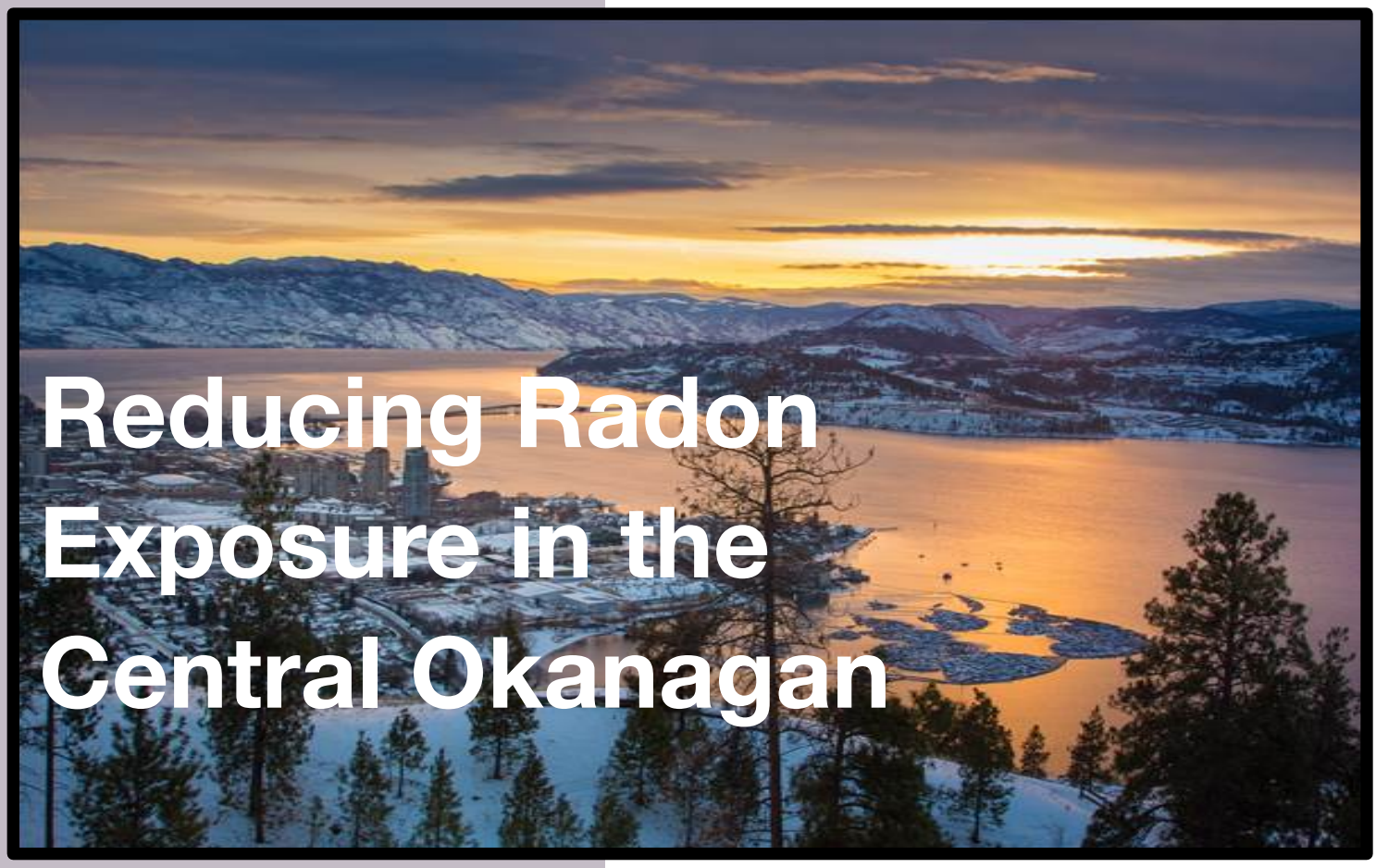

Reducing Radon Exposure in the Central Okanagan

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Table of Contents

List of Figures

List of Tables

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.

About this Guide

This Guide was made possible by the Law Foundation of British Columbia and its support for our programs on Radon, Rights and Duties and Radon Policies for Local Governments. This Guide draws on a series of draft documents prepared by Healthy Indoor Environments for Health Canada's National Radon Program and is used with their permission. This includes a Draft Radon Action Guide for Municipalities, a legal analysis of municipal powers to address radon, and Justifying Radon Action which sets out policy rationales for government action on radon. These draft documents are available from the Radon Action Guides consultation page hosted by Take Action on Radon. Final reports are expected from Health Canada in early 2022. As well, the Healthy Indoor Environments program has prepared Radon and Local Government: Municipal Law Powers in BC, offering an in-depth legal analysis of local powers to address radon.

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Executive Summary

Radon gas is released from the natural breakdown of uranium found in soils and rocks. Although radon is natural, it can build up inside buildings and become harmful to human health. Radon gas causes lung cancer. International radiation guidance recommends action levels (or the level of radon gas concentrations in air at which point remedial measures should be taken) between 100 and 300 Bq/m^3. Health Canada has set Canada's Radon Guideline at 200 Bq/m^3.

The Central Okanagan has high radon levels. In 2014, Interior Health tested approximately 400 daycares, and found 11% reported levels above Canada's Radon Guideline. Some facilities had startling numbers of more than 1000 Bq/m^3. In 2020 the Regional Air Quality program of the Central Okanagan joined with Take Action on Radon and the British Columbia Lung Association (now British Columbia Lung Foundation) to help residents learn about the radon levels. The Regional Air Quality Program is a joint initiative of the City of Kelowna, Regional District of Central Okanagan, District of Peachland, City of West Kelowna, Westbank First Nation and the District of Lake Country. Over a thousand test kits were distributed in the Central Okanagan region. The testing process confirmed that the Central Okanagan has very high radon levels, with some communities recording more than half of homes tested over Canada's Radon Guideline. The Air Quality program sought and obtained approval from the RDCO Governance and Services Committee on July 8, 2021 to work further to see how radon could be addressed.

Local governments have the power to act to address radon and save lives. The Regional District of Central Okanagan contains the most populated urban area in the province with recognized elevated or high radon. Local governments' Council and staff can be leaders and catalyze action in other communities and the provincial level. This report suggests steps local governments in the Central Okanagan can take. Part 1 introduces radon gas, its health risks, and how it can be fixed. This section considers known radon levels in the Central Okanagan, reasons for action and existing law and policy that touches on radon in the region, setting the context for action.

In Part 2, this report covers action steps on radon, including recommendations that local governments can implement to begin the process of tackling high radon levels in buildings. These various approaches draw on existing work on radon , including Health Canada's Draft Radon Action Guide for Municipalities, the BC Lung Foundation's program on Radon, Rights and Duties and Radon and Local Government: Municipal Law Powers in BC. Potential actions are organized into three types, starting with the actions already taken in the Central Okanagan municipalities. The second type of action considered are 'easier measures' – steps that local governments can consider that do not involve changing strategic plans or passing new bylaws. These recommendations can be initially implemented on a trial basis, can be adjusted over time, and for which there need not be significant up-front expenditures. The third type of action involves longer term commitments, changes to planning documents, and amendments to bylaws. In an Appendix, we provide a model radon policy a local government could work to implement.

A made in the Central Okanagan radon strategy could begin now, through reflection on existing actions and framing them as part of a response to an important problem, moving forward quickly with easier measures, and planning for adopting longer term measures. This report is a Guide that outlines concrete steps for action to reduce radon gas. We recommend it be followed up with clear decisions on what to do. We urge the local governments in the Central Okanagan region to take action on radon.

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Table 1. List of Strategies

Strategy Type	Strategy	**Details**
Easier	Education and Awareness	Websites. Publishing and distributing informational guides. Hosting information sessions and talks. Declaration of November as Radon Awareness Month.
Easier	Expanding Voluntary Testing and Mitigation	Distribute free or subsidize radon test kits. Work with NGO housing providers in the region to test their facilities. Target developers and new homeowners in testing campaigns. Strategies to share local test results with the BC Radon Data Repository.
Easier	Government Operations	Test and mitigate radon in owned and operated buildings/facilities.
Easier	Building Code Application	Ensure BC Building Code radon provisions are being applied in your jursidiction. Participate in studies assessing the BC Building Code radon provisions.
Easier	Building Code Enforcement	Provide training for relevant staff. Enforce radon provisions in the Building Code.
Easier	Form a Radon Working Group	Provide opportunity for inter-departmental collaboration on radon action (e.g. building inspection, air quality, housing policy, planning).
Easier	Advocate to Other Orders of Government	Advocate to the provincial government for funding and technical support. Seek support and financial assistance from UBCM. Seek technical assistance from the National Radon Program in Health Canada.
Easier	Energy Efficiency Programs Consider radon	Educate energy advisors and retrofit companies on radon and ensure any support programs for energy efficiency include radon testing and mitigation
Longer Term	Incorporate radon in long term planning	Consider adding radon testing and mitigation to existing or future long-range planning documents such as OCPs, Regional Growth Strategies and Housing Strategies.
Longer Term	Link radon to Broader Energy and Indoor Air Quality Initiatives	Include radon considerations in all energy strategies and indoor air quality initiatives. Seek synergies between energy retrofits and radon mitigation to maximize funding dollars.
Longer Term	Set Community Radon Testing and Mitigation Goals	Consider a goal of ensuring all homes and workplaces in the community are tested and, if necessary, mitigated through a mix of education and awareness, new bylaws and subsidies for testing and mitigation.
Longer Term	Help Renters	Standards of Maintenance bylaws can be created and updated to include radon levels.
Longer Term	Establish radon requirements in public spaces	Clean Air" or "Health" bylaws can be created or expanded to include rules requiring testing and necessary mitigation of radon in public indoor spaces.
Longer Term	Ensuring measures are in place to test and mitigate new homes	Consider adding radon in building bylaws to require radon testing and activation of rough-in systems as part of building and occupancy permits. Work with builders and developers and new homeowners to promote radon action in new homes.

