

NATURALLY OCCURRING RADIONUCLIDES
IN DRINKING WATER SUPPLIES
IN THE SOUTH WEST OF WESTERN AUSTRALIA
AND THEIR POTENTIAL IMPACT ON HUMAN HEALTH

By

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STATEMENT OF ORIGINALTY

I declare that this thesis is my own account of my research and contains as its main content work which has not previously been submitted for a degree at any tertiary educational institution.

Maurice Walsh

This thesis is dedicated to my children Gracie, Hannah and Ben.

ABSTRACT

Radioactivity in drinking water is a concerning international public health issue. Recently attention has been drawn to this issue by moves in the USA and several other developed countries to lower the permissible levels of naturally occurring radioisotopes in drinking water.

The primary goal of this thesis is to investigate the levels of naturally occurring radioisotopes in drinking water supplies in the South West of Western Australia particularly those that are predominately sourced from groundwater and to determine whether any elevated levels exist. As isotopes, such as Ra-228 and Po-210, are difficult to measure in low concentrations a secondary aim of the project was to develop faster, reliable techniques for measuring them at low levels commonly found in drinking water derived from groundwater.

Radiochemical analysis of samples taken from 52 public drinking water supplies in Western Australia was carried out at the University of Vienna, Austria during 2005-2006. All samples were analyzed for Ra-226, Ra-228 and Pb-210. Twenty five of the samples were analyzed for Po-210 and twenty three were analyzed for U-234 and U-238. Ra-224 was only found in one sample.

Radionuclide activities in the drinking water samples ranged from < 5.0 to 77.7 mBq L^{-1} for Ra-224, 3.2 to 151.1 mBq L^{-1} for Ra-226, < 4.0 to 296.1 mBq L^{-1} for Ra-228, < 2.0 to 13.4 mBq L^{-1} for Pb-210, 0.6 to 21.7 mBq L^{-1} for Po-210, 0.6 to 12.8 mBq L^{-1} for U-234 and 0.4 to 14.3 mBq L^{-1} for U-238. The mean concentrations were 1.5 mBq L^{-1} for Ra-224, 32.6 mBq L^{-1} for Ra-226, 47.3 mBq L^{-1} for Ra-228, 0.7 mBq L^{-1} for Pb-210, 7.1 mBq L^{-1} for Po-210, 3.3 mBq L^{-1} for U-234 and 2.3 mBq L^{-1} for U-238.

A comparison was made to determine whether or not the 52 drinking water samples from Western Australia comply with the radiological safety guidelines of other developed countries. Particular attention was paid to potential impacts on children with regard to setting radiological safety parameters for drinking water.

The annual dose received by the population in the sampled Western Australian communities, ranged from 0.002 to 2.059 mSv y⁻¹ with a mean annual dose of 0.15 mSv y⁻¹. The main contributing radionuclides to the annual dose were Ra-226 and Ra-228. These trends are explained in terms of the local geology and groundwater resources, particularly the historical development of the heavy mineral sands industry along the southern coastline and known uranium deposits in Western Australia.

Of the 52 drinking water samples tested, 94% complied with the current Australian Drinking Water Guidelines, 15% complied with the current Canadian, European, United Kingdom and the WHO's radiological guidelines for drinking water, 12% complied with the US EPA's radiological guideline for drinking water but none of the samples complied with the new 2006 California EPA's Public Health Goals for Ra-226 and Ra-228 in drinking water.

Based on these findings recommendations are made about the need for further monitoring and possible epidemiological studies of communities that have elevated levels of radionuclides in their drinking water supplies.

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LIST OF ABBREVIATIONS

ARMC	Agricultural and Resource Management Council of Australia and New Zealand.
ADWG	Australian Drinking Water Guidelines.
ARL	Australian Radiation Laboratory.
ARPANSA	Australian Radiation Protection and Nuclear Safety Agency.
AWRC	Australian Water Resources Council.
DFWA	Department of Fisheries of Western Australia.
DOHWA	Department of Health of Western Australia.
DNA	Deoxyribonucleic acid.
DW	Drinking Water.
EPA	Environmental Protection Agency.
EU	European Union.
EWG	Environmental Working Group.
ICRP	International Commission on Radiological Protection.
LET	Linear energy transfer.
NHMRC	National Health and Medical Research Council of Australia.
NRMMC	Natural Resource Management Ministerial Council of Australia.
MCL	Maximum Contaminant Level/s.
OEHHA	Office of Environment Health Hazard Assessment.
PHG	Public Health Goals.
SW	South West.
UK	United Kingdom.
US	United States.
USA	United States of America.
US EPA	United States Environmental Protection Agency.
USGS	United States Geological Survey.
NAIMFNB	National Academies, Institute of Medicine, Food and Nutrition Board.
USNRC	United States National Research Council.
UNSCEAR	United Nations Scientific Committee on the Effects of Atomic Radiation.
WA	Western Australia.
WAWA	Water Authority of Western Australia.
WCWA	Water Corporation of Western Australia.
WHO	World Health Organization.
WRCWA	Water and Rivers Commission of Western Australia.

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