppliers is preferred. Internally prepared reference materials are checked as far as technically and economically feasible. Refer to individual test methods for information on the use of reference materials.

5.6.3.3 Intermediate Checks

Where checks are needed to maintain confidence in the calibration status of reference standards, primary standards, working standards, or reference materials, such checks will be carried out according to defined procedures and schedules.

5.6.3.4 Transportation and Storage

Reference standards and materials are handled, stored, and transported in a manner that protects their integrity and operation. Local procedures relate criteria for the transportation and storage of reference standards where needed. Refer to individual test methods for handling and storage of reference materials. ALS laboratories do not normally transport reference materials. If needed, transportation procedures will be developed based on the requirements of the circumstance.

5.7 SAMPLING

5.7.1 ALS Canada locations do not collect field samples, except in rare situations where requested by the client. In these cases the client is asked to provide detailed sampling instructions.

Subsampling from submitted sample containers is conducted in a manner to obtain representative sub-samples. The error associated with subsampling is statistically monitored by collecting duplicate sub-samples for test procedures where subsampling occurs. Sub-sampling instructions are included or referenced in test methods where applicable.

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5.7.2 Where a client requires deviations, additions, or exclusions from our documented sampling procedures, they are recorded in detail with the appropriate sampling data, are communicated to all appropriate personnel, and are indicated in final test reports.

5.7.3 Where applicable, ALS laboratories record relevant data and operations related to sub-sampling. The records include for example, identification of the sampler, date of sampling, applicable weights or volumes, deviations, and other information where relevant.

5.8 HANDLING OF SAMPLES

Refer to NA-SP-0325 Protocols for Sample Handling on Receipt for details.

ALS sample handling procedures include transportation conditions, receipt, handling, protection, storage, retention, and disposal. Sampling and Handling Guides are provided to customers where needed. The procedures are designed to protect the integrity of the test samples and the interests of the customer and ALS.

ALS requests that our customers use our Chain of Custody (COC) form for every shipment of samples. The form includes sufficient space to record field sampling date, time and location of sampling, sample ID, and information relating to the integrity of the sample as collected. COCs are shipped with field supplies, and are also available on the alsglobal.com web site.

Samples are given a unique identification upon receipt. The identification is retained by the sample throughout its life in the laboratory, and ensures samples are not confused either physically or in records or reports. Where appropriate, the system allows for subdivision of test items and transfer within and between laboratories.

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Abnormalities or other departures from specified sampling or transportation procedures are documented. Where there is doubt concerning the integrity of the sample, its identification or suitability for testing, or the requested tests, the customer is consulted for further instructions before proceeding, and the discussion is documented.

All ALS locations have appropriate facilities to securely maintain sample integrity, both before testing and where archiving for future testing is required. Sample storage and handling criteria are identified in test methods. Where important to protecting sample integrity, storage conditions are monitored and recorded.

5.9 ASSURING THE QUALITY OF TEST RESULTS

Refer to NA-SP-0104 Quality Control Protocols, NA-SP-0105 Recheck Protocol, NA-SP-0109 Creating, Maintaining and Monitoring Control Charts, NA-SP-0110 GEL Control Chart Protocol, NA-SP-0175 Data Validation of Test Data and supplemental procedures describing the proficiency testing program for details.

The ALS quality control (QC) protocols monitor the validity of tests performed by its laboratories. Individual test methods specify quality control requirements, including frequency of use and data quality objectives (DQOs) that trigger corrective action when exceeded. DQOs are based on a combination of reference method objectives, customer requirements, and historical test method performance. Where applicable, regulatory requirements or prescriptive elements of reference methods take precedence over internal DQOs.

QC elements utilized include but are not limited to functional checks of measuring and testing equipment, calibration standards, reference samples, control samples, verification standards, blanks, sample duplicates, surrogate compounds, and matrix spikes as appropriate to the field of testing.

Where appropriate, QC results are recorded on control charts. Control limits and statistical techniques are used to monitor test method performance for important trends. Planned action is taken to correct problems and to prevent incorrect results from being reported.

ALS laboratories participate in an extensive range of proficiency testing (PT) programs. PT samples are treated and analyzed on-site in a manner as similar to customer samples as possible, to ensure the test results represent customer test results. PT samples often require handling steps that are unique to the PT samples that differ from the steps in authorized test procedures. In these cases the unique steps are communicated to the applicable analytical departments by QA staff through Mobilization Meetings in order to minimize preventable errors. When various locations analyze the same PT samples, test results are not discussed or compared in any manner prior to the publication of the PT evaluation. Each accrediting body has specific policies regarding the analysis and reporting of proficiency testing samples. Local procedures describe the approaches used to meet the requirements.

Where possible, ALS will store samples for the following durations to accommodate retesting, measured from date of sample submission: 45 days for Soil and Water samples; 6 months for Tissue/Biota samples; 14 days for air samples collected on re-usable media; and 3 days for water samples submitted for microbiological testing. Where retesting identifies a nonconformance to policies and/or procedures, a nonconformance and corrective action is initiated – refer to section 4.9 and 4.11).

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All ALS test results proceed through several validation steps by qualified individuals prior to the release of final test reports. The data validation process includes test result validation, inter-parameter validation, and report validation. Where data validation steps are prescribed by accrediting bodies, local procedures will provide details on responsibilities and processes.

The reporting of PT sample results to PT agencies requires unique manual data conversion and manual data entry steps after the report validation step is complete. A self-transcription check of the additional reporting steps is required at minimum, and a peer review is performed as needed. A record is maintained in either case.

5.10 REPORTING RESULTS

All information listed below is either included in the final report or kept on file at ALS in the case of abbreviated or customized reports, and can be provided to clients upon request:

- Title of report.
- Name and address of the laboratory issuing the report.
- Location where each test was conducted.
- Unique identification of the test report on each page, and the total number of pages.
- Customer name and address.
- Identification of test method(s) used.

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- Unique identification of each sample, description of the sample such as matrix and customer identification, and condition where applicable.
- Date of sample receipt.
- Date of analysis.
- Test results and units.
- Report qualifiers.
- Name, function, and signature of the person authorizing the report.
- Statement that the results relate only to the samples identified in the report.
- The decision rule: when statements of conformity are requested on test reports, measurement uncertainty is not applied to test results prior to the evaluation.

Other information necessary for the interpretation of results or requested by the customer may also be included in reports, such as test method deviations or exclusions, specific test conditions, measurement uncertainty estimates, date of sampling, location of sampling, and other sampling information.

Statements of compliance, opinions, and interpretations may be included on test reports for specific analyses. In all such cases, the basis on which they have been made will be documented and clearly identified in the test report.

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ALS obtains subcontract laboratory results in hard or electronic reports. When these results are presented to the customer in ALS reports, the identification of the subcontractor is clearly indicated on the final report.

When test reports are transmitted by telephone, facsimile, e-mail or other electronic means, the procedure for protecting the integrity and confidentiality of data includes:

- Only providing results to those individuals specified by the client for each sample submission.
- Use of a standardized facsimile cover page or email footer that relates the procedures to follow if received in error.

It is ALS practice to never disclose information about a client’s test results to a third party without the prior consent of the client, or unless compelled to by law. If ALS is obligated by law to disclose such information, the client will be informed prior to doing so.

Test report formats are designed to accommodate each type of test and customer specifications. In all cases, ALS ensures that final results are reported in a manner that minimizes the possibility of misunderstanding or misuse.

Test report amendments are made by issuing a replacement report, identifying that a revision was made, and describing all changes in the cover page comment section.

6.0 REFERENCES

Documents are available on the ALS network at: N:\Life Sciences\Environmental\Technical\Regulations & Standards\STANDARDS FOR ACCREDITATION, unless otherwise noted.

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6.1 PRIMARY REFERENCES

ISO/IEC 17025:2005 General Requirements for the competence of testing and calibration laboratories, Second Edition, 2005-05-15.

ISO/IEC 17025:2017 General Requirements for the competence of testing and calibration laboratories, Third Edition, 2017:11.

Perry Johnson Laboratory Accreditation (PJLA) program requirements at: pjla.com.

Quebec Accreditation Program for Analytical Laboratories (PALA) Requirements and Standards, DR-12-PALA, March 6, 2012, and supporting policies and program documents.

The Canadian Association for Laboratory Accreditation (CALA) program requirements at: cala.ca.

The NELAC Institute (TNI) Standard ELV1-2016-Rev2.1.

The USA Department of Defense (DOD) Quality Systems Manual Version 5.3 2019.

7.0 VERSION HISTORY

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Doc ID	Version No.	Version Date	Summary of Changes
NAQM1	01	18-Feb-2007	Defining the harmonized ALS management system. / L. Neimor / P. Mueller
NAQM1	02	07-Sep-2007	Refer to v02 for details. / L. Neimor
NA-QM-1	03	01-Jun-2009	Refer to v03 for details. / L. Neimor
NA-QM-0001	04	22-Nov-2011	Refer to v04 for details. / L. Neimor
NA-QM-0002	01	01-Mar-2018	Refer to NA-QM-0002 v01 for details. / L. Neimor
NA-QM-0002	02	02-Oct-2018	Refer to NA-QM-0002 v01 for details. / L. Neimor
NA-QM-0002	03	03-June-2021	Minor clarifications and the following updates, by L. Neimor and D. Gurdibaniuk - 1.0: Added ALS Limited Quality Management Policy. - 2.0: Updated for current SharePoint and website processes. - 4.1.5 d): Added the ALS integrity and Compliance Helpline. - 4.4.6: Added this clause for Terms & Conditions including decision rule. - 4.16: Expanded on section based on feedback from 2020 CALA QS reassessment. - 5.1: Added ALS Limited Information Management Policy IT-GL-GRP-POL-002 and NA-SP-0152 GEL Method and Test Authorization and Verification; added GEL Support & methods to text. - 5.2: Added NA-SP-0300 Quality System and Job-Specific Training Protocols. - 5.4.7: Added NA-SP-0152 GEL Method and Test Authorization and Verification. - 5.6: Added NA-SP-0075 Volumetric Device Calibration and Verification, NA-SP-0082 Balance and Weight Use, Calibration and Verification. - 5.6.3.2: Added reference materials are purchased from ISO/IEC 17034 accredited suppliers where available and where practical. Where not available or practical, purchasing from ISO/IEC 17025 accredited suppliers is preferred. - 5.6.3.4: Added RM transportation requirements will be defined as needed based on the circumstances. - 5.9: Added NA-SP-0105 Recheck Protocol & NA-SP-0110 GEL Control Chart Protocol. - 5.10 last bullet: Added decision rule. - 6.1: Updated DOD version. June 3, 2021 Reissued/ D. Gurdibaniuk Corrected typos in Global ALS policy IDs throughout.

8.0 TNI / DOD ADDITIONAL LABORATORY INFORMATION

Only locations that hold TNI and/or DOD accreditations are to complete this section. Note that this manual applies to all organizational units as described within the document.

