Radon in BC: Does Your Community Need to Test?

BC LUNG FOUNDATION

Executive Summary

All homes should be tested for radon. However, some communities have much higher radon than others. We think it is important for BC residents to know how much radon there is where they live, and encourage local governments to conduct sample community testing. In this report, we explain why sample community testing for radon is important and why communities should ensure they have a good sample size of radon tests to have confidence in local radon levels.

The good news is that for many of BC's larger cities, such as Vancouver, Victoria, Prince George and Kelowna, there are enough radon tests to give high confidence in radon prevalence. However, we found many communities which need more testing to have confidence in radon levels.

We think the highest priority for radon testing should be given to the following communities:

Communities likely to have over 10 percent of homes over Canada's Radon Guideline, but for which more testing is needed.

100 Mile House, Armstrong/Spallumchean, Arrow Lakes/Nakusp, Enderby, Golden, Kootenay Lake/Kaslo, Lumby, McBride/Valemount, Osoyoos, Princeton, Quesnel, Vanderhoof, Williams Lake, Windemere/Radium Hot Springs

Communities with insufficient radon data, but situated in local health areas (LHAs) or health service delivery areas (where the LHA has insufficient data) where at least 10% of homes tested are over the Guideline:

Fort St. James, Grand Forks, Keremeos, Lillooet, Mackenzie, Merritt

We also recommend further community testing to improve sample sizes in the following locations:

BC Communities with insufficient data or require more testing to have a good sample size:

Bella Coola Valley, Burns Lake, Central Saanich, Chetwynd, City of Langley, Dawson Creek, Duncan, Esquimalt, Fort Nelson, Fort St. James, Gibsons, Haida Gwaii, Hope, Kitimat, Ladysmith, Maple Ridge, Metchosin, New Westminster, North Saanich, Oak Bay, Parksville, Pitt Meadows, Port Coquitlam, Port Moody/ Annemore/Belcarra, Powell River, Prince Rupert, Sechelt, Sidney, Smithers, Sooke, Southern Gulf Islands (Pender/Galiano/Saturna/Mayne), Tumbler Ridge, View Royal, White Rock

The following communities have decent sample sizes which show there is clearly a radon problem, but still not enough to meet our threshold of confidence (for a given percent of homes over 200 Bq/m^3 a 90 percent confident level of plus or minus three percent).

Cranbrook, Creston, Fernie, Kamloops, Kimberley, Penticton, Summerland

In the body of this report, we explain how we define 'community' and obtained the relevant data and the statistical analysis performed. For each community we identify we provide the current sample size, the number of homes tested over 200 Bq/m^3 in that sample, the uncertainty range given the sample size, and what an appropriate sample size would be to have 90% confidence in the results with a margin of error of plus or minus 3% (See Table 2, starting on page 11). Our methods could not capture some of BC's smaller communities and rural areas. This does not remove the need for testing in those places, especially where high radon prevalence is found at the larger regional scale.

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To find project documents, visit BC Lung's website on Community Radon Testing: https://bclung.ca/radon-community-testing-bc

About our program. The BC Lung Foundation's Healthy Indoor Environments program is focused on providing education, resources, and policy options for addressing priority indoor air pollutants in British Columbia. Canadians spend 90% of their day indoors, with about 70% at home and 20% at work or school. The air we breathe indoors can contain particulates, gases, allergens and fumes that can significantly affect our health in both the short and long term. Knowing the main indoor air pollutants, their sources, and how to reduce them are key to reducing harm to our health. Radon has been identified as the leading environmental carcinogen in Canada. For more information visit our website at https://bclung.ca/programs-initiatives/healthy-indoor-environments-program

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What is Radon?

Radon is an odorless, tasteless, and colorless radioactive gas. It released through the natural process whereby uranium in soil and rocks decays. Radon emanates from soil and is quickly diluted in air. However, it can build up inside homes and other buildings, and creates a lung cancer risk. While almost all buildings have some radon, some have much more than others. While exposure to any amounts of radon can increase risks of lung cancer, the risks increase at higher radon concentrations. The World Health Organization chose the risk adverse action level of 100 Bq/m^3 while Health Canada opted for the compromise of 200 Bq/m^3. For new construction, radon levels can be lowered by 50% or more through building in "passive" radon systems—a vent pipe that moves air from under the building slab. Once new occupants move in, they can also test for radon and if elevated levels persist, call in radon mitigation professionals to add a fan. This almost always reduces radon to under 100 bq/m^3.

Radon and Lung Cancer

Currently in Canada, lung cancer makes up 24% of all cancer deaths.[1] For the past thirty years there has been a strong focus on reducing tobacco smoking. We now think there are significant inroads in the fight against cancer to be had from avoiding radon.

