Lupin Mines Incorporated

A wholly owned indirect subsidiary of Mandalay Resources Corporation

Lupin Mine Site

Nunavut, Canada

Water Quality Monitoring Plan and Water and Soil Quality Assurance/ Quality Control Plan

(Care and Maintenance)

August 2020

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Document Control

Revision No.	Date	Details	Author	Approver
1.0	30/03/2013	Replaces Care and Maintenance Plan – *Sampling Procedure: Tailings Containment Area and Sewage Lakes Disposal Facility*, March 2012 Replaces the *Environmental Laboratory Quality Assurance / Control Plan*, Prepared: March 1993, Revised: December 1995 Update contact and general information Revised to include bioassay sample requirements	D. Vokey	W. Osborne
2.0	18/03/2016	Updated to reflect new water licence Added Landfill and Landfarm facility requirements Updated parameters and frequency of testing for all stations Added provisions for the annual sampling of the interior ponds of the TCA Updated contact and general information Updated UTM coordinates for sample stations to agree with those shown on the figures. Corrected reference to ammonia as NH_3 not NH_4 (NH_4 is ammonium) Updated laboratory accreditations Provided additional direction for the discharge from the sewage and TCA added	SRK	K. Lewis
3.0	14/08/2020	Updated to reflect new water licence Updated parameters and frequency of testing for all stations Updated laboratory accreditations Added QA/QC for Soils	Golder	K. Lewis

Executive Summary

Lupin Mines Incorporated (LMI), a wholly owned indirect subsidiary of Mandalay Resources Corporation (Mandalay), has prepared this Monitoring Plan.

A review of the Plan takes place and revisions are submitted as necessary with the annual report. The current Type A Water Licence 2AM-LUP2032 (Water Licence) for the Lupin Gold Mine (Lupin or the Lupin Mine or the Site) is valid until February 27, 2032.

Executive Summary Inuktitut

Awaiting translation – to be provided as soon as possible

Executive Summary Inuinnaqtun

Awaiting translation – to be provided as soon as possible

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1 Introduction

Lupin Mines Incorporated (LMI), a wholly owned indirect subsidiary of Mandalay Resources Corporation (Mandalay), has prepared this Water Quality Monitoring Plan and Quality Assurance / Quality Control Plan (the Plan).

An annual review of the Plan takes place and revisions are submitted as necessary with the Annual Report to the Nunavut Water Board (NWB). The current Type A Water Licence 2AM-LUP2032 (Water Licence) for the Lupin Gold Mine (Lupin or the Lupin Mine or the Site) is valid until February 27, 2032.

1.1 Project and Company Information

Mandalay is a Canadian based company focused on producing assets in Australia, Chile and Sweden, a development project in Chile and the exploration and development of the past-producing Lupin Gold Mine and the Ulu gold project, both located in Nunavut, Canada.

Mandalay purchased Elgin Mining Inc., which owns LMI and the Lupin Mine, in September 2014. Lupin was in operation from 1982 to 2005 with temporary suspensions of activities between January 1998 and April 2000, and again between August 2003 and March 2004. The mine resumed production in March 2004 until February 2005.

Lupin Mine is currently in Closure and Reclamation with final reclamation and closure of on-site facilities being conducted in accordance with the *Final Closure and Reclamation Plan* and the *Closure and Reclamation Plan for the Tailings Containment Area.* Progressive reclamation will be implemented during the Closure and Post Closure Phase in accordance with *Care and Maintenance Plan* for the Project. Surface exploration is conducted under Water Licence 2BE-LEP1217. All camp infrastructure required for the surface exploration program currently exists at the Lupin Mine

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Project:	Lupin Mine, Nunavut
Company Address:	Suite 330, 76 Richmond Street East, Toronto, ON M5C 1P1 Telephone: 778-386-7340
Email:	klewis@elginmining.com
Attention:	Karyn Lewis, General Administration
Effective date:	14 Aug 2020
Distribution List:	
Karyn Lewis	General Administration
Discovery Mining Services	Site Contractor
Golder Associates	Site Consultant
SRK Consulting	Site Consultant

Additional copies of this Plan are available from General Administration. This Plan will be posted in key locations at the Site, and all employees and contractors will be made aware of its contents.

1.2 Site Location

The Lupin Mine is located in the Kitikmeot Region, Nunavut, 400 km north of Yellowknife, Northwest Territories and 285 km southeast of Kugluktuk, Nunavut. The airport serving this Site is at 65°46'00" N and 111 14'41" W. The Site is on the western shore of Contwoyto Lake, approximately 60 km south of the Arctic Circle (Figure 1).

1.3 Environmental and Sustainable Development Policy

Lupin Mine Incorporated (LMI) is committed to maintaining a safe, clean, compliant and respectful work environment. LMI looks to our employees, contractors and managers to adopt and grow a culture of social responsibility and environmental excellence. Together we achieve this by:

- Promoting environmental stewardship in all tasks. Nothing is too important that it cannot be done in a clean and responsible manner. We strive towards maintaining a zero-incident work place.
- Recognizing that we have a shared responsibility as stewards of the environment in which we operate. We will not walk away from a non-compliant act.
- Identifying, managing and mitigating environmental, business and social risks in an open, honest and transparent manner.
- Planning our work so it is done in the cleanest possible manner and executing work according to plan.
- Continually improving environmental and operational performance by setting and reviewing achievable targets.
- Providing appropriate and necessary resources in the form of training, personnel and capital, including that required for closure planning and reclamation.
- Managing our materials and waste streams, maintaining a high degree of emergency response preparedness and minimizing our operational footprint to maintain environmental protection at all stages of project development.
- Procuring goods and services locally, where available, and favouring suppliers with environmentally and socially responsible business practices.
- Seeking to understand, learn from and mitigate the root causes of environmental incidents and near misses when they do occur.
- Employing systems and technology to achieve compliance, increase efficiency and promote industry best practices in development, operations and environmental stewardship.
- Working with stakeholders to identify and pursue opportunities for sustainable social and economic development and capacity building.
- Conducting early and ongoing stakeholder engagement relevant to the stage of project and mine development and operation.
- Recognizing diversity in the workplace and building meaningful relationships with all stakeholders in a timely, collaborative and transparent manner.

Through implementation of this policy, LMI seeks to earn the public's trust and be recognized as a respectful and conscientious employer, neighbor, and environmental steward.

1.4 Purpose and Scope

The purpose of this Plan is to identify water quality and soils monitoring requirements for the Site and minimize the impacts of potential sampling and analytical errors by providing a set of standardized procedures for sampling, analysis and reporting. These procedures are to be implemented by any personnel involved in monitoring for the purpose of regulatory compliance or internal environmental management.

The Plan documents Quality Assurance (QA) and Quality Control (QC) procedures for the Lupin Mine Monitoring Program as required by Type A Water Licence 2AM-LUP2032 Part J, Items 5, 6 and 7. The Plan also documents QA/QC procedures for the Lupin Mine Monitoring Program as required by the *Metal and Diamond Mine Effluent Regulations* (MDMER) under the *Fisheries* Act Part 2 Division 1 Item 11 and Part 2 Division 2 Items 12(1) and (2), 14(1), (2), and (3), 17(1) and (2), and 19(3) as well as Schedule 4 and 5.

QA/QC planning has been developed in accordance with the Crown-Indigenous Relations and Northern Affairs Canada (CCIRNAC), *Quality Assurance (QA) and Quality Control (QC) Guidelines for use by Class 'A' Licensees in meeting SNP Requirements and for Submission of a QA/QC Plan*, July 1996 which defines QA and QC as follows:

Quality Assurance: is the system of activities designed to better ensure that quality control is done effectively.

Quality Control: is the use of established procedures to achieve standards of measurement for the three principal components of quality: precision, accuracy and reliability.

This Plan outlines field sample collection procedures including sampling requirements and methods; field sample identification, preservation and transport procedures; field sampling quality control measures; analytical laboratory information; and reporting requirements.

2 Field Sampling

2.1 Sample Collection

2.1.1 Sampling Station Locations, Requirements and Parameters

Sampling station locations, requirements, and parameter analyses are set out in the Type A Water Licence 2AM-LUP2032 Table 1 of Schedule J and in the MDMER Part 2 Division 2 Items 12 thru 18 and Schedules 4 and 5. In addition, LMI's site monitoring program includes the collection of additional samples to assess the progression of water quality and the performance of or need for treatment measures.

Generally, samples are required from the following locations:

- Freshwater intake at Contwoyto Lake,
- Tailings Containment Area (TCA):
    - Annual characterization samples;
    - Prior to discharge;
    - During discharge;
    - Reference areas; and
    - Downstream exposure areas,
- Sewage Lakes Disposal Facility,
- Bulk Fuel Storage Facility
- Landfarm Facility, and
- Landfill Facility.

The monitoring requirements outlined in the Water Licence and MDMER effluent monitoring requirements are outlined in Table 2.1. Water sampling under the Environmental Effects Monitoring Program of the MDMER will accompany any planned discharges from the TCA. Monitoring guided by LMI's initiative are also outlined.

A sample event schedule is also provided in Table 2.2 which outlines the Water Licence and MDMER effluent monitoring requirements as well as field monitoring and QC sample requirements (see Section 3 of this Plan for more details about QC monitoring). LMI's routine sampling initiatives are also listed. This table is intended to serve as a guide to on-site personnel with sampling responsibilities.

Regulatory authorities are to be notified of planned discharge events. Table 2.3 provides the notification schedule.

Table 2.1: Sample collection requirements

Station ID	Location Description	Parameters												Frequency
		Field[a]	Conventional[b]	Metals and Mercury	Nutrients[c]	Cyanide	Ra-226	Anions and TP[d]	Fecal Coliform	BOD, TKN and ortho-phosphorus[e]	BTEX and O&G[f]	Bioassay		
												Acute[g]	Sublethal[h]	
LUP-01	Freshwater Intake from Contwoyto Lake	X	X	X	-	-	-	-	X	-	-	-	-	Annually
LUP-10	Pond 2 discharge at Dam 1A	X	X	X	-	X	-	-	-	-	-	-	-	Daily during periods of discharge
		X	X	X	X	X	X	-	-	-	-	-	-	Weekly
		X	X	X	X	X	X	X	-	-	-	X	-	Monthly (no less than one month Intervals) commencing with the first day of decant
		X	X	X	X	X	X	X	-	-	-	X	X	Once per calendar quarter
LUP10a (LUP-102)	Internal station in TCA Pond 2, approximately 100 m upstream from siphon intake	X	X	X	X	X	X	-	-	-	-	X	-	Once prior to initiation of decant and once prior to termination of decant
LUP-11	Mine-water discharge at automatic sampler in the mill	-	-	-	-	-	-	-	-	-	-	-	-	Not Active
LUP-12	Mill tailings taken at the mill	-	-	-	-	-	-	-	-	-	-	-	-	Not Active
LUP-14	Decant structure from the Sewage Lakes Disposal Facilities	X	X	X	X	-	-	-	X	X	-	-	-	First day of discharge and then monthly thereafter during periods of flow
LUP-15	Discharge from TCA Pond 1 (east pond) into TCA Pond 2 (west pond)	-	-	-	-	-	-	-	-	-	-	-	-	Not Active

Table 2.1: Sample collection requirements

Station ID	Location Description	Parameters												Frequency
		Field[a]	Conventional[b]	Metals and Mercury	Nutrients[c]	Cyanide	Ra-226	Anions and TP[d]	Fecal Coliform	BOD, TKN and ortho-phosphorus[e]	BTEX and O&G[f]	Bioassay		
												Acute[g]	Sublethal[h]	
LUP-16	TCA Pond 2 at center	-	-	-	-	-	-	-	-	-	-	-	-	Not Active
LUP-17	TCA Pond 2 upstream of Station LUP-10	-	-	-	-	-	-	-	-	-	-	-	-	Not Active
LUP-19	East end of Seep Creek in Dam 2 Lake	-	-	-	-	-	-	-	-	-	-	-	-	Not Active
LUP-20	West end of Seep Creek before discharge into Unnamed Lake	X	X	X	X	X	X	-	-	-	-	-	-	Weekly during discharge from the Tailings Containment Area, commencing with the first day of decant
LUP-21	North end of Concession Creek before discharge into Unnamed Lake	X	X	X	X	X	X	-	-	-	-	-	-	Weekly during discharge from the Tailings Containment Area, commencing with the first day of decant
		X	X	X	X	X	X	X	-	-	-	-	-	Four times per year
LUP-22	Inner Sun Bay near center and midway between end of peninsula and west shore	X	X	X	X	X	X	-	-	-	-	-	-	Weekly at mid-depth, commencing one (1) week prior to discharge from the Tailings Containment Area and concluding two (2) weeks after cessation of the discharge

Table 2.1: Sample collection requirements

Station ID	Location Description	Parameters												Frequency
		Field[a]	Conventional[b]	Metals and Mercury	Nutrients[c]	Cyanide	Ra-226	Anions and TP[d]	Fecal Coliform	BOD, TKN and ortho-phosphorus[e]	BTEX and O&G[f]	Bioassay		
												Acute[g]	Sublethal[h]	
LUP-24	Inner Sun Bay at mid-way point in narrows	X	X	X	X	X	X	-	-	-	-	-	-	Weekly at mid-depth, commencing one (1) week prior to discharge from the Tailings Containment Area, and concluding two (2) weeks after cessation of the discharge and when bioassay sample is collected at LUP-10 just prior to termination of decant
		X	X	X	X	X	X	X	-	-	-	-	-	Four times per year
LUP-25	Outer Sun Bay (Total Rather than specific metals)	X	X	X	X	X	X	-	-	-	-	-	-	Weekly at mid-depth, commencing one (1) week prior to discharge from the Tailings Containment Area, and concluding two (2) weeks after cessation of the discharge
LUP-26	Contwoyto Lake in bay east of water intake	-	-	-	-	-	-	-	-	-	-	-	-	Inactive
LUP-27	Bulk Fuel Storage Facility	X	X	X	X	-	-	-	-	-	X	-	-	Once prior to discharge and weekly during periods of discharge
LUP-28	Discharge from the Landfarm Facility.	X	X	X	X	-	-	-	-	-	X	-	-	Once prior to discharge and weekly during periods of discharge

Table 2.1: Sample collection requirements

Station ID	Location Description	Parameters												Frequency
		Field[a]	Conventional[b]	Metals and Mercury	Nutrients[c]	Cyanide	Ra-226	Anions and TP[d]	Fecal Coliform	BOD, TKN and ortho-phosphorus[e]	BTEX and O&G[f]	Bioassay		
												Acute[g]	Sublethal[h]	
LUP-29	Landfarm Facility Monitoring Well – Up gradient	X	X	X	X	-	-	-	-	-	X	-	-	Monthly during periods of observed flow – June through September
LUP-30a	Landfarm Facility Monitoring Well – Down gradient	X	X	X	X	-	-	-	-	-	X	-	-	Monthly during periods of observed flow – June through September
LUP-30b	Landfarm Facility Monitoring Well – Down gradient	X	X	X	X	-	-	-	-	-	X	-	-	Monthly during periods of observed flow – June through September
LUP-31	Seepage from the Landfill Facility	X	X	X	X	-	-	-	-	-	X	-	-	Monthly during periods of observed flow
LUP-32	Landfill Facility Monitoring Well – Up gradient	X	X	X	X	-	-	-	-	-	X	-	-	Monthly during periods of observed flow – June through September
LUP-33a	Landfill Facility Monitoring Well – Down gradient	X	X	X	X	-	-	-	-	-	X	-	-	Monthly during periods of observed flow – June through September
LUP-34b	Landfill Facility Monitoring Well – Down gradient	X	X	X	X	-	-	-	-	-	X	-	-	Monthly during periods of observed flow – June through September
LUP-35	Seepage from the Landfill Facility	X	X	X	X	-	-	-	-	-	X	-	-	Monthly during periods of observed flow – June through September

