

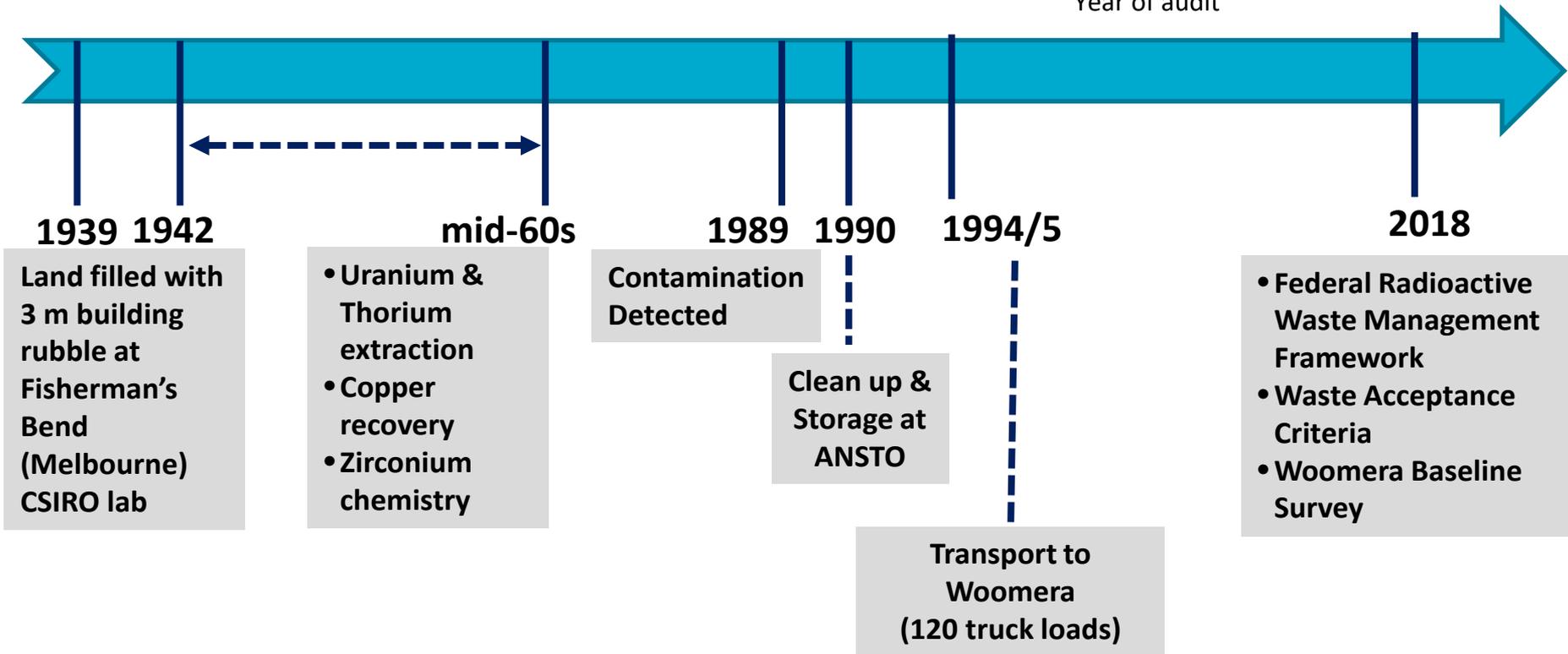
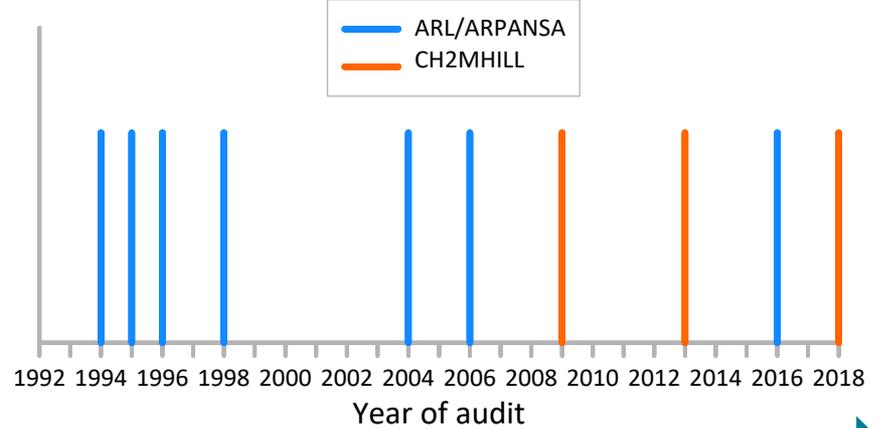
# CSIRO Woomera waste holdings: Update

Dirk Mallants, Gordon McLachlan, Raphael Viscarra-Rossel, Michael Leviton  
25-26 July 2018

# Content

- Timeline of activities
- Removal of soil material from Fisherman's Bend
- Soil analysis
- Environmental baseline survey
- Next steps

# Timeline of activities



# Removal of material from Car Park (Fisherman's Bend)











Diverse soils with fill and other inclusions







# Soil Analysis at ANSTO (Lucas Heights)

## Level of radioactivity (Nov. 1991, ANSTO)

- 9646 (99.2%) drums had surface dose rates  $<5 \mu\text{Sv/hr}$
- 68 ( $<1\%$ ) drums had surface dose rates 5-17  $\mu\text{Sv/hr}$   
[20 mSv/y dose limit workers  $\Rightarrow$  10  $\mu\text{Sv/hr}$ , 40 hours/wk, 50 wks/y]

## Level of radioactivity (1993, ANSTO)

- Investigation of 2893 drums showed
  - Approx 78% had external dose rates  $<1 \mu\text{Sv/hr}$ ;
  - Approx 96% had external dose rates  $<5 \mu\text{Sv/hr}$ ;
- Average total specific activity calculated = 12 Bq/g
- 98% of the drums have radioactive content  $<70 \text{ Bq/g}$  and would have been classified as non-radioactive for transport purposes at that time



