

Assessing Radon Flux From Earthen Radon Barriers over Uranium Mill Tailings Disposal Facilities

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Performance and Risk Assessment Community of Practice
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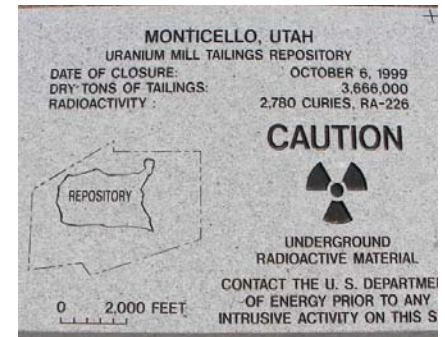
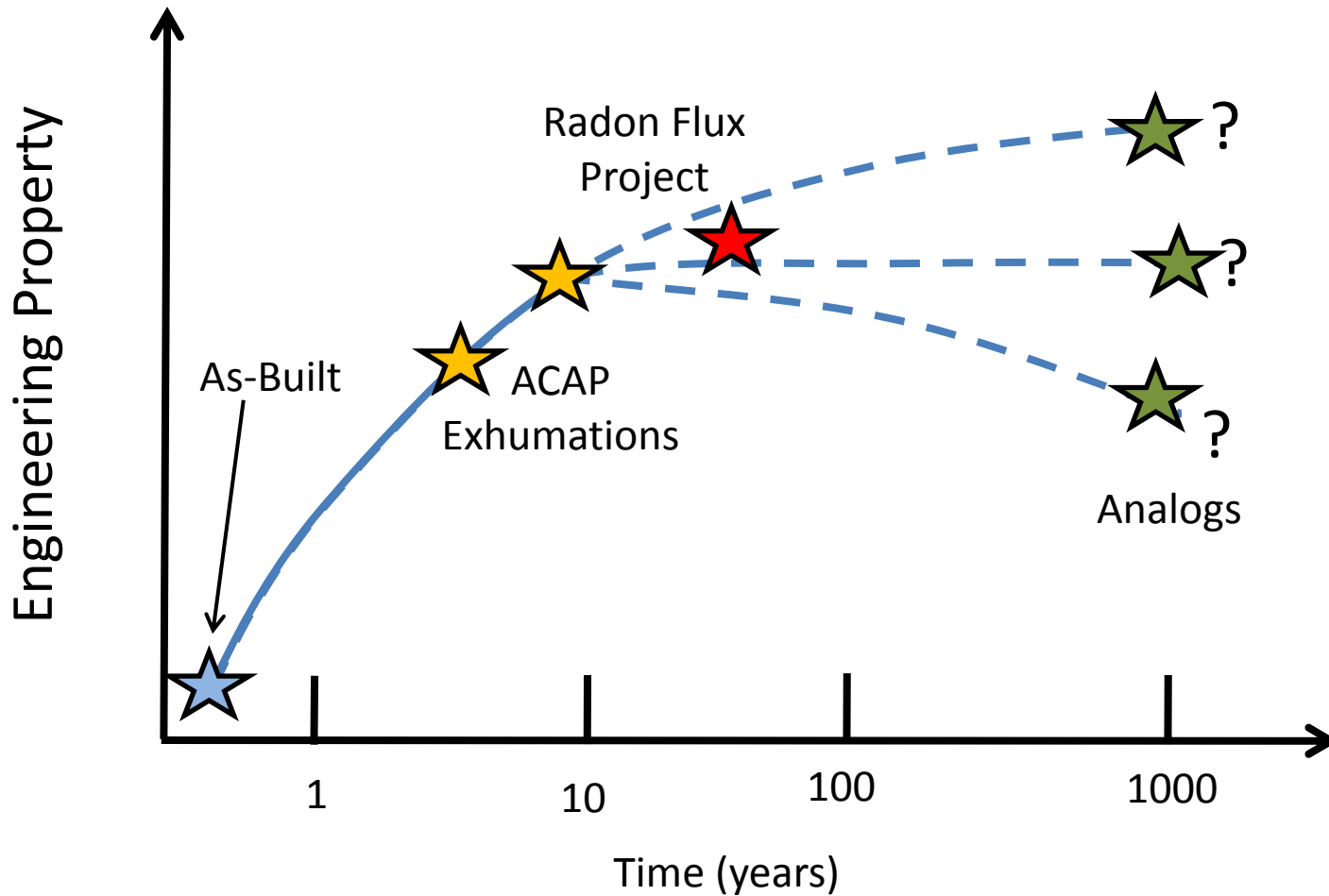