Radon is leading cause of lung cancer after smoking and the leading cause amongst non-smokers. Radon emits alpha participles that can damage lung cells. Approximately 16% of lung cancer deaths can be attributed to radon exposure. According to the Canadian Cancer Society, these numbers result in over 3,300 people a year dying of radon related lung cancer. It is estimated that 1 in 20 Canadians exposed to high radon levels (800 Bq/m^3) over a lifetime will develop lung cancer. There is also an increased risk for developing lung cancer for those who smoke combined with long term exposure to radon. It is estimated that 1 in 3 smokers who live a lifetime in 800 Bq/m^3 radon environments will develop lung cancer.[2] These numbers are not natural and this situation can be changed through testing and fixing existing buildings and putting proper systems into new construction.

Why Learn Local Radon Levels?

Health Canada recommends that every home be tested. As well, there is an increasing push to have passive radon systems installed in all new single family or low rise residential buildings. We think community testing is still important.

People are more likely to act when they can see local radon levels. Testing initiatives in BC have found very high radon prevalence in some parts of BC such as the District of Lake Country (52%)[3], Barriere (63%)[4] and Castlegar (49%).[5] However, even within regions there can be considerable different from town to town. In our experience, people are more likely to test their homes and workplaces if they see that there are many homes and other buildings in their community with elevated radon levels. When policy makers know local radon levels, it can be much easier to act. We have seen repeatedly that the press reports on the results of community testing and these efforts improve local knowledge of the problem.[6] We think the first step should be making sure there is a good sample size of radon tests in all BC communities.

Government can focus attention on higher radon regions. Government dollars are more wisely spent focusing on high radon areas.[7] If half of homes have radon, we can predict that for each two homes tested, one will be discovered to have high radon. But if only 1 percent of homes have high radon, chances are that for each hundred homes tested, only one will have high radon. For these reasons, it is much more cost effective to address radon in areas with higher prevalence of indoor radon.[8] Health economists have found that in higher

radon prone locations in BC such as Kelowna, paying for radon testing and mitigation of older homes is a cheaper way for governments to save lives and ensure a good quality of life than many routine hospital procedures.[9] Ensuring a community has a good sample size showing high radon levels is a first step in garnering attention from higher levels of government.

A better provincial database and map will help expand knowledge Knowledge of radon exposure of a population can help researchers to understand risk factors for cancer at a local level. The last decade has seen a vast improvement in knowledge of local radon levels in BC. The British Columbia Radon Data Repository (BCRDR) collects data from diverse sources, such as Health Canada's country-wide survey in 2012, data from test kit manufacturers and radon mitigators, and results of testing initiatives from non-profits such as the Donna Schmidt Lung Cancer Memorial Society, BC Lung Foundation and Take Action on Radon. This data can be used by health researchers, and is also fed into the BC Radon Map (available online at https://bccdc.shinyapps.io/bcradonmap/). We have analyzed the BCRDR data and found many communities do not have a large enough sample size to have confidence in radon levels.

Why Test Homes?

There is a strong correlation of elevated radon in buildings with underlying geography (such as uranium in the soil and bedrock).[10] As well, researchers have found a strong correlation of indoor radon with radon in soil.[11] That said, testing indoor air in homes is considered more reliable because this also incorporates dwelling characteristics and user behaviours-- important factors in determining indoor radon levels. [12]

Canada's Radon Guideline applies to all indoor spaces regularly occupied for four or more hours a day, so workplace testing remains important. That said, most radon exposure occurs in homes.[13] As well, the vast majority of radon data collected in BC is of radon levels in homes.

Methodology

BC Lung Foundation requested and received radon data from the BCRDR, updated to November 3, 2022. BCRDR uses the British Columbia Health Administrative Boundaries[14] for data classification purposes. The smallest units are Community Health Service Areas (CHSAs).

Local communities may have conducted further testing after that date. For instance, community testing initiatives were held in Saltspring Island, Kimberley, Mission, Chilliwack, Aggasiz/Harrison and Hope in 2022-2023 which we were not able to include here. These communities may already or soon have much better sample sizes than this report indicates and we also expect the BCRDR and BC Radon Map to be regularly updated.

Sources of radon data remain anonymous, but these measurements are typically results of long-term (ninety-one day plus) alpha track radon detector measurements. To account for variable precision among radon monitors, values were rounded to the nearest 10 Bq/m^3. Data was limited to unique residential measurements –if a building had multiple measurements, only the concentration value from the lowest unmitigated space was used.

Delineating Communities

Because of the mismatch between political jurisdictions (e.g. municipalities) and health boundaries we had to create an appropriate unit to reflect 'community' from the data classified by health administrative boundary. In larger cities, such as Vancouver, there are several CHSAs, but which taken together fit within the municipal boundary, but in some other towns the CHSA can extend well beyond or cut across municipal borders. Moving up to the next larger unit, the Local Health Area often extends too far beyond municipal boundaries. For instance, the BC