Part 1: Setting the Context

1. Radon Gas is a Health Risk

a. What is Radon?

Radon occurs naturally when uranium breaks down in rock and soil. It is an invisible, odourless, and tasteless radioactive gas. When radon leaves the ground, it becomes diluted in air and is usually relatively harmless. However, indoors, radon can seep into spaces through small cracks and openings. In some homes, workplaces and other indoor spaces, it can accumulate to higher concentrations, posing a health risk.

b. Lung Cancer Risks from Radon

Radon is a radioactive gas – when it decays alpha particles are released. When radon is breathed in, alpha particles travel into lung tissue and can break DNA bonds. The World Health Organization has identified radon as a human carcinogen[1] and numerous international studies confirm the link.[2] In fact, radon gas is the number one cause of lung cancer in non-smokers. Lung cancer is a deadly disease, with only one in five patients living beyond five years after diagnosis. [3] While there are many causes of lung cancer, exposure to radon gas is considered the leading cause of the disease after smoking. Radon exposure causes 16% of all lung cancer deaths in Canada or approximately 3,360 deaths each year.[4] This can also be calculated as about 1% of all deaths in Canada.[5]

The risk of developing lung cancer due to radon depends on:

1) the average radon concentration in the building,

2) the length of time a person is exposed, and

3) their smoking habits or exposure to tobacco smoke.

Radon levels vary across Canada, based on building construction methods, type, age, occupant's behaviour and underlying geography. International radiation guidance recommends action levels between 100 and 300 Bq/m^3. The World Health Organization recommends buildings be under 100 Bq/m^3. ***The Canadian Radon Guideline was set by Health Canada in 2007 at 200 Bq/m^3*** representing then current estimations of reductions that could be reasonably achieved in the country.[6]

Figure 1. How radon enters a home. Courtesy of CAREX Canada

The Guideline is now also part of Health Canada's broader suite of Residential Indoor Air Quality Guidelines. We now know that most if not all buildings can reduce the radon to levels below 100 Bq/m^3 at reasonable costs. Radon action is important for the communities in the Central Okanagan and its municipalities.

The interior region of British Columbia has one of the highest lung cancer rates in the province. ***In the Central Okanagan lung cancer accounted for 13% of all new cancer diagnoses between 2013-2017. Deaths in the Central Okanagan due to lung cancer accounted for 24% of all cancer deaths in the same period (or 594 of 2,467 deaths)***.

Almost 100% of those diagnosed with lung cancer will be over the age of 40 when they are diagnosed. According to BC Cancer data sources, in 2021 an estimated 3,845 British Columbians will be newly diagnosed with lung cancer. ***It is estimated that in BC 1 in 13 females and 1 in 14 males will develop lung cancer during their lifetime***.[7]

The risks of lung cancer from radon are strongly linked to smoking. Non-smokers who are exposed to high levels of radon over a lifetime (800 Bq/m^3) have a 1 in 20 chance of developing lung cancer, but the risk increases significantly for smokers, rising to a 1 in 3 chance.[8] Unlike smoking, radon exposure does not cause symptoms such as coughing. Elevated radon has no side effects or warning signals until the person develops lung cancer.[9]

The smoking rate in the Interior region of British Columbia continue to be higher than the provincial average, with 16% of the population identifying as regular smokers (14% provincially).[10]

A particularly troubling aspect of this is that smoking rates continue to be high among persons for 18 to 34 years (20%). Recent Canadian research suggests that radon is worse in newer homes, likely due to construction methods and a tighter, more energy efficient building envelope. Because younger families tend to live in newer homes, radon exposure is a growing problem for younger Canadians.[11]

c. Testing for Radon

High radon levels can vary significantly from building to building. Even houses next to each other can have very different average radon concentrations. This is because the type of soil, housing type, foundation construction or other factors, can vary greatly. The only way to know the radon level in a building is to measure it by testing. It is best to test for radon during October through April rather than in the summer because radon levels inside can vary with the seasons.

During the winter, windows and doors are less likely to be open, and indoor heated air results in the stack effect drawing more radon from the soil. Testing in the summer may give a result that underestimates occupants' annual exposure.[12] To find out a building's radon level, best practice testing is by placing a long-term "alpha track" home radon detector in the lowest inhabited rooms (such as living room or basement rec room) for at least 91 days. These hockey-puck sized units cost $20 to $60 and are available at leading retailers or from the British Columbia Lung Foundation's test kit sale webpage.

d. Fixing Radon

Over time, a number of technologies and methods have been developed to fix radon in existing buildings. Health Canada, for instance, has produced the guide "Reducing Radon Levels in Existing Homes: A Canadian Guide for Professional Contractors". As well the Canadian National Radon Proficiency Program (C-NRPP) provides training, standards, and certification for radon mitigation professionals. In older homes, the main techniques include: Inspecting the foundation layer to look for any holes or cracks that might let radon in, better sealing the foundation, and then installing an "active sub-slab depressurization system". This involves a pipe installed through the foundation that runs upwards through the inside of the building and vents to the atmosphere outside. A small electric fan further drives radon through the system. Professional mitigators can usually do this work in one or two days, with an average cost of about 3,000 dollars—about the same as replacing a furnace.

In new homes, similar systems can be built in at a much lower cost. Since 2012 the BC Building Code, in select areas, including Kelowna, has required 'rough ins'—partial forms of a sub-slab depressurization system that if testing high after the home is built, can be easily activated by fan installation.

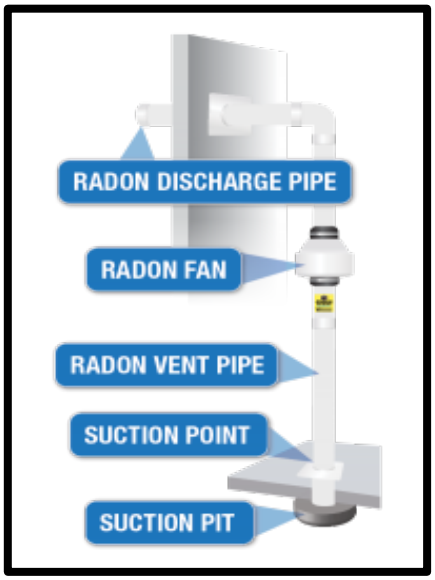

Figure 2. A close-up of a typical radon system.

Source: Understanding a Radon Mitigation System.

Figure 3. House with a radon system in the basement.

Source: Canadian National Radon Proficiency Program, 2021.

2. Radon Levels in the Central Okanagan

Radon levels vary by building type and geography and it is important to know local radon risks. Health Canada stresses that all homes have some level of radon and should be tested. However, in regions with high radon, raising public awareness can help motivate people to test and guide collective action. Radon concentrations also depend on building structure and design, and collecting indoor tests is also an important way to estimate local radon risks. Buildings anywhere can test high, and the only way to know the level is to test. Therefore, a sample database is very important for healthy community planning, and to inform homeowners, real estate agents, employers, landlords, and others who need to pay attention to the health risks in buildings.

Health Canada's 2012 Cross-Canada Survey of Radon Concentrations in Homes was an important first step. But, due to the budget and logistics of surveying all of Canada, it has a limited sample size and sampled by health service delivery areas. For the Okanagan Health Service Delivery Area, 109 results were obtained, with 17.4% recording over 200 Bq/m^3 – considerably higher than the national average of 6.9%.

In 2014, Interior Health conducted a large sampling project to test radon in childcare facilities. Radon testing was conducted at approximately 400 facilities across the Interior Health region. While businesses typically have lower radon levels than residences, ***the childcare testing results showed high radon levels. 11% reported levels above 200 Bq/m^3 and 29% above the WHO recommended Reference Level of 100 Bq/m^3. Some facilities had startling numbers of more than 1000 Bq/m^3***.[13]

In the Fall of 2020 the Air Quality Program at the Regional District of Central Okanagan collaborated with Take Action on Radon (TAOR), a national radon awareness program funded by Health Canada, and the Healthy Indoor Environments program (HIE) at the British Columbia Lung Foundation. 1,400 test kits were made available. The results are summarized in Table 1, showing an extremely high number of buildings testing above Canada's Radon Guideline—among some of the highest percentages recorded in the country.

The British Columbia Radon Data Repository (BCRDR), housed at the British Columbia Centre for Disease Control, now compiles radon data for the province. It has entered into formal data sharing agreements with diverse agencies that compile radon data, including Health Canada, Take Action on Radon, health authorities, private laboratories, radon measurement and mitigation companies, researchers, academics, and branches of the BC government. BCRDR released aggregated data to this report's author on September 1, 2021, based on 12,626 residential test results for the province recorded between 1999 and 2021 (see Table 2). These numbers incorporate the results of the 2020-2021 RDCO testing initiative. They show that ***57% of homes tested in the RDCO were over the WHO Guideline of 100Bq/m^3 and 28% over the Canadian Guideline of 200 Bq/m^3***.

The British Columbia Centre for Disease Control has more recently used the Radon Repository data to create an excellent radon map for BC.

