

# **LABRADOR WEST COMMUNITY MONITORING**

**For Overburdened Project**

***September 2004***

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## **EXECUTIVE SUMMARY**

The *Labrador West Community Monitoring* project is part of a broader women's health profile initiative by two women's organizations, the Femmes Francophones de l'Ouest du Labrador and the Labrador West Status of Women Council. CCSG Associates provided training on community monitoring techniques for sampling and analysis of water, soil and vegetation quality, as well as house dust metal content and quantity of total and respirable particulates.

This report presents preliminary results because both mines in the Labrador West region were on strike at the time of sampling, September 1-5, 2004, and follow up sampling is recommended. The Wabush mine began its strike on July 5 (300 workers) and the Iron Ore Company of Canada (IOCC-800 workers) began its strike on July 19. It had been reported that while the mines were not operating the watering of mine facilities for dust control was not done and there was substantial blowing of dust. The community monitoring project took the opportunity of the mines being shut down to take preliminary samples that could be compared to further analysis once the mines re-open to better understand the contribution of metals and dust to the community under different operational conditions.

Water Analysis: Water analysis of drinking water sources, Beverly Lake and Wahnahnish Lake, show elevated levels of molybdenum, nickel and barium that did not exceed WHO drinking water standards. Analysis of a tap water filter indicates that these minerals can be effectively removed in the home using standard filters.

Water analysis of recreational and fishing areas show very high aluminum, nickel and iron in Wabush Lake, and elevated aluminum in most of the Labrador West area Lakes. This is of concern for aquatic health, though it is reported by locals that Wabush Lake is a good fishing area and fish seem healthy.

Soil Analysis: Soil samples were taken from two recreational areas noted for blowing dust, Labrador City playground and Wabush sand pits. Chromium levels minimally exceeded CCME soil guidelines. Aluminum, iron, manganese and titanium were higher concentrations and might be of greater concern for chronic exposures, but there is no comparative CCME soil guideline.

Vegetation Analysis: Vegetation samples, potato from the community garden and blueberries from Smoky Mountain, had elevated levels of minerals as compared to average mineral content, but would not present a health risk for daily consumption. The potato had a higher content of zinc, copper, manganese and nickel. The blueberry sample had slightly elevated content of copper and high iron, sodium, calcium and manganese.

***Dust Analysis:*** The dust analysis for total and respirable particulates indicates results with some cause for concern, particularly given that scattered rain throughout the sampling week had substantially reduced blowing dust. The hospital lobby and LSWWC office had the highest levels of respirable particulates, since these locations were the busiest locations with opening doors to outside it may be representative of warmer summer conditions in homes when windows are more likely to be open. The slightly elevated total suspended particulates sampled in two Wabush homes are less of a concern because the levels were not extremely high and larger sized particulates are not as harmful to health because they do not penetrate the lungs in the same way as the finer respirable particulates. The mineral content analysed in the dust samples were very low and do not pose a significant health risk.

***Recommendations:*** The sampling regime should be replicated next summer when the mines are operating and house dust levels are highest to compare to the current results taken during the mine strikes. Petrie dishes are a non-intrusive method that can be used to collect total suspended particulates over a longer duration to get a representative sample of a range of weather patterns, but these would not be directly comparable to the air pump and filter 24 hour method. Additional sampling could include LC50 for rainbow trout and daphnia to determine the water quality impact on aquatic life.

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# LABRADOR WEST COMMUNITY MONITORING REPORT For Overburdened Project

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## **1.0 INTRODUCTION**

The project, entitled *Effects of mining extraction on women's health in Labrador West*, was initiated by two women's organizations, the Femmes Francophones de l'Ouest du Labrador and the Labrador West Status of Women Council. As part of the Labrador West health survey, CCSG Associates provided training on community monitoring techniques for sampling and analysis of water, soil and vegetation quality, as well as house dust metal content and quantity. The preliminary sampling results of the Labrador West community monitoring project are presented in this report and follow up monitoring is recommended.