Table 2.1: Sample collection requirements

Station ID	Location Description	Parameters												Frequency
		Field[a]	Conventional[b]	Metals and Mercury	Nutrients[c]	Cyanide	Ra-226	Anions and TP[d]	Fecal Coliform	BOD, TKN and ortho-phosphorus[e]	BTEX and O&G[f]	Bioassay		
												Acute[g]	Sublethal[h]	
LUP-36[i]	Demolition Landfill Facility Monitoring Well – Up gradient	X	X	X	X	-	-	-	-	-	X	-	-	Monthly during periods of observed flow – June through September
LUP-37a[i]	Demolition Landfill Facility Monitoring Well – Down gradient	X	X	X	X	-	-	-	-	-	X	-	-	Monthly during periods of observed flow – June through September
LUP-37b[i]	Demolition Landfill Facility Monitoring Well – Down gradient	X	X	X	X	-	-	-	-	-	X	-	-	Monthly during periods of observed flow – June through September
LUP-EL-01	East Lake near shoreline near the potential seepage inputs	X	X	X	-	-	-	-	-	-	-	-	-	Twice-yearly: Once in freshet and once in late open-water season, ensuring that baseline samples are collected prior to construction of the waste rock dome.
LUP-BL-01	Boot Lake near shoreline near the potential seepage inputs	X	X	X	-	-	-	-	-	-	-	-	-	Twice-yearly: Once in freshet and once in late open-water season, ensuring that baseline samples are collected prior to construction of the waste rock dome.
LUP-LSL-01	Lower Sewage Lake near shoreline near the potential seepage inputs	X	X	X	-	-	-	-	-	-	-	-	-	Twice-yearly: Once in freshet and once in late open-water season, ensuring that baseline samples are collected prior to construction of the waste rock dome.

Table 2.1: Sample collection requirements

Station ID	Location Description	Parameters												Frequency
		Field[a]	Conventional[b]	Metals and Mercury	Nutrients[c]	Cyanide	Ra-226	Anions and TP[d]	Fecal Coliform	BOD, TKN and ortho-phosphorus[e]	BTEX and O&G[f]	Bioassay		
												Acute[g]	Sublethal[h]	
LUP-SP-01 to LUP-SP-XX[j]	Seeps from the Waste Rock Dome, Locations of observed seepage or flow from waste rock pile	X	X	X	-	-	-	-	-	-	-	-	-	Twice-yearly: Once in freshet and once in late open-water season
LUP-TCA-01 to LUP-TCA-XX[j]	Seeps from the Tailings Containment Area (TCA), Locations of observed seepage or flow from waste rock pile	X	X	X	-	-	-	-	-	-	-	-	-	Twice-yearly: Once in freshet and once in late open-water season

Notes:

(a) pH, conductivity, temperature and dissolved oxygen (receiving environment only).

(b) pH, conductivity, total suspended solids, alkalinity, hardness.

(c) Total ammonia, nitrate, and nitrite.

(d) Chloride and sulphate. TP = Total Phosphorus.

(e) Biochemical Oxygen Demand, Total Kjedahl Nitrogen and ortho-phosphorus.

(f) Benzene, toluene, ethyl benzene, xylene, and Oil and Grease.

(g) Acute Toxicity Testing: Rainbow Trout and *Daphnia Magna*.

(h) Sublethal Toxicity Testing for Fathead Minnows, *Ceriodaphnia dubia*, *Lemna minor* and *P. subcapitata*.

(i) Monitoring requirements are as per Water Licence, but are not applicable because the Demolition Landfill is not planned for construction.

(j) Seep sampling locations will be added to the post-closure monitoring program as new seeps are documented.

Table 2.2: Sampling event schedule.

Sampling Events	Station	Samples and Parameters	Quality Control[(1)]
TAILINGS CONTAINMENT FACILITY			
Annually	LUP-10a (LUP-102) LUP-POND1 LUP-CELL4 LUP-CELL5	Field pH, temperature, conductivity	1 field duplicate
		pH, TSS, hardness	
		Total Metals	
		Dissolved Metals	
One month prior to discharge	LUP-10a (LUP-102)	Field pH, temperature, conductivity	-
		pH, conductivity, TSS, alkalinity, hardness,	
		NO_2, NO_3, NH_3	
		Total Metals and Hg	
		CN (total cyanide)	
		^{226}Ra	
Upon receipt of results meeting discharge criteria (expect pH) and not less than two weeks prior to discharge	LUP-10a (LUP-102)	Field pH, temperature and conductivity	-
		Static pass/ fail Bioassay with pH adjustment[(2)]	
One week prior to discharge	Pond 2 (various locations and depths)	Field pH, temperature conductivity	1 field duplicate or field blank
		Field pH, temperature, and conductivity (Daily)	
	LUP-22, 24, 25 (at mid-depth)	pH, conductivity, TSS, alkalinity, hardness	
		Total Metals and Hg	
		NO_2, NO_3, NH_3	
		CN	
Daily during discharge	LUP-10	Field pH, temperature, and conductivity	1 field duplicate or field blank per week
		Field observation of visual sheen	
		flow rate m^3	
		pH, conductivity, TSS, alkalinity, hardness	
		CN	
		Total Metals and Hg	

Table 2.2: Sampling event schedule.

Sampling Events	Station	Samples and Parameters	Quality Control[1]
First day of discharge (in addition to daily sampling)	LUP-10	NO_2, NO_3, NH_3	1 field duplicate or field blank
		Total Metals and Hg	
		MDMER Bioassays: LC50	
		^{226}Ra	
	LUP-20, 21 (surface), LUP-22, 24, 25 (at mid-depth)	Field pH, temperature, conductivity, dissolved oxygen	
		pH, conductivity, TSS, alkalinity, hardness	
		Total Metals and Hg	
		NO_2, NO_3, NH_3	
		CN	
	LUP-21 (surface), LUP-24 (at mid-depth)	Anions and Total Phosphorus	
Weekly during discharge (in addition to daily sampling)	LUP-10	NO_2, NO_3, NH_3	1 field duplicate or field blank
		^{226}Ra	
	LUP-20, 21 (surface), LUP-22, 24, 25 (at mid-depth)	pH, conductivity, TSS, alkalinity, hardness	
		Total Metals and Hg	
		NO_2, NO_3, NH_3	
		CN	
		^{226}Ra	
Monthly during discharge (in addition to daily and weekly sampling	LUP-10	MDMER Bioassay LC50 and sublethal[3]	1 field duplicate or field blank
	LUP-21 (surface), LUP-24 (at mid-depth)	Total Hg	
		Field dissolved oxygen	
		Anions and Total Phosphorus	

Table 2.2: Sampling event schedule.

Sampling Events	Station	Samples and Parameters	Quality Control[(1)]
Just before the bioassay sample at LUP- 102 prior to termination of decant	LUP-21 (surface), LUP-24 (at mid- depth)	pH, conductivity, TSS, alkalinity, hardness	1 field duplicate or field blank
		Total Metals and Hg	
		NO_2, NO_3, NH_3	
		CN	
		^{226}Ra	
Last day of discharge	LUP-10a (LUP-102)	Static Pass/ Fail Bioassay	-
		Field pH, temperature, conductivity and dissolved oxygen	
		pH, TSS, alkalinity, hardness	
		Total Metals and Hg	
		CN	
		NO_2, NO_3, NH_3	
		^{226}Ra	
Weekly for two weeks following termination of discharge	LUP-22, 24, 25 (at mid-depth)	pH, TSS, alkalinity, hardness	1 field duplicate or field blank
		Total Metals	
		NO_2, NO_3, NH_3	
		CN	
SEWAGE LAKES DISPOSAL FACILITY			
Three weeks prior to discharge	LUP-14	Field pH, temperature, conductivity	1 field duplicate
		Field observation for visual sheen	
		pH, conductivity, TSS, alkalinity, hardness	
		Total Metals and Hg	
		NO_2, NO_3, NH_3, TKN, TP, OPO4	
		BOD5	
		Fecal Coliforms	
Daily during discharge		Field flow rate in m^3	-
		Field pH, temperature, conductivity	
		Field observation for visual sheen	

Table 2.2: Sampling event schedule.

Sampling Events	Station	Samples and Parameters	Quality Control[(1)]
First day of discharge and Monthly thereafter [(2)] (in addition to daily sampling)		pH, TSS, alkalinity, hardness	1 field duplicate or field blank
		Total Metals and Hg	
		BOD5	
		Fecal Coliforms	
		NO_2, NO_3, NH_3, TKN, TP, OPO4	
FRESHWATER INTAKE FACILITY			
Daily during intake	LUP-01	Field flow rate in m^3	-
Annually		Field pH, temperature, conductivity	
		pH, conductivity, TSS, conductivity	
		Total Metals and Hg	
		Fecal Coliforms	
BULK FUEL STORAGE FACILITY			
One week prior to discharge (RUSH 48 hour turnaround for sample results are to be requested of the laboratory)	LUP-27	Field pH, temperature, conductivity	1 field duplicate
		Field observation for visual sheen	
		pH, conductivity, TSS, hardness, alkalinity	
		Total Metals and Hg	
		Total Oil and Grease	
		BTEX	
		NO_2, NO_3, NH_3	
Daily during discharge		Field flow rate in m^3	-
		Field pH, temperature, conductivity	
		Field observation for visual sheen	
Weekly during discharge (in addition to daily testing)		pH, conductivity, TSS, hardness, alkalinity	1 field duplicate or field blank
		Total Metals and Hg	
		Total Oil and Grease	
		BTEX	
		NO_2, NO_3, NH_3	

Table 2.2: Sampling event schedule.

Sampling Events	Station	Samples and Parameters	Quality Control[(1)]
LANDFARM			
Monthly during discharge during periods of observed flow – June through September	LUP-28, LUP-29, LUP- 30a, LUP-30b	pH, conductivity, TSS, hardness, alkalinity	1 field duplicate or field blank
		Total Metals and Hg	
		Total Oil and Grease	
		BTEX	
		NO_2, NO_3, NH_3	
LANDFILL FACILITY			
Monthly during discharge during periods of observed flow – June through September	LUP-31, LUP-32, LUP- 33a, LUP-33b	pH, conductivity, TSS, hardness, alkalinity	1 field duplicate or field blank
		Total Metals and Hg	
		NO_2, NO_3, NH_3	

Notes:

(1) Duplicate and Blank samples must be collected for approximately every ten (10) field samples collected across the range of parameters. At least one duplicate must be submitted per sample shipment.

(2) Samples are to be collected on the morning of the next plane departure after discharge commences where hold time restraints apply.

(3) Twice per year. Nautilus Environmental should be advised that the dilution series for *Ceriodaphnia* and *Lemna* should be adjusted prior to sublethal testing.

Table 2.3: Discharge notification schedule.

Discharge Event	Schedule	Action Required
TAILINGS CONTAINMENT AREA	30 days prior to MDMER Bioassay	Provide notice to Environment and Climate Change Canada (ECCC) of planned sample date.
	10 days prior to discharge	Provide notice to the CIRNAC inspector, include analytical results and estimated volume of discharge.
LOWER SEWAGE LAKE	10 days prior to discharge	Provide notice to the CIRNAC inspector, include analytical results and estimated volume of discharge.
BULK FUEL STORAGE FACILITY	10 days prior to discharge	Provide notice to the CIRNAC inspector and estimated volume of discharge (1). Analytical results will be provided upon receipt and no discharge to occur prior to CIRNAC acknowledgment of receipt.

Note:

(1) Discharge from the bulk fuel storage facilities needs to commence as soon as possible when water starts accumulating in the spring.

Active monitoring (sampling) station locations as shown in Figure 2.1 are clearly identified in the field with permanent stakes and appropriate signage.

Samples must always be collected from the same locations, unless the sampling locations are relocated at the request of the designated CIRNAC Inspector or sampling location modifications are approved in writing by the NWB. The following Table 2.4 summarizes the current UTM coordinates of the active sampling locations:

Table 2.4: Lupin Mine sampling locations using the UTM NAD85, Zone 12N coordinates

Monitoring Station No.	Description	UTM Northing	UTM Easting
LUP-01	Freshwater intake from Contwoyto Lake	7294933	490030
LUP-10	TCA Pond 2 discharge at Dam 1A	7289689	485843
LUP-102 (Station 102)	Approximately 100 m upstream from the siphon intake in TCA Pond 2	7289875	486196
LUP-14	Decant structure from the Sewage Lakes Disposal Facilities	7293013	490187
LUP-20	West end of Seep Creek before discharge into Unnamed Lake	7290197	480149
LUP-21	North end of Concession Creek before discharge into Unnamed Lake	7290217	479841
LUP-22	Inner Sun Bay near centre midway between end of peninsula and west shore	7291715	479160
LUP-24	Inner Sun Bay near narrows	7293125	478989
LUP-25	Outer Sun Bay	7293770	478330
LUP-27	Bulk Fuel Storage Facility	7293609	489072
LUP-28	Discharge from the Landfarm Facility	TBD	TBD
LUP-29	Landfarm Facility monitoring well – upgradient	TBD	TBD
LUP-30a	Landfarm Facility monitoring well – downgradient	TBD	TBD

Table 2.4: Lupin Mine sampling locations using the UTM NAD85, Zone 12N coordinates

Monitoring Station No.	Description	UTM Northing	UTM Easting
LUP-30b	Landfarm Facility monitoring well – downgradient	TBD	TBD
LUP-31	Seepage from the Landfill Facility	TBD	TBD
LUP-32	Landfill Facility monitoring well – upgradient	TBD	TBD
LUP-33a	Landfill Facility monitoring well – downgradient	TBD	TBD
LUP-33b	Landfill Facility monitoring well – downgradient	TBD	TBD
LUP-EL-01	East Lake near shoreline near the potential seepage inputs	7293910	490496
LUP-BL-01	Boot Lake near shoreline near the potential seepage inputs	7294246	488593
LUP-LSL-01	Lower Sewage Lake near shoreline near the potential seepage inputs	7293164	489874

2.1.2 Field Measurements and Field Log Book

Where required by the monitoring program, pH, temperature, conductivity and dissolved oxygen of water is measured and recorded in the field directly from the water body being sampled wherever possible. Where it is not possible to take field measurements directly from the water body, the measurements can be taken from the sample bottle.

The pH and conductivity meters must be calibrated in advance of each day's sampling activities according to the manufacturer's instructions, using fresh standard calibration solutions. Any discrepancies must be recorded in the Field Log Book along with the sampling data; however recorded field measurements must not be altered due to calibration issues. Refer to the pH and conductivity meter manuals for instructions regarding how to calibrate and take measurements with the particular devices.

