

Radiological Parameters in Groundwater Public Drinking Water Supplies in Newfoundland and Labrador

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Summary

Health Canada released a revised Guideline Technical Document for Radiological Parameters in May 2009. In anticipation of this document and new Guidelines for Canadian Drinking Water Quality for radiological parameters, the Department of Environment and Conservation developed an extensive monitoring program to determine the extent, if any, of radiological parameters in the province's public drinking water supplies. This monitoring program was a multi-year program that extended to all public groundwater supplies in NL.

This extensive monitoring program was designed to establish baseline water quality information on radiological parameters throughout the province. The monitoring schedule entailed sampling all public groundwater supplies from 2008-2010. The initial monitoring program was designed to assess the presence of radioactivity for each public groundwater well using gross alpha and gross beta measurements. All results that indicated the possible presence of radioactivity were monitored more extensively for specific radiological parameters (lead-210 and radium-226) as outlined in the Guideline Technical Document provided by Health Canada. This report provides the results from the monitoring program and discusses the key findings and recommendations for long-term monitoring for radiological parameters.

The monitoring program monitored 184 public groundwater supplies for the presence of radioactivity using gross alpha and gross beta measurements. Monitoring results indicated that there are only six public groundwater wells with the possible presence of radioactivity. Additional sampling of these six wells indicates that radiological parameters for natural radionuclides were well below the Guidelines for Canadian Drinking Water Quality for both lead-210 and radium-226.

It is recommended that public groundwater supplies be monitored for baseline radioactivity presence every five years to ensure that water quality does not change over time. The six public groundwater supplies that indicated a potential for radioactivity presence should be monitored every two years for both lead-210 and radium-226 to ensure that concentrations do not exceed recommended guidelines.

This report is based solely on public groundwater wells and no private wells were monitored. There are many areas in the province that rely on private wells that are utilized by individual residents. Some of these areas do not have any public groundwater supplies in the areas to extrapolate results. These areas should be monitored to provide baseline information to determine the extent, if any, of radioactivity in areas serviced by private wells.

Introduction

Radionuclides are material with an unstable atomic nucleus that spontaneously decay or disintegrate, producing radiation. (AWWA, 2000).

Although radionuclides are commonly produced artificially, mainly for industrial and medical needs, everyday exposure to radioactivity is more commonly experienced as a product of the natural environment. The increasing demand for uranium (primarily for nuclear reactors and weaponry) has led to extensive exploration for the commodity. With regards to drinking water, Health Canada has particular concern with the presence of Total Uranium, Lead-210 (^{210}Pb) and Radium-226 (^{226}Ra) in aquatic reservoirs and has established maximum acceptable concentrations (MACs) for each of these naturally occurring radionuclides.

Geologically, radionuclides can be found over a variety of different rock types, and their influence on water depends on a variety of circumstances. Since Radium-226 (^{226}Ra) and Lead-210 (^{210}Pb) are daughter isotopes from the Uranium-238 (^{238}U) decay chain, the presence of one of these three nuclides in a geologic setting may indicate the presence of other daughter isotopes. Due to this, it would be optimal to test for the three radionuclides as a group or extend testing for the other two in the event one of the radionuclides has been found.

In comparison to surface water, groundwater is generally more prone to radionuclide accumulation. This is in part due to the longer residence time in which the water is in direct contact with the surrounding bedrock. Natural radioactivity in continental waters results from the weathering of rocks and the dissolution of the primordial radionuclides they contain (Vandecasteele, 2004). Surface water has far shorter contact time with underlying bedrock when compared to groundwater and is free to move throughout the environment. Although this makes surface water more susceptible to contamination, there is less opportunity to accumulate radionuclides. Additionally, during storm events and annual precipitation, surface water sources often receive influxes of water that may help to dilute contamination.

Due to the incompatible nature of the uranium element and its inability to enter into the crystal structure of many rock forming minerals, it often differentiates into the felsic upper crust. Because of this, uranium is often concentrated into granitic rocks and associated pegmatite dykes (Makofske et al., 1988). Groundwater found within granitic rocks and pegmatites can therefore be particularly high in uranium concentration (Schmoll and Oliver, 2006). In relation to this, metamorphic rocks such as gneiss and schist are also known to contain notable amounts of uranium.

Although granites and gnesises are generally enriched in uranium, groundwater from these host rocks often have low to intermediate uranium concentrations. Conversely, groundwater from sandstone and carbonate aquifers show elevated uranium up to several hundred mg/l from natural sources (Merkel, Broder, Planar-Friedrich, Britta,

Wolkersdorfer, Christian, 2002). Of all lithologies however, shales typically have the highest radioactivity; sands are intermediate; limestones, and dolomites are low and anhydrite, salt, coal, and chert are least active (Khan and Mussett, 2000). Sedimentary rocks that contain abundant amounts of uranium are commonly composed of sediments derived from weathered granites that are also rich in uranium (Hans et al., 2001).

