



SUMMARY REPORT HUMAN HEALTH RISK ASSESSMENT

**TOWN OF BUCHANS
BUCHANS, NEWFOUNDLAND AND LABRADOR**

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1.0 INTRODUCTION

This report presents a summary of the Human Health Risk Assessment (HHRA)¹ related to surface soil in the Town of Buchans (Town). Conestoga-Rovers & Associates (CRA) completed this HHRA at the request of the Province of Newfoundland and Labrador (Province). The HHRA evaluated potential human health impacts due to the deposition of dusts containing metals from historic mining and waste disposal around the Town (see Figure 1).

CRA completed a Phase II Environmental Site Assessment (ESA) for the Province of Newfoundland and Labrador (Province) in 2009. To develop the Scope of Work for its ESA, CRA reviewed previous environmental reports, completed a site inspection, interviewed former mine employees and town representatives, and completed a review of additional documents provided by the Province's lawyers. A total of 33 Potential Areas of Concern (PAOCs), were identified as part of the Phase II ESA. Impacts above generic environmental criteria were identified in 30 of the 33 PAOCs investigated. The Phase II ESA concluded that there were 30 PAOCs where remediation was required. This report presents the results of a HHRA conducted at one of the PAOCs identified, namely residential surface soils in Buchans. The HHRA does not affect the conclusions and recommendations of the Phase II ESA for the remaining PAOCs. Additional studies at these remaining 29 PAOCs with impacted media (soil, groundwater, surface water sediments) have yet to be completed. The additional studies for those 29 PAOCs are intended to determine the extent of the remediation required, and not whether remediation is required.

To date all soil data generated as part of the Phase II ESA have been compared to generic criteria developed and published by the Canadian Council of Ministers of the Environment. Those criteria reflect the lowest concentration identified to be protective of all possible receptors (humans, mammals, birds, fish, microorganisms etc.). A HHRA is a study that uses specific information for the Site, identifies potential human receptors, and uses available analytical data and regulatory-derived methodology to determine specific criteria for the Site. The calculations estimate potential cancer and non-cancer health effects from exposure to the chemicals present at the Site, which in this particular case, are metals in surface soils. The calculations are based on standard exposure factors (for example, how often a person is present in the location, how much soil is typically ingested, and how the body adsorbs the chemicals once exposure takes place).

¹ This document is a brief summary of the complete HHRA, which is available upon request.

The HHRA uses information that more closely reflects practices in the area (in this case the Town) and other relevant site-specific factors rather than default generic exposure factors. In this case, the HHRA includes an assessment of the ability of the body to absorb the metals that are present in the soil once the soil is ingested (called "bioavailability").

The objectives of the HHRA were to:

- Identify metals of potential concern, which are those metals with maximum detected concentrations that were greater than generic residential screening criteria, (e.g., Canadian Council of Ministers of the Environment (CCME) residential/parkland concentrations)
- Develop site-specific risk based concentrations (site-specific RBCs) for metals of potential concern
- Identify metals and locations where detected concentrations were greater than site-specific RBCs
- Provide recommendations for future actions

2.0 SURFACE SOIL DATA

The Town is located 72 kilometres from the Trans-Canada Highway at the terminus of Route 370. Figure 1 depicts the Town and surrounding areas. In 2001, the Town included approximately 900 residents and 443 private dwellings.

Lands surrounding the Town are rural, and are dominated by former and current mining operations, which are the primary industrial operations for the Town. Areas surrounding the Town are undeveloped and used predominately for recreational purposes including sport fishing, winter sports, hunting, etc. Buchans Lake is north of the Town and Red Indian Lake is south of the Town. Buchans River connects both lakes and flows from Buchans Lake to Red Indian Lake.

2.1 RECENT INVESTIGATIONS

CRA completed a Phase II Environmental Site Assessment (ESA) for the Province in 2009. As part of this investigation, CRA identified the potential for metals impacts to residential surface soil from tailings, handling operations, storage and spills. CRA then collected 12 residential surface soil samples from within the town and 12 background surface soil samples (from areas outside of town and upwind from the tailings spill area

and tailings ponds). Figures 2 and 3 present the residential and background surface soil sample locations.

The following table presents a summary of the metals most frequently detected in these samples.

