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# Radon control options for new construction in low rise residential buildings

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## Introduction:

A recent Health Canada study in 2011 showed that there are no areas of Canada that are radon free. The level of radon in a completed home cannot be predicted; hence all homeowners need to test their homes for radon, ideally by conducting a long term test during the first heating season after completion of the home.

The Canadian radon guideline is 200 Bq/m$^3$. The application of the requirements of this standard do not guarantee that the Canadian guideline for indoor radon will be attained.

Many building codes address the need to mitigate potentially high radon levels by requiring a rough-in for future radon reduction in all new homes. There is a general consensus that the requirement for a radon rough-in does not go far enough to ensure occupant safety from radon.

The purpose of this standard is to provide technical recommendations for radon control measures in new low-rise residential buildings. The body of this standard outlines best practice knowledge to date of radon mitigation techniques, materials, products and installation. The data in Annex M (below) may be used to determine which areas of the country might be served best by each of the 3 Levels of protection from radon ingress described in this standard.

The practices outlined in this standard are intended for the use by a contractor or management teams among which at least one individual on site is specifically trained in the technology of radon reduction. Organizations such as the Canadian National Radon Proficiency Program (C-NRPP) can provide information on radon mitigation training for new construction.

The three levels of protection from radon ingress are:

Level 1 = rough-in for active soil depressurization,

Level 2 = full passive vertical radon stack, (Level 1 plus a stack)

Level 3 = full active soil depressurization system (Level 2 plus a fan).

Level 1 facilitates the future addition of a full passive or active system if the home tests high after occupancy.

Level 2 is a full passive radon reduction system which intermittently reduces indoor radon levels due to the stack effect and does not require electrical power. A Level 2 system will typically reduce radon levels by 50%

"Level 3 is the most effective radon reduction system, often reducing high radon levels in a home by 90% or more, but requires a fan to be operating continuously

While, most provinces and territories already require protection from radon similar to Level 1 in all homes, Level 2 and Level 3 requirements in this national standard are intended for higher risk areas. In areas where significant proportions of homes are likely to test above the 200 $Bq/m^3$ Canadian radon guideline, authorities may find it prudent to adopt either a Level 2 or Level 3 protection requirement in new construction.

An approximately 50% reduction in radon exposure offered by a properly implemented Level 2 (full passive vertical radon stack) system will result in a significant reduction in radon exposure and risk from radon-induced lung cancer whether homes are tested or not. A radon reduction of approximately 90% or more can be offered (in the case of high radon levels) by installing a Level 3 (full active (fan driven)) radon mitigation system.

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# Preface

This is the first edition of CAN/CGSB 149.11 *Radon Control Options for New Construction in Low Rise Residential Buildings.*

Compliance with this Standard will not guarantee that specific indoor radon concentrations will be attained.

This standard has been developed to apply to Canadian environments. While it may be appropriate for other jurisdictions, users are responsible for assessing its applicability.

This standard does not apply to radon control measures that have been installed prior to the effective date of this standard.

In reference to language, in this Standard, “shall” states a mandatory requirement, “should” expresses a recommendation and “may” is used to express an option or that which is permissible within the limits of this Standard. Notes accompanying clauses do not include requirements or alternative requirements; the purpose of a note accompanying a clause is to separate from the text explanatory or informative material.

# Radon control options for new construction in low rise residential buildings

## 1 Scope

This National Standard of Canada (NSC) addresses requirements for radon control in the design and construction of new, low-rise residential buildings. (see Definitions)

This standard provides design criteria, design tools, methods and techniques, and sample construction specifications to minimize radon entry into new homes prior to initial occupancy and prepare for future mitigation measures if deemed necessary after occupancy has occurred.

This standard specifically addresses mitigation techniques for radon emanating from soil gas sources.

**Exclusions:**
It does not address the mitigation techniques for radon from other sources. (see Annex D)

This Standard does not address the mitigation of radon in existing buildings (see 149.12 - Radon mitigation options for existing low rise residential buildings).

The testing and evaluation of a product against this standard may require the use of materials and/or equipment that could be hazardous. This standard does not purport to address all the safety aspects associated with its use. Anyone using this standard has the responsibility to consult the appropriate authorities and to establish appropriate health and safety practices in conjunction with any applicable regulatory requirements prior to its use. CGSB neither assumes nor accepts any responsibility for any injury or damage that may occur during or as the result of tests, wherever performed.

## 2 Normative references

The following normative documents contain provisions that, through reference in this text, constitute provisions of this method. The referenced documents may be obtained from the sources noted below.

NOTE The addresses provided below were valid at the date of publication of this standard.

An undated reference is to the latest edition or revision of the reference or document in question, unless otherwise specified by the authority applying this method. A dated reference is to the specified revision or edition of the reference or document in question. However, parties to agreements based on this method are encouraged to investigate the possibility of applying the most recent editions of the normative documents indicated below.

### 2.1 Canadian Standards Association

CAN/CSA-B181.1-96 – *ABS drain, waste, and vent pipe and pipe fittings*

CAN/CSA-B181.2-M87 – *PVC drain, waste, and vent pipe and pipe fittings*

CAN/CSA-B182.1-M92 – *Plastic drain and sewer pipe and pipe fittings*

#### 2.1.1 Source

The above may be obtained from the Canadian Standards Association, Standards Sales, 5060 Spectrum Way, Suite 100, Mississauga, Ontario, Canada L4W 5N6. Telephone 416-747-4044 or 1-800-463-6727. Fax 416-747-2510 Web site www.csa.ca.

### 2.2 ASTM International

ASTM D1785 – *Specification for poly (vinyl chloride) (PVC) plastic pipe, schedules 40, 80 and 120*

ASTM D2564 – *Standard specification for solvent cements for poly (vinyl chloride) (PVC) plastic piping systems*

ASTM D6392 - *Confirmed bonded seam strength testing*

ASTM E1465-08a – *Standard practice for radon control options for the design and construction of new low-rise residential buildings*

ASTM E1745 – *Standard specification for plastic water vapor retarders used in contact with soil or granular fill under concrete slabs*

ASTM E631 - *Terminology of building constructions*

ASTM E1465-08a - *Standard practice for radon control options for the design and construction of new low-rise residential buildings*

ASTM F628 - *Specification for acrylonitrile-butadiene-styrene (ABS) schedule 40 plastic drain, waste, and vent pipe with a cellular core*

ASTM F891 - *Specification for coextruded poly (vinyl chloride) (PVC) plastic pipe with a cellular core*.

ASTM C33/C33M – *Standard specification for concrete aggregates*

ASTM C920 – *Standard specification for elastomeric joint sealants.*

#### 2.2.1 Source

The above may be obtained from ASTM International, 100 Barr Harbor Drive, West Conshohocken, PA 19428-2959, U.S.A., telephone 610-832-9585, fax 610-832-9555, Web site www.astm.org, or from IHS Canada, 1 Antares Drive, Suite 200, Ottawa, Ontario K2E 8C4, telephone 613-237-4250 or 1-800-267-8220, fax 613-237-4251, e-mail gic@ihscanada.ca, Web site www.ihs.com.

### 2.3 Other Radon References

National Building Code of Canada 2015 Part 9

#### 2.3.1 Source

The above may be obtained from National Research Council, 1200 Montreal Road, M-23A, Ottawa, Ontario K1A 0R6, telephone 1-800-672-7990 or 1-613-993-2463, fax 1-613-952-7673, E-Mail CONSTPubSalesVentes@nrc-cnrc.gc.ca, Web site http://www.nrc-cnrc.gc.ca/eng/publications/codes_centre/2010_national_building_code.html.

## 2.4 UL Canada

ULC-S636-08 – *Standard for type BH gas venting system*

### 2.4.1 Source

The above may be obtained from IHS Canada, 1 Antares Drive, Suite 200, Ottawa, Ontario K2E 8C4, telephone 613-237-4250 or 1-800- 387-4408, fax 613-237-4251, e-mail gic@ihscanada.ca, Web site canada.ihs.com.

# 3 Terms and Definitions

For the purposes of this Standard, the following terms and definitions apply.

**3.1**
**active soil depressurisation (ASD)**
a group of radon mitigation systems involving fan-powered soil depressurization, including but not limited to the most common variant called sub-slab depressurisation, and other related techniques such as sub-membrane depressurisation (ex. crawl space depressurisation), block-wall depressurisation, and drain tile depressurisation. This fan-powered soil depressurization is employed to draw radon-bearing soil gas away from the foundation and safely exhaust it outdoors before it can enter a building.

NOTE ASD is the most effective way to reduce high radon levels in a building, with reductions of ≥90% or more being possible.

**3.2**
**ASD fan**
a type of fan that is designed and approved by the manufacturer for continuous duty and for use in an ASD system.

**3.3**
**as low as reasonably achievable (ALARA)**
an internationally recognized guiding practice employed in radiation protection.

NOTE ALARA indicates that radiation doses be reduced to as low a level as practical, with economic and social factors being considered. For additional information on ALARA please see http://nuclearsafety.gc.ca/pubs_catalogue/uploads/G129rev1_e.pdf and http://apps.who.int/iris/handle/10665/42973

**3.4**
**back-drafting**
the reverse flow of outdoor air into a building through the barometric damper, draft hood, burner unit, or fire box, as a result of chimney blockage or a pressure differential greater than can be drawn by the chimney.

NOTE Backdrafting can cause the products of combustion (odour, smoke, toxic gases, particulates) from fuel-fired appliances to be spilled back into the interior of a building. Cold backdrafting occurs when the chimney is acting as an air inlet but there is no burner operation. Hot backdrafting occurs when the hot flue gas products are prevented from exhausting by flue reversal. Also called flow reversal.

**3. 5**

**becquerels per cubic meter (Bq/m$^3$)**

SI unit of measure for the concentration of radioactivity in a volume of air.

NOTE One becquerel is one radioactive disintegration per second. The American unit that measures radon is pCi/L.

37 Bq/m$^3$= 1 pCi/L

**3.6**

**Canadian national radon proficiency program (C-NRPP)**

the national radon certification program used by laboratories, measurement and mitigation professionals in Canada.

NOTE Canadian National Radon Proficiency Program (C-NRPP) may provide designation to individuals or companies that have met qualification requirements or are authorized by a certification program to provide radon laboratory, measurement or mitigation services.

**3.7**

**Canadian radon guideline**

the indoor radon concentration at which mitigation is recommended, which was set at 200 Bq/m$^3$ , as established by Health Canada in 2007 (Canada Gazette Part I June 9$^{th}$ 2007).

3.8

**cold joint**

contact joint between the foundation wall and the basement slab or the parts of a slab that were poured at different times.

**3.9**

**communication testing**

the typical process whereby a radon mitigator makes diagnostic pressure measurements of the under slab area in order to properly size an ASD mitigation system.

NOTE Properly sizing an ASD mitigation system includes determining the type of fan(s) to be utilized, fan location, and number of required suction points.

**3.10**

**convective movement**

the bulk flow of radon-containing soil gas into the building as result of pressure differences between the building and the soil.

NOTE Also known as pressure driven airflow. To be distinguished from diffusive movement.

**3.11 continuous duty**

a motor that can continue to operate within the motor insulation temperature limits after it has reached normal operating temperature.

**3.12**

**crawl space**

shallow space between the lowest floor of a house and the ground beneath.

NOTE The crawl space can have a height ranging from a few inches to several feet (hence the origin of the term “crawl”). The crawl space may or may not be ventilated to the outdoors.

**3.13**
**depressurisation**
a negative pressure induced in one area relative to another.

NOTE In a building during cold weather, the lower levels experience depressurization due to the stack effect (buoyant forces acting on the warm air). The air pressure within the soil outdoors is also often higher than that in the basement which also acts to draw soil gas into the building.

**3.14**
**diagnostic tests**
procedures that typically include communication tests used to identify or characterize conditions under, beside and within buildings that could contribute to radon entry or elevated radon levels or that could provide information regarding the performance of a radon mitigation system.

**3.15**
building **entry points**
openings in the foundation floor or walls in contact with the soil, which allow soil gas to enter.

**3.16**
**exfiltration**
unintended flow of indoor air out of the building through holes or cracks in the building envelope.

**3.17**
**gas permeable layer**
the layer of gas permeable material installed under the basement sub-slab membrane which facilitates a negative pressure field to extend from the suction point to the foundation walls and footings.

NOTE An efficient gas permeable layer permits a radon reduction system to draw radon laden soil gas from the entire sub-slab area.

**3.18**
**geotextile drainage matting**
dimpled membrane typically made from a suitable polymer (which may be high-density polyethylene (HDPE) , polypropylene (PP), etc.) with non-woven geotextile pre-attached to the dimpled core to allow air movement.

NOTE The void space is created through a matrix of woven mesh, or “egg crate” support of a fabric enclosure, or hollow polymeric blocks, or other similar means. Also referred to as “Vent Strip”.

**3.19**
**habitable space**
any enclosed space that residents use or could reasonably adapt for use as living space within the building.

**3.20**
**infiltration**
unintended movement of outdoor air or soil gas into a building.

**3.21**
**low rise residential building**
building three storeys or less in , having a building area not exceeding 600m2.

**3.22**
**micromanometer**

a sensitive differential air pressure indicating device used to determine very small pressure differences across a boundary

NOTE Generally reads in units of Pascals (Pa)

**3.23 radon mitigation**

act of repairing or altering a building or building design for the purpose in whole or in part of reducing the concentration of radon in the indoor atmosphere.

**3.24**

**radon mitigation system**

a system, component, design or installation for reducing radon concentrations in the indoor air of a building.

**3.25**

**radon**

**mitigator**

qualified individual who reduces indoor radon concentrations, and is experienced in radon mitigation.

NOTE In Canada, the Canadian National Radon Proficiency Program (C-NRPP) maintains lists of mitigation professionals/companies that have met qualification requirements or are authorized to provide radon laboratory measurement or mitigation services

**3.26**

**neutral pressure plane**

that plane within the building envelope at which the pressure indoors equals the pressure outdoors.

NOTE During cold weather when the thermal stack effect is occurring, indoor pressure below the neutral pressure plane is lower than the pressure outdoors, so that outdoor air and soil gas may infiltrate the building. Above the neutral pressure plane, indoor pressure is higher than the pressure outdoors so that building air may exfiltrate the building.

**3.27**

**outdoor ambient radon level**

the concentration of radon naturally occurring in outdoor air.

NOTE The outdoor ambient radon level is typically in the 10-15 Bq/m3 range but varies locally depending on the prevailing geological conditions. [1]

**3.28**

**passive vertical radon stack**

feature of building construction whereby a full-height vertical pipe run is installed within the building with the inlet originating beneath the basement floor slab and the outlet terminating above the roof deck for the purpose of using the stack effect to depressurize the sub-slab space to exhaust radon containing soil gas without the use of a fan.

NOTE The passive radon stack allows one to exploit the natural stack effect within a building in order to draw radon containing soil gas from beneath the slab and expel it to the outdoors. This technique generally leads to radon reductions of less than 50% as compared to an active radon reduction system which can yield radon reductions of 90% or more. A passive radon stack is readily converted to an active system by the installation of an ASD fan, following appropriate diagnostic measurements to confirm the system design.

**3.29**

**pipe loop**

a continuous length of perforated pipe extending around the inside perimeter of the foundation.

**3.30**
**polyolefin**
any polymer produced from a simple olefin as a monomer.

NOTE example, polyethylene is the polyolefin produced by polymerizing the olefin ethylene Polypropylene is another common polyolefin which is made from the olefin propylene.

[1] (see R.L. Grasty, Summer Outdoor Radon Variations in Canada and Their Relation to Soil Moisture, Health Physics, Vol 66 No 2 pp 185-93, 1994).

**3.31**
**post-mitigation radon level**
the radon concentration measured within the habitable space of the building as a result of a long-term (3-month/90+ days) radon test conducted after radon mitigation work has been performed.

NOTE The radon level should be reduced to below the Canadian guideline value of 200 Bq/m$^3$ and in fact to ALARA. For most buildings it will be possible to reduce the radon level to below 100 Bq/m$^3$. It is recognized that it may not be possible to reduce radon levels below 100 Bq/m$^3$ in all buildings by following the best practices outlined in this standard. The 3-month test is ideally conducted during the heating season to give a conservative estimate of the radon reduction achieved

**3. 32**
**pressure field extension**
spatial extension of the area of reduced pressure as occurs under a slab when a mitigation fan ventilates at one or more distinct points.

**3.33**
**radon**
the only naturally occurring radioactive element which is a gas.

NOTE Technically, the term "radon" can refer to any of a number of radioactive isotopes having atomic number 86. In this document, the term is used to refer specifically to the isotope radon-222, the primary longest lived isotope present inside buildings. Radon-222 is directly created by the decay of radium-226, and has a half-life of 3.82 d. Chemical symbol : Rn-222.

**3.34**
**sill plate**
a horizontal framing member that lies flat on top of foundation wall and extends around the entire perimeter of the building.

NOTE The ends of the floor joists, which support the floor above the foundation wall, rest upon the sill plate. For slab-on-grade construction, the sill plate is the bottom plate of the wall.

**3.35**
**slab**
layer of concrete which commonly serves as the floor of any part of a building whenever the floor is supported on a foundation or is in direct contact with the underlying soil.

**3.36**
**slab on grade**
type of building construction where the bottom floor of a house is a slab which is at grade level on any side of the building.

**3.37**
**soil gas**

gas which is always present underground, in the small spaces between particles of the soil or in crevices inside the rock and consists mostly of air with some components from the soil (such as radon and water vapour).

**3.38**

**soil gas barrier**

a continuous membrane installed in order to reduce the flow of air containing radon gas into a building.

NOTE A soil gas barrier is often made of polyolefin, but other more radon-specific membranes have been developed. Other types of soil gas proof continuous layers of material are also possible.

**3.39**

**soil gas collection plenum**

a constructed enclosure for collecting radon and other soil gases from under a foundation.

**3.40**

**soil gas collector**

a gas permeable conduit constructed of gravel, perforated pipe, sub-slab ventilation panels or geotextile matting for collecting radon and other soil gases from within a soil gas collection plenum and connecting the plenum to the ASD pipe system.

**3.41**

**stack effect**

the vertical movement of air due to differences in indoor-outdoor air density that increases the buoyancy of the indoor air relative to that of the outdoor air. This difference occurs as a result of differences in indoor-outdoor temperature. The buoyancy forces driving stack effect increase with building height and temperature difference. In cold climates, stack effect tends to cause air to leak into the bottom of a building and out of the top.

**3.42**

**sub-membrane depressurization (SMD)**

radon mitigation technique designed to maintain lower air pressure in the space under a soil gas barrier membrane by use of an ASD fan drawing air from beneath the membrane. The technique is quite often used in crawl spaces.

**3.43**

**sub-slab depressurization (SSD)**

radon mitigation technique designed to maintain lower air pressure under a floor slab

NOTE Sub-slab depressurisation can be either active or passive. A passive system uses the natural stack effect to draw air from below the floor slab. .An active sub-slab depressurization system uses a fan installed in the radon system piping that draws air from below the floor slab.

**3.44**

**sub-slab ventilation panels**

a product similar to geotextile drainage matting in that it allows for effective depressurization of the sub-slab area but may also incorporate additional features such as providing insulation value

**3.45**

**suction point**

location where the soil gas collector is connected to the ASD system piping.

**3.46**

**top voids, block voids, voids**

air space(s) within masonry walls made of concrete block or cinder block.

NOTE Top void specifically refers to the air space in the top course of such walls; that is, the course of block to which the sill plate is attached and on which the walls of the building rest. The top course of such walls needs to have filled or sealed blocks so that no void is present.

**3.47**
**ventilation rate**

rate of movement of outdoor air through a building's exterior envelope via intended leaks or openings, both inward and outward (infiltration and exfiltration).

NOTE Ventilation is commonly expressed in units of air changes per hour, litres per second, or cubic feet per minute

NOTE The ventilation rate depends on the tightness of the building shell, weather conditions, and the operation of appliances (such as fans) influencing air movement commonly expressed in terms of air changes per hour. The ventilation system of a building should be designed to balance exhaust and fresh air flows.

## 4 Abbreviations

| | |
|---|---|
| ABS: | Acrylonitrile Butadiene Styrene |
| ALARA: | As Low As Reasonably Achievable |
| ASD: | Active Soil Depressurization |
| ASTM: | American Society for Testing and Materials |
| ATD: | Alpha Track Detector |
| CGSB | Canadian General Standards Board |
| C-NRPP | Canadian – National Radon Proficiency Program |
| CRM: | Continuous Radon Monitor |
| DTD: | Drain Tile Depressurization |
| EIC: | Electret Ion Chamber |
| HVAC: | Heating, Ventilation and Air Conditioning |
| HRV: | Heat Recovery Ventilator |
| MSDS | Material Safety Data Sheets |
| NBC: | National Building Code (of Canada) |
| PFE: | Pressure Field Extension |
| PVC: | Polyvinyl Chloride |
| QA: | Quality Assurance |
| QC: | Quality Control |

| | |
|---|---|
| RH: | Relative Humidity |
| SCH: | Schedule (as in pipe size) |
| SDR : | Standard Dimension Ratio |
| SMD: | Sub-Membrane Depressurization |
| SSD: | Sub-Slab Depressurization |

*For additional information, see Annex K*

# 5 Classification

Level 1 construction provides minimum protection and provides provisions for a radon rough-in stub, as well as provisions for sealing soil gas entry points. Level 1 is not a complete radon reduction system, but allows for easier conversion to one in the future, should it become necessary.

Level 2 construction provides moderate protection and includes all provisions of Level 1, with the addition of extending the pipe stub to create a full, vertical passive (without a fan) radon stack system that runs upwards through the inside of the building shell and vents above the roof. Level 2 is a complete passive soil depressurization radon reduction system.

Level 3 construction provides maximum protection and includes all provisions from Levels 1 and 2, with the addition of a radon fan to create an active soil depressurization system (ASD). Level 3 is a complete radon reduction system. For active soil depressurization systems, a radon fan draws air up the vent stack to depressurize the gas-permeable layer. A fan driven ASD system will usually lead to greater radon reductions than the passive system described above.

NOTE Classification of areas of radon risk is beyond the scope of this standard. Indoor radon levels cannot be predicted prior to the construction and occupancy of a new home, therefore every new home needs to be tested. Annex M provides some data that may help authorities to determine which areas of Canada may be best served by the 3 levels of radon protection (Level 1 = rough-in for active soil depressurization, Level 2 = full passive vertical radon stack, Level 3 = full active soil depressurization system) described in this standard.

# 6 General requirements

## 6.1 Determination of radon risk

### 6.1.1 Pre-construction assessment

Presently there are no protocols, standards or guidelines which address building site characterization for radon risk. This is due to the fact that the level of radon in a completed home or building cannot be predicted prior to construction.

This Standard outlines three levels of basic construction, see Section 6.2, one of which shall be implemented during the construction phase to either reduce radon ingress and prepare the building for radon mitigation at a future date (Level 1) or to further reduce radon levels in the new building (Level 2 or Level 3).

## 6.2 Basic construction

### 6.2.1 Level 1 - Rough-in for active soil depressurization

Level 1 provides provisions for a radon rough-in stub, as well as provisions for sealing soil gas entry points. Level 1 is not a complete radon reduction system, but allows for easier conversion to one in the future, should it become necessary. The radon protection measures in building units built to Level 1 shall be designed and constructed according to Section 7.1, 8.1.1, 8.2, and 8.3.

### 6.2.2 Level 2 - Full passive vertical radon stack

Level 2 includes all provisions of Level 1, with the addition of extending the pipe stub to create a full, vertical passive radon stack system that runs upwards through the inside of the building shell and vents above the roof. Level 2 is a complete passive soil depressurization radon reduction system. The radon protection measures in building units built to Level 2 shall be designed and constructed according to Section 7.2, 8.1.2, 8.2, and 8.3.

NOTE 1 For soil depressurization systems, when air in the vent stack is warmer than that outdoors, the buoyancy forces inside the stack cause the gas-permeable layer to be depressurized. This is a complete passive (without a fan) radon reduction system that also allows for easy conversion to an active (fan powered) soil depressurization system in the future, should it become necessary. The section of the stack that runs through the attic should be insulated to preserve the momentum of the stack effect and a hardwired receptacle should also be installed to facilitate conversion to Level 3 (activation by a radon fan) if required.

NOTE 2 Should long-term testing after completion and occupancy find high radon levels please refer to 149.12 Standard Radon mitigation options for existing low rise residential buildings

### 6.2.3 Level 3 - Full active soil depressurization system

Level 3 includes all provisions from Levels 1 and 2, with the addition of a radon fan to create an active soil depressurization system (ASD). Level 3 is a complete active radon reduction system. For active soil depressurization systems, a radon fan draws air up the vent stack to depressurize the gas-permeable layer. A fan driven ASD system will usually lead to greater radon reductions than the passive system described above. The radon protection measures in building units built to Level 3 shall be designed and constructed according to Section 7.3, 8.1.3, 8.2, and 8.3.

NOTE Should long-term testing after completion and occupancy find high radon levels please refer to 149.12 Standard Radon mitigation options for existing low rise residential buildings

## 6.3 Construction features which bear special consideration

In new construction there are several possible features which may not be common in new construction but that bear special consideration from a radon ingress standpoint. See Annex N for more details.

# 7 Detailed requirements

## 7.1 Level 1 - Rough-in for active soil depressurization

### 7.1.1 Subfloor environment

**7.1.1.1** A layer of gas-permeable material shall be provided under all concrete slabs within the building footprint.

**7.1.1.2** The gas-permeable layer shall conform to the following:

**7.1.1.2.1** Vertical pipe and conduit runs are permitted to pass through the gas-permeable layer.

**7.1.1.2.2** Horizontal runs of utility pipe and conduit shall be installed below the gas-permeable layer and shall not interfere with effective depressurization and any sub-slab construction.