Background on Selective Radiological Parameter Monitoring for Public Groundwater Supplies in NL: 2005-2006

The province of Newfoundland and Labrador completed sampling for radionuclides in 2005 and 2006. The special sampling in 2005 included a total of 14 public groundwater supplies (from 13 communities) chosen based on previous uranium concentration results and a uranium risk map produced as a joint project by the Departments of Natural Resources and Environment and Conservation. These 14 supplies were tested at the tap for gross alpha, gross beta and tritium. The special sampling in 2006 included water samples collected from 21 public groundwater supplies (from 13 communities) and analyzed for gross alpha, gross beta, lead-210, radium-226 and radium-228 or a combination of the five parameters. The supplies selected were a combination of the previous communities sampled in 2005 that exceeded limits and additional communities across the province based on previous uranium concentrations. This selective monitoring indicated there were communities in Newfoundland and Labrador that had groundwater sources that did exceed the limits for gross alpha and beta and therefore, additional monitoring was required to determine if radiological parameters were an issue in the province. The implementation of an extensive monitoring program was recommended to determine the extent, if any, of radiological parameters in public groundwater supplies in Newfoundland and Labrador.

Guidelines for Canadian Drinking Water Quality for Radiological Parameters

Health Canada published a revised *Guidelines for Canadian Drinking Water Quality: Guideline Technical Document – Radiological Parameters* in May 2009. This document outlines the current information, guidelines, sources and health effects of radiological parameters.

The *Guideline Technical Document* states that to assess the presence of radioactivity, water samples can initially be sampled using gross alpha and gross beta activity measurements. Gross alpha emissions are typically associated with natural radionuclides and gross beta emissions with artificial radionuclides. These measurements provide for a preliminary screen for radioactivity to determine if additional, parameter specific analysis is required. Non-compliance of either of the limits in Table 1 would indicate that additional parameter-specific monitoring would be required for the groundwater supply.

Table 1: Health Canada Limits for Gross Alpha and Gross Beta Activity

<i>Screening Techniques</i>	<i>Limits</i>
Gross Alpha Activity	0.5 Bq/L
Gross Beta Activity	1.0 Bq/L

The *Guideline Technical Document* provides maximum acceptable concentrations (MACs) for the most commonly detected radionuclides in Canadian drinking water supplies. The revised guidelines are available in Table 1. The MACs are based on specific radiological parameters but the effects of two or more radiological parameters are considered to be additive. The sum of all radiological parameter results should not exceed a value of 1. All guidelines (with the exception of total uranium) have the units of Becquerel (Bq) which is referred to as the activity or the rate at which transformations occur in a radioactive substance. (Health Canada, 2009) The MAC for total uranium is reported in milligrams per litre.

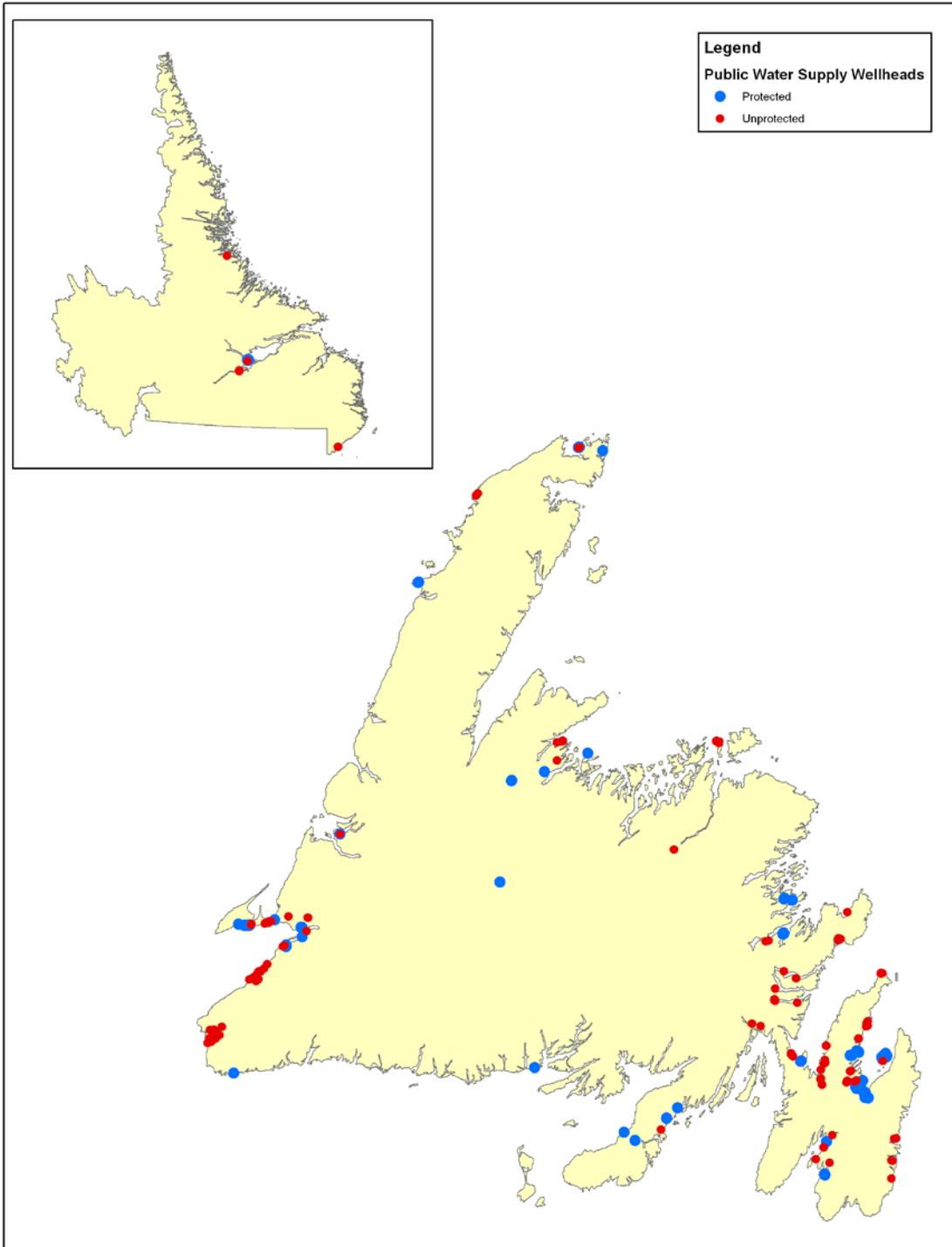
Table 2: Health Canada Guidelines for Common Radiological Parameters