Details of all sampling activities are recorded in the Field Log Book including:

- Date and time of each sample collected,
- Sampling location visited,
- Weather conditions and air temperature,
- Flow rates where applicable,
- Integrity of sample location and water observations,
- Samples collected at each location including identification number (see Section 2.2), whether the sample will be submitted for analysis, and type of analysis as well and sample preservation measures,
- Sample depth where applicable, and
- Field measurements (i.e. pH, conductivity, temperature, dissolved oxygen) as well as any calibration discrepancies with the field meters.

Immediately following field activities, an electronic copy of the Field Log data must be made. Field log entries in the Field Log Book must not be altered; pages must not be removed; space or pages left blank must be labeled as such and crossed with a diagonal line; and errors must be crossed out, not erased.

2.1.3 Sample Containers

Sample container sizes and materials of construction depend upon the parameter(s) to be analyzed. A summary of sample container requirements for various parameters is provided in Table 2.5 (Section 2.3 of this Plan).

All water quality sample containers will be prepared and supplied by the contracted laboratory. Only clean, unused containers should be used to limit contamination and preservation errors. Samples analyzed for fecal coliform tests must be contained in bottles provided by the laboratory to ensure that the bottle is sterilized prior to use. Toxicity samples are to be collected in food grade containers, such as water jugs or buckets. The food grade containers must be thoroughly cleaned and rinsed and then triple rinsed with the sample water prior to being filled.

2.1.4 Sampling Methods

Water quality sampling methods are as follows:

- Record details of the sampling activity and field measurements in the Field Log Book (see Section 2.1.2 for details).
- In the field, disposable nitrile sampling gloves must be worn during handling of all the bottles and equipment.
- Triple rinse sample bottles with the source water prior to sample collection, except for those bottles with preservative already added by the laboratory (i.e., BTEX), as well as those bottles for Oil and Grease or Fecal Coliform analysis.
- Collect samples off-shore as much as possible without disturbing bottom sediments.
- When collecting samples from flowing bodies of waters (i.e. stream, creeks):
    - The sample must be collected as close as possible to the middle of the flowing water body. To prevent the stirring up of sediment, use a container attached to a pole extension. Otherwise, if wading into the stream is unavoidable, wait for the sediment to settle or flow away before collecting the sample.
    - When rinsing, plunge the sample bottle into the flowing water toward the current allowing it to fill at a depth of approximately half the stream depth. If the stream depth is too shallow to collect a clean sample without disturbing sediment or too shallow to fill the bottle completely, use a smaller bottle and transfer the water to the larger sample bottle.
    - Empty rinse water downstream of the sample locations so as not to disturb sediments.
- When collecting samples from surface water bodies (ponds, lakes) follow the same procedures as above for flowing bodies of water, ensuring that subsequent samples are collected at the same location, and by plunging the sample bottle into the water to a depth of about six (6) inches below the water surface.

- Sample bottles must be filled with room left for preservative addition and mixing. Add preservatives after filling as directed by the laboratory (unless the bottle was provided pre- loaded with preservatives by the laboratory).
- Record field measurements (pH, temperature, conductivity, dissolved oxygen) and any deviations from the sample collection method in the Field Log Book.

2.2 Sample Identification

All water samples must be provided with a unique sample identification number based on the following example:

Example: LUP-22-200801-50

LUP-22 Refers to the monitoring station.

130801 Refers to the date that the sample was collected (yy/mm/dd). In this example the date the sample was collected was August 1, 2020.

50 Refers to the depth in centimeters from surface which the same was collected. If the depth of the sample is not applicable do not include the suffix.

Sample labels including at a minimum: sample identification number, location, date, and parameters for analyses should be prepared as much as possible before entering the field for the sampling event with a waterproof, non-smear pen. Then, sample labels, bottles and preservatives should be packed, preferably in a cooler to maintain constant temperature, for transport to the field.

Sample bottle labels must be clearly and consistently labeled prior to being sent to the external laboratory with the following information:

- Company name,
- Site name,
- Sample Station Number,
- Sample Number,
- Sample Date and Time, and
- Analysis required.

Quality Control (QC) samples (i.e., field blanks, trip blanks, duplicates) are provided with unique sample identification numbers and note of the sample as a QC sample is recorded in the Field Log Book.

2.3 Sample Preservation

Water quality samples must be preserved, either by laboratory issued chemical preservative or temperature control, immediately following sample collection to ensure that the quality of the water sample remains similar to the source water. The following Table 2.5 summarizes the required containers, preservatives, and holding times for each parameter as outlined in ALS Sample Collection pocket Guide, Version 2 and additional information provided directly by ALS staff.

Table 2.5: Required sample containers, preservation, holding times, and sample volumes for analysis of specific parameters.

Parameter	Container Type	Preservative	Holding Time
pH [1,5]	500 mL plastic	4° C	0.25 hours
TSS [1]	500 mL plastic	4° C	7 days
Conductivity [1,5]	500 mL plastic	4° C	28 days
Total Metals and Hardness [4]	80 mL plastic	3 mL 1:3 Nitric Acid	6 months
Mercury	40 mL glass vial	2 mL Hydrochloric acid	28 days
Radium226	0.5 – 1 L plastic	6 mL 1:3 Nitric Acid	6 months
Cyanide (Total or WAD (low level))	60 mL plastic	3 mL 6N Sodium Hydroxide	14 days
Alkalinity [1]	500 mL plastic	4° C	14 days
Total Ammonia	100 mL amber glass with septa cap	1 mL 1:1 Sulphuric Acid	28 days
Nitrogen, Nitrate and Nitrite	500 mL plastic	4° C	28 days
Kjeldahl or Organic Nitrogen	100 mL amber glass with septa cap	1 mL 1:1 Sulphuric Acid	28 days
Total Phosphorus	100 mL amber glass with septa cap	1 mL 1:1 Sulphuric Acid	28 days
Ortho Phosphate[1]	500 mL plastic	4° C	2 days
BOD5 [1]	500 mL plastic	500 mL plastic	2 days
Fecal Coliforms	250 mL sterilized plastic	Sodium Thiosulphate	30 hours
Oil and Grease	2 x 250 mL amber glass	2 mL 1:1 H2SO4	28 days
BTEX [2,3]	2 x 40 mL glass vials	Sodium Bisulphate or Thiosulphate	14 days
Daphnia magna (pass/fail, LC50) [6]	2 x 20 L carboy	4° C	5 days
Rainbow Trout (pass/ fail, LC50) [7]		4° C	5 days
Fathead Minnows (sublethal)	3 x 20 L carboy	4° C	5 days
C. dubia (sublethal)		4° C	5 days
L. minor (sublethal)		4° C	5 days
P. subcapitata (sublethal)		4° C	5 days

Notes:

(1) Parameters may be analyzed from a single unpreserved bottle.

(2) 40 mL glass vials must be filled with no headspace. May contain preservative. Do not pre-rinse with sample. If sample is chlorinated use thiosulphate preservative.

(3) All volatile organics in water (chlorinated aromatics, BTEX, volatile organics, THMs and halogenated aliphatics) can be analyzed from the same set of vials. Consult ALS whether 2 or 3 vials are required.

(4) If field filtering is not possible, or poses unacceptable risks for sample contamination, then send the samples unfiltered to and unpreserved to the laboratory as soon as possible.

(5) Testing in the field is recommended.

(6) For Daphnia Magna (LC50), require 2 L minimum volume. For Daphnia Magna (Pass/Fail), require 1 L minimum volume.

(7) For Rainbow Trout (LC50), 2 x 20 L bladder and 40 L minimum volume required. For Rainbow Trout (Pass/Fail), 1 x 20 L bladder and 20 L minimum volume required.

2.4 Sample Transportation

Sample integrity will be preserved from the time of sample collection to completion of delivery to the laboratory by limiting exposure of samples to heat, light, and agitation.

Sample bottles will be packed standing upright and immobile in a new or laboratory issued portable cooler. Samples suspected of elevated contaminant levels, such as a sewage sample, will be shipped separately from clean samples. All samples will be stored and transported at 10°C to 1°C in the coolers with ice packs and the cooler will be securely closed prior to shipping. Samples will be shipped as soon as possible following sample collection with appropriate transportation instructions such as "refrigerate" and "do not freeze".

2.5 Chain of Custody Forms

A Chain of Custody Form containing the following information is completed by the sampler for every cooler shipment of samples:

- Company name and contact information,
- Analytical laboratory name, address , and contact person,
- Invoicing instructions,
- Report format requested,
- Project information,
- Sampler's name,
- Sample identification number, time and date of sampling, sample type, and analyses requested,
- Any special instructions, and
- Name of person releasing the shipment as well as date and time of release. Each person relinquishing and receiving the samples, including the courier, must sign the Chain of Custody form.

Each cooler shipped must have a Chain of Custody form indicating those samples contained in the particular cooler. Chain of Custody forms should be enclosed in a Ziploc bag to protect them from possible water damage during shipment.

One copy of the Chain of Custody form is included with the shipment and one copy must remain at the mine site for recording keeping. An example of the Chain of Custody Form is provided in Appendix A.

3 Water Field Quality Control

3.1 Trip or Travel Blanks

Travel blanks are supplied and shipped by the laboratory to test for possible contamination that might arise during the handling, transport, or storage of the samples. The identity of these samples must be recorded in the Field Log Book.

One travel blank must be submitted per sample shipment.

3.2 Duplicates or Replicates

Duplicate or replicate sampling is the collection of more than one sample for a given analysis at a given location to test the validity of sampling procedures and laboratory methodology. Duplicates are collected, handled, and analysed using the same procedures applied to routine samples. Duplicates are submitted to the laboratory with a unique (fictitious) identifier to prevent association of the paired samples. The identity of these samples must be recorded in the Field Log Book.

Duplicate samples must be collected for approximately every ten (10) field samples collected across the range of parameters. At least one duplicate must be submitted per sample shipment.

4 Laboratory Analyses

ALS Environmental laboratories (ALS) located in Yellowknife, NWT performs the required environmental analyses for the Lupin Mine, with the exception of MDMER toxicity testing which is completed by Nautilus Environmental in Calgary, AB.

ALS is accredited by the Canadian Association for Laboratory Accreditation Inc. (CALA) and conforms to the requirements of ISO/IEC Standard 17025. Attached in Appendix B is a copy of the ALS Yellowknife laboratory scope of accreditation. The scope of accreditation of all ALS laboratories is available from their website at:

https://www.alsglobal.com/en/myals/downloads

Nautilus Environmental is accredited by the CALA to conduct acute lethality and Daphnia magna monitoring tests and conforms to the requirements of ISO/IEC Standard 17025. Nautilus Environmental should be advised that the dilution series for *Ceridodaphnia* and *Lemna* should be adjusted prior to sublethal testing. Attached in Appendix B is a copy of the Nautilus Environmental Burnaby laboratory scope of accreditation.

All analyses are conducted in accordance with methods prescribed in the current edition of Standard Methods for the Examination of Water and Wastewater including regular QA/QC during the analysis of field samples including a program of method blanks, laboratory control samples, instrument calibration samples, matrix spikes, and duplicates.

5 Reporting

All analytical results will be forwarded in electronic format from ALS to LMI for data collection and management. Upon receipt, LMI will review the results to identify any anomalies. Anomalous results will be either re-analyzed by the laboratory or new samples will be collected to confirm the analytical results.

Any analytical results that indicate exceedance of regulatory criteria will be reported to the appropriate agencies including the NWB and the CIRNAC inspector.

Part J Item 10 of the Lupin Mine Water Licence requires LMI to include in its Annual Report (due March 31st), all data, monitoring results and information required by Part J of the Water Licence. Under the MDMER effluent monitoring reporting of all tests and monitoring conducted during each quarter is to be reported not later than 45 days after the end of a quarter. A report summarizing the previous calendar year is also required under the MDMER to Environment and Climate Change Canada (due March 31st).

To facilitate the required annual reporting, LMI prepares written monthly reports supported by laboratory analyses results table summaries and quality assurance review. Each monthly report includes the following:

- A description of the sample activities undertaken,
- Description of the existing conditions at each sampling station,
- Tabular summary of analytical lab result including the results of the quality control samples (travel blank, field blank, duplicate samples), and
- Interpretation of the analytical lab results including comparison of the results with water licence criteria and assessment of the reliability of the results.
- Within the annual report, the acceptability of samples will be evaluated qualitatively by examination of the trip blanks and field duplicate sample data. Reproducibility of samples will be expressed as relative percent difference (RPD):

$$RPD = 100 * ((X_1 – X_2) / (X_1 + X_2) / 2)$$

Where X_1 is the original sample concentration, X_2 is the duplicate sample concentration, and X_1-X_2 denotes the absolute value of the difference between these two concentrations.

Quality Assurance/Quality Control Plan for Soils at the Lupin Mine

The purpose of this document is to provide a quality assurance (QA) / quality control (QC) plan for the remediation of contaminated soils at Lupin Mine (the Site). This QA/QC plan for contaminated soils outlines the field screening and confirmatory sampling program for the remediation of contaminated soils that will be required as part of Site closure. The objective of this QA/QC plan is to confirm that the contractor successfully remediates the areas of contaminated soils and meets the intent of the design.

The remediation of contaminated soils will require a field QA/QC plan to confirm compliance with the established remedial criteria. The QA/QC program will include four primary components:

- Field layout and remedial excavation.
- Field screening.
- Confirmation sampling.
- Reporting.

6. Field Layout and Remedial Excavations

The excavation of contaminated soils will be initially defined in the field based on the locations of test pits where contaminated soils were identified as part of the 2006 Phase I and II ESA (Morrow 2006) and the 2017 Phase I and II ESA Update (Golder 2017a). The layout of the locations of the planned remedial excavations will be surveyed in the field and the locations will be verified prior to remedial work commencing.

The remedial excavations of contaminated soils will be monitored, and the type and quantity of excavated material will be documented as remedial activities advance. Visual observations will initially be used to identify the limits of contaminated materials and a photographic log of remedial activities will be maintained. The advancement of remedial activities will be tracked and compared with the design estimates of remedial volumes and excavation limits.

7. Field Screening

Soil samples will be screened to obtain "real-time" field data to guide the remedial activities and to enable the collection of a subset of confirmatory samples for laboratory analysis. Field screening techniques such as portable combustible gas instruments (CGIs) and x-ray fluorescence (XRF) instruments are widely used during remediation activities. Although these field tools do not replace the collection of confirmation laboratory analysis, they provide complimentary data to support field decisions with respect to soil excavation and will be used to verify soil quality compliance.

The CGI and XRF instruments must be calibrated by the equipment supplier prior to shipment to the Site. Afterwards, regular "bump" tests of the CGI instrument should be completed according to the manufacture's instructions. As part of the daily field screening, field notes should be collected which include the following information:

- Date of field screening.
- Weather conditions.
- Excavation and field screening sample identifications.
- Field screening sample depths.
- Field screening concentrations.

The following sections summarize the field screening instruments and methodologies for the primary contaminants of concern: PHCs and total arsenic.

7.1. Petroleum Hydrocarbons (PHCs)

Field screening of PHCs will consist of a combination of visual assessment of staining and the use of a portable CGI. The presence of residual volatile hydrocarbons within soil affected by weathered diesel and fuel oil is likely low and it is therefore expected that field screening for PHCs may not be highly effective. The portable CGI measures concentrations of volatile hydrocarbons from soil in either the parts per million (ppm) or percentage Lower Explosive Limit ranges. The unit will be calibrated to a reference gas, typically operated in methane elimination mode.

