

APPENDIX B-2
SUMMARY OF COPC SCREENING OUTCOMES FROM THE
PHASE II ENVIRONMENTAL SITE ASSESSMENT

Appendix B2- Summary COPC Screening Outcomes from the Phase II Environmental Site Assessment

In August of 2021, Wood (2021) completed a Phase II Environmental Site Assessment (ESA) in accordance with the Nova Scotia Environment (NSE) Contaminated Site Regulations (CSRs) Phase II ESA Protocol (PRO-400) and Checklist (CHK-400), for Crown land associated with the former Montague Gold Mine site. The main purpose of the investigation was to further delineate soil, groundwater, and surface water contamination at the former Montague Gold Mine site. A total of two hundred (200) soil samples, including eighteen (18) duplicate samples were collected from eighty-six (86) hand auger locations and six (6) borehole locations. All soil samples were submitted for the analysis of metals including mercury. Select samples were also submitted for the analysis of cyanide (sample locations within known areas of tailings), total petroleum hydrocarbons (TPH), and benzene, ethylbenzene, toluene and xylene (BTEX) (sample locations of known historical infrastructure). Monitoring wells were installed in all six (6) boreholes. A total of seven (7) groundwater samples, including one (1) field duplicate, were collected and submitted for laboratory analysis of dissolved metals (including both dissolved and total mercury), cyanide, BTEX/PHCs, and general chemistry. Three (3) surface water samples were collected from the small tailings area on the southern portion of the Site (i.e., AEC 2). These three (3) samples were collected for analysis of total metals, including total and dissolved mercury, and general chemistry (Wood, 2021).

As part of the investigation, Wood (2021) compared the soil, groundwater and surface water data collected to the following criteria:

- NSE Tier 1 Environmental Quality Standards (EQS) for Soil at a Potable Site (agricultural land use, coarse-grained soil), (accessed online September 2021);
- NSE Tier 1 EQS for Soil at a Potable Site (residential land use, coarse-grained soil), (accessed online September 2021);
- NSE Tier 1 EQS for Groundwater (potable groundwater, coarse-grained soil, agricultural/residential land use), (accessed online September 2021); and,
- NSE Tier 1 EQS for Freshwater Surface Water.

A summary of the exceedances identified by Wood (2021) are provided in Table B-1. Complete screening tables are provided in Tables E-2 through E-8 in Appendix E of Wood (2021).

Table B-1 Summary of Metal Exceedances in Soil, Groundwater and Surface Water at Montague Relative to the Nova Scotia Environment Tier 1 Environmental Quality Standards (Wood, 2021)

<i>Media</i>	<i>Metal</i>	<i>Number of Samples</i>	<i>Maximum Concentration</i>	<i>Mean Concentration</i>	<i>NSE Tier 1 Standard (Agricultural)</i>	<i>NSE Tier 1 Standard (Residential)</i>	<i>Number of Samples/ Locations Exceeding NSE Tier 1 Standard (Agricultural)</i>	<i>Number of Samples/ Locations Exceeding NSE Tier 1 Standard (Residential)</i>
Soil (mg/kg)	Aluminum	200	34,000	11,347	15,400	15,400	95/60	95/60
	Antimony	200	24	2.1	7.5	7.5	8/5	8/5
	Arsenic	200	18,000	1,075	17	31	168/81	155/73
	Cobalt	200	160	7.9	20	22	11/8	9/7
	Copper	200	490	32.5	63	1,100	20/14	1/1
	Iron	200	110,000	21,969	11,000	11,000	143/70	143/70
	Lead	200	470	48.1	70	140	33/22	12/7
	Mercury	200	79	3.1	6.6	6.6	18/9	18/9
	Nickel	200	100	15	50	330	5/5	-
	Selenium	200	8	0.96	1	80	47/33	1/1
	Silver	200	34	0.59	20	77	2/1	-
	Tin	200	5	2.7	5	9,400	5/3	-
	Vanadium	200	240	24.6	39	39	16/12	16/12
	Zinc	200	400	53.5	200	5,600	11/8	-
Cyanide	46	4.9	1.3	0.9	29	6/5	-	

Table B-1 Summary of Metal Exceedances in Soil, Groundwater and Surface Water at Montague Relative to the Nova Scotia Environment Tier 1 Environmental Quality Standards (Wood, 2021)