<i>Natural radionuclides</i>	<i>MAC</i>	<i>Artificial radionuclides</i>	<i>MAC</i>
Total uranium	0.02 mg/L	Tritium (³H)	7000 Bq/L
Lead-210 (²¹⁰Pb)	0.2 Bq/L	Strontium-90 (⁹⁰Sr)	5 Bq/L
Radium-226 (²²⁶Ra)	0.5 Bq/L	Iodine-131 (¹³¹I)	6 Bq/L
		Cesium-137 (¹³⁷Cs)	10 Bq/L

Extensive Province-Wide Monitoring Program for Public Groundwater Supplies to Assess Radiological Parameters in NL: 2008-2010

In April 2008, the Department of Environment and Conservation developed an extensive sampling program for the monitoring of radiological parameters in all public groundwater supplies in Newfoundland and Labrador. This program was in anticipation of the revised guidelines for radiological parameters being developed by Health Canada and the recommendation that all groundwater supplies used for drinking water sources be assessed for the risk of radioactivity. The program was implemented over a three year period and involved the monitoring of 185 public groundwater wells. Only one groundwater well was not tested due to the fact that it is a seasonal supply, is rarely in use and access to it was not available during the three year period of monitoring. The public groundwater supplies monitored are illustrated in Figure 1.

Figure 1: Groundwater Supplies Monitored for Radiological Parameters



All public groundwater supplies were scheduled for gross alpha and gross beta monitoring as a preliminary screening for radioactivity. Samples were sent to an accredited laboratory for analysis. Results for the gross alpha and gross beta monitoring are available in Appendix A. As indicated in Table 3, of the 184 supplies monitored, 23 water supplies (12.5%) were scheduled for additional monitoring for specific radiological parameters. The specific monitoring included six water supplies that exceeded the preliminary screening limits for gross alpha and gross beta and 17 randomly selected water supplies for quality assurance/quality control (QA/QC) purposes. The 17 water supplies selected for QA/QC purposes were used to ensure that the screening tools of gross alpha and gross beta were applicable to water quality available in NL.

Table 3: Number of Public Wells Monitored for Radiological Parameters by Year

<i>Year</i>	<i># of Groundwater Well Monitored for Gross Alpha & Gross Beta</i>	<i># of Groundwater Well Monitored for Lead-210 & Radium-226</i>
2008	58	0
2009	116	17
2010	10	6
TOTAL	184	23

Of the 184 public water supplies monitored, only six (3%) exceeded recommended levels for either gross alpha or gross beta, as illustrated in Table 4.

Table 4: Public Wells with Gross Alpha and/or Gross Beta Exceedances above Recommended Levels

<i>Community</i>	<i>Water Supply</i>	<i>Parameter(s) Exceeded</i>
Bay St. George South	#2B Well Highlands	gross alpha
Bear Cove	Lower Bear Cove	gross alpha & gross beta
Bear Cove	Upper Bear Cove	gross beta
Chance Cove	Edgar Crann Well	gross alpha
McCallum	Drilled	gross alpha
St. Lunaire-Griquet	Drilled	gross alpha

Water supplies with gross alpha and/or gross beta exceedances above the recommended levels were scheduled for lead-210 and radium-226 monitoring. These parameters are two of the three natural radiological parameters indicated in Table 1. The third parameter, total uranium, is regularly monitored in Newfoundland and Labrador through the drinking water quality monitoring program conducted by WRMD. There is no reason to suspect any artificial radiological parameters in NL, hence, additional monitoring for the artificial radiological parameters were not conducted.