**7.1.1.2.3** Where aggregate is used as the gas permeable layer, course clean granular material shall be provided on the undisturbed soil to a depth not less than 10 cm (4”). Aggregate shall contain no more than 10% of material that will pass a 4 mm (5/32”) sieve.

NOTE There may be other ways to achieve depressurization under the slab for example using inert, non-toxic, non-biodegradable, structural materials crushed concrete, pervious concrete, and post-industrial or post-consumer materials such as crushed glass. It should be noted that the materials providing depressurization may also fulfill other functions in the building envelope. If other structural materials aside from aggregate are used, they shall not have sharp edges in order to minimize the risk of puncturing the soil gas barrier membrane from underneath. Other substitutes for sub-slab aggregate should not pose a puncture risk to the sub-slab membrane.

**7.1.1.2.4** Where sub-slab ventilation panels are included in the building design as a substitute for aggregate, the panels shall be placed on undisturbed soil or on compacted base following engineering design. Panels shall allow the lateral flow of soil gases to the system’s suction point and shall have an interconnected void area of not less than that of the aggregate being substituted.

**7.1.1.2.5** Where a uniform layer of geotextile drainage matting is included in the building design as a substitute for aggregate, it shall be placed over a minimum of 10 cm of sand. The uniform layer of geotextile drainage matting used shall allow the lateral flow of soil gases to the system’s suction point fitting and shall have an interconnected void area of not less than that of the aggregate being substituted.

### 7.1.2 Soil gas collector and suction points

**7.1.2.1** A soil gas collector shall consist of a gas permeable layer and a collection system

NOTE In a typical installation the soil gas collector may consist of gravel as the gas permeable layer, a pipe construction to collect the soil gas and to conduct it into the suction point. The soil gas collector would be sealed with a soil gas barrier that protects the building against radon ingress or - in the case of an active system – minimizes the depressurization of the building due to the suction created by the radon fan.

**7.1.2.2** Each building shall be provided with a separate suction point and soil gas collector.

**7.1.2.3** Pipe used for the construction of the soil gas collector shall meet specifications as per 7.1.3.

**7.1.2.4** Each suction point shall consist of a single pipe installed that extends from the bottom of the sub-floor environment to not less than 150 mm above the finished floor slab.

NOTE The top end of the vertical pipe extension of the suction point (stub) should ideally be located in a mechanical room

**7.1.2.4.1** The vertical pipe extension, or riser of the suction point described in clause 7.1.2.2. shall be made of solid pipe and provided with a permanent style sealed cap that is securely glued on to the top opening of the pipe in order to prevent radon present in the sub-slab area from entering the building.

**7.1.2.4.2** The vertical pipe extension of the suction point described in clause 7.1.2.2. shall be clearly labelled as being for radon removal.

NOTE A single suction point may suffice for slab areas up to 280 m² (3000 sq feet). However the number of suction points required in any individual building will need to be determined based on the actual footprint and geometry of the sub- slab area of the building, and the communication capacity within the gas permeable barrier layer. It is important that the number of suction points required is established by trained individuals (ex. architects, engineers and professionals that hold a C-NRPP designation for Controlling Radon in New Homes in Canada).

**7.1.2.5** Each building shall be provided with at least one suction point and soil gas collector.

**7.1.2.6** A soil gas collector shall be provided with at least one suction point for each sub-slab area that is confined by the surrounding footings or be connected to another soil gas collector served by one or more suction points. See figure 7.1.2.7 Possible Interconnection of Two Gas Permeable Layers as one possible example below.

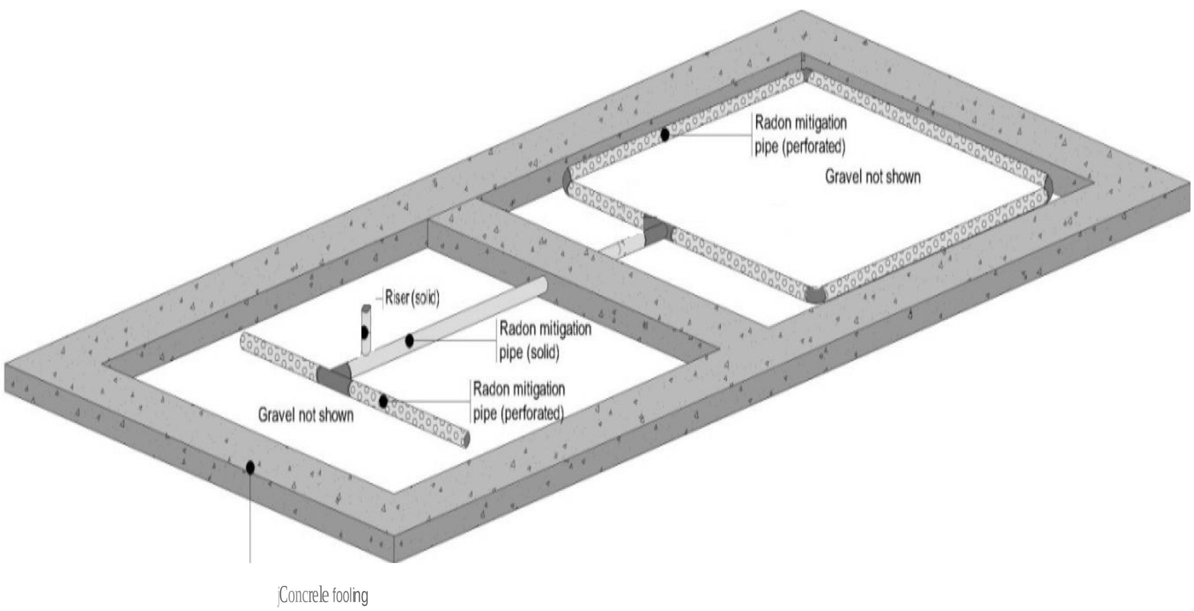
**7.1.2.6.1** A soil gas collector shall be constructed using 100 mm (4”) nominal internal diameter piping or tubing that extends into the gas-permeable layer and shall be located near or be oriented in the direction of the center of building, or per manufacturer’s instructions if using an alternative soil gas collection system.

NOTE If only using the solid horizontal radon mitigation pipe shown in Figure 7.1.2.7, it can be of varying length and this allows the vertical riser outlet stub portion above the slab to be positioned in a wide variety of locations. The inlet of the solid horizontal radon mitigation pipe located beneath the slab should be near the center of the floor slab.

**7.1.2.6.2** The pipe length used for the soil gas collector buried in the gravel subfloor, shall not be less than 3 m for every 46 $m^2$ of the building footprint or per manufacturer’s instructions if using a alternative soil gas collection system.

**7.1.2.7** For a soil gas collector with a gravel subfloor, the pipe shall be installed in one of the configurations shown in Figure 7.1.2.7 below entitled Possible Interconnection of Two Gas Permeable layers.

Figure 7.1.2.7- Possible Interconnection of Two Gas Permeable Layers



**7.1.2.7.1** Where a pipe loop is used as a soil gas collector, a tee fitting or pipe saddle installed as part of the loop shall be used as the suction point. The suction point riser will be made of solid pipe. If using a capped rough-in pipe stub only, care should be taken not to insert the bottom end (inlet) of the pipe too deeply down into the gas permeable layer in order to avoid creating undue flow restrictions.

**7.1.2.7.2.** The pipe loop shall consist of perforated pipe installed not less than 45 cm (16”) o.c. from the inside perimeter of the foundation or footings to form a continuous loop, except to avoid obstacles.

**7.1.2.7.3** A communication test may be performed to confirm the selected suction point is suitable. For more information on communication testing, please refer to Annex J.

**7.1.2.8** For a soil gas collector with sub-slab ventilation panels, the pipe shall be installed according to the manufacturer’s instructions.

**7.1.2.9** For a soil gas collector with a geotextile drainage matting, the system shall be installed according to the manufacturer’s instructions.

**7.1.2.10**

If an ASD suction point inlet is installed on a sump pit cover, the sump pit cover shall be fitted with a leak proof seal, and a leak-proof flexible decoupler shall also be provided to ensure that the inlet of the ASD system can be disconnected to allow for servicing of the sump area. See Annex N

### 7.1.3 Pipe and fittings

**7.1.3.1** The following are the minimum requirements for permitted pipe used in the construction of soil gas collector and suction points.

**7.1.3.1.1** Pipes shall have a nominal internal diameter of not less than 10 cm (4”).

**7.1.3.1.2** The pipe material shall be resistant to the service environment or shall comply with 7.1.3.2.

**7.1.3.1.3** PVC pipes installed completely or in part above grade shall comply with Schedule 40 specifications regarding wall thickness, inside and outside diameters and pressure ratings.

**Note: Where possible,** radon pipe should have a different color or identifying markings than pipes used for drain, waste and venting.

**7.1.3.1.4** Where vertical pipe is installed in the cavity of a wood-frame or steel-frame wall, the top and bottom plates and any horizontal framing members (such as blocking) shall have hidden steel shield plate installed to protect the pipe.

**7.1.3.1.5** Horizontal pipe runs shall be minimized.

Note: If horizontal runs are required it is suggested that 22.5 degree fittings be used so that the stack momentum is maintained.

**7.1.3.1.6** Where horizontal pipe runs are necessary, pipes shall be supported as required by the local plumbing code for DWV piping

**7.1.3.1.7** Pipes shall be installed so as to minimize exposure to cold temperature and shall be insulated where located in unconditioned space.

**7.1.3.1.8** Horizontal pipes above and below ground shall be installed with at least a 1% slope to return water to the soil or according to Table 7.1.3.1.8.A

**Table 7.1.3.1.8.A**

| Nominal Pipe Size (ID) | **Recommended Gradient** | | |
|---|---|---|---|
| | @10 L/s | @25 L/s | @ 50 L/s |
| 100 mm | 1/100 | 1/50 | 1/30 |

**7.1.3.1.9** The application of glues, cements, priming materials and pipe materials shall be selected according to the manufacturer's requirements for the applicable site conditions and service environment. All pipes, fittings, primer and cement products used in the same soil collector and suction point system shall be compatible.

### 7.1.3.2 Acceptable pipe and fitting specifications

Where the pipe material conforms to one of the following standards, it shall be deemed to comply with Clause 7.1.3.1.2 of this standard.

**7.1.3.2.1** PVC Flue Gas Venting pipe and fittings shall meet the requirements of ULC S636 and all pipe, fittings and cement must come from one manufacturer and the cement shall conform to manufacturer's specification and be adequate for the application conditions.

**7.1.3.2.2** Pipe materials shall conform to one of the following standards: ASTM F891 "*Specification for coextruded poly (vinyl chloride) (PVC) plastic pipe with a cellular core*" or CSA B181.1 "*ABS drain, waste, and vent pipe and pipe fittings*" or ASTM F628 "*Specification for acrylonitrile-butadiene-styrene (ABS) schedule 40 plastic drain, waste, and vent pipe with a cellular core*"

**7.1.3.2.3** Pipes and fittings described in 7.1.3.2 shall be joined with products meeting the requirements of the respective pipe manufacturer.

**7.1.3.2.4** Primer shall be applied where required.

**7.1.3.2.5** PVC Building Drain Sewer Pipe shall meet the requirements of CSA B182.1 and shall conform to SDR 35 specifications. Fittings shall be made of PVC and conform to the requirements of CSA B182.1. Pipes and Fittings shall be joined with PVC solvent cement meeting manufacturer's specification and application conditions. This pipe shall only be used for below ground applications unless otherwise specified by the local authority.

**7.1.3.2.6** Other types of piping not mentioned in this standard shall meet or exceed the minimum performance criteria specified in Clauses 7.1.3.1.1 and 7.1.3.1.2

### 7.1.4 Sealing the soil gas collector

**7.1.4.1** The soil gas collector and all exposed soil shall be covered with a soil gas barrier.

NOTE Ideally a soil gas barrier should be covered with a concrete slab.

**7.1.4.2** Soil gas barriers installed over an exposed dirt crawlspace shall conform to Section 7.1.4.4.

**7.1.4.3** Soil gas barriers installed under a concrete slab shall conform to Section 7.1.4.5.

#### 7.1.4.4 Soil gas barriers over exposed dirt crawlspaces

**7.1.4.4.1** An exposed dirt crawlspace shall be covered with a polyolefin soil gas barrier at least 10 mil thick. Thicker membranes may be required to cover an exposed dirt crawlspace depending on the intended use of the crawlspace area, for example if the area will be used for storage and have regular foot traffic.

**7.1.4.4.2** In the case of an exposed dirt crawlspace, a piece of pipe should be placed on the dirt floor prior to installing the soil gas barrier membrane over the dirt crawlspace.

NOTE The intention of having the piece of pipe under the membrane is to ensure that a volume or headspace is created under the membrane which acts as a soil gas collector and can be effectively depressurized rather than acting as a vapour barrier.

**7.1.4.4.3** The soil gas barrier installed over a dirt crawlspace shall be completely sealed and clamped to the foundation wall using a suitable method of adhesion so that it completely separates the soil gas collector from the building, and constructed in a matter that prevents soil gases from entering the structure.

**7.1.4.4.4** All joints in the sheets of polyolefin soil gas barrier covering a dirt crawlspace shall be lapped by 300 mm and sealed using a compatible sealant as required by the local building code.

**7.1.4.4.5** Any tears, punctures or other deficiencies in a soil gas barrier covering a dirt crawlspace shall be repaired and sealed using compatible materials.

**7.1.4.4.6** Any openings in the soil gas barrier covering a dirt crawlspace for plumbing, utilities, and structure shall be sealed using compatible materials.

**7.1.4.4.7** Although it is possible to connect the area under the soil gas barrier covering a dirt crawlspace to either a passive (Level 2) or an active (Level 3) radon stack by having a 100 mm nominal internal diameter Sch 40 pipe properly sealed where the inlet of the pipe passes through the soil gas barrier, and by connecting the outlet of the Sch 40 pipe to the Sch 40 radon stack using an approved coupler, a dirt crawlspace will be effectively depressurised when connected to an active system (Level 3) as opposed to a passive system (Level 2).

See **Figure 7.3.4.d.**

#### 7.1.4.5 Soil gas barriers under concrete slabs

**7.1.4.5.1** The soil gas barrier material used under a concrete slab shall be 10 mil thick polyethylene or equivalent polyolefin, be gas and puncture resistant,

**7.1.4.5.3** The soil gas barrier shall completely separate the soil gas collector from the building and be constructed in a matter that minimizes soil gases from entering the structure.

**7.1.4.5.4** Any tears, punctures or other deficiencies in a sub-slab membrane shall be sealed prior to concrete being placed.

**7.1.4.5.5** The soil gas barrier shall be sealed in one of the following two manners:

7.1.4.5.6 The soil gas barrier shall be extended along the edges of the slab to above the concrete slab and shall be sealed and clamped to the foundation wall with appropriate sealant prior to the concrete slab pour. See Figure 7.1.4.5.6 below.

NOTE Damp proofing/capillary break shown in Fig 7.1.4.5.6 below is not a current code requirement but may be regarded as a best practice

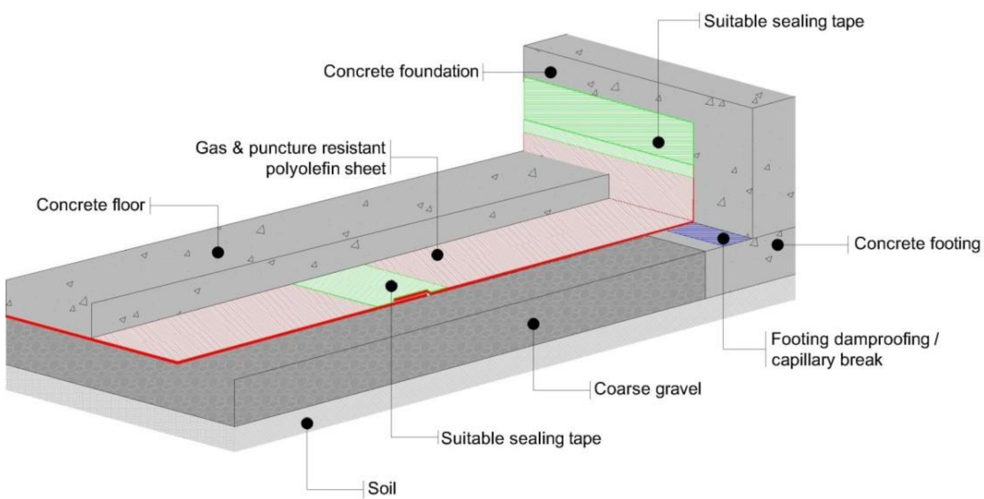



**Figure 7.1.4.5.6 – Sealing Sub-Slab Membrane Vertically to Concrete Foundation Wall**

7.1.4.5.7 The soil gas barrier shall be sealed to the horizontal footings using appropriate sealing tape prior to the concrete slab pour. See Figure 7.1.4.5.7 below

NOTE Damp proofing/capillary break shown in Fig 7.1.4.5.7 below is not a current code requirement but may be regarded as a best practice

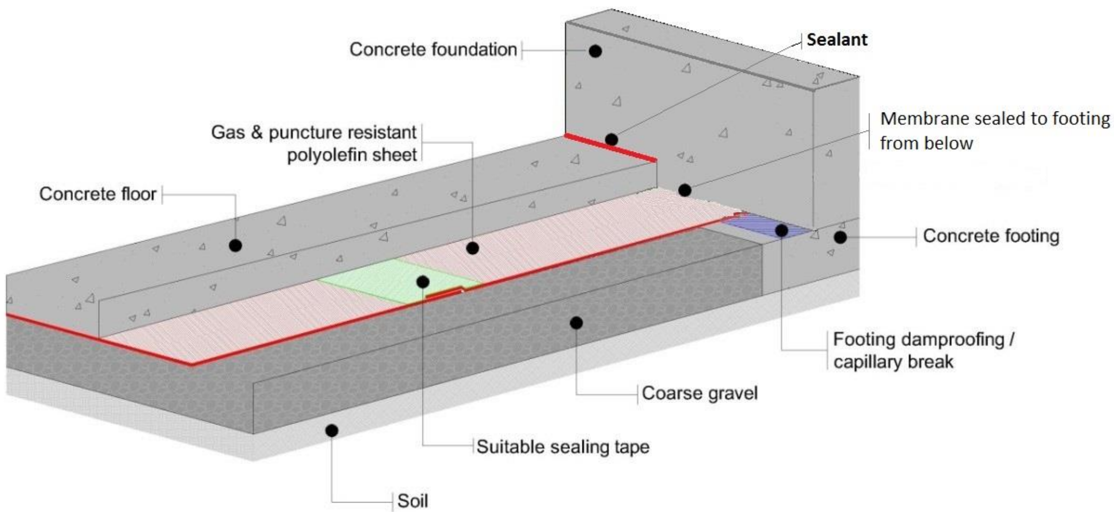



**Figure 7.1.4.5.7- Sealing Sub-Slab Membrane Horizontally to Concrete Footing Prior to Slab Pour and of the Slab/Wall Expansion Joint After the Slab Pour**

(I modified Fig 7.1.4.5.6 to remove the membrane running up the foundation wall and sealing here is shown both of the sub-slab membrane with tape to the footing prior to the slab pour and of the slab/ foundation expansion joint above after the slab pour)

**7.1.4.5.8** Where insulation is extended between the foundation wall and the floor slab, the soil gas barrier shall be installed behind the insulation and sealed and clamped to the foundation wall above the slab. See Figure 7.1.4.5.8 below.

NOTE Damp proofing/capillary break shown in Fig 7.1.4.5.8 below is not a current code requirement but may be regarded as a best practice

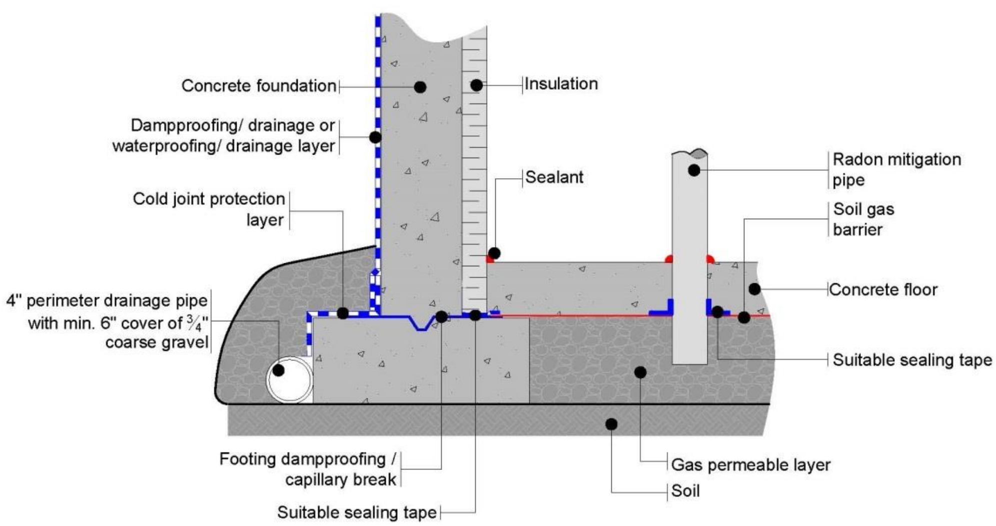



**Figure 7.1.4.5.8- SealingSub-Slab Membrane Horizontally to Concrete Footing When Insulation is Between the Foundation Wall and Floor Slab**

**7.1.4.5.9** Where the foundation is concrete or masonry, and where the slab meets another portion of the slab or the foundation wall, the soil gas barrier shall be lapped and clamped or otherwise be completely sealed with a sealant that is compatible and adheres to the substrates to which it is applied. Where necessary, a primer shall be used as required by manufacturer’s instructions.

**7.1.4.5.10** Openings in the soil gas barrier for plumbing, utilities, and structure shall be sealed. Any tears or punctures shall be sealed using compatible materials.

**7.1.4.5.11** Where rigid insulation sheet is installed under the concrete slab and does not meet the material requirements for a soil gas barrier and is not sealed as a soil gas barrier, a polyolefin sheeting shall be installed above the rigid insulation.

**7.1.4.5.12** All joints in the soil gas barrier shall be lapped by 300 mm and sealed using a compatible sealant.

**7.1.4.5.13** The concrete slab and foundation wall shall be installed, caulked and sealed at all joints, intersections, and penetrations as required by the local building code.

### 7.1.5 Sealing entry points in the slab

**7.1.5.1** **The sealed sump cover** shall be provided with rigid lids that are hermetically sealed with a gasket or silicone caulking, or be mechanically fastened which could be purchased or fabricated. Any penetrations through the lid shall be sealed. Where the sump basin penetrates the slab, the joint between the slab shall be sealed with a compatible sealant.

**7.1.5.2** Floor drains, condensate drains, and foundation drains shall be designed and installed to ensure all drains maintain a water-tight seal in the trap.

**7.1.5.3** Openings through the slab for plumbing fixtures (for example bathtub or shower cutouts) shall be sealed to isolate from the building framing, and to prevent leakage into the conditioned space from sub-slab or crawlspace areas.

**7.1.5.4** Other penetrations through the slab, including access openings, shall be designed and installed to prevent the ingress of soil gas.

**7.1.5.5.** The sealing of entry points is permitted to be constructed with manufactured polymeric/rubber elements used to enclose components where they penetrate the basement slab such as posts, columns, or pipes.

NOTE A good seal around the membrane and slab to reduce radon ingress is obtained using the process as shown in the UK's Building Research Establishment (BRE) BR 211-Radon-Guidance on protective measures for new buildingsBuilding (2015 Edition) guidance document in Fig 25 and Fig 26 p 18. Seals may also be fabricated on-site using appropriately cut, shaped, overlapped and taped pieces of membrane material. Care should be taken in the case of teleposts since these are often hollow and have open adjustment holes inside the basement which may present an unusual entry path for radon

### 7.1.6 Sealing entry points in the foundation

**7.1.6.1** For foundation walls constructed of hollow masonry units, the top course shall be made of solid masonry units or shall be fully grouted. In addition, the top course under door and window openings shall also be solid masonry units or fully grouted.

**7.1.6.2** Other penetrations through foundation walls shall be sealed with appropriate materials.

### 7.1.7 Radon testing devices

**7.1.7.1** A C-NRPP certified listed and approved long-term radon testing device and testing instructions shall be provided to the homeowner at the time of occupancy.

NOTE For more information, please refer to Appendix I. It is recommended that a long-term radon test should be conducted during the first heating season after occupancy.

