RADIATION MANAGEMENT PLAN

BEVERLEY MINE

Occupational Monitoring Program

Annual Report - 2012

25 Grenfell Street, Suite1, Level 4, Adelaide SA 5000 Ph: +61 8 8110 0500 Fax: +61 8 8212 5559 ABN 31 011 018 232
Website: www.heathgate.com.au

TABLE OF CONTENTS

1 EXECUTIVE SUMMARY 3
1.1 Introduction 3
1.2 Occupational Radiation Monitoring 3
1.3 Occupational Dose Estimation 3
1.4 Adequacy and Effectiveness of Equipment and Procedures 3
2 INTRODUCTION 4
2.1 HGR Management Personnel 5
2.2 Summary of Process Activities and Changes 5
3 OCCUPATIONAL RADIATION MONITORING 7
3.1 Radon Decay Products 7
3.2 Long Lived Alpha Activity 9
3.3 External Gamma Dose Rate 12
3.3.1 Area Gamma Dose Rate Surveys 12
3.3.2 Thermoluminescent Dosimeter Results 13
3.4 Alpha Surface Contamination 14
4 OCCUPATIONAL DOSE ESTIMATION 15
4.1 Dose Assessment 15
5 ADEQUACY AND EFFECTIVENESS OF EQUIPMENT AND PROCEDURES 17
6 CONCLUSIONS 18
7 REFERENCES 18

1 EXECUTIVE SUMMARY

1.1 Introduction

This report is prepared in accordance with the requirements of the Heathgate Resources Pty Ltd (Heathgate) Beverley Uranium Mine Radiation Management Plan, December 2010.

1.2 Occupational Radiation Monitoring

Radon decay products monitoring carried out in the plants and wellfields showed that the concentrations remained low during the year.

Area monitoring conducted at the plant supervised, wellfield and office areas, showed that Long Lived Alpha Activity in dust remained consistently low.

Gamma dose rates throughout the plant and wellfield remained consistent with previous years monitoring results.

Alpha surface contamination in the plant and wellfield areas remained consistent with previous years monitoring results. Pressure cleaning helped to minimise surface contamination levels in these areas.

1.3 Occupational Dose Estimation

Doses to employees and contractors at the Beverley Uranium Mine remained low during the year.

The average dose of 0.32 mSv was less than the annual effective dose limit of 1 mSv to members of the public as stipulated in the South Australian Radiation Protection and Control (Ionising Radiation) Regulations 2000. The maximum dose for the year was 6.17 mSv, also well below the employee dose limits of 20 mSv/yr averaged over 5 years or 50 mSv/yr in any one year.

There were a total of 221 employees and contractors at the Beverley Mine during 2012.

1.4 Adequacy and Effectiveness of Equipment and Procedures

The policies and procedures implemented and equipment installed to manage radiation doses require constant review to ensure that doses to employees remain as low as reasonably achievable (ALARA). Some specific examples for the year ending 31 December 2012 are as follows:

- Reviewed and updated many Standard Operating Procedures and Work Instructions
- Conducted several sessions of radiation safety training
- Employee safety meetings were used as a platform to discuss the radiation safety issues and implement corrective actions when required
- Supervisors Safety Meetings were used to discuss radiation safety related items and to implement corrective actions.

2 INTRODUCTION

This report is prepared in accordance with the requirements of the Beverley Uranium Mine Radiation Management Plan (RMP), December 2010 and the conditions of the License to Mine and Mill Radioactive Ores (LM4) under the Radiation Protection and Control Act, 1982. It provides a summary of all monitoring conducted during the calendar year 2012, previously reported quarterly in the Beverley Mine Occupational Radiation Monitoring Quarterly Reports.

The RMP documents the strategies developed by Heathgate Resources for the:

- Identification of potential radiation sources
- Monitoring of radiation exposures
- Assessment of employee dose
- Management of radiation exposures to ensure compliance with the ALARA principle.

The objective of the RMP is to assist Heathgate to fulfil its statutory requirements detailed in the Code of Practice on Radiation Protection and Radioactive Waste Management in Mining and Mineral Processing (2005) and to comply with the relevant State and Commonwealth legislation.

The main radiation issues considered by the RMP and reported in this document are:

- Radon decay products inhalation
- Long lived alpha activity in dust inhalation
- Gamma dose external exposure
- Alpha contamination of surfaces
- Calculation of employee radiation dose
- Compliance with the ALARA principle.

2.1 HGR Management Personnel

Heathgate personnel, who are currently responsible for radiation management at the Beverley site, are as follows:

- President – Craig Bartels
- Operations Manager — Gary Birch
- Production Managers — Chris Every and Chris Heinrich
- Acting Production Manager — Paul Vuaran
- Health, Safety, Security and Environment Manager – Sue Carter
- Senior Radiation Advisor — Sankaran Kutty.

