



**Radiological Protection Institute of Ireland**  
An Institiúid Éireannach um Chosaint Raideolaíoch

# **A Survey of Natural Radioactivity in Groundwater in Ireland**

**Alison Dowdall**

**IRRS 7<sup>th</sup> Sept. 2012**

# Surface Water Supplies

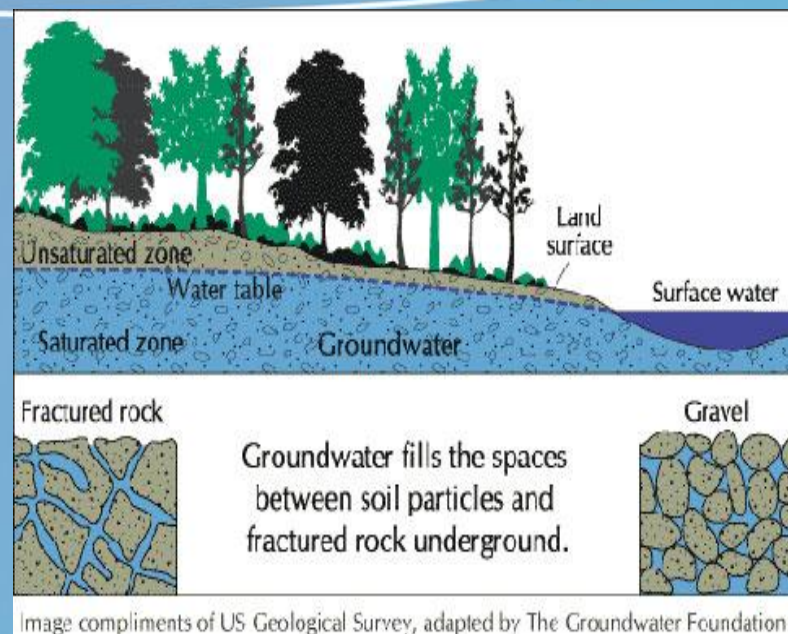


- **Approx. 82% of drinking water in Ireland comes from surface water**
- **Water from rivers, lakes, treated**
- **Stored in reservoirs**



# What is groundwater?

- **Water in pore spaces of rocks and gravel**
- **Where water deposit is sufficient to provide supply, it is termed an aquifer**
- **Boreholes and springs or input to rivers**





# Groundwater supplies in Ireland

- **18% of Irish drinking water comes from groundwater supplies, comprised of boreholes (10%) and springs (8%)**
- **Approx 100,000 wells in Ireland (public and private)**



# Why do the RPII monitor water for Radioactivity

## EU requirements

1. Water monitoring required under Article 35 and 36 of Euratom Treaty
2. Drinking Water Directive, 1998 (DWD)

## Irish Legislation

1. S.I. 278 of 2007
  - WHO Guidelines for drinking water, 1993  
100 mBq/l gross alpha, 1000 mBq/l gross beta  
Further analysis if these are exceeded
  - Large surface water supplies



# Objectives of the study

- 1. Knowledge gap regarding natural radioactivity in groundwater**
- 2. Assess levels of natural radioactivity in groundwater for compliance with Drinking Water Directive and WHO guidelines**
- 3. Assess levels of radon in groundwater with RPII recommended level**
- 4. Publish the findings**



# Sampling

- **EPA Groundwater Monitoring points**
- **Approx. 220 sites sampled quarterly**
- **RPII samples collected by EPA as part of their sampling programme**
- **Samples collected for**
  - ✓ **radon analysis**
  - ✓ **gross alpha and beta analysis**
  - ✓ **radium**
  - ✓ **polonium analysis**





# A wise decision!!



**Radiological Protection Institute of Ireland**

An Institiúid Éireannach um Chosaint Raideolaíoch



# Analysis

## **Drinking Water Directive 1998**

- Groundwater sources screened using WHO screening limit of 100 mBq/l for gross alpha, 1,000 mBq/l for gross beta
- Where a limit is exceeded, identify radionuclide causing the activity
- Uranium, polonium, radium
- Drinking Water Directive - Total indicative dose should be <0.1 mSv per year

## **Radon in Water (EU recommendation of 2001)**

- Radon in water measured for 217 locations
- 3 samples from each source collected
- RPII recommended level of 500 Bq/l