During the summer of 2004, both mines in the Labrador West region were on strike. The Wabush mine began its strike on July 5 (300 workers) and the Iron Ore Company of Canada (IOCC-800 workers) began its strike on July 19. The mines remained closed during the community monitoring project which was conducted September 1-5, 2004. It had been reported that while the mines were not operating the watering of mine facilities for dust control was not done and there was substantial blowing of dust. The community monitoring project took the opportunity of the mines being shut down to take preliminary samples that could be compared to further analysis once the mines re-open to better understand the contribution of metals and dust to the community under different operational conditions. This does not provide a pristine background analysis.

## **2.0 PREVIOUS STUDIES**

The following section summarizes key information from previous studies relevant to the Labrador West health survey and monitoring project.

### ***2.1 Labrador West Dust Study-Level I Report, Volume 2-Scully Mines***

The Labrador West Dust Study<sup>1</sup> was conducted in the early 1980's and is quite dated in its methods. This report focused primarily on mine workers and concluded that the Scully Mine had working conditions that were below acceptable standards and that there was a lack of sufficient awareness and concern<sup>2</sup>. Ten new pneumoconiosis cases were discovered, and a total of 14 cases reported<sup>3</sup>.

Though the report noted 6 exceedences of total suspended particulate levels, it concluded that there were no adverse community health effects. This assertion was not substantiated.

## **2.2 Labrador West Dust Study- Level II Report- Community Health Survey**

The Labrador West Dust Study Health Survey<sup>4</sup> was conducted in the early 1980's and is quite dated in its methods.

There is no comparison to a control town provided, only comparison between Wabush and Labrador City. Wabush generally had a higher percentage for health effects in adults than Labrador City, for example shortness of breath, cough, bronchitis and high blood pressure. Health effects such as cough, colds, wheezing and bronchitis were more prevalent in Labrador City children than Wabush children but asthma and dust allergy were more common in the Wabush children<sup>5</sup>. However, a smaller sample size from Wabush may have skewed the analysis<sup>6</sup>. The report mostly compared smokers to non-smokers and showed that smokers had poorer health. The report did not compare smokers and non-smokers to a control town to determine if the described health effects were greater or less than in a non-mining town.

The study indicated that there was a weak association between duration of residence in Lab West and increasing poor health symptoms<sup>7</sup>. At the time of this health survey, the population was generally younger<sup>8</sup> as compared to the current population which has longer term residents.

The health survey did not provide a comparison between the health of mine workers and community members that did not work in the mine. No gender specific analysis was provided.

## **2.3 Labrador West Dust Study- Level II Report- Ambient Air Study**

The Labrador West Dust Study, Ambient Air Study<sup>9</sup> was conducted in the early 1980's. This study tested only total suspended particulate and not respirable particulate. Some of the sample locations were on top of buildings (for example 9.8 metres above ground).

Some dust of the dust content was characterized. Silicon levels were higher at Scully than IOCC Mine. Iron and manganese were higher at IOCC, but Wabush town had higher manganese levels than Labrador City<sup>10</sup>. Manganese tended to be more associated with the fine particulates than the coarse<sup>11</sup>. Calcium levels at IOCC were 3-5%, higher than the 0.25% at Scully Mine.

## **2.4 National Pollutants Release Inventory**

The National Pollutants Release Inventory (NPRI)<sup>12</sup> requires industries in Canada to report total particulate matter (Total PM) which includes all sizes of particulates and the finer respirable particulate matter (PM 10 are less than 10 microns in diameter and PM 2.5 are less than 2.5 microns in diameter). The finer particulate matter is able to be breathed deep into the lungs and is therefore a greater concern for health effects.

NPRI data from 2002 indicate that IOCC and Wabush mines rank among the largest emitters of total particulate matter and respirable particulate matter in Canada. The rank listed below is out of 1056 mines.

