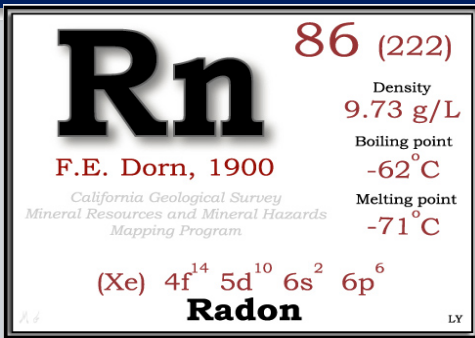


# Radon in Virginia Real Estate Transactions

Ryan Paris – Radiation Safety Specialist & Radon Coordinator  
Virginia Dept. of Health, Office of Radiological Health

804-864-8150

[ryan.paris@vdh.virginia.gov](mailto:ryan.paris@vdh.virginia.gov)



# Radon...

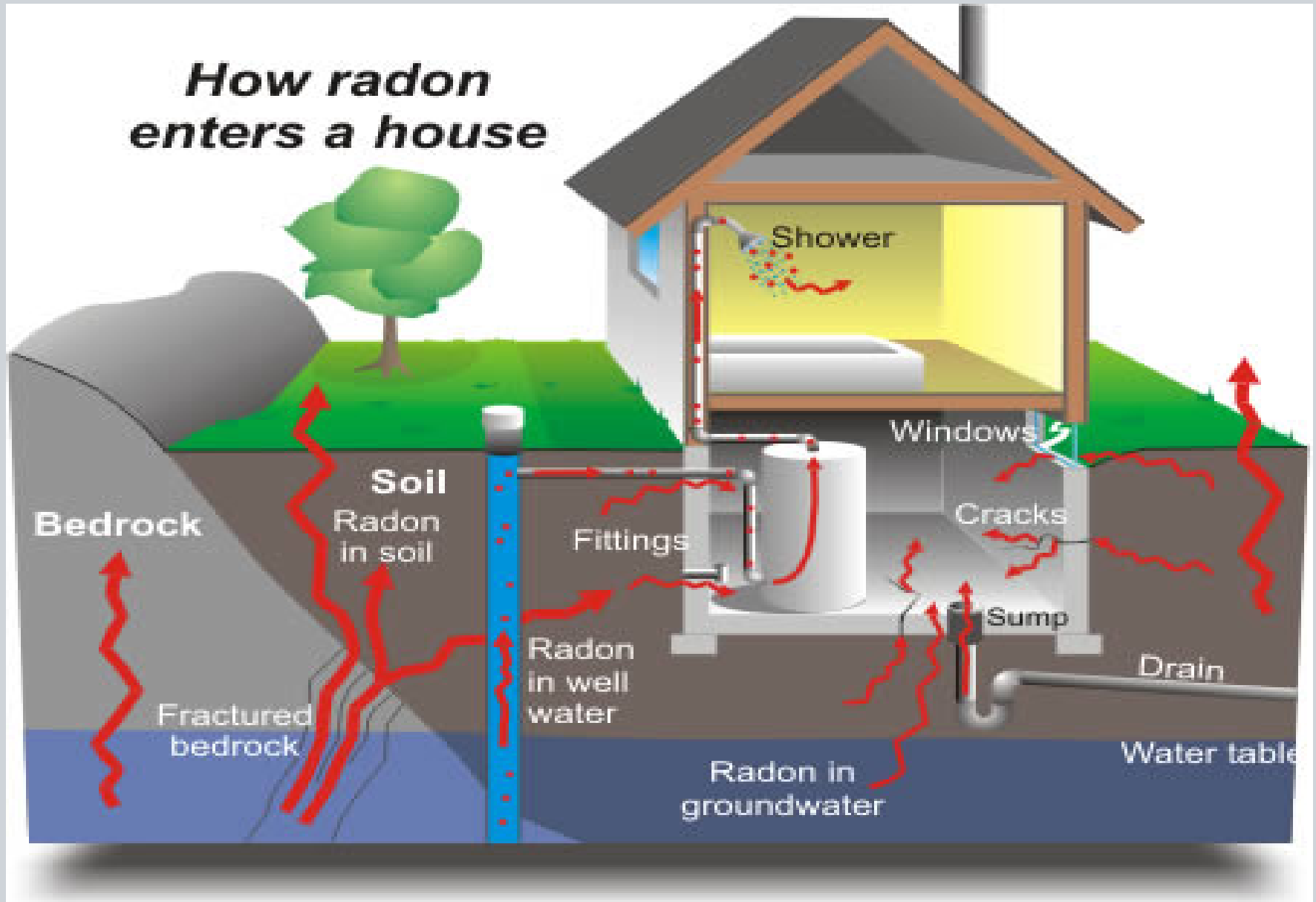


- is a naturally occurring radioactive decay product of Uranium & has a radioactive half-life of approx. 3.8 days
- Radon's short-lived radon decay products (RDPs) are *solids* that can adhere to dust particles and lung tissue
- Radon and three RDPs (Po-218, Po-214, Po-210) all emit alpha particles which have limited range/penetrating power, but they can damage lung tissue if inhaled.

# You can find Radon...

- In many types of rocks (in VA – mostly granite and shale) or associated soils & ground water
- In the livable space of **ANY** type of home - whether it is built over a basement, slab, or even a crawlspace.
- You **cannot** detect the presence of radon with your senses and it has *not* been proven to cause allergic reactions or any other known physical symptom(s). It has definitely been tied to an **increased risk of lung cancer**.