A schematic of a Level 1 rough-in for active soil depressurization is shown below in Figure 7.1a Level 1-Rough –In for Active Soil Depressurisation

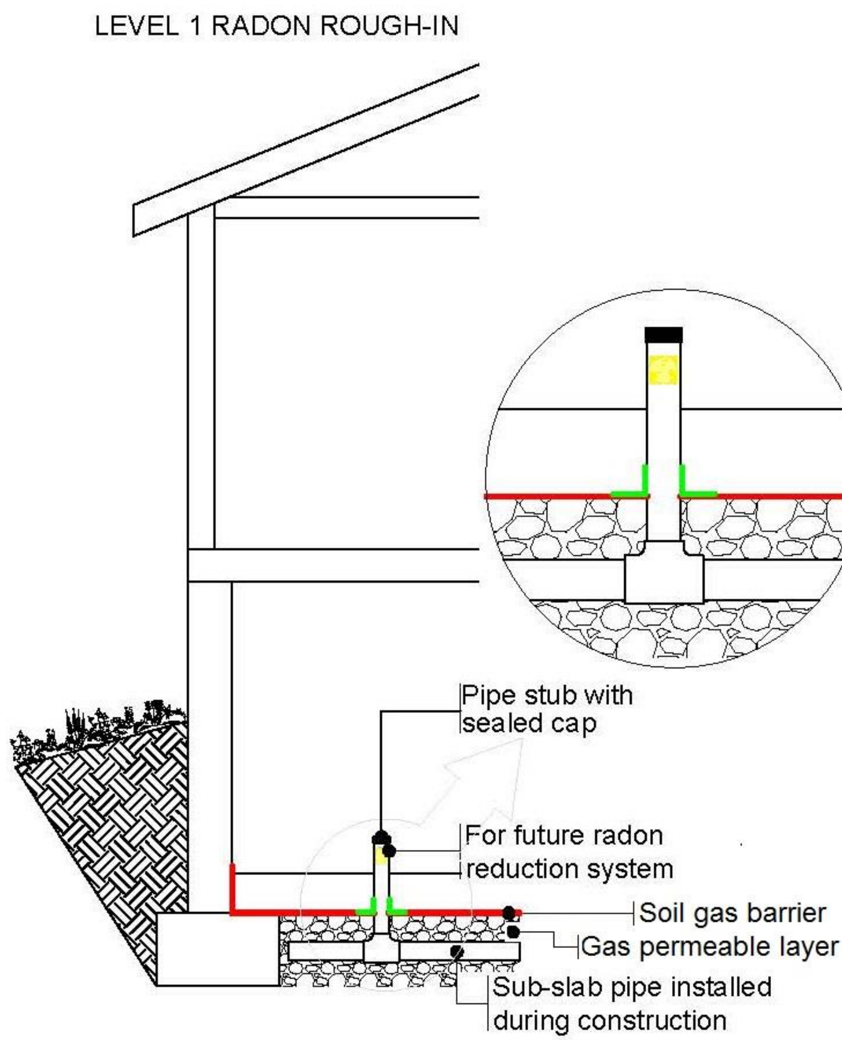



**Figure 7.1a - Level 1 - Rough-In For Active Soil Depressurization**

## 7.2 Level 2 - Full passive vertical radon stack

### 7.2.1 Includes level 1

**7.2.1.1** The construction for a full passive vertical radon stack (Level 2) requires compliance with the provisions of Section 7.1 (Level 1) in addition to the requirements in Section 7.2.

### 7.2.2 Passive stack

**7.2.2.1** The radon rough-in stub, as described in Section 7.1 (Level 1) shall be extended vertically and terminated outdoors, as required in Sections 7.2.4. and 7.2.5.

NOTE The system relies on the naturally occurring stack effect to draw radon containing soil gas from beneath the slab and exhaust it outdoors in order to further reduce indoor radon levels. The discharge should ideally be above the highest roof line in order to maximize the height of the stack which in turn should lead to greater radon reductions.

**7.2.2.2** Wherever possible passive stacks shall be installed in the vertical direction. If necessary, horizontal offsets in the passive stack shall be made with 22 ½ degree fittings.

**7.2.2.3** The portion of the passive stack passing through habitable space shall be located within walls <u>that are completely surrounded by</u> conditioned space.

**7.2.2.4** The portion of the passive stack passing through unconditioned space (i.e. the attic) shall be located such that sufficient space is available to allow for future installation of an active system.

NOTE Generally, 1 m of space in each direction including vertically, is sufficient to cut the pipe and install a fan.

**7.2.2.5** The section of the passive stack passing through unconditioned space (i.e. an attic) shall be insulated to a minimum thermal resistance of 2.47 $m^2K/W$ (R 14) to maintain the stack effect flow momentum and to minimize condensation on the inside of the pipe.

**7.2.2.6** Installation of a branch circuit receptacle shall be located in the attic within 1.8 m of the portion of the passive stack passing through the attic.

NOTE This is to facilitate a future fan installation if required

### 7.2.3 Pipe

**7.2.3.1** Pipe shall conform to section 7.1.3.

**7.2.3.2** The entire pre-assembled portion of the radon passive stack to be installed within the conditioned space of the building shall be tested for leaks by either one of two methods described in 7.2.3.2.1 or 7.2.3.2.2.

**7.2.3.2.1** The standard hydraulic test consists of capping the bottom end of the passive stack column and filling it with water from the top end. The pipe system shall be visually inspected for leaks while the water level is maintained for 15 minutes.

NOTE Standard hydraulic tests for determining leak tightness of pipe assemblies are documented in best practice guidance documents or in the applicable National or Provincial Plumbing Codes

**7.2.3.2.2** The standard air pressure test consists of pressurizing the passive stack sealed at both ends to 5 psi. The pressure shall be maintained for 15 minutes and the pipe system shall be inspected for pressure loss by conducting a soap test on each joint.

NOTE Standard air pressure tests for determining leak tightness of pipe assemblies are documented in best practice guidance documents or in the applicable National or Provincial Plumbing Codes

### 7.2.4 Mitigation system termination

**7.2.4.1** The passive stack for the radon reduction system shall terminate outdoors.

**7.2.4.2** The passive stack for the radon reduction system shall be installed in such a position to prevent ice accumulation or hazardous falling of ice onto walkways or the accumulation of frost onto adjacent properties or surfaces.

**7.2.4.3** The passive stack for the radon reduction system shall be installed in such a position that it will not be covered with snow or other materials from adjacent roofs and gutters.

**7.2.4.4** Where possible, the discharge pipe shall discharge above the highest roofline.

7.2.4.5 A passive stack shall not be installed as a side-wall discharge near ground level. The vertical height of such a stack is not sufficient for it to be functional.

NOTE The length of the vertical section of the passive stack passing thru the unconditioned attic space will require sufficient insulation in order to maintain the stack driving force obtained by the portion of the vertical stack passing through the conditioned space of the building envelope.

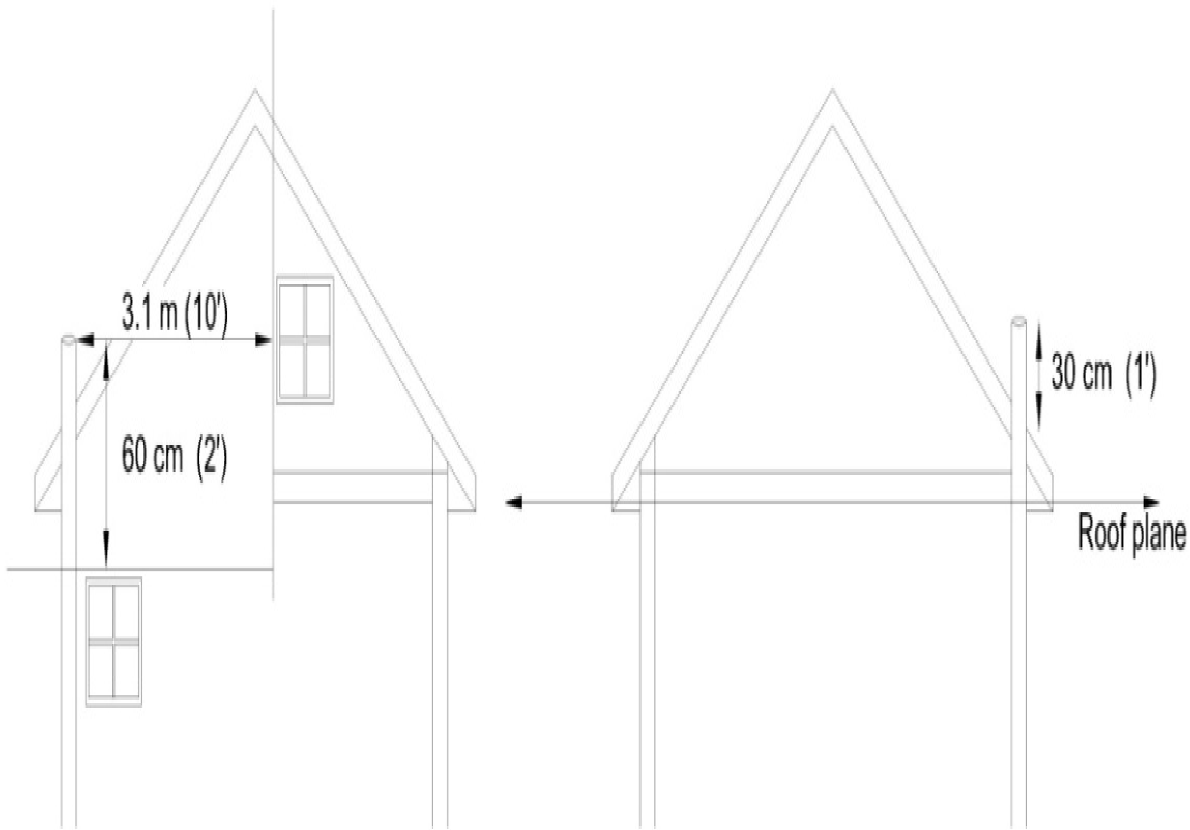
**7.2.4.6.** The exterior pipe termination of the passive stack terminated above the roof top shall be directed vertically conforming to Table 7.2.4.6. and Figure 7.2.4.6

**Table 7.2.4.6. Minimum Passive Radon Stack Termination Clearances for Roof Top Discharge**

| **Location** | **Minimum Dimension** |
|---|---|
| Vertical clearance above the roof at the point of penetration | 0.30 m |
| Vertical clearance above windows or doors | 0.60 m |
| Vertical clearance above mechanical air supply inlet (air intake) | 0.90 m |
| Horizontal clearance from windows, doors or mechanical air supply inlet | 3m |
| Clearance horizontally from a vertical wall that extends above the roof penetrated | 3m |

**Figure 7.2.4.6 – Illustration of Rooftop Passive Stack Discharge Geometry**




### 7.2.5 Future system activation provisions

**7.2.5.1** A cylindrical space of height not less than 1200 mm and a diameter not less than 500 mm shall be provided for the future installation of a radon active soil depressurization (ASD) fan in accordance with 7.3.2.

**7.2.5.2** A boxed electrical receptacle outlet on a branched circuit shall be located within 1.8 m of the future fan location described in Clause 7.2.5.1.

**7.2.5.3** Access shall be provided for the future fan location for installation and replacement purposes.

See Figure 7.2b Level 2 -Full Passive Vertical Radon Stack below

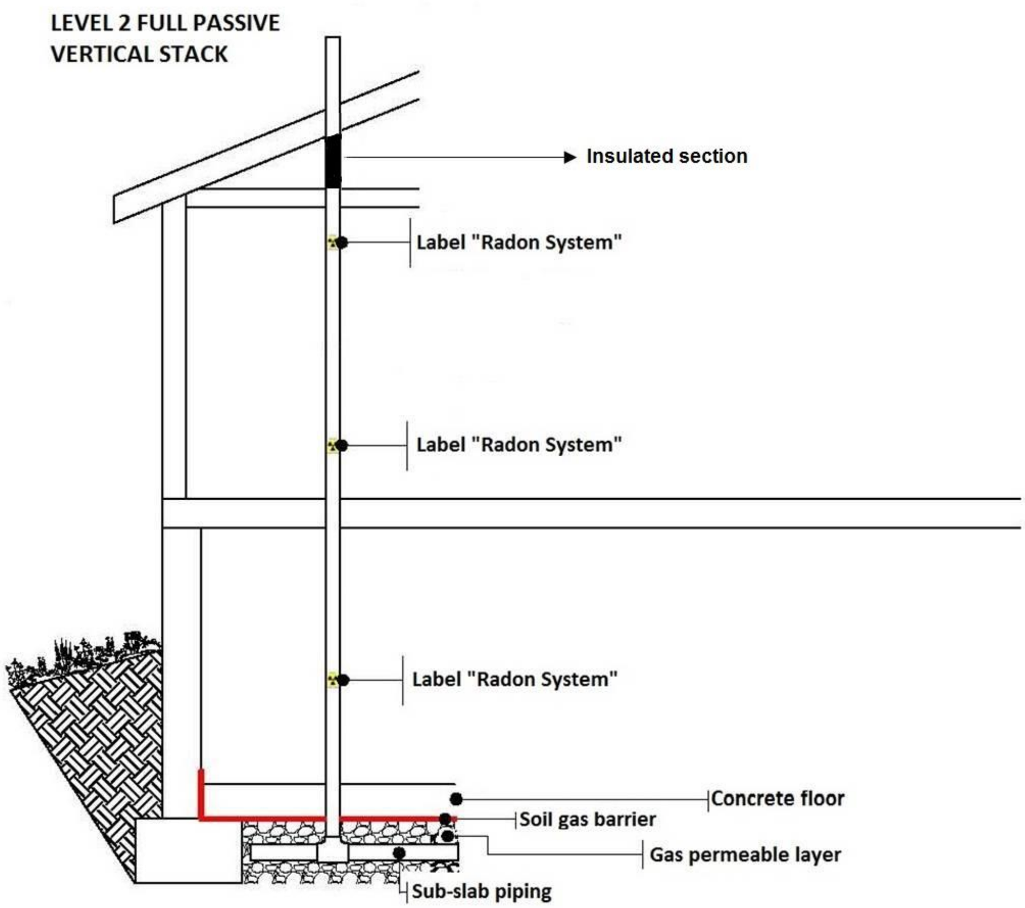



**Figure 7.2b - Level 2 - Full Passive Vertical Radon Stack**

### 7.2.6 Radon testing devices

**7.2.6.1** A C-NRPP certified listed and approved long-term radon testing device and testing instructions shall be provided to the homeowner at the time of occupancy.

NOTE For more information, please refer to Appendix I. It is recommended that a long-term radon test should be conducted during the first heating season after occupancy.

## 7.3 Level 3 - Full active soil depressurization system

### 7.3.1 Includes level 1 and level 2

**7.3.1.1** The construction for a full active soil depressurization (ASD) system (Level 3) requires compliance with the provisions of Section 7.1 (Level 1), Section 7.2. (Level 2), in addition to the requirements in Section 7.3.

NOTE Level 3 includes the installation of an active soil depressurization system (ASD), which uses the installed piping, as installed in Level 2 and includes installation of a radon fan, as required in Section 7.3. below. The system relies on the radon fan to induce a pressure difference to draw radon from beneath the building and exhaust it outdoors in order to reduce indoor radon levels. An active system can be used to mitigate a concrete sub-slab area or a dirt crawlspace area.

### 7.3.2 Active soil depressurization fans

**7.3.2.1** Fans shall be of the in-line, centrifugal type,

**7.3.2.1.1** Fans shall be rated for continuous duty operation.

**7.3.2.1.2** Fans shall have a minimum 3 year warranty against factory defect.

**7.3.2.1.3** Fans shall conform to CSA-C22.2 No.113.

**7.3.2.1.4** Fans shall be specifically designated by the manufacturer for radon mitigation.

**7.3.2.2** Fan and ducting shall not be located outdoors except for buildings located in geographic areas where the heating degree day (HDD) value is 3999 or lower.

NOTE Climatic variations exist in each area and each site should be considered independently.

**7.3.2.3** Fans shall be installed only on vertical piping and as per the manufacturer's instructions to allow for condensation drainage. A condensation by-pass should be installed which diverts condensation within the discharge pipe away from the fan where the fan is installed outdoors.

**7.3.2.4** The fan shall be connected to the piping with flexible plumbing couplers that hold the fan 1 cm from the pipe.

**7.3.2.5** Wiring and electrical components shall comply with applicable electrical codes-

**7.3.2.6** The fan disconnect shall be located less than or equal to 1.8 m from the fan.

NOTE The term "disconnect" leaves some flexibility as to the option of using a service switch or a receptacle

**7.3.2.7** A U-tube manometer shall be installed to monitor the fan performance and be located indoors in a location observable by the occupants.

**7.3.2.8** The start-up system pressure shall be clearly marked on a durable label (see 8.1.3.)

NOTE The term "start-up system pressure" refers to the suction vacuum level achieved when the fan is running at the time the system is first activated.

**7.3.2.9** The fan shall be suitable for use with 100 mm (4 in.) nominal internal diameter pipe and shall be selected according to Table 7.3.2.9 – Fan Sizing below.

**Table 7.3.2.9 – Fan Sizing**

<table>
<tr><th rowspan="2">Fan Selection Criteria</th><th colspan="2">Total Foundation Area</th></tr>
<tr><th>< 232 m² (< 2500 ft²)</th><th>> 232 m² (> 2500 ft²)</th></tr>
<tr><td>Use Radon Fan Type:</td><td>RF1</td><td rowspan="2">Radon fan to be sized by certified/licensed radon mitigator</td></tr>
<tr><td>Minimum Rating:</td><td>85 m³/h @ 125 Pa<br>[50 cfm @ 0.5 in. WC]</td></tr>
</table>

Radon Fan Type RF1 minimum flow and pressure ratings are manufacturer specifications.

Table 7.3.2.9 above taken from AARST/ANSI #CCAH-2013 standard (courtesy of the AARST Consortium)

**7.3.2.10** A leak test should be performed on the pressurised part of the system (under positive pressure) according to Clause 7.2.3.2.

**7.3.2.11** Once installed in the piping system, fans shall be electrically energized.

### 7.3.3 Conditions for mounting active soil depressurization fans indoors

#### 7.3.3.1 Fan criteria

**7.3.3.1.1** The radon fan used shall meet the product safety requirements in accordance with CAN CSA-C22.2 No. 113 and the motor shall comply with the applicable requirements of CAN CSA-C22.2 No. 100 for motors having continuous duty.

**7.3.3.1.2** The radon fan seams and enclosure openings other than the inlet and outlet ports, shall be sealed so that the combined area of all gaps or openings of the fan housing shall not exceed a total area of a single 3.17 mm (0.125”) diameter hole which would result in a maximum 0.425 $m^3$/hr (0.25 cubic foot per minute cfm) leakage at 375 Pa (1.5” WC pressure).

#### 7.3.3.2 Leak test

**7.3.3.2.1** The installer shall check each connection, fan joint and system component subject to fan-induced positive pressure while under normal operating pressure with either a liquid bubble solution or a leak-detection device to locate any source of a leak.

**7.3.3.2.2** The installer shall seal any detected leak in a manner recommended by the component manufacturer and retest.

**7.3.3.2.3** Fans requiring bubble leak testing or fans installed outdoors shall meet the requirements of CAN CSA 22.2 No. 113 for outdoor use.

**7.3.3.2.4** **Leak test exception:** Radon fans mounted outdoors, in attics or attached garages, or radon fans with all critical seams under negative pressure or housed in a negative pressure enclosure shall not require a leak test.

#### 7.3.3.3 Labeling

After completion of the Leak Test, a label shall be applied by the Installer to the radon fan. The label shall contain the following information:

***"The Installer has tested this system for leaks during installation. Please note that physical damage or aging may result in leakage which can increase indoor radon levels. You are advised that your system should be routinely inspected and your radon levels retested every 5 years or after major structural, or ventilation/air circulation equipment changes to your home."***

#### 7.3.3.4 Post occupancy radon measurement

**7.3.3.4.1** A short-term radon measurement of a duration no shorter than 48 hours using an approved radon testing device shall be performed no sooner than 24 hours after activation, while the system is operating, within the first month of system activation.

**7.3.3.4.2** Upon verification of the short-term test a long- term test shall be performed using an approved radon testing device.

**7.3.3.4.3** A re-test should be performed every 5 years with a long-term radon testing device.

**7.3.3.4.4** The radon testing device shall be approved by C-NRPP, NRPP or equivalent.

NOTE Long term radon test "should be conducted by a C-NRPP certified radon measurement professional. For additional testing information please see the Health Canada website: www.hc-sc.gc.ca

### 7.3.4 Mitigation system termination

**7.3.4.1** Active radon reduction systems shall discharge to the outdoors as shown in Figure 7.3.4a. (roof top), in Figure 7.3.4b. (gable end), or in Figure 7.3.4c (side-wall discharge near ground level).

**7.3.4.2** The 3 possible choices of active radon reduction system discharges above (roof top, gable end, or side-wall discharge near ground level) shall conform to the clearance distances shown in Table 7.3.4.2 below.

**Table 7.3.4.2. Clearance Distances for Active Radon Reduction Systems (meters)**

| | Suggested | Minimal |
|---|---|---|
| Clearance to a mechanical air supply inlet | 3 | 2 |
| Clearance to permanently closed window | 1 | 0.60 |
| Clearance to a openable window | 2 | 2 |
| Clearance from a door that may be opened | 2 | 1 |
| Clearance to outside corner | 0.30 | 0.30 |
| Clearance to inside corner | 0.30 | 0.30 |
| Clearance above paved sidewalk or paved driveway located on public property | 2 | 2 |

| | | |
|---|---|---|
| Clearance above grade, veranda, porch, deck, or balcony | 1 | 0.30 |
| Vertical Clearance below soffits or from any attic venting component | 1 | 1 |
| Horizontal clearance from an area directly below the discharge where there is a risk of injury from ice fall. | 2 | 1 |

**7.3.4.2.1** The pipe shall be located where the discharged air and moisture will not directly strike surfaces on the property or adjacent properties.

NOTE This is to prevent ice accumulation, frost, or water damage on those surfaces.

**7.3.4.2.2** The pipe for a gable ended discharge shall discharge horizontally with a minimal length of 50 mm protruding beyond the plane of the vertical structure and a maximum length protruding of 150 mm. Note : Care should be taken to ensure that the gable ended discharge termination point is not located directly above a walkway to ensure that any ice that may form on the outlet of the pipe does not fall onto persons walking below.

**7.3.4.2.3** The pipe shall be installed in such a position that it will not be covered with snow or other materials from adjacent roofs and gutters.

Diagrams of three Level 3 full active soil depressurization (ASD) systems are shown below in Fig 7.3.4a (above-roof), and Fig 7.3.4b (above roof gable ended discharge), and Fig 7.3.4c (side-wall discharge near ground level).