**Figure 1: Particulate matter emissions and rank as reported in 2002 NPRI data for IOCC Mine, Wabush Mine and Wabush Incinerator**

<i>Industry</i>	<i>Total PM</i>		<i>PM 10 &amp; 2.5</i>	
	<i>tonnes/year</i>	<i>rank</i>	<i>tonnes/year</i>	<i>rank</i>
<i>IOCC Mine</i>	3061	7	2356	5
<i>Wabush Mine</i>	1418	23	237	56
<i>Wabush Incinerator</i>			129*	

\*note that the incinerator contribution to Labrador West dust is very small compared to the mines.

### **2.5 Wabush Mines Ambient Particulate Data**

Wabush Mines has recorded ambient particulate data at three locations (Substation, Shea Street and Blueberry Hill) since 1983. The school was monitored until 1997, the firehall was monitored until 2002, and Reid Street was monitored 1988-1994.

Under the Canadian Environmental Protection Act (CEPA) PM 2.5 is considered toxic. The limits for particulate emissions are based on a duration of 24 hours and are 120 ug/m<sup>3</sup> for total suspended particulate (with an annual average limit of 60 ug/m<sup>3</sup>), 50 ug/m<sup>3</sup> for PM10 and 25 ug/m<sup>3</sup> for PM2.5.

The 24 maximum of 120 ug/m<sup>3</sup> for total suspended particulate has been exceeded during the summer months in 2003, 2002, 1995, 1989, and 1983. PM10 and PM2.5 have not been recorded.

### **2.6 IOCC Mines Ambient Particulate Data**

IOCC Mines has recorded ambient particulate data at 4 sites (AP Low, Tamarack Drive, Ryan's Yard and Labrador Mall) since 1987. Total suspended particulate is measured at each site. At AP Low PM10 and PM 2.5 have also been measured since 1997.

IOCC data show the 24 maximum of 120 ug/m<sup>3</sup> for total suspended particulate has been consistently exceeded at the Ryan's Yard monitoring site throughout the year (sometimes by a factor of 10) and often exceeded the limit at the other sites as well. Ryan's Yard is located on Tamarack Drive directly across the lake from the Wabush tailings and may also contribute to the total particulates.

In 2000, 1999, 1998, and 1997 the 24 hour maximum of 50 ug/m<sup>3</sup> for PM10 was exceeded mostly in summer months. The 24 hour maximum of 25 ug/m<sup>3</sup> for PM2.5 was exceeded in 2000, 1999, and 1997.

### ***2.7 Department of Environment- AP Low Ambient Particulate Data***

The Government of Newfoundland and Labrador, Department of the Environment monitoring network recorded total suspended particulate at AP Low from 1983-1995. This data shows that the 24 maximum of 120 ug/m<sup>3</sup> for total suspended particulate has been consistently exceeded at AP Low.

### ***2.8 Department of Environment- Bruno- Labrador City Ambient Particulate Data***

The Government of Newfoundland and Labrador, Department of the Environment monitoring network recorded total suspended particulate at Bruno- Labrador City from 1983-1993. This data shows that the 24 maximum of 120 ug/m<sup>3</sup> for total suspended particulate has been consistently exceeded at Bruno throughout the year.

### ***2.9 Stack Emission Reports***

Wabush and IOCC Mines are required to test their stack emissions with a third party consultant every two years. The stack emission data is used to model the plume dispersion. Plume dispersion models predict particulate matter fall out patterns based on weather data, terrain data, stack and building dimensions etc. However, it unclear why the dispersion plume is being modeled instead of sampled when there is an actual plume to sample. The actual stack emission data has not been available publicly, nor has the plume dispersion models been accessed.

### ***2.10 Department of Environment- Tap Water Quality Data***

The Government of Newfoundland and Labrador Department of the Environment, Water Resources Division records tap water quality data for public water supplies. Data from 2001 for Labrador City and Wabush show that tap water quality follow the CCME Drinking Water Guidelines for acceptable levels of metals<sup>13</sup>.

