Oregon Radioactive Waste Disposal Regulations

Division 50 February 2022 Meeting

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OREGON DEPARTMENT OF ENERGY

AGENDA

9:00 Welcome and Introductions

9:15 Discussion of Pathway Exemption Rules (OAR 345-050-0035 to 345-050-0038)

Staff will provide an overview of the current rules and will ask the RAC to provide input on:

- *Whether the 500 millirem dose limit in rule adequately protects public health and safety*
- *Whether the current methods for estimating the potential exposure that could result from materials are appropriate.*
- *Whether the pathways other than direct gamma radiation exposure and the release of effluents to air and water should be considering when determining if a material qualifies for exemption.*

9:00 Wrap up and Next Steps

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Questions for rulemaking

- Is the 500 mrem gamma standard appropriate for the rule?
- What alternatives should be considered?
- Considering existing statutes, can land cover be accounted in a pathway exemption determination? Should it be?

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Statutory Prohibition on Disposal

Oregon Revised Statute 469.525

469.525. (1) Notwithstanding any other provision of this chapter, no radioactive waste shall be disposed of within this state, no person may arrange for disposal of radioactive waste within this state, no person may transport radioactive waste for disposal in this state and no waste disposal facility for any radioactive waste shall be established, operated or licensed within this state, except as follows . . .

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Statutory Definition Review

Oregon Revised Statute 469.300

(31) <u>"Waste disposal facility" means a geographical site in or upon which radioactive waste is held or placed</u> but does not include a site at which radioactive waste used or generated pursuant to a license granted under is stored temporarily, a site of a thermal power plant used for the temporary storage of radioactive waste from that plant for which a site certificate has been issued pursuant to this chapter or a site used for temporary storage of radioactive waste from a reactor operated by a college, university or graduate center for research purposes and not connected to the Northwest Power Grid. As used in this subsection, "temporary storage" includes storage of radioactive waste on the site of a nuclear-fueled thermal power plant for which a site certificate has been issued until a permanent storage site is available by the federal government.

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Statutory Definition Review

(23)(a) "Radioactive waste" includes all material which is discarded, unwanted or has no present lawful economic use, and contains mined or refined naturally occurring isotopes, accelerator produced isotopes and by-product material, source material or special nuclear material as those terms are defined in ORS 453.605.

"Radioactive waste" does not include:

(A) Materials identified by the council by rule as presenting no significant danger to the public health and safety.

(B) Uranium mine overburden or uranium mill tailings, mill wastes or mill by-product materials as those terms are defined in Title 42, United States Code, section 2014, on June 25, 1979.

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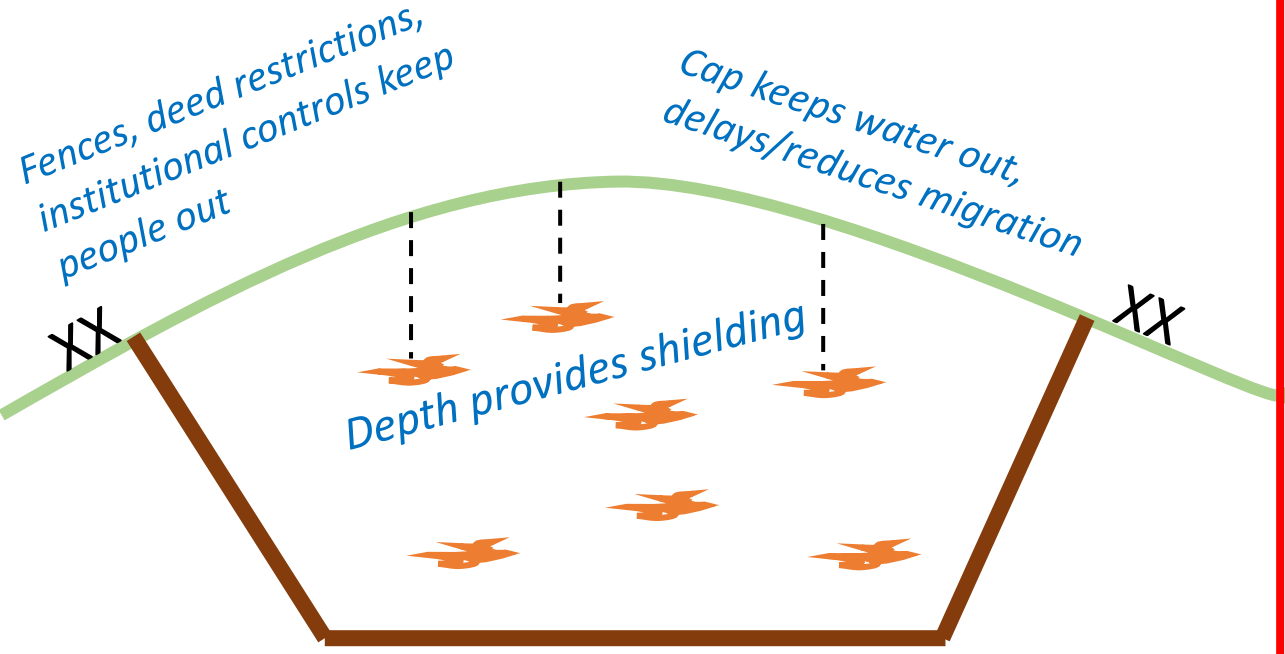
Oregon's rules are fundamentally different