The statutory position of Radiation Safety Officer is held by Sankaran Kutty, whose contact details are provided below:

Sankaran Kutty
Senior Radiation Advisor
Heathgate Resources
Suite 1, Level 4, 25 Grenfell St
Adelaide SA 5000

Adelaide Office:	Ph: 08 8110 0500	Fax: 08 8212 5559
Beverley Site:	Ph: 08 8648 4650	Fax: 08 8648 4628

2.2 Summary of Process Activities and Changes

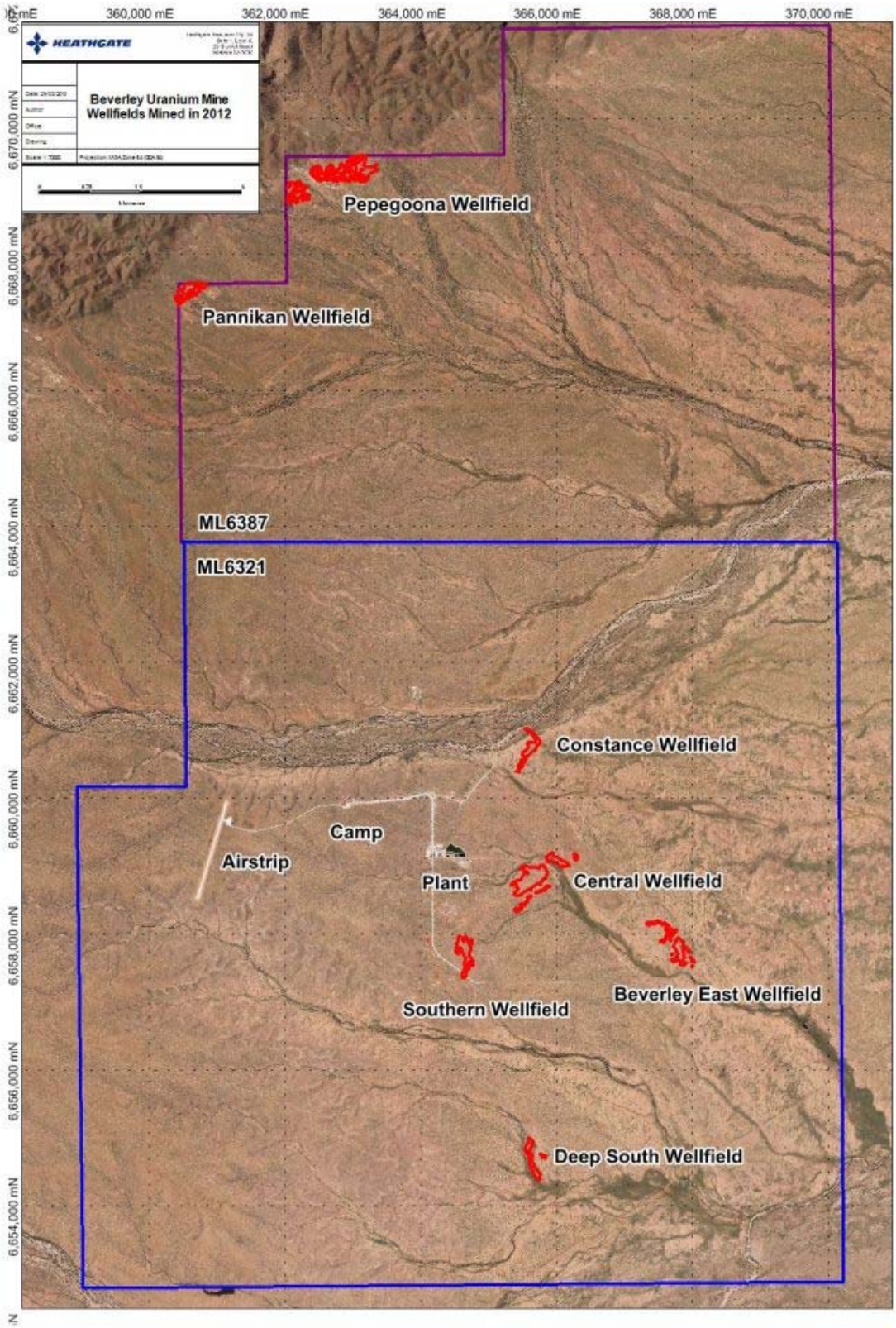
A current diagram of the Beverley Site with wellfields operated during 2012 is provided in Figure 2.2.1.

A number of modifications were made to processes during the year which had an impact on occupational exposures:

- Carried out preventive maintenance of Drier and Packaging System
- Carried out inspections and preventive maintenance of Ion Exchange Columns
- Overhauled drier dust extractors and blowers

Mining continued in the Central, South, Deep South, East and Beverley North Wellfields during the year.

Figure 2.2.1


360,000 mE
362,000 mE
364,000 mE
366,000 mE
368,000 mE
370,000 mE
6,670,000 mN
6,668,000 mN
6,666,000 mN
6,664,000 mN
6,662,000 mN
6,660,000 mN
6,658,000 mN
6,656,000 mN
6,654,000 mN
HEATHGATE
Beverley Uranium Mine
Wellfields Mined in 2012
Pepegoona Wellfield
Pannikan Wellfield
ML6387
ML6321
Constance Wellfield
Camp
Airstrip
Plant
Central Wellfield
Beverley East Wellfield
Southern Wellfield
Deep South Wellfield

3 OCCUPATIONAL RADIATION MONITORING

The occupational radiation monitoring conducted throughout the year included the measurement of radiation levels at the Beverley Process Plant and Wellfields, Process Plant Office, Weather Tower, Camp and Beverley North Satellite Plants and Wellfields. The frequency of monitoring was conducted according to the Radiation Management Plan. This monitoring included the following:

- Radon Decay Products area monitoring
- Long Lived Alpha Activity (LLAA) in dust personal and area monitoring
- Area gamma radiation surveys
- Alpha surface contamination monitoring.