### ***2.11 Wabush Mine Fact Sheet 56***

The Wabush Mine Fact Sheet 56 provides 1991 relating to effluent, water quality and fish. In 1991, the mine produced effluent at a rate 26,060 m<sup>3</sup>/day. This effluent contained 6,800 kg/day suspended sediment and 5,500 kg/day iron.



### **3.0 METHODS**

Sampling priorities were determined at a community monitoring training workshop that was attended by 16 community members on September 2, 2004. Appendix A lists the notes from the monitoring workshop.

Standard sampling protocols were used for soil, vegetation and water analysis. Conductivity, pH and temperature were recorded in the field for water samples.

House dust analysis was carried out according to the methods of NIOSH Manual of Analytic Methods, Fourth Edition (1994). Sample sites were chosen to represent different areas of Labrador West and locations with public use as well as homes. At each location an pump was set up to measure total particulate matter and total metals, and another was set at the same time with a cyclone to measure respirable particulates. Results were standardized to 24 hour duration and standard temperature and pressure.

Chain of custody for sample was recorded and samples were analyzed by a CAEL accredited laboratory.

### **4.0 RESULTS AND DISCUSSION**

A list of sample sites are provided in Appendix B. Laboratory analysis data sheets for soil, vegetation, water and air filter samples are provided in Appendix C. The following discussion focuses on results that may be of concern for human or environmental health.

#### ***4.1 Water Sample Results***

##### **Drinking Water**

Water samples were taken from the two drinking water supply lakes for Labrador West. Beverly Lake supplies drinking water to Labrador City and Wahnahnish Lake supplies drinking water to Wabush. The sample analysis results for total metals were compared to Canadian Council of the Ministers of the Environment (CCME) and the World Health Organization (WHO) drinking water guidelines and the chart in Figure 2 compares those metals that were close to the guidelines' recommendations.

**Figure 2: Comparison of Beverly Lake and Wahnahnish Lake water quality to CCME and WHO drinking water guidelines for Total Barium, Total Molybdenum and Total Nickel.**

<b>Total Metal Concentration</b>	<b>Beverly Lake</b>	<b>Wahnahnish Lake</b>	<b>CCME</b>	<b>WHO</b>
<b>Barium (Ba)</b>	10.3 ug/L	11.3 ug/L	1000 ug/L	700 ug/L
<b>Molybdenum (Mo)</b>	6.0 ug/L	3.0 ug/L	no guideline	70 ug/L
<b>Nickel (Ni)</b>	2.5 ug/L	2.0 ug/L	no guideline	20 ug/L

Barium is not thought to be carcinogenic<sup>14</sup>. Studies have been inconclusive on long term effects of barium on blood pressure, stroke, heart and kidney disease<sup>15</sup>, but the levels detected were low.

The molybdenum and nickel levels detected in the drinking water sources were below the CCME and WHO guidelines and would not be acutely or chronically toxic at these levels. Nickel and molybdenum are essential nutrients in small doses but can be toxic in higher levels. Nickel can induce cancer, tends to be accumulated in the kidney and can cause central nervous system effects. There is not a lot of information on molybdenum toxicity in humans. Children living in areas with high molybdenum may have more dental caries.

A water tap filter was analyzed to determine the metal content of the residue filtered out of the tap water in a semi-quantitative manner. The filter had been in use for three months and had removed high levels of aluminum, copper, iron, lower levels of strontium, calcium and sulphur, and significant levels of barium, phosphate and magnesium.

#### Environmental Water Quality

Water samples were taken from areas of concern that were identified due to their use as recreational or fishing areas, as well as the tailings outfall areas. Note that due to the picket line we were unable to access the IOCC tailings outfall area, but sampled in Wabush Lake where some of the IOCC tailings are deposited. These water bodies include Wabush tailings outfall, Wabush Lake, Duley Lake, Tanya Lake and Albert Lake.