## How radon enters a house



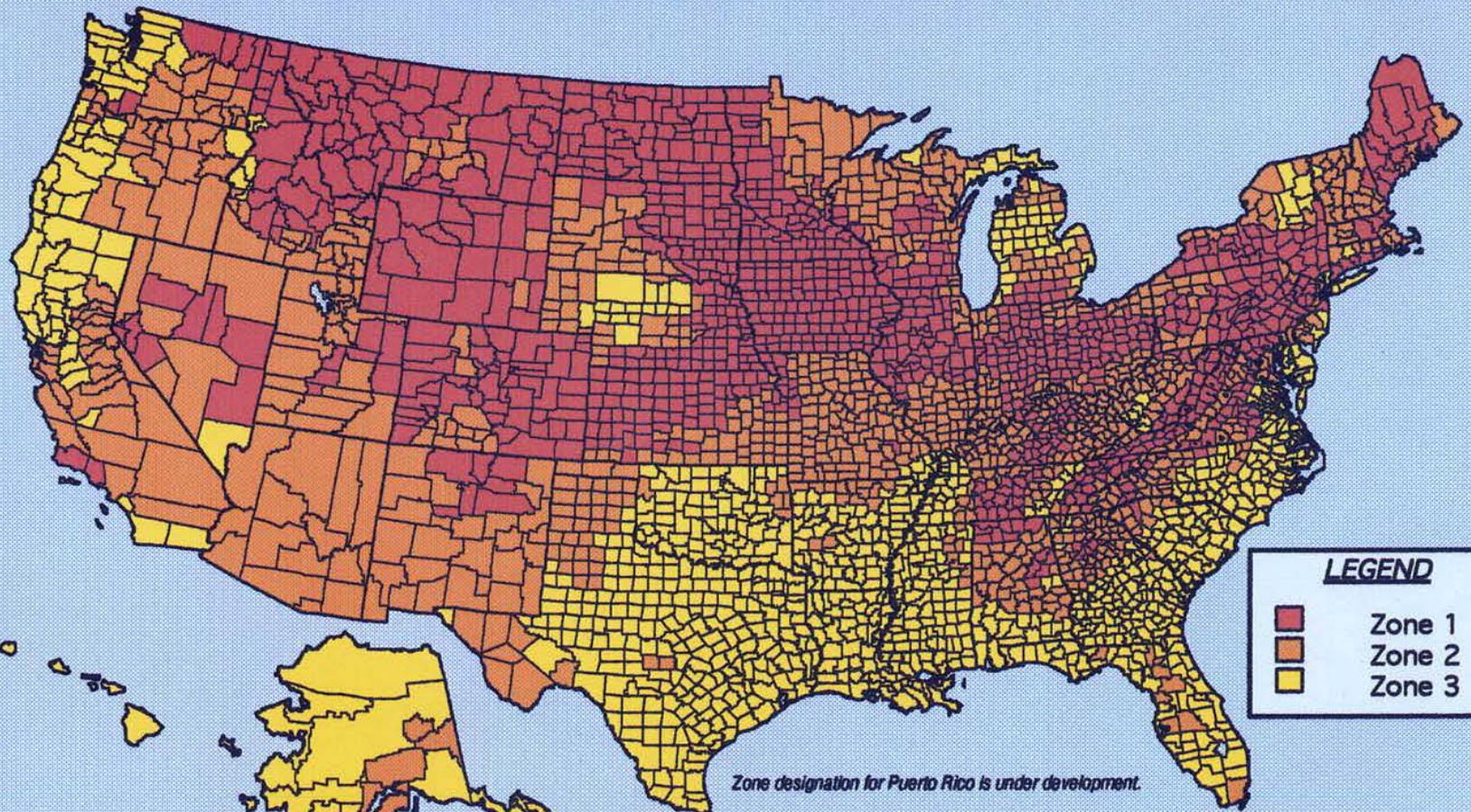
Nearly 1 in 15 US homes is estimated to have elevated levels of radon.

# Where is the Greatest Radon Risk?

- High levels of indoor Radon can be found in nearly every US state and every VA County.
- In 1994, USEPA classified all counties in USA as either High (Zone 1), Moderate (Zone 2) or Low (Zone 3) risk for Radon based on underlying geology, aerial measurements and limited test data.
- VA has 46 high risk counties, 24 moderates and 26 at low risk. Testing data now indicates that this map needs some revision.
- Testing your home is even MORE important if you live in a zone 1 or 2 area and/or you spend most of your time on a level in contact with or below the ground



# EPA Map of Radon Zones



**LEGEND**

	Zone 1
	Zone 2
	Zone 3

Zone designation for Puerto Rico is under development.

The purpose of this map is to assist National, State, and local organizations to target their resources and to implement radon-resistant building codes. This map is not intended to be used to determine if a home in a given zone should be tested for radon. Homes with elevated levels of radon have been found in all three zones. All homes should be tested regardless of geographic location.

**IMPORTANT :** Consult the EPA Map of Radon Zones document (EPA-402-R-93-071) before using this map. This document contains information on radon potential variations within counties. EPA also recommends that this map be supplemented with any available local data in order to further understand and predict the radon potential of a specific area.



