Radon In Private Well Water Mitigation

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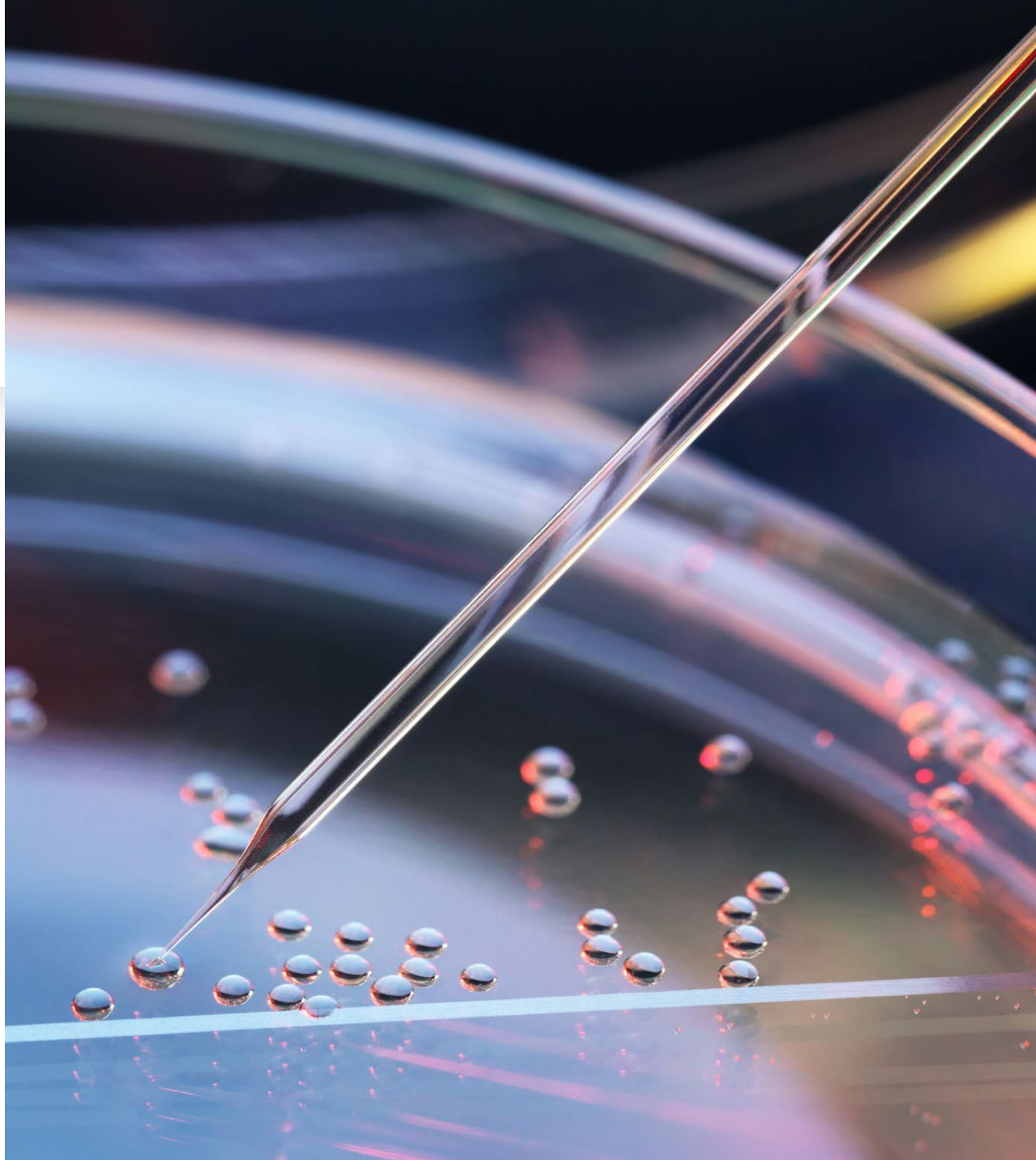
Mitigation Techniques

- Storage Tanks
- Blending
- Reverse Osmosis
- Activated Charcoal
- Aeration Units

What’s In The Water?

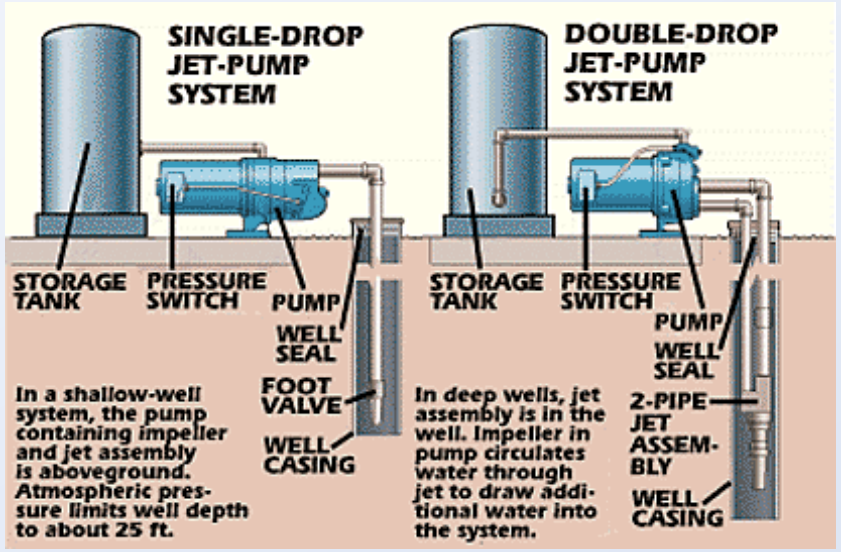
- Radon
- Radionuclides
- Microorganisms
- Hardness
- Corrosivity
- Total Dissolved Solids
- pH
- O 2
- Metals
- Turbidity