The BCRDR data provides a large enough sample size to have high confidence that the results reflect the underlying radon levels across Central Okanagan residences. These numbers suggest a unique situation for the communities in the region - that of a large urban centre in British Columbia with high radon levels and in a good position to start addressing the situation.

Table 2. RDCO Air Quality Program Testing Results, 2020-2021, by municipality

City	Total Number of Homes Tested	Percentage under 100 Bq/m³	100-200 Bq/m³	Over 200 Bq/m³
Kelowna	573	44%	33%	23%
Lake Country	214	17%	31%	52%
Peachland	39	16%	33%	51%
West Kelowna	207	29%	35%	36%

Table 3. BC Radon Data Repository Compilation of Radon Data as of September 1, 2021

Community Health Service Area	No. of Buildings tested	No. of Buildings and percentage over 100 Bq/m³	No. of Buildings and percentage over 200 Bq/m³	No. of Buildings and percentage over 600 Bq/m³	No. of Buildings and percentage over 1000 Bq/m³	Dates
Central Okanagan Rural	103	75, **73%**	49, **48%**	16, **16%**	7, **7%**	2007-03-20 to 2021-03-22
Downtown Kelowna	179	41, **23%**	7,**4%**	2,**1%**	1, **<1%**	2001-05-26 to 2021-03-24
Glenmore	304	174, **57%**	70, **23%**	4, **1%**	1, **<1%**	1999-02-03 to 2021-04-26
Lake Country	241	183, **76%**	114,**47%**	21,**9%**	9, **4%**	2002-10-26 to 2021-06-16
Okanagan Mission	298	164, **55%**	72,**24%**	6, **2%**	1, **<1%**	2001-11-20 to 2021-07-01
Rutland	96	45, **47%**	13, **14%**	0	0	2001-09-27 to 2021-04-03
West Kelowna	308	193, **63%**	101, **33%**	16, **5%**	4, **1%**	1999-02-19 to 2021-04-30
Total	1529	875, **57%**	426, **28%**	65,**4%**	23, **2%**	

Note: Thie BCRDR data incorporates results from the RDCO Air Quality Program's 2020-2021 Radon Testing

3. Why Local Radon Action is Important within the Central Okanagan

a. Indoor Air and Health

The wildfire season and heat dome of summer 2021 amplified the importance of quality indoor air as populations sought shelter from the extreme outdoor elements for weeks on end. Health Canada and many Canadian health professionals have been moving in recent years to focus on indoor environmental health. Radon is included in Health Canada's Residential Indoor Air Quality Guidelines. Canadians look to their governments and community leaders to help them reduce risks and lead healthier, safer lives and it's important that governing bodies take steps to ensure people live and work in safe spaces.

b. Leadership

Local governments can take a leadership role and show that bold action on radon is possible. Municipalities enforce areas which make up core components of radon policy, including but not limited to building codes, construction permits, air quality in indoor public spaces (as is currently done for smoking and COVID-19), and standards of maintenance for rental accommodation. Local governments in the Central Okanagan are in the unique position of overseeing the most populated metropolitan area in BC with a high prevalence of elevated radon in homes. Collectively, these governing bodies are well positioned to catalyze provincial action.

c. Risk Management

Local governments are also employers, building owners, and operators. They are subject to laws that impose general duties to ensure spaces are safe—and increasingly these laws are recognized as including protection from elevated radon. Local government also needs to exercise a duty of care when inspecting buildings as part of the permitting process. Becoming aware of radon and taking steps to address it can be good due diligence to avoid exposure to legal liabilities.

d. Radon Mitigation is Cost Effective

Repeated studies from around the world have shown that early action to test and mitigate for radon is a cost-effective intervention—and in higher radon prone areas can be much cheaper that many routine procedures conducted in hospitals.[14] Such studies consider cost savings to the medical system from preventing disease and the total costs health care systems are willing to spend to prolong good quality of life. A Canadian study from 2019 led by Dr. Janet Gaskin included a specific analysis of the Kelowna Census Metropolitan Area (CMA), drawing from the results of the 2012 Cross Canada Survey of Radon Concentrations in Homes.[15]

This study considered a program of action that combined "passive preventive measures in new construction" (similar to what is now in the Building Code), activated depressurization in new construction (e.g. ensuring that new occupants add a fan if needed), and testing and retrofits for activated depressurization of all existing housing. It found, for the Kelowna CMA that this would be cost effective—

whether targeted at 100 Bq/m^3 or 200 Bq/m^3.[16] These studies suggest radon testing and mitigation is a justified social cost, whether financed by government or mandated by law for the private sector.

e. Health Equity

Health equity means that all people can reach their full health potential and should not be disadvantaged from attaining it due to social position or other socially determined circumstances (such as gender or race).[17] Improving the health outcomes of the whole population often requires focusing on the needs of less advantaged populations.[18] Health equity supports targeted interventions that aim to improve health outcomes for particular groups. Extra effort may be required on the part of governments to make sure that resources are available to those who need them. For radon, special areas of concern include low-income people who own their own homes, renters who have very little control over the spaces they live, and workers who depend on government regulation of workspaces. 36% of households in the Kelowna metropolitan area are renters.[19]

5. Current Radon Law and Policy that apply to the Central Okanagan

Since 2007 and the formation of the new Government of Canada Radon Guideline, there has been significant momentum to address radon in Canada. The National Radon Program leads an extensive public education program and has conducted surveys[20] as well as health research.[21] It has developed and validated technical guidance for radon risk reduction.[22] The program also ensures Canadians have access to accredited radon services and resources to help them test and mitigate, through the C-NRPP.[23] It has also funded Take Action on Radon. The National Radon Program has also worked with the National Research Council to ensure some radon provisions exist in the National Building Code. Federal government buildings have been tested for radon.[24] The Canadian General Standards Board has also issued guidance on best practices in radon mitigation. [25]

In Canada's division of powers, local action on radon—affecting as it does the built environment—falls under the jurisdiction of provinces and local governments.[26] There is significant variation in radon levels, with the Metro Vancouver and Victoria/Capital Regional District having low levels relative to most of Canada, but parts of the Interior having much higher-than-average radon levels. British Columbia, as a hot spot for radon, has much more to do on the law and policy front.

a. Explicit Radon Requirements

So far, the only explicit requirements mandating radon action in the Central Okanagan apply to new buildings and to daycares.

BC Building Code, 2018

British Columbia's Building Code started in 2012 with the rough-in "stub" (following the National Building Code) – that is a short pipe under a meter-tall capping a hole in the foundation. The idea here was that if high radon levels were found, the stub being already in place would lower the cost of installing the other mitigation features. In late 2014 the Building Code moved to require a full vent pipe.[27] This would apply in a broad geographical area east of the Coast Mountains. These rough-ins cannot be relied on to reduce high radon concentrations to below the guideline level. Homes with rough-ins should still have the radon level tested and when tests reflect elevated radon, the system completed by adding a fan.

In 2018 the BC Building Code radon provisions were revised.[28] The Code now lists municipalities (generally east of the Coast Mountains), based on where the Building Standards Branch has received information about high radon being found. Of the communities in the Central Okanagan, only Kelowna is explicitly mentioned in the Code.[29] However, a provision in the Code allows the jurisdiction having authority to adopt the provisions if they have data showing elevated risk of radon.[30]

Daycare Testing

Rules and guidelines for licensed childcare facilities are found in the *Community Care and Assisted Living Act*, the Child Care Licensing Regulation, and the standards of practice. There are many provisions that relate to health and safety of children, such as the broad provision in the *Act* that a licensee must operate

the community care facility in a manner that will promote the health, safety and dignity of persons in care (s. 7(1)(b)) and in the Regulation that "A licensee must ensure that a healthy and safe environment is provided at all times while children are under the supervision of employees" (s. 13(1)). As well, under section 17 of the Regulation a licensee must ensure that children do not have access to any object or substance that may be hazardous to the health or safety of a child.

Health authorities have the power to make radon testing a licensing requirement. The *Community Care and Assisted Living Act* empowers medical health officers to attach terms and conditions to a license (s. 11) and to revoke licenses if there is a risk to persons in the care of such facilities (s. 14). Once there are licensing requirements, health officers can inspect as part of the licensing process (s. 19 (2)(b)). In May 2017 Interior Health Authority (IHA) began to use these powers to address radon. IHA invoked s. 17 of the Regulation and mandated that childcares test as a condition of licensing.[31]

b. Professional Standards

A variety of professions, from engineering to law to real estate services, include explicit requirements to be vigilant in protecting the best interests of clients. In the real estate field, there are now a series of policy decisions and written guidance that foreground radon.

In 2020 the Real Estate Council of British Columbia issued guidelines for radon, which have now been transferred to the British Columbia Financial Services Authority as Radon Precautions Guidelines. ***Radon is considered a latent defect in homes for sale. This means that if sellers (or their real estate agents) or landlords know there is a radon problem, they must tell buyers or renters.***

This has led to new guidance and education for real estate licensees to discuss radon with their clients. Rental property managers are directed to disclose any known high radon levels to tenants.[32] As well, in 2020 radon was also added to the Property Disclosure Statement forms from the British Columbia Real Estate Association.[33] It should be noted that these provisions only apply where sellers or landlords know they have radon above the Canadian Radon Guideline. The provisions are new, and there is a need for research to ascertain whether real estate agents have changed their practices.

c. General Duties to Keep Spaces Safe

Across a wide number of different areas, there are legal requirements for people who control spaces to ensure they are safe. Considerable work is needed to spread the word that these provisions apply to radon.