## Compare with background radiation

(travel by plane-return flight Melbourne-London): 5  $\mu\text{Sv/hr}$

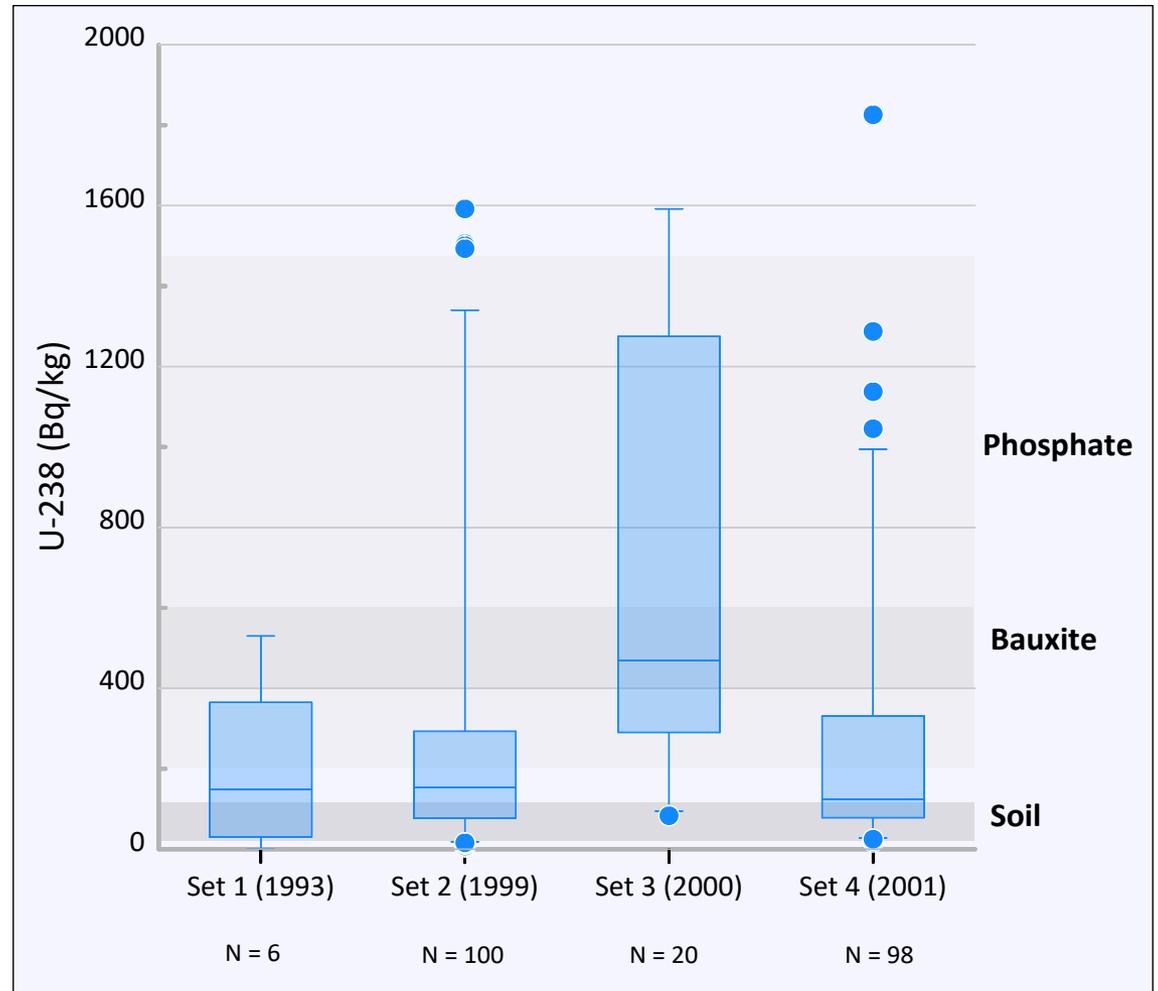
# Transfer from Lucas Heights to Woomera

- Following legal action by Sutherland Shire Council, ANSTO ordered in 1992 to remove waste by 5 Jan 1995
- 9725 drums transferred from Lucas Heights to Defence Land at Woomera between 17 November 1994 and 11 January 1995

# Soil Analysis of Drums at Woomera

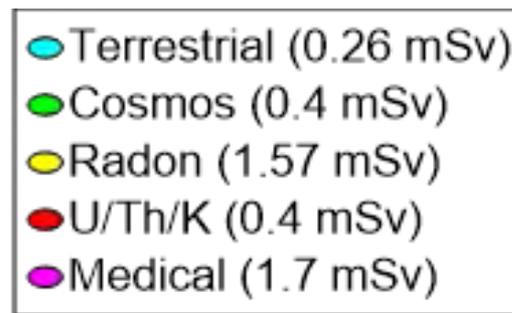
Investigation of drums (ANSTO, CSIRO) in 1993, 1999, 2000, and 2001:

- Sampling, in-situ analysis (U-238, Th-232, Ra-226,...)
- U-238 similar to natural radioactivity in soil and minerals (Bauxite, Phosphate)

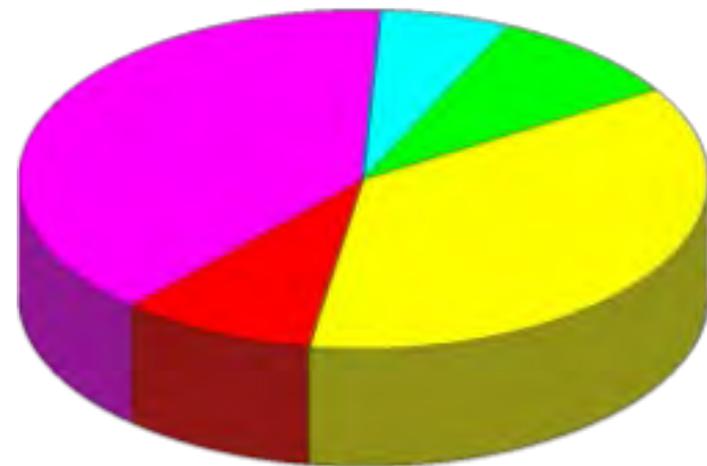


# Natural Background Radiation in Australia

Source	Dose (mSv/year)	microSv/hour
Terrestrial	0.26	0.030
Cosmic	0.4	0.046
Radon	1.57	0.179
U/Th/K in body	0.4	0.046
Medical	1.7	0.194
Total	4.33	0.494



Adelaide Hills Rocks



# Environmental Baseline Survey

- Purpose:
  - Establish current level of background radiation prior to remove drums from storage facility and commence processing
  - Detect any level of above-background radiation and determine cause
- Scope:
  - Determine background radiation using gamma scanning (U-238, Th-232, K-40), XRF (U-238, Th-232) and spectroscopic analysis (several radionuclides)
  - Organic and inorganic chemicals in soil
  - Radon in air
  - Radon flux from soil
  - Radon in air (inside storage facility)
  - Robotics analysis (inside storage facility)
  - Drum scanning (inside storage facility)