LABORATORY ADDRESS AND PHONE NUMBER	
Street Address:	
City, Province, Postal Code:	

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Phone Number:	

RESPONSIBLE PARTIES			
Title	**Name**	**Signature**	**Date**
General Manager:			
Technical Manager:			
Quality Coordinator:			

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APPENDIX I
ALS ANALYTICAL DETECTION LIMITS

Appendix I
ALS Analytical Detection Limits
Teck Metals Ltd. Pine Point Mine Tailings Impoundment Area
Quality Assurance Quality Control Plan

	Permit Limits			Laboratory Information					
Parameters	Maximum Average Concentration	Maximum Grab Concentration	Action Level for Station 35-1b	Analytical Test Method	Laboratory Reporting Limit	LCS %R Limit	MS/MSD %R Limit	RPD Limit	SOP Reference
pH	6.5 to 9.5 s.u.	6.5 to 9.5 s.u.	9.3 s.u. maximum	APHA4500-pHA&B	0.1 s.u.	±0.2 s.u.	na	±0.3 s.u.	ED-TM-1026 v06
Total Arsenic	0.50 mg/L	1.00 mg/L	0.50 mg/L	EPA 6020	0.0001 mg/L	80-120	70-130	20	NA-TM-1002 v09
Total Copper	0.15 mg/L	0.30 mg/L	0.15 mg/L	EPA 6020	0.0005 mg/L	80-120	70-130	20	
Total Lead	0.20 mg/L	0.40 mg/L	0.20 mg/L	EPA 6020	0.00005 mg/L	80-120	70-130	20	
Total Zinc	0.50 mg/L	1.00 mg/L	0.50 mg/L	EPA 6020	0.003 mg/L	80-120	70-130	20	
Total Cyanide	0.10 mg/L	0.20 mg/L	0.10 mg/L	APHA 4500-CN-I	0.002 mg/L	85-115	75-125	20	NA-TM-1003 v03
Ammonia as N	2.00 mg/L	4.00 mg/L	2.00 mg/L	EPA 350.1 v 2.0 APHA 4500-NH3-G	0.005 mg/L	85-115	75-125	20	NA-TM-1009 v01
Total Suspended Solids	25.00 mg/L	50.00 mg/L	25.00 mg/L	APHA2540D	3 mg/L	85-115	na	20	NA-TM-1008 v01

mg/L = milligrams per liter
s.u = standard units
APHA = American Public Health Association
EPA = United States Environmental Protection Agency
LCS = laboratory control sample
MS = matrix spike sample
MSD = matrix spike duplicate sample
na = not applicable
RPD = relative percent difference

APPENDIX J
ALS TEST METHODS

METALS IN ENVIRONMENTAL MATRICES BY ICPMS

1.0 SCOPE AND APPLICATION

1.1 Scope

NA-TM-1002 describes the method requirements and capabilities for the analysis of metals in water (surface water, groundwater, potable water, effluents, and waste waters). Instrumental analysis is by Collision-Reaction Cell Inductively Coupled Plasma Mass Spectrometry (CRC-ICPMS). This method is also suitable for other liquid or solid samples including soils, sediments, sludge, biological and geological samples after appropriate sample pre-treatment and/or sample digestion procedures.

1.2 Parameters and Limits of Reporting

The following parameters and Limits of Reporting (LORs) are typically achievable by this method and represent ALS Canada Harmonized LOR objectives. Refer to local documentation for further details on laboratory specific LORs and parameter lists. Parameter and Matrix combinations which do not have an LOR listed in this table are typically not reported for that matrix.

Parameter	Water Ultra-Low ICPMS LORs (mg/L)[1]	Total Metals in Water LORs (mg/L)	Dissolved Metals in Water LORs (mg/L)	Soil 200.2 LORs (mg/kg dry)[2]	Biota LORs (mg/kg dry)[3]	TCLP Leachate LORs (mg/L)[4]
Aluminum (Al)	0.0007	0.003	0.001	50	2	▨
Antimony (Sb)	0.00002	0.0001	0.0001	0.1	0.01	1
Arsenic (As)	0.00002	0.0001	0.0001	0.1	0.02	1
Barium (Ba)	0.00002	0.00005	0.00005	0.5	0.05	2.5
Beryllium (Be)	0.00001	0.0001	0.0001	0.1	0.01	0.025
Bismuth (Bi)	0.000005	0.00005	0.00005	0.2	0.01	▨
Boron (B)	0.005	0.01	0.01	5	1	0.5
Cadmium (Cd)	0.000005	0.000005	0.000005	0.02	0.005	0.05
Calcium (Ca)	0.02	0.05	0.05	50	20	2
Cesium (Cs)	0.00001	0.00001	0.00001	▨	0.005	▨
Chromium (Cr)	0.0001	0.0001	0.0001	0.5	0.05	0.25
Cobalt (Co)	0.000005	0.0001	0.0001	0.1	0.02	0.05
Copper (Cu)	0.0001	0.0005	0.0002	0.5	0.1	0.05
Iron (Fe)	0.001	0.01	0.01	50	3	0.15
Lead (Pb)	0.00001	0.00005	0.00005	0.5	0.02	0.1
Lithium (Li)	0.0005	0.001	0.001	2	0.5	▨
Magnesium (Mg)	0.005	0.005	0.005	20	2	0.5
Manganese (Mn)	0.00005	0.0001	0.0001	1	0.05	▨
Molybdenum (Mo)	0.00005	0.00005	0.00005	0.1	0.02	▨
Nickel (Ni)	0.00005	0.0005	0.0005	0.5	0.2	0.25
Phosphorus (P)	0.02	0.05	0.05	50	10	▨
Potassium (K)	0.05	0.05	0.05	100	20	▨

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[1] Ultra-low Level LORs: samples are analyzed with no sample prep and may require CRC-ICPMS instrumentation for some analyte and LOR combinations.

[2] 200.2 soil digest LORs are based on CRC-ICPMS analysis and a dry weight preparation factor of 50 and a dilution factor of 20.

[3] Biota LORs are based on a dry weight preparation factor of 50 and a dilution factor of 10.

[4] TCLP Leachate LORs are based on a dilution factor of 50.

Parameter	Water Ultra-Low ICPMS LORs (mg/L)[1]	Total Metals in Water LORs (mg/L)	Dissolved Metals in Water LORs (mg/L)	Soil 200.2 LORs (mg/kg dry)[2]	Biota LORs (mg/kg dry)[3]	TCLP Leachate LORs (mg/L)[4]
Rubidium (Rb)	0.0002	0.0002	0.0002	▨	0.05	▨
Selenium (Se)	0.00004	0.00005	0.00005	0.2	0.05	0.2
Silicon (Si)	0.05	0.1	0.05	▨	▨	▨
Silver (Ag)	0.000005	0.00001	0.00001	0.1	0.005	0.05
Sodium (Na)	0.01	0.05	0.05	100	20	▨
Strontium (Sr)	0.00005	0.0002	0.0002	0.5	0.05	▨
Sulfur (S)	0.5	0.5	0.5	1000	100	▨
Tellurium (Te)	0.0002	0.0002	0.0002	▨	0.02	▨
Thallium (Tl)	0.000002	0.00001	0.00001	0.05	0.002	0.5
Thorium (Th)	0.0001	0.0001	0.0001	▨	▨	▨
Tin (Sn)	0.00002	0.0001	0.0001	2	0.1	▨
Titanium (Ti)	0.0003	0.0003	0.0003	1	0.1	▨
Tungsten (W)	0.0001	0.0001	0.0001	0.5	▨	▨
Uranium (U)	0.000003	0.00001	0.00001	0.05	0.002	0.2
Vanadium (V)	0.00005	0.0005	0.0005	0.2	0.1	0.15
Zinc (Zn)	0.0005	0.003	0.001	2	0.5	0.5
Zirconium (Zr)	0.00006	0.00006	0.00006	1	0.2	5

1.3 Method Performance Data and Measurement Uncertainty

For each matrix/analyte pair, complete method validation must be in place and at a minimum each laboratory using this method must demonstrate competency to meet local LORs. Ultra-trace sample handling procedures may be required to meet the ultra-low water LORs. Validation and evaluation of Method Blanks must demonstrate that these levels can be defensibly met.

Method blank subtraction is not permitted by this method. If Method Blank contamination is present above LOR, the contamination level must be qualified along with batch-associated samples and their LORs raised to compensate for the contamination, or data is rejected. If Method Blank contamination is found consistently between preparation batches either the root cause should be determined and corrected or the lab's LOR must be changed to reflect achievable performance.

Refer to NA-SP-0100 Initial Method Validation – Chemistry and NA-SP-0102 Method Revalidation and MU – Chemistry for policies on determination and storage of method performance data.

2.0 PRINCIPLE OF METHOD

Inductively Coupled Plasma Mass Spectrometry (ICPMS) is applicable to the multi-elemental analysis of a wide range of elements in various matrices in the concentration range of parts per trillion (ppt) to parts per million (ppm). Aqueous samples are introduced into the ICPMS through the sample introduction system, which is composed of an autosampler, peristaltic pump, nebulizer, spray chamber, injector, and torch. The sample is nebulized with argon gas and the fine aerosol is separated from the bigger droplets in a spray chamber. The fine aerosol is carried by a flow of argon gas into the argon plasma through an injector. The plasma consists of a flowing stream of argon gas ionized by a spark and maintained by an applied radio frequency field. In the plasma, where the temperature can reach up to 10,000 K, the sample is desolvated and the elements are ionized. Elemental ionization is dependent on ionization potentials and chemical species.

Ions are extracted from the center of the plasma at the sampling interface through the orifice of a liquid-cooled sampler cone. Ions are transmitted through this reduced pressure stage (~4 torr) behind the sampling interface, through a second cone (skimmer cone) and into the ion lens region. This area operates at a pressure of approximately 1×10^{-5} torr maintained by a turbo molecular vacuum pump.

Once in the mass spectrometer, ions are focused towards the entrance of the quadrupole by the ion lens stack while the light emitted by the plasma is stopped from entering the detector by an off-axis ion lens. The quadrupole mass filter separates ions according to their mass to charge ratio (m/z), with approximately unit mass resolution. Mass filtering of ions is achieved by varying the radio frequency voltage applied to the quadrupole mass filter, allowing only a selected m/z range to the detector. For each targeted m/z, the ion signal is collected from an electron multiplier detector at the exit of the quadrupole mass filter. Detector responses are processed using computerized data processing software to derive qualitative and quantitative test results for the samples that were analyzed.

Some instruments utilize a collision/reaction cell (CRC) prior to the quadrupole mass filter in order to reduce polyatomic interferences in ICPMS analysis. The three main modes of interference reduction are collisionally induced dissociation, chemical reaction, and kinetic energy discrimination.

3.0 DEFINITIONS

Refer to NA-SP-0001 Definitions of Key Terms for definitions of common terms.

4.0 INTERFERENCES

Contaminants may be present in reagents, labware and other sample processing equipment. Contamination from supplies or equipment must be routinely monitored with Method Blanks.

ICPMS can suffer from many sources of interference which can cause either suppression or enhancement of the signals. Interferences can be broadly divided into spectroscopic, matrix effects and memory effects.

4.1 General Interference Principles

4.1.1 Matrix Interferences

Matrix interferences are also known as physical interferences. This type of interference is associated with the efficiencies of sample nebulization, aerosol transport to the plasma, and ion-transmission into and through the MS.