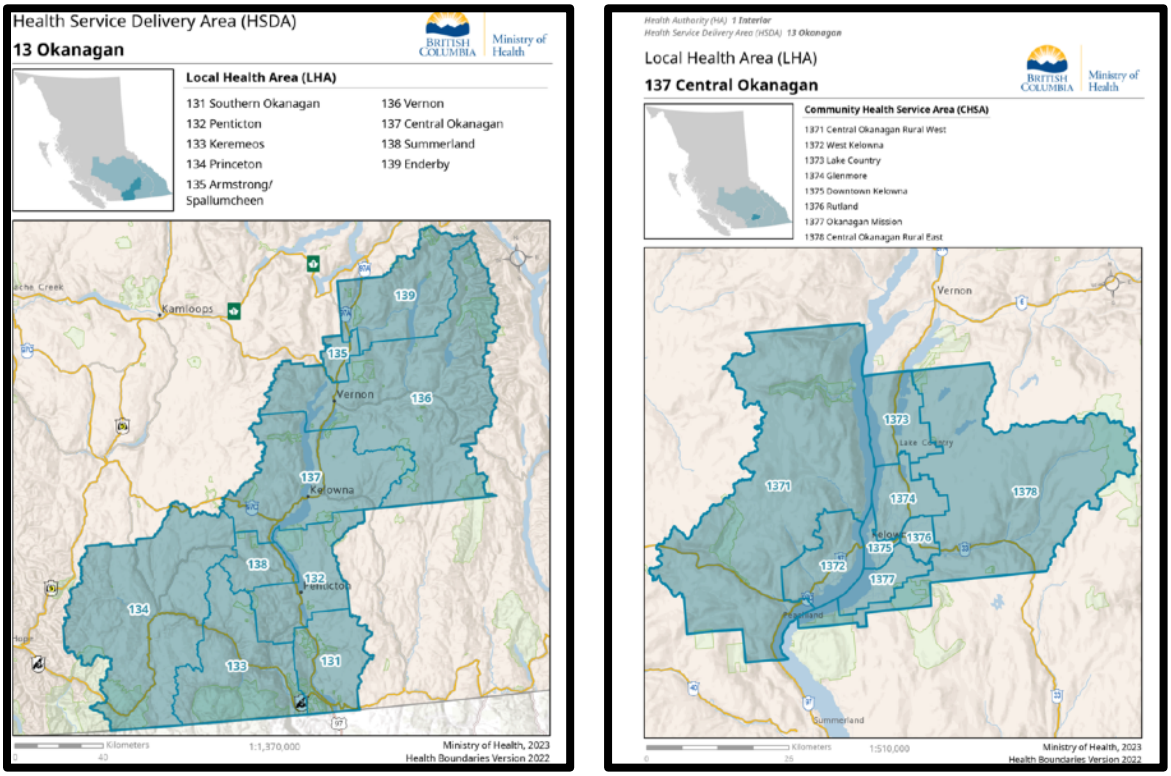

Figure 1: BC Health Administrative Boundaries in Okanagan

Health Administrative Boundaries aggregates 7 CHSAs to form the Local Health Area (LHA) "Central Okanagan" but that LHA encompasses the distinct political boundaries of multiple municipalities (see Fig.1). We created a unique delineation of 'community' by aggregating Community Health Service Areas (CHSAs) through visual comparison of health boundary and municipal boundary maps. For "Kelowna" we aggregated numbers for the CHSAs of Glenmore (1374), Downtown Kelowna (1375), Rutland (1376), and Okanagan Mission (1377) (see Fig 1 a and b). We eliminated some CHSAs in remote rural locations, as covering very large geographical areas, and so unlikely to represent the small towns that fell within them. In Appendix 1, Table A we list communities with links to the underlying CHSAs. We also had to eliminate some CHSAs as predominantly rural or covering a very large geographical area (See Appendix B, Table B).

As such, some smaller communities in BC will not be represented on our list. This does not remove the need for testing, especially in locations where high radon prevalence is found at the larger scale such as LHA or Health Service Delivery Area (HSDA). Persons who do not recognize their community in our list should check the Health Administrative Boundaries to locate their CHSA and refer to Appendix 1 to see if they fall within communities we have included or excluded.

Finding the Right Sample Size

First, the existing data for each community was graphed. Even in communities with a small number of initial tests, radon data typically fits to a log-normal distribution.

Second, an estimation was made of how uncertainty decreases with number of samples. Simulations were made using radon measurements from the larger HSDA within which communities were located. By using the HSDA, with many more measurements, it was possible to examine how different sample sizes were affected by random chance (see Figure 2). For each community, a random set of radon measurements was taken from the HSDA, of size equal to the existing sample size of the community. The summary statistic (e.g. number of homes over 200 Bq/m^3) was calculated. This random sampling and summary statistic calculation was repeated 100 times for each community, to give a wide range of percentages of homes over 200 Bq/m^3. We treated the 5th to 95th percentile range as a proxy 90% confidence interval of the distribution for each community.