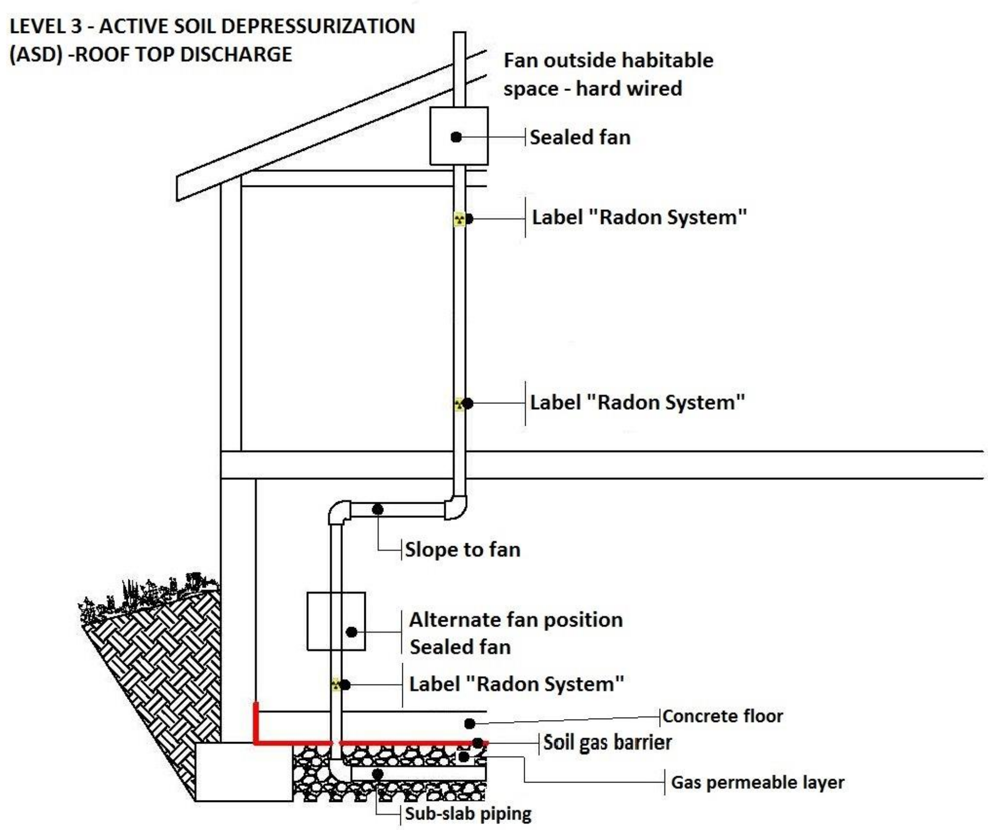



**Figure 7.3.4a - Level 3 - Full Active Soil Depressurization System-Rooftop Discharge**

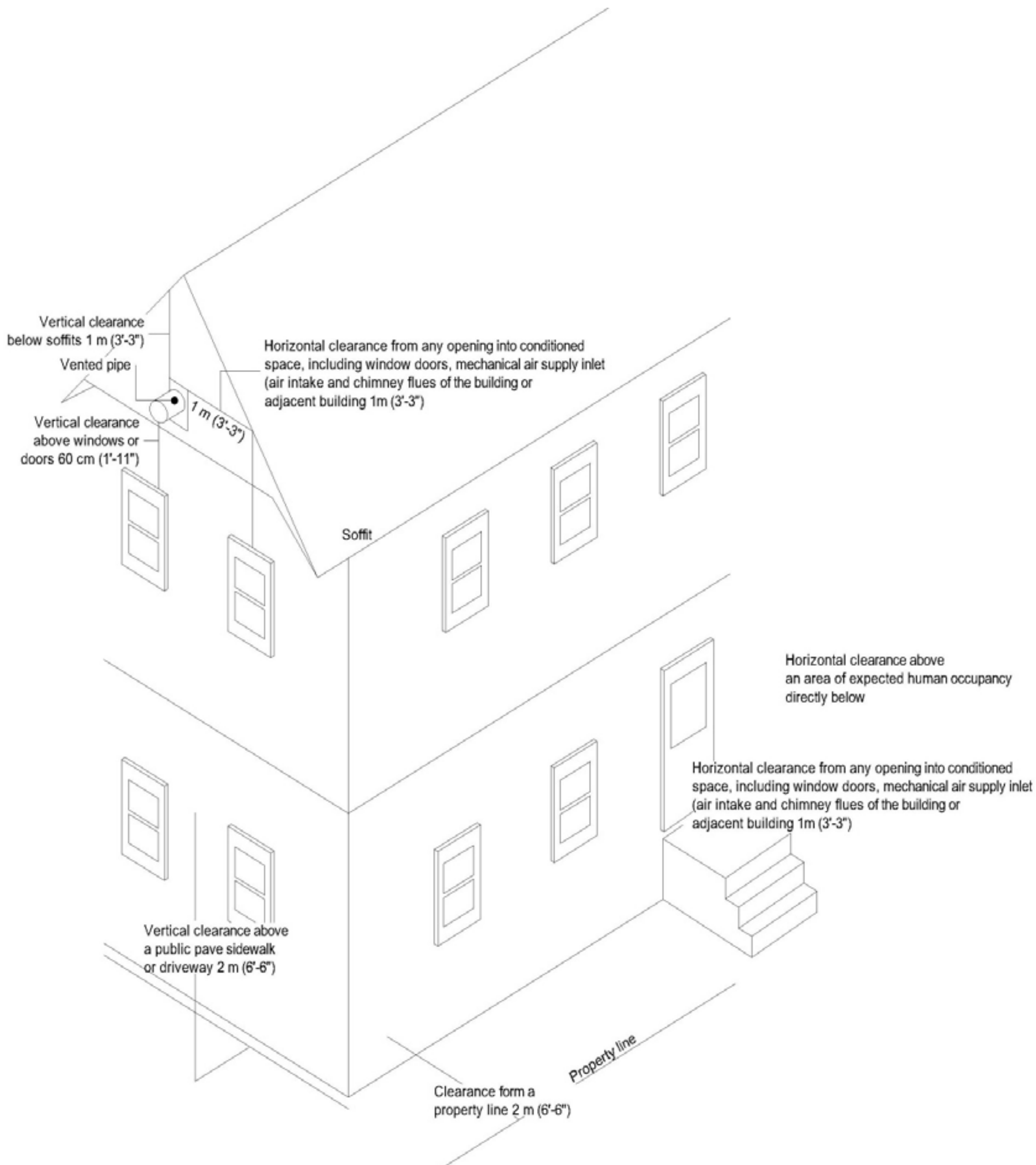



**Figure 7.3.4b Gable Ended Roof Discharge**

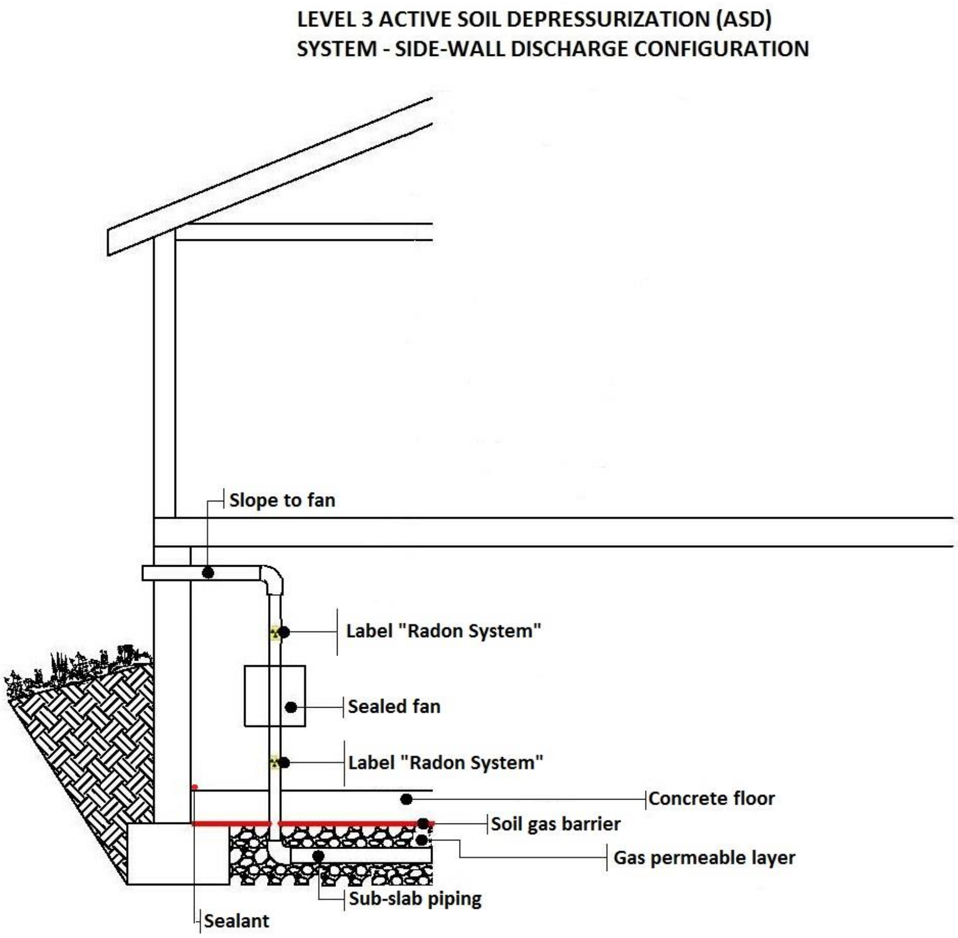



**Figure 7.3.4c- Level 3 – Full Active Soil Depressurization (ASD) System - Side-Wall Discharge Near Ground Level with Indoor Fan**

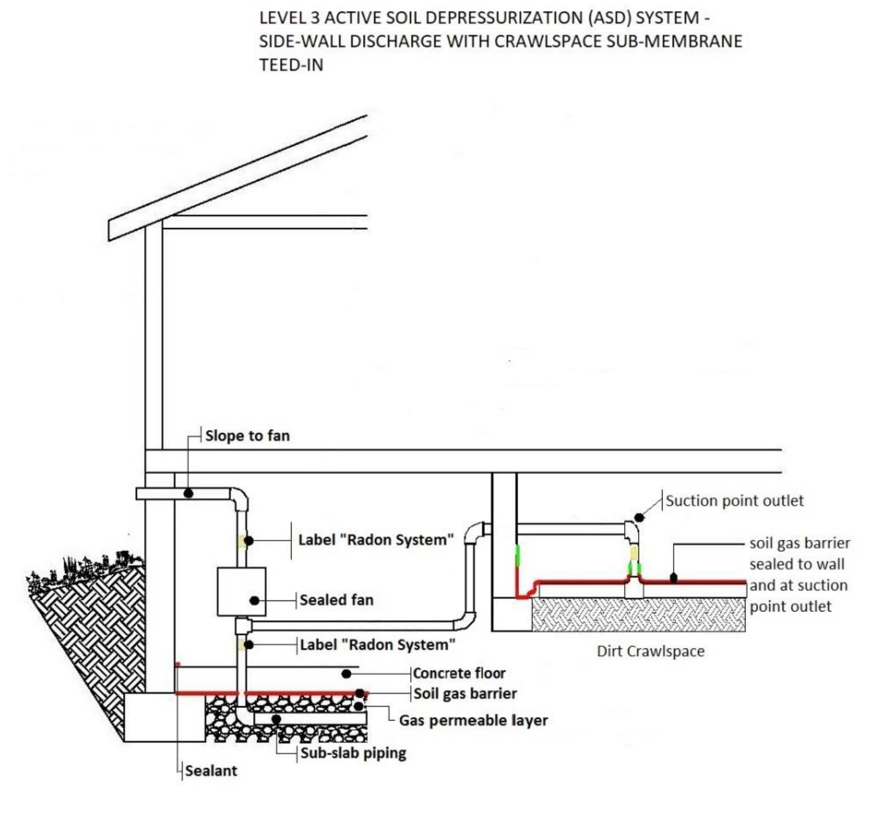



Figure 7.3.4d – Level 3 – Full Active Soil Depressurization (ASD) System –Side-Wall Discharge Near Ground Level with Indoor Fan and a Crawlspace Sub-Membrane Depressurization Teed-In

# 8 Labelling

For the three levels of radon control options, durable labels shall be provided as outlined by this standard. Labels shall clearly indicate that the systems are only intended for the removal of radon gas from below the floor-on-ground. The labels serve the purposes of identifying the radon control systems for future work by radon professionals, identifying the systems to contractors who may mistakenly use the system for other purposes, and identifying the systems to homeowners who may be unaware of radon and/or its control options. All labels shall be printed and composed of lettering that is in a contrasting colour to the background. There are six label types: air barrier membrane labels, pipe labels, fan labels, sump labels, active system start-up pressure marking labels, and radon maintenance and information labels. All applicable labels are to be applied before occupancy. A homeowner documentation package shall be provided to occupants upon occupancy.

## 8.1 Radon reduction system component labels

### 8.1.1 Level 1 requirements

**8.1.1.1 Air barrier membrane labels** For residences with ground covering sealed membranes such as in crawlspaces, a label shall be installed in a prominent location and shall state “This is a component of a Radon Reduction Rough-In System. Do not tamper with or disconnect”.

#### 8.1.1.2 Pipe labels

The capped rough-in piping for the radon control systems located in the interior of the building must be identified with the label “This is a component of a Radon Rough-in System. Do not tamper with or disconnect”. The label shall be applied to the sealed cap at the top of the stub.

#### 8.1.1.3 Sump labels

Where sumps are installed and used as an inlet for an ASD system, the sealed sump pit cover shall be provided with a durable label, “This is a component of a Radon Reduction System. Do not tamper with or remove sump cover except for situations where the sump area requires servicing”.

### 8.1.2 Level 2 requirements

Building

#### 8.1.2.1 Pipe labels

The piping for the passive radon stack radon control system located in the interior of the building must be identified with the label “This is a component of a Radon Reduction System. Do not tamper with or disconnect”. The label shall be applied every 1.8 m or at a change in direction. The labels shall be applied before wall cavities are closed.

**8.1.2.3 Electrical box label** – “An electrical rough-in receptacle has been provided in the attic for addition of a radon fan to allow easy conversion to an active Level 3 system if required. Do not use for any other electrical installation”.

### 8.1.3 Level 3 requirements

#### 8.1.3.1 Level 1 and level 2 labels

Buildings constructed with a Level 3 system shall include the provisions of Level 1 and Level 2, in addition to the following requirements.

#### 8.1.3.2 Fan labels

Radon fans installed as part of Level 3 control systems shall be labelled "This is a component of a Radon Reduction System. Do not tamper with or disconnect". The circuit breakers for the fan and any system failure warning device shall also be labelled "This is a component of a Radon Reduction System. Do not tamper with or disconnect. For fans that have an electrical disconnect instead of a cord and plug, it shall also be labelled.

#### 8.1.3.3 Active system start-up pressure label

When an active system is installed (Level 3), the initial differential system pressure value shall be clearly marked on the system pressure monitor label (typically a u-tube manometer). The monitor device shall have a durable label that states "This is a component of a Radon Reduction System. Do not tamper with or disconnect", it shall describe how a homeowner should read the gauge, and when and who to call for servicing; this description will vary with each device. The label shall also include bolded wording "***This gauge measures suction pressure in Inches Water Column, it does not measure radon.***"

## 8.2 Radon maintenance and information sheets

The control systems shall also be provided with one information sheet for the purposes of homeowner information. The three levels of radon reduction systems shall each have a unique information sheet. The information sheet shall follow the following formats and shall be part of the new homeowner manual or information package furnished to the homeowner by the builder upon closing.

Level 1 :

## Radon Reduction System

**Radon System Specification:** CGSB ______

**Type:** Level 1 Radon Reduction System Rough-In For Active Soil Depressurization

**Status:** System Not Operational,

**Upgrade Option:** Convert to a passive system by installing additional vertical piping run terminating above the roofline, or convert to an active radon reduction system with additional piping and a fan.

**Description:** A radon system rough-in is installed in this building. This system is not operational. The cap on the top of this rough-in pipe stub needs to be kept sealed and in-place until such time that it is converted to either a full passive vertical stack (Level 2) or to a full active (with a fan) radon reduction system (Level 3).

**Radon Testing:** Test the building for radon during the first winter after occupancy using a long-term radon test (3 months). The building should be re-tested for radon every 5 years, or as recommended by Health Canada.

Also, retest the building for radon whenever there has been a change in ownership, of heating, cooling or ventilation equipment, or after renovations or additions have been completed.

**Radon Testing Interpretation:** If radon test results are above 200 $Bq/m^3$, take steps to activate your radon reduction system as soon as is reasonably possible. Contact Health Canada for more information – contact information is provided below.

**Homeowner Maintenance:** Some components of this radon reduction system require maintenance and monitoring by the homeowner.

**Installer's Name:**

**Company:**

**Company Address:**

**Company Telephone Number:**

**Applicable Certification Identification:**

**Date of Installation:**

**Signature:**

**Additional Radon Information:** Visit the Health Canada Website www.Canada.ca/radon or call 1-866-225-0709 for more information on radon and your reduction system.

Level 2 :

## Radon Reduction System

**Radon System Specification:** CGSB ______

**Type:** Level 2 Full Passive Vertical Radon Stack

**Status:** System Operational, Monitor Operational

**Upgrade Option:** Convert to active system with fan.

**Description:** A passive (without a fan) radon soil depressurization system has been designed, installed, and is operating in this building.

**Radon Testing: This system has been installed to the industry's best practices. However, for various reasons, radon levels may be elevated.** Test the building for radon during the first winter after occupancy using a long-term radon test (3 months). The building should be re-tested for radon every 5 years, or as recommended by Health Canada.

Also, retest the building for radon whenever there has been a change in ownership, of heating, cooling or ventilation equipment, or after renovations or additions have been completed.

**Radon Testing Interpretation:** If radon test results are above 200 Bq/m$^3$, take steps to activate your radon reduction system as soon as is reasonably possible. Contact Health Canada for more information – contact information is provided below.

**Homeowner Maintenance:** Some components of this radon reduction system require maintenance and monitoring by the homeowner.

**Installer's Name:**

**Company:**

**Company Address:**

**Company Telephone Number:**

**Applicable Certification Identification:**

**Date of Installation:**

**Signature:**

**Additional Radon Information:** Visit the Health Canada Website www.canada.ca/radon or call 1-866-225-0709 for more information on radon and your reduction system.

Level 3 :

## Radon Reduction System

**Radon System Specification:** CGSB ______

**Type:** Level 3 Full Active Soil Depressurization System

**Status:** System Operational, Monitor Operational

**Upgrade Option:** Please consult a professional radon mitigator.

**Description:** An active soil depressurization system has been designed, installed, and is operating in this building. The fan should NEVER be turned off.

**System Monitoring:** The radon system pressure gauge should be read periodically. The gauge displays vent stack suction pressure, which indicates the system's performance. Call for radon reduction system service if the readings are outside of the normal operating range. The initial piping pressure was __________.

**Radon Testing: This system has been installed to the industry's best practices. However, for various reasons, radon levels may be elevated.** Test the building for radon during the first winter after occupancy using a long-term radon test (3 months). The building should be re-tested for radon every 5 years, any time a fan has been replaced, or as recommended by Health Canada.

Also, retest the building for radon whenever there has been a change in ownership, of heating, cooling or ventilation equipment, or after renovations or additions have been completed.

**Radon Testing Interpretation:** If radon test results are above 200 $Bq/m^3$ , take steps to activate your radon reduction system as soon as is reasonably possible. Contact Health Canada for more information – contact information is provided below.

**Homeowner Maintenance:** Some components of this radon reduction system require maintenance and monitoring by the homeowner.

**Installer's Name:**

**Company:**

**Company Address:**

**Company Telephone Number:**

**Applicable Certification Identification:**

**Date of Installation:**

**Signature:**

**Additional Radon Information:** Visit the Health Canada Website www.canada.ca/radon or call 1-866-225-0709 for more information on radon and your reduction system.

### 8.3 Label application

The labels described in Section 8.1 shall be applied to clean and dry surfaces.

### 8.4 Homeowner radon reduction system package

The homeowner shall be provided with a documentation package that includes the following:

A copy of the appropriate information label outlined in 8.2;

All manuals for the installed systems, including fans, if applicable;

All radon test data for the property, if applicable;

## 9 Inspection

Inspections will verify if minimum standards and provisions provided in this standard have been met. Items requiring inspection for Levels 1, 2 and 3 are presented in Annex C (Inspection Checklist).

## 10 Testing

Section 2.0 on Normative References refers to other standards which may refer to various relevant tests. There are 2 annexes of this standard which refer to testing. Annex I gives some guidance on long-term (3-month) radon testing of a new building which would occur after occupancy, ideally in the first heating season. Annex J provides guidance on communication testing which is used to determine the degree of pressure field extension under a concrete floor slab which helps to determine the size of fan and number of suction points that may be required for an active soil depressurization system.

# Annex A
informative
# General Information on Radon

Information from *Reducing Radon in Existing Homes: A Canadian Guide for Professional Contractors*, Health Canada, 2010. Figure A-1 courtesy of Physics Solutions Inc.

## What is Radon?

The natural radioactive element uranium is present everywhere in rocks and soil. The radioactive decay of uranium produces radium, which in turn decays to radon, a radioactive colourless and odourless inert gas (see Figure A-1). As it is a gas, it can move easily through bedrock, soil and ground water; escaping into the outdoor air or seep into a building or building. *All* soil contains uranium, so radon is present in all types of soil. Radon that moves from the ground into the outdoor air is rapidly diluted to low concentrations and is not a health concern. However, inside a building, radon can accumulate to a high level and become a long term health concern.

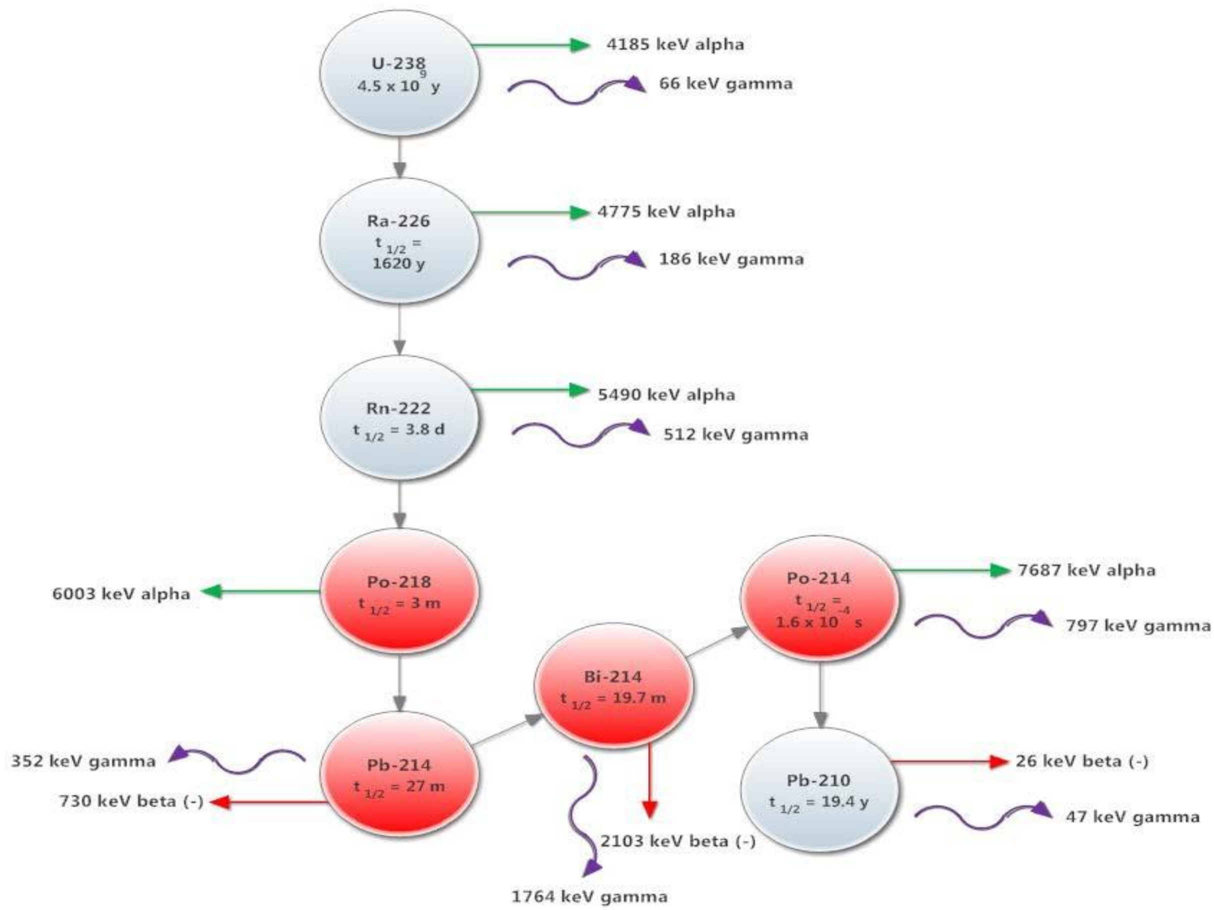



**Figure A-1 – *The Uranium Decay Chain***

## How Does Radon Enter a Building

The air pressure inside a (building) is usually lower than in the soil surrounding the foundation. This difference in pressure draws in gases, including radon, through openings in the foundation where it is in contact with the ground. This includes construction joints, gaps around service pipes and support posts, floor drains and sumps, cracks in foundation walls and in floor slabs, and openings in concrete block walls.

In some areas, radon in the water supply can contribute to the indoor air radon concentration in the building. In such cases, radon dissolves in the water as it travels through rocks and soils. This situation is generally associated with ground water and thus is more likely to affect well water sources rather than surface waters used for most municipal water supplies. Large volumes of water are used for showers, washing etc., and when agitated, radon, if present in the water, can be released into the air. However, the health risk associated with radon dissolved in water is not from drinking the water, but from breathing the air into which radon has been released.

All these routes are illustrated in Figure A-2.

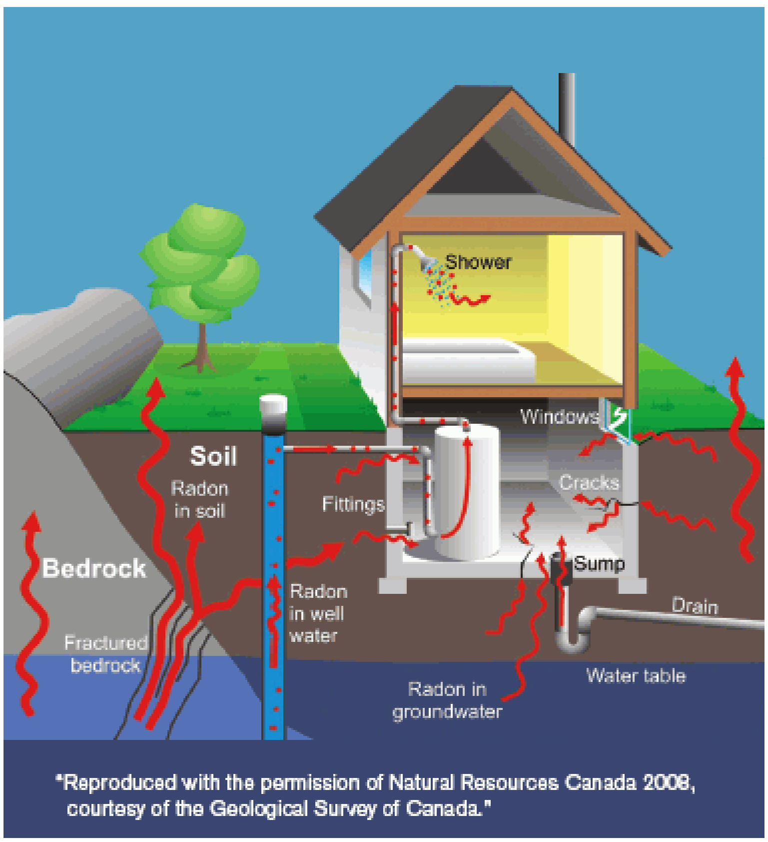



**Figure A-2 – Radon Entry Routes**

Although high radon concentrations are associated with some geological formations, type of soil, housing type, and foundation construction vary so much from place to place that “radon potential maps” are poor indicators of the radon concentration in an individual building. Even similar buildings next to each other can have very different average radon concentrations. **The only way to know if a building has a high radon level is to measure the radon concentration**.

**Why is it a Health Hazard?**

The only known health risk associated with exposure to radon is an increased risk of developing lung cancer. The risk of developing lung cancer depends on:

1. The average radon concentration in the building.
2. The length of time a person is exposed.
3. The smoking habits of the exposed person.

Health Canada estimates a non-smoker exposed to elevated levels (i. e 800 Bq/m$^3$ ) of radon over a lifetime has a 1 in 20 chance of developing lung cancer. The combined effects of radon exposure and smoking tobacco significantly increase the risk of lung cancer (tobacco leaves also uptake radioactive Po-210 from the soil). If a smoker is exposed to the same elevated level of radon over a lifetime, the risk increases to a 1 in 3 chance.