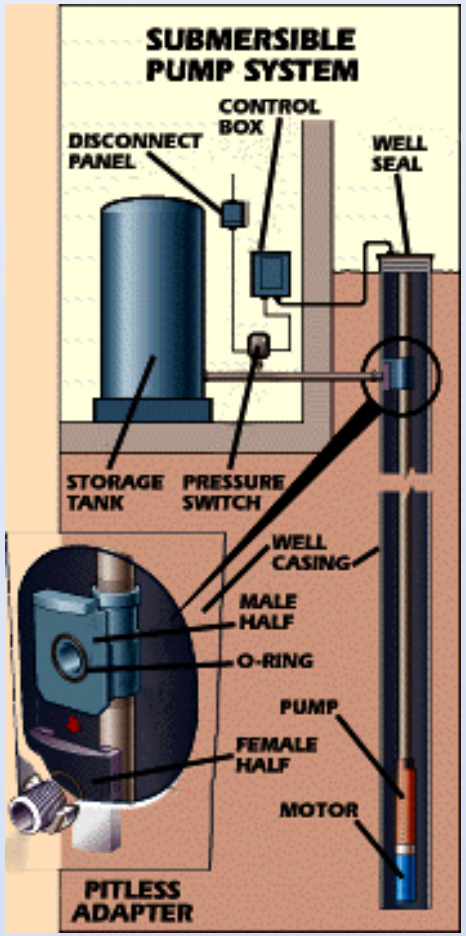


What is the Radon Level?

- **Minimum of Two** Samples: ANSI/AARST MW-RN-2020
- Best **Practice: Samples From Different Times During The Year**
- Radon Levels Will Vary
- Treat The Highest Level
- Treatment Goal

Well Characteristics





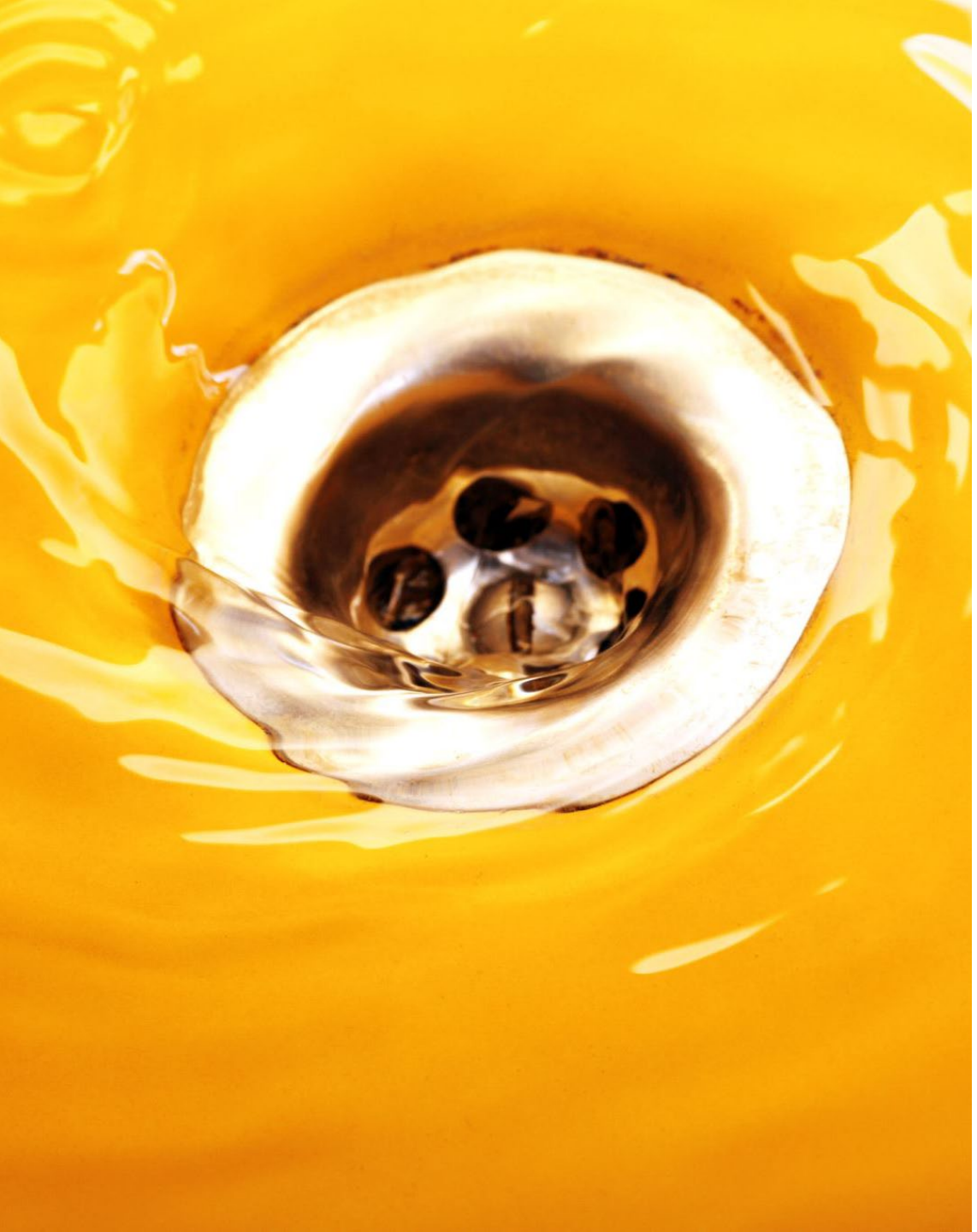
- **Shallow well**: single drop jet pump
- **Medium well**: double drop jet pump
- **Deep well**: submersible pump

Flow Rate

Recommended Flow Rates for Home Water System (Gallons/Minute)

No of Bedrooms	Number of Bathrooms in Home			
	1	1.5	2	3
2	*6*	*8*	*10*	*12*
3	*8*	*10*	*12*	*14*
4	*10*	*12*	*14*	*16*
5	*12*	*13*	*15*	*17*
6	*13*	*15*	*16*	*18*
	Flow rate in Gallons per Minute			

(Modified from Private Water Systems Handbook)



Determining Gallons/Minute

- Ensure no one is using water
- Tank should be at full pressure with pump off
- Shut off pump
- Drain water into bucket of known volume
- Calculate gallons drained
- Turn off water and close drain valve
- Turn on well pump and time until shutoff
- Convert seconds to minutes = gallons/minute