Guam - Preliminary Zone designation

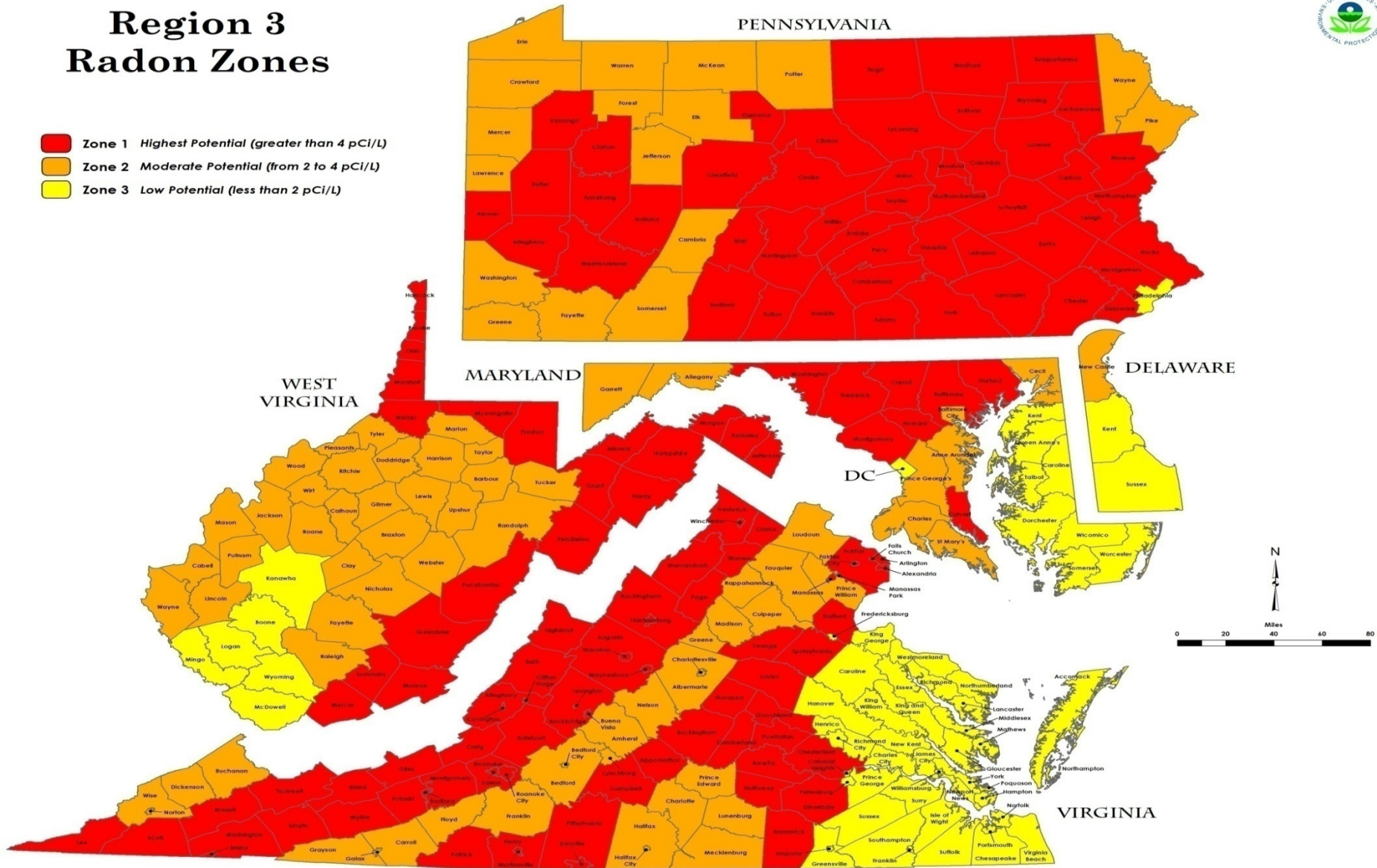


# USEPA Region 3 Radon Risk Zone Map for the Mid Atlantic States



## Region 3 Radon Zones

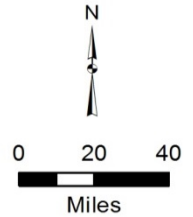
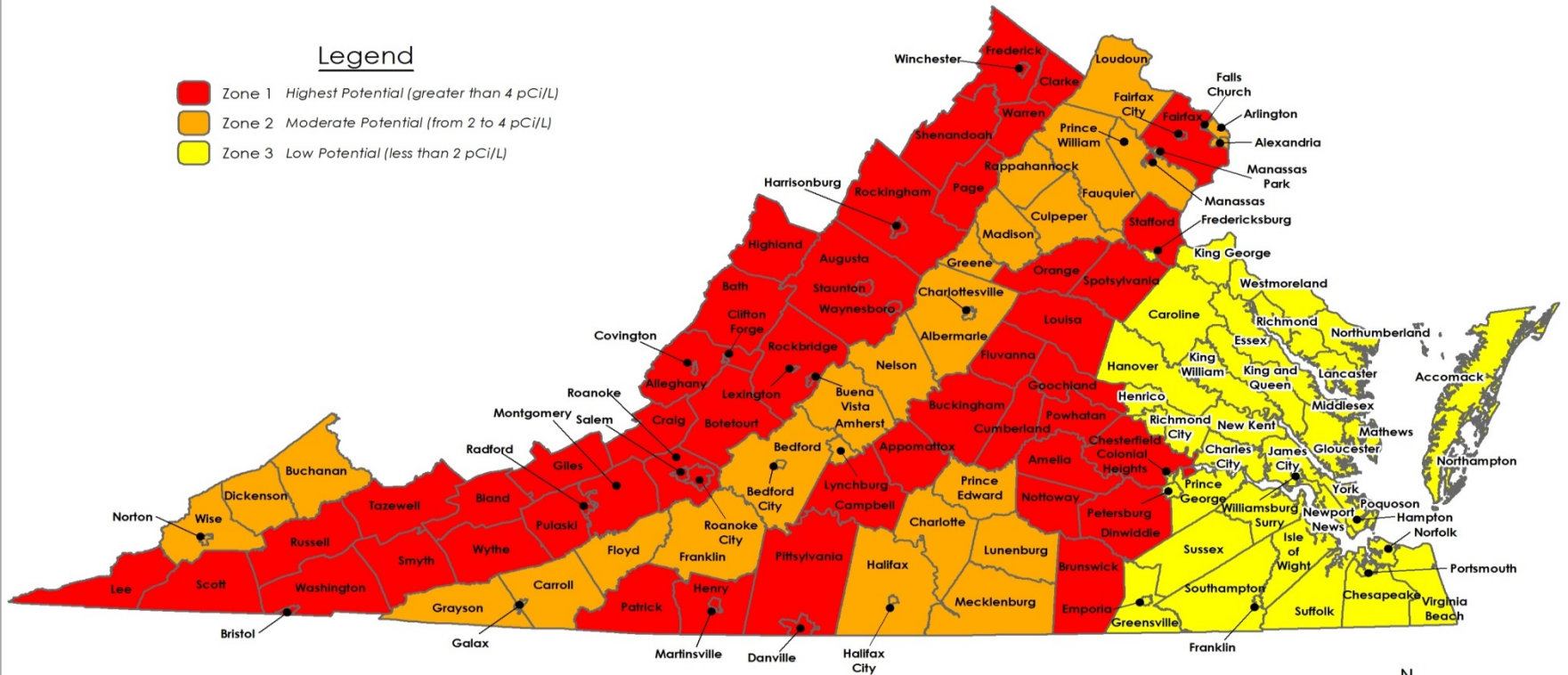
- Zone 1 Highest Potential (greater than 4 pCi/L)
- Zone 2 Moderate Potential (from 2 to 4 pCi/L)
- Zone 3 Low Potential (less than 2 pCi/L)