**Figure 3: Comparison of water quality in Wabush tailings outfall, Wabush Lake, Duley Lake, Tanya Lake and Albert Lake to CCME Guidelines for the Protection of Freshwater Aquatic Life for total Aluminum, Total Nickel and Total Iron.**

	Aluminum (Al) (ug/L)	Nickel (Ni) (ug/L)	Iron (Fe) (ug/L)
Wabush Tailings Outfall	14	1.7	110
Wabush Lake	664	47.6	2,310
Duley Lake	74	1.2	140
Tanya Lake	12	1.8	250
Albert Lake	47	2.3	120
CCME Aquatic Life Guidelines	5	25.0	300

Wabush Lake is a common fishing lake. Though it is a big lake, there are tailings deposited directly to Wabush Lake from IOCC. The aluminum concentration in Wabush Lake was very high and exceeded the CCME guidelines in all the lakes of the area. Fish are very sensitive to aluminum toxicity as it forms a gel in their gills and suffocates them. Chronic aluminum exposure affects the protective coating of fish scales and increases their susceptibility to fungal infections (this can be seen as large red sores). The nickel concentration in Wabush Lake exceeds the CCME guidelines and may compromise the ecology of the lake through its tendency to bioaccumulate and concentrate in aquatic plants and further up the food chain. The iron concentration is very high in Wabush Lake and is toxic to the insects larvae (mayflies, caddisflies and stoneflies) that are a food source for fish.

#### **4.2 Soil Sample Results**

CCME Guidelines for Soil Quality are not available for many parameters. IN mineralized areas where mines are located, the surrounding soils may also be elevated. Therefore the surface soil samples show the combined metal content of the natural soils and the dust deposition from mine sources. The soil samples were taken from a playground in Labrador City (gravel around the playground had been placed there and was not the natural soil) and the sandpits in Wabush (a recreational area used for biking, motorcycles, hiking etc. where there is blown sand and dust).

**Figure 4: Comparison of soil quality of Wabush sandpits and Labrador City playground to CCME soil guidelines.**

<b>Total Metals</b>	<b>Wabush Sandpits (mg/kg)</b>	<b>Labrador City Playground (mg/kg)</b>	<b>CCME Soil Guidelines (mg/kg)</b>
<b>Aluminum (Al)</b>	2570	3870	no guideline
<b>Chromium (Cr)</b>	13.7	22.9	20
<b>Iron (Fe)</b>	75200	20400	no guideline
<b>Manganese</b>	1410	280	no guideline
<b>Titanium (Ti)</b>	263	335	no guideline

Both sample sites had been noted for blowing dust. Only total chromium levels exceeds official CCME guidelines, and only minimally exceeds these. Aluminum, iron, manganese and titanium might be of greater concern for chronic exposures, but there is no comparative guideline.

### **4.3 Vegetation Sample Results**

Two vegetation samples were taken from the Circular Road area behind Smoky Mountain, a potato from the community garden and blueberries from farther up the hill at a commonly picked area. Blowing dust from IOCC has been noted in this area.

The potato sample had slightly elevated cadmium, zinc, and copper levels as compared to average potato content<sup>16</sup>. Manganese and nickel were more elevated but would not pose a health risk with daily consumption of potatoes<sup>17</sup>.

The blueberry sample had slightly elevated concentrations of copper and high iron, sodium, calcium and manganese as compared to average blueberry metal content<sup>18</sup>. These elevated levels would not pose a health risk with daily consumption. When the mines re-open and there is potentially more dust blowing, it is recommended that berries be washed before consumption.

### **4.4 Air Particulate Sample Results**

#### House Dust Particulates

House dust was sampled at 10 locations throughout the Labrador West region at individual homes and organizations. In Labrador City samples were taken at the hospital, the offices of the Femmes Francophones de l'ouest du Labrador, the Labrador West Status of Women Council and the Association Francophone du Labrador, at a B&B on Tamarack, and at homes on Bartlette (at Juniper and in the trailer court). Wabush samples were taken from homes on Anderson Street, Grenfell Drive and Bowater Drive. Two locations in Labrador City had elevated respirable particulates (the lobby of the hospital and LSWC office) and two locations in Wabush had elevated total particulates (Anderson Street and Grenfell Drive). The Occupational Safety and Health Administration (OSHA) and

the American Conference of Government Industrial Hygienists (ACGIH) provide health and safety guidelines recommending appropriate indoor dust levels.