<i>Media</i>	<i>Metal</i>	<i>Number of Samples</i>	<i>Maximum Concentration</i>	<i>Mean Concentration</i>	<i>NSE Tier 1 Standard (Agricultural)</i>	<i>NSE Tier 1 Standard (Residential)</i>	<i>Number of Samples/ Locations Exceeding NSE Tier 1 Standard (Agricultural)</i>	<i>Number of Samples/ Locations Exceeding NSE Tier 1 Standard (Residential)</i>
Groundwater (µg/L)	Arsenic	7	90	70.9	10		3/3	
Surface water (µg/L)	Aluminum	3	361	225	5		3/3	
	Arsenic	3	4520	2,839	5		3/3	
	Cadmium	3	0.045	0.04	0.01		2/2	
	Cobalt	3	10.7	4.40	10		1/1	
	Copper	3	15.8	7.09	2		3/3	
	Iron	3	8,940	6,773	300		3/3	
	Lead	3	46.6	17.8	1		3/3	
	Manganese	3	1280	527	820		1/1	
	Mercury	3	0.69	0.28	0.026		3/3	
	Zinc	3	35.1	18.6	30		1/1	

Notes: Soil samples were compared to the NSE Tier 1 EQS for Soil at a Potable Site (agricultural/residential land use, coarse-grained soil), (accessed online September 2021). Groundwater samples were compared to the NSE Tier 1 EQS for Groundwater (potable groundwater, coarse-grained soil, agricultural/residential land use), (accessed online September 2021). Surface water samples were compared to the NSE Tier 1 EQS for Freshwater Surface Water.

A full COPC screening was provided in the Problem Formulation document for Montague (Intrinsic et al, 2020) and a summary of the final COPC screening outcomes for data collected in the historical sampling programs and 2020 field program is provided in Appendix B. Given that the screening conducted in Appendix B did not account for the data collected in the Wood (2021) Phase II ESA, an additional screening was conducted using concentrations of chemicals measured in soil, groundwater and surface water that were identified as exceeding the NSE Tier 1 EQS by Wood (2021; see Table B-1). For those chemicals that had concentrations greater than NS Tier 1 EQS, bioaccumulative and biomagnitive characteristics, background concentrations and statistics (i.e., frequency of exceedance, margin of exceedance and/or 95th percentiles) were utilized to determine which COPCs would be retained for further evaluation in the ERA. A detailed summary of the final COPC screening outcomes for each media is provided below.

Inorganic Chemicals

Soil

For those metals that had concentrations greater than NS Tier 1 EQS, the following was completed:

- Frequency and margin of exceedance above the NS Tier 1 Ecological EQS were determined and evaluated for each metal exceeding the standards;
- Comparison of the 95th percentile of inorganics in soil data to the NS Tier 1 Ecological EQS was also conducted. The 95th percentile of site data is an accepted screening metric, as outlined in CCME (2020);
- Metals identified through these comparisons as potential COPCs and those metals with no applicable NSE Tier 1 Ecological EQS were moved forward to screening against background soil concentrations to finalize COPC selection.

Table B-2 summarizes comparisons of additional statistics (i.e., frequency of exceedance and margin of exceedance for maximum concentrations and 95th percentiles) of the fifteen (15) metals in soil to the NSE Tier 1 Ecological EQS and background concentrations.

Based on these comparisons the following can be concluded:

- Metals with < 15% frequency of exceedance over NS Tier 1 Ecological EQS included antimony, cobalt, copper, mercury, nickel, silver, tin, vanadium, zinc, and cyanide.
- Metals with a margin of exceedance within 2.5-fold over NS Tier 1 Ecological EQS included antimony, nickel, silver, tin, vanadium and zinc.
- Metals wherein the 95th percentile of site data did not exceed the NS Tier 1 EQS included antimony, nickel, silver, tin and vanadium.
- Metals wherein the 95th percentile of site data was within 2.5-fold of the NS Tier 1 EQS included cobalt, copper, lead, mercury and zinc.
- Metals wherein the 95th percentile of site data was within 2.5-fold of background included aluminum, iron and selenium.

Based on these comparisons, aluminum, antimony, cobalt, copper, iron, nickel, selenium, silver, tin, vanadium, zinc and cyanide are not considered to be COPCs at the Site, as these substances are unlikely to be drivers in terms of toxicity or remedial decision making. Arsenic was retained due its high frequency and margins of exceedance (maximum concentration and/or 95th percentiles) over the NS Tier 1 EQS and background metric (Table B-2). Lead and mercury were also retained due to their bioaccumulative and/or biomagnitive properties.

Therefore, based on a secondary screening of the available Phase II ESA data, terrestrial COPCs at the Site include arsenic, lead and mercury.