Figure 2 compares different Okanagan and South Vancouver Island communities, showing variation in sample size between communities and how uncertainty decreases with sample size. It also shows how it is possible to move along the x axis (e.g. number of samples) to find a sample size that would reduce the uncertainty in the percentage of homes over 200 Bq/m^3 to an acceptable level. Specifically, we sought the minimum number of tested homes that would yield a distribution of percentages of homes over 200 Bq/m^3 whose 90th percentile range was no wider than 6%. Note that for South Vancouver Island, the lower radon concentrations means fewer tests are needed for a sufficient sample size. A similar analysis was done for all HSDAs (see Table 1). In this manner, we generated for each community a sufficient sample size for 90 percent confidence for a percentage over 200 Bq/m^3 plus or minus 3 percent. Ultimately, the choice of confidence level and allowable margin of error is a judgment call and we chose this on the basis of combining pragmatic considerations of cost and effort in testing with intuitions as to how precise knowledge of local radon prevalence needs to be.

Table 2 list all the communities we could define using CHSA data, provides the existing

Table 1: Sample Sizes for 90% Confidence plus or minus 3% on the basis of HSDA

HSDA the Community Falls In	Desired sample size	HSDA the Community Falls In	Desired sample size
Central Vancouver Island	20	Northeast	115
East Kootenay	280	Northern Interior	335
Fraser East	70	Northwest	100
Fraser North	60	Okanagan	380
Fraser South	20	Richmond	20
Kootenay Boundary	470	South Vancouver Island	45
North Shore-Coast Garibaldi	20	Thompson Cariboo Shuswap	340
North Vancouver Island	20	Vancouver	30