High concentrations of dissolved solids in the sample, varying acid concentrations, and high concentrations of major elements can contribute to matrix interferences. Increased concentrations of dissolved solids result in more substances being deposited onto the nebulizer, injector, and interface cones, reducing their orifice sizes and affecting instrument performance by restricting sample flow and transport efficiencies. Varying acid concentrations can cause changes in surface tension or viscosity and as a result can cause signal suppression or enhancement when compared to calibration standards that are made using a certain acid concentration. The use of internal standards corrects for minor differences in acid concentrations. The theoretical upper limit of total dissolved solids that the ICPMS can handle is 0.2-0.3%, not including the acid matrix.

In addition to deposit formation, high concentrations of elements create supersonic expansion and space-charge effects in the vacuum chamber of the MS, which are also responsible for the apparent suppression of signals since ion-transmission efficiencies are reduced. This suppression is more pronounced for low mass elements/isotopes because they are physically more affected than heavier masses.

Correction of the data using internal standards (IS) that cover the applicable mass range and ionization potentials can usually compensate for most matrix effects. A set of internal standards covering the whole mass spectrum of analyzed elements (Ge, In, Li^6, Lu) is added to every sample in the analytical run (including QC samples and standards). Internal Standard corrections are performed from within the instrument data processing software. Internal Standards correct for both sensitivity drift during the run and for matrix effects (i.e. suppression of the analyte signal caused by the sample matrix). Some drift is mass dependent in which case the use of internal standards provides a good approximation of the affect the matrix will have on different analytes, however corrections applied may not completely account for intensity drift. Care should be taken with the use of internal standards as some sample/matrix types may contain some IS elements as naturally occurring element, which may lead to incorrect corrections being applied (Scandium in soils is the most common example of this, but this method no longer uses Sc as an IS for this reason). Refer to instrument procedures for further details on correction methods.

4.1.2 Spectroscopic Interferences

Spectral interferences are the result of other chemical species (elemental or polyatomic) which form singly or doubly charged ions with a similar nominal mass to charge ratio (m/z) and that cannot be resolved by the quadrupole mass spectrometer. Typically, the isotope with the least interferences is chosen for analysis. Instrument level correction equations and post-acquisition corrections are used for the correction of interferences due to isobaric overlaps, polyatomic ions and refractory oxides.

4.1.2.1 Isobaric Overlap

Most elements have more than one isotope. Isobaric overlap exists when the isotopes of two different elements have the same mass (e.g. ^{116}Sn and ^{116}Cd, ^{98}Mo and ^{98}Ru). These masses are actually slightly different but they cannot be differentiated by the quadrupole mass filter.

Most multi-isotopic elements have at least one isotope which is not affected by isobaric overlap; however, there are exceptions. Both Indium isotopes, ^{113}In and ^{115}In, overlap with the isotopes of other elements: ^{113}Cd and ^{115}Sn. Isobaric overlap is practically non-existent for masses lower than 23 amu. Minor isobaric overlaps can be corrected by measuring the intensity of the interfering element at one of its major isotopes. Then, using the known isotope ratio, it is possible to subtract the intensity of the interfering isotope which is contributing to the overall analyte signal. Since isotopic overlaps are known and well understood, this correction is done automatically by the instrument software in real time. As a rule of thumb, odd mass isotopes do not have isobaric overlaps. Most of the elemental ions chosen for analysis do not have isobaric overlaps from other elements. If isotopes with isobaric overlaps are used, a proper interference correction equation is applied. Refer to instrument specific operating procedures for further information regarding correction equations that may be in use.

4.1.2.2 Polyatomic Ions

Polyatomic ions are short-lived species formed by a combination of two or more ions (e.g. ArO^+). Argon, oxygen, and hydrogen are the most abundant species in the plasma. They can combine with each other and with other ions in the plasma.

Polyatomic ions can also be formed from elements present in the sample matrix (e.g. nitrogen, sulfur and chlorine). Formation of polyatomic ions is dependent on instrument type, operating parameters, and sample matrix. Radio Frequency (RF) power and nebulizer gas flow have a very big impact on the level of polyatomic ion formation. Higher RF power (1200-1400W) and lower nebulizer gas flow reduces polyatomic ion formation. Correction is possible and necessary for some polyatomic interferences.

Most of the polyatomic species occur in the mass spectrum up to 82 m/z. It is much more difficult to deal with polyatomic ions than with isobaric interferences, since the formation of the former is dependent on instrument type, operating parameters and sample matrix. CRC technology can effectively resolve most polyatomic ion interferences. (e.g. through the use of helium mode or hydrogen mode with Agilent ICPMS)

4.1.2.3 Refractory Oxides

Refractory oxides result from either incomplete dissociation in the plasma or recombination in the plasma tail and are a type of polyatomic ions. The level of refractory oxides depends on the M-O bond strength (M=metal). The elements with the greatest M-O bond strengths give the highest level of oxides. RF power and nebulizer gas flow have a similar effect on the formation of refractory oxides as on the formation of polyatomic ions. Under normal operating conditions the level of oxides does not exceed 2-3% of their associated metal depending on specific instrumentation used. CRC technology also in this case can effectively resolve most of these interferences and correction equations are not necessary.

4.1.2.4 Doubly Charged Ions

The level of ionization in the plasma depends on the ionization potentials of the elements. The formation of doubly charged ions is controlled by the second ionization potential. Elements with low second ionization potentials form M^{2+} ions more easily. M^{2+} ion formation also depends on the operating parameters of the instrument, particularly the RF power and nebulizer gas flow. Under normal operating conditions the level of M^{2+} ions does not exceed 2% of the M^+ ions. This value is checked daily so corrections are typically not required.

4.1.3 Memory Effects

Memory interferences or carry-over can occur when there are large concentration differences between samples or standards which are analyzed sequentially. Sample deposition on the sampler and skimmer cones, spray chamber design, tubing, rinse times and the type of nebulizer affect the extent of the memory interferences which are observed.

4.1.4 Element Stability

Some elements may have stability issues in the digestion and/or storage matrix. Silver digests of water samples from NA-TP-2001 have an upper limit of 0.1 mg/L in digests. Samples with > 0.1 mg/L of silver must be diluted and redigested. Soil digests are suitable for silver up to a concentration of 0.5 mg/L in the final extract (equivalent to 25 mg/kg). Refer to the tissue digestion procedures NA-TP-2003 and NA-TP-2006 for information on silver stability in the various Tissue digests applicable to this method. Refer to preparation procedure for additional details on stability issues. Other elements prone to sample stability issues include Antimony, Barium, Silicon, and Tin.

4.2 Element Specific Interferences

The interferences listed below are not an exhaustive list of potential interferences but represent the most commonly observed interferences. Refer to secondary references listed in section 11.2 for additional information on interferences that may not be listed below.

4.2.1 Arsenic Interference

As^{75} – Polyatomic Interferences from $Cl^{35}Ar^{40}$

As^{75} – Double Charge Interferences from $(Sm^{150})^{2+}$ and $(Nd^{150})^{2+}$.

For most analysis the interference of concern is that of chloride. Tuning of the system in 0.5% HCl is normally sufficient to remove this interference for samples high in chloride. Monitor ICS solutions and method blanks to assess the effectiveness of the interference removal. Monitoring of method blanks is particularly critical for samples digested with HCl.

For samples which may contain the rare earth elements Samarium (Sm) and Neodymium (Nd), the double charged ions of these elements will cause a positive interference on Arsenic. Refer to reference 11.2 #10 for more information. This interference can be significant in some vegetation samples and is particularly evident in the standard reference material NIST 1515 Apple Leaves. In order to correct for this interference it is required to calibrate for Sm and Nd. Calculate the correction coefficient from the calibration standards and update the correction equation daily, refer to NA-TP-2007 for details on updating correction equations. If either Sm or Nd is detected in a sample at a concentration greater than 2.5 ppb in solution the Agilent.xls macros will flag the result. Results should be scrutinized and LORs raised if appropriate.

Carbon enhancement is the effect where carbon in a sample increases the ionization of certain low ionizing elements. Arsenic is one of these elements. High carbon samples can show signal enhancement. In order to match carbon content of samples and standards a carbon source is added to the internal standard solution. Refer to reference 11.2 #12 for more details on this effect. Typically, this Internal Standard solution is used for tissue analysis however other matrices may also exhibit this effect.

4.2.2 Cadmium Interference

Cd^{111} – Interferences from $Mo^{95}O^{16}$.

Cd has 8 isotopes, 7 of which suffer from molybdenum oxide interferences (108-116 amu). The 8th isotope, Cd^{106}, suffers from isobaric overlap with Pd^{106}.

The isotope of choice is Cd^{111} (abundance 12.75%). This element is typically analyzed in both helium mode and in standard mode. Helium mode will reduce some of the MoO interference.

To improve this interference removal refer to NA-TP-2007 for optional additional analysis modes that can result in lower LORs for Cd in the presence of very high Mo. This mode uses a mix of both hydrogen and helium modes to improve the removal of this interference. Refer to Techsys TM.0403 for more information. Section 11.5 #9.

In either analysis, use the ratio of Cd interference to Mo concentration present in the ICS-A standard to estimate the magnitude of interference present in the analysis run. For example, if in the ICS-A sample the Cadmium signal is 30 ppt for Cd^{111} with 0.1 mg/L Mo present, then if a sample contains 0.05 mg/L Mo you should expect a Cadmium interference of 15 ppt.

For results where the observed signal is greater than 5x the expected interference the result from the lowest of the Cd^{111} analysis modes can be reported. If the observed result is less than 5x the expected interference then the LOR must be raised so that a <LOR is reported and the result qualified with the DLM qualifier.

All sample results with Mo greater than 0.025mg/L will be automatically flagged by the Agilent.xls macros for further review.

4.2.3 Calcium Interference

Ca^{43} – Double Charge interference from $(Sr^{86})^{2+}$

Ca^{43} – Interference from $Al^{27}O^{16}$

Calcium is analyzed in both helium and no-gas modes. Typically, the no-gas mode result is chosen since it exhibits greater linearity.

Calcium levels in samples are typically very high when compared to either of these interference sources, so in nearly all cases the effect is negligible. In the case of the double charge interference any sample where the concentration of Sr is > ½ the Ca concentration, the result will be flagged by the Agilent.xls data processing tool automatically. The observed interference will be greater in helium mode. If a result is flagged raise the LOR to be equal to or greater than the no-gas result.

Refer to Techsys TM.0407 (Section 11.5 #10) for more info on the Strontium interference on Calcium. Very high levels of aluminum, 10ppm or higher, may bias calcium results if the calcium levels are near the LOR. In this case helium mode is the preferred mode of analysis. It is extremely unlikely that natural samples will have aluminum levels this high with only trace level calcium present.

4.2.4 Chromium Interference

Cr^{52} – Interferences from $C^{12}Ar^{40}$

Cr^{53} – Interferences from $Cl^{37}O^{16}$ (major) and $C^{12}Ar^{40}H^{1}/C^{13}Ar^{40}$ (minor)

Only Cr^{52} is analyzed in this method. The ICS solution should be checked to ensure effectiveness of interference removal. Typically, carbon levels up to 800 ppm will not pose significant problems for Cr^{52}, however more complex matrices may reduce the effectiveness of the helium collision mode.

4.2.5 Cobalt Interference

Co^{59} – Interferences from $Ca^{43}O^{16}$

Cobalt is analyzed using helium mode to remove CaO interferences. Monitor ICS solution to ensure removal of the CaO interference.