# Virginia - Radon Zones

## Legend

- Zone 1 Highest Potential (greater than 4 pCi/L)
- Zone 2 Moderate Potential (from 2 to 4 pCi/L)
- Zone 3 Low Potential (less than 2 pCi/L)





## Radon Test Results in Selected Areas in Virginia

County/City	Avg. (pCi/L)	Tests	% $\geq$ 4.0 pCi/L	EPA Risk Designation
Augusta	5.0	283	41	High
Chesterfield	3.5	1319	26	High
Clarke	5.3	290	49	High
Danville	4.0	303	37	High
Fairfax	3.1	23192	24	High
Frederick	7.2	798	45	High
Hanover	4.9	195	19	*Low
Harrisonburg	4.5	1081	35	High
King George	3.6	212	26	*Low
Loudoun	4.1	4632	31	*Moderate
Montgomery	3.8	1906	31	High
Pittsylvania	2.9	222	27	High
Prince William	2.9	3487	22	Moderate
Richmond City	2.5	611	18	*Low
Roanoke City	3.1	3584	24	High
Salem	3.1	1161	25	High
Stafford	2.4	1257	19	*High
Tazewell	5.2	526	33	High
Warren	5.0	264	36	High
Washington	6.2	400	46	High
Winchester	7.2	512	58	High

Test kits provided & analyzed by Air Chek from 1990-2017. Jurisdictions with <50 test results not shown.

\*Test data does not agree with official EPA risk designation

# Radon Recommendations/Benchmarks

- The only way to know your indoor radon level is to TEST! It is impossible to predict because there are too many factors that can influence the results.
- Average US indoor radon levels ~ 1.3 pCi/L. Average US outdoor radon levels ~ 0.4 pCi/L.
- The USEPA recommends mitigation if the radon level is 4.0 pCi/L or higher and mitigation should be *considered* between 2.0 – 3.9 pCi/L. It is not possible to reduce indoor radon levels to zero, but < 2.0 is optimal.
- Canada and many European countries now use 5.4 pCi/L (200 Bq/m<sup>3</sup>). The World Health Organization recently recommended mitigation at 2.7 pCi/L (100 Bq/m<sup>3</sup>) or higher.
- No level of radon is absolutely “safe” - levels below 4 pCi/L still pose some risk!

# Radon Lung Cancer Risk for a full lifetime (70 yr.) exposure:

Radon is thought to be the second leading cause of lung cancer after smoking. It may cause as many as 21,000 lung cancer deaths/yr. in the USA – which includes approx. 670/yr. in Virginia!

What are the chances of lung cancer?

IF NEVER SMOKED:

At 20 pCi/L: = 36/1000

At 10 pCi/L: = 18/1000

At 4 pCi/L: = 7/1000

At 1.3 pCi/L = 2/1000

CURRENT SMOKER:

= 260/1000

= 150/1000

= 62/1000

= 20/1000



# Radon and the Law in Virginia:

- NO state or federal law currently REQUIRES radon testing prior to a sale nor does any law require mitigation if the radon levels are found to be elevated. *It is entirely negotiable between the parties involved!*
- Real estate sales contract paperwork may include a radon test/mitigation contingency clause.
- VA law requires that all professional radon testers and mitigators operating in the Commonwealth must be currently certified and listed by either National Radon Proficiency Program (NRPP) ([www.nrsb.org](http://www.nrsb.org)) or the National Radon Safety Board (NRSB) ([www.nrpp.info](http://www.nrpp.info)).
- VA law requires that all radon mitigators who charge \$1000 or more for a mitigation job must possess a VA Contractor's License with a Radon Mitigation Contractor (RMC) specialty. The RMC may be obtained after 5 yrs. of experience. Contractors are licensed by the VA Dept. of Professional & Occupational Regulation ([www.dpor.virginia.gov](http://www.dpor.virginia.gov))

# Enforcement of Radon Professionals

- VDH-ORH will investigate complaints involving radon professionals who are uncertified or who have performed work that is non-compliant with radon testing and/or mitigation standards. **Evidence is needed (ex. paperwork/photos)**
- VDH staff will speak to the radon professional and if merited, a compliance letter will be sent which will request corrective action within 30 days.

The customer may also consider writing letters of complaint to:

- The radon professional's certificate provider (NRSB or NRPP) **Only NRSB/NRPP can revoke a radon professional's certificate.**
- the local office of the Better Business Bureau

# How to Test?

- To insure the validity of the test for real estate transactions, it is recommended that an NRSB or NRPP certified professional tester be used – do NOT let parties involved in the transaction conduct the testing themselves!
- EPA recommends any one of these choices:
  - ONE short term (48 hr. minimum) continuous radon monitor (CRM) test
  - Or an average of TWO short term tests using other technologies
  - Or ONE long-term test (91 day minimum)



# Short term vs. Long Term Tests:

- **SHORT TERM: 2 day minimum – some may run up to 90 days**

Common devices: activated charcoal test kits, electret ion chambers (E-perm), continuous radon monitor (CRM).

CRMs are probably the most popular and most expensive (\$150-250) method, but have the following advantages:

- results usually available in 1-2 days, other methods may take longer
- records/prints radon levels every hour and may record temperature & barometric pressure (good for detecting tampering or major storm conditions)

- **LONG –TERM: 91 day (minimum) up to 1 year**

Most common device: alpha track detector

***A long term test that lasts an entire year is considered the most accurate method to test a property!***

- Electronic digital “real-time” plug in radon monitors can also be purchased (approx. \$125.) but they have not yet been approved by NRPP/NRSB to the same level of accuracy as the other test devices. **Therefore they should NOT be used to determine radon levels for real-estate transactions!** They are most useful for monitoring approximate radon levels AFTER a mitigation system has been installed.