ENGINEERING

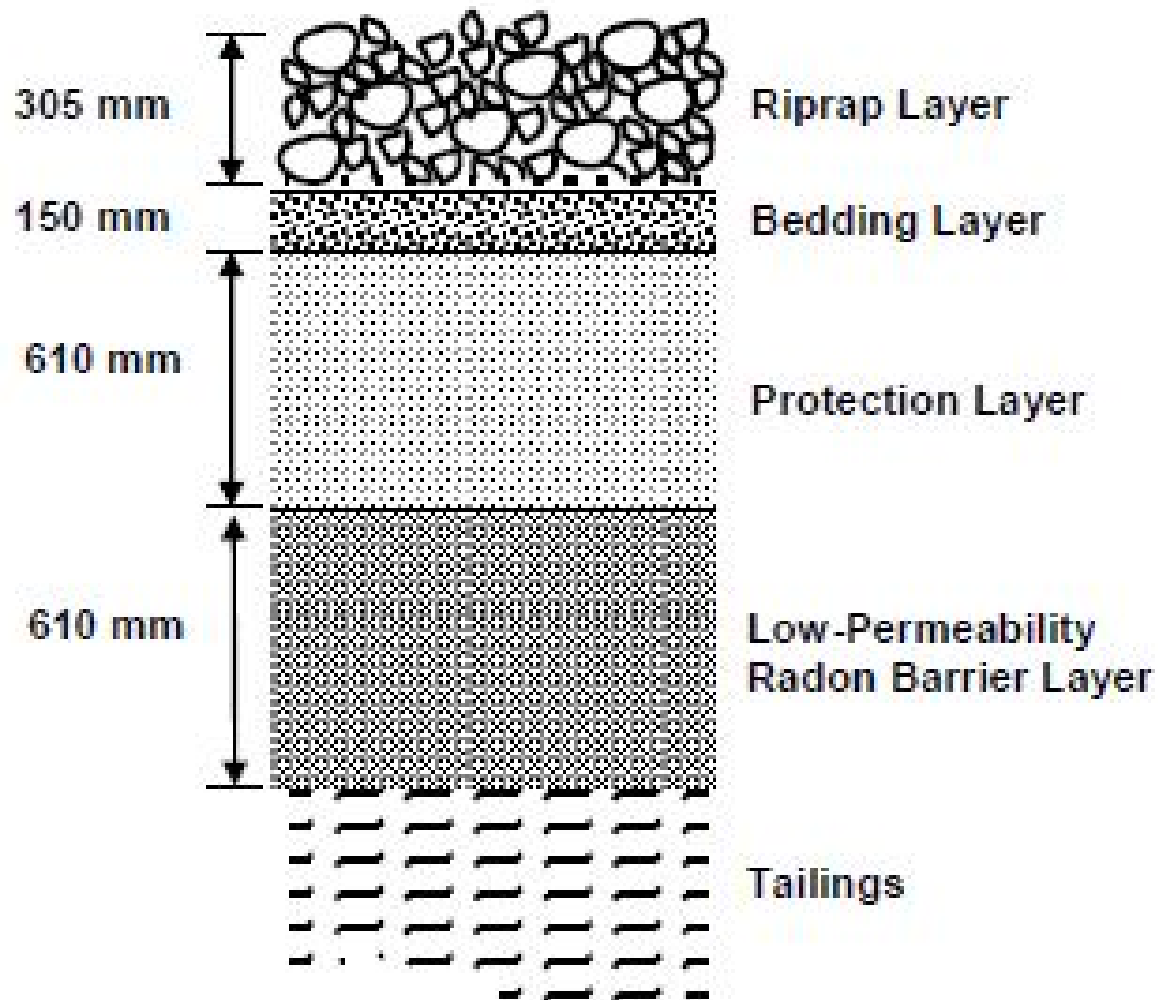




Challenges – Predicting the Future



UMTRCA Typical Earthen Cover Profile



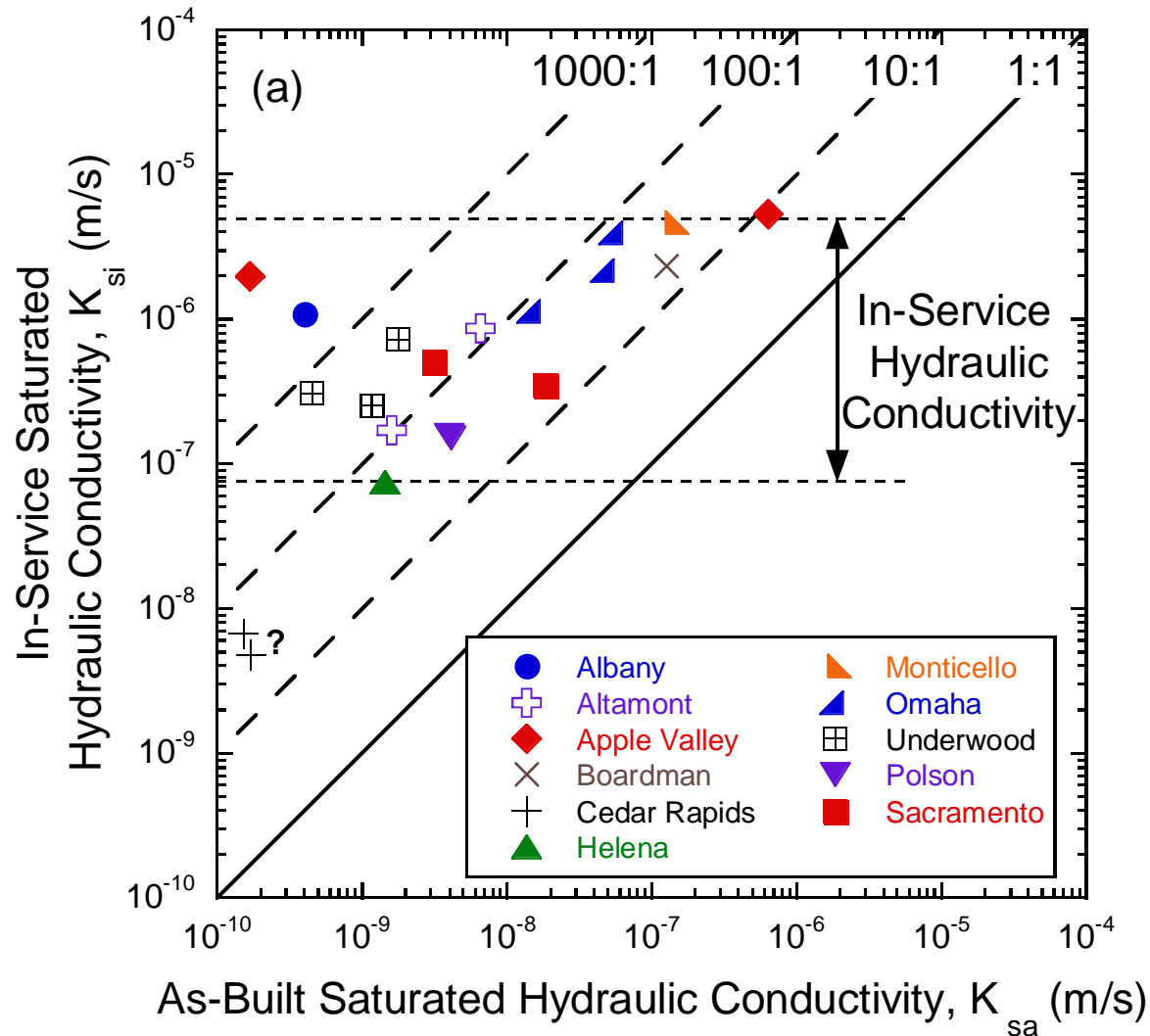
- Control radon flux & infiltration using fine-textured barrier layer.
- Barrier has high water saturation and therefore low radon gas diffusion coefficient.
- Surface may be rip rap (common) or vegetated surface layer (less common).

Radon Barrier – Monticello, UT Lysimeter



Roots seek out water in wet fine-grained soils, e.g., clay radon barriers, even at 1.6-1.9 m depth

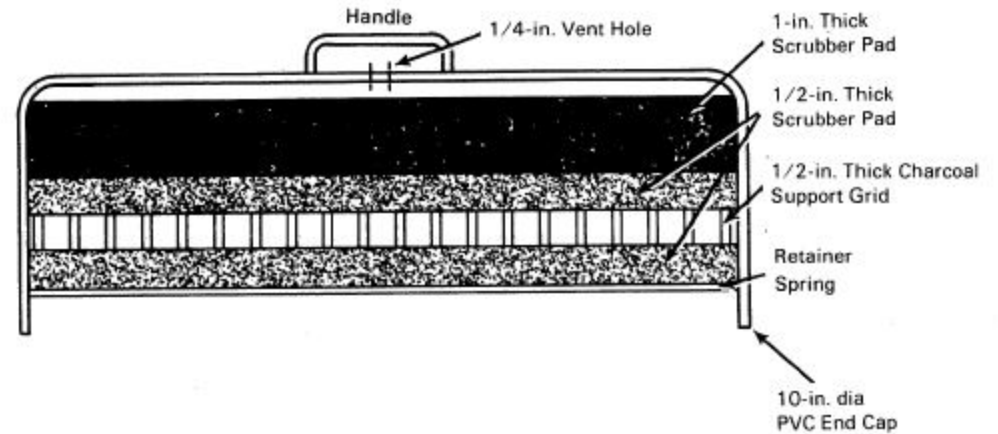
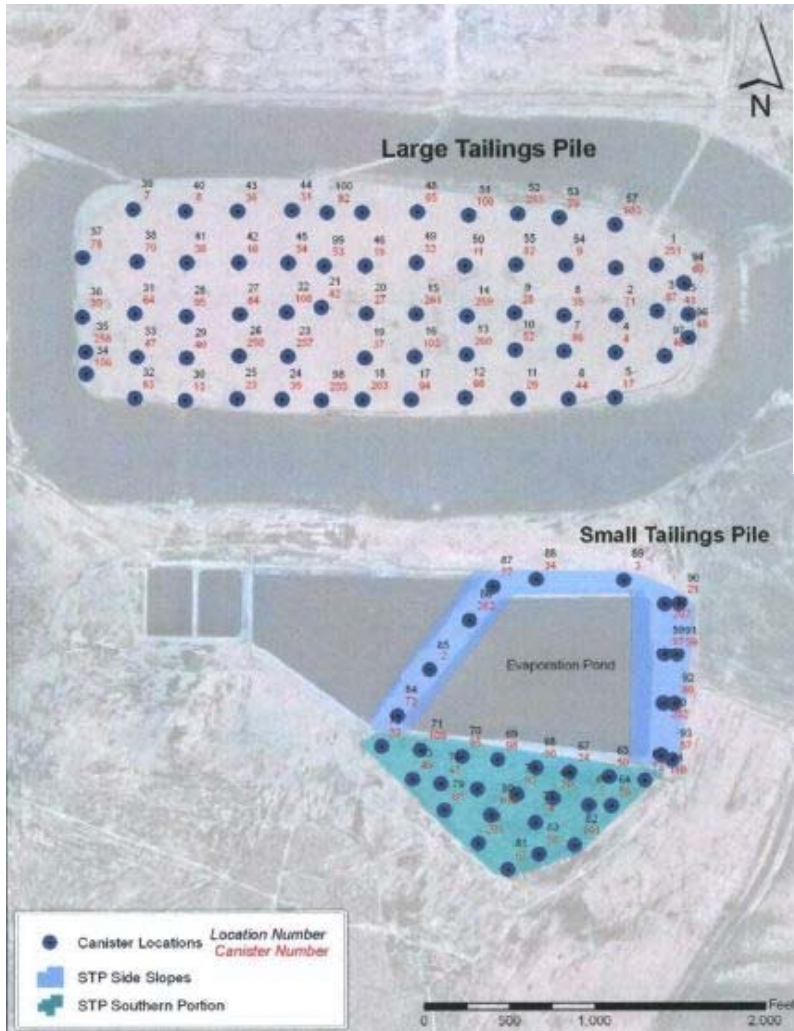
Impact of Pedogenesis on Hydraulic Properties



- If *no* change, data would scatter around 1:1 line
- Data coalesce into band with $K_s = 10^{-7} - 10^{-5}$ cm/s independent of initial K_s

Does radon flux change similarly?