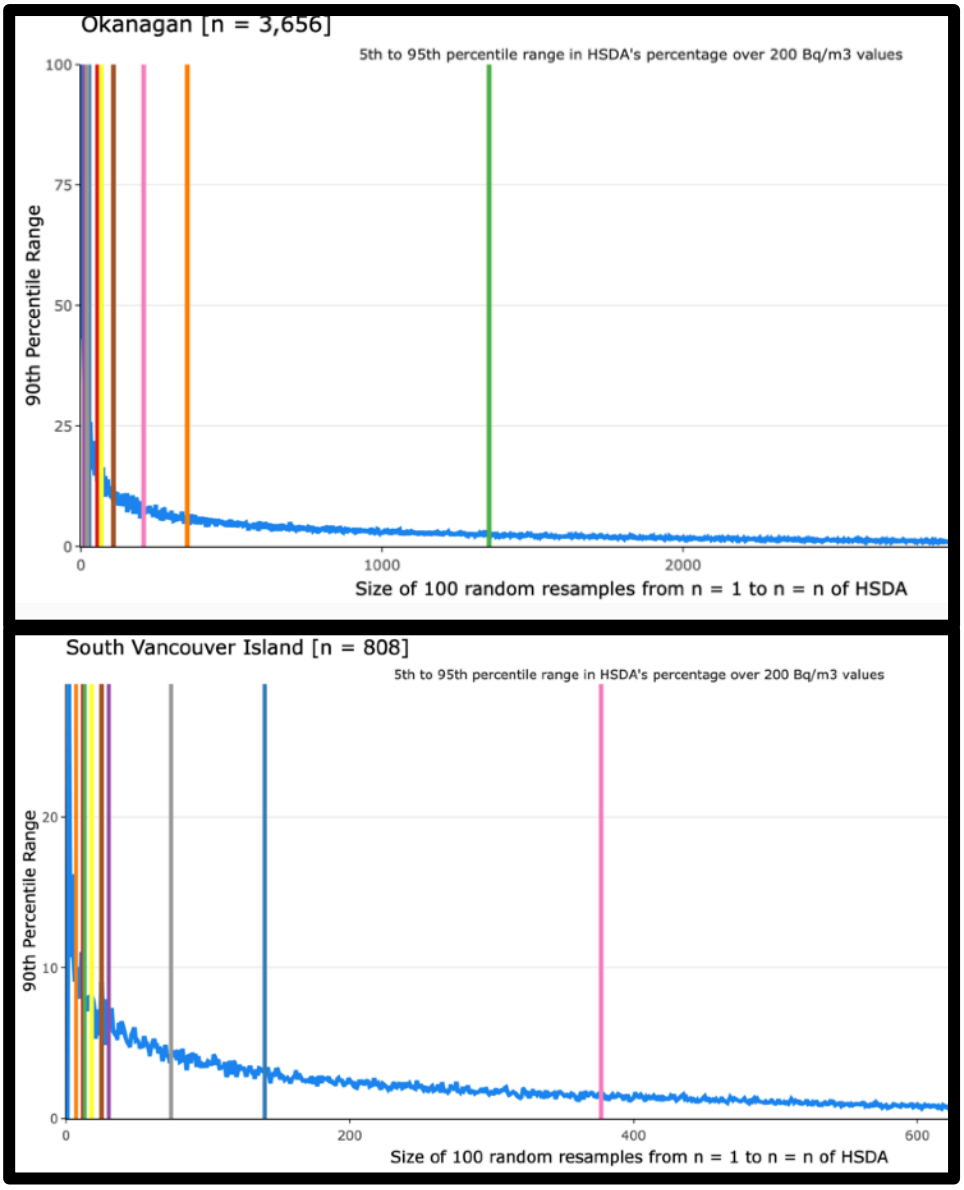

Figure 2: Uncertainty Curves. Vertical coloured lines show readings for particular communities. For Okanagan: Green–Kelowna, orange–Lake Country, pink–Penticton, brown-Osoyoos, yellow–Lumby, red–Armstrong-Spallumcheen, blue–Enderby, grey–Princeton. For South Vancouver Island: Pink –Cental Sannich, dark blue– Colwood, grey–Saltspring Island, purple–Langford/Highlands, brown–Oak Bay,yellow-North Saanich; green–Esquimalt, orange–Southern Gulf Islands, red–Sooke, light blue-View Royal. Courtesy of BCCDC.

sample size, the current estimated margin of error, and the desired sample size for 90 percent confidence in results plus or minus 3%. Communities with under 20 radon readings are listed as having insufficient data to have meaningful results.

Results and Discussion

We could quickly see that required sampled size for confidence varies with radon concentration. In communities with a lower percentage of homes above 200 Bq/m^3, fewer samples were needed to reach a given level of certainty. This means that there are some communities in BC with a small percentage of homes over 200 Bq/m^3 and a small number (such as under 30) readings, but sufficient sample size. There are also communities with fairly large samples (into the few hundred) but for which more readings are needed for certainty.

We have many communities in BC for which we have high certainty that at least 10 percent of homes are over 200 Bq/m^3, but for which the low sample size means the margin of error is over plus or minus 5%: **100 Mile House, Armstrong/Spallumchean, Arrow Lakes, Enderby, Golden, Kootenay Lake/Kaslo, Lumby, McBride/Valemount, Osoyoos, Princeton, Quesnel, Vanderhoof, Williams Lake,**

Windemere/Radium Hot Springs (dark blue on Table 2).

We also identified communities with an insufficient sample size for reporting results but for which the larger Local Health Area (LHA) or HSDA have at least 10 percent of homes tested over 200 Bq/m^3: **Fort St. James, Grand Forks Keremeos, Lillooet, Mackenzie, Merritt** (dark orange). These first two groups should be prioritized for testing.

We also found a large number of BC communities not included in the above groups, but which require more testing to have high confidence (90% confidence plus or minus 3%) in radon numbers. **Bella Coola Valley, Burns Lake, Central Saanich, Chetwynd, City of Langley, Dawson Creek, Duncan, Esquimalt, Fort Nelson, Fort St. James, Gibsons, Haida Gwaii, Hope, Kitimat, Ladysmith, Maple Ridge, Metchosin, New Westminster, North Saanich, Oak Bay, Parksville, Pitt Meadows, Port Coquitlam, Port Moody/Annemore/Belcarra, Powell River, Prince Rupert, Sechelt, Sidney, Smithers, Sooke, Southern Gulf Islands (Pender/ Galiano/Saturna/Mayne), Tumbler Ridge, View Royal, White Rock** (light orange if insufficient data, light blue otherwise). .

One outcome to note is that for communities with higher radon levels, a higher number of tests are needed to be confident of numbers of homes over the Guideline. For instance, Windemere/Radium Hot Spings (n= 54), would need 280 tests to estimate 90 percent confidence in numver of homes over 200 Bq/m^3 with a margin of error of plus or minus 3 percent. However, the analysis suggests good confidence that between 25% and 38% of homes have radon over Guideline, which is certainly enough information for homeowners and local governments to take the issue seriously.

We used as threshold a margin of error of plus or minus 5% for whether to prioritize further testing in such high radon communities. As such, we listed Windemere/Radium Hot Springs as a priority for testing (at plus or minus 6.4%), but created a separate group for which we felt there was less urgency for improving the sample size. Communities in this group included **Cranbrook, Creston, Fernie, Kamloops, Kimberley, Penticton, Summerland** (light green). We would still encourage more testing in these communities to increase the accuracy of radon knowledge and because there is a clear need for all homes in these locations to be tested.

In deciding whether to conduct further community testing in such situations, it is worth noting additional benefits of such testing– spreading education and awareness on radon, increasing the numbers of people who have tested, and and encouraging yet more people to take the initiative to test on their own.

Limitations

Most radon testing is initiated by homeowners taking the initiative. This creates a possibility of selection bias, and overestimates risk compared to a randomized sample. That said, the degree to which this skews the results is not known and we think it is unlikely that people who chose to test have any special indicia that their homes have higher radon. In order for us to arrive at sample sizes that would give certainty, we needed to assume that the spread of radon levels in buildings in each community would look similar to the broader HSDA (e.g. a uniform distribution). We know this is not always the case. We expect more radon testing in the future will lead to a more nuanced analysis.

These analyses examine the proportion of homes above the 200 Bq/m^3 guideline. For more information about the magnitude and range of radon levels in specific communities or regions, please see the BCCDC Radon Map. While rural regions and some smaller towns are not included in these analyses, there is still a need to test homes in these areas. Numbers reported by the BCCDC Radon Map for local health areas can be an entry point in estimating likely radon levels at smaller scales.