# Radon Test Devices

Continuous Radon Monitors →



Electret Ion Chambers →

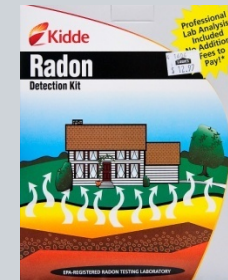


Continuous Digital Radon Monitor ←

Long-term Alpha Track Detectors →



Activated Charcoal Test Kits →



# Short-term testing under “Closed House Conditions”

- ALL windows must remain shut for the entire testing period. Exterior doors should be used only for normal entry/exit.
- Do not run whole house exhaust fans or smaller fans that are near the device. Do not leave smaller exhaust fans (kitchen, bathroom) on for extended periods. Limit the use of a clothes dryer.
- A normal indoor room temperature range should be maintained during the test.
- These conditions should begin 12 hours before starting the radon test and be maintained for the entire test which must last a minimum of 48 hrs.



# General Radon Testing Guidelines

- Especially in cases where the seller still occupies the property, tamper resistant techniques should be used!
- Avoid testing closets, storerooms, kitchens, bathrooms and crawlspaces. Bedrooms or family rooms are ideal. **The lowest “livable” level of the home should be tested.** That level should already be suitable for occupancy or could be easily converted. If there is a conflict, the buyer’s wishes are given preference.
- Test devices should be placed in *breathable* air (3-6’ off floor is best) and not too close to walls or windows or other suspect areas (ex. sump pump or exposed soil/rock).
- Test device should not be placed in contact with building materials made of natural rock and should be a minimum of 20 inches off the floor.
- Every section of the home that it is contact with the ground should be tested!
- Try to avoid testing during extended storms with high sustained winds and/or heavy precipitation

# Other Important Radon Testing Facts to Know:

- **Most homes usually test at their highest levels in the winter and lowest in the summer.** Test results taken in the spring and fall (especially if exterior high temps. between 60-70 degrees) are usually closer to the year round average.  
Exception: Some clayish soils subjected to extended heat/drought can sometimes cause *higher* indoor radon levels in summer!
- **The highest radon levels are usually found in the lowest livable level of the home.** There is typically a 25-50% reduction in radon levels between the basement and the first floor and then usually smaller reductions as you go up to additional floors.
- Radon can sometimes follow unusual pathways and cause higher than expected readings on the upper floors. (ex. HVAC which draws air from basement, utility chase or elevator shaft).

# What to do for Borderline Test Results that are very close to 4.0 pCi/L ?

- The testing season is critical. For example, a a 3.9 pCi/L taken in July is of more concern than a 3.9 pCi/L. Why?
- Although it is negotiable, the seller is justifiably less likely to pay for mitigation if the test result is <4.0 pCi/L.

## **POSSIBLE SOLUTIONS FOR BORDERLINE CASES:**

- 1) Do another professional short-term test and take the *average* of the two results.
- 2) Get estimates and put mitigation money in *escrow* pending the results of a professionally conducted long-term test that lasts an entire year!

# Active Radon Mitigation

- A Radon mitigation system is usually a vent pipe system powered by an electric fan (15-120 watts)
- Seal foundation cracks or openings (ex. sump pump well) to make it more effective. Use silicone caulk for sumps and polyurethane sealant (graded for indoor use) for walls & floors.
- Cost: usually \$800-2500. Multiple pipes will add to cost. Usually one penetration pipe will handle a footprint of up to 2000 square feet. Mitigating crawlspaces is more expensive.
- Some older homes built directly on rock or hard soil can be more difficult to mitigate. A permeable layer of gravel under the slab is optimal.
- After the mitigation system is up and running for a minimum of 24 hours the house must be RETESTED.

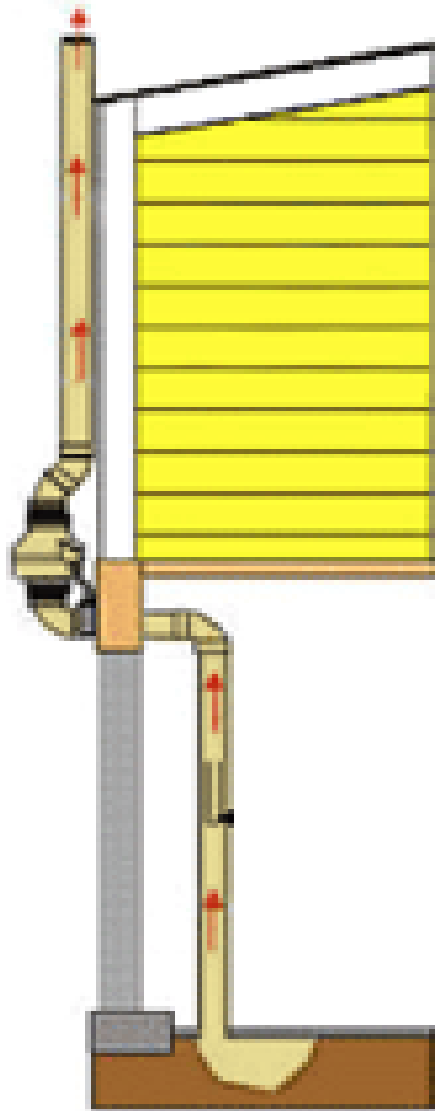
# Radon Mitigation & the Sales Contract

- A detailed radon test & mitigation contingency clause in the contract is strongly recommended!
- The radon testing and mitigation should **NOT** be done by the same individual/company – **this is a conflict of interest!**
- The **buyer** should also be involved. If mortgage lender/insurer allows – may want to give buyer money off sales price or in escrow so that he can select the mitigation installer & location instead of the seller?
- Allow enough time!
  - start closed house conditions – 12 hrs. prior to test
  - pre-test – 48 hr. minimum
  - install mitigation system – usually 1 day
  - waiting period before post test – 24 hr. min. (closed house conditions)
  - post installation test – 48 hr. minimum
- It is NOT absolutely necessary that this entire process be finished before closing.  
Ex. the post test could take place under the control of the buyer.