Also selected, were a number of water supplies chosen at random for sampling for lead-210 & radium-226 (9% of samples taken). These additional water supplies were monitored to ensure quality assurance/quality control of the monitoring program. Results of the lead-210 and radium-226 monitoring are available in Appendix B.

Of the 23 water supplies selected for additional radiological parameter analysis, no water supplies exceeded the lead-210 or radium-226 guidelines developed by Health Canada.

Total uranium levels in public groundwater supplies have been monitored twice per year since 2002 as part of the regular drinking water quality monitoring program conducted by WRMD. Of the over 2500 records for uranium in groundwater supplies, there has not been an exceedance of the *GCDWQ* to date. Summary statistics for total uranium is available in Appendix C.

Conclusions and Path Forward

The monitoring program conducted from 2008 to 2010 indicates that Newfoundland and Labrador does not have an issue with radiological parameters in public groundwater supplies. It is necessary however, to ensure that this analysis is revisited on a long-term basis to ensure that the baseline information collected through this monitoring program does not change over time.

Due to this observation, it is recommended that WRMD assess the presence of radioactivity of all public groundwater supplies by monitoring for gross alpha and gross beta activity every five years.

It is also recommended that the six groundwater supplies that exceeded the gross alpha and/or gross beta limits listed in Table 4 be monitored for lead-210 and radium-226 every two years.

This monitoring program was developed for all public water supplies. It is recommended that a similar monitoring program be initiated to determine the existence and extent, if any, of radiological parameters in private groundwater wells. This would be particularly relevant to areas that currently have no public groundwater supplies in the area.

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Appendices
Radiological Parameter Results 2008-2010

Appendix A – Gross Alpha and Gross Beta Results

<i>Community Name</i>	<i>Supply Name</i>	<i>Region</i>	<i>Date</i>	<i>Gross Alpha (0.5Bq/L)</i>	<i>Gross Beta (1.0Bq/L)</i>
Admiral's Beach	2 Well Fields	E	14-Aug-08	0.12	<0.06
Badger	Well Field, 2 wells on standby	C	01-Aug-08	0.14	0.12
Baine Harbour	Dug	E	02-Sep-09	<0.04	<0.04
Barachois Brook	Drilled	W	22-Sep-08	<0.04	<0.04
Bauline	#1 Brook Path Well	E	29-Sep-08	<0.08	0.06
Bay St. George South	#1 Well Heatherton	W	22-Sep-09	<0.35	<0.33
Bay St. George South	#2B Well Highlands	W	27-Aug-09	<0.62	0.9
Bay St. George South	Pumphrey Well Highlands	W	27-Aug-09	<0.24	<0.16
Bay St. George South	#1 Well Jeffrey's	W	22-Sep-09	<0.3	0.5
Bay St. George South	#2 Well Jeffrey's	W	22-Sep-09	<0.15	0.5
Bay St. George South	#3 Well Jeffrey's	W	22-Sep-09	<0.13	0.38
Bay St. George South	#6 Well Loch Leven	W	27-Aug-09	<0.3	<0.2
Bay St. George South	#2B Lions Club Well	W	22-Sep-09	<0.27	<0.19
Bay St. George South	#3 Woodworth Well McKay's	W	2-Mar-10	<0.31	<0.17
Bay St. George South	#7 Well McKay's	W	19-Sep-08	<0.16	0.2
Bay St. George South	#1 Well Robinson's	W	22-Sep-09	<0.16	0.2
Bay St. George South	#1 Well St. Fintan's	W	27-Aug-09	<0.15	0.1
Bay St. George South	#2 Well St. Fintan's	W	27-Aug-09	<0.25	<0.18
Bear Cove	Lower Bear Cove	W	18-Aug-09	<1.2	1.6
Bear Cove	Upper Bear Cove	W	18-Aug-09	<0.22	1
Benoit's Siding	Drilled	W	26-Aug-09	<0.2	0.2
Benoit's Siding	#2 Well Doyles	W	27-Aug-10	<0.14	0.51
Black Duck	#1 Well	W	8-Sep-09	<0.1	<0.07
Black Duck	#2 Well	W	9-Feb-10	<0.09	<0.05
Blaketown	#2 Daphne Pincent Well	E	4-Sep-09	<0.12	0.08
Blaketown	#3 Fred Osborne Well	E	4-Sep-09	0.15	0.1
Blaketown	#4 Hilda Barrett Well	E	4-Sep-09	<0.08	0.06
Blaketown	#1 Selby Mercer Well	E	4-Sep-09	<0.06	0.05
Brigus South	#2 Well Dunphey's Hill	E	11-Sep-09	<0.09	<0.06
Brigus South	#1 Well Forge Hill	E	11-Sep-09	<0.13	0.12
Brigus South	#3 Well Main Road	E	11-Sep-09	<0.03	0.07
Bryant's Cove	#1 Well-Bert James Well #2 Well-Baxter Bowering Well	E	17-Sep-08	<0.06	0.06
Bunyan's Cove	#1 Well	E	4-Aug-08	0.16	0.14
Bunyan's Cove	#2 Well	E	8-Sep-09	0.1	0.06
Canning's Cove	#3 Well – Glenda Penney	E	8-Sep-09	0.12	0.1
Canning's Cove	#1 Well – Pleman Pitts	E	8-Sep-09	0.08	0.06
Canning's Cove	#2 Well – Eugene Ellis	E	8-Sep-09	<0.05	0.03
Cavendish	#1 Well – Max Bishop	E	11-Sep-09	<0.13	0.16
Cavendish	#2 Well – Tom Critch	E	11-Sep-09	0.12	0.12
Chance Cove	Olive Smith Well	E	4-Aug-09	0.08	0.08
Chance Cove	Albert Rowe Well	E	4-Aug-09	0.19	0.1
Chance Cove	Eugene Smith Well	E	4-Aug-09	<0.18	<0.2
Chance Cove	New Housing Area Well	E	4-Aug-09	0.03	0.09
Chance Cove	Angus Brace Well	E	4-Aug-09	0.18	0.1