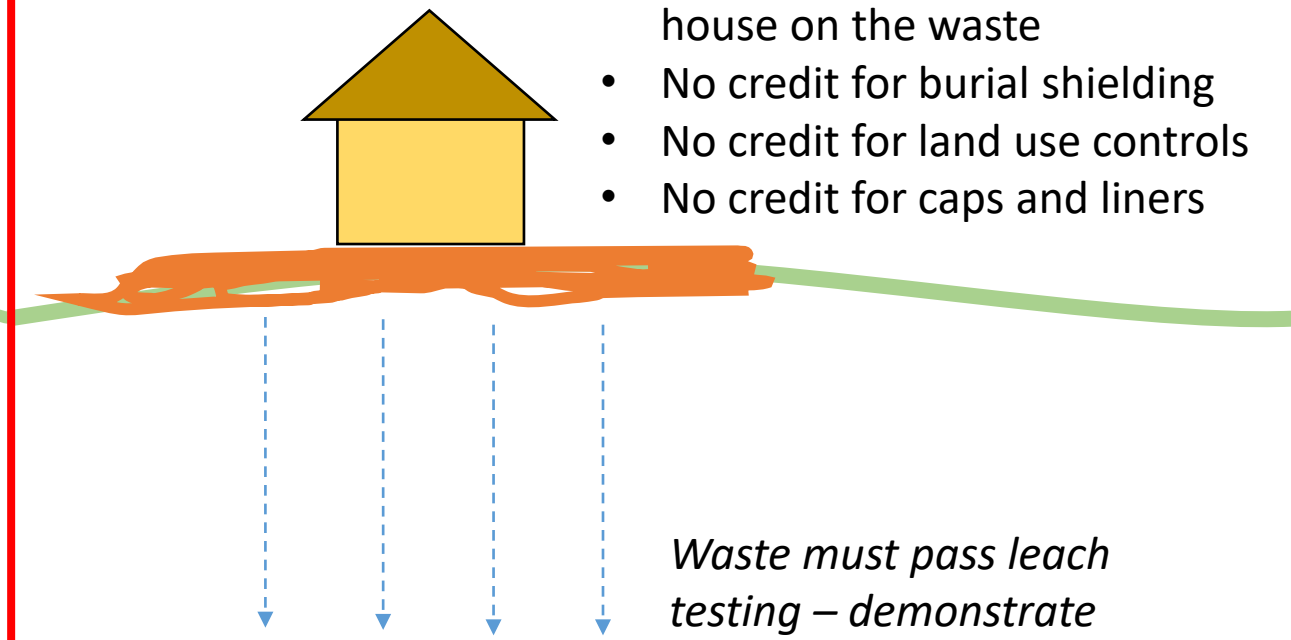
Some other states allow disposal in permitted facilities with safety features

(supported by predictive environmental model)



ORS 469.525: Radioactive waste disposal facilities prohibited

("Radioactive waste" is defined by its risk properties)



- Assume a person builds a house on the waste
- No credit for burial shielding
- No credit for land use controls
- No credit for caps and liners

Waste must pass leach testing – demonstrate inherently low migration

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How is exempt NORM defined now?

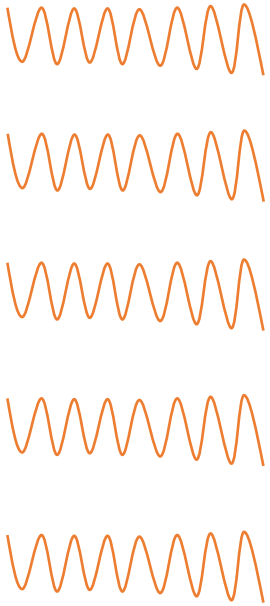
"Exempt" means the NORM does not qualify as "radioactive waste" in Oregon and may be disposed anywhere (i.e., landfill not assumed).

1. Quantity/Concentration thresholds for Uranium, Thorium, and Radium are low and generally consistent with many other states.
2. Pathway Exemption (if thresholds are exceeded):
   - **a)** **External gamma** dose of **500 millirem/year** based on direct measurement + model
   - b) Testing of actual waste required to ensure it will not **leach to water and air** above specified concentrations in Table 3 of the rule (based on **25 millirem/year**).
   - **c)** **Radon-specific value** must be met (based on **3 pCi/L** or 0.033 WL) as supported by measurements and a model assuming a house built on the waste.

Test 1: Gamma Pathway

- 500 millirem per year dose to a future individual.
- Assume no dilution.
- Do not consider effects of land use restriction or cover material.
- Allows consideration of “annual solid waste stream leaving a site for landfill disposal”.
- Interpretive rule based on a computer model of a house.