3.1 Radon Decay Products

The Potential Alpha Energy Concentration (PAEC) of radon decay products was measured throughout the plant and wellfield areas. Monitoring was conducted according to the approved Standard Operating Procedure (SOP)[4].

The average and maximum concentrations measured at various locations throughout the year are given in Table 3.1.1. Trends of annual averages since commencement of operations are presented in Figure 3.1.1.

Radon Decay Products monitoring throughout the site showed PAEC to remain consistently low. Average concentrations across the site remain well below the internal investigation level of 2 μJm^{-3}.

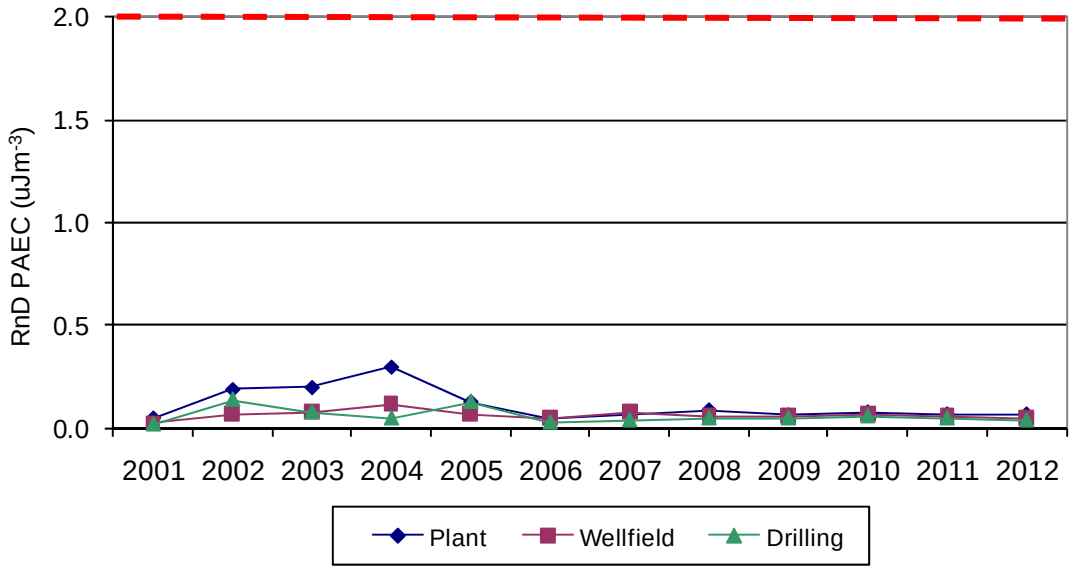
Table 3.1.1

Radon Decay Product PAEC in the Plant and Wellfield

Location	PAEC (μJm^{-3})		
	Average	Max	Number 12 Hours Samples
Drilling	0.04	0.13	4
Environmental	0.06	0.24	8
Other	0.04	0.11	6
Plant Clean	0.07	0.36	23
Plant Controlled	0.06	0.31	12
Plant Supervised	0.07	0.90	95
Wellfield	0.05	0.17	11

Figure 3.1.1

Radon Decay Products Monitoring Trends



The Potential Alpha Energy Concentration (PAEC) of radon decay products was also monitored continually outside the Control Room.

The average and maximum concentrations measured remained below the investigation level and are given in Table 3.1.2.

Table 3.1.2

Radon Decay Product PAEC outside the Control Room

Month	PAEC (μJm^{-3})	
	Average	Max
Jan 12	0.07	1.70
Feb 12	0.07	0.50
Mar 12	0.07	0.40
Apr 12	0.08	0.45
May 12	0.06	0.44
Jun 12	0.07	0.74
Jul 12	0.06	0.33
Aug 12	0.05	0.33
Sep 12	0.04	0.33
Oct 12	0.04	0.24
Nov 12	0.04	0.28
Dec 12	0.04	0.29

3.2 Long Lived Alpha Activity

Long Lived Alpha Activity (LLAA) sampling was conducted throughout the Plant controlled and supervised areas and in the Wellfield. Monitoring was conducted according to the approved SOP[5] and frequencies.

Details of the average, maximum and minimum concentrations at locations around the site, the controlled area and for personal monitoring are given in Tables 3.2.1, 3.2.2 and 3.2.3 respectively. Trends of annual averages since commencement of operations are presented in Figure 3.2.1.

Long Lived Alpha Activity in dust monitoring conducted in the Plant, Wellfield and other areas of the site remain low. The dust management programmes detailed in the radiation management plan are thus considered sufficient to ensure doses via this pathway remain as low as reasonably achievable.

Table 3.2.1

LLAA Concentrations from Dust at the Plant and Wellfield

Location	LLAA (Bqm^{-3})				
	Average	Max	Min	Std Dev	Number
Environmental	0.02	0.03	0.00	0.01	8
FLT	0.02	0.03	0.01	0.01	4
Other	0.02	0.05	0.00	0.02	8
Plant Clean	0.01	0.08	0.00	0.02	70
Plant Supervised	0.02	0.50	0.00	0.04	193
Wellfield	0.02	0.09	0.00	0.03	26

The average and maximum dust concentrations in all the above areas remained low.