Occupiers Liability

The *Occupiers Liability Act* provides that an occupier of premises owes a legal duty to take reasonable care to see that those who use or are present on the premises are reasonably safe. This will apply to private residences, schools, daycares, rental accommodation, and many businesses which members of the public can visit. People who control spaces should address radon both because it is a legal duty, and to avoid risks of litigation. However, if plaintiffs want to proceed to litigation, they will need to provide evidence concerning significant exposure (such as extended periods of time in environments that are over Canada's Radon Guideline). In most cases there will likely be a long-time lapse between exposure and later development of lung cancer. Evidentiary issues are likely to reduce the occurrence of lawsuits.

Residential Tenancies

Each province and territory has residential tenancy law with provisions that say rented spaces must be in good repair and safe for tenants—in BC the relevant provision is the *Residential Tenancy Act*, section 32.[34] Tribunals in Ontario and Quebec have found that radon above 200 Bq/m^3 is unacceptable in rental accommodation, following rules that rented spaces be fit for habitation.[35] BC's Residential Tenancy Branch has not yet seen cases but would likely come to the same conclusion given similar legislative provisions in BC.

Workplace Occupational Health and Safety

Canada's Radon Guideline applies in 'normally occupied areas' and explicitly applies to workplaces. As well, the Federal-Provincial Territorial Radiation Protection Committee has issued Naturally Occurring Radioactive Materials (NORM) Guidelines (2013) which also discuss workplace radon exposure.[36] This document confirms an action level of 200 Bq/m^3 whereby workplaces should take steps to reduce radon exposure. It also offers calculations on how radon exposure translates into radiation doses, so radon can be understood alongside other types of workplace radiation.

Under British Columbia's Occupational Health and Safety Regulation (OHSR), there are 'general duties' to ensure workplaces are safe.[37] WorkSafeBC has not yet adopted formal radon policies, but Ontario has adopted the formal policy that the 'general duty clause' includes protection from elevated radon. The guidance is easily accessed through an Ontario Government website titled "Radon in the Workplace" [38] It follows the NORM Guidelines to establish 200 Bq/m^3 as the level at which radon mitigation to as low as reasonably achievable should begin. As well, BC's OHSR has special provisions on ionizing radiation.[39] Radon is widely understood to produce ionizing radiation,[40] and the NORM Guidelines can be used to calculate the relationship between exposure to elevated radon and effective radiation dose for workers.

Part 2: Taking Action

5. Taking Stock of Radon Action in the Central Okanagan

The last 7 years has seen growing momentum around radon in the Central Okanagan. Interior Health initiated a process of testing radon in childcares in 2014, leading to requirements for testing and mitigation by 2017.

The RDCO included in its Clean Air Strategy, 2015, a line item about improving radon education on its website.[41] The Radon Detector Library Lending Program allows patrons to check out digital monitors to assess radon levels in real time in their homes. The program startup costs were financed by Health Canada and the program is overseen by the British Columbia Lung Foundation. Since 2020, it has run in branches of the Okanagan Regional Library, including the Kelowna, Kelowna Mission, Rutland, Lake Country, Oyama, Peachland, Westbank and Westbank Learning Lab libraries. [42] Interior Health has a webpage dedicated to radon exposure.[43]

The RDCO Air Quality program, together with Take Action on Radon and the Healthy Indoor Environments program at the BC Lung Foundation undertook large scale residential testing in Fall 2020, with over 1080 homes tested that provided a good sample size to reflect known radon levels of geographic concern. In 2020, the City of Kelowna declared November Radon Action Month—following many cities across Canada.

The RDCO Air Quality program has initiated a new Radon Outreach Project to test 55 public and independent schools in 2020-2022 (in collaboration with School District 23, Interior Health, Health Canada and the Canadian Association of Radon Scientists and Technologists). A smaller program of distributing 300 free test kits continued in the Fall of 2021 (as a follow up to the previous year's testing, and again with a collaboration of RDCO, Take Action on Radon and the BC Lung Foundation).

Building officials in Kelowna have cooperated to help the British Columbia Lung Foundation's study of radon and the BC Building Code—this aims to assess current radon provisions and whether builders are following it.

These are important developments. We need to move beyond education and awareness and the assumption that this is enough to initiate behavioral change without further support. The majority of owner-occupied homes, rented homes, offices, and businesses remain untested for radon. Many spaces will have higher radiation levels than allowed, even for nuclear workers.[44] Clearer direction is needed to ensure indoor spaces are tested for radon and mitigated if over the Canadian Radon Guideline. There is a lot of need for, and potential, for action.

6. Easier Radon Specific Measures

a. Education and Awareness

Local governments will have a broad mandate to address radon through providing services to the public. This can include providing education on websites, publishing informational guides, hosting information sessions and talks. ***This information can include up to date information from the BC Centre for Disease Control on known radon prevalence in Central Okanagan communities***. Local governments in the region can follow other governments to ***proclaim November Radon Action Month*****.** Other steps include expanding the radon detector library lending programs to school libraries.

b. Expanding Voluntary Testing and Mitigation

Central Okanagan communities now have a good sample size of homes tested. The challenge moving forward is to ensure that as many homes and businesses in the region as possible are tested for radon. ***Local governments should consider ongoing distribution of free or subsidized radon test kits***. Targeted outreach could be directed at people who might not readily think of fixing and maintaining their own buildings. For instance, local governments could work with non-market housing providers such as Columbian Centennial Housing Society, John Howard Society or Ki-Low-Na Friendship Society.

Additionally, staff can work with developers to ensure that anytime someone moves into a new home, they test for radon. Local government distribution of test kits could be conditional on people consenting to share results with the British Columbia Radon Data Repository (which in turn will protect privacy interests) —this will increase local knowledge of radon levels and allow for better research. Local governments should monitor (through surveys or randomized site visits) numbers of homes and other buildings tested and mitigated.

c. Government Operations

There are good reasons why local governments in the Central Okanagan ***should test and mitigate elevated radon within their own operations***. A government might choose to construct its own buildings to higher standards as a way of meeting legal obligations, acting ethically, or leading by example. As discussed above, municipalities acting as occupiers, employers, and landlords will have legal obligations to ensure spaces are safe—which should, in practical terms, extend to radon. Both the federal and BC provincial governments have already tested their own buildings.[45]

d. Building Code Application

There is now a good evidentiary basis for the radon provisions of the BC Building Code (at s. 9.13.4) to apply throughout the Central Okanagan. However, in the Code, radon provisions only explicitly apply to municipalities listed in Division B, Appendix C (Climatic and Seismic Information for Building Design in British Columbia) at Table C-4 (Locations in British Columbia Requiring Radon Rough-Ins) (as specified in Division B, s. 1.1.3.3 (1). As it now stands only Kelowna is listed and there is no mention of other Central Okanagan municipalities or unincorporated areas. However, there is a further provision in the Code that states that a local government may identify additional geographical locations requiring rough-ins if they have relevant data (at Division B, s. 1.1.3.3 (2)).

Local governments in the Central Okanagan can use the data in this report to establish that radon is a problem and start to apply the Code. Alternatively, they can reference the British Columbia Centre for Disease Control Radon Map, or directly request data from the British Columbia Centre for Disese Control. Local governments can also contact the BC Building Standards Branch to inform them that the Building Code radon provisions apply in their jurisdiction. Local government building officials could also participate with the BC Lung Foundation's Building Code Assessment project, such as by helping its researchers find homes to assess.

e. Building Code Enforcement

Local governments in the Central Okanagan will also need to be prepared to enforce the radon provisions in the Building Code in the areas where they have jurisdiction. Indeed, this will be part of routine duties of care to ensure inspections are carried out right—and particularly important given that faulty radon systems can lead to cases of lung cancer. For increased knowledge translation, local governments can consider specialized training for the relevant officials, such as attending courses (and receiving certification) from C-NRPP. C-NRPP can design courses that fit with inspectors' busy schedules. Inspectors should be prepared to use enforcement powers to ensure new buildings have the proper required radon rough-in works in place.

f. Forming a Radon Working Group

Developing radon plans should include collaboration, consultation, and partnerships. Within government this should include ways of collaborating between persons in diverse departments that are concerned with buildings and health—building inspectors need to talk to air quality people and those concerned with housing policy.

Ultimately, successful action in the region will likely involve collaboration with other regional municipalities and First Nations as well as having individual radon action planning processes. Local government personnel can also use the working group to reach out to independent organizations that have a strong presence at the local level and can play an important role concerning radon. Health authorities are likely to have significant knowledge about radon and be prepared to engage in education campaigns and site investigations. School boards can ensure testing and mitigation in educational spaces. Non-profit health associations and foundations may also have special insight into the problem and lend grassroots support (such as housing advocates concerned with health standards in buildings).[46]

g. Engage with other Orders of Government

Local governments in the Central Okanagan are well positioned to bring radon to the attention of the provincial government. Likewise, provincial support will be important as a potential source of technical help, funding, and to help coordinate facilitation with other local governments. Radon action in the region can be geared towards setting a provincial example and igniting provincial change on this issue, but also harnessing provincial government support to make local radon programs stronger.

Another important partner will be the Union of British Columbia Municipalities (UBCM), which can provide funding support for new planning initiatives. Local governments can also play an important role in getting radon on the agenda. Advocacy can be done independently or collaboratively with other communities in the region in seeking assistance from the UBCM.