4.2.6 Copper Interference

Cu^{63} – Interferences from $Ar^{40}Na^{23}$

Cu^{65} – Interferences from $S^{32}S^{33}$

Both Cu isotopes are analyzed utilizing helium mode and issues with interferences should be rare. Monitor ICS solution for effectiveness of interference removal. The Agilent.xls macro will select the lower of the two isotopes automatically.

4.2.7 Iron Interference

Fe^{56} – Interferences from $Ar^{40}O^{16}$ & $Ca^{40}O^{16}$

Fe^{56} is analyzed in both hydrogen and helium mode to remove the argon and calcium interferences. Tuning of the hydrogen reaction mode should be sufficient to remove the $Ar^{40}O^{16}$ interference. Monitoring of ICS solution is also required to ensure removal of the CaO interference. Typically, hydrogen mode is more effective at removing the ArO interference while helium mode is more effective at removing CaO interferences. The Agilent.xls macro will select the lower of the two isotopes automatically. Fe^{56} analyzed in helium mode will typically have higher linear range than in hydrogen mode.

4.2.8 Lead Interference

Isotopic abundance variations in Natural samples.

Lead has 4 naturally occurring isotopes: Pb^{204}, Pb^{206}, Pb^{207}, and Pb^{208}. The isotopic ratios in nature are not always identical depending on the specific sample matrix. This is because all lead isotopes except Pb^{204} are the result of natural radioactive decay: Pb^{208} from Th^{232}, Pb^{207} from U^{235}, and Pb^{206} from U^{238}. Each parent isotope has a different rate of decay causing different ratios to be present in samples depending on the source material. In order to be able to calibrate and analyze for lead in a variety of matrices, the sum of the isotopes, excluding Pb^{204}, is always used for the analysis of Pb. Pb^{204} is omitted as it suffers from an isotope overlap with Hg^{204}.

4.2.9 Lithium Interference

An isotopically enriched lithium standard (Li^{6}) is sometimes used as an internal standard. There is an interference correction equation to correct the Li^{6} signal in samples since this isotope is also present naturally (7.6% abundant). Since Li^{6} is primarily used for monitoring purposes and not for actual corrections by this method, issues are rare. However, the isotopically enriched standard used for the IS will still contain some Li^{7} which will elevate the signal background for Li^{7} analysis. If ultra-low LORs are needed for Li^{7}, use an internal standard mix that does not contain any Li^{6} may be substituted.

4.2.10 Nickel Interference

Ni^{60} – Interferences from $Ca^{44}O^{16}$

Nickel is analyzed using helium mode to remove CaO interferences. Monitor ICS solution to ensure removal of the CaO interference.

4.2.11 Selenium Interference

Se^{78} – Interferences from Ar^{40} Ar^{38}

Selenium is analyzed using Se^{78} by hydrogen reaction mode for improved sensitivity. Tuning of the reaction mode should be sufficient to remove all interferences on Se^{78}. Monitor ICS and CVSDL solution to determine the effectiveness of interference removal and to ensure sufficient sensitivity.

Carbon enhancement is the effect where carbon in a sample increases the ionization of certain low ionizing elements. Selenium is one of these elements. High carbon samples can show signal enhancement. In order to match carbon content of samples and standards, a carbon source is added to the internal standard solution. Refer to reference 11.2 #12 for more details on this effect. Refer to NA-TP-2007 Agilent ICPMS instrument procedure for more details. Typically, this Internal Standard solution is used for tissue analysis however other matrices may also exhibit this effect.

4.2.12 Silicon Interference

Si^{28} – Interferences from $C^{12}O^{16}$ & $N^{14}{}_2$

Silicon is analyzed using hydrogen reaction mode to remove these plasma-based interferences. Tuning of the reaction mode should be sufficient to remove all interferences on Si. Monitor ICS solution to assess effectiveness of interference removal.

4.2.13 Sulfur Interference

S^{33} – Interferences primarily from $N^{15}O^{18}$ & $O^{16}O^{17}$

Sulfur is analyzed using hydrogen mode to remove these and other plasma based interferences. Tuning of reaction mode should be sufficient to reduce this interference.

4.2.14 Thallium Interference

Tl^{205} – Peak overlap interference from Pb^{206}

Abundance sensitivity is a measure of the contribution of the peak tail of an isotope (with a certain m/z ratio) to an adjacent m/z value. This value is dependent on the resolving power of the mass spectrometer. For the Agilent 7700x or 7900 under normal operating conditions and standard tune conditions the abundance sensitivity for this instrument is 5×10^{-7} for low mass isotopes and 1×10^{-7} for high mass isotopes. A value of 1×10^{-7} means that a 10,000,000 cps signal would produce a signal of 1 cps on an adjacent m/z peak. This is an exceptionally small interference and typically is not a concern for environmental matrices. The overlap of Pb^{206}/Tl^{205} would require a concentration greater than approximately 40ppm Pb in order to see a false positive at a LOR of 5ppt for Thallium[5]. However, the resolving power of the quadrupole can be compromised in rare cases due to contamination of the quadrupole itself. If this occurs the abundance sensitivity of the instrument can drop drastically causing this overlap to increase. Both Tl^{205} and Tl^{203} are analyzed and monitored in this method. In cases with very high Pb concentrations, Tl^{203} is less prone to this interference and should be chosen over Tl^{205}. If the Thallium results from both isotopes do not agree within duplicate DQOs and when compared to observed lead concentrations, this indicates that the instrument has lost some abundance

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[5] ~500 cps of Tl^{205} is roughly equivalent to 5ppt, which requires a Pb signal of 5 billion cps. Depending on isotopic abundances, this is equivalent to approximately a sample result of >40ppm Pb in solution.

sensitivity which indicates that instrument service is required (quadrupole cleaning may be required). The ALS Canada Agilent.xls macro will automatically flag Tl results where this is suspected. Raise the LOR in this case to be equal or above Tl^{203} which should be the lower of the two results.

4.2.15 Titanium Interference

Ti^{47} – Interferences from $S^{32}N^{15}$ (major) with a potential contribution from $^{94}Zr^{2+}$, $C^{12}Cl^{35}$, $P^{31}O^{16}$ (Minor).

Ti^{49} – Interferences from $S^{32}O^{17}$, $Cl^{35}N^{14}$, $S^{34}N^{15}$ (Major) with a potential contribution from $^{98}Mo^{2+}$, $C^{12}Cl^{37}$, $P^{31}O^{18}$ (Minor).

Titanium suffers primarily from sulfur and nitrogen interferences. Both titanium isotopes are analyzed using helium mode to monitor this interference. The ALS Canada Agilent.xls macro will automatically select the lower result of the two isotopes provided they agree within 20% (soon to be updated to 30%). If they do not agree, an interference is present and the macro will flag both results and will not select either. If there is no reason to suspect that the lower result suffers significantly from an interference, report this result. If the lower of the two results suffers from an interference, raise the LOR to be equal or greater than the result of the lower of the two isotopes.

4.2.16 Vanadium Interference

V^{51} – Interferences from $Cl^{35}O^{16}$

Vanadium is analyzed in helium mode. Tuning of the Helium mode should be sufficient to remove the chloride interference. Monitor ICS solution and Method Blanks to ensure removal of this interference. Monitoring of method blanks is particularly critical for samples digested with HCl.

4.2.17 Zinc Interference

Zn^{66} – Interferences from $S^{32}S^{34}$, $S^{33}{}_2$, & $Ti^{50}O^{16}$

Zn^{68} – Interferences from $^{136}Ba^{2+}$, $S^{34}{}_2$, $S^{36}O^{16}$ & $Ar^{40}N^{14}$

Only Zn^{66} is analyzed by this method. Monitor ICS solution for effectiveness of interference removal.

The nitric acid concentration in the samples can also affect the Zinc signal. Generally, the greater the nitric acid concentration the more the zinc signal is suppressed. Refer to reference 11.2 #11 for more information on this behavior. The presence of Nitric acid in the internal standard solution and the relatively close matrix matching for acid concentrations reduces this interference.

5.0 SAMPLE HANDLING AND STORAGE

Parameter(s) and Matrix: All Parameters – Water	
Container	60mL HDPE bottles, Systems Plus Cat# NZ60/L16M, MEOL# 4010036 Reference: EPA SW-846 Ch3, July 2014
Preservative	HNO_3 to pH <2, 0.8mL 1:4 HNO_3 per 60mL sample. Systems Plus VP4N-288, MEOL# 4001647 Reference: EPA 200.2 Rev 2.8 1994
Min. Sample Amount	Refer to specific preparatory method SOP
Sample Pre-treatment	Total Metals: Digestion of sample if >1 NTU Dissolved Metals: Filtration by 0.45 µm filter
Lab Storage Conditions	Ambient temperature Reference: EPA SW-846 Ch3, July 2014
Maximum Sample Holding Time	Default: 180 days (EPA SW-846 Ch3, July 2014) Ontario: 60 days (Reg153, Ontario Drinking Water Practices 2009) Ontario Effluents: 30 days (MISA guidelines) Refer to Section 11.2 for more details on holding time references.
Parameter(s) and Matrix: All Parameters - Sediments and Soils	
Container	125 mL clear glass jar with Teflon-lined lid (Systems Plus GSJ120/PC or equivalent), 1 per sample Reference: CCME 2016, Table 3A
Preservation	None
Min Sample Amount	Refer to specific preparatory method SOP
Sample Pre-treatment	Digestion or Leaching
Lab Storage Conditions	>0 - 6°C Ambient temperature if dried Reference: CCME 2016 Table 3A
Maximum Sample Holding Time (Reference)	180 days as received Indefinite when dried Reference: CCME 2016 Table 3A
Max Extract / Digest Holding Time	No requirement. Storage of sample digests for 28 days (based on Hg hold times) is recommended.
Parameter(s) and Matrix: All Parameters - Biota	
Container	Glass or plastic, project/sample type specific Reference: BC Lab Manual 2015
Preservative	None
Min Sample Amount	Refer to specific preparatory method SOP
Sample Pre-treatment	Digestion
Lab Storage Conditions	Frozen at ≤ -18 °C Reference: BC Lab Manual 2015
Maximum Sample Holding Time	2 years Reference: BC Lab Manual 2015
Max Extract / Digest Holding Time	No requirement. Storage of sample digests for 28 days (based on Hg hold times) is recommended.

5.1 Sampling Instructions

Sample collection is not conducted by the laboratory.

5.2 Sampling Handling and Transportation

Refer to ALS Sample Handling and Preservation Guidelines for further details on the sample handling procedures recommended by ALS.

1. Samples for total metals should be preserved with nitric acid to pH <2. Samples must be checked by the lab to ensure preservation was done (by spot checking within each sample submission with verifying of client sampling records at minimum). Samples for total metals

received unpreserved are preserved at the lab in their original container, and must be allowed to equilibrate for ≥ 16 hours prior to subsampling or analysis. If it is not possible to add acid to the original sample container the results must be qualified using the qualifier LPMB: Lab-Preserved for Metals. Sample received with pH > 2 and preserved at the lab. Metals results may be biased low.