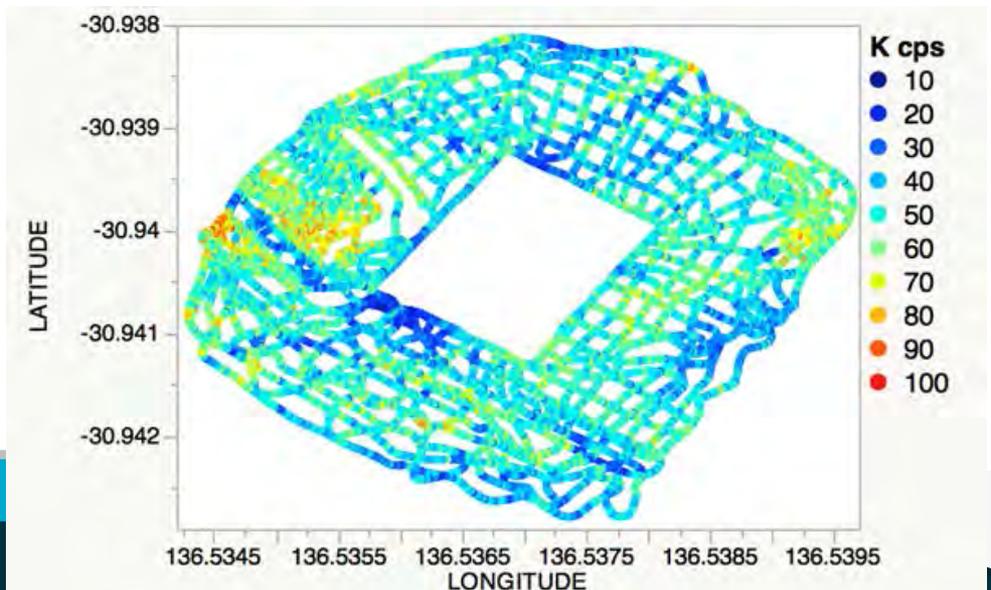
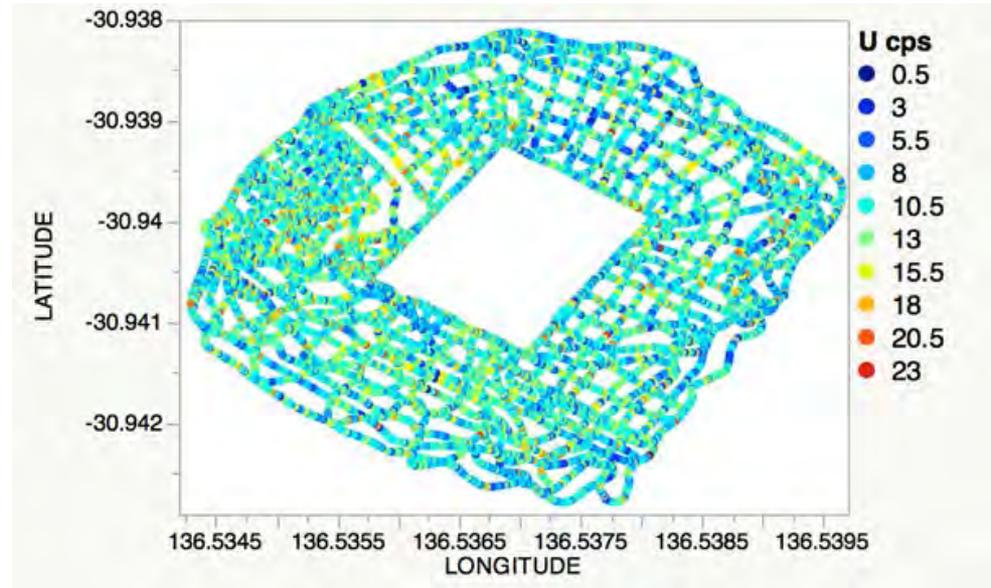
External

# Environmental Baseline Survey – Gamma radiation

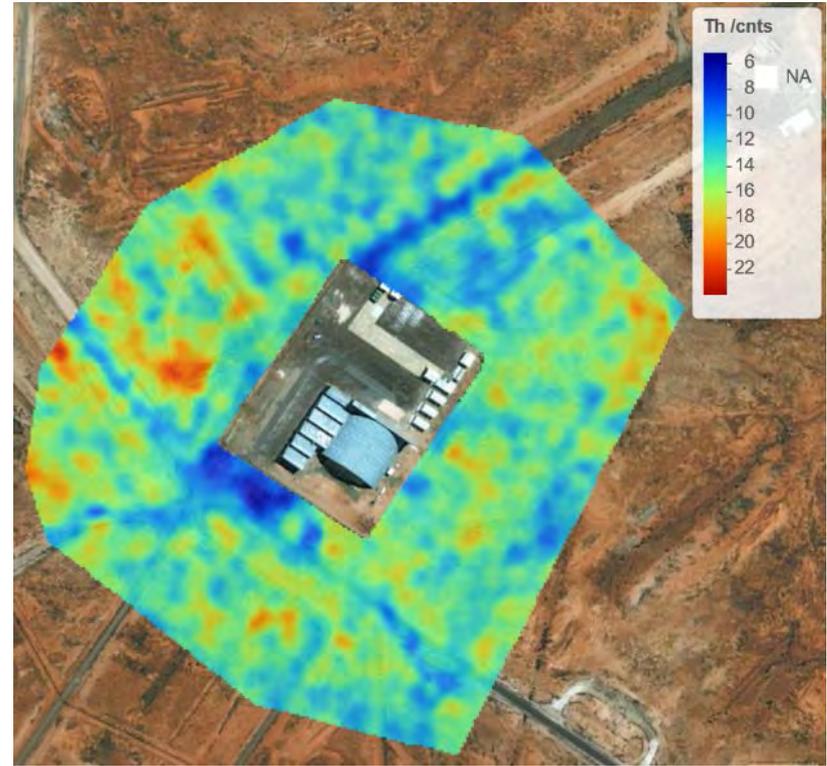
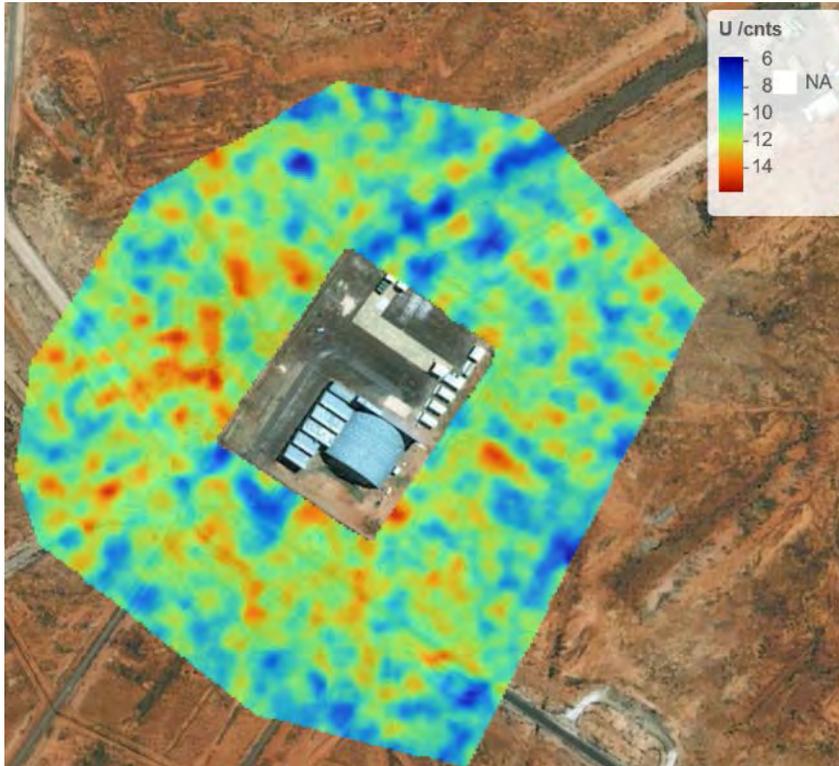