Water Pressure Requirements

Water Pressure/Pipe Size/GPM

Size of:		Water Pressure (PSI)							
Water Meter	Service Line	*30*	*35*	*40*	*45*	*50*	*55*	*60*	*65*
		Gallons Per Minute (GPM)							
5/8"	1/2"	*2*	*3.5*	*5*	*6*	*6.5*	*7*	*7.5*	*8*
5/8"	3/4"	*3.5*	*5*	*7*	*8.5*	*9.5*	*10*	*11*	*11.5*
3/4"	3/4"	*5*	*7*	*8*	*9*	*11*	*12*	*14*	*15*
3/4"	1"	*7.5*	*10*	*11.5*	*13.5*	*15*	*16*	*17.5*	*18.5*
1"	3/4"	*6*	*7.5*	*9*	*10*	*12*	*13*	*15*	*16*
1"	1"	*9*	*12*	*13.5*	*17*	*19*	*20*	*21*	*21*

Checking Pressure

- Turn on water near system
- Note when pumps turns on and goes off
- Low pressure is when pump goes on (20-35 psi)
- High pressure when pump goes off (40-60 psi)
- On/Off pump cycle should take about 45 seconds

Well Room Characteristics

Codes

- Check local codes
- Follow local codes, e.g.
  - ***No placement within 3 feet of electrical panel***
  - ***No placement that blocks other systems***
- Licensed plumber
- Licensed electrician (treatment specific)
- Certified water treatment professional
- Certified radon professional
  - Waterborne radon training is available

Pretreat The Water

- Contaminants can foul/damage the radon system
  - Iron
  - Hardness
  - Manganese
  - Bacteria
  - PH
- A blended treatment approach may be necessary

Radon System Placement

- Locate equipment:
  - After other treatment systems
    - Before disinfection equipment
  - Before final pressure tank
  - By-pass outdoor spigots and sprinklers

Residential Mitigation Systems

- Activated Charcoal
- Aeration Units

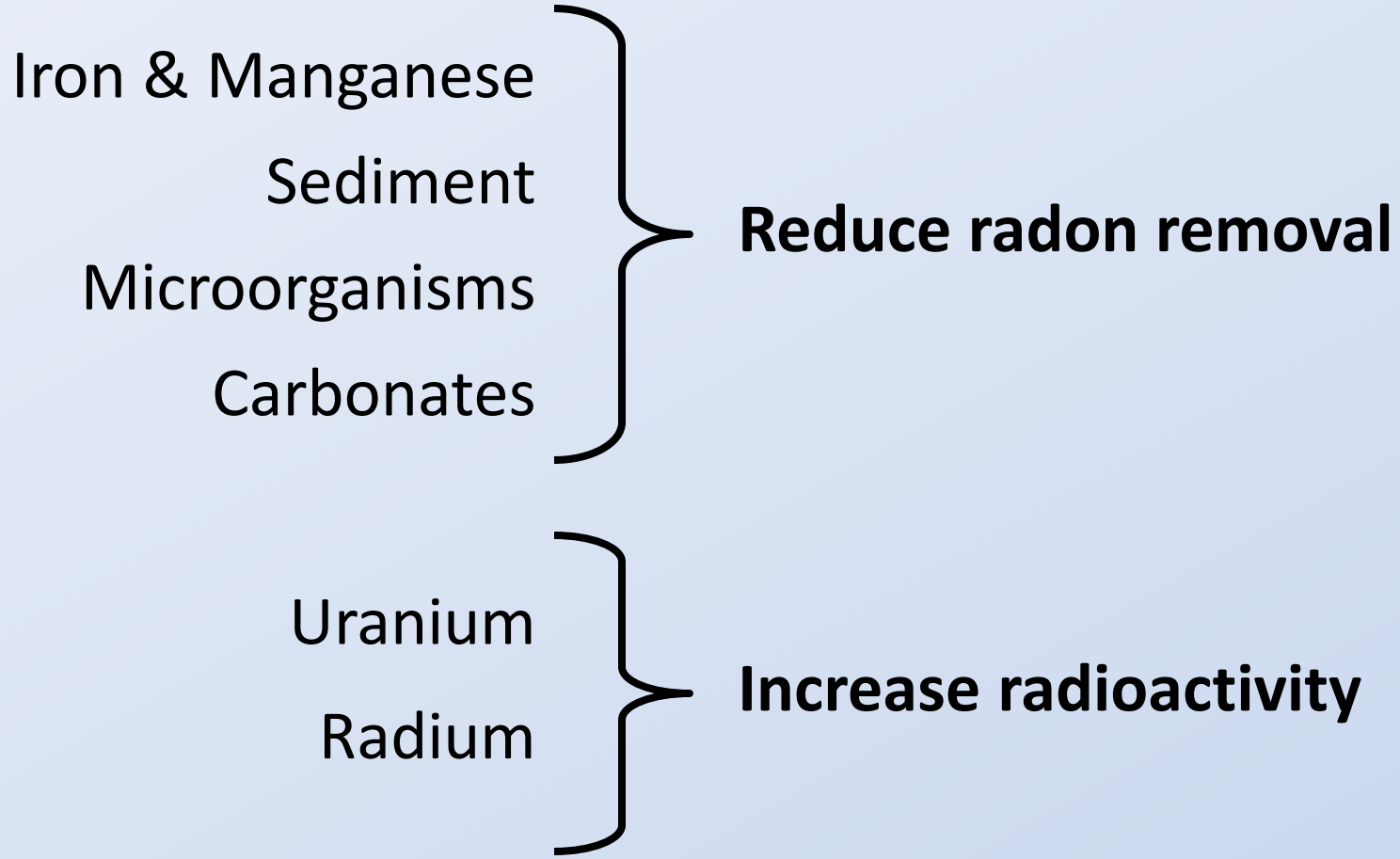
BEST AVAILABLE TECHNOLOGY

- Best Available Technology based on:
  - Large removal efficiencies
  - Compatibility with other treatment processes
  - Availability of treatment technologies

Granular Activated Carbon (GAC)

- The GAC system adsorbs radon from the water without the use of mechanical components
- GAC systems, when properly sized and installed, can yield 90+% reduction of radon when initially installed. Other contaminants in the water can adversely affect the radon removal efficiency of the GAC system over time