Discrete soil samples will be collected from the walls and base of the remedial excavations following the definition of the potential limits. The frequency of discrete field screening will be determined on an excavation by excavation basis based upon the lateral and vertical extents. If bedrock or permafrost is encountered below PHC contaminated soil, discrete soil samples will be collected if possible. However, if ex-situ screening can not be completed due to terrain limitations, a visual assessment of the bedrock or permafrost surface will be completed and documented.

Discrete soil samples will be collected in the field from the excavation or the excavator bucket depending on the depth of the excavation and applicable health and safety requirements. Samples will be stored in re-sealable plastic bags and allowed to acclimatise to room temperature for approximately 15 minutes. The CGI probe is then inserted into the bag for measurement of combustible vapours. It is anticipated that field screening results using the CGI will generally fall into two categories:

- Field screening data indicates a high likelihood of a below applicable criteria confirmation laboratory result. Field screening data should include CGI readings less than 50 ppm and no staining or olfactory indications of contamination observed.
- Field screening data characterized by elevated CGI readings exceeding 50 ppm and/or significant staining or olfactory indications of contamination observed indicates a low likelihood of a below applicable criteria confirmation laboratory result.

It is recognized that the interpretation of field screening data will evolve as correlations between laboratory and field screening results become established. The results of the field screening program will be used to identify sample locations designated for confirmatory sampling.

7.2. Total Arsenic

Field screening of total arsenic will be completed using a portable XRF instrument, which allows for the detection of mg/kg concentrations of a wide spectrum of metals within soil. The XRF instrument will be used to estimate total arsenic concentrations in the field and the results will be used to determine whether additional excavation is required or if confirmatory soil sampling may be initiated. The XRF is a radiation source and requires health and safety training for use as well as specific Transport Canada documentation associated with land and air transport.

Upon completion of the remedial excavations, it is assumed that residual soil will be present along the base and walls of the excavations. As a result, once the potential limits of the remedial excavations are encountered, detailed field screening of the walls and bases will be completed using discrete samples collected on a grid pattern. Discrete soil samples (approximately 250 ml in size) will be collected directly from the excavation or bucket of the excavator depending on the depth of the excavation and applicable health and safety requirements. Samples will be collected such that minimal organic material and/or gravel-sized fragments are present in order to minimize interference with the XRF. Three methods will be used to complete the XRF field screening:

- Unprocessed ex-situ method. This method involves sample placement in thin walled plastic bags. No sample processing (i.e., drying, sieving, or blending) will occur. Measurements are taken in a trailer located on-site with the instrument mounted to a stand.
- Processed ex-situ method. This method requires sample preparation (i.e., drying, sieving, and blending) and compaction/placement in XRF sample cups. Measurements are also taken in an on-site trailer with instrument mounted to stand.
- In-Situ “point and shoot” method. This method involves collecting in-field readings of total arsenic concentrations from soil remaining on bedrock terrain or permafrost exposed during remedial activities. Although this method is generally not considered to provide as accurate of results as the ex-situ methods, it will be used to assess soil quality in bedrock terrain or permafrost where sample collection for ex-situ screening methods is not considered feasible.

The majority of the discrete soil samples will be field screened using the unprocessed ex-situ method in order to reduce the time and effort required to prepare each sample. If a discrete sample is observed to be frozen or have excessive moisture, that sample will need to be field screened using the processed ex-situ method as moisture content will interfere with the XRF readings. For each of the methods, a minimum of three readings will be taken per sample using the XRF. These three readings will be collected sequentially and averaged to produce a single screening value. The frequency of discrete field screening will be determined on an excavation by excavation basis and will be based on the final extents of the excavation.

The results of the field screening program will be used to either: (i) temporarily suspend excavation activities and proceed with confirmatory sampling; or (ii) continue remedial excavation activities. The field screening results will be used to predict expected compliance with the applicable criteria, whereas the confirmatory sampling analytical data will be used to verify compliance with the applicable criteria. It is recognized that the interpretation of field screening data will evolve as correlations between laboratory and field screening results become established. It is anticipated that field screening results using the XRF will generally fall into three categories:

- Field screening data indicates a high likelihood of a below applicable criteria confirmation laboratory result.
- Field screening result is marginally below the applicable criteria, suggesting the confirmation laboratory result may be just below or above the applicable criteria.
- Field screening data indicates a low likelihood of a below applicable criteria confirmation laboratory result.

Table 7.1 summarizes the planned strategy for the interpretation of the XRF field screening results.

Table 7.1: Strategy for Interpretation of XRF Field Screening Results

XRF Screening Result	Strategy
Less than 50% of arsenic “hotspot” value (<2,000 mg/kg total arsenic)	Proceed with confirmatory sample collection
Between 50% to 100% of arsenic “hotspot” value (2,000 mg/kg to 4,000 mg/kg total arsenic)	Proceed with limited additional remedial work and field screening
Greater than 100% of arsenic “hotspot” value (>4,000 mg/kg total arsenic)	Continue with remedial work and field screening

7.3. Confirmation Sampling

Confirmatory sampling will be completed throughout the remedial works for the purposes of verifying the contaminant concentrations prior to proceeding with backfilling activities. It is expected that the field screening results for both the CGI and XRF will correlate with the laboratory results. However, this correlation will be assessed following the collection of approximately 100 sample pairs.

The analytical testing program will focus on verifying contaminant concentrations at the limits of remedial excavations and thereby confirming compliance with the remedial objectives. Discrete soil samples,

selected based on field screening results, will be submitted to an accredited analytical laboratory for chemical analysis. Discrete confirmatory soil samples will be collected within a grid pattern from the walls and bases of the excavations. The frequency of confirmatory soil sample submission will be determined on an excavation by excavation basis and will consider the lateral extents of the excavation. However, the generally frequency for confirmatory soil sampling will consist of a maximum confirmatory soil sampling grid pattern of 10 m by 10 m (CCME 2016).

7.4. Sample Collection and Handling

Confirmatory samples will be collected for laboratory analysis of either benzene, toluene, ethylbenzene, xylenes (BTEX), and PHC Fractions F1 through F4 or total arsenic. All samples will be collected directly from the excavator bucket and will be gathered using dedicated Terracore samplers and/or a putty knife. All samples will be handled using dedicated nitrile gloves and sampling equipment will be decontaminated using Liquinox and distilled water between sample locations. The confirmatory samples will be placed within laboratory supplied sample containers. Samples for analysis of BTEX and PHC Fractions F1 through F4 will be placed into two 40 mL vials pre-charged with methanol for field preservation and one 125 mL jar, while samples for analysis of total arsenic will be placed in sealable plastic bags. Afterwards the samples will be placed in coolers with ice packs in order to limit the loss of volatile compounds.

7.5. Sample Labelling

Samples must be clearly and consistently labeled using a waterproof, non-smear pen prior to being sent to the laboratory with the following information:

- Company name.
- Site name.
- Sample identification.
- Sample date and time.
- Analysis required.

7.6. Sample Transportation

Sample integrity will be preserved from the time of sample collection to completion of delivery to the laboratory by limiting exposure of samples to heat, light, and agitation. The sample containers will be packed standing upright and immobile in a new or laboratory issued portable cooler. Samples suspected of elevated contaminant levels will be shipped separately from clean samples. All samples will be stored and transported at 10°C to 1°C in the coolers with ice packs and the cooler will be securely closed prior to shipping. Samples will be shipped as soon as possible following sample collection with appropriate transportation instructions such as “refrigerate” and “do not freeze”.

7.7. Chain of Custody Forms

A Chain of Custody (CoC) form containing the following information must be completed by the sampler for every cooler shipment of samples:

- Company name and contact information.
- Analytical laboratory name, address, and contact person.
- Invoicing instructions.
- Report format requested.
- Project information.
- Sampler's name.
- Sample identification number, time and date of sampling, sample type, and analyses requested.
- Any special instructions.
- Name of person releasing the shipment as well as date and time of release.

Each person relinquishing and receiving the samples, including the courier, must sign the CoC form. Each cooler shipped must have a CoC form indicating those samples contained in the particular cooler. CoC forms should be enclosed in a Ziploc bag to protect them from possible water damage during shipment. One copy of the CoC form is included with the shipment and one copy must remain at the Site for recording keeping.

8. Duplicate Samples

Duplicate or replicate sampling is the collection of more than one sample for a given analysis at a given location to test the validity of sampling procedures and laboratory methodology. Duplicates are collected, handled, and analyzed using the same procedures applied to the parent samples. Duplicate soil samples will be collected at an approximate 10% frequency. The location of the duplicate soil samples will be recorded in the field notebook. The duplicate soil samples will be submitted to the laboratory with a unique (fictitious) identifier to prevent association of the paired samples and should be stored and handled the same as the parent samples. At least one duplicate soil sample should be submitted per sample shipment.

9. Laboratory Analysis

ALS Environmental Laboratories (ALS) located in Yellowknife, Northwest Territories will perform the required environmental analyses for the confirmatory samples. ALS is accredited by the Canadian Association for Laboratory Accreditation Inc. (CALA) and conforms to the requirements of ISO/IEC Standard 17025. The scope of accreditation of all ALS laboratories is available from their website at: https://www.alsglobal.com/en/myals/downloads

Should results of the laboratory analysis confirm contaminant concentrations below the applicable remedial objectives, the limits of the remedial excavations will be documented, and backfilling activities will commence. However, should the results identify contaminant concentrations exceeding the applicable remedial objectives, additional excavation will be required, and new samples will be collected

from the revised excavation limits for field screening and confirmatory sampling. This process will continue until the analytical results from all soil samples confirm the contaminant concentrations are below the applicable remedial objectives.

10. Reporting

Throughout the remedial works, daily reports will be produced which will include the following information:

- Date and hours worked.
- Weather and other notable site conditions.
- Daily construction activities completed.
- Daily monitoring activities completed.
- Drawings showing excavation extents and sample locations.
- Field screening concentrations.
- Samples submitted for confirmation sampling.
- Select photographs of the daily work.

In addition, on a weekly basis, field data, field notes, and photographs will be scanned and uploaded to an electronic server for ease of retrieval. As analytical results are received from the laboratory, the results will be communicated by e-mail to the contractor, client, and any other relevant parties.

At the conclusion of the contaminated soils remedial works, a closure report will be produced for LMI. This report will document the results of the remedial excavation activities and will include a description and summary of the remedial works, a summary of the field screening concentrations, a comparison of the results of the confirmatory soil sample analyses to the applicable criteria, and a discussion of the results. The report will also include tables summarizing the analytical results and figures outlining the Site features, excavation extents, confirmatory sampling locations, and analytical results. The report will also include appendices with select photographs of the daily work and copies of the laboratory certificates of analysis.

Legend

Project Location

Coordinate System: NAD_1983_UTM_Zone_12N

Map Sources/Notes:
Various Canadian Government Websites - Feb 2012

0 60 120 240 360 480 600 Km

1:15,000,000

Approved By: SH
Project No.: LUP
Prepared By: PW
Date Revised: 21 Mar 2012

File Name: Lup-12-10-01-LocationMap-A.mxd

Project: **Lupin Project**
Location: Kitikmeot Region, Nunavut, Canada

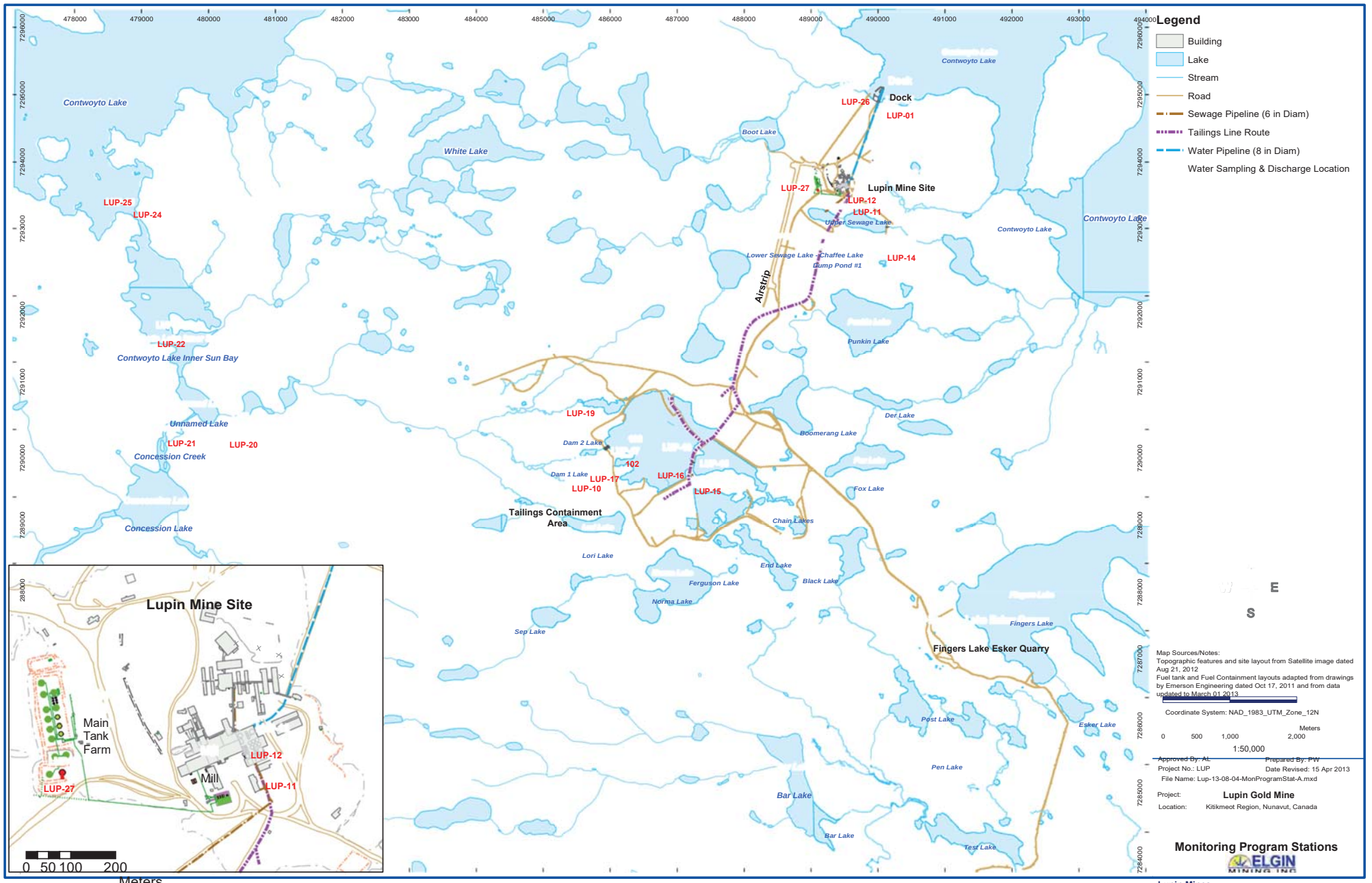
Lupin Mine Annual Report - Water Licence 2AM-LUP0914

Location Map - Lupin Mine

Lupin Mines Incorporated

ELGIN MINING INC.