When a radon atom decays, it emits an alpha particle and produces new elements, called “radon progeny”. Unlike radon, the radon progeny (also referred to as radon decay products or radon daughters) are solids.

When alpha particles hit an object, such as a cell, their energies are transferred to that object, resulting in damage. Human skin is thick enough that the alpha particles cannot penetrate to more vulnerable tissues beneath, but if you breathe in radon or its progeny, the alpha particles they emit can damage unprotected and sensitive bronchial and lung tissues, which can then lead to lung cancer.

Originally, the estimate of lung cancer risk from radon exposure was based on exposures to high concentrations found in uranium mines, and the risk from lower concentrations typically found in buildings was uncertain. However, recent residential studies have confirmed that even exposure to the lower radon concentrations found in buildings carries a lung cancer risk. The time between exposure and the onset of the disease is usually many years (the average age of onset for lung cancer is age 60). Unlike smoking, besides lung cancer, exposure to radon does not cause other diseases or respiratory conditions nor does it result produce symptoms such as coughing or headaches.

**Radon Guideline**

Beginning in 2005, Health Canada collaborated with the Federal Provincial Territorial Radiation Protection Committee (FPTRPC) to review the health risk from exposure to radon. The risk assessment was based on new scientific information and was the subject of a broad public consultation. Using the risk assessment and feedback obtained from the public consultation, the Government of Canada updated its guideline for exposure to radon in indoor air in 2007. This updated guideline provides advice that is more broadly applicable and more protective than the previous FPTRPC guideline.

The current Government of Canada guideline for exposure to radon in indoor air is:

Remedial measures should be undertaken in a building whenever the average annual radon concentration exceeds 200 $Bq/m^3$ in the normal occupancy area.

The higher the radon concentration, the sooner remedial measures should be undertaken.

When remedial action is taken, the radon level should be reduced to a level or concentration as low as practicable.

The construction of new buildings should employ techniques that will minimize radon entry and facilitate post-construction radon removal should this subsequently prove necessary.

For more information about radon and the Guideline, visit the Health Canada Website: www.canada.ca/radon or call 1-800-O-Canada.

# Annex B
informative
# Radon Reduction Systems: Information for Builders and Building Officials

## What is radon?

The natural radioactive element uranium is present everywhere in rocks and soil. The radioactive decay of uranium produces radium, which in turn decays to radon, a radioactive colourless and odourless inert gas (see Figure A-1). As it is a gas, it can move easily through bedrock, soil and ground water; escaping into the outdoor air or seep into a building or building. *All* soil contains uranium, so radon is present in all types of soil. Radon that moves from the ground into the outdoor air is rapidly diluted to low concentrations and is not a health concern. However, inside a building, radon can accumulate to a high level and become a long term health concern.

## What are the health effects of radon?

Exposure to high levels of radon in indoor air results in an increased risk of developing lung cancer. The risk of cancer depends on the level of radon and how long a person is exposed to those levels.

## How can radon get into a building?

The air pressure inside a building is usually lower than in the soil surrounding the foundation. This difference in pressure (also known as the stack effect) draws air and other gases, including radon, from the soil into the building.

Radon can enter a building any place it finds an opening where the building contacts the soil: cracks in foundation walls and in floor slabs, construction joints, gaps around service pipes, support posts, window casements, floor drains, sumps or cavities inside walls.

## Radon mitigation

Radon levels vary from building to building depending on lot conditions and construction, and there is currently no way to determine the radon concentrations within a building before construction. Testing is required after construction to determine radon concentrations, and mitigation efforts may be required should radon concentrations be found to be above the Canadian guideline of 200 Bq/m$^3$. During construction, steps should be taken to facilitate the efforts to increase the effectiveness of mitigation systems. There are three levels of radon reduction system installation that can be installed in new construction, outlined below.

<u>Level 1-</u> Rough-In For Active Soil Depressurization

Level 1 consists of a rough-in stub for a radon reduction system. A pipe extends into a soil gas collector(often gravel) under the foundation floor, which acts as an entry point for radon and other soil gases to a radon reduction system. The pipe then terminates just above the slab and is capped. This system is only a rough in, and forms the basis for either a Level 2 (passive radon stack) or Level 3 (active fan driven) radon mitigation system. Level 1 also includes a membrane installed underneath the concrete slab which is sealed to the foundation wall in order to minimize radon ingress, in addition to sealing the expansion or cold joint around the perimeter of the foundation between the foundation wall and the concrete slab.

(See Figure 7.1 a - Level 1 - Rough-In For Active Soil Depressurization)

It is also important that the continuity of the air barrier be maintained in the basement, including sump pit covers, floor drains, other slab service pipe penetrations, and caulking any cracks and joints in the foundation.

Level 2- Full Passive Vertical Radon Stack

Level 2 extends the pipe from Level 1 up through the conditioned space vertically to terminate outdoors. There are provisions for the termination of the pipe to ensure re-entrainment of radon does not occur. The system relies on naturally occurring pressure differentials generated by the stack effect to mitigate radon. (See Figure 7.2b - Level 2 - Full Passive Vertical Radon Stack).

Level 3- Full Active Soil Depressurization System

Level 3 uses the pipe from Level 2 and also includes a low wattage radon fan. The system relies on the radon fan to induce a pressure difference to exhaust soil gases and radon from under the slab. Radon fans run continuously, and a system pressure monitor is installed for the monitoring of the system.  This method has been shown to be highly effective at reducing radon concentrations in a building. (See Figure 7.3c – Level 3 – Full Active Soil Depressurization System).

For more information about radon, visit the Health Canada Website: www.canada.ca/radon or call 1-800-O-Canada.

# Annex C
informative
# Inspection Checklist

**Level 1- Rough-In For Active Soil Depressurization**

OK NIC* *NIC = Not in Compliance

| OK | NIC* | | |
|---|---|---|---|
| | | Gas permeable layer | 7.1.1.1 |
| □ | □ | Permitted gas permeable material provided | 7.1.1.2 |

Soil Gas collector

| OK | NIC* | | |
|---|---|---|---|
| □ | □ | Permitted pipe | 7.1.2.1 |
| □ | □ | One suction point for each soil gas collector | 7.1.2.2 |
| □ | □ | Suction point inlet located near centre of slab and proper installation of capped pipe | 7.1.2.3 |
| □ | □ | Proper installation of soil gas collector | 7.1.2.4, 7.1.2.5, 7.1.2.6, 7.1.2.7, 7.1.2.8 7.1.2.9, 7.1.2.10 |

Pipe

| OK | NIC* | | |
|---|---|---|---|
| □ | □ | Permitted pipe, installation, gluing, and priming materials | 7.1.3.2, 7.1.3.2.3, 7.1.3.1.9 |
| □ | □ | At least 1% slope | 7.1.3.1.8 |
| □ | □ | Does not block doorways or windows, or areas requiring maintenance | 7.1.3.4, 7.1.3.5 |

Sealing Soil Gas Plenum

| OK | NIC* | | |
|---|---|---|---|
| □ | □ | polyolefin membrane installation | 7.1.4.1 |
| □ | □ | Slab and foundation sealed | 7.1.4.2, 7.1.4.3 |

Sealing Entry Points in the Slab

| OK | NIC* | | |
|---|---|---|---|
| □ | □ | Sump pits | 7.1.5.1 |
| □ | □ | Drains | 7.1.5.2 |
| □ | □ | Openings | 7.1.5.3 |
| □ | □ | Other penetrations | 7.1.5.4 |

Sealing Entry Points in Foundation

| OK | NIC* | | |
|---|---|---|---|
| □ | □ | Hollow masonry units | 7.1.6.1 |
| □ | □ | Other penetrations (e.g. bathtub or shower cut-outs) | 7.1.6.2 |

Radon testing devices

| | | | |
|---|---|---|---|
| □ | □ | Device provided to owner | 7.1.7.1 |

Labelling

| | | | |
|---|---|---|---|
| □ | □ | Air barrier membrane label | 8.1.1.1 |
| □ | □ | Pipe label | 8.1.1.2 |
| □ | □ | Sump label | 8.1.1.3 |
| □ | □ | Radon maintenance and information label | 8.2 |
| □ | □ | Homeowner radon reduction system package | 8.4 |

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**Level 2 - Full Passive Vertical Radon Stack**

Includes Level 1

| | | | |
|---|---|---|---|
| □ | □ | Includes Level 1 | 7.2.1.1 |

Pipe

| | | | |
|---|---|---|---|
| □ | □ | Permitted pipe | 7.2.3.1 |
| □ | □ | Tested for leaks | 7.2.3.2 |

System Termination

| | | | |
|---|---|---|---|
| □ | □ | Permitted distances and other requirements | 7.2.4.1 |

Future System Activation Provisions

| | | | |
|---|---|---|---|
| □ | □ | Space for fan | 7.2.5.1 |
| □ | □ | Boxed receptacle outlet | 7.2.5.2 |
| □ | □ | Access | 7.2.5.3 |

Labelling

| | | | |
|---|---|---|---|
| □ | □ | Includes Level 1 Labels | 8.1.2.1 |
| □ | □ | Pipe labels | 8.1.2.2 |
| □ | □ | Radon maintenance and information label | 8.2 |
| □ | □ | Homeowner radon reduction system package | 8.4 |

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**Level 3 - Full Active Soil Depressurization System**

Includes levels 1 and 2

| | | | |
|---|---|---|---|
| □ | □ | Includes levels 1 and 2 | 7.3.1.1 |

ASD Fans

| | | | |
|---|---|---|---|
| □ | □ | Permitted fans | 7.3.2 |
| □ | □ | Permitted location | 7.3.3. |
| □ | □ | Condensation drainage | 7.3.2.3 |
| □ | □ | Connection to piping | 7.3.2.3/7.3.2.4 |

| | | | |
|---|---|---|---|
| | | | 7.3.2.9/7.3.2.10 |
| □ | □ | Airtight fan meeting criteria for indoor use | 7.3.3 |
| □ | □ | Leak testing positive pressurized part of system | 7.3.2.10 |
| □ | □ | Wiring | 7.3.25/7.3.2.6 |
| □ | □ | Pressure Monitor | 7.3.2.7 |
| □ | □ | Appropriate sizing | 7.3.2.9 |
| □ | □ | Electrically energized | 7.3.2.11 |

System Termination

| | | | |
|---|---|---|---|
| □ | □ | Permitted distances and other requirements | 7.3.4.1 |

Labelling

| | | | |
|---|---|---|---|
| □ | □ | Includes level 2 labels | 8.1.3.1 |
| □ | □ | Fan labels | 8.1.3.2 |
| □ | □ | Active system start-up pressure label | 8.1.3.3 |
| □ | □ | Radon maintenance and information label | 8.2 |
| □ | □ | Homeowner radon reduction system package | 8.4 |

# Annex D
informative
# Radon from Water and Construction Materials

This national standard describes reducing radon in new construction where the radon in air originates in the soil surrounding and beneath the home. Radon can enter a building via two other mechanisms primarily.

Radon can be present dissolved in well water which enters the building from the distribution piping. When a faucet is opened, radon dissolved in the water will outgas into the air. This can happen for example during periods when occupants are showering, washing dishes, or doing laundry. This radon outgassing is generally speaking, a very small contributor to indoor radon levels.

Radon levels in municipally treated water systems are usually extremely low due to a combination of water treatment methods and delays in water treatment processing and distribution. Radon levels in well water can be significant depending on the source, but again, it requires extremely high radon levels dissolved in well water to impact indoor radon levels appreciably. A general rule of thumb used in the radon profession is that one requires roughly 10,000 times the radon in water concentrations per m3 of water (i.e. 2,000,000 Bq/m3 radon in water) before radon in water is likely to impact the radon in air concentrations significantly. This radon in water concentration is a rare occurrence, but can happen occasionally in private or community wells. If the air of a building supplied with groundwater tests above 200 Becquerels per cubic meter (Bq/m3), testing for radon levels in water should be considered. Radon in water test kits are commercially available. Depending on the results, it may be necessary to mitigate for radon from the soil, the water, or from both, in order to obtain an acceptable radon reduction in air.

Well water systems having high radon levels can be treated in several ways in order to remove radon from the water before it can outgas into a home. The main techniques used today are aeration (to displace radon) or treatment with granulated activated carbon (to trap radon). Both techniques require consideration of the overall composition of the source water to prevent clogging or fouling of these treatment systems, and the levels of radon in the water. Aeration is the preferred treatment technique for removing high levels of radon from well water.

Treatment with activated carbon requires consideration of long-term storage and disposal of the cartridges as gamma emitting radioactive radon decay products may buildup on the filter. This may require shielding of the cartridge, or mounting the cartridge outdoors or in an uninhabited part of the basement to reduce exposure of occupants to gamma radiation. Depending on the levels of radon in water and the length of time the granulated activated carbon filter is used, spent cartridges may require specialized hazardous waste disposal.

The other potential source of radon entering a building can originate in the materials of construction, depending on the radium-226 levels (the immediate parent of radon-222) present in the material. Radon can emanate from materials such as concrete, drywall, tiles, or granite countertops. Again, the contribution made by materials of construction to indoor radon levels in Canada is generally very small. Health Canada performed a study of radon emanation from a number of the most popular tiles and granite countertops sold into Canada and found that these were unlikely to contribute significantly to indoor radon levels.

Please see: Radon Exhalation From Building Materials for Decorative Use, Chen, J. et. al., Journal of Environmental Radioactivity, Volume 101, Issue 4, April 2010, Pages 317–322

Health Canada also recently performed a small study on emanation of radon from aggregate samples from various Canadian sources and found that these generally would be small contributors to indoor radon levels.

Please see: Radon Exhalation From Sub-Slab Aggregate Used in Home Construction in Canada, Bergman,L. et.al., Radiation Protection Dosimetry, , doi:10.1093/rpd/ncv320, May 2015, Pages1- 6

# Annex E
informative
# Radon Reduction System Information for Homeowners

## What is radon?

The natural radioactive element uranium is present everywhere in rocks and soil. The radioactive decay of uranium produces radium, which in turn decays to radon, a radioactive colourless and odourless inert gas (see Figure A-1). As it is a gas, it can move easily through bedrock, soil and ground water; escaping into the outdoor air or seep into a building or building. *All* soil contains uranium, so radon is present in all types of soil. Radon that moves from the ground into the outdoor air is rapidly diluted to low concentrations and is not a health concern. However, inside a building, radon can accumulate to a high level and become a long term health concern.

## What are the health effects of radon?

Exposure to high levels of radon in indoor air results in an increased risk of developing lung cancer. The risk of cancer depends on the level of radon and how long a person is exposed to those levels.

## How can radon get into my building?

The air pressure inside your building is usually lower than in the soil surrounding the foundation. This difference in pressure (also known as the stack effect) draws air and other gases, including radon, from the soil into your building.

Radon can enter a building any place it finds an opening where the building contacts the soil: cracks in foundation walls and in floor slabs, construction joints, gaps around service pipes, support posts, window casements, floor drains, sumps or cavities inside walls.

## Do I have a radon reduction system?

Yes if your building has been constructed with:

<u>Level 1- Rough-In For Active Soil Depressurization</u>

Level 1 consists of a rough-in stub for a radon reduction system. A pipe extends into a soil gas collection plenum in the gas permeable layer (which is generally gravel) under the foundation floor, which acts as an entry for radon and other soil gases to a radon reduction system. The pipe then terminates just above the slab and is capped. This system is only a rough in, and forms the basis for either a Level 2 (passive) or Level 3 (active) mitigation system. Level 1 also includes a membrane installed underneath the concrete slab which is sealed to the foundation in order to minimize radon ingress, in addition to sealing the expansion joint around the perimeter of the foundation between the wall and the concrete slab.

It is also important that the continuity of the air barrier be maintained in the basement, including sump pit covers, floor drains, other slab service pipe penetrations, and caulking any cracks and joints in the foundation.

Level 2- Full Passive Vertical Radon Stack

Level 2 extends the pipe from Level 1 up through the interior of the building vertically to terminate outdoors. There are provisions for the termination of the pipe to ensure re-entrainment of radon does not occur. The system relies on naturally occurring pressure differentials (generated by the stack effect) to mitigate radon.

Level 3- Full Active Soil Depressurization System

Level 3 uses the pipe from Level 2 and also includes a low wattage radon fan. The system relies on the radon fan to induce a pressure difference to exhaust soil gases and radon from under the slab. Radon fans run continuously, and a system pressure monitor is installed for the monitoring of the system. This method has been shown to be highly effective at reducing radon concentrations in a building.

## Is there system maintenance?

Your radon system has been labelled in various locations, such as pipe, air barriers, and electrical panels and fans, if applicable. DO NOT ALTER OR DISCONNECT any of these components.

Pipe
Multiple times per year, inspect all exposed piping for damage.

Membranes
The plastic membrane, used in crawlspaces if applicable, should be inspected multiple times per year for tears, cuts, or leaks in its seals, and any damage should be repaired as soon as is reasonably possible. The radon reduction system can have its performance reduced if damage to the membrane results in air leakage. Whenever there is an object resting on the membrane, check to ensure the membrane is protected from damage.

Sump Pit
For sump pits, if applicable, an active (fan driven) radon reduction system can have its performance reduced if the sump pit cover is not tightly sealed. An unsealed sump cover may result in conditioned air from inside the building being removed instead of radon soil gas only being removed from beneath the slab as intended. The sump cover's condition should be periodically inspected to ensure the integrity of its seals. This includes checking if gaskets are in good condition, and mechanical fasteners are installed to hold the cover in place. When repairing or replacing caulking, a removable type of caulk should always be used to seal the cover. If the sump basin requires maintenance, restore it to the original condition immediately after completing the work.

Foundation
Foundation settling, renovations (including openings associated with plumbing), or additions to your building can alter the radon concentrations in your building. You should test your building for radon after any of the above.

Water Traps
Water traps or other devices should be fitted for drains to control sewer/soil-gas entry. Where water traps are installed, they should be refilled periodically to replace evaporated water.

Radon Alarms
Where Home Radon Alarms are installed, they should be sent to recalibration every two years at least one week before the calibration certificate expires.

System Pressure Gauge

Active radon reduction systems (Level 3) have a system pressure gauge that indicates the pressure in the piping system created by the radon fan. The initial pressure should have been marked by the system installer. You should regularly check the gauge to ensure the system is operating properly. If the gauge indicates a substantial change from the original marked pressure, or if it reads zero pressure, your radon reduction system may not be working properly and you should call for service. ***This gauge measures suction pressure in Inches Water Column, it does not measure radon.***

Fans

Radon fans for active systems should NEVER be turned off; if turned off, the system will no longer function as intended. The lifespan of a radon fan typically varies between five to ten years. Radon fans can cost $200-$300 to replace.

## Should I test for radon?

Your building has not yet been tested for radon. Health Canada recommends that buildings be tested for a minimum of three months, ideally between October and April. You should test your building during the first winter of occupancy, and subsequently every 5 years. Testing is easy and inexpensive.

You should have received a C-NRPP approved radon test kit from the builder at the time of occupancy.

Radon testing can be easily carried out by the homeowner using special detectors available from commercial businesses, building improvement stores, some municipalities, and many provincial lung associations. These devices are simply placed in your building, exposed to indoor air for a specified period of time and then returned to the company to be analyzed. Other businesses will send a trained technician to your building to do the testing for you. For a list of service providers you may also contact the Canadian National Radon Proficiency Program (C-NRPP) at 1 800 269-4174 or contact Health Canada at:

Radiation Protection Bureau
775 Brookfield Road,
Ottawa, Ontario Canada K1A 1C1
613-954-6647
radon@hc-sc.gc.ca

## WHERE CAN I LEARN MORE?

Visit the Health Canada Website www.canada.ca/radonor call 1-866-225-0709 for more information on radon and testing your building.

Health Canada publishes a booklet called “Radon Reduction Guide for Canadians” that will give you more information on radon, testing for radon, and reducing high levels of radon. For a free copy, visit Health Canada’s website.

***When you sell the building, this information package should be left with the building for reference by the new owners.***

# Annex G
informative
# Expected Radon Reduction

A home or building having high radon levels can have the radon levels reduced most significantly by using some variant of the active soil depressurization technique, whether that be by sub-slab depressurization or sub-membrane depressurization.  The percentage radon reduction achieved by active sub-slab depressurization for instance is typically around 90.is typically around 90% when high radon levels are present but can be as high as 99% in some cases.

Therefore in most new homes, radon levels will be able to be reduced to below the Canadian radon guideline of 200 $Bq/m^3$ value, and in fact in many instances, one should be able to reduce radon levels to below the WHO reference value of 100 $Bq/m^3$.

The intent will be to reduce radon levels to as low as reasonably achievable (ALARA).

Homes with very high radon levels (for example >10,000 $Bq/m^3$), may require more effort and expense to reduce radon levels to below the Canadian radon guideline of 200 $Bq/m^3$.

# Annex I
informative
# Radon Testing Devices

A radon testing device should be provided to the homeowners for every level of mitigation system. For Level 1 mitigation, this is required so that the homeowner knows if it is necessary to activate the system. For Levels 2 and 3, this is required to ensure the mitigation steps already taken are effective and to know if additional steps are necessary to achieve the desired radon mitigation levels.

Radon levels in a home vary significantly over time in the short term. They can rise and fall from one hour or day to the next and seasonally. For this reason, measurements taken over a longer period of time are more accurate. Health Canada recommends that homeowners do a long-term radon test, for a minimum of three months, during the fall or winter (i.e. October through April) and that the detector is placed in the lowest level of the home (where homeowners spend a minimum of 4 hours per day (i.e. fixed basement). A three-month test represents a person's annual average exposure and should be used to determine if a home's radon concentration exceeds the Canadian radon guideline level of 200 $Bq/m^3$.

The long term radon detectors that are most commonly used in Canada are alpha track detectors (ATD) and electret ion chambers (EIC). For a list of Canadian National Radon Proficiency Program (C-NRPP) approved long-term measurement devices please go to http://c-nrpp.ca/approved-radon-measurement-devices. The builder/mitigator can choose which certified and approved long-term radon testing device they provide to the homeowner. Instructions on how to use the device must also be provided to the homeowner, and usually they are provided with the testing device packaging.

Digital radon monitors for short- and long-term testing typically sold to homeowners are also available on the market, however, they have not yet been evaluated and approved by the Canadian National Radon Proficiency Program (C-NRPP). If and when they are approved, these devices may be an option for builders/mitigators to provide to homeowners.

More information on radon measurement can be found in Health Canada's radon measurement guides for homes: http://www.hc-sc.gc.ca/ewh-semt/pubs/radiation/radon_homes-maisons/index-eng.php

References:
*Radon Reduction Guide for Canadians*. Health Canada. Publication date: November 2013. Pages 8, 10

# **Annex J** informative
# Communication Testing

Communication testing is conducted when a sub-slab depressurization system is selected as a potential mitigation method to lower radon concentrations within a building. It involves the manipulation of air pressure under a floor slab from a suction point which is typically generated using a shop vacuum. Pressure differentials that are generated under the floor slab are measured at representative test point locations throughout the slab. The areas under the slab where the pressure differentials are impacted by the vacuum being applied defines the extent of the pressure field extension, which is also known as communication. The practice of conducting these measurements to determine the degree of pressure field extension under the slab is known as communication testing. Pressure and air flow readings measured at the suction point, in addition to pressure readings at the test point locations, are used to determine sub-slab depressurization system requirements such as: number and size of fans and the location of the suction point(s).

For more information, please refer to Health Canada's *Reducing Radon in Existing Homes: A Canadian Guide for Professional Contractors*.

# Annex K
informative
# Terms, Definitions & Conversions

### Table K-1 Select System International (SI) Prefixes

| Prefix | Name | Units |
|---|---|---|
| ρ | pico | $10^{-12}$ |
| *n* | nano | $10^{-9}$ |
| µ | micro | $10^{-6}$ |
| m | milli | $10^{-3}$ |
| k | kilo | $10^{3}$ |
| M | Mega | $10^{6}$ |
| G | Giga | $10^{9}$ |

### Table K-2 Terms, Definitions & Conversions

| Term | Definition | Conversion |
|---|---|---|
| ACH | Air Changes per Hour – the rate at which the air inside a house, escapes or is forced out and replaced by outdoor air To calculate fan-assisted air changes per hour in a house, divide the capacity of the fan (expressed as air volume per hour) by the **10.1.1** volume of the house (make sure volume is expressed in same base units). Also **10.1.2** referred to as ventilation rate. | Not applicable. |
| Bq | Becquerel – an SI measure of the rate at which radiation is emitted by a radioactive source. It is expressed as the number of radioactive decays per second (dps). | 1 Bq = 1 dps = 27 pCi |
| $Bq/m^3$ | Becquerels per cubic metre – an SI measure of (Rn) activity concentration in a cubic meter volume of air. | 1 $Bq/m^3$ = 0.027 ρCi/L |
| Ci | Curie – a conventional (non-SI) measure of the rate at which radiation is emitted by a radioactive source. Originally defined as the decay rate of 1 gram of Ra, i.e., approximately $3.7 \times 10^{10}$ dps. | 1 Ci = $3.7 \times 10^{10}$ dps<br>= $37 \times 10^{9}$ Bq |
| CFM | Cubic Feet per Minute – a conventional (non-SI) measure of the capacity of a fan or other air-moving device, to move a cubic foot volume of air in a one minute period. The volumetric flow rate expressed as the volume of fluid (air) passing through a given volume per unit time. | 1 $ft^3/min$ = 1.699 $m^3/h$ |
| CMH | Cubic Metres per Hour – an SI measure of the capacity of a fan or other air-moving device, to move a cubic metre volume of air in a one hour period. The volumetric flow rate expressed as the volume of fluid (air) passing through a given volume per unit time. | 1 $m^3/h$ = 0.589 $ft^3/min$ |
| eV<br>eV | electron volt – the energy required to raise an electron through a potential difference of 1 volt. | Not applicable. |

| Term | Definition | Conversion |
|---|---|---|
| In,WC<br><br>In. WC | Inches (of) Water Column – a conventional measure of pressure, 1 in. WC = 249 Pascal. Also written as Water Column [inch]. | 1 In. WC = 249 Pa |
| Pa | Pascal – an SI measure of pressure. | 1 Pa = 0.004 In. WC |
| ρCi | Picocurie $10^{-12}$ curies or 0.037 Becquerels or 0.037 decays per second. | 1 ρCi = 0.037 Bq |
| ρCi/L | picocuries per litre – a non-SI measure of (Rn) activity concentration in one litre of | 1 ρCi/L = 37 $Bq/m^3$ |

C

# Annex M
informative
# Radon Risk

From 2009 to 2011 Health Canada conducted a two year study in order to begin to define the distribution of indoor radon levels in Canada. The study covered all geographic areas of Canada and involved long-term (3 -months or more) radon measurements conducted during the heating season.