Table 3.2.2

LLAA Concentrations from Dust in the Controlled Area

Location	LLAA (Bqm^{-3})				
	Average	Max	Min	Std Dev	Number
Drier *	1.85	10.5	0.00	1.92	44
Drier security room	0.02	0.08	0.00	0.02	21
Packing room *	1.23	5.75	0.00	1.24	21
Packing Warehouse	0.03	0.15	0.00	0.04	21

* Airstream helmets are worn by all personnel entering the drier and packing room; protection factor is not included but would reduce concentrations by 10 times.

Table 3.2.3

LLAA Concentrations from Personal Monitoring of Work Groups

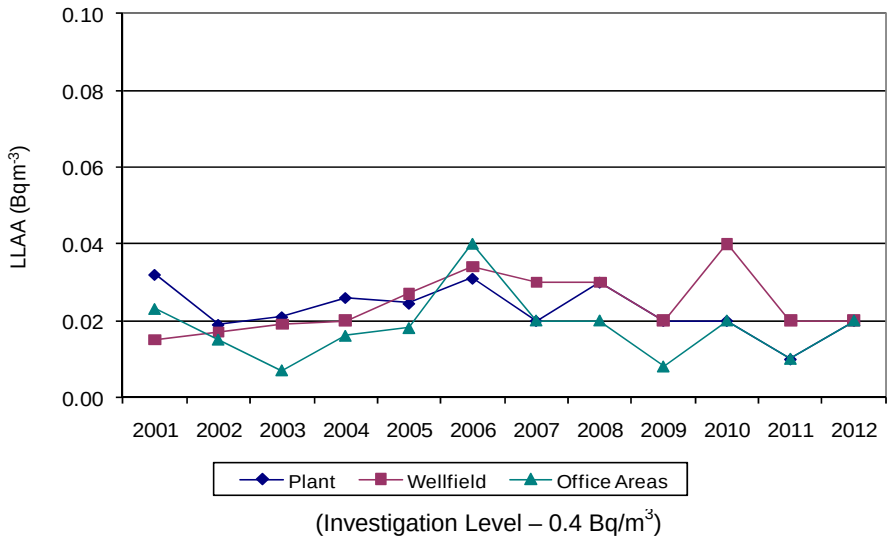
Type	LLAA (Bqm^{-3})				
	Average	Max	Min	Std Dev	Number
Drier Operator *	0.03	0.07	0.00	0.04	3
Maintenance	0.05	1.33	0.00	0.18	90
Plant	0.03	0.37	0.00	0.06	43
Wellfield	0.02	0.14	0.00	0.03	18
Cleaner	0.03	0.07	0.00	0.04	3

* Airstream Helmets are worn by these operators; protection factor is not included but would reduce concentrations by 10 times.

Figure 3.2.1

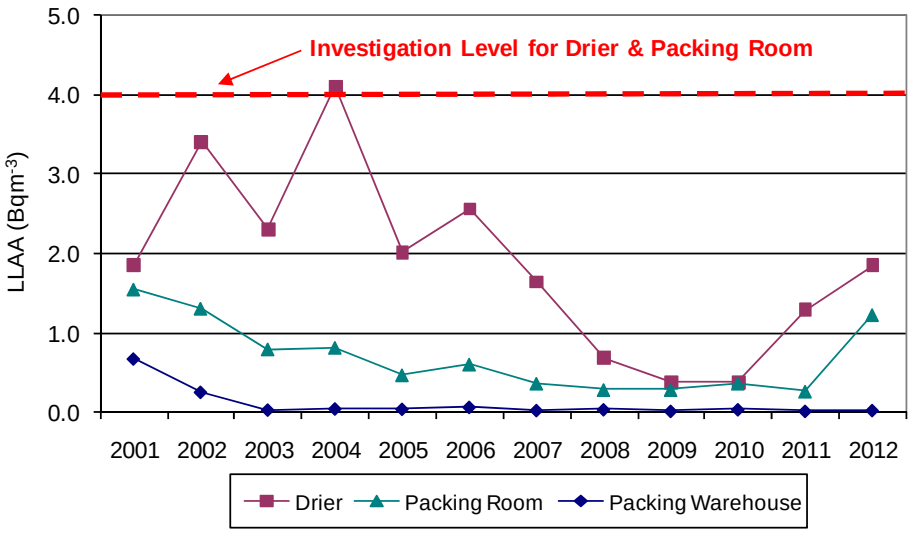
LLAA Concentration in Dust Monitoring Trends

