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Cross-Canada Survey of Radon Concentrations in Homes

Final Report

Canada

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Publications
Health Canada
Ottawa, Ontario K1A 0K9
Tel.: 613-954-5995
Fax: 613-941-5366
Email: info@hc-sc.gc.ca

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Final Report

March 2012

Table of Contents

List of Appendices

Cross-Canada Survey of Radon Concentrations in Homes
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Executive Summary

This report summarizes the results from the Cross-Canada Survey of Radon Concentrations in Homes, a two-year study conducted by Health Canada's National Radon Program.

The aims of this study were to obtain an estimate of the proportion of the Canadian population living in homes with radon gas levels above the guideline[1] of 200 Bq/m^3, to identify previously unknown areas where radon gas exposure may constitute a health risk, and to build, over time, a map of indoor radon gas exposure levels across Canada.

Participants for the study were recruited by Prairie Research Associates (PRA) via telephone. Homes were sampled across Canada and a long-term (three-month) radon test was conducted by participants during the fall and winter heating season. By sampling in all Health Regions[2] as opposed to a few large cities, an estimate of the geographic distribution of radon levels across Canada was obtained. Participants also completed a questionnaire about their home's characteristics.

The results from this two-year study indicate that 6.9% of Canadians are living in homes with radon levels above the current radon guideline of 200 Bq/m^3. These results are in line with the year 1 results of 7%. This estimate is also similar to the Cross-Canada Survey results from the late 1970s which showed that 5% of Canadians lived in homes that were above the 200 Bq/m^3 radon guideline.

This survey confirmed that radon levels vary significantly across the country and that there are areas where high levels of indoor radon are more prevalent. Manitoba, New Brunswick, Saskatchewan, and the Yukon had the highest percentages of participant homes which tested above the radon guideline. Conversely, Nunavut and Prince Edward Island had the lowest percentages. Of the 121 Health Regions tested, there were 14 Health Regions where the raw percentage of homes testing above the guideline ranged from 23 to 44%. Five of these were in Manitoba, four in New Brunswick, three in Saskatchewan, and one each in Quebec and British Columbia. There were another nine Health Regions where the raw percentage of homes above the radon guideline ranged from 16 to 21%. Fifty-four (45%) of the Health Regions had 10% or more homes above the guideline level.

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[1] ***The Canadian Guideline for Radon in Indoor Air*** provides Canadians with guidance on when remedial action should be taken to reduce radon levels. This guideline recommends action to reduce radon levels in a dwelling when the average annual concentration exceeds 200 Bq/m^3. The concentration of radon in air is measured in units of becquerels per cubic meter (Bq/m^3), a measurement of radioactive concentration.

[2] "Health Region" is a term that generally applies to a geographic administrative area of responsibility for a hospital board or regional health authority, and which is ultimately defined by a provincial ministry of health. Regions have become an important geographic unit by which health and health-related data are collected.

There are no areas of the country that are 'radon free'. The results of this study show that even for those provinces where the overall results indicate a lower incidence of homes with elevated radon levels, there were still areas of those provinces with high radon levels and a significant number of homes with radon concentrations above the guideline. For example, in Ontario, where the population-weighted estimate was 4.6% of homes exceeding the guideline, 13 of 36 Health Regions (greater than one third of the Health Regions) had more than 10% of the homes test above the guideline.

The results of this study can be used by governments and health professionals to help prioritize radon outreach and education efforts, and to encourage testing and remediation where necessary. This survey's results **should not** be used as a tool to determine radon risk potential or whether or not to test a home for radon. **The only way to know if a home has an elevated level of radon is to test, regardless of location.**

Now that the radon results have been obtained and analyzed for this survey, the next step will be to review the questionnaire data from the full two-year study to see if any correlations can be drawn between radon levels and home characteristics. This is expected to be completed in 2012. The radon data will also be used to support the development of a radon potential mapping methodology for Canada.

Cross-Canada Survey of Radon Concentrations in Homes
Final Report

Introduction

Radon is a radioactive gas that is found naturally throughout our environment. It is produced by the decay of uranium found in rocks and soil. Since radon is a gas, it can move freely through the soil enabling it to escape into the atmosphere or seep into buildings. Radon is invisible, odourless and tasteless, but can be easily measured with a radon detector. There are two options for testing a house for radon: to purchase a do-it-yourself radon test kit or to hire a radon measurement professional. If you choose to purchase a radon test kit, you must closely follow the instructions on how to set up the test. If you choose to hire a service provider to perform a radon test in your house, it is recommended that you ensure they are certified and will conduct a long-term test.

In outdoor air, radon gas is diluted and does not pose a health risk. However, radon that enters an enclosed space, such as a home or building, can accumulate to high levels. Prolonged exposure to high levels of radon has been associated with an increased risk of developing lung cancer. It is estimated that about 10% of all lung cancers worldwide are related to radon exposure.

Health Canada has established a guideline for radon in indoor air. The guideline is a voluntary (non-regulatory) level at which Health Canada recommends that Canadians take action. The SI unit for radioactivity is the becquerel (symbol: Bq), and it corresponds to one radioactive disintegration per second. Radon concentration in air is, therefore, expressed in SI units of Bq/m^3 (becquerels per cubic meter). Health Canada first established a radon guideline in 1988 with an action level of 800 Bq/m^3. The 1988 guideline was based on the best information available at the time which included data from studies of uranium miners. The earliest associations between radon and lung cancer were from studies of uranium miners exposed to elevated radon levels in their workplaces. However, evidence now exists that indicates the risk of developing lung cancer from radon exposure extends to levels found in some residences.

Therefore, in 2004, Health Canada began to collaborate with the Federal Provincial Territorial Radiation Protection Committee (FPTRPC) to review the health risk from exposure to radon and to revise the radon guideline. The risk assessment was based on new scientific information and was the subject of a broad Canadian public consultation in 2006. Based on the assessment and feedback from the consultation, the Government of Canada revised the guideline for exposure to radon in indoor air from 800 Bq/m^3 to 200 Bq/m^3 in June 2007.

The new guideline recommends the following:

- Remedial measures should be undertaken in a dwelling whenever the average annual radon concentration exceeds 200 Bq/m^3 in the normal occupancy area.
- The higher the radon concentration, the sooner remedial measures should be undertaken.
- When remedial action is taken, the radon level should be reduced to a value that is as low as practicable.
- The construction of new dwellings should employ techniques that will minimize radon entry and will facilitate post-construction radon removal, should this subsequently prove necessary.