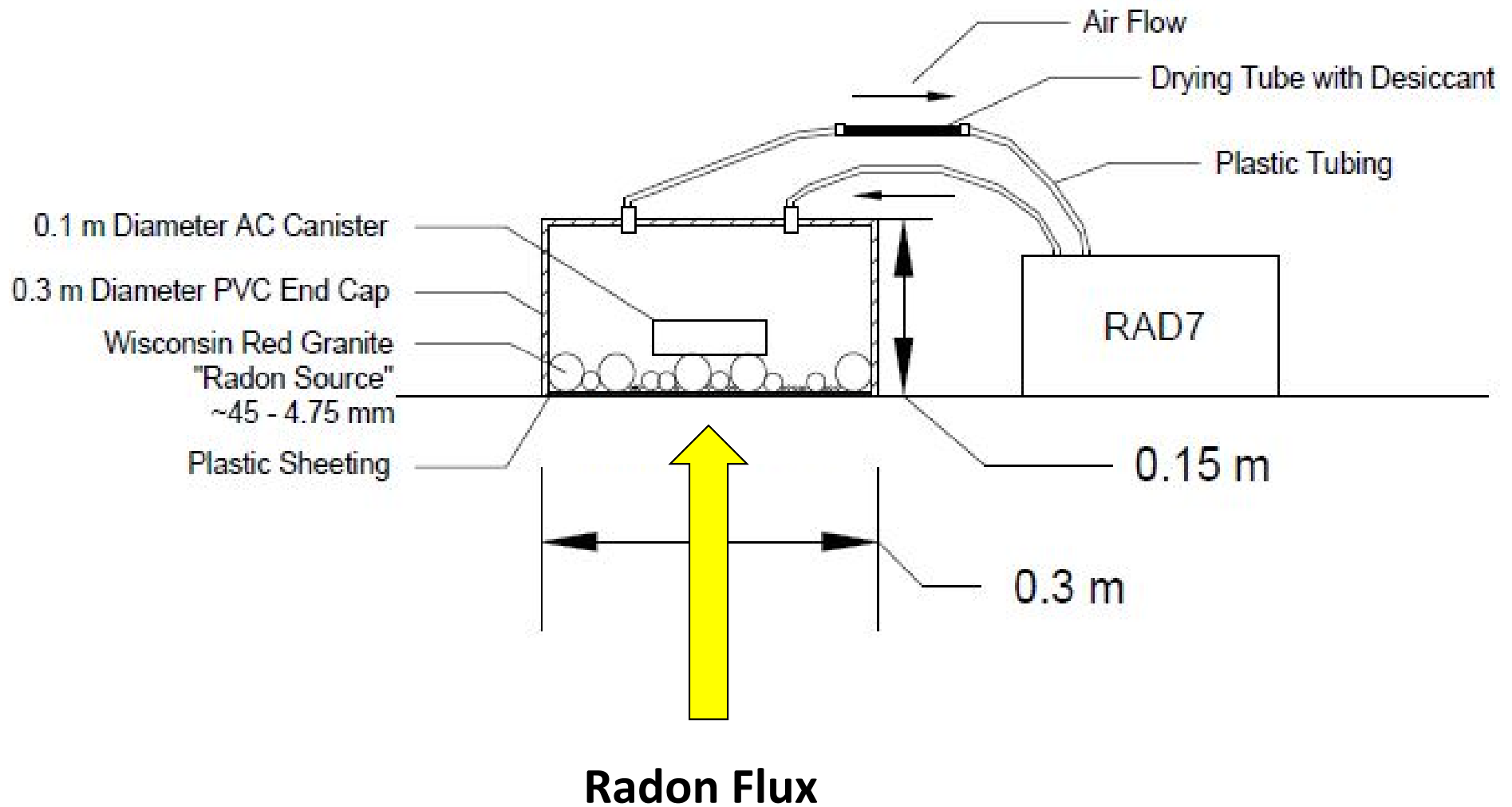
CNWRA (2012) is one of a few studies to measure high variations in Rn Flux.



Radon Barriers Show Evidence of Pedogenesis



Flux Chamber with Dual Measurements



RAD7: Solid-State Alpha Detector

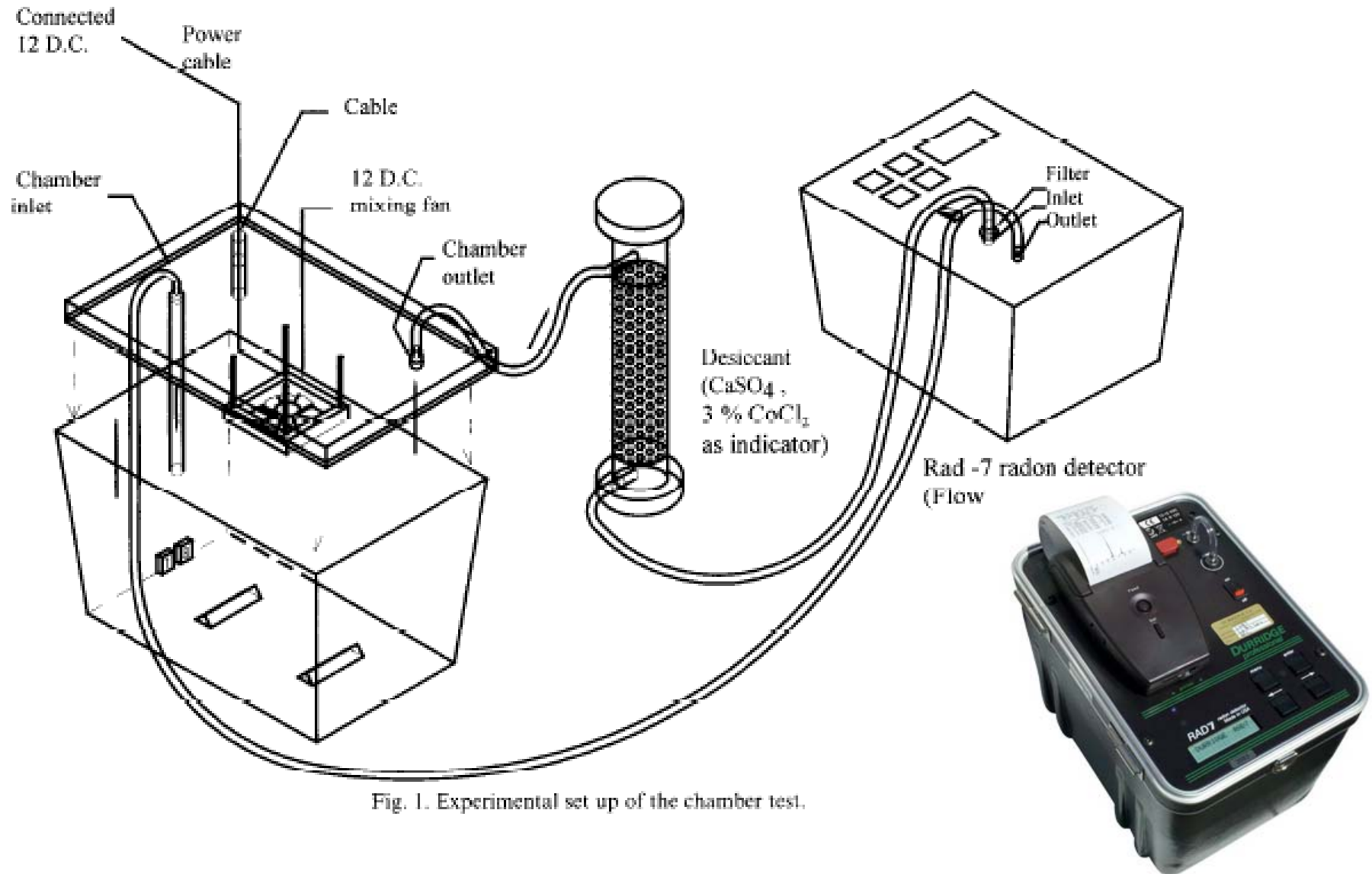
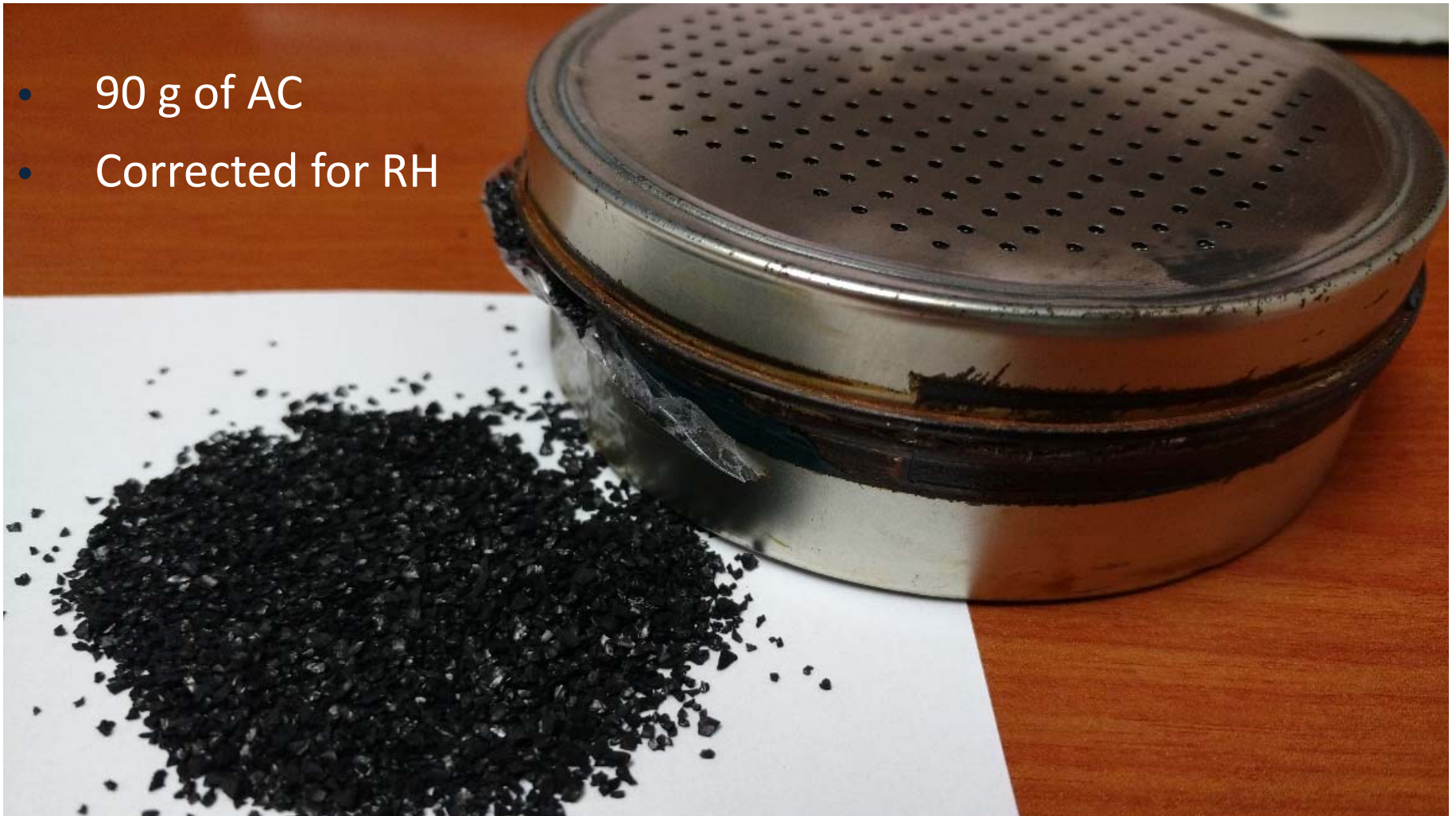