Figure: 1
Rev: 120321


Legend
Building
Lake
Stream
Road
Sewage Pipeline (6 in Diam)
Tailings Line Route
Water Pipeline (8 in Diam)
Water Sampling & Discharge Location
Lupin Mine Site
Dock
LUP-01
LUP-26
LUP-27
LUP-12
LUP-11
LUP-14
LUP-25
LUP-24
LUP-22
LUP-21
LUP-20
LUP-19
LUP-17
LUP-16
LUP-15
LUP-10
102
Tailings Containment Area
Airstrip
Contwoyto Lake
Boot Lake
White Lake
Upper Sewage Lake
Lower Sewage Lake
Chaffee Lake
Dump Pond #1
Punkin Lake
Contwoyto Lake Inner Sun Bay
Unnamed Lake
Concession Creek
Concession Lake
Dam 2 Lake
Dam 1 Lake
Der Lake
Boomerang Lake
Fox Lake
Chain Lakes
Lori Lake
End Lake
Ferguson Lake
Black Lake
Norma Lake
Sep Lake
Fingers Lake
Fingers Lake Esker Quarry
Esker Lake
Post Lake
Pen Lake
Bar Lake
Test Lake
Main Tank Farm
Mill
0 50 100 200
Meters
Map Sources/Notes:
Topographic features and site layout from Satellite image dated Aug 21, 2012
Fuel tank and Fuel Containment layouts adapted from drawings by Emerson Engineering dated Oct 17, 2011 and from data updated to March 01 2013
Coordinate System: NAD_1983_UTM_Zone_12N
0 500 1,000 2,000
Meters
1:50,000
Approved By: AL
Prepared By: PW
Project No.: LUP
Date Revised: 15 Apr 2013
File Name: Lup-13-08-04-MonProgramStat-A.mxd
Project: Lupin Gold Mine
Location: Kitikmeot Region, Nunavut, Canada
Monitoring Program Stations
ELGIN MINING INC.
Lupin Mines Incorporated
Figure:
Rev:
130415

Appendix A: Chain of Custody

Chain of Custody (COC) / Analytical Request Form

www.alsglobal.com

Canada Toll Free: 1 800 668 9878

Affix ALS barcode label here
(lab use only)

COC Number:

Page of

Report To	Contact and company name below will appear on the final report
Company:	Lupin Mines Inc.
Contact:	Karyn Lewis
Phone:	
	Company address below will appear on the final report
Street:	76 Richmond Street, Suite 330
City/Province:	Toronto ON
Postal Code:	M5C 1P1

Report Format / Distribution

Select Report Format: ☑ PDF ☐ EXCEL ☐ EDD (DIGITAL)
Quality Control (QC) Report with Report ☐ YES ☐ NO
☐ Compare Results to Criteria on Report - provide details below if box checked
Select Distribution: ☑ EMAIL ☐ MAIL ☐ FAX

Email 1 or Fax: k.lewis@mandalayresources.com
Email 2: erichard@golder.com
Email 3: jim.mckinley@stantec.com

Select Service Level Below - Contact your AM to confirm all E&P TATs (surcharges may apply)

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

PRIORITY (Business Days)
- **4 day [P4-20%]** ☐
- **3 day [P3-25%]** ☐
- **2 day [P2-50%]** ☐

EMERGENCY
- **1 Business day [E - 100%]** ☐
- **Same Day, Weekend or Statutory holiday [E2 -200%** ☐
  (Laboratory opening fees may apply)]

Date and Time Required for all E&P TATs: dd-mmm-yy hh:mm

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

Invoice To	Same as Report To ☑ YES ☐ NO
	Copy of Invoice with Report ☑ YES ☐ NO
Company:	
Contact:	k.lewis@mandalayresources.com

Invoice Distribution

Select Invoice Distribution: ☐ EMAIL ☑ MAIL ☐ FAX
Email 1 or Fax:
Email 2:

Project Information

ALS Account # / Quote #: Q80133
Job #:
PO / AFE:
LSD:

Oil and Gas Required Fields (client use)

AFE/Cost Center: PO#
Major/Minor Code: Routing Code:
Requisitioner:
Location:

ALS Lab Work Order # (lab use only):

ALS Contact: Oliver Gregg **Sampler:**

Analysis Request

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

NUMBER OF CONTAINERS

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	Conventional (pH, EC, Alk-Tot, hardness, TS	Nutrients (Nitrate, Nitrite and total ammonia)	Total Metals + Hg	Cyanide	Radium-226	Acute Toxicity Daphnia magna	Acute Toxicity Rainbowm Trout	Major Ions	Phosphorus (colorimetric)	Sublethal Toxicity - Fathead Minnows	Sublethal Toxicity - Ceridaphinia dubia	Sublethal Toxicity - Lemna minor	Sublethal Toxicity - P. subcapitata		**SAMPLES ON HOLD**	**SUSPECTED HAZARD (see Special Instructions)**
	LUP-10			Effluent	R	R	R	R	R	R	R	R	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 consumption/ use?
☐ YES ☐ NO

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

SAMPLE CONDITION AS RECEIVED (lab use only)

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

INITIAL COOLER TEMPERATURES ºC				FINAL COOLER TEMPERATURES ºC			

SHIPMENT RELEASE (client use)		
Released by:	Date:	Time:

INITIAL SHIPMENT RECEPTION (lab use only)		
Received by:	Date:	Time:

FINAL SHIPMENT RECEPTION (lab use only)		
Received by:	Date:	Time:

REFER TO BACK PAGE FOR ALS LOCATIONS AND SAMPLING INFORMATION

WHITE - LABORATORY COPY YELLOW - CLIENT COPY

OCT 2018 FRONT

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 B: Scope of Accreditations

Canadian Association for Laboratory Accreditation Inc.

Certificate of Accreditation

ALS Environmental (Vancouver)
ALS Canada Ltd.
8081 Lougheed Highway
Suite 100
Burnaby, British Columbia

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.:	A1719
Issued On:	December 12, 2018
Accreditation Date:	January 3, 2005
Expiry Date:	June 11, 2021

President & CEO

CALA
Canadian Association for
Laboratory Accreditation Inc.

CALA Directory of Laboratories

Membership Number: 1719
Laboratory Name: ALS Environmental (Vancouver)
Parent Institution: ALS Canada Ltd.
Address: 8081 Lougheed Highway Suite 100 Burnaby BC V5A 1W9
Contact: Ms. Helenita Franco
Phone: (604) 253-4188
Fax: (604) 253-6700
Email: quality.vancouver@alsglobal.com

Standard: Conforms with requirements of ISO/IEC 17025
Clients Served: All Interested Parties
Revised On: June 18, 2020
Valid To: June 11, 2021

Scope of Accreditation

Air (Inorganic)
Dustfall - Air [Dustfall] (227)
VA-TM-1039; ASTM D1739-98 and BC MOE LABORATORY MANUAL
GRAVIMETRIC
Fixed Dustfall
Total Dustfall
Total Insoluble Dustfall
Total Soluble Dustfall

Air (Inorganic)
Mercury - Air [Dustfall] (271)
NA-TM-1005, NA-TP-2012, VA-TP-2063; modified from BC MOE LABORATORY MANUAL and EPA 1631E
COLD VAPOUR AAS - DIGESTION
Mercury

Air (Inorganic)
Metals - Air [Dustfall] (224)
NA-TM-1002, NA-TP-2007, VA-TP-2063; modified from BC MOE LABORATORY MANUAL and EPA 6020B
ICP/MS - DIGESTION
Aluminum
Antimony
Arsenic
Barium
Beryllium
Bismuth
Boron

† "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

Calcium
Chromium
Cobalt
Copper
Lead
Lithium
Magnesium
Manganese
Molybdenum
Nickel
Potassium
Selenium
Silver
Sodium
Strontium
Thallium
Tin
Uranium
Vanadium
Zinc

Air (Inorganic)
Total Particulates - Air [Filter, Particulate] (035)
VA-TM-1041; modified from ASTM D2009-65 and BC WORKERS COMPENSATION BOARD STANDARDS (BCWCB) 1150
GRAVIMETRIC
Respirable Dust
Total Particulate Matter

Air (Organic)
Volatile Organic Compounds (VOC) - Air (206)
VA-TM-1109; modified from EPA TO-17
GC/MS
1,1-Dichloroethane
1,1-Dichloroethylene
1,1-Dichloropropene
1,1,1-Trichloroethane
1,1,1,2-Tetrachloroethane
1,1,2-Trichloroethane
1,1,2-Trichlorotrifluoroethane
1,1,2,2-Tetrachloroethane
1,2-Dibromo-3-chloropropane (DBCP)
1,2-Dibromoethane (Ethylene dibromide)
1,2-Dichlorobenzene
1,2-Dichloroethane
1,2-Dichloropropane
1,2,3-Trichlorobenzene
1,2,3-Trichloropropane

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1,2,4-Trichlorobenzene
1,2,4-Trimethylbenzene
1,3-Butadiene
1,3-Dichlorobenzene
1,3-Dichloropropane
1,3,5-Trimethylbenzene
1,4-Dichlorobenzene
2-Butanone (Methyl ethyl ketone, MEK)
2-Chlorophenol
2-Chlorotoluene
2-Hexanone (Methyl butyl ketone, MBK)
2-Propanol (Isopropyl alcohol)
2,2-Dichloropropane
4-Chlorotoluene (p-Chlorotoluene)
4-isopropyltoluene (p-Cymene)
4-Methyl-2-pentanone (MIBK)
Acetone (2-Propanone)
Benzene
Biphenyl (1,1-Biphenyl)
Bromobenzene
Bromochloromethane
Bromodichloromethane
Bromoform
Bromomethane
Carbon disulfide
Carbon tetrachloride
Chlorobenzene
Chloroethane (Ethyl Chloride)
Chloroethene (Vinyl chloride)
Chloroform
Chloromethane (Methyl chloride)
cis-1,2-Dichloroethylene
cis-1,3-Dichloropropene
Cyclohexane
Decane
Dibromochloromethane
Dibromomethane
Dichlorodifluoromethane
Dichloromethane (Methylene Chloride)
Ethyl acetate
Ethylbenzene
Hexachlorobutadiene
Isopropylbenzene (Cumene)
m,p-Xylene
Methyl tert-butyl ether (MTBE)
Methylcyclohexane

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n-Butylbenzene
n-Heptane
n-Hexane
n-Octane
n-Propylbenzene
Naphthalene
o-Xylene
sec-Butylbenzene
Styrene
tert-Butylbenzene
Tetrachloroethylene
Toluene
trans-1,2-Dichloroethylene
trans-1,3-Dichloropropene
Trichloroethylene
Trichlorofluoromethane

Air (Organic)
Volatile Organic Compounds (VOC) - Air (207)
VA-TM-1109; modified from EPA TO-17
GC/FID
F1: C6-C10
F2: C10-C16
Total Volatile Organic Compounds (TVOC): >C10-C12
Total Volatile Organic Compounds (TVOC): >C12-C16
Total Volatile Organic Compounds (TVOC): >C6-C8
Total Volatile Organic Compounds (TVOC): >C8-C10
Volatile Hydrocarbons (VH): C6-C13

Dust (Inorganic)
Soluble Anions - Dustfall (255)
NA-TM-1001, VA-TM-1039; modified from BC MOE LABORATORY MANUAL and EPA 300.0 and SM 4110
ION CHROMATOGRAPHY
Chloride
Nitrate

Food
Arsenic Speciation - Food [Egg, Fresh Fruit, Meat, Processed Food, Vegetables] (236)
NA-TM-1002, NA-TP-2007, VA-TM-1082; modified from CFIA SOM-DAR-CHE-053-04 and EPA 6020A
HPLC - ICP/MS
Arsenate (As(V))
Arsenite (As(III))
Arsenobetaine (AsB)
Arsenocholine (AsC)
Dimethylarsinic acid (DMA)
Monomethyl arsenate (MMA)

Food (Inorganic)
Methyl mercury - Seafood (272)
NA-TM-1002, VA-TM-1088; modified from FDA METHOD 4.8
HPLC - ICP/MS
Methyl mercury

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Oil (Organic)
Total Polychlorinated Biphenyls (PCB) - Oil (080)
VA-TM-1118, VA-TP-2116; modified from EPA 3620C and EPA 3660B and EPA 3665A and EPA 600/4-81-045 and EPA 8082A
GC/ECD
Aroclor 1016
Aroclor 1221
Aroclor 1232
Aroclor 1242
Aroclor 1248
Aroclor 1254
Aroclor 1260
Aroclor 1262
Aroclor 1268
Total PCB

Paint (Inorganic)
Lead - Paint (261)
NA-TM-1002, NA-TP-2004; modified from EPA 200.2 and EPA 6020B
ICP/MS - DIGESTION
Lead

Soil (Inorganic)
Acidity - Solids [Soil] (257)
VA-TM-1053, VA-TM-1074; modified from MEND REPORT 1.20.1 and SM 2320 B
TITRIMETRIC - SHAKEFLASK EXTRACTION
Acidity

Soil (Inorganic)
Alkalinity - Solids [Soil] (258)
VA-TM-1053, VA-TM-1074; modified from MEND REPORT 1.20.1 and SM 2320 B
TITRIMETRIC - SHAKEFLASK EXTRACTION
Alkalinity

Soil (Inorganic)
Anions - Solids [Leachate] (256)
NA-TM-1001, VA-TM-1078; modified from BC MOE LABORATORY MANUAL and EPA 300.0 and SM 4110
ION CHROMATOGRAPHY (IC) - FIXED RATIO EXTRACTION
Chloride
Chloride
Sulphate
Sulphate (Sulfate)

Soil (Inorganic)
Leachable Anions - Solids [Soil] (244)
NA-TM-1001, VM-TM-1074; modified from EPA 300.1 and MEND REPORT 1.20.1
IC - SHAKEFLASK EXTRACTION
Bromide
Chloride
Fluoride
Nitrate as Nitrogen
Nitrite as Nitrogen
Sulphate (Sulfate)

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Soil (Inorganic)
Leachable Metals - Solids [Soil] (247)
NA-TM-1002, NA-TP-2007, VA-TM-1074; modified from EPA 6020B and MEND REPORT 1.20.1
ICP/MS - SHAKEFLASK EXTRACTION
Aluminum
Antimony
Arsenic
Barium
Beryllium
Bismuth
Boron
Cadmium
Calcium
Chromium
Cobalt
Copper
Iron
Lead
Lithium
Magnesium
Manganese
Molybdenum
Nickel
Phosphorus
Potassium
Selenium
Silicon
Silver
Sodium
Strontium
Thallium
Tin
Uranium
Vanadium
Zinc

Soil (Inorganic)
pH - Solids [Soil] (250)
VA-TM-1074; modified from MEND REPORT 1.20.1 and SM 4500-H
pH METER-Shake flask Extraction
pH

Soil (Microbiology)
Fecal (Thermotolerant) Coliforms - Solids [Soil] (245)
VA-TM-1200; modified from EPA 1680
MOST PROBABLE NUMBER
Fecal (Thermotolerant) Coliforms

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Solids (Inorganic)
Acid Volatile Sulphide (AVS) - Solids [Soil] (230)
VA-TM-1021; modified from EPA 821-R-91-100
COLORIMETRIC - EXTRACTION
Acid Volatile Sulfides