# Environmental Baseline Survey – Gamma radiation [1]

- Background radiation from U, Th, and K radionuclides
- Uranium (U-238)
- Thorium (Th-232)
- K – potassium (K-40)
  
- Primordial radionuclides: U-238, Th-232, K-40 in rock and soil since origin of the Earth; formed during Big Bang, Supernovas, etc.

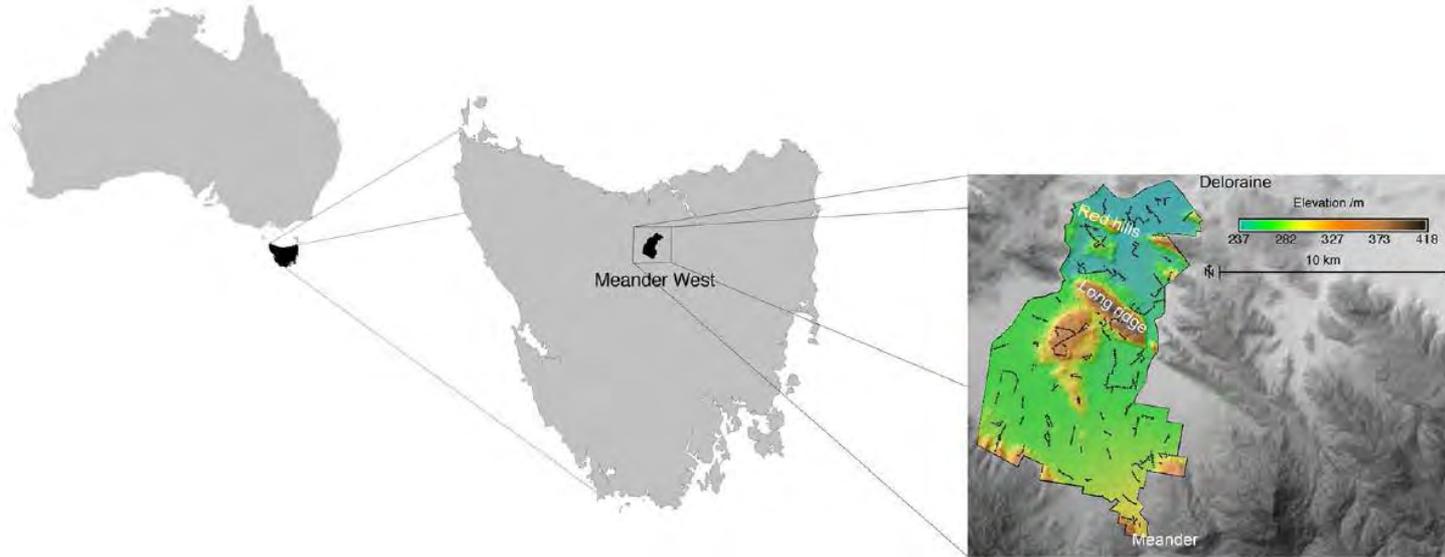


# Environmental Baseline Survey – Gamma radiation [2]



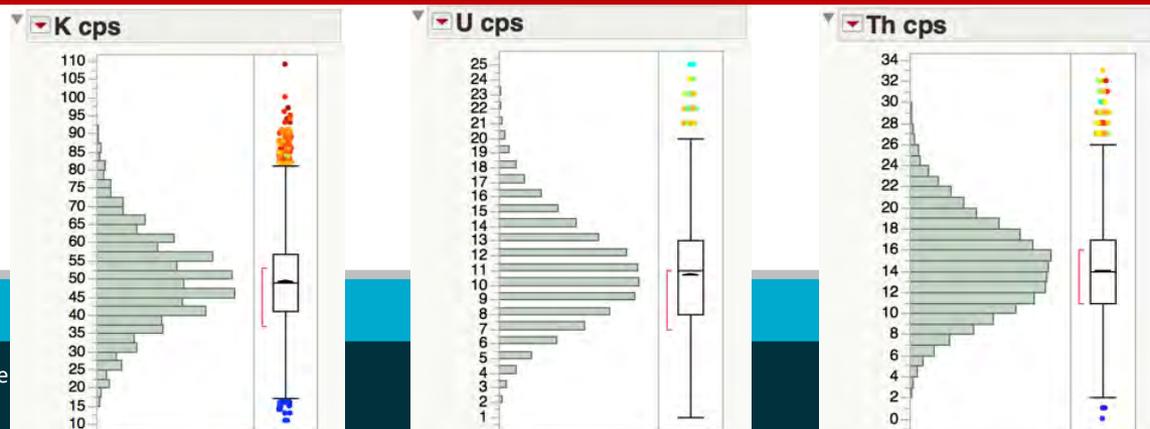
# Environmental Baseline Survey – Gamma radiation [3]