**Figure 5: Comparison of respirable particulate analysis at the LSWWC Office and Hospital and total particulate analysis at two Wabush homes on Anderson Street and Grenfell Drive to OSHA, ACGIH and mine industrial emission 24 hour standards.**

	<b>Respirable Particulate 24 hour ug/m<sup>3</sup></b>	<b>Total Particulate 24 hour ug/m<sup>3</sup></b>
<b>LWSWC Office</b>	10.7 ug/m <sup>3</sup>	
<b>Hospital Lobby</b>	20.7 ug/m <sup>3</sup>	
<b>Anderson Street Home</b>		12.8 ug/m <sup>3</sup>
<b>Grenfell Drive Home</b>		6.5ug/m <sup>3</sup>
<b>OSHA Guideline 24 hour ug/m<sup>3</sup></b>	5.0 ug/m <sup>3</sup>	15.0 ug/m <sup>3</sup>
<b>ACGIH Guideline 24 hour ug/m<sup>3</sup></b>	3.0 ug/m <sup>3</sup>	10.0 ug/m <sup>3</sup>
<b>Mine Industrial Emission Standard* 24 hour ug/m<sup>3</sup></b>	25.0 ug/m <sup>3</sup>	120.0 ug/m <sup>3</sup>

\*note that this is an outdoor emission standard not an in-house dust standard

The elevated level of respirable particulates in two well travelled public areas is a significant concern, particularly because respirable particulates have a greater associated health risk. The slightly elevated total particulates on Anderson Street fall between two recommended guideline levels (exceeding ACGIH but not exceeding OSHA) and are not as great a concern as respirable particulates because the health risk associated is lower.

#### House Dust Metal Analysis

A variety of metals were detectable in the dust samples. The Occupational Safety and Health Administration (OSHA) provides guidelines for permissible levels of metals in indoor air.

**Figure 6: Comparison of mineral content- Calcium (Ca), Copper (Cu), Iron (Fe), Magnesium (Mg), Zinc (Zn), Sodium (Na), Bismuth (Bi), and Chromium (Cr)- of house dust samples to OSHA permissible exposure limits in time weighted average (TWA).**

	<b>Ca</b> ug/m <sup>3</sup>	<b>Cu</b> ug/m <sup>3</sup>	<b>Fe</b> ug/m <sup>3</sup>	<b>Mg</b> ug/m <sup>3</sup>	<b>Zn</b> ug/m <sup>3</sup>	<b>Na</b> ug/m <sup>3</sup>	<b>Bi</b> ug/m <sup>3</sup>	<b>Cr</b> ug/m <sup>3</sup>
<b>OSHA (TWA)</b>	5000	1000	10000	10000	10000	5000	5000	1000
<b>Wabush:</b>								
<b>Grenfell</b>	0.42	0.06	0.21	0.94	0.03	0.86		
<b>Anderson</b>			0.14	0.07				
<b>Bowater</b>				0.03				
<b>Labrador City:</b>								
<b>Hudson</b>	0.11					2.1		
<b>Bartlette-Trailer Court</b>	0.11	0.11	0.08	0.07	0.13			
<b>Tamarack</b>	1.23			0.08	0.06	2.80	0.41	
<b>Drake</b>	1.82				0.06	2.32	0.48	
<b>Bristol</b>					0.03	1.30		0.04
<b>Hospital</b>	4.14							
<b>Bartlette @ Juniper</b>	0.41			0.04				

All the dust samples analyzed had mineral content levels orders of magnitude lower than the OSHA permissible exposure limit standards.