Groundwater

As shown in Table B-1, three (3) groundwater samples collected from 2021-MW3, 2021-MW5 and 2021-MW6 exceeded the NSE Tier 1 EQS (10 µg/L) for groundwater for sites located 0-10 m from a surface water body. It is noted that all monitoring wells were located >10 m from a surface water body and the NSE Tier 1 EQS for groundwater for sites located at >10 m from a surface waterbody is 50 µg/L. Two (2) groundwater samples (i.e., 2021-MW3 and 2021-MW6) exceeded this metric. To further refine the potential risks of arsenic to aquatic life, surface water data was collected (see discussion below).

Surface Water

For those metals that had concentrations greater than NS Tier 1 EQS, the following was completed:

- Frequency and margin of exceedance above the NS Tier 1 EQS were determined and evaluated for each metal exceeding the standards;
- Metals identified through these comparisons as potential COPCs were moved forward to screening against background soil concentrations to finalize COPC selection.

Table B-3 summarizes comparisons of additional statistics (i.e., frequency of exceedance and margin of exceedance for maximum concentrations) of the ten (10) metals in surface water to the NSE Tier 1 EQS and background concentrations.

Based on these comparisons the following can be concluded:

- Metals with a margin of exceedance within 2.5-fold over NS Tier 1 EQS included cobalt, manganese and zinc.
- Metals with a margin of exceedance within 2.5-fold over background concentrations included aluminum and cadmium.

Based on these comparisons, aluminum, cadmium, cobalt, manganese, and zinc are not considered to be COPCs in AEC 2 as these substances are unlikely to be drivers in terms of toxicity or remedial decision making. Although the maximum concentration of iron exceeded the NSE Tier 1 EQS and background metric, the high total arsenic concentration reflects the iron present, ubiquitously, in particulate matter and the risks associated with particulate matter are being evaluated though consideration of COPCs (e.g. arsenic, copper, lead and mercury). Additionally, iron was not identified as a COPC in previous screenings (see Appendix B). As

such, iron was not retained as a COPC in AEC 2. Given that the maximum concentrations of arsenic, copper, lead and mercury exceeded the NS Tier 1 EQS and background concentrations and lead and mercury have bioaccumulative and biomagnitive properties, respectively, **arsenic, copper, lead and mercury were retained as aquatic COPCs in AEC 2 for further evaluation in the ERA.**

Organic Chemicals

Wood (2021) analyzed a total of eleven (11) soil samples and all seven (7) groundwater samples for non-inorganic chemicals, including total petroleum hydrocarbons (TPH), benzene, ethylbenzene, toluene and xylene (BTEX) and compared these data to the NSE Tier 1 EQS. Modified TPH (Tier 1) marginally exceeded the agricultural and residential EQS in one (1) sample (i.e., 2021-SS63-A) collected in AEC 1. All groundwater samples met the applicable NSE Tier 1 EQS. Based on these data, and the lack of exceedances, or minor degree of exceedances, these compounds were not considered to merit further assessment.

Table B-2 Step 2 Screening of Metals in Soil

<i>Metal</i>	<i>NSE Tier 1 Soil Standard (mg/kg)^a</i>	<i>Maximum Concentration (mg/kg)</i>	<i>Frequency of Exceedance >NSE Tier 1 Soil Standard</i>	<i>Margin of Exceedance >NSE Tier 1 Soil Standard^b</i>	<i>95th Percentile of Soil Inorganics (mg/kg)</i>	<i>Margin of Exceedance >NSE Tier 1 Soil Standard^c</i>	<i>Background Concentration (mg/kg)^d</i>	<i>Margin of Exceedance >Background^e</i>
Aluminum	NV	34,000	NA	NA	24,050	NA	20,200	1.2
Antimony	20	24	2/200 (1.0%)	1.20	7.2	DNE	NA	-
Arsenic	17	18,000	168/200 (84%)	1,059	6,445	379	218	30
Cobalt	20	160	11/200 (5.5%)	8.00	21	1.05	NA	-
Copper	63	490	20/200 (10%)	7.78	96	1.52	NA	-
Iron	NV	110,000	NA	NA	44,150	NA	35,400	1.2
Lead	70	470	33/200 (17%)	6.71	170	2.43	NA	-
Mercury	12	79	17/200 (8.5%)	6.58	18	1.50	NA	-
Nickel	50	100	5/200 (2.5%)	2.00	36	DNE	NA	-
Selenium	1	8	47/200 (23.5%)	8.00	3.11	3.11	1.9	1.63
Silver	20	34	2/200 (1.0%)	1.70	0.72	DNE	NA	-
Tin	5	5	5/200 (2.5%)	1.00	3	DNE	NA	-
Vanadium	130	240	2/200 (1.0%)	1.85	47	DNE	NA	-
Zinc	200	400	11/200 (5.5%)	2.00	210	1.05	NA	-
Cyanide	0.9	4.9	6/200 (13%)	5.44	5	5.56	NA	-

Bolded values in greyscale exceeded the Step 2 screening criteria.