The results of this study showed that there are no areas of Canada that are radon free. The results from the various areas of Canada (2007 Health Regions were used as geographic boundaries) are shown in Table 1 below. The data are shown as the percentage of homes in each Health Region that tested above the radon guideline of 200 Bq/m3. Also provided below are maps which show the geographic boundaries of the various Health Regions used in the study.

The data in this Annex can be used by authorities to help them to determine which areas of the country might be served best by the 3 Levels of radon mitigation:

Level 1 = 2010 National Building Code Rough-In For Active Soil Depressurization

Level 2 = - Full Passive Vertical Radon Stack

Level 3 = Full Active Soil Depressurization System (Level 2 plus a fan)

The level of radon in a completed home cannot be predicted; hence all homeowners need to test their homes for radon, ideally by conducting a long term test during the first heating season after completion of the home.

It may also be useful for authorities to base the decision to adopt one of the 3 levels described in this standard on the basis of a cost benefit analysis. Such a cost benefit analysis is beyond the scope of this national standard but could include an analysis of the incremental costs of each of the 3 levels of protection described in this standard at the time of construction, in combination with the costs of lung cancer treatment, survival rates, years of life lost, and estimated incidence of radon induced lung cancer given the percentage of homes that tested above the guideline in various areas from the study referenced in this Annex.

While, most provinces and territories already require protection from radon similar to Level 1 in all homes, Level 2 and Level 3 requirements in this national standard are intended for higher risk areas. In areas where significant proportions of homes are likely to test above the 200 Bq/m$^3$ radon guideline, authorities may find it prudent to adopt either a Level 2 or Level 3 protection in new construction. Level 1 will offer a basic level of reduction of radon ingress, whereas Level 2 is a full passive radon reduction system which intermittently reduces indoor radon levels due to the stack effect and does not require any electrical power. A Level 2 system will typically reduce radon levels by 50% and only requires a small incremental cost over the basic Level 1 system. Level 3 is the most effective radon reduction system, often reducing the radon level in a home by >90%, but requires a fan to be operating continuously. The incremental cost of Level 3 over Level 2 at construction is roughly the cost of a fan and wiring it plus the annual electricity costs of a low wattage fan. The fan will likely need to be replaced roughly every 7-10 years. A Level 2 full passive vertical radon stack will lead to significant radon reductions in new construction without requiring any electrical power or ongoing maintenance costs. Since radon induced lung cancer is believed to follow a linear no threshold risk profile, many lung cancers occur at radon levels below the 200 Bq/m$^3$ guideline value. An approximately 50% reduction in radon exposure offered by a Level 2 (full passive radon stack) system will result in a significant reduction in radon exposure and risk from radon-induced lung cancer whether homes are tested or not. Those homes which test high after occupancy can easily convert to an active Level 3 system for a small incremental cost and would yield a further significant reduction in radon exposure.

Table 1 below shows results from the large cross-Canada residential radon survey conducted by Health Canada from 2009-11. The survey was based on the geography of the 2007 Health Regions shown by the maps of various provinces and territories which follow below after Table 1.

**Table M-1: Raw Percentage of Homes Tested with Radon Concentrations Below 200 Bq/m3, Between 200 and 600 Bq/m3, Above 600 Bq/m3 and Above 200 Bq/m3 for Each Health Region**

| Prov/ Terr | Health Region | Health Region Name | Number of Homes | % Below 200 Bq/m3 | % 200 to 600 Bq/m3 | % Above 600 Bq/m3 | % Above 200 Bq/m3 |
|---|---|---|---|---|---|---|---|
| NL | 1011 | Eastern Regional Integrated Health Authority | 100 | 96 | 4 | 0 | 4 |
| NL | 1012 | Central Regional Integrated Health Authority | 201 | 95 | 3 | 2 | 5 |
| NL | 1013 | Western Regional Integrated Health Authority | 211 | 89.6 | 8.5 | 1.9 | 10.4 |
| NL | 1014 | Labrador-Grenfell Regional Integrated Health Authority | 201 | 97 | 2.5 | 0.5 | 3 |
| PE | 1111 | Prince Edward Island | 113 | 96.5 | 3.5 | 0 | 3.5 |
| NS | 1201 | Zone 1 | 97 | 93.8 | 4.1 | 2.1 | 6.2 |
| NS | 1202 | Zone 2 | 106 | 95.3 | 2.8 | 1.9 | 4.7 |
| NS | 1203 | Zone 3 | 95 | 87.4 | 9.5 | 3.1 | 12.6 |
| NS | 1204 | Zone 4 | 99 | 98 | 2 | 0 | 2 |
| NS | 1205 | Zone 5 | 92 | 85.9 | 7.6 | 6.5 | 14.1 |
| NS | 1206 | Zone 6 | 103 | 86.4 | 11.7 | 1.9 | 13.6 |
| NB | 1301 | Region 1 | 106 | 80.2 | 16 | 3.8 | 19.8 |
| NB | 1302 | Region 2 | 101 | 89.1 | 9.9 | 1 | 10.9 |
| NB | 1303 | Region 3 | 112 | 83 | 10.7 | 6.3 | 17 |
| NB | 1304 | Region 4 | 86 | 70.9 | 24.4 | 4.7 | 29.1 |
| NB | 1305 | Region 5 | 110 | 76.4 | 19.1 | 4.5 | 23.6 |
| NB | 1306 | Region 6 | 115 | 60 | 23.5 | 16.5 | 40 |
| NB | 1307 | Region 7 | 200 | 71 | 24 | 5 | 29 |
| QC | 2401 | Région du Bas-Saint-Laurent | 171 | 86 | 12.3 | 1.7 | 14 |
| QC | 2402 | Région du Saguenay - Lac-Saint-Jean | 72 | 97.2 | 1.4 | 1.4 | 2.8 |
| QC | 2403 | Région de la Capitale-Nationale | 160 | 91.2 | 6.3 | 2.5 | 8.8 |
| QC | 2404 | Région de la Mauricie et du Centre-du-Québec | 59 | 100 | 0 | 0 | 0 |
| QC | 2405 | Région de l'Estrie | 54 | 90.7 | 9.3 | 0 | 9.3 |
| QC | 2406 | Région de Montréal | 73 | 93.1 | 6.9 | 0 | 6.9 |
| QC | 2407 | Région de l'Outaouais | 62 | 87.1 | 8.1 | 4.8 | 12.9 |
| QC | 2408 | Région de l'Abitibi-Témiscamingue | 69 | 95.7 | 4.3 | 0 | 4.3 |
| QC | 2409 | Région de la Côte-Nord | 106 | 96.2 | 3.8 | 0 | 3.8 |
| QC | 2410 | Région du Nord-du-Québec | 224 | 94.2 | 5.8 | 0 | 5.8 |

| Prov/ Terr | Health Region | Health Region Name | Number of Homes | % Below 200 Bq/m3 | % 200 to 600 Bq/m3 | % Above 600 Bq/m3 | % Above 200 Bq/m3 |
|---|---|---|---|---|---|---|---|
| QC | 2411 | Région de la Gaspésie - Îles-de-la-Madeleine | 174 | 74.7 | 21.8 | 3.5 | 25.3 |
| QC | 2412 | Région de la Chaudière-Appalaches | 175 | 86.9 | 12.5 | 0.6 | 13.1 |
| QC | 2413 | Région de Laval | 107 | 87.9 | 11.2 | 0.9 | 12.1 |
| QC | 2414 | Région de Lanaudière | 76 | 96.1 | 3.9 | 0 | 3.9 |
| QC | 2415 | Région des Laurentides | 78 | 89.7 | 9 | 1.3 | 10.3 |
| QC | 2416 | Région de la Montérégie | 112 | 91.1 | 8.9 | 0 | 8.9 |
| QC | 2417 | Région du Nunavik | 9 | 88.9 | 11.1 | 0 | 11.1 |
| QC | 2418 | Région des Terres-Cries-de-la-Baie-James | 3 | 100 | 0 | 0 | 0 |
| ON | 3526 | District of Algoma Health Unit | 93 | 91.4 | 7.5 | 1.1 | 8.6 |
| ON | 3527 | Brant County Health Unit | 96 | 89.6 | 9.4 | 1 | 10.4 |
| ON | 3530 | Durham Regional Health Unit | 95 | 100 | 0 | 0 | 0 |
| ON | 3531 | Elgin-St. Thomas Health Unit | 92 | 92.4 | 6.5 | 1.1 | 7.6 |
| ON | 3533 | Grey Bruce Health Unit | 99 | 88.9 | 10.1 | 1 | 11.1 |
| ON | 3534 | Haldimand-Norfolk Health Unit | 116 | 97.4 | 2.6 | 0 | 2.6 |
| ON | 3535 | Haliburton, Kawartha, Pine Ridge District Health Unit | 98 | 93.9 | 5.1 | 1 | 6.1 |
| ON | 3536 | Halton Regional Health Unit | 102 | 95.1 | 4.9 | 0 | 4.9 |
| ON | 3537 | City of Hamilton Health Unit | 100 | 95 | 5 | 0 | 5 |
| ON | 3538 | Hastings and Prince Edward Counties Health Unit | 99 | 87.9 | 10.1 | 2 | 12.1 |
| ON | 3539 | Huron County Health Unit | 109 | 89 | 10.1 | 0.9 | 11 |
| ON | 3540 | Chatham-Kent Health Unit | 201 | 81.6 | 15.4 | 3 | 18.4 |
| ON | 3541 | Kingston, Frontenac and Lennox and Addington Health Unit | 99 | 88.9 | 10.1 | 1 | 11.1 |
| ON | 3542 | Lambton Health Unit | 176 | 91.5 | 7.9 | 0.6 | 8.5 |
| ON | 3543 | Leeds, Grenville and Lanark District Health Unit | 108 | 80.6 | 17.6 | 1.8 | 19.4 |
| ON | 3544 | Middlesex-London Health Unit | 109 | 98.2 | 1.8 | 0 | 1.8 |
| ON | 3546 | Niagara Regional Area Health Unit | 100 | 98 | 0 | 2 | 2 |
| ON | 3547 | North Bay Parry Sound District Health Unit | 104 | 98.1 | 1.9 | 0 | 1.9 |
| ON | 3549 | Northwestern Health Unit | 209 | 86.1 | 12 | 1.9 | 13.9 |
| ON | 3551 | City of Ottawa Health Unit | 64 | 93.8 | 6.2 | 0 | 6.2 |
| ON | 3552 | Oxford County Health Unit | 104 | 88.5 | 10.6 | 0.9 | 11.5 |
| ON | 3553 | Peel Regional Health Unit | 89 | 100 | 0 | 0 | 0 |
| ON | 3554 | Perth District Health Unit | 108 | 88 | 11.1 | 0.9 | 12 |
| ON | 3555 | Peterborough County-City Health Unit | 112 | 90.2 | 8.9 | 0.9 | 9.8 |
| ON | 3556 | Porcupine Health Unit | 96 | 99 | 1 | 0 | 1 |
| ON | 3557 | Renfrew County and District Health Unit | 100 | 91 | 8 | 1 | 9 |
| ON | 3558 | Eastern Ontario Health Unit | 99 | 93.9 | 5.1 | 1 | 6.1 |
| ON | 3560 | Simcoe Muskoka District Health Unit | 110 | 99.1 | 0.9 | 0 | 0.9 |
| ON | 3561 | Sudbury and District Health Unit | 97 | 94.9 | 4.1 | 1 | 5.1 |

| Prov/ Terr | Health Region | Health Region Name | Number of Homes | % Below 200 Bq/m3 | % 200 to 600 Bq/m3 | % Above 600 Bq/m3 | % Above 200 Bq/m3 |
|---|---|---|---|---|---|---|---|
| ON | 3562 | Thunder Bay District Health Unit | 108 | 88 | 11.1 | 0.9 | 12 |
| ON | 3563 | Timiskaming Health Unit | 102 | 92.2 | 6.8 | 1 | 7.8 |
| ON | 3565 | Waterloo Health Unit | 101 | 96 | 4 | 0 | 4 |
| ON | 3566 | Wellington-Dufferin-Guelph Health Unit | 92 | 89.1 | 8.7 | 2.2 | 10.9 |
| ON | 3568 | Windsor-Essex County Health Unit | 195 | 86.2 | 12.8 | 1 | 13.8 |
| ON | 3570 | York Regional Health Unit | 95 | 100 | 0 | 0 | 0 |
| ON | 3595 | City of Toronto Health Unit | 73 | 97.3 | 2.7 | 0 | 2.7 |
| MB | 4610 | Winnipeg Regional Health Authority | 66 | 87.9 | 12.1 | 0 | 12.1 |
| MB | 4615 | Brandon Regional Health Authority | 79 | 55.7 | 40.5 | 3.8 | 44.3 |
| MB | 4620 | North Eastman Regional Health Authority | 100 | 79 | 20 | 1 | 21 |
| MB | 4625 | South Eastman Regional Health Authority | 113 | 90.3 | 9.7 | 0 | 9.7 |
| MB | 4630 | Interlake Regional Health Authority | 121 | 75.2 | 24.8 | 0 | 24.8 |
| MB | 4640 | Central Regional Health Authority | 108 | 57.4 | 35.2 | 7.4 | 42.6 |
| MB | 4645 | Assiniboine Regional Health Authority | 110 | 65.5 | 32.7 | 1.8 | 34.5 |
| MB | 4660 | Parkland Regional Health Authority | 122 | 56.6 | 31.9 | 11.5 | 43.4 |
| MB | 4670 | Norman Regional Health Authority | 212 | 87.7 | 11.8 | 0.5 | 12.3 |
| MB | 4685 | Burntwood/Churchill | 152 | 92.1 | 7.2 | 0.7 | 7.9 |
| SK | 4701 | Sun Country Regional Health Authority | 116 | 85.3 | 14.7 | 0 | 14.7 |
| SK | 4702 | Five Hills Regional Health Authority | 118 | 87.3 | 11.9 | 0.8 | 12.7 |
| SK | 4703 | Cypress Regional Health Authority | 106 | 74.5 | 23.6 | 1.9 | 25.5 |
| SK | 4704 | Regina Qu'Appelle Regional Health Authority | 94 | 74.5 | 21.3 | 4.2 | 25.5 |
| SK | 4705 | Sunrise Regional Health Authority | 108 | 75 | 25 | 0 | 25 |
| SK | 4706 | Saskatoon Regional Health Authority | 76 | 92.1 | 7.9 | 0 | 7.9 |
| SK | 4707 | Heartland Regional Health Authority | 111 | 80.2 | 17.1 | 2.7 | 19.8 |
| SK | 4708 | Kelsey Trail Regional Health Authority | 100 | 84 | 16 | 0 | 16 |
| SK | 4709 | Prince Albert Parkland Regional Health Authority | 108 | 92.6 | 7.4 | 0 | 7.4 |
| SK | 4710 | Prairie North Regional Health Authority | 103 | 89.3 | 10.7 | 0 | 10.7 |
| SK | 4714 | Mamawetan/Keewatin/Athabasca | 166 | 86.1 | 12.7 | 1.2 | 13.9 |
| AB | 4821 | Chinook Regional Health Authority | 111 | 91 | 8.1 | 0.9 | 9 |
| AB | 4822 | Palliser Health Region | 91 | 95.6 | 2.2 | 2.2 | 4.4 |
| AB | 4823 | Calgary Health Region | 86 | 91.9 | 8.1 | 0 | 8.1 |
| AB | 4824 | David Thompson Regional Health Authority | 107 | 92.5 | 7.5 | 0 | 7.5 |
| AB | 4825 | East Central Health | 97 | 94.9 | 4.1 | 1 | 5.1 |
| AB | 4826 | Capital Health | 73 | 98.6 | 1.4 | 0 | 1.4 |
| AB | 4827 | Aspen Regional Health Authority | 219 | 90.4 | 9.1 | 0.5 | 9.6 |
| AB | 4828 | Peace Country Health | 203 | 91.1 | 7.9 | 1 | 8.9 |
| AB | 4829 | Northern Lights Health Region | 144 | 99.3 | 0.7 | 0 | 0.7 |

| Prov/ Terr | Health Region | Health Region Name | Number of Homes | % Below 200 Bq/m3 | % 200 to 600 Bq/m3 | % Above 600 Bq/m3 | % Above 200 Bq/m3 |
|---|---|---|---|---|---|---|---|
| BC | 5911 | East Kootenay Health Service Delivery Area | 105 | 81 | 16.2 | 2.8 | 19 |
| BC | 5912 | Kootenay-Boundary Health Service Delivery Area | 109 | 70.7 | 22 | 7.3 | 29.3 |
| BC | 5913 | Okanagan Health Service Delivery Area | 109 | 82.6 | 14.7 | 2.7 | 17.4 |
| BC | 5914 | Thompson/Cariboo Health Service Delivery Area | 109 | 93.6 | 6.4 | 0 | 6.4 |
| BC | 5921 | Fraser East Health Service Delivery Area | 100 | 97 | 3 | 0 | 3 |
| BC | 5922 | Fraser North Health Service Delivery Area | 109 | 100 | 0 | 0 | 0 |
| BC | 5923 | Fraser South Health Service Delivery Area | 69 | 100 | 0 | 0 | 0 |
| BC | 5931 | Richmond Health Service Delivery Area | 54 | 100 | 0 | 0 | 0 |
| BC | 5932 | Vancouver Health Service Delivery Area | 83 | 98.8 | 1.2 | 0 | 1.2 |
| BC | 5933 | North Shore/Coast Garibaldi Health Service Delivery Area | 81 | 97.5 | 2.5 | 0 | 2.5 |
| BC | 5941 | South Vancouver Island Health Service Delivery Area | 55 | 98.2 | 1.8 | 0 | 1.8 |
| BC | 5942 | Central Vancouver Island Health Service Delivery Area | 109 | 99.1 | 0.9 | 0 | 0.9 |
| BC | 5943 | North Vancouver Island Health Service Delivery Area | 106 | 99.1 | 0.9 | 0 | 0.9 |
| BC | 5951 | Northwest Health Service Delivery Area | 211 | 94.8 | 3.8 | 1.4 | 5.2 |
| BC | 5952 | Northern Interior Health Service Delivery Area | 208 | 88 | 10.1 | 1.9 | 12 |
| BC | 5953 | Northeast Health Service Delivery Area | 200 | 90 | 9.5 | 0.5 | 10 |
| YT | 6001 | Yukon | 225 | 80.4 | 13.8 | 5.8 | 19.6 |
| NT | 6101 | Northwest Territories | 185 | 94.6 | 4.9 | 0.5 | 5.4 |
| NU | 6201 | Nunavut | 78 | 100 | 0 | 0 | 0 |

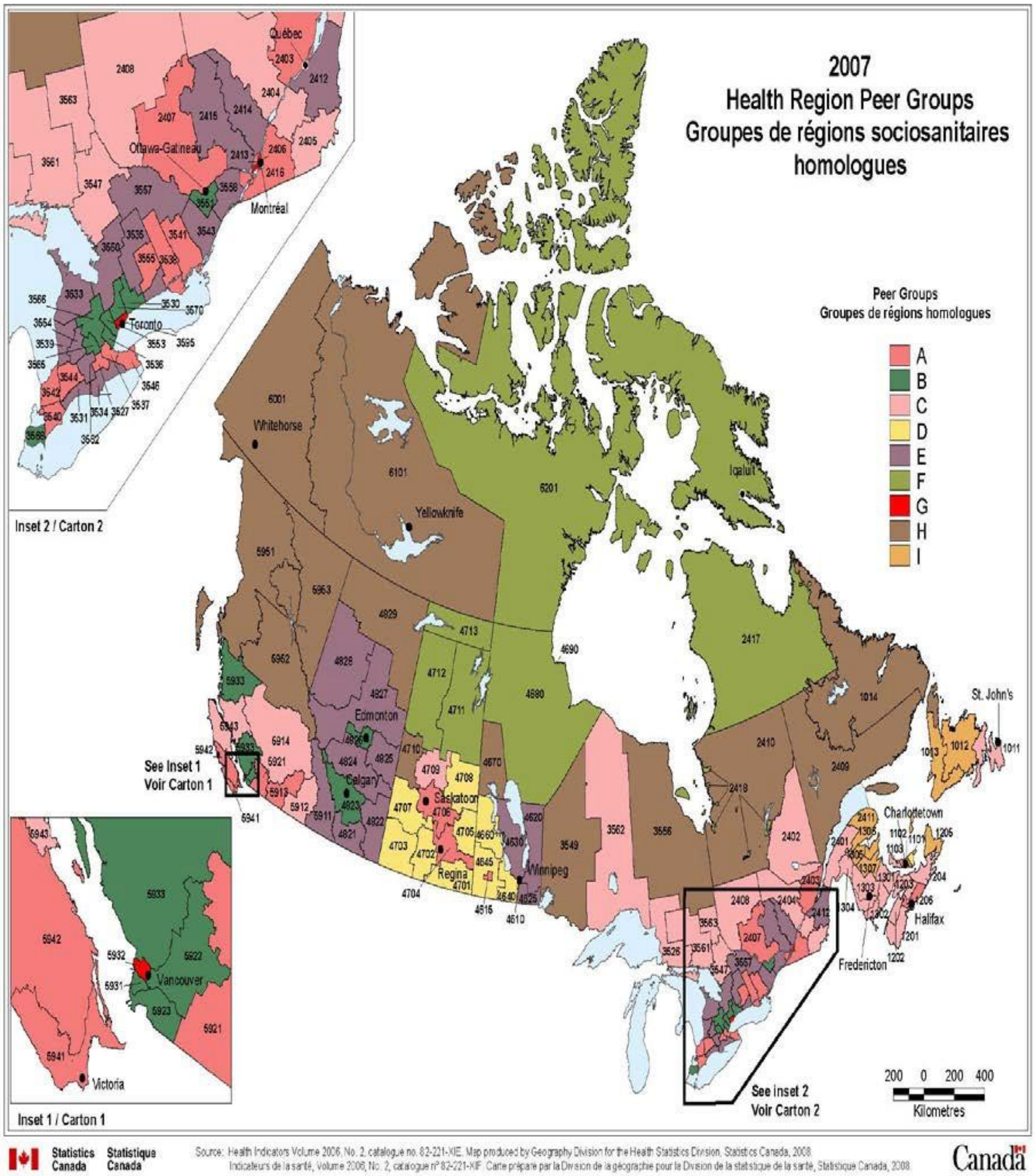

2007
Health Region Peer Groups
Groupes de régions sociosanitaires homologues
Peer Groups
Groupes de régions homologues
A
B
C
D
E
F
G
H
I
Whitehorse
Yellowknife
Iqaluit
Edmonton
Calgary
Saskatoon
Regina
Winnipeg
St. John's
Charlottetown
Halifax
Fredericton
Québec
Ottawa-Gatineau
Montréal
Toronto
Vancouver
Victoria
See Inset 1
Voir Carton 1
See inset 2
Voir Carton 2
Inset 1 / Carton 1
Inset 2 / Carton 2
200 0 200 400
Kilometres
Statistics Canada
Statistique Canada
Source: Health Indicators Volume 2006, No. 2, catalogue no. 82-221-XIE. Map produced by Geography Division for the Health Statistics Division, Statistics Canada, 2008.
Indicateurs de la santé, Volume 2006, No. 2, catalogue n° 82-221-XIF. Carte préparé par la Division de la géographie pour la Division de la statistique de la santé, Statistique Canada, 2008.
Canada