Following the change to the Canadian guideline, Health Canada and the FPTRPC continued to work collaboratively to develop a program for the effective implementation of the new guideline. This resulted in the creation of the National Radon Program, which consists of five components:

1. A National Radon Laboratory (NRL) established in 2007 to support radon testing projects and provide expertise and advice to governments and the Canadian public.
2. Radon testing projects, which will assess the levels of radon in federal workplaces as well as residential levels across the country.
3. Development of a radon potential mapping methodology for Canada. Data from Health Canada radon testing projects as well as aerial and land radiation surveys and provincial geological surveys will be used in the development of a map of radon rich areas across Canada. Radon potential mapping can assist governments in more effectively targeting their communication and outreach efforts.
4. Radon-related research projects designed to assess and reduce the health impacts from exposure to radon.
5. A public education and awareness program which focuses on homeowners, commercial building owners, the building industry and public health practitioners. The goals of this program are to raise awareness of radon and the potential health risks from exposure, and to encourage Canadians to test for radon in their homes and take appropriate measures to reduce levels, if necessary.

The Cross-Canada Survey of Radon Concentrations in Homes, the subject of this report, is one of the key projects Health Canada has undertaken as part of its National Radon Program.

Purpose

The purpose of the Cross-Canada Survey of Radon Concentrations in Homes project was to gather long-term (three months or longer) indoor radon test results from across Canada in order to:

1. obtain an estimate of the proportion of the Canadian population living in homes with radon gas levels above the guideline of 200 Bq/m^3;
2. identify previously unknown areas where radon gas exposure may constitute a health risk; and
3. build, over time, a map of indoor radon gas exposure levels.

The measurements were conducted during the fall and winter heating season when most homeowners maintain closed windows and doors, and indoor radon levels tend to be higher.

The sampling included all Health Regions in Canada and covered both rural and urban areas. “Health Region” is a term that generally applies to a geographic administrative area of responsibility for a hospital board or regional health authority, and which is ultimately defined by a provincial ministry of health. Since they are provincial administrative areas of responsibility, Health Regions are subject to change. Health Regions have become an important geographic unit by which health and health-related data are collected. Thus, collection of radon measurement data by Health Region was deemed appropriate for this study.

Methodology

The study was designed to recruit 18,000 participants over two calendar years based on various qualifying criteria. Participants were recruited over the telephone by a contracted market research firm. Once they agreed to participate, recruits were then mailed a radon detector test kit and asked to deploy the detector in the lowest lived-in level of the home, where someone spends at least four hours a day. Participants were asked to conduct a long-term test since radon levels fluctuate in the short term (hours to days). In order for the result to be indicative of the average annual radon exposure, the test needed to be conducted for a period of at least three months. The radon test kit contained the following:

1. a sealed radon detector along with instructions for deploying it;
2. an information brochure on radon;
3. a short questionnaire for the homeowner to answer about their home;
4. a zip-top bag to place the used detector in at the end of the test period to minimize potential radon exposure during mail back to the NRL; and
5. a postage-paid return envelope with which to return the bagged used detector and the completed questionnaire to the NRL at the end of the 3-month test period.

The participants were instructed to install the alpha track radon detector (a small black cylindrical plastic object 45 mm in diameter and 17 mm tall) in a suitable location within their home where someone spends at least four hours a day. The instructions contained guidance regarding areas of the house that are suitable for placing the detector as well as a few areas to avoid. The participants were to record the start date and time of the test, and then, roughly 91 days later, they were to record the stop date and time of the test. Participants were to fill out a questionnaire on their home, and mail the detector and completed questionnaire back to the NRL for analysis.

The contractor was responsible for following up with participants during the testing period. The initial follow-up was to make sure participants received their radon detector, installed it, and recorded the start date of the test. Similar follow-up was conducted at the end of the test period to remind participants to end the test, record the stop date, complete the questionnaire, and return the detector and completed questionnaire to the NRL.

After the detectors were analyzed, the NRL sent a letter to each participant with their results. Participants whose results were above the radon guideline of 200 Bq/m^3 also received a copy of the joint Health Canada/Canada Mortgage and Housing Corporation (CMHC) publication entitled *Radon: A Guide for Canadian Homeowners*. The guide provides information about radon and describes how to reduce radon levels in the home.

Through a competitive bid process, the contract for the participant recruitment and follow-up activities was awarded to Prairie Research Associates (PRA) of Winnipeg, Manitoba, who partnered with Jolicoeur and Associates of Montreal, Quebec, to provide services in both official languages across the country.

The Sampling Frame

The goal of the study was to recruit 18,000 participants over two years (approximately 9000 each summer) with radon testing to occur in the 2009-10 and 2010-11 fall/winter (October to March) periods. In 2007, there were 124 Health Regions in Canada, and the intent of the study was to sample homes in each of these Health Regions. Unfortunately, because the population was very low in several Health Regions, a number of regions were combined to ensure a reasonable chance of obtaining the required number of samples. Two Health Regions in northern Manitoba, namely Burntwood and Churchill, were combined into one Health Region for this study. Similarly, three Health Regions in northern Saskatchewan, namely Mamawetan, Keewatin, and Athabasca, were combined into a single Health Region. This resulted in 121 Health Regions being sampled.

There were several qualifying criteria that had to be satisfied for a participant to be eligible to take part in the study. First, participants had to be the head of the household and 18 years of age or older. Participants also had to be homeowners, and be living in their primary residence. People who rented a home were not included in the study because there is no requirement on the part of landlords to remediate high radon levels if they are found in a home. In addition, participants could not live on military bases or on-reserve, since these homes were, or were expected to be, covered in other surveys.

Homes that were built on stilts or high-rise condo units that were above the second floor did not qualify. Finally, homeowners could not have planned to move or be away during the proposed timeline of the study (October to March).

Please see Appendix 1 for a more detailed explanation of how the 18,000 participants were assigned and mapped to the 121 Health Regions.

Recruiting Statistics

In year 1 of the study, 8,966 participants were recruited. A very small number of them (23) withdrew shortly after the recruitment phase but before the detector kits were mailed out. This left 8,943 participants to receive detector kits. PRA recruited 9,138 participants in year 2, which resulted in 18,081 recruits over the study period. It was hoped that the recruitment of roughly 18,000 participants would provide approximately 14,000 results, yielding a completion rate of between 75 and 80%.

PRA and Jolicoeur dialed nearly 100,000 telephone numbers to obtain the desired number of recruits for year 1. A similar quantity of telephone numbers were dialed during year 2. Appendices 2 and 3 provide statistics pertaining to these calls.

In the vast majority of the Health Regions (114; 94%), PRA and Jolicoeur achieved at least 95% of the desired number of recruits for year 1 of the study. There were two Health Regions located in northern Quebec, namely Nunavik and Terres-Cries-de-la-Baie-James, where recruitment was extremely difficult. The entire sets of telephone numbers in these two Health Regions were exhausted in year 1. Therefore, in year 2, the remaining number of participants, that were to be recruited from these two Health Regions, were re-distributed to other Health Regions, mostly in Quebec. For year 2, the sample size for each of Bas-Saint-Laurent, Capitale-Nationale, Gaspésie–Îles-de-la-Madeleine, Chaudière-Appalaches, and Laval was increased by 70 recruits, and Calgary Health Region was increased by 39 recruits.