NA Not applicable

DNE Does not exceed standard

a. Represents the lowest/most sensitive ecological NS Tier 1 EQS.

b. Difference between maximum soil concentration (mg/kg) and the lowest/most sensitive NS Tier 1 EQS (mg/kg) (expressed as fold-difference).

c. Difference between 95th percentile (mg/kg) and the lowest/most sensitive NS Tier 1 EQS (mg/kg) (expressed as fold-difference).

Table B-2 Step 2 Screening of Metals in Soil

<i>Metal</i>	<i>NSE Tier 1 Soil Standard (mg/kg)^a</i>	<i>Maximum Concentration (mg/kg)</i>	<i>Frequency of Exceedance >NSE Tier 1 Soil Standard</i>	<i>Margin of Exceedance >NSE Tier 1 Soil Standard^b</i>	<i>95th Percentile of Soil Inorganics (mg/kg)</i>	<i>Margin of Exceedance >NSE Tier 1 Soil Standard^c</i>	<i>Background Concentration (mg/kg)^d</i>	<i>Margin of Exceedance >Background^e</i>
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- d. Represents maximum of Public Health soils (0–5 cm of soils; <2 mm size fraction; ACME aqua regia digestion) collected at the Montague Mine Site (Parsons and Little unpublished data).
- e. Difference between 95th percentile (mg/kg) and the background concentration (expressed as fold-difference).

Table B-3 Step 2 Screening of Metals in Surface Water

<i>Metal</i>	<i>NSE Tier 1 Standard (µg/L)^a</i>	<i>Maximum Concentration (µg/L)</i>	<i>Frequency of Exceedance >NSE Tier 1 Soil Standard</i>	<i>Margin of Exceedance >NSE Tier 1 Soil Standard^b</i>	<i>Background Concentration (µg/L)^c</i>	<i>Margin of Exceedance >Background^d</i>
Aluminum	5	361	3/3 (100%)	72	206	1.75
Arsenic	5	4,520	3/3 (100%)	904	0.76/30 ^e	5,947
Cadmium	0.01	0.045	2/3 (66%)	4.5	0.0173	2.6
Cobalt	10	10.7	1/3 (33%)	1.1	NA	-
Copper	2	15.8	3/3 (100%)	7.9	0.97	16
Iron	300	8,940	3/3 (100%)	30	140	64
Lead	1	46.6	3/3 (100%)	47	0.243	192
Manganese	820	1,280	1/3 (33%)	1.6	NA	-
Mercury	0.026	0.69	3/3 (100%)	27	0.002/0.026 ^e	345
Zinc	30	35.1	1/3 (33%)	1.2	NA	-

Bolded values in greyscale exceeded the Step 2 screening criteria.

NA Not applicable

- a. Represents the NSE Tier 1 EQS for Freshwater Surface Water.

Table B-3 Step 2 Screening of Metals in Surface Water						
<i>Metal</i>	<i>NSE Tier 1 Standard (µg/L)^a</i>	<i>Maximum Concentration (µg/L)</i>	<i>Frequency of Exceedance >NSE Tier 1 Soil Standard</i>	<i>Margin of Exceedance >NSE Tier 1 Soil Standard^b</i>	<i>Background Concentration (µg/L)^c</i>	<i>Margin of Exceedance >Background^d</i>

- b. Difference between maximum surface water concentration (µg/L) and the lowest/most sensitive NS Tier 1 EQS (µg/L) (expressed as fold-difference).
- c. Represents the maximum background concentration from Loon Lake and Lake Major (Intrinsic et al., 2019).
- d. Difference between maximum surface water concentration (µg/L) and the background concentration (µg/L) (expressed as fold-difference).
- e. Second value is Tier 2 Closure Criterion.

References

Intrinsic et al, 2019. Conceptual Closure Study for the Historical Montague Mines Tailings Areas, Halifax Nova Scotia. Final Report. Submitted to Nova Scotia Lands, Sydney Nova Scotia. Submitted by: Intrinsic Corp, EcoMetrix, Klohn Crippen Berger and Wood. July 24, 2019.

Intrinsic et al, 2020. Problem Formulation of the Ecological Risk Assessment for the Historic Montague Mines Tailings Areas. Final Report. November 16, 2020.

NSE, 2014. Nova Scotia Environment Environmental Quality Standards for Contaminated Sites. Rationale and Guidance Document. April 2014. (Accessed online September 2021).

Wood. 2021. Phase II Environmental Site Assessment Former Montague Gold Mines, Dartmouth, Nova Scotia Final Report. Project #: TV183013.3000.52. October 2021.