Local governments can also seek technical help from the National Radon Program in Health Canada, which has already begun a process of providing guidance to municipalities on radon planning.

h. Link Radon to Broader Energy and Indoor Air Quality Concerns

It is becoming clear that we need significant changes to our building stock—to reduce energy demand and carbon emissions, to protect people from extreme heat, to ensure we are prepared for anthrogenic climate change, and to ensure good indoor air quality to protect from viruses (such as SARS-CoV-2) and pollutants (whether $PM_{2.5}$, formaldehyde, or radon). Organizations such as BC Housing,[47] Plan H,[48] and the Vancouver Planning Commission[49] are beginning to link these issues together. Once we are upgrading our Building Codes or retrofitting our buildings it only makes sense to find synergistic ways to achieve multiple goals and ensure people are protected.

Green building programs are a core part of many local government strategies in the Central Okanagan, whether this be in Clean Air Strategies, Climate Action Plans, implementation of the Energy Step Code for net-zero energy by 2032, or specific objectives in Official Community Plans. However, energy efficiency often relies on controlling indoor air flow, and can increase radon levels unless this is specifically accounted for in the system design.

Since the 1980s building scientists have been aware that "tight" buildings can prevent radon from escaping to the outdoors.[50] ***There is evidence that in some cases increasing airtightness can elevate mean radon concentrations by over 50%***.[51] In newer homes there may be applicable radon standards in Building Codes, but in retrofits the Code may not be engaged. The result can be that radon issues are ignored and made worse.[52]

Any energy efficiency programs should be coupled with attention to ventilation rates as well as testing and mitigating for radon.[53] At minimum, home occupants should be advised to test for radon after any energy retrofits. Radon policy should include measures to ensure energy advisors and retrofit companies pay attention to radon and ensure it doesn't become a problem. Local governments should be careful, when promoting energy efficiency, to also draw attention to radon and other indoor air quality issues. There are possibilities to help link energy retrofit and radon mitigation financing—for instance, with low-interest loans which are paid back on monthly utility bills (sometimes called" on-bill financing").

7. Longer Term Measures

Local governments regularly engage in long-term proactive planning, as found in long-term land use plans, sustainability plans, healthy community strategies, or housing initiatives. Not only do local governments have the power to include radon in these plans but doing so follows from existing roles of planning for housing and Healthy Built Environments. Radon planning is well established in many countries, as now documented by the World Health Organization's Radon Database. Local governments can begin to put in place many of the core features of a Radon Action Plan. Key features include adopting long term goals of reducing indoor radon exposure in the community, ensuring radon is considered through the planning process, and establishing specific bylaws and operating policies.

a. Ensure Radon is Worked into Longer Term Planning Strategies

Radon fits within a variety of policy platforms local governments already use, such as sustainability planning, housing policies, healthy built environments, clean air strategies, and standards of maintenance bylaws. An advantage of doing so is not only because of the potential for longer term planning but so that radon is addressed at a more systematic level. We now know that health improvements come not only from educating people, but can also include financial incentives, legal change, such as requirements for seatbelts, or forms of community building and empowerment, such as supporting patient groups and including them in public consultations.[54] Putting radon into longer term plans help support a "Whole of Society" approach that ensures policy does not become siloed[55] and can use synergies and systems thinking.[56]

A survey of existing longer-term planning strategies shows many existing objectives and principles which suggest radon action:

- The Regional District of Central Okanagan has already made "Sustainable Communities" and a "Healthy Built Environment" part of the Okanagan Regional Board's strategic priorities.[57]

- In Lake Country, "Our Sustainable Lake Country" includes in its vision creating a healthy, and safe community[58], a commitment to advancing green buildings [59] and environmental health[60]. The OCP includes objectives of minimizing risk to citizens and development from natural hazards.[61] and recognizes the right to a healthy environment.[62] There are broad provisions to improve air quality.[63] Sections on housing emphasize suitable housing for all segments of society.[64]

- Kelowna's Healthy City Strategy recognizes that the built environment, including homes, when strategically designed, can reduce chronic diseases.[65] The Healthy Housing Strategy recognizes that quality housing is both adequate and suitable. 'Adequate' refers to housing that is in good physical condition and that is of an appropriate size. The Strategy states that typical challenges include indoor health and safety hazards [66]

Paying attention to radon is an important way to ensure Central Okanagan community residents enjoy a high quality of life with access to safe neighbourhoods and housing. Radon can also fit within existing initiatives, such as Official Community Plans, Regional Growth Strategies and Housing Strategies.

b. Long Term Testing and Mitigation Goals

Ultimately, the aim of a radon strategy should be to reduce exposure to radon and save lives. Local governments in the Central Okanagan can take the bold step of aiming to eliminate high radon through the built environment. This will require broad coordination across the regional district, and longer-term planning to ensure that all buildings are tested, and if necessary mitigated. We can effectively save lives through reducing exposure to radon but doing so requires clear commitments and law and policy change, and administrative enforcement to make sure this happens.

Local governments in the Central Okanagan could consider as a goal ***"that all homes and workplaces in the region are tested and mitigated within 10 years"***. This meets the "SMART" criteria-- Specific (simple, sensible, significant), Measurable (meaningful, motivating), Achievable (agreed, attainable), and Relevant (reasonable, realistic and resourced, results-based).

Radon reductions can be achieved through a mix of education and awareness and new bylaws, as described in this Guide. However, a key component will be subsidies for testing and mitigation. There are many ways in which subsidies can be offered—distribution of free or reduced-price test kits, and for mitigation low- and no-interest loans, on bill financing, direct payments, or reduction of other taxes or fees. Subsidies for mitigation should only be made available where mitigation is performed by C-NRPP certified radon professionals. The mix of subsidies and new bylaws should be evaluated over time to ensure they are sufficient to reach milestones (such as half of homes tested and mitigated after 5 years).

The Central Okanagan will not be the first to offer subsidies-the Habitation Durable program in Quebec offers financial subsidies to home renovations, including radon, and applies in Dixville, Piessisville, Ham-Sud, Dixville, Petite-Rivière-St-François, St-Valérien, Varennes and Victoriaville. The City of Vaudreuil-Dorion began selling radon detectors for just $5, including analysis and shipping. It will reimburse 50 per cent of the cost of installing a radon mitigation system to a maximum of $500 per residence. Realizing a strong long-term goal of eliminating exposure to elevated radon will require collaboration and coordination with municipalities.

c. Standards of Maintenance Bylaws

Local governments through BC have standards of maintenance bylaws—indeed ***this is promoted by the provincial government through a Standards of Maintenance Guide and Model Standard of Maintenance Bylaw*** available on its website for Local Government Housing Guides. This includes provisions that aim at preserving health and dignity of residents (such as ensuring ventilation systems are working). RDCO's Occupancy and Building Maintenance Standards Bylaw, No. 183 could be updated, and other Central Okanagan governments could introduce bylaws to provide protection from radon for renters in line with the Canada's Radon Guideline of 200 Bq/m^3. Radon specific provisions can specify that

- rental accommodation should comply with Canada's Radon Guideline
- landlords are required to test for radon following Health Canada approved procedures
- tenants and prospective tenants must be notified test results
- tenants have the right to conduct their own tests
- for average long-term results over Canada's Radon Guideline mitigation must be performed by a C-NRPP certified radon professional to as low as reasonably achievable under the Guideline
- that testing be repeated every five years.

The BC Lung Foundation has prepared guidance on procedures and conflict resolution on radon for landlords and tenants and local governments can make this available.[67]

An important further step is ensuring enforcement. The Model Standard of Maintenance Bylaw includes enforcement provisions (in Part 2) and provides that municipal officials should administer the bylaw, with rights of entry, ability to give notices of compliance, and allowing for summary conviction to landlords for non-compliance.

A further step can be to use the business licensing process. For instance, in Waterloo, Ontario, the city uses the business license process to enforce standards of maintenance, denying permits to landlords who do not maintain rental properties in good condition, and allowing enforcement by medical officers of health, as well as building inspectors, enforcement officers, and police officers.[68]

d. Radon Requirements for Public Indoor Spaces

Radon is the leading cause of lung cancer after smoking—and just as local governments have worked to prohibit smoking in indoor places, they can also work to prohibit elevated radon. Requirements to ensure low radon levels will not severely impact businesses, will protect workers and the public, and help employers follow the law. “Clean Air” or “Health” bylaws can be created or expanded to include rules requiring testing and necessary mitigation of radon in public indoor spaces. Government operations and rental accommodation have already been considered in previous recommendations: Here, the emphasis is on a broader bylaw that covers businesses in general. Details can include:

- Indoor spaces open to the public should have radon levels below Canada’s Radon Guideline of 200 Bq/m^3
- Business owners and other occupiers of buildings are required to test for radon following Health Canada approved procedures
- Test results should be clearly identifiable, posted, and visible to workers and the public
- For average long-term results over the Canadian Guideline, mitigation must be performed by a C-NRPP certified radon professional to as low as reasonably achievable below the Guideline
- Testing be repeated every five years
- An inspection process to verify testing and mitigation
- Enforcement through business licensing and permitting.

e. Ensuring Good Testing and Mitigation in New Homes

Local governments need to accept that the BC Building Code applies across the province as a uniform standard. The Building Code, 2018, notes however, that it is important to test for radon after occupancy but provides no mechanism for making this happen. There is room for local government staff to work with developers and new homeowners to help promote radon action in new homes, through promoting testing and post-occupancy mitigation (such as through adding fans to the rough-in).

Changes should be considered to building development bylaws. For example, in the RDCO's Building Bylaw No. 835, at section 9.4 there is a list of required items for obtaining a building permit.