(a) Supervised and Office Areas

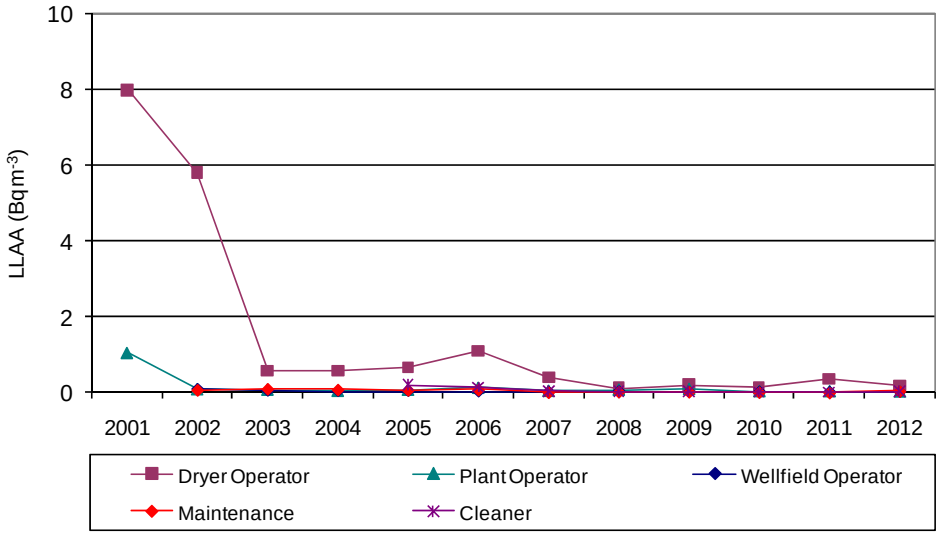


(Investigation Level – 0.4 Bq/m^3)

(b) Controlled Areas



(c) Personal Monitoring



(Investigation Level – 0.4 B q/m^3)

3.3 External Gamma Dose Rate

3.3.1 Area Gamma Dose Rate Surveys

External gamma dose rate surveys were conducted throughout all work areas in the Plant and Wellfield. Monitoring was conducted according to the approved SOP[6].

Details of the average, maximum and minimum dose rates at each location are given in Table 3.3.1. Trends in annual average dose rates since commencement of operations are presented in Figure 3.3.1.

Average gamma dose rates remained consistent throughout the year.

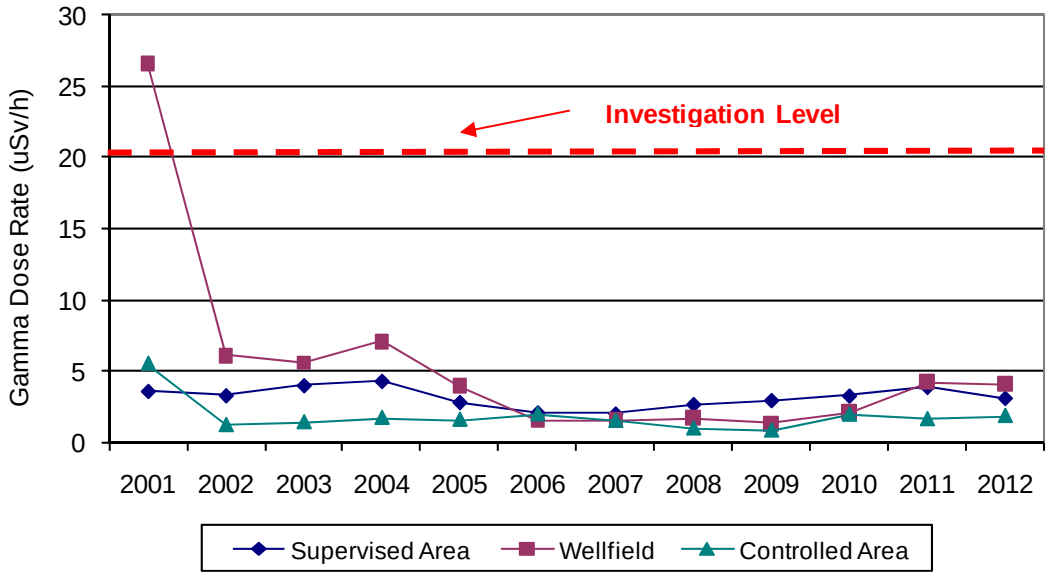
Table 3.3.1

Gamma Dose Rate Survey Results for the Plant and Wellfield

Location	Gamma Dose Rate (µSv/h)				
	Average	Max	Min	Std Dev	Number
Drilling	0.88	5.00	0.05	1.23	24
Plant Clean	0.22	0.80	0.04	0.12	51
Plant Controlled	1.84	12.0	0.30	2.75	37
Plant Supervised	3.12	20.0	0.10	4.42	57
Wellfield	4.08	30.0	0.20	6.19	102

Figure 3.3.1

Gamma Dose Rate Monitoring Trend



3.3.2 Thermoluminescent Dosimeter Results

Thermoluminescent Dosimeter (TLD) badges are issued to all permanent staff and long term contractors at the Beverley Site. They are also issued to temporary contractors who may be undertaking work in areas of higher than usual gamma dose rates.

Details of the average, maximum and minimum gamma dose on TLD badges for each workgroup are given in Table 3.3.2. Trends in annual average gamma doses since commencement of operations are presented in Figure 3.3.2. These average results are hourly weighted for each workgroup then allocated as an hourly dose rate to personnel who have either lost their badges or have not yet been issued with a badge. The final gamma dose statistics, including allocated doses, are presented in Table 4.1.2.

Average TLD badge doses remained consistently low.