Carbon Fouling

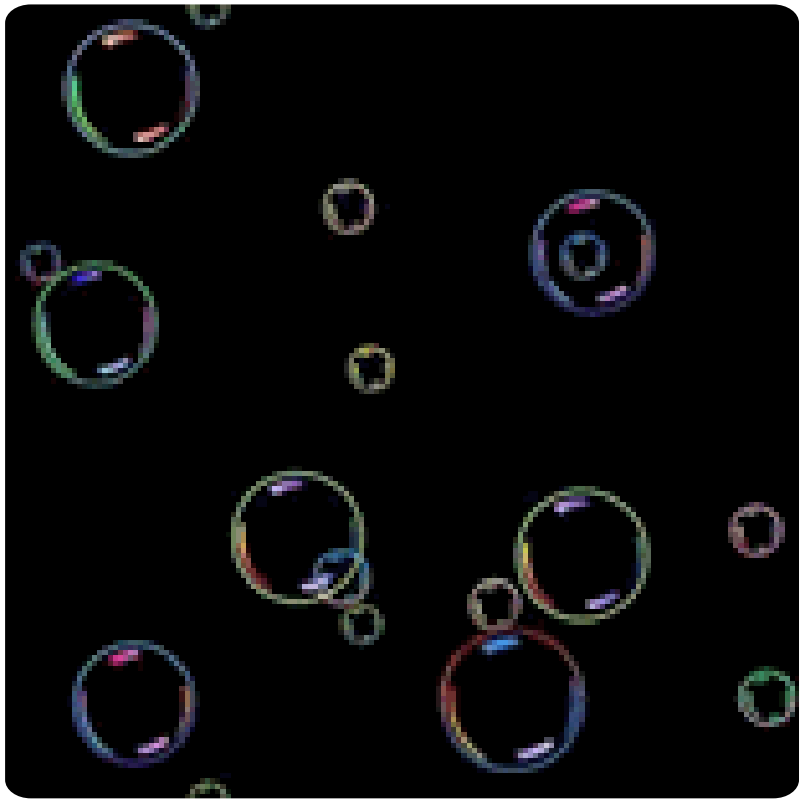


Carbon Cautions

- Fouling maintenance
- Gamma emanations
- Carbon disposal
- Collection of radioactivity on pre-filters

Aeration Principles

- Radon has high Henry's Constant (easily released from water)
- "Air-stripping": Increases surface area of air: water contact
- Allows radon to off-gas
- Lots of small bubbles in small amount of water releases more radon

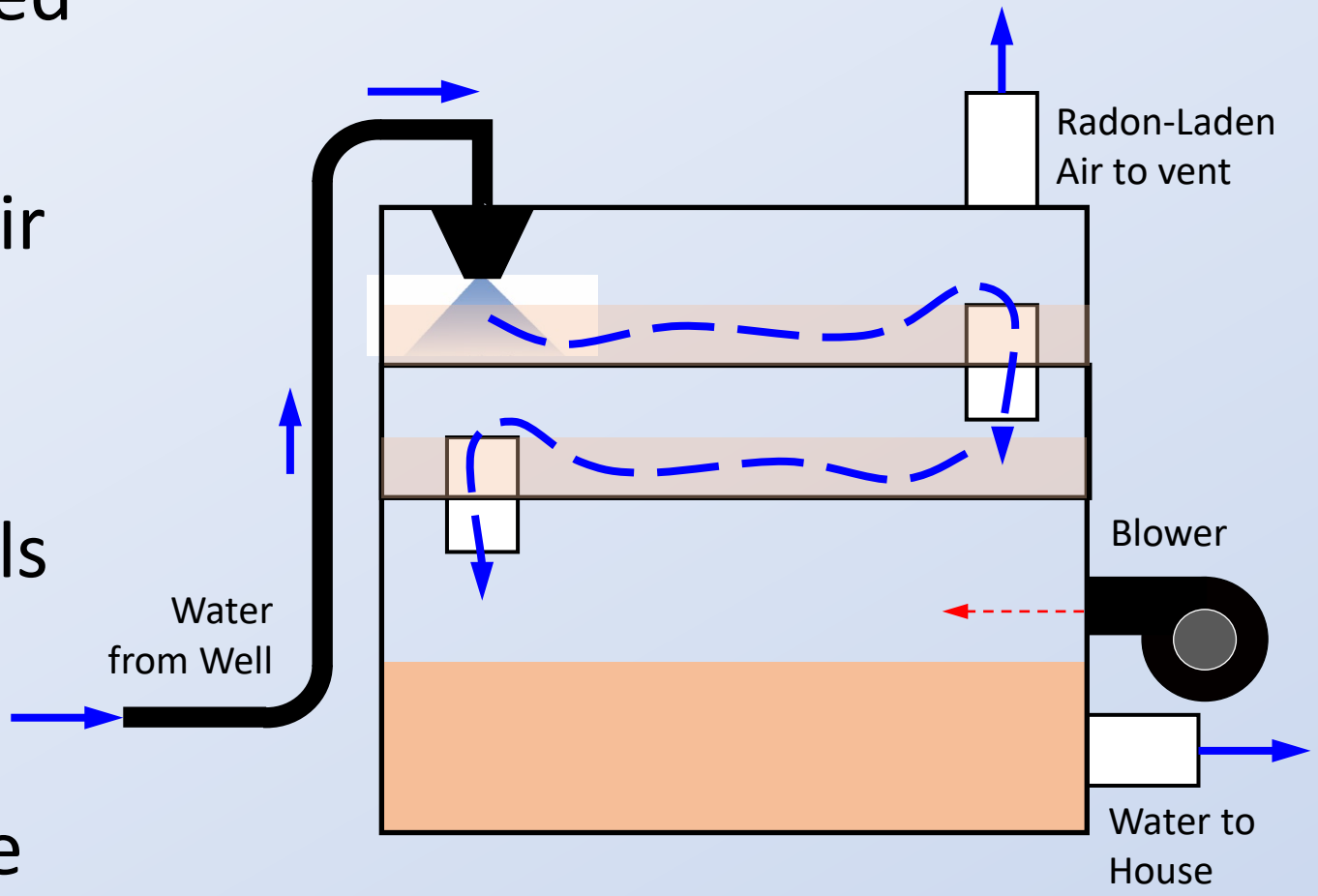


Common Residential Aeration

- Spray
- Packed Tower
- Shallow Tray
- Air Sparging
- Diffused-bubble
- Combination of techniques