Gamma Pathway Interpretive Rule:
18 micro-R / hr
At 1-foot away
corresponds to
500 mrem/yr
based on a prior
computer model

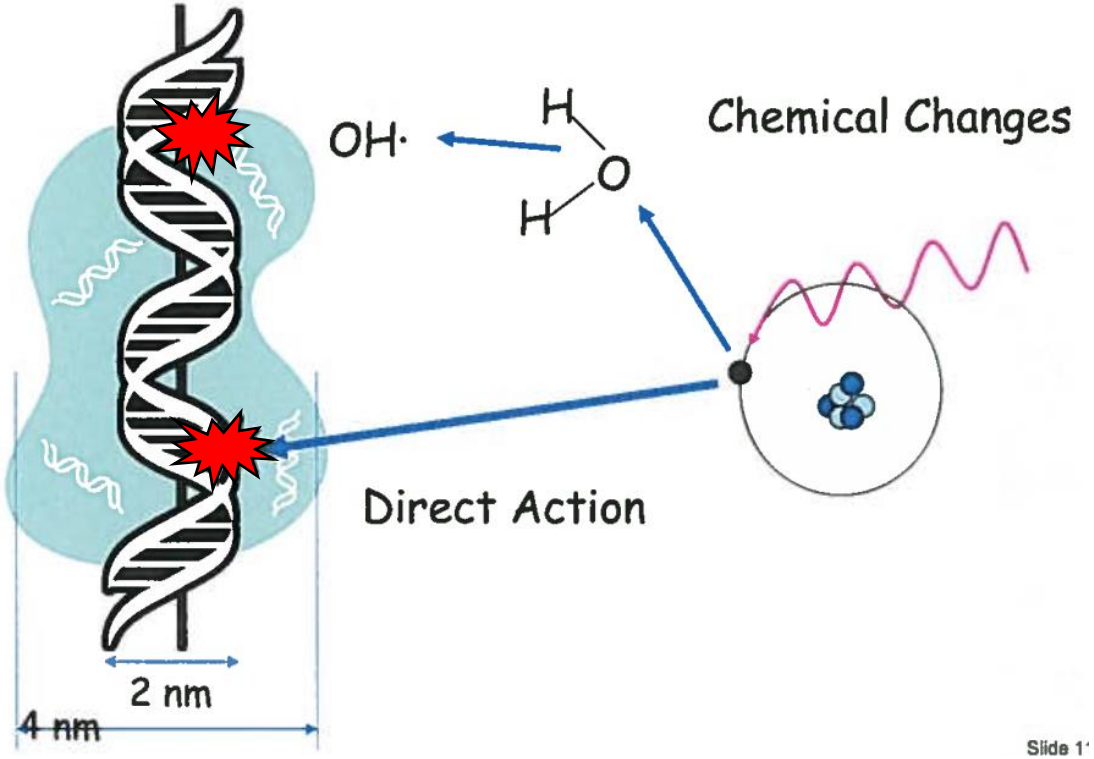


Question for RAC

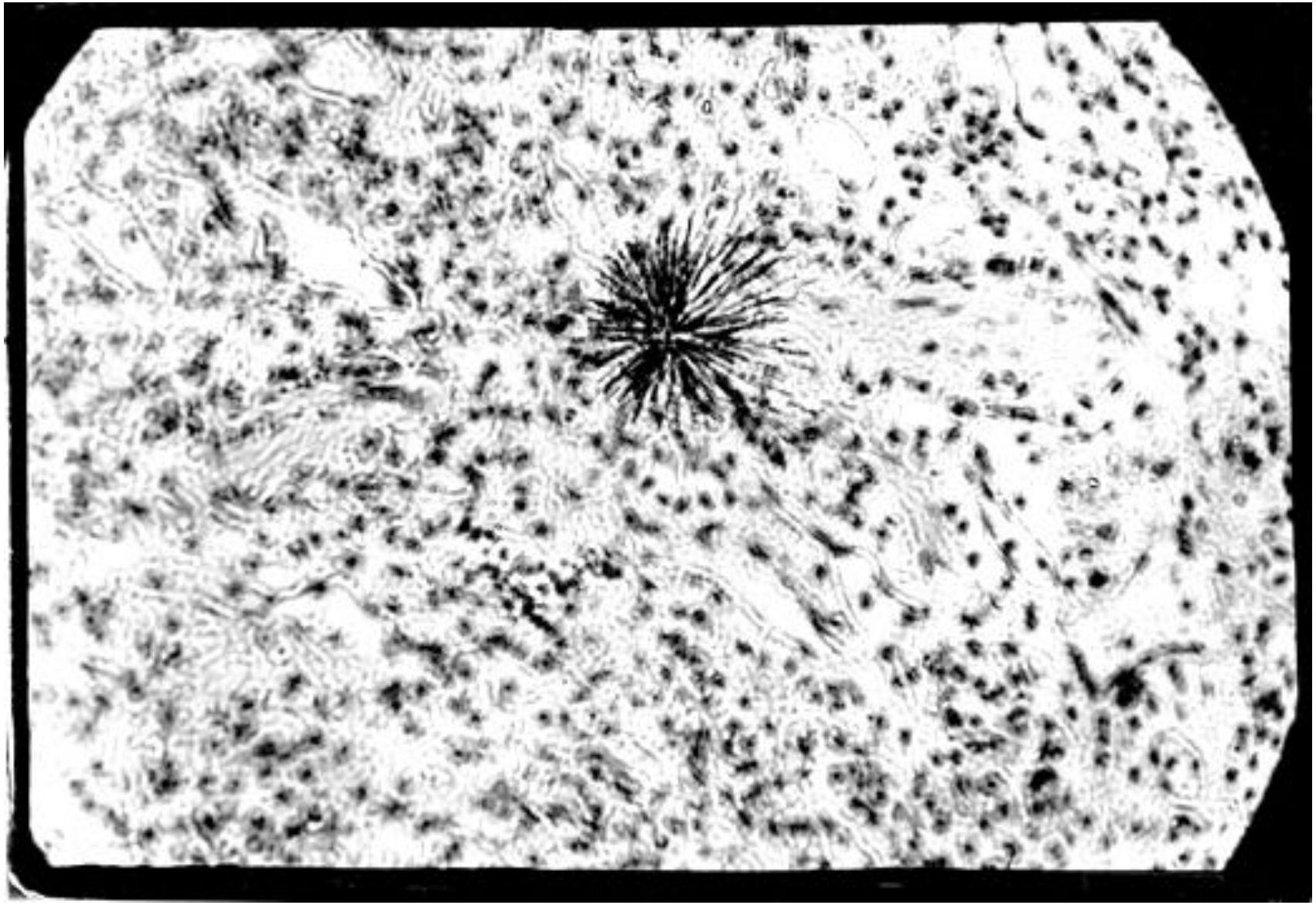
Does the 500 millirem gamma dose limit adequately protect public health and safety?