Early in the recruitment process for year 2, it became apparent that the desired quotas would not be met in several large northern geographic Health Regions, namely Burntwood/Churchill (Manitoba), Mamawetan/Keewatin/Athabasca (Saskatchewan), Northern Lights (Alberta), and Nunavut. This was due to their sparse populations and the inability to meet the study participant requirements. It was estimated that roughly 290 participants would need to be re-distributed to other Health Regions as a result. It was decided that these participants would be re-distributed to ten Health Regions across Canada (i.e., 29 each). These ten Health Regions were: Region 4 (New Brunswick), Montreal (Quebec), Lanaudière (Quebec), Laurentides (Quebec), Toronto (Ontario), Brandon (Manitoba), Regina (Saskatchewan), Saskatoon (Saskatchewan), Capital Health (Alberta), and North Shore/Coast Garibaldi (British Columbia). These ten Health Regions were chosen since they had been destined for under sampling originally (see Appendix 1). By increasing the number of recruits in these regions, it was hoped that an increased number of completed tests would be received, resulting in better radon estimates.

Detector Mail Out

The detector kit consisted of a sealed alpha track detector, a set of instructions for conducting the test, a zip-top bag to place the detector in at the end of the test, a questionnaire related to the home (type of construction, year of construction, heating system, heating fuel, etc.), a postage-paid return mailer kit, and an information brochure on radon and its health effects.

In both years, detector shipments to participants were staggered so that the mailing process would be manageable for NRL staff and the return of detectors would be spread out over a period of time to facilitate analysis in the laboratory. In year 1, some of the detectors were sent out in late November resulting in a delay in recipients starting the testing period because of the holiday season. To avoid this situation in year 2 of the study, the NRL shipped out the test kits in two waves, in late September and early November.

Detector Return Rates

Overall detector return rates for both years of the study, by province and territory, are shown below in Table 1. Return rates on a Health Region basis ranged from 58 to 89%.

Table 1: Returned Detectors by Province (Courtesy of PRA)

Province	Participants	Returned Kits	% Returned
British Columbia	2,354	1,878	79.8
Alberta	1,507	1,166	77.4
Saskatchewan	1,513	1,251	82.7
Manitoba	1,479	1,202	81.3
Ontario	5,345	3,891	72.8
Quebec	2,220	1,849	83.3
New Brunswick	1,059	839	79.2
Nova Scotia	816	595	72.9
Newfoundland and Labrador	956	684	71.5
Prince Edward Island	137	116	84.7
Yukon	274	228	83.2
Northwest Territories	274	192	70.1
Nunavut	147	85	57.8
Total	**18,081**	**13,976**	**77.3**

Roughly 4% of those participants who had initially volunteered to participate in the study subsequently declined when they received their detector package. In the majority of these cases (75 %), the returned kits contained no written explanation for declining. Of the returned kits that had explanations, the most prevalent reasons for declining to participate were due to upcoming renovations (11%) or because the participants were no longer going to be home during the fall/winter testing period (9%). A small percentage admitted they forgot to conduct the test.

At the time of preparing this report, 13,976 participants had returned packages to the NRL and there were 13,807 valid results. These results are for returns where the testing data were complete and of sufficient duration. They represented roughly 76% of all participants. This return rate was reasonable, and demonstrated that Canadians are willing to participate in such a study.

The NRL continues to receive completed test kits at the time of writing this report, with the longest test duration currently being 456 days. Approximately 9% of participants in each year of the study could not be reached for follow-up by PRA, despite numerous attempts. Even without the follow-up contact, some of these participants did eventually complete their tests and return their detectors to the NRL. It is expected that completed test kits will continue to arrive throughout 2012.

Issues with the Testing Process

There were very few participants who had problems conducting their test. Only a small number of participants returned their kits stating that they thought the test was too complicated. A significant number of participants tended to misplace parts of their test kit which resulted in the NRL having to ship out replacement items. Some 265 items were re-shipped to 170 participants during year 1. The most common items re-shipped to participants during year 1 were the postage-paid return mailer (45%), the paper questionnaire (30%) and the zip-top bag (23%). During year 2, a slightly smaller number of participants (158) requested that items be re-shipped to them. The return envelope, questionnaire and zip-top bags were the items re-shipped most frequently. However, those who required replacement items represented 2% of total participants over the length of the study, which was acceptable.

The vast majority of participants, roughly 96%, performed a test of at least 90 days in duration. Only 1.9% of participants conducted tests that were less than 84 days in length, 0.29% were between 30-60 days duration, and less than 0.1 % of participants conducted tests that were less than 30 days in duration. Participants who conducted tests shorter than 30 days were issued results letters, but their results were not used in the Health Region survey statistics in this report. The average test duration for the participants was 95.6 days and the median test duration was 92 days. A slightly higher percentage of year 2 participants (89%) than those in year 1 (84%) conducted their test for 91 days or longer. This probably resulted from a combination of the changes made to both the year 2 instructions and PRA's follow-up procedures with participants during year 2.

Results

A summary of the results from both years of the study is shown in the tables (Tables 2 to 4) below. Table 2 shows the percentage of participants in each province/territory with results below 200 Bq/m^3, between 200 and 600 Bq/m^3, above 600 Bq/m^3, and then the total above 200 Bq/m^3 (sum of the percentages between 200 and 600 Bq/m^3 and

above 600 Bq/m^3). These are "raw" percentages, that is, simply the number of results in a particular radon concentration category for each province or territory divided by the total number of results for that province or territory multiplied by 100.

Table 3 shows the same data, but as a population-weighted estimate of the percentage of the population in each province/territory that fall into each radon concentration category. The population weighted data for each province/territory were derived by taking the raw results from each Health Region and using the population of each Health Region from the 2006 Census data (the most recent census conducted) to arrive at an estimate of the population-weighted percentage of Canadians falling into each concentration range in each Health Region and then in each province/territory. In this way, an estimate of the population in different areas of Canada living in homes that are above the radon guideline of 200 Bq/m^3 was obtained. The data are the same in both tables for the province (Prince Edward Island) and all three territories that had only one Health Region. Table 4 shows the estimate for Canada.