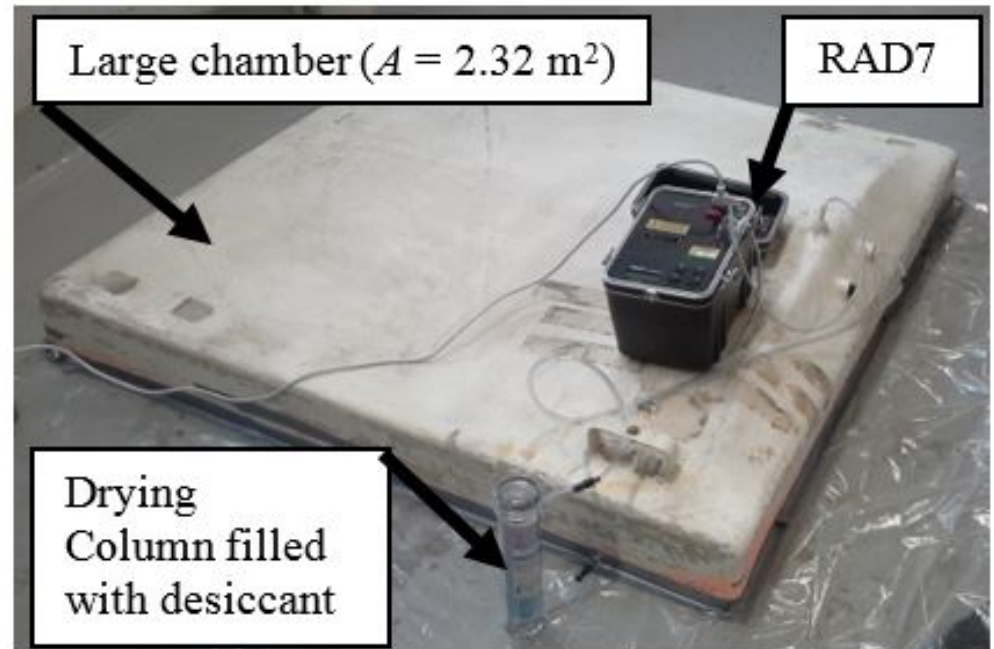
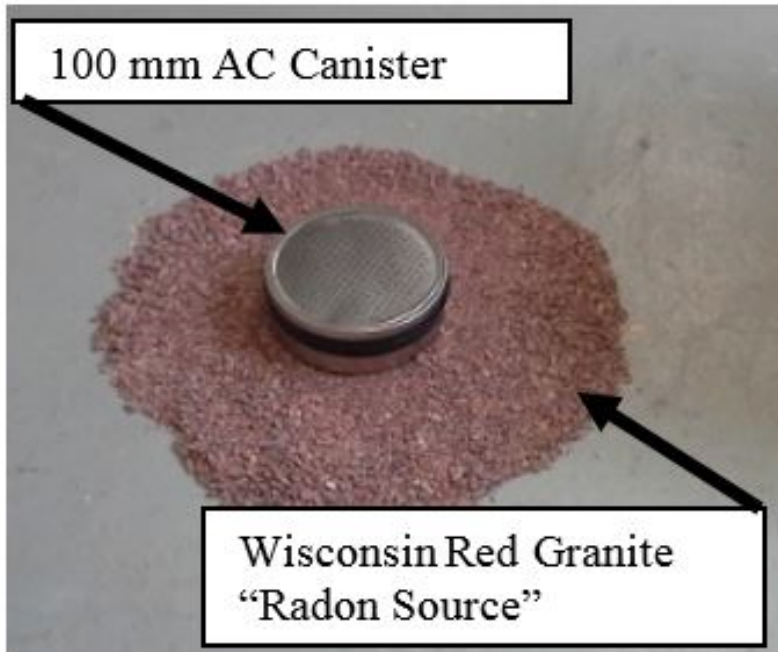
Fig. 1. Experimental set up of the chamber test.

Activated Carbon Canisters (residential home use - basements)