Why are we concerned about ionizing radiation in humans?

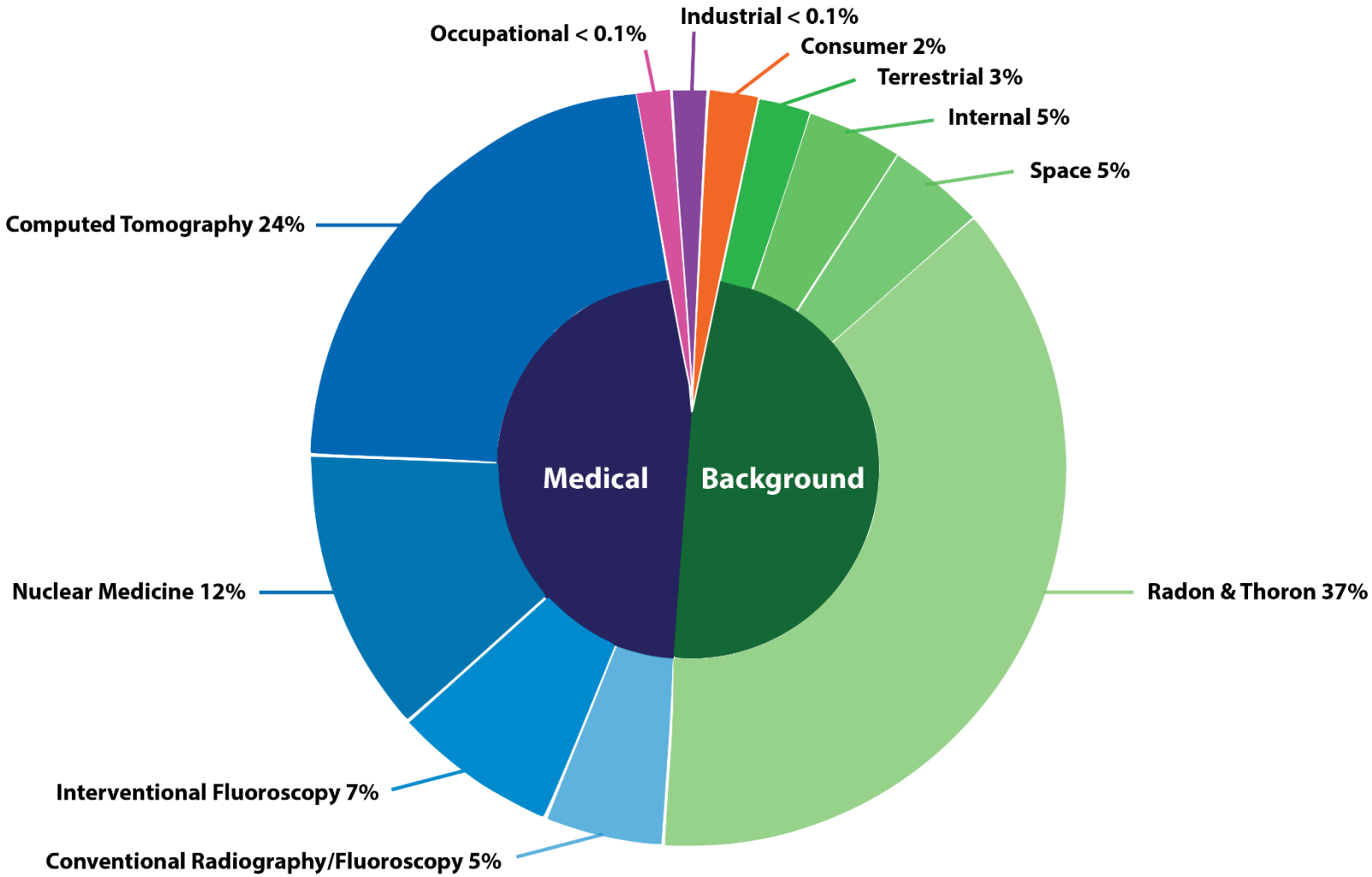
- Acute (high) doses of radiation can cause illness, cancer, or death
- Chronic (low) doses of radiation are linked with a higher probability of developing cancer.
  - Ionizing radiation is like “subatomic bullets” fired at random, which can alter any atom it hits
  - If replicating DNA is directly damaged by radiation, it may reproduce uncontrollably with errors (i.e., tumors)
  - Radiation can split the chemical bonds of water in the body to create free radicals, which can cause damage to cells and DNA.