Table 2: Percentage of Homes Tested with Radon Concentrations Below 200 Bq/m^3, Between 200 and 600 Bq/m^3, Above 600 Bq/m^3 and Above 200 Bq/m^3 for Each Province and Territory

	"Raw" Percentage of Homes with Radon Concentrations:			
Province/Territory	**% Below 200 Bq/m^3**	**% 200 to 600 Bq/m^3**	**% Above 600 Bq/m^3**	**% Above 200 Bq/m^3**
Alberta (AB)	93.4	6.0	0.6	6.6
British Columbia (BC)	92.1	6.7	1.2	7.9
Manitoba (MB)	76.3	21.1	2.6	23.7
New Brunswick (NB)	75.2	18.7	6.1	24.8
Newfoundland and Labrador (NL)	94.1	4.6	1.3	5.9
Nova Scotia (NS)	91.2	6.3	2.5	8.8
Northwest Territories (NT)	94.6	4.9	0.5	5.4
Nunavut (NU)	100.0	0.0	0.0	0.0
Ontario (ON)	91.8	7.3	0.9	8.2
Prince Edward Island (PE)	96.5	3.5	0.0	3.5
Quebec (QC)	89.9	9.0	1.1	10.1
Saskatchewan (SK)	83.7	15.3	1.0	16.3
Yukon (YT)	80.4	13.8	5.8	19.6

Table 3: Population-Weighted Percentage of Canadians Living in Homes with Radon Concentrations Below 200 Bq/m^3, Between 200 and 600 Bq/m^3, Above 600 Bq/m^3 and Above 200 Bq/m^3 for Each Province and Territory

	Population-Weighted Percentage of Canadians Living in Homes with Radon Concentrations:			
Province/Territory	**% Below 200 Bq/m^3**	**% 200 to 600 Bq/m^3**	**% Above 600 Bq/m^3**	**% Above 200 Bq/m^3**
AB	94.3	5.5	0.2	5.7
BC	96.1	3.4	0.5	3.9
MB	80.6	18.0	1.4	19.4
NB	79.4	15.2	5.4	20.6
NL	94.9	4.4	0.7	5.1
NS	89.3	8.2	2.5	10.7
NT	94.6	4.9	0.5	5.4
NU	100.0	0.0	0.0	0.0
ON	95.4	4.2	0.4	4.6
PE	96.5	3.5	0.0	3.5
QC	91.8	7.5	0.7	8.2
SK	84.3	14.4	1.3	15.7
YT	80.4	13.8	5.8	19.6

Table 4: Population-Weighted Percentage of Canadians Living in Homes with Radon Concentrations Below 200 Bq/m^3, Between 200 and 600 Bq/m^3, Above 600 Bq/m^3 and Above 200 Bq/m^3

Canada-Population Weighted %	**% Below 200 Bq/m^3**	**% 200 to 600 Bq/m^3**	**% Above 600 Bq/m^3**	**% Above 200 Bq/m^3**
Canada	93.1	6.2	0.7	6.9

Where test results for homes exceeded the Canadian Radon Guideline (200 Bq/m^3), recommendations were made that the homeowners take action within a two-year (where results were greater than 200 Bq/m^3 but less than 600 Bq/m^3) or a one-year (where results were greater than 600 Bq/m^3) time period. Homeowners who had test results above the guideline also received a copy of the Health Canada/CMHC joint publication entitled *Radon: A Guide for Canadian Homeowners*. This guide explains what radon is, its health effects, how radon enters a home, describes methods of radon analysis, and also provides guidance on ways to reduce radon concentrations in a home.

Table 5 shows the number of results and a breakdown of raw percentages below 200 Bq/m^3, between 200 and 600 Bq/m^3, greater than 600 Bq/m^3, and finally above 200 Bq/m^3 in each Health Region. These are not population-weighted percentages.

Table 5: Raw Percentage of Homes Tested with Radon Concentrations Below 200 Bq/m^3, Between 200 and 600 Bq/m^3, Above 600 Bq/m^3 and Above 200 Bq/m^3 for Each Health Region

Province or Territory	Health Region	Health Region Name	Number of Survey Participants	% Below 200 Bq/m^3	% 200 to 600 Bq/m^3	% Above 600 Bq/m^3	% Above 200 Bq/m^3
NL	1011	Eastern Regional Integrated Health Authority	100	96.0	4.0	0.0	4.0
NL	1012	Central Regional Integrated Health Authority	201	95.0	3.0	2.0	5.0
NL	1013	Western Regional Integrated Health Authority	211	89.6	8.5	1.9	10.4
NL	1014	Labrador-Grenfell Regional Integrated Health Authority	201	97.0	2.5	0.5	3.0
PE	1111	Prince Edward Island	113	96.5	3.5	0.0	3.5
NS	1201	Zone 1	97	93.8	4.1	2.1	6.2
NS	1202	Zone 2	106	95.3	2.8	1.9	4.7
NS	1203	Zone 3	95	87.4	9.5	3.1	12.6
NS	1204	Zone 4	99	98.0	2.0	0.0	2.0
NS	1205	Zone 5	92	85.9	7.6	6.5	14.1
NS	1206	Zone 6	103	86.4	11.7	1.9	13.6
NB	1301	Region 1	106	80.2	16.0	3.8	19.8
NB	1302	Region 2	101	89.1	9.9	1.0	10.9
NB	1303	Region 3	112	83.0	9.8	7.1	17.0
NB	1304	Region 4	86	70.9	24.4	4.7	29.1
NB	1305	Region 5	110	76.4	19.1	4.5	23.6
NB	1306	Region 6	115	60.0	23.5	16.5	40.0
NB	1307	Region 7	200	71.0	24.0	5.0	29.0
QC	2401	Région du Bas-Saint-Laurent	171	86.0	12.3	1.7	14.0
QC	2402	Région du Saguenay - Lac-Saint-Jean	72	97.2	1.4	1.4	2.8
QC	2403	Région de la Capitale-Nationale	160	91.2	6.3	2.5	8.8
QC	2404	Région de la Mauricie et du Centre-du-Québec	59	100.0	0.0	0.0	0.0
QC	2405	Région de l'Estrie	54	90.7	9.3	0.0	9.3
QC	2406	Région de Montréal	73	93.1	6.9	0.0	6.9
QC	2407	Région de l'Outaouais	62	87.1	8.1	4.8	12.9
QC	2408	Région de l'Abitibi-Témiscamingue	69	95.7	4.3	0.0	4.3
QC	2409	Région de la Côte-Nord	106	96.2	3.8	0.0	3.8
QC	2410	Région du Nord-du-Québec	224	94.2	5.8	0.0	5.8
QC	2411	Région de la Gaspésie - Îles-de-la-Madeleine	174	74.7	21.8	3.5	25.3
QC	2412	Région de la Chaudière-Appalaches	175	86.9	12.5	0.6	13.1
QC	2413	Région de Laval	107	87.9	11.2	0.9	12.1
QC	2414	Région de Lanaudière	76	96.1	3.9	0.0	3.9
QC	2415	Région des Laurentides	78	89.7	9.0	1.3	10.3
QC	2416	Région de la Montérégie	112	91.1	8.9	0.0	8.9
QC	2417	Région du Nunavik	9	88.9	11.1	0.0	11.1
QC	2418	Région des Terres-Cries-de-la-Baie-James	3	100.0	0.0	0.0	0.0
ON	3526	District of Algoma Health Unit	93	91.4	7.5	1.1	8.6
ON	3527	Brant County Health Unit	96	89.6	9.4	1.0	10.4
ON	3530	Durham Regional Health Unit	95	100.0	0.0	0.0	0.0