Rules concerning building permitting could be amended to clarify the importance of a radon rough-in—e.g., to require specification of a radon rough-in system as part of building plans. Where local governments publish checklists, such as the City of Kelowna's Checklist: Building Permit Single Family Dwelling, this could include drawing specifications for a radon rough-in. Building bylaws could be amended to require builders to leave radon testing devices with new owners (Health Canada takes the position that 91-day tests in the heating season are required to properly estimate average radon levels). This will be a very small expenditure (on the order of 30 dollars) for builders compared to overall building construction costs. Provisional occupancy permits could be issued allowing homes to be lived in until testing is complete, with final occupancy permits pending proof of radon testing and any needed mitigation.

There are also possibilities for the local government to negotiate directly with builders to secure additional radon provisions. Municipalities can secure agreements with builders over higher standards than the Building Code provides.[69] Ideally, we want to see all new homes be tested and mitigated if over 200 Bq/m^3, therefore formal arrangements with builders is likely to come closer to making this a reality than leaving the issue to homeowners. Builders could build improved radon rough-ins, e.g., vertical, insulated vent pipes in conjunction with balanced heat recovery ventilation systems can often reduce radon levels to below 200 Bq/m^3 without additional fans.[70] Testing is still required, so an alternative approach is for builders to equip homeowners with a tesk kit upon occupancy, and for the builder to return to activate the rough-in with a fan if needed. Given the relatively low cost of building in radon protections from the get-go, the high incidence of radon in the Central Okanagan region, and the benefit to builders' reputation, securing agreement has significant merits.

8. Conclusion

Radon action has begun in the region—The RDCO has successfully conducted some community testing and other projects in the communities in the Central Okanagan. This report has outlined key steps, both as initial easier measures that can be implemented quickly and in terms of longer-term planning. Local government in this area has many reasons to act on radon—to ensure it follows existing law to protect workers and the public in its own operations, to provide a cost-effective intervention for saving lives, and to ensure health equity for occupants, renters and others who rely on legal protections. Central Okanagan local governments are well positioned to be a leader in BC and catalyze action by other communities and the province.

Appendix 1: Model Radon Policy for a Central Okanagan Local Government

Guidance Principle

Radon is a radioactive gas – it emits alpha particles. When radon or its decay products are breathed in, alpha particles travel into lung tissue and can break DNA bonds. The World Health Organization has identified radon as a human carcinogen. Radon gas is considered the leading cause of lung cancer after smoking, killing over 3,300 people a year in Canada. The Canadian Radon Guideline was set by Health Canada in 2007 at 200 Bq/m^3. Radon is easy to test and fix and Health Canada recommends that, all regularly occupied interior spaces be tested, and if levels are found to be over 200 Bq/m^3, mitigated to as low as reasonably achievable below 200 Bq/m^3.

In the Central Okanagan lung cancer accounted for 13% of all new cancer diagnoses between 2013-2017. As the following Table shows, there is a significant radon problem in the Central Okanagan. Radon policy can reduce radon exposure, and in doing so reduce lung cancer incidence and save lives.

Table 1 : BC Radon Repository Compilation of Radon Data as of September 1, 2021

Community Health Service Area	No. of Buildings tested	No. of Buildings and percentage over 100 Bq/m^3	No. of Buildings and percentage over 200 Bq/m^3	No. of Buildings and percentage over 600 Bq/m^3	No. of Buildings and percentage over 1000 Bq/m^3	Dates
Central Okanagan Rural	103	75, **73%**	49, **48%**	16, **16%**	7, **7%**	2007-03-20 to 2021-03-22
Downtown Kelowna	179	41, **23%**	7,**4%**	2,**1%**	1, **<1%**	2001-05-26 to 2021-03-24
Glenmore	304	174, **57%**	70, **23%**	4, **1%**	1, **<1%**	1999-02-03 to 2021-04-26
Lake Country	241	183, **76%**	114,**47%**	21,**9%**	9, **4%**	2002-10-26 to 2021-06-16
Okanagan Mission	298	164, **55%**	72,**24%**	6, **2%**	1, **<1%**	2001-11-20 to 2021-07-01
Rutland	96	45, **47%**	13, **14%**	0	0	2001-09-27 to 2021-04-03
West Kelowna	308	193, **63%**	101, **33%**	16, **5%**	4, **1%**	1999-02-19 to 2021-04-30
Total	1529	875, **57%**	426, **28%**	65,**4%**	23, **2%**	

Purpose

This policy aims to reduce exposure to radon gas within indoor spaces in this jurisdiction. It sets out a plan for increasing education and awareness, having indoor spaces tested, and if necessary mitigated. It seeks to ensure that persons in this jurisdiction can live, work, and play in environments that do not have unsafe levels of radon.

Policy Scope

This policy applies to all indoor spaces within this municipality for which the municipal government has jurisdiction. This includes:

- New construction that requires building and occupancy permits from this municipal government
- Public indoor spaces owned or used by the municipal government
- Rental properties located within this municipality
- Businesses located in this municipality that operate pursuant to business licenses

Education and outreach on radon will be directed towards all residents of this municipality, and everyone who works or owns businesses in this municipality.

Policy Statement

Prolonged exposure to radon gas over Canada's Radon Guideline of 200 Bq/m^3 constitutes a danger to lung health. Everyone has the right to protection from radon concentrations over the Canadian Guideline. Addressing radon is an important component of this municipality's sustainability goals, creating a Healthy Built Environment, and ensuring adequate housing for its residents.

This municipality will work to ensure that all homes and places of business within its municipal boundaries are tested and mitigated. We will work to ensure that at least half of all homes and businesses in this municipality are tested and mitigated within 5 years of this policy being adopted. We aim to have no buildings in this municipality with high radon within 10 years.

We will test all municipally owned and operated buildings and mitigate for radon if necessary, within 5 years.

Initial Actions

The following actions will be programmed for the first year this policy is in place.

Radon Action Month

This municipality will declare November of each year Radon Action Month as do many other governments across Canada. This will create a yearly time around which to plan education and outreach activities, and will focus attention on the need to start testing for radon in the Fall and Winter.

Whereas,

The City of ____ is considered to be at a greater risk for high levels of indoor radon gas; and

Indoor radon gas is known to be a serious public health risk causing as many as 16% of lung cancer deaths in Canada each year; and

Detecting levels of indoor radon gas is simple with a low cost and easy to administer test; and

If high levels of indoor radon are present in a home cost-effective solution exist to reduce unsafe levels.

Now, therefore,

I, _____, Mayor of the City of _____do hereby proclaim November 1st to November 30th as RADON ACTION MONTH in the City of _____

Update Website

This will explain radon to the general public and this municipality's plans to address it.

Expand the Radon Detector Library Lending Program

This program provides digital monitors for people to learn about radon (as an odourless, colourless gas) and to check radon levels. This program was started by the British Columbia Lung Foundation but should be given long term financial viability. We will work with our local school district to expand the program to schools.

Continuing Program for Testing and Mitigation

In 2020 and 2021 the Central Okanagan Air Quality Program distributed free radon test kits. This will be made a permanent program run by this municipal government, offering a larger number of subsidized test kits and targeting free test kits for those in financial need. The municipality will obtain bulk tests at low cost, sell them from municipal offices, and provide drop boxes to help lower the cost for residences sending

devices to laboratories. Participants will be asked to consent that radon data will be shared with the British Columbia Radon Data Repository. This will help ongoing monitoring and studies of radon in this municipality.

Link Efficiency Programs to Radon and Indoor Air Quality

Municipal policies will be scoped to see where energy retrofits are supported. Education and awareness campaigns will be targeted at energy advisors, retrofit companies and clients engaged in energy retrofits. A program will be developed to ensure any municipal financial support (subsidies) for energy retrofitting extend to radon testing and mitigation. Where this municipality offers financial support for energy retrofits new requirements will be instituted requiring advisors and contractors to inform clients about radon and warn of the need for radon testing.

Radon Policy for Municipal Government Buildings

A program will be started for testing and mitigating all municipal government owned and operated buildings. Municipal staff may do testing work, following Health Canada's Guide for Radon Measurements in Residential Dwellings(Homes) and Guide for Radon Measurements in Public Buildings, or an environmental consulting company with Canadian National Radon Proficiency Program (C-NRPP) certified testers can be hired. C-NRPP mitigators will do the mitigation work. This municipal government will aim to have all buildings tested and mitigated within 5 years. Testing results and mitigation history will be posted in visible locations in each building. Results will also be compiled into an open and transparent publicly accessible database and report including particular building addresses, testing results and mitigation history.

Building Code

The radon provisions in the BC Building Code apply will be applied. BC Building Code 2018, at Article 1.1.3.3. of Division B states where radon provisions apply in BC. A list of municipalities is found at Table C-4, Locations in British Columbia Requiring Radon Rough-Ins (in Division B, Appendix C, Climatic and Seismic Information for Building Design in British Columbia). Article 1.1.3.3 (2) states that the authority having jurisdiction may identify additional geographical locations requiring rough-ins. The section requires that the authority have indicating the location is at an elevated risk of the presence of indoor radon levels exceeding Health Canada guidelines. For the Central Okanagan, only Kelowna is currenly listed in Table-C4. However, current data from the British Columbia Centre for Disease Control's Radon Map confirm that all parts of the Central Okanagan are at an elevated risk. This data can also be requested directly from the BC Centre for Disease Control-- visit the Data Request webpage or write to datarequest@bccdc.ca

Municipal building Inspectors will be trained in radon. C-NRPP offers courses, and can be consulted about designing a specific course for BC-based municipal inspectors that . Contact info@c-nrpp.ca

Inspectors will use their powers to deny building and occupancy permits to new buildings that do no meet the BC Building Code's radon provisions.