Table A: Summary of August 2009 Analytical Data

<i>Parameters</i>	<i>CCME Criteria</i>	<i>Residential Samples September 2009</i>			<i>Background Samples September 2009</i>		
		<i>Number of Detects</i>	<i>Min. Detected Conc. (mg/kg)</i>	<i>Max. Detected Conc. (mg/kg)</i>	<i>Number of Detects</i>	<i>Min. Detected Conc. (mg/kg)</i>	<i>Max. Detected Conc. (mg/kg)</i>
Aluminum	NC	12	2800	12000	12	2100	19000
Arsenic	12	9	3	160	6	2	4
Barium	500	12	180	2200	12	19	1100
Cadmium	10	11	0.4	8.8	11	0.4	5.3
Chromium	64	12	3	26	12	3	9
Cobalt	50	9	1	5	8	2	7
Copper	63	12	8	510	12	10	90
Iron	NC	12	1800	31000	12	3300	28000
Lead	140	12	27	4800	12	22	660
Lithium	NC	7	3	4	3	4	5
Manganese	NC	12	30	220	12	26	2100
Mercury Elemental	NC	4	0.2	1.4	6	0.1	0.5
Nickel	50	9	2	5	3	2	3
Silver	20	7	0.6	20	4	0.6	1.8
Strontium	NC	12	5	28	6	8	24
Thallium	1	8	0.1	1.4	2	0.1	0.2
Uranium	23	12	0.2	70	12	0.1	4.5
Vanadium	130	12	12	67	12	7	82
Zinc	200	12	65	2000	12	51	880

Notes:

CRA collected 12 residential and 12 background surface soil samples.

mg/kg = milligrams per kilogram

conc. = concentration

NC = No CCME Criterion

2.2 FOCUSED RESIDENTIAL SOIL INVESTIGATION

CRA collected additional soil samples from residential lots, gardens, and recreational locations between October 12 and 15, 2009 to more fully assess the soil quality in residential and recreational areas of the Town. CRA collected 41 residential surface soil samples and nine garden soil samples from 42 residential properties in the Town. In

addition CRA collected nine surface soil samples from public areas in town and one background soil sample approximately three kilometres west of town. All surface soil sampling locations are shown on Figure 4.

The following table presents a summary of the metals most frequently detected in these samples.

Table B: Summary of Analytical Test Results from October 2009 Sampling

<i>Parameters</i>	<i>CCME Criteria Residential /Parkland (mg/kg)</i>	<i>Number of Detections October 2009</i>	<i>Min Detected Conc. (mg/kg)</i>	<i>Max Detected Conc. (mg/kg)</i>
Aluminum	NC	59	4700	14000
Antimony	20	18	2	15
Arsenic	12	57	2	42
Barium	500	59	140	1900
Cadmium	10	58	0.3	18
Chromium	64	59	5	24
Cobalt	50	59	1	11
Copper	63	59	22	700
Iron	NC	59	6200	27000
Lead	140	59	25	3300
Lithium	NC	59	2	11
Manganese	NC	59	98	840
Mercury	NC	33	0.1	1
Molybdenum	10	12	2	7
Nickel	50	58	2	18
Rubidium	NC	20	2	8
Silver	20	44	0.5	5.7
Strontium	NC	59	6	36
Thallium	1	31	0.1	1.1
Uranium	23	59	0.4	9.5
Vanadium	130	59	15	63
Zinc	200	59	83	5100

Notes:

CRA collected soil samples from 59 locations in October 2009.

mg/kg = milligrams per kilogram

conc. = concentration

In addition to the analyses for total metal concentrations, CRA also submitted samples to the Laboratory of Environment and Geological Sciences at the University of Colorado to determine bioavailability.

The laboratory extracted the metals from each soil sample using a simulated gastric solution and this solution was then analyzed for metals. The laboratory then calculated the ratio of the amount extracted by the gastric solution compared to the total metals result. This ratio reflects the bioaccessibility of the metal, which refers to the fraction of metals absorbed from the gastrointestinal tract.

Methods for lead and arsenic bioaccessibility are available. Therefore, CRA regarded the bioavailability data for both lead and arsenic as appropriate for use in this HHRA.

Because of the absence of available methods, CRA assumed that 100 percent of the remaining metals was bioavailable.

CRA used the bioavailability data to produce a statistically-based bioavailability factor that was used in the HHRA. Those factors were as follows:

<i>Metal</i>	<i>Bioavailability Factor²</i>
Lead	0.74
Arsenic	0.26

3.0 HUMAN HEALTH RISK ASSESSMENT (HHRA)

A HHRA estimates potential cancer and non-cancer health impacts from exposure to chemicals of potential concern. The estimates are based on methods, calculations, and input assumptions developed by regulatory agencies.