Radiological Parameters in Newfoundland and Labrador

<i>Community Name</i>	<i>Supply Name</i>	<i>Region</i>	<i>Date</i>	<i>Gross Alpha (0.5Bq/L)</i>	<i>Gross Beta (1.0Bq/L)</i>
Chance Cove	Edgar Crann Well	E	4-Aug-09	0.6	0.2
Charlottetown	Charlottetown Rec Centre	L	8-Nov-10	0.17	<0.15
Clarke's Beach	#1 Well – Quinlon Well	E	6-Aug-09	<0.07	<0.06
Clarke's Beach	#2 Well – Delaney Well	E	6-Aug-09	<0.07	0.1
Colliers	#5 Well – Whelan's Well	E	3-Aug-09	<0.04	0.08
Colliers	#3 Well – Griffin's Well	E	3-Aug-09	<0.13	<0.1
Colliers	#1 Well – Mahoney's Well	E	3-Aug-09	<0.12	<0.09
Colliers	#2 Well – Merrigan's Well	E	3-Aug-09	<0.13	0.1
Conception Harbour	Cemetery Road Well	E	3-Aug-09	<0.07	0.07
Conception Harbour	Healey's Pond Road Well	E	3-Aug-09	0.2	0.13
Conception Harbour	Lower Bacon Cove Well	E	3-Aug-09	0.1	0.13
Conception Harbour	Upper Bacon Cove Well	E	3-Aug-09	0.2	0.2
Cox's Cove	Upper Area Well #1	W	25-Sep-09	<0.16	0.1
Deep Bight	Deep Bight Well Field	E	10-Sep-09	0.4	<0.06
Dildo	#2 Well	E	4-Sep-09	<0.08	0.05
Eastport	Dug	C	10-Sep-08	0.02	0.05
Fermeuse	Port Kirwan Road Well	E	10-Sep-09	<0.07	0.17
Flat Bay	#1 Well	W	2-Sep-09	<0.46	<0.31
Flat Bay	#2 Well	W	2-Sep-09	<0.12	0.1
Flat Bay	#3 Well	W	22-Sep-08	<0.07	<0.07
Flat Bay West	#1 Well	W	2-Sep-09	<0.14	<0.03
Flat Bay West	#3 Well	W	2-Sep-09	<0.1	0.08
Fox Roost-Margaree	Drilled 8 inch	W	25-Aug-09	0.1	0.1
Frenchman's Cove	Dug Well	E	2-Sep-09	0.19	0.13
Freshwater	#2 Well – Covage's Lane Well	E	4-Aug-09	<0.07	0.08
Freshwater	#3 Well – Wallace Snow Well	E	4-Aug-09	<0.15	<0.11
Georgetown	Drilled	E	3-Aug-09	<0.06	0.05
Grate's Cove	#1 Cyril Meadus Well	E	14-Sep-09	0.08	0.08
Grate's Cove	#2 Frank Janes Well	E	14-Sep-09	0.11	0.07
Grate's Cove	#4 Stoyles Hill Well	E	14-Sep-09	<0.14	<0.1
Great Codroy	#1 Well	W	26-Aug-09	<0.14	<0.11
Great Codroy	#2 Well	W	26-Aug-09	<0.19	<0.14
Happy Valley-Goose Bay	Well Field (connect summer 2002)	L	10-Jul-08	<0.11	0.11
Happy Valley-Goose Bay	Spring Gulch	L	10-Jul-08	<0.02	0.07
Harbour Grace	Southside Well	E	4-Aug-09	<0.08	<0.07
Harbour Grace	Mercer's Rd. Well	E	4-Aug-09	<0.06	0.08
Harbour Grace	#1 Thicket Susie Galway Well	E	4-Aug-09	0.07	0.07
Harbour Grace	#2 Thicket New Well	E	4-Aug-09	0.2	0.18
Harbour Main-Chapel's Cove-Lakeview	Flynn's Hill Well	E	3-Aug-09	<0.13	0.1
Harbour Main-Chapel's Cove-Lakeview	Holden's Road Well	E	3-Aug-09	<0.07	0.11
Harcourt-Monroe-Waterville	Developed Spring	E	8-Sep-09	0.02	0.05