Alpha Radiation Cell Damage in Lung Tissue (Plutonium-239)



Sources of Radiation Exposure



Average Annual Radiation Dose

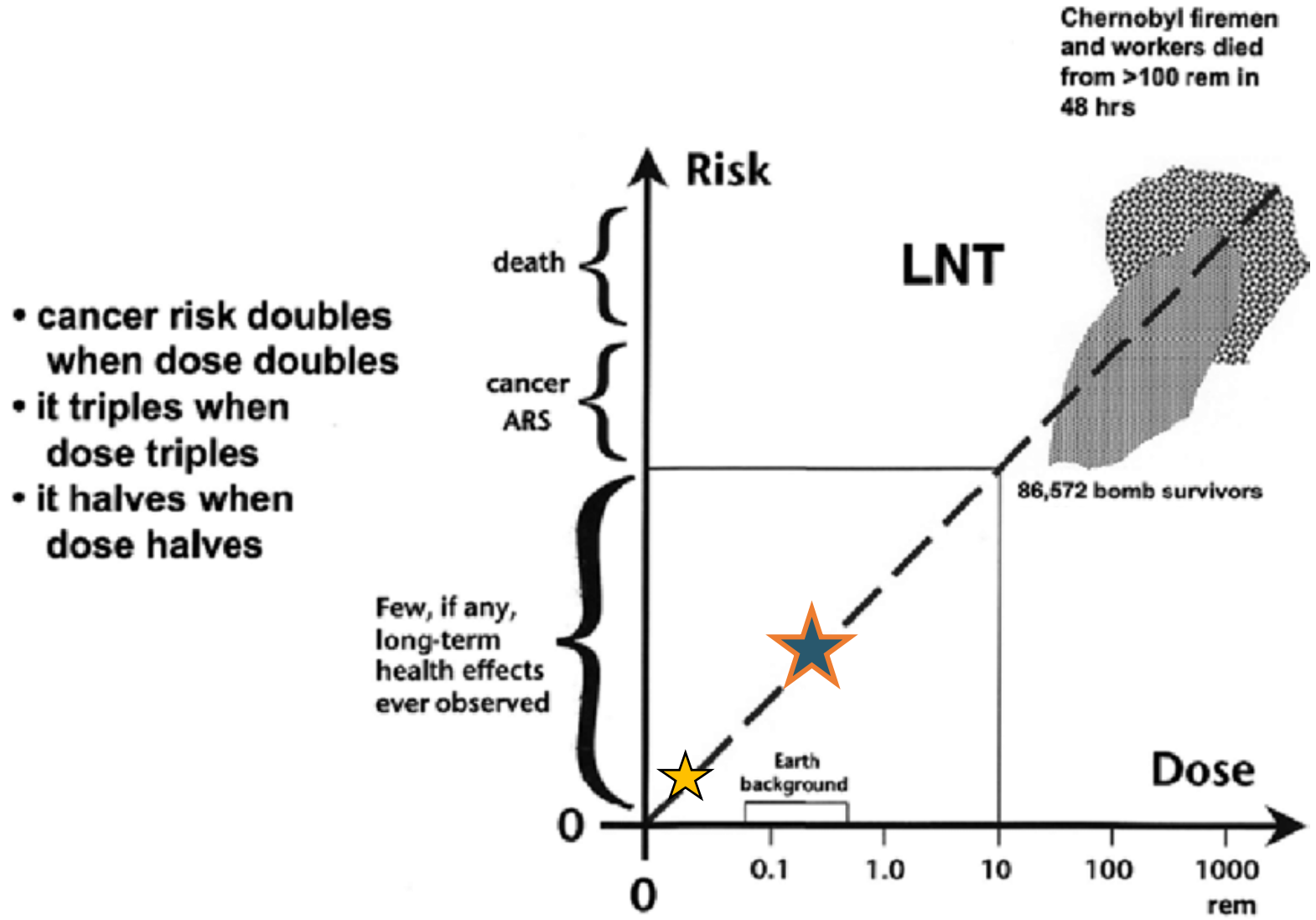
Sources	Radon & Thoron	Computed Tomography	Nuclear Medicine	Interventional Fluoroscopy	Space	Conventional Radiography/ Fluoroscopy	Internal	Terrestrial	Consumer	Occupational	Industrial
Units											
mrem (United States)	228 mrem	147 mrem	77 mrem	43 mrem	33 mrem	33 mrem	29 mrem	21 mrem	13 mrem	0.5 mrem	0.3 mrem
mSv (International)	2.28 mSv	1.47 mSv	0.77 mSv	0.43 mSv	0.33 mSv	0.33mSv	0.29 mSv	0.21 mSv	0.13 mSv	0.005 mSv	0.003 mSv

(Source: National Council on Radiation Protection & Measurements, Report No. 160)