The HHRA was conducted using surface soil data obtained from the sampling conducted in and around the Town. Soil data from the other 29 PAOCs were not used in this evaluation. CRA screened the metals data by comparing the maximum concentrations detected in the August and October surface soil samples to generic residential soil screening criteria developed by federal and provincial agencies to determine the "metals of potential concern".

There were nine metals with maximum concentrations that were greater than the generic residential screening criteria. These metals of potential concern and their respective Health Canada classification are as follows:

² For example, if the amount of ingested lead was 100 mg, the amount the body would adsorb in the stomach is $100 \times 0.74 = 74$ mg.

- Antimony - non-carcinogenic
- Arsenic - carcinogenic
- Barium- non-carcinogenic
- Cadmium - carcinogenic
- Iron- non-carcinogenic
- Lead - non-carcinogenic
- Manganese- non-carcinogenic
- Thallium- non-carcinogenic
- Uranium- non-carcinogenic

3.1 DEVELOPMENT OF SITE-SPECIFIC RISK-BASED CONCENTRATIONS

The HHRA develops site-specific RBCs and subsequently evaluates the significance of the metals concentrations by first examining the potential pathways by which individuals may come in contact with the surface soil in the Town. In this case, the potential pathways that could lead to exposure include the following:

- Potential Source of Metals - Tailings Spill area and exposed tailings around existing tailings ponds and soils around the Town
- Release of Mechanism - Airborne particulate dust dispersion
- Media of Concern - Surface soil in Town
- Receptors - Adults and children with children being the identified as the most sensitive receptors for non carcinogens such as lead
- Exposure Routes - Incidental ingestion, direct dermal contact, and dust inhalation

3.1.1 SITE-SPECIFIC RISK-BASED CONCENTRATIONS

As noted previously, CRA developed site-specific RBCs for the nine metals of potential concern using methods consistent with those specified by the CCME and Health Canada. The following table summarizes the site-specific RBCs and the maximum detected concentration from the August and October 2009 residential/public area surface soil samples for the nine metals of concern.

Table C: RBCs and Maximum Concentration in Surface Soil

<i>Metals of Interest</i>	<i>Risk-Based Concentrations RBC_{soil}⁽¹⁾ (µg/g)</i>	<i>Maximum Soil Concentration (µg/g)</i>
Antimony	22	22
Arsenic	43	160
Barium	10,180	2,200
Cadmium	64	18
Iron	73,914	31,000
Lead	622	4,800
Manganese	8,698	840
Thallium	1.6	1.4
Uranium	135	70

Notes:

1 Calculated RBC_{soil} are protective of all age groups.

= Maximum soil concentration greater than the calculated RBC_{soil}.

The maximum detected concentration of all metals other than arsenic and lead were equal to, or less than, the site-specific RBCs. Therefore, these other metals do not likely pose an unacceptable health risk so the HHRA did not evaluate these further.

As noted, the maximum detected concentrations of two metals were greater than the site-specific RBCs; arsenic and lead. CRA compared the analytical data for these metals to site-specific RBCs to identify sample locations where the concentrations of one or both metals were greater than the site-specific RBCs. Lead was greater than the site-specific RBCs in 20 of 71 soil samples. The concentration of arsenic at one location exceeded its site-specific RBC.

Figure 5 presents the locations where arsenic and/or lead were detected at concentrations greater than the site-specific RBCs. Three of these locations were associated with areas of former mining operations. Five of these locations are public areas around town. The remaining twelve locations were distributed throughout residential areas of the Town with the exception of the extreme southeastern portion of the Town.

3.1.2 DEVELOPMENT OF SITE-SPECIFIC RISK-BASED CONCENTRATIONS FOR ADULTS

In order to provide additional information regarding the potential risks to adults in Buchans, CRA developed site-specific RBCs for lead and arsenic based on potential adult exposures. The site-specific RBCs presented in Section 3.1.1 above were based on children (for non-carcinogens) for lead and lifetime exposures including childhood for arsenic. These will be carried forward as the Site-specific screening criteria as they were developed consistent with regulatory guidance and children are more sensitive to the effects of exposure particularly to lead.

The most sensitive adult receptors regarding potential exposure to lead are women of child-bearing age or more specifically, the developing fetus in pregnant women.