Table 3.3.2

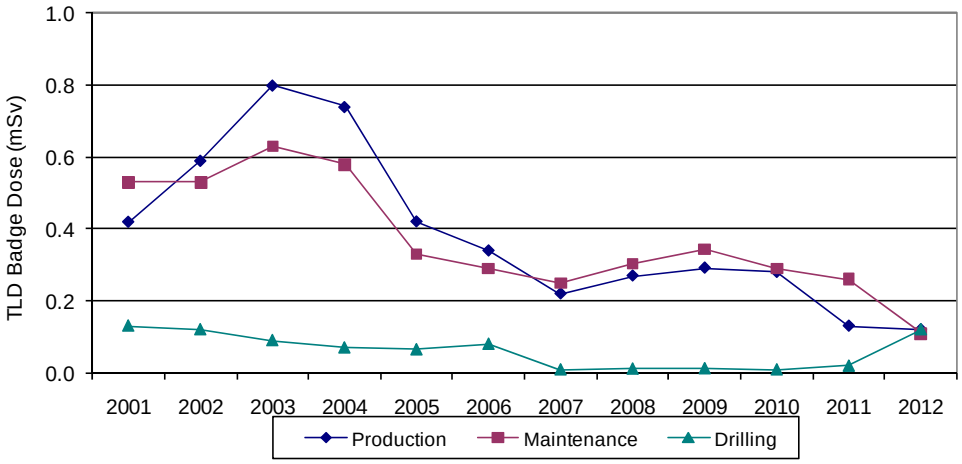
TLD Badge Dose by Work Group

Work Group	Gamma Dose (mSv)			
	Average	Max	Min	Number
Production	0.12	0.71	0.00	78
Maintenance	0.11	0.70	0.00	24
Geology & Drilling	0.12	5.82	0.00	70
Projects	0.07	0.90	0.00	14
Other	0.02	0.14	0.00	14
Contractors	0.03	0.23	0.00	21

* Production Personnel – Plant and Wellfield Operators, laboratory staff and supervisors
Geology & Drilling – Drillers, geologists and support staff
Others – Environment, Safety, Radiation and other office based staff
Contractors – All site contractors with exception of drillers
Projects – Construction personnel

Figure 3.3.2

TLD Badge Dose Trends



3.4 Alpha Surface Contamination

Alpha surface contamination surveys were conducted in the Crib Rooms, Control Rooms, Offices, Change Rooms, Plants and Wellfields. Measurements were conducted using a Ludlum Model 4 survey meter.

Details of the contamination monitoring conducted in the Plant, Wellfield and Clean Areas are given in Table 3.4.1. Trends in annual average surface contamination values are presented in Figure 3.4.1.

Regular pressure cleaning is conducted in the plant supervised and controlled areas to reduce the surface contamination levels.

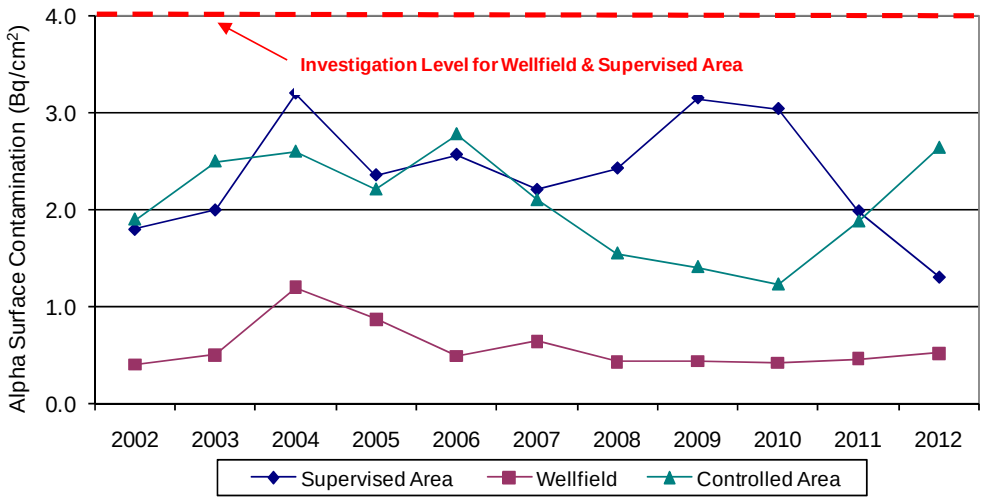
Table 3.4.1

Alpha Surface Contamination Survey Results for Plant and Wellfield

Location	Alpha Surface Contamination ($Bqcm^{-2}$)				
	Average	Max	Min	Std Dev	Number
Drilling	0.24	6.67	0.01	0.99	114
Other	0.01	0.40	0.00	0.04	141
Plant Clean	0.06	1.33	0.00	0.16	321
Plant Controlled	2.64	33.3	0.01	5.34	796
Plant Supervised	1.31	29.3	0.00	2.80	495
Wellfield	0.52	2.67	0.00	0.54	423

Figure 3.4.1

Alpha Surface Contamination Trends



4 OCCUPATIONAL DOSE ESTIMATION

This chapter presents the results of annual occupational dose calculations for 2012. Dose assessment methodology is presented in Appendix 1 and is based on the 1994 *ICRP 68* and 1996 *IAEA Safety Series 115* methodology.

4.1 Dose Assessment

During the year, there were a total of 221 employees and contractors working at the Beverley Site. The total effective dose descriptive statistics for these employees are given in Table 4.1.1. Trends of the average and maximum dose since commencement of operations are presented in Figure 4.1.1.