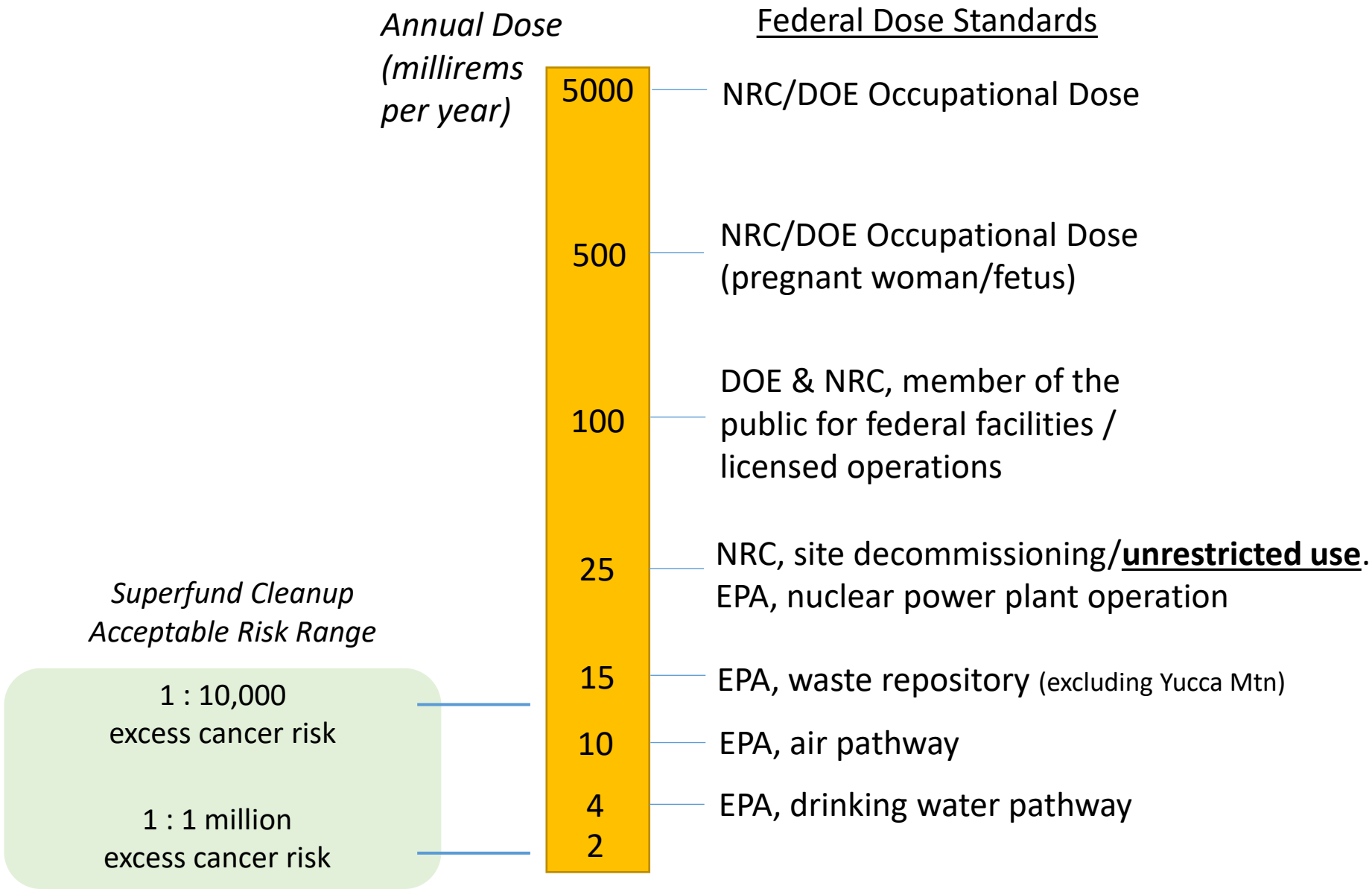
Low dose health effects

Average US background radiation: **310 millirem per year** (mrem)

Average including medical procedures: **620 mrem**



How much above background is "acceptable"?



Dose vs. Risk

- Standardized dose/risk coefficient: Every mrem = 8.46E-7 excess lifetime cancer risk (1:1.2 million chance) *(per EPA FGR 13)*

- EPA risk assessment based on 30-year continuous exposure

- Excess Lifetime Cancer Risk (Mortality) by annual dose standard:
  - 12 mrem/yr = 1:3,333 ← Upper bound of CERCLA/Superfund risk range
  - 25 mrem/yr = 1:1,600 ← Unrestricted land use per NRC/OR law
  - 100 mrem/yr = 1:400 ← Annual Public Dose Limit in the US
  - 500 mrem/yr = 1:80 ← Current ODOE gamma dose standard

Question for RAC

Are the current methods for estimating the potential gamma exposure appropriate?

500 Millirem Gamma Pathway Standard

1992 OSU study:

- 100 pCi/g of U-238 = **42 uR/hr** 1 foot from standard box.
- 42 pCi/g = **18 uR/hr**.

Correlation between 18 uR/hr and 500 mrem/yr not available.

RESRAD (42 pCi/g Ra-226) = 281 mrem/yr direct gamma.

2/25/94

Attachment A

Gamma Exposures for Containers

Container	Container Dimensions (feet) Height	Length	Width	Oregon Base Material(a) (uR/hr)	Ratio of Container To Box Exp Rate	Gamma Exp @ 1 Ft Equiv Criteria (uR/hr)
Base exposure rate for Standard Box:				18		
RAE Calculations Using MICROSHIELD Code, Version 3, 1988						
#1 Std Box	1.50	2.00	1.00	42	1.00	18
Result from Oregon State U Calc.				42		
#2 Oak Grov	4.60	16.00	7.50	128	3.03	55
#3 MDC LSBO	2.60	14.00	7.60	91	2.17	39
#4 C'Stores	5.50	20.00	7.60	133	3.16	57
#5 LSBO cer	4.00	12.00	6.00	122	2.90	52
Average of Four Large Waste Containers					2.82	51

a Base material used by S. Binney, Oregon State University (October 29, 1992). Concentrations for Th-232 of 30 ppm or 3.3 pCi/g, and U-238 of 300 ppm or 101 pCi/g.