2. Samples for dissolved metals should be filtered through a 0.45 µm filter and immediately preserved with nitric acid to pH <2. Samples filtered in the field but not preserved must be preserved at the lab in the original container, and must be allowed to equilibrate for ≥ 16 hours prior to subsampling or analysis. If it is not possible to add acid to the original sample container the results must be qualified using the qualifier LPMB: Lab-Preserved for Metals. Sample received with pH > 2 and preserved at the lab. Metals results may be biased low.
3. Sample filtered in the lab are qualified as “Lab Filtered”.

6.0 QUALITY CONTROL

6.1 Method QC

Maximum (Sample Preparation) Batch Size =	20 Client Samples.

Method QC (Waters)	Min. Frequency	Data Quality Objective
Method Blank (MB)	1 per batch	|MB| < LOR
Laboratory Control Sample (LCS)	1 per batch	80-120%
Matrix Spike (MS)	1 per batch	70-130%
Sample Duplicate (DUP)	1 per batch	< 20% RPD
Method QC (Other Matrices)	Min. Frequency	Data Quality Objective
Soils	Refer to NA-TP-2004	Refer to NA-TP-2004
Biota	Refer to NA-TP-2003 & NA-TP-2006	Refer to NA-TP-2003 & NA-TP-2006
TCLP	Refer to NA-TM-1700	Refer to NA-TM-1700
Other QC	Min. Frequency	Data Quality Objective
Dilution Blank	Daily and when new diluent is prepared	< LOR

6.2 Instrument QC

Refer to NA-TP-2007 – Agilent ICPMS Instrument Operating procedure for instrument QC requirements.

7.0 REFERENCES

7.1 Primary Reference

US EPA Method 6020B, Inductively Coupled Plasma Mass Spectrometry Rev 2, Jul 2014.

7.2 Secondary Reference

1. US EPA SW-846 Chapter 3, July 2014, Table 3-2. *Primary Holding Time reference.*
2. US EPA 200.2 Rev 2.8, 1994. 16 hour in-lab preservation reference.
3. Standard Methods method 3125, Metals by ICPMS. Detailed reference on common interferences.

4. Practices for the Collection and Handling of Drinking Water Samples, Ontario Ministry of the Environment. V 2. April 1, 2009. *Reference for 60 day ON drinking water holding time.*
5. Ontario Protocol for Analytical Methods Used in the assessment of Properties under Part XV. 1 of the Environmental Protection Act. July 1, 2011 amendment. *Reference for ON R.153 metals holding time.*
6. Protocol for the Sampling and Analysis of Industrial/Municipal Waste Water. Ontario Ministry of the Environment, Aug 1999. *Reference for MISA metals holding time*.
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9. *British Columbia Environmental Laboratory Manual (2015)*. Environmental Monitoring, Reporting & Economics Section, Knowledge Management Branch, B.C. Ministry of Environment, Victoria, BC, ISBN 978-0-7726-6956-8. *Used for biota sample handling and storage conditions.*
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8.0 DEVIATIONS FROM THE PRIMARY REFERENCE

8.1 Interference Check Standards

Interference check standards included in this method assess a wider array of interferences than those described in EPA 6020B.

8.2 Correction Equations

Section 4.2 of EPA 6020B list correction equations for isobaric interferences on Arsenic and Cadmium. These correction equations are not used. Instead both Arsenic and Cadmium are acquired using Helium as a collision gas, which provides more effective interference reduction. Isobaric interference on Cadmium is further minimized by acquiring 111Cd which doesn’t overlap with Pd, Sn and In.

8.3 Linear Range

Section 9.6 of EPA 6020B requires a linear range check standard to be analyzed on every run in order to accept results that are above the highest calibration standard. Due to the large analytical range of the instrument and due to the fact that this method uses LORs far lower than 6020B, this would require unreasonable amount of rinsing to clean out the system sufficiently to prevent carryover. ICPMS is widely recognized to have a very high and stable linear dynamic range. For this method, the linear range of all 7700x and 7900 instruments are fully characterized and documented during initial validation, and after any significant methodology changes. Daily checks, of selected high level elements are conducted with the carryover standard. Refer to TechSys Issue TM.0398 for details.

8.4 Dilution Test

The EPA 6020B reference contains a dilution test to verifying if a dilution will alleviate matrix effects on a sample. Internal standards added online and the monitoring of interferences and sample composition are utilized to determine if matrix effects are occurring in any given sample. This specific procedure is omitted from this method as additional methods are employed to verify the absence or presence of matrix effects, and because collision/reaction cell modes are used to reduce or eliminate most polyatomic interferences.

8.5 IDL Determinations

Instrument Detection Limits (IDLs) are not determined every time there is major maintenance done. Instead, ALS periodically calculates MDL based on historical method QC data as which is more applicable and more conservative representation of the method performance. IDLs are then assumed to be equivalent to the lowest calculated MDLs which typically includes metals method blank data. This procedure is conducted as a component of method re-validation, which is referred to in section 1.3 of this test method.

8.6 Resloping and Drift Correction

Section 9.3.4 of EPA 200.8 allows for “Resloping” as a method to correct for sensitivity drift. This method allows for drift corrections following the EPA 200.8 guidance, such that drift correction is only permitted when CCV performance is within 85-115% from the initial calibration or re-slope. Monitoring of CCV’s throughout the run as well as numerous second source checks serve to validate ALS ICPMS correction procedures. Sensitivity and low-level accuracy are also monitored through the use of CVSDL standards.

8.7 Calibration Acceptance Criteria

Section 10.4 of EPA 6020B specifies that R^2 values should be used as acceptance criteria. ALS policy is to evaluate the error at each calibration point. In this case a maximum of 10% error for each standard is permitted. This is a more conservative and restrictive approach to calibration acceptance than the evaluation of R^2 values, which can in some cases indicate linearity when gross errors, particularly on the low end of the curve, are present.

8.8 Lowest Calibration Standard

Section 10.4 of EPA 6020B states that the lowest calibration standard in a multi-point calibration must be at or below the Lowest Limit of Quantification (LLOQ). The lowest calibration standard is in most cases well above the LLOQ but the CVSDL standard that is run at the beginning of the analytical batch verifies the accuracy of the calibration at the detection limit.

8.9 Continuing Calibration Verification

Section 10.5.5 of EPA 6020B states that a CCV must be run every 10 samples and that each CCV must be within ±10% of the true value for the calibration to be valid. ALS Canada only requires a CCV after initial calibration that is within ±10% and then one CCV every 20 samples within ±15% for each consecutive CCV (as per British Columbia Lab Manual Requirements).

8.10 Sample Container Size

EPA SW-846 Chapter 3 Table 3-2 states a recommended minimum sample collection volume of 600 mL and default digestion volume of 100 mL for metals, which is based on classical digestion technology using beakers or crucibles. ALS Canada utilizes an optimized micro-digestion using newer hotblock technology, which requires only 10 mL of sample, facilitating a proportional reduction in required sampling volume and reagents. ALS now utilizes a 60 mL sample container for metals (by default), which reduces our carbon footprint (primarily due to reduced shipping weights), reduces acid usage, and introduces significant health and safety benefits for field sampling staff due to reductions in sample and cooler weights that are handled in the field.

The EPA footnote on Table 3-2 states “These recommendations are intended as guidance only”. EPA Method 200.2 (the primary reference for the ALS NA-TP-2001 digestion method) also states that smaller sample aliquot volumes may be used for digestion. The Ontario MOE “Practices for the Collection and Handling of Drinking Water Samples” (secondary reference #4 in section 11.2) recommends a much lower minimum sample collection volume than SW-846 (100 mL), but this is applicable only to samples submitted to the OMOE laboratory for testing by their methods. The use of reduced sample volumes in this method has been fully validated and meets all ALS data quality objectives.

ALS | Environmental (Canada)

Edmonton
Test Method

ID: ED-TM-1026 v06 Acidity, Alkalinity, Conductivity and pH in Aqueous Samples by Potentiometry
Date: 09-Mar-2022
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ACIDITY, ALKALINITY, CONDUCTIVITY AND PH IN AQUEOUS SAMPLES BY POTENTIOMETRY
SOP SUMMARY

1.0 SCOPE AND APPLICATION

1.1 Scope

This method is applicable for testing of aqueous samples for acidity, alkalinity, conductivity and pH by automated potentiometry.

1.2 Parameters and Limits of Reporting

The most common analyte lists and Limits of Reporting for ALS Canada labs are listed. All Limits of Reporting (LOR) are subject to validation by each lab. Other lists and LORs may be offered where validated.

Parameter	Matrix		Reporting Limit	Instrument Calibration Range
	Matnum	Name	(units)	(units)
Acidity	1	Water	**2.0** mg/L	0 to 800 mg/L[1]
Alkalinity	1	Water	2.0 mg/L	0 to 3900 mg/L[1]
Alkalinity, Phenolphthalein	1	Water	2.0 mg/L	0 to 3900 mg/L[1]
Bicarbonate (calc)	1	water	5 mg/L	n/a
Carbonate (calc)	1	water	5 mg/L	n/a
Hydroxide (calc)	1	water	5 mg/L	n/a
pH	1	Water	0.1 pH units	4 to 10 pH units
Conductivity at 25˚C	1	Water	2.0 µS/cm	0 to 1412 µS/cm [2]
Conductivity - swabs (special request only)	14	Misc	2.0 µS/cm	0 to 1412 µS/cm
Bicarbonate (sat paste)	2	Soil	5 mg/L	n/a
Carbonate (sat paste)	2	Soil	5 mg/L	n/a

[1] Linear range can be extended for Acidity and Alkalinity by using a reduced volume or dilution.

[2] Linear range can be extended for EC, high EC CVS will be run for linearity check

1.3 Method Performance Data and Measurement Uncertainty

Refer to NA-SP-0100 Initial Method Validation – Chemistry and NA-SP-0102 Method Revalidation and MU – Chemistry for policies on determination and storage of method performance data.

2.0 PRINCIPLE OF METHOD

2.1 Electrical Conductivity

The measurement of conductivity is performed using a conductivity cell and meter which supplies an alternating current to two platinum plates in the cell. The current passing between the plates while immersed in the test solution is measured as the conductivity.

2.2 pH

pH is measured using a combination electrode, consisting of a glass-membrane indicator electrode and a reference electrode. When the electrodes are immersed in a solution the potential developed measures the hydrogen activity in the solution.

2.3 Alkalinity

Alkalinity is determined by titrating a test solution with standard acid. Because alkalinity is an aggregate property of water that depends on the solutes in the water, it depends on the end-point pH used. Phenolphthalein alkalinity is the term conventionally used for the quantity measured by titration to pH 8.3. Total alkalinity is conventionally taken to an end point of pH 4.5. Total alkalinity is used to determine carbonate, bicarbonate and hydroxide.

2.4 Acidity

Acidity is determined by potentiometric titration of a sample aliquot with a standard solution of sodium hydroxide to a fixed end point. Since dissolved carbon dioxide is usually the major acidic component of unpolluted surface waters, the endpoint is set at pH 8.3 which corresponds to the neutralization of carbonic acid to bicarbonate. Mineral acidity corresponds to the value obtained from the titration to endpoint 4.5.

3.0 DEFINITIONS

Refer to NA-SP-0001 Definitions of Key Terms for definitions of common terms.

EC – Electrical Conductivity at 25˚C

SAR – Sodium Absorption Ratio

BIC- Bicarbonate

CO3= Carbonate

4.0 INTERFERENCES

4.1 Electrical Conductivity

Most problems in obtaining good data with conductivity monitoring equipment are related to electrode fouling and to inadequate sample circulation. Conductivities greater than 10,000 to 50,000 µmho/cm or less than about 10 µmho/cm may be difficult to measure.