Province or Territory	Health Region	Health Region Name	Number of Survey Participants	% Below 200 Bq/m^3	% 200 to 600 Bq/m^3	% Above 600 Bq/m^3	% Above 200 Bq/m^3
ON	3531	Elgin-St. Thomas Health Unit	92	92.4	6.5	1.1	7.6
ON	3533	Grey Bruce Health Unit	99	88.9	10.1	1.0	11.1
ON	3534	Haldimand-Norfolk Health Unit	116	97.4	2.6	0.0	2.6
ON	3535	Haliburton, Kawartha, Pine Ridge District Health Unit	98	93.9	5.1	1.0	6.1
ON	3536	Halton Regional Health Unit	102	95.1	4.9	0.0	4.9
ON	3537	City of Hamilton Health Unit	100	95.0	5.0	0.0	5.0
ON	3538	Hastings and Prince Edward Counties Health Unit	99	87.9	10.1	2.0	12.1
ON	3539	Huron County Health Unit	109	89.0	10.1	0.9	11.0
ON	3540	Chatham-Kent Health Unit	201	81.6	15.4	3.0	18.4
ON	3541	Kingston, Frontenac and Lennox and Addington Health Unit	99	88.9	10.1	1.0	11.1
ON	3542	Lambton Health Unit	176	91.5	7.9	0.6	8.5
ON	3543	Leeds, Grenville and Lanark District Health Unit	108	80.6	17.6	1.8	19.4
ON	3544	Middlesex-London Health Unit	109	98.2	1.8	0.0	1.8
ON	3546	Niagara Regional Area Health Unit	100	98.0	0.0	2.0	2.0
ON	3547	North Bay Parry Sound District Health Unit	104	98.1	1.9	0.0	1.9
ON	3549	Northwestern Health Unit	209	86.1	12.0	1.9	13.9
ON	3551	City of Ottawa Health Unit	64	93.8	6.2	0.0	6.2
ON	3552	Oxford County Health Unit	104	88.5	10.6	0.9	11.5
ON	3553	Peel Regional Health Unit	89	100.0	0.0	0.0	0.0
ON	3554	Perth District Health Unit	108	88.0	11.1	0.9	12.0
ON	3555	Peterborough County-City Health Unit	112	90.2	8.9	0.9	9.8
ON	3556	Porcupine Health Unit	96	99.0	1.0	0.0	1.0
ON	3557	Renfrew County and District Health Unit	100	91.0	8.0	1.0	9.0
ON	3558	Eastern Ontario Health Unit	99	93.9	5.1	1.0	6.1
ON	3560	Simcoe Muskoka District Health Unit	110	99.1	0.9	0.0	0.9
ON	3561	Sudbury and District Health Unit	97	94.9	4.1	1.0	5.1
ON	3562	Thunder Bay District Health Unit	108	88.0	11.1	0.9	12.0
ON	3563	Timiskaming Health Unit	102	92.2	6.8	1.0	7.8
ON	3565	Waterloo Health Unit	101	96.0	4.0	0.0	4.0
ON	3566	Wellington-Dufferin-Guelph Health Unit	92	89.1	8.7	2.2	10.9
ON	3568	Windsor-Essex County Health Unit	195	86.2	12.8	1.0	13.8
ON	3570	York Regional Health Unit	95	100.0	0.0	0.0	0.0
ON	3595	City of Toronto Health Unit	73	97.3	2.7	0.0	2.7
MB	4610	Winnipeg Regional Health Authority	66	87.9	12.1	0.0	12.1
MB	4615	Brandon Regional Health Authority	79	55.7	40.5	3.8	44.3
MB	4620	North Eastman Regional Health Authority	100	79.0	20.0	1.0	21.0
MB	4625	South Eastman Regional Health Authority	113	90.3	9.7	0.0	9.7

Province or Territory	Health Region	Health Region Name	Number of Survey Participants	% Below 200 Bq/m^3	% 200 to 600 Bq/m^3	% Above 600 Bq/m^3	% Above 200 Bq/m^3
MB	4630	Interlake Regional Health Authority	121	75.2	24.8	0.0	24.8
MB	4640	Central Regional Health Authority	108	57.4	35.2	7.4	42.6
MB	4645	Assiniboine Regional Health Authority	110	65.5	32.7	1.8	34.5
MB	4660	Parkland Regional Health Authority	122	56.6	31.9	11.5	43.4
MB	4670	Nor-Man Regional Health Authority	212	87.7	11.8	0.5	12.3
MB	4685	Burntwood/Churchill	152	92.1	7.2	0.7	7.9
SK	4701	Sun Country Regional Health Authority	116	85.3	14.7	0.0	14.7
SK	4702	Five Hills Regional Health Authority	118	87.3	11.9	0.8	12.7
SK	4703	Cypress Regional Health Authority	106	74.5	23.6	1.9	25.5
SK	4704	Regina Qu'Appelle Regional Health Authority	94	74.5	21.3	4.2	25.5
SK	4705	Sunrise Regional Health Authority	108	75.0	25.0	0.0	25.0
SK	4706	Saskatoon Regional Health Authority	76	92.1	7.9	0.0	7.9
SK	4707	Heartland Regional Health Authority	111	80.2	17.1	2.7	19.8
SK	4708	Kelsey Trail Regional Health Authority	100	83.0	17.0	0.0	17.0
SK	4709	Prince Albert Parkland Regional Health Authority	108	92.6	7.4	0.0	7.4
SK	4710	Prairie North Regional Health Authority	103	89.3	10.7	0.0	10.7
SK	4714	Mamawetan/Keewatin/Athabasca	166	86.1	12.7	1.2	13.9
AB	4821	Chinook Regional Health Authority	111	91.0	8.1	0.9	9.0
AB	4822	Palliser Health Region	91	95.6	2.2	2.2	4.4
AB	4823	Calgary Health Region	86	91.9	8.1	0.0	8.1
AB	4824	David Thompson Regional Health Authority	107	92.5	7.5	0.0	7.5
AB	4825	East Central Health	97	94.9	4.1	1.0	5.1
AB	4826	Capital Health	73	98.6	1.4	0.0	1.4
AB	4827	Aspen Regional Health Authority	219	90.4	9.1	0.5	9.6
AB	4828	Peace Country Health	203	91.1	7.9	1.0	8.9
AB	4829	Northern Lights Health Region	144	99.3	0.7	0.0	0.7
BC	5911	East Kootenay Health Service Delivery Area	105	81.0	16.2	2.8	19.0
BC	5912	Kootenay-Boundary Health Service Delivery Area	109	70.7	22.0	7.3	29.3
BC	5913	Okanagan Health Service Delivery Area	109	82.6	14.7	2.7	17.4
BC	5914	Thompson/Cariboo Health Service Delivery Area	109	93.6	6.4	0.0	6.4
BC	5921	Fraser East Health Service Delivery Area	100	97.0	3.0	0.0	3.0

