

## CONTRIBUTORS TO THE REPORT

This report was compiled by the Institute for Water Quality Studies, together with the assistance and contribution from many individuals and organisations, specifically the members of the Technical Committee. Dr P.L.Kempster compiled and edited the report.

Mr P Botes (Institute for Water Quality Studies)

Mr J Carter (formerly Institute for Water Quality Studies)

Mr H Coetzee (Council for Geoscience)

Ms K Erasmus (Institute for Water Quality Studies)

Mr D Esterhuizen (Gauteng Region, Department of Water Affairs & Forestry)

Dr A Faanhof (Atomic Energy Corporation)

Mr D Grobler (formerly Institute for Water Quality Studies)

Mr S Guy (formerly with Council for Nuclear Safety)

Ms A Howman (Institute for Water Quality Studies)

Mr M Keet (Gauteng Region, Department of Water Affairs & Forestry)

Dr P Kempster (Institute for Water Quality Studies)

Mr M Ludick (formerly with Gauteng Region, Department of Water Affairs & Forestry)

Ms L Mkhondl (Institute for Water Quality Studies)

Mr T Pather (Council for Nuclear Safety)

Ms M Shai (Institute for Water Quality Studies)

Ms M Smidt (Institute for Water Quality Studies)

Ms C Smith (Gauteng Region, Department of Water Affairs & Forestry)

Mr S van der Woude (Council for Nuclear Safety)

Dr D Wymer (Chamber of Mines)

A note of gratitude must also be extended to the sampling teams, and the staff of the respective analytical laboratories who undertook sample analysis.

## COMMITTEE FOR CO-ORDINATION OF THE MOOI RIVER MONITORING

The following people participated at some point in the activities of the Committee. Please note that designations are as given by participants at the time of joining the committee, and that affiliations may have changed in the interim.

P Botes	Institute for Water Quality Studies (IWQS)
J Botha	Anglo Cold Limited
J Carter	IWQS
H Coetzee	Council for Geoscience
D Dorling	Randfontein Estates Gold Mine
M Eksteen	Directorate: Water Quality Management, Department of Water Affairs & Forestry (DWAF).
E Erasmus	Gold Fields of South Africa.
D Esterhuizen	Gauteng Region, DWAF
A Faanhof	Atomic Energy Corporation (AEC)
F Fouche	AEC
H Fourie	Johannesburg Chamber of Industries (JCI)
A Gerber	IWQS
D Grobler	IWQS
S Guy	Council for Nuclear Safety (CNS)
G Hoorn	Free State Region, DWAF
A Howman	IWQS (Chairperson)
J Katabua	Rand Water (RW)
M Keet	Gauteng Region, DWAF
P Kempster	IWQS
M Kruger	Western Transvaal Water Company
H McKay	IWQS
A Mc Laren	Group Water Technologist, Gold Fields of South Africa.
S Meintjies	Dept Mineral and Energy Affairs
E Meintjies	RW
I Meyers	JCI
S Miller	Gold Fields of South Africa
J Moolman	IWQS
A van der Merwe	Randfontein Estates Gold Mine
B Nell	Potchefstroom Municipality.
T Pather	CNS
J Pieterse	Western Transvaal Water Company
J Slabbert	Gold Fields of South Africa.
M Smidt	IWQS
L Stoch	Welverdiend
H Theunissen	Anglo American

D Traut	Gold Fields Water
L van den Bergh	Directorate: Water Quality Management, DWAF
J van der Merwe	Fochville
J van der Merwe	Free State Region, DWAF
S van der Woude	CNS
R van Rensburg	Bothaville
F Wanders	University of Potchefstroom
R Webster	Dept Mineral and Energy Affairs
D Wymer	Chamber of Mines

**NOTE:** While the compilation of this report was the responsibility of the Institute for Water Quality Studies, every attempt was made to incorporate the views of members of the Co-ordinating Committee, and this was to a large extent achieved. Mr A McLaren did not accept the report.

