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# Radionuclides in Water

## BACKGROUND

ALS now offers accredited Radionuclide analysis through our Canberra Laboratory.

### RADIONUCLIDES – WHAT ARE THEY, WHERE DO THEY COME FROM?

A radionuclide is an atom with an unstable nucleus, which in the process of radioactive decay can emit gamma ray(s) and/or subatomic particles such as alpha and beta. This process tends to lead the nucleus to a more stable state.

Radioactive materials occur naturally in the environment (e.g. uranium, thorium and potassium). Some radioactive compounds arise from human activities (e.g. from medical or industrial uses). Some natural sources of radiation can be concentrated by mining and other industrial activities such as CSG water processing, coal processing, rail corridors, infrastructure and ports and shipping.

By far the largest proportion of human exposure to radiation comes from natural sources – from external sources of radiation, including cosmic radiation, or from ingestion or inhalation of radioactive materials. A very low proportion of the total human exposure comes from water. Radiological contamination of drinking, surface and ground waters can result from:

» Naturally occurring radioactive species (e.g. the thorium and uranium series)

» Mining, transport and processing of minerals e.g. metals; mineral sands, phosphate fertiliser and of course uranium)

» Manufactured radionuclides, which may enter water bodies from the medical and industrial use of radioactive materials.

### METHOD INFORMATION

| Method Code | Parameter | Method Reference | LOR (Bq/L) |
|---|---|---|---|
| **EA250** | Gross alpha (α) | ASTM D7283-13 | 0.05 |
| | Gross beta (β) | ASTM D7283-13 | 0.1 |
| **EA257** | Lead 210 | ISO Method 13163 | 0.05 |
| **EA251** | Radium 226 | ISO Draft Method | 0.05 |
| | Radium 228 | ISO Draft Method | 0.08 |

## REGULATORY GUIDELINES

A number of different regulatory guidelines cover water such as ADWG[1] or ANZECC Guidelines. These assist to monitor and manage radioactivity levels. The guidance covers irrigation waters, livestock drinking waters, drinking and recreational waters. Recommended screening levels for waters are in the table below.

| Water Use | Guideline Value | |
|---|---|---|
| | Gross α (Bq/L) | Gross β (Bq/L) |
| Drinking | 0.5 | 0.5* |
| Irrigation | 0.5 | 0.5 |
| Recreational | 0.1 | 0.1 |

*(* after $^{40}$K correction)*

Gross α and β activity screening procedures have been developed to determine if specific radionuclide analysis is required.

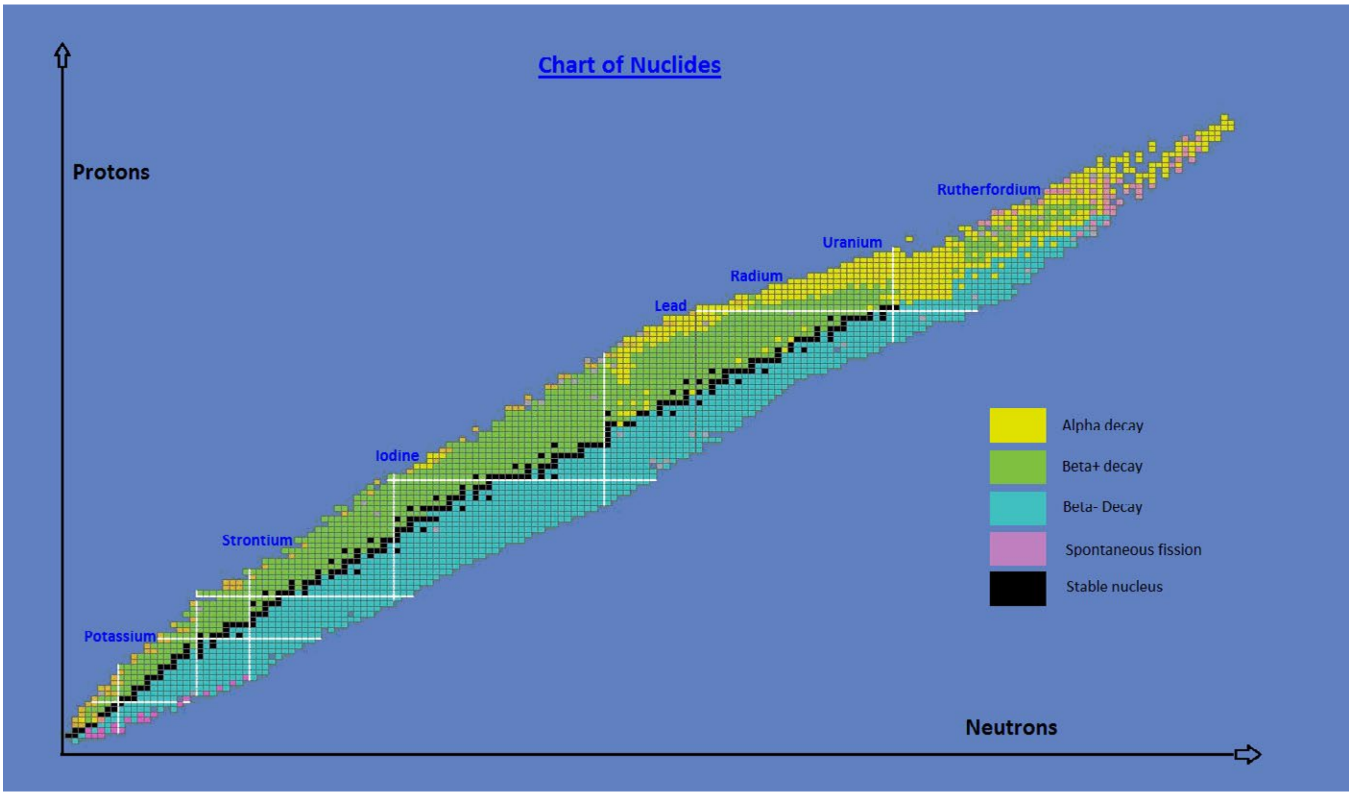
If either of these activity concentrations is exceeded, specific radionuclides should be identified and their activity concentrations determined. The concentrations of both Radium 226 and 228 should always be determined, as these are the most significant naturally occurring radionuclides in Australian water supplies