Shallow Tray Aeration

- Well water sprayed into shallow tray
- High volume of air pumped through water in tray
- Treated water falls to reservoir on bottom and is pumped to house

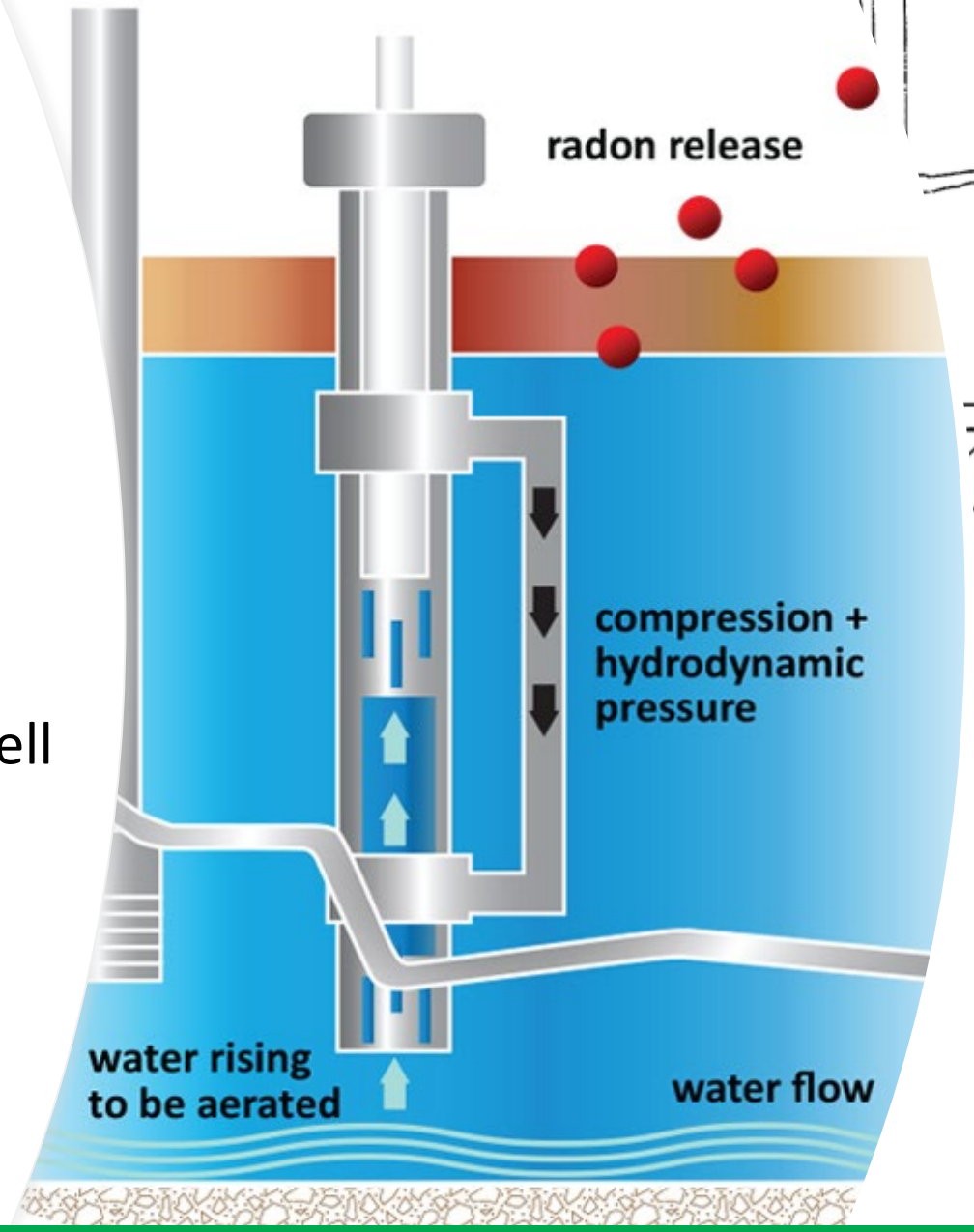


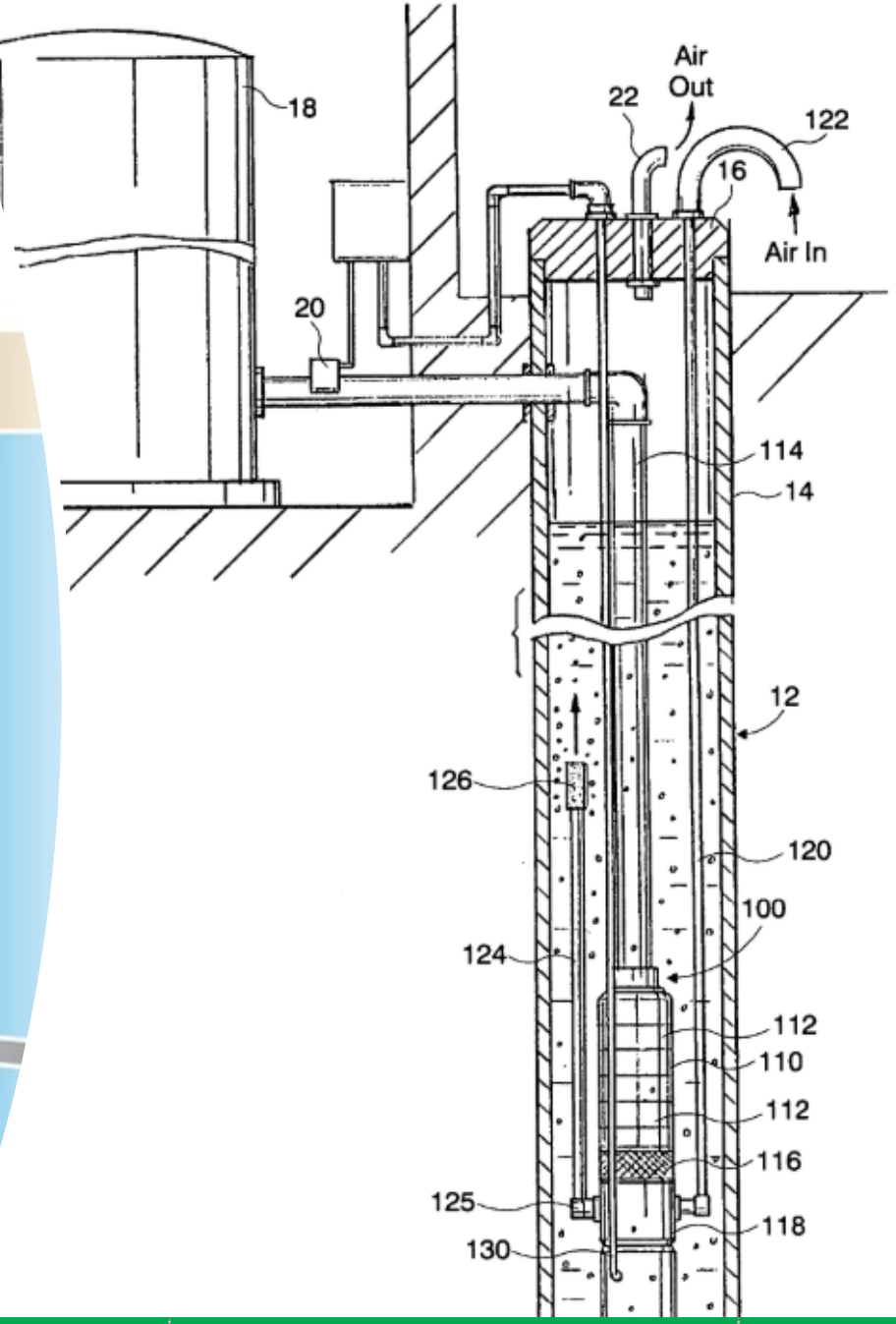
Shallow Tray Cautions