Create a Radon Working Group

This will help to coordinate government departments. This will include representatives from Interior Health Authority, school boards, non-profit health associations and radon testing and mitigation professionals. A senior municipal official or planner will provide a home for this group and maintain oversight over the radon planning process.

Tracking Progress

A system will be created to learn numbers of homes and other buildings tested and mitigated in the municipality, and to help track progress of this policy over time. This can include a periodic (bi-yearly) survey and sample site visits, working with the BC Radon Data Repository, and periodic reporting of success in meeting policy goals.

Engaging with other Governments and Agencies

Work with other governments in the Central Okanagan to provide a coordinated response. The provincial government has a clear role to play given existing municipal law frameworks. Municipal staff will work with the provincial government to advance a provincial radon strategy, and to ensure action within the provinces jurisdiction that touches on this municipality. This will include promoting policies covering workplaces, Residential Tenancies, real estate transactions, provincial tax credits for subsidies and mitigation, and ensuring the BC Building Code includes best practices in radon resistant construction techniques in new construction and major renovations. Other potential partners include the Interior Health Authority, the Union of British Columbia Municipalities, and Health Canada's National Radon Program (send email to hc.radon.sc@canada.ca). We will engage with these organizations to advance a coordinated response to radon and to gain access to funds for radon testing, mitigation, and planning.

Adopt policy to work with developers to ensure good radon systems built

A policy will be formulated and adopted to ensure that in negotiations with developers over new developments, the municipality will seek to have the best possible radon systems built. Best efforts will be made to ascertain optimal radon systems at point of construction, following the Canadian General Standards Board (CGSB)'s Radon control options for new construction in low-rise residential buildings, (CAN/CGSB-149.11-2019) and other research.

Integrating Radon into Key Planning Strategies

Radon will be integrated with key municipal planning strategies. When these plans are written or renewed, radon action will be included as important strategic goals, and to ensure coordination and harmonization across municipal planning instruments.

Sustainability plans

- Make indoor air quality and radon reduction part of sustainability strategy
- Include radon reduction as part of Healthy Built Environment goals
- clarify that indoor air quality and reducing radon exposure are part of green buildings
- ensure that any support for energy retrofitting be linked to ensuring no negative impacts on indoor air quality and radon

Official Community Plans and Growth Strategies

- Include reducing indoor radon exposure as part of goals of improving air quality
- Emphasize housing must be suitable, in good condition, and conducive to good health
- Include Radon Action Plan

Healthy City Strategies

- Make explicit that healthy indoor environments are an important part of health planning and preventing disease, and link to radon action

Housing Strategies

- Recognize health outcomes as important element of housing planning
- State that home design can reduce chronic diseases
- Place importance on housing being adequate and in good physical condition
- Make reducing radon exposure explicit objectives
- Link radon to other indoor air quality goals
- Ensure healthy indoor environments for renters, including protection from elevated radon

Examples of Integrating Radon into Key Planning Strategies

District of Lake Country Integrated Community Sustainability Plan (ICSP) July 2014

- Amend vision circle in introduction graphic to read "diverse, ***safe and healthy*** housing options"
- In the District of Lake Country Sustainability Framework, at p 1, under 'environmental factors' (s. 1.1.1) add new bullet point describing increasing exposure to radon and latest results of radon testing and databases (as found on the radon page for the BC Centre for Disease Control).

3.1 Strategies and "Big Wins"

- Develop approaches to improve housing affordability, ***and indoor environmental quality***
- Big Win: ***A purpose built rental housing complex is developed including having good radon rough-ins and where appropriate, mitigation systems built in at the time of construction, post- occupancy radon testing, and if necessary mitigation, and radon testing results clearly visible to tenants.***
- More ambitious big win: ***Realization of goal of halving number of homes and businesses with elevated radon exposure within 5 years.***

Sustainability Action Plan, Strategy 7 (at p 24.) .Add new paragraph:

- ***Indoor air quality continues to be a concern across Canada and in Lake Country. Health Canada has produced Residential Indoor Air Quality Guidelines, including for radon, to draw attention to the issue. Radon is of particular concern in Lake Country, with the British Columbia Centre for Disease Control recording close to half of homes being over Canada's Radon Guideline of 200 Bq/m^3. Radon testing is relatively easy and inexpensive and radon in a building can be fixed for less than the cost of replacing a furnace.***

Under Long-term District Action include

- ***Create a Radon Action Plan. A suite of policies, bylaw changes and financial support can help ensure the spaces for living, work and play in Lake Country do not have radon over 200 Bq/m^3. A Radon Action Plan can provide a 10-year time frame for ensuring that elevated radon is no longer an issue in Lake Country's indoor spaces.***

Peachland, Official Community Plan Bylaw No. 2220

- Make explicit that healthy indoor environments are a goal of the OCP. Include available indoor air quality measures (for which radon can be prominent) under Community Profiles, (e.g. in addition to dwelling characteristics (c.f. s. 2.2., p. 14). Add "***ensure healthy indoor environments***" as Objective, and "***minimize risk to residents from indoor pollutants such as radon gas through a Radon Action Plan***" " as accompanying policy under "2.3 Neighbourhoods & Character Areas" (p. 16).
- Make explicit that healthy indoor environments are a component of sustainability outcomes, e.g. adding, where there is reference to green buildings, explicit goals of "***reducing radon gas exposure***" (e.g. 2.37 New Manaco, ss. 2.1, p. 48)

- Under 5.6.7 Climate Action make explicit that 'green building' ***includes radon testing and mitigation*** (at .15) and add a line (after .22) stating that ***energy efficiency measures should be coupled with attention to indoor air quality and radon***.
- Under 6.5.1.18, in discussion of Green Building Strategies, ***include radon testing and mitigation***.

Regional District of Central Okanagan, Regional Growth Strategy

- At 3.2.4 Our Health, add new policy: "***The Central Okanagan regional partners agree to… Focus attention on indoor air quality issues, including radon gas exposure as important components of ensuring resident's health and preventing disease***" (p. 14)
- At 3.2.6 Our Housing. Add new policy. "The central Okanagan regional partners agree to***…. Ensure housing is healthy and safe, by taking steps to reduce indoor air pollutants, including radon, through focused plans***" (p. 16)
- At 3.2.7 Our Climate. Add new policy. "The Central Okanagan regional partners agree to… ***work to ensure that energy efficiency upgrades to buildings do not have negative effects on indoor air quality, through Radon Action planning, and ensuring retrofitting of buildings is accompanied by radon testing and mitigation***" (p. 17)

Kelowna's Healthy City Strategy: Community for All. Kelowna's All Ages & Abilities Action Plan

- At p. 18, under Recommendations, Healthy Housing, add new objective: ***Address indoor air quality and reduce radon exposure***. The corresponding action item can be: ***Create Municipal Radon Action Plan***. Under details: ***A stand-alone Radon Action Plan and Policy will work to reduce exposure to elevated radon through Kelowna's housing supply and other indoor spaces***.
- Objective of promoting energy efficiencies can also be reframed—***to promote energy efficiency for all housing while protecting and advancing indoor air quality and radon protection***. Under Action add: ***inform residents that energy efficiency retrofitting should always be accompanied by radon testing***.

Kelowna's Healthy City Strategy: Healthy Housing Strategy.

Importantly already recognizes that healthy housing must also be of "quality": "Quality housing is both adequate and suitable. 'Adequate' refers to housing that is in good physical condition and that is of an appropriate size and design per Building Code and Health Regulation. Typical challenges here result from indoor health and safety hazards and overcrowding ". (p. 6)

- Suggested addition to key directions to add a fifth key direction: "***improve residential indoor air quality including protection from radon gas exposure***".
- Ensure levels of radon exposure, level of radon awareness and testing added to housing needs assessment (p. 9)
- Add Radon Action Plan as a recommended action.

Relevant Bylaw Amendments

Standards of Maintenance Bylaws

- New bylaws or amendments to old bylaws ensure protections for renters from radon gas exposure over Canada's Radon Guideline.
- Proposed action. Adopt (or incorporate into Good Neighbour bylaws) the Government of British Columbia Standards of Maintenance Model Bylaw
- Add New clause on Radon under Part 3, Maintenance Standards

27. Radon.

a. Landlords must ensure that a rental accommodation unit does not have radon levels over 200 Bq/m³.

b. Landlords shall test residential premises to ascertain radon concentrations, initially, and again every five years.

c. Testing shall conform to Health Canada's Guide for Radon Measurements in Residential Dwellings (Homes) (2017). A checklist for compliance with this procedure is provided in Schedule 1.

d. Landlords will notify tenants and prospective tenants of test results through providing copies of laboratory reports.

e. Notwithstanding any testing by landlords, tenants may conduct their own radon tests.

f. Mitigation will be performed by professional radon mitigators certified by the Canadian National Radon Proficiency Program, using best practices, to as low as reasonably achievable under 200 Bq/m³.

Business Licensing Bylaws, re Rental Accommodation

- Once new standard of maintenance bylaw (or amendment made) business licencing bylaws can be amended as a form of enforcement

Example: Westbank First Nation 2019 Business Law

In Definition section (s.2.1) clarify that "business" includes providing rental accommodation. Add definition of rental accommodation.