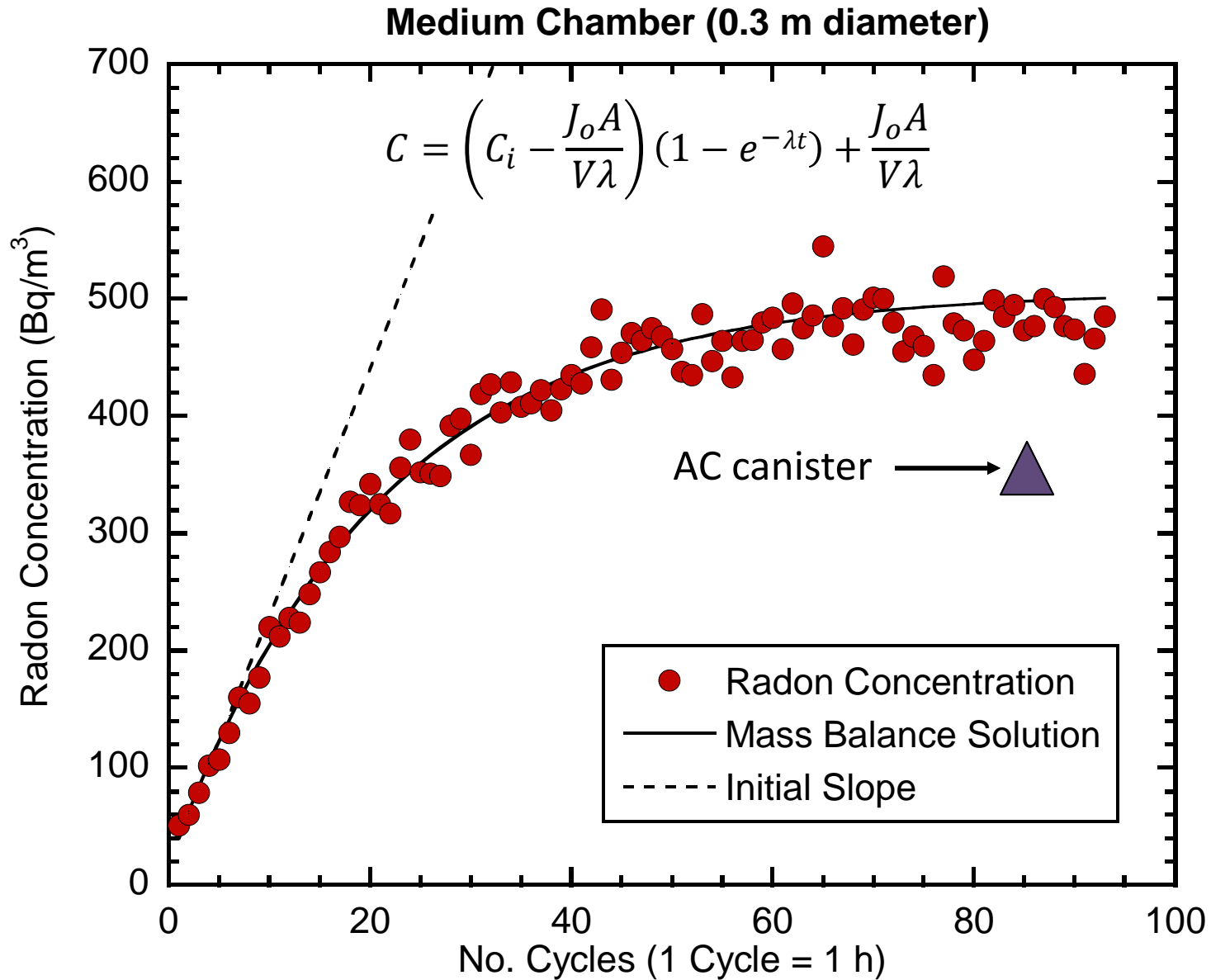
- 90 g of AC
- Corrected for RH



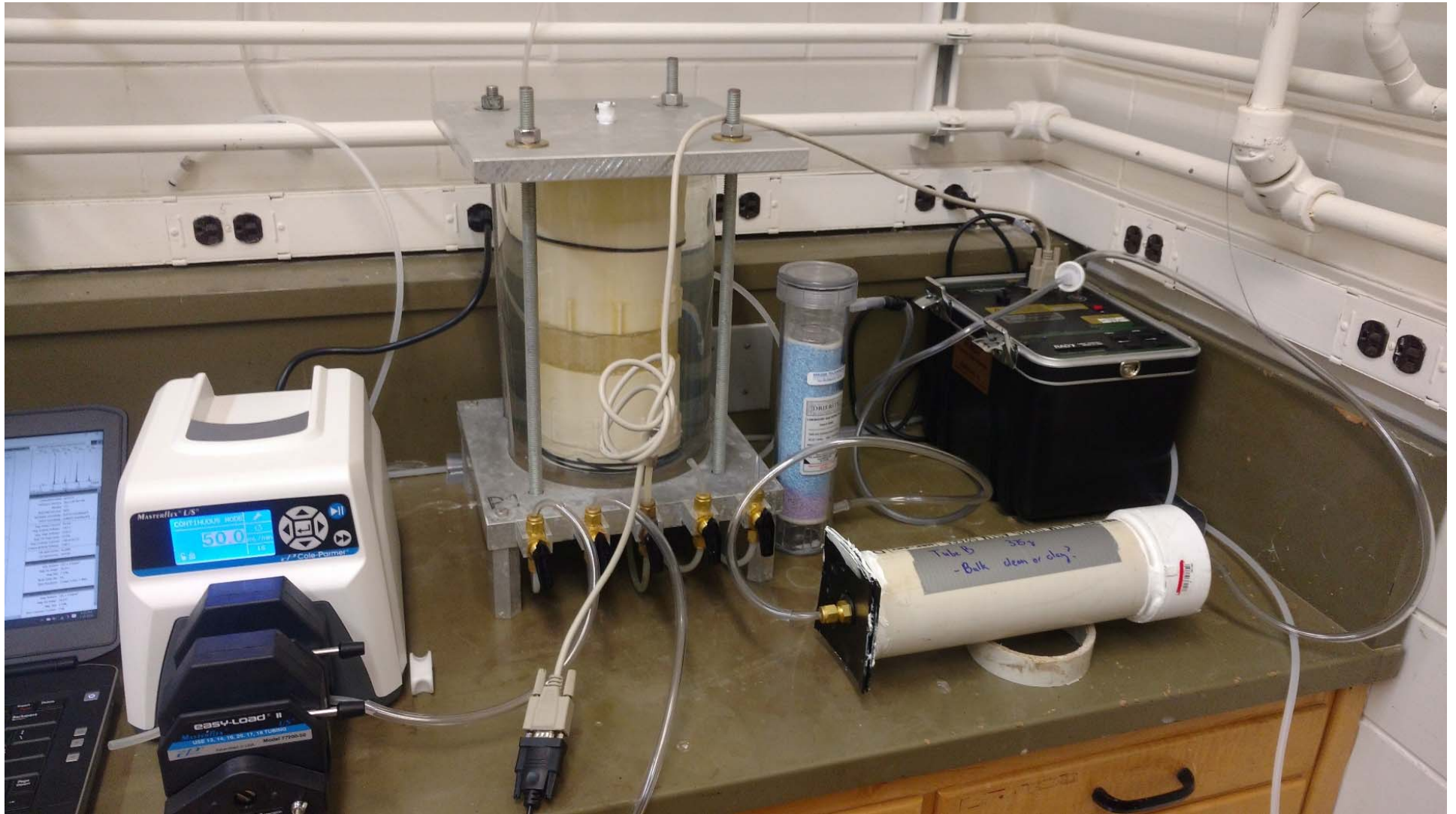
Methods to Measure Radon Flux



Typical Radon Buildup Curves



Lab Set Up for Radon Diffusion



FALLS CITY, TEXAS

DATE OF CLOSURE: FEBRUARY 9, 1994

DRY TONS OF TAILINGS: 7,143,100

RADIOACTIVITY: 1,277 CURIES, RA-226

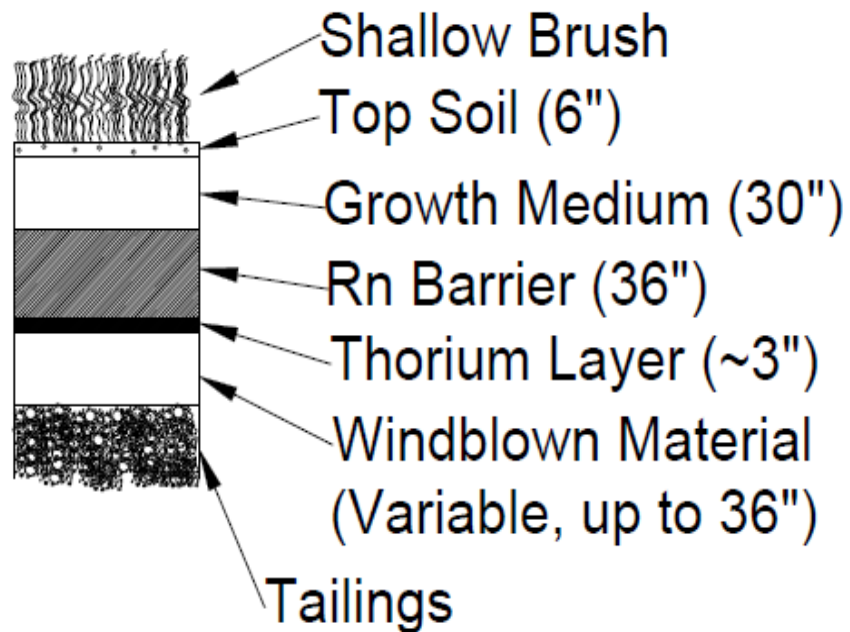


0 1,000 2,000

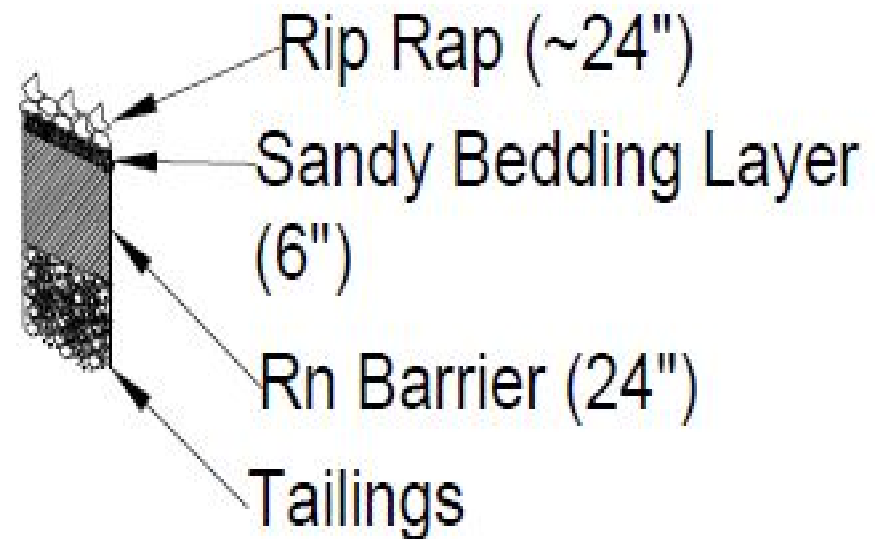
SCALE FEET

Falls City Cover Profiles

Top Deck

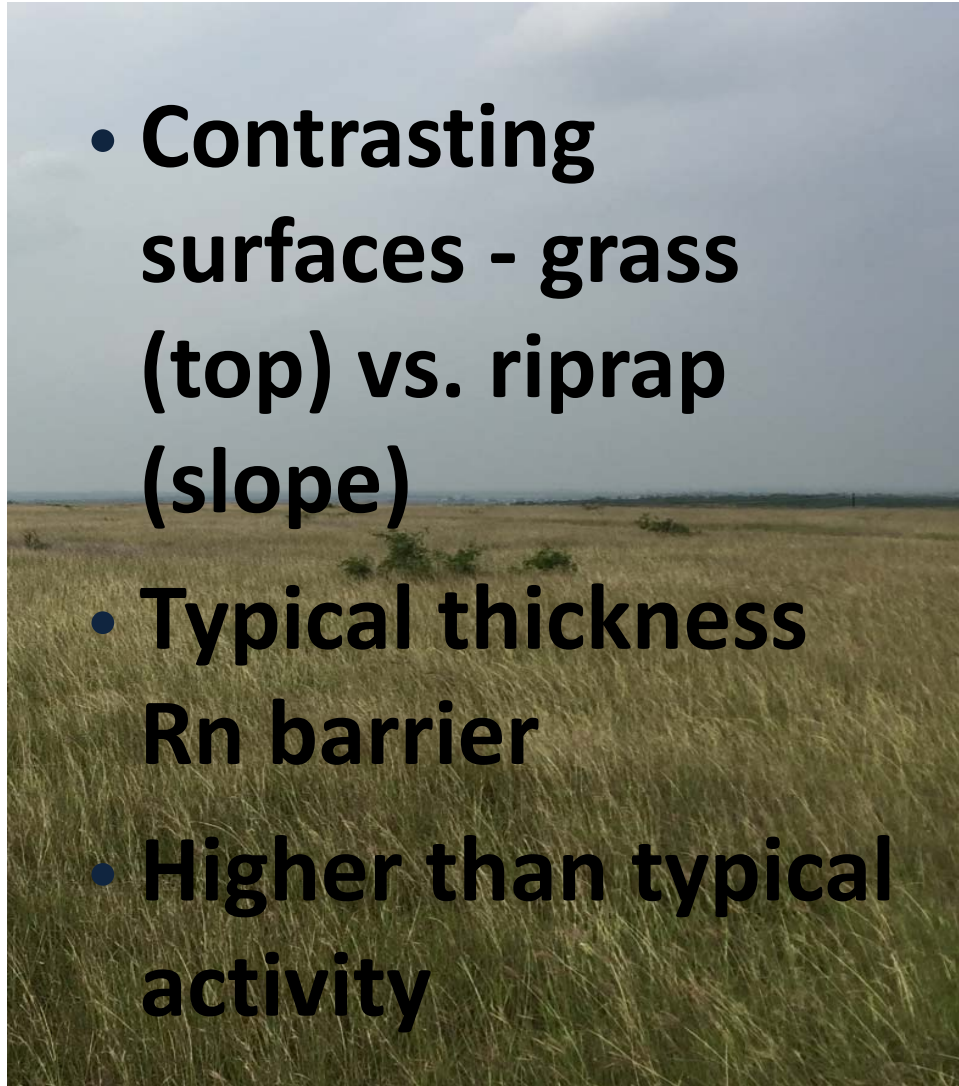


Slope