## **5.0 CONCLUSION**

Water analysis of drinking water sources, Beverly Lake and Wahnahnish Lake, show elevated levels of molybdenum, nickel and barium that did not exceed WHO drinking water standards. Analysis of a tap water filter indicates that these minerals can be effectively removed in the home.

Water analysis of recreational and fishing areas show very high aluminum, nickel and iron in Wabush Lake, and elevated aluminum in most of the Labrador West area Lakes. This is of concern for aquatic health, though it is reported by locals that Wabush Lake is a good fishing area and fish seem healthy.

Soil samples were taken from two recreational areas noted for blowing dust, Labrador City playground and Wabush sandpits.. Only total chromium levels

exceeds official CCME guidelines, and only minimally exceeds these. Aluminum, iron, manganese and titanium might be of greater concern for chronic exposures, but there is no comparative CCME soil guideline.

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The dust analysis for total and respirable particulates indicates results with some cause for concern, particularly given that scattered rain throughout the sampling week had substantially reduced blowing dust. The hospital lobby and LWSWC office had the highest levels of respirable particulates, since these locations were the busiest locations with opening doors to outside it may be representative of warmer summer conditions in homes when windows are more likely to be open. The slightly elevated total suspended particulates sampled in two Wabush homes are less of a concern because the levels were not extremely high and larger sized particulates are not as harmful to health because they do not penetrate the lungs in the same way as the finer respirable particulates. The mineral content analysed in the dust samples were very low and do not pose a significant health risk.

## **6.0 RECOMMENDATIONS**

The sampling regime should be replicated next summer when the mines are operating and house dust levels are highest to compare to the current results taken during the mine strikes. Petrie dishes are a non-intrusive method that can be used to collect total suspended particulates over a longer duration to get a representative sample of a range of weather patterns, but these would not be directly comparable to the air pump and filter 24 hour method. Additional sampling could include LC50 for rainbow trout and daphnia to determine the water quality impact on aquatic life.

## **ENDNOTES**

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<sup>1</sup> Labrador Institute of Northern Studies. 1982. *Labrador West Dust Study, Level I Report, Volume 2- Scully Mines*. Memorial University of Newfoundland.

<sup>2</sup> Page 7.

<sup>3</sup> Page 8.

<sup>4</sup> Labrador Institute of Northern Studies. 1982. *Labrador West Dust Study, Level II Report, Point VI, Community Health Survey, Wabush- Labrador City*. Memorial University of Newfoundland.

<sup>5</sup> Table 16.

<sup>6</sup> Tables 11, 12 and 13.

<sup>7</sup> Page 41.

<sup>8</sup> Page 42.

<sup>9</sup> Labrador Institute of Northern Studies. 1982. *Labrador West Dust Study, Level II Report, Point V, Ambient Air Study*. Memorial University of Newfoundland.

<sup>10</sup> 7-19.

<sup>11</sup> 7-18.

<sup>12</sup> [www.ec.gc.ca/pdb/npri/npri\\_home\\_e.cfm](http://www.ec.gc.ca/pdb/npri/npri_home_e.cfm)

<sup>13</sup> [www.gov.nf.ca/env/Env/water\\_resources.asp](http://www.gov.nf.ca/env/Env/water_resources.asp)

<sup>14</sup> WHO. 1990. *Barium Environmental Health Criteria, 107*. 148p.

<sup>15</sup> WHO. 1990. *Barium Environmental Health Criteria, 107*. 148p.

<sup>16</sup> Auermann, E., H.G. Daessler, J. Jacobi, J. Cumbrowski and U. Meckel. 1981. *Heavy metal contents of cereals and potatoes*. *Nahrung*; **24**(10): 925-938.

<sup>17</sup> Ocker, H.D., J. Brueggermann, W. Bergthaller and B. Putz. 1984. *Heavy metal contents of potato and potato products*. *Z Lebensm*; **179**(4): 322-329.

<sup>18</sup> Sheppard, S.C. 1991. *A field and literature survey, with interpretation, of elemental concentrations in blueberry*. *Can J Bot*; **69**(1):63-77.