Temperature will affect conductivity readings. Low ionic strength samples that are run after high ionic strength samples should be rerun.

4.2 pH

The glass pH electrode is relatively free from interference from color, turbidity, colloidal matter, oxidants, reductants or high salinity, except for a sodium error at pH>10. Soaps, oily matter, suspended solids, or precipitates may coat the glass electrode and cause a sluggish response. Do not filter, concentrate or alter sample.

4.3 Alkalinity & Acidity

Samples should not be exposed to the air: trace amounts of carbon dioxide from the air can slowly dissolve into the samples forming carbonate and bicarbonate. This effect is only significant on samples that have low electrical conductivity samples (examples: blanks or samples have EC<100 µS/cm). It is recommended that client should sample without headspace to eliminate carbon dioxide exposure. For blanks and low level water, data should be confirmed if there is any doubt of the alkalinity or acidity results.

Dissolved gases that contribute to acidity or alkalinity, such as CO2, hydrogen sulfide or ammonia can be lost or gained during sampling, storage, or titration. These effects can be minimized by titration to endpoint promptly after opening, avoiding vigorous shaking or mixing, protecting the sample from atmosphere during titration and not letting sample become warmer than it was at collection.

5.0 SAMPLE HANDLING AND STORAGE

Parameter(s) and Matrix: EC, pH, Alkalinity, and Acidity in Water	
Container	250mL HDPE, 1 per sample Reference: APHA Table 1060:I (2011, revised 2021), CCME Analytical Methods Manual (2016)
Preservative	Chill (4˚C)
Min. Sample Amount	50 mL
Sample Pre-treatment	None.
Lab Storage Conditions	>0 - 6˚C Reference: APHA Table 1060:I (2011, revised 2021). CCME Analytical Methods Manual (2016)
Maximum Sample Holding Time (Provinces / Reference)	0.25 hours for pH (field testing recommended) 28 days for Conductivity 14 days for Alkalinity 14 days for Acidity Reference: APHA Table 1060:I (2011, revised 2021), CCME Analytical Methods Manual (2016)

Note: Always use the non-preserved routine sample for water analysis.

6.0 QUALITY CONTROL

6.1 Method QC

Maximum (Sample Preparation) Batch Size =	20 Client Samples or every 24 hr whichever comes first.

6.1.1 pH

Method QC	Min. Frequency	Data Quality Objective (units)
Laboratory Control Sample (LCS)	1 per batch	±0.2 pH units
Sample Duplicate	1 per batch	±0.3 pH units

6.1.2 Conductivity

Method QC	Min. Frequency	Data Quality Objective (units)
Method Blank (MB)	1 per batch	|MB| < LOR
Laboratory Control Sample (LCS)	1 per batch	90-110%
Sample Duplicate	1 per batch	< 10% RPD

6.1.3 Alkalinity and Acidity

Method QC	Min. Frequency	Data Quality Objective (units)
Method Blank (MB)	1 per batch	|MB| < 3mg/L (Acidity) |MB| < LOR (Alkalinity)
Laboratory Control Sample (LCS)	1 per batch	85-115%
Sample Duplicate	1 per batch	< 20% RPD

6.2 Instrument QC

No maximum batch size is defined for this method.

6.2.1 pH

Instrument QC	Minimum Frequency	Control Limit
Initial Calibration Curve (IC)[i]	Daily	Slope value 97 – 103%
Continuing Calibration Verification (CCV)[ii]	One every 20 samples and at the end of the run	± 0.2 pH unit
Instrument Blank (IB)	At the start of each batch.	4.00 – 6.00

6.2.2 Conductivity

Instrument QC	Minimum Frequency	Control Limit
Initial Calibration Curve (IC)[1]	As needed	90-110%
Continuing Calibration Verification (CCV)[2]	Every 20 samples and at the end of each batch.	± 20% error vs. initial cal
Instrument Blank	Every analytical batch.	< LOR
CVS- linearity check	1 per day batch.	90-110%

6.2.3 Alkalinity & Acidity

Instrument QC	Minimum Frequency	Control Limit
Continuing Calibration Verification (CCV)[2]	Rerun the LCS at end of batch to verify the calibration.	± 15% of expected value
Detection Limit Check[iii]	Daily, before samples	± 50% of target

7.0 REFERENCES

7.1 Primary Reference

APHA 2320 Alkalinity (1997, revised 2011).

APHA 2510 Conductivity (1997, revised 2011).

APHA 4500-pH pH Value, A & B (2000, revised 2011 & 2017).

APHA 2310 Acidity, B (1997, revised 2011 & 2020).

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[i] If any calibration criteria are not met, system must be evaluated and corrective action must be taken; the entire initial calibration procedure must be repeated before sample analysis begins.

[ii] If all acceptance criteria are met for the Continuing Calibration Verification Standard, then the initial calibration can be used for the analysis of additional samples.

[iii] If the Detection Limit Check Standard does not meet acceptance criteria, check the instrument blank to determine if background contamination is present (e.g. near or above LOR). Determine cause of contamination, and perform appropriate maintenance procedures.

7.2 Secondary Reference

1. APHA Table 1060:I (2011, revised 2021). Used as a reference for sample containers and holding times.
2. CCME Analytical Methods Manual (2016). Used as a reference for holding times.

8.0 DEVIATIONS FROM THE PRIMARY REFERENCE

1. Titrants are not standardized as per the reference methods. Instead, a certified standardized titrant is purchased. Refer to Techsys Issue ED.I.0110 for validation.
2. DI water is not boiled prior to being used for the method blank. Blanks aren't true blanks because pure water will have a target due to CO2 absorption and so MB DQO set higher than the LOR due to ambient CO2 causing natural acidity in DI water. Refer to Techsys Issue ED.I.0155 for validation of this deviation.

AMMONIA IN WATER
BY FLUOROMETRY (SKALAR)
SOP SUMMARY

1.0 SCOPE AND APPLICATION

1.1 Scope

This method is applicable to the determination of Ammonia (NH_3) in water and seawater by fluorometry. For matrix types other than water refer to individual preparation/extraction procedure for preparation instructions, calculations, and final Limits of Reporting and units used such as NA-TM-1700 TCLP Extractions, NA-TP-2008 Saturated Paste Preparation, etc.

1.2 Parameters and Limits of Reporting

The most common analyte lists and Limits of Reporting for ALS Canada labs are listed. All Limits of Reporting (LOR) are subject to validation by each lab. Other parameter names and LORs may be offered where validated.

Parameter	Matrix	Reporting Limit	Instrument Calibration Range
		(mg/L)	(mg/L)
Ammonia, Total (as N)	Water	0.005	0.005 - 0.50
Ammonia, Total Dissolved (as N)	Water	0.005	0.005 - 0.50

1.3 Method Performance Data and Measurement Uncertainty

Refer to NA-SP-0100 Method Validation and NA-SP-0102 Method Revalidation and MU – Chemistry for policies on determination and storage of method performance data.

2.0 PRINCIPLE OF METHOD

This method uses continuous flow-injection, derivatization and fluorescence detection. Samples are mixed in-line with an alkaline solution to adjust pH from acidic to basic which converts dissolved ammonium to ammonia gas. As the basic sample is pushed through the dialyzer through a Teflon membrane, a fluorescent derivative is formed by reaction of ammonium with ortho-phthaldialdehyde (OPA) and sulfite. The derivative is measured fluorometrically to determine ammonia concentration using an excitation wavelength of 370±5 nm and emission wavelength of 425±5 nm.

3.0 DEFINITIONS

Refer to NA-SP-0001 Definitions of Key Terms for definitions of common terms.

4.0 INTERFERENCES

1. Sample turbidity (specifically if high in TOC) can interfere as it could negatively affect the dialysis membrane. Prior to analysis, letting the sample settle, centrifuging, filtering (after preservation), or decanting will remove the interference.
2. Highly saline samples can precipitate upon mixing with the hydroxide solution which can physically affect the transport of ammonia across the membrane. The use of boric acid / EDTA within the alkaline reagent helps to mitigate this precipitation.

3. Untested bottles or apparatus made from clear plastic (e.g. PS-Polystyrene) must be avoided. The manufacturing process to make some plastic bottles optically clear involves the use of ammonia. Ammonia will leach from this plastic especially if the solutions are acidic. Some polyethylene (PE) bottles have been noted to have similar issues. Reagent, standard, and sample containers must be made of polypropylene or glass.
4. Acidic solutions quickly absorb atmospheric ammonia gas. Never not use ammonia based cleaners in the laboratory. Ensure janitorial cleaners are aware that ammonia-free cleaners must be used.
5. Trace levels of ammonia contamination in acidic trip blanks and acid-preserved samples during storage and transport has been a common industry problem due to the ubiquitous nature of ammonia based cleaning products, the wide range of ammonia concentrations found in water samples, and occasionally due to inadvertent exposure from ammonia-based preservatives used for other tests (e.g. ammonium sulfate preservative used in hexavalent chromium tests in Ontario). ALS Canada isolates samples and preservatives from ambient vapours using glass sample bottles and a Teflon-lined septum-sealed cap with airtight seal. Pre-charged empty sample bottles and client samples for ammonia testing must still be segregated from ammonium sulfate preservatives.

5.0 SAMPLE HANDLING AND STORAGE

Parameter(s) and Matrix: Ammonia - Water	
Container	**Pre-charged 100 mL amber glass, System Plus GL100A/SPCP11/L16TKN, MEOL# 4001717 (preferred),** or 100 mL amber glass bottle, System Plus GL100A/SPC/L16TKN, MEOL# 4001718 plus separate preservative vial. Reference: APHA Table 1060:I 2015
Preservative	0.8 mL of 1:3 H_2SO_4 per 100 mL bottle System Plus VP1M-288, MEOL# 4001552. Preservative is included in sample bottle for MEOL# 4001717. Reference: APHA 1060:I, 2015.
Min. Sample Amount	50 mL (Sample bottles must be > 50% full or preservative amount will be too high). Test requires 10 mL of sample for analysis.
Sample Pre-treatment	Filtration prior to preservation is required if dissolved ammonia is requested
Lab Storage Conditions	>0 to 6C Reference: CCME 2016, US EPA 40CFR Part 136 2017.
Maximum Sample Holding Time	**Unpreserved Samples:** 3 days from sampling date Reference: CCME 2016, MISA 2016, BC Lab Manual A 2020. **Preserved Samples:** ON Drinking water samples: ON Practices for the Collection and Handling of Drinking Water Samples, v 2.0, April 1, 2009: 7 days (preserved or unpreserved). 14 days from sampling date for MISA samples (MISA 2016) 28 days from sampling date for all other jurisdictions (APHA, CCME 2016)

6.0 QUALITY CONTROL

6.1 Method QC

Maximum (Sample Preparation) Batch Size =	20 Client Samples or every 24 hr. whichever comes first.

Method QC	Min. Frequency	Data Quality Objective (units)
Method Blank (MB)	1 per batch	|MB| < LOR

Method QC	Min. Frequency	Data Quality Objective (units)
Laboratory Control Sample (LCS)	1 per batch	85-115%
Matrix Spike (MS)	1 per batch	75-125%
Sample Duplicate	1 per batch	< 20% RPD

6.2 Instrument QC

Maximum Batch Size =	Indicated in the table below.