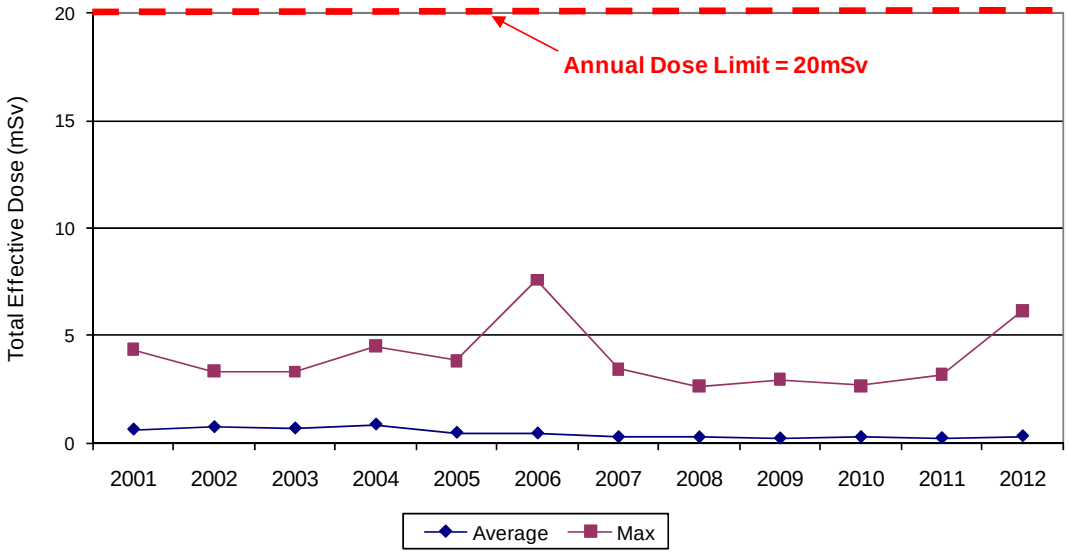
Table 4.1.1

Total Effective Dose Statistics

Statistic	Value
Average Dose (mSv)	0.32
Maximum Dose (mSv)	6.17
Minimum Dose (mSv)	0.00
Standard Deviation	0.47
Number of Employees	221
Dose limit (mSv)	20

Figure 4.1.1

Total Effective Dose Trends



Employees and contractors were assigned to various work groups based on their major tasks. The average and maximum effective doses to each of these work groups from each of the exposure pathways are presented in Table 4.1.2 and the average is presented in Figure 4.1.2.

Doses to employees at the Beverley Site remained consistently low and below all applicable limits.

Table 4.1.2

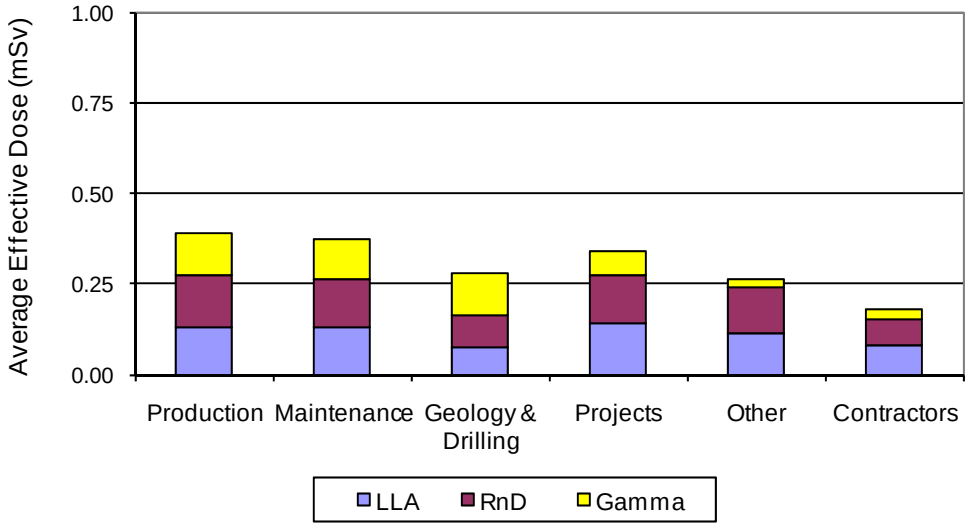
Average and Maximum Effective Dose for Exposure Pathways by Work Group

Work Group *	LLAA (mSv)		RnD (mSv)		Gamma (mSv)		Number
	Average	Max	Average	Max	Average	Max	
Production	0.13	0.73	0.14	0.24	0.12	0.71	78
Maintenance	0.13	0.21	0.13	0.24	0.11	0.70	24
Geology & Drilling	0.07	0.22	0.09	0.21	0.12	5.82	70
Projects	0.14	0.24	0.13	0.23	0.07	0.90	14
Other	0.11	0.19	0.13	0.19	0.02	0.14	14
Contractors	0.08	0.25	0.07	0.23	0.03	0.23	21

* Production – Plant and Wellfield operators, laboratory staff and supervisors
Geology & Drilling – Drillers, geologists and support staff
Others – Environment, Safety, Radiation and other office based staff
Contractors – All site contractors with exception of drillers
Projects – Construction personnel

Figure 4.1.2

Average Total Effective Dose to each Workgroup from each Pathway



5 ADEQUACY AND EFFECTIVENESS OF EQUIPMENT AND PROCEDURES

The average and maximum doses received by workers at the Beverley Mine Site during the year remained well below the statutory limits. The average dose received by employees and contractors at the Beverley Site is lower than the statutory limit for members of the public.