Radiological Parameters in Newfoundland and Labrador

<i>Community Name</i>	<i>Supply Name</i>	<i>Region</i>	<i>Date</i>	<i>Gross Alpha (0.5Bq/L)</i>	<i>Gross Beta (1.0Bq/L)</i>
Harry's Harbour	#1 Well-Northeast Well	C	11-Aug-08	<0.07	<0.06
Harry's Harbour	#3 Well-South Well	C	11-Aug-08	<0.08	<0.08
Harry's Harbour	#2 Well-Northwest Hill/Country Road	C	11-Aug-08	<0.09	<0.08
Hodge's Cove	Drilled	E	10-Sep-09	0.2	<0.08
Holyrood	Main Line	E	16-Sep-08	<0.05	0.04
Holyrood	O'Connell's Well	E	3-Aug-09	<0.15	<0.11
Holyrood	Woodford Station-Healey's Well and Quinlan's Well	E	3-Aug-09	0.2	0.09
Hopeall	Gilberts Hill Well	E	11-Sep-09	0.03	0.07
Hopeall	Charles Cumby Well	E	11-Sep-09	<0.07	0.09
Jackson's Cove-Langdon's Cove-Silverdale	#3 Well Langdon's Cove Well	C	11-Aug-08	<0.07	0.08
Jackson's Cove-Langdon's Cove-Silverdale	#1 Well-Jackson's Cove	C	11-Aug-08	<0.1	<0.09
Jackson's Cove-Langdon's Cove-Silverdale	#2 Well-Jackson's Cove	C	11-Aug-08	<0.1	0.1
Jean de Baie	#1 Well	E	9-Sep-08	<0.04	0.04
Kippens	Well Field	W	16-Sep-08	<0.08	<0.09
Lance Cove	LSD Well	E	25-Sep-09	<0.17	<0.12
Makinsons	Country Path Wells	E	18-Sep-08	0.1	<0.07
Makinsons	Taylor's Wells	E	3-Aug-09	<0.15	0.1
Marysvale	Drilled	E	17-Sep-08	<0.02	0.03
Mattis Point	Drilled	W	11-Mar-10	<0.11	<0.06
McCallum	Drilled	C	10-Sep-08	0.74	0.81
Natuashish	Well Field	L	9-Jul-08	0.2	0.19
North Harbour	Communal Well	E	3-Sep-09	<0.12	<0.08
Northwest Brook-Ivany's Cove	#1 Well-Cabot Road South Well	E	10-Sep-09	<0.36	<0.25
Northwest Brook-Ivany's Cove	#2 Well	E	10-Sep-09	<0.08	<0.05
Northwest Brook-Ivany's Cove	#3 Well-Harbour Well	E	10-Sep-09	<0.12	<0.08
Northwest River	Wellfield (#1 & #3 Well) + #2 Well	L	10-Jul-08	<0.04	0.17
O'Donnell's	Well Field	E	14-Aug-08	<0.08	0.09
O'Regans East	Drilled	W	26-Aug-08	0.14	0.2
Petley	Drilled	E	8-Sep-09	0.2	0.16
Piccadilly Slant-Abraham's Cove	#2 Well-Abraham's Cove	W	16-Sep-08	0.1	0.2
Piccadilly Slant-Abraham's Cove	#1 Well-Piccadilly Slant	W	16-Sep-08	<0.14	<0.14
Port au Choix	Well Field	W	10-Sep-08	<0.09	<0.09
Port au Port East	Drill Well-75-80%; Berry Head Watershed-20-25%	W	16-Sep-08	<0.1	<0.1
Port au Port West-Aguathuna-Felix Cove	#1 & #3 Drilled	W	16-Sep-08	<0.11	0.1