Table 2 Legend	
	Insufficient data, but in LHA or HDSA with over 10% of homes tested over 200 Bq/m^3
	Current sample size shows over 10% of homes tested over 200 Bq/m^3, more testing needed for good sample size (90% confidence in results, plus or minus 3%)
	Insufficient data, in LHSA or HDSA with 10% or less of homes tested over 200 Bq/m^3
	Current sample size shows 10% of homes or less tested over 200 Bq/m^3, more testing needed for good sample size
	Current sample size shows over 10% of homes tested over 200 Bqm^3, but margin of error falls between 3% and 5%
	Sufficient sample size for 90% confidence in results, plus or minus 3%

Table 2: Results by Community

Community	Sample Size	Percent of homes over 200 Bq/m^3	Current margin of error (plus or minus x %)	Estimated Sample size for 90% confidence in results,plus or minus 3 %, based on HSDA
100 Mile House	43	13.05	8.82	340
Abbotsford	190	4.66	1.18	70
Armstrong/Spallumcheen	55	24.43	7.62	380
Arrow Lakes/Nakusp	141	31.23	5.69	470
Bella Coola Valley	Insufficient data			20
Bowen Island/Lions Bay	51	11.06	1.02	20
Burnaby	115	2.25	1.43	60
Burns Lake	21	0.76	7.4	335
Campbell River	34	0.02	0.9	20
Castlegar	1261	48.34	1.19	470
Central Saanich	insufficient data			45
Chetwynd	insufficient data			115
Chilliwack	53	4.29	2.5	70
City of Langley	insufficient data			20
Colwood	140	3.86	1.54	45
Comox	23	0.79	1.3	20
Coquitlam	289	3.17	0.87	60
Courtenay	24	0.01	0.89	20

Table 2: Results by Community

Community	Sample Size	Percent of homes over 200 Bq/m^3	Current margin of error (plus or minus x %)	Estimated Sample size for 90% confidence in results,plus or minus 3 %, based on HSDA
Cranbrook	211	10.44	3.87	280
Creston	97	17.91	4.58	280
Dawson Creek	72	4.07	3.7	115
Delta	58	0.52	0.69	20
Duncan	35	8.8	2.12	35
Enderby	26	19.12	11.88	380
Esquimalt	Insufficient data			45
Fernie	122	33.96	4.73	280
Fort Nelson	71	6.71	3.56	115
Fort St. James	Insufficient data			335
Fort St. John	147	5.5	2.03	115
Gibsons	Insufficient data			20
Golden	53	21.31	7.05	280
Grand Forks	insufficient data			280
Haida Gwaii	79	0.48	1.82	100
Hope	insufficient data			70
Kamloops	158	12.3	4.56	340
Kelowna	1356	21.67	1.11	380
Keremeos	insufficient data			380
Kimberley	179	32.42	3.45	280
Kitimat	35	0	2.35	100
Kootenay Lake/Kaslo	27	33.65	11.11	470
Ladysmith	insufficient data			35
Lake Country	353	44.47	2.68	380
Langford/Highlands	30	1.29	2.26	45
Langley Township	25	0.53	0.81	20

Table 2: Results by Community

Community	Sample Size	Percent of homes over 200 Bq/m^3	Current margin of error (plus or minus x %)	Estimated Sample size for 90% confidence in results,plus or minus 3 %, based on HSDA
Lillooet	insufficient data			340
Lumby	67	23.94	7.25	280
Mackenzie	Insufficient data			335
Maple Ridge	41	0.98	2.02	60
McBride/Valemount	77	14.5	6.35	335
Merritt	Insufficient data			340
Metchosin	Insufficient data			45
Mission	Insufficient data			70
Nanaimo	237	0.94	0.71	35
Nelson	909	37.26	1.67	470
New Westminister	Insufficient data			60
North Saanich	Insufficient data			45
North Vancouver	253	1.55	0.23	20
Oak Bay	25	8.74	4.51	45
Osoyoos	107	31.77	5.16	380
Parksville	Insufficient data			35
Penticton	207	21.67	3.44	380
Pitt Meadows	Insufficient data			60
Port Coquitlam	43	0.69	1.79	60
Port Moody/Anmore/Belcarra	44	4.77	2.52	60
Powell River	Insufficient data			20
Prince George	2245	32.04	0.5	335
Prince Rupert	63	0.2	1.92	100
Princeton	20	32.57	12.07	380
Quesnel	66	9.88	6.61	335
Revelstoke	371	40.38	2.7	340