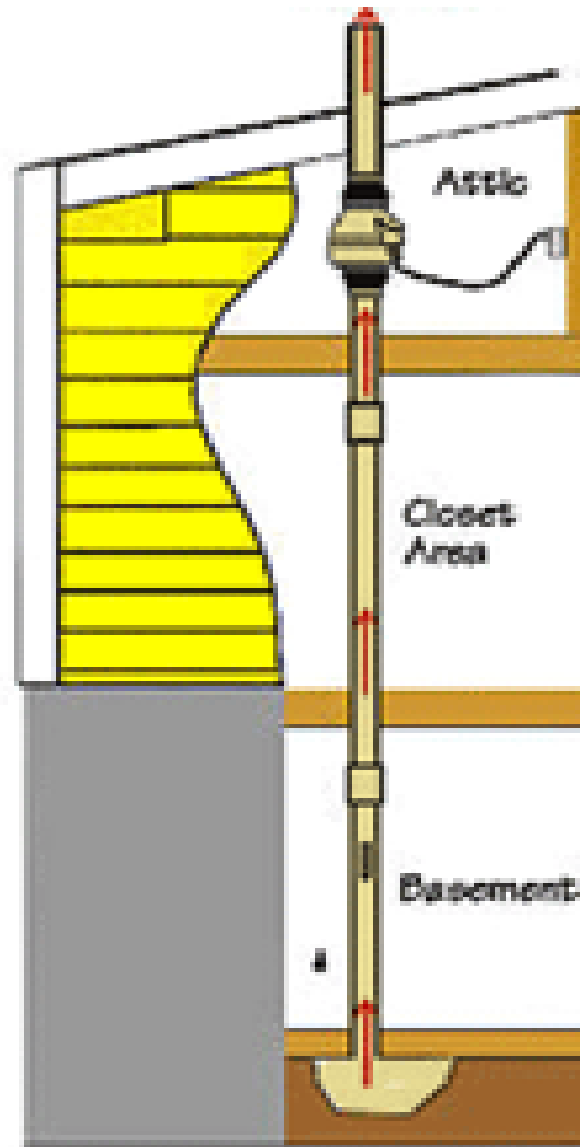
# Radon Mitigation System

RADON GAS



EXTERIOR

RADON GAS



INTERIOR





## Manometer Flow Indicator with Installer Label - NOT a radon meter!



# Radon Mitigation Piping

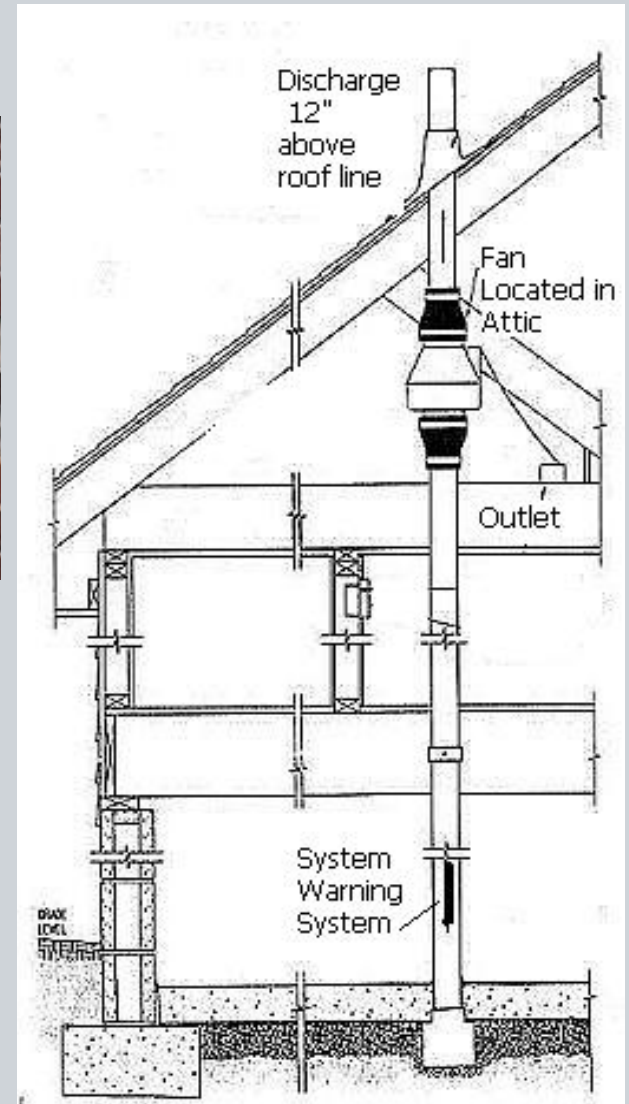


Proper exterior riser pipe

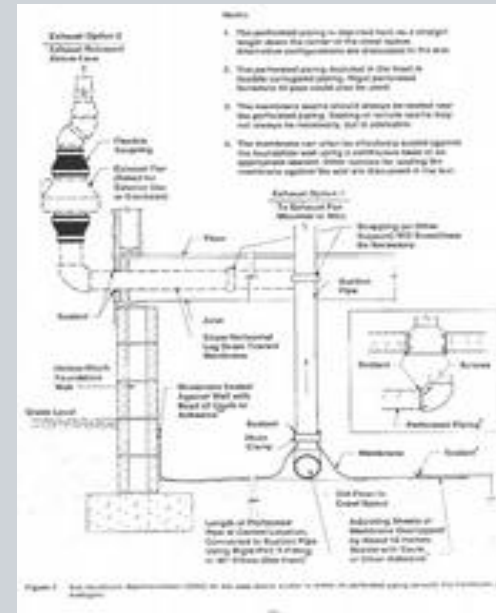
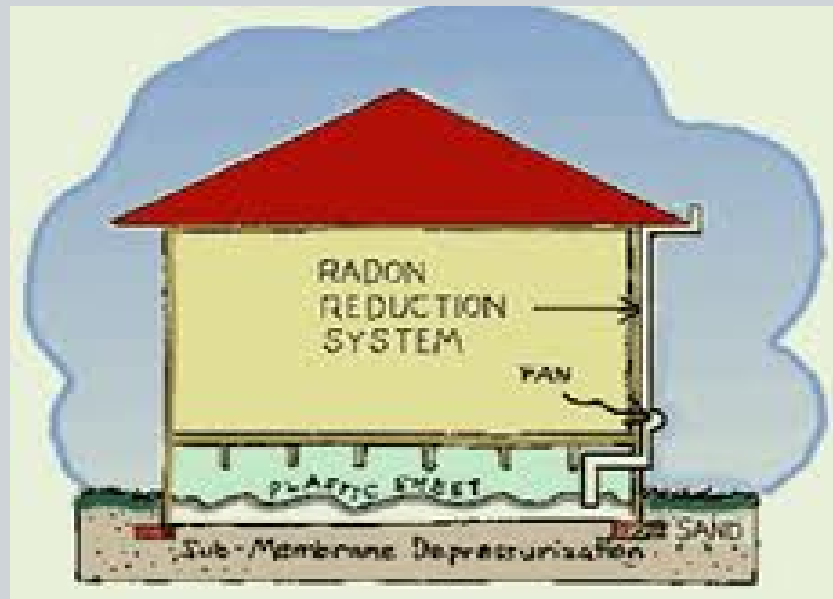