Instrument QC	Minimum Frequency	Control Limit
Initial Calibration Curve (IC)	Once per sequence, daily.	Assess calibration error of each standard: Standard 1 < ± LOR Standard 2 ± 40% Standard 3 ± 20 % Standard 4 ± 15 % Standard 5,6,7 ± 10 %
Calibration Verification Standard (CVS)[1]	Once per sequence at beginning of the run.	± 10%
Tracer (7.2.3)[2]	Beginning of analytical batch, daily	85-115%
Continuing Calibration Verification (CCV)[3]	Every analytical batch, and after 20 samples and end.	85-115%
Drift[4]	Every analytical batch, and after 20 samples	80-120%
Instrument Wash (7.1.8)	Every analytical batch, and after 20 samples.	< LOR
Dilution Check Standard	Once per sequence, daily	± 5% of the expected target

Refer to NA-SP-0140 QC Protocols for more information

7.0 REFERENCES

7.1 Primary Reference

Method Fialab 100, 2018

7.2 Secondary Reference

1. Skalar Ammonia Method, catnr 157/158, issue 051319/99347648. Used for application of Skalar instrumentation.
2. Flow-injection analysis with fluorescence detection for the determination of trace levels of ammonium in seawater, J. Environ. Monit, (2005), 7:37–42. Information on seawater samples.
3. Ontario Practices for the Collection and Handling of Drinking Water Samples, version 2.0, April 1, 2019. Reference for sample hold time for ON drinking water samples only.

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[1] Calibration Verification Standard (CVS) uses the Working LCS standard from 7.2.6.
[2] Use same standard as Drift and CCV (7.2.3).
[3] Same standard as Tracer/Drift (7.2.3) but a separate tube is poured.
[4] Same standard as Tracer/CCV (7.2.3) but a separate tube is poured.

4. Protocol for the Sample and Analysis of Industrial/Municipal Wastewater. Version 2.0. January 2016. Reference for MISA regulations, for hold time preserved and unpreserved.
5. APHA 1060 B Table 1060:1, 2011. Reference for sample bottles, lab storage, hold time.
6. CCME Guidance Manual for Environmental Site Characterization in Support of Environmental and Human Health Risk Assessment Volume 4 Analytical Methods, 2016. Reference for hold time.
7. BC Environmental Laboratory Manual, Section A, 2020. Reference for hold time.

8.0 DEVIATIONS FROM THE PRIMARY REFERENCE

Calibration standards are prepared from a commercially purchased stock standard and to different concentration levels. This has been shown to be fit for purpose though validation studies.

EFFECTIVE DATE: Oct 2018 Ref#: NA-TM-1003 v03

METHOD SUMMARY
Total, WAD, & Free CN by Continuous Flow Analyzer

SCOPE:

This test method covers the determination of cyanides in water and soil. Analysis is by a Continuous Flow Analyzer (CFA) utilizing a colourimetric determination of cyanide. The operationally defined form of cyanides that can be determined are Total Cyanide (TCN), Weak Acid Dissociable Cyanide (WAD-CN), and Free Cyanide (FCN). TCN is determined by UV decomposition with inline distillation (@pH 3.8) with a photometric determination. WAD-CN is determined by inline distillation (@pH4.5) with a photometric determination. FCN uses an inline dialyzer (@pH 6.0) with a photometric determination. Soil samples follow a leaching procedure with a basic solution before being analyzed by any of these methods.

Samples can also be analyzed following off-line manual distillation by this method. Refer to NA-TP-2009 SimpleDist Cyanide Distillation for TCN, WAD-CN, FCN in water for details on the manual distillation method.

This method is also applicable for the analysis of seawaters, if diluted 5x (or more) to ensure that TDS levels are below 10 g/L.

PRINICIPLE:

Total Cyanide (TCN)

Complex bound cyanide is decomposed by Ultra Violet (UV) light in a continuously flowing stream at a pH of 3.8. A UV-B lamp (312 nm) and a decomposition spiral of borosilicate glass are used to filter out UV light with wavelength of less than 290 nm to limit the conversion of thiocyanate into cyanide. Hydrogen cyanide is separated by inline distillation at 125°C under vacuum and is then determined photometrically, based on the reaction of cyanide with chloramine-T to form cyanogen chloride. Cyanogen chloride subsequently reacts with isonicotinic acid and 1,3-dimethylbarbituric acid to give a red coloured complex. The intensity of this colour is measured at 600 nm. (Method is according to ISO/DIS 14403-02:2012).

Weak Acid Dissociable Cyanide (WAD-CN)

Hydrogen cyanide (HCN) is liberated in a continuously flowing stream at a slightly acidified pH of 4.5 and is separated by inline distillation at 120°C. Strongly bound CN-complexes that would not be amenable to oxidation by chlorine are not converted. Iron cyanide complexes are precipitated with zinc sulfate. Cyanides are further converted to cyanogen chloride by reaction with chloramine-T. Cyanogen chloride subsequently reacts with isonicotinic acid and 1,3-dimethyl barbituric acid to give a red coloured complex. The intensity of this colour is measured at 600 nm. (Method is modified from APHA 4500-CN- – I.).

Free Cyanide (FCN)

Hydrogen cyanide (HCN) is liberated in a continuously flowing stream at a pH of 6 and is separated by gas dialysis into a pH 5.2 Buffer stream. The hydrogen cyanide is then determined photometrically, based on the reaction of cyanide with chloramine-T to form cyanogen chloride. Cyanogen chloride subsequently reacts with isonicotinic acid and 1,3-dimethyl barbituric acid to give a red coloured complex. The intensity of this colour is measured at 600 nm. (Method is modified from ASTM D7237-10).

SAMPLE HANDLING AND STORAGE

Parameter(s) and Matrix: TCN, WAD–CN and FCN in Water	
Container	60 UV resistant HDPE, 1 per sample. Systems Plus cat# BR60/L16C (MEOL# 4010862) or 60mL Pre-charged bottles UV resistant HDPE, 1 per sample. Systems Plus cat# BR60/P17/L16C (MEOL# 4010863)
Preservative	0.4 mL of 5 N NaOH per mL sample bottle, to pH > 12 (APHA 1060). Systems Plus cat# VP3K-288. MEOL# 4382473. Preservative vials are not required for pre-charged bottles
Min. Sample Amount	30 mL
Sample Pre-treatment	Homogenize by shaking
Lab Storage Conditions	Store in the dark at >0-6 °C (APHA 1060)
Maximum Sample Holding Time	BCMOE, APHA, ONTDW: 14 days for preserved, 1 day unpreserved ON MISA: 7 days

Parameter(s) and Matrix: TCN, WAD–CN and FCN in Soil	
Container	125-500 mL glass, 1 per sample
Preservative	None
Min. Sample Amount	25 grams
Sample Pre-treatment	Homogenous mixing
Lab Storage Conditions	Store at >0-6 °C
Maximum Sample Holding Time	14 days (USEPA 9013A)
Maximum Extract / Digest Holding Time	14 days for extract (USEPA 9013A)

REFERENCES:

1. TCN: ISO/DIS 14403-2:2012 – Water Quality – Determination of total cyanide and free cyanide using flow analysis (CFA) – Part 2 – Method with continuous flow analysis (CFA).
2. WAD-CN: APHA 4500-CN$^-$ – I Weak Acid Dissociable Cyanide, 1999 revised 2011.
3. FCN: ASTM D7237-15a – Standard Test Method for Free Cyanide and Aquatic Free Cyanide with Flow Injection Analysis (FIA) Utilizing Gas Diffusion Separation and Amperometric Detection.

ALS | Environmental (Canada)

National
Test Method

Method ID: NA-TM-1008 v01 Total, Fixed, and Volatile Suspended Solids
Date: May 15, 2020
Page: 1 of 4

Total, Fixed and Volatile Suspended Solids – Method Summary

1.0 SCOPE AND APPLICATION

1.1 Scope

This method describes the determination of Total, Fixed, and Volatile Suspended Solids in water as well as Total, Fixed, and Volatile Solids in water by gravimetric measurement. The method applies to all water samples including surface waters, wastewaters, sludges, and seawaters.

1.2 Parameters and Limits of Reporting

The most common analytes and Limits of Reporting for ALS Canada labs are listed below. All Limits of Reporting (LOR) are subject to validation by each lab. Other LORs may be offered where validated.

Parameter	Matrix	Limit of Reporting	Instrument Method Range
	Name	mg/L	g
Total Suspended Solids (TSS) Low Level	Water	1	0.00015 – 0.200
Total Suspended Solids (TSS)	Water	3	0.00015 - 0.200
Fixed Suspended Solids (FSS)	Water	3	0.00015 - 0.200
Volatile Suspended Solids (VSS) – calculated product	Water	3	n/a

1.3 Method Performance Data and Measurement Uncertainty

Refer to NA-SP-0100 Initial Method Validation - Chemistry, NA-SP-0101 MU Principles, and NA-SP-0102 Method Revalidation and MU - Chemistry, or equivalent local SP(s).

2.0 PRINCIPLE OF METHOD

A well-mixed sample is filtered through a pre-weighed standard glass fiber filter and the residue retained on the filter is dried to a constant weight at 104 ± 1ºC. The increase in weight of the filter represents the total suspended solids (TSS). The filter may then be ignited at 550ºC ± 50ºC and the remaining residue represents the fixed suspended solids (FSS). The weight lost on ignition is the volatile suspended solids (VSS).

3.0 DEFINITIONS

Refer to NA-SP-0001 Definitions of Key Terms for definitions of common terms.

4.0 INTERFERENCES

Exclude large floating particles or submerged agglomerates of non-homogenous materials (e.g. twigs, insects, worms) if they are not representative of the sample. Notify the Account Manager if any material is removed.

Prolonged filtration times (maximum 30 minutes) resulting from filter clogging may produce inaccurately high results due to colloidal materials on the clogged filter. To prevent this, reduce the sample volume.

Excessive residue on the filter may form a water-entrapping crust, producing inaccurately high results. Sample size must be limited such that less than 200 mg of residue is generated. If any sample yields a residue weight >200 mg, reduce the sample size appropriately and re-analyze.

Samples high in dissolved salts (e.g. seawater, brines) can produce false positive or high biased results due to the weight of dissolved salts absorbed and trapped in the filter, especially at the edge of the filter that cannot be effectively rinsed (because the filter edge is obstructed by the filter manifold). Pre-wetting the filter with DI water immediately prior to sample addition ensures that the filter edge is pre-wetted with clean water, which prevents dissolved salts from high TDS samples from becoming trapped. Carefully follow filter pre-wetting and rinsing instructions in Section 9.8 to prevent high bias from dissolved salts.

This method may not be appropriate for the analysis of samples that contain a discrete layer or phase of oil or grease. If such samples are encountered for this test, inform the Account Manager to contact the client. Available options are to analyze a sub-sample which excludes the oil layer (with report qualification indicating exclusion of oil layer), or to disperse oils by shaking the sample bottle vigorously to emulsify the oil prior to taking a sub-sample. If necessary, a blender may be used to dispense and emulsify a floating oil phase prior to sub-sampling.