# Results of Gross Alpha and Beta Analysis (1)

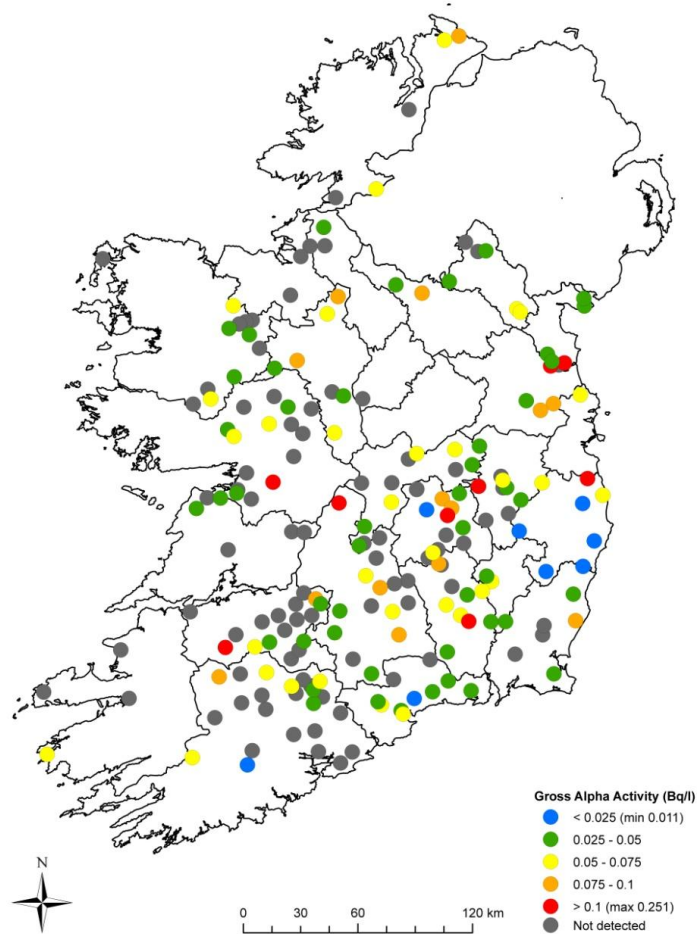
Analysis Type	Activity Concentration Range (mBq/l)
Gross Alpha	<8.1 – 250.8
Gross Beta	<48.25 – 553.63

- **203 samples screened for gross alpha and beta**
- **28 exceeded gross alpha screening limit of 100 mBq/l (13% of samples tested)**
- **Further analysis required for these samples – uranium, radium and polonium**