- Background radiation similar to Tasmania (Irrigation Area)



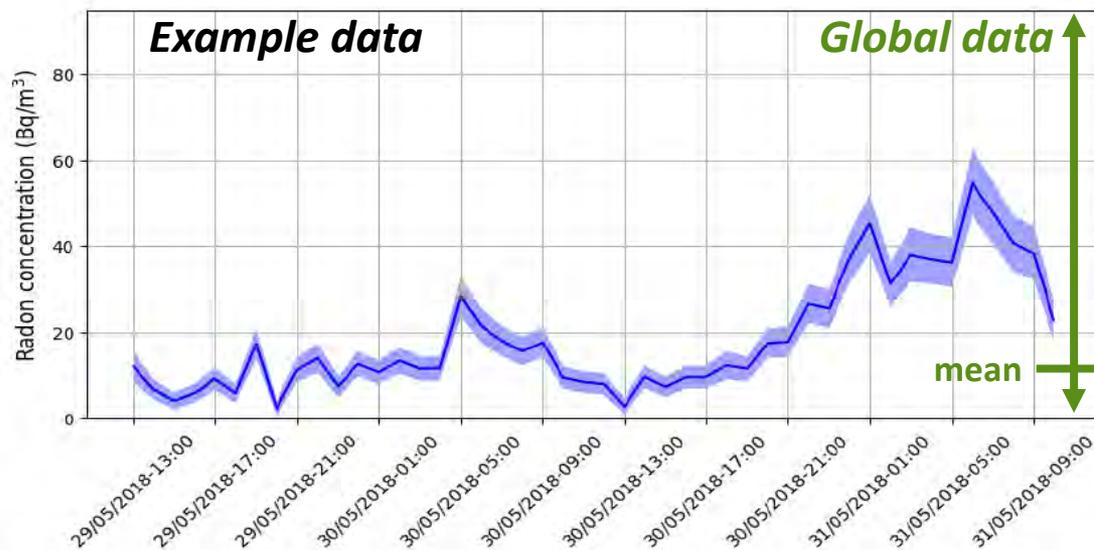
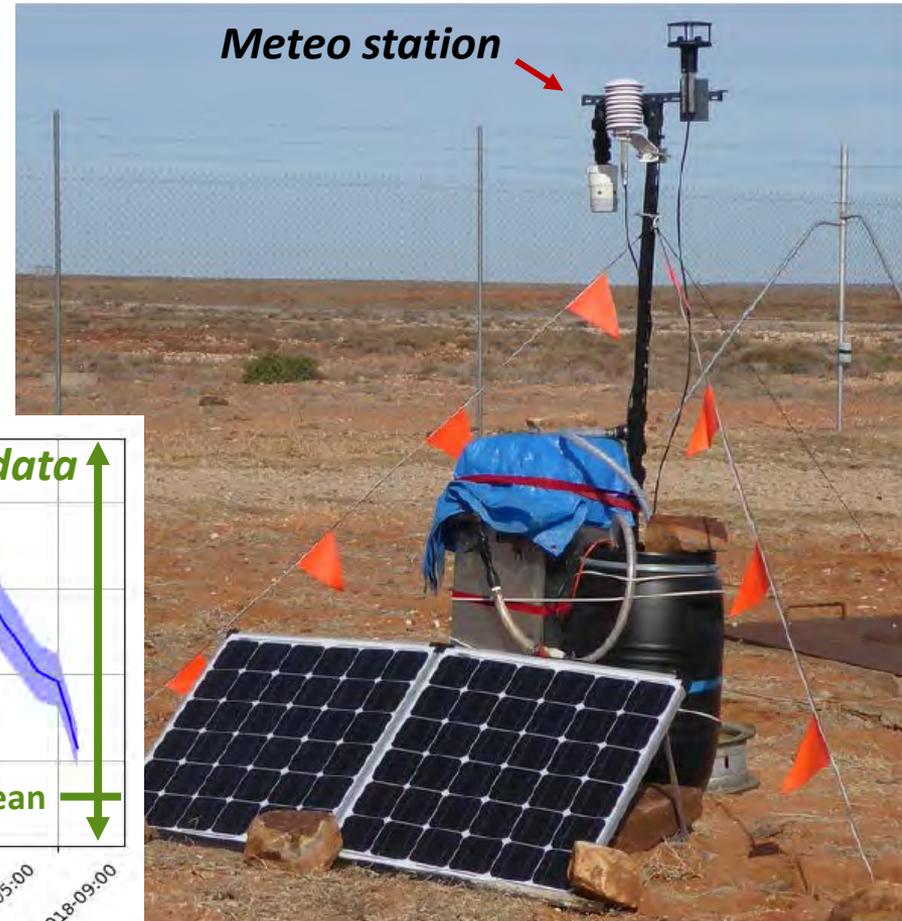
Statistic	K-40	U-238	Th-232
Mean (counts/sec)	32	9.5	13.5