Fan with coupling from PVC to gutter downspout piping

Interior piping schematic



# Radon Mitigation in Crawl Spaces





# Poor Radon Mitigation



# Selling a Home with a Radon Mitigation System already in place

- Added protection of a working radon mitigation system can be a good selling point – at least you know the house has been tested and fixed!
- BUT: System must be monitored and the home should be retested periodically (every 2-5 yrs.) or use a continuous monitoring device. This is especially important for newer homes that have not yet completed the settling process. **Most mitigation systems tend to lose efficiency over time.** Mitigation fans usually last an average of 10-20 yrs.
- A home with an old mitigation system should be tested prior to the sale if there is no available retest data within the last 2 years.

# Passive Radon Reduction New Construction (RRNC)

- New homes can be constructed with passive radon resistant construction features (a.k.a. RRCT or RRNC) already in place
- Homebuilders are exempt from VA law requiring NRPP/NRSB certification when installing RRNC, but they should not install fans!
- VA currently gives all Zone 1 VA counties/cities the **OPTION** of requiring RRNC for all new homes built under their jurisdiction. As of 2014, only four eligible counties (Amelia, Buckingham, Rockbridge and Shenandoah) and 7 independent cities (Blacksburg, Buena Vista, Christiansburg, Lexington, Radford, Roanoke and Salem) are known to have adopted that ordinance into their building codes.
- It is easier, less expensive (\$500-1000) and less intrusive to install radon piping that can be hidden in the walls as the house is built.
- **Must TEST home after construction is completed!**
- If necessary, a certified mitigator can convert to an active system by installing a fan (usually located in the attic) to provide suction and improve effectiveness

# RRNC Diagram

Properly installed RRNC is thought to reduce indoor radon levels by approx. 50%!

## What are Radon-resistant construction techniques?

The techniques may vary for different foundations and site requirements, but the basic elements are:

### Gas Permeable Layer

This layer is placed beneath the slab or flooring system to allow the soil gas to move freely underneath the house. In many cases, the material used is a 4-inch layer of clean gravel.

### Plastic Sheeting

Plastic sheeting is placed on top of the gas permeable layer and under the slab to help prevent the soil gas from entering the home. In crawlspaces, the sheeting is placed over the crawlspace floor.

### Sealing and Caulking

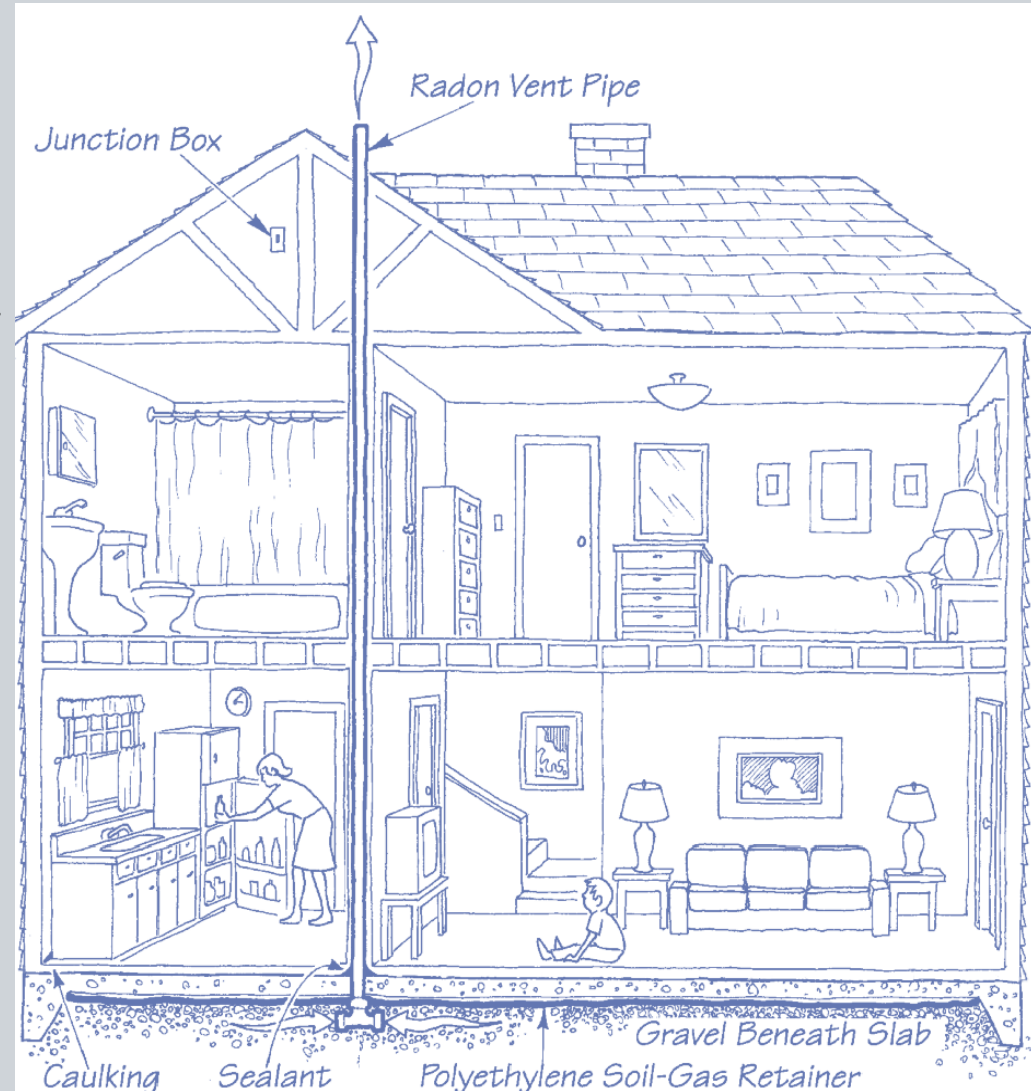
All openings in the concrete foundation floor are sealed to reduce soil gas entry into the home.