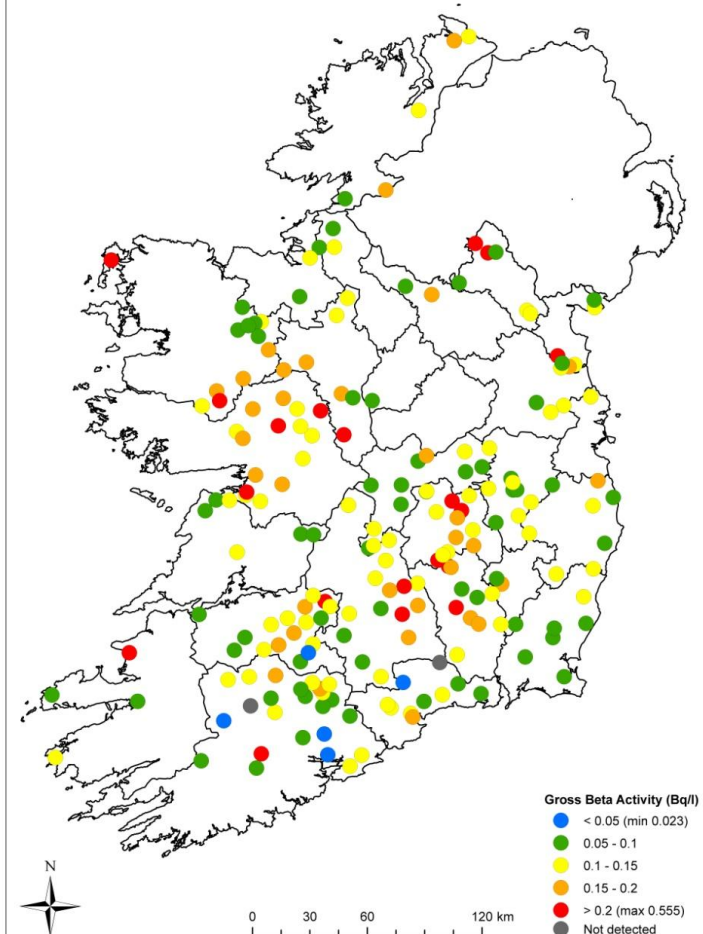


# Results of Gross Alpha and Beta Analysis (2)

Gross Alpha Activity Concentrations in Groundwater 2007 - 2011



Gross Beta Activity Concentrations in Groundwater 2007 - 2011



**Radiological Protection Institute of Ireland**

An Institiúid Éireannach um Chosaint Raideolaíoch



# Uranium Contribution to Gross Alpha Activity

- **EPA measure uranium concentration**
- **Use this data to assess the uranium contribution to the gross alpha activity**
- **Assuming uranium isotopes are present in equilibrium, then using natural abundances and ICRP 1996 ingested dose coefficients, activity concentrations calculated**
- **For 12 samples, uranium accounted for elevated alpha activity**
- **Other 16 require Po-210 and Ra-226 analysis**



# Results of individual radionuclide measurements

Radionuclide	Ingested Dose Coefficient for Adults (Sv/Bq) <sup>1</sup>	Activity per radionuclide (mBq/l) equivalent to 0.1 mSv	Maximum activity concentration measured (mBq/l)
Polonium-210	$1.2 \times 10^{-6}$	117	14.48
Radium-226	$2.80 \times 10^{-7}$	500	73.00
Thorium-232	$2.3 \times 10^{-7}$	600	Not measured
Uranium-234	$4.9 \times 10^{-8}$	3000	163
Uranium-235	$4.7 \times 10^{-8}$		
Uranium-238	$4.5 \times 10^{-8}$		

Note <sup>1</sup> Source: ICRP,1996

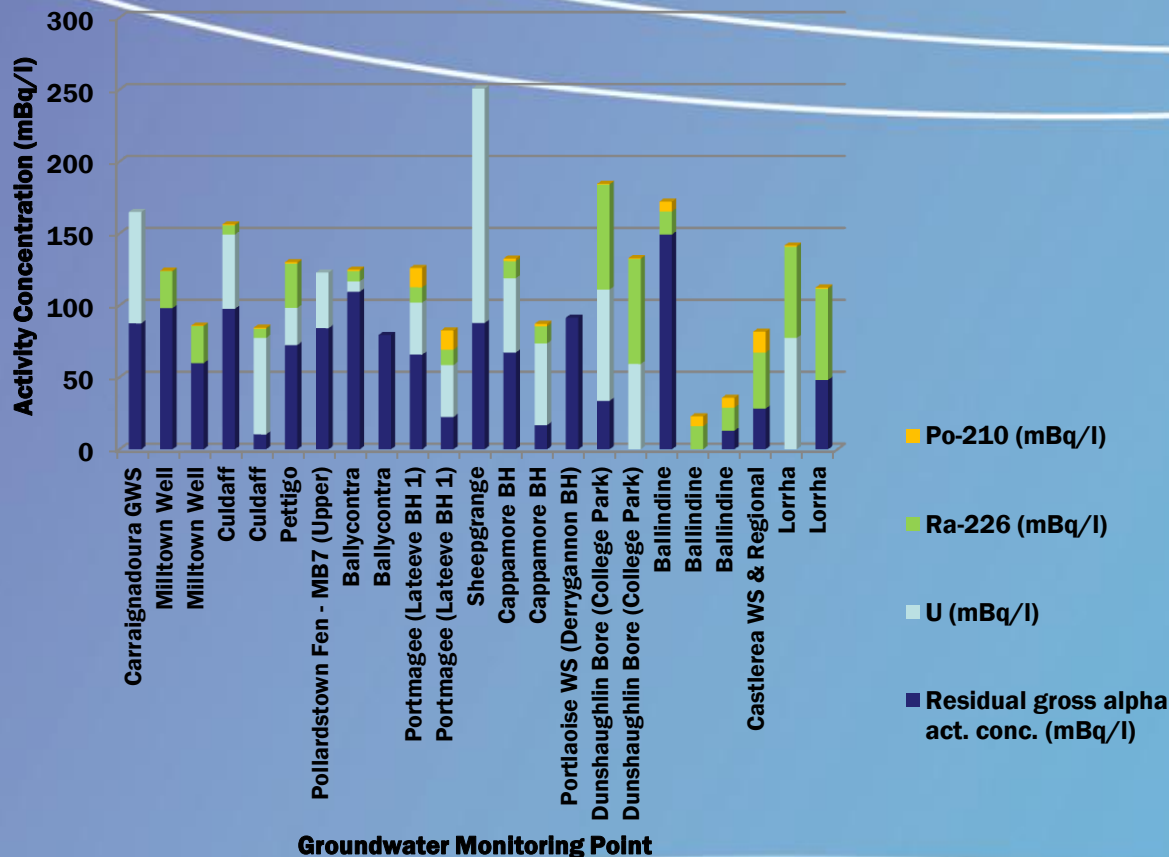
**WHO provisional guideline for uranium = 15 µg/l**