Province or Territory	Health Region	Health Region Name	Number of Survey Participants	% Below 200 Bq/m^3	% 200 to 600 Bq/m^3	% Above 600 Bq/m^3	% Above 200 Bq/m^3
BC	5922	Fraser North Health Service Delivery Area	109	100.0	0.0	0.0	0.0
BC	5923	Fraser South Health Service Delivery Area	69	100.0	0.0	0.0	0.0
BC	5931	Richmond Health Service Delivery Area	54	100.0	0.0	0.0	0.0
BC	5932	Vancouver Health Service Delivery Area	83	98.8	1.2	0.0	1.2
BC	5933	North Shore/Coast Garibaldi Health Service Delivery Area	81	97.5	2.5	0.0	2.5
BC	5941	South Vancouver Island Health Service Delivery Area	55	98.2	1.8	0.0	1.8
BC	5942	Central Vancouver Island Health Service Delivery Area	109	99.1	0.9	0.0	0.9
BC	5943	North Vancouver Island Health Service Delivery Area	106	99.1	0.9	0.0	0.9
BC	5951	Northwest Health Service Delivery Area	211	94.8	3.8	1.4	5.2
BC	5952	Northern Interior Health Service Delivery Area	208	88.0	10.1	1.9	12.0
BC	5953	Northeast Health Service Delivery Area	200	90.0	9.5	0.5	10.0
YT	6001	Yukon	225	80.4	13.8	5.8	19.6
NT	6101	Northwest Territories	185	94.6	4.9	0.5	5.4
NU	6201	Nunavut	78	100.0	0.0	0.0	0.0

Discussion

The results in Tables 2 through 5 indicate that radon levels vary across the country and that there are areas where indoor radon is more prevalent. Manitoba, New Brunswick, Saskatchewan, and the Yukon had the highest percentage of participant homes which tested above the radon guideline. Conversely, Nunavut and Prince Edward Island had the lowest levels.

It must be stressed that even in those provinces which do not have a large percentage of homes above the guideline based on the population-weighted averages, there were still Health Regions within those provinces where significant percentages of homes tested above the guideline. For example, in Ontario, where the population-weighted estimate showed that 4.6% of homes exceeded the guideline, 13 of 36 Health Regions (greater than one third of the Health Regions) had >10% of homes testing above the guideline.

The results for Nunavut may seem surprising since there were no radon results above the Canadian Radon Guideline. However, this was noted in a total of nine (7.4%) of the Health Regions sampled. Of course this does not mean that radon will not be present at elevated levels in some homes in Nunavut and the eight other Health Regions. In fact, the data in Tables 2 to 5 should never be used by a homeowner in making a decision to test their home for radon. At best, these data are an estimate of the number of homes with

levels above the Canadian Radon Guideline in any province/territory or Health Region. Of the 121 Health Regions, 112 (92.6%) had homes with radon concentrations above the guideline. **The only way to know if a home has an elevated level of radon is to test, regardless of location.**

Prior to this survey, the estimate of the population-weighted percentage of Canadians living in homes with radon levels above 200 Bq/m^3 was 5%. This estimate was based on the best available data at the time. This included data from the limited cross-country survey conducted between 1978 and 1980 which focussed on major cities using short-term radon measurements conducted in the summer. Major population centres such as Vancouver, Toronto, and Montreal showed low radon levels in that study leading to a lower overall estimate when compared to that obtained in the current study. The revised estimate is 6.9%, which, while slightly higher, is more geographically balanced and the result of more rigorous testing methods that provide a more accurate picture of the average annual radon concentrations in homes across the country.

Questionnaire Responses Versus Radon Concentrations

As already described, each participant household received a questionnaire to complete with their radon detector package. The questionnaire was designed to provide additional detail on the home in order to allow Health Canada to determine whether the radon levels measured were related to a particular home's construction or ventilation system. A copy of this questionnaire is provided in Appendix 4. Now that the survey has been completed, a detailed analysis of the responses from the roughly 14,000 participants is on-going and expected to be completed in 2012.

Recommendations for Year 2

Despite the very high rate of compliance for most aspects of the testing performed in year 1, an effort was made to simplify and further improve the documentation (instructions for the test and the questionnaire) for year 2 of the study. The changes were made based on feedback from NRL staff and PRA. These efforts made the test easier to complete, and resulted in a higher return rate than that achieved in year 1. The year 1 test completion rate was approximately 73%. It rose to about 81% for year 2, suggesting that the improvements were effective in achieving a higher test completion rate. The overall completion rate for the study was approximately 77%.

There was more emphasis placed on the items that needed to be retained by participants upon receipt of the detector package in the year 2 instructions. The items were bundled together in the package as well to reduce the odds of items being thrown away or misplaced when the package was first opened. There was also a sticker reminding participants which items they needed to retain to mail back at the end of the test period. Additional emphasis was also built into the year 2 detector documentation which stressed the importance of participants providing the test start and stop dates/times to the NRL.

The number of incomplete tests was reduced considerably in year 2 of the study. This likely resulted from a combination of the improvements made in the year 2 instructions, earlier and more frequent follow up by PRA, having the detectors shipped out in two waves (in late September and early November 2010), and by having a slightly shorter time lag between recruitment and detector mail out.

Conclusions

From the data, it can be seen that there are several regions of the country where indoor radon is more prevalent. The current estimate of the percentage of Canadians living in homes above the 200 Bq/m^3 guideline, based on the completed two-year dataset, is 6.9%. This percentage is slightly higher than the previous estimate of 5% of Canadians, however, the current estimate factors geographic locations and is based on long-term (three-month) radon testing. New Brunswick, Manitoba, Saskatchewan, and Yukon Territory are the provinces/territories which showed the highest percentages of homes testing above the guideline in this study. There were 14 Health Regions where the raw percentage of homes testing above the guideline ranged from 23 to 44%. Five of these were in Manitoba, four in New Brunswick, three in Saskatchewan, and one each in Quebec and British Columbia. There were another nine Health Regions where the raw percentage of homes above the radon guideline ranged from 16 to 21%. Fifty-four (45%) of the Health Regions had 10% or more of their homes above the guideline level. The data obtained from this survey will enable Health Canada to more effectively target testing and awareness programs; however, it must be re-iterated that all Canadians are encouraged to test their homes to determine their indoor radon levels.