## WOOMERA DATA

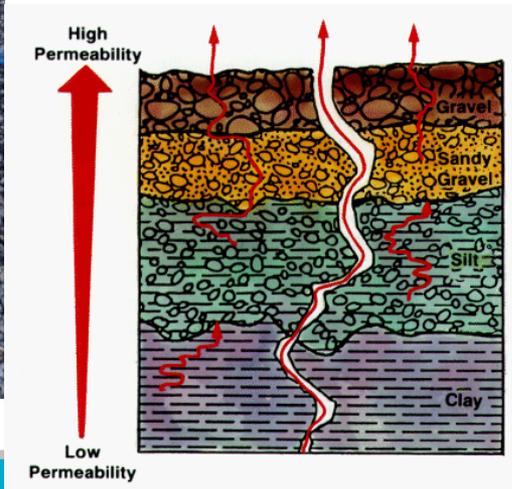
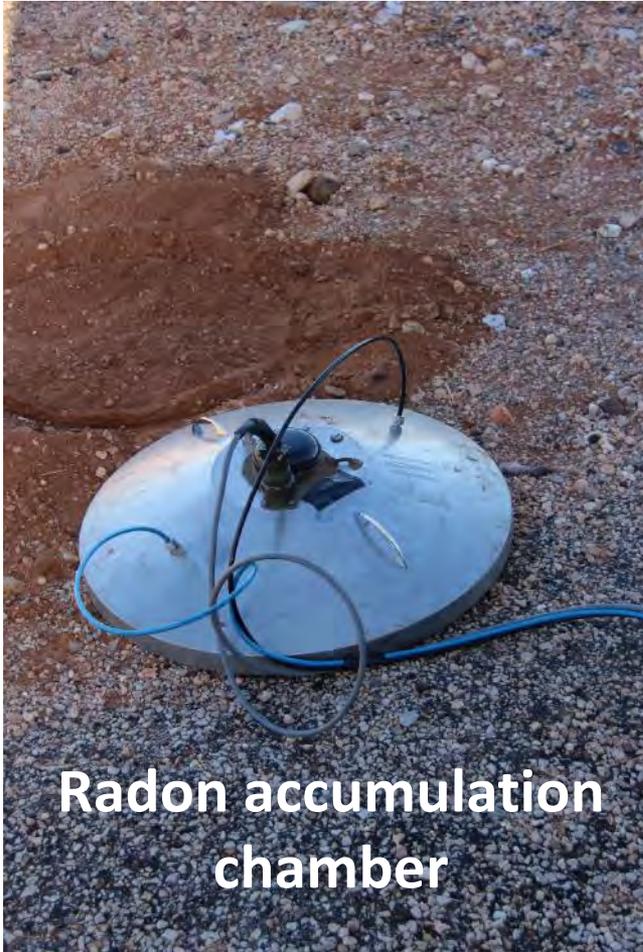


# Environmental Baseline Survey – Radon in air

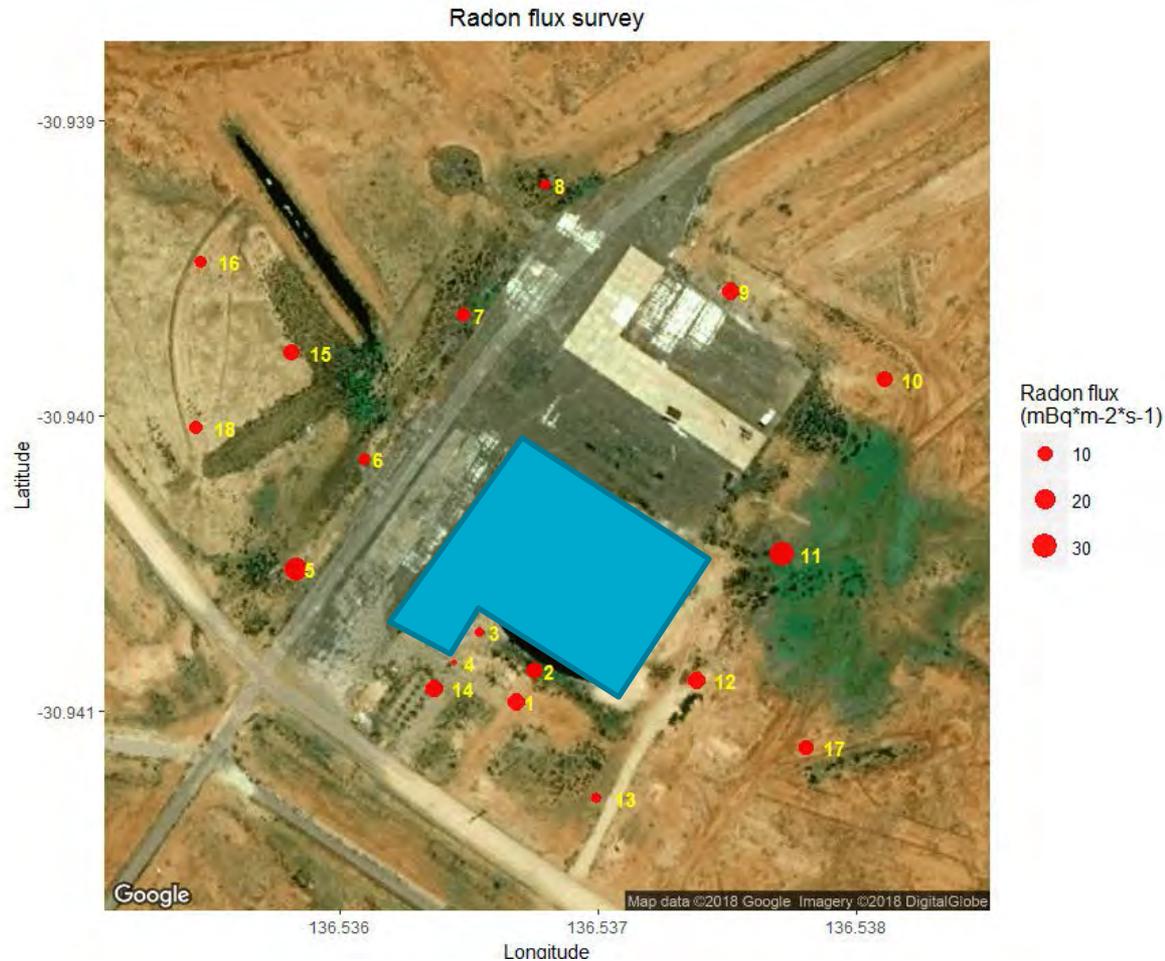
- Radon in air measurements
- ANSTO 100L radon detector
- 3-months of data, 30-min interval
- Background  $\leftrightarrow$  inside storage facility