Based on the most sensitive adult receptor, women of children bearing age, the calculated adult RBC for lead was 4,075 mg/kg. For arsenic, an adult RBC of 60 mg/kg resulted from consideration of adult-only exposures.

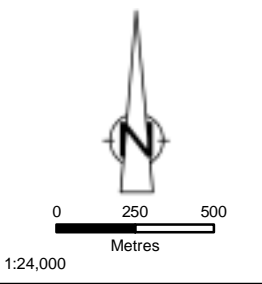
CRA compared the analytical data for these metals to adult RBCs to identify sample locations where the concentrations of one or both metals were greater than the site-specific RBCs. Lead and Arsenic were greater than the adult RBCs in one soil sample collected from an area immediately southwest of Town.

4.0 SUMMARY AND CONCLUSIONS

The HHRA concludes that the concentration of lead in surface soils was greater than its site-specific residential RBC at 20 locations in the Town. Also, the concentration of arsenic was greater than its site-specific residential risk based concentration at one location (near the TSA southwest of the Town).

5.0 RECOMMENDED ACTION

Lead concentrations in soil are greater than the site-specific RBCs at multiple locations in the Town. CRA recommends the development of a Risk Management Plan to mitigate potential exposure to these metals (primarily for small children). The report should assess and recommend remedial options or controls measures that reduce the exposures and the potential health risks associated with lead in surface soil in the Town.



Town of Buchans, 2007, 2008 Datum: NAD 83 Projection: WGS84 (Latitude/Longitude)

Figure 1

SITE LOCATION PLAN
 HUMAN HEALTH RISK ASSESSMENT
 TOWN OF BUCHANS
 Buchans, Newfoundland





Town of Buchans, 2007.

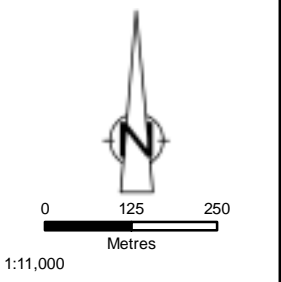
Legend



▲ Surficial Soil Sample

figure 2

AUGUST 2009 SAMPLING LOCATIONS: PAOC32 RESIDENTIAL SURFACE SOILS
 HUMAN HEALTH RISK ASSESSMENT
 TOWN OF BUCHANS
 Buchans, Newfoundland



Town of Buchans, 2007.

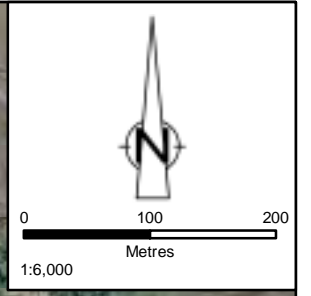
Legend

▲ Surficial Soil Sample



figure 3

AUGUST 2009 SAMPLING LOCATIONS: PAOC32 BACKGROUND SURFACE SOILS
 HUMAN HEALTH RISK ASSESSMENT
 TOWN OF BUCHANS
 Buchans, Newfoundland



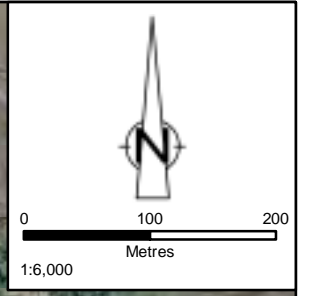
2007 Aerial provided by the Town of Buchans.

Legend

- Public Recreation Areas Surficial Soil Samples
- Residential Surficial Soil Samples
- Garden Soil Samples



figure 4
 OCTOBER 2009 SAMPLING LOCATIONS: COMPOSITE RESIDENTIAL SURFACE SOILS
 HUMAN HEALTH RISK ASSESSMENT
 TOWN OF BUCHANS
 Buchans, Newfoundland



2007 Aerial provided by the Town of Buchans.

Legend

- ▲ Surficial Soil Sample
- Public Recreation Areas Surficial Soil Samples
- Residential Surficial Soil Samples
- Garden Soil Sample

Sample Location
 Lead Exceedance Concentration (mg/kg)
 Arsenic Exceedance Concentration (mg/kg)

Risk-Based Concentration
 Lead - 622 mg/kg
 Arsenic - 43 mg/kg

EXCEEDANCES OF SITE - SPECIFIC RISK BASED CONCENTRATIONS
 HUMAN HEALTH RISK ASSESSMENT
 TOWN OF BUCHANS
 Buchans, Newfoundland

figure 5