Table 2: Results by Community

Community	Sample Size	Percent of homes over 200 Bq/m^3	Current margin of error (plus or minus x %)	Estimated Sample size for 90% confidence in results,plus or minus 3 %, based on HSDA
Richmond	99	0.04	0.02	20
Saanich (District of)	377	0.73	0.68	45
Salmon Arm	321	17.57	2.68	340
Saltspring Island	74	8.21	2.03	45
Sechelt	Insufficient data			20
Sidney	Insufficient data			45
Smithers	62	4.26	3.68	100
Sooke	insufficient data			45
Southern Gulf Islands (Pender/ Galiano/Saturna/Mayne)	Insufficient data			45
Squamish	63	4.55	1.01	20
Summerland	143	30.87	4.13	380
Surrey	82	0.31	0.49	20
Terrace	127	11.52	2.72	100
Trail	472	30.36	3	470
Tumbler Ridge	Insufficient data			115
Vancouver	343	1.98	0.08	30
Vanderhoof	21	20.82	14.14	335
Vernon	598	29.97	2.28	380
Victoria	65	3.07	2.15	45
View Royal	Insufficient data			45
West Kelowna	486	31.76	2.23	380
West Vancouver	34	1.71	1.23	20
Whistler	47	1.82	0.84	20
White Rock	Insufficient data			20
Williams Lake	60	10.41	8.26	340
Windermere/Radium Hot Springs	54	31.52	6.4	280

Appendix 1: Defining Communities

Table 1, Appendix 1 Defining Communities		
Community Name	Underlying CHSA	CHSA Number(s)
100 Mile House	100 Mile House	1440
Abbotsford	Abbotsford Rural, Central Abbotsford, East Abbotsford, West Abbotsford	2134, 2132, 2131, 2133
Armstrong/ Spallumcheen	Armstrong/Spallumcheen	1350
Arrow Lakes/ Nakusp	Arrow Lakes	1240
Bella Coola Valley	Bella Coola Valley	3360
Bowen Island/ Lions Bay	Bowen Island/Lions Bay	3322
Burnaby	Burnaby Northeast, Burnaby Northwest, Burnaby Southeast & Burnaby Southwest	2221, 2222, 2223 & 2224
Burns Lake	Burns Lake Town Centre	5221
Campbell River	Campbell River	4321
Castlegar	Castlegar	1230
Central Saanich	Central Saanich	4132
Chemainus	Chemainus	4233
Chetwynd	Chetwynd	5312
Chilliwack	North Chilliwack & South Chilliwack	2121 & 2122
City of Langley	City of Langley	2311
Colwood	Colwood	4121
Comox	Comox	4311
Coquitlam	North Coquitlam, South Coquiltam & Southwest Coquitlam	2241, 2242 & 2243
Courtenay	Courtenay	4313
Cranbrook	Cranbrook	1120
Creston	Creston	1150
Dawson Creek	Dawson Creek	5311
Delta	Ladner, North Delta & Tsawwassen	2321, 2322 & 2323
Duncan	Central Cowichan	4212
Enderby	Enderby	1390
Esquimalt	Esquimalt	4119
Fernie	Fernie	1110
Fort Nelson	Fort Nelson Population Centre	5331
Fort St. James	Fort St. James North	5233
Fort St. John	Fort St. John	5321
Gabriola Island	Gabriola Island	4247
Gibsons	Gibsons	3331

Table 1, Appendix 1 Defining Communities		
Golden	Golden	1160
Grand Forks	Grand Forks	3331
Haida Gwaii	Haida Gwaii North & Haida Gwaii South	5101 & 5102
Hope	Hope	2110
Hudson's Hope	Hudson's Hope	5322
Kamloops	Kamloops Centre North & Kamloops Centre South	1431 & 1432
Kelowna	Downtown Kelowna, Glenmore, Okanagan Mission & Rutland	1374, 1375, 1376 & 1377
Keremeos	Keremeos	1330
Kimberley	Kimberley	1130
Kitimat	Kitimat	5150
Kootenay Lake/ Kaslo	Kootenay Lake	1210
Ladysmith	Ladysmith	4231
Lake Country	Lake Country	1373
Langford/ Highlands	Langford/Highlands	4123
Langley Township	Brookswood/Murrayville, North Langley Township & Willoughby	2313, 2314 & 2316
Lillooet	Lillooet	1470
Lumby	North Okanagan/Lumby	1362
Mackenzie	Mackenzie	5247
Maple Ridge	Haney, Maple Ridge Rural	2231, 2233
McBride/ Valemount	McBride/Valemount	5246
Metchosin	Metchosin	4122
Merritt	Merritt	1490
Mission	South Mission	2141
Nanaimo	Cedar/Wellington, Departure Bay, Downtown Nanaimo, Downtown Nanaimo, Nanaimo North/Lantzville, Nanaimo South	4241, 4242, 4243,4244, 4246
Nelson	Nelson	1220
New Westminister	New Westminster	2210
North Saanich	North Saanich	4133
North Vancouver	North Vancouver City - East, North Vancouver City - West, North Vancouver DM - Central, North Vancouver DM - East & North Vancouver DM - West	3311, 3312, 3313, 3314 & 3315
Oak Bay	Oak Bay	4114
Osoyoos	Southern Okanagan	1310
Parksville	Parksville	4251
Peachland	Okanagan Rural West	1371
Penelakut and Thetis Islands	Penelakut and Thetis Islands	4234