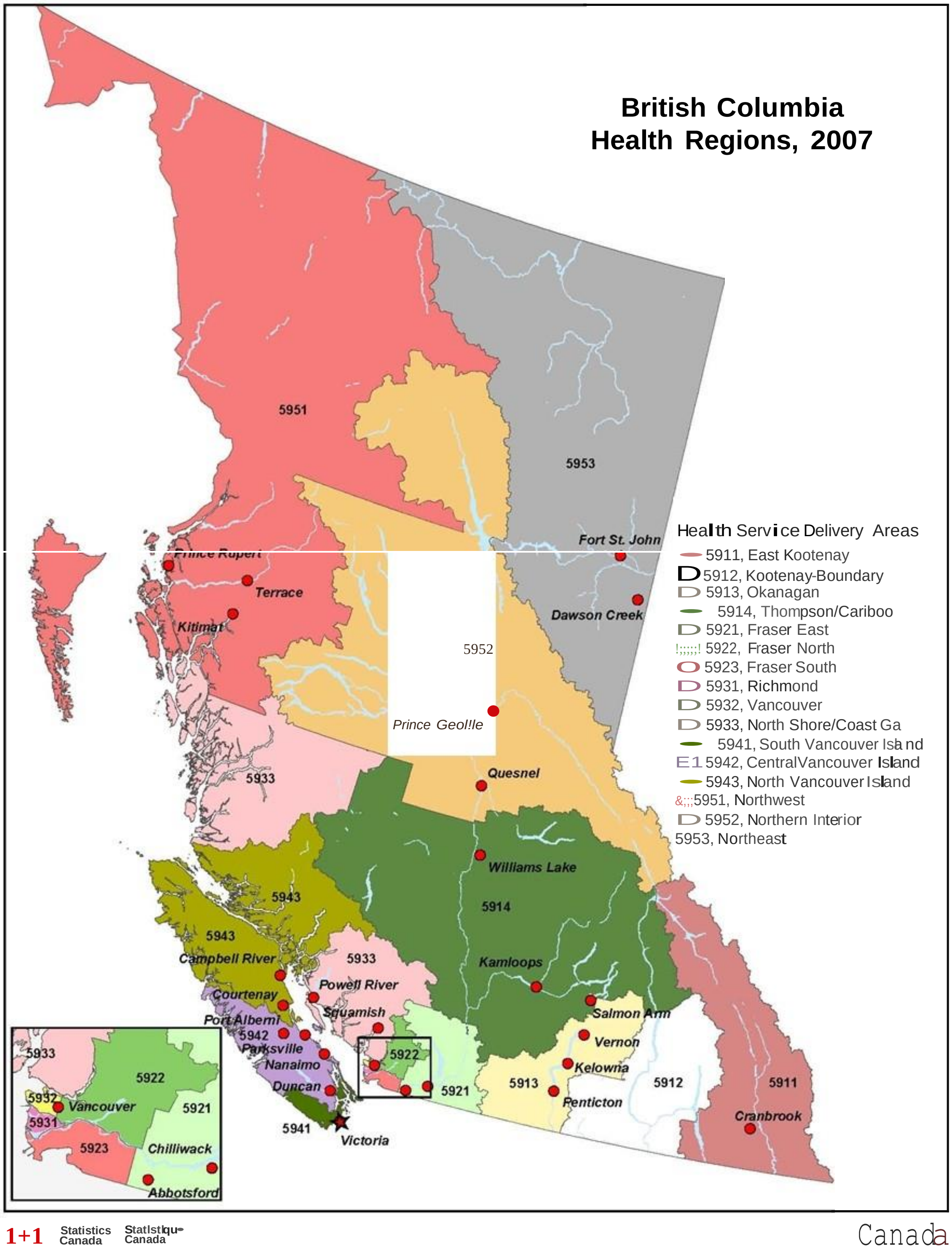
**Figure M-1**


4829
Wood Buffalo
4828
Grande Prairie
4827
Cold Lake
4826
Edmonton
Lloydminster
Camrose
4825
Wetaskiwin
4824
Red Deer
Alberta
Health Regions, 2007
Canmore
Calgary
4823
Brooks
4822
Medicine Hat
Lethbridge
4821
Regional Health Authorities
4821, Chinook Regional Health Authority
4822, Palliser Health Region
4823, Calgary Health Region
4824, David Thompson Regional Health Authority
4825, East Central Health
4826, Capital Health
4827, Aspen Regional Health Authority
4828, Peace Country Health
4829, Northern Lights Health Region
Statistics Canada
Statistique Canada
Canada

**Figure M-2**


British Columbia
Health Regions, 2007
Health Service Delivery Areas
5911, East Kootenay
5912, Kootenay-Boundary
5913, Okanagan
5914, Thompson/Cariboo
5921, Fraser East
5922, Fraser North
5923, Fraser South
5931, Richmond
5932, Vancouver
5933, North Shore/Coast Ga
5941, South Vancouver Island
5942, Central Vancouver Island
5943, North Vancouver Island
5951, Northwest
5952, Northern Interior
5953, Northeast
5951
5953
5952
5933
5943
5914
5922
5921
5913
5912
5911
5941
5942
5923
5931
5932
Prince Rupert
Terrace
Kitimat
Fort St. John
Dawson Creek
Prince George
Quesnel
Williams Lake
Kamloops
Salmon Arm
Vernon
Kelowna
Penticton
Cranbrook
Campbell River
Courtenay
Port Alberni
Parksville
Nanaimo
Duncan
Victoria
Powell River
Squamish
Vancouver
Chilliwack
Abbotsford
Statistics Canada
Statistique Canada
Canada


British Columbia
Health Regions, 2007
Health Service Delivery Areas
5911, East Kootenay
5912, Kootenay-Boundary
5913, Okanagan
5914, Thompson/Cariboo
5921, Fraser East
5922, Fraser North
5923, Fraser South
5931, Richmond
5932, Vancouver
5933, North Shore/Coast Garibaldi
5941, South Vancouver Island
5942, Central Vancouver Island
5943, North Vancouver Island
5951, Northwest
5952, Northern Interior
5953, Northeast
5951
5953
5952
5933
5943
5914
5921
5922
5913
5912
5911
5941
5942
5923
5931
5932
Prince Rupert
Terrace
Kitimat
Fort St. John
Dawson Creek
Prince George
Quesnel
Williams Lake
Kamloops
Salmon Arm
Vernon
Kelowna
Penticton
Cranbrook
Campbell River
Courtenay
Powell River
Squamish
Port Alberni
Parksville
Nanaimo
Duncan
Victoria
Vancouver
Chilliwack
Abbotsford
Statistics Canada
Statistique Canada
Canada

**Figure M-3**

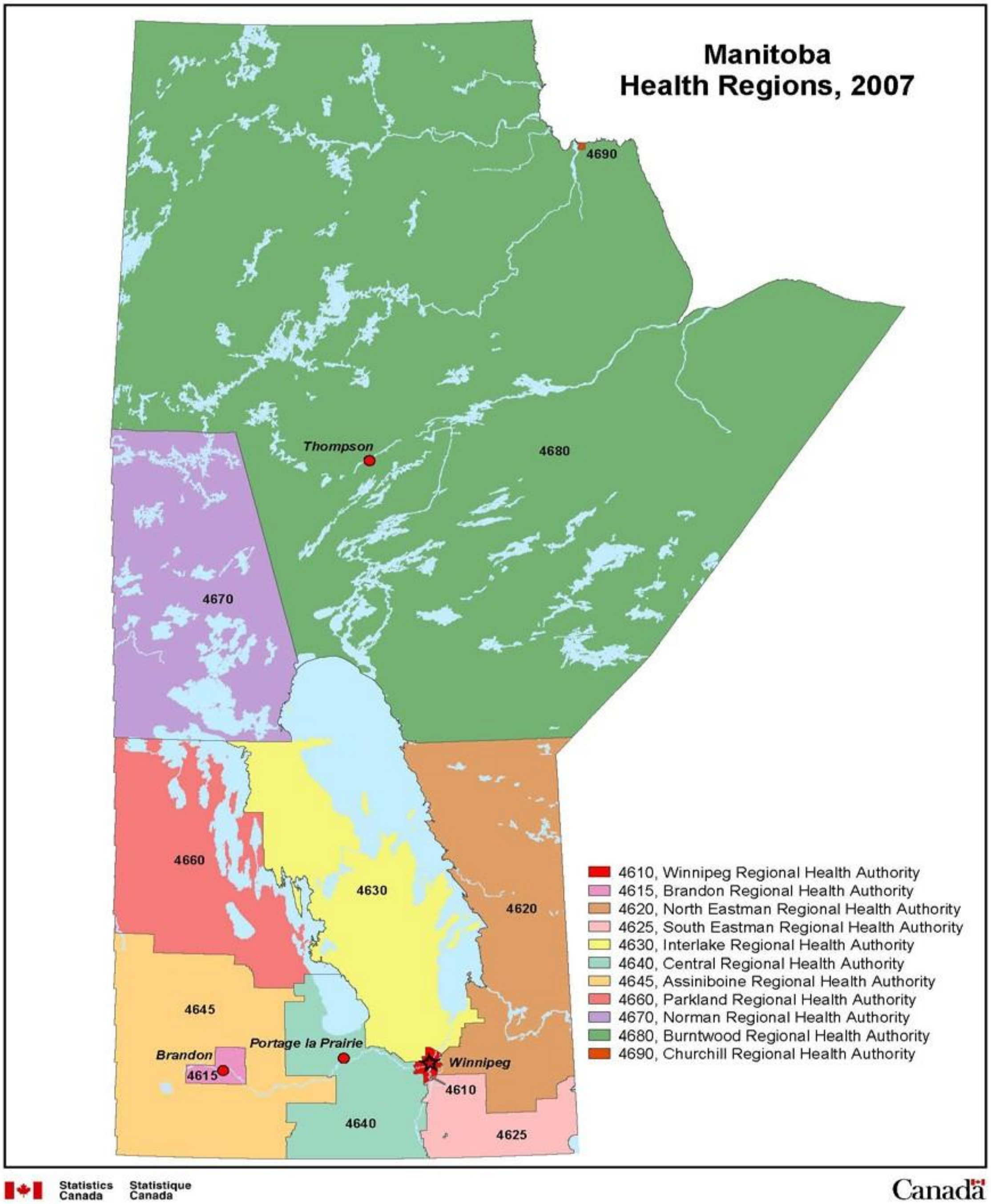

Manitoba
Health Regions, 2007
4690
Thompson
4680
4670
4660
4630
4620
4645
Portage la Prairie
Brandon
4615
Winnipeg
4610
4640
4625
4610, Winnipeg Regional Health Authority
4615, Brandon Regional Health Authority
4620, North Eastman Regional Health Authority
4625, South Eastman Regional Health Authority
4630, Interlake Regional Health Authority
4640, Central Regional Health Authority
4645, Assiniboine Regional Health Authority
4660, Parkland Regional Health Authority
4670, Norman Regional Health Authority
4680, Burntwood Regional Health Authority
4690, Churchill Regional Health Authority
Statistics Canada Statistique Canada
Canada

**Figure M-4**

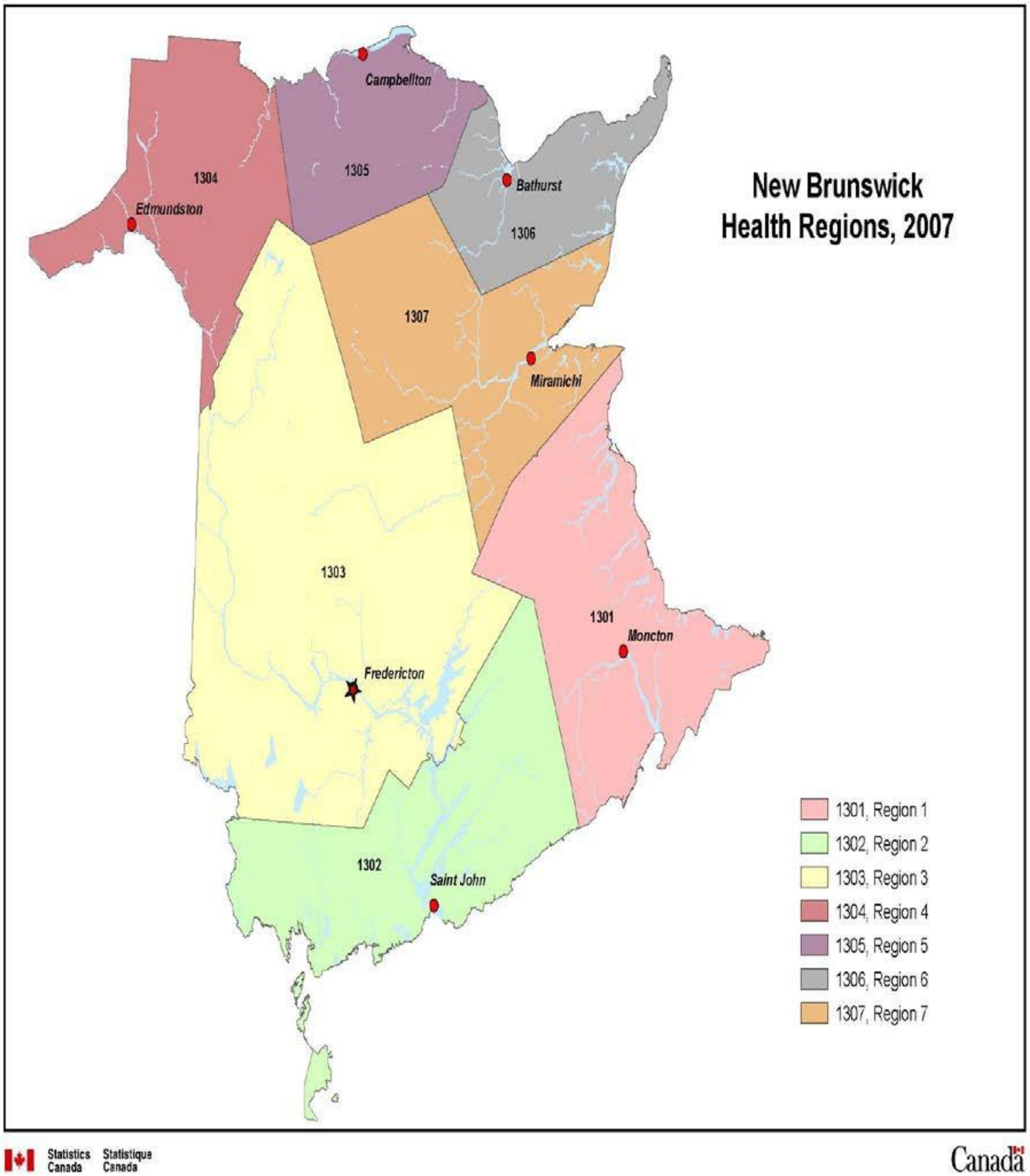

New Brunswick
Health Regions, 2007
Campbellton
Bathurst
Edmundston
Miramichi
Moncton
Fredericton
Saint John
1301
1302
1303
1304
1305
1306
1307
1301, Region 1
1302, Region 2
1303, Region 3
1304, Region 4
1305, Region 5
1306, Region 6
1307, Region 7
Statistics Canada
Statistique Canada
Canada

**Figure M-5**

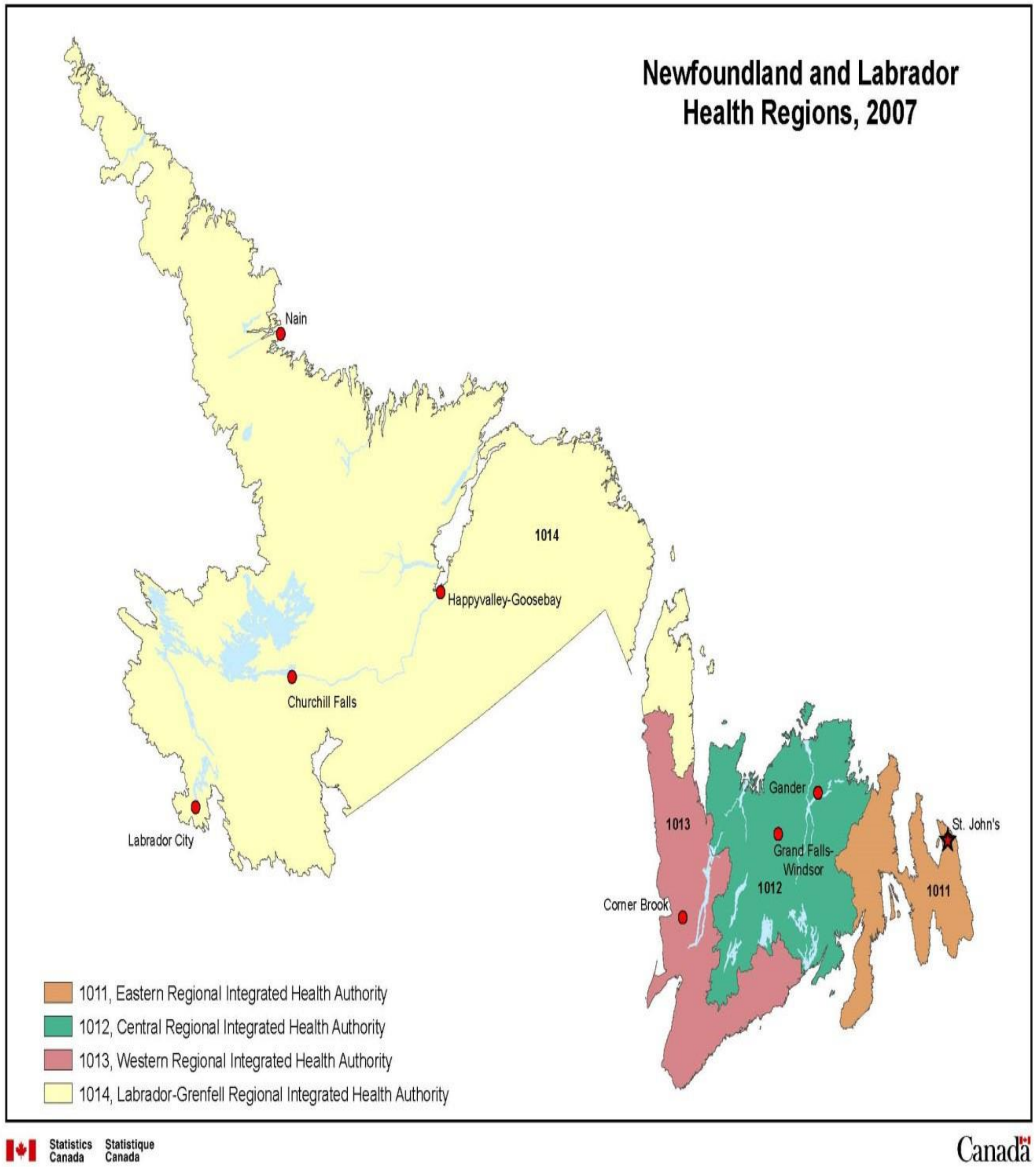
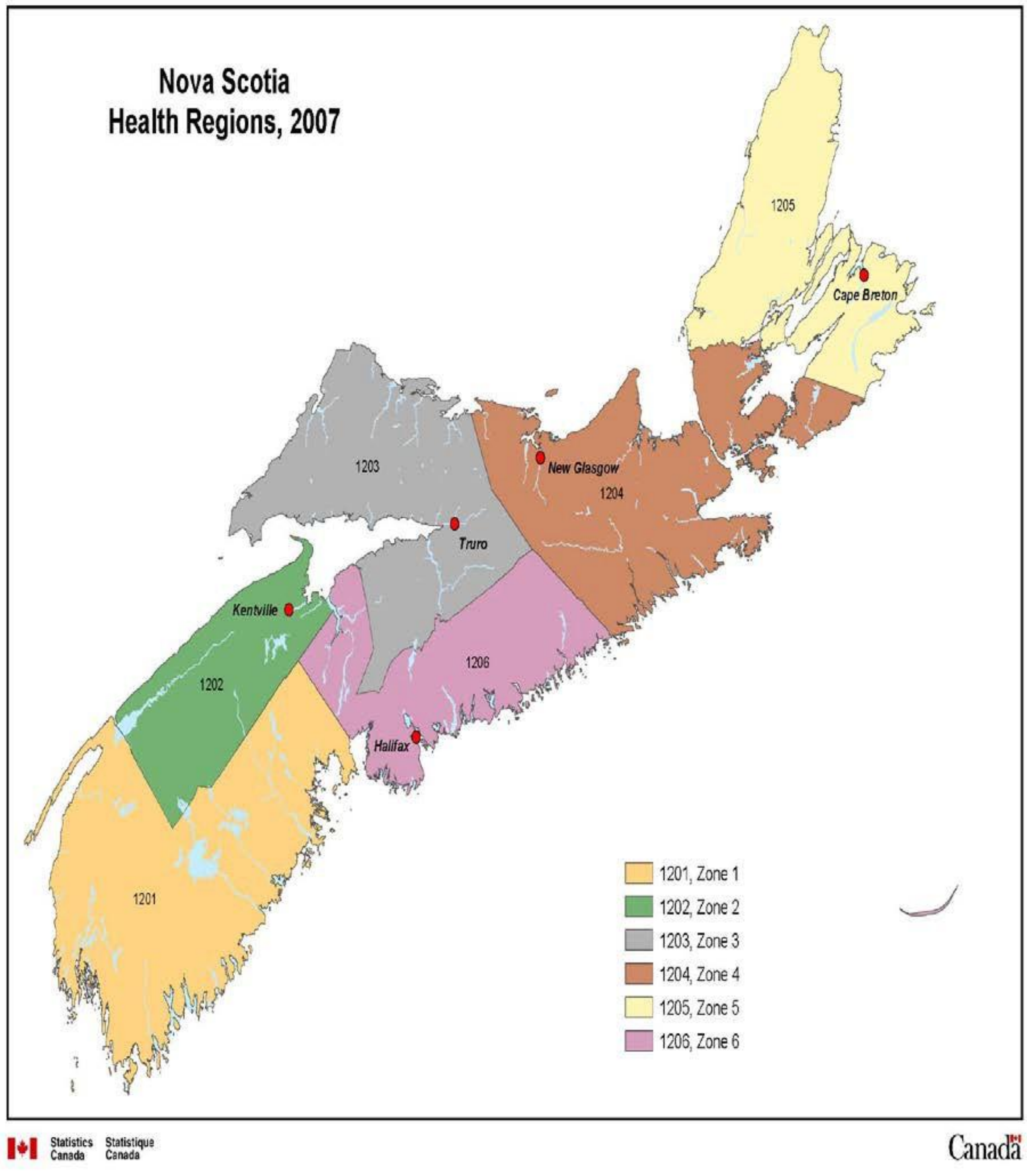

Newfoundland and Labrador
Health Regions, 2007
Nain
1014
Happyvalley-Goosebay
Churchill Falls
Labrador City
Gander
1013
St. John's
Grand Falls-
Windsor
1012
1011
Corner Brook
1011, Eastern Regional Integrated Health Authority
1012, Central Regional Integrated Health Authority
1013, Western Regional Integrated Health Authority
1014, Labrador-Grenfell Regional Integrated Health Authority
Statistics Canada
Statistique Canada
Canada

**Figure M-6**



Nova Scotia
Health Regions, 2007
1205
Cape Breton
1203
New Glasgow
1204
Truro
Kentville
1202
1206
Halifax
1201
1201, Zone 1
1202, Zone 2
1203, Zone 3
1204, Zone 4
1205, Zone 5
1206, Zone 6
Statistics Canada
Statistique Canada
Canada


**Figure M-7**

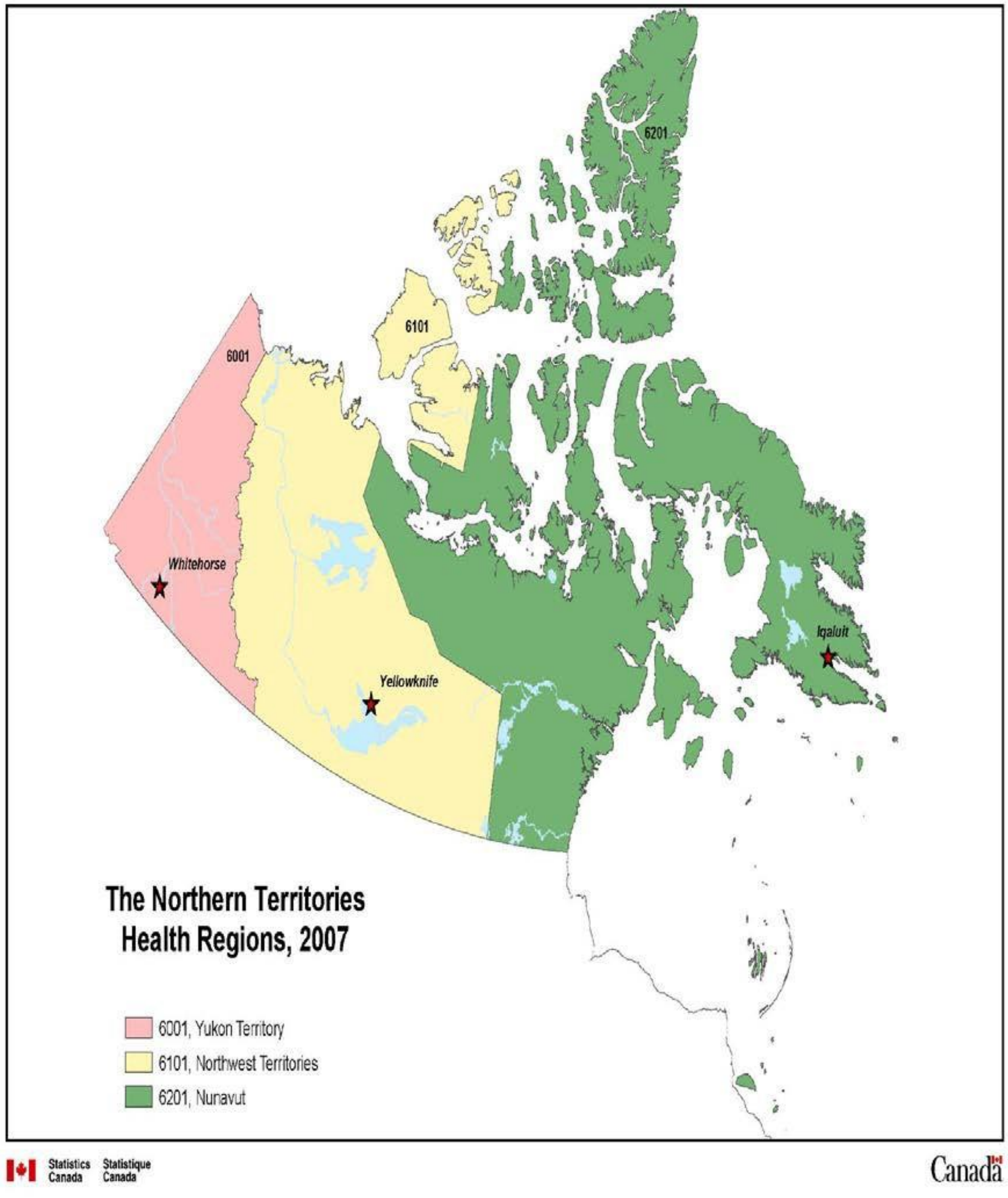

6201
6101
6001
Whitehorse
Yellowknife
Iqaluit
The Northern Territories
Health Regions, 2007
6001, Yukon Territory
6101, Northwest Territories
6201, Nunavut
Statistics Canada
Statistique Canada
Canada