Solids (Inorganic)
Anions - Solids [Soil] (148)
NA-TM-1001, VA-TP-2066; modified from EPA 300.1 and SM 4110 B and SOIL SAMPLING & METHODS OF ANALYSIS CHAPTER 15
IC-SATURATED EXTRACTION
Bromide
Chloride
Fluoride
Nitrate-N
Nitrite
Sulphate

Solids (Inorganic)
Conductivity - Solids [Soil] (147)
VA-TM-1053, VA-TP-2066; modified from SM 2510 B and SOIL SAMPLING & METHODS OF ANALYSIS CHAPTER 15
METER - SATURATION EXTRACTION
Conductivity

Solids (Inorganic)
Cyanide - Solids [Soil] (213)
NA-TM-1003, VA-WI-3019; modified from BC MOE LABORATORY MANUAL and ISO 14403 and ON MOECC E3015 and SM 4500-CN- I
AUTO COLOR - DISTILLATION-EXTRACTION
Cyanide (SAD)
Cyanide (WAD)

Solids (Inorganic)
Cyanide - Solids [Soil] (214)
NA-TM-1003, VA-WI-3019; modified from ASTM 7237 and BC MOE LABORATORY MANUAL and ON MOECC E3015
AUTO COLOR/GAS DIFFUSION-EXTRACTION
Cyanide, Free

Solids (Inorganic)
Flashpoint - Solids [Ash] (264)
VA-TM-1090; modified from ASTM D93-15
PENSKE-MARTEN CLOSED CUP
Flashpoint

Solids (Inorganic)
Leachable Mercury - Solids [Soil] (270)
NA-TM-1005, NA-TP-2012, VA-TM-1074; modified from MEND REPORT 1.20.1
COLD VAPOUR AA - SPECTROMETRIC SHAKE FLASK EXTRACTION
Mercury

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Solids (Inorganic)
Leachable Mercury - Solids [Waste] (267)
NA-TM-1005, NA-TP-2012, VA-TM-1071; modified from BC MOE ENVIRONMENTAL MANAGEMENT ACT HAZARDOUS WASTE REGULATION (EMA/HWR) and EPA 1631E
CVAAS-MELP EXTRACTION
Mercury

Solids (Inorganic)
Leachable Mercury - Solids [Waste] (268)
NA-TM-1005, NA-TM-1700, NA-TP-2012; modified from EPA 1311 (PREPARATION) and EPA 1631E (ANALYSIS)
COLD VAPOUR AA - TCLP EXTRACTION
Mercury

Solids (Inorganic)
Leachable Metals - Solids (121)
VA-TM-1066, VA-TM-1071, VA-TP-2072; modified from BC MOE ENVIRONMENTAL MANAGEMENT ACT HAZARDOUS WASTE REGULATION (EMA/HWR) and EPA 6010D
ICP/OES- MLEP EXTRACTION
Arsenic
Barium
Boron
Cadmium
Chromium
Copper
Lead
Selenium
Silver
Uranium
Zinc

Solids (Inorganic)
Leachable Metals - Solids (122)
NA-TM-1700, VA-TM-1066, VA-TP-2072; modified from EPA 1311 (PREPARATION) and EPA 6010D (ANALYSIS)
ICP/OES - EXTRACTION - TCLP
Antimony
Arsenic
Barium
Beryllium
Boron
Cadmium
Calcium
Chromium
Cobalt
Copper
Iron
Lead
Magnesium
Nickel
Selenium

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Silver
Thallium
Vanadium
Zinc
Zirconium

Solids (Inorganic)
Leachable Metals - Solids [Soil] (235)
NA-TM-1002, NA-TM-1700, NA-TP-2007; modified from BC PROTOCOL 13 (ANALYSIS) and EPA 1311 (PREPARATION) and EPA 6020B (ANALYSIS)
ICP/MS - Extraction - TCLP
Antimony
Arsenic
Barium
Beryllium
Boron
Cadmium
Calcium
Chromium
Cobalt
Copper
Iron
Lead
Magnesium
Nickel
Selenium
Silver
Thallium
Uranium
Vanadium
Zinc
Zirconium

Solids (Inorganic)
Mercury - Solids [Soil] (269)
NA-TM-1005, NA-TP-2004, NA-TP-2012; modified from BC MOE LABORATORY MANUAL, SALM (PREPARATION) and EPA 1631E (ANALYSIS) and EPA 200.2 (ANALYSIS)
COLD VAPOUR AAS - DIGESTION
Mercury

Solids (Inorganic)
Metals - Solids [Soil] (152)
NA-TM-1002, NA-TP-2004, NA-TP-2007; modified from BC MOE LABORATORY MANUAL, SALM (PREPARATION) and EPA 200.2 (ANALYSIS) and EPA 6020B (ANALYSIS)
ICP/MS - DIGESTION
Aluminum
Antimony
Arsenic
Barium
Beryllium
Bismuth

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Boron
Cadmium
Calcium
Chromium
Cobalt
Copper
Iron
Lead
Lithium
Magnesium
Manganese
Molybdenum
Nickel
Phosphorus
Potassium
Selenium
Silver
Sodium
Strontium
Thallium
Tin
Titanium
Uranium
Vanadium
Zinc
Zirconium

Solids (Inorganic)
Metals - Solids [Soil] (153)
VA-TM-1066, VA-TP-2066, VA-TP-2072; modified from EPA 6010D and SOIL SAMPLING & METHODS OF ANALYSIS CHAPTER 15
ICP/OES - SATURATION EXTRACTION
Calcium
Magnesium
Potassium
Sodium

Solids (Inorganic)
Methyl Mercury - Solids [Soil] (173)
VA-TM-1062; modified from EPA 1630
P&T - GC - CVAFS - EXTRACTION
Methyl mercury

Solids (Inorganic)
Moisture - Solids [Soil] (089)
NA-TM-1200; CCME CWS PETROLEUM HYDROCARBONS IN SOIL - TIER 1 METHOD
GRAVIMETRIC
Percent Moisture

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Solids (Inorganic)
Oil and Grease - Solids [Soil] (239)
VA-TM-1125; modified from BC MOE LABORATORY MANUAL
GRAVIMETRIC - EXTRACTION
Mineral Oil and Grease

Solids (Inorganic)
Paint Filter - Solids [Paint] (262)
VA-TM-1055; modified from EPA 9095B
FILTRATION
Paint Filter (Free Liquid)

Solids (Inorganic)
Percent Saturation - Solids [Saturated Paste] (149)
VA-TP-2066; modified from SOIL SAMPLING & METHODS OF ANALYSIS CHAPTER 15
GRAVIMETRIC - SATURATED PASTE
Percent Saturation

Solids (Inorganic)
pH - Solids [Soil] (120)
VA-TM-1078, VA-TP-2066; modified from SM 4500-H+ B and SOIL SAMPLING & METHODS OF ANALYSIS CHAPTER 15
METER - SATURATION EXTRACTION
pH

Solids (Inorganic)
pH - Solids [Soil] (169)
VA-TM-1078; modified from BC MOE LABORATORY MANUAL and SM 4500-H+ B
METER - FIXED RATIO EXTRACTION
pH

Solids (Inorganic)
Simultaneously Extracted Metals (SEM) - Solids [Soil] (228)
NA-TM-1005, NA-TP-2011, NA-TP-2012, VA-TM-1021; modified from EPA 1631E and EPA 821-R-91-100
CVAFS - SEM EXTRACTION
Mercury

Solids (Inorganic)
Simultaneously Extracted Metals (SEM) - Solids [Soil] (229)
VA-TM-1021, VA-TM-1066, VA-TP-2072; modified from EPA 6010D and EPA 821-R-91-100
ICP/OES - SEM EXTRACTION
Arsenic
Cadmium
Copper
Lead
Nickel
Zinc

Solids (Inorganic)
Waste Oil - Solids (123)
VA-TM-1111; BC MOE LABORATORY MANUAL
GRAVIMETRIC - EXTRACTION
Waste Oil Content

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Solids (Organic)
Extractable Hydrocarbons - Solids [Soil] (184)
NA-TM-1106, NA-TP-2106; modified from BC MOE LABORATORY MANUAL and EPA 3570
GC/FID - EXTRACTION (COLD SHAKE)
EPH C10-C19 (sg)
EPH C19-C32 (sg)
Extractable Petroleum Hydrocarbons (EPH): C10-C19
Extractable Petroleum Hydrocarbons (EPH): C19-C32

Solids (Organic)
Glycols - Solids [Soil] (156)
VA-TM-1113; modified from EPA 8015B
GC/FID - EXTRACTION
Diethylene glycol
Ethylene glycol
Propylene glycol
Triethylene glycol

Solids (Organic)
Organochlorine (OC) Pesticides - Solids [Soil] (079)
VA-TM-1121, VA-TP-2117; modified from EPA 3540C and EPA 3630C and EPA 3660B and EPA 8081B
GC/ECD - EXTRACTION
2,4'-DDD (o,p'-DDD)
2,4'-DDE (o,p'-DDE)
2,4'-DDT (o,p'-DDT)
4,4'-DDD (p,p'-DDD)
4,4'-DDE (p,p'-DDE)
4,4'-DDT (p,p'-DDT)
4,4'-Methoxychlor (p,p'-Methoxychlor)
Aldrin
alpha-BHC
alpha-Chlordane
beta-BHC
beta-HCH (beta-Hexachlorocyclohexane (b-HCH, b-BHC, beta-BHC, beta-Hexachlorocyclohexane)
cis-Nonachlor
Dieldrin
Endosulfan I (a-Endosulfan)
Endosulfan II (b-Endosulfan)
Endosulfan Sulfate
Endrin
gamma-Chlordane
Heptachlor
Heptachlor epoxide
Lindane (gamma-BHC)
Mirex
Oxychlordane
trans-Nonachlor

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Solids (Organic)
Petroleum Hydrocarbons (PHC) - Solids [Soil] (189)
NA-TM-1100, NA-TP-2100; modified from ALBERTA ENVIRONMENT INTERPRETATION, SEPT 2003 and CCME CWS PETROLEUM HYDROCARBONS IN SOIL - TIER 1 METHOD (DEC 2000 NO. 1310)
GC/FID - TUMBLER EXTRACTION
F2: C10-C16
F3: C16-C34
F4: C34-C50

Solids (Organic)
Petroleum Hydrocarbons (PHC) - Solids [Soil] (190)
NA-TM-1100; modified from ALBERTA ENVIRONMENT INTERPRETATION, SEPT 2003 and CCME CWS PETROLEUM HYDROCARBONS IN SOIL - TIER 1 METHOD (DEC 2000 NO. 1310)
GRAVIMETRIC - TUMBLER EXTRACTION
F4: Gravimetric
F4G-SG: Gravimetric Heavy Hydrocarbons - Silica

Solids (Organic)
Phenols - Solids [Soil] (071)
VA-TM-1122, VA-TP-2113; modified from EPA 3570 and EPA 8270D and KNAPP 1979
GC/MS - EXTRACTION
2-Chlorophenol
2-Methylphenol (o-Cresol)
2,3-Dichlorophenol
2,3,4-Trichlorophenol
2,3,4,5-Tetrachlorophenol
2,3,4,6-Tetrachlorophenol
2,3,5-Trichlorophenol
2,3,5,6-Tetrachlorophenol
2,3,6-Trichlorophenol
2,4-Dichlorophenol + 2,5-Dichlorophenol
2,4-Dimethylphenol
2,4,5-Trichlorophenol
2,4,6-Trichlorophenol
2,6-Dichlorophenol
3-Chlorophenol
3,4-Dichlorophenol
3,4,5-Trichlorophenol
3,5-Dichlorophenol
4-Chloro-3-methylphenol
4-Chlorophenol
4-Methylphenol (p-Cresol)
m-Cresol
Pentachlorophenol
Phenol

Solids (Organic)
Polycyclic Aromatic Hydrocarbons (PAH) - Solids [Soil] (185)
NA-TM-1106, NA-TP-2103; modified from EPA 3570 and EPA 8270D
GC/MS - EXTRACTION (COLD SHAKE)
2-Methylnaphthalene

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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
Phenanthrene
Pyrene
Quinoline

Solids (Organic)
Total Polychlorinated Biphenyls (PCB) - Solids [Soil] (112)
VA-TM-1119, VA-TP-2116; modified from EPA 3570 and EPA 3620C and EPA 3660B and EPA 3665A and EPA 8082A
GC/ECD - EXTRACTION
Aroclor 1016
Aroclor 1221
Aroclor 1232
Aroclor 1242
Aroclor 1248
Aroclor 1254
Aroclor 1260
Aroclor 1262
Aroclor 1268
Total PCB

Solids (Organic)
Volatile Hydrocarbons (VH) - Solids [Soil] (202)
NA-TM-1102, NA-TP-2102; modified from BC MOE LABORATORY MANUAL and CCME CWS PETROLEUM HYDROCARBONS IN SOIL - TIER 1 METHOD and EPA 5021A
GC/FID - HEADSPACE
F1: C6-C10
VH: C6-C10

Solids (Organic)
Volatile Organic Compounds (VOC) - Solids (263)
NA-TM-1102, VA-TM-1126; modified from EPA 1311 (PREPARATION) and EPA 8260C (ANALYSIS)
GC/MS - HEADSPACE - TCLP
1,1-Dichloroethene
1,2-Dichlorobenzene
1,2-Dichloroethane
1,4-Dichlorobenzene
Benzene

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Bromodichloromethane
Bromoform
Carbon tetrachloride
Chlorobenzene
Chlorodibromomethane
Chloroethene (Vinyl chloride)
Chloroform
Dichloromethane (Methylene Chloride)
Ethylbenzene
m,p-Xylene
Methyl ethyl ketone
o-Xylene
Tetrachloroethylene
Toluene
Trichloroethylene

Solids (Organic)
Volatile Organic Compounds (VOC) - Solids [Soil] (201)
NA-TM-1102, NA-TP-2102; modified from EPA 5021A and EPA 8260C
GC/MS - HEADSPACE
1,1-Dichloroethane
1,1-Dichloroethylene
1,1,1-Trichloroethane
1,1,1,2-Tetrachloroethane
1,1,2-Trichloroethane
1,1,2,2-Tetrachloroethane
1,2-Dichlorobenzene
1,2-Dichloroethane
1,2-Dichloropropane
1,2,4-Trimethylbenzene
1,3-Dichlorobenzene
1,3,5-Trimethylbenzene
1,4-Dichlorobenzene
4-Isopropylbenzene
Benzene
Bromodichloromethane
Bromoform
Carbon tetrachloride
Chlorobenzene
Chlorodibromomethane
Chloroethane (Ethyl Chloride)
Chloroethene (Vinyl chloride)
Chloroform
Chloromethane (Methyl chloride)
cis-1,2-Dichloroethylene
cis-1,3-Dichloropropene
Dichloromethane

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Ethylbenzene
Ethylene Dibromide
Isopropylbenzene (Cumene)
m,p-Xylene
Methyl t-butyl ether
n-Propylbenzene
Naphthalene
o-Xylene
Styrene
Tetrachloroethylene
Toluene
trans-1,2-Dichloroethylene
trans-1,3-Dichloropropene
Trichloroethylene
Trichlorofluoromethane