# Environmental Baseline Survey – Radon flux [1]



# Environmental Baseline Survey – Radon Flux [2]

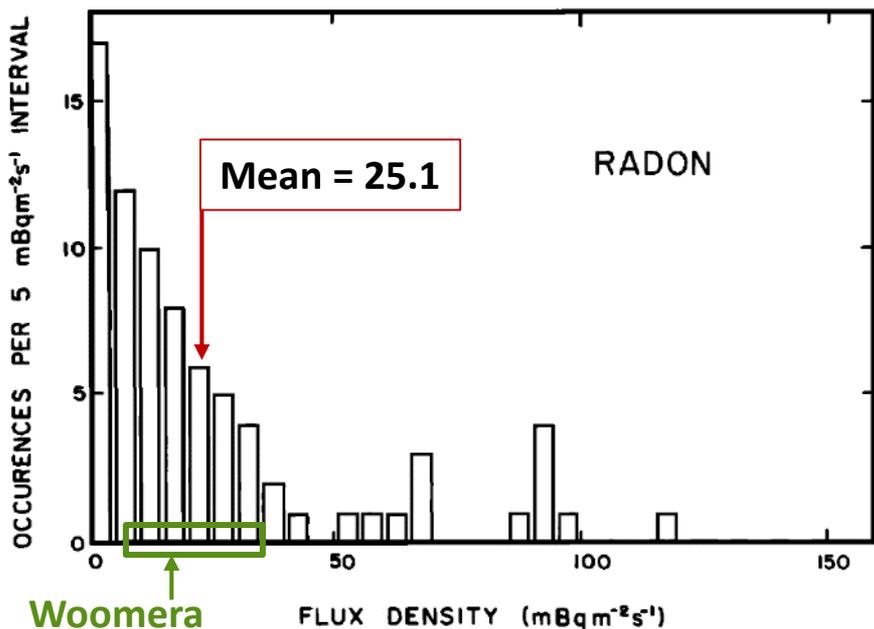
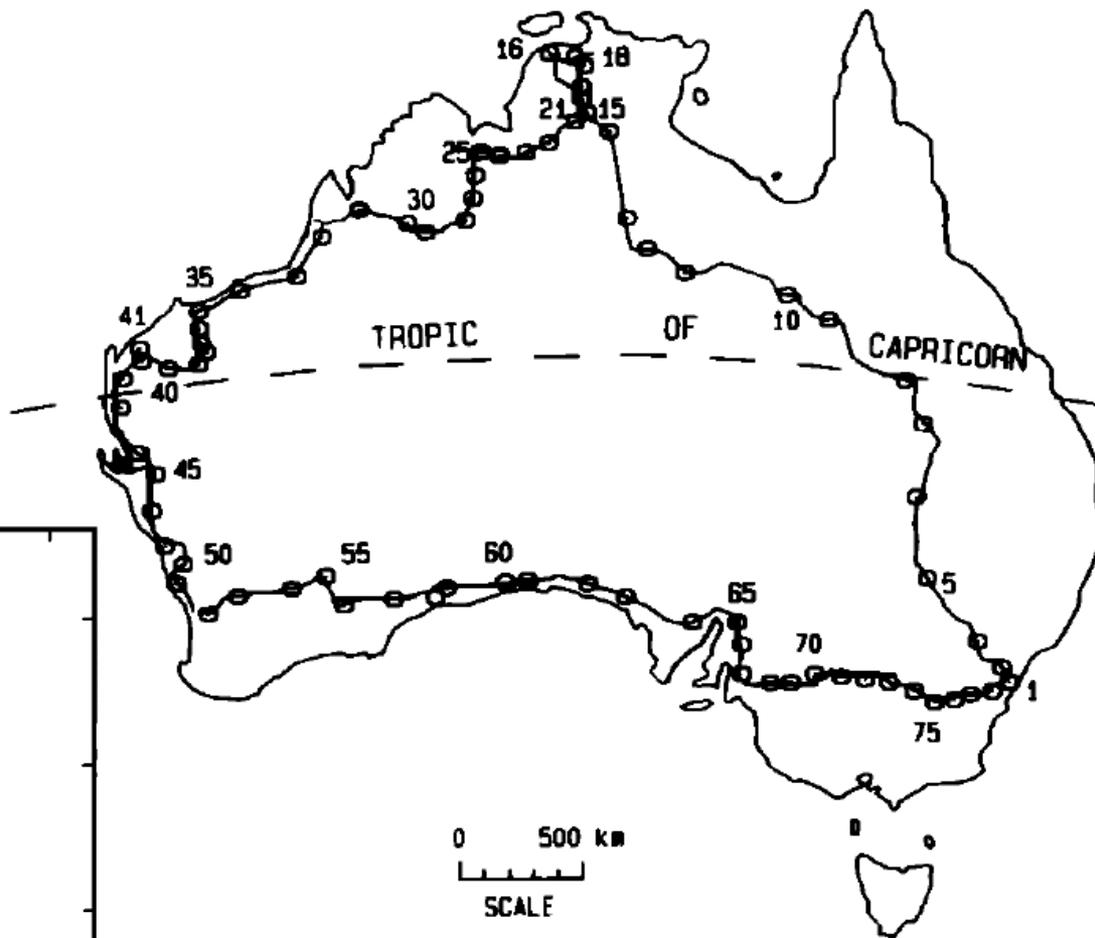


## Radon flux

Statistic	mBq/m <sup>2</sup> /sec
Minimum	2.6
Maximum	30.1
Mean	11.4

# Environmental Baseline Survey – Radon Flux [3]

- Comparison with data from National Survey (Schery et al. 1986)



# Environmental Baseline Survey: Organics & Inorganics

## Organic chemicals

- BTEX: all 5 chemicals smaller than detection level
- PAH (Polycyclic aromatic hydrocarbons): all 25 chemicals smaller than detection level