- Uses 100 ft^3/minute of air
- Can depressurize basement and/or back draft appliances
- Vent Line requires an inline fan

In Well Aeration

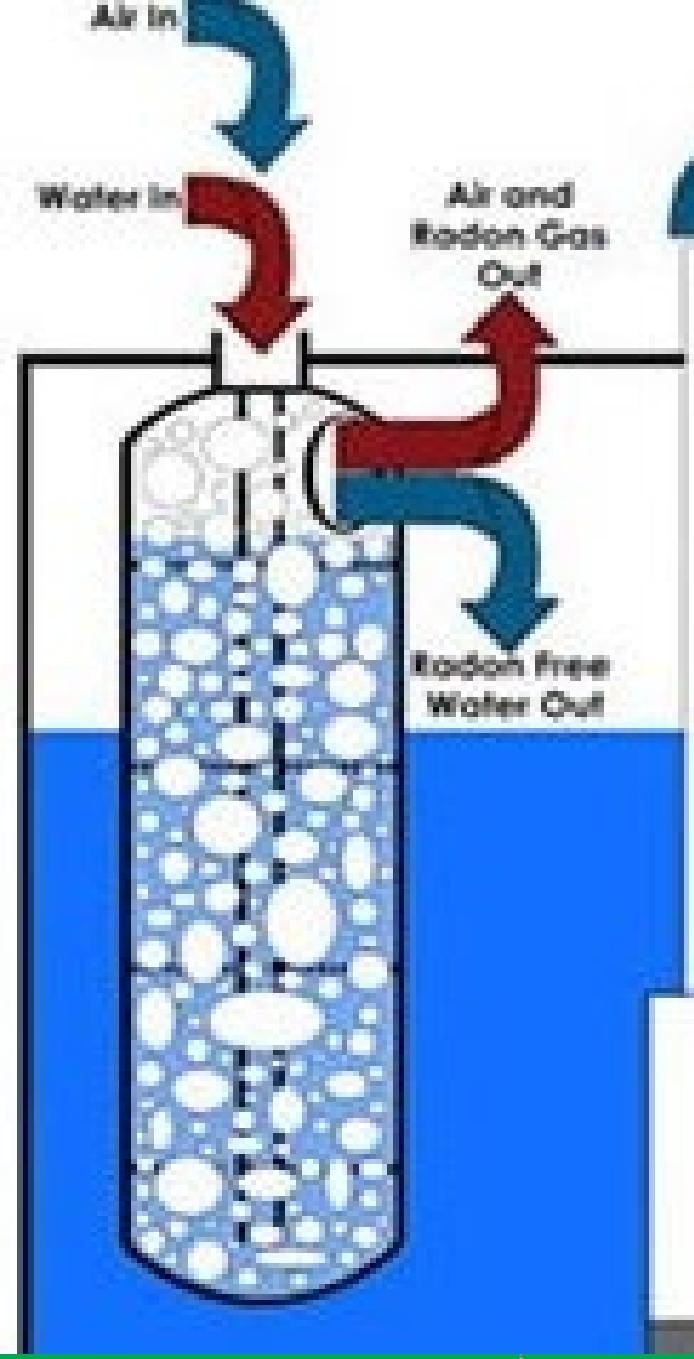
- Air pumped down pipe into well
- Air pump located outside
- Radon vented at well head