Radiological Parameters in Newfoundland and Labrador

<i>Community Name</i>	<i>Supply Name</i>	<i>Region</i>	<i>Date</i>	<i>Gross Alpha (0.5Bq/L)</i>	<i>Gross Beta (1.0Bq/L)</i>
Port au Port West-Aguathuna-Felix Cove	#4-Goose Pond Road Well	W	16-Sep-08	0.2	0.2
Port au Port West-Aguathuna-Felix Cove	#5 Ocean View Drive Well	W	9-Sep-09	<0.2	<0.14
Port Kirwan	Dug Well/Drilled Well	E	10-Sep-09	<0.08	0.08
Port Rexton	Champney's Arm Well	E	9-Sep-09	0.07	0.08
Port Rexton	#3 Well-Harold Vivian's Well	E	9-Sep-09	<0.13	<0.09
Port Rexton	#1 Well-Lois Long Well	E	9-Sep-09	<0.09	0.06
Port Rexton	#5 Well-Mabel Clarke's Well	E	9-Sep-09	0.06	0.18
Port Rexton	#6 Well-Banister's Well	E	9-Sep-09	<0.13	0.13
Raleigh	#4 Well	W	8-Sep-08	<0.11	0.2
Red Harbour	Drilled	E	9-Sep-08	0.15	0.1
Renews-Cappahayden	#1 Dinn's Well	E	10-Sep-09	<0.11	<0.08
Riverhead	Well Field	E	14-Aug-08	<0.02	<0.02
Sandringham	Drilled	C	10-Sep-08	<0.03	0.08
Sandy Cove	Dug	C	10-Sep-08	0.05	0.08
Sheaves Cove	Drilled	W	29-Sep-09	<0.2	<0.13
Sheppardville	Drilled	W	23-Sep-08	0.12	0.06
Sheshatsheits	Well 1,2 & 3	L	10-Jul-08	<0.26	<0.15
Ship Cove-Lower Cove-Jerry's Nose	#6 Well-Lower Cove Well	W	23-Feb-10	<0.24	<0.12
Ship Cove-Lower Cove-Jerry's Nose	#3 Well-Bernard Brake Well	W	29-Sep-09	<0.18	0.1
Ship Cove-Lower Cove-Jerry's Nose	#1 Well-PJ's Variety Well	W	29-Sep-09	0.3	<0.15
Ship Cove-Lower Cove-Jerry's Nose	#2 Well-Howard & Rodney Jesso Well	W	23-Feb-10	<0.32	0.2
Ship Cove-Lower Cove-Jerry's Nose	#4 Well-Nancy Rowe Well	W	23-Feb-10	<0.21	<0.11
Ship Cove-Lower Cove-Jerry's Nose	#5 Well-Murdock Wheeler Well	W	23-Feb-10	<0.21	<0.11
Small Point-Adam's Cove-Blackhead-Broad Cove	#1 Well-Reg Bursery Well	E	9-Feb-10	0.05	0.02
Small Point-Adam's Cove-Blackhead-Broad Cove	#4 Well-Leonard King Well	E	26-Aug-08	0.07	0.06
Small Point-Adam's Cove-Blackhead-Broad Cove	#6 Well-Herb Trickett Well	E	4-Aug-09	<0.12	0.13
Small Point-Adam's Cove-Blackhead-Broad Cove	#7 Well-Gin Badcock Well	E	4-Aug-09	<0.1	0.09
Small Point-Adam's Cove-Blackhead-Broad Cove	#8 Well-Effie Flight Wells	E	4-Aug-09	0.15	0.14
Small Point-Adam's Cove-Blackhead-Broad Cove	#9 Well-Walter Reynolds Well	E	4-Aug-09	<0.03	0.05