**Figure M-8**

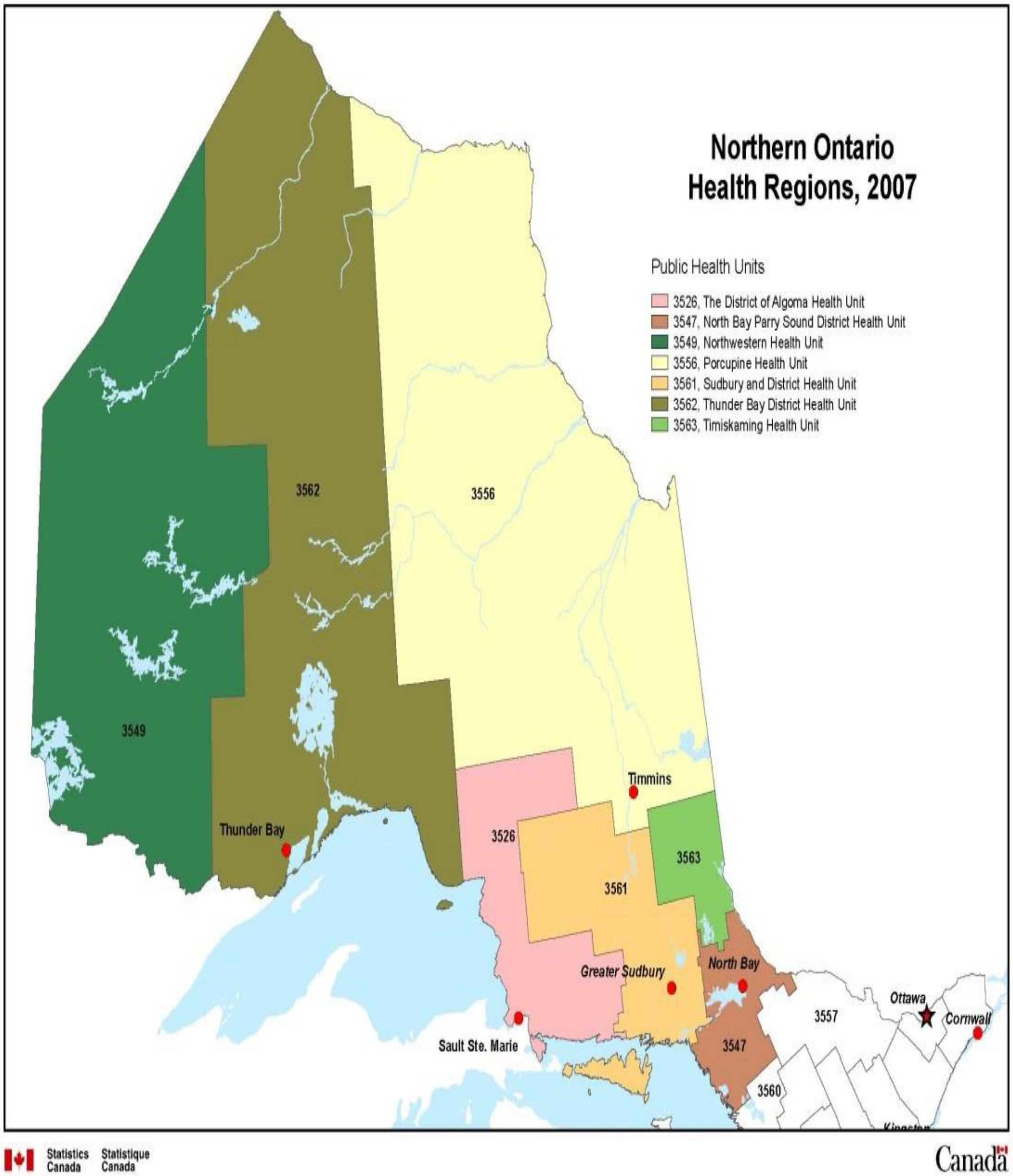
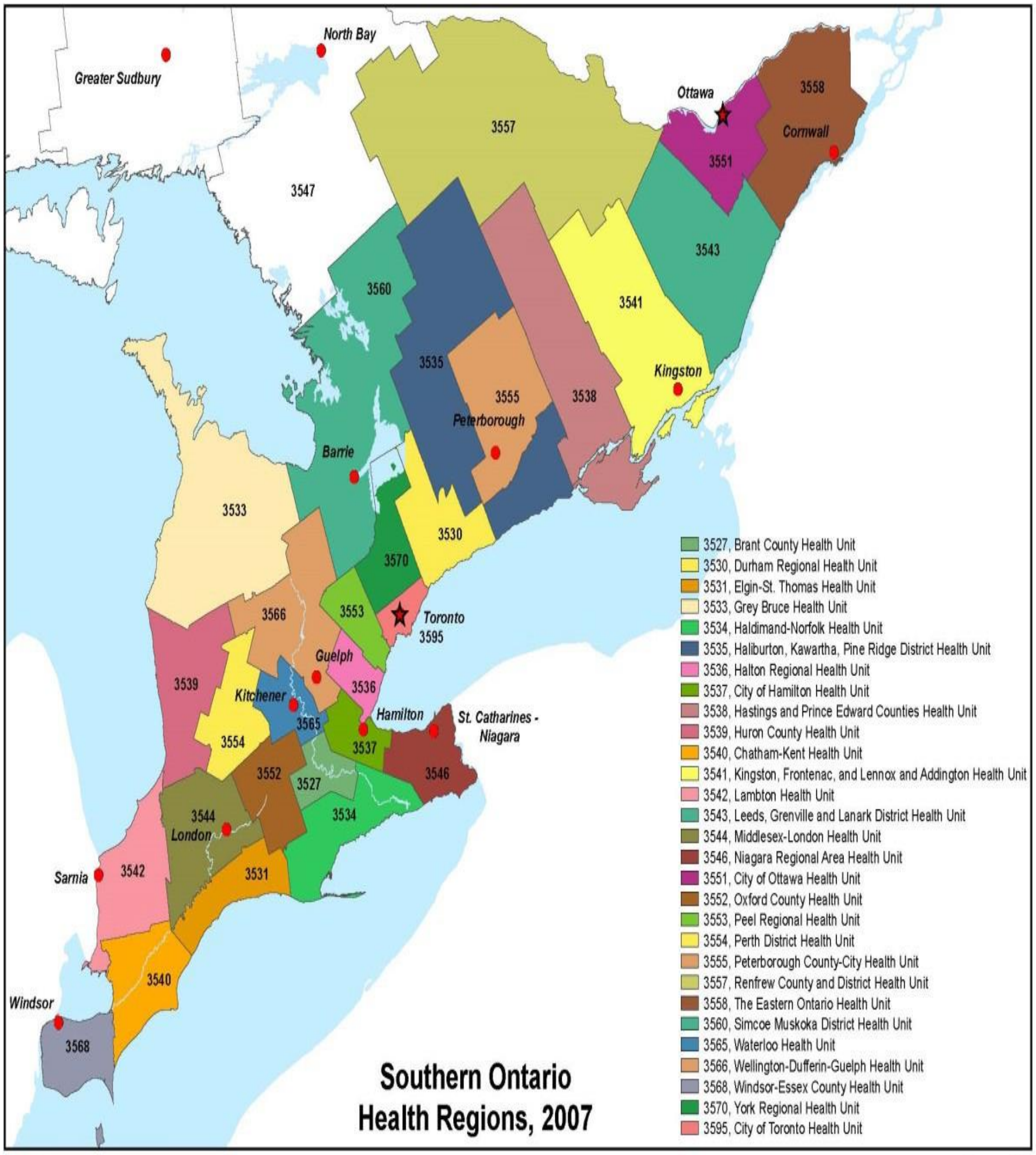

Northern Ontario
Health Regions, 2007
Public Health Units
3526, The District of Algoma Health Unit
3547, North Bay Parry Sound District Health Unit
3549, Northwestern Health Unit
3556, Porcupine Health Unit
3561, Sudbury and District Health Unit
3562, Thunder Bay District Health Unit
3563, Timiskaming Health Unit
3562
3556
3549
Timmins
Thunder Bay
3526
3563
3561
Greater Sudbury
North Bay
Ottawa
3557
Cornwall
Sault Ste. Marie
3547
3560
Statistics Canada
Statistique Canada
Canada

**Figure M-9**

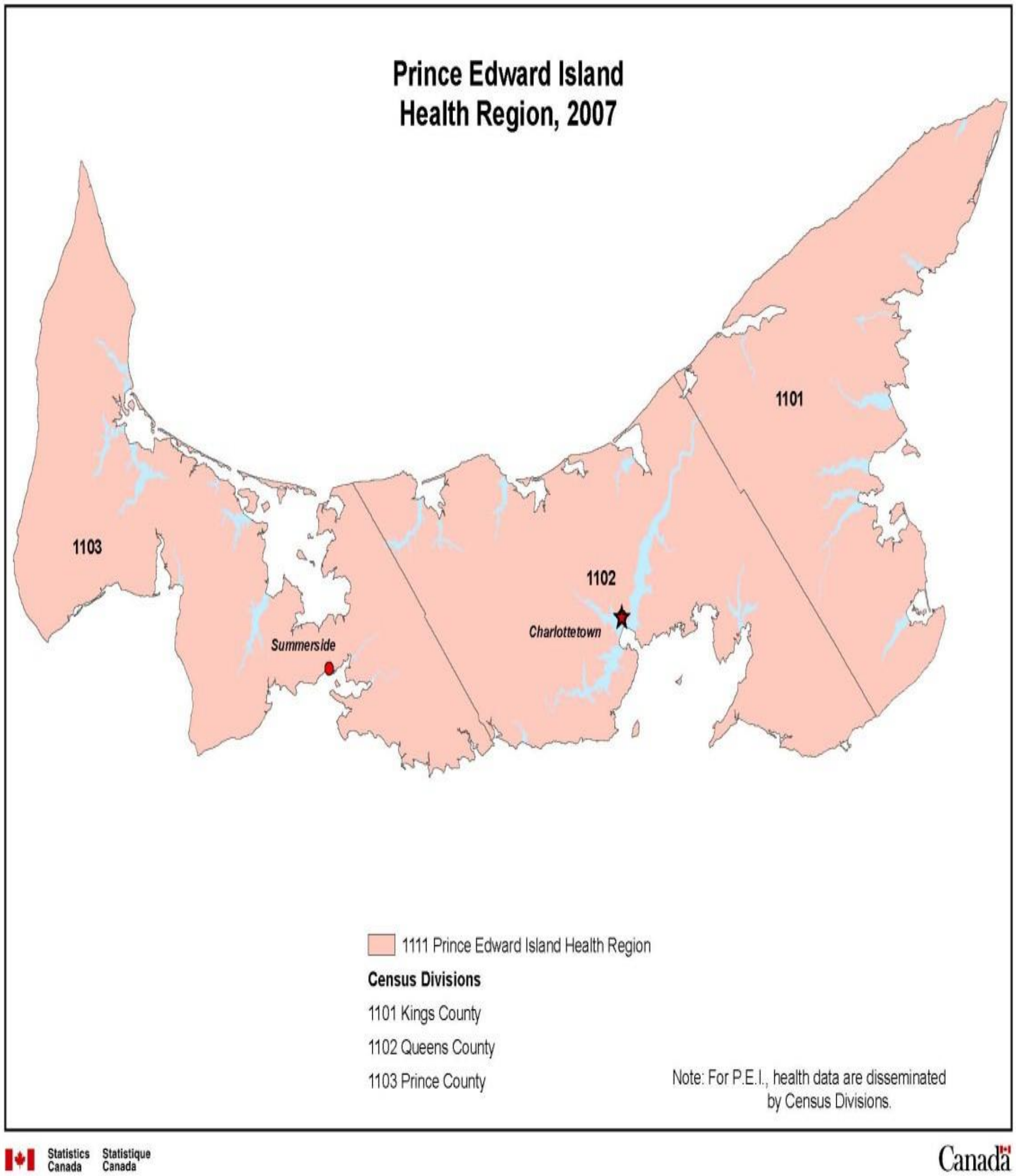



Statistics Canada Statistique Canada

Canada

**Figure M-10**



Prince Edward Island
Health Region, 2007
1103
1102
1101
Summerside
Charlottetown
1111 Prince Edward Island Health Region
Census Divisions
1101 Kings County
1102 Queens County
1103 Prince County
Note: For P.E.I., health data are disseminated by Census Divisions.
Statistics Canada Statistique Canada
Canada


**Figure M-11**

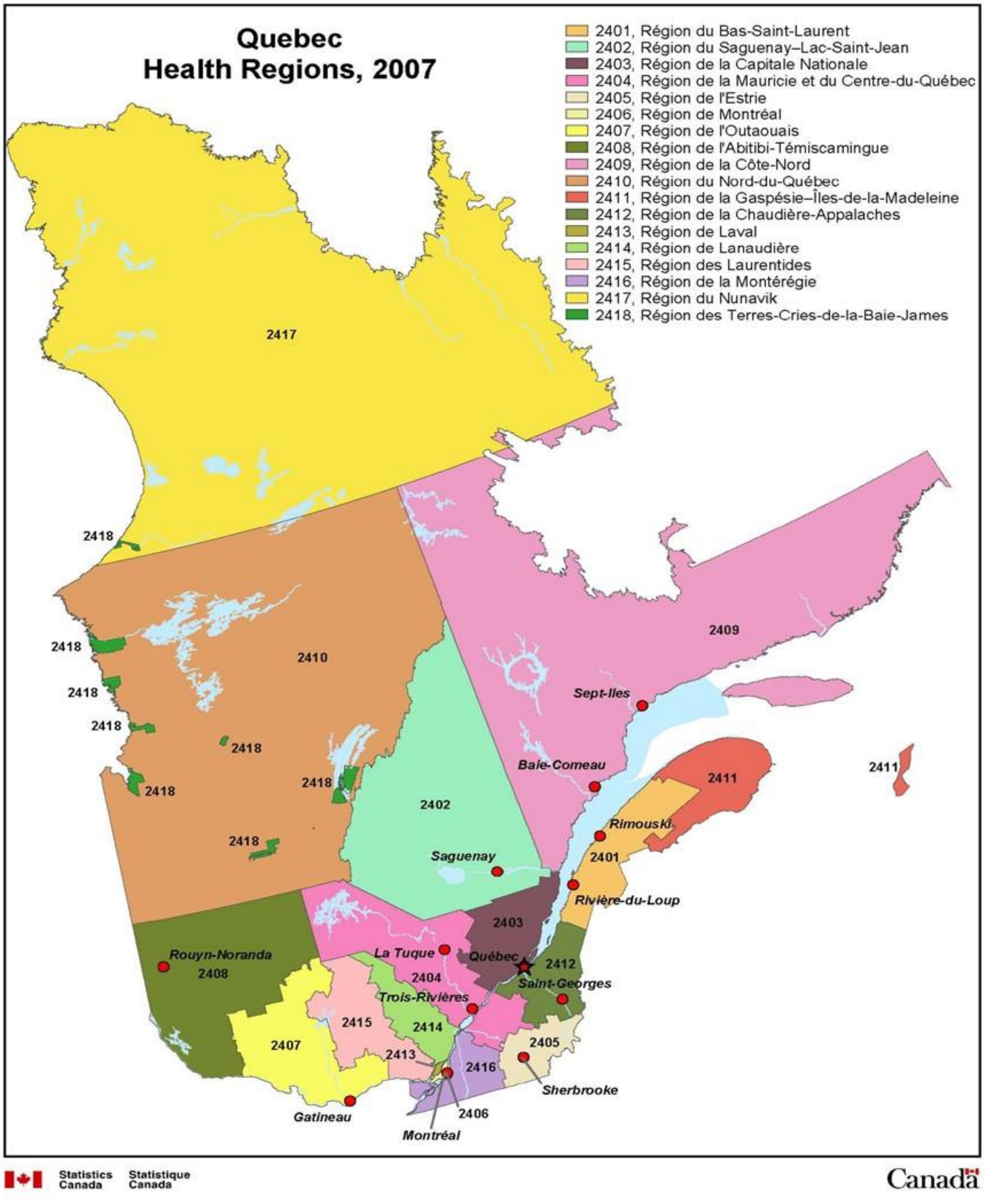

Quebec
Health Regions, 2007
2401, Région du Bas-Saint-Laurent
2402, Région du Saguenay–Lac-Saint-Jean
2403, Région de la Capitale Nationale
2404, Région de la Mauricie et du Centre-du-Québec
2405, Région de l'Estrie
2406, Région de Montréal
2407, Région de l'Outaouais
2408, Région de l'Abitibi-Témiscamingue
2409, Région de la Côte-Nord
2410, Région du Nord-du-Québec
2411, Région de la Gaspésie–Îles-de-la-Madeleine
2412, Région de la Chaudière-Appalaches
2413, Région de Laval
2414, Région de Lanaudière
2415, Région des Laurentides
2416, Région de la Montérégie
2417, Région du Nunavik
2418, Région des Terres-Cries-de-la-Baie-James
2417
2418
2410
2409
2402
2411
2401
2403
2404
2408
2407
2415
2414
2413
2416
2405
2406
2412
Sept-Iles
Baie-Comeau
Rimouski
Saguenay
Rivière-du-Loup
Rouyn-Noranda
La Tuque
Québec
Saint-Georges
Trois-Rivières
Sherbrooke
Gatineau
Montréal
Statistics Canada
Statistique Canada
Canada

Figure M-12

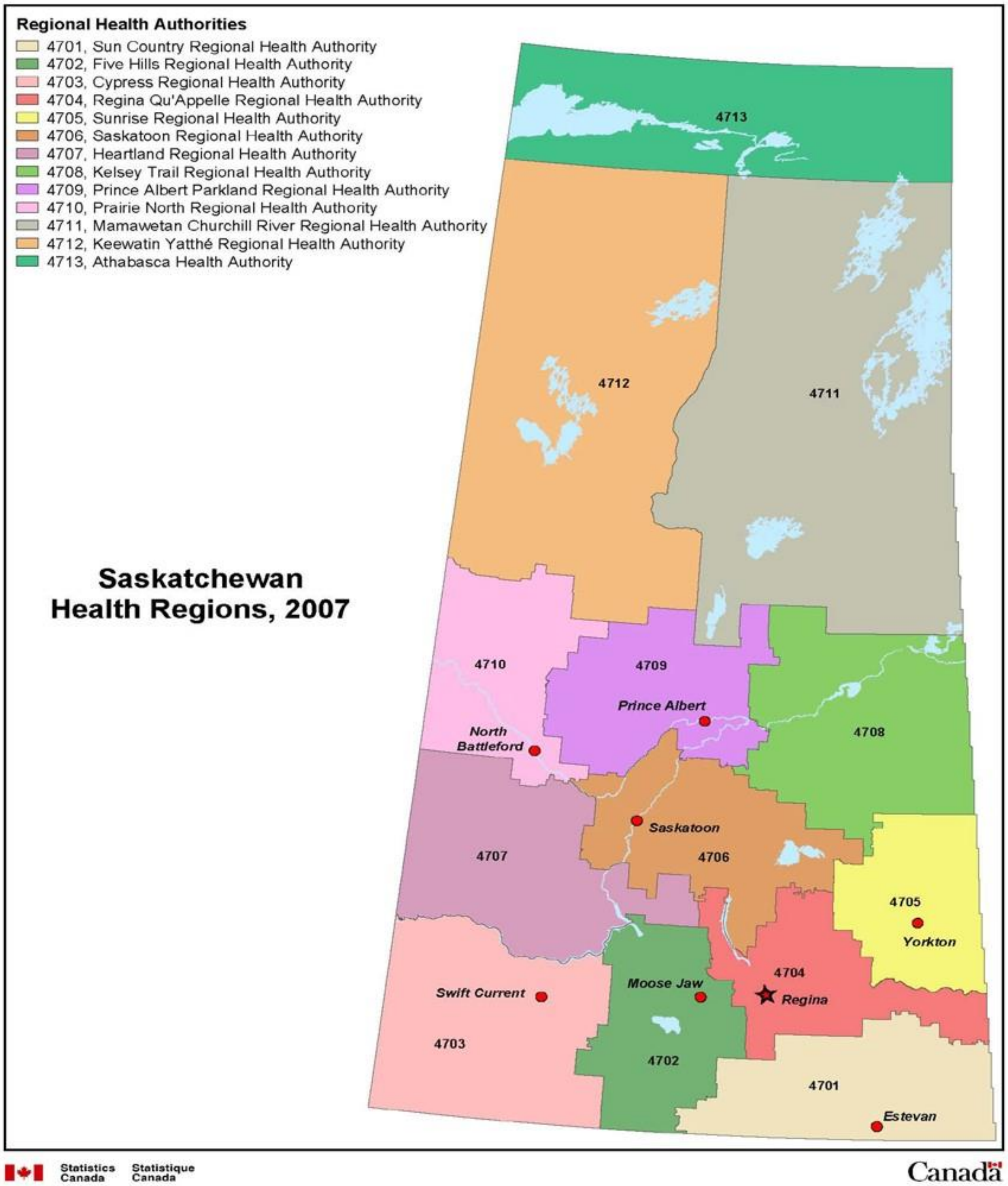

Regional Health Authorities
4701, Sun Country Regional Health Authority
4702, Five Hills Regional Health Authority
4703, Cypress Regional Health Authority
4704, Regina Qu'Appelle Regional Health Authority
4705, Sunrise Regional Health Authority
4706, Saskatoon Regional Health Authority
4707, Heartland Regional Health Authority
4708, Kelsey Trail Regional Health Authority
4709, Prince Albert Parkland Regional Health Authority
4710, Prairie North Regional Health Authority
4711, Mamawetan Churchill River Regional Health Authority
4712, Keewatin Yatthé Regional Health Authority
4713, Athabasca Health Authority
Saskatchewan
Health Regions, 2007
4713
4712
4711
4710
4709
Prince Albert
North Battleford
4708
Saskatoon
4707
4706
4705
Yorkton
4704
Moose Jaw
Regina
Swift Current
4703
4702
4701
Estevan
Statistics Canada
Statistique Canada
Canada

**Figure M-13**

# Annex N
informative
# Other New Construction Considerations

In new construction there are several possible features which may not be common in new construction but that bear special consideration from a radon ingress standpoint.

The following features in this Annex bear special mention.

Sump Pit Depressurization – Where sump pits are used as the inlet of an active or passive soil depressurization system in new construction, special design considerations should be addressed. These areas collect water and are used to divert this water away from the foundation or basement area using pumps and often auxiliary back-up pumps. Installing an ASD inlet in such a location may result in challenges with servicing or accessing the sump pit area for its main purpose of water removal. If sump pit lids are not well sealed this may result in radon ingress and may also result in a significant reduction in the efficiency of an active (fan driven) or passive soil depressurization system since a leaking sump pit cover will result in conditioned air being evacuated from within the building by an active system instead of the intended goal of only removing soil gases from beneath the slab. In addition, proper decoupling of the pipe connection has to be considered to minimize the noise generated by the radon fan transmitted through the radon pipe to the sump pit cover and to provide for convenient servicing of the sump area.

Drain Tile Depressurization - Exterior drain tiles that are open to daylight should not be connected to an ASD system. This can interfere with how the drainage system around the perimeter of a home is intended to perform. During freeze-up periods, this could also result in an ASD system which functions much less efficiently or not at all if pipes are either filled with water or with ice.

Pressure Treated Wood Foundations - Because pressure treated wood foundations may be difficult to seal, installation of an ASD system in a home with such a foundation requires that the perimeter interface be well sealed. If the base of the foundation is not well sealed and the location of the ASD inlet is placed close to a foundation wall, then the ASD system may well be drawing outdoor air into it rather than removing radon containing soil gas from beneath the basement slab area as intended.

Block Wall Foundation Construction - Block wall construction presents special challenges potentially in radon removal. Since block walls are typically hollow, they present additional entry flow paths for radon containing soil gas. As a result it is recommended that top and bottom courses of block walls be solid block construction to reduce the odds of radon entry through the walls. It is also important that the mortar joints between blocks are well-sealed in order to minimize radon ingress. The top course of blocks is usually above grade, as such, it does not represent a pathway for Rn entry into the building. The bottom course of the block that is in contact with the foundation should be sealed to prevent radon ingress.

Insulated Concrete Forms - Insulated concrete forms present another possible challenge for radon entry. This is because it is often difficult to obtain a good concrete to concrete seal at the slab-wall interface. The sub slab moisture barrier must be caulked and sealed to the vertical foundation wall above the floor slab, not just to the outside of the insulation. It is recommended to remove the insulation to approximately 2 – 3 cm above the final floor slab level. This would allow adequate sealing of the barrier and the slab after the pour.