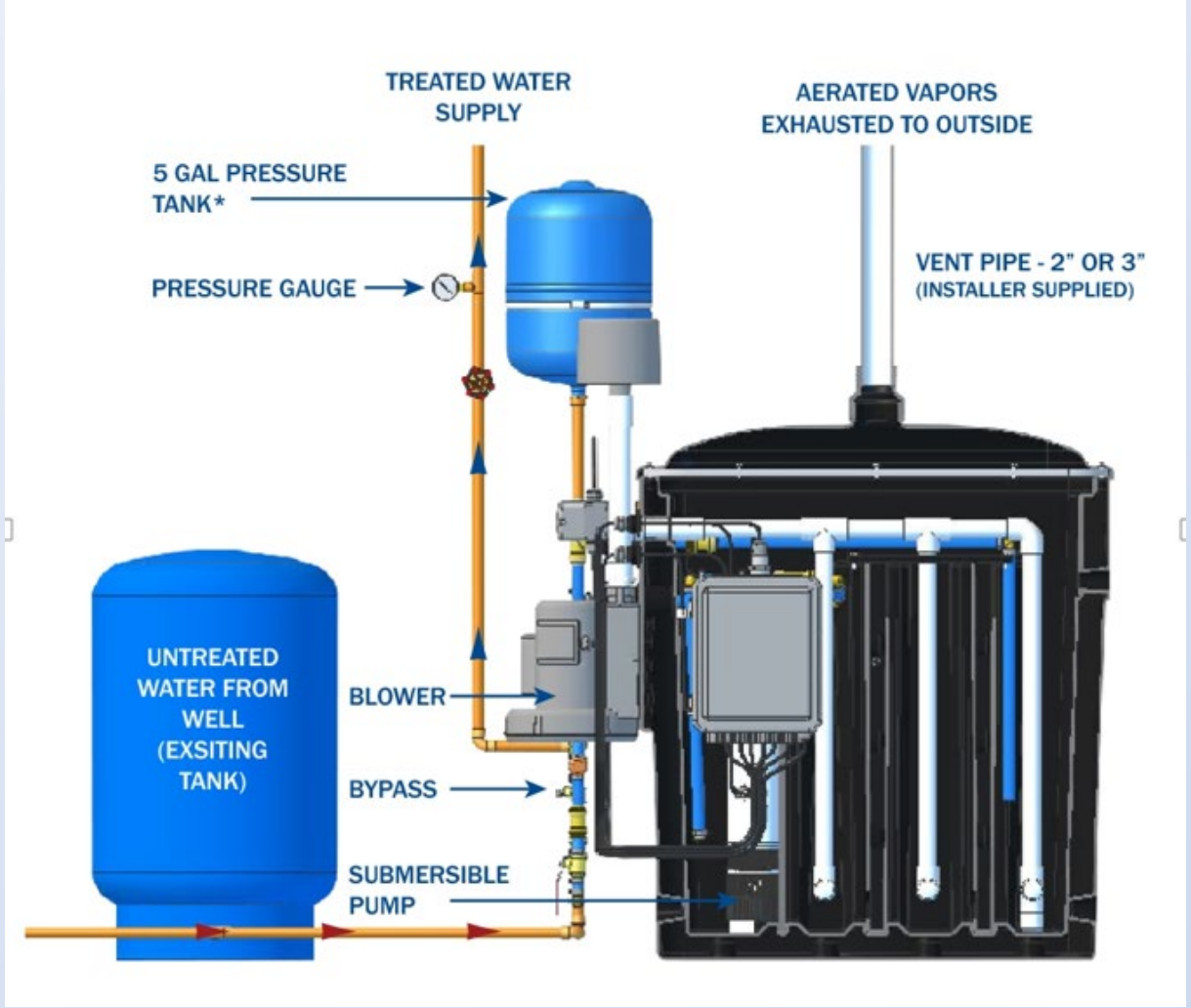
Bubble Aeration

- Combination of spray/jet and air sparging
- Water sprayed into chamber
- Air pumped into bottom of the chamber
- Radon vented to outside



Diffused-Bubble Aeration

- Water enters the bottom of the first aeration chamber
- High pressure air is pumped through diffusers
- Flows in a cascade pattern from aerated chamber to aerated chamber
- Radon vented to outside