Swab (Organic)
Total Polychlorinated Biphenyls (PCB) - Solids [Swab] (249)
VA-TM-1120, VA-TP-2116; modified from EPA 3620C and EPA 3660B and EPA 3665A and EPA 8082A
GC/ECD - EXTRACTION
Aroclor 1016
Aroclor 1221
Aroclor 1232
Aroclor 1242
Aroclor 1248
Aroclor 1254
Aroclor 1260
Aroclor 1262
Aroclor 1268

Tissue (Inorganic)
Ashfree - Tissue (259)
VM-TM-1051; modified from SM 10300
GRAVIMETRIC
Ash-free weight

Tissue (Inorganic)
Lipid Content - Tissue (241)
VA-TM-1112; modified from EPA 3570 and EPA 8290A
GRAVIMETRIC
Lipid Content

Tissue (Inorganic)
Methyl Mercury - Tissue (172)
VA-TM-1062; modified from EPA 1630
P&T - GC - CVAFS - DIGESTION
Methyl mercury

Tissue (Inorganic)
Moisture - Tissue (090)
VA-TM-1087; modified from PUGET SOUND PROTOCOLS
GRAVIMETRIC
Percent Moisture

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Tissue (Inorganic)
Selenium Speciation - Tissue (253)
NA-TM-1002, NA-TP-2007, VA-TM-1085; CFIA METHOD SOM-DAR CHE-053-04
HPLC - ICP/MS
Selenium (IV)
Selenium (VI)
SelenoMethionine

Tissue (Inorganic)
Total Mercury - Tissue (266)
NA-TM-1005, NA-TP-2006, NA-TP-2012; modified from EPA 1631E and EPA 200.3
COLD VAPOUR AA - SPECTROMETRIC
Mercury

Tissue (Inorganic)
Total Metals - Tissue (100)
NA-TM-1002, NA-TP-2006, NA-TP-2007; modified from EPA 200.3 and EPA 6020A
ICP/MS - DIGESTION
Aluminum
Antimony
Arsenic
Barium
Beryllium
Bismuth
Boron
Cadmium
Calcium
Cesium
Chromium
Cobalt
Copper
Iron
Lead
Lithium
Magnesium
Manganese
Molybdenum
Nickel
Phosphorus
Potassium
Rubidium
Selenium
Silver
Sodium
Strontium
Sulphur (Sulfur)
Tellurium
Thallium
Tin

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Titanium

Uranium

Vanadium

Zinc

Zirconium

Urine (Inorganic)
Creatinine - Biomaterials [Urine] (234)
VA-TM-1052; THERMO DRI CREATININE-DETECT SPECIMEN VALIDITY TEST
COLORIMETRIC

Creatinine

Urine (Organic)
Arsenic Speciation - Biomaterials [Urine] (233)
NA-TM-1002, NA-TP-2007, VA-TM-1081; modified from CDC METHOD ID ITU003B, 2004 and EPA 6020A
HPLC-ICPMS

Arsenate (As(V))

Arsenite (As(III))

Arsenobetaine (AsB)

Dimethylarsinic acid (DMA)

Monomethyl arsenate (MMA)

Total Arsenic Species

Total Inorganic Arsenic

Total Inorganic Arsenic and Methylated Metabolites

Water (Inorganic)
Acidity - Water (219)
VA-TM-1053; modified from SM 2310
TITRIMETRIC

Acidity

Water (Inorganic)
Alkalinity - Water (001)
VA-TM-1053; modified from SM 2320 B
TITRIMETRIC

Alkalinity (pH 4.5)

Alkalinity-Bicarbonate

Alkalinity-Carbonate

Alkalinity-Hydroxide

Phenolphthalein Alkalinity

Water (Inorganic)
Ammonia - Water (208)
VA-TM-1024; JOURNAL OF ENVIRONMENTAL MONITORING (2005) SECTION 7, P. 37-42
AUTO-FLUORESCENCE

Ammonia

Water (Inorganic)
Anions - Water (026)
NA-TM-1001; modified from EPA 300.1
IC

Bromide

Chloride

Fluoride

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Nitrate

Nitrate plus Nitrite

Nitrite

Sulfate

Water (Inorganic)
Arsenic - Water (232)
NA-TM-1002, NA-TP-2007, VA-TM-1086; modified from USGS Water Resources Investigation Report 02-4144
HPLC - ICPMS

Arsenate (AsV)

Arsenite (ASIII)

Arsenobetaine (AsB)

Dimethylarsinic acid (DMA)

Monomethyl arsenate (MMA)

Total Arsenic Species

Total Inorganic Arsenic

Total Inorganic Arsenic and Methylated Metabolites

Water (Inorganic)
Biochemical Oxygen Demand (BOD) - Water (027)
VA-TM-1032; modified from SM 5210 B
D.O. METER

BOD (5 day)

CBOD (5 day)

Soluble Biological Oxygen Demand (SBOD)

Water (Inorganic)
Carbon - Water (091)
VA-TM-1037; modified from SM 5310 B
IR - COMBUSTION

Inorganic Carbon

Organic Carbon

Total Carbon (TC)

Water (Inorganic)
Chemical Oxygen Demand (COD) - Water (028)
VA-TM-1033; modified from SM 5220 D
COLOR - DIGESTION

COD

Water (Inorganic)
Chlorophyll A - Water (220)
VA-TM-1038, VA-TP-2011; modified from EPA 445.0
FLUORIMETRY

Chlorophyll a

Water (Inorganic)
Colour - Water (015)
VA-TM-1004; modified from BC MOE Laboratory Manual and SM 2120 C
COLORIMETRIC

Apparent Colour

True Colour

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Water (Inorganic)
Conductivity - Water (004)
VA-TM-1053; modified from SM 2510 B
CONDUCTIVITY METER
Conductivity (25˚C)

Water (Inorganic)
Cyanide - Water (209)
NA-TM-1003; modified from ISO 14403 and SM 4500-CN- I
AUTO COLOR - DISTILLATION
Cyanide (SAD)
Cyanide (WAD)

Water (Inorganic)
Cyanide - Water (210)
NA-TM-1003; modified from ASTM D7237
AUTO COLOR (GAS DIFFUSION)
Cyanide, Free

Water (Inorganic)
Dissolved Ferrous Iron - Water (242)
VA-TM-1046, VA-TP-2009; modified from SM 3500-FE
COLORIMETRIC - FILTRATION
Ferrous Iron

Water (Inorganic)
Dissolved Metals - Water (032)
NA-TM-1002, NA-TP-2002, NA-TP-2007; modified from EPA 6020B and SM 3030 B
ICP/MS - FILTRATION
Aluminum
Antimony
Arsenic
Barium
Beryllium
Bismuth
Boron
Cadmium
Calcium
Cesium
Chromium
Cobalt
Copper
Gallium
Gold
Indium
Iron
Lanthanum
Lead
Lithium
Magnesium
Manganese
Molybdenum

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Nickel
Niobium
Phosphorus
Potassium
Rhenium
Rubidium
Selenium
Silicon
Silver
Sodium
Strontium
Sulphur (Sulfur)
Tantalum
Tellurium
Thallium
Thorium
Tin
Titanium
Tungsten
Uranium
Vanadium
Yttrium
Zinc
Zirconium

Water (Inorganic)
Dissolved Metals - Water (036)
NA-TP-2002, VA-TM-1066, VA-TP-2072; modified from EPA 6010D and SM 3030 B
ICP/OES
Aluminum
Antimony
Arsenic
Barium
Beryllium
Bismuth
Boron
Cadmium
Calcium
Chromium
Cobalt
Copper
Iron
Lead
Lithium
Magnesium
Manganese
Molybdenum

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Nickel
Phosphorus
Potassium
Selenium
Silicon
Silver
Sodium
Strontium
Thallium
Tin
Titanium
Vanadium
Zinc

Water (Inorganic)
Mercury - Water (136)
NA-TM-1005, NA-TP-2002, VA-TP-2068; modified from EPA 1631E
CVAFS - BrCl DIGESTION
Mercury

Water (Inorganic)
Mercury - Water (265)
NA-TM-1005, NA-TP-2002, NA-TP-2012; modified from EPA 1631E
COLD VAPOUR AA - SPECTROMETRIC
Mercury

Water (Inorganic)
Methyl Mercury - Water (192)
VA-TM-1062; modified from EPA 1630
P&T GC-CVAFS-DISTILLATION
Methyl mercury

Water (Inorganic)
Nitrogen - Water (217)
VA-TM-1047, VA-WI-3046; modified from SM 4500-P J
AUTO COLOR - DIGESTION
Total Dissolved Nitrogen
Total Nitrogen

Water (Inorganic)
Oil and Grease - Water (061)
NA-TM-1107; modified from EPA 1664
GRAVIMETRIC - EXTRACTION
Mineral Oil and Grease
Total Oil and Grease

Water (Inorganic)
pH - Water (018)
VA-TM-1053; modified from SM 4500-H+ B
pH METER
pH

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Water (Inorganic)
Phosphorus - Water (179)
VA-TM-1025, VA-TP-2009, VA-WI-3046; modified from SM 4500-P B and SM 4500-P E
COLOR - DIGESTION (AUTOCLAVE)
Phosphate
Total Dissolved Phosphorus
Total Phosphorus

Water (Inorganic)
Reactive Silica - Water (008)
VA-TM-1018; modified from SM 4500-SIO2 D
COLORIMETRIC
Reactive Silica

Water (Inorganic)
Selenium Speciation - Water (252)
NA-TM-1002, NA-TP-2007, VA-TM-1084; Spectrochimica Acta Part B60 (2005) 633-641
HPLC - ICP/MS
Selenium (IV)
Selenium (VI)
SelenoMethionine

Water (Inorganic)
Solids - Water (016)
NA-TM-1004, VA-TM-1009, VA-TM-1050; modified from SM 2540 B and SM 2540 C and SM 2540 D and SM 2540 E
GRAVIMETRIC
Fixed Suspended Solids
Total Dissolved Solids
Total Solids (TS)
Total Suspended Solids
Volatile Suspended Solids

Water (Inorganic)
Sulphide - Water (010)
VA-TM-1020; modified from SM 4500-S2- D
COLOR
Sulphide

Water (Inorganic)
Thiocyanate - Water (014)
VA-TM-1029; modified from SM 4500-CN- M
COLOR
Thiocyanate

Water (Inorganic)
Total Kjeldahl Nitrogen (TKN) - Water (211)
VA-TM-1044; modified from SM 4500-NORG D
AUTO FLUORESCENCE - DIGESTION
Dissolved Kjeldahl Nitrogen
Total Kjeldahl Nitrogen

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Water (Inorganic)

Total Metals - Water (031)

NA-TM-1002, NA-TP-2001, NA-TP-2007; modified from EPA 200.2 and EPA 6020B

ICP/MS - DIGESTION

- Aluminum
- Antimony
- Arsenic
- Barium
- Beryllium
- Bismuth
- Boron
- Cadmium
- Calcium
- Cesium
- Chromium
- Cobalt
- Copper
- Gallium
- Gold
- Indium
- Iron
- Lanthanum
- Lead
- Lithium
- Magnesium
- Manganese
- Molybdenum
- Nickel
- Niobium
- Phosphorus
- Potassium
- Rhenium
- Rubidium
- Selenium
- Silicon
- Silver
- Sodium
- Strontium
- Sulphur (Sulfur)
- Tantalum
- Tellurium
- Thallium
- Thorium
- Tin
- Titanium
- Tungsten

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Uranium
Vanadium
Yttrium
Zinc
Zirconium

Water (Inorganic)
Total Metals - Water (041)
NA-TP-2001, VA-TM-1066, VA-TP-2072; modified from EPA 6010D and SM 3030 E
ICP/OES - DIGESTION
Aluminum
Antimony
Arsenic
Barium
Beryllium
Bismuth
Boron
Cadmium
Calcium
Chromium
Cobalt
Copper
Iron
Lead
Lithium
Magnesium
Manganese
Molybdenum
Nickel
Phosphorus
Potassium
Selenium
Selenium
Silicon
Silver
Sodium
Strontium
Thallium
Tin
Titanium
Vanadium
Zinc

Water (Inorganic)
Turbidity - Water (020)
VA-TM-1011; modified from SM 2130 B
TURBIDIMETRIC
Turbidity

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Water (Inorganic)
UV Absorbance and Transmittance - Water (254)
VA-TM-1042, VA-TP-2011; modified from SM 5910 B
SPECTROPHOTOMETRIC
UV Absorbance
UV Transmittance

Water (Microbiology)
Coliforms - Water (145)
NA-TM-1300; modified from SM 9223 B
MOST PROBABLE NUMBER (ENZYME SUBSTRATE)
Escherichia coli
Fecal (Thermotolerant) Coliforms
Total Coliforms

Water (Microbiology)
Enterococci - Water (186)
VA-TM-1203; modified from SM 9230 C
MEMBRANE FILTRATION (mENTEROCOCCUS)
Enterococci

Water (Microbiology)
Escherichia coli (E. coli) - Water (240)
VA-TM-1201; modified from SM 9222 G
MEMBRANE FILTRATION (mFC/NA-MUG)
Escherichia coli

Water (Microbiology)
Fecal (Thermotolerant) Coliforms - Water (029)
VA-TM-1200; modified from SM 9221 E
MOST PROBABLE NUMBER
Fecal (Thermotolerant) Coliforms

Water (Microbiology)
Fecal (Thermotolerant) Coliforms - Water (030)
VA-TM-1201; modified from SM 9222 D
MEMBRANE FILTRATION (mFC)
Fecal (Thermotolerant) Coliforms

Water (Microbiology)
Heterotrophic Plate Count (HPC) - Water (126)
NA-TM-1301; modified from SM 9215 B
POUR PLATE (PLATE COUNT AGAR)
Heterotrophic Plate Count (HPC)

Water (Microbiology)
Pseudomonas aeruginosa - Water (187)
VA-TM-1204; modified from SM 9213 E
MEMBRANE FILTRATION (mPAC)
Pseudomonas aeruginosa

Water (Microbiology)
Total Coliforms - Water (142)
VA-TM-1200; modified from SM 9221 B
MOST PROBABLE NUMBER
Total Coliforms

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Water (Microbiology)
Total Coliforms - Water (143)
VA-TM-1201; modified from SM 9222 B
MEMBRANE FILTRATION (mENDO)
Total Coliforms

Water (Organic)
Extractable Petroleum Hydrocarbons (EPH) - Water (251)
NA-TM-1112, VA-TP-2127, VA-TP-2129; BC MOE LABORATORY MANUAL
GC/FID - EXTRACTION
EPH C10-C19 (sg)
EPH C19-C32 (sg)
Extractable Petroleum Hydrocarbons (EPH): C10-C19
Extractable Petroleum Hydrocarbons (EPH): C19-C32
Total Extractable Hydrocarbons (TEH): C10-C30

Water (Organic)
Glycols - Water (155)
VA-TM-1113; modified from EPA 8015C
GC/FID - EXTRACTION
Diethylene glycol
Ethylene glycol
Propylene glycol
Triethylene glycol

Water (Organic)
Petroleum Hydrocarbons (PHC) - Water (238)
NA-TM-1112, NA-TP-2100; modified from CCME CWS PETROLEUM HYDROCARBONS IN SOIL - TIER 1 METHOD and EPA 3511
GC/FID - EXTRACTION
F2: C10-C16
F3: C16-C34
F4: C34-C50