Radiological Parameters in Newfoundland and Labrador

<i>Community Name</i>	<i>Supply Name</i>	<i>Region</i>	<i>Date</i>	<i>Gross Alpha (0.5Bq/L)</i>	<i>Gross Beta (1.0Bq/L)</i>
Small Point-Adam's Cove-Blackhead-Broad Cove	#10 Les Gover Well	E	4-Aug-09	<0.03	0.03
Springdale	Well	C	12-Aug-08	<0.08	<0.07
South Dildo	#5 Well-Calvin Reid Well	E	4-Sep-09	<0.11	0.09
St. Alban's	Well Field	C	15-Sep-08	0.02	0.05
St. Andrew's	#2 Well	W	25-Aug-08	0.4	0.1
St. Andrew's	#4 Well Strip Road Well	W	26-Aug-09	<0.19	0.3
St. Andrew's	#1 Well	W	26-Aug-09	<0.22	<0.15
St. Andrew's	#3 Well	W	26-Aug-09	<0.16	0.2
St. John's	Barton's Road Well	E	28-Sep-09	<0.11	<0.07
St. Joesph's	Drilled	E	9-Sep-09	<0.09	0.08
St. Lunaire-Griquet	Drilled	W	17-Aug-09	1	0.6
St. Mary's	Wellfield	E	14-Aug-08	0.07	<0.05
St. Patricks	David Joy Well	C	5-Sep-08	0.15	0.15
Stephenville	Well Field	W	10-Sep-08	<0.09	<0.08
Stephenville Crossing	Well Fields 1 & 2	W	10-Sep-08	<0.1	<0.09
Swift Current	Drilled	E	3-Sep-09	0.18	0.15
Tompkins	Greg Wall Well	W	25-Aug-08	<0.1	0.1
Upper Amherst Cove	Drilled	E	9-Sep-09	<0.13	<0.09
Upper Ferry	#4 Well-Angus MacNeil Well	W	26-Aug-09	<0.19	0.4
Upper Ferry	#1 Well-Gerard Brownrigg Well	W	26-Aug-09	<0.12	<0.09
Upper Ferry	#2 Well-Hughie MacIssac Well	W	26-Aug-09	<0.11	0.08
Upper Ferry	#3 Well-Marshall Devoe Well	W	26-Aug-09	0.2	0.2
Wabana	Main Street	E	25-Sep-08	0.1	0.08
Wabana	#4-West Mines Road	E	25-Sep-08	0.09	<0.07
Wabana	#3 Yard West Mines Road	E	25-Sep-08	0.12	<0.08
Wabana	Normore Crescent East #1	E	25-Sep-08	<0.1	<0.08
Wabana	Quigley's Line	E	25-Sep-08	<0.09	<0.08
Wabana	Scotia #1	E	25-Sep-08	<0.08	<0.06
Wabana	Davidson Avenue	E	25-Sep-08	<0.09	<0.08
Wabana	Fancy Hill Main Street	E	25-Sep-09	<0.14	<0.1
Wabana	Kavanagh's Lane	E	25-Sep-09	<0.16	0.1
Wabana	Kelloway's Memorial St.	E	25-Sep-09	<0.15	<0.1
Wabana	Middleton Avenue	E	25-Sep-09	<0.11	<0.07
Wabana	St. Edward's Memorial St.	E	25-Sep-09	<0.16	0.1
West St. Modeste	Well Field	L	7-Jul-08	0.36	0.24
Winterland	Well Field	E	9-Sep-08	0.25	0.13

Note: Detection limits differ due to the total amount of solids, dissolved and suspended, present in the sample.

Appendix B – Lead-210 and Radium-226 Results

<i>Community Name</i>	<i>Supply Name</i>	<i>Region</i>	<i>Date</i>	<i>Lead-210 (0.2Bq/L)</i>	<i>Radium-226 (0.5Bq/L)</i>	<i>Sum (1.0Bq/L)</i>
Admiral's Beach	2 Well Fields	E	27-Jan-09	<0.02	<0.005	0
Badger	Well Field, 2 wells on standby	C	2-Feb-09	<0.02	<0.005	0
Bear Cove	Lower Bear Cove	W	26-Jan-10	<0.02	0.02	0.02
Bear Cove	Upper Bear Cove	W	17-Aug-10	<0.02	0.04	0.04
Bunyan's Cove	#1 Well	E	19-Jan-09	<0.02	<0.005	0
Chance Cove	Edgar Crann Well	E	2-Feb-10	<0.04	0.02	0.02
Makinsons	Country Path Wells	E	11-Feb-09	<0.02	<0.005	0
McCallum	Drilled	C	16-Feb-10	<0.02	0.008	0.008
Natuashish	Well Field	L	16-Feb-09	<0.02	0.007	0.007
O'Regans East	Drilled	W	30-Jan-09	<0.02	<0.005	0
Piccadilly Slant- Abraham's Cove	#2 Well-Abraham's Cove	W	4-Mar-09	<0.02	0.01	0.01
Port au Port West- Aguathuna-Felix Cove	#1 & #3 Drilled	W	3-Feb-09	<0.02	0.01	0.01
Port au Port West- Aguathuna-Felix Cove	#4-Goose Pond Road Well	W	18-Mar-09	<0.02	0.006	0.006
Red Harbour	Drilled	W	2-Feb-09	0.04	<0.005	0.04
Sheppardville	Drilled	W	4-Feb-09	<0.02	<0.005	0
St. Andrew's	#2 Well	W	3-Feb-09	<0.02	<0.005	0
St. Lunaire-Griquet	Drilled	W	25-Jan-10	0.04	0.18	0.22
St. Patricks	David Joy Well	C	5-Mar-09	<0.02	0.006	0.006
Wabana	Main Street	E	26-Feb-09	<0.02	0.02	0.02
Wabana	#3 Yard West Mines Road	E	26-Feb-09	<0.02	0.01	0.01
West St. Modeste	Well Field	L	16-Feb-09	<0.02	<0.005	0
Winterland	Well Field	E	2-Feb-09	0.05	<0.005	0.05

Appendix C – Total Uranium Summary Statistics

<i>Summary Statistic</i>	<i>Uranium Levels</i>
Minimum	0.0 mg/L
Maximum	0.018 mg/L
Mean	0.001 mg/L