Table 1, Appendix 1 Defining Communities		
Penticton	Penticton	1320
Pitt Meadows	Pitt Meadows	2232
Port Coquitlam	Port Coquitlam	2244
Port McNeill/ Sointula	Port McNeill/Sointula	4342
Port Moody/ Anmore/Belcarra	Port Moody/Anmore/Belcarra	2245
Powell River	Powell River City	3341
Prince George	Prince George City - Central, Prince George City - North & Prince George City - Southwest	5241, 5242 & 5243
Prince Rupert	Prince Rupert City Centre	5121
Princeton	Princeton	1340
Quesnel	Quesnel City Centre	5211
Revelstoke	Revelstoke	1410
Richmond	Blundell, Broadmoor, Gilmore/Shellmont/East/Hamilton, Steveston & Thompson/Seafair	3112, 3113, 3114, 3115, & 3117
Saanich (District of)	Gordon Head/Shelbourne, Quadra/Swan Lake, Interurban/ Tillicum, Royal Oak, Cordova Bay, Prospect	4115, 4116, 4117, 4131
Salmon Arm	Salmon Arm	1420
Saltspring Island	Salt Spring Island	4141
Sechelt	Sechelt	3332
Smithers	Smithers Town Centre	5141
Sooke	Sooke	4124
Southern Gulf Islands (Pender/ Galiano/Saturna/ Mayne)	Gabriola Island, Pender/Galiano/Saturna/Mayne & Salt Spring Island	4142
Squamish	Squamish	3351
Summerland	Summerland	1380
Sidney	Sidney	4134
Surrey	Cloverdale, East Newton, Fleetwood, Guildford, North Surrey, Panorama, South Surrey & Whalley	2331, 2332, 2333, 2334, 2335, 2336, 2337, 2341
Terrace	Terrace City Centre	5171
Trail	Trail	1250
Tumbler Ridge	Tumbler Ridge	5313
Vancouver	Cedar Cottage, Downtown Vancouver, Fairview, Grandview-Woodland, Hastings-Sunrise, Kensington, Killarney, Kitsilano, Mount Pleasant, Oakridge/Marpole, Renfrew-Collingwood, Shaughnessy/Arbutus Ridge/Kerrisdale, South Cambie/Riley Park, Sunset, University of British Columbia, Victoria-Fraserview, West End & West Point Grey/Dunbar-Southlands	3231, 3211, 3213, 3223, 3232, 3251, 3261, 3244, 3252, 3262, 3233, 3241, 3253, 3263, 3243, 3264, 3212 & 3242
Vanderhoof	Vanderhoof	5231
Vernon	Vernon Centre/Coldstream	1361

Table 1, Appendix 1 Defining Communities		
Victoria	Downtown Victoria/Vic West, James Bay/Fairfield, Oaklands/ Fernwood,	4111, 4112, 4113
View Royal	View Royal	4118
West Kelowna	West Kelowna	1372
West Vancouver	West Vancouver - Lower & West Vancouver - Upper	3321 & 3323
Whistler	Whistler	3352
White Rock	White Rock	2342
Williams Lake	Williams Lake/East Cariboo	1462
Windermere/ Radium Hot Springs	Windermere	1140

Table 2, Appendix 1 CHSAs excluded as primarily rural and covering a large geographical area	
Agassiz/Kent	2150
Campbell River Rural	4322
Comox Valley Rural	4312
Cowichan Valley West	4220
Burns Lake North	5223
Burns Lake South	5222
Fraser Lake	5234
Houston	5143
Howe Sound Rural	3353
Juan de Fuca Coast	4125
Kettle Valley	1270
Ladysmith Rural	4232
Lower Thompson	1433
Nanaimo Rural	4245
North Thompson	1450
North Mission	2142
Oceanside Rural	4253
Okanagan Rural East	1378
Peace River North Rural	5323
Peace River South Rural	5314

Table 2, Appendix 1 CHSAs excluded as primarily rural and covering a large geographical area	
Prince George North Fraser Rural	5245
Prince George Southwest Rural	5244
Qathet Rural	3342
Quesnel Rural	5212
Smithers Rural	5142
Snow Country	5110
South Cariboo	1480
Stikine	5160
Sunshine Coast Rural	3333
Telegraph Creek	5190
Terrace Rural	5172
Upper Skeena	5130
Vanderhoof Rural	5232
West Cariboo	1461

Endnotes

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[12] Brenner, ibid. para 63; see also Simms, J.A., Pearson, D.D., Cholowsky, N.L., Irvine, J.L., Nielsen, M.E., Jacques, W.R., Taron, J.M., Peters, C.E., Carlson, L.E. and Goodarzi, A.A., 2021. Younger North Americans are exposed to more radon gas due to occupancy biases within the residential built environment. Scientific reports, 11(1), pp.1-10.

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