**Radiological Protection Institute of Ireland**

An Institiúid Éireannach um Chosaint Raideolaíoch

# Contribution of Uranium, Ra-226 and Po-210 to Gross Alpha Activity Concentration



- For 28 sources, gross alpha result ~ 100 mBq/l

- Summing uranium, Ra-226 and Po-210, activity in 23 sources accounted for

- Gross alpha analysis repeated for 5 sources and gross alpha activity lower

- At low environmental levels, uranium contributes significantly to gross alpha activity concentration



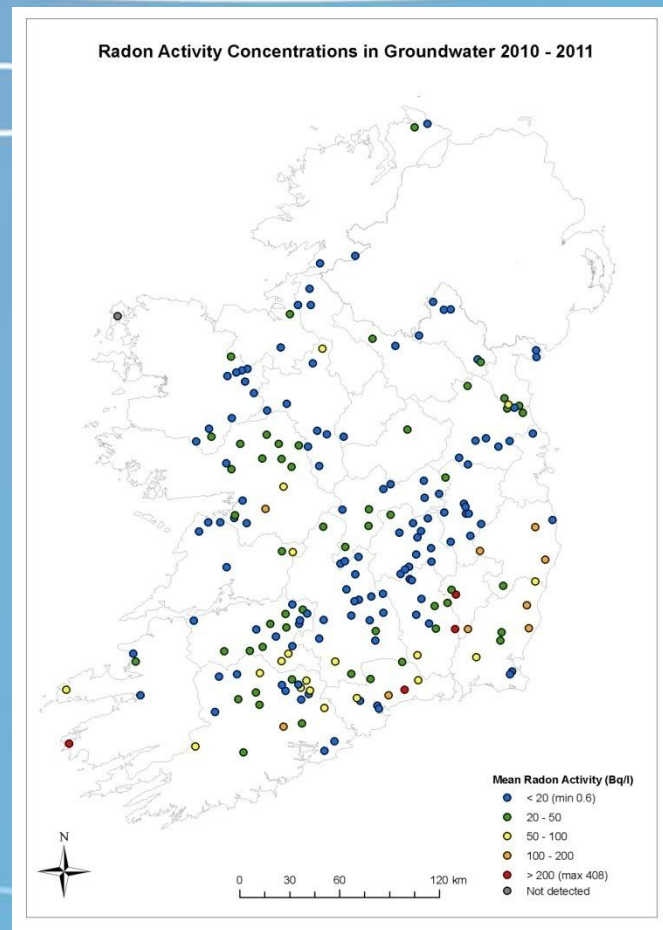
**Radiological Protection Institute of Ireland**

An Institiúid Éireannach um Chosaint Raideolaíoch



# Radon in water results

- **Max. activity concentration measured was 344.5 Bq/l**
- **RPII level for public supply is 500 Bq/l**
- **Estimated dose of 2.52 mSv per year (at source => Worst case scenario)**
- **No correlation was found between uranium and radon activity concentration**



# Conclusions



## Gross Alpha Activity

- 28 sources exceeded WHO gross alpha screening limit of 100 mBq/l
- Uranium accounted for gross alpha activity in 12 sources
- In 16 sources, Uranium, Ra-226 and Po-210 activity concentration measured would not give rise to a TID exceeding 0.1 mSv dose



## Beta Activity

- All gross beta activity concentrations < 1,000 mBq/l
- TID not exceeded



## Radon Activity

- All radon activity concentrations were below RPII recommended level of 500 Bq/l

**First draft of report written, due to be published end of 2012**



# Thank You!

- **To the EPA, for all their assistance with our sampling, for their uranium dataset and all other requests for information during this project**
- **Colleagues in Environmental Surveillance, RPII**
- **Audience of IRRS meeting**