5.0 SAMPLE HANDLING AND STORAGE

Parameter(s) and Matrix: All Parameters - Water	
Containers	250 mL HDPE (Systems Plus C250/L16R, MEOL# 4001720), one per sample (APHA 1060 B, 2011), for routine 3 mg/L LOR. 500 mL HDPE (Systems Plus, C500W/ASFM/L16R, MEOL# 4019046), for low level 1 mg/L LOR. 145 mL HDPE (Systems Plus, B125/L16TSSL, MEOL# 4010864), for whole bottle low level TSS/TDS.
Preservative	None (APHA 1060 B, 2011)
Min. Sample Amount	50 mL (3 mg/L); Low Level (1 mg/L) & Whole Bottle require 150 mL
Sample Pre-treatment	None
Lab Storage Conditions	>0 - ≤6°C (US EPA 40CFR Part 136, Aug 2017)
Maximum Sample Holding Time	7 days (APHA 1060 B, 2011/ BC MOE 2015 / CCME 2016)

5.1 Sampling Instructions

Sample collection is not conducted by the laboratory.

5.2 Sampling Handling and Transportation

Refer to ALS Sample Handling and Preservation Guidelines for further details on the sample handling procedures recommended by ALS.

6.0 QUALITY CONTROL

6.1 Method QC

Maximum Batch Size =	20 Client Samples

Method QC	Min. Frequency	Data Quality Objective (units)
Method Blank (MB)	1 per batch	< LOR
Laboratory Control Sample - LCS (7.2.1)	1 per batch	85-115%

Sample Duplicate	1 per batch	< 20% RPD

6.2 Instrument QC

Instrument QC	Minimum Frequency	Control Limit
Balance Check	Daily	Refer to Section 9.4
Balance Blank[1]	1 per batch, minimum 2 per analytical run	Average of Balance Blanks ≤ 0.00020 g (all Balance Blanks used for correction must be within 0.00010 g of average)

7.0 REFERENCES

7.1 Primary Reference

APHA Method 2540 Solids B, D and E, 2017.

7.2 Secondary References

1. Competence in volume measurement, VITLAB. 2014 Edition. Page 8. Electronic copy stored at N:\Life Sciences\Environmental\Technical\References and Literature\Volumetric Devices\VITLAB Volumetric Instruments.pdf. Secondary reference detailing that for plastic volumetric labware purchased from VITLAB the "to contain" and "to deliver" volumes are the same due to the hydrophobic properties of the material used.
2. Weighing the Right Way Guidebook, Mettler Toledo. 05/2012. Electronic copy stored at N:\Life Sciences\Environmental\Technical\References and Literature\Balances\. Secondary reference for good weighing principles and environmental conditions including recommended humidity levels in the laboratory.
3. CCME Guidance Manual for Environmental Site Characterization in Support of Environmental and Human Health Risk Assessment, Volume 4 Analytical Methods, PN 1557, 2016.

8.0 DEVIATIONS FROM THE PRIMARY REFERENCE

8.1 Duplicate DQO

The 20% Duplicate DQO used by ALS (rather than 10% as per the APHA reference) has been established as the standard for Canadian labs as per CCME guidance manual (see Section 11.2). This supersedes the APHA reference method guidance.

8.2 Use of Balance/Correction Blank

This method utilizes a balance/correction blank to correct for day to day variability in balance readings (e.g. due to balance drift or electrostatic effects) and for any minor variations in filter weight caused by the drying process. All QC checks within the batch also undergo this procedure. A maximum correction factor of ± 0.0002 g is permitted. None of the balance/correction blanks may deviate by more than 0.0001 grams from the average of all the balance/correction blanks. This ensures that corrections are only applied for systematic effects and not for random effects.

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[1] If balance blank fails review with Supervisor. Consistent blanks up to 2x the LOR equivalent, based on sample volume for the test (e.g. 50 or 150 mL), can be accepted with Supervisor approval. Failures above this require the LOR to be raised.

8.3 Drying Time

Samples are dried by default for a minimum of 16 hours, which is much longer than the time required to achieve constant weight for most samples. ALS studies (see below) have demonstrated that a 16-hour drying time is sufficient to achieve constant weight even for samples that contain high levels of bicarbonate salts, which are believed to represent worst case drying time requirements for this method. Only rush samples that require shorter drying times are individually verified as being dried to constant weight. Supporting data includes the following:

Techsys ID ED.I.0041, Reference 11.4 item 1, indicates that for TSS 16 hours is consistently sufficient to dry to constant weight. Based on this data overnight drying has been determined to be fit for purpose for routine sample types.

The VSS ignition time used in this method is 1 hour. APHA states to ignite to constant weight however APHA also states that for 200 mg of sample 15-20 minutes is typically required. A one hour drying time ensures that in all cases the sample will be at constant weight.

8.4 Constant Weight Definition

The primary reference (APHA 2540) uses a definition for constant weight as two consecutive weights with <0.5 mg difference, and recommends drying to constant weight, hour by hour. When required (i.e. when test results are required as quickly as possible), this method defines constant weight as when two consecutive weights fall within 2% difference of each other or within ± 0.5 mg, whichever is greater, when the two weights are separated by at least one additional hour of drying. In practice, using the additional criteria in the primary reference of ±0.5 mg requires results near the LOR be tighter than is reasonable or practically achievable. A maximum 2% difference in residue weight has been determined to be fit for purpose and well within ALS DQO’s.

8.5 Minimum Sample Residue Weight

The classical APHA method specifies to obtain a minimum residue weight of 2.5 mg (except for samples that are below DL, or where a DL of less than 2.5 mg/L is required). The APHA minimum residue amount assumes that a 4-place balance is used, with a sample size of up to 1 L. Through the use of modern 5-place balances with suitable humidity controls and using balance blank correction, this method has been fully validated to meet ALS DQOs for accuracy and precision down to a minimum residue weight of 0.15 mg (at the 99% confidence MDL and Limit of Reporting), which permits micro-scaling of the test to achieve significant HSE, cost, and efficiency benefits for ALS clients.

8.6 Filter Pre-Wetting Procedure

This method uses a filter pre-wetting procedure when filtering samples. Studies have confirmed that this procedure effectively reduces the amount of salts that remain entrained on the filter and eliminates the positive bias causes by these salts. This substantially reduces the amount of filter rinsing that would otherwise be required, especially for high TDS samples.

EFFECTIVE DATE: Oct 2018 Ref#: NA-TM-1003 v03

METHOD SUMMARY
Total, WAD, & Free CN by Continuous Flow Analyzer

SCOPE:

This test method covers the determination of cyanides in water and soil. Analysis is by a Continuous Flow Analyzer (CFA) utilizing a colourimetric determination of cyanide. The operationally defined form of cyanides that can be determined are Total Cyanide (TCN), Weak Acid Dissociable Cyanide (WAD-CN), and Free Cyanide (FCN). TCN is determined by UV decomposition with inline distillation (@pH 3.8) with a photometric determination. WAD-CN is determined by inline distillation (@pH4.5) with a photometric determination. FCN uses an inline dialyzer (@pH 6.0) with a photometric determination. Soil samples follow a leaching procedure with a basic solution before being analyzed by any of these methods.

Samples can also be analyzed following off-line manual distillation by this method. Refer to NA-TP-2009 SimpleDist Cyanide Distillation for TCN, WAD-CN, FCN in water for details on the manual distillation method.

This method is also applicable for the analysis of seawaters, if diluted 5x (or more) to ensure that TDS levels are below 10 g/L.

PRINICIPLE:

Total Cyanide (TCN)

Complex bound cyanide is decomposed by Ultra Violet (UV) light in a continuously flowing stream at a pH of 3.8. A UV-B lamp (312 nm) and a decomposition spiral of borosilicate glass are used to filter out UV light with wavelength of less than 290 nm to limit the conversion of thiocyanate into cyanide. Hydrogen cyanide is separated by inline distillation at 125°C under vacuum and is then determined photometrically, based on the reaction of cyanide with chloramine-T to form cyanogen chloride. Cyanogen chloride subsequently reacts with isonicotinic acid and 1,3-dimethylbarbituric acid to give a red coloured complex. The intensity of this colour is measured at 600 nm. (Method is according to ISO/DIS 14403-02:2012).

Weak Acid Dissociable Cyanide (WAD-CN)

Hydrogen cyanide (HCN) is liberated in a continuously flowing stream at a slightly acidified pH of 4.5 and is separated by inline distillation at 120°C. Strongly bound CN-complexes that would not be amenable to oxidation by chlorine are not converted. Iron cyanide complexes are precipitated with zinc sulfate. Cyanides are further converted to cyanogen chloride by reaction with chloramine-T. Cyanogen chloride subsequently reacts with isonicotinic acid and 1,3-dimethyl barbituric acid to give a red coloured complex. The intensity of this colour is measured at 600 nm. (Method is modified from APHA 4500-CN- – I.).

Free Cyanide (FCN)
Hydrogen cyanide (HCN) is liberated in a continuously flowing stream at a pH of 6 and is separated by gas dialysis into a pH 5.2 Buffer stream. The hydrogen cyanide is then determined photometrically, based on the reaction of cyanide with chloramine-T to form cyanogen chloride. Cyanogen chloride subsequently reacts with isonicotinic acid and 1,3-dimethyl barbituric acid to give a red coloured complex. The intensity of this colour is measured at 600 nm. (Method is modified from ASTM D7237-10).

SAMPLE HANDLING AND STORAGE

Parameter(s) and Matrix: TCN, WAD–CN and FCN in Water	
Container	60 UV resistant HDPE, 1 per sample. Systems Plus cat# BR60/L16C (MEOL# 4010862) or 60mL Pre-charged bottles UV resistant HDPE, 1 per sample. Systems Plus cat# BR60/P17/L16C (MEOL# 4010863)
Preservative	0.4 mL of 5 N NaOH per mL sample bottle, to pH > 12 (APHA 1060). Systems Plus cat# VP3K-288. MEOL# 4382473. Preservative vials are not required for pre-charged bottles
Min. Sample Amount	30 mL
Sample Pre-treatment	Homogenize by shaking
Lab Storage Conditions	Store in the dark at >0-6 °C (APHA 1060)
Maximum Sample Holding Time	BCMOE, APHA, ONTDW: 14 days for preserved, 1 day unpreserved ON MISA: 7 days

Parameter(s) and Matrix: TCN, WAD–CN and FCN in Soil	
Container	125-500 mL glass, 1 per sample
Preservative	None
Min. Sample Amount	25 grams
Sample Pre-treatment	Homogenous mixing
Lab Storage Conditions	Store at >0-6 °C
Maximum Sample Holding Time	14 days (USEPA 9013A)
Maximum Extract / Digest Holding Time	14 days for extract (USEPA 9013A)

REFERENCES:

1. TCN: ISO/DIS 14403-2:2012 – Water Quality – Determination of total cyanide and free cyanide using flow analysis (CFA) – Part 2 – Method with continuous flow analysis (CFA).
2. WAD-CN: APHA 4500-CN^- – I Weak Acid Dissociable Cyanide, 1999 revised 2011.
3. FCN: ASTM D7237-15a – Standard Test Method for Free Cyanide and Aquatic Free Cyanide with Flow Injection Analysis (FIA) Utilizing Gas Diffusion Separation and Amperometric Detection.