Falls City, Texas UMTRCA Cover

- **Contrasting surfaces - grass (top) vs. riprap (slope)**
- **Typical thickness Rn barrier**
- **Higher than typical activity**



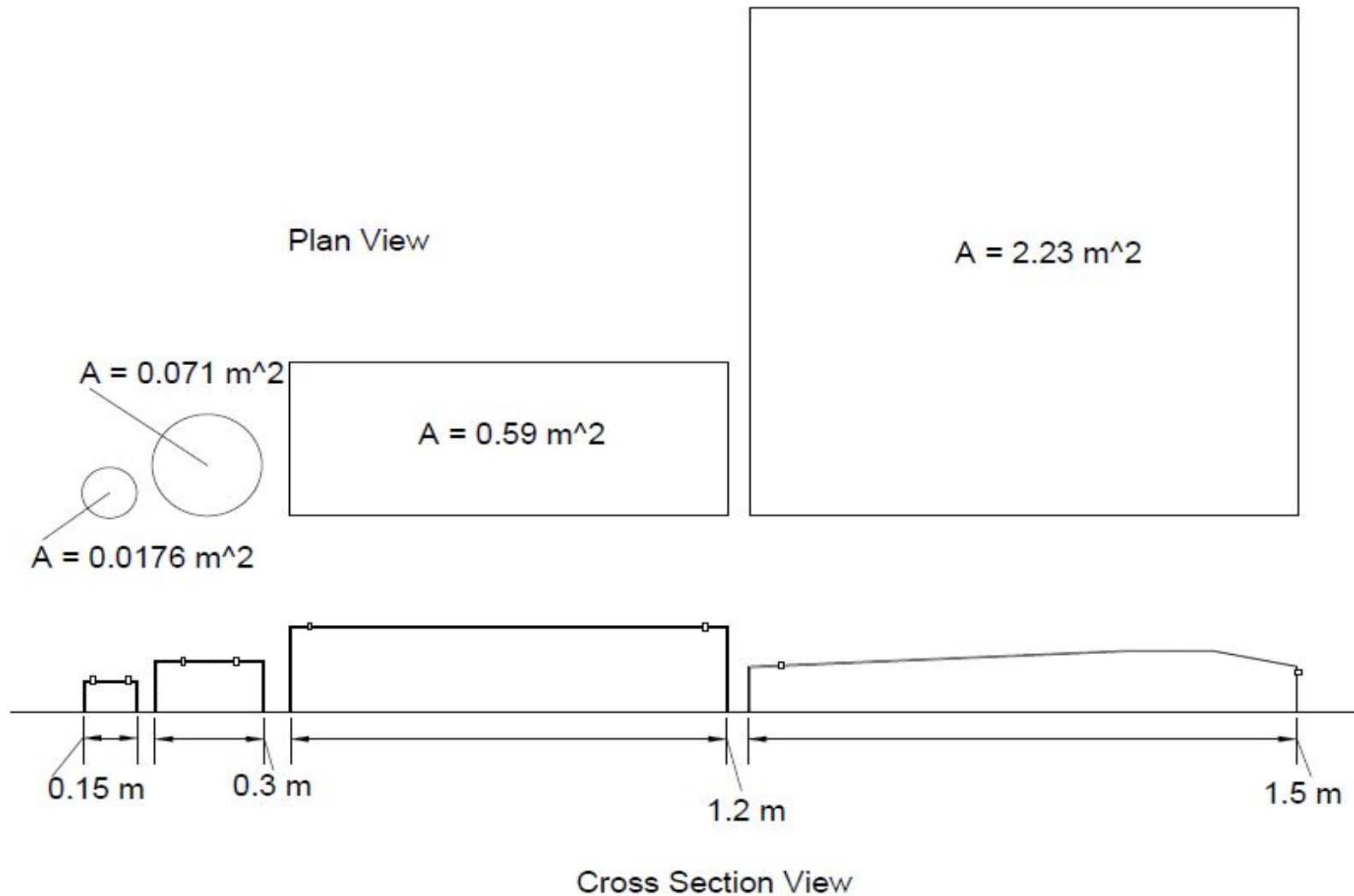
Test Pits for Flux Measurements at Falls City, Texas

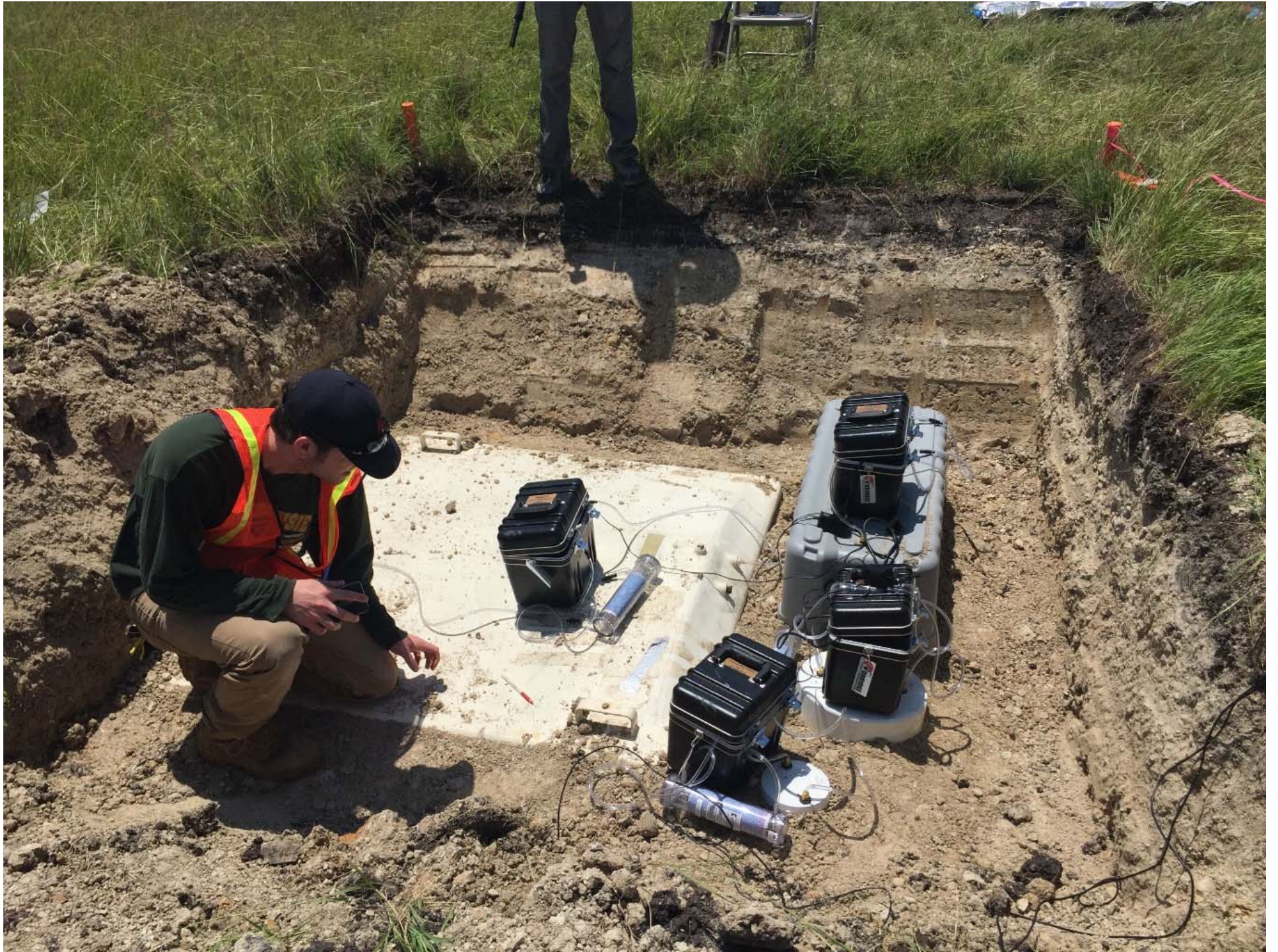
Test Pit	Location	Surface	Tailings Activity (pCi/m²-s)
1	Top Deck	Mesquite	1.0-4.0
2	Top Deck	Shallow Grasses	1.0-4.0
3	Top Deck	Mesquite	0.5
4	Top Deck	Shallow Grasses	0.5
5	Side Slope	Rip Rap	1.0-4.0
6	Side Slope	Rip Rap	1.0-4.0