### Vent Pipe

A 3- or 4-inch gas-tight or PVC pipe (commonly used for plumbing) runs from the gas permeable layer through the house to the roof to safely vent radon and other soil gases above the house.

### Junction Box

An electrical junction box is installed in case an electric venting fan is needed later.



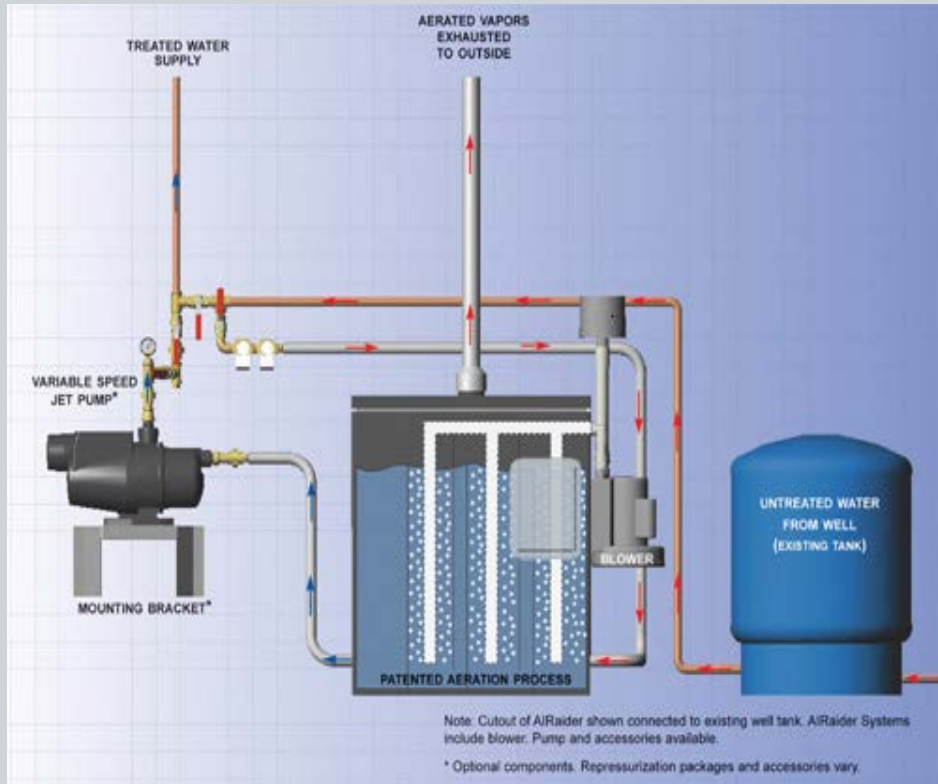


# Radon in Water

- Radon is usually only a potential problem in wells (ground water)
- A proposed USEPA radon in water standard was issued in 2000, but never finalized. That standard recommended mitigation at 4,000 pCi/L or higher. Test results > 4,000 pCi/L are uncommon in VA, but levels up to 50,000 pCi/L have been found.
- Radon in water ingestion risk is very small, but radon in water escapes into the air – especially when the water is agitated (showers faucets, dish/clothes washers).  
**10,000 pCi/L in water is thought to contribute an additional 1 pCi/L to indoor radon air levels.**
- For water sampling, the pipes should be newly flushed and no aeration should occur. The preferred laboratory testing analysis is **Liquid Scintillation (LS)**.
- At this time, neither NRPP or NRSB certifies radon in water testers, mitigators or laboratories. A new radon in water standard is scheduled for release in 2018?



# Radon in Water Mitigation



Best available technology: Aeration system

Cost: \$3500-6000+

- Can handle any level of radon
- Exhaust air must be vented safely
- Needs periodic cleaning



Whole house water treatment w.  
granulated activated charcoal

Cost: \$1500-2500

- Originally not recommended for radon levels >5,000 pCi/L , but may work up to 10,000 pCi/L
- May expose occupants to gamma radiation
- Possible radioactive disposal issues for old carbon

# Radon in Granite Counter Tops:

- Many sensationalistic TV/newspaper reports inaccurately publicized the results of inappropriate testing methods
- Many types of granite *are* naturally radioactive and some *may* emit small amounts of radon, but **the vast majority of granite slabs are NOT significant contributors to indoor Radon levels.**
- You cannot accurately predict granite radon risk based on color or country of origin
- If you are concerned, test the breathable air above the slab, do NOT place the device on the slab itself and follow all normal short-term testing procedures. Compare the result to a short-term test done in the lowest level of the home during the same time period.
- Some granite vendors now screen slabs and do not sell those that emit excessive radioactivity.

# Further Information

- Va. Dept. of Health – Division of Radiological Health:  
Office: 804-864-8150 Toll free in VA: 800-468-0138  
Website: [www.vdh.virginia.gov](http://www.vdh.virginia.gov) & find Radon in “Health Topics A-Z”
- USEPA Radon publications available at: [www.epa.gov/radon/publications-about-radon](http://www.epa.gov/radon/publications-about-radon)
  - “Home Buyer’s & Seller’s Guide to Radon”
  - “Consumer’s Guide to Radon Reduction”Or: bulk quantities can be purchased at: [www.aarst.org/bookstore](http://www.aarst.org/bookstore)
- Current radon mitigation standard referenced in the Virginia Code: **ASTM E2121-13**  
available for purchase at: [www.astm.org/Standard/standards-and-publications](http://www.astm.org/Standard/standards-and-publications)
- Toll free EPA national radon hotlines:
  - 1-800-SOS Radon
  - Spanish 1-800-725-8312
  - Safe Drinking Water 1-800-426-4791