- In section 12.1 add language referencing standards of maintenance, e.g. "The Licence Inspector may suspend a licence for any period as determined to be necessary by the Licensee"

Add a new section specific to Residential Accommodation (e.g. after s. 22, Vending Machines) which states:

1. *every application for an initial license for a business providing residential accommodation shall swear or state on oath that they are able to comply with the Standard of Maintenance Bylaw*
2. *the City may deny a license if the premises are subject to an order, or orders, made pursuant to the City's Standards of Maintenance Bylaw.*
3. *every applicant will provide to the License Inspector any reports of radon testing and mitigation or clearly indicate if no radon tests have been performed.*
4. *In complying with s. 13.1 (displaying license) this can be fulfilled by giving tenants or prospective tenants a copy of the license*
5. *The License Inspector may revoke or suspend a license where*
    a. *there is non-compliance with this bylaw or the Standards of Maintenance bylaw, or there is a threat to the health and safety of the public or tenants of rental accommodation, and*
    b. *this would not cause undue harm to the tenants' access to safe and affordable housing*
6. *The License Inspector can issue an order to a landlord to rectify a situation that poses a threat to health, safety or fitness for habitation as provided in the Standards of Maintenance bylaw.*
7. *Where emergency steps are required to rectify a threat to health and safety, the License Inspector can issue a work order and recover the costs from the landlord.*

Add rental accommodation to the 2019 Business License Law-Business License Schedule.

Business Licensing Bylaws—re Radon in Public Spaces

- Create new bylaw or make amendments to make radon testing and mitigation a condition of opening a physical location for a business

Example: West Kelowna's - Business Licensing and Regulations Bylaw No. 0087

Add a new section 2.16 which states

2.16 Radon Protection.

1. *Businesses shall ensure that all indoor spaces open to the public and regularly occupied for four hours or more per day should have radon levels below Canada's Radon Guideline of 200 Bq/m³.*
2. *All spaces described in subsection (1) will be tested for radon every five years following Health Canada's Guide for Radon Measurements in Public Buildings.*

3. ***For average long-term results over 200 Bq/m³ mitigation must be performed by a C-NRPP certified radon professional using best practices to as low as reasonably achievable below 200 Bq/m³.***

4. ***Businesses will keep proof of testing and any mitigation, post copies in a place visible to the public and employees, and otherwise make them available for inspection by the License Inspector.***

Building Development Bylaws

Amend bylaws to ensure building permitting process includes radon, and that any occupancy is provisional until radon is tested—e.g., final occupancy permits will require proof of radon testing, and where appropriate, mitigation.

Example: Regional District of Central Okanagan, Building Bylaw No. 835

Radon Systems Described in Plans submitted for Permit.

9.4 Where the application is for a permit for a building, an addition, an alteration, or the moving of a building, the application shall state the intended use or uses of the building and include, where necessary, in support of the application, 2 (two) copies of the specifications and scale drawings of the project and site with respect to which the work is to be carried out. Such specifications and scale drawings shall show, in addition to the requirements of Part 2 of the Code

…(o) the location and design of the radon rough-in or further completed radon system

Inspection of Radon Rough-in or further completed system

19.1.4 For all other projects and additions and alterations thereto the required inspections are…:

c) Plumbing inspections – after any part of a plumbing system is in place, including water and sewer services prior to backfilling. Separate inspections will be done for water service, sewer service, rough in drain waste and vent piping, above ground rough-in drain waste and vent piping, water distribution system, ***and radon systems***

19.9.1 When doing a radon system inspection, the Inspector is authorized to review only the following items:

a. Radon mitigation plans

b. air barrier system

c. gas-permeable layer

d. any access points for gas from sub-slab into the conditioned space

e. radon vent pipe

f. radon vent pipe terminations

g. fans, if any

h. heating, ventilation, and air conditioning systems, including heat recovery or heat energy ventilators

i. and any other items that may make up part of a radon mitigation system

Occupancy Permit and Radon

19.14. Any occupancy permits issued will be provisional until the following radon protection conditions are met

i. radon testing of at least 91 days during the heating season

ii. submission to the Inspector of a statement verifying completion of a radon test that complies with the following guidelines:

1. *For residential dwellings testing will conform to Health Canada's Guide for Radon Measurements in Residential Dwellings (Homes) (2017). A checklist for compliance with this procedure is provided in Schedule 1.*
2. *For workplaces, schools, day cares, hospitals, care facilities, and correctional centres testing will conform to Health Canada's Guide for Radon Measurements in Public Buildings.*

Schedule 1

Checklist for Radon Testing

This checklist is designed to help people ensure they have followed correct procedure in testing for radon. By filling in the form, a person can show they have taken care to follow appropriate procedure. This will help landlords and tenants agree as to how testing should be carried out. We encourage all parties to cooperate on friendly terms. In the event of a conflict, this checklist can also serve as evidence correct procedure was followed. This checklist is based on Health Canada's Guide for Radon Measurements in Residential Dwellings (Homes)(2017).

1. Obtain a C-NRPP Certified Testing Device

Testing devices should be designed to allow for 91-day tests.

If you are testing a multi-unit residential building and plan on deploying 10 detectors or more, Health Canada advises using duplicate measurements to ensure quality control. One duplicate should be deployed for each 10 detectors. Duplicate measurements are made by placing two detectors side-by-side (< 10 cm or 4 inches apart). In the case of multi-unit residential buildings, please ensure duplicated are placed evenly across units being tested.

To find testing devices visit https://takeactiononradon.ca/test/radon-test-kits/#local_1

To check whether the device is C-NRPP listed visit https://c-nrpp.ca/approved-radon-measurement-devices/

Company and product name of device_____

Serial or identification number_____

Is the device C-NRPP listed?_____

State how you know its C-NRPP listed? _____

Number of test devices deployed including duplicates for quality control _____

2. Place the Detector in Your Home

Choice of room

Place the radon detector in the normal occupancy area of the lowest lived-in level of the home.

You can test in bedrooms, hallways, living rooms, dining rooms and home offices.

Place the detector in a location where it is unlikely to be disturbed.

Do not test in bathrooms, kitchens, laundry rooms, closets, cupboards, sumps, crawlspaces or nooks within the foundation. These are locations where radon concentrations are likely to be different from other living spaces, or where people do not typically spend at least 4 hours per day

For basements, only test if

(a) the basement has finished rooms that are inhabited for four hours a day or more, such as bedrooms, playrooms, family rooms, or

(b) if it will be renovated for purposes where it will be inhabited for four hours a day or more.

Place the device in a basement area that is or will be used for more than 4 hours each day. If the basement does not have any areas where people spend more than 4 hours per day (i.e. work, play or sleep), then test on the main level.

Room(s) in which radon detector placed _____

Location in the room

The preferred device location is:

- near an interior wall at a height of the typical breathing zone, keeping within
- 0.8 to 2 m (3 to 6.5 feet) from the floor in the typical breathing zone.
- at least 50 cm (20 inches) from the ceiling and 20 cm (8 inches) from other objects so as to allow normal airflow around the detector.
- approximately 40 cm (16 inches) from an interior wall or approximately 50 cm (20 inches) from an exterior wall.
- Do not place the detector near heating, ventilating, and air-conditioning vents, doors, fans, windows, fireplaces, electrically powered equipment, television sets, stereos and speakers, or in direct sunlight. Air currents, sources of heat, and electrically powered appliances can affect some measurement devices.

Did placement conform to preferred device locations? Yes_____ No_____.

If No explain here:

Some detectors may have further instructions for placement.

Did the detector include further instructions on placement not yet mentioned on this checklist?

Yes_____ No_____

If so, please state what they are.

Did you follow those instructions? **Yes_____ No_____**

Further explanations if necessary.

3. Measurement Process

Health Canada recommends that every homeowner test their home for radon through the placement of at least one long-term detector for a minimum of 91 days (3 months). Ideally, this testing period should be when indoor radon levels are highest. In Canada, this is typically during the heating season from October to April, when homeowners keep windows closed for extended periods of time, and heating systems tend to create negative pressure, drawing more radon into the home.

Beginning the Test

Individual radon detectors have instructions for starting the test (such as removing from a bag).

Please state requirements of your device for beginning the radon test.

Did you follow the requirements? **Yes____ No._____**

It is important to record the date the radon test begun

Date Radon Test begun _____
Is your living space normally heated by this date? **Yes____ No____**

During the test

Generally, the measurement device should not be disturbed during the measurement period. Slight movements, such as moving a few inches to access a book, should not have a significant impact.

Was the measurement device moved during the measurement period? **Yes____No_____**

If so, please explain the movement.

Ending the test

Health Canada recommends at least 91 days (3 months), but in many cases longer tests are acceptable.

Date Radon Test ended _____

Individual radon detectors may have instructions for ending the test (such as placing into an envelope).

Please state requirements of your device for beginning the radon test.

Did you follow the requirements? **Yes____ No._____**

4. Acquiring and Interpreting Results

After the monitoring period is complete, return the detector to the certified radon professional or analytical laboratory for processing and evaluation of radon concentrations.

Was a certified radon professional involved? **Yes___ No____**

If so, name of certified radon professional_____

Did you send the radon detector to a laboratory? **Yes___ No____**

If so, name of laboratory or company handling testing_____

Radon Test Result. Average radon levels _____Bq/m³

(Note: The United States of America uses pCi/L and some laboratories will report results in pCi/L: Please convert units in pCi/L to Bq/m³. 1pCi/L equals 37 Bq/m³. Simply multiple the number in pCi/L by 37 to give the figure in Bq/m³. For example 5.4 pCi/L is equivalent = 200 Bq/m³)

Attach laboratory results if available

5.Signature

Your Name_____

Signature_____

Date_____

6. Declaration

If this form is to be used in legal proceeding (such as before the Residential Tenancy Branch), please consider having it notarized as follows:

I solemnly declare or make oath that I followed the procedure in this checklist, that I filled it in honestly, and the contents I have added are true.

Your Name_____

Signature_____

Date_____

Witness (fill in name and signature or stamp below)

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