**No organic contamination**

## Inorganic chemicals

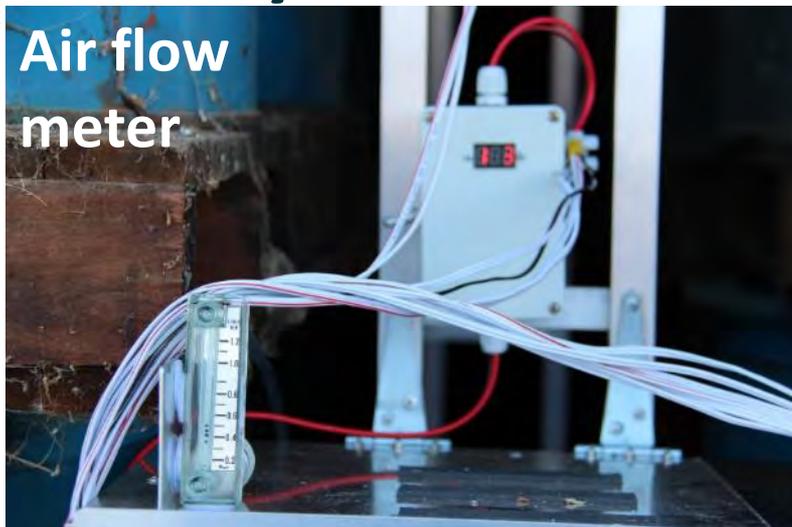
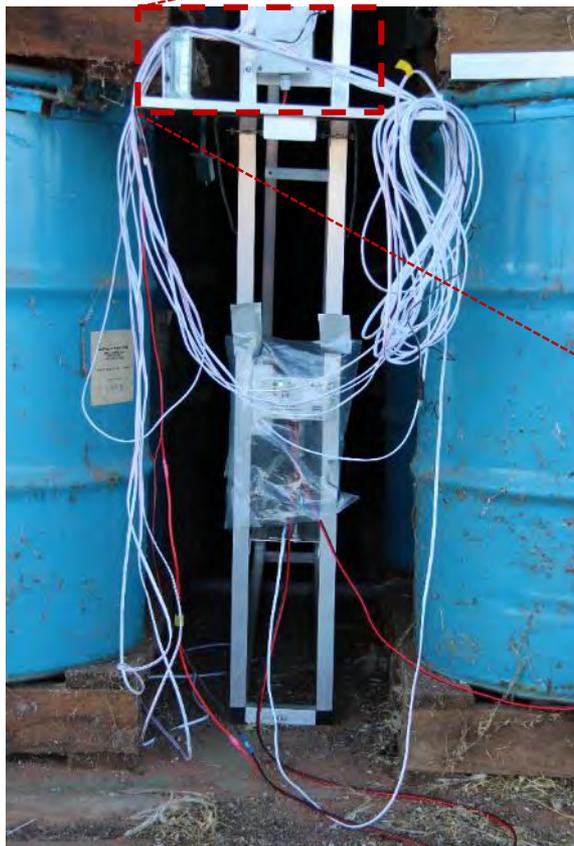
- 8 chemicals tested (Arsenic, Cadmium, Copper, Chromium, Lead, Mercury, Nickel, Zinc): levels smaller than Health Investigation Level

**No inorganic contamination**

# Environmental Baseline Survey – Indoor monitoring

- Radioactive gases: Radon
  - Monitoring for 12 months
- Non-radioactive gases: Hydrogen, methane, ...
- Visual inspection of drums: Robot
  - Initial testing successful – expand capability
- Radiological inspection of drums: Gamma scanning

# Environmental Baseline Survey – Indoor Radon



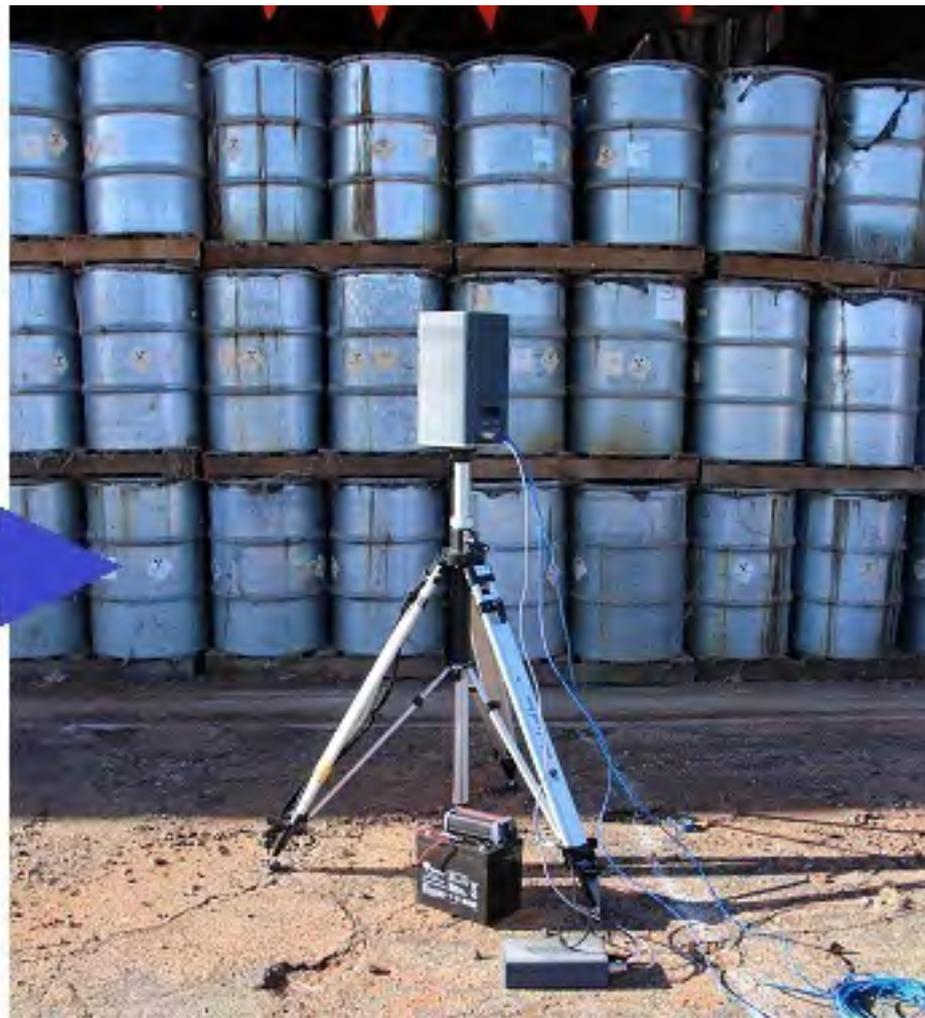
# Environmental Baseline Survey – Robot

- Visual inspection of drums: Robot
  - Initial testing successful – expand capability



# ANSTO Gamma Imaging of Woomera Drums

**This is the only drum  
pictured which is  
emanating any radiation  
- about the typical dose  
rate of an international  
flight**



# Next Steps – Processing of drums

- Determine level of radiation
- Separate radionuclide-free drums from waste drums
- Radionuclide-free drums:
  - If no organic/inorganic chemicals: disposal at non-radioactive dump
  - If organic/inorganic chemicals above ILS: soil cleaning/separation/solidification: disposal at hazardous waste dump
- Waste drums:
  - Determine class of radioactive waste (very low-level, low-level, intermediate-level)
  - Separate waste classes
  - For each waste class:
    - condition waste material in solid matrix (cementation) - WAC
    - pour waste and matrix in 400 litre steel drum
    - transport drums to NRWMF (disposal – interim storage)



# Thank you

**CSIRO Land and Water**

Dirk Mallants

Senior Principal Research Scientist

**t** +61 8 8303 8595

**e** [dirk.mallants@csiro.au](mailto:dirk.mallants@csiro.au)

**W** <http://www.csiro.au/en/Organisation-Structure/Divisions/Land-and-Water/DirkMallants.aspx>