In 2012, a complete analysis of the questionnaire responses will be done to see if any correlations can be drawn between radon levels and specific home characteristics.

Appendix 1 – Details of Sampling Frame and Mapping Participants to Health Regions

Sampling Frame Details

If each of the 121 Health Regions considered in this study were allocated the same number of the 18,000 contacted homes, approximately 149 homes would be sampled per Health Region.

Health Canada had data from previous radon surveys. Between 1978 and 1980, Health Canada carried out a previous cross-country residential survey. This survey analyzed roughly 13,500 homes in 18 cities across Canada. Unfortunately, testing was performed using instantaneous grab samples (short-term testing) during the summer months when radon concentrations are typically at their lowest. As a result, the data from this study are not reliable or useful for mapping purposes. However, data are available from a large study of the Winnipeg area, conducted in the late 1980s, by Health Canada using long-term alpha track testing, as well as other surveys conducted by Health Canada or in conjunction with the provinces or other stakeholders. Therefore, sufficient reliable radon test data were available for some Health Regions making under-sampling possible (i.e., a reduced number of new radon tests were needed). Conversely, many Health Regions that are geographically large, and for which little data existed, were assessed as requiring over-sampling. The aim of this study was to obtain a reasonable degree of geographic coverage (not to just cover Canada's largest cities where most of the population currently live). In total, 22 Health Regions were under-sampled, 77 Health Regions were normally sampled, and 22 Health Regions were over-sampled. The factors for over-, normal-, and under-sampling were chosen to be 2X, 1X, and 0.5X, respectively. In other words, an under-sampled Health Region was sampled half as often as a normally-sampled Health Region, and an over-sampled Health Region was allocated twice the samples of a normally-sampled Health Region.

An equation describing this relationship is shown below, and was solved to determine x:

$22(0.5x) + 77x + 22(2x) = 18{,}000$
$11x + 77x + 44x = 18{,}000$
$132\ x = 18{,}000$
$x = 136.36$

Thus, roughly 136 homes were to be recruited for normal-sampling, 273 homes for over-sampling, and 68 homes for under-sampling. When these values are substituted back into the equation, 22(68) + 77 (136) + 22 (273) = 17,974, there was a remainder of 26 homes. In order to use these remaining homes, all under-sample Health Regions received an extra home, giving the 22 under-sampled Health Regions a total of 69 homes. The four remaining homes were then attributed to the four largest geographic Health Regions that were to be over-sampled, namely Nunavut, Yukon, the Northwest Territory and the combined Mamawetan/Keewatin/Athabasca Health Region. Therefore, each of these four Health Regions received an extra home resulting in a sample size of 274 homes. In this way, all 18,000 homes were assigned to the 121 Health Regions.

This project required reasonable geographic coverage for testing. To ensure this condition in a rural Health Region where a large urban centre was present, a maximum of 50% of the homes recruited for survey participation from that Health Region could be taken from that urban centre. This ensured the remaining 50% of homes recruited were spread throughout the more rural areas of that Health Region.

Mapping Samples to Health Regions

There are no databases of telephone numbers that map directly to the Health Regions within Canada. In addition, telephone numbers are somewhat portable in that people can move to a new location and keep their existing telephone number if they are not moving a great distance. There are, however, databases of telephone numbers that are related to census divisions (CDs) and census sub-divisions (CSDs). Therefore, PRA contracted with ASDE Survey Sampler Inc. to develop a list of Health Regions linked to CSDs. They matched Health Region geography from maps of Health Regions to maps of CSDs, and provided samples of phone numbers to be dialed in each Health Region. The mapping of CSDs to Health Regions was not exact in all areas of the country, but it is very close in most areas. This means the vast majority of the sample, in excess of 98%, fell into the desired Health Regions at the time of recruitment. The required adjustments were made once the addresses of the participants were known.

Upon analysis at the end of year 2, it was discovered that there were still some houses which had been assigned to the wrong Health Region. Consequently, their results were moved to the actual Health Region where the house was located. This was done by Health Canada officials at the Radiation Protection Bureau who possessed the necessary expertise and the requisite GIS mapping tools and software.

PRA also utilized software that employed random digit dialing to recruit participants given the known telephone exchange prefixes for an area. This ensured that new telephone numbers that resulted from new home construction between quarterly updates of the database, or telephone numbers that were not part of the database of published phone numbers, had a chance of being dialed as well. Much of the time, this random dialing component dialed non-existent telephone numbers.

Appendix 2 – Summary of Calling Statistics for Year 1 of Recruitment (Courtesy of PRA)

1. Total phone numbers dialed	**98,879**
a. Not in service	19,603
b. Business/non-residential	1,339
c. Problem with telephone line	109
d. Fax	2,556
e. Wrong number	47
2. Invalid phone numbers (a+b+c+d+e)	**23,654**
3. Valid phone numbers (Line 1 – Line 2)	**75,225**
f. Not eligible	767
g. Language barrier	2,010
h. Age/illness	376
i. Other	392
4. Not valid sample (f+g+h+ i)	**3,545**
5. Valid sample (Line 3 – Line 4)	**71,680**
j. Household refusal	14,477
k. Respondent refusal	8,014
l. Final refusal	12
m. Prolonged absence	95
n. Terminate survey mid-interview	210
o. No answer/busy signal	27,875
p. Appointment/callback	4,069
6. Completed surveys	**8,943**
7. Disqualified (q+r+s+t+u+v+w+x)	**7,985**
q. Renter	5,116
r. Lives in apartment/condo	452
s. Area open under home	403
t. Not primary residence	359
u. Located on-reserve	674
v. Located on military base	4
w. Planning on moving	732
x. No one available during time of study	245
Refusal rate ((j+k+l)/Line 5)	**31.4%**
Eligibility rate (k+l+m+n+p+Line 6)/(Line 4+k+l+m+n+p+Line 6)	**85.8%**
Response rate (Line 7 + Line 6)/Line 3	**22.5%**

Appendix 3 – Summary of Calling Statistics for Year 2 of Recruitment (Courtesy of PRA)

1. Total phone numbers dialed	**106,291**
a. Not in service	21,688
b. Business/non-residential	1,968
c. Problem with telephone line	107
d. Fax	2,349
e. Wrong number	9
2. Invalid phone numbers (a+b+c+d+e)	**26,121**
3. Valid phone numbers (Line 1 – Line 2)	**80,170**
f. Not eligible	307
g. Language barrier	377
h. Age/illness	1,871
i. Other	513
4. Not valid sample (f+g+h+i)	**3,068**
5. Valid sample (Line 3 – Line 4)	**77,102**
j. Household refusal	17,693
k. Respondent refusal	9,673
l. Final refusal	37
m. Prolonged absence	127
n. Terminate survey mid-interview	212
o. No answer/busy signal	29,702
p. Appointment/callback	3,435
6. Completed surveys	**9,138**
7. Disqualified (q+r+s+t+u+v+w+x)	**7,085**
q. Renter	4,500
r. Lives in apartment/condo	524
s. Area open under home	281
t. Not primary residence	549
u. Located on a reserve	220
v. Located on military base	9
w. Planning on moving	763
x. No one available during time of study	239
Refusal rate ((j+k+l)/Line 5)	**35.5%**
Eligibility rate (k+l+m+n+p+Line 6)/(Line 4+k+l+m+n+p+Line 6)	**88.1%**
Response rate (Line 7+Line 6)/Line3	**20.2%**

Appendix 4 – Radon Questionnaire

Radon Study Questionnaire

Where did you place the radon detector?