Water (Organic)
Phenols - Water (059)
VA-TM-1101, VA-TP-2113; modified from BC MOE LABORATORY MANUAL and EPA 3510C and EPA 8270D
GC/MS - EXTRACTION
2-Chlorophenol
2-Methylphenol (o-Cresol)
2,3-Dichlorophenol
2,3,4-Trichlorophenol
2,3,4,5-Tetrachlorophenol
2,3,4,6-tetrachlorophenol
2,3,5-Trichlorophenol
2,3,5,6-Tetrachlorophenol
2,3,6-Trichlorophenol
2,4-Dichlorophenol
2,4-Dimethylphenol
2,4,5-Trichlorophenol
2,4,6-trichlorophenol
2,6-Dichlorophenol

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3-Chlorophenol
3,4-Dichlorophenol
3,4,5-Trichlorophenol
3,5-Dichlorophenol
4-Chloro-3-methylphenol
4-Chlorophenol
4-Methylphenol (p-Cresol)
m-Cresol
Pentachlorophenol
Phenol

Water (Organic)
Polycyclic Aromatic Hydrocarbons (PAH) - Water (237)
NA-TM-1112, VA-TP-2128; modified from EPA 3511 and EPA 8270D
GC/MS - EXTRACTION
1-Methylnaphthalene
2-Methylnaphthalene
Acenaphthene
Acenaphthylene
Acridine
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
Phenanthrene
Pyrene
Quinoline

Water (Organic)
Resin and Fatty Acids - Water (212)
VA-TM-1105, VA-TP-2114; modified from EPA 3510C and EPA 8270D
GC/MS/LIQUID-LIQUID EXTRACTION
12-Chlorodehydroabietic acid
14-Chlorodehydroabietic acid
Abietic acid
Arachidic acid
Behenic acid
Dehydroabietic acid
Dichlorodehydroabietic acid
Dodecanoic acid (Lauric acid)
Hexadecanoic acid (Palmitic acid)

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Isopimaric acid + Palustric acid
Levopimaric acid
Lignoceric acid
Linoleic acid
Linolenic acid (Octadecadienoic acid)
Myristic acid (Tetradecanoic Acid)
Neoabietic acid
Oleic acid
Pimaric acid
Sandaracopimaric acid
Stearic acid (Octadecanoic acid)

Water (Organic)
Total Polychlorinated Biphenyls (PCB) - Water (115)
VA-TM-1115, VA-TP-2116; modified from EPA 3510C and EPA 3620C and EPA 3660B and EPA 3665A and EPA 8082A
GC/ECD - EXTRACTION
Aroclor 1016
Aroclor 1221
Aroclor 1232
Aroclor 1242
Aroclor 1248
Aroclor 1254
Aroclor 1260
Aroclor 1262
Aroclor 1268
Total PCB

Water (Organic)
Volatile Hydrocarbons (VH) - Water (197)
NA-TM-1102; modified from BC MOE LABORATORY MANUAL and CCME CWS PETROLEUM HYDROCARBONS IN SOIL - TIER 1 METHOD and EPA 5021A
GC/FID - HEADSPACE
F1: C6-C10
Volatile Hydrocarbons (VH): C6-C10

Water (Organic)
Volatile Organic Compounds (VOC) - Water (196)
NA-TM-1102, NA-TP-2102; modified from EPA 5021A and EPA 8260C
GC/MS - HEADSPACE
1,1-Dichloroethane
1,1-Dichloroethylene
1,1,1-Trichloroethane
1,1,1,2-Tetrachloroethane
1,1,2-Trichloroethane
1,1,2,2-Tetrachloroethane
1,2-Dichlorobenzene
1,2-Dichloroethane
1,2-Dichloropropane
1,2,4-Trimethylbenzene
1,3-Dichlorobenzene

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1,3,5-Trimethylbenzene
1,4-Dichlorobenzene
4-isopropyltoluene (p-Cymene)
Acetone (2-Propanone)
Benzene
Bromodichloromethane
Bromoform
Carbon tetrachloride
Chlorobenzene
Chlorodibromomethane
Chloroethane (Ethyl Chloride)
Chloroform
Chloromethane (Methyl chloride)
cis-1,2-Dichloroethylene
cis-1,3-Dichloropropene
Dichloromethane
Ethylbenzene
Ethylene Dibromide
Isopropylbenzene (Cumene)
m,p-Xylene
Methyl ethyl ketone
Methyl isobutyl ketone (MIBK)
Methyl t-butyl ether
n-Propylbenzene
Naphthalene
o-Xylene
Styrene
Tetrachloroethylene
Toluene
trans-1,2-Dichloroethylene
trans-1,3-Dichloropropene
Trichloroethylene
Trichlorofluoromethane
Vinyl chloride

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CALA
Canadian Association for
Laboratory Accreditation Inc.

CALA Directory of Laboratories

Membership Number: 2800
Laboratory Name: Nautilus Environmental-Calgary
Parent Institution: Nautilus Environmental Company Inc.
Address: #4, 6125 12th St. S.E. Calgary AB T2H 2K1
Contact: Ms. Tamara Pomeroy
Phone: (403) 253-7121
Fax: (403) 252-9363
Email: tamara@nautilusenvironmental.ca; tanya@nautilusenvironmental.ca

Standard: Conforms with requirements of ISO/IEC 17025
Clients Served: All Interested Parties
Revised On: September 12, 2019
Valid To: November 25, 2021

Scope of Accreditation

Solids (Toxicology)
Chironomids - Solids [Sediment] (013)
WTR-ME-026; EPS 1/RM/32
SURVIVAL AND GROWTH
Freshwater midge Chironomus dilutus (formerly Chironomus tentans) (10d)

Solids (Toxicology)
Hyalella azteca - Solids [Sediment] (014)
WTR-ME-021; EPS 1/RM/33
SURVIVAL AND GROWTH
Freshwater Amphipod Hyalella Azteca (14d)

Water (Microbiology)
Microcystins - Water (058)
WTRQ-ME-016; ENZYME-LINKED IMMUNOSORBENT ASSAY FOR THE CONGENER-INDEPENDENT DETERMINATION OF MICROCYSTINS & NODULARINS IN WATER SAMPLES
ELISA
Microcystins

Water (Toxicology)
Ceriodaphnia dubia - Water (006)
WTR-ME-018; EPS 1/RM/21
SURVIVAL AND REPRODUCTION
Ceriodaphnia dubia

Water (Toxicology)
Daphnia magna - Water (002)
WTR-ME-015; EPS 1/RM/11 and EPS 1/RM/14
ACUTE LETHALITY (SURVIVAL)
Daphnia LC50 (48 h)

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Daphnia Single Concentration (48h)

Water (Toxicology)
Fathead Minnow - Water (007)
WTR-ME-046; EPS 1/RM/22
GROWTH AND SURVIVAL
Fathead minnow (Pimephales promelas)

Water (Toxicology)
Hyalella azteca - Water (059)
WTR-ME-065; EPS 1/RM/33
SURVIVAL AND GROWTH
Hyalella azteca

Water (Toxicology)
Lemna minor - Water (017)
WTR-ME-030; EPS 1/RM/37
GROWTH INHIBITION
Freshwater macrophyte (Lemna minor)

Water (Toxicology)
Microtox - Water (003)
SOIL-ME-001; EPS 1/RM/24
BIOLUMINESCENCE
Microtox IC50 (15 min)

Water (Toxicology)
Pseudokirchneriella subcapitata - Water (008)
WTR-ME-034; EPS 1/RM/25
GROWTH INHIBITION
Freshwater alga (Pseudokirchneriella subcapitata)

Water (Toxicology)
Rainbow Trout - Water (001)
WTR-ME-041; EPS 1/RM/13 and EPS 1/RM/9
ACUTE LETHALITY (SURVIVAL)
Single Concentration (96h)
Trout LC50 (96 h)

Water (Toxicology)
Rainbow Trout [pH Stabilization] - Water (057)
WTR-ME-062; EPS 1/RM/13 and EPS 1/RM/50
ACUTE LETHALITY (pH STABILIZATION)
Single Concentration (96h)
Trout LC50 (96h)

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CALA Directory of Laboratories

Membership Number: 2635
Laboratory Name: Taiga Environmental Laboratory
Parent Institution: Government of Northwest Territories (GNWT)
Address: P.O. Box 1320 4601 - 52nd Avenue Yellowknife NT X1A 2L9
Contact: Mr. Bruce Stuart
Phone: (867) 767-9235
Fax: (867) 920-8740
Email: bruce_stuart@gov.nt.ca; taiga@gov.nt.ca; Glen_hudy@gov.nt.ca

Standard: Conforms with requirements of ISO/IEC 17025
Clients Served: All Interested Parties
Revised On: December 11, 2019
Valid To: March 5, 2022

Scope of Accreditation

Solids (Inorganic)
Moisture - Solids [Soil] (030)
TEL007; CCME CWS PETROLEUM HYDROCARBONS IN SOIL - TIER 1 METHOD
GRAVIMETRIC
Percent Moisture

Solids (Organic)
BTEX - Solids [Soil] (072)
TEL038; modified from EPA 502.2 and EPA 5030B and EPA 602
GC/MS - PURGE AND TRAP
Benzene
Ethylbenzene
m,p-Xylene
o-Xylene
Toluene

Solids (Organic)
Purgeable Hydrocarbons - Solids [Soil] (074)
TEL056; CCME CWS PETROLEUM HYDROCARBONS IN SOIL - TIER 1 METHOD
GC/FID - PURGE AND TRAP
F1: C6-C10

Water (Inorganic)
Alkalinity - Water (066)
TEL060:PC TITRATE; modified from SM 2320 A and SM 2320 B
AUTO TITRIMETRIC
Alkalinity (pH 4.5)

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Water (Inorganic)
Ammonia Nitrogen - Water (089)
TEL068; modified from SM 4500-NH3 G
COLORIMETRIC - DISCRETE
Ammonia

Water (Inorganic)
Anions - Water (059)
TEL055; modified from SM 4110 B
ION CHROMATOGRAPHY
Chloride
Fluoride
Nitrate
Nitrite
Sulfate

Water (Inorganic)
Biochemical Oxygen Demand (BOD) - Water (004)
TEL019; modified from SM 5210 A and SM 5210 B
D.O. METER
BOD (5 day)
CBOD (5 day)

Water (Inorganic)
Carbon - Water (029)
TEL033; modified from SM 5310 B
INFRARED
Organic Carbon

Water (Inorganic)
Cations - Water (042)
TEL055; modified from SM 4110 B
ION CHROMATOGRAPHY
Calcium
Magnesium
Potassium
Sodium

Water (Inorganic)
Chemical Oxygen Demand (COD) - Water (061)
TEL016; modified from SM 5220 D
REFLUX - COLORIMETRIC
COD

Water (Inorganic)
Colour - Water (063)
TEL051; modified from SM 2120 C
SPECTROPHOTOMETRIC
Apparent Colour
True Colour

Water (Inorganic)
Conductivity - Water (068)
TEL059:PC TITRATE; modified from SM 2510 B
AUTO CONDUCTIVITY METER
Conductivity (25˚C)

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Water (Inorganic)
Dissolved Metals - Water (013)
TEL035; modified from EPA 200.8
ICP/MS
Aluminum
Antimony
Arsenic
Barium
Beryllium
Boron
Cadmium
Cesium
Chromium
Cobalt
Copper
Iron
Lead
Lithium
Manganese
Molybdenum
Nickel
Rubidium
Selenium
Silver
Strontium
Thallium
Tin
Titanium
Uranium
Vanadium
Zinc

Water (Inorganic)
Mercury - Water (080)
TEL062; modified from EPA 245.7
ATOMIC FLUORESCENCE
Mercury

Water (Inorganic)
Oil and Grease - Water (060)
TEL024: HEM; modified from EPA 1664A (REVISION A)
GRAVIMETRIC - EXTRACTION
Total Oil and Grease

Water (Inorganic)
pH - Water (067)
TEL058:PC TITRATE; modified from SM 4500-H+ A and SM 4500-H+ B
AUTO - pH METER
pH

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Water (Inorganic)
Phosphate - Water (087)
TEL069; modified from SM 4500-P F
COLORIMETRIC - DISCRETE
Phosphate

Water (Inorganic)
Reactive Silica - Water (090)
TEL070; modified from SM 4500-SI F
COLORIMETRIC - DISCRETE
Reactive Silica

Water (Inorganic)
Solids - Water (011)
TEL008, TEL009; modified from SM 2540 C and SM 2540 D
GRAVIMETRIC
Total Dissolved Solids
Total Suspended Solids

Water (Inorganic)
Total and Dissolved Nitrogen - Water (086)
TEL066; modified from ASTM D5176-91 and ISO 11905
PYROLYSIS - CHEMILUMINESCENCE
Dissolved Nitrogen
Total Nitrogen

Water (Inorganic)
Total and Dissolved Phosphorus - Water (088)
TEL069; modified from SM 4500-P F
COLORIMETRIC - DISCRETE
Dissolved Phosphorus
Total Phosphorus

Water (Inorganic)
Total Metals - Water (054)
TEL035; modified from EPA 200.8
ICP/MS
Aluminum
Arsenic
Barium
Beryllium
Boron
Cadmium
Cesium
Chromium
Cobalt
Copper
Iron
Lead
Lithium
Manganese
Mercury
Molybdenum

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Nickel
Rubidium
Selenium
Silver
Strontium
Thallium
Tin
Titanium
Uranium
Vanadium
Zinc

Water (Inorganic)
Turbidity - Water (028)
TEL006; modified from SM 2130 B
NEPHELOMETRY
Turbidity

Water (Microbiology)
Coliforms - Water (045)
TEL053; modified from IDEXX QUANTI-TRAY
MOST PROBABLE NUMBER (QUANTI-TRAY)
Escherichia coli
Total Coliforms

Water (Microbiology)
Fecal (Thermotolerant) Coliforms - Water (041)
TEL017; modified from SM 9222 D
MEMBRANE FILTRATION (mFC)
Fecal (Thermotolerant) Coliforms

Water (Microbiology)
Fecal Streptococci - Water (055)
TEL053; modified from IDEXX QUANTI-TRAY
MOST PROBABLE NUMBER (QUANTI-TRAY)
Fecal streptococci

Water (Organic)
BTEX - Water (070)
TEL037:BTEX; modified from EPA 502.2 and EPA 5030B and EPA 602
GC/MS - PURGE AND TRAP
Benzene
Ethylbenzene
m,p-Xylene
o-Xylene
Toluene

Water (Organic)
Extractable Hydrocarbons - Water (085)
TEL067; modified from EPA 3510C and EPA 3630C and SM 6010
GC/FID - SOLID PHASE EXTRACTION
C10-C50

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Water (Organic)
Purgeable Hydrocarbons - Water (084)
TEL044; modified from EPA 5030 and EPA 8000 and EPA 8015 and EPA 8260B
GC/FID - PURGE AND TRAP
C6-C10

Water (Organic)
Trihalomethanes (THM) - Water (077)
TEL039:THM; modified from EPA 502.2 and EPA 5030B and EPA 602
GC/MS - PURGE AND TRAP
Bromodichloromethane
Bromoform
Chlorodibromomethane
Chloroform

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