Falls City, Texas Field Measurements

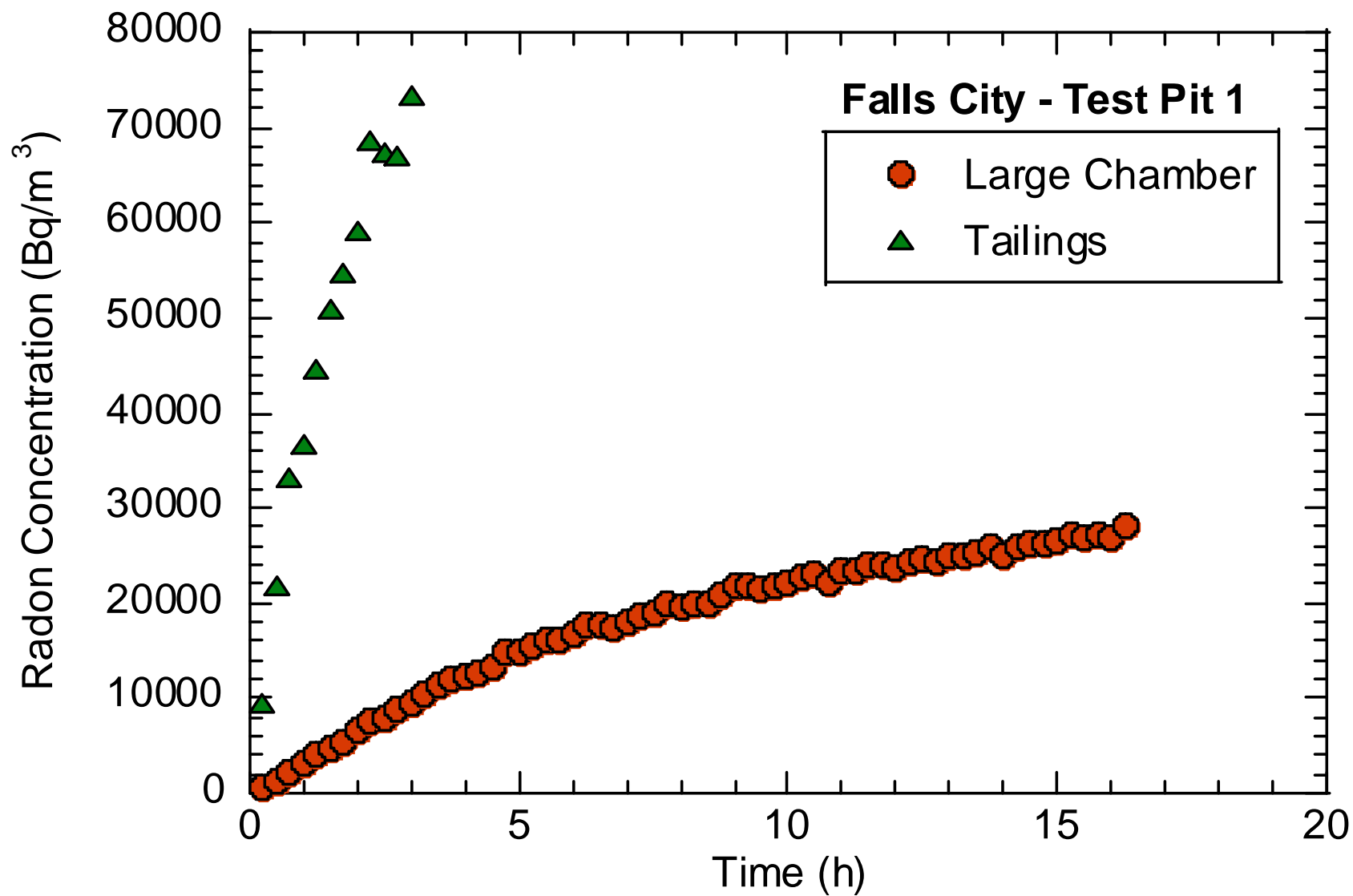


Large, Medium, Small, & Extra Small Flux Chambers

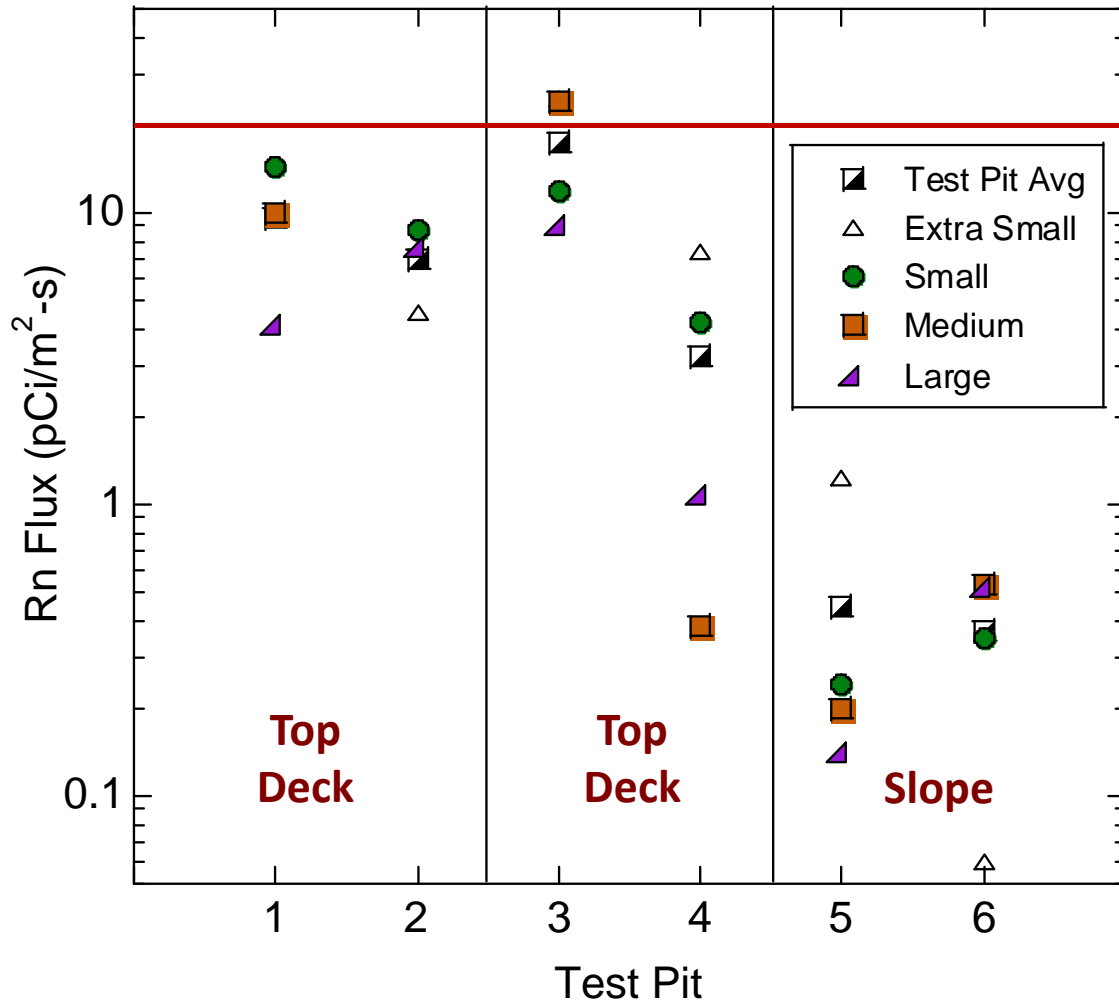




Radon Buildup Curves - Test Pit 1



Summary of Fluxes



**Test Pits 1 & 3 –
mesquite & grasses**

**Test Pits 2 & 4 –
grasses**

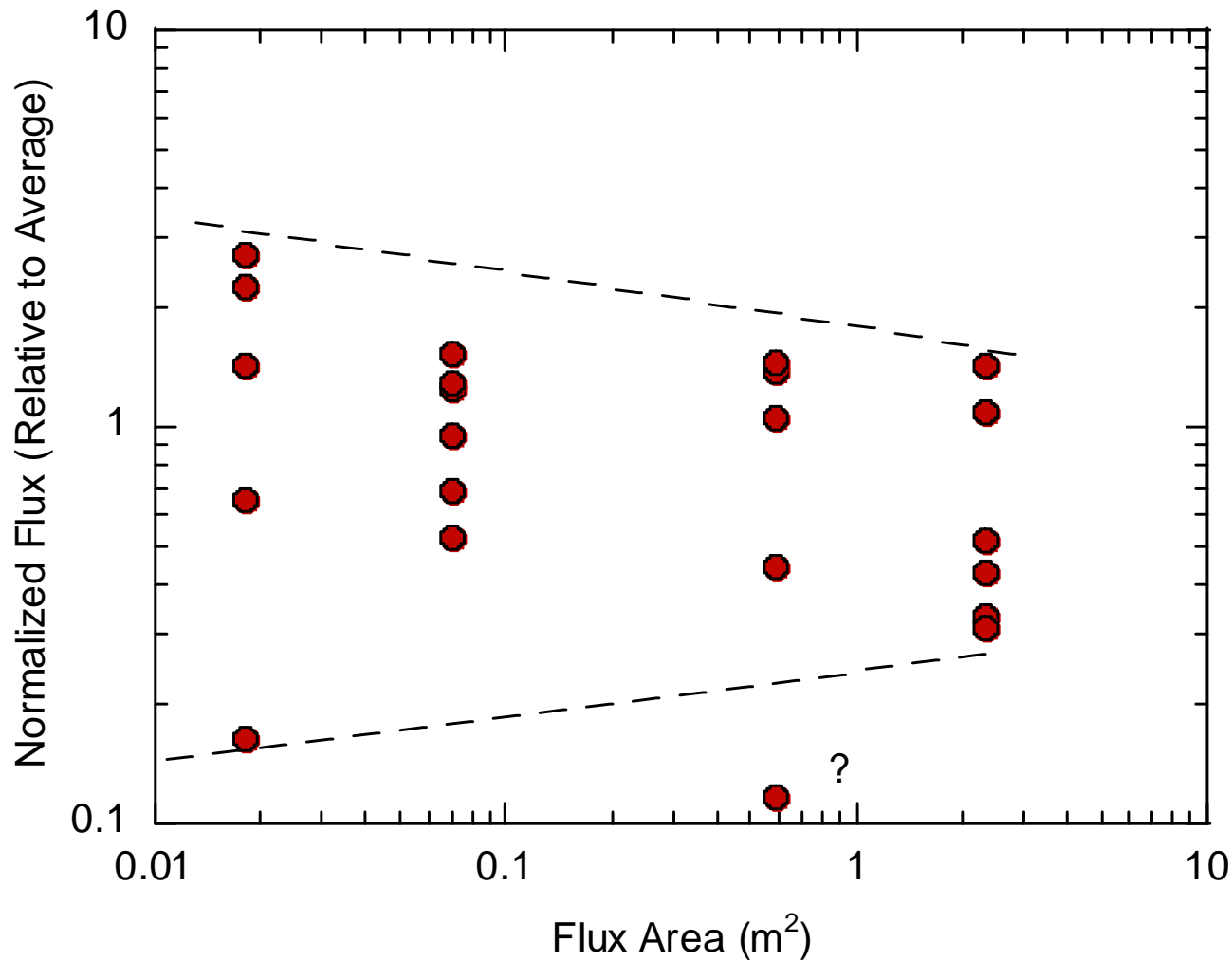
**Test Pits 5 & 6 –
riprap**

**Test Pit 4 had some
data quality
problems.**

Root Structure in Radon Barrier – Test Pit 4

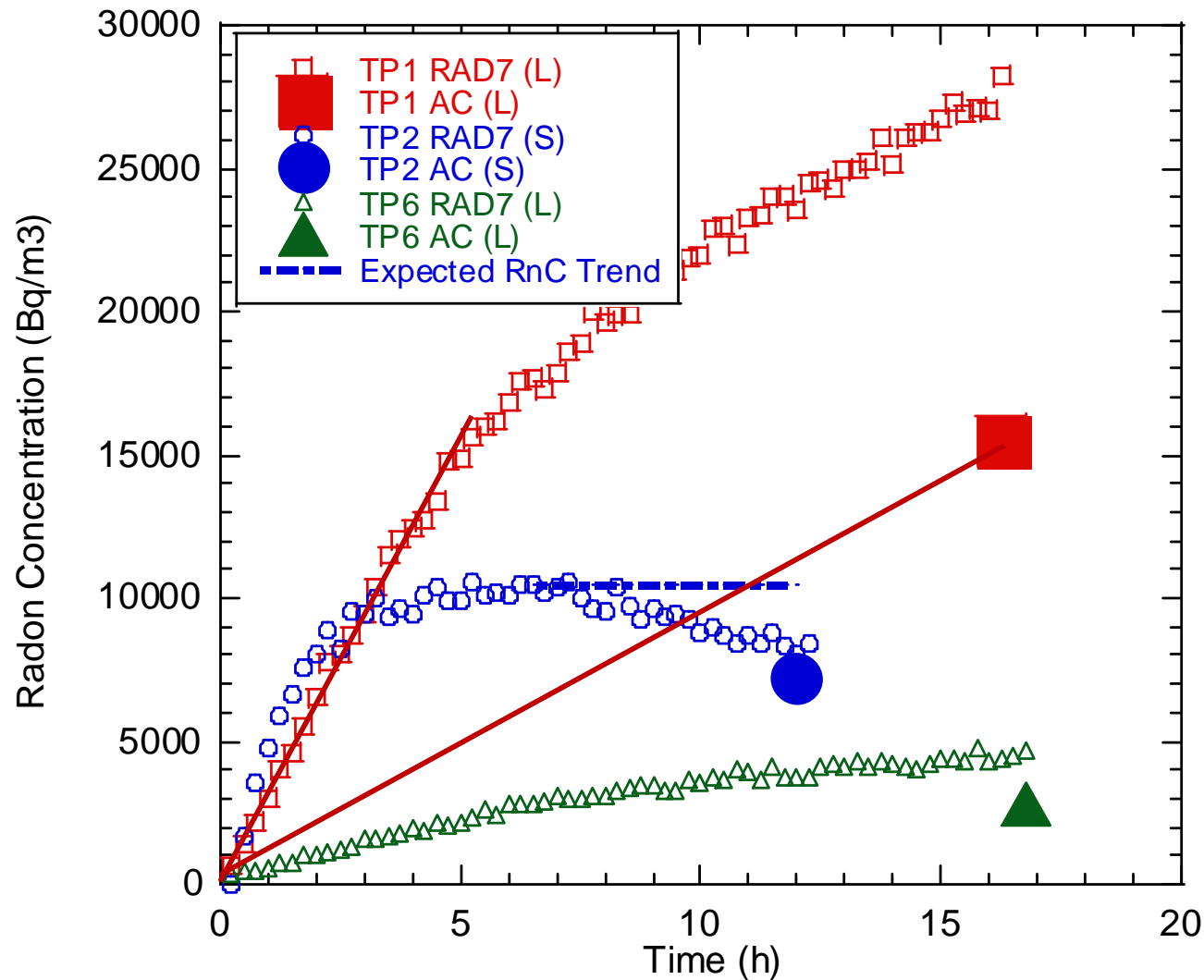


Influence of Scale Effect on Radon Measurements



- No bias with test size.
- Less variability with larger test due to spatial averaging.

AC vs. RAD7 Radon Concentrations and Fluxes



- Relative humidity correction applied.
- Bias in flux about 0.4 (40% of flux with AC)

Conclusions

- Highly reliable and practical method to measure radon flux in field.
- Pedogenesis is occurring in earthen barriers over U tailings – and expect at other sites too.
- Structure from pedogenesis known to affect hydraulic properties and percolation, but not affecting gaseous flux in a similar manner
 - Percolation – advection controlled (large scale effect)
 - Radon flux – diffusion controlled (no scale effect)
- Bias in radon flux using traditional activated carbon (AC) – eq. concentration 60% and flux 40% of RAD7.

Acknowledgement

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