1. **On what floor? (Remember, it should be on the lowest lived-in level of your home, where you spend a minimum of 4 hours per day.)**

   Basement (underground)..... ☐1
   Main (first) floor (on the ground)..... ☐2
   Second floor (above ground)..... ☐3
   Other (SPECIFY)_____ ☐4

2. **In which room in your home was the detector placed?**

   Rec room ..... ☐01
   Storage room ..... ☐02
   Living room ..... ☐03
   Bedroom ..... ☐04
   Den/Study..... ☐05
   Other (SPECIFY)_____ ☐66

3. **The instructions asked that you place the detector in a certain location. We know some homes may not allow you to place the detector as indicated. Were you able to place the detector according to the instructions?**

   Yes..... ☐1 ⇒ SKIP to Q5
   No ..... ☐0

4. **If No, describe how its position differs from the instructions.**

Section B: Your home

Please answer the following questions about your home:

5. **What type of residence do you live in?** (CHECK ONE)

   Single-detached home, that is, a single house on its own property

   Bungalow ..... ☐01
   Two-story ..... ☐02
   Three-story..... ☐03
   Split-level..... ☐04

   A semi-detached home, that is, a home that shares one common wall with another home

   Side-by-side ..... ☐05
   Row house ..... ☐06
   Duplex ..... ☐07
   Townhouse..... ☐08

Other

Trailer/mobile home ..... ☐ 09
Pre-fabricated home ..... ☐ 10
Other (SPECIFY): _____ ☐ 66

6. Approximately, when was your residence originally built? (CHECK ONE)

1920 or before ..... ☐ 01
1921–1945 ..... ☐ 02
1946–1960 ..... ☐ 03
1961–1970 ..... ☐ 04
1971–1980 ..... ☐ 05
1981–1990 ..... ☐ 06
1991–2000 ..... ☐ 07
2001–2009 ..... ☐ 08
Not Sure ..... ☐ 88

7. Does your home have a basement?

Yes, a full basement (that is, it is underneath the entire building)..... ☐ 1
Yes, a partial basement (that is, underneath part of the building)..... ☐ 2
There is a crawl space under all or part of the building, but no basement . ☐ 3 ⇒ SKIP TO Q14
The house sits directly on the ground, with no basement..... ☐ 4 ⇒ SKIP TO Q15

8. Is your basement …

Completely finished ..... ☐ 1
Partially finished ..... ☐ 2
Unfinished ..... ☐ 3

9. Which of the following is in your basement? (CHECK ALL THAT APPLY)

A rec/living room ..... ☐ 01
A bedroom ..... ☐ 02
A laundry room ..... ☐ 03
A furnace room ..... ☐ 04
A storage room ..... ☐ 05
Other (SPECIFY) _____ ☐ 66
No basement ..... ☐ 77

10. Approximately, how often are the windows in your basement open?

Almost never (Less than 1 day per year) ..... ☐ 01
Once in a while (2 to 30 days a year) ..... ☐ 02
Frequently (31 to 120 days a year) ..... ☐ 03
Often (121 or more days a year) ..... ☐ 04
No windows in basement ..... ☐ 77

11. For how many hours a day is anyone in the basement?

Less than 4 hours a day ..... ☐1
4 to 8 hours a day ..... ☐2
More than 8 hours a day ..... ☐3

12. Does anyone in your home regularly sleep in the basement?

Yes ..... ☐1
No ..... ☐0

13. What type of floor is in your basement or crawl space? (CHECK ALL THAT APPLY)

Poured concrete ..... ☐01
Earth/dirt ..... ☐02
Rock ..... ☐03
Other (SPECIFY) _____ ☐66

14. Some homes include a sewer or sump hole. Most sump holes are covered, but not all are sealed or capped. Do you have a sealed cover or capped sump hole in the basement?

Yes ..... ☐1
No ..... ☐0

15. What type of foundation does your residence have? Is it… (CHECK ALL THAT APPLY)

Poured concrete ..... ☐01
Cinder block ..... ☐02
Brick ..... ☐03
Stone ..... ☐04
Wood ..... ☐05
Other (SPECIFY) _____ ☐66

16. What type of heating fuel do you use in your home? (CHECK ALL THAT APPLY)

Natural gas ..... ☐01
Electric ..... ☐02
Oil ..... ☐03
Propane ..... ☐04
Geothermal ..... ☐05
Wood ..... ☐06
Solar ..... ☐07
Other (SPECIFY) _____ ☐66

17. Is the heating system… (CHECK ALL THAT APPLY)

Forced air ..... ☐01
Radiant (water) ..... ☐02
Baseboard ..... ☐03
Other (SPECIFY) _____ ☐66

18. Does your home have air conditioning?

Yes ..... ☐1
No ..... ☐0 ⇒ SKIP TO Q20

19. What type of air conditioning do you have in your home?

Central air ..... ☐1
Window unit ..... ☐2

20. How is water supplied to your home?

Municipal distribution system (piped/trucked in)…….. ☐01
Private well water…….. ☐02
Other (SPECIFY) _____ ☐66

21. Does anyone in your household smoke?

Yes ..... ☐1
No ..... ☐0

22. In the last year, have you had any of the following renovations done in your home? (CHECK ALL THAT APPLY)

Renovated or upgraded the ventilation system in your home (ex. kitchen or bathroom fans) ..... ☐1
Made changes or upgraded the main ventilation or heating system in your home ..... ☐2
Made an addition to your home ..... ☐3
Finished or converted your basement ..... ☐4
None of these renovations done in last year ..... ☐7

23. Have you tested your home for radon in the past?

Yes ..... ☐1
No ..... ☐0

24. What type of test was performed?

Short-term (7 days or less) ..... ☐01
Long-term (over 30 days) ..... ☐02
Other (SPECIFY) _____ ☐66
Don't know ..... ☐88

25. What radon level was provided with test results? (RECORD NUMBER AND, IF YOU KNOW, THE MEASUREMENT UNIT)

NUMBER: _____
pCi/L – Picocuries per litre ..... ☐1
Bq/m^3 - becquerels per metre cubed ..... ☐2
Don't know ..... ☐8