RAE/DEB
47-cont.ls

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500 Millirem Gamma Pathway Standard

The Linear "Dial Down" Approach

Millirem/ year	pCi/g Ra-226	uR/hr at 1 foot
500	42	18
100	8.4	3.6
25	2.1	0.9

Difficult to implement in the field

Annual dose (*risk-based standard*)

Concentration of radium in waste (*lab sampling*)

Radiation readings in the field (*portals and handheld meters*)

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500 Millirem Gamma Pathway Standard

The Linear "Dial Down" Approach – other geometries

Millirem /year	pCi/g Ra-226	uR/hr @ 1' (Barrel)	uR/hr @ 1' (10 yd box)	uR/hr @ 1' (20 yd box)
500	42	18	40	55
100	8.4	3.6	8	6.9
25	2.1	0.9	2	2.8

Note: values are approximate and for illustration purposes only. Actual gamma rates depend on other factors such as density, specific container geometry, combination of radionuclides, etc.

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500 Millirem Gamma Pathway Standard

The "RESRAD Default" Approach

Millirem/ year	pCi/g Ra-226 (30% shield)	pCi/g Ra-226 (18% shield)	uR/hr @ 1' from Standard ODOE Box (30% shield)	uR/hr @ 1' from 10 yd Box (30% shield)	uR/hr @ 1' from 20 yd Box (30% shield)
500	75	65	31.5	70	96
100	15	13	6.3	14	19.2
25	4	3	1.7	3.8	5.2

Note: values are approximate and for illustration purposes only. Actual gamma rates depend on other factors such as density, specific container geometry, combination of radionuclides, etc.

Model assumes 90% indoor occupancy with a gamma shielding factor ranging from 0.7 (default) to 0.82 (approximating a house with crawlspace and wood floor).

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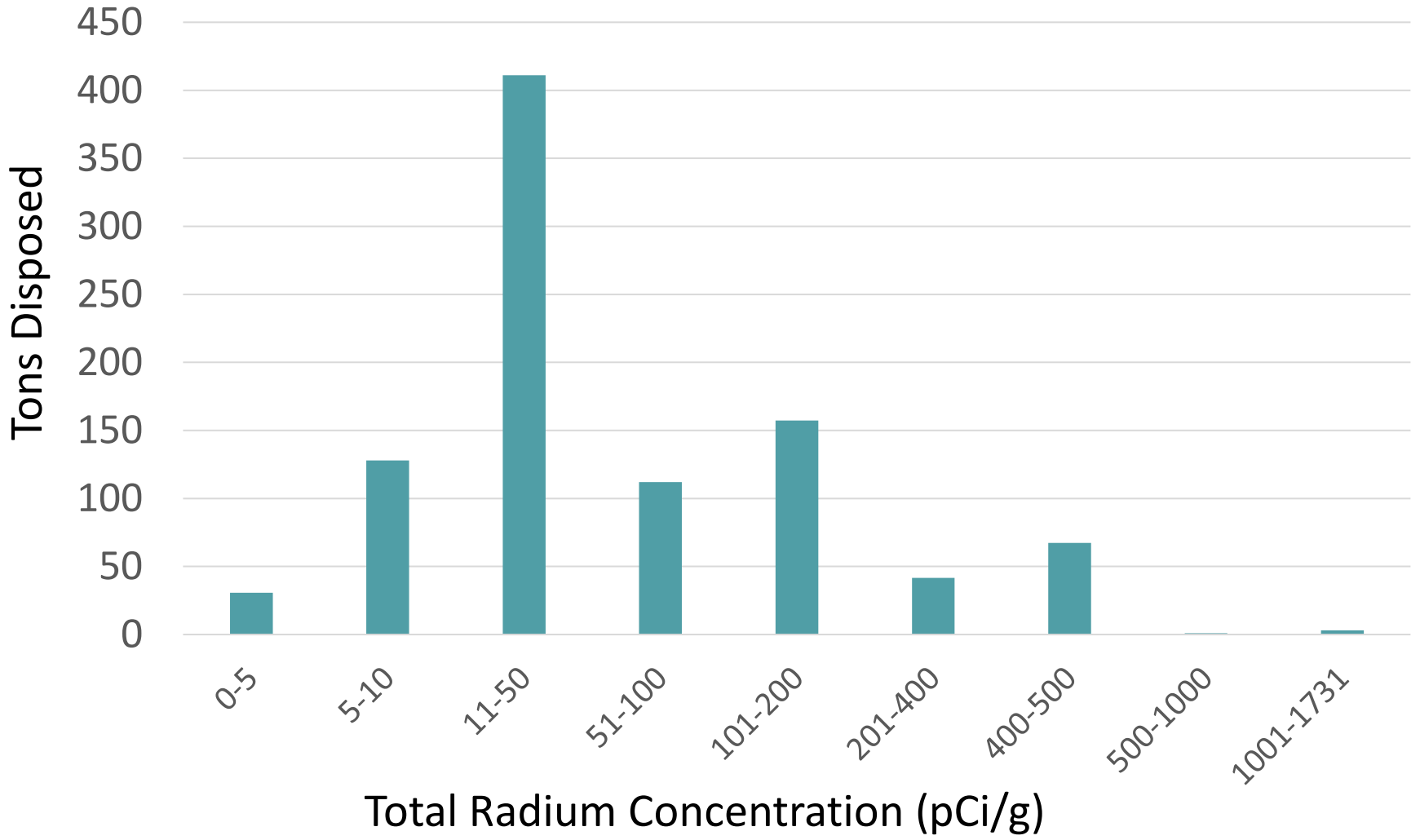
2016-2019 TENORM Disposal Incident: Tons of Waste Disposed by Concentration of Radium