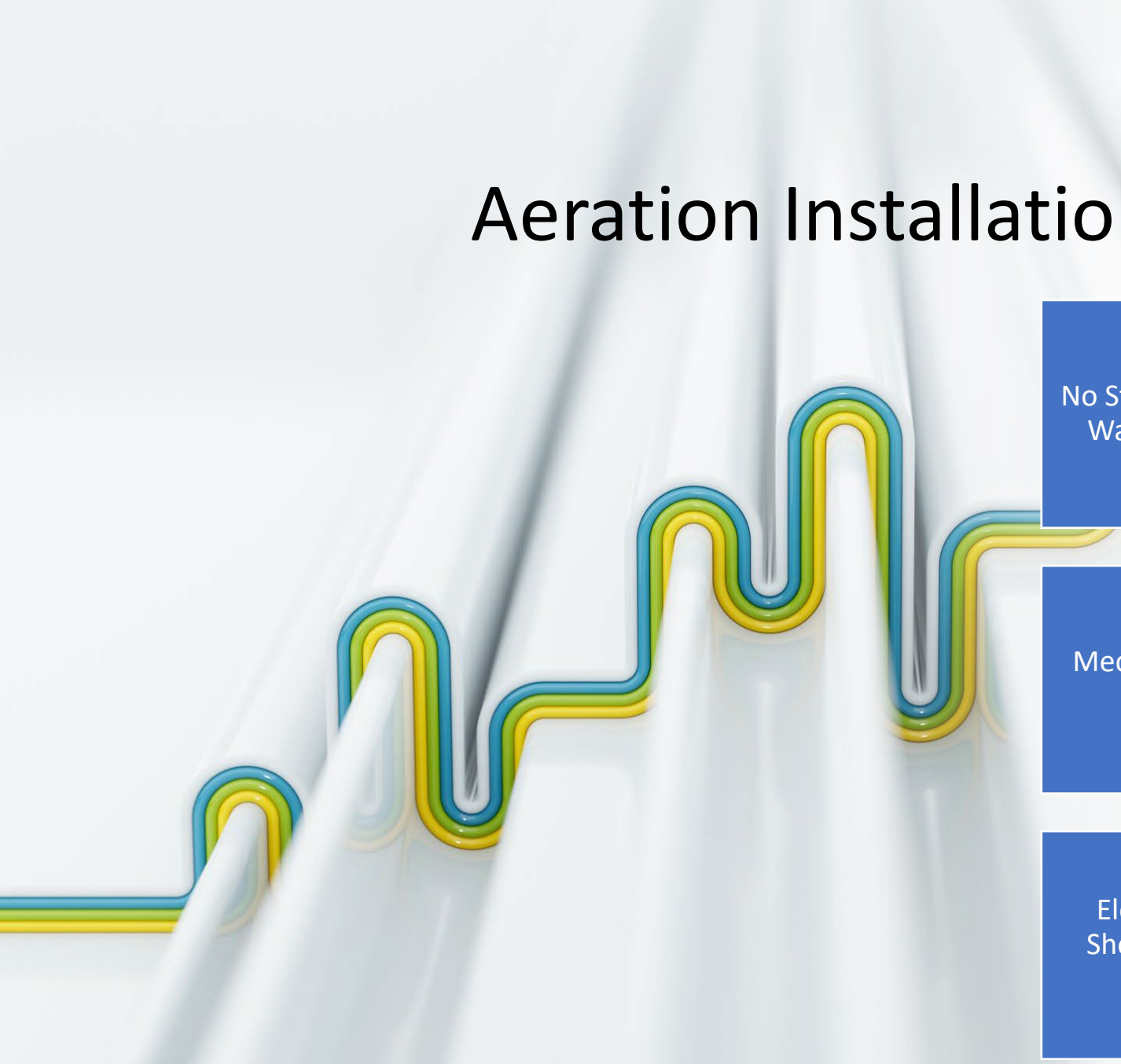



Diffused-Bubble Aeration

Aeration Comparison

Treatment Method	Removal Efficiency, %	Flow Range, $m^3\ d^{-1}$	Unit Construction Cost, $ $m^{-3}\ d^{-1}$
I. Aeration Methods			
1. Packed tower	79 to >99%	49 to 102,740	18 to 481
2. Diffused bubble			
a. Single-stage	93	431	312
b. Multi-stage	71 to >99	65 to 6,540	11 to 433
3. Spray Aeration	~88[a] (est)	1,025	5.3
4. Slat tray	86 to 94	1,989 to 2,453	5.3 to 124
5.Cascade aeration	~88[a] (est)	5,450	7.9
II. Granular Activated Carbon	20 to >99	11 to 981	77 to 365
[a] Estimated.		Source: Drago (1998), Pontius (1998).	

Aeration Installation Challenges



No Standards For Radon In Water Mitigation Yet...

System Must Be Sealed

Mechanical Components Can Fail

Venting High Levels of Radon

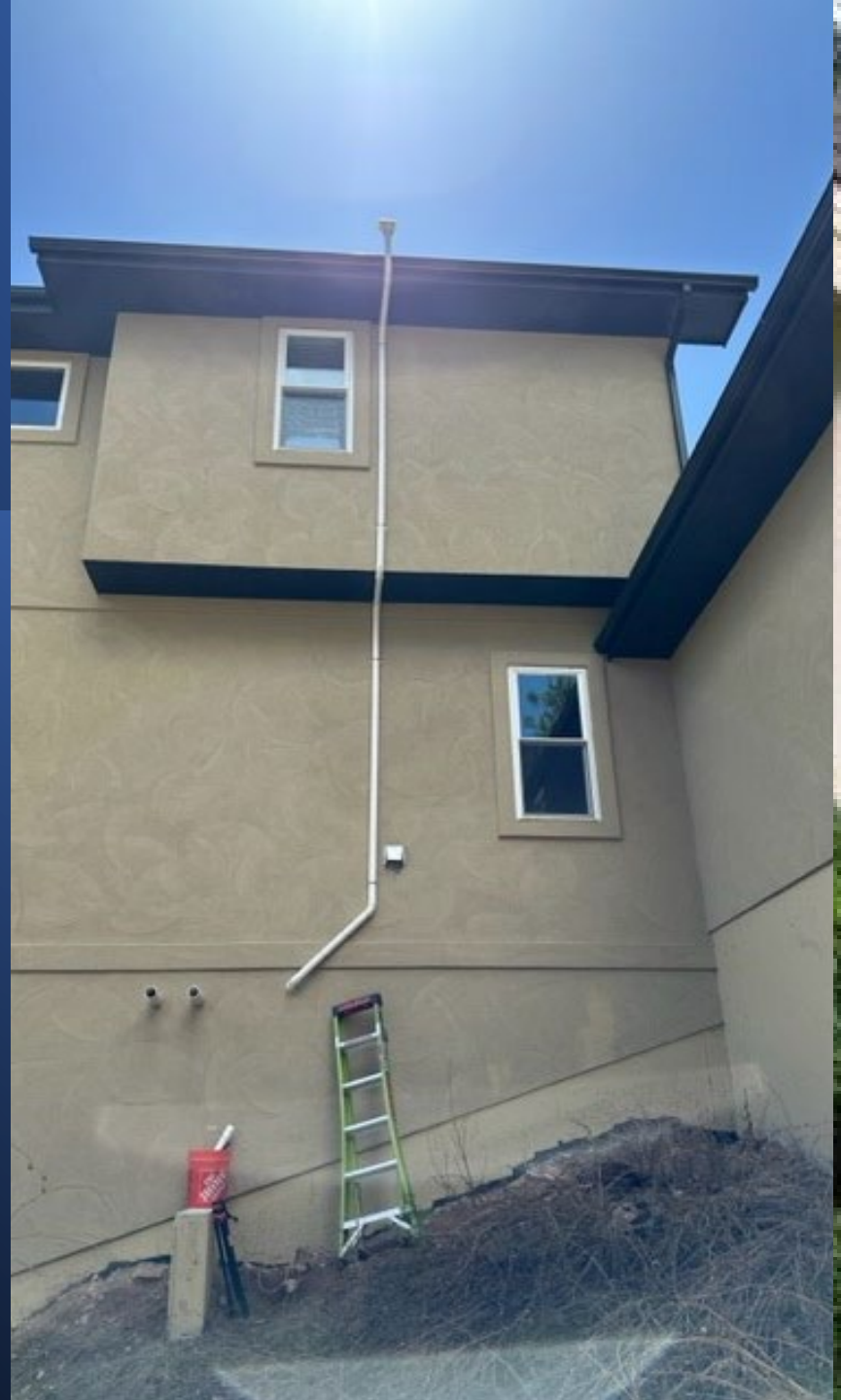
- Follow Venting Standards For Air

Electrical Connection Should Be A Dedicated Circuit

Multiple Professional Skills/Licenses Needed

- Radon
- Electrical
- Plumbing
- Water Treatment

Venting Challenges



Point of Entry Systems Must Be Sealed

Operation, Maintenance, & Monitoring

- Retesting Is a Must
- Operational manual must be left with system
- Label All Components For Future Servicing
- Annual Service Is a Requirement

ANNUAL SERVICE AND TESTING IS A REQUIREMENT!

Thank you

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