Several radionuclides that are classified as β emitters may occasionally be present in drinking water. The significant long-lived nuclides in this group are the naturally occurring isotopes Potassium 40, Lead 210 and Radium 228, and artificial radionuclides Caesium 137 and Strontium 90.

The measurement of Gross β activity however can include a significant contribution from Potassium 40, which occurs naturally in a fixed ratio to stable Potassium. Potassium is an essential element for humans and remains at a constant level in the body. It does not bio-accumulate and has negligible toxicity and hence is of limited concern.

The Canberra laboratory will report Gross β minus the contribution of Potassium 40 in addition to Gross β.

# Radioactivity




**Examples of Decay modes:**

Alpha Decay: $^{226}_{88}Ra \rightarrow ^{222}_{86}Rn + ^{4}_{2}He$

Beta- Decay: $^{40}_{19}K \rightarrow ^{40}_{20}Ca + ^{0}_{-1}\beta$

Beta+ Decay: $^{11}_{6}C \rightarrow ^{11}_{5}B + ^{0}_{+1}\beta$

Spontaneous Fission: $^{254}_{98}Cf \rightarrow ^{118}_{46}Pd + ^{132}_{52}Te + 4^{1}_{0}n$

## GROSS ALPHA AND BETA ACTIVITY DETERMINATIONS

Analysis of water for Gross α or β activities requires concentration, mixing with a scintillation cocktail containing a solvent and an additive known as "fluor' and then measurement via a Liquid Scintillation Counter (LSC). Any α or β particle emitted from the sample transfers energy to the fluor via the solvent. The excited fluor molecule then dissipates energy by emitting light. Each light pulse emission is detected by photomultiplier tubes with α and β determined separately. Due to the high sensitivty of the instrumentation, Gross α and β measurement can be made with a high degree of accuracy and low detection limits. For specific nuclides, and appropriate preparation method is utilised to isolate only that element, then counting can proceed.

## GENERAL SAMPLING & PRESERVATION REQUIREMENTS

### Drinking, Ground, Waste and Surface Waters:

| | | |
|---|---|---|
| Gross α/β | 1 Litre Plastic Bottle Unpreserved. (Laboratory acidified) | |
| Lead 210 | 1 Litre Plastic Bottle Unpreserved. (Laboratory acidified) | Holding Time: 180 days |
| Radium 226/228 | 2 Litres Plastic Bottle Unpreserved. (Laboratory acidified) | (acidification within 5 days) |

For further information please contact ALS Canberra on (02) 6202 5400 or your local Client Services team.

### REFERENCES

(1) Australian Government. National Health and Medical Research Council. Australian Drinking Water Guidelines (ADWG) (2011). Available at: http://www.nhmrc.gov.au/guidelines/publications/eh52