**MEMBERS OF THE TECHNICAL COMMITTEE AS ON 5 MARCH 1999**

P Botes	-	IWQS
J Carter	-	IWQS
H Coetzee	-	Council for Geoscience.
D Esterhuizen	-	Gauteng Region (DWAF)
A Faanhof	-	AEC
D Grobler	-	IWQS
A Howman	-	IWQS
M Keet	-	Gauteng Region (DWAF)
P Kempster	-	IWQS
A Leuschner	-	Gold Fields Ltd., on invitation of M. Keet.
T Pather	-	CNS
S van der Woude	-	CNS
D Wymer	-	Chamber of Mines

## TABLE OF CONTENTS

	Page
Executive Summary	1
1. Introduction	3
1.1 Background	3
1.2 Aims of the Study and Strategy adopted	3
1.3 Management and Co-ordination of the programme	4
2. Monitoring Programme	4
2.1 Selection of Catchment	4
2.2 Characterisation of the Mooi River Catchment and Water Use	4
2.3 Selection of Monitoring Sites	5
2.4 Sampling Frequency and Duration	7
2.5 Geological and Radiological Characterisation of the Catchment	7
2.6 Variables Measured and Data Collected	7
2.6.1 Radionuclides	7
2.6.2 Chemical Variables	8
2.6.3 Other Data	8
2.6.4 Access to Analytical Data	8
2.7 Quality Control	9
3. Basic Radiological Considerations	9
3.1 Exposure from Natural Background Radioactivity and Medical Procedures	9
3.2 Exposure Pathways	10
3.3 Health Effects of Ionizing Radiation	10
3.4 Radiation Protection Principles and the System of Radiation Protection	11
3.5 Calculation of Dose for the Drinking Water Ingestion Pathway	11
3.5.1 Dose Conversion Factor	12
3.5.2 Activity Concentration	12
4. Drinking Water Quality Considerations	13
5. Discussion of Results	16
5.1 Annual Dose within the Mooi River Catchment for the Drinking Water Exposure Route	16
5.2 Discussion of Predominance and Uranium	17
5.3 Annual Radiation Dose from Background Radiation Levels in Water	18
<b>5.4</b> Relationship between Gross Alpha Activity and the Annual Dose	19
5.5 Relationship between Uranium Concentration and the Annual Dose	18
5.6 Verification of Dose Calculations	19
5.7 Possible Uncertainties in Dose Calculations	20
5.8 Suspended Solids	21
5.9 Chemical Results: Sulphate	21

6.	The Gauteng Regional Office Water Quality Management Strategy for the Mooi River	21
6.1	Source Directed Controls	21
6.2	Water User Assessments	22
6.3	Actions taken at Sites 7a and 12	22
6.4	Monitoring	22
7.	Conclusions and Recommendations	23
7.1	General Conclusions	23
7.2	Municipal Water Supplies	23
7.3	Indicators of Radiological Water Quality	23
7.4	Suspended Solids	24
7.5	Guideline Development	24
7.6	Recommendations	24
8.	References	26

## LIST OF APPENDICES

Appendix 1:	Water Users in the Mooi River Catchment	A1-1
Appendix 2:	Methods of Analysis for Radionuclides	A2-1
Appendix 3:	Sampling and IWQS Analytical Procedures	A3-1
Appendix 4:	Information on Decay Chains	A4-1
Appendix 5:	Inter laboratory Split Sample Quality Control	A5-1
Appendix 6:	Quality Control and Validation done in the AEC Laboratory	A6-1
Appendix 7:	Evaluation of dose from the drinking water pathway as opposed to other possible pathways of exposure	A7-1
Appendix 7A:	Calculations Involving Irrigation	A7A-1
Appendix 7B:	Significance of dose to drinking water pathway relative to that of other ingestion pathways	A7B-1
Appendix 8:	Method One (IWQS), used for dose calculation	A8-1
Appendix 9:	Method Two (AEC), used for independent dose verification	A9-1
Appendix 10:	Estimation of possible uncertainties	A10-1