Estimated total radioactivity from all waste = **0.123 Curies**

Filter socks comprised ~80% of waste



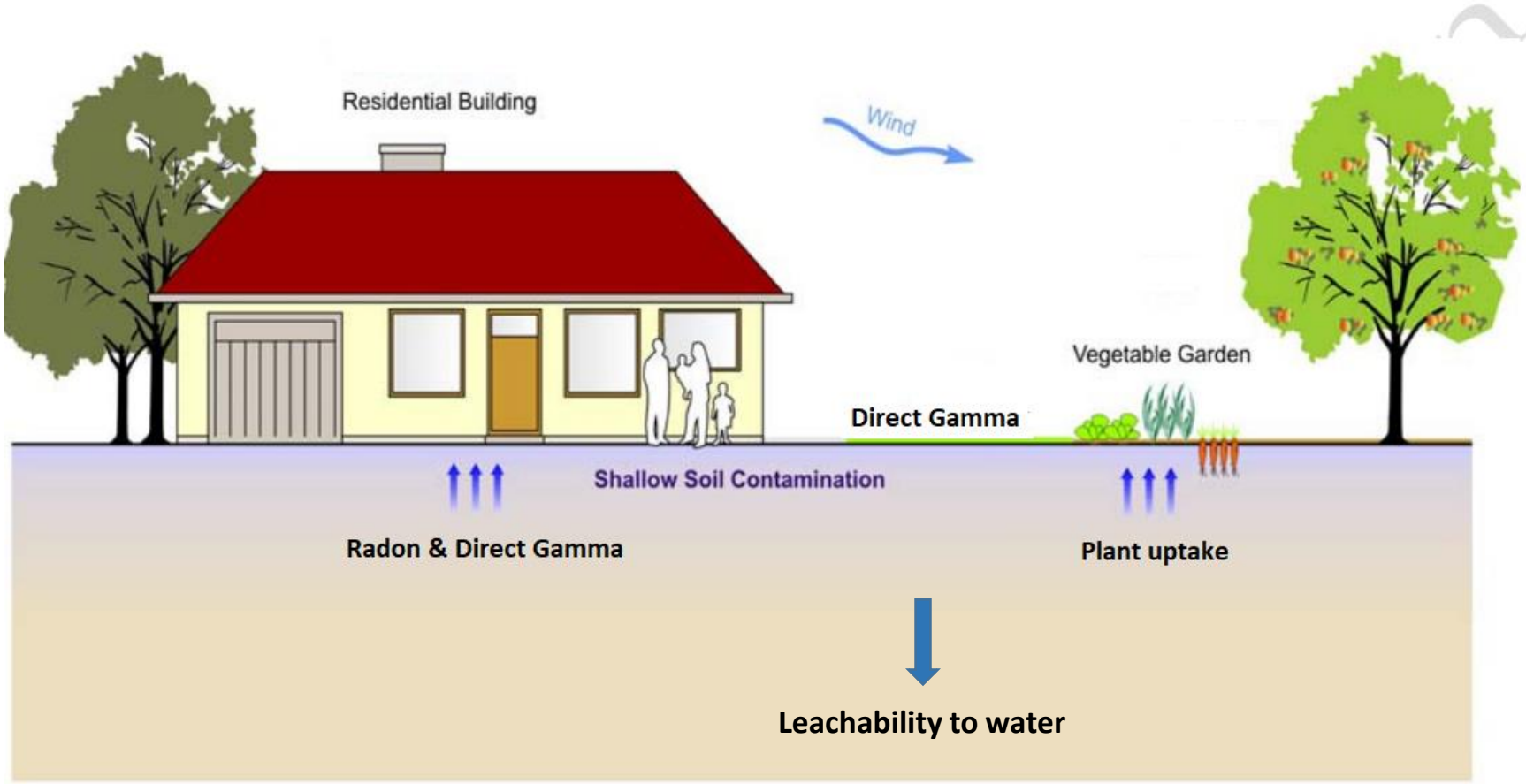
**Radioactivity in this chart based on North Dakota tracking information and does not represent total volume of waste.*

Question for RAC

Should additional pathways be included in the rule?

Consider Additional Pathways?

- Current Pathway Exemption includes direct gamma, water use, and radon in air.
- Ingestion of NORM via plant uptake not included in pathway exemption tests.
- Plant uptake not a likely exposure scenario when disposed in a landfill.
- Relates to question about applicability of disposal context/ land cover.



Plant Ingestion Pathway RESRAD Results

pCi/g Ra-226	pCi/g Pb-210	Millirem/year from plant ingestion	Dose including external gamma (default, 90% occupancy)
5	5	54	92
10	10	109	185
20	20	219	371
30	30	328	558

Note: values are approximate and for discussion purposes only.

Questions?

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Alpha radiation emitting from natural U-238