The policies and procedures were under constant review to ensure that the doses to employees remain As Low As Reasonably Achievable (ALARA). Some of the examples for the year ending 31 December 2012 are given below:

- Reviewed and updated many Standard Operating Procedures and Work Instructions
- Conducted several sessions of radiation safety training
- Employee safety meetings were used as a platform to discuss the radiation safety issues and implement corrective actions when required
- Supervisors Safety Meetings were used to discuss radiation safety related items and to implement corrective actions.

6 CONCLUSIONS

The results of the Beverley Uranium Mine Radiation Monitoring Program have shown that no employee was exposed to unacceptable levels of radiation during 2012.

Doses received by employees and contractors working at the Beverley site remain well below all statutory limits. The Radiation Management Plan and associated site procedures like the Radiation Work Permit system have also ensured doses have remained As Low As Reasonably Achievable.

7 REFERENCES

1. Beverley Uranium Mine Radiation Management Plan, Heathgate Resources Pty Ltd, December 2010.
2. Code of Practice on Radiation Protection and Radioactive Waste Management in Mining and Mineral Processing (2005) ARPANSA (RPS 1)
3. IAEA Safety Series No. 115, Basic Safety Standards for the Protection Against Ionizing Radiation and for the Safety of Radiation Sources, IAEA, 1996
4. Radon Decay Products Area Monitoring using ERDM/PRDM, Standard Operating Procedure RAD-02, Heathgate Resources, November 2012.
5. Long Lived Alpha Activity in Dust Personal and Area Monitoring, Standard Operating Procedure RAD-05, Heathgate Resources, November 2012.
6. Gamma Dose Rate Survey, Standard Operating Procedure RAD-01, Heathgate Resources, November 2012.
7. Alpha Surface Contamination Monitoring, Standard Operating Procedure RAD-07, Heathgate Resources, November 2012.
8. ICRP 68, Dose Coefficients for Intakes of Radionuclides by Workers, Ann. ICRP 24 (4), 1994

APPENDIX 1

Occupational Dose Assessment Methodology

METHOD

Total effective dose was calculated as the sum of the three exposure pathways as detailed in the Code of Practice on Radiation Protection and Radioactive Waste Management in Mining and Mineral Processing, 2005[2].

- Inhalation of Long Lived Alpha Activity in Dust
- Inhalation of Radon Decay Products
- External exposure to Gamma Radiation.

Inhalation of Long Lived Alpha Activity in Dust.

The effective dose due to the inhalation of Long Lived Alpha Activity (LLAA) in Dusts has been calculated from the following equation.

$$E_{LLAA} = [LLAA] \,.\, DCF \,.\, BR \,.\, IT$$

Where:

E_{LLAA}	=	Effective dose due to inhalation of LLAA (mSv)
[LLAA]	=	Average Concentration of LLAA (Bqm^{-3})
DCF	=	Dose conversion factor (mSv/Bq)
BR	=	Breathing Rate (1.2 m^3h^{-1})
IT	=	Inhalation Time (h).

The dose conversion factor used for the Beverley Uranium Mine is 0.0019 mSv/Bq, obtained from IAEA Safety Series 115 [3] using the default AMAD of 5 mm and a solubility class of M.

Doses for workgroups other than Geology and Drilling, Contractors and ESH/Admin are calculated monthly from the average of all personal dust monitoring conducted during the month for each workgroup and the hours spent by each employee in that workgroup. Time information was taken from the “In Flight” database where the onsite working time of all employees is recorded. No allowance for any respiratory protection that may have been worn has been made. The lack of this allowance for respiratory protection factor gives a slight overestimate in the drier operator dose, however the majority of their shift is spent in clean areas where no respirator is worn and the dust sample is still being collected. This method was considered the closest estimate obtainable.

Dose to the Geology and Drilling workgroup is taken from the average of area dust monitoring in the wellfield and drilling areas for the months and hours worked. Time information is obtained from the “In Flight” database.

Dose to the Contractors and ESH/Admin workgroups is taken from the average of all area monitoring conducted around site for the month. Area sampling conducted in the Drier and packaging areas is divided by the respiratory protection factor 10 before being averaged since these areas require the compulsory wearing of an airstream helmet. Hours are obtained from the “In Flight” database.

Inhalation of Radon Decay Products

The committed effective dose due to the inhalation of radon decay products (RnD) has been calculated from the following equation.

$$E_{RnD} = PAEC \,.\, DCF \,.\, IT$$

Where:

E_{RnD}	=	Effective dose due to inhalation of RnD (mSv)
PAEC	=	Average Potential Alpha Energy Concentration (μJm^{-3})
DCF	=	Dose conversion factor (0.0014 mSv/μJm^{-3}/h)
IT	=	Inhalation Time (h).

Doses were calculated monthly from the average PAEC in each work area and the time spent by each employee in that area.

External Exposure to Gamma Radiation

The external exposure to gamma radiation is monitored using Thermoluminescent Dosimeter (TLD) badges supplied by the Australian Radiation Protection and Nuclear Safety Agency (ARPANSA). Badges are issued to all employees and longer-term contractors for a period of three months. Any short-term contractors or employees who lose their badges are assigned a pro-rata dose based on their work group average and total hours.

Badges are worn close to the employee's body for the duration